NETWORK PLANNING REPORT - P003

NORTHERN SYSTEM WITHDRAWAL ZONE (Planning)

April 2007

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Executive Summary

As indicated in VENCorp's Network Planning Report (T003) - Northern System Withdrawal Zone (Timing), April 2007, two Northern system withdrawal zone (Northern Zone) issues have been identified:

1. A capacity constraint due to a lack of injection from Culcairn.

   Due to the growth in the Northern Zone, VENCorp's assessment indicates that with no imports from Culcairn, a breach of the minimum pressure obligation is likely to occur at Shepparton under 1 in 20 peak day demand conditions in 2010.

2. Culcairn's Authorised Maximum Daily Quantity (AMDQ) allocation.

   GasNet has an AMDQ allocation of 17 TJ/d for export of gas through Culcairn. Under the MSO Rules, any exports through Culcairn up to 17 TJ/d must have priority over non-authorised loads, as long as gas is being injected to match the withdrawal. Currently, there is insufficient capacity on the Wollert – Wodonga pipeline to achieve 17 TJ/d of exports through Culcairn on days of high (over 800 TJ/d) Principal Transmission System (PTS) demand.

Several options to solve the constraints were considered, which include:

- reversing the existing Springhurst Compressor Station to enable compression northwards;
- upgrading the Wollert Compressor Station;
- installing a new compressor station at Euroa; and
- partially duplicating the Wollert – Wodonga pipeline.

Based on current modelling, the preferred solutions to these constraints are as follows:

1. To address the minimum pressure obligation issue at Shepparton (due to the lack of available imports at Culcairn), requires installing additional compressor power at Wollert, or a new compressor at Euroa, by 2010.
2. To achieve 17 TJ/d of AMDQ export at Culcairn, a number of augmentations are required:
   - Additional compressor power at Wollert.
   - A new compressor at Euroa or a Springhurst Compressor Station upgrade. A new compressor at Euroa is identified as the more effective option, and is the preferred long-term solution.
   - Pipeline duplication from Wollert (northwards) or Barnawartha (southwards). Modelling results indicate that the duplication from Wollert (northwards) is more effective. Longer-term analysis also indicates that the preferred solution is to use 450 mm pipe in preference to 300 mm pipe.

In relation to GasNet's Compressor Strategy Document, VENCorp has undertaken some preliminary modelling of the effects of that strategy on the PTS. Further detailed modelling will be conducted to identify whether there is any scope for system optimisation in line with the GasNet compressor strategy.

Introduction

VENCorp's Network Planning Report (T003) - Northern System Withdrawal Zone (Timing), April 2007, indicated that the Wollert – Wodonga pipeline has insufficient capacity to deliver 17 TJ/d of export Authorised Maximum Daily Quantity (AMDQ) at Culcairn. The report also indicated that a breach in the 2,400 kPa minimum pressure obligation will occur on the Echuca lateral at Shepparton under 1 in 20 peak day demand conditions in 2010. Figure 1 shows the Northern Zone schematic.

This report presents:

- the options to address the two scenarios identified in the Northern System Withdrawal Zone (Timing) report, being the 0 TJ/d and 17 TJ/d Culcairn export cases; and
- a detailed review of the most appropriate option.

