# Response to ERA amendments to the Final Decision for the Access Arrangement for the Mid-West and South-West Gas Distribution System

**27 August 2015**

Connecting WA to natural gas

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# 1. Introduction

1. This document is ATCO Gas Australia's (AGA) submission on the ERA's 21 August 2015 consultation paper on proposed amendments to the *Final Decision on the Access Arrangement for the Mid-West and South-West Gas Distribution Systems* (Final Decision).

2. AGA welcomes the opportunity to comment on the ERA's proposed amendments, and appreciates that many of the amendments proposed are in response to issues raised by AGA in its meetings and correspondence with the ERA following release of the Final Decision. This submission discusses each of the amendments proposed by the ERA, highlighting any issues or concerns where relevant.

3. AGA supports amendments where a typographical or calculation error is being corrected. However, AGA is concerned by some aspects of the ERA's proposal, for example amendments that appear to represent a reversal of its Final Decision (the decision to exclude $2.1 million of operating expenditure).

4. AGA also notes that a number of issues raised with the ERA following the Final Decision have not been addressed. AGA has taken the opportunity in this submission to highlight the outstanding issues for the ERA's further consideration, and to provide transparency for interested parties.

5. Appendix A of this document provides a copy of correspondence provided to the ERA on 22 July 2015, highlighting items that required clarification in the ERA's Final Decision. While the ERA's amendments to the Final Decision have addressed some of the issues, there remain several items that are not discussed in the ERA's consultation paper and have not been resolved to date:

   - Use of forecast revenue from 1 July to 31 December 2014
   - Cost pass-through for licence fees
   - Provision of the ERA's operating and capital expenditure models
   - Cost pass-through mechanisms for security of supply expenditure

6. These outstanding issues are discussed in section 3 of this submission, supported by the correspondence provided in Appendix A. AGA requests that the ERA addresses these issues in any amendments to the Final Decision / publication of the final access arrangement.

7. This submission also includes expert advice obtained by AGA on the debt risk premium from CEG (provided in Appendix B and Appendix D), and an expert report from HoustonKemp on the ERA's depreciation analysis (Appendix C). A further HoustonKemp report addressing the ERA's proposed amendments to depreciation modelling will be provided separately.

# 2. Amendments proposed in ERA's consultation paper

## 2.1 Operating expenditure

8. The ERA proposes to amend 'erroneous wording' in paragraph 380 of the Final Decision. The ERA intends to amend the Final Decision to state that it has **not** allowed operating expenditure of $2.1 million over 2014 and 2015 for corporate support to prepare this revised access arrangement, and that it has only allowed one-off expenditure of $2.1 million for preparing the next access arrangement across 2018 and 2019.

9. The proposed amendment appears to be a reversal of the Final Decision, which clearly states that that the ERA approves $2.1 million on preparation costs for this (AA4) proposed revised access arrangement divided over 2014 and 2015, and approves $2.4 million on preparation costs for the next (AA5) proposed revised access arrangement divided over 2018 and 2019. There is no ambiguity in the wording.

10. The ERA considers its proposed amendment to paragraph 380 is consistent with its Draft Decision. However, AGA notes that the ERA's Draft Decision on this matter is inconsistent in itself.

11. In paragraph 243 of the Draft Decision, the ERA refers to advice from its consultant EMCa that AGA has provided sufficient justification for the $2.1 million expenditure for preparation of the access arrangement for the AA4 period (the current access arrangement review). Based on this advice, the ERA approved that $2.1 million is a prudent and justified amount of expenditure for preparation of a revised access arrangement for the **AA5 period** (scheduled for 2018-19).

12. However, despite EMCa's view that the expenditure is justified; the ERA did not provide an amount to cover the $2.1 million of costs for preparation of the current (**AA4**) access arrangement.

13. Paragraph 380 in the Final Decision appeared to have addressed this inconsistency, by approving amounts to cover the costs of both the AA4 and AA5 access arrangement preparation. As such, noting the discrepancy between the ERA's Final Decision wording and its numbers, and working under the reasonable assumption that these efficient costs had been approved, AGA wrote to the ERA on 22 July 2015 (see Appendix A) asking for clarification of where the $2.1 million for preparation of the access arrangement for the AA4 period had been allocated.

14. Rather than clarify where AGA can recover these efficient costs, the ERA now seeks to characterise this $2.1 million discrepancy as 'erroneous wording'.

15. This has the effect of denying AGA the opportunity to recover the efficient costs relating to preparation of the access arrangement, which it has incurred during 2014 and 2015, and continues to incur as the current review process is delayed further and runs deeper into the AA4 period.

## 2.2 Opening capital base

16. The ERA proposes to amend the Final Decision to include $0.65 million in the opening capital base for IT capital expenditure. This adjustment is consistent with evidence provided by AGA on 22 July, highlighting that $0.65 million for a GIS enhancement project had been erroneously excluded in the Final Decision, having been accepted as conforming capital expenditure in the Draft Decision.

17. AGA supports this amendment.

## 2.3 Projected capital base

18. The ERA proposes to correct a typographical error in Table 67 of the Final Decision, changing the amount of capitalised overheads from $16.31 million to $16.91 million. AGA accepts that this is a typographical error and supports this amendment.

## 2.4 Rate of Return

19. The ERA proposes minor amendments to the rate of return section of its Final Decision.

20. AGA supports the ERA's amendment to extend the debt risk premium averaging window to 31 October. On 6 July AGA emailed the ERA requesting clarity on whether the averaging window should be a three or a four month period, as the Final Decision contained two different closing dates to the window; (30 September in paragraph 1700 and 31 October in paragraph 1533). The ERA's proposed amendment resolves this issue.

21. AGA has not been able to determine the relevance of the ERA's proposed amendment to footnote 591. If the ERA considers this amendment must be made, AGA requests the ERA includes explanation of the relevance and implications for the Final Decision on AGA's access arrangement.

22. AGA has no concerns regarding the ERA's proposed amendments to remove unnecessary wording and an incorrect table reference in paragraph 1711.

## 2.5 Depreciation

23. The ERA proposes to include additional paragraphs in support of its decision to reject adoption of historical cost accounting (HCA).

24. AGA considers it inappropriate for the ERA to rely on Part 2 r.7 of the *National Gas Access (WA) (Local Provisions) Regulations 2009* to justify its decision to reject HCA. Firstly, these clauses require the ERA to consider price impact on small use customers. They do not provide a mechanism for the ERA to maximise price decreases.

25. Though the transition to HCA approach would result in tariffs approximately 3% higher over the AA4 period than those that result from the CCA approach, the overall effect of the Final Decision would still result in price decreases, even if HCA was adopted. Therefore a transition to the HCA approach over the AA4 period in the context of the Final Decision does not result in price increases for small use customers compared to the AA3 period; it simply reduces the magnitude of the overall price **decrease**. Therefore the impact on small use customers is not significant.

26. Secondly, these provisions require the ERA to consider the impact resulting from the access arrangement it is currently approving or making. The regulations referred to do not direct attention to future regulatory periods, nor enable the ERA to make changes to the access arrangement for the coming regulatory period based on its view about future regulatory periods.

## 2.6 Haulage tariffs

27. The ERA proposes to correct a typographical error in table 122. AGA accepts that this is a typographical error and supports this amendment.

## 2.7 Haulage tariff variation mechanism

28. The ERA proposes several changes to the formulas for the haulage tariff variation mechanism. While AGA can understand what the ERA may be attempting to achieve via these formula amendments, AGA has identified a number of issues that arise as a result of these changes.

29. AGA supports the proposed changes to the haulage tariff variation mechanism for Tariff Class A1, A2, B1, B2 and B3 in the Final Decision. However, AGA requests that the ERA reviews the defined terms in section 1.3.1 of *Attachment 2 – Proposed revised haulage tariff variation mechanism* as there appears to be an error in the definition of $P_1^{ij}$.

30. AGA does not support the amendment to incorporate the cost pass-through within the tariff variation mechanism, rather than as a separate calculated process. While AGA understands combining the two

processes offers some convenience when it comes to calculating taxation and working capital impacts, it results in a mechanism that is overly complex and less transparent than having two distinct processes. AGA considers two separate, simpler processes would be easier and more informative for customers.

31. Combining cost pass-throughs in the tariff variation mechanism also raises timing issues for recovery of efficient costs. The tariff variation mechanism takes effect on 1 January of each year of the AA4 period. The variation must be lodged with the at least ERA 40 business days before this date (early November). However, pass-through events such as changes of law or new fees can occur at any point during the year. By limiting cost pass-throughs to single annual tariff variation mechanism, AGA will not have opportunity to recover these costs until the next scheduled tariff variation process.

32. A further consideration is how any cost pass-through events that occur during the final year of access arrangement period will be managed. The final tariff variation mechanism for the AA4 period takes effect on 1 January 2019 and must be lodged with the ERA in November 2018. If the cost pass-throughs are managed through this tariff variation process, there would be no way for AGA to recover costs associated with changes in law or new fees that occur between November 2018 and 31 December 2019.

33. Finally, given the proposed tariff variation formulas and the calculation of the X-factor component within the tariff model, it is not clear from the proposed amendment how cost pass-through items relating to a specific tariff class will be varied. It is also unclear whether the tariff variation mechanisms will allow correct allocation of cost pass-through items to the standing and usage components of tariffs.

## 2.8 Appendix 8: Automatic updating formulas for the return on debt.

34. The ERA proposes several amendments to the formulas for updating the return on debt. The amendments are designed to allow parties to replicate the bond yield approach for estimating the debt risk premium (DRP).

35. AGA welcomes the ERA's move towards a more transparent and replicable process. However, AGA is concerned that the automatic update outlined in paragraphs 18 to 45 of Appendix 8 is unnecessarily complex.

36. As previously submitted, AGA's preference would be to estimate the DRP using the RBA series, consistent with CEG's recommendation set out in its November 2014 report. The RBA series is publicly available, robust, relevant, and the best source of data for estimating the cost of debt. RBA data in the estimation of the DRP and annual update would be more transparent, easier to administer and better meet the requirements of NGR 87(12).

37. Nonetheless, AGA considers the ERA's revised formulas are an improvement on the Final Decision, and notes many of the proposed amendments reflect the recommendations of AGA's expert CEG, which were provided to the ERA on 10 August 2015[1]. However, AGA remains concerned that there are still errors in the ERA's annual update approach. These errors, as well as recommended solutions, are discussed in the memorandum from CEG provided in Appendix D[2], which forms part of this submission.

38. Further to the issues outlined above, it remains unclear whether it is AGA or the ERA's responsibility to calculate the annual update of the debt risk premium for the purposes of the tariff variation mechanism. If the ERA is to perform the update, then it is important the calculation can be verified by all parties and provided to AGA in a timely manner for inclusion in the annual tariff variation.

39. If AGA is required to perform the calculation, the ERA's bond yield approach requires access to a Bloomberg terminal. AGA does not currently have a Bloomberg subscription or staff adequately trained in its use, and would incur additional regulatory costs if these services were procured.

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1 See Appendix B: CEG, *Automatic annual updating, Dr. Tom Hird, August 2015.*

2 CEG, *ERA's proposed amendments to Final Decision - Cost of debt*, 27 August 2015.

40. This issue further supports the use of RBA data rather than the bond yield approach, as all parties would be able to produce and validate the annual update easily, without incurring additional costs.

## 2.9 Appendix 9: Modelling depreciation outcomes to 2080

41. The ERA proposes to remove an erroneous footnote 1157. AGA accepts that this is an error and supports this amendment.

42. The ERA proposes to amend Figure 29 and 31 of the Final Decision in order to correct the Weighted Average Cost of Capital (WACC) used in the analysis of depreciation. The ERA also proposes to amend Table 144 and Table 145 of the Final Decision to report the real 2014 dollars estimates of the estimated long run marginal costs used in the ERA's depreciation analysis.

43. On Monday 24 August 2015, the ERA provided AGA with its updated depreciation model underpinning the proposed amendments to the Final Decision. AGA and its expert advisors have had only three business days to consider this complex issue, and in that time have not been able to complete a review of the proposed amendments and the updated model. AGA will provide a supplementary submission and further analysis from its expert HoustonKemp on the amendments described in paragraph 42 above very shortly.

44. AGA remains concerned by errors observed in the ERA's analysis underpinning its depreciation schedule for the Final Decision. A copy of the 4 August 2015 expert report by HoustonKemp[3], which was provided to the ERA on 11 August 2015, is attached at Appendix C of this submission.

## 2.10 Appendix 10: Public reference tariff model

45. The ERA proposes several adjustments to the tariff model. AGA's position on each of these amendments is summarised below.

### 2.10.1 Express the time period 1 July 2014 to 31 December 2014 in days/365 rather than as a half year fraction when applying the rate of return in the building block

46. In its Final Decision the ERA the ERA used the parameter '0.5 years' to calculate the rate of return applicable to the period 1 July 2014 to 31 December 2014. In its letter to the ERA on 22 July 2015, AGA highlighted that to use a fraction of a year as the parameter rather than the actual number of days in that six-month period results in an understatement of revenue.

47. The ERA proposes to address this issue in the tariff model, expressing the parameter as days/365 rather than 0.5 years. AGA supports this amendment.

### 2.10.2 Remove six months of capital expenditure (1 January to 30 June 2000), which has been double counted in the initial tax asset base.

48. In its letter to the ERA on 22 July 2015, AGA highlighted that capital expenditure from 2000 included in the tax asset base was overstated by 50%. This is because AGA's tax asset base was established on 30 June 2000, meaning the capital expenditure for the period 1 January 2000 to 30 June 2000 had already been recorded.

49. The ERA recognises this error and proposes to remove the double count. AGA supports this amendment.

[3] HoustonKemp, *A note on the Authority's Final Decision on depreciation*, 4 August 2015.

### 2.10.3 Apply the same discount rate and inflation throughout the periods 1 January 2015 to 31 December 2015 to calculate tariff revenue; and to be consistent with the discount rate and inflation used in the building block revenue.

50. In its letter to the ERA on 22 July 2015, AGA advised that different discounting periods had been used for tariff revenue compared to building block revenue in the Final Decision. This means that the tariff and building block revenue in 2015 are not equal.

51. The ERA proposes to resolve this issue by applying an end of period assumption for tariff and building block revenue. AGA supports this amendment.

### 2.10.4 Add an amount for commercial meters that was erroneously deducted from the tax asset base.

52. The ERA proposes to increase the value of the initial tax asset base at 30 June 2000 and associated depreciation by including an amount for commercial meters.

53. AGA accepts that commercial meters may be included in the tax asset base, but only if the associated revenue from those meters and user specific charges are included as taxable revenue in the calculation of AGA's tax allowance in total revenue. To do otherwise is inconsistent.

54. It also appears that when amending its Final Decision, the ERA has not included commercial meters purchased after 30 June 2000 in the tax asset base nor the related tax depreciation in the calculation of the tax allowance.

55. The value of all commercial meters, associated tax depreciation and forecast user specific charges are included at rows 372 to 377 of the confidential tariff model sent to the ERA on 10 December 2014.

# 3. Outstanding items for consideration

56. On 7 July 2015 AGA met with the ERA's Secretariat to discuss a number of items that required clarification in the ERA's Final Decision. AGA followed up this meeting with formal correspondence on 22 July 2015, outlining the issues AGA brought to the ERA's attention. A copy of this correspondence is provided at Appendix A of this document.

57. While several of these items have been addressed in the ERA's consultation paper, there remain some outstanding issues. This section summarises the items that do not appear to have been addressed by the ERA in its proposed amendments to the Final Decision.

58. Where an issue has not yet been resolved, or no advice has been provided to date, AGA requests that the ERA addresses the issue in any amendment to the Final Decision / its publication of the final access arrangement.

## 3.1 Use of forecast revenue from 1 July to 31 December 2014

59. In its letter to the ERA on 22 July 2015, AGA highlighted that the ERA's Final Decision applied a **forecast** of tariff revenue for the period 1 July to 31 December 2014, despite the fact that **actual revenue** for this period had been provided to the ERA in February 2015.

60. AGA notes that the ERA used actual expenditure for the period 1 July to 31 December 2014 in its operating expenditure, capital expenditure and UAFG forecast.

61. AGA's actual revenue for the period is $3.628 million less than the forecast adopted by the ERA in its tariff model. This discrepancy results in forecast revenue from reference services over the access arrangement period not being equalised with total revenue allocated to reference services over the period, as required under National Gas Rule 92.

62. Unless this discrepancy is corrected over the remainder of the AA4 period, AGA is denied the opportunity to recover its efficient costs of providing reference services (as required by the revenue and pricing principles).

## 3.2 Cost pass-through for licence fees

63. Historically, the tariff variation mechanism provided that AGA can submit a cost pass-through for unforeseen costs. In its amendments to the access arrangement, AGA proposed that variations in licence fees payable to regulatory agencies such as Energy*Safety* and the ERA should be permitted as cost pass-throughs, as these costs tend to vary significantly and cannot be accurately forecast.

64. To support their inclusion as cost pass-throughs, in Table 6-23 of its response to the ERA's Draft Decision AGA provided a summary of historical licence fee costs. These values were provided as a placeholder so that any variations to be collected as a cost pass-through can be calculated. Table 6-23 was not designed to be a forecast of future licence fee costs.

65. In its Final Decision the ERA rejected the explicit inclusion of licence fees as a potential cost pass-through, instead pointing out (in paragraph 2322) that the tariff variation mechanism provides for recovery of licence fees due to a change of law. The ERA also considers that AGA should be able to accurately forecast regulatory costs, incorrectly concluding that Table 6-23 provides a reasonable estimate.

66. In its letter to the ERA on 22 July 2015, AGA highlighted that regulatory costs, including licence fees, often vary for reasons other than a change in law, and that the volatility of consultancy costs and other disbursements charged to AGA by regulatory agencies means that these costs cannot be accurately forecast.

67. For example, specific charges[4] invoiced by the ERA for the current access arrangement review are already $136,643 higher than the amount approved for 2015 in the ERA's Final Decision, with no amount provided for in 2016 to 2018. The most recent ERA invoice was issued on 17 August 2015. AGA expects there will be further specific charges invoiced as part of this ongoing access arrangement review, yet AGA has no reasonable way of forecasting these charges. AGA also notes that variations to the ERA's specific charges are not due to change in law; therefore under the Final Decision as it stands AGA is not able to recover these costs.

68. AGA has requested clarification of how changes in licence fees arising for reasons other than a change in law will be provided for in the access arrangement. The ERA has provided no advice on this issue to date.

## 3.3 Provision of operating and capital expenditure models

69. In its letter to the ERA on 22 July 2015, AGA requested a copy of the underlying spreadsheets that the ERA used to calculate forecast operating and capital expenditure by regulatory category. The purpose of the request was to allow AGA to reconcile any differences between the Final Decision text, tables and the tariff model, so it could fully understand which of AGA's proposed costs have and have not been included in the tariff revenue amount.

70. On 12 August 2015 the ERA responded by email, refusing to provide the spreadsheets. The ERA stated: *the Authority considers that the Final Decision provides sufficient detail for ATCO to understand the capital and operating expenditure calculations and numbers. The Authority will not be providing any additional material with regard to these items.*

71. However, the ERA's proposal to amend paragraph 380 of its Final Decision to disallow $2.1 million of corporate support expenditure it originally stated was approved, shows there are discrepancies between the ERA's Final Decision and the numbers in the underlying models.

72. Without the ERA's underlying expenditure models, it is not possible for AGA to verify that the tariffs comply with the National Gas Rules or are consistent with the ERA's Final Decision and reasons.

## 3.4 Cost pass-through mechanisms for security of supply

73. The ERA's Final Decision provides for a new cost pass-through event to allow AGA to recover any conforming capital or operating expenditure incurred as a result of addressing an intermediate security of supply risk.

74. This new pass-through event is a result of the ERA disallowing AGA's proposed capital expenditure to address security of supply risk in the northern network, Peel, Hillarys, Canning Vale, Fremantle and Lathlain. In the Final Decision, the ERA considers that the security of supply risk in these areas is 'intermediate' rather than the 'high' rating proposed by AGA and supported by the safety regulator Energy*Safety*.

75. The cost pass-through mechanism provides that AGA can recover capital expenditure to address the 'intermediate' supply risk in these areas, however no guidance is provided on how the 'intermediate' risk will be assessed or the authoritative body that will determine it.

76. If the network risk is to be determined by the ERA or its consultants, this has potential to cause a compliance issue if Energy*Safety* considers the network risk higher and issues an order that requires AGA to undertake greater levels of expenditure than allowed for in the access arrangement.

77. As this is a new and unprecedented cost pass-through event, in its 22 July 2015 letter AGA requested the ERA provides clarification on how the mechanism will work in practice. The ERA has provided no advice on this issue to date.

