11 August 2017

Anna Panarina
Project Administrator, Energy
Essential Services Commission
Level 37, 2 Lonsdale Street
Melbourne VIC 3000

Dear Anna,

Submission to ESC final decision on UAFG benchmarks methodology

AusNet Services welcomes the opportunity to make a submission in response to the Essential Services Commission's (ESC) final decision on its proposed methodology for calculating Unaccounted for Gas (UAFG) benchmarks, which will apply to the Victorian gas distributors for the 2018-22 Access Arrangement (AA) period.

UAFG refers to the difference between the measured quantities of gas entering the gas distribution system and the measured quantity of gas withdrawn by customers. UAFG can arise because of metering errors; theft; inaccuracy in the conversion from quantity of gas measured to energy (reflecting discrepancies in temperature, pressure, heating value, altitude or the gas compressibility factor); leakage and a number of other minor factors.

AusNet Services' gas distribution network is subject to a UAFG incentive mechanism, which requires it to compensate retailers for any UAFG in excess of its benchmark and, conversely, retailers to compensate AusNet Services where actual UAFG is lower than the benchmark. This mechanism is designed to ensure that capital and operating expenditure decisions take UAFG into account, to the extent that these decisions can impact UAFG. It is recognised by the ESC that there is a large degree of uncertainty regarding the degree to which individual factors drive UAFG, and to which these factors are within the control of networks.[1]

The ESC's final decision on the methodology to calculate UAFG benchmarks, which is largely unchanged from the draft decision, comprises the following elements:

1. The Commission will use the revealed cost approach with a multi-year average to calculate the UAFG benchmarks.
2. The Commission will use actual UAFG data that has been settled by distributors and retailers to calculate the UAFG benchmarks.
3. The Commission will not account for possible reductions in UAFG resulting from the distributors' mains replacement programs.
4. The Commission will not account for possible increases in UAFG caused by continued deterioration of the distribution networks.
5. The Commission will consider whether there are any efficiencies that can be achieved by the distributors, and may decide to adjust the forward UAFG benchmarks accordingly.
6. The Commission will retain separate UAFG benchmarks for class A and class B customers.

[1] Essential Services Commission 2017, *Review of Unaccounted for Gas Benchmarks: Final Decision – Methodology*, July, p.5

The ESC has also sought the following information from the Victorian gas distributors:

- Actual UAFG data that has been settled as part of the reconciliation process that is administered by AEMO.
- A detailed assessment of the causes of UAFG to support their respective UAFG benchmark proposals.
- A detailed explanation of how they have efficiently sought to reduce UAFG levels during the 2013-2017 regulatory period.
- A comprehensive strategy for how they will seek efficiencies to minimise UAFG levels during the 2018-2022 regulatory period.

Finally, the ESC has invited submissions on amending clause 2.4 of the Gas Distribution System Code (GDSC) to amend the date by which distributors must provide UAFG volumes to AEMO each year.

The remainder of this submission:

- Sets out our views in respect of the ESC's final decision on the methodology to calculate UAFG benchmarks;
- Provides the information sought by the ESC; and
- Discusses amendments to clause 2.4 of the GDSC.

The ESC's final decision on the methodology to calculate UAFG benchmarks

1. Use of the revealed cost approach with a multi-year average

AusNet Services supports the use of the revealed cost approach to setting UAFG benchmarks. However, as detailed in our submission to the draft decision, we consider that, where a clear trend exists in the historical data that is likely to continue, automatically applying a multi-year average to set benchmarks for each future year will not result in a sound benchmark. [2]

In these circumstances, the most recent year of data, or a multi-year average with an adjustment to reflect the historic trend, are more appropriate bases to set benchmarks. These approaches will result in benchmarks that reflect the distributor's efficient level of UAFG – as they are based on revealed costs – while still providing a strong incentive to reduce UAFG where it is possible to do so.

In respect of adopting the most recent year as a benchmark, the ESC stated the following:[3]

> *The Commission considers that there is more merit in using a multi-year average than the most recent year of UAFG data to calculate UAFG benchmarks. Accounting for the variations in year-to-year UAFG data outweighs the benefits of using the most recent year of data. This is because year-to-year variations in UAFG levels have been observed across the network whereas the changing characteristics of the network over time are much less clear. The Commission also notes that a multi-year average still incorporates the most recent year of data*.

[2] AusNet Services, S*ubmission to ESC Review of UAFG benchmarks*, June 2017 p. 3
[3] Essential Services Commission 2017, *Review of Unaccounted for Gas Benchmarks: Final Decision – Methodology*, July, p.16

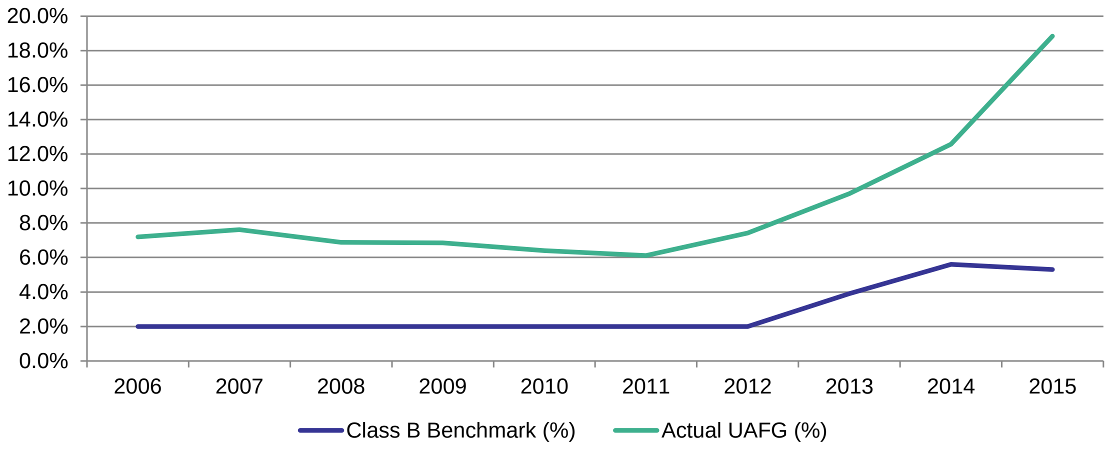
We have reservations about the prescriptive approach described above by the ESC. We consider that the most appropriate revealed cost approach should be informed, on a case-by-case basis, by the historical data.

While the ESC is correct in saying that UAFG variations have been observed across networks, such variations should be taken into account when determining the most appropriate revealed cost approach. Where the historical performance data is subject to large amounts of variation with no apparent trend, we agree that adopting the most recent year is **not** a robust and a multi-year average is instead more appropriate.

However, where a trend has persisted for a prolonged period of time, a multi-year average is likely to result in a less accurate projection of efficient future UAFG (which the benchmark is intended to reflect) than the most recent data point.

The figure below shows AusNet Services' actual non-DTS UAFG using the settled data available from 2006-15.

Figure 1: Actual UAFG vs. benchmark, non-DTS



Source: AusNet Services analysis

After a period of relative stability from 2006-2011, non-DTS UAFG has been increasing steadily since 2011, with a particularly sharp increase in 2015 to 18.9% from 12.6% in the prior year. The duration of this upward trend – currently five years based on settled data – suggests that a return to pre-2014 levels is unlikely in the short term. Indeed, unsettled 2016 data (provided as Attachment 3 to this submission) indicates this trend has not abated.

Accordingly, for AusNet Services' non-DTS network, a multi-year average will understate, from the first year of the new benchmark period, the UAFG that may eventuate. This would have the effect of embedding an immediate penalty in the forthcoming AA period, despite our best endeavours to reduce non-DTS UAFG below the benchmark. Our strategy and plans to reduce our network's UAFG, including the findings of an internal investigation into the possible drivers of the non-DTS UAFG trend shown in Figure 1, are provided as attachments to this submission, and discussed further in the sections below.

Importantly, adopting the most recent year remains consistent with the revealed cost approach, but is likely to produce symmetrical and more robust benchmarks than a simple multi-year average. In its recent Draft Decision on AusNet Services' Gas Access Arrangements Review, the AER accepted a similar argument made with respect to declining marginal penetration rates for gas connections.[4] AusNet Services noted that the number of new gas connections per number of new dwellings had been declining in recent years. For its forecasts, rather than continuing this trend into the forthcoming AA period, or relying on multi-year average, AusNet Services adopted the revealed penetration rate for the most recent year of actuals. Both the AER's consultant and the AER accepted that the most recent year, which captures the most current information, was a reasonable forecasting methodology.

In relation to using a multi-year average with an adjustment to account for the historical trend, the ESC stated the following:[5]

> *In relation to AusNet's argument, the Commission considers that it would be difficult to establish whether a 'sustained trend' will continue over time as the drivers of the trend – namely the causes of UAFG – are uncertain. The uncertainty surrounding the causes of UAFG, and their specific impact on UAFG levels, means that assessing whether a 'sustained trend' is likely to continue is problematic. Therefore, the Commission considers it prudent not to adjust a multi-year average for a 'sustained trend'.*

While we recognise that establishing whether a sustained trend will continue is difficult due to the inherent uncertainty of UAFG, we again consider that a case-by-case, flexible approach is preferable to the prescriptive approach set out in the final decision. Where actual UAFG has exhibits a sustained trend, as demonstrated by Figure 1, we consider that a robust adjustment could be determined (e.g. using simple regression analysis) to result in a more sound UAFG benchmark than a simple average. While this adjustment will inevitably require some regulatory judgement, and be subject to some degree of forecasting error, this applies equally to forecasts produced by alternative methods, including a multi-year average.

Nonetheless, should the ESC elect to apply a simple multi-year average, we submit that a three-year average is the most appropriate time period to include in the average, consistent with the ESC's approach at the 2013 UAFG review. Not applying a consistent approach between UAFG reviews exposes networks to asymmetric risk. For instance, where a network's UAFG performance improves during an access arrangement period, but a different approach is used at the next review to set benchmarks, the network may be unable to recoup penalties arising from its relatively poorer UAFG performance in the prior period.

We note that other regulatory incentive schemes apply this principle, such as the AER's Service Target Performance Incentive Schemes applied to electricity distribution and transmission networks, which consistently use five-year averages of historical performance to set future performance benchmarks. This promotes regulatory certainty and ensures networks face symmetrical incentives when making investment decisions aimed at improving performance.

[4] Australian Energy Regulator (AER), 2017, *Attachment 13 − Demand | Draft decision - AusNet Services gas access arrangement 2018–22*, p.13-8

[5] Essential Services Commission 2017, *Review of Unaccounted for Gas Benchmarks: Final Decision – Methodology*, July, p.18

2. Use of actual, settled UAFG data to calculate UAFG benchmarks

The ESC's final decision is to use actual, settled data only to set UAFG benchmarks. Settled data is currently available for AusNet Services up to 2015.

AusNet Services supports the use of the most recent, reliable UAFG data to set benchmarks, in line with good regulatory practice. While we consider that more recent, unsettled data may be more relevant for benchmark setting purposes, we accept that the ESC's practice has been to use settled data only. Accordingly, we accept this aspect of the final decision's methodology as it applies to AusNet Services.

While settled 2016 data for AusNet Services is not available at the time of this submission, it may become available prior to the conclusion of this UAFG review. In these circumstances, we consider that this data should be reflected in the final decision's UAFG benchmarks, consistent with the ESC's preferred approach of using the most recent settled data. We will keep the ESC informed in respect of the status of our 2016 data in the coming months.

3. Not accounting for possible reductions in UAFG resulting from mains replacement

For the reasons stated in its earlier submission,[6] AusNet Services supports the ESC's approach of not accounting for possible UAFG reductions due to mains replacement activities in UAFG benchmarks.

4. Not accounting for possible increases in UAFG caused by continued asset deterioration of the network

We also support the ESC's approach to not account for possible increases in UAFG due to asset deterioration, for the reasons set out in our earlier submission.[7]

5. Adjusting the forward UAFG benchmarks for potential efficiencies

For the reasons set out in our earlier submission, we do not support adjusting forward UAFG benchmarks to reflect potential efficiencies if these efficiencies cannot be clearly established and robustly quantified.[8]

In the final decision, the ESC states that it will retain the discretion to adjust the forward UAFG benchmarks for efficiencies in appropriate circumstances. The ESC also stated that it would only adjust for expected efficiency if the efficiency can be identified and its impact on UAFG levels can be quantified.[9] While we have concerns about adjusting for efficiencies, we agree that any expected efficiency improvement identified by the ESC would need to be robustly quantified before an adjustment could be justified.

Our earlier submission provided the following example of where efficiencies estimated by the ESC at the last UAFG review did not eventuate in the current period:[10]

[6] AusNet Services, S*ubmission to ESC Review of UAFG benchmarks*, June 2017 p. 3
[7] AusNet Services, S*ubmission to ESC Review of UAFG benchmarks*, June 2017 p. 4
[8] AusNet Services, *Submission to ESC Review of UAFG benchmarks*, June 2017 pp.4-5
[9] Essential Services Commission 2017, *Review of Unaccounted for Gas Benchmarks: Final Decision – Methodology*, July, p.27
[10] AusNet Services, S*ubmission to ESC Review of UAFG benchmarks*, June 2017 p. 5

The "further scope for significant UAFG efficiencies" forecast by the ESC has not eventuated during the 2013-17 period. Despite AusNet Services' reasonable endeavours to reduce UAFG below the benchmark, outturn non-DTS UAFG has increased since 2011. This highlights the danger of reflecting possible efficiencies into benchmarks when it is not clear distributors are able to achieve such efficiencies.