Planning Inputs

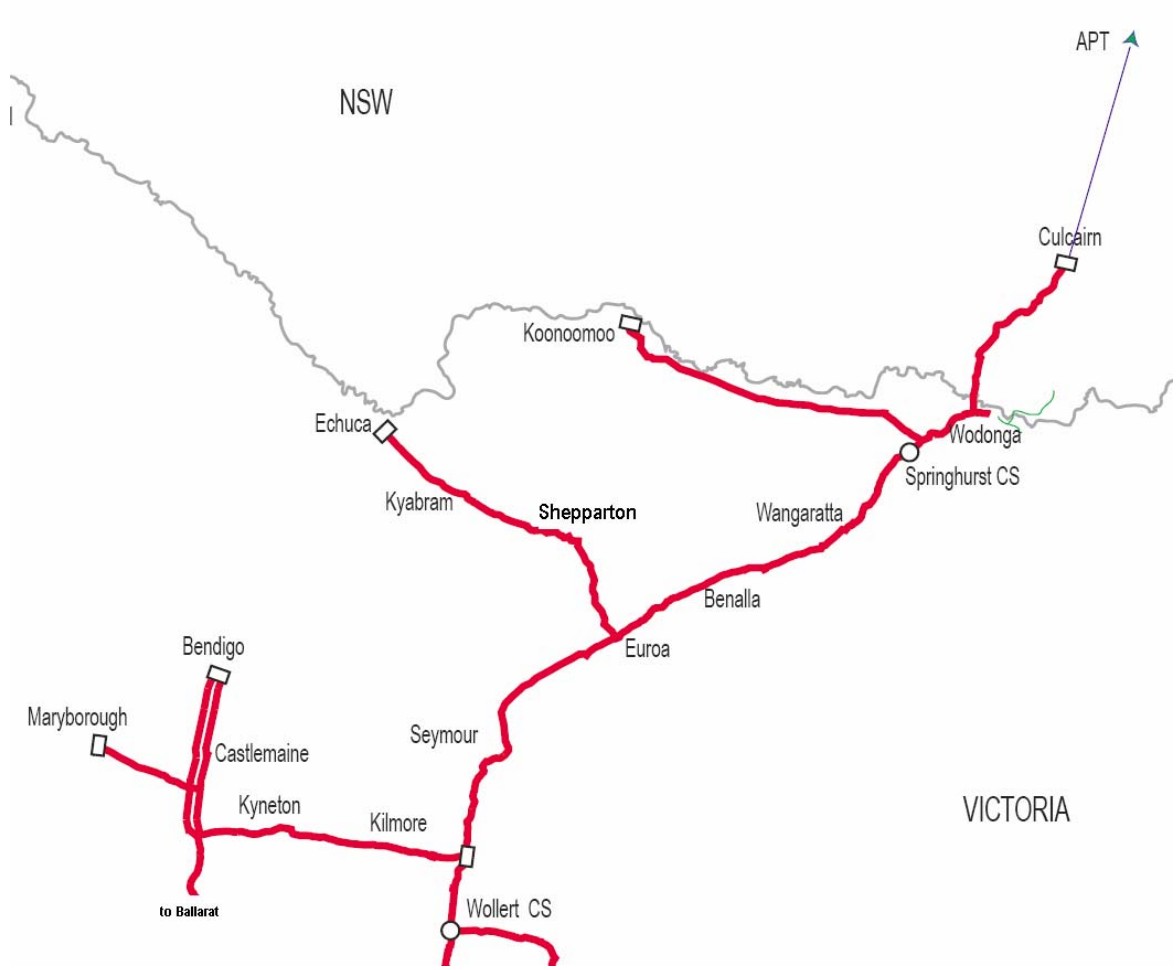
Table 1 lists the key planning inputs used in the modelling.

Table 1 - Key planning inputs

Item	Detail
Forecast demand data	2005 [1] Gas APR
Historical data	Extracted from VENCorp's TADIS database
Modelling software	Gregg Engineering WinFlow version 4.060503.3081 Gregg Engineering WinTran version 4.060505.9089
Model of PTS used	Common Model version 2006
Network Planning Report - T003 Northern System Withdrawal Zone (Timing)	VENDocs_#179149
GasNet Capex Plan 2008-2012 Version 6	Cost estimation of augmentations produced by GasNet

[1] The 2005 report represents the latest information available at the time of the analysis. A later review of 2006 demand found that changes in the demand forecasts were minor and have no material impact on the timing and nature of the augmentations.

Figure 1 - Northern Zone schematic



Constraint Timing

The Wollert – Wodonga pipeline currently has insufficient capacity to meet the 17 TJ/d of AMDQ for export through Culcairn.

No minimum pressure obligation breaches in the Northern Zone are expected during the forecast period, based on the assumption that imports of approximately 15 TJ/d from Culcairn are likely to occur under 1 in 20 peak day demand conditions. However, with no imports from Culcairn, a breach in the 2,400 kPa minimum pressure obligation will occur on the Echuca lateral at Shepparton under 1 in 20 peak day demand conditions in 2010. Any exports at Culcairn will bring forward this timing.

Augmentation Options

Five major augmentation options were considered to achieve the AMDQ export capacity through Culcairn, and to maintain minimum pressure obligations:

- Reconfigure the existing Springhurst Compressor Station to enable compression northwards.

