AUGUST 2024
CM REF: D24/212000

Victorian response to CGC 2025 Review

Draft Report - Transport Addendum

VICTORIA State Government | Treasury and Finance

The Secretary
Department of Treasury and Finance
1 Treasury Place
Melbourne Victoria 3002
Australia
Telephone: +61 3 9651 5111
dtf.vic.gov.au

Authorised by the Victorian Government
1 Treasury Place, Melbourne, 3002

If you have copyright queries or would like to receive this publication in an accessible format email information@dtf.vic.gov.au

This document is available in Word and PDF format at dtf.vic.gov.au

Contents

1. Introduction

In August 2024, the Commonwealth Grants Commission (CGC) provided states and territories (states) an addendum to its draft report of its 2025 methodology review on the transport assessment. Victoria thanks the CGC and its staff for the opportunity to comment.

This response provides Victoria's views on the transport addendum and should be considered in conjunction with Victoria's response to the full draft report provided to the CGC in August 2024. Comments in this response cover the:

- results of the urban transport econometric model
- calculation of population-weighted density
- blending of the recurrent expenses assessment between the model and urban populations
- assessment approach to urban transport investment
- assessment of expenditure on urban transport provided by V/Line.

Victoria's positions on transport provided in this response on the listed topics supersede those provided earlier in response to the draft report. Victoria's views on any transport assessment issues not noted remain the same as those provided in response to the draft report.

2. Summary of Victoria's recommendations

Victoria's recommendations in response to the transport addendum	
Urban transport econometric model	• Victoria continues to support the CGC's broad approach to assessing urban transport expenses using the model developed as part of the 2020 Review. • Victoria reiterates that it does not support incorporating 2022-23 expenditure data and considers they are overly influenced by COVID-19. As noted in its response to the draft report, as a compromise Victoria recommends the CGC make an additional data request ahead of the 2030 review for 2025-26 expenses data as soon as they are available to update the urban transport model. • Victoria supports retaining the variables used in the econometric model from the 2020 approach.
Calculation of population-weighted density	• Victoria continues to support the inclusion of population density as an important driver of states' urban transport needs. • Victoria does not support changing the basis for calculation of PWD and recommends the CGC retain the SA1-based approach to calculating density.

Blending of the recurrent expenses assessment	• Victoria does not support the change to the blending ratio of the model to urban populations for the urban transport expenditure assessment and considers the current blending sufficiently accounts for any data concerns. Victoria recommends a blending share of 75 per cent of the econometric model and 25 per cent urban populations remains appropriate.
Population squared approach to investment	• Victoria supports the CGC's position to retain the urban population squared approach for the population component of the urban transport investment assessment.
Blending the investment assessment	• Victoria recommends the CGC retain the population squared approach for the population-based share of the urban transport investment assessment. • Victoria recommends the CGC blend the investment component 35 per cent to populations squared and 65 per cent using the econometric model.
Non-urban transport	• Victoria recommends the CGC allocate a proportion of V/Line expenditures to the urban transport component, based on the detailed data provided.

3. Urban transport recurrent expenditures

3.1 Results from updating the urban transport model

Since the draft report, the transport addendum provides updated results from the urban transport econometric model using states' 2022-23 financial data and implementing the draft report's proposed changes to the proxy variables. Additionally, the CGC has provided states directly with further econometric outputs.

Victoria reiterates its concerns around using 2022-23 and 2023-24 state expenditure data for urban transport. As noted in its tranche 1 submission, 2022-23 is too early to ascertain post-COVID-19 'normal' conditions that will persist until the 2030 review. This will likely be the case for 2023-24 data yet to be collected.

Victoria supports the conclusion in the addendum to retain the variables used in the econometric model from the 2020 review methods. As noted in its response to tranche 1, Victoria considers while some are statistically insignificant, they have merit for inclusion.

Victoria's recommendations

- Victoria continues to support the CGC's broad approach to assessing urban transport expenses using the model developed as part of the 2020 Review.
- Victoria reiterates that it does not support incorporating 2022-23 expenditure data and considers they are overly influenced by COVID-19. As noted in its response to the draft report, as a compromise Victoria recommends the CGC make an additional data request ahead of the 2030 review for 2025-26 expenses data as soon as they are available to update the urban transport model.

- Victoria supports retaining the variables used in the econometric model from the 2020 approach.

3.2 Re-calculating population-weighted density using the square kilometre grid

The results provided in the addendum indicate that the most significant change to the urban transport assessment is the proposal to change the basis of calculation of population-weighted density (PWD). The CGC propose to move from using the Australian Bureau of Statistics' (ABS) statistical area level 1s (SA1s) to a square kilometre grid to aggregate for the PWD of ABS Significant Urban Areas (SUAs).

Victoria has significant concerns with this approach and recommends the CGC does not adopt the square kilometre grid approach and instead retains the calculation based on SA1s. Victoria does not consider the issues identified are commensurate with the scale of the change the CGC has suggested. In addition, the square km grid approach introduces additional technical issues as well as a greater degree of complexity.

Combining the impact of the CGC's proposed changes in states' GST shares of the new measure and the changes to the regression model, the total impact on GST distribution reported in the addendum across all states is $676 million (if applied to 2024-25). The total effect of the transport recurrent expenses assessment in the 2024 Update for 2024-25 was a redistribution of $1.9 billion compared to an equal per capita share (including urban and non-urban transport). This means the change to calculating PWD is worth over a third (35 per cent) of the total previous effect of the transport assessment, including non-urban transport. Victoria does not consider a change of this magnitude is appropriate given Victoria's concerns with the measure around accuracy, robustness and the loss of simplicity.

In summary, Victoria considers the significant GST redistribution proposed is not warranted as the square kilometre grid approach:

- understates the variation in density between states and its effect on expenses
- leads to a less robust econometric model, introducing greater potential for errors
- is motivated by reducing the volatility of the SA1-based measure, which Victoria considers is not an issue in the context of the CGC's methods, and causes a smaller, less frequent impacts on the GST distribution than other drivers not considered volatile
- does not align to the CGC's concept of urban areas and introduces additional complexity and errors to fit the assessment methods with the change in geography
- is considered by the external stakeholders the addendum references to be more appropriate for non-urban areas and analysis over time, which are not relevant for this assessment
- is not the preferred method in the academic literature, which utilises a variation of possible measures
- does not appear to resolve the issue raised around inconsistency of the inclusion of non-residential land within SA1s.

These issues are discussed in turn in the following sections 3.2.1 to 3.2.7.

Victoria's recommendations

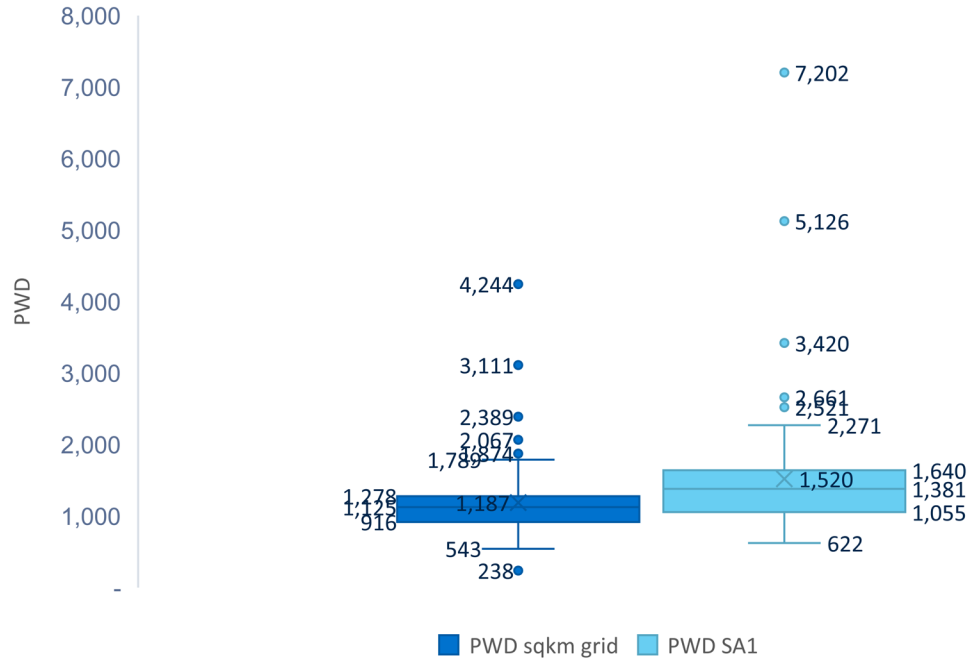
- Victoria continues to support the inclusion of population density as an important driver of states' urban transport needs.
- Victoria does not support changing the basis for calculation of PWD and recommends the CGC retain the SA1-based approach to calculating density.

3.2.1 Underestimation of the effect of density

The significant impacts of the proposed change are concerning as the two PWD measures (calculated on SA1s and the square kilometre grid) are intended to measure the same underlying concept. The proposal does not represent a change in the CGC's conceptual view such that Victoria and NSW are less densely populated, or that density is less important to urban transport needs. Rather the change is motivated by technical concerns and volatility, which Victoria considers should not so significantly change the importance of density in the assessments.

The change to the square kilometre grid approach essentially has the effect of condensing the variation in density between SUAs, thereby reducing the importance of PWD in the assessment. Figure 1 and Table 1 below show the range of values of PWD is reduced under the square kilometre grid approach. Measures of variance in the PWD of SUAs are lower using the grid approach, and the range and interquartile range are smaller. Given (as discussed below) the CGC's model is less robust using the square kilometre grid approach, Victoria considers that the greater variation using the SA1 method reflects differences in the need for spending on urban transport that the CGC's methods should account for.

Figure 1: Plot values, range and interquartile range of PWD measures, 2021-22



Source: DTF calculation on CGC supplementary data for the addendum

Table 2: Summary statistics on variance of PWD measures

Statistic	Square kilometre grid PWD	SA1 PWD
Variance	256,352	667,615
Standard deviation	506	817
Range	4,006	6,580
Interquartile range	356	576

Source: DTF calculation on CGC supplementary data for the addendum

The draft report raises the extent of changes in PWD from the ABS' 2021 Census rebasing and revisions to population and area definitions as a cause for concern. Victoria considers the data revisions by the ABS after the Census reflect that Melbourne became relatively denser compared to other areas, and that this should be incorporated in the assessments. The assessments should change in response to these revisions for a more accurate reflection of states' needs, using the most up to date data.