In response to this, the final decision states:[11]

In relation to AusNet's comment about the efficiency adjustment that was applied to its non-PTS benchmarks in the 2013 UAFG review, the Commission considers that AusNet has not presented any evidence to suggest that the expected efficiency improvements did not eventuate during the 2013-17 regulatory period. The statement that UAFG for AusNet's non-PTS network has increased since 2011 does not establish that the efficiency adjustment was incorrectly applied by the Commission. Given the uncertainty regarding the degree to which individual factors drive UAFG – which AusNet acknowledges in its submission – the increase in UAFG for the particular network may have been due to reasons other than an inability by AusNet to achieve the expected efficiencies.

While not provided in our earlier submission, Figure 1 provides clear evidence that the ESC's forecast of efficiency improvements has not eventuated, and suggests this adjustment was incorrectly applied.

The ESC considers that the increase in non-DTS UAFG may have been due to reasons other than an inability by AusNet Services to achieve the expected efficiencies. As discussed in Attachment 1, the increases in non-DTS UAFG are indeed due to other factors other than our ability to drive UAFG efficiencies. However, it does not follow from this that the ESC's forecast of efficiencies was robust, particularly given the strong incentive AusNet Services faces to efficiently reduce UAFG where it is able to do so. Furthermore, the efficiencies were established by the ESC in a 'top-down' manner, not with regard to any specific projects or programs that AusNet Services could deliver in order to reduce UAFG.

Accordingly, we consider that imposing efficiency improvement in benchmarks is problematic due to the inherent uncertainty around the drivers of UAFG. This is supported, prima facie, by the historical evidence.

6. Retaining separate UAFG benchmarks for class A and class B customers

AusNet Services supports determining separate benchmarks for class A and class B customers.

Actual, settled UAFG data

AusNet Services' actual, settled UAFG data to 2015, and unsettled data for 2016, are provided as Attachment 3.

[11] Essential Services Commission 2017, *Review of Unaccounted for Gas Benchmarks: Final Decision – Methodology*, July, p.27

The causes of UAFG on our network

In 2013, AusNet Services engaged Asset Integrity Australasia (AIA) to undertake a study of the categories of drivers of UAFG on AusNet Services' gas distribution network. Importantly, a key finding of AIA's study was that the cause of a large proportion of UAFG on our network is essentially unknown:[12]

> *The estimation of UAfG to each category results in 54% of actual UAfG not attributed to any category. This emphasizes the uncertainty associated with UAfG.*

As the AIA analysis is relatively up to date, and AusNet Services' network has not undergone any substantive changes since it was undertaken, we have not obtained further external advice on the causes of UAFG on our network.

However, we have provided our internal UAFG strategy (see Attachment 2). This strategy sets out, among other things, the likely causes of UAFG on our network, including both measurement based and fugitive emissions sources. It also identifies potential projects that could potentially lead to incremental UAFG reductions.

As AusNet Services' DTS UAFG has been relatively stable for a long period of time, and due to the inherent uncertainty in the causes of UAFG, the initiatives discussed in the strategy have not all necessarily been pursued. This is consistent with the incentive properties of the UAFG benchmark regime, which incentivises gas distributors to incur expenditure to reduce UAFG where doing so will result in a financial reward that exceed this expenditure.

How we have efficiently sought to reduce UAFG levels during the 2013-2017 period

As noted above, the attached UAFG strategy details the sources of UAFG on our network and identifies potential projects that could potentially lead to incremental UAFG reductions. However, due to the inherent uncertainty in the drivers of UAFG, limited projects have been initiated during the current AA period with the specific objective of reducing UAFG. This approach recognises the limited extent to which AusNet Service is able to actively reduce UAFG through asset replacement or metering projects, and that UAFG is instead best managed indirectly through prudent asset management practices.

As noted in our earlier submission, our mains replacement programs, which are justified on a safety and operational risk mitigation basis, have not appeared to have had noticeable effects on UAFG. Although intuitively mains replacement should have a discernible impact on UAFG, in reality, the relationship is unclear.

In light of the above, our general approach to managing UAFG on our network during the current period has involved:

- Driving high reliability and network performance through best practice asset management; and
- Conducting investigations into UAFG trends on a case by case basis (e.g. our ongoing investigation of non-DTS UAFG).

[12] Asset Integrity Australia, *Review of SP AusNet Strategy and Data Requirements for Desktop UAFG Review*, May 2011, p.2

Our strategy for minimising UAFG levels during the 2018-2022 period

Our strategy for managing UAFG on our network over the 2018-22 period is not expected to change materially from the current strategy, as summarised above and detailed in Attachment 2. However, due to the trend observed in non-DTS UAFG, an investigation is ongoing into the causes of this trend and possible mitigation strategies. This investigation is described in detail in Attachment 1.

Amendments to clause 2.4 of the GDSC

Clause 2.4 of the GDSC requires the Victorian gas distributors to provide written notice of UAFG volumes to AEMO by 30 April each year, for the UAFG occurring in the prior calendar year.

In their submissions to the ESC's draft methodology, AGN and Multinet Gas considered the timing prescribed by clause 2.4 was problematic because AEMO is not able to provide metering and other data until around June each year, making it impossible for distributors to meet their obligations under clause 2.4. To address this, AGN and Multinet Gas proposed to either remove or amend clause 2.4. Specifically, Multinet Gas suggested extending the date by one year (e.g. written notice of 2016 UAFG volumes would be due to AEMO by 30 April 2018).[13]

The ESC considered that the clause should not be removed as it provides an important compliance obligation for distributors, but invited submissions on alternative dates. AusNet Services supports Multinet Gas' proposal to extend the current deadline by one year. This would allow sufficient time for all parties to review and agree on the UAFG data, and avoid further non-compliance with the current GDSC requirements.

Should you have any questions on this submission, please don't hesitate to contact Rob Ball, Senior Economist,

Sincerely,

C. Eddy

Charlotte Eddy
Manager, Economic Regulation
AusNet Services

[13] Multinet Gas, *Submission re: review of Unaccounted for benchmarks*, June 2017, p.4

AUSNET SERVICES

ATTACHMENT 1: INVESTIGATION INTO CAUSES OF NON-DTS UAFG

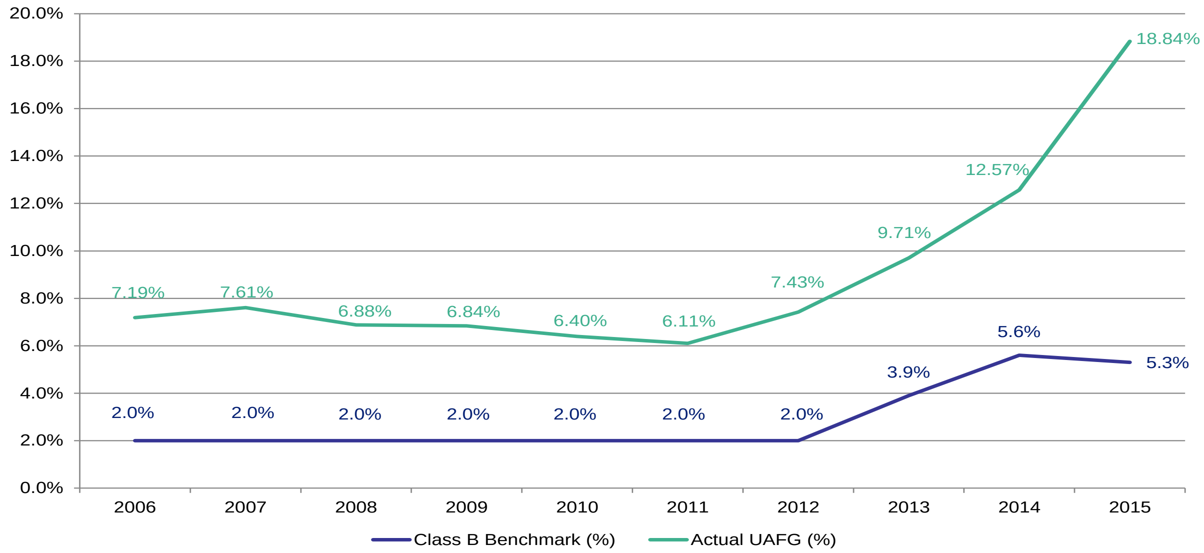
Background

Non-DTS UAFG consistently fell each year between 2007 and 2011. The ESC determined that this downward trend was indicative of "efficiencies" AusNet Services was experiencing in relation to this network and adjusted the 2013-2017 UAFG benchmarks to (1) first bring the benchmark into line with recent actual UAFG and (2) continue the downward trend. AusNet Services did not agree with the ESC's approach to setting this forward benchmark.[1]

In 2012 and 2013, non-DTS UAFG increased from 6.11% to 9.71%. Whilst this was higher than previous years, it was more in line with historical actuals (UAFG had historically been around 7% in 2006 and 2007) and although 2013 was high, UAFG is known to fluctuate year-on-year.

Final 2014 UAFG data was not received from AEMO until May 2016 and final 2015 UAFG data was not received until September 2016. This data showed that non-DTS UAFG increased to 12.57% in 2014 and 18.84% in 2015, per Figure 1.

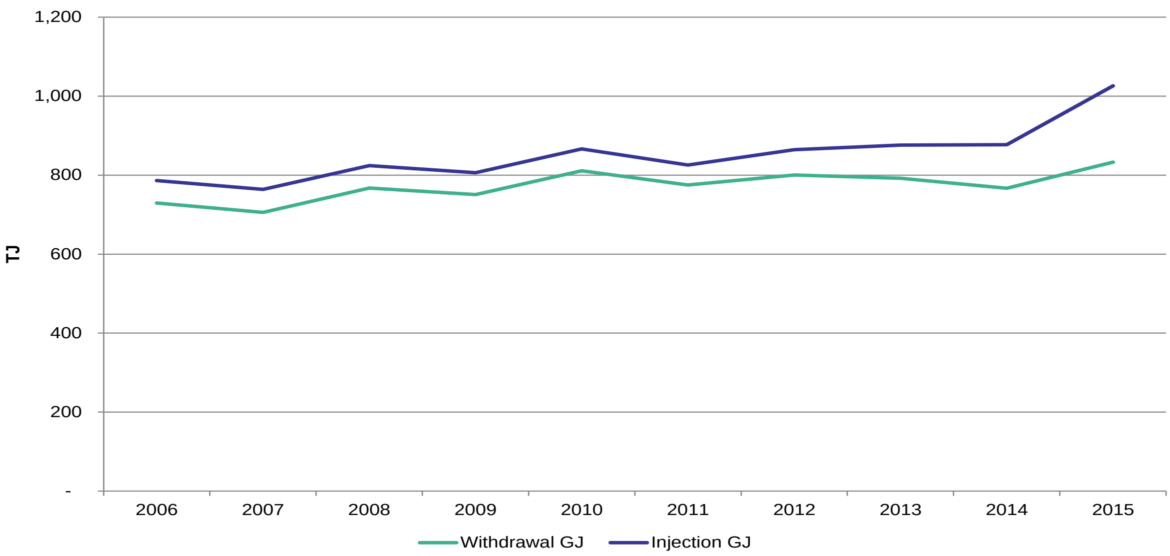
Figure 1. Non-DTS UAFG v. benchmark 2006-2015



UAFG represents the difference in injections into the distribution network (via a Custody Transfer Meter (CTM) operated by the transmission pipeline operator APA) and withdrawals from the distribution network, as measured by meters at the distribution customers' premises. Figure 2 presents the injections into and withdrawals from the non-DTS network over the past decade.

[1] SP AusNet, *UAFG Benchmarks Submission: Attachment*, December 2012, p.7

Figure 2. Non-DTS injections and withdrawals 2006-2015



The sharp increase in non-DTS UAFG has led AusNet Services to undertake several investigations of the potential causes for the increase. These are described in the sections below.

Investigations

Actual v. measured loss

At the outset, it is important to note that the recorded UAFG can either be an *actual* loss or a loss associated with a *measurement error*. That is, if the injection and withdrawal figures accurately reflect the physical amount of gas flowing into and out of the network, the loss is an *actual* one – the gas is in fact escaping from the distribution network.

On the other hand, if either (or both) of the measured injection or measured withdrawal values are incorrect, there can be UAFG, but no *physical*, or *actual*, loss of gas from the network.

In practice, UAFG is usually a combination of both a physical loss of gas and a loss due to measurement error. One of the questions that needed to be answered by AusNet Services was whether the spike in non-DTS UAFG represented an actual or measured loss.