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[4] Specific charges are costs incurred by the ERA when conducting the access arrangement review, for example consultancy, advertising and legal fees. AGA is required to pay these fees.

# Appendix A :

## 22 July 2015 letter to ERA - Items requiring clarification in the Final Decision

Connecting WA to natural gas

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22 July 2015

Mr. Greg Watkinson
Chief Executive Officer
Economic Regulation Authority
Level 4, Albert Facey House
469 Wellington Street
Perth, WA 6000

Dear Mr Watkinson,

**RE: ITEMS REQUIRING CLARIFICATION IN THE FINAL DECISION**

On 7 July 2015, ATCO Gas Australia (AGA) met with the ERA's Secretariat to discuss errors and items requiring clarification identified in the ERA's Final Decision on Proposed Revision to the Access Arrangement for the Mid-West and South-West Gas Distribution Systems.

For the purpose of clarity, ATCO Gas Australia has outlined the items discussed and some additional items to be resolved as well as recommendations for addressing them in this correspondence.

This letter is provided to the Secretariat as a submission to assist the Authority in resolving issues in the Final Decision that have been highlighted by AGA, prior to the publication of the ERA's proposed revisions to the access arrangement pursuant to National Gas Rule 64.

We respectfully request the ERA responds to these items at its earliest convenience, in order to facilitate the development of an approved access arrangement within the time frames specified by the National Gas Rules. We welcome the opportunity to discuss any of these issues further.

Yours sincerely

S McMahon

**Sally McMahon**
**General Manager Commercial and Regulatory**

## Outstanding items for resolution

AGA has identified a number of issues and potential errors in the Final Decision, which AGA believes should be corrected prior to publication of the ERA's proposed revisions to the access arrangement. The following discussion outlines errors identified by AGA and discussed with the ERA to-date, as well as an additional request for the ERA's formula for obtaining raw data from Bloomberg for the purposes of calculating the cost of debt.

AGA has also identified several issues in the ERA's Final Decision version of the tariff model. These errors were not previously identified in AGA's response to the Draft Decision as they are result of changes to the modelling undertaken for the Final Decision.

### 1. AA3 conforming capital expenditure

The ERA has made an error in assuming the $0.65 million GIS enhancement project was included in Table 7-6 of the response to the Draft Decision, and that it was a double count.

As demonstrated in Table 51 of AGA's initial submission (March 2014), the GIS enhancement project is discrete from the GIS (ESRI) upgrade. In the initial submission, a total of $3.45 million was included for the GIS (ESRI) upgrade and GIS enhancement projects. This was broken into:

a) $2.8 million for GIS (ESRI) upgrade
b) $0.65 million for the GIS enhancement

Table 51 in the initial submission highlighted that capital expenditure on the GIS (ESRI) upgrade was $2.34 million higher than forecast and capital expenditure on the GIS enhancement was $0.2 million higher than forecast.

In paragraph 391 of the ERA's Draft Decision, the ERA said AGA had not provided evidence to justify the $2.34 million additional expenditure on the GIS (ESRI) upgrade (identified as (a) above) and therefore disallowed it from the opening capital base for the AA4 period. However, the ERA included the $0.65 million for the GIS enhancement project (identified as (b) above) in the opening capital base; therefore it is assumed to have been deemed efficient.

In its response to the Draft Decision, AGA provided evidence to justify the $2.34 million capital expenditure on the GIS (ESRI) upgrade, which the ERA had disallowed. This evidence was presented in Table 7-6 and paragraphs 531-554, and details the components of the $2.8 million GIS upgrade project only. AGA did not discuss or include the $0.65 million GIS enhancement project in its justification of the additional $2.34 million for the GIS (ESRI) upgrade, as it was a separate project and was assumed conforming capital expenditure in the Draft Decision.

Therefore the ERA has made an error when it states: *The Authority considers that the $0.65 million for the GIS enhancement project has been double counted as it is included in the $2.8 million as shown in Table 7-6*[1], as the GIS enhancement project was not considered at all in the Draft Decision response and the two projects have been treated entirely separately in AGA's proposal.

In the Final Decision the ERA notes that AGA's March 2014 submission contained $3.45 million for 2 GIS projects but its response to the Draft Decision only includes 4 business cases that add up to $2.8 million. Again, these four business cases were for the **GIS (ESRI) upgrade only**; the GIS enhancement had already been approved as conforming in the ERA's Draft Decision.

As a result, in making the Final Decision it appears the ERA has erred by assuming the $0.65 million for the GIS enhancement was a double count and has wrongly assumed the $2.8 million justified by AGA in its response to the Draft Decision represented the total value of GIS projects. As demonstrated above, the two projects have been treated separately by AGA and there is no double counting. The ERA has therefore made an error by concluding the $0.65 million was double counted and disallowing it from the AA4 opening capital base.

***Recommended action:***

- The ERA adds the previously-approved $0.65 million for GIS enhancements back into the AA4 opening capital base.

## 2. Use of forecast revenue from 1 July to 31 December 2014

In its Final Decision the ERA has applied a forecast of tariff revenue for the period 1 July to 31 December 2014. However, actual revenue for this period was available prior to the ERA making its Final Decision, and was provided in AGA's regulatory financial statements on 23 February 2015. AGA notes that the ERA has used actual expenditure in this period for forecasting operating and capital expenditure and UAFG.

AGA's actual revenue for 1 July to 31 December 2014 ($96.030 million) is $3.628 million less than the forecast used in the ERA's tariff model. This discrepancy will result in forecast tariff revenue not being equalised with forecast total revenue allocated to reference services.

In the absence of any mechanism allowing AGA to recover this discrepancy over the remainder of AA4, this will also result in AGA being unable to recover $3.628 million in revenue, which the ERA has determined is appropriate and recoverable pursuant to the National Gas Rules, and deprives AGA of the opportunity to recover its efficient costs of providing reference services (as required by the revenue and pricing principles).

[1] Paragraph 521, Final Decision.

***Recommended action:***

- The ERA applies AGA's actual tariff revenue for the period 1 July 2014 to 31 December 2015 in the revised access arrangement.

### 3. Tariff Model – use of actual information

In the modelling of the 1 July to 31December 2014 cost of service revenue, the ERA appears to have rounded the periods used for return on assets, NPV discount factors and inflation. That is, in order to measure the six-month period 1 July to 31 December 2014, the ERA has applied a year portion of 0.5 rather than the more precise actual of 184 days. This can be seen in the excel model provided to AGA in the 'CoS' tab rows 37 to 48. The effect of applying the portion of a year measure rather than the actual number of days in that six month period is an understatement of revenue.

***Recommended action:***

- The return on asset component of building block revenue, NPV discount factors and inflation should be calculated on the basis of 184 days consistent with the 184 days during the period 1 July to 31 December 2014.

### 4. Tariff Model - tax asset base

There is an error of fact in the calculation of the tax asset base. It appears that the capital expenditure incurred in 2000 and included in the tax asset base has been overstated by 50%. The tax asset base has been calculated as at 30 June 2000. Therefore, half of the capital expenditure for the regulatory year to 31 December 2000 is already in the opening tax asset base. As the tax asset base was established at 30 June 2000 it is an error to include a full year of capital expenditure for 1 January to 31 December 2000.

***Recommended action:***

- The ERA should remove six months of capital expenditure (1 January to 30 June 2000), which has been included in the tax asset base. This capital expenditure has already been incorporated into the opening tax asset base and results in a double count.

## 5. Tariff Model – equalisation of tariff and building block revenue

The ERA has implemented different discounting periods for tariff revenue compared to building block revenue. Therefore the tariff and building block revenue in 2015 are not equal. This is because the ERA has discounted and inflated the tariff revenue for the two periods January to September 2015 and October to December 2015 at different rates. However, the building block revenue has only been discounted or inflated at the rate for December 2015. This inconsistency is also present in the tariff variation mechanism, which inflates nominal tariff revenue to the end of period.

***Recommended action:***

- The ERA should be consistent in discounting or inflating both building block and tariff revenue, using an end of period assumption (cash flows received on 31 December), which is consistent with the timing assumptions applied elsewhere in the tariff model to ensure consistent assumptions necessary to achieve National Gas Rule 92(2).

## 6. Cost pass-through for licence fees

As noted by the ERA in paragraph 2322 of its Final Decision, the reference tariff variation mechanism allows for a cost pass-through of any change to licence fees as a result of a change in law. However, the ERA considers AGA should be able to forecast licence fees accurately and has removed AGA's proposed explicit inclusion of variations in regulatory costs (which include licence fees) from the cost pass-through mechanism.

It is not possible to provide a reasonable forecast of licence fees, as AGA does not have visibility of these costs until it is invoiced by the relevant agency. The most extreme example of this is the "specific charges" that AGA may be required to pay under regulation 6 of the *Economic Regulation Authority (National Gas Access Funding) Regulations 2009*. These include the costs of consultants or contractors engaged by, and other disbursements incurred by, the ERA (including during the access arrangement review process), which AGA has no control over and no reasonable way of forecasting.

The summary of historical licence fee costs submitted by AGA during the access arrangement review process was provided as a placeholder for future costs on the basis that variations would be passed through via the proposed cost pass-through mechanism. The values provided in Table 6-23 of AGA's response to the Draft Decision were not designed to be a reasonable estimate of future costs and therefore the ERA has erred in adopting these values as the forecast for licence fees.

It is likely that licence fees during the period will vary from the amount provided for by the ERA in the Final Decision. While the reference tariff variation mechanism provides for variance in fees resulting from a change in law, licence fees have been shown to vary for a variety of reasons.

AGA would like clarification from the ERA on how changes in licence fees arising for reasons other than a change in law will be provided for in the access arrangement, to the extent AGA is not able to reasonably forecast costs which are efficient, prudently incurred and outside of its control.

***Recommended action:***

- The ERA reinstates recovery of licence fees into the cost pass through component of the reference tariff variation mechanism for the AA4 period.

## 7. Explicit inclusion of tax in cost pass-through mechanisms

Required Amendment 14 states that if a cost pass through event occurs AGA can recover only the *…direct conforming operating expenditure and depreciation of and return on direct conforming capital expenditure incurred or forecast to be incurred...*

Given that the National Gas Rules now state we operate in a nominal post-tax framework it would be appropriate to explicitly state that the cost pass-through should also include a corresponding amount for the tax building block.

***Recommended action:***

- The ERA should include wording in the revised access arrangement that explicitly provides for cost pass-throughs to include an amount for the tax building block component.

## 8. Tariff variation mechanism – Annexure B of the proposed revised access arrangement, section 1.3.1, tariff classes A1, A2 and B1

AGA has identified a number of errors with the proposed tariff variation mechanism. The equations presented in section 1.3.1 of Annexure B of the proposed revised access arrangement[2] appear to be a price cap that is constrained by a revenue cap, which works only in the one direction. The second of the two formulas presented is asymmetric, where prices can fall if quantities increase but prices cannot rise if quantities fall.

No explanation has been provided for the application of the asymmetric revenue cap constraint and it is inconsistent with the price cap form of control outlined in the ERA's decision.

[2] Paragraph 2329, Final Decision.

***Recommended action:***

- The ERA modifies the tariff variation mechanism so that it gives effect to the form of control outlined in the ERA's decision[3].

## 9. Tariff variation mechanism – Annexure B of the proposed revised access arrangement, section 1.3.1, tariff class B3

AGA is concerned that the current specification of the B3 tariff variation mechanism is overly complicated and will not work in practice. In particular AGA is concerned that the specification of $Q^j$ into a measure for the first 2GJ, next 8GJ and next 5GJ is unnecessarily complex and will not be easily implementable at each annual tariff variation.

***Recommended action:***

- It is recommended that the ERA undertake comprehensive modelling to test whether this tariff variation mechanism will work in practice[4].

## 10. Provision of operating and capital expenditure models

AGA acknowledges that for the purpose of calculating the return on assets and depreciation, the ERA has presented the total Final Decision capital expenditure by asset class.

AGA requests access to the underlying spreadsheets for capital and operating expenditure by regulatory category. This will enable AGA to review the reductions for capitalised overheads and labour cost escalation and address differences between the Final Decision text, tables and tariff model. For example, AGA considers that the $2.1 million (divided over 2014 and 2015) and $2.4 million (divided over 2018 and 2019) for preparation costs of the revised access arrangements has not been included in the Corporate Support costs forecast. While paragraph 380 of the Final Decision is clear that these costs have been incorporated into the ERA's forecast, this is not observable from the tables included in the Final Decision.

***Recommended action:***

- The Secretariat provides AGA the Microsoft Excel files that contain the ERA's forecast operating and capital expenditure for the AA4 period.
- The ERA ensure that the preparation costs for revising access arrangements are included in the corporate support costs as outlined in the Final Decision.

---

[3] The ERA may wish to refer to the mechanisms in Jemena's Access Arrangement as a cross-check of the formulaic interpretation of the tariff variation mechanism. Please see the relevant extract which is attached to this correspondence.
[4] It is also recommended that the ERA consider Jemena's Access Arrangement as a cross-check of the formulaic interpretation of the tariff variation mechanism. Please see the relevant extract which is attached to this correspondence.

## 11. Provision of depreciation model

In its Final Decision the ERA has defined an adjustment for inflationary gain as a sub-component of the depreciation revenue block and applies the AER's PTRM approach to depreciation. AGA observes that the conclusions made by the ERA do not necessarily follow the analysis presented and would like to better understand the analysis the ERA has relied on in its decision.

AGA requests that the ERA provides AGA the models that support the depreciation analysis in the Final Decision. These models were previously provided to AGA following the ERA's Draft Decision.

These models will enable AGA to review the analysis undertaken by the ERA in relation to the long run marginal cost and changes in prices and revenue that has been relied upon in the ERA's decision in regard to depreciation.

***Recommended action:***

- The Secretariat provides AGA the Microsoft Excel files that support the ERA's depreciation analysis in the Final Decision; and
- The Secretariat provides AGA the ERA's analysis on change in prices and revenue.

## 12. Cost pass-through mechanism for security of supply

In paragraph 2325 of the Final Decision, the ERA considers a new pass through-event 3.1(e) should be provided to allow AGA to recover any conforming capital expenditure or conforming operating expenditure as a result of addressing an 'intermediate' security of supply risk. This new cost pass-through event is a result of the ERA rejecting proposed sustaining capital expenditure on the following areas of the network: Northern Network, Peel, Hillarys, Canning Vale, Fremantle and Lathlain.

AGA requests clarification from the ERA on how the mechanism will work in practice.

AGA understands that the ERA's assessment of 'intermediate' risk is based on consideration of Australian Standard 4645 (AS 4546). It therefore follows that for the ERA to approve costs submitted for pass-through under this mechanism, the expenditure would have to be assessed as 'intermediate' against AS 4546.

Can the ERA confirm the process it will undertake for determining satisfaction of AS 4546 and whether it will conduct the risk assessment itself, seek input from Energy*Safety* or seek advice from a technical expert?

Determination of risk under AS 4645 has been historically the domain of the safety regulator Energy*Safety.* Can the ERA confirm how the cost pass-through mechanism will be applied

should Energy*Safety* remain of the view that the risk is high, and issues an order for AGA to undertake the proposed expenditure?

***Recommended action:***

- The ERA clarifies the process for determining risk and assessing expenditure under pass-through event 3.1(e); and
- The ERA clarifies how the expenditure could be passed through where it is required to be undertaken as a result of an order from Energy*Safety*.

# 3 Reference Tariff variation mechanism

## 3.1 Initial Reference Tariffs

(a) The Initial Reference Tariffs for the Reference Service are set out in the Initial Reference Tariff Schedule. These will apply on and from the Effective Date, until varied in accordance with this clause 3.

(b) The Service Provider may vary Reference Tariffs at any time during the Access Arrangement Period with the approval of the AER in accordance with this clause 3. Such variations may be effected through:

(i) Reference Tariff components, elements or variables comprised within any Reference Tariff;

(ii) the introduction of a new Reference Tariff (to apply in place of any pre-existing Reference Tariff);

(iii) the withdrawal of any Reference Tariff; or

(iv) any combination of these changes.

## 3.2 Annual Reference Tariff variation mechanism: Haulage Reference Tariffs

(a) Where the Service Provider proposes to vary Reference Tariffs to apply from the start of the next Financial Year, the mechanisms set out below will apply.

(b) The Service Provider may propose to vary Reference Tariffs consistent with the following tariff basket price control formula:

$$(1+CPI_t)(1-X_t)(1+A_t)(1+PT_t) \geq \frac{\sum_{x=1}^{n}\sum_{y=1}^{m} p_t^{xy} q_{t-2}^{xy}}{\sum_{x=1}^{n}\sum_{y=1}^{m} p_{t-1}^{xy} q_{t-2}^{xy}}$$

and rebalancing side constraint formula, for each Reference Tariff:

$$(1+CPI_t)(1-X_t)(1+A_t)(1+PT_t)(1+0.1) \geq \frac{\sum_{x=1}^{n}\sum_{y=1}^{m} p_t^{xy} q_{t-2}^{xy}}{\sum_{x=1}^{n}\sum_{y=1}^{m} p_{t-1}^{xy} q_{t-2}^{xy}}$$

where the Service Provider has *n* Reference Tariffs, which each have up to *m* tariff components, and where:

$t$ is the Financial Year for which the tariffs are being set;

$p_t^{xy}$ is the proposed tariff for component *y* of Reference Tariff $x$ in Financial Year *t*, i.e. the new tariff to apply from the commencement of Financial Year *t*;

$p_{t-1}^{xy}$ is the tariff for component *y* of Reference Tariff $x$ that is being charged at the time the Variation Notice is submitted to the AER for assessment;

$q_{t-2}^{xy}$ is the quantity of component *y* of Reference Tariff $x$ that was sold in Financial Year *t-2;*

$CPI_t$ means:

(i) for the Financial Year beginning 1 July 2014 and ending 30 June 2015, 1.72 per cent;

(ii) for Financial Years beginning after 30 June 2015:

(A) the CPI for the December Quarter immediately preceding the start of the relevant Financial Year; divided by

(B) the CPI for the December Quarter immediately preceding the December Quarter referred to in paragraph (i);

minus one,

provided that if the Australian Bureau of Statistics does not, or ceases to, calculate and publish the CPI, then in this Access Arrangement CPI will mean an inflation index or measure agreed between the AER and the Service Provider;

$X_t$ means the $X$ factor for each Financial Year, determined in accordance with the JGN Revenue Model, updated for the return on debt in accordance with section 5;

$A_t$ is the automatic adjustment factor calculated in accordance with Schedule 3; and

$PT_t$ is the Cost Pass Through factor calculated in accordance with Schedule 3.

### 3.3 Intra-year Reference Tariff variation mechanism

The Service Provider can propose to vary Reference Tariffs during a Financial Year to apply at a date prior to the start of the next Financial Year, including for the purposes of passing-through an amount relating to a Cost Pass Through Event, as long as the Service Provider complies with the tariff basket price control formula set out in clause 3.2(b), and making such adjustments as necessary to vary the Reference Tariff for the remainder of the Financial Year.

### 3.4 Cost pass through

**Cost Pass Through Events**

(a) The following are Cost Pass Through Events:

(i) Terrorism Event;

(ii) Natural Disaster Event;

# Appendix B :

## CEG - Automatic annual updating, Dr. Tom Hird, August 2015

Connecting WA to natural gas

ATCO Gas AUSTRALIA

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10 August 2015

Mr Greg Watkinson
CEO
Economic Regulation Authority
Level 4, Albert Facey House
469-489 Wellington Street
Perth, WA 6000

Dear Mr Watkinson,

**RE: RESPONDING SUBMISSION TO ERA FINAL DECISION- RETURN ON DEBT**

I refer to our previous correspondence in relation to the ERA's Final Decision on Proposed Revisions to the Access Arrangement for the Midwest and Southwest Gas Distribution System.

In addition to the matters noted in our letter of 22 July 2015, ATCO Gas Australia (AGA) and its consultant CEG have given further consideration to the ERA's Final Decision in relation to the return on debt and in particular the use of the ERA's bond yield approach for the purposes of the annual update of the return on debt.

In the Final Decision, the ERA proposes to use its bond yield approach in the following ways:

- To estimate 25% of the July 2014 to June 2015 DRP estimate to be used in the 10 year trailing average DRP for the 2014-2015 financial year (with the prior years in the 10 year trailing average and 75% for the 2014/2015 year estimated as the simple average of RBA DRP estimates)
- To estimate 75% of the January to December 2015 DRP estimate to be used in the 10 year trailing average DRP for the 2015 calendar year (with the prior years in the 10 year trailing average and 25% for the 2015 year estimated as the simple average of RBA DRP estimates)
- For the purposes of the annual update to the DRP from 2016 onward.