The CGC's position in the 2024 Update paper released earlier in 2024 was that the 2021 Census-based SA1s were appropriate for its purposes. It is unclear why this conclusion should change in a such a short time period, with no change to quality of the underlying ABS data. In the paper the CGC noted:

- "There is no indication that the definition of SA1s in the 2016 Census is more or less reflective of urban transport needs than the 2021 Census-based definitions. Nor does the Commission have a reason to believe the 2021 Census-based geographies are unreliable."
- "The assessment was designed to model urban transport costs as cities grow and density changes. As noted in the 2024 Update new issues discussion paper, the newly defined urban areas have similar urban centre characteristics to those modelled in the regression using 2016 Census-based geographies. This is evidenced by the lack of statistically significant differences between 2016 Census areas and the 2021 Census areas for all of the urban centre characteristic variables … In addition, while some individual urban area boundaries were altered to capture new developments, over 90% of urban area boundaries remained unchanged."[1]

Other sources corroborate the growth in Melbourne's population and density which should be reflected in the assessments. In terms of raw population growth, Melbourne is the fastest growing capital city in Australia, and has overtaken Sydney as Australia's largest city (using the SUA definition).[2,3] Property consulting firm CoreLogic notes in 2003, Melbourne only had one of the top 20 densest SA2s in Australia (Melbourne CBD East), whereas by 2023 it had 7, displacing 3 from Sydney. CoreLogic is quoted by the ABC as finding that "Melbourne has increased its population

[1] CGC 2024 Update (https://www.cgc.gov.au/sites/default/files/2024-06/2024%20Update_FINAL.pdf)
[2] https://www.theguardian.com/world/2023/apr/17/melbourne-overtakes-sydney-as-australias-most-populous-city#:~:text=Melbourne's%20population%20was%204%2C875%2C400%20at,it%20last%20held%20in%201905.
[3] https://www.abs.gov.au/media-centre/media-releases/capital-city-growth-highest-record

density by 45 per cent over the past two decades. In the same period, Sydney has managed only a 31 per cent rise in density."[4]

ABS boundary changes were a relatively minor factor in the 2021 Census revisions compared to changes in populations. In addition, the ABS' boundary revisions are not arbitrary and reflect when areas reach a certain size or infrastructure level. These criteria are applied consistently and systematically across states. The CGC's assessments should reflect changes to the structures of urban areas these revisions represent. On the 2021 Australian Statistical Geographic Standard (ASGS) revision, the ABS noted:

- "Alterations to Mesh Blocks, SA1s and SA2s are made, primarily through splitting areas, to mirror changes occurring on the ground, such as new housing developments or altered transport infrastructure. These changes reflect recent population growth, and allow users to access meaningful statistics on communities of interest."
- "A relatively small number have changed; 1% of Mesh Blocks and 4% of SA1s changed since ASGS Edition 2 (2016)… This very small amount of change is mainly due to splitting large areas in growth areas into two or more smaller areas." [5]

According to the New Issues paper in the 2024 Update, the change in Melbourne's population due to the 2021 Census revision relative to other cities was similar to the change in its PWD. Between the 2016 and 2021 Census Melbourne's population increased 2.1 per cent or 2.6 times the national capital-city average, and its PWD increased 21.8 per cent or 2.1 times the national capital-city average.[6]

Victoria considers it is critical the urban transport assessment fully account for the pressures states face due to density and congestion, as this is currently the only area of the assessments to do so. Victoria's response to the draft report noted evidence of congestion and density effects across state service areas in response to the administrative scale assessment. In addition, Victoria has presented evidence of the additional costs of density for investment in other areas including social infrastructure as part of its response to tranche 2 consultation. The square kilometre grid approach significantly detracts from the effect of density overall, which Victoria considers is inappropriate given its preexisting lack of representation in the assessments.

3.2.2 Loss of robustness in the econometric model

The econometric results the CGC has provided show that using SA1s is the most robust quantitative approach, despite the technical rationale stated for the change to the square kilometre grid approach.

Table 2 presents the information the CGC has provided on the robustness of its models using the different PWD measures. The SA1-based approach using the 2020 Review model has the highest adjusted R-squared and the lowest residual standard error. Data provided directly to states shows the SA1-based approach is also preferred when the model is updated using the changes proposed in the addendum on other aspects of the assessment (using 2022-23 expenses data and adjustments to 2021 Census data). The adjusted R-squared is higher and standard errors are lower using the

[4] https://www.abc.net.au/news/2024-04-28/housing-density-surging-in-sydney-and-melbourne-but-prices-rise/103773604
[5] https://www.abs.gov.au/statistics/standards/australian-statistical-geography-standard-asgs-edition-3/jul2021-jun2026/main-structure-and-greater-capital-city-statistical-areas/changes-previous-edition-asgs
[6] CGC 2024 Update (https://www.cgc.gov.au/sites/default/files/2024-06/2024%20Update_FINAL.pdf)

SA1-based approach to PWD compared to the square kilometre grid approach. Evaluating the information provided, the SA1 approach is technically preferred.

Qualitatively the draft report preferences a reduction in 'volatility' to the robustness of the SA1 approach. Victoria favours the more robust model as a more accurate representation of HFE.

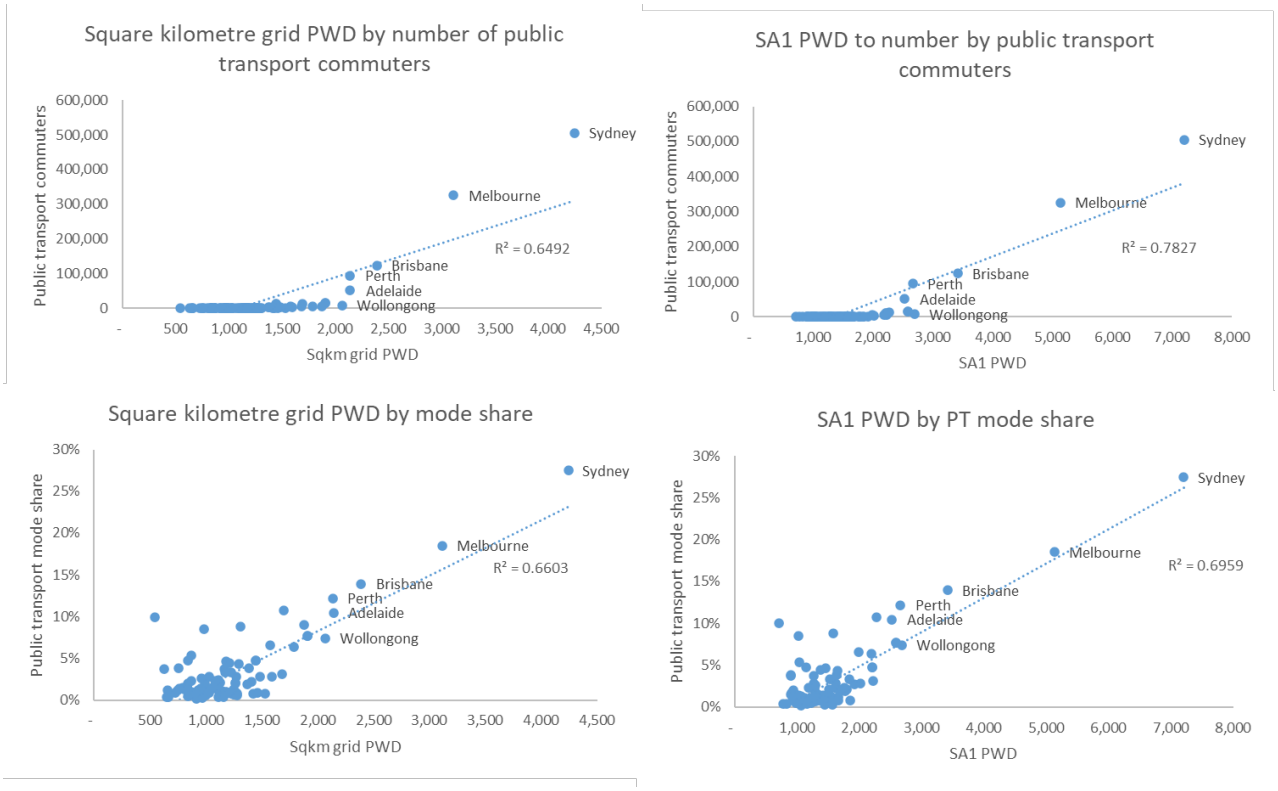
Table 2: Select statistical measures from CGC's urban transport models

Model	Density measure	Adjusted R-squared	Residual standard error
2020 Review model	SA1-based	0.8303	56.22
	Square kilometre grid	0.8107	59.69
Draft report addendum model	SA1-based	0.8127	72.11
	Square kilometre grid	0.7855	77.16

Source: CGC transport addendum supplementary data

Illustrating this point, Figure 2 compares the square kilometre grid and SA1-based PWDs to measures used in the assessment of transport services – the number of public transport commuters in each SUA and the share of public transport use in the SUA. Both measures of density are highly related to public transport use, however the SA1-based measure is more related to the transport measures. Square kilometre grid-based PWD explains 65 per cent of the variation in the number of public transport commuters, whereas the SA1-based approach explains 78 per cent (R-squared values). For the share of public transport commuters, the R-squared values are 66 per cent for the square kilometre grid approach and 70 per cent for the SA1-based approach.

Figure 2: Relationships between PWD measures and the number of public transport commuters and the public transport mode share in SUAs, 2021-22



Source: CGC transport addendum supplementary data. Note: 2021-22 PWD is presented for closest relation to 2021 Census variables.

3.2.3 Inconsistency defining issues with volatility

The draft report presents the volatility of the SA1 PWD measure as the most significant rationale for the move to the square kilometre grid approach. Victoria considers this is not an adequate motivation for such a significant change in the redistribution of GST revenue. Victoria considers the PWD measure is not significantly volatile within the context of the GST distribution.

Ensuring predictability of GST revenues to the extent reasonable is a worthwhile aim for the CGC's methods. This is recognised in part through the 'practicality' supporting principle, noting the practical need for states to have predictability and stability in GST revenues.[7]

However, predictability should not be weighted above achieving HFE or the other supporting principles, in particular, simplicity. Victoria's view is that the change in PWD measure detracts from HFE and increases complexity and as such, any gain in predictability is not justified.

[7] CGC 2025 Methodology Review - Commission's position on fiscal equalisation, supporting principles & assessment guidelines

3.2.3.1 A 5-yearly cycle has been accepted for significant changes to the GST distribution and does not constitute volatility

Victoria does not consider changes every 5 years due to the Census constitute 'volatility'. Volatility by definition refers to frequent changes over short time periods. In the context of the CGC's methods, volatility is an issue where it becomes difficult for states to have a reasonable expectation of their future GST revenues. In the position paper on fiscal equalisation, supporting principles and assessment guidelines, the CGC noted "In the 2020 Review the Commission recognised that, while stability and predictability were not essential to achieving horizontal fiscal equalisation, they were of practical relevance in its choice of methods through their impact on state budget processes."[8]

The Census constitutes significant new detailed data for the CGC's assessments. Material changes across assessments should be regarded as accepted practice, and unavoidable to achieve HFE using the best, most up to date data. While the changes to PWD between Censuses may cause large impacts on the GST distribution, Victoria does not consider they constitute volatility as they:

- occur only every 5 years (they are infrequent), and
- are known to occur at set times in advance (they are expected).

A 5-yearly cycle for changes is explicitly considered an appropriate balance between stability and responsiveness for the CGC's context in the case of the method review cycle. The draft report noted "The Commission considers that, in most cases, the approach of 5-yearly reviews and annual updates has appropriately balanced stability in methods with the need to capture changes in state circumstances over time."

The 5 yearly reviews result in significant changes to the GST distribution that states are expected to manage. However, these are not considered volatile and states and the CGC broadly accept the cadence of review process and that this may cause significant redistributions of GST revenue. The 2020 Review caused a change in redistribution of GST revenue of $1.3 billion due to method changes alone (across all categories, not only transport).[9] In contrast, data updates from the 2021 Census to urban centre characteristics were smaller, redistributing $737 million in GST revenue in the 2024 Update.[10]

Victoria has worked with the CGC to improve the flows of information to assist states' forecasting. Specifically in the case of the 2021 Census, Victoria requested early information to understand the potential impacts ahead of the relevant update report's release. Victoria considers these initiatives, including providing states earlier access to more of the assessment data, are a more appropriate mechanism to tackle the perceived volatility in this case.