Actual loss

The volume of UAFG depicted in Figure 2 is significant, at approximately 200 TJ. This is the equivalent of 5,000 residential customers' annual consumption lost in a network that only has approximately 12,000 residential customers connected. Put another way, it is almost the entire annual consumption of the eight large industrial users in the non-DTS network.

On this basis, AusNet Services is of the firm opinion that the UAFG in the non-DTS network is not an actual loss, rather it is a loss associated with a measurement error.

In support of this view, AusNet Services consulted the leakage surveys that were conducted on the three towns in the non-DTS network and these confirmed that leaks were minor in nature.

In addition, if a leak was to occur on the network it would be heard and visible due to the volume and pressure of the gas.

The combination of the leakage surveys, engineering assessments and engineering experience has led AusNet Services to rule out an actual leak in the network as being the cause of the high UAFG.

Unauthorised consumption (theft)

Unauthorised consumption, or theft, of gas is part-actual and part-measured loss. In one sense, it is an actual loss of gas because gas is being physically withdrawn from the network. On the other hand, the only reason this gas consumption is undetected is because there is not a measurement device (a meter) connected to the off take point.

Theft, as a reason for the increase in UAFG, faces the same issues as the actual losses referred to above. The amount of gas that would need to have been illegally withdrawn from the network is significant. Due to the high variance in losses, it would be unusual that theft would be due to a single source of theft. Conversely a large development with no gas metering within the distribution network would also be easily identified.

Injection measurement error

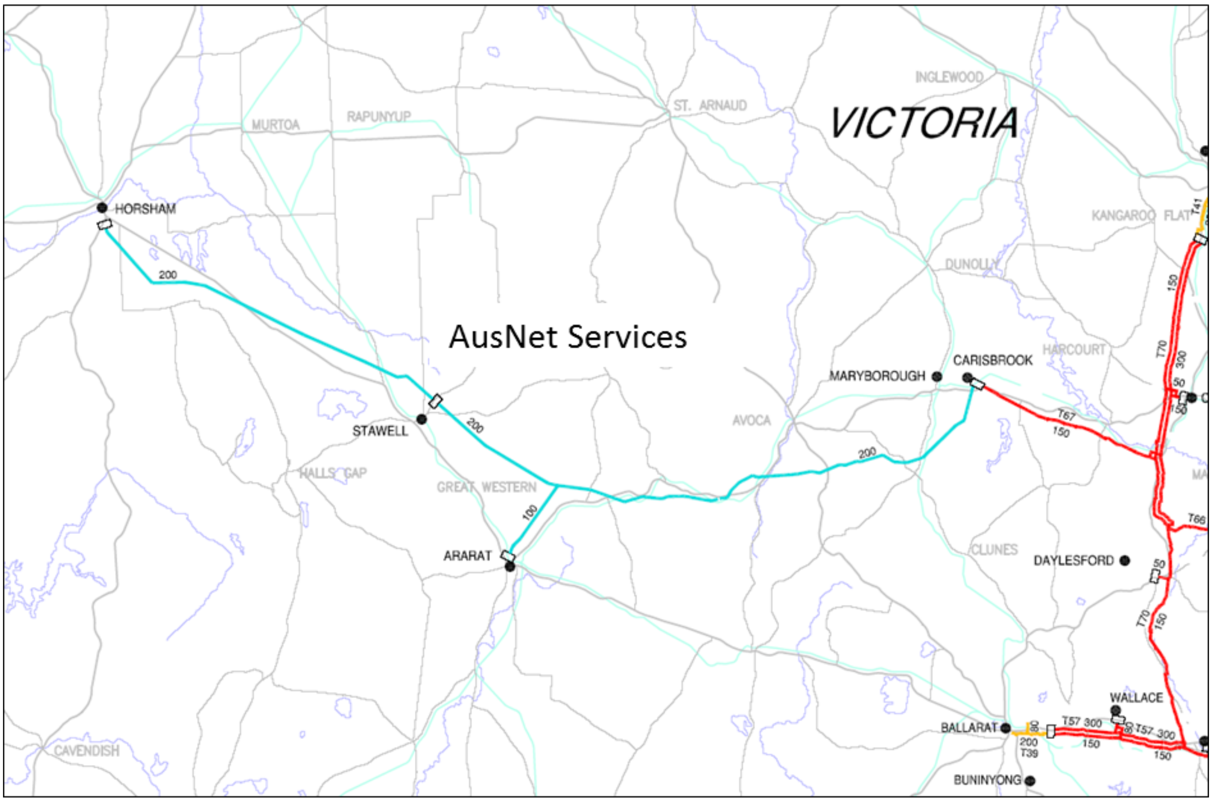
The time series presented in Figure 2 suggests that it is the injection volume, rather than the withdrawal volume, which may have a measurement error associated with it. This is because the injection value in 2015 is significantly higher than any other year in the time series.

The injection point for the non-DTS network is the Carisbrook CTM. The injections data from this CTM is received by AusNet Services from AEMO. On noting that the injections figure in Carisbrook was at historically high levels, AusNet Services requested that AEMO confirm that the injection value in its database was correct. In an email to AusNet Services, AEMO confirmed that the value was accurate.

AusNet Services then requested that the party responsible for calibrating the Carisbrook CTM (IM&C Engineering send the details of the most recent calibration. These calibration reports all showed the Carisbrook CTM to be measuring flow within the expected level of accuracy.

The towns of Horsham, Stawell and Ararat, which comprise the non-DTS network, are located some 100-170km from the Carisbrook CTM. The pipeline connecting the Carisbrook CTM to AusNet Services' distribution network in those towns is the Carisbrook to Horsham Gas Transmission Pipeline (see Figure 3), owned by Gas Pipelines Victoria (GPV).

Figure 3. Non-DTS network



It is possible that the increase in UAFG is not associated with AusNet Services' distribution network in Horsham, Stawell and Ararat, but rather associated with GPV's pipeline connecting those towns to the Carisbrook CTM.

In 2014, AusNet Services installed meters at the city gate site, which is the interface between GPV's pipeline and the entry point to each of the three towns. As a way of checking the volume recorded at Carisbrook, AusNet Services summed the metered energy at each of the three towns and compared it to the AEMO-reported energy at Carisbrook. The results are presented in Table 1 and as can be seen, the difference in energy is marginal. The flow from 2016 is included in the below table, although 2016 values have not been settled between AusNet Services, AEMO and the retailer and therefore do not form part of the ESC's review.

Table 1 Comparison of Carisbrook (AEMO) and non-DTS towns (AusNet Services), GJ

Injection point	2015	2016
Carisbrook (AEMO)	1,025,893	1,054,327
Non-DTS towns (AusNet Services)	1,014,665	1,032,500
% variance	-1.1%	-2.1%

AusNet Services also requested that AEMO provide the Carisbrook flow in cubic meters, rather than energy, so it could compare the volumetric flow. This allows the flow to be compared without the interim step of converting volume to energy. As Table 2 demonstrates, the volumetric flow was again very close.

Table 2 Comparison of Carisbrook (AEMO) and non-DTS towns (AusNet Services), m^3

Injection point	**2015**	**2016**
Carisbrook (AEMO)	26,573,495	27,552,283
Non-DTS towns (AusNet Services)	26,218,727	26,679,587
% variance	-1.3%	-3.2%

As an additional test, AusNet Services compared the daily flow at Carisbrook CTM with the daily flow at the three towns, to determine if the two data series were in alignment at the daily level, as well as the annual level. Due to the large distance between the three towns and Carisbrook, one would not expect the daily values to be identical, as there can be days where the line pack in the GPV pipeline is used to supply the three towns, rather than flow via Carisbrook.

However, one would expect there to be an evident relationship between the two data series and this was in fact found. Figure 4 shows the daily flow at Carisbrook and the three towns, whilst Figure 5 overlays a 4 day moving average of the Carisbrook flow, which aligns almost perfectly with the flow at the three towns.

Figure 4. Carisbrook and non-DTS towns daily flow (MJ)

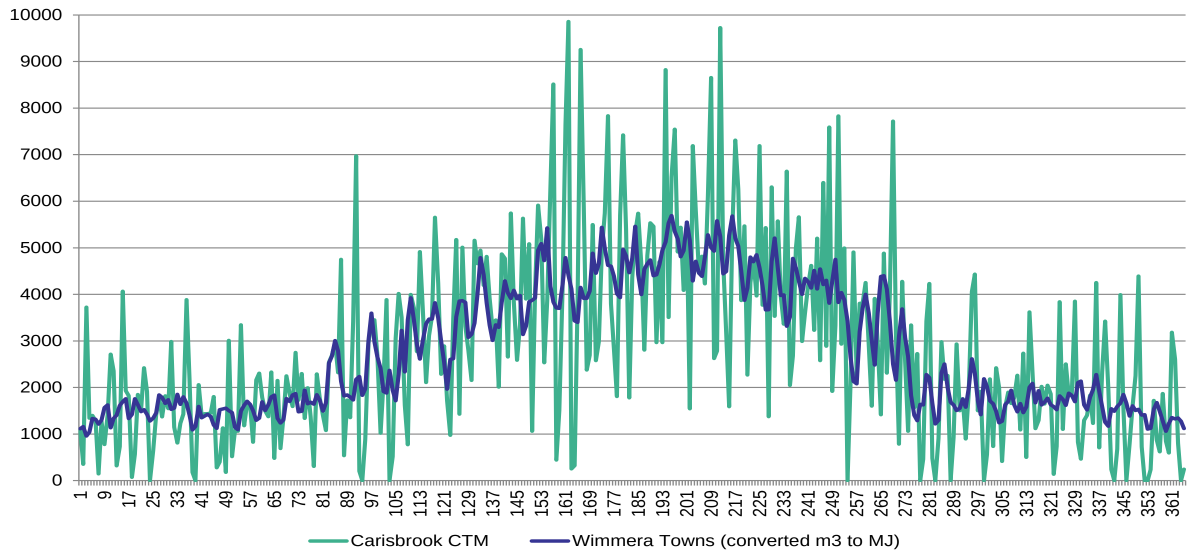
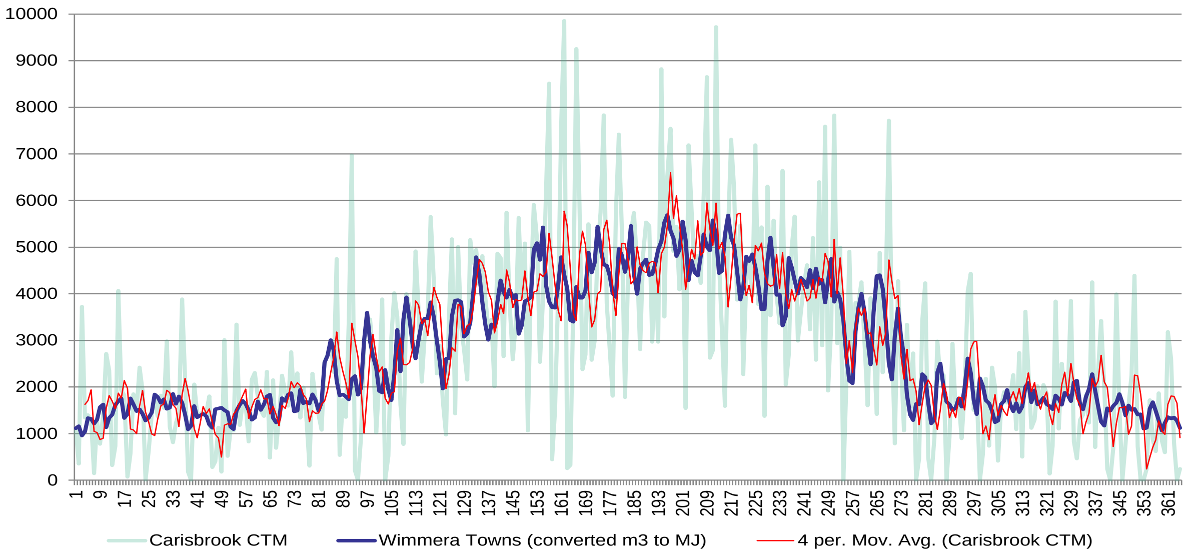


Figure 5. Carisbrook (incl. 4 day moving average) and non-DTS towns daily flow (MJ)



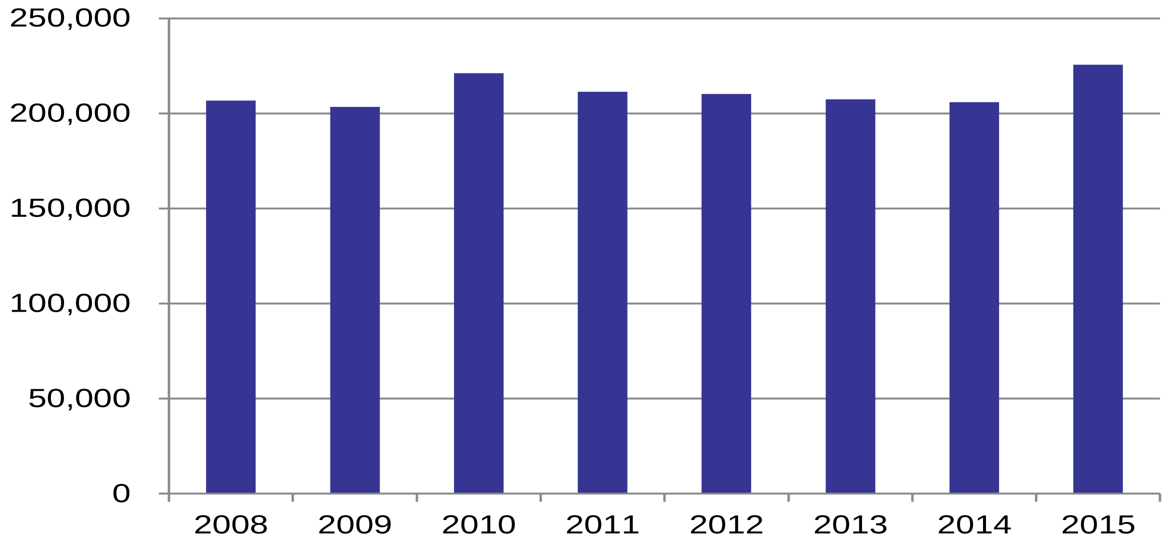
AusNet Services' investigations into the injection value described above offered strong evidence that the injection at Carisbrook, used in the UAFG calculation, was materially correct, despite the suggestion in Figure 2 that the increasing injection value could have been the cause of the measurement error. The strongest piece of evidence that the 2015 Carisbrook injection was correct was that the sum of the flow through the meters in three non-DTS towns was within 1% of the flow at Carisbrook, using either energy (GJ) or volume (m^3).