In its submission in response to the Draft Decision, AGA set out its concerns with the ERA's bond yield approach, in particular that it does not result in a reliable estimate of the prevailing cost of debt because it is not a transparent or replicable process.[1]

For the reasons set out in the enclosed report from CEG, the lack of transparency and replicability of the ERA's bond yield approach persists in the Final Decision.

In particular, AGA is concerned that the ERA's annual update of the return on debt using its bond yield approach set out in the Final Decision does not comply with National Gas Rule 87(12). That Rule requires that if the return on debt is to be estimated using a methodology which results in the return on debt being different for each regulatory year (as is the case here), then:

*"a resulting change to the service provider's total revenue must be effected through the automatic application of a formula that is specified in the decision on the access arrangement for that access arrangement period."*

In its Final Rule Determination the AEMC made the following comment in respect of the new NGR 87(12):

"*The formula for calculating the updated return on debt must be specified in the regulatory determination or access arrangement and must be capable of applying automatically."*[2]

CEG have identified in the enclosed report that, in a number of respects, the ERA's bond yield approach to updating the trailing average DRP in future averaging periods involves the exercise of discretion or judgment by the ERA. It follows that the ERA's proposed method for annually updating the return on debt and AGA's total revenue is not effected through the *automatic application* of a formula specified in the decision as required by Rule 87(12).

As CEG point out, the simplest way to resolve this issue would be to estimate the DRP using the RBA series consistent with AGA's previous submissions and CEG's recommendation set out in its November 2014 report. Alternatively, CEG has identified in the enclosed report steps that could be taken to ensure that the ERA's methodology is more transparent and unambiguous. However, for the reasons set out by CEG, that approach would still not result in a method for estimating the DRP that would be as reliable and transparent as using the RBA data series, which remains the best approach.

This letter and the enclosed CEG report are provided to the ERA as a submission in response to the ERA's Final Decision.

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[1] See AGA response to the ERA's Draft Decision, section 9.2.5 and CEG *Cost of debt consistent with the NFR and NGL*, November 2014

[2] Final Rule Determination, November 2012, page 91.

I invite the ERA to contact AGA should any further information or clarification be required to assist in the completion of the review process and the release of the access arrangement decision.

Yours sincerely,

pp.

**Sally McMahon**
**General Manager Regulatory**

COMPETITION ECONOMISTS GROUP

# Automatic annual updating

Dr. Tom Hird

August 2015

COMPETITION ECONOMISTS GROUP

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# 1 Overview

1. The ERA has nominated to use its "bond yield approach" for updating the trailing average DRP starting in 2015 (using the 20 days ending 2 April 2015 to contribute to the 2015 cost of debt) and in future averaging periods to update the cost of debt for each regulatory year. This approach involves elements of judgement or discretion, as set out in section 2, and we are of the view that the approach, as currently set out by the ERA in its final decision, does not constitute the automatic application of a formula in the manner envisioned by 87(12) of the National Gas Rules (NGR):

> *If the return on debt is to be estimated using a methodology of the type referred to in subrule (9)(b) then a resulting change to the service provider's total revenue must be effected through the automatic application of a formula that is specified in the decision on the access arrangement for that access arrangement period.*

2. The simplest way to resolve this would be to simply rely on the RBA series consistent with our advice that the RBA was a suitable source of information for the purpose of estimating the cost of debt.[1] The RBA data is transparent and could be used to provide an automatic update of the return on debt consistent with NGR 87(12).

3. If the ERA is to continue with its bond yield approach, section 5 suggests steps that could be taken to make aspects of the ERA's bond yield approach more transparent and unambiguous. An approach for estimating Gaussian kernel, Nelson-Siegel and Nelson-Siegel-Svensson curves that can be effected without the use of judgement in section 3. However, as discussed in section 4, we consider that there is a trade-off between the degree of automaticity in Nelson-Siegel and Nelson-Siegel-Svensson curve-fitting and the certainty of obtaining solutions that are reasonable.

4. Additionally, while the implementation of the Gaussian kernel is, in a strict mathematic sense, the application of a formula (once the input data have been collected), Nelson-Siegel and Nelson-Siegel-Svensson curve-fitting involves using algorithms to solve for parameters in the Nelson-Siegel and Nelson-Siegel-Svensson formulae which are then used to calculate a 10 year yield. The process of solving for parameters cannot be mathematically described as the "application of a formula".

5. We therefore consider it preferable to rely on the RBA series to update the DRP.

[1] CEG, *Cost of debt consistent with the NGR and NGL,* November 2014, p. 63.

# 2 ERA approach is not formulaic

6. Table 1 sets out areas where the ERA's approach cannot reasonably be described as "formulaic" and cannot be applied in future periods without exercising discretion. Where possible, we suggest possible solutions to these issues.

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## Table 1: Non-formulaic/ambiguous aspects of the ERA's methodology

| | Issue | Description |
|---|---|---|
| Benchmark sample | Credit ratings Bloomberg field | The ERA has not specified which Standard and Poor credit rating field in Bloomberg it will rely on. We have used the credit rating of the bond (SP_RTG) to replicate their sample. However, we could have used the credit rating of the issuer (of which there are two one for domestic currency and one for foreign currency) or S&P's long term credit rating. |
| | Timing of criteria | The averaging period the ERA will use to update the cost of debt for each regulatory period will be 20 days long. During this time, bonds may be up- or down-graded, called, or go from having more than 2 years' to less than 2 years' remaining maturity. The ERA has not specified whether the ratings, called and minimum 2 years' maturity criteria apply at the beginning, end or on each individual day of the averaging period.<br>The ERA has not specified how it excludes called bonds. If the ERA uses the "was called" field in Bloomberg's search function then any bonds that were called before the search date (including on any dates during or after the averaging period) will be excluded. Consequently, if the bond search is undertaken after the end of the averaging period then bonds that have been called after the end of the averaging period could potentially be excluded. Whether this would be done is currently ill-defined. |
| | Minimum 50% observations requirement | Additionally, the ERA explicitly states it will exercise judgment to decide whether to include the minimum 50% observations requirement in future periods. The ERA specifies that:[i]<br>The Authority notes that there is a tendency for fewer bonds to be available on the long end of the yield curve. If circumstances arise where this criterion results in a paucity of bonds such that curve fitting is impractical the Authority may exercise judgement to determine whether exclusion of bonds based on this criterion is appropriate. |
| Sourcing yields | Formula not set out | The ERA does not set out a formula or sufficient details to affect its approach to convert yields into AUD equivalents. We have made significant efforts to replicate the ERA's approach for converting foreign-denominated bonds into fully hedged fixed rate Australian dollar yields, but have been unsuccessful.<br>The ERA claims that its approach is:[ii]<br>*transparent and replicable – anyone with access to a Bloomberg terminal can enable the functionality [sic: and] will get the same hedged Australian dollar equivalent yield for any given bond, provided they use the same date, currency, payment frequency and deal type…*<br>However, Bloomberg's "Swaps Toolkit (beta)", relied on by the ERA, can only be accessed using a Bloomberg Anywhere account. Contrary to the ERA's claim, not all Bloomberg terminals can access this functionality.<br>Nevertheless, even after we have accessed the "Swaps Toolkit (beta)" functionality using Bloomberg Anywhere, we have still not been able to replicate the ERA's yield curves despite extensive liaison with Bloomberg Helpdesk and Bloomberg representatives. The ERA has not set out its precise Excel formula and the various Bloomberg overrides that it might have used for obtaining the asset swap spreads. Footnotes 1128 and 1129 of the Final Decision do make reference to two overrides for the "BPRICE" formula and one |

| | | |
|---|---|---|
| | | override for the "BView" formula. We have engaged an expert from Bloomberg's Fixed Income Desk, and we note that the expert's spreadsheet made reference to a "BSTRUCTURE" function in the Excel command that calls the Bloomberg Swap Manager functionality. This function was not referenced in the Final Decision. |
| Curve-fitting: Gaussian kernel | Adjusting target tenor | The ERA selects a target tenor such that it estimates a value for an effective tenor of exactly 10 years.[iii] The effective tenor differs from the target tenor because of asymmetry in the distribution of maturities in the bond sample. It would not be possible to define a target maturity associated with an effective maturity of exactly 10 years if there were no bonds with at least 10 years to maturity. Based on the RBA's sample selection criteria (which are similar to the ERA's) this has occurred in 10 months since January 2005 (most recently in 2007).<br><br>The impossibility of implementing the ERA's method to obtain a 10 year effective maturity in this circumstance reflects the fact that the effective maturity is the weighted average maturity of the full sample. Clearly, the weighted average maturity cannot be higher than the highest maturity in the set. The ERA has not specified its approach in such a scenario and would have to apply judgement as to how to proceed if this were to occur in future averaging periods. |
| | Yields vs spreads | The ERA has not made it clear whether it applies the Gaussian kernel methodology to bond yields or to debt risk premiums. Rather than describing its own methodology, the ERA refers to its description of the RBA's Gaussian kernel approach which, as noted by the ERA in the formula in paragraph 1562, is applied at average debt risk premiums.[iv] On the other hand, the Gaussian kernel results reported by the ERA suggest that the ERA applied its Gaussian kernel approach to hedged Australian dollar yields.[v] Additionally, the ERA states that one step in estimating the regulated debt risk premium in its bond yield approach is to:[vi]<br><br>*"estimate yield curves on the 20 day averages of the Australian dollar yield data applying the Gaussian Kernel, Nelson-Siegel and Nelson-Siegel-Svensson techniques"* |
| Curve-fitting: NS and NSS | Method not set out | Nelson-Siegel and Nelson-Siegel-Svensson methods fit curves of a particular form through bond data by minimising the sum of squared errors. The approach requires a program that can solve for the parameters that minimise the sum of squared errors. The ERA has not specified what program it has used and will use in future periods to conduct this analysis.[vii] It has also not detailed settings applied, e.g. starting values or parameter windows. Our analysis suggests that the choice of starting values can have considerable impact on parameter estimates and the overall shape of the curve (see section 2.2). |
| | Yields vs spreads | As with the Gaussian kernel, the ERA is inconsistent on whether it fits NS and NSS curves to bond yields or spreads. Various descriptions of the approach[viii], as well as the curve-fitting results reported by the ERA suggest that the ERA applied curve-fitting on hedged Australian dollar yields. However, the formulae setting out the parametric forms for the NS and NSS methodology specify *"the term structure of the DRP"*, with the credit spread and time to maturity of each bond specified as the inputs.[ix] Indeed in a single paragraph the ERA inconsistently refers to fitting yield curves through debt risk premium data:[x]<br><br>*The Nelson-Siegel methodology uses observed data from the bond market to estimate the parameters $\beta 0t$, $\beta 1t$, $\beta 2t$, $\lambda$ by using the observed debt risk premium and maturities for bonds. With the estimated parameters $\beta 0t$, $\beta 1t$, $\beta 2t$, $\lambda$, a yield curve is produced by substituting these estimates into the above equation and plotting the resulting estimated debt risk premium $\hat{y}(\tau)$ by varying the maturity $\tau$. $\hat{y}(\tau)$ has the interpretation of being the estimated debt risk premium for a benchmark bond with a maturity of $\tau$ for a given credit rating.* |

[i] ERA Final Decision, p. 339.

[ii] ERA Final Decision, p. 341.

[iii] ERA Final Decision, p. 332.

[iv] ERA Final Decision, pp. 329, 337, 678.

[v] ERA Final Decision, pp. 682, 683.

[vi] ERA Final Decision, p. 679.

[vii] In our report (CEG, *Cost of debt consistent with the NGR and NGL,* November 2014, p. 74) we specified the approach we used to conduct NS and NSS curve-fitting, including the program and method for choosing starting parameters (which involved using judgement):

> *The ERA did not specify the details of its methodology for curve fitting. For both Nelson-Siegel and Nelson-Siegel-Svensson curve-fitting, I relied on the solver function in Excel to minimise the sum of squared errors between the fitted values and the bond spread observations. This function requires starting values as inputs. I used the multistart function combined with sense-checking to develop starting values.*

[viii] ERA Final Decision, pp. 344, 679 and 684.

[ix] ERA Final Decision, pp. 337, 338, 678, 679.

[x] ERA Final Decision, p. 678.

## 2.1 Adjusting target tenor for Gaussian kernel

### 2.1.1 Not formulaic in certain circumstances

7. The ERA selects a target tenor such that it estimates a value for an effective tenor of exactly 10 years.[2] The effective tenor differs from the target tenor because of asymmetry in the distribution of maturities in the bond sample. However, this will not be possible if there are no bonds with at least 10 years to maturity. Based on the RBA's sample selection criteria (which are similar to the ERA's) this has occurred in 10 months since January 2005 (most recently in 2007).

8. The impossibility of implementing the ERA's method to obtain a 10 year effective maturity in this circumstance reflects the fact that the effective maturity is the weighted average maturity of the full sample. Clearly, the weighted average maturity cannot be higher than the highest maturity in the set. The ERA has not specified its approach in such a scenario and would have to apply judgement as to how to proceed if this were to occur in future averaging periods.

9. Consequently, at a minimum, the ERA would need to specify its approach in this eventuality.

### 2.1.2 Economic issues

10. There are also potentially undesirable properties of the ERA's approach in some bond samples; even where there is one or more bonds with maturity above 10 years. That is, even where the ERA's approach is mathematically possible it may not be economically desirable. This issue applies to the bond yield approach in the initial as well as the update periods.

11. The ERA applies the Gaussian kernel method to fitting a curve through its bond data. This approach assigns weight to each observation based on a Gaussian (normal) distribution centred at the target tenor. As stated by the ERA:[3]

> *The RBA notes that this method recognises that the observed spreads on bonds with residual maturities close to the target tenor contain more information about the underlying spread at that tenor than spreads on bonds with residual maturities further away.*

[2] ERA Final Decision, p. 332.

[3] ERA Final Decision, pp. 328-29.

12. The ERA selects a target tenor such that it estimates a value for an effective tenor of exactly 10 years.[4] The effective tenor differs from the target tenor because of asymmetry in the distribution of maturities in the bond sample. This:

    - gives higher relative weight to bonds near the determined target tenor than with close to 10 years' tenor; and
    - may result in a high relative weight being given to a single bond or a small set of bonds, depending on the distribution of bonds.

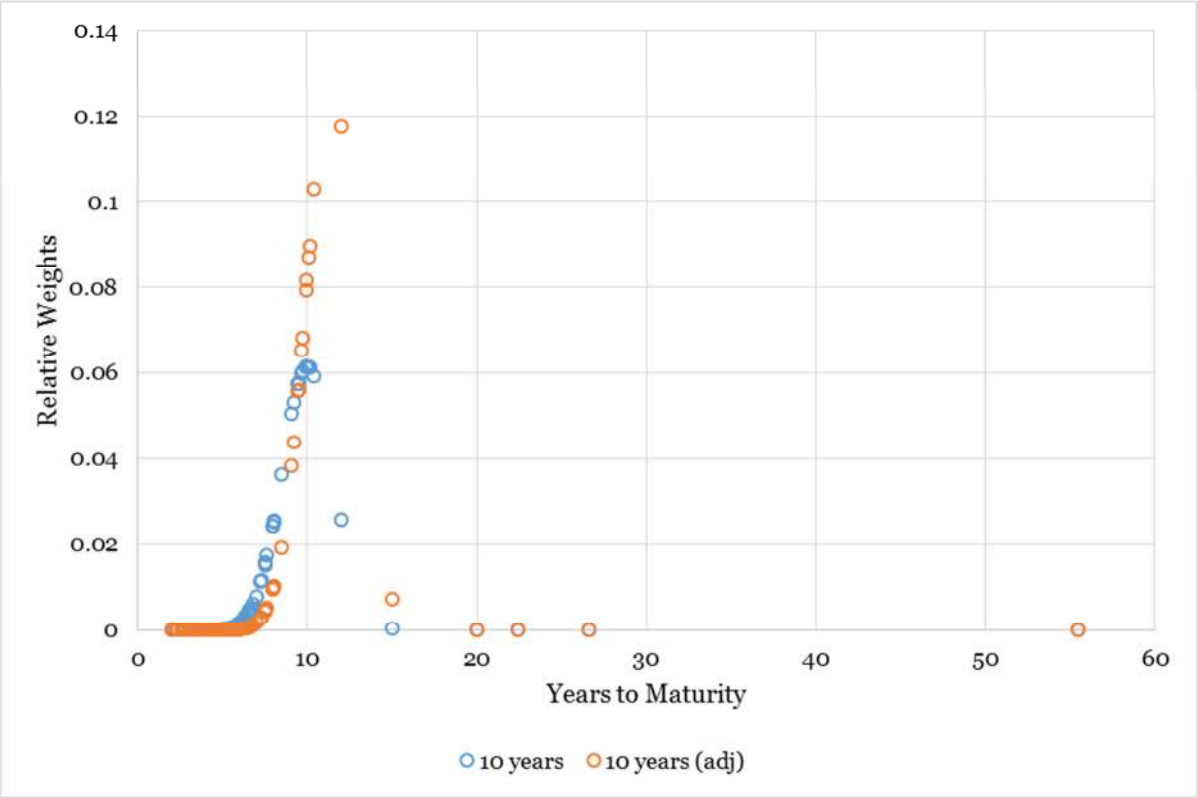
13. In the 2 April 2015 averaging period, the ERA's approach involved setting a target tenor higher than 10 years. Figure 1 shows the relative weights applied to bonds in the bond set applying a target tenor of 10 years and a higher target tenor associated with an effective tenor of 10 years (10 years (adj)). The Gaussian kernel with a 10-year target produces relative weights that peak at 10 years. On the other hand, the relative weights with an effective tenor of 10 years have a peak at 11.4 years, which is equal to the corresponding target tenor.

14. Under the latter approach, a bond with a residual maturity of 11.97 years is given more weight than a bond with a residual maturity of 9.97 years, which is arguably contradictory to the principle behind the approach which is to give the most weight to bonds with maturities closest to the maturity of interest.

15. Figure 1 also shows that under the ERA's approach, a single bond (with a time to maturity of 11.97 years) was given close to 12% relative weight. This is double the weight given to that bond when a 10-year target tenor is used (6%).

4 ERA Final Decision, p. 332.

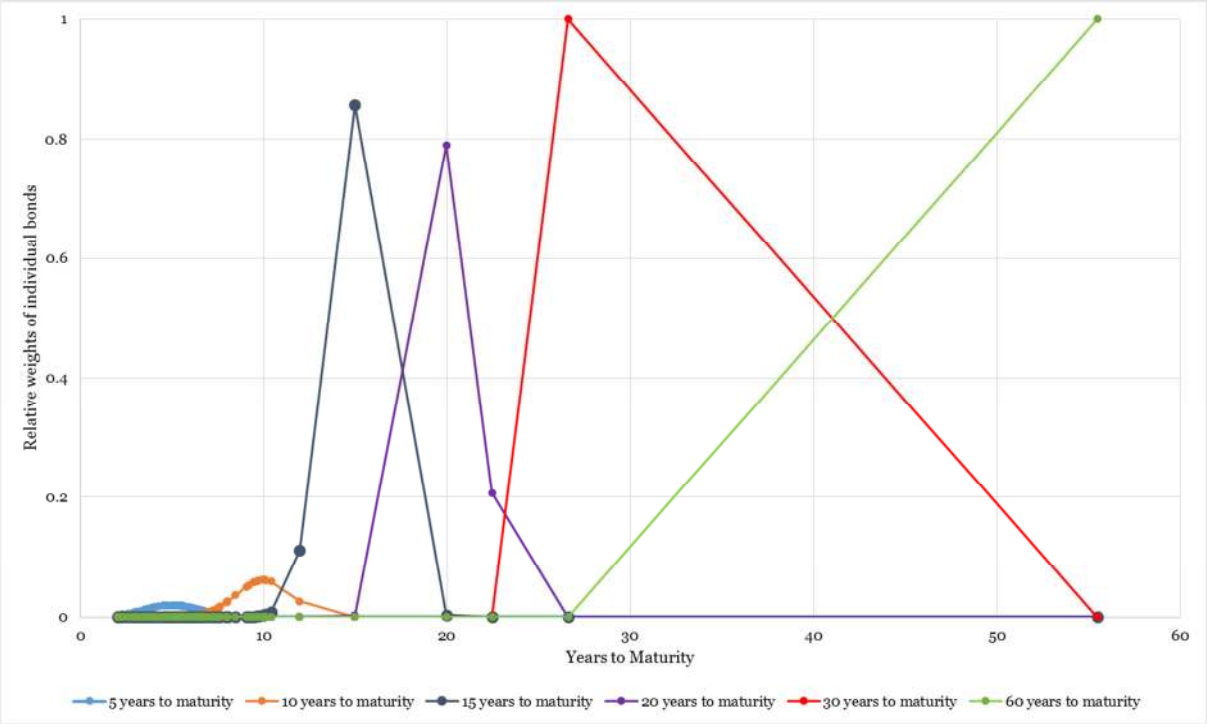
**Figure 1: Gaussian kernel relative bond weights**




*Source: CEG analysis*

16. It is also worth noting that even with bonds of greater than 10 years in the sample, the ERA's approach can give rise to very peculiar weightings. Figure 2 shows the relative weights that individual bonds in the ERA's sample would receive as the target tenor increases. It can be seen that the individual weights attributed by the Gaussian kernel becomes highly volatile as the target tenor shifts towards an interval that contains very few bonds. In particular, when the target tenor reaches 15 years and above, the Gaussian kernel approach places extremely high weight on only one or two bonds. As seen in Figure 2, the interval from 15 years to maturity and above only has one bond for each increment of approximately five years.