3.2.3.2 Other data changes are more significant and not considered volatile

Identifying changes to SA1-based PWD as volatile is inconsistent with the treatment of other significant data updates. Revisions to PWD should not be considered volatile, in the same way as other Census data revisions are not considered volatile.

The rebasing of populations after the 2021 Census caused a more significant impact on GST distributions than changes in PWD but has not been described as volatile in the CGC's context. The

---

[8] CGC 2025 Methodology Review - Commission's position on fiscal equalisation, supporting principles & assessment guidelines
[9] CGC 2020 Review report volume 1 - GST relativities
[10] Note the change attributable to only PWD is likely smaller than this figure, as it represents changes to 'urban centre characteristics' which capture changes to PWD among other variables such as populations in urban areas.

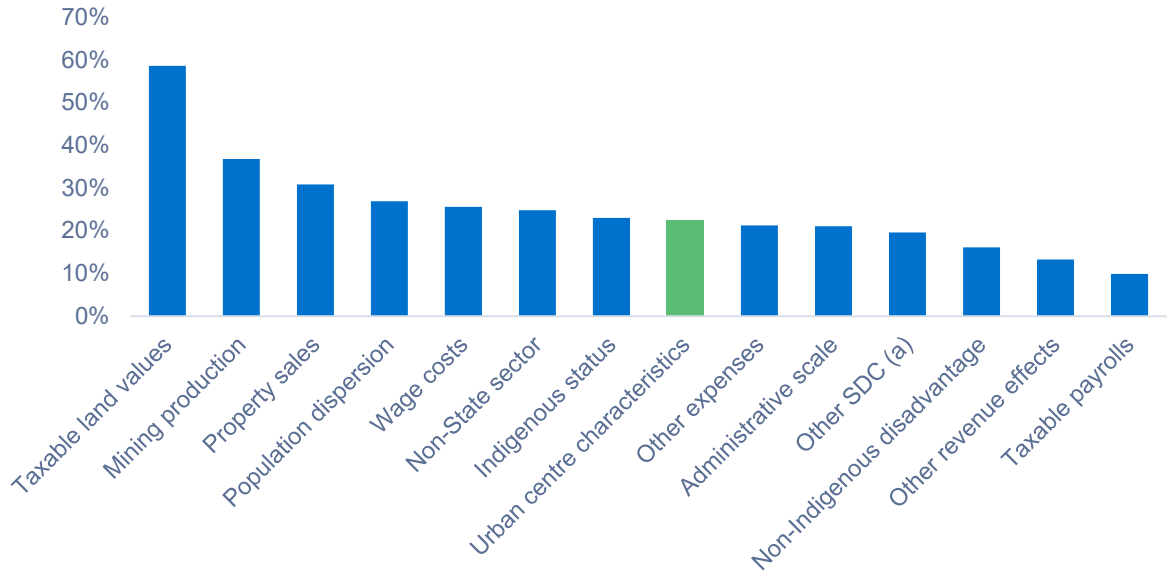
2023 Update for example incorporated rebased populations from the 2021 Census which redistributed $1.2 billion of GST revenue, greater than the $737 million redistributed from updating PWD.[11]

The incorporation of updated 2021 Census-based sub-state First Nations population data in the 2024 Update was also more significant than the change in PWD but was not considered volatile. Nationally people identifying as of Aboriginal and/or Torres Strait Islander origin increased by 25 per cent from the 2016 to 2021 Censuses. This was of a similar magnitude to the intercensal changes of First Nations populations in the 2011 (20.5 per cent) and 2016 Censuses (18.4 per cent).[12]

In comparison, the largest change among states in PWD between the 2016 and 2021 Censuses reported in the transport addendum was 21.8 per cent for Victoria (noting the average change for all SUAs was an increase of 4 per cent). This is commensurate with the magnitude of the change in First Nations populations, which was not considered an issue for volatility. The share of First Nations populations is a more significant measure in the GST distribution than PWD, used across a greater share of the assessment methods to redistribute $2.9 billion in 2024-25.

As a simple analysis on the volatility of factors influencing the GST distribution, Victoria has collated the 'Drivers of difference from an EPC distribution of GST' from the past 10 years of CGC updates. This covers the full period of the 2015 Review and 2020 Review methods. Figure 3 shows below that over the full period, urban centre characteristics was one of the least variable drivers, ranked 8th of 14 by relative standard deviation.[13] As is expected, property related taxes and mining revenues were areas with the largest variance over the period.

Figure 3: Relative standard deviation of drivers of the difference from an EPC distribution of GST



Source: CGC Update reports from 2015 to 2024

[11] CGC 2023 Update of GST revenue sharing relativities
[12] Noting the figure relates to counts rather than populations, typically the ABS' post-enumeration survey process aims to address undercounting of First Nations populations meaning the growth rate of populations may have been higher. https://www.abs.gov.au/statistics/people/aboriginal-and-torres-strait-islander-peoples/understanding-change-counts-aboriginal-and-torres-strait-islander-australians-census/latest-release
[13] Note population growth, capital improvements, cost of construction and Commonwealth payments are all excluded as the data are not presented consistently over the 10 year period.

Victoria questions why PWD is singled out as a volatility concern when issues with other more variable assessments have not been discussed in the review. It is notable that no significant method changes have been proposed to smooth volatility in the property tax or mining revenue assessments, a position Victoria supports. Mining for example was a significant topic of the CGC's first Research Paper on Fiscal equalisation and mining booms, which noted "Volatility in mineral prices has contributed to significant fluctuations in states' GST shares, particularly for Western Australia." The conclusion of the paper is that alternatives to reduce volatility in that case would have worsened HFE: "Other options the Commission considered to reduce volatility would not have captured states' revenue capacity nor achieved the same degree of fiscal equalisation." [14] Victoria considers the same applies to PWD in this case, where changes are being proposed to minimise perceived volatility, but serve to reduce the accuracy of the assessments and achievement of HFE.

3.2.3.3 There are key differences between the calculation of PWD to other areas where the CGC has smoothed volatility

Victoria supported the CGC's approach to smooth volatility in the wages assessment as part of the 2025 review. However, this case has key differences to the calculation of PWD that illustrate why it was appropriate to mitigate volatility in that case that are not relevant for PWD:

- Significant changes to the wages model occurred annually, meaning they were frequent and created volatility at each CGC update impacting states' ability to forecast. This contrasts to the 5-yearly adjustments to PWD.
- There was no conceptual basis to believe that conditions in states' labour markets fluctuated as significantly or frequently as the results of the wages model suggested.[15] In contrast, it is reasonable to expect over a 5-year period between Censuses the composition of population dispersion can change significantly.

3.2.3.4 The square kilometre grid does not remove the need for revisions

As the CGC's model is based on SUAs, any smaller area definition cannot avoid the issue of Census-based boundary revisions, as SUA boundaries are also amended at each Census. Victoria acknowledges the addendum shows variability in the SA2 and square kilometre grid approaches is lower than the SA1-based measure. However, there are still changes attributed to changes in boundaries that cannot be completely eliminated.

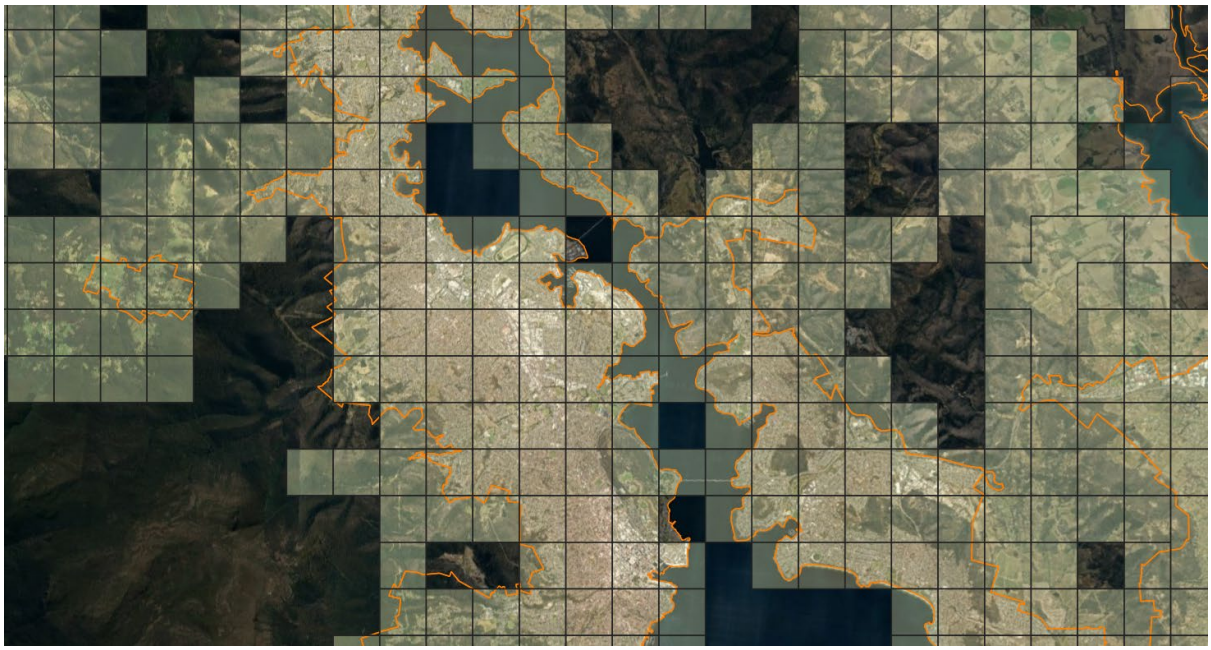
As discussed in Section 3.2.4, grid square populations are calculated from SA1 populations. Further, ABS Urban Centre and Locality (UCL) areas used in the PWD calculation are collections of SA1 areas. An SA1 is classified as a UCL if it meets density and/or urban infrastructure criteria, for example, if the SA1 has a population density greater than or equal to 200 persons per square kilometre.[16]

As demonstrated in Figure 4, covering Hobart, UCL boundaries are not aligned with the 1km square grid.

---

[14] CGC Research Paper #1 Fiscal equalisation and mining booms
[15] In the consultation paper on wages from June 2023, the CGC stated "Since the ABS produced data enabling annual estimates of relative state wage levels in 2014–15, the assessment has been quite volatile. This volatility does not align with recognised stability of wages. Wages are known to be 'sticky' and slow to respond to shocks."
[16] https://www.abs.gov.au/statistics/standards/australian-statistical-geography-standard-asgs-edition-3/jul2021-jun2026/significant-urban-areas-urban-centres-and-localities-section-state/urban-centres-and-localities

Figure 4 : Hobart UCL and 1km grid squares



Source: ABS 2021 UCL boundaries (orange) and Australian population grid 2023

Note: Dark squares contain zero population.

The CGC provided states with the code used to calculate PWD using the square grid method. Because, the grid squares do not align with UCL, the CGC must determine which grid squares 'overlap' each UCL to calculate PWD. When SA1 boundaries are revised, UCL boundaries will also be revised. Consequently, the grid squares, or portions of grid squares, that overlap the UCL will change too. Therefore, since UCL are composed of SA1, changes to SA1 boundaries will still affect the calculation of PWD.