With the injections seemingly verified, AusNet Services undertook a number of discrete analyses on the withdrawals value.

Withdrawals

Because of the size of the UAFG, the first thing AusNet Services did was to make sure all of the major industrial users were included in the UAFG dataset. This was confirmed and the consumption from these eight major users was consistent year-on-year, as shown in Figure 6.

Figure 6 Major non-DTS customer consumption 2008-2015 (GJ)

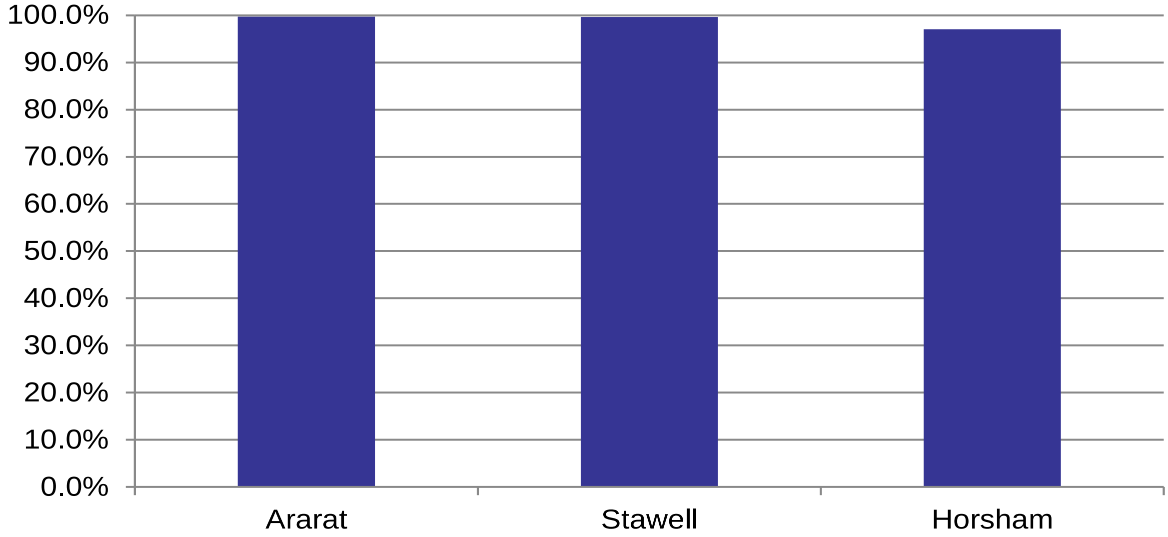


To confirm that no additional major users had been connected, but hadn't made their way into the data, AusNet Services contacted field staff in the non-DTS network and confirmed there were no additional major users. AusNet Services also contacted the electricity distribution business that services the area (Powercor) and asked whether they had recently connected any major electricity users in these towns. Powercor advised that it had not.

The withdrawals data used by AusNet Services in the UAFG calculation is sourced from billing records. To ensure that the billing database was not missing any customers, AusNet Services compared the list of MIRNs in the billing system, Kinetiq, to the list of MIRNs in AusNet Services' outage management system, PowerOn Gas. The two databases reconciled, which proved that there were no MIRNs missing from the withdrawals data used in the UAFG calculation. As a separate exercise, PowerOn Gas was also reconciled to the meter database (Hansen) and again, all MIRNs were accounted for. In addition, the recent annual growth in the number of customers is in line with expectations – around 1.2% per annum since 2011.

Given that withdrawals data is based on billing data and this billing data is in turn based on meter reads, the reliability of the meter reads was next investigated. In most circumstances, a meter read is based on an actual value, read by a meter reader. In some instances, however, a meter reader is unable to gain access to a meter and has to insert an estimated read for the billing cycle. AusNet Services determined that the billed volumes were overwhelmingly based on actual meter reads (Figure 7).

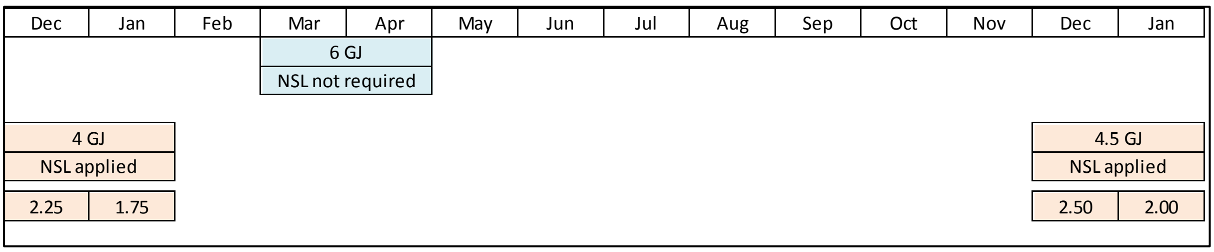
Figure 7 Proportion of billed volume based on actual meter reads, by town



Gas meter reading cycles are typically around 60 days. UAFG is calculated on a calendar year basis. This means that for any period within a calendar year that is not 100% covered by a single meter reading cycle, AusNet Services must apply an assumption about how much energy was consumed within the calendar year in question. For example, a meter read on 31 January 2015 might cover the period 1 December 2014 – 31 January 2015, but the UAFG calculation must include an assumption about how much energy was used in January only.

To perform this calculation, AusNet Services uses the Net System Load (NSL) profile prepared by AEMO. This is depicted in Figure 8, below.

Figure 8 Application of the NSL profile (example only)



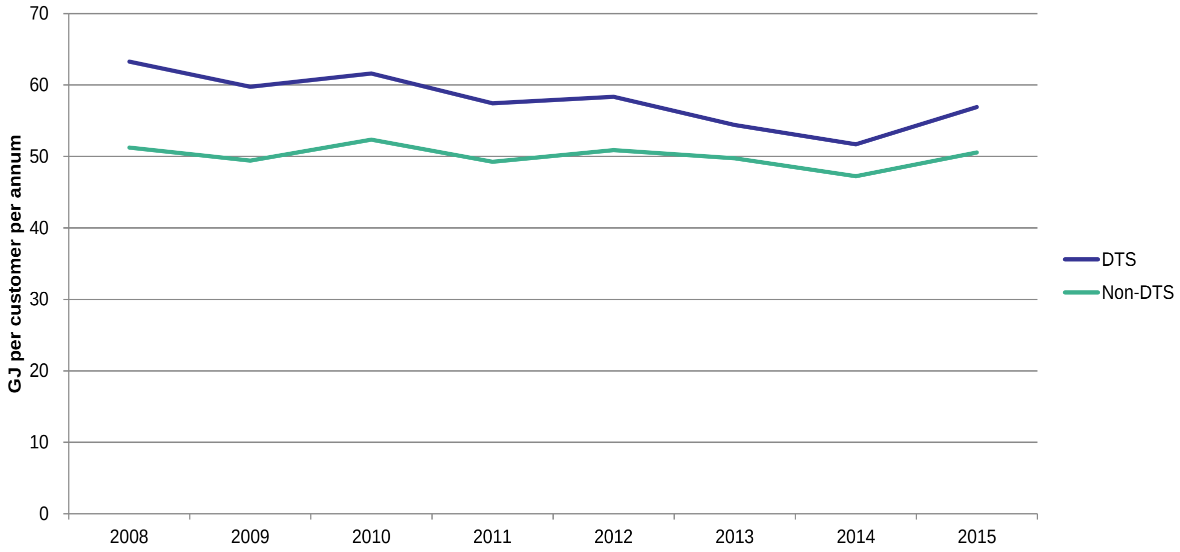
If the NSL published by AEMO does not actually align with the actual daily consumption in the non-DTS network, this could introduce an error in the withdrawal volume.

AusNet Services determined that 95% of consumption in the non-DTS network did not use the NSL profile because those meter reads fell entirely within the calendar year. AusNet Services then tested an unrealistic and extreme scenario where it took the total volume that had the NSL applied to it and apportioned 100% of the volume to the 2015 calendar year. This would be the equivalent of including 4GJ and 4.5GJ in the above example, instead of

1.75GJ and 2.50GJ. This sort of error is practically impossible,[2] but even if it was possible, the non-DTS UAFG would still be 15% - nearly 3 times the benchmark and 2.5 times what it was in 2011.

AusNet Services next looked at the trends in consumption for small to medium users (major user trends have already been discussed). As presented in Figure 9, average consumption per customer in the non-DTS network has moved more or less in line with the rest of AusNet Services' network (the DTS network). This again provides evidence that the meter reads in the non-DTS network are not in error.

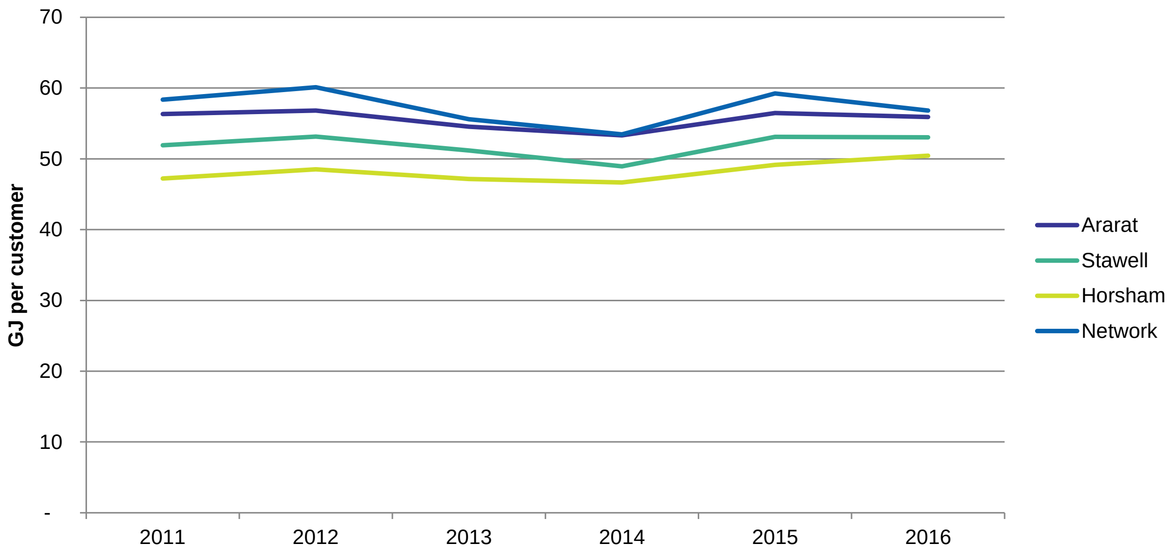
Figure 9 Average consumption per residential and commercial (R&C) customer



A similar pattern exists within each town. Figure 10 depicts the last six years of average consumption per customer in each non-DTS network town compared to the overall DTS network. Whilst the average consumption is lower in the non-DTS network, each town has maintained a similar relationship to the DTS network, at odds with the spike in the non-DTS network UAFG.

[2] In reality, even if there was an error in the NSL – it would be symmetrical. That is, if the NSL resulted in the 4GJ coming into the 2015 year, it would also result in the 4.5GJ being pushed into the next year.