## Figure 2: Relative weights given to bonds in the bond set at different target maturities



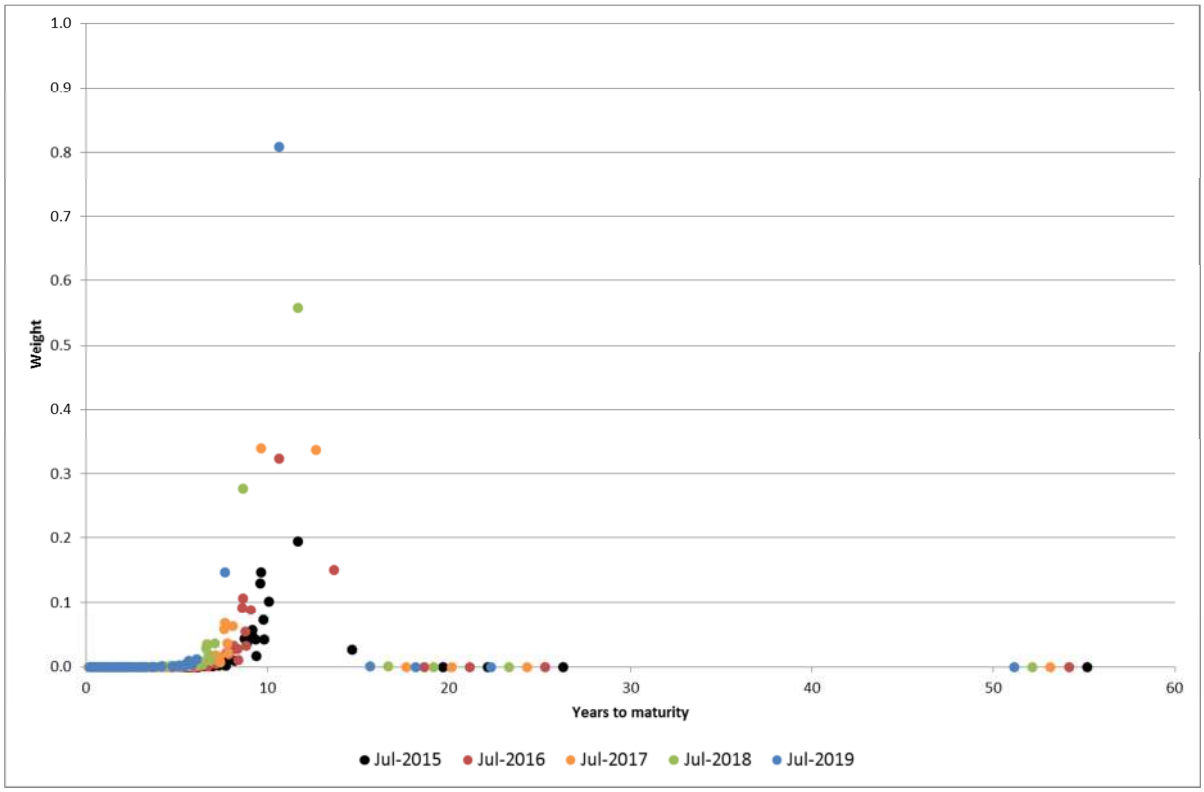

*Source: Bloomberg, CEG analysis*

17. While the distribution of weights for the adjusted 10-year curve shown in Figure 2 might look relatively normal, the future distribution of the sample is unknown, and the ERA's approach of adjusting the target tenor to produce an effective tenor of 10 years runs the risk of placing disproportionate weight on a small segment of its bond sample.

18. The ERA's approach of increasing the target tenor also may result in close to 100% weight being given to a single bond, depending on the distribution of bonds. Consider, for example, the weights that would be assigned in July of each year if the bond sample remained constant from July 2015, except for bonds dropping out as they mature.[5] Figure 3 shows the weights that would be assigned to each bond based on the issue amount and distance from the target tenor, according to the Gaussian distribution. The target tenor is set for each sample such that the effective tenor equals 10 years, as per the ERA's bond yield approach. The figure shows that a large amount of weight would be assigned to a small number of bonds in future years under this scenario. For example, in July 2016, 47% of total weight would be assigned to just two bonds. Over 80% of the total weight in July 2019 would be assigned to a single bond.

5 The bond sample in Figure 3 is based on the ERA criteria, as at 24 July 2015.

**Figure 3: Gaussian kernel bond weights over five years**




*Source: Bloomberg, CEG analysis*

### 2.1.3 Alternative approach

19. As set out in Table 1 above, there are implementation and economic issues associated with the ERA's approach of adjusting the target tenor for the Gaussian kernel analysis. The ERA could resolve these issues by always setting the target tenor to 10 years and extrapolating the yield, which may be associated with an effective tenor of less than 10 years, using the approach set out in section 3.1 below.[6]

20. At the very least, the ERA needs to specify the approach it will take in the case that there are no bonds with at least 10 years' maturity (in which case the target tenor is undefined under its approach). The ERA could specify that if there are no bonds with at least 10 years' residual maturity, the target tenor will be set at 10 years and

[6] This approach was set out in CEG's report for the purpose of extrapolating Bloomberg and RBA curves. CEG, *Cost of debt consistent with the NGR and NGL,* July 2015*, p. 91.* Submitted by ATCO in response to the ERA's draft decision.

that the resulting yield, which would be associated with an effective tenor of less than 10 years, will be extrapolated as set out in the previous paragraph.

21. A contingency of this, or another, type is necessary whether the ERA continues with its adjusted target tenor approach or sets a target tenor of 10 years in all cases where there is at least one bond with at least 10 years' maturity.

## 2.2 Sensitivity of NS and NSS analysis to starting values

22. This section demonstrates the point made in Table 1 that for some algorithms requiring starting values, the choice of starting values can have a material impact on the estimate. Using the "GRG nonlinear" algorithm in Excel to apply NS and NSS curve-fitting to the annualised yields,[7] we have compared the results from using two different sets of starting values:

    - All parameters equal to zero, except for the $\lambda_1$ parameters, which begin with a value of 0.001, with the lower bounds of their corresponding constraints also changed from zero to 0.001. With the NSS curve, the starting point for $\lambda_2$ is set at the lower bound of 2.5.[8]
    - All parameters at the upper bounds of their respective NSS constraints, as specified by the ERA. As the ERA did not impose any upper bounds on the parameters of thee NS curve, we set the starting values of the NS parameters at the upper bounds of the NSS constraints, with the starting value of $\lambda_1$ at 5.5, which is the max of the upper bounds for $\lambda_1$ and $\lambda_2$. Once again, the lower bound for $\lambda_1$ is set at 0.001 for both curves.

23. The resulting parameter estimates and effective annual spot yields for each set of starting values are set out in Table 2, Table 3, Table 4 and Table 5. Both the parameter estimates and the resulting yield estimates are significantly different given different starting parameters.

7 Yields are estimated using the method set out in Appendix A, since the ERA has not provided sufficient detail for us to replicate its approach for obtaining yield data.

8 Setting every parameter to be equal to zero as a starting point is not possible because the $\lambda_i$ parameters of the NS and NSS curves are in the denominators of the curve equations.

## Table 2: Parameter estimates for NS curves

| | Original | Start at zero | Start at upper bound |
|---|---|---|---|
| $\beta_{0t}$ | 0.207 | 147.211 | 4.197 |
| $\beta_{1t}$ | 2.816 | -144.002 | 0.010 |
| $\beta_{2t}$ | 48.102 | 144.002 | -0.010 |
| $\lambda_1$ | 0.008 | 0.001 | 5.825 |

*Source: Bloomberg, CEG analysis*

## Table 3: Parameter estimates for NSS curves

| | Original | Start at zero | Start at upper bound |
|---|---|---|---|
| $\beta_{0t}$ | 12.000 | 8.901 | 12.712 |
| $\beta_{1t}$ | -9.957 | -0.009 | -14.998 |
| $\beta_{2t}$ | -0.632 | -4.240 | -6.164 |
| $\beta_{3t}$ | -18.395 | -17.587 | -22.600 |
| $\lambda_1$ | 1.713 | 0.001 | 0.691 |
| $\lambda_2$ | 5.500 | 2.500 | 5.496 |

*Source: Bloomberg, CEG analysis*

## Table 4: Effective annual spot yields for NS curves

| Year | Original | Start at zero | Start at upper bound |
|---|---|---|---|
| 3 | 3.561 | 3.641 | 4.197 |
| 5 | 3.910 | 3.929 | 4.197 |
| 7 | 4.251 | 4.216 | 4.197 |
| 10 | 4.748 | 4.646 | 4.197 |

*Source: Bloomberg, CEG analysis*

## Table 5: Effective annual spot yields for NSS curves

| | Original | Start at zero | Start at upper bound |
|---|---|---|---|
| 3 | 3.594 | 3.955 | 3.661 |
| 5 | 3.930 | 3.676 | 4.055 |
| 7 | 4.208 | 4.070 | 4.169 |
| 10 | 4.703 | 4.906 | 4.507 |

*Source: Bloomberg, CEG analysis*

24. The use of judgement may improve the result if it can be used to identify non-sensible results and to identify an approach to find a better solution (e.g. setting

new starting values). This is one example of how curve-fitting can be problematic for updating the cost of debt for each regulatory year in the context of Rule 87(12), as discussed further in section 4. The simplest alternative is to rely on the RBA series.

# 3 Formulaic approach for estimating the Gaussian kernel, NS, and NSS curves

25. The ERA has not fully set out its method for fitting curves, including the software program(s) it has used and will use in future periods for NS and NSS curve-fitting nor has it detailed the settings applied within that/those program(s). Its approach needs to be formulaic and not require the use of judgement. In this section we suggest an approach that relies on a 10 year target tenor for estimating the Gaussian kernel. For NS and NSS we suggest an approach that relies on three methodologies in two separate software platforms – R and Excel - and selects the estimate that has the lowest sum of squared errors. We provide reasoning for our proposed approaches in Appendix B.

## 3.1 Estimate Gaussian kernel

26. We propose the following formalised steps that can be applied for estimating the Gaussian kernel for a 10-year effective tenor once the bond yield input data has been collected.

    i. Estimate yields and effective tenors using the Gaussian kernel approach with a sigma of 1.5 for eight target tenors starting with 3 years and increasing in increments of 1 year to 10 years' target maturity.

    ii. If the effective tenor associated with the 10 year target tenor is less than 10 years, extrapolate to a 10-year effective tenor by:

        a. taking the spread to swap at each effective tenor on the fair value curve by subtracting the swap rate for the effective tenor, interpolated from "ADSWAP" sourced from Bloomberg;

        b. calculating a slope for the spread to swap curve from (a) using simple linear regression (ie., ordinary least squares with an intercept and slope coefficient) of the spreads to swap against the effective tenors associated with the eight target tenors from 3 to 10 years, as set out in (i) above;

        c. multiplying the slope estimated in point (b) by the difference between 10 years and the effective tenor associated with the 10 year target tenor;

        d. adding the amount calculated in point (c) to the spread to swap associated with the 10 year target tenor; and

        e. estimating the 10 year extrapolated yield by adding the 10 year swap rate (interpolated from ADSWAP sourced from Bloomberg) to the spread to swap calculated in (d).

## 3.2 Estimate the NS curve

27. To estimate the NS curve, we propose the following steps:

    i. Use a $\lambda$-conditional approach to obtain OLS estimates of $\beta_i$, where $i$ = 0, 1, 2 for the NS curve applied to bond yields. This involves obtaining estimates of each $\beta_i$ through OLS for each $\lambda$ in a range of possible fixed values of $\lambda$ between 0.01 and 100 in increments of 0.01. Out of these estimates, the set of parameters ($\lambda$ and $\beta_i$) that produce the smallest sum of squared residuals are used to estimate the 10 year yield. Non-negativity of $\beta_0$ and positivity of $\lambda$ constraints should be implemented by transforming them to their natural exponents.

    ii. Set $\lambda$ = 0.7173 and obtain the resulting OLS estimates for $\beta_i$. Use the resulting set of parameters as starting values for the GRG Nonlinear algorithm in Excel Solver. This optimisation should be carried out with $\beta_0$, $\lambda$, and the sum of $\beta_0$ and $\beta_1$ being constrained to be non-negative. The multistart option in Solver should be used, with default settings.

    iii. Run the Levenberg-Marquandt algorithm in R using the `nls.lm` function in the `minpack.lm` package, using the same starting values estimated in step (ii) (using OLS to estimate values for $\beta_i$, associated with $\lambda$ = 0.7173). Impose the constraint that $\beta_0$ and $\lambda$ must be non-negative. We note that the `nls.lm` function is unable to set a non-negativity constraint on the sum of $\beta_0$ and $\beta_1$.

    iv. Of the solutions from steps (i) to (iii), adopt the solution with the lowest sum of squared residuals and use this to estimate the 10 year yield.

28. More detail on this approach and a discussion of constraints are provided in Appendix B.

## 3.3 Estimate the NSS curve

29. Unlike the NS, the NSS cannot easily be implemented with a $\lambda$-conditional approach due to the need to specify two separate $\lambda$ values to obtain a linear regression. Consequently, we propose to rely on two alternative estimation procedures set out below – both of which have a common first step:

    i. For the first year, use the estimates of $\lambda_1$ and $\lambda_2$ from the ERA's Final Decision to obtain OLS estimates of $\beta_i$, where $i$ = 0, 1, 2, 3 for the NSS curve. For each subsequent year, use the previous year's estimates of $\lambda_1$ and $\lambda_2$ to obtain the OLS estimates of $\beta_i$ when applied to bond yields.

    ii. Use the set of parameters obtained in (i) as starting values for:

        a. the GRG Nonlinear algorithm in Excel Solver, with non-negativity constraints for $\beta_0$ and the sum of $\beta_0$ and $\beta_1$ and positivity constraints on $\lambda_1$

and $\lambda_2$. The multistart option in Solver should be used, with default settings.

b. the Levenberg-Marquandt algorithm in R using the `nls.lm` function in the `minpack.lm` package, using the estimates defined in step (i) as the starting values of the algorithm. Impose the constraints that $\beta_0$ must be non-negative and $\lambda_1$, and $\lambda_2$ must be positive. We note that the `nls.lm` function is unable to set a non-negativity constraint on the sum of $\beta_0$ and $\beta_1$.

iii. Of the solutions obtained in step (ii), use the one with the lowest sum of squared residuals to estimate the 10 year yield.

30. More detail on this approach and a discussion of constraints are provided in Appendix B.

## 3.4 Average the three estimates

31. Adopt the benchmark 10-year yield as the average of the 10-year estimates from the Gaussian kernel, NS, and NSS curves, estimated in sections 3.1, 3.2 and 3.3.

# 4 Curve-fitting is problematic in the context of Rule 87(12)

32. In the previous section, we proposed a mechanical approach for estimating the Gaussian kernel, as well as the NS and NSS curves. Using this approach will not require any additional judgement. However Nelson-Siegel and Nelson-Siegel-Svensson curve-fitting involves using algorithms to solve for parameters in the Nelson-Siegel and Nelson-Siegel-Svensson formulae which are then used to calculate a 10 year yield.

33. It is clear that there is a trade-off between the degree of automaticity that a particular approach has, versus the certainty of obtaining results with desirable properties. Although it is possible for an approach to be mechanical in application, such an approach will not be guaranteed to produce sensible results. The shape of the resulting curve fit to the available bond data may not be a reasonable yield curve. However, judgement cannot be used in order to rule out or re-estimate such a curve.

34. The GRG nonlinear algorithm in Excel and the Levenberg-Marquandt algorithm in R are gradient descent algorithms which may produce solutions that are local, rather than global, minima in sum of squared errors. The $\lambda$-conditional Ordinary Least Squares approach may also exclude the global minimum because, in practice, the range of $\lambda$ must be restricted. This is also true of use of the differential evolution algorithm in R (which we have not recommended) which requires a range to be set for all parameters. The use of judgement may improve the result if it can be used to identify non-sensible results and to identify an approach to find a better solution (e.g. setting new starting values, extending the range for parameters).

35. A preferable approach available to the ERA in light of Rule 87(12) is to rely on the RBA's Gaussian kernel and extrapolating its 10-year spread for an effective tenor of 10 years. By relying on the RBA's Gaussian kernel, investors can therefore have far more confidence that future estimated spreads will be sensible, to a level that cannot be ensured by any mechanistic formula.

# 5 Proposed approach

36. For the above reasons, we recommend the ERA relies on the RBA series consistent with our advice that the RBA was a suitable source of information for the purpose of estimating the cost of debt.[9] The RBA data is transparent and could be used to provide an automatic update of the return on debt consistent with NGR 87(12).

37. However, if the ERA is to continue with its bond yield approach, Table 6 identifies suggested solutions to some of the issues identified in Table 1 of this report in order to make these aspects of the ERA's methodology more transparent and unambiguous. However, as discussed in section 4, we consider that there is a trade-off between the degree of automaticity in Nelson-Siegel and Nelson-Siegel-Svensson curve-fitting and the certainty of obtaining sensible results. We therefore consider it preferable to rely on the RBA series to update the DRP.

9 CEG, *Cost of debt consistent with the NGR and NGL,* November 2014, p. 63.

## Table 6: Suggested solutions to issues with updating ERA bond yield approach

| | Issue | Suggested solution |
|---|---|---|
| Benchmark sample | Credit ratings Bloomberg field | Specify use of "SP_RTG" Bloomberg field on each bond |
| | Timing of criteria | Apply bond criteria on each individual day of the averaging period. In order to do so, source bond credit ratings for each individual day in the averaging period.[10] The ERA should establish whether a bond has been called before each individual day.[11] |
| | Minimum 50% observations requirement | Specify a hard requirement which is not subject to discretion. we recommend no minimum number of observations |
| Sourcing yields | Formula not set out | Specify Bloomberg formula used in Excel to obtain yields |
| Curve-fitting: Gaussian kernel | Adjusting target tenor | Specify the use of a target tenor of 10 years in all circumstances. At the very least, specify the use of a target tenor of 10 years when there are no bonds with at least 10 years' remaining time to maturity. The resulting yield, which would be associated with an effective tenor of less than 10 years, will be extrapolated as set out in section 2.1.3 below. |
| | Yields vs spreads | Consistently specify use of bond yields for application of Gaussian kernel approach |
| Curve-fitting: NS and NSS | Method not set out | Use the mechanical approach set out in section 3 to estimate yield curves. This involves applying three mechanical methods and selecting the solution with lowest sum of squared errors. |
| | Yields vs spreads | Consistently specify use of bond yields for application of NS and NSS curve-fitting |

[10] Bond ratings on each day can be established either by sourcing the data on each day or by identifying bonds that have been rerated since the beginning of the averaging period using the "SP_EFF_DT" field in Excel which gives the date from which the current S&P rating was effective, and manually sourcing previous bond ratings for these bonds through the Bloomberg terminal – through the "DES" page for each bond.

[11] In bond search, include bonds that are either "no" to "was called" or have "Called date" before the beginning of the averaging period. Use "Called date" field in Excel to further identify bonds that have not been called before each day in the averaging period.

# Appendix A Implementation of our own data collection procedure

38. Notwithstanding that we have not been able to implement the procedures described by the ERA, we have implemented our own method for extracting the relevant data from Bloomberg for the purpose of conducting the analysis presented in 2.2 above. This involves the following three main stages as set out in the ERA's draft decision:

    - **Cross-currency basis swap**: used to convert foreign currency payments into Australian dollars.
    - **Interest rate swap**: used to convert semi-annual coupon payments to the 3-month foreign currency interbank rate and to convert the 3-month Australian dollar equivalent spread to the semi-annual coupons on Australian dollar bonds.
    - **Conversion factor (CF)**: adjusts for interest rate differentials when calculating the spread between benchmarks denominated in different currencies.