The Victorian Department of Treasury and Finance has used the code provided by the CGC to calculate PWD using the previous UCL boundaries from the 2016 census, holding populations fixed at 2021-22 values. As shown in Table 3 below, using the grid method, the impacts on PWD of a change in UCL boundary definitions alone, from the 2016 Census to the 2021 Census, are of significantly greater magnitude than the CGC's calculated change in PWD between the 2016 and 2021 Census periods shown in Table 1 of the Transport chapter of the draft report, partially reproduced as Table 4 below. The results outlined in Table 4 appear to mask the level of underlying variation driven by boundary redefinitions under the square grid method. Given unknown future population variability, Victoria considers that future variability in PWD under the square grid method could potentially be substantially higher than that indicated by the single reference point presented in Table 4.

Table 3. Population-weighted density of SUA based on square kilometre grid comparing 2016 Census UCL boundaries with 2021 Census UCL boundaries (persons per square kilometre, 2021-22 population)

	Sydney	Melbourne	Brisbane	Perth	Adelaide	Hobart	Canberra	Darwin
2016 UCL boundaries	4,250	3,109	2,561	2,304	2,207	1,587	2,106	1,887
2021 UCL boundaries	4,244	3,111	2,389	2,137	2,140	1,575	2,022	1,874
Change (%)	-0.14	0.07	-6.73	-7.26	-3.06	-0.77	-3.98	-0.73

Source: Victorian Department of Treasury and Finance calculations, based on CGC-provided R code and ABS boundary and square grid population data.

Table 4. Population-weighted density based on the square kilometre grid, (persons per square kilometre, 2021–22), reproduced from CGC 2025 Review Draft Report

	Sydney	Melbourne	Brisbane	Perth	Adelaide	Hobart	Canberra	Darwin
2016 Census	4,234	3,034	2,381	2,120	2,135	1,574	1,975	1,874
2021 Census	4,244	3,111	2,389	2,137	2,140	1,575	2,022	1,874
Change (%)	0.24	2.54	0.34	0.78	0.21	0.06	2.36	-0.01

Source: CGC 2025 Review Draft Report, Transport chapter, Table 1.

3.2.4 Lack of alignment to urban areas causing additional complexity and introducing errors

The CGC uses the ABS SUAs as its definition of urban areas.[17] Any smaller area used to calculate PWD (SA1s or square kilometre grids) need to be aggregated to the SUA level for use in the CGC's model. The square kilometre grid introduces issues with this aggregation as it:

- is not conceptually related to a concept of urban or transport services and infrastructure, and so does not capture the principle of what states do
- does not align with the CGC and ABS's definitions of urban under UCLs and SUAs, and so creates complexity and calculation issues to meet a definition of urban.

3.2.4.1 Conceptual issues with the square kilometre grid and 'what states do'

The urban spatial units from the ASGS have a conceptual basis that link to a definition of urban areas, population density or transport services and infrastructure. The square kilometre grid on the other hand does not have a conceptual basis related to urban areas or transport services. The alignment of the grid is arbitrary and not related to where people live or public transport provision.

The ABS notes specifically how its urban units are designed to build on one another to capture the concept of urban areas:

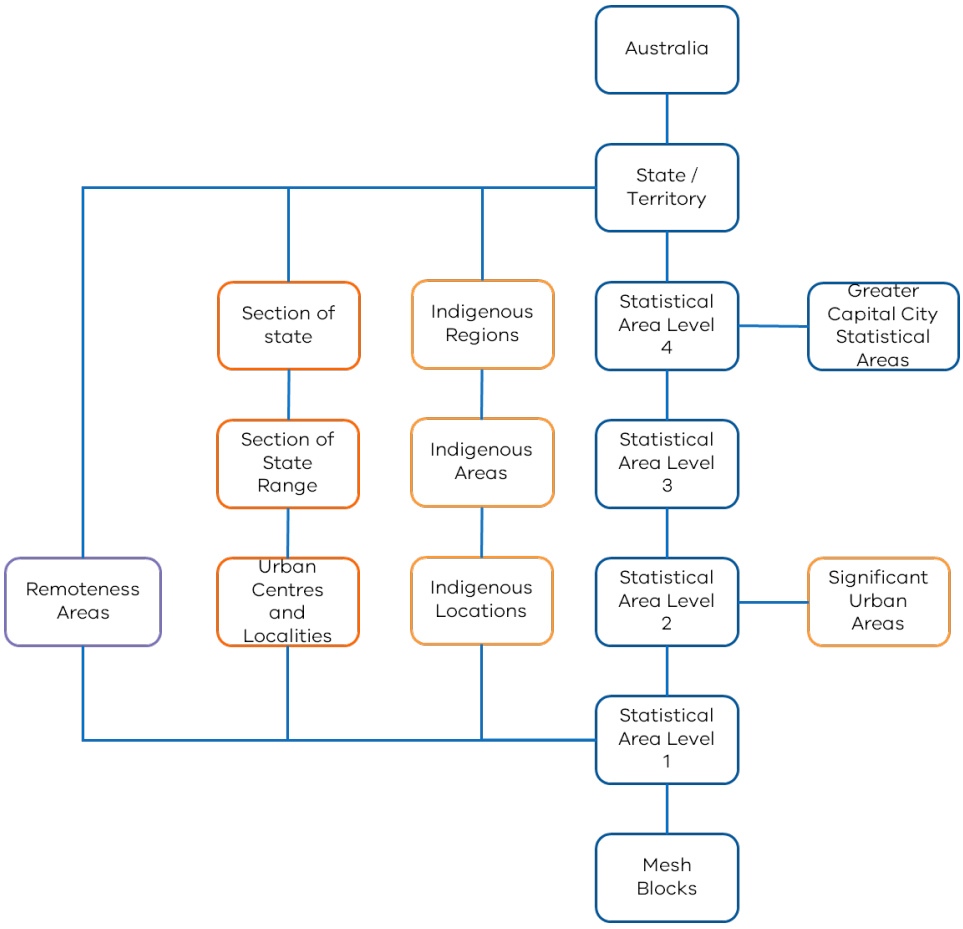
- "The Urban Centre and Locality (UCL) classification is aggregated from Statistical Areas Level 1 (SA1) which meet population density criteria or contain urban infrastructure."[18]
- "Urban Centres and Localities (UCLs) represent areas of concentrated urban development."[19]
- "Urban Centres and Localities are designed to facilitate the visualisation and analysis of statistical data, in particular data from the Census of Population and Housing. The criteria for inclusion (such as minimum population sizes) enable users to access cross classified Census data (such as population counts by various age ranges), without limiting the usability of the associated data."[20]
- "Significant Urban Areas (SUAs) represent Urban Centres, or groups of Urban Centres, that contain population of 10,000 persons or more. They are based on Urban Centres and

[17] The CGC's calculation of PWD for SUAs is built up from the SA1s within UCLs.
[18] https://www.abs.gov.au/statistics/standards/australian-statistical-geography-standard-asgs-edition-3/jul2021-jun2026/significant-urban-areas-urban-centres-and-localities-section-state
[19] https://www.abs.gov.au/statistics/standards/australian-statistical-geography-standard-asgs-edition-3/jul2021-jun2026/significant-urban-areas-urban-centres-and-localities-section-state/urban-centres-and-localities
[20] ibid

Localities (UCLs) and built from Statistical Areas Level 2 (SA2). This enables a wider variety of statistical data to be available on this geography including non-Census data such as Estimated Resident Population (ERP)."[21]

The smaller geographic areas under the ASGS, such as SA1s, build up into the larger areas by design as seen in Figure 5 below. In contrast, the grid cannot exactly capture the CGCs' concept of urban as the areas in the square kilometre grid cannot be aggregated directly into SUAs, as individual square kilometres cut across urban boundaries.

Figure 5: Diagram of structure of the ASGS



Source: ABS, https://www.abs.gov.au/statistics/standards/australian-statistical-geography-standard-asgs-edition-3/jul2021-jun2026

The square kilometre grid approach does not reflect what states do, both in that conceptually the ASGS structures relate more closely to how transport planning decisions are made, and that states use these in their own modelling. Victoria's Department of Transport and Planning (DTP) confirms its modelling uses a modified ASGS structure for its transport modelling.

[21] https://www.abs.gov.au/statistics/standards/australian-statistical-geography-standard-asgs-edition-3/jul2021-jun2026/significant-urban-areas-urban-centres-and-localities-section-state/significant-urban-areas

Victoria notes Transport for NSW uses a bespoke unit of area for its analysis of PWD "Travel Zones" rather than a square kilometre grid.[22] NSW's Tavel Zones more closely resemble the ASGS structures than the square kilometre grid (noted to be similar to mesh blocks or SA1s), however, are modified to additionally capture employment, housing and transport infrastructure.[23]

3.2.4.2 Complexity and decreased robustness from aggregating the square kilometre grid

Victoria considers the change to PWD calculated using the square kilometre grid creates additional complexity and reduces empirical robustness. Victoria's view is that introducing these issues is not warranted given the relatively minor benefits.

Victoria has noted in its responses to previous consultation that it considers simplicity should be elevated among the CGC's supporting principles, rather than being subsidiary to practicality. As such, Victoria considers the loss to simplicity from the square grid population measure and impact on robustness are not justified by the reduction in volatility. The draft report already notes the complexity with the transport assessment overall, this change only adds to it.

The misalignment between grid squares and UCL boundaries requires assumptions about how grid squares that are not fully contained within a UCL boundary are treated. The CGC's proposed method of including only those squares that overlap by more than 50 per cent has merit, for example in avoiding double-counting.[24]

However, not only does it add complexity, but it also introduces errors. Many coastal UCL will have large proportions of overlapping grid squares excluded, sometimes even 100 per cent of overlapping grid squares excluded, resulting in the UCL being omitted entirely. Furthermore, a significant proportion of Australia's population live on coastal and river boundaries, often in dense neighbourhoods. UCL boundaries in such zones can be highly irregular due to topography and geographic constraints. The arbitrary alignment of the grid squares means significant information is lost from the assessment, potentially in a biased way.

Table 5 shows the relationship between population and the change in PWD between the SA1 method and the grid square method. Many of the UCL with large falls in PWD are coastal or state border UCL. The exclusion of coastal grid squares is particularly problematic since all of the population must actually reside in the excluded land component.

The use of the square grid method means that 62 per cent of Australia's urban population (in a UCL within an SUA) live within an SUA that had a 30 per cent or greater fall in PWD, as seen in Table 5. Although this reduction is largely due to the increase in size of the area (the square kilometre cells are typically geographically larger than SA1s in large cities) and loss of granularity, some of the decrease is likely due to excluded grid squares and loss of information. The SUA in Table 5 vary in population but are predominantly situated in coastal or state border locations where UCL boundaries can be highly irregular.

[22] https://www.movementandplace.nsw.gov.au/place-and-network/built-environment-indicators/population-density
[23] https://opendata.transport.nsw.gov.au/dataset/travel-zones-2016
[24] In code and commentary provided to states, the CGC includes all of the population of the overlapping grid square but only the area that overlaps, potentially overstating PWD.