- Upgrade the Wollert Compressor Station.
- Install a new compressor station at Euroa.
- Pipeline duplication northwards of the Wollert Compressor Station.
- Pipeline duplication northwards of the Springhurst Compressor Station.

Discussion

In general, the Northern Zone constraint can be resolved by augmentation in the Northern Zone, or in other parts of the PTS. However, augmenting the Northern Zone is considered to be the most cost effective option.

Reconfigure Springhurst Compressor Station

The existing compressor station has a single 4,500 kW Centaur compressor. This machine was installed for winter 1999, and was set up to compress gas southwards (only). This compressor is too large for compression northwards. Compression northwards would require installation of a smaller unit, or the ability to operate the existing compressor at reduced power, or in recycling mode, for a prolonged period. Further investigation is required to determine the required pipe-work alterations to enable the existing compressor to compress northwards. As a result, a more appropriately sized Saturn 850 kW compressor was modelled.

Upgrade Wollert Compressor Station

The Wollert Compressor Station has three wet seal 850 kW Saturn compressors. Expansion of the compressor station is required to address the Echuca lateral and Culcairn constraints. For modelling purposes, 3,400 kW compression was used, comprising a combination of Saturn and/or Centaur compressors.

Install a New Compressor Station at Euroa

A compressor station at Euroa has the ability to address the Echuca lateral and Culcairn constraints. In 1998, a compressor was temporarily relocated from Brooklyn to Euroa to compress gas southwards after the Longford emergency, and remained in place for winter 1999. This compressor was subsequently removed. This site would be ideal for compression northwards. A large compressor at this location could also reduce the Euroa Compressor Station's suction pressure, which causes low pressure issues along the Echuca pipeline. This could be solved by additional pipe work at the station, allowing the compressor to discharge to both the Wodonga pipeline and the Echuca pipeline. A Euroa compressor's outlet would also need to be connected to the Shepparton branch, and the branch valve would need to be shut to avoid pressure problems on the Shepparton branch.

GasNet has also advised that installing a new compressor at the site may be significantly delayed due to the:

- council permit lead times; and
- likelihood of opposition via the Victorian Civil and Administrative Tribunal (VCAT).

Pipeline Duplication Northwards of the Wollert and the Springhurst Compressor Stations

Some pipeline duplication, in conjunction with additional compressors, represents a potential solution. Pipeline duplication in general would be the preferred option, as it provides additional pipeline capacity and the ability to manage peak demands through within-day linepack management. Duplicating the pipeline at the upstream where pressures and flows are highest, offers the greatest benefits. Two locations will be considered: north of the Wollert Compressor Station and the Springhurst Compressor Station.

Assessment

A Wollert Compressor Station upgrade is considered the most appropriate solution to the Shepparton constraint, and is the subject of this report's modelling results.

To facilitate exports of 17 TJ/d through Culcairn, additional modelling is required to assess augmentation options.

Modelling Methodology

Combinations of all five augmentation options were modeled under 1 in 20 peak day demand for 2012 [2]. The outlook to 2022 was carried out to assist in evaluating duplicated pipeline diameter options of 300 mm and 450 mm.

The current forecast indicates that the 1 in 20 peak day demand forecast for 2012 is 1,300.9 TJ/d. The 1 in 20 peak day demand forecast for 2022 is 1,463.7 TJ/d (calculated using a 1.1% annual growth rate from the latest available forecast to 2020).

The modelling simulated 1 in 20 peak day demand for five continuous days. This was done to ensure the system was stable and was not relying on linepack to maintain minimum pressure obligations. The underlying assumption is that this will address the case of partial forecast error, when the system would use linepack on one day but would recover on a subsequent day of lower demand.

Modelling Assumptions

The modelling assumptions include the following:

- Forecast PTS demand for 2012 and 2022.
- Beginning of Day (BoD) linepack on target.
- Ideal distribution of linepack throughout the PTS.
- No forecast error throughout the day.
- No gas injection rescheduling throughout the day.
- Full availability of transmission assets, with no forced outages.
- Pressure at Culcairn to meet the Culcairn operating agreement, with daily average pressure of 3,200 kPa or above (3,000 kPa minimum).
- Flat profiles of export at Culcairn and injections at all injection points.