39. When calculating the cross-currency basis swap, we also included an intermediate step of first converting the foreign currency basis swap to the equivalent US dollar basis swap and then converting the US dollar basis swap to an Australian dollar basis swap. This intermediate step is required because the data for a direct cross-currency basis swap from the foreign currency to Australian dollars may not be readily available, and using the US dollar basis swap as an intermediate step will often yield better data.

40. Since swaps data is only available for certain whole-numbered years, linear interpolation was used to estimate the hedging costs that correspond to the years to maturity of each bond. Where the time to maturity falls outside the range of swap durations available from Bloomberg, data from the two durations at the end of the available range were then used to linearly extrapolate the required hedging costs.

41. The above steps for calculating hedging costs is summarised in the following equation:

$$AUD\ basis\ swap + [\ foreign\ to\ USD\ basis\ swap + OAS \times CF\ to\ USD] \times CF\ to\ AUD - AUD\ basis\ change$$

42. The above equation produces the historical set of hedged Australian dollar spreads for each bond. These were then converted back to yields by adding the interpolated Australian dollar swap rates before annualising the resulting semi-annual yields.

# Appendix B Explanation of estimation approaches to estimating the NS and NSS curves

## B.1 Methods

### B.1.1 λ-conditional Ordinary Least Squares in Excel

43. The λ-conditional Ordinary Least Squares approach estimates the NS curve using Ordinary Least Squares (OLS), conditional on a range of values for λ and taking the one with the smallest sum of squared residuals. The NS curve is linear on all parameters except for λ meaning that OLS can be used to estimate the optimal values for all non-λ parameters for each λ. λ is a decay factor in the NS function and therefore must be greater than 0.

44. To see that the NS curve is linear on all parameters except for λ this, note that the non-intercept components of the NS curve equation can be rewritten as functions of λ. The formula for the Nelson-Siegel curve as shown in the Final Decision is reproduced below:

$$y_t(\tau) = \beta_{0t} + \beta_{1t}\frac{1-e^{-\lambda\tau}}{\lambda\tau} + \beta_{2t}\left(\frac{1-e^{-\lambda\tau}}{\lambda\tau} - e^{-\lambda\tau}\right)$$

45. Defining $f(\lambda) = \frac{1-e^{-\lambda\tau}}{\lambda\tau}$ and $g(\lambda) = \frac{1-e^{-\lambda\tau}}{\lambda\tau} - e^{-\lambda\tau}$, the formula for the NS curve becomes a linear function of $\beta_{0t}$, $\beta_{1t}$, and $\beta_{2t}$:

$$y_t(\tau) = \beta_{0t} + \beta_{1t}\, f(\lambda) + \beta_{2t}\, g(\lambda),$$

which is easily estimated using OLS.

46. The λ-conditional Ordinary Least Squares method uses the following steps:

i. Use OLS regression to estimate the parameters of $\beta_{it}$, conditional on different values of λ over a range from 0.01 to 100 in increments of 0.01; then

ii. Identify the parameters at which the sum of squared residuals in Step (i) is the smallest.

47. The $\lambda$-conditional approach is generally not feasible for sufficiently large ranges of $\lambda_1$ and $\lambda_2$ since the number of estimations that must be carried out for the NSS curve is the square of that required for the NS curve.

### B.1.2 GRG nonlinear algorithm in Excel

48. Use the "GRG nonlinear" algorithm in Excel Solver to minimise the sum of squared errors of the estimated curve. This approach requires input of parameter starting values and allows parameter constraints to be applied.

49. Diebold and Li (2005) utilised the Nelson-Siegel curve to forecast the term structure of US Treasury yields. In their estimation, they assumed a fixed $\lambda$ of 0.0609, which corresponds to the value that maximises the loading on the medium-term factor of the Nelson-Siegel function at a time to maturity of 30 months, which they regard as the average maturity of medium-term bonds. This approach for identifying the value of $\lambda$ has also been applied by other authors in literature.[12] We note that the authors have further confirmed that their estimate of $\lambda$ = 0.0609 was imprecise due to rounding errors, and that the correct value should be 0.0598.[13]

50. Applying this reasoning to the ERA's Final Decision requires the time to maturity of 30 months to be converted to 2.5 years, consistent with the unit of years to maturity. The Diebold and Li (2006) estimate of $\lambda$ in the Nelson-Siegel curve would thus correspond to the value of $\lambda$ that maximises the third component of the Nelson-Siegel curve at 2.5 years: $\left(\frac{1-e^{-2.5\lambda}}{2.5\lambda} - e^{-2.5\lambda}\right)$. This corresponds to an estimate of $\lambda$ = 0.7173.

51. The estimate of $\lambda$ = 0.7173 can then be used to obtain OLS estimates of $\beta_{0t}$, $\beta_{1t}$, and $\beta_{2t}$, after which these four estimates can in turn be used as starting values in Excel Solver.

52. With the NSS curve, there does not appear to be an analogous estimate of $\lambda_1$ and $\lambda_2$ that is commonly used in literature. We propose using the estimates of $\lambda_1$ and $\lambda_2$ from the previous year and then use them to obtain OLS estimates of $\beta_{0t}$, $\beta_{1t}$, $\beta_{2t}$, and $\beta_{3t}$, before using all six estimates as starting values in Excel Solver.

[12] For example, see Molenaars, T., Reinerink, N. and Hemminga, M. (2013), Forecasting the yield curve – Forecast performance of the dynamic Nelson-Siegel model from 1971 to 2008.

[13] See Diamond, L. and Brooks, R. (2014), A Review of Measures of Australian Corporate Credit Spreads published by the Reserve Bank of Australia, p. 25.

### B.1.3 Levenberg-Marquandt algorithm in R

53. This method applies the Levenberg-Marquandt algorithm in R, using the `nls.lm` function in the `minpack.lm` package. The Levenberg-Marquandt algorithm applies nonlinear least squares to optimise the yield curves.

54. We propose to use the algorithm with the same starting values as for GRG nonlinear algorithm in Excel.

## B.2 Constraints

55. The ERA did not specify any reasons for its choice of constraints. Its NS constraints are economically justified, as discussed below, however its NSS constraints are not. The NSS constraints are identical to the ones used in Gilli, Groβe, and Schumann (2010). That study, however, was carried out on German government bonds, and the authors did not explicitly provide a reason for their choice of constraints, merely arguing that "these values should become apparent from" charts that showed the Bundesbank's historical NSS parameter estimates of the yields of German government bonds.

56. There does not appear to be a theoretical basis Gilli *et al*'s (2010) choice of constraints, and we note that these constraints were applied to a dataset of bond yields issued by the same (risk free) entity. In contrast, the ERA is attempting to estimate the NSS curve for a more heterogeneous sample of bonds issued by several companies that may have different characteristics. It is therefore unlikely that the constraints used in Gilli *et al* (2010) can, even if justified in that context, be applied verbatim to the ERA's sample of bonds.

57. Our proposed constraints are less restrictive than the ERA's and are grounded in an economic interpretation of the parameters. The ERA's constraints may be driven by its choice of (undisclosed) software program. We are proposing a software program that does not require restrictive constraints.

58. There are economic reasons for imposing a positivity constraint on $\lambda_i$, and non-negativity constraints on $\beta_{ot}$ and the sum of $\beta_{ot}$ and $\beta_{1t}$.[14] Positive values for any decay factors ($\lambda_i$) ensure that the yield curve converges to its long-run yield. Non-negative $\beta_{ot}$ ensures that the long-run yield level is non-negative. Non-negative $\beta_{ot}$ + $\beta_{1t}$ ensures that the yield curve has a non-negative y-intercept.[15]

[14] Gilli *et al* (2010) used this set of constraints for estimating the NS curve.

[15] The ERA listed constraint (ii) as $\beta_{1t} + \beta_{2t} > 0$, which we view as a notational error since such a constraint does not appear to be supported by empirical literature.

59. In practice, however, it is not possible to impose the non-negativity constraint on the sum of $\beta_{0t}$ and $\beta_{1t}$ on the $\lambda$-conditional OLS approach or the Levenberg-Marquandt approach. The $\lambda$-conditional approach is based on OLS and thus cannot impose inequality constraints. The constraints on $\beta_{0t}$ and $\lambda_1$ can be implemented by transforming them to their natural exponents however the non-negativity constraint on the sum of $\beta_{0t}$ and $\beta_{1t}$ cannot be implemented in the $\lambda$-conditional approach. The `nls.lm` function within R's `minpack.lm` package only allows constraints on individual parameters, and is thus unable to accommodate the non-negativity constraint on the sum of $\beta_{0t}$ and $\beta_{1t}$ either. Only the remaining approach using the GRG nonlinear algorithm in Excel Solver is able to impose all three constraints without issue.

60. While the implementation of the non-negativity constraint on the sum of $\beta_{0t}$ and $\beta_{1t}$ may be important at the lower end of the curve, we consider it is unlikely to be important for a sensible estimate of the 10 year. Since the ERA's bond set only includes bonds with a minimum time to maturity of 2 years, how the curve fits the data from 2 years and above will drive the choice of parameters in the NS and NSS curve-fitting. Therefore, the fact that the results of the $\lambda$-conditional OLS approach and the Levenberg-Marquandt algorithm may not satisfy non-negativity constraint on the sum of $\beta_{0t}$ and $\beta_{1t}$ does not provide a sound reason to eliminate either solution.

61. However, if the ERA is minded to strictly apply the non-negativity of $\beta_{0t}$ plus $\beta_{1t}$ constraint as well, it could perform the following modification to the steps outlined in section 3

### B.2.1 Nelson-Siegel with non-negativity of $\beta_{0t}$ plus $\beta_{1t}$

62. To estimate the NS curve,

    i. Use a $\lambda$-conditional approach to obtain OLS estimates of $\beta_i$, where $i$ = 0, 1, 2 for the NS curve applied to bond yields. This involves obtaining estimates of each $\beta_i$ through OLS for each $\lambda$ in a range of possible fixed values of $\lambda$ between 0.01 and 100 in increments of 0.01. Out of these estimates, the set of parameters ($\lambda$ and $\beta_i$) that produce the smallest sum of squared residuals is used to estimate the 10 year yield. Non-negativity of $\beta_{0t}$ and positivity of $\lambda_1$ constraints should be implemented by transforming them to their natural exponents.

    ii. Set $\lambda$ = 0.7173 and obtain the resulting OLS estimates for $\beta_i$. Use the resulting set of parameters as starting values for the GRG Nonlinear algorithm in Excel Solver. This optimisation should be carried out with $\beta_0$, $\lambda$, and the sum of $\beta_0$ and $\beta_1$ being constrained to be non-negative. The multistart option in Solver should be used, with default settings.

    iii. Run the Levenberg-Marquandt algorithm in R using the `nls.lm` function in the `minpack.lm` package, using the same starting values estimated in step (ii)

(using OLS to estimate values for $\beta_{i,}$ associated with $\lambda$ = 0.7173). Impose the constraint that $\beta_o$ and $\lambda$ must be non-negative. We note that the `nls.lm` function is unable to set a non-negativity constraint on the sum of $\beta_o$ and $\beta_1$.

iv. disregard the estimates that do not conform to the non-negativity constraint on sum of $\beta_{ot}$ and $\beta_{1t}$; and

v. Of the solutions in steps (i) to (iii) that have not been disregarded in step iv), adopt the solution with the lowest sum of squared residuals and use this to estimate the 10 year yield.

### B.2.2 Nelson-Siegel-Svensson

63. The $\lambda$-conditional approach is generally not feasible for sufficiently large ranges of $\lambda_1$ and $\lambda_2$ since the number of estimations that must be carried out for the NSS curve is the square of that required for the NS curve.

64. For NSS, we propose that the ERA carry out estimations using the GRG nonlinear algorithm and Levenberg-Marquandt algorithm, imposing constraints[16] where practical (as described in section B.2 above) and disregard the estimates that do not conform to the non-negativity constraint on sum of $\beta_{ot}$ and $\beta_{1t}$; and

65. Select between the remaining solutions based on which has the lowest sum of squared residuals.

[16] Positivity constraint on $\lambda_i$, and non-negativity constraints on $\beta_{ot}$ and the sum of $\beta_{ot}$ and $\beta_{1t}$ where practical

# Appendix C :

## HoustonKemp - A note on the Authority's Final Decision on depreciation, 4 August 2015

Connecting WA to natural gas

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11 August 2015

Mr Greg Watkinson
CEO
Economic Regulation Authority
Level 4, Albert Facey House
469-489 Wellington Street
Perth, WA 6000

Dear Mr Watkinson,

**RE: RESPONDING SUBMISSION TO ERA FINAL DECISION- DEPRECIATION**

I refer to our previous correspondence in relation to the ERA's Final Decision on Proposed Revisions to the Access Arrangement for the Midwest and Southwest Gas Distribution System.

In addition to the matters noted in our letter of 22 July 2015, ATCO Gas Australia (AGA) and its consultant HoustonKemp have given further consideration to the ERA's Final Decision in relation to depreciation. AGA has requested a copy of the ERA's models that support is Final Decision analysis on depreciation, but as at the date of this letter they have not been provided.

In the Final Decision, the ERA accepts the methodology proposed by AGA to determine the depreciation schedule that complies with National Gas Rule 89(1). That is, that efficient growth in the market for natural gas services will be promoted by a time profile of depreciation that minimises the extent of departure, over time, between price and long run marginal cost (LRMC).[1] This involves a comparison of LRMC and prices over time.

The ERA's Final Decision draws a different conclusion as to the time profile of LRMC as compared to the Draft Decision. Notwithstanding this, the ERA maintains its conclusion that the transitional approach to determining depreciation proposed by AGA (which transitions to straight line depreciation) does not comply with NGR 89(1) and an indexed straight line depreciation method does comply with that Rule.

The enclosed report from HoustonKemp identifies a number of errors in the ERA's analysis which underpins its conclusions in the Final Decision. In particular, the ERA has erroneously disregarded ABS evidence on capital price deflators. In addition, the ERA's conclusion that

[1] For example at paragraph 2036 of the ERA's Final Decision.

LRMC is rising through time is based on a flawed comparison of LRMC per GJ in nominal terms with prices per GJ in real terms.

HoustonKemp find that correcting these errors in the ERA's Final Decision analysis will likely show that the LRMC will remain flat over time. On that basis, an analysis of the time profile of prices per GJ as set out in the Final Decision shows that the extent of the departure between LRMC per GJ and prices per GJ:

- is less over time under AGA's transitional approach as compared with indexed straight line depreciation; and
- is not minimised under indexed straight line depreciation.[2]

Based on this evidence, it remains AGA's submission that its proposed transitional approach to depreciation complies with NGR 89(1). Rule 89(1) is a limited discretion rule and in these circumstances the ERA may not withhold its approval of AGA's proposed approach to depreciation and it should be accepted.

This letter and the enclosed HoustonKemp report are provided to the ERA as a submission in response to the ERA's Final Decision.

I invite the ERA to contact AGA should any further information or clarification be required to assist in the completion of the review process and the release of the access arrangement decision.

Yours sincerely,

pp.

**Sally McMahon**
**General Manager Commercial and Regulatory**

[2] HoustonKemp: *A Note on the Authority's Final Decision on Depreciation*, 4 August 2015, Figure 2, page 14 and subsequent paragraphs

HOUSTONKEMP
Economists

# A Note on the Authority's Final Decision on Depreciation

A note for Johnson Winter & Slattery

4 August 2015

## Report Author

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## Disclaimer

# Contents

# 1. Introduction

We have been asked by Johnson Winter & Slattery (JWS) to prepare this note on behalf of ATCO Gas Australia Pty Ltd (ATCO).JWS has asked that we comment on particular aspects of the Economic Regulation Authority of Western Australia's (the Authority's) final decision on proposed revisions to the access arrangement for the mid-west and south-west gas distribution systems submitted by ATCO (the final decision).[1]

The particular aspect of the final decision on which JWS has asked us to comment is the analysis underpinning the Authority's decision to index the capital base for the effect of consumer price inflation (CPI) and so to determine the depreciation schedule for ATCO using the indexed straight line depreciation, otherwise referred to as current cost accounting (CCA).[2]

We have not been provided with the models underpinning the Authority's analysis of average prices or long run marginal cost (LRMC) in the final decision. Nevertheless, on the basis of the information presented in the final decision, it appears that the Authority's analysis of LRMC incorporates a number of significant errors.

[1] The Authority, *Final Decision on Proposed Revisions to the Access Arrangement for the Mid-West and South-West Gas Distribution Systems,* June 2015.

[2] For an explanation of the approaches to determining the depreciation schedule please see: HoustonKemp, *Evaluation of ERA's Draft Decision on ATCO's Depreciation Allowance,* November 2014, section 3.

# 2. Average Prices and Long Run Marginal Cost

In the final decision the Authority accepts the methodology we used to determine the depreciation schedule that complies with rule 89(1)(a) of the National Electricity Rules (the rules), which requires that: [3]

> 'The depreciation schedule should be designed… so that reference tariffs will vary, over time, in a way that promotes efficient growth in the market for reference services.'

In particular, the Authority accepts that efficient growth in the market for natural gas services will be promoted by a time profile of depreciation that minimises the extent of departure, over time, between the price of natural gas services and the LRMC of providing natural gas services.[4]

It follows that determining the depreciation schedule that complies with rule 89(1)(a) requires a comparative analysis of LRMC and prices over time. On the basis of its analysis of LRMC and prices over time, the Authority's final decision is that:

- the transitional approach to determining depreciation proposed by ATCO does not comply with rule 89(1)(a); and
- indexed straight line depreciation does comply with rule 89(1)(a).

## 2.1 Background

It is instructive to summarise the evolution of the Authority's final decision, by reference to both its draft decision and our earlier report submitted as part of ATCO's proposed revised access arrangement.

### 2.1.1 The draft decision

In the draft decision the Authority considered the extent of departure between the price and LRMC of natural gas services over time and concluded that:[8]

- LRMC is flat or slightly declining over time;[9] and
- average prices per gigajoule (GJ) are decreasing through time under both indexed straight line deprecation (CCA) and straight line depreciation, where the downward trend is stronger under straight line depreciation.[10]

On this basis, the Authority's draft decision was that indexed straight line depreciation minimises the extent of departure between prices and the LRMC of natural gas services and so promotes efficient growth in the market for natural gas services, thereby complying with rule 89(1)(a).[11]

[3] NGR, rule 89(1)(a)

[4] The Authority, *Final Decision on Proposed Revisions to the Access Arrangement for the Mid-West and South-West Gas Distribution Systems,* June 2015, paragraph 2036, page 430.

[8] We explain in our earlier report that, in the draft decision, the Authority's precise interpretation of the historical trend data for the purposes of forming a view of the future trend in LRMC was unclear. See: HoustonKemp, *Evaluation of ERA's Draft Decision on ATCO's Depreciation Allowance,* November 2014, page 17.

[9] The Authority, *Draft Decision on Proposed Revisions to the Access Arrangement for the Mid-West and South West Gas Distribution System*, October 2014, paragraph 1028.

[10] The Authority, *Draft Decision on Proposed Revisions to the Access Arrangement for the Mid-West and South West Gas Distribution System*, October 2014, paragraph 1022.

[11] The Authority, *Draft Decision on Proposed Revisions to the Access Arrangement for the Mid-West and South West Gas Distribution System*, October 2014, paragraph 1038.

### 2.1.2 ATCO's proposed revised access arrangement

ATCO's proposed revised access arrangement attached a report by HoustonKemp (our earlier report) identifying errors in the Authority's analysis of average prices that, once corrected, resulted in a materially different time profile of average prices.[12]

In our earlier report we concluded that LRMC is likely to decrease over time. Nevertheless, we adopted a highly conservative assumption that LRMC will be constant through time and showed that, where LRMC is constant, indexed straight line depreciation does not minimise the extent of departure between prices per GJ and LRMC per GJ and so does not meet the requirements of rule 89(1)(a).[13]

Further, in our earlier report we concluded that:[14]

> …after accounting for any price shocks during the transition, the adoption of an unindexed capital base with straight line depreciation better meets the requirements of rule 89(1)(a), as compared with an indexed capital base with indexed straight line depreciation, as proposed to be adopted by the ERA.

## 2.2 The final decision

The Authority's final decision as to the depreciation approach that minimises the extent of departure between LRMC and prices over time, and so promotes efficient growth in the market and thereby complies with rule 89(1)(a), is based on an analysis of LRMC and prices over time:

- on a per GJ basis; and
- on a per connection basis.