Table 5: SUA (UCL only) with largest change in PWD between SA1 and square grid method, 2022-23

SUA	Geography	% change	Population
Mildura - Buronga (NSW)	Border	-63%	4,300
St Georges Basin - Sanctuary Point	Coastal	-42%	20,204
Sydney	Coastal	-39%	4,878,490
Port Hedland	Coastal	-39%	16,858
Canberra - Queanbeyan (ACT)	Border	-39%	459,958
Nelson Bay	Coastal	-39%	26,459
Melbourne	Coastal	-38%	4,987,884
Gold Coast - Tweed Heads (QLD)	Coastal	-37%	636,404
Alice Springs	Inland	-37%	28,200
Gold Coast - Tweed Heads (NSW)	Coastal	-36%	73,884
Ballina	Coastal	-34%	39,460
Batemans Bay	Coastal	-33%	17,411
Broome	Coastal	-33%	16,017
Griffith	Inland	-33%	20,458
Yeppoon	Coastal	-32%	20,987
Darwin	Coastal	-30%	130,936
Brisbane	Coastal	-30%	2,509,988

Source: Transport addendum supplementary data provided by the CGC

Analysis of the CGC's square grid method for 2022-23 found that 62 per cent of UCL (261 of 420) that fall within an SUA had more than half of overlapping and contained squares excluded from the calculation, with 15 per cent (63 of 420) of total UCLs that fall within an SUA being excluded entirely. Capital city UCLs had the least proportion of excluded grid squares, but even the lowest, Melbourne, had 13 per cent excluded.

Victoria considers the scale of these exclusions to be problematic, given the existence of a better alternative, the SA1 method, that is demonstrated to achieve superior quantitative results, as noted in Section 3.2.2.

3.2.4.3 Issues with the alternative approach using SA2s

While Victoria supports the use of SA1s and the ASGS as a standard accepted approach to define geographic areas throughout the assessments, it prefers SA1s are used for the urban transport assessment rather than the larger SA2s.

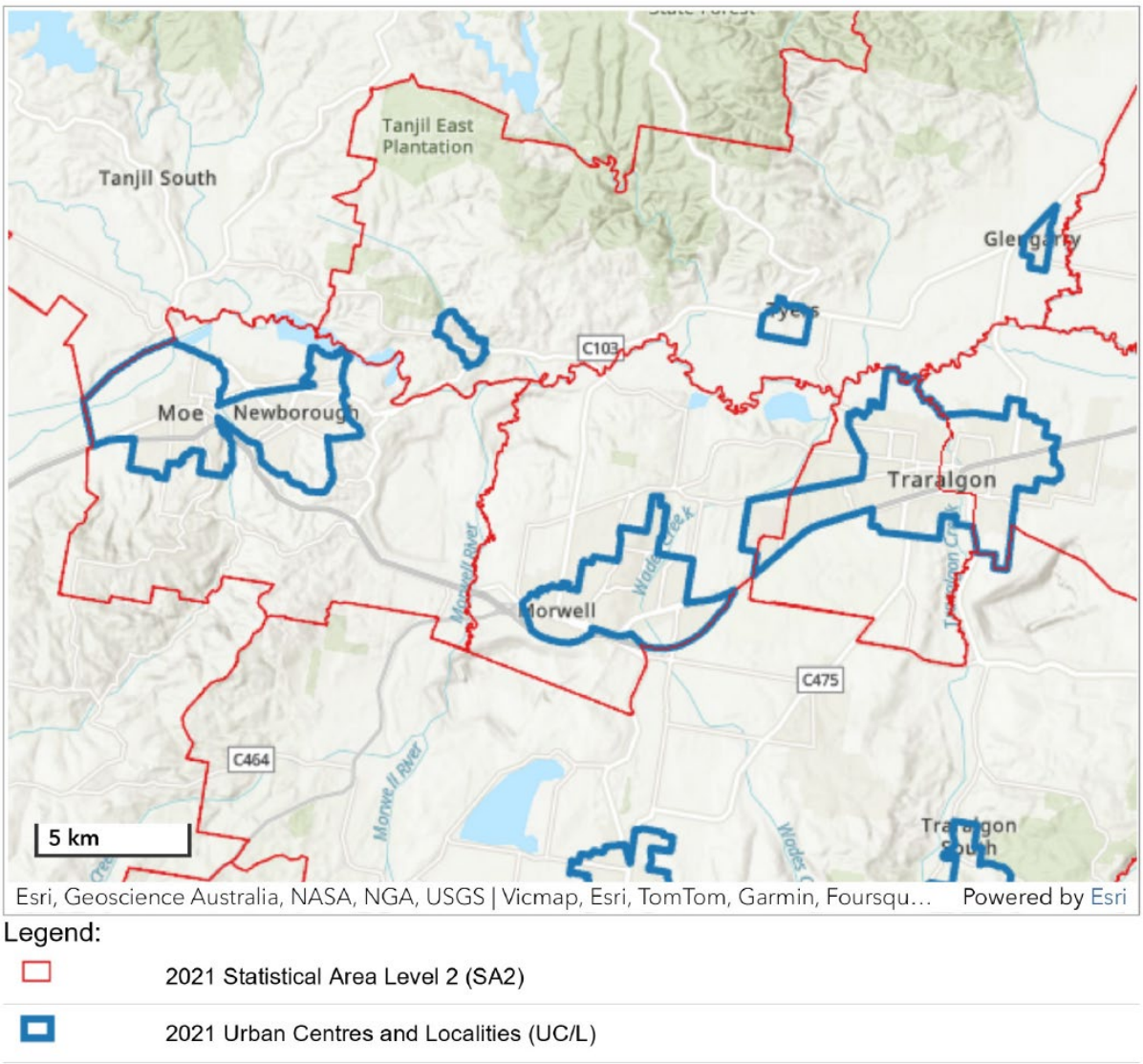
SA2s are composed of SA1s but are designed by the ABS to be more stable over time than SA1s. However, SA2 have neither approximately consistent population (like SA1) nor consistent area (like the square grid). SA2 are designed using multiple, potentially conflicting criteria such as population and estimated population growth, and alignment with suburbs and local government areas. The result is that SA2 boundaries are still revised after Census revisions, but to a lesser extent than SA1 boundaries.[25]

More importantly, although SA2s are aligned with SUA, they are not aligned with UCL boundaries. Many SA2s are much larger than the UCL contained within, and many UCL boundaries cut across SA2s and vice versa. Figure 6 illustrates how the Victorian UCL of Moe-Newborough and

[25] Changes from the previous edition of the ASGS | ASGS Edition 3, Australian Bureau of Statistics (abs.gov.au)

Traralgon-Morwell are contained within much larger SA2 and/or split by multiple SA2. SA2s often contain a mix of urban and non-urban areas and a wide range of density within urban areas. As such, the use of SA2s would artificially dilute PWD and fail to adequately capture the true density of some areas within them. To avoid this issue, some academic literature points to favouring smaller area definitions to calculate PWD, for example Morton (2015) cited in Section 3.2.6.

Figure 6: Incoherence between SA2 and UCL



Source: https://maps.abs.gov.au/

As discussed in Section 3.2.5, the fact that the grid squares do not align with ASGS at any level increases the complexity of the assessment and introduces errors. Similar issues arise with the misalignment of SA2s and the UCL boundaries.

The draft report disregards the larger SA3s and SA4s due to their lack of alignment to SUAs, as they capture intervening non-urban area outside UCL boundaries. SA2s should also be disregarded as they have a similar issue with a lack of alignment to UCLs.

3.2.5 Concerns raised from stakeholder views

Victora notes that the square kilometre grid method has merit and is used by some Australian government departments and international agencies. However, Victoria is concerned that the benefits of the square kilometre grid method noted for other contexts do not translate for the CGC's purposes.

The draft report and addendum do not indicate that the CGC has consulted with the ABS on this change. Victoria considers the ABS is best placed to comment on any issues raised with the definition of SA1s, including potential inconsistency between SA1s. Without specific consultation with the ABS, Victoria considers it is premature to change the basis of the PWD measure. Victoria recommends the CGC consult with the ABS and report back to states on the outcomes of this before making any changes to the PWD measure.

The draft report provides a quote from the ABS noting the benefits of the square kilometre grid approach. Victoria notes however the ABS makes explicit mention of its preferred use for non-urban areas: "The population grid offers a consistently sized spatial unit and gives a refined model of population distribution, particularly for the non-urban areas of Australia."[26] Given the purpose of PWD for the CGC is to estimate the need for urban transport, this indicates the benefits of the measure do not translate for the CGC's purposes.

The ABS also advise caution in using the square kilometre grid data noting "This is modelled data and caution must be used in its interpretation, as the population has not been measured at the one square kilometre grid cell level."[27] Population data are not collected at the square kilometre grid level but are prepared using transformations on SA1 data indicating the grid is a less accurate measure and the SA1-based approach should be preferred.

Victoria appreciates that the CGC consulted with the Commonwealth Department of Infrastructure, Transport, Regional Development, Communications and the Arts (the Department), and that it uses the population grid measure of PWD. Victoria notes the Department formerly used mesh blocks to "provide the most detailed and spatially accurate point measure of density". Victoria considers the CGC should use the most accurate point measure, as this is the more appropriate metric for its assessments.[28]

Victoria also notes the Department specifically mention the use of the grid involves a trade-off in its applicability to urban areas for greater accuracy for remote areas. A report by the Department notes "The consistent size of grid cells (1 square km) provides a more robust estimate of spatial relationships, a consistent estimate of population density and greater spatial accuracy in sparsely populated areas. However, this comes at the cost of spatial accuracy in more densely populated areas."[29] Given the urban transport assessment aims to analyse transport needs within urban areas, Victoria favours having the most accurate measure for this purpose based on SA1s.

The Department notes its rationale for moving to the population grid is that it "provides more consistent area sizes and unit of measure over time". While this may be beneficial for the department's analysis, benefits in comparing areas over time are not relevant for the CGC's assessments. The assessments are snapshot, point in time analyses. The assessments are not a

[26] https://www.abs.gov.au/methodologies/regional-population-methodology/2022-23
[27] https://www.abs.gov.au/methodologies/regional-population-methodology/2022-23
[28] In this case the most accurate point estimate would be from SA1s rather than mesh blocks as in the CGC's context the 2020 review consultant determined mesh blocks were not practical.
[29] https://www.bitre.gov.au/sites/default/files/An-introduction-to-where-Australians-live-BITRE-Information-Sheet-96.pdf

longitudinal analysis, and do not compare changes in the same areas over time. Each assessment year is an independent evaluation of expenditure needs in that year.

For the urban transport assessment, the econometric model is a fixed snapshot at the time of the last review. The model is not updated dynamically to measure trends over time: for the 2025 review, the draft report proposes to hold the results of the model using 2023-24 data constant until updated at an expected future 2030 review.

3.2.6 Variation in views in academic literature and other works

Victoria questions the conclusion in the draft report that the square kilometre grid measure is the most accepted and widely used measure of population density internationally and by experts. Victoria's review of the academic literature or works by other practitioners suggests there is no consensus view on the "best" definition of population density for all contexts.

There are many choices that can be made in calculating a density measure leading to "an infinite number of possibilities" according to a literature review by Ottensmann (2021)[30]. These choices include the calculation method ("conventional" or population weighed destiny), sub-area definitions (which area definition to use), the measure of central tendency used for aggregation (arithmetic mean, geometric mean, median) among others. Academic and practitioner works do not present a consistent 'best-practice' approach and are varied. The conclusion from the literature is that all approaches have merit in different contexts, and none are incorrect.