Additional assumptions for the 2022 modelling include the following augmentations (mentioned in the VENCorp Vision 2030 document):

- A new pipeline (500 mm) from the Corio Loop (at Rockbank) to the Wollert Compressor Station.
- Pipeline duplication (300 mm) Mt Franklin – Ballan (Ballarat off-take).

[2] The final year of the GasNet tariff reset period.

- A new compressor station at Stonehaven.
- Pipeline duplication (500 mm) Iona – Stonehaven.

Results Analysis

Modelling was carried out to determine the augmentations required to solve the breach of minimum pressure obligations that would occur under 1 in 20 peak day demand conditions in 2012 under the following scenarios:

- Scenario 1 - zero flow at Culcairn.
- Scenario 2 - export of 17 TJ/d at Culcairn for 2012 and 2022.

Scenario 1

Under this scenario, a breach of minimum pressure obligations occurs at Shepparton. Past experience indicates that an additional compressor (similar to the existing units) at Wollert will solve the constraint.

With three operating compressors at Wollert (currently a maximum of two), modelling results show that with no imports from Culcairn, the minimum pressure at Shepparton under 1 in 20 peak day demand conditions in 2012 is 3,696 kPa. This is in excess of the minimum pressure obligation of 2,400 kPa.

Scenario 2

This scenario looks at combinations of the five options mentioned above for levels of demand in 2012 and 2022. Modelling Cases 6-10 are used for 2012, and modelling Cases 11-17 for 2022. Modelling Cases 1-5 are not relevant to this study. Only subsets of each case (identified by the letters) that were relevant to this study are shown.

All cases assumed a fully augmented Wollert Compressor Station that has enough power to maintain a discharge pressure of 7,400 kPa.

The modelling runs compare various combinations of compressor augmentations at Euroa and Springhurst, and various locations, lengths and diameters of pipeline duplication.

Table 3 shows a matrix of compressor and pipeline augmentations that will provide the additional Wollert – Wodonga pipeline capacity to enable 17 TJ/d export at Culcairn under 1 in 20 peak day demand conditions in 2012, given that the average daily Culcairn pressure is required to be at least 3,200 kPa.

Estimated capital costs were provided by GasNet. The Estimated Capital Cost columns in Table 3 and Table 4 list the estimated costs of the individual augmentations (where applicable) shown in the Wollert (kW), Euroa (kW), Springhurst (kW), and Pipeline columns, respectively. The resulting average pressure at Culcairn and the total estimated augmentation costs are also shown.

Each case shown also lists the available power at each compressor station, and identifies the pipeline duplication for the specified pipe diameter (in the Pipeline column). A description of the pipeline duplication is shown in Table 2.

The results are sorted in ascending cost order, so the lowest cost options appear first.

Table 2 - Description of pipeline duplication on the Wollert – Wodonga pipeline

Pipeline	Description	Length (km)
Woll-LV3	Wollert north to line valve 3	11.5

Woll-LV4	Wollert north to line valve 4	23.4
Woll-Wandong	Wollert north to Wandong	27.3
Woll-Clonbinane	Wollert north to Clonbinane	34.9
Woll-Broadford CG	Wollert north to Broadford city gate	44.6
Woll-LV6	Wollert north to line valve 6	47.8
Spring-Chiltern Valley	Springhurst north to Chiltern Valley	5.6
Spring-Barn	Springhurst north to Barnawartha	20.2

Table 3 - Summary of results, 2012 peak demand [1]