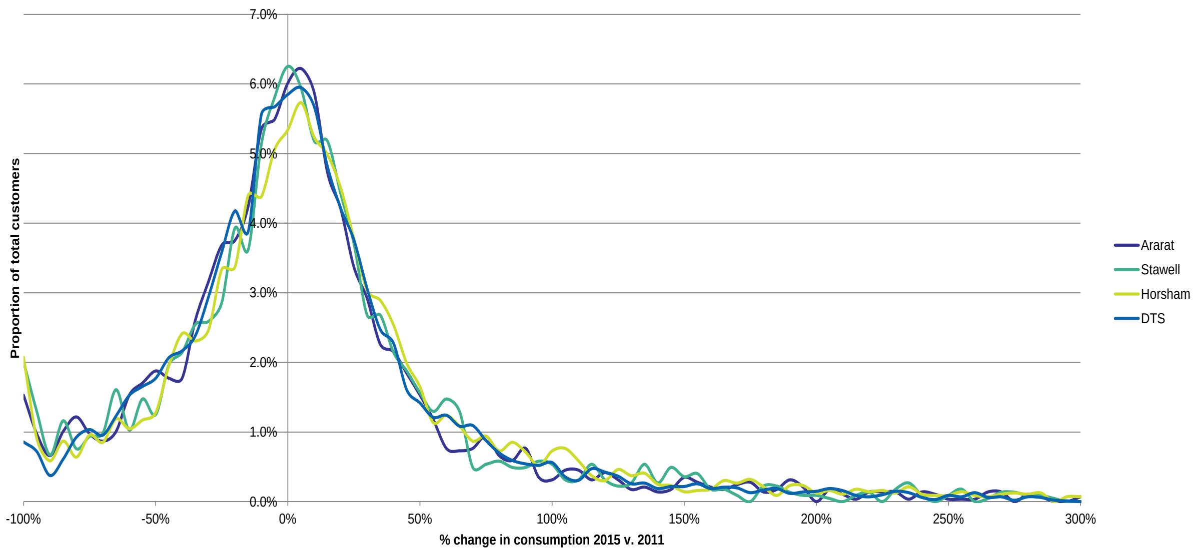
Figure 10 Average consumption per R&C customer: non-DTS towns v. DTS



As a further check on the consumption trend over time and how it compared to the rest of the network (which has not experienced a spike in UAFG above historic levels), AusNet Services compared the percentage change in consumption between two years: 2011 and 2015. UAFG in the non-DTS network has tripled over this timeframe, whilst UAFG in the DTS network has remained fairly constant.

The distribution of changes in consumption is presented in Figure 11. It shows that consumption at the customer level has changed more or less consistently across the whole network. If the non-DTS withdrawals in 2015 were for some reason understated, causing the spike in UAFG, one would expect the non-DTS distribution to be skewed to the left, relative to the DTS network.

Figure 11 Consumption change 2011 – 2015 by customer



Whilst the above analysis strongly suggested that the withdrawal values used in the UAFG calculation were complete and accurate, AusNet Services undertook further analysis on the withdrawals. The first analysis compared consumption trends by street in each of the towns. The reason for doing this was to see if there were pockets within each town in which consumption had fallen by more than other areas of the town. This analysis did not identify any such pockets – some streets had recorded declines in consumption, but these streets were not clustered together, offering evidence that UAFG was not driven by faulty sections of the distribution network.

Using the injections and withdrawals data referred to above, AusNet Services was able to calculate an estimated UAFG in each of the three non-DTS towns. Both Ararat and Stawell have a high proportion of low pressure mains (63% and 70% respectively), whilst Horsham has a lower proportion (29%). Since low pressure mains are one of the potential causes of higher UAFG, calculating UAFG at the town level may show a correlation between UAFG and low pressure mains.

The results of this analysis are presented in Table 3. In fact, Horsham, which has the lowest proportion of low pressure mains, has the highest UAFG.

Table 3 Low pressure mains and UAFG by non-DTS town

	Ararat	Stawell	Horsham
% of low pressure mains	63%	70%	29%
2015 UAFG	9.8%	6.8%	28.7%
2016 UAFG (estimate)	12.3%	11.3%	28.3%

The calculated UAFG for Horsham, which is near 30%, is close to six times the non-DTS UAFG benchmark. The town meters did not exist for a full year prior to 2015, so it is not possible to determine whether the recent increase in UAFG in these towns is solely due to Horsham or not.

Finally, to ensure that the energy billed to customers (and therefore reported as withdrawals) matched the underlying meter reads, AusNet Services obtained the raw meter reads for each of the non-DTS customers. The energy billed to customers is derived from meter reads, however the meters themselves do not measure energy, they measure flow in cubic meters. This volumetric value is converted to an energy value (e.g. GJ) using a number of factors, including pressure correction and a heating value.

Using the raw meter reads (in m^3), AusNet Services was able to calculate UAFG in both volumetric (m^3) and energy (GJ) terms. If the reason for the spike in UAFG was due to the conversion between volume and energy, the calculated UAFG for m^3 and GJ should be different, e.g. UAFG in m^3 would be normal whilst UAFG in GJ would be high.

The analysis, however, showed that UAFG based on m^3 was reasonably consistent with UAFG based on GJ. This was true at both the network level and at the town level.

Table 4 2015 non-DTS UAFG by town, by measurement method

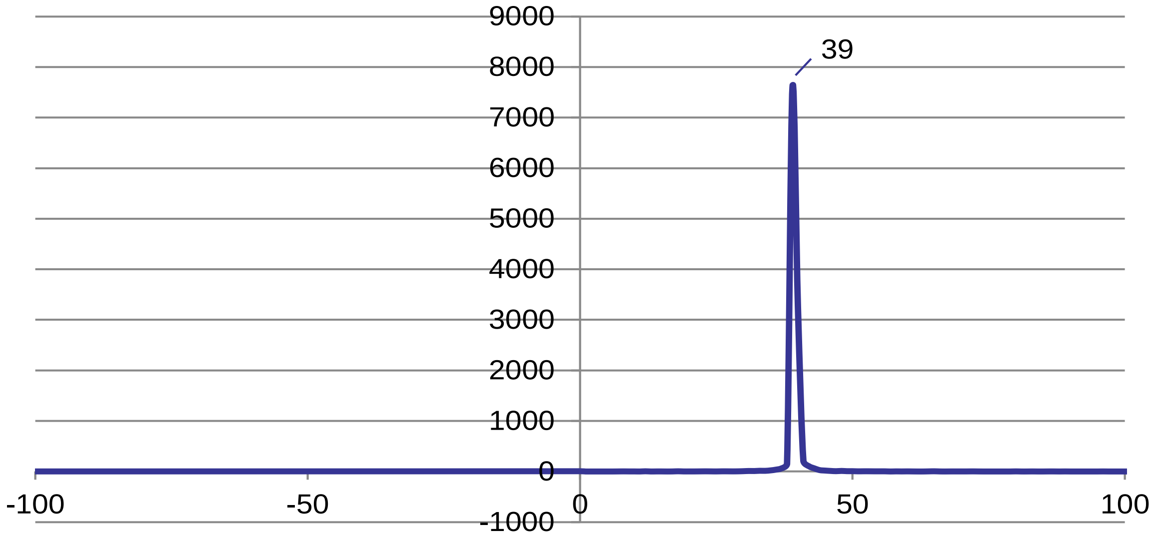
	Non-DTS network	Ararat	Stawell	Horsham
UAFG – GJ	18.8%	9.8%	6.8%	28.7%
UAFG – m^3	20.0%	12.0%	7.0%	30.3%

The results presented in Table 4 seem to rule out an error in the parameters used to convert volume to energy for billing and UAFG purposes. This is further supported by a detailed analysis of the meter reads and their corresponding billed energy values.

AusNet Services compared the annual flow in m^3 for each meter to the annual amount of billed energy for each meter. The expected multiplier between m^3 and MJ is around 38-40 as a combination of heating value and pressure correction. That is, if a meter has recorded a 1,000m^3 increase over the course of a year, the expected energy would be somewhere between 38,000 MJ and 40,000 MJ, given the knowledge of the appropriate pressure correction factors and heating values.

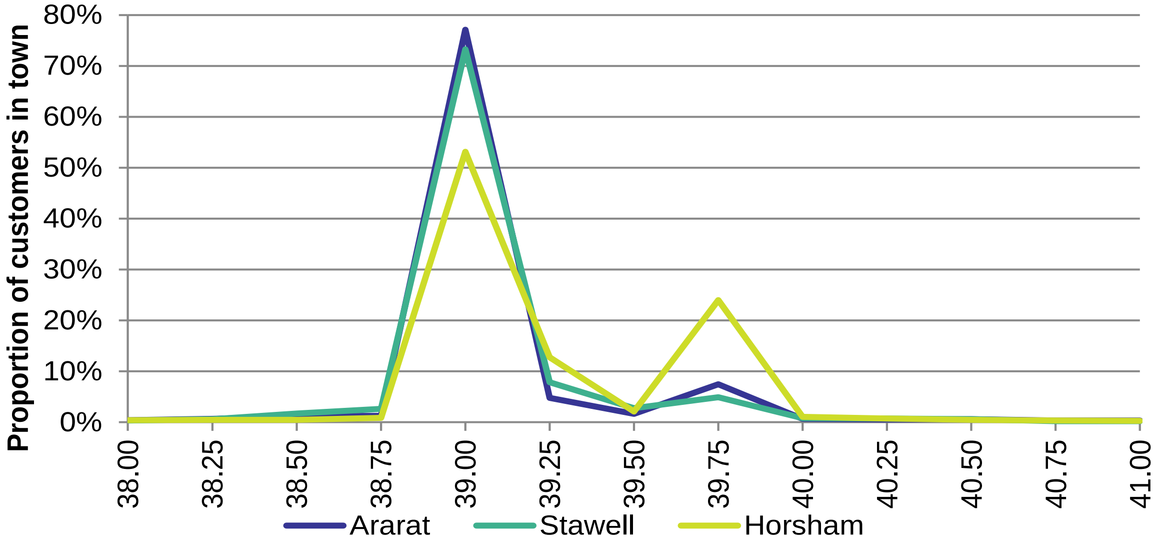
Figure 12 shows the distribution of conversion factors for the ~12,000 non-DTS customers. Whilst there are a very small number of outliers, around 92% of customers had a conversion of between 38-40 and 97% were between 36-42.

Figure 12 Distribution of conversion multiple between m^3 and MJ



Zooming in on the area of the curve where most customers are gathered, and looking separately at each of the towns, it is clear that the large majority of customers have conversion factors of 39.00 or 39.75 (Figure 13). Horsham, with a higher proportion of high pressure mains, has relatively more customers with the higher conversion factor.

Figure 13 Non-DTS towns' distribution of conversion multiple between m3 and MJ



In summary, AusNet Services' investigation into the withdrawals used in the UAFG calculation:

- Confirmed that all known major users were accounted for in the data and that major user consumption was in line with historical patterns
- Confirmed that the number of MIRNs used to derive the withdrawal value was complete and consistent with the outage management and meter systems
- Confirmed that the vast majority of consumption used in the UAFG calculation was based on actual, rather than estimated, reads
- Ruled out the possibility that the Net System Load profile used in the UAFG calculation could be responsible for the UAFG result
- Confirmed that consumption trends in the non-DTS towns matched those in the broader DTS network
- Could not find any evidence of unusual consumption patterns within specific pockets of the non-DTS towns
- Cross-checked UAFG with the proportion of low pressure mains and, counterintuitively, found that the town with the lowest proportion of low pressure mains had the highest UAFG
- Confirmed that UAFG was broadly the same whether it was calculated on a GJ or m^3 basis
- Confirmed that the conversion from m^3 to MJ was consistent with engineering expectations.

These findings strongly support a conclusion that the withdrawal value used in the UAFG calculation is complete and accurate.

Conclusions

The investigations undertaken by AusNet Services have so far returned a set of conclusions which are on face value inconsistent:

1. The reported UAFG is too high to be an actual loss, therefore it must be due to a measurement error in the injection value or withdrawal value
2. The injection value reconciles to three independent downstream meters operated by AusNet Services and therefore the injections measurement seems to be correct
3. The withdrawal value comprises a full set of customers, consumption has been reconciled to the underlying meter reads and consumption trends are consistent with the DTS network. Therefore the withdrawal measurement seems to be correct.

In an attempt to overcome these seemingly inconsistent conclusions, AusNet Services is undertaking a series of further investigations. These are described below

Ongoing investigations

AusNet Services on-going strategies to understand the discrepancies in the network include the following:

- An independent review of the Carisbrook CTM in terms of calibration, performance and operation. This will confirm that the source supply of gas metering is correct and accurate. This will then isolate the issue to AusNet Services network rather than the GPV pipeline.
- Confirm that conversion characteristic applied for billing purposes (Pressure and Heating Value) is aligned with the DTS network. This will confirm that the end to end billing process in the non-DTS network is accurate and consistent with the DTS network.
- Complete asset audit of meters installed in the three towns to determine if there are any new meters that have not been accounted for.
- Perform downstream flow balance on the Horsham network to understand if there are any un-accounted for losses on the network. This will identify the location of network of potential losses that have not been accounted for.