For the CGC's purposes, this broad view of the literature suggests any of its proposed density measures are theoretically appropriate, and any could be selected recognising the relevant trade-offs. The CGC has certainly considered its selection of measure thoroughly from the analysis in the draft report. However, it cannot be said that PWD (compared to conventional density) or calculation based on uniform sub-areas are the most accepted or appropriate measure as the draft report suggests. In addition, the CGC has not considered other variables such as the method of aggregation (using a geometric mean or median for example) or using other measures of density such as conventional density, employment weighted density or density-weighted population (area populations weighted by relative density[31]).

Victoria's view is that the variation of measures in the literature suggests the CGC should not create a significant re-distribution in GST revenue to change the calculation of PWD to a measure that has as much merit as the previous method, or others that have not been explored. This is especially so given the increased complexity and loss of technical accuracy from a less robust model from the population grid method.

The academic literature shows a disparity of calculation methods used for PWD, including:

- Ottensmann (2021)[32] reviews uses of PWD among academic and other works, noting the variation in approaches, concluding "there is no single, correct value for the population-weighted density as different sets of subareas can always be used for its calculation."
- A number of papers examining the relationship between density and COVID-19 internationally use an arc-grid approach for sub-areas to calculate PWD (a measure of area relative to the

[30] Ottensmann, John. (2021). The Use (and Misuse) of Population-Weighted Density. https://www.researchgate.net/publication/356474767_The_Use_and_Misuse_of_Population-Weighted_Density
[31] https://arxiv.org/pdf/1412.4332
[32] https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3970248

equator using longitude and latitude) including by Henderson, Negmatulina, and Kriticos (2019), [33] Levy and Moscona (2021),[34] Garland, et al. (2021),[35] and Riley, et al. (2020).[36] Afshordi, et al. (2020) also studying COVID-19 and density instead used 250 square metre grids.[37]

- A US Census Bureau report (2012) credited with popularising the concept of PWD, calculated using US statistical area definitions 'census tracts' as these are "closest in scale to urban and suburban neighborhoods".[38] Many academic papers in the US context use the US Census-based geographies including "Census tracts" such as Schroeder and Pacas (2019) (who also present the arithmetic and geometric means),[39] Carrozzi, Provenzano, and Roth (2020) (studying COVID-19 using US Census blocks).[40]
- Morton (2015) from the University of Melbourne commented in a review of uses of PWD that "Measures of density are often defined differently from place to place or inconsistently applied."[41]
- Four papers by Burton (2000, 2001, 2002 and 2003) present 14 potential measures of density to analyse city structures.[42]
- Seminal articles on the subject by Craig present both the geometric and arithmetic means to calculate PWD (1984)[43] and note that conventional density and PWD can be used appropriately in different circumstances (1985).[44]

The literature also presents evidence supporting the rationale for elements of the SA1 approach as compared to the square kilometre grid approach including:

- Ottensmann (2021) notes caution calculating PWD from grid cells where "populations that have been estimated from other sources of data rather than having been based on actual population counts", as is the case with the ABS' population grid.
- Morton (2015) also notes a preference for the smallest possible areas, "one cannot entirely dispense with the need to define urban boundaries, or to work preferentially with the smallest parcels of land for which one has data." Morton shows using stylised areas that the smallest area definitions are preferred and recommends that calculations "Ensure that parcels are small enough that any high-density development is contained entirely within a single parcel, rather than part of a larger parcel encompassing both high and low density areas."[45]

---

[33] https://www.sciencedirect.com/science/article/abs/pii/S0094119019300658
[34] https://papers.ssrn.com/sol3/papers.cfm?abstract_id=4259355
[35] https://arxiv.org/abs/2005.01167
[36] https://pubmed.ncbi.nlm.nih.gov/35446873/
[37] https://arxiv.org/abs/2007.00159
[38] As noted in Ottensmann (2021) referenced elsewhere, many works followed the Census report. https://www.census.gov/library/publications/2012/dec/c2010sr-01.html
[39] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8323948/
[40] https://www.iza.org/publications/dp/13440/urban-density-and-covid-19
[41] https://arxiv.org/pdf/1412.4332
[42] https://journals.sagepub.com/doi/10.1080/00420980050162184, https://www.researchgate.net/publication/253587711_The_Compact_City_and_Social_Justice, https://journals.sagepub.com/doi/10.1068/b2713, https://www.tandfonline.com/doi/abs/10.1080/02673030304249
[43] https://www.jstor.org/stable/2061168,
[44] https://www.jstor.org/stable/2736997
[45] https://arxiv.org/pdf/1412.4332

- Adli et al (2017) use meshblocks as the basis for calculation of PWD in Australia as they are "the smallest geographic region in the Australian Statistical Geography Standard (ASGS), and the smallest geographical unit for which Census data are available."[46]

3.2.7 Consistency of areas within boundaries

While the population grid measure may have some benefits with regards to the consistency of zoning within urban areas, these do not outweigh the disadvantages of this approach as noted earlier in this response.

Victoria does not consider any potential inconsistency of zoning treatments is a fundamental issue that precludes the use of the SA1 measure. This issue is already accounted for by the CGC's calculation of density in that it is population weighted. Areas with large shares of non-residential land have fewer residents and so their relatively low population density has a lower weighting in the PWD calculation.

Morton (2015) notes that PWD "is also held to be less sensitive to the detail of how one delineates an urban area, as the definition of PWD automatically discounts sparsely populated non-urban land."[47] Ottensman (2021) notes "An advantage often cited for the use of population-weighted density as the measure for urban areas is that it is much less sensitive to how the urban area has been defined and the extent to which land that is not urban has been included, which can vary greatly for metropolitan areas."[48]

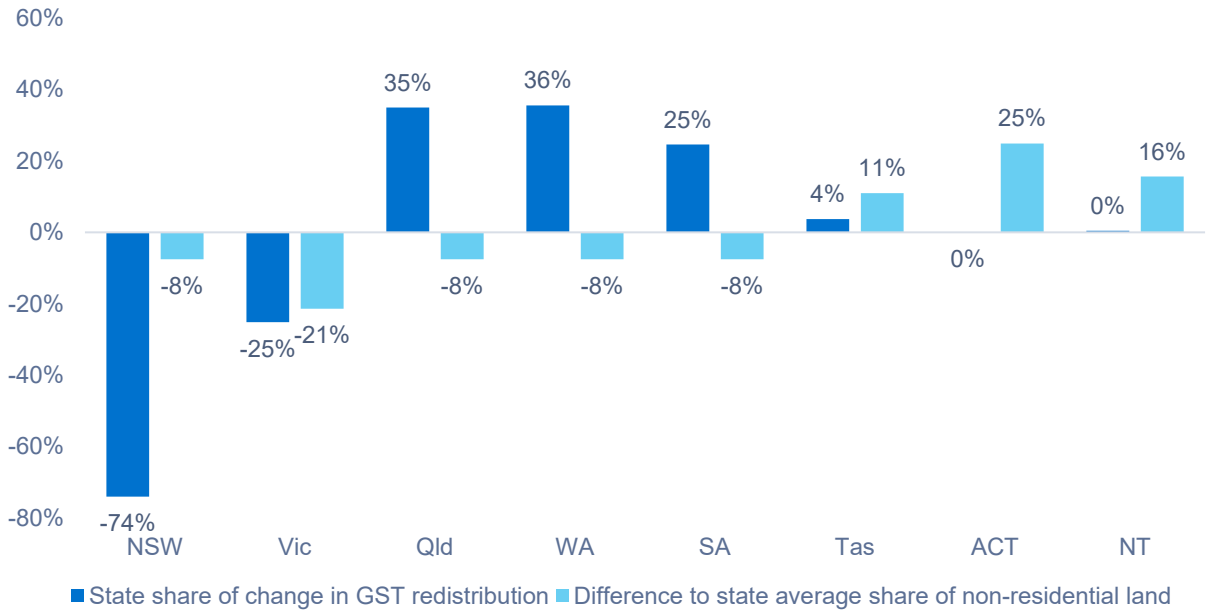
The results presented by the CGC also do not make clear that the issue of differences in treatment of non-residential land are resolved with the square kilometre grid approach. The draft report notes part of the rationale for considering this issue was that states suggested that "non-residential areas … were more likely to be included as separate SA1s in Sydney, while being combined with residential land in other capital cities". Based on the CGC's analysis presented in table 2 of the draft report, this does not appear to be the case. NSW has the same share of non-residential land in SA1s as Queensland, WA and SA and a higher share than Victoria.

Figure 7 compares the redistributive revenue impact of the change in PWD measure to the share of non-residential land in SA1s. It appears these are largely unrelated, suggesting the method change either does not resolve the issue with the treatment of land, or predominantly represents other factors.

For example, while Queensland, WA and SA all had below the state average share of non-residential land in SA1s, their GST shares increased. NSW had the same share of non-residential land in SA1s as these states but is estimated to experience a significant decrease in GST revenue. Victoria had the lowest share of non-residential land, however its decrease in GST share was smaller than NSW's (half in per capita terms).

[46] https://australasiantransportresearchforum.org.au/wp-content/uploads/2022/03/ATRF2017_075.pdf
[47] Note Morton compares PWD to conventional density in this case. https://arxiv.org/pdf/1412.4332
[48] Ottensman makes this point to conclude that PWD is "an entirely different measure of density" to conventional density, cautioning conflating the two measures.

Figure 7: Percentage share of change in GST redistribution from the change in PWD measure (2024-25), compared to percentage difference to state average share of non-residential land in SA1s (2021)



Source: DTF calculation on CGC draft report data.

Victoria notes other elements of the ASGS are used in the CGC's assessments without issue. The socioeconomic status of areas is typically analysed at the SA2 level. The remoteness boundaries used across assessments also are defined as part of the ASGS.[49] For consistency it is preferred to continue to use the ASGS area definitions.

3.3 Blending of the urban transport expenditure component

Victoria does not support the proposed change to the blending of the urban transport assessment between the econometric model and the population-based approach. The addendum maintains the position from the draft report to decrease the share of the urban transport econometric model from 75 per cent to 65 per cent in favour of a higher share of urban populations.

Victoria supports the use of the CGC's urban transport model developed in the 2020 Review for recurrent expenses. Victoria considers, as the CGC has noted, that it provides a more accurate picture of urban transport demand incorporating a wider range of variables than only using urban populations. The draft report notes that "The Commission considers that, with the changes outlined [in the draft report], the current approach remains appropriate, and is preferable to a return to using state shares of urban populations".

The urban population approach is a simpler, less accurate proxy. The blending with the population approach is not ideal, however the CGC states it implements it to account for uncertainty in the model due to:

[49] https://www.abs.gov.au/statistics/standards/australian-statistical-geography-standard-asgs-edition-3/jul2021-jun2026/remoteness-structure/remoteness-areas

1. the fact that data sources are only proxies for the underlying drivers of need (PWD measuring demand for example)
2. concerns with the quality of data.

As Victoria noted in its response to the draft report, while there are transient concerns with the quality of COVID-19 influenced data, the underlying relationships of the model remain robust. While a future review can re-examine the assessment, it is expected once a 'new-normal' state of transport service use is reached the model will continue to represent an accurate picture of states' service provision.

The fact that the variables used in urban transport model are proxies has not changed since the 2020 Review and does not motivate an increase to the blending share.