Case	Wollert (kW)	Euroa (kW)	Springhurst (kW)	Pipeline	Culcairn Average Pressure (kPA)	Estimated Capital Cost ($M) [2]	Total Cost ($M)
8a	3,400	850		Woll-LV3 300mm	3,397	39.6+24.9+12.5	77
8c	3,400		850	Woll-LV4 300mm	3,795	39.6+13.0+25.1	77.7
7	3,400	2 X 850			3,393	39.6+38.5	78.1
8aa	3,400	850		Woll-LV3 450mm	3,629	39.6+24.9+14.6	79.1
8ca	3,400		850	Woll-LV4 450mm	4,320	39.6+13.0+29.3	81.9
6a	3,400	850	850	Spring-Chiltern Valley 300mm	3,283	39.6+24.9+13.0+5.0	82.5
6b	3,400	850	850	Spring-Chiltern Valley 450mm	3,305	39.6+24.9+13.0+6.0	83.5
10a	3,400		850	Woll-LV3 450mm & Spring-Barn 450mm	3,231	39.6+13.0+14.6+19.4	86.6
8e	3,400	850		Woll-LV4 300mm	4,325	39.6+24.9+25.1	89.6
6c	3,400	850	850	Woll-LV3 300mm	4,459	39.6+24.9+13.0+12.5	90
6d	3,400	850	850	Woll-LV3 450mm	4,755	39.6+24.9+13.0+14.6	92.1
8ea	3,400	850		Woll-LV4 450mm	4,735	39.6+24.9+29.3	93.8
6e	3,400	850	850	Spring-Barn 300mm	3,398	39.6+24.9+13.0+16.6	94.1
6f	3,400	850	850	Spring-Barn 450mm	3,435	39.6+24.9+13.0+19.4	96.9
6	3,400	850	850		3,181		
8b	3,400		850	Woll-LV3 300mm	2,788		
8ba	3,400		850	Woll-LV3 450mm	3,075		
8d	3,400			Woll-LV4 450mm	3,044		
9	3,400		2 X 850		fail		
10	3,400		850	Woll-LV3 450mm & Spring-Barn 300mm	3,181		
10b	3,400		850	Spring-Barn 450mm	fail		

1. Case numbers are model simulation references used in VENCorp's software. Cases 1-5 exist but are not relevant to this study.

2. Extracted from GasNet Capex Plan 2008-2012, Version 6.

Further information relevant to the 2012 peak demand study includes the following:

- GasNet has further advised that the duplication between Wollert to line valve 4 (LV4) is not possible due to a site issue. An alternative to this option is an extension of the duplication further to Wandong. The additional duplicated length (approximately 4 km) has not been modelled, however, it is expected to provide additional benefits by increasing Culcairn's pressure. To enable a comparison with the other options, the cost for the duplication between Wollert to LV4 is based on a prorated Wollert – Wandong pipeline duplication cost.
- The estimated cost breakdown was provided by GasNet in the GasNet Capex Plan 2008–2012.
- The compressor power listed in Table 3 represents the total operating power of the machines at each station. This could be equivalent to a single compressor or a combination of compressors.

The pipeline duplication shown in Table 3 assumes the use of either a 300 mm or 450 mm pipeline. However, the outlook to 2012 may be insufficient to determine the optimal pipeline size for duplication. Further modelling runs were carried out to 2022 to ensure a long-term solution is being presented. Table 4 lists the modelling results for 2022.

Table 4 - Summary of Results, 2022 Peak Demand

Case	Wollert (kW)	Euroa (kW)	Springhurst (kW)	Pipeline	Culcairn Average Pressure (kPa)	Estimated Capital Cost ($M) [2]	Total Cost ($M)
11	1,700 [3]	1,185 [1]		Woll-Wandong 450 mm	3,292	39.6+24.9+29.3	93.8
14	1,700		1,185	Woll-Broadford CG 450 mm	3,260	39.6+13.0+46.0	98.6
12	1,700	1,185		Woll-LV6 300 mm	3,351	39.6+24.9+39.8	104.3
17	1,700	2 X 1,185		Woll-Wandong 450 mm	4,639	39.6+38.5+29.3	107.4
13	1,700		1,185	Woll-Broadford CG and Springhurst-Barna 450 mm	3,465	39.6+13.0+39.8+19.4	111.8
11a	1,700	1,185		Woll-Wandong 300 mm	2,366		
15	1,700		1,185	Woll-Clonbinane and Springhurst-Barna 450 mm	2,657		
16	1,700	2 X 1,185		Woll-LV3 450 mm	1,980		

1. Subsequent advice from GasNet is that a new Saturn T1602 has higher power of 1,185 kW.
2. Extracted from GasNet Capex Plan 2008-2012, Version 6.
3. To achieve a more realistic simulation of conditions for 2022, the modelled maximum compressor power at Wollert was reduced to 1,700 kW.