### 2.2.1 LRMC and average prices on a per GJ basis

The Authority appears to have corrected the errors in its analysis of average prices per GJ in the draft decision and, consistent with the findings in our earlier report, concludes that average prices per GJ are increasing under both indexed straight line deprecation (CCA) and straight line depreciation (HCA), where average prices per GJ rise more steeply, and to a higher level, under indexed straight line depreciation.[15]

However, this gives rise to a time profile of average prices that, when combined with the time profile of LRMC in the draft decision, does not support the Authority's draft decision that:

- the transitional approach proposed by ATCO does not comply with rule 89(1)(a); and
- indexed straight line depreciation complies with rule 89(1)(a).

Notwithstanding, the Authority's final decision draws a different conclusion as to the time profile of LRMC per GJ, as compared with that in the draft decision and, in so doing, the Authority's final decision maintains the conclusion it drew in the draft decision.

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[12] HoustonKemp, *Evaluation of ERA's Draft Decision on ATCO's Depreciation Allowance,* November 2014, section 5.2.

[13] HoustonKemp, *Evaluation of ERA's Draft Decision on ATCO's Depreciation Allowance,* November 2014, page 25.

[14] HoustonKemp, *Evaluation of ERA's Draft Decision on ATCO's Depreciation Allowance,* November 2014, page 27.

[15] We note the Authority states that average prices are increasing in the final decision, as compared with decreasing in the draft decision, due to changes in model inputs; namely, the increased level of capital expenditure in the final decision. However, although we have not reviewed the Authority's model, in our opinion, the change in trend in average prices is due to the Authority correcting the errors we identified in our earlier report.

Further, we note that the Authority contends that the model used in our earlier report applies a level of capital expenditure per new connection that is incorrect; however, we used the level of capital expenditure per connection in the draft decision. Indeed, we simply took the Authority's model and corrected an error.

Table 1 below illustrates the inconsistency between the Authority's draft and final decisions as to the time profile of LRMC per GJ and average prices per GJ, which has led it maintaining its decision that indexed straight line depreciation complies with rule 89(1)(a).

Table 1 High level history of positions on LRMC, revenue per GJ and the depreciation approach

| | Time profile of LRMC | Time profile of average prices | | Minimises the extent of departure and so complies with rule 89(1)(a) | |
|---|---|---|---|---|---|
| | | Indexed straight line depreciation (CCA) | Straight line depreciation (HCA) | Indexed straight line depreciation | Straight line depreciation |
| **Draft Decision** | Flat or decreasing[16] | Decreasing slightly[17] | Decreasing steeply[18] | ✓ | ✗ |
| **HoustonKemp** | Flat or decreasing[19] | Rising then falling[20] | Flat to decreasing[21] | ✗ | ✓ |
| **Final Decision** | Rising[22] | Increasing steeply[23] | Increasing slightly[24] | ✓ | ✗ |

The Authority's analysis of LRMC per GJ and prices per GJ leads it to the conclusion that:

- the transitional approach to determining depreciation proposed by ATCO, which transitions to straight line depreciation, does not comply with rule 89(1)(a); and
- indexed straight line depreciation complies with rule 89(1)(a).

However, the inconsistency in the Authority's conclusions as to LRMC per GJ in the final decision, as compared with that in the draft decision, is reflected in the reliability of the analysis supporting the Authority's final decision that LRMC per GJ is rising over time. Specifically, on the information presented in the final decision, there appear to be a number of significant errors in the Authority's analysis of LRMC per GJ that lead it to draw erroneous conclusions as to the time profile of LRMC per GJ. We describe these errors in section 3.

[16] The Authority, *Draft Decision on Proposed Revisions to the Access Arrangement for the Mid-West and South West Gas Distribution System*, October 2014, paragraph 1028. We explain in our earlier report that in the draft decision the authority's precise interpretation of the historical trend data for the purposes of forming a view of the future trend in LRMC was unclear, see: HoustonKemp, *Evaluation of ERA's Draft Decision on ATCO's Depreciation Allowance,* November 2014, page 17.

[17] The Authority, *Draft Decision on Proposed Revisions to the Access Arrangement for the Mid-West and South West Gas Distribution System*, October 2014, Figure 36, page 229.

[18] The Authority, *Draft Decision on Proposed Revisions to the Access Arrangement for the Mid-West and South West Gas Distribution System*, October 2014, Figure 36, page 229.

[19] HoustonKemp, *Evaluation of ERA's Draft Decision on ATCO's Depreciation Allowance,* November 2014, page 18.

[20] HoustonKemp, *Evaluation of ERA's Draft Decision on ATCO's Depreciation Allowance,* November 2014, Figure 9 and 10, page 23 and 24.

[21] HoustonKemp, *Evaluation of ERA's Draft Decision on ATCO's Depreciation Allowance,* November 2014, Figure 9 and 10, page 23 and 24.

[22] The Authority, *Final Decision on Proposed Revisions to the Access Arrangement for the Mid-West and South-West Gas Distribution Systems,* June 2015, Appendix 9, paragraph 17 to 20.

[23] The Authority, *Final Decision on Proposed Revisions to the Access Arrangement for the Mid-West and South-West Gas Distribution Systems,* June 2015, Figure 29 and paragraph 12, page 694.

[24] The Authority, *Final Decision on Proposed Revisions to the Access Arrangement for the Mid-West and South-West Gas Distribution Systems,* June 2015, Figure 29 and paragraph 12, page 694.

### 2.2.2 LRMC and average prices on a per connection basis

The Authority's draft decision as to the depreciation approach that complies with rule 89(1)(a) was informed by an analysis of LRMC and prices on a per GJ basis only. However, the Authority's final decision introduces a new dimension of analysis, ie, of LRMC and prices on a per connection basis.

We understand that the ATCO has requested the models and calculations underpinning the Authority's final decision. Access to this information would enable us to comment on the Authority's analysis of prices and LRMC on a per connection basis and the conclusions drawn from that analysis.

The Authority finds that average prices per connection are:

- decreasing through time under straight line depreciation;[28] and
- flat to rising through time under indexed straight line depreciation.[29]

The Authority's analysis concludes that LRMC per connection:[30]

> … is likely **to remain flat or perhaps slightly rising** in real terms, given the recent trends in the long run capital costs of the industry.

It further concludes that this:[31]

> …expectation for **flat to rising costs per connection** is confirmed by the rising trend in the actual marginal costs of connection.

The Authority's analysis of LRMC per connection and prices per connection through time appears then to proceed on the basis that LRMC per connection is increasing through time, ie, the Authority states that:

> In line with this **increase in the long run marginal cost**, the long run average revenue per connection under the CCA depreciation approach is flat to rising over time. [32] [Emphasis added]

And that:

> ….This [straight line depreciation] results in a declining average revenue per connection over time, which is not consistent with **the rising LRMC of connections**. [34] [Emphasis added]

Notwithstanding, there is an error in the Authority's analysis of the LRMC per connection that, when corrected, is likely to result in a materially different conclusion as to the time profile of LRMC per connection and so the depreciation approach that minimises the extent of departure between LRMC and prices, in accordance with the requirement of rule 89(1)(a).

### 2.2.3 Summary

On the basis of its analysis of LRMC and prices over time on a per GJ and per connection basis, the Authority's final decision is that:

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[28] The Authority, *Draft Decision on Proposed Revisions to the Access Arrangement for the Mid-West and South West Gas Distribution System*, October 2014, Appendix 9, paragraph 26.

[29] The Authority, *Draft Decision on Proposed Revisions to the Access Arrangement for the Mid-West and South West Gas Distribution System*, October 2014, Appendix 9, paragraph 25.

[30] The Authority, *Draft Decision on Proposed Revisions to the Access Arrangement for the Mid-West and South West Gas Distribution System*, October 2014, Appendix 9, paragraph 23.

[31] The Authority, *Draft Decision on Proposed Revisions to the Access Arrangement for the Mid-West and South West Gas Distribution System*, October 2014, Appendix 9, paragraph 24.

[32] The Authority, *Draft Decision on Proposed Revisions to the Access Arrangement for the Mid-West and South West Gas Distribution System*, October 2014, Appendix 9, paragraph 25.

[34] The Authority, *Draft Decision on Proposed Revisions to the Access Arrangement for the Mid-West and South West Gas Distribution System*, October 2014, Appendix 9, paragraph 26.

- the transitional approach to determining depreciation proposed by ATCO does not comply with rule 89(1)(a); and
- indexed straight line depreciation complies with rule 89(1)(a).

We have not been provided with the model and calculations underpinning the Authority's analyses of the time profile of LRMC and average prices over time. However, on the basis of the information presented in the final decision alone, the Authority's analysis of LRMC in the final decision incorporates a number of errors that, once corrected, would likely give rise to different conclusion as to the depreciation approach that complies with rule 89(1)(a).

## 2.3 Long run marginal cost

Before describing the errors in the Authority's analysis, it is helpful to explain the concept of LRMC.

LRMC is a forward looking concept and is the additional cost incurred as a result of an incremental (or relatively small) increase in output, assuming all factors of production are able to be varied. As a matter of principle, setting prices equal to LRMC will promote efficient use and production of goods and services because:

- it ensures that consumers face price signals that reflect the resource cost of providing services, which encourages demand for services only when the benefit to consumers exceeds the cost of their provision; and
- it provides signals to infrastructure providers as to how much users value additional capacity, and thereby plays an important role in financing that capacity.

# 3. Errors in the Authority's analysis of LRMC

The Authority's final decision as to the time profile of LRMC is predicated on the basis of:

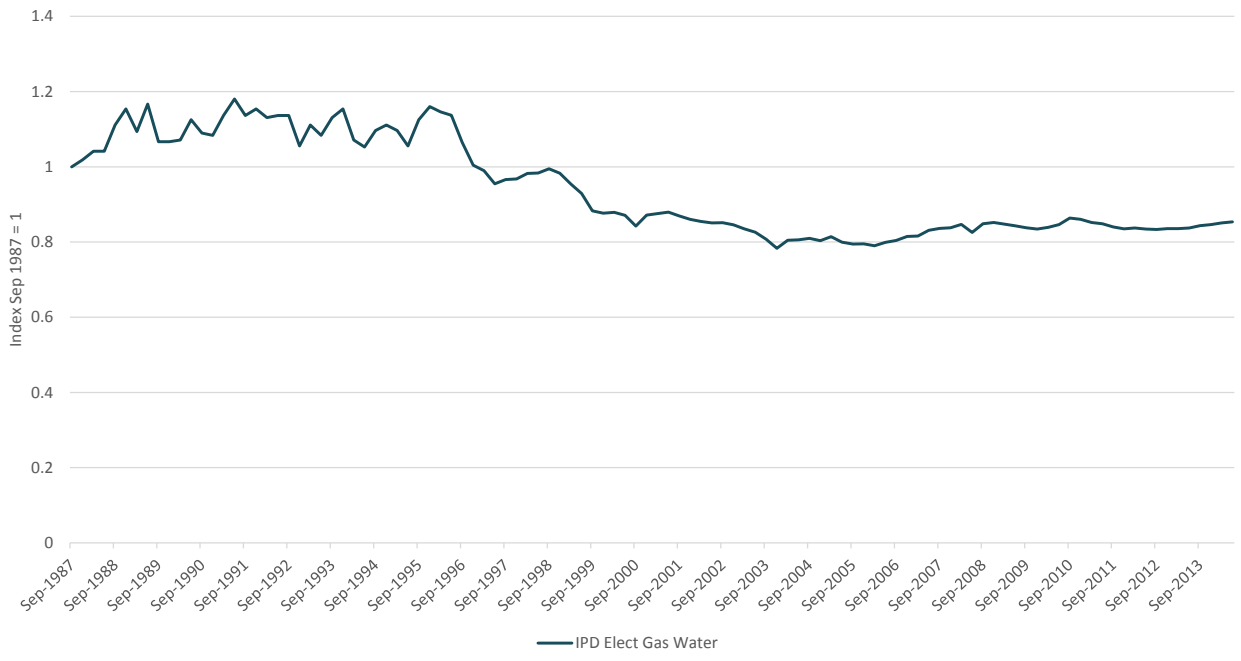
- data provided by the Australian Bureau of Statistics (ABS); and
- a comparison of LRMC in nominal terms (dollars of the day) and average prices in real or constant price terms (dollars by reference to a common price base).

On the basis of the information presented in the final decision, there are significant errors in the Authority's analysis of LRMC.

## 3.1 The ABS data

In the draft decision the Authority acquired unpublished data from the ABS so as to estimate implicit capital price deflators for the 'electricity, gas, water and waste' industry. We agree with the Authority that it is appropriate to use this evidence to draw inferences as to the trend in LRMC. The ABS data is presented in Figure 1 below.

Figure 1 The Authority's capital implicit price deflator (IPD) for the electricity, gas, water and waste industry from1987 to 2014




We explain in our earlier report that, in the draft decision, the Authority's precise interpretation of the historical trend data for the purposes of forming a view of the future trend in LRMC was nebulous.[46] Nevertheless, the Authority explains in the final decision that its draft decision was that LRMC would:[47]

> …remain close to flat in real terms.

[46] HoustonKemp, *Evaluation of ERA's Draft Decision on ATCO's Depreciation Allowance,* November 2014, page 17.

[47] The Authority, *Final Decision on Proposed Revisions to the Access Arrangement for the Mid-West and South-West Gas Distribution Systems,* June 2015, paragraph 2003.

On the basis of the same information considered in the draft decision, the Authority's final decision is that LRMC:[48]

> … is likely to remain flat or perhaps slightly rising in real terms, given the recent trends in the long run capital costs of the industry (Figure 30). [Figure 1 above].

The Authority contends that the drop in capital input prices from 1995 to 2003 is attributable to the microeconomic reform during that period and that LRMC has been flat or slightly increasing thereafter. However, the Authority appears to set aside the observation raised in our earlier report, ie:[49]

> … the last decade – during which the capital implicit price deflator has been stable – coincides with a mining investment boom of unprecedented scale, the likely effect of which was to put significant upwards pressure on capital prices across a number of sectors. On these considerations, in my opinion the best estimate of the likely trend in the prices of inputs that make up LRMC is a resumption of the decline seen from 1995 to 2003, since this is consistent with the mining boom ramping down and the reasonable prospect of further productivity gains being achieved in the sector.

With reference to the ABS data, the Authority also highlights an observation by NERA that the wage price index, a proxy for the cost of operating inputs, is rising and concludes that:[50]

> … this suggests that the overall trend for the electricity, gas, water and waste price index, and hence its long run marginal cost, is flat or perhaps even slightly increasing.

However, NERA highlights that the provision of natural gas services is capital intensive and that capital-related costs account for over half of ATCO Gas's total costs, with that proportion expected to rise materially in the future. The Authority appears not to have considered the capital intensity of natural gas services in coming to its final decision that LRMC is flat or rising.

We explain in our earlier report that a long term decline in LRMC is consistent with the 'in principle' conclusion that can be drawn from the economic relationships that underpin long term trends in economic growth, ie:[51]

> '… the unit price of capital assets can be expected to fall over time, relative to economy-wide consumer prices. By contrast, the unit cost of labour and land can be expected to rise over time, relative to economy-wide consumer prices.'

To summarise, the Authority's final decision does not provide robust evidence to the contrary of the clear reduction in LRMC over the past 27 years, as illustrated in the data provided by the ABS. Therefore, we maintain the conclusion in our earlier report that:[52]

> … LRMC is likely to decrease in future years and, at its most conservative, to be relatively stable. Notwithstanding, for the purpose of the comparisons of LRMC and average prices through time that I undertake below, I adopt the highly conservative assumption that LRMC will be constant in future years.

Further, we explain in section 4.1 that the Authority appears to apply the ABS data selectively to draw inferences as to the time profile of LRMC per connection, but not LRMC per GJ.

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[48] The Authority, *Final Decision on Proposed Revisions to the Access Arrangement for the Mid-West and South-West Gas Distribution Systems,* June 2015, Appendix 9, paragraph 23, page 696.

[49] HoustonKemp, *Evaluation of ERA's Draft Decision on ATCO's Depreciation Allowance,* November 2014, page 17.

[50] The Authority, *Final Decision on Proposed Revisions to the Access Arrangement for the Mid-West and South-West Gas Distribution Systems,* June 2015, Appendix 9, paragraph 23, page 696.

[51] NERA, Depreciation Options for ATCO Gas, Expert Report of Gregory Houston, 13 March 2014, page 19.

[52] HoustonKemp, *Evaluation of ERA's Draft Decision on ATCO's Depreciation Allowance,* November 2014, page 18.

To summarise, in our opinion the Authority:

- has erred in its interpretation of the ABS data; and
- has erred by implicitly disregarding the ABS data for the purposes of analysing the time profile of LRMC per GJ.

## 3.2 Comparing estimates of LRMC and prices

The Authority uses the average incremental cost approach to draw inferences as to the time profile of LRMC. The average incremental cost (AIC) approach estimates LRMC equal to the average change in projected operating and capital expenditure attributable to future increases in demand. In other words, the AIC approach averages the total cost of supplying new growth in demand across that growth in demand.

The formula for estimating the AIC is:

$$LRMC = \frac{PV(expenditure\ relating\ to\ new\ network\ capacity)}{PV(additional\ demand\ serviced)}$$

Information as to the time profile of LRMC can be inferred by using the AIC approach to estimate LRMC in different periods and then by examining how, or if, those estimates change through time. The Authority uses the AIC approach to estimate the LRMC in three different periods.

It is relevant to note that LRMC can be estimated in real terms (constant price dollars) or in nominal terms (dollars of the day). The Authority applies the AIC approach using forecast expenditure in nominal terms (dollars of the day), and so its estimate of LRMC is in nominal terms.

However, the Authority's comparison of the resulting estimates of LRMC in nominal terms (dollars of the day) with average prices in real terms (constant dollars) over time is a significant error.

### 3.2.1 The basis of comparison

It is important that any comparative analysis of two variables is undertaken on a consistent basis. By way of example, consider a shopkeeper assessing the extent of divergence between forecast total revenue and total cost, ie, the forecast profit margin, where:

- forecast inflation is positive;
- forecast total revenue in real terms (constant dollars) is rising through time; and
- forecast total cost in real terms (constant dollars) is stable through time.

Assuming forecast total revenue exceeds forecast total costs, it is clear that the shopkeeper's profit margin is increasing through time when assessed on a consistent basis. However, if the shopkeeper was to compare forecast total revenue in real terms (constant dollars) and forecast total costs in nominal terms (dollars of the day), the shopkeeper will erroneously infer that both forecast revenue and forecast costs are rising, and so underestimate the extent of divergence between total revenue and total cost, ie, the forecast profit margin.

It is an intuitive and fundamental requirement that a reliable and robust comparison of two variables must be undertaken on a consistent basis.

### 3.2.2 The Authority compares LRMC and prices on an inconsistent basis.

For the purpose of analysing the extent of divergence between LRMC and prices, the Authority undertakes a comparative analysis, over time, of:

- LRMC in nominal terms (dollars of the day); with
- average prices in real terms (constant dollars).

The inconsistent basis on which the Authority undertakes this comparative analysis is a significant error and is likely to lead to an erroneous conclusion that, like average prices, LRMC is rising through time.

By way of example, if both prices and LRMC are constant in real terms, but rising in nominal terms due to positive inflation, a comparison of prices in real terms (constant dollars) and LRMC in nominal terms (dollars of the day) would lead to an erroneous conclusion that prices and LRMC are converging over time.

Table 2 and Table 3 set out a simple numerical example illustrating how the basis on which LRMC is estimated has material implications as to the time profile of LRMC. Specifically, Table 2 and Table 3 show that, where LRMC in real terms is constant through time and there is positive inflation, LRMC in nominal terms will, by construction, increase through time.

Table 2 Illustrative example of growth expenditure per connection in nominal and real terms[53]

| | 2015 | 2016 | 2018 | 2019 | 2020 | 2021 |
|---|---|---|---|---|---|---|
| Growth expenditure ($ nominal) | 100 | 103 | 105 | 108 | 110 | 113 |
| Growth expenditure ($ real) | 100 | 100 | 100 | 100 | 100 | 100 |
| **Additional Capacity installed** | **2** | **2** | **2** | **2** | **2** | **2** |
| Growth expenditure/connection ($ nominal) | 50 | 51 | 53 | 54 | 55 | 57 |
| Growth expenditure/connection ($ real) | 50 | 50 | 50 | 50 | 50 | 50 |

Table 2 shows that the cost of a unit of an additional capacity in real terms (constant dollars) is constant through time, ie, $50 per unit of additional capacity.[54] Nevertheless, inflation is positive and so the cost of a unit of additional capacity in nominal terms (dollars of the day) is rising through time.