As Victoria noted in its responses to tranche 1 and the draft report, there are now greater concerns around data quality due to the influences of COVID-19, however Victoria considers these are already accounted for with the current 25 per cent share of the urban population approach. As stated in the tranche 1 response, Victoria considers the most appropriate response is to not incorporate COVID-19 influenced data and retain the previous data.

The CGC's initial analysis agreed with this approach, stating for Tranche 1 consultation that "changing the ratio would not address issues associated with retaining 2016 Census data in the assessment until 2026 Census data are available."[50] The draft report and addendum have not detailed how the change in blending addresses any issues with the Census data.

Victoria agrees with the addendum that the blending ratios do not have to be consistent between expenses and investment and considers the CGC should utilise different rates if warranted. Victoria considers there is a greater rationale to decrease the share of the model in the investment assessment, as it was developed for recurrent expenses and is a better representation of those pressures as distinct from investment. As a result, the model would be expected to have a greater weighting for recurrent expenses than investment. This is discussed further in the investment component of this response, section 4.2.

Victoria's recommendations

- Victoria does not support the change to the blending ratio of the model to urban populations for the urban transport expenditure assessment and considers the current blending sufficiently accounts for any data concerns. Victoria recommends a blending share of 75 per cent of the econometric model and 25 per cent urban populations remains appropriate.

4. Investment in urban transport

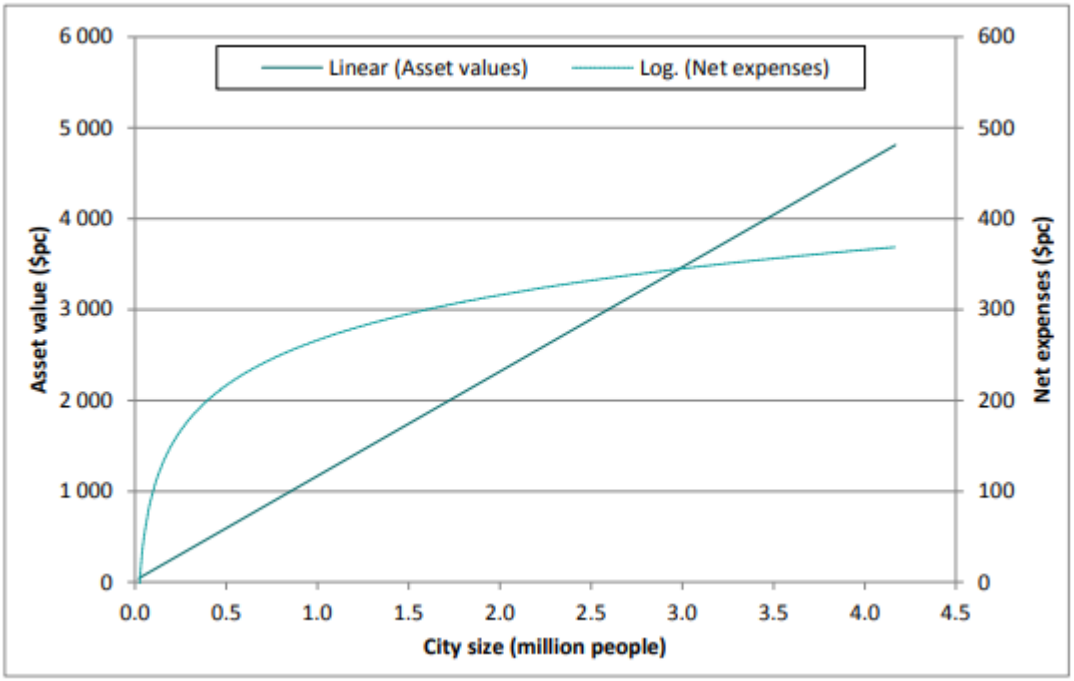
4.1 Support for the urban population squared approach

Victoria supports the addendum's conclusion to maintain the population squared approach for assessing urban transport investment needs. Victoria supports the evidence provided that there is a linear relationship between urban transport asset requirements and population.

[50] CGC 2025 Methodology Review consultation paper - Transport

Victoria supports the conclusion of the 2015 Review, that while net operating expenses may increase at a declining rate to scale, capital needs continue at a constant rate, shown in Figure 8 below. CGC analysis conducted as part of the 2015 Review and the consultant for the 2010 Review both concluded that asset values increase linearly with population. In the 2015 Review, the CGC noted "we have concluded the conceptual case is proven"[51], referring to the linear relationship between asset requirements and population.

Figure 8: CGC chart from 2015 Review: Comparison of relationships between transport assets and net expenses and city size, 2011–12

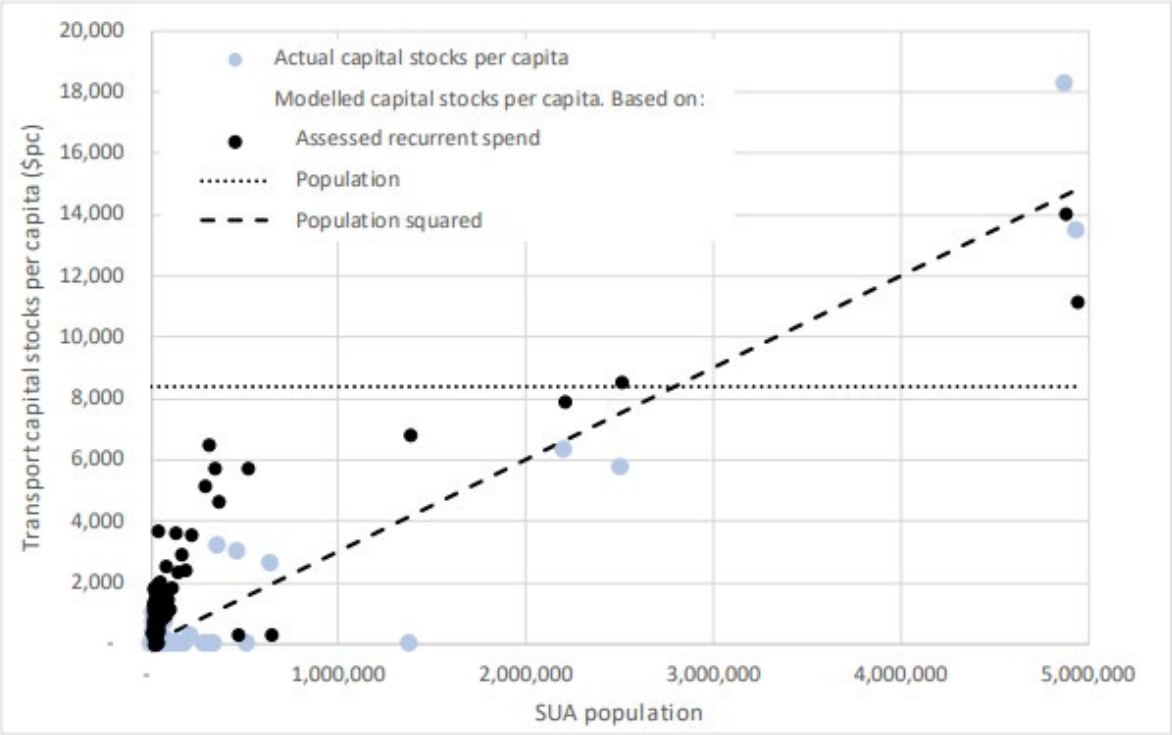


Source: CGC 2015 Review

It is clear from the data presented in the addendum that the linear relationship between asset values and population previous reviews theorised still holds in an Australian context. The data provided by states show that actual capital stocks per capita increase linearly with SUA populations, see Figure 9 below from the addendum. The data also indicate that an approach based on population does not represent actual trends. It assumes a constant amount of capital stock that is too high for most SUAs and too low for the largest SUAs.

[51] CGC 2015 Review report - Volume 2 - Assessments

Figure 9: Options for modelling capital stocks per capita



Source: CGC draft report transport addendum Figure 2

Outside the data recently collected by the CGC, there is limited data on urban transport asset values in cities in Australia or internationally to cross reference these results. As an additional indication of the relationship, Figure 10 below presents the number of public transport vehicles (for example trains and buses, among others) in US urban areas as a proxy for total asset value. The data generally support the rationale for the population squared assessment of urban transport investment requirements, with linearly increasing amounts of assets (measured by the number of vehicles) per person in more populated urban areas.

Figure 10: Public transport vehicles owned or leased per capita in urban areas in the USA by population

Source: American Public Transportation Association 2020 Fact Book

Note: Population data are from the 2020 US Census, and vehicles are from 2018. Vehicles are counted for all public transport modes reported, rail and bus.

Further support is provided in academic literature – for example a paper on urban transport expenses by Coulombel and Moncambert (2019) model the cost of public transport services and find that "if demand exceeds a second threshold, the public transit system operates under diseconomies of scale" or is a "hypercongested regime" and the optimal vehicle size (or capital stock) increases with greater demand. This implies greater population or scale increase the need for capital per person, proxied by vehicle size. [52]

Previous responses from other states have suggested that economies of scale exist in larger cities meaning the population squared approach may not be appropriate. As Victoria noted in its response to the draft report, economies of scale are not an appropriate framing for this issue. The CGC's assessment measures the amount of transport infrastructure required for a given population, not the unit costs. Other states' arguments do not recognise this difference.

[52] Coulombel, N. and Monchambert, G.; Congestion, diseconomies of scale and subsidies in urban public transportation; HAL open science; HAL Id: hal-02373768, 2019: https://hal.science/hal-02373768/document

Victoria's recommendations

- Victoria supports the CGC's position to retain the urban population squared approach for the population component of the urban transport investment assessment.

4.2 Blending of the urban transport investment assessment

Victoria does not support the addendum's proposal to retain the blending ratio of the urban transport model and population approaches for investment at 75 and 25 per cent respectively. Victoria recommends the CGC move the investment assessment to 65 and 35 per cent of the model and population squared approaches respectively.

Victoria considers there is a rationale to decrease the blending share in investment, regardless of the COVID-19 impacts, as the econometric model does not relate directly to investment.

Separately, if the CGC considers it should adjust the blending ratios due to the influence of COVID-19 on data, Victoria considers the stated rationale for recurrent expenses applies equally to investment.

4.2.1.1 The relationships in the econometric model do not apply directly to investment

Victoria supports the use of the regression model for urban transport recurrent expenditures but questions its application to investment needs. Victoria considers these are related but separate issues, and benefit from separate assessment methods. The urban transport model was developed for recurrent expenditures and does not fully capture investment needs.

The relationship to scale (demand or population) in the urban transport model can be interpreted in part as logarithmic, reflecting economies of scale. That is, the model reflects that the rate of growth in transport expenditure needs declines as scale increases (proxied by passenger numbers). The draft report notes "In the Commission's regression these [scale] economies are captured through the passenger number variable. Applying a logarithmic form to passenger numbers implies that the impact on net expenses per capita decreases as additional passengers are added to a transport network."

Victoria's position is that it has not been established this is accurate for investment, and a linear relationship is more appropriate (with constant growth in assets per capita with population to scale). Victoria notes the PWD variable has a linear relationship in the model, however the CGC has characterised the passenger share variable as being the analogue for the relationship to population or scale in this case (capturing economies of scale) as quoted above.