From Tables 3 and 4, Cases 6, 8b, 8ba, 8d, 9, 10, 10b, 11a, 15 and 16 are considered unsuitable, because the average pressure at Culcairn is less than the required average pressure of 3,200 kPa. The estimated capital costs for these cases were not examined.

Installing two compressors at Euroa is less cost effective than installing just one compressor plus pipeline duplication, as shown in Table 3, by Cases 7 and 8a. Also demonstrated in Table 4, by Cases 16 and 17, in 2022, Case 7 would require, as a minimum, the same pipeline duplication as if there were only one compressor at Euroa, as shown in the modelled result in Table 4, Case 11.

Analysis of the modelling results reveals the following:

1. Compression at Euroa is more effective than at Springhurst.

   As demonstrated by Cases 8a and 8aa, and 8b and 8ba, a compressor of the same size at Euroa produces a much higher average pressure at Culcairn than when locating a compressor at Springhurst.

   Also, as shown in Cases 11 and 14, to achieve a similar pressure average at Culcairn, compression at Springhurst requires a further 17 kilometres of pipeline duplication when compared to the case of compression at Euroa.

   A Euroa compressor increases Northern Zone capacity more effectively than a Springhurst compressor.

2. Pipeline duplication from Wollert northwards is more effective than from Springhurst northwards.

   With equivalent pipe duplication, Cases 8aa and 10b show that northwards duplication from Wollert is far more effective than from Springhurst. This is due to the benefit of duplicating the pipe where flows are highest. Pipeline duplication provides a significant increase in pressure and the linepack capacity of the Northern Zone, allowing more robust operation.

   The results indicate that duplication of the Wollert – Wodonga pipeline, from Wollert northwards, is more effective in increasing Northern Zone capacity than the same length of duplication from Springhurst northwards.

3. 450 mm diameter pipe is preferred to 300 mm diameter pipe.

   A comparison of Cases 11 and 12 shows that, to meet the minimum pressure obligations, a 300 mm pipeline requires double the length of pipe to achieve a similar result. This makes the 300 mm option less cost effective. The preferred long-term solution, from an engineering perspective, taking into account the capital costs, would be to use the larger 450 mm pipe for the proposed pipeline duplication, based on analysis to 2022.

Conclusion

To address the pressure constraint due to insufficient Culcairn injections during high demand days, the required augmentation involves installing additional compressor power at Wollert, or a new compressor at Euroa, by winter 2010.

To achieve 17 TJ/d of AMDQ for export through Culcairn, a number of augmentations are required:

- Installation of additional compressor power at Wollert.
- Installation of a new compressor station at Euroa or an upgrade of the existing Springhurst Compressor Station. Compression at Euroa is more effective than at Springhurst, and is the preferred long-term option. However, the estimated capital cost of upgrading the Springhurst Compressor Station is lower than constructing a new compressor station at Euroa. Other factors,

such as the possible operational constraint (oversize of the existing Springhurst compressor), and the possible delay for Euroa, should be considered.

- Pipeline duplication from Wollert northwards, using 450 mm diameter pipe.

Definitions

Barnawartha	The point of connection between the PTS and the interconnect pipeline from Culcairn.
DB	A Distribution Business; a distribution pipeline network operator.
DB Connection Deed	An agreement between VENCorp and a Distribution Business.
Gas APR	The Gas Annual Planning Report, published by VENCorp by 30 November each year.
GasNet's Compressor Strategy	GasNet's document, dated September 2006, sets out the compressor strategy to support GasNet's Corporate Plan. The document provides details about the current and proposed operations at the existing compressor stations, and details the facilities and proposed augmentations.
Interconnect pipeline	The 450 mm pipeline between Bomen in New South Wales and Barnawartha in Victoria, completed in 1998, allowing bi-directional flows between the States.
Minimum Pressure Obligation	The minimum pressure obligation stipulated in the System Security Guidelines and/or Distribution Business Connection Deeds that VENCorp must operate the system to maintain.
PTS	The Principal Transmission System, serving Gippsland, Melbourne, Central and Northern Victoria, Albury, the Murray Valley region, Geelong, and the western region of Victoria. The PTS is owned by GasNet and operated by VENCorp.
SSG	System Security Guidelines, developed and maintained by VENCorp, for the operation and security of the PTS.
SWZ	System withdrawal zone.
VCAT	Victorian Civil and Administrative Tribunal.