Taking this illustrative example, Table 3 contains estimates of the LRMC in nominal and real terms for three different periods.

Table 3 Illustrative example of LRMC in nominal and real terms[55]

| | 2015 to 2016 | 2018 to 2019 | 2020 to 2021 |
|---|---|---|---|
| Average incremental cost ($ nominal) | 51 | 53 | 56 |
| Average incremental cost ($ real) | 50 | 50 | 50 |

Table 3 shows that where LRMC in real terms is constant through time and there is positive inflation, LRMC in nominal terms will, by construction, increase through time. It follows that the basis on which LRMC is estimated has material implications as to the estimated time profile of LRMC.

Further, although we have not reviewed the model used by the Authority in the final decision, we understand that the model incorporates an assumption that capital cost per connection in real terms is constant. It is therefore unsurprising that the Authority finds that LRMC in nominal terms is rising since capital costs per

[53] Assuming forecast inflation is 2.5 per cent.

[54] Calculated equal to $100 of growth expenditure divided by two units of capacity.

[55] Assuming forecast inflation is 2.5 per cent, the nominal WACC is 11.48 per cent and the real WACC is 8.76 per cent.

connection in nominal terms is rising.[56] In our opinion, it is likely that correcting the Authority's approach by calculating LRMC in real terms over time, for the purpose of comparison with prices in real terms over time, will show that LRMC is constant through time in real terms.

Importantly, such an analysis is likely to show that the Authority's final decision to use indexed straight line depreciation does not comply with rule 89(1)(a).

[56] It is unclear how the Authority calculates LRMC to increases and then decrease during the 2020 to 2080 period, see: The Authority, *Final Decision on Proposed Revisions to the Access Arrangement for the Mid-West and South-West Gas Distribution Systems,* June 2015, Table 144 and Table 145.

# 4. Summary

In this section we summarise, on the information presented in the final decision, the errors in the Authority's analysis and explain the likely implications of those errors by reference to the depreciation approach that complies with rule 89(1)(a).

## 4.1 Errors in the Authority's analysis of LRMC per GJ

We have not been provided with the information needed to review the Authority's analysis of the time profile of average prices per GJ under indexed straight line depreciation and straight line depreciation. However, on the information presented in the final decision, it appears reasonable that average prices per GJ in the final decision:[58]

- rise steeply over time under indexed straight line depreciation; and
- rise slightly over time under straight line depreciation.

However, the Authority's conclusion that LRMC per GJ is rising through time[59] is based on a flawed comparison of LRMC per GJ in nominal terms with prices per GJ in real terms. Further, the Authority's conclusion as to the LRMC per GJ is based solely on this analysis and, in so doing, the AER has erred by disregarding the evidence on implicit capital price deflators for the 'electricity, gas, water and waste' industry provided by the ABS.

Notwithstanding that the Authority's analysis implicitly disregards the ABS data:

- the Authority uses the ABS data to draw inferences as to the time profile of LRMC per GJ in the draft decision;
- in our earlier report we agreed with the Authority that, when analysing LRMC per GJ, this evidence was robust;[60]
- the Authority uses the ABS data to draw inferences as to the time profile of LRMC per connection in the final decision; and
- the Authority presents no evidence as to why the ABS data should be disregarded for the purpose of analysing LRMC per GJ through time in the final decision.

In our opinion, the ABS data provides robust evidence to the contrary of the Authority's conclusion that LRMC per GJ is rising through time. Moreover, the ABS data does not support the Authority's apparent inference that there will be a sharp increase in LRMC per GJ.[61]

In our opinion, correcting theses errors, ie, comparing LRMC and prices in real terms and having regard to the ABS data, will show that there is no strong evidence for departing from a conservative assumption that LRMC per GJ will be flat in the future.

[58] The Authority, *Final Decision on Proposed Revisions to the Access Arrangement for the Mid-West and South-West Gas Distribution Systems,* June 2015, Appendix 9, Figure 29, page 694.

[59] The Authority, *Final Decision on Proposed Revisions to the Access Arrangement for the Mid-West and South-West Gas Distribution Systems,* June 2015, Appendix 9, paragraph 17 to 20.

[60] HoustonKemp, *Evaluation of ERA's Draft Decision on ATCO's Depreciation Allowance,* November 2014, page 17.

[61] The Authority, *Final Decision on Proposed Revisions to the Access Arrangement for the Mid-West and South-West Gas Distribution Systems,* June 2015, Appendix 9, paragraph 1

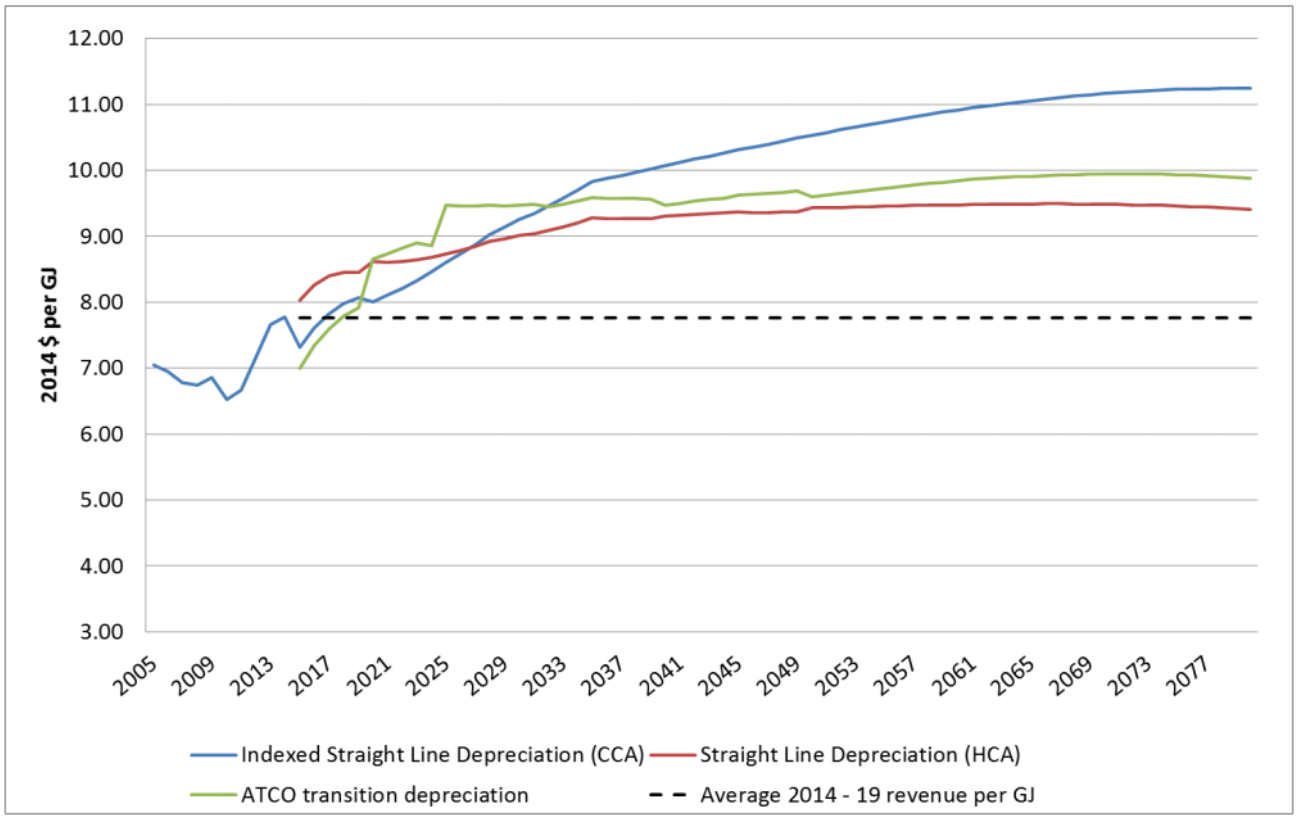
### 4.1.1 Implications of the errors in the Authority's analysis

The time profile or trend in LRMC does not, in and of itself, illicit any information as to the depreciation approach that complies with rule 89(1)(a). Rather, its relevance derives from the extent to which the trend in LRMC can be used to draw inferences as to the extent of divergence between LRMC and prices over time.

We have explained that correcting the errors in the Authority's analysis is likely to show that a conservative analysis of LRMC and prices over time should be undertaken on the basis that LRMC will remain flat over time. Importantly, such an analysis does not support the Authority's final decision that the transitional approach to determining depreciation, as proposed by ATCO, does not comply with rule 89(1)(a).

By way of example, consider the Authority's final decision as to the time profile of prices per GJ presented in Figure 2 below.

Figure 2 Average revenue (prices) per GJ, constant prices[62]




On the basis of the time profile of prices per GJ illustrated above, being that referenced in the final decision, and a conservative assumption that LRMC per GJ is flat over time, it is clear that the extent of departure between LRMC per GJ and prices per GJ:

- is less under ATCO's transitional approach, as compared with indexed straight line depreciation; and
- is not minimised under indexed straight line depreciation.

It follows that, in our opinion the Authority has erred in concluding that:

[62] The Authority, *Final Decision on Proposed Revisions to the Access Arrangement for the Mid-West and South-West Gas Distribution Systems,* June 2015, Appendix 9, Figure 29, page 694.

- the transitional approach to determining depreciation proposed by ATCO does not comply with rule 89(1)(a); and
- indexed straight line depreciation complies with rule 89(1)(a).

We therefore maintain the view in our earlier report that an analysis of LRMC per GJ and average prices per GJ over time shows that: [63]

> …after accounting for any price shocks during the transition, the adoption of an unindexed capital base with straight line depreciation better meets the requirements of rule 89(1)(a), as compared with an indexed capital base with indexed straight line depreciation, as proposed to be adopted by the ERA.

We understand that the ATCO has requested the models and calculations underpinning the Authority's final decision. Our expectation is that the information contained therein is likely to reinforce the above conclusion.

## 4.2 Other comments

In this section we make a number of other comments on the Authority's final decision.

### 4.2.1 Errors in the Authority's analysis of LRMC per connection

The Authority's conclusion that LRMC per connection is flat or rising through time is based on two analyses, both of which incorporate material errors. In particular:

- the Authority uses the average incremental cost approach to estimate LRMC per connection in nominal terms over time and then erroneously compares LRMC per connection in nominal terms with prices per connection in real terms; and
- the Authority erroneously interprets the data provided by the ABS to support a conclusion that LRMC is flat or slightly rising through time.

Notwithstanding that the Authority's comparison of LRMC and prices per connection appears to be undertaken on the basis that LRMC is rising,[64] these errors lead the Authority to conclude that LRMC per connection is flat or slightly rising through time.

In our opinion, correcting these errors would support a conclusion that LRMC per connection is flat or reducing through time and that a conservative assumption as to the likely trend in LRMC is that it will be flat over time.

### 4.2.2 Other considerations presented by the Authority

We note that, as in the draft decision, the Authority's final decision identifies two other considerations that it contends will cause either the straight line depreciation or the transition approach proposed by ATCO not to promote the rule 89(1)(a) criterion of efficient growth in the market for reference services. These are that not to adopt indexed straight line depreciation would lead to:[65]

- an unnecessary price shock in the near term; and
- inefficient use of upstream and downstream assets as they near the end of their lives.

[63] HoustonKemp, *Evaluation of ERA's Draft Decision on ATCO's Depreciation Allowance,* November 2014, page 27.

[64] See section 2.2.2 of this note and The Authority, *Draft Decision on Proposed Revisions to the Access Arrangement for the Mid-West and South West Gas Distribution System*, October 2014, Appendix 9, paragraphs 25 and 26.

[65] The Authority, *Final Decision on Proposed Revisions to the Access Arrangement for the Mid-West and South-West Gas Distribution Systems,* June 2015, page 431 to 434.

We address these considerations in our earlier report, ie, by way of example we explain that:[66]

> By its nature, the criterion established by rule 89(1)(a) addresses the objective of long term investment efficiency – both in pipeline assets and by upstream and downstream users. In other words, the most appropriate long term incentives for both pipeline owners and users will be created when the gap between best estimates of long term prices and long term LRMC is minimised. Once this essential test is met, there is no basis on which to conclude that a depreciation methodology that differs from that which meets the requirements of rule 89(1)(a) will give rise to superior long term investment outcomes.

[66] HoustonKemp, *Evaluation of ERA's Draft Decision on ATCO's Depreciation Allowance,* November 2014, page 27.

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# Appendix D :

## CEG - ERA's proposed amendments to Final Decision - Cost of debt, 27 August 2015

Connecting WA to natural gas

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# Memorandum

| | |
|---|---|
| To: | ATCO |
| From: | CEG – Asia Pacific |
| Date: | 27 August 2015 |
| Subject: | **ERA's proposed amendments to Final Decision – Cost of debt** |

## 1 Introduction

1. CEG provided ATCO with a report in early August 2015 that addressed the extent to which the ERA's description of its bond yield methodology was transparent and capable of being automatically updated.[1] One of the issues raised in that report was a lack of clarity about the instructions used to extract data from Bloomberg ("Bloomberg formulae").

2. Since then, the ERA has released a more detailed description of its methodology and a number of changes to its methodology[2] that, in part, responds to issues raised by CEG. In setting out their proposed amendments to the Final Decision, the ERA specifies:

   i. Exact search parameters on Bloomberg's Fixed Income Search ("SRCH") function;

   ii. Exact steps for downloading search results from Bloomberg to Excel, as well as obtaining data and yields of the downloaded bonds;

   iii. Exact formulae for converting foreign currency yields into AUD fixed equivalents using Bloomberg's Asset Swap (ASW) spreads formulae and the Bloomberg Swap Manager;

   iv. Exact steps for curve-fitting and calculating 10-year yields from the AUD fixed yields obtained in Step (iii); and

   v. Contingency approaches to data related issues.

3. Steps (i) to (iii) appear to be unchanged from the Final Decision, and the proposed amendments merely remove any remaining ambiguity in their initial descriptions.

[1] CEG, Automatic annual updating, August 2015.

[2] ERA, Mid-West and South-West Gas Distribution Systems Access Arrangement 2015 – 2019, Consultation on Proposed Amendments to the Final Decision, 21 August 2015.

Step (iv), however, contains a number of substantial changes to the methodology, as compared to the methodology stipulated in the Final Decision. These changes include the following all of which were proposed by CEG:

i. Using the "GRG nonlinear" algorithm in Excel Solver to fit the curves, as compared to an unspecified program in the Final Decision;[3]

ii. Extrapolating the Gaussian Kernel's effective **yields** using a different approach to the approaches used in the Final Decision;

iii. Estimating the Nelson-Siegel curve using the method set out in Diebold and Li (2006) to generate starting values for the optimisation algorithm before using those starting values to estimate the NS curve,[4] as well as changing one of the optimisation constraints;[5] and

iv. Estimating the Nelson-Siegel-Svensson curve using starting values that are partially based on the "previous years'" estimates,[6] as well as changing the optimisation constraints.[7]

4. Step (v) from paragraph 2. is newly added in the proposed arrangements, and was not included in the Final Decision. This step attempts to make the estimation approach mechanical without requiring any further judgement to be used in the event that the estimation output produces inconsistent results.

5. The remainder of this memo has the following structure:

- Section 2 notes that the detail the ERA has provided allows us to conclude that the ERA's initial application of the bond yield approach in the Final Decision is for a single day (2 April 2015) rather than a 20 day average ending on that day.

3 Based on the academic paper from which the ERA obtained their choice of constraints in the Final Decision, it appears likely that they had used the R software for estimating the NS and NSS curves.

4 Diebold and Li's (2006) method to generate starting values stipulates a specific choice of the decay factor $\lambda$ as a starting value and then obtains starting values for other parameters via linear regression. The Final Decision did not specify any starting values.

5 The Final Decision contained three constraints, one of which was changed in the proposed amendments. Specifically, the $\beta_{1t} + \beta_{2t} > 0$ constraint has been changed to $\beta_{0t} + \beta_{1t} > 0$. Since the estimated parameters in the Final Decision already conformed to the new constraints, the estimated NS curve should theoretically remain unchanged if the same starting value was used. This is confirmed in our analysis.

6 The proposed amendment generates starting values using the previous year's estimates of $\lambda_1$ and $\lambda_2$, and then obtains starting values for the other parameters via linear regression. The Final Decision did not specify any starting values, possibly because the Differential Evolution algorithm that the ERA might have used did not require starting values to be set out.

7 The Final Decision originally contained six sets of constraints that each featured upper and lower bounds. The proposed amendment has four constraints, which are similar to the three constraints set out in the amendment for the NS curve, with one constraint being added for the additional decay factor.

We consider that this creates an error in the DRP estimated by the ERA – which subtracts a 20 day average swap rate to arrive at its DRP estimate.[8]

- Section 3 sets out issues and suggested changes we have with the ERA's proposed amendments;
- Section 4 shows the impact, on various dates, of changing from the ERA's Final Decision methodology to either its amended methodology or to the CEG suggested amended methodology. In general there are only very small differences that result from the different methodologies. However, that conclusion is specific to the dates examined and need not hold on all future dates.

## 2 The DRP must be estimated using a bond yield and risk free rate estimated over the same averaging period

6. The debt risk premium (DRP) is the difference between the estimated yield on 10 year debt and the yield on the risk free base rate of interest (the 10 year swap rate). In section 4 of this memo we set out, amongst other things, why we believe that the ERA's bond yield was estimated on a single day (2 April 2015) rather than over the same 20 trading day period over which the risk free rate (the 10 year swap rate) as estimated. In this section we describe why we consider that this is an error. We also attempt to parse the ERA's intentions as expressed in its final decision.

7. Any economically meaningful estimate of the DRP under the bond yield approach must estimate the 10 year yield and the 10 year swap rate (the difference between which is the DRP) over the same period. If this is not the case then the resulting estimate is not a measure of the risk premium paid on corporate debt.

8. As set out in the appendix to this memo we have estimated the bond yield approach over the 20 days to 15 April 2015 as 4.880% using the ERA's amended methodology (or 4.884%/4.879% using the Final Decision/CEG recommended methodology). This is 11.5bp higher than the 2 April 2015 yield reported in the Final Decision. Therefore, the DRP should be 11.5% higher than estimated by the ERA. Specifically, the DRP should be 2.042% (rather than 1.927%).

9. In the alternative we note that the 10 year swap rate on 2 April 2015 was 2.72% - which is 11.7% lower than the average over the 20 day period. Therefore, even if the single day estimate of 4.765% yield was retained, the DRP estimated using a swap rate from a consistent period (i.e., the same day) would be 11.7bp higher (i.e., 2.044%).

10. Unless the base rate and the DRP are estimated over the same period, the resulting DRP estimate will be an estimate of the yield on corporate debt in "period A" (which

[8] ERA, ATCO Final Decision, paragraph 1624 on page 344.

reflects the base rate and DRP in "period A") less the base rate of interest in "period B". Consequently, the resulting estimate will be equal to the DRP in "period A" plus the difference in base rates of interest between "period A" and "period B". It will not, in fact, be a pure estimate of the DRP.

11. The final decision appears to be generally consistent with this logic an requires that averaging periods for estimating the bond yield and the base rate of interest must be the same 20 trading day periods.

> *The averaging periods for each year must be a nominated 20 trading days in the window 1 July to 31 October in the year prior to the relevant tariff variation, which will allow estimation of the updated DRP for inclusion in the relevant annual tariff variation.* [9]
>
> ...
>
> *The Authority considers that adopting* ***a consistent length for the averaging period – therefore of the same length as that used for the risk free rate*** *– has clear advantages for internal consistency.* [10] [Emphasis added]

12. However, the precise set of words used by the ERA to describe how it arrived at an estimate of the DRP under its initial application of the bond yield approach are somewhat ambiguous.

> *First, the Authority has developed a forward looking estimate for the DRP – for the period in 2015 that falls after 2 April 2015 –* ***that is consistent with the 20 day averaging period ending 2 April 2015****. Prior to that date, the Authority will use RBA monthly data in the trailing average DRP estimates.* [11] [Emphasis added]

13. In this passage the ERA refers to an estimate of the DRP that "that is consistent with the 20 day averaging period ending 2 April 2015" rather than explicitly saying it was estimated over this period. Subsequently the ERA states:

> *1623. For the purposes of calculating the 10 year DRP for the period 2015 in the Final Decision the Authority will use the 10 year cost of debt estimate of 4.765 per cent based on the average of all three ERA methods, estimated as at 2 April 2015.*

---

9 ERA, Final Decision on Proposed Revisions to the Access Arrangement for the Mid-West and South-West Gas Distribution Systems, 30 June 2015, p. 375.