Un-Accounted for Gas (UAfG) Strategy

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Issue number	3
Status	Approved
Approver	L. Burridge
Date of approval	9/8/2017

ISSUE/AMENDMENT STATUS

Issue Number	Date	Description	Author	Approved by
1	December 2009	Strategy developed from a combination of sources. Structure of document build around the existing draft document "Unaccounted for Gas – Avenues for Mitigation".		
2	November 2011	Strategy updated to contain reconciled 2009 UAfG data and updated Recommends and Actions.	M. Cooper	N. Nithianandan
3	August 2017	Reviewed.	M. Horomidis	L. Burridge

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Table of Contents

1 PURPOSE

This document sets out the strategy to be employed for the fifth regulatory period (2018 through to 2022) with regards to the reduction/mitigation of Un-Accounted for Gas (UAfG). In general the strategy aims to reduce and account for methane emissions from the gas distribution network installation and provide economic benefits via benchmark incentives.

This strategy demonstrates that AusNet Services has long term plans in place to minimise methane emissions and therefore limit the impact of carbon emissions, in-line with the Federal Government's global commitment to the COP21 Paris Agreement[A]

2 REFERENCES

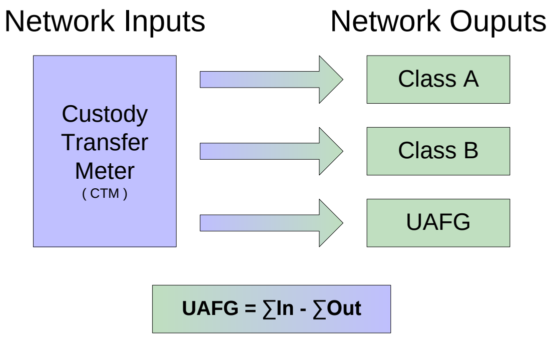
AMS 30-51	Network Regulator Strategy
AMS 30-52	Mains and Services Strategy
AMS 30-57	Supervisory Control And Data Acquisition (SCADA) Strategy

3 INTRODUCTION

Un-Accounted for Gas or UAfG is the difference between the total measurements of gas injected into a pipeline system and the total measurements of gas withdrawn from the same pipeline system with a correction for any changes in the quantity of gas stored in the pipeline over the measurement period. The gas stored (under pressure) in the pipeline at any instant is called the "linepack".

Specific to AusNet Services, UAfG is the difference between the amount of gas injected into the distribution network via Custody Transfer Meters (CTM's) and the amount of gas withdrawn by end consumers via individual consumer gas meters (refer to Figure 1). In relation to the number of these metering points there are a total of 40 CTM's or measurement injection points and a fleet of approximately 691,800 consumer meters. These consumer meters are broken into two classes; Class A and Class B (Refer to Section 4.1 for an explanation).

Figure 1: Un-Accounted for Gas flow diagram



The difference or unaccounted amount is currently calculated and reconciled on an annual basis from data supplied by the Australian Energy Market Operator (AEMO) and retailer consumer usage data. The Distribution Tariff Agreement (DTA) requires AMEO to calculate the Reconciliation Amount in accordance with the formula and methodology as defined in the Gas Distribution System Code (GDSC).

This strategy presents some of the main contributors to the distribution network's UAfG and explores potential avenues for mitigation.

[A] The agreement was made at the 21st Conference of the Parties (COP21) held in Paris from 30th November – 12th December 2015.

4 BACKGROUND

4.1 UAfG Regulatory Benchmarks

The Gas Distribution System Code (GDSC) Version 11.0 currently sets out UAfG benchmarks for each Victorian gas distributor in Schedule 1, Part C and also stipulates the responsibilities of a gas distributor with respect to UAfG in Clause 2.4. The benchmarks express UAfG as a percentage of the aggregate quantity of gas injected into the distribution system for each Victorian gas distributor. Separate benchmarks are applied in respect of volumes delivered from the high and low pressure systems.

There are currently two classes of UAfG benchmarks applied on the Declared Transmission System (DTS) and Non-DTS networks, based on whether a customer's annual consumption is greater than or less than 250 TJ (250,000 GJ).

Class A: >= 250,000 GJ/pa
Class B: < 250,000 GJ/pa

Class A customers use more than 250 TJ's per annum and are typically serviced by the transmission/high pressure networks. Class B customers use less than 250 TJ's per annum and are typically serviced by high, medium and low pressure networks.

Under the current Victorian UAfG model, retailers are required to purchase sufficient gas from producers to cover customer consumption and actual UAfG. Distributors are not funded for UAfG in their revenue requirements, consequently, retailers initially bear the cost of all UAfG. However if actual UAfG is greater than the benchmark, then the distributor pays an amount to the relevant retailer(s) equal to the cost of the additional gas lost. Where UAfG is lower than the benchmark, the relevant retailer(s) pay the distributor an amount equal to the cost of the gas that would have been required to meet the benchmark.

The UAfG requirements in the GDSC are intended to incentivise the gas distributors to take steps to minimise the level of UAfG. As a result, the UAfG benchmarks affect the three Victorian distributors, as well as the cost of gas supply to the retailers and ultimately, Victorian households and businesses.

Specific to AusNet Services are the following benchmarks for the current access arrangement period, 2013 to 2017 taken from GDSC Version 11.0 Schedule 1, Part C.

Table 1: DTS and non-DTS system Un-Accounted for Gas benchmarks applicable to AusNet Services effective from 1 July 2013

	Class B benchmarks < 250,000 GJ/pa					Class A benchmarks ≥ 250,000 GJ/pa
	2013	2014	2015	2016	2017	2013-2017
DTS	5.4%	5.4%	5.4%	5.4%	5.4%	0.3%
Non-DTS[B]	5.8%	5.6%	5.3%	5.1%	4.9%	0.3%

The reconciliation amount calculation between the retailers and distributors is performed annually by AEMO in accordance with the current UAfG Reconciliation Amount formula which is stated in the GDSC Version 11.0 Schedule 2, Part C. An extract of the Reconciliation Amount formula is provided in Appendix A of this document along with a working example of the Reconciliation Amount and Actual UAfG percentage in Appendix B.

[B] Non-DTS benchmarks do not distinguish between Class A and Class B.

4.2 National Greenhouse and Energy Reporting System (NGERS)

The *National Greenhouse and Energy Reporting Act 2007*, the Regulations under that Act and the National Greenhouse and Energy Reporting (Measurement) Determination 2008 establish the legislative framework for a national greenhouse and energy reporting system.

The Australian Government's Department of the Environment and Energy publish NGER Technical Guidelines which describe the latest methods for estimating emissions and are based on the National Greenhouse and Energy Reporting (Measurement) Determination 2008 as amended ('the Determination') through the periodic public consultation and review process.

The Technical Guidelines provide additional guidance and commentary to assist reporters in estimating greenhouse gas emissions for reporting under the NGER system. The most current publication applies to the 2016-2017 reporting year.

The NGER Scheme's objectives are set out in the *National Greenhouse and Energy Reporting Act 2007*.

These comprise:

- informing government policy formulation and the Australian public
- meeting Australia's international reporting obligations
- assisting Commonwealth, state and territory government programs and activities
- avoiding the duplication of similar reporting requirements in the states and territories.

For AusNet Services, the National Greenhouse and Energy Reporting System (NGERS) calculation will be based on asset count with emissions estimated and adopted from the American Petroleum Institute & American Gas Association.

As such, based on the NGERS calculation no direct correlation exists between the calculation of emissions and UAfG.

4.3 Historical UAfG Trends

In relation to historical UAfG rates, between 2003-2011, AusNet Services had exceeded the benchmark. From 2012 onwards, the benchmark has not been exceeded.

Table 4.2 DTS - Past historical trend and UAfG Payments

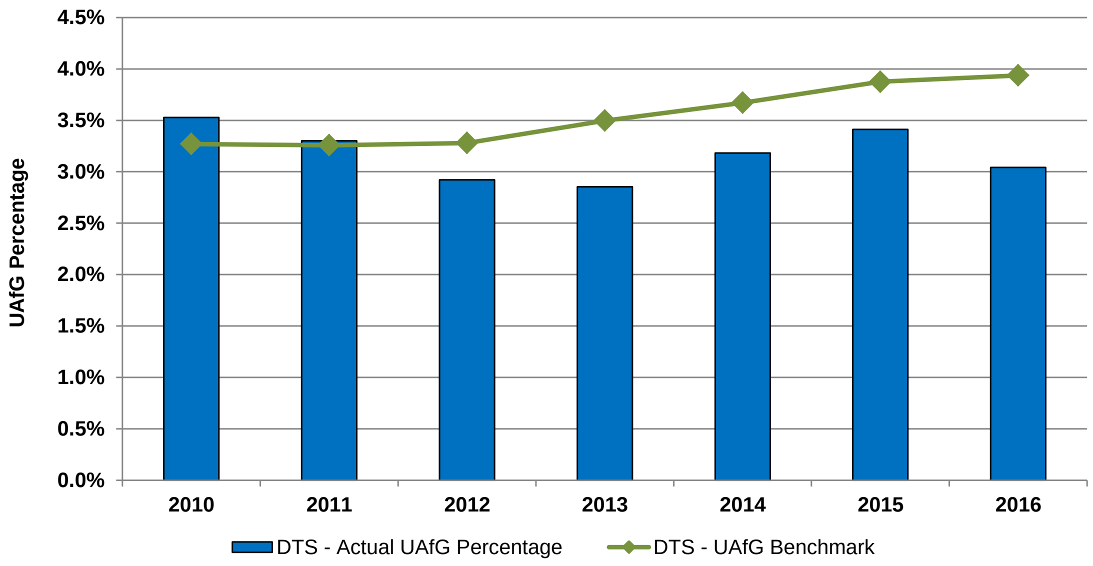
	2010	2011	2012	2013	2014	2015	2016[C]
Class A Benchmark	0.30%	0.30%	0.30%	0.30%	0.30%	0.30%	0.30%
Class B Benchmark	5.00%	5.00%	4.90%	4.9%/5.4%	5.40%	5.40%	5.40%
Weighted Average Benchmark	3.27%	3.26%	3.28%	3.50%	3.67%	3.87%	3.94%
Actual UAfG %	**3.53%**	**3.30%**	**2.92%**	**2.85%**	**3.18%**	**3.41%**	**3.04%**
UAfG Above Benchmark	0.26%	0.04%	-0.36%	-0.64%	-0.49%	-0.46%	-0.89%
Reconciliation Amount $'000	**-713**	**-121**	**1,053**	**1,759**	**1,244**	**1,472**	**2,711**

[C] Note, 2016 data had not been settled at the time of writing.

Table 2: Non-DTS Past historical trend and UAfG Payments

	2010	2011	2012	2013	2014	2015	2016[C]
Class A Benchmark	2.00%	2.00%	2.00%	0.30%	0.30%	0.30%	0.30%
Class B Benchmark	2.00%	2.00%	2.00%	2.0%/5.8%	5.60%	5.30%	5.10%
Weighted Average Benchmark	2.00%	2.00%	2.00%	4.19%	5.60%	5.30%	5.10%
Actual UAfG %	**6.40%**	**6.11%**	**7.43%**	**9.62%**	**12.57%**	**18.84%**	**17.82%**
UAfG Above Benchmark	4.40%	4.11%	5.43%	5.43%	6.97%	13.54%	12.72%
Reconciliation Amount $'000	**-143**	**-133**	**-190**	**-198**	**-261**	**-680**	**-1,146**

Figure 2: Actual DTS UAfG percentage[D] for the period 2010 to 2016 including Weighted Average Benchmark.



5 SOURCES OF UAFG

In general, sources that contribute to the value of the gas networks' UAfG can be divided into two categories:

1. *Measurement based* - Discrepancies in readings from various metering equipment, along with the various assumptions made during calculations of supply (ie heating values).

2. *Fugitive emissions* - These emissions comprise mainly leakage of gas, smaller amounts of leaked CO_2 and CO_2 produced via the oxidation of methane as it seeps through soil, before being released into the atmosphere.

The following sections briefly cover aspects of these two levels.

5.1 Measurement Based

Discrepancies in measurement of gas provided by metering equipment can be attributed to the age, condition and operating limits of meters, as well as the mismatch in the timing of when meters are read. Pressure and

[D] Values displayed as positive numbers but are calculated as negative for loss from network.

temperature compensation also needs to be considered when comparing measurements made at meters, to measurements made at CTMs on the supply side. These contributing factors are covered below, along with some suggestions for remedial action.

5.1.1 Dedicated Measurement-Based Data Acquisition System

The discrepancies between volumes of UAfG that are calculated by accounting systems and volumes determined by measurement systems can be attributed to a mismatch in timing of the systems. For example, residential and commercial meters are read on a quarterly basis (and registered in the measurement system) in the middle of the third month, leaving the remainder of that month billed (and registered in the accounting system) as part of the following quarter. A difference between the two values can arise if there is a notable change in consumption in the latter part of the month.

5.1.2 Purchase Meter Compensation

Gas purchased and metered at injection points has uncertainties of ±2.0% (energy basis). The values for supply from CTMs should be adjusted accordingly in UAFG calculations, in conjunction with known CTM accuracy. Where possible, CTMs should be up-to-date and kept within tolerance to minimise the value of UAfG.

All CTM's supplying gas to AusNet Services' downstream networks are maintained and calibrated by APA Group on a regular basis.