This is evident in the chart provided in the addendum, reproduced at Figure 9 above. While the population squared approach aligns well with capital stocks, it noticeably differs to assessed recurrent spend which demonstrates a logarithmic relationship (the rate of growth decreases with scale). This decrease in growth to scale is included in the model through the logarithmic transformation. The data in Figure 9 show this is not appropriate for assets, where a linear relationship is more representative (relating more to a straight line with constant growth).

The 2020 Review justifies the current blending between the population squared and regression model methods stating that "while there is strong evidence that per capita asset values increase as city size increases, the rate of this [sic] decrease is less clear". Victoria considers there is not sufficient evidence to weight the assessment significantly more towards an assumption of decreasing assets to scale using the urban transport econometric model.

The addendum's proposed approach implies there is more evidence for a decreasing rate of growth in capital requirements when this has not been established. While elements of the urban transport

model may influence the need for and cost of urban transport infrastructure, the fundamental logarithmic relationship makes it inappropriate for capital needs.

4.2.1.2 The same rationale for decreasing the share of the model for expenses also applies to investment

While Victoria does not support the CGC's proposal to decrease the blending share of the model for recurrent expenses, it considers that the same logic applies to investment if the CGC chooses to take this approach. The addendum notes COVID-19 largely impacted issues facing recurrent spending (declines in commuters and revenues) but considers these issues do not apply to the same extent to investment as "investment decisions are determined over a longer timeframe". While it is the case that investment decisions are made over a long-time frame, Victoria does not agree with the CGC's conclusions.

In the first instance, it is the econometric model based on recurrent expenses that faces issues with COVID-19 influenced data, and the same model is applied to the CGC's expense and investment assessments. While states' total investment may not have been impacted by the pandemic to the same extent as expenses as the addendum suggests, this is not relevant for the use of the model which is based entirely on expenses. The CGC's rationale for changing the blending for expenses applies the same to investment as the same model is used. The CGC has concluded data in the model are COVID-19 influenced and are only proxies for the underlying concepts, and so a greater blending with populations is required. This applies equally to the expenses and investment assessments as they both use the same model. The potential for investment spending to be more consistent over time is only relevant in the assessments for the value of total investment (which are not related to the blending of the model), not the assessment factors derived from the recurrent expenses model.

In addition, Victoria's DTP noted for Victoria's tranche 1 response that expenditure decisions and planning are not reactive over the short term but are also made over the medium and longer term. Victoria noted that expenses were maintained or even increased over the pandemic to keep service levels. The CGC acknowledged this in the draft report stating "During the pandemic, states maintained public transport services to minimise the risk of transmission and provide transport for essential workers, despite steep declines in demand." As such, Victoria does not support the addendum's rationale for the difference between expenses and investment in COVID-19 impacts as they were both relatively inelastic to the pandemic, and take time to adjust to changes in conditions.

Victoria's recommendations

- Victoria recommends the CGC retain the population squared approach for the population-based share of the urban transport investment assessment.
- Victoria recommends the CGC blend the investment component 35 per cent to populations squared and 65 per cent using the econometric model.

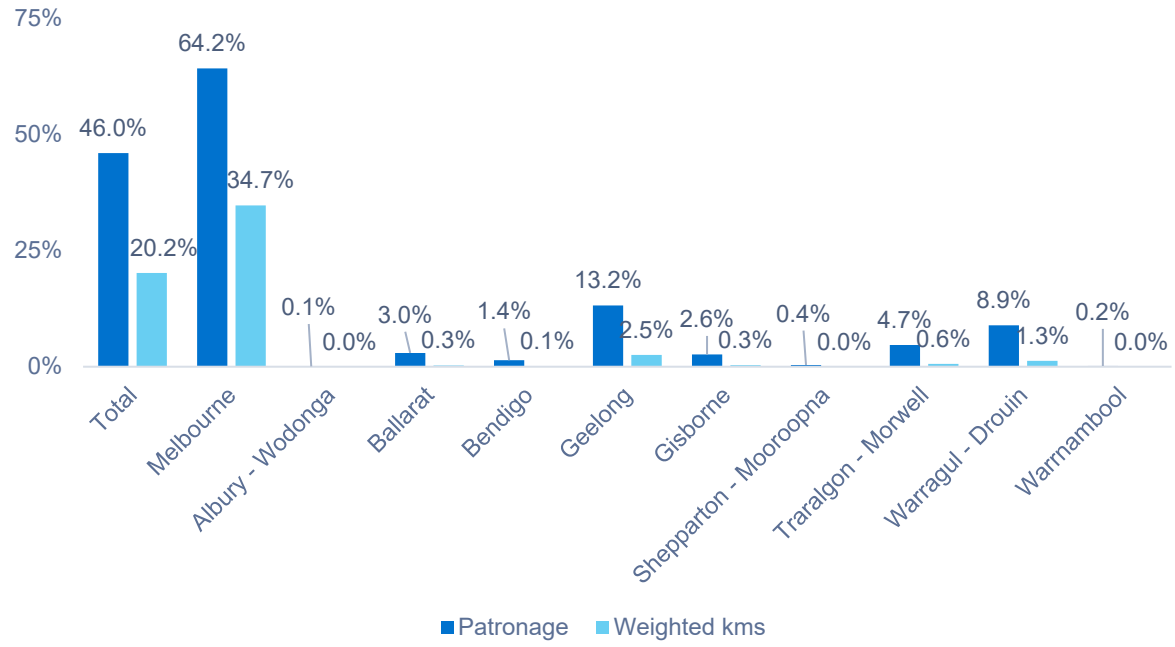
5. Non-urban transport

Victoria noted in its response to the draft report that it would continue to work with the CGC to provide the data required to make an adjustment for V/Line expenses for trips within urban areas. Victoria broadly accepts the issue the CGC raised in the draft report, that differing types of trips on V/Line may have different cost implications. For example, V/Line passengers that take shorter trips only within urban areas may have lower costs than passengers who travel longer distances between regional centres.

Since the draft report, Victoria's DTP has sourced data on the distance travelled by V/Line passengers. This data has been used to adjust the travel data previously provided to the CGC on the share of trips wholly within SUAs. The results of this analysis are presented below. Victoria will provide the CGC the detailed underlying data to enable it to adjust its assessment calculations accordingly.

The data show that adjusted for distance travelled, a significant share of V/Line trips occur within urban areas and meet the CGC's definition of urban transport. Figure 11 shows that for 2023-24 46 per cent of all V/Line trips occurred within the same SUA.[53] Figure 11 also shows that 20.2 per cent of distances travelled on V/Line services were within the same SUA. This share was greatest for trips originating within the Melbourne SUA with just over a third of all distances travelled on V/Line occurring within the SUA.

Figure 11: Share of total V/Line rail patronage and distance travelled within the same SUA, by origin SUA, 2023-24

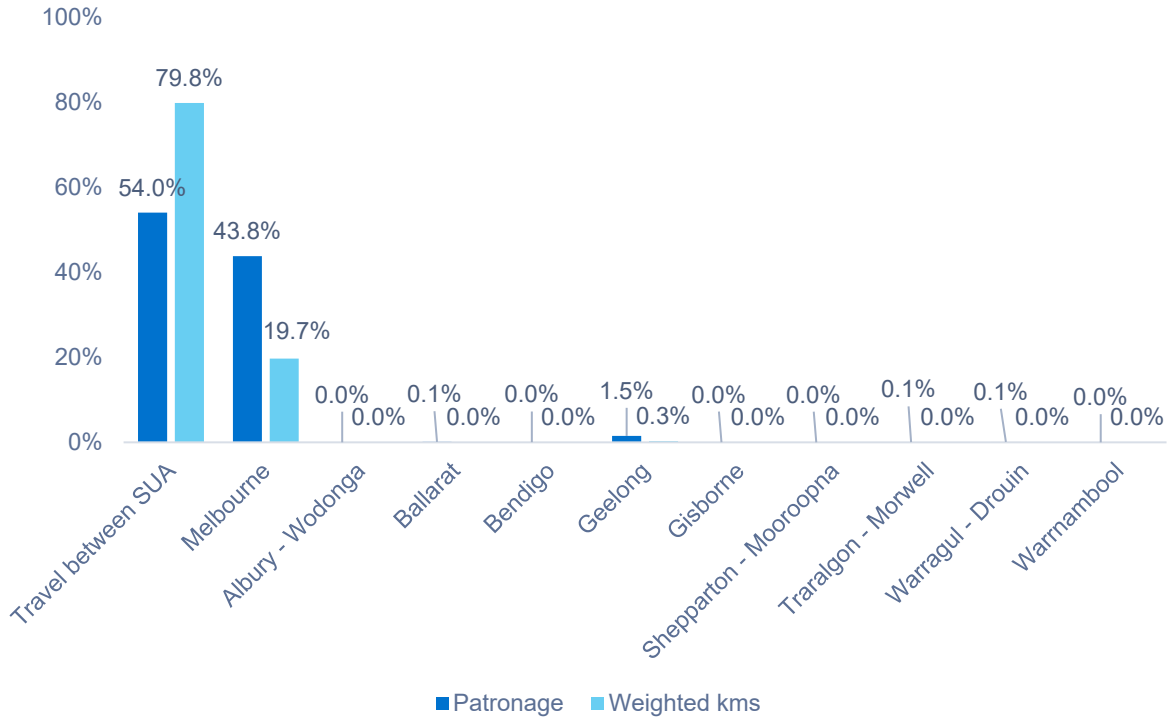


Source: Victorian DTP

Figure 12 below presents the same data as the share of total V/Line travel, rather than the shares within SUAs. Figure 12 shows that 54 per cent of V/Line's total patronage was between SUAs in 2023-24, while the remaining 46 per cent was within the same SUA. In 2023-24, 43.8 per cent of V/Line's total patronage was for trips within the Melbourne SUA. Figure 12 also shows 79.8 per cent of distances travelled on V/Line services were between SUAs, with the remaining 20.2 per cent within the same SUA. 19.7 per cent of all distances travelled on V/Line services were wholly within the Melbourne SUA.

[53] Note Victoria's response to the draft report reported data for 2022-23 which showed similar trends, with 46 per cent of V/Line journeys occurring within the same SUA.

Figure 12: Share of total V/Line rail patronage and distance travelled by SUA group, 2023-24



Source: Victorian DTP

Victoria's DTP has provided the following technical notes on the data analysis:

- V/Line trip data is sourced from two sources:
    - Trips within the myki zones are sourced from the Train Service Usage Model ('Train SUM', managed by DTP). The estimates of patronage from Train SUM integrate a range of data sources - including timetable, ticketing, manual survey, and V/Line conductor counts. The volume of data is large, and the algorithms for integration of data sources means that the model's estimates will contain minor errors.
    - Trips where the origin or destination (or both) are outside the myki zone, are sourced from the VNet ticket system (paper tickets, managed by V/Line).
- Data include rail travel wholly on the Vline network only. Any connecting trip to a metropolitan service (operated by Metro Trains) has been removed. Only the rail mode is included and the analysis excludes V/Line's coach services.
- Refunded VNet and free travel tickets are excluded.
- Distances travelled are calculated by line distance from Southern Cross Station and are available at VicSig.[54]
- Weighted passenger kms have been calculated as the line km distance between origin and destination multiplied by the count of trips undertaken.

[54] https://vicsig.net/index.php?page=infrastructure&section=locations

Victoria's recommendations

- Victoria recommends the CGC allocate a proportion of V/Line expenditures to the urban transport component, based on the detailed data provided.

VICTORIA State Government | Treasury and Finance