10 Ibid, paragraph 1534, p. 323.

11 ERA, Final Decision on Proposed Revisions to the Access Arrangement for the Mid-West and South-West Gas Distribution Systems, 30 June 2015, paragraph 1529, p. 322.

> *1624. The 20 day average of the Australian dollar swap rate as at 2 April 2015 expressed as an annual effective yield was 2.838 per cent.*
>
> ...
>
> *1626.* ***Subtracting the 10 year swap rate of 2.838 per cent from the 10 year cost of debt gives a spread to swap of 1.927 per cent****. The Authority will therefore apply a DRP of 1.927 per cent as the spot estimate for the 2015 year for the purposes of the Final Decision.* [12] [Emphasis added]

14. We note that at paragraph 1623, unlike in paragraph 1624, the ERA's use of the phrase "as at 2 April 2015" is not immediately preceded by a statement that this is a 20 day trailing average ending "as at 2 April 2015". This may be an oversight or it may reflect a conscious decision by the ERA to estimate the DRP as the difference between the yield in one period and the risk free rate in another.

# 3 Issues with the proposed amendments

15. The proposed amendments are largely unambiguous and transparent, but there nevertheless appear to be a few remaining errors.

## 3.1 Step (i): Searching for bonds using Bloomberg's SRCH function

16. Our initial replication of the ERA's bond sample made use of a similar set of search parameters as the ones specified in the proposed amendments. Our search produced the same set of 92 bonds obtained by the ERA. As such, step (i) appears to have been carried out correctly.

## 3.2 Step (ii): Exporting bond search results to Excel, as well as obtaining bond data and yields

### *3.2.1 Incorrect implementation of the "pricing waterfall"*

17. Table 132 of the Final Decision set out a "pricing waterfall" of sources for retrieving bond price data, which is reproduced in Table 1 below.

[12] Ibid, paragraph 1623-1626, p. 344.

**Table 1: Pricing Waterfall Set in Bloomberg for AUD Equivalent Yield Conversion**

| Currency of Issuance | 1st Pricing Source | 2nd Pricing Source |
|---|---|---|
| USD | BVAL | TRAC |
| EUR | BVAL | BGN |
| GBP | BVAL | BGN |
| AUD | BVAL | CBBT |

*Source: ERA Final Decision, Table 132*

18. The ERA's intended usage of the pricing waterfall appears to involve obtaining price data from the first pricing source in each day and then using the second pricing source only for days in which the first pricing source did not produce any data. The ERA's implementation of the pricing waterfall thus involves modifying Bloomberg's default pricing sources and then using individual Excel formulae to obtain historical prices of the bonds. These Excel formulae are shown in cells G2 and H2 of Table 143 in the proposed amendments.

19. Such an approach, however, does not implement the pricing waterfall correctly. Instead, the ERA's method actually searches the first pricing source to identify whether any price data is available as at *the date that the spreadsheet is run*, failing which it uses the second pricing source and then the default exchange ("EXCH") price. The final choice of the pricing source is then automatically applied to the entire historical series of 20 days, instead of searching the pricing sources for every single date in the 20-day period.

20. This error causes the incorrect pricing sources to be used, and also means that running the spreadsheet on different days could potentially lead to different sets of bond prices being obtained.[13]

21. An alternative method that implements the pricing waterfall correctly would be to modify the Excel formula with an override that specifies the pricing source to be used, before collecting price data from the two relevant pricing sources for all 20 days, and then using an IF function in Excel to select one of the two pricing sources.

### *3.2.2 Usage of most recent price if there is no price data available on a particular date*

22. The ERA's formulae shown in rows G2 and H2 of Table 143 in the proposed amendments involve an override ("fill", "P") that responds to missing data on a particular date by filling in the previous known price of the bond.

[13] We note that there happens to be no missing observations between 2 April 2015 and 30 April 2015. As such, in this particular case, the ERA's methodology would obtain the correct pricing observations if its spreadsheet was run between 2 April 2015 and 30 April 2015.

23. This approach appears to contradict the intention behind requiring at least 10 yield observations over the averaging period of 20 days,[14] because it implies that any bond that had at least one pricing observation before the 20-day averaging period would always appear to have a full set of 20 observations throughout the period.

24. The correct method would thus be to modify the override to output an error whenever data is not available ("fill", "E") instead of returning the previous price.

## 3.3 Step (iii): Converting foreign currency yields into AUD fixed equivalents

25. The ERA's Excel formulae for converting foreign currency yields into AUD floating equivalents are shown in rows I2 and J2 of Table 143 in the proposed amendments, while the formulae for further converting these AUD floating yields into AUD fixed yields are shown in rows P2, Q2, and R2.

26. There appear to be two minor errors in these formulae, with the incorrect effective date and curve date being used as overrides.

### *3.3.1 Incorrect curve date of the swap curve*

27. Rows I2 and J2 of Table 143 in the proposed amendments, which convert foreign currency yields into AUD floating equivalents, each contain an override for the date of the swap curve to be used ("SW_CURVE_DT"). This is not a valid override for the field being searched, with the correct override being "OAS_CURVE_DT".

28. In spite of the above error, the ERA's formula still generates the intended asset swap spread, because Bloomberg sets the curve date to be equal to the settlement date by default if no curve date override is used. Since the incorrect "SW_CURVE_DT" override is not recognised, the default curve date will be used, which also happens to be the ERA's intended date.[15]

29. One possible modification to the formula would be to set the settlement date at 3 trading days after the trade date, which is the market convention for bonds issued in Australia. Our consultation with representatives from Bloomberg suggests that this practice is commonly used when valuing swaps, although it was also acknowledged that setting the settlement date on the same day as the trading date was sometimes used for simplicity. If such a modification were to be carried out, correcting the override of the swap curve date would be required.

[14] Final Decision, p. 680; Proposed amendments, p. 17.

[15] Refer to "3 days after" date.

### 3.3.2 *Incorrect effective date*

30. The formula in row P2 contains an override for the effective date ("EffectiveDate") of the floating-fixed swap, which the ERA sets at the issue date of the bond.

31. The effective date of the swap represents the date at which payment obligations begin. Since the desired output of Step (iii) is to convert all of the bond yields as at the trading day date (cell A1 in Table 143 of the proposed amendments) into their AUD fixed-rate equivalents, the correct effective date to be used should therefore also be the trading date (or three trading days after the trading date) instead of the issue date of the bond. This is also confirmed from our extensive consultation with representatives from Bloomberg.

32. The effect of this error is that the ERA ends up setting an effective date that is earlier than it should be, which in turn results in an asset swap that is of a slightly longer tenor than the correct one. If the effective date is set before the trading date then Bloomberg overrides this with the last payment date of the swap before the trading date. Consequently the tenor will be overestimated by up to 6 months. Intuitively, a longer swap tenor would result in higher yields as long as the swap curve is upward sloping.

## 3.4 Step (iv): Estimating the Gaussian Kernel, NS and NSS curves to obtain 10-year yields

33. The ERA's proposed amendments appear to address majority of the issues that CEG had previously identified, particularly in terms of the various ambiguities in the approach set out in the Final Decision, as well as the issues concerning its mechanical application. The amendments also adopt a variation of the Gaussian Kernel extrapolation method that was proposed by CEG, as opposed to the approach used in the Final Decision, whereby the target tenor is adjusted to result in an effective tenor of 10 years.[16]

34. Nevertheless, we note that the proposed amendments do not explicitly set out whether the ERA intends to re-estimate the cost of debt for its 20-day estimate as at 2 April 2015, or whether the amendments only apply to the estimates for subsequent averaging periods. Assuming that the proposed amendments also apply to the cost of debt estimate for 2015, then in stating that the starting values of $\lambda_1$ and $\lambda_2$ for the estimation of the NSS curve would be based on "last years'" starting values, the ERA did not state which values it would apply to the first set of estimations in 2015. It would be reasonable, however, to assume that the $\lambda_1$ and $\lambda_2$

[16] The AER's methodology uses the margin between the RBA's 7- and 10-year BBB **DRP**s to extrapolate the RBA Gaussian Kernel yield from its initial effective tenor to a 10-year effective tenor. In contrast, the ERA carries out extrapolation on its estimated Gaussian Kernel using the margin between its 7- and 10-year **yields**.

parameters in the Final Decision (1.642 and 4.583, respectively) would be used as the starting values.

## 3.5 Step (v): Contingency approaches to data related issues

35. The contingency approaches set out in the proposed amendments are not fully specified for the reasons set out below.

### *3.5.1 Event A – no bonds with more than 10 years maturity*

36. The current specification, repeated below, of the contingency is incomplete and ambiguous.

> *A linear extrapolation will be carried out using the formula outlined below this table and the averages of all three methods at 7 and at the effective tenor that results from target of 10 years.* (Table 157 on page 46, first row, second column)

37. We consider that the ERA's intention is best described by the following 'marked up' amendment to the above description

> *A linear extrapolation will be carried out using the formula outlined below this table where the yield inputs into that formula will be ~~and~~ the averages of all three methods (Gaussian kernel, NS and NSS) at a 7 year tenor (where this means "effective tenor" when applied to the Gaussian kernel) and at the ~~effective~~ tenor (where this means "effective tenor" when applied to the Gaussian kernel) that is equal to the effective tenor that results from adopting a target tenor of 10 years in the Gaussian kernel. (The effective tenor is the weighted average tenor of the sample using the Gaussian kernel weights associated with the target tenor).*

38. The objective of this approach is to attempt to prevent the possibility that the NS or NSS curves may behave erratically in a region where there is no data. We consider that this contingency is appropriate and reasonable.

### *3.5.2 Event B – non robust estimate*

39. Here the ERA is proposing a contingency that, if there are large differences between the yield estimates from the three methodologies, the averaging period will be extended by increments of 20 days until the differences fall below a threshold.

40. As specified the ERA does not state whether the averaging period will be extended 20 days forward (beyond the averaging period) or backwards (prior to the averaging period) or, potentially, 10 days in either direction. This should be specified.

# 4 Replicating the ERA's proposed methodology

41. We assess the effect of our proposed corrections to Step (iii) in paragraph 2. by replicating the ERA's proposed methodology with and without the corrections to Step (iii), as set out in Section 3.3 above.[17] We have not investigated the individual effects of Steps (i), (iv), and (v), since they have been modified to accommodate our previous advice, while Step (ii) cannot be exactly replicated since its output might differ depending on the day that the spreadsheet is run on.

42. The estimated on-the-day yields are presented in Table 2, Table 3, and Table 4 for 2 April 2015, 30 June 2015, and 31 July 2015. We note that, on these dates, there are only very small differences generated by the ERA's amended methodology and by our proposed modifications to the methodology. However, this need not always be the case.

43. We note that the ERA's Final Decision application of the bond yield approach (4.765%) appears to be an on the day (2 April 15) estimate and not an estimate over 20 trading days. We reach this conclusion based on the numbers reported in Table 2 - where our estimates are very close (on average less than one 10th of a basis point difference) to the ERA's published estimates that underpin its 4.765% value.

44. The ERA's estimates are presented only in Table 2 (for the date where the ERA has published an estimate). In addition, we present a further 3 estimates which are defined as follows:

    - CEG Gaussian kernel/NS/NSS (FD) is CEG's estimate following the methodology set out in the Final Decision using the clarifications provided in the ERA's most recent 21 August 2015 Notice;
    - CEG Gaussian kernel/NS/NSS (PA) is CEG's estimate following the methodology set out in the ERA's most recent 21 August 2015 Notice – including where this deviates from the methodology set out in the Final Decision. "PA" stands for the ERA's "proposed amendments";
    - CEG Gaussian kernel/NS/NSS ( (PAM) is CEG's estimate following the methodology set out in the ERA's most recent 21 August 2015 Notice but including modifications (M) proposed in this memo.

45. As seen in Table 2, all three estimates as at 2 April 2015 are very close, with the 10-year estimated cost of debt being separated by 0.2 bp. The standard deviations of the proposed amendments are both lower than 105 bp.

[17] Our estimations of the NSS curves use the $\lambda_1$ and $\lambda_2$ parameters in the Final Decision (1.642 and 4.583, respectively) as starting values.

## Table 2: Estimated on-the-day cost of debt – 2 Apr 2015

| | 3 | 5 | 7 | 10 | 10 (adj) |
|---|---|---|---|---|---|
| ERA Gaussian Kernel (FD) | 3.684 | 3.963 | 4.298 | 4.597 | 4.707 |
| CEG Gaussian Kernel (FD) | 3.694 | 3.966 | 4.302 | 4.599 | 4.707 |
| CEG Gaussian Kernel (PA) | 3.694 | 3.966 | 4.302 | 4.599 | 4.707 |
| CEG Gaussian Kernel (PAM) | 3.687 | 3.962 | 4.298 | 4.596 | 4.704 |
| | | | | | |
| ERA NS (FD) | 3.436 | 3.859 | 4.257 | 4.813 | 4.813 |
| CEG NS (FD) | 3.450 | 3.868 | 4.262 | 4.812 | 4.812 |
| CEG NS (PA) | 3.510 | 3.839 | 4.218 | 4.809 | 4.809 |
| CEG NS (PAM) | 3.500 | 3.834 | 4.215 | 4.808 | 4.808 |
| | | | | | |
| ERA NSS (FD) | 3.502 | 3.855 | 4.204 | 4.776 | 4.776 |
| CEG NSS (FD) | 3.518 | 3.859 | 4.207 | 4.779 | 4.779 |
| CEG NSS (PA) | 3.518 | 3.859 | 4.207 | 4.779 | 4.779 |
| CEG NSS (PAM) | 3.509 | 3.854 | 4.204 | 4.777 | 4.777 |
| | | | | | |
| **ERA average (FD)** | **3.540** | **3.892** | **4.253** | | **4.765** |
| **CEG average (FD)** | **3.554** | **3.898** | **4.257** | | **4.766** |
| **CEG average (PA)** | **3.574** | **3.888** | **4.242** | | **4.765** (0.052)* |
| **CEG average (PAM)** | **3.565** | **3.883** | **4.239** | | **4.763** (0.053)* |

*Source: FD: Final Decision; PA: Proposed amendments; PAM: Proposed amendments with Step (iii) modified; *numbers in brackets represent the standard deviation of the three estimates as per ERA contingency for Event B.*

46. It can be seen from Table 3 that all three cost of debt estimates are once again very close, although the Final Decision method produces a 10-year estimate that is 0.8 bp lower than the proposed amendments. This is largely attributed to the 10-year adjusted Gaussian Kernel estimate, since the Final Decision obtains the adjusted estimate by selecting the target tenor that corresponds to an effective tenor of 10 years, while the proposed amendments make use of a variation of the AER extrapolation method.

## Table 3: Estimated on-the-day cost of debt – 30 Jun 2015

| | 3 | 5 | 7 | 10 | 10 (adj) |
|---|---|---|---|---|---|
| CEG Gaussian Kernel (FD) | 4.188 | 4.537 | 4.919 | 5.273 | 5.372 |
| CEG Gaussian Kernel (PA) | 4.188 | 4.537 | 4.919 | 5.273 | 5.389 |
| CEG Gaussian Kernel (PAM) | 4.185 | 4.535 | 4.918 | 5.272 | 5.388 |
| CEG NS (FD) | 3.898 | 4.397 | 4.860 | 5.491 | 5.491 |
| CEG NS (PA) | 3.910 | 4.390 | 4.854 | 5.497 | 5.497 |
| CEG NS (PAM) | 3.907 | 4.389 | 4.853 | 5.496 | 5.496 |
| CEG NSS (FD) | 3.924 | 4.420 | 4.833 | 5.455 | 5.455 |
| CEG NSS (PA) | 3.924 | 4.420 | 4.833 | 5.455 | 5.455 |
| CEG NSS (PAM) | 3.921 | 4.418 | 4.832 | 5.454 | 5.454 |
| **CEG average (FD)** | **4.003** | **4.451** | **4.871** | | **5.439** |
| **CEG average (PA)** | **4.007** | **4.449** | **4.869** | | **5.447** (0.054) |
| **CEG average (PAM)** | **4.004** | **4.447** | **4.868** | | **5.446** (0.054) |

*Source: FD: Final Decision; PA: Proposed amendments; PAM: Proposed amendments with Step (iii) modified; numbers in brackets represent the standard deviation of the three estimates*

## Table 4: Estimated on-the-day cost of debt – 31 Jul 2015

| | 3 | 5 | 7 | 10 | 10 (adj) |
|---|---|---|---|---|---|
| CEG Gaussian Kernel (FD) | 4.094 | 4.419 | 4.799 | 5.050 | 5.124 |
| CEG Gaussian Kernel (PA) | 4.094 | 4.419 | 4.799 | 5.050 | 5.136 |
| CEG Gaussian Kernel (PAM) | 4.092 | 4.418 | 4.798 | 5.049 | 5.136 |
| CEG NS (FD) | 3.797 | 4.254 | 4.686 | 5.289 | 5.289 |
| CEG NS (PA) | 3.823 | 4.250 | 4.671 | 5.281 | 5.281 |
| CEG NS (PAM) | 3.821 | 4.248 | 4.671 | 5.280 | 5.280 |
| CEG NSS (FD) | 3.785 | 4.289 | 4.668 | 5.217 | 5.217 |
| CEG NSS (PA) | 3.780 | 4.292 | 4.670 | 5.206 | 5.206 |
| CEG NSS (PAM) | 3.778 | 4.291 | 4.669 | 5.206 | 5.206 |
| **CEG average (FD)** | **3.892** | **4.321** | **4.718** | | **5.210** |
| **CEG average (PA)** | **3.899** | **4.320** | **4.714** | | **5.208** (0.072) |
| **CEG average (PAM)** | **3.897** | **4.319** | **4.713** | | **5.208** (0.072) |

*Source: FD: Final Decision; PA: Proposed amendments; PAM: Proposed amendments with Step (iii) modified; numbers in brackets represent the standard deviation of the three estimates*

47. A similar observation can be made for Table 4, with the Final Decision method producing a 10-year estimate that differs from the proposed amendments. The 10-year adjusted estimate of the Gaussian Kernel remains different for the Final Decision method compared to the proposed amendments, but the NS and NSS estimates differ as well. Furthermore, for the 31 July 2015 dataset, the Final Decision method produces a higher 10-year estimate than the proposed amendments.

# 5 Appendix: 20 day average ending 2 April 15 vs on the day estimate for 2 April 2015

48. The table below compares the ERA's published estimates in the Final Decision for the bond yield approach with the estimates for a 20 day average ending 2 April 2015. Cross referencing to Table 2 shows that we replicate the ERA's published estimates when we perform the analysis on 2 April 2015 only. However, using a 20 day average ending on that date results in an 11.5bp higher estimate.

**Table 5: Estimated 20-day average cost of debt –2 Apr 2015**

| | 3 | 5 | 7 | 10 | 10 (adj) |
|---|---|---|---|---|---|
| ERA Gaussian Kernel (FD) | 3.684 | 3.963 | 4.298 | 4.597 | 4.707 |
| CEG Gaussian Kernel (FD) | 3.832 | 4.091 | 4.410 | 4.724 | 4.843 |
| CEG Gaussian Kernel (PA) | 3.832 | 4.091 | 4.410 | 4.724 | 4.838 |
| CEG Gaussian Kernel (PAM) | 3.819 | 4.085 | 4.407 | 4.722 | 4.837 |
| | | | | | |
| ERA NS (FD) | 3.436 | 3.859 | 4.257 | 4.813 | 4.813 |
| CEG NS (FD) | 3.584 | 3.992 | 4.379 | 4.922 | 4.922 |
| CEG NS (PA) | 3.652 | 3.961 | 4.328 | 4.915 | 4.915 |
| CEG NS (PAM) | 3.638 | 3.956 | 4.327 | 4.915 | 4.915 |
| | | | | | |
| ERA NSS (FD) | 3.502 | 3.855 | 4.204 | 4.776 | 4.776 |
| CEG NSS (FD) | 3.660 | 3.980 | 4.319 | 4.886 | 4.886 |
| CEG NSS (PA) | 3.660 | 3.980 | 4.319 | 4.886 | 4.886 |
| CEG NSS (PAM) | 3.646 | 3.975 | 4.317 | 4.885 | 4.885 |
| | | | | | |
| **ERA average (FD)** | **3.540** | **3.892** | **4.253** | | **4.765** |
| **CEG average (FD)** | **3.692** | **4.021** | **4.369** | | **4.884** |
| **CEG average (PA)** | **3.714** | **4.011** | **4.352** | | **4.880** (0.039) |
| **CEG average (PAM)** | **3.701** | **4.005** | **4.350** | | **4.879** (0.039) |

*Source: FD: Final Decision; PA: Proposed amendments; PAM: Proposed amendments with Step (iii) modified; numbers in brackets represent the standard deviation of the three estimates*