5.1.3 Company's Own Use

AusNet Services' own gas consumption from the network is metered but not declared as sales. This amount of gas is overlooked if consumption values in UAfG calculations are based purely on gas sales. The company's own use needs to be accounted for.

Current areas which account for this type of use are City Gate gas heater facilities. Network gas is used to fuel the heater burners, which in turn heat the gas before its pressure is regulated. These facilities differ in the degree to which gas is been metered and billed.

5.1.4 Inclusion of High-Volume Meters

Previous studies on gas networks have identified that approximately 80% of gas volumes are measured by about 20% of meters. However in large, complex systems, results can be very random if data from high-volume meters (Class A) are overlooked. These high-volume meters should be identified and included in the calculation to ensure that this gas is accounted for and not incorrectly considered as emissions.

5.1.5 Pressure and Temperature Compensation for Meters

The gas purchased from Longford is supplied at 15°C and 101.325kPa – metric standard temperature and pressure. The volume of gas sales measured at a customer meter, now at a much lower pressure and temperature, is multiplied by a factor of 1.010856 (1.0856%) to correct the value to the metric standard conditions at the supply source. This 1.0856% discrepancy forms part of the network's overall UAfG.

Changes in metering pressure and atmospheric pressure affect the volume of gas that is metered. These changes are more profound at lower metering pressures (i.e. 1.1kPa). To compensate for the change in atmospheric pressure based on ground elevation, the following calculation could be performed to correct the values for UAFG volume:

$$UAFG_{atm} = V_m \left[\frac{(P_a - P)}{101.325} - 1 \right]$$

$UAFG_{atm}$ = UAFG due to variation in atmospheric pressure at elevation

V_m	= volume of gas metered
P_a	= atmospheric pressure at sea level (mB)
P	= pressure correction at elevation (mB)

Assuming the average ground elevation of Melbourne is 70m above sea level, a pressure correction of 8.24mB in atmospheric pressure is applied. Modelling of the elevation at the meter locations where UAfG readings are taken, could be performed to further refine this estimate.

Temperature compensation is required since the temperature of the gas supplied will vary depending on the soil temperature. It is assumed that the gas temperature is the same as the soil temperature at the pipe depth. For UAfG due to the temperature variation between Longford and the meter:

$$UAFG_{temp} = V_m \left[\frac{288.15}{(T_m + 273.15)} - 1 \right]$$

$UAFG_{temp}$	= UAFG due to temperature variation of gas
V_m	= volume of gas metered
T_m	= temperature of gas metered (degrees Celsius)

A potential solution to incorporating UAfG due to the pressure variations at consumer meters is to gather altitude data for network areas and calculating the overall $UAfG_{atm}$. For a value of $UAfG_{temp}$, measurements of soil temperature at pipe depth can be taken at various locations within a network and then used in the above calculation for a general value for that particular network. The calculation of values for UAfG due to pressure and temperature compensation can be performed in an automated fashion, e.g. via SCADA monitoring at field and district regulators, or by performing on-the-spot measurements with mobile equipment at fringe points, during the collection of fringe pressure chart recordings.

5.1.6 Higher Heating Value (HHV) Compensation

Unaccounted for gas is generally specified in gigajoules (GJ). This value is based on the volume metered at CTMs, and the HHV for the source gas that is injected at each location. This calculation is performed at each CTM, resulting in the GJ of gas that is supplied into the network at that CTM location. On the customer side, the average HHV for all CTMs across the entire network is used to calculate the consumption in GJ. With all other factors constant, a discrepancy remains between the total amounts of gas metered at CTMs, and the total customer consumption (in GJ). A possible remedy may involve the use of the HHV recorded at the city gate supplying a particular network in the billing/consumption calculations for customers supplied by that network.

5.1.7 Meter Accuracy and Regulator Setting

Inaccuracies in UAfG estimates can arise due to incorrectly set customer regulators. The magnitude of this error is expressed by the following:

$$\%Error = \frac{(P_m - P_b) \times 100}{(P_m + 101.325)}$$

P_m	= actual metering pressure (kPa)
P_b	= correct metering pressure (kPa)

If customer metering pressure is set too high (e.g. 0.5% higher), the result is a metering error of 0.5% which contributes excessively to UAfG. This error increases for large customers that have incorrectly calibrated regulators with a greater deviation between actual and correct metering pressure.

The accuracy of meter readings is also affected by the age and model of meters. The detection of out-of-range meters can lead to a replacement scheme and contribute to a more accurate estimate of UAfG. Meters should also be correctly matched to operating conditions, to ensure that the maximum possible accuracy is achieved across the entire range of measurement.

Calibration of industrial and commercial meters can also account for UAfG.

Inline with Regulatory requirements stipulated in the GDSC, Gas Distribution businesses are required to test families of meters for accuracy on an annual basis as per the requirements set out in AS/NZS 4944. This ongoing testing and replacement program enables meter accuracy to be maintained within a range and assists in bounding UAfG related to meter inaccuracy to a range.

5.1.8 Estimation of Gas Consumed During Mains Commissioning

It has been documented that a small percentage of UAFG is attributed to purging and filling of mains, during commissioning and related maintenance activities. This quantity of gas can be estimated using the following equation:

$$UAFG_{com} = V\left(\frac{P_{avg}+101}{101}\right)\times\frac{1}{Z}\times HV\times 10^{6}$$

UAfG = quantity of gas used to commission main (TJ)
V = internal volume of the main (m^3)
P_{avg} = average operating pressure of the main (kPa)
Z = supercompressibility of gas at average pressure, P_{avg}
HV = heating value of gas = 38.7 MJ/m^3

Any quantity of gas used to commission any new asset is not sold and directly contributes to UAfG.

5.2 Fugitive Emissions

The fugitive emissions level offers arguably the greatest potential for reduction in the value of UAfG. Historic data has shown that a large amount of UAfG can be attributed to direct losses in the distribution network. These fugitive emissions from the distribution network comprise general leakage, theft and other instances of unintended release of gas. Some sources of UAfG on the fugitive emissions level are mentioned below, accompanied by strategies for reduction.

5.2.1 Mains Renewals

A component of UAfG can be attributed to leaks within the distribution system. The completion of mains renewal programs, to replace old, leak-prone cast iron pipes with high pressure-rated, polyethylene pipes will act to curb the number of gas leaks originating from pipes in the distribution system.

In accordance with AusNet Services' Mains and Services strategy, renewal programs are performed in areas considered to be 'high risk and high benefit'. Strategic analysis is used to identify areas that fit these criteria, including areas with high rates of pipe breakage (High Breakage Zones) and low pressure (LP) areas with cast iron pipes that are within close proximity to existing high pressure (HP) networks.

Moreover, as LP networks are replaced by HP, decreasing the overall demand in the remaining LP network, the outlet pressure from the district regulators which feed the LP networks can be reduced, which in turn reduces the rate of leakage from the remaining LP cast iron pipes. It also includes decommissioning of district regulators which can be a potential source of UAfG.

5.2.2 Leakage from Valves and Regulators

Faulty valves, CTMs and customer regulators also contribute to UAfG. Faulty customer regulators should be replaced in a timely manner to minimise possible leakage losses.

An example of this strategy is about to be underway in the upcoming regulatory period 2018-22. AusNet Services received approval to implement a proactive domestic regulator replacement program which will progressively replace domestic regulators before they get faulty and vent gas into the atmosphere. This could potentially lead to a small reduction in UAfG.

5.2.4 Third Party Damages

Third party damages are a common occurrence on gas distribution assets. Some damage can be superficial without any detrimental long term damage to the asset, while other damage can result in leakage of gas which results in UAfG. While third party damages can occur on any part of the network, the majority are related to service damages by consumers and contractors (i.e. fencing contractors) working without adequately ascertaining the location of the buried gas assets.

AusNet Services provides a free asset locating service for members of the public, and also provides asset maps to the Dial-Before-You-Dig (DBYD) service.

5.2.5 Meter Bypass and Theft

Although uncommon, theft of gas can occur, whereby industrial customers can open the bypass around a meter to reduce the metered consumption. Similarly, domestic customers could disconnect their meters and turn them around to make them run backwards. Measures can be taken to reduce the incidence of both of these modes of theft, by placing tamper-proof seals on valves and changing the design of couplings so that everyday tools cannot be used to disconnect meters.

6 SUMMARY

Future management of UAfG will involve review of the measurement of gas supply and consumption within the distribution network, and the minimisation of fugitive emissions.

Improvements in measurement equipment could be implemented gradually to supplement these refined techniques to arrive at an improved estimate for UAfG. Cost of such equipment requires additional work to derive whether such capital investment would yield substantial benefits to be economically justified. We also note that our current meter replacement strategy is consistent with our regulatory obligations, and that meter accuracy is not a current area of concern.

On the fugitive emissions level, a number of longer-term measures can be taken to reduce UAFG, including the renewal of old, leak-prone mains, replacement of equipment that is out-of-calibration, and reducing third party damages.

Consideration should be given to all of these measures along with other emerging techniques and technologies, to form a cost-effective approach to reducing UAfG. Importantly, our ongoing strategy will be influenced by current UAFG trends on our network, and the incentive properties of the UAfG benchmark regime. Under this regime, gas distributors will only incur expenditure to reduce UAfG where doing so will result in a financial reward that exceed this expenditure.

7 APPENDICES

7.1 APPENDIX A – UafG Reconciliation Amount

Reconciliation Amount

The reconciliation Amount is:	(X+Y) x (B-A)
Where:	
X =	the quantity annual price of Gas, using spot and contract prices and quantities, as determined by AEMO for the previous calendar year expressed in $ per gigajoule.;
Y =	the average transmission tariff for the previous calendar year expressed in $ per gigajoule as calculated under the transmission provider's prevailing reference tariffs.;
A =	D – (E/(1-G))
Where:	
D =	the quantity of Gas withdrawn from the Transmission System by the Distributor for Retailer at the Connection Points for the previous calendar year;
E =	the quantity of Gas withdrawn by Distributor for Retailer at all Class A Supply Points fro the previous calendar year.
B =	H/(1-F)
H =	the quantity of Gas withdrawn by Distributor for Retailer at all Class B Supply Points for the previous calendar year;
F =	the benchmark flow rate for gas for Class B Supply points set out above.
G =	the benchmark flow rate of Gas for Class A Supply Points set out above.

7.2 APPENDIX B – Working Example of UAfG Reconciliation Amount

Reconciliation Amount

The reconciliation Amount is: (X+Y) x (B-A)

Where:

X =	$2.956400
Y =	$0.337600
D = (CTM)	71,833,005 (GJ)
E = (Class A Usage)	28,826,726 (GJ)
G = (Class A Benchmark)	0.3%
H = (Class B Usage)	40,499,032 (GJ)
F = (Class B Benchmark)	4.5%

Calculations

A =	D – (E/(1-G)) = 71,833,005 – (28,826,726/(1-0.003)) = 42,919,539 (GJ)
B =	H/(1-F) = 40,499,032/(1-0.045) = 42,407,363 (GJ)

Reconciliation Amount is: (X+Y) x (B-A)
(2.956400+0.337600) x (42,407,363-42,919,539)
(3.294000) x (-512,176)
-$1,687,108

Actual UAfG is: ((E+H)/D)-1
((28,826,726+40,499,032)/ 71,833,005)-1
(69,325,758/71,833,005)-1
0.965096-1
-0.0349 or -3.49%

7.3 APPENDIX C – Working Example of Gas Consumed During Mains Commissioning

This quantity of gas can be estimated using the following equation:

$$UAFG_{com} = V\left(\frac{P_{avg}+101}{101}\right)\times\frac{1}{Z}\times HV\times 10^{6}$$

UAfG = quantity of gas used to commission main (TJ)
V = internal volume of the main (m^3)
P_{avg} = average operating pressure of the main (kPa)
Z = supercompressibility of gas at average pressure, P_{avg}
HV = heating value of gas = 38.7 MJ/m^3

$UAfG_{\text{quantity of gas used to commission main}}$ = 0.0837 + 0.0335 + 0.0111 = **0.1283 (TJ) or 1,283 (GJ)**

Assumptions:

Mains Breakdown based on 220km.pa

Small Diameter:
- 200km @ 63mm Polyethylene
- Internal Diameter 50mm
- Volume 393m^3

Large Diameter:
- 20km @ 125mm Polyethylene
- Internal Diameter 100mm
- Volume 157m^3

Services Breakdown

- Based one service per 10m of main laid
- Equates to 22,000 services/annum
- Service size 16mm Polyethylene
- Internal Diameter 11mm
- Volume 52m^3

Where:

V = 393+157+52=602 m^3
P_{avg} = 450kPa
Z = 0.99
HV = 38.7 MJ/m^3

7.4 APPENDIX D –Non-DTS System: Carisbrook

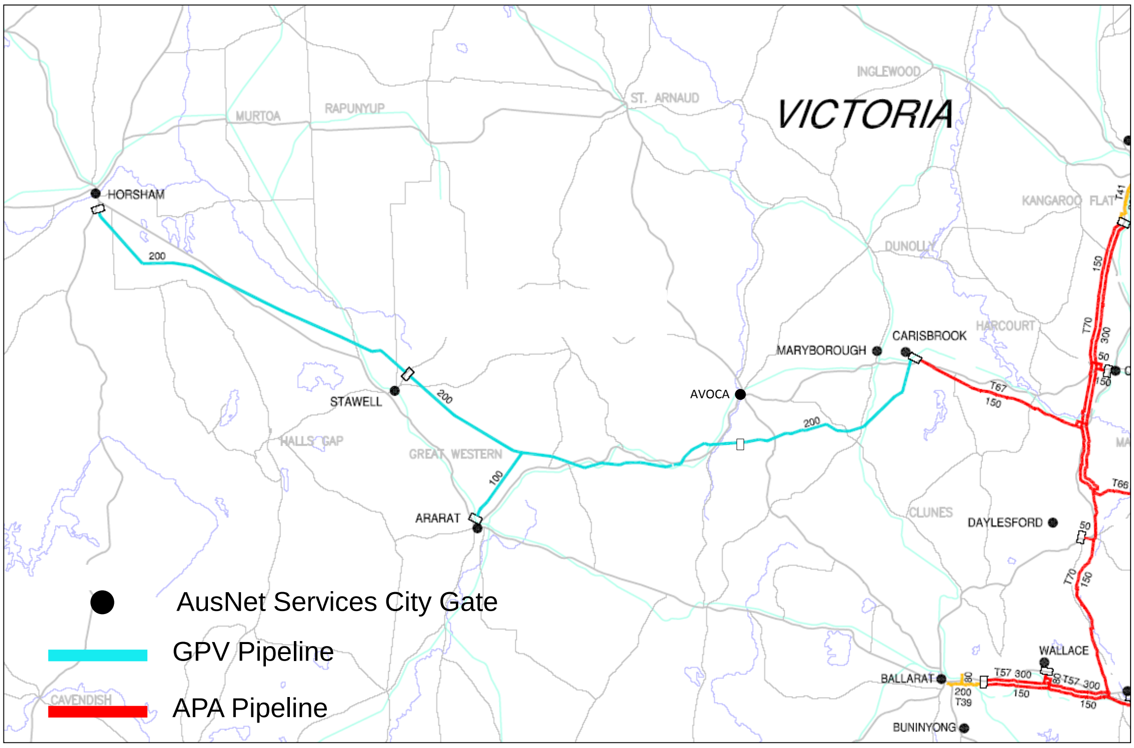
AusNet Services currently has four townships, Avoca, Ararat, Stawell and Horsham, fed from an intermediate pipe-line known as the Carisbrook to Horsham Gas Transmission Pipeline. This pipeline is in-turn fed from the 150mm DTS (T67-18) at Carisbrook. The Carisbrook to Horsham Gas Pipeline System encompasses the Carisbrook Custody Transfer Station (CTS), the Ararat Takeoff Station (ATO), the connecting pipelines between the CTS, the ATO and the city gates at Avoca, Ararat, Stawell and Horsham (plus valves, pig receiver/launchers etc). The majority of the transmission pipeline is 168.8km of DN200 (8”) with an additional 13.8km of DN100 (4”) pipeline from the ATO to Ararat City Gate.

Built in 1998, the Carisbrook to Horsham pipeline operates around 6800kPa and is reduced to distribution pressures of approximately 450kPa at Avoca, Ararat, Stawell and Horsham city gates.

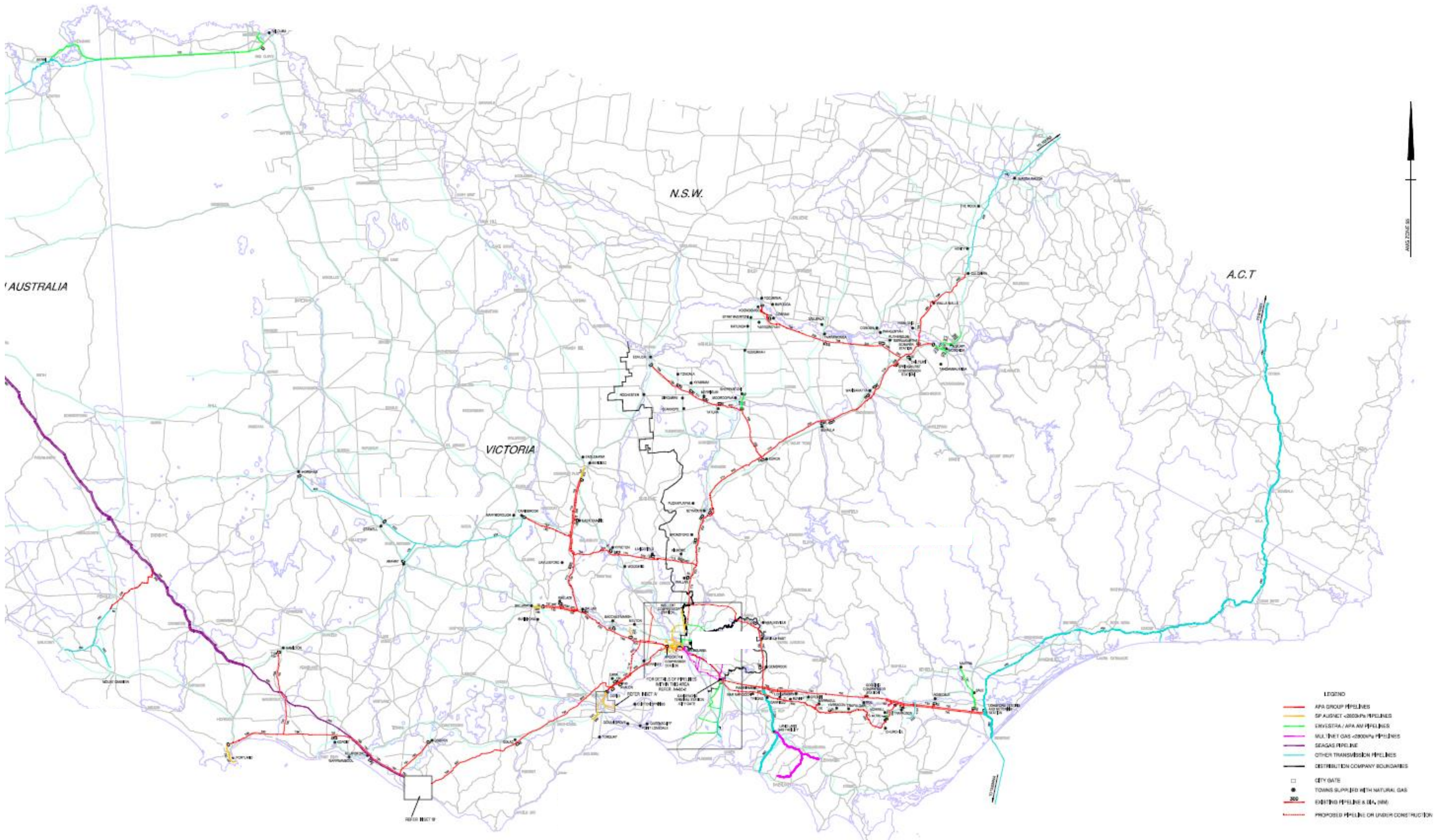
Un-Accounted for Gas (UAfG) Strategy

In terms of ownership the Carisbrook to Horsham Gas Transmission Pipeline is currently owned and operated by Gas Pipelines Victoria Pty Ltd (GPV). GPV is a wholly-owned subsidiary of the Energy Infrastructure Trust which is managed by ANZ Infrastructure Services Limited ("ANZIS").

Figure 3: Carisbrook Pipeline and AusNet Services City Gates



7.5 APPENDIX E – Victorian DTS Map



UAFG data required by the Essential Services Commission

AusNet Services - DTS network

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	Unsettled 2016
CTM injections (GJ)	72,181,337	73,245,335	68,834,009	73,336,357	71,833,005	78,084,549	73,815,406	75,020,365	73,533,567	74,152,587	69,558,374	65,380,489	68,519,222	67,488,126
Total withdrawals (GJ)	69,709,807	70,859,514	66,644,514	70,901,018	69,325,758	75,289,225	71,373,518	72,373,964	71,106,285	71,986,500	67,573,376	63,300,490	66,181,316	65,435,078
Class A withdrawals (GJ)	27,197,233	28,340,460	26,912,674	27,888,555	28,826,726	30,602,032	28,681,291	27,327,426	27,136,721	26,327,415	24,412,964	22,438,678	20,755,606	19,788,632
Class B withdrawals - D customers (GJ)	11,960,339	11,932,865	11,361,782	11,001,833	11,006,391	11,320,789	10,169,612	10,455,906	10,697,128	10,819,843	9,968,683	8,650,648	9,148,545	9,346,468
Class B withdrawals - V customers (GJ)	30,552,236	30,586,188	28,370,057	32,010,630	29,492,641	33,366,404	32,522,614	34,590,632	33,272,436	34,839,242	33,191,729	32,211,164	36,277,165	36,299,978
Actual UAFG (GJ)	(2,471,530)	(2,385,821)	(2,189,495)	(2,435,339)	(2,507,247)	(2,795,324)	(2,441,888)	(2,646,401)	(2,427,283)	(2,166,086)	(1,984,999)	(2,079,999)	(2,337,906)	(2,053,048)
Class A UAFG (GJ)	(81,592)	(85,021)	(80,738)	(83,666)	(86,480)	(91,806)	(86,044)	(81,982)	(81,410)	(78,982)	(73,239)	(67,316)	(62,267)	59,366
Class B UAFG (GJ)	(2,389,938)	(2,300,800)	(2,108,757)	(2,351,673)	(2,420,767)	(2,703,518)	(2,355,844)	(2,564,419)	(2,345,872)	(2,087,104)	(1,911,760)	(2,012,683)	(2,275,639)	(2,112,414)
% UAFG	-3.42%	-3.26%	-3.18%	-3.32%	-3.49%	-3.58%	-3.31%	-3.53%	-3.30%	-2.92%	-2.85%	-3.18%	-3.41%	-3.04%
% Class A UAFG	-0.30%	-0.30%	-0.30%	-0.30%	-0.30%	-0.30%	-0.30%	-0.30%	-0.30%	-0.30%	-0.30%	-0.30%	-0.30%	0.30%
% Class B UAFG	-5.32%	-5.13%	-5.04%	-5.18%	-5.64%	-5.70%	-5.23%	-5.39%	-5.06%	-4.37%	-4.24%	-4.69%	-4.77%	-4.42%

Reconciliation amounts received/(paid) $000	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	Unsettled 2016
[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]
[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]
[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]
[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]
[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]
[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]
[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]
[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]
[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]
[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]
[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]
[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]
[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]
[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]
[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]
Total	(1,199,819)	(911,865)	(737,524)	(1,030,544)	(1,687,104)	(2,117,643)	(218,913)	(713,144)	(120,902)	1,052,643	1,758,772	1,243,554	1,471,532	2,710,558

Note:

If any unsettled data is provided, please indicate.

UAFG data required by the Essential Services Commission

AusNet Services - Non-DTS network	N/A	N/A	N/A	No scheme	No scheme	No scheme								Unsettled
	2003	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
CTM injections (GJ)				786,031	763,823	823,826	806,067	866,115	825,411	864,480	876,103	877,186	1,025,893	1,054,327
Total withdrawals (GJ)				729,550	705,689	767,173	750,911	810,716	775,014	800,289	791,793	766,939	832,657	866,439
Class A withdrawals (GJ)				0	0	0	0	0	0	0	0	0	0	0
Class B withdrawals - D customers (GJ)				n/a	n/a	206,791	203,373	221,136	211,432	210,226	207,363	205,952	225,554	225,032
Class B withdrawals - V customers (GJ)				n/a	n/a	560,383	547,538	589,579	563,582	590,064	584,430	560,987	607,103	641,407
Actual UAFG (GJ)				(56,481)	(58,134)	(56,653)	(55,156)	(55,400)	(50,397)	(64,191)	(84,311)	(110,247)	(193,236)	(187,889)
Class A UAFG (GJ)				0	0	0	0	0	0	0	0	0	0	0
Class B UAFG (GJ)				(56,481)	(58,134)	(56,653)	(55,156)	(55,400)	(50,397)	(64,191)	(84,311)	(110,247)	(193,236)	(187,889)
% UAFG				-7.19%	-7.61%	-6.88%	-6.84%	-6.40%	-6.11%	-7.43%	-9.62%	-12.57%	-18.84%	-17.82%
% Class A UAFG				0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
% Class B UAFG				-7.19%	-7.61%	-6.88%	-6.84%	-6.40%	-6.11%	-7.43%	-9.62%	-12.57%	-18.84%	-17.82%

														Unsettled
Reconciliation amounts received/(paid) $000	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]
[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]
[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]
[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]
[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]
[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]
[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]
[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]
[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]
[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]
[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]
[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]
Total							(142,309)	(143,346)	(132,978)	(189,600)	(197,839)	(260,693)	(680,216)	(1,146,365)

Note:

If any unsettled data is provided, please indicate.