Australian Government | Infrastructure Australia

April 2023

Infrastructure Market Capacity

2022 Report



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Online ISBN: 978-1-925352-68-9

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Revision

This report was first published in December 2022 and revised and republished in April 2023. For more information on revisions refer to the table on page 95.

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Acknowledgements

Infrastructure Australia would like to acknowledge the contributions of:

Professor Anthony Mills, BIS Oxford Economics, Turner & Townsend, Nous Group, Australian Road Research Board, EY, EY Sweeney, GlobalData, ecologiQ Victoria, Civil Contractors Federation and CSIRO.

Steve Brogan, Jonathan Cartledge, Peter Colacino, Chengzi Cui, Sandra Qian, Jo Sood, David Tang, Ben van Deventer, and the extended Infrastructure Australia team.

Infrastructure Australia would like to acknowledge the generous provision of resources from:

Department of Infrastructure, Planning and Logistics, Infrastructure NT (the NT Government), Chief Minister, Treasury and Economic Development Directorate (the ACT), Infrastructure NSW (NSW Government), Infrastructure SA (SA Government), Infrastructure Tasmania (Tas Government), Office of Projects Victoria (Vic Government), Infrastructure WA and Department of Treasury (WA Government), Department of State Development, Infrastructure, Local Government and Planning (Qld Government).

Department of Infrastructure, Transport, Regional Development, Communications and the Arts (Australian Government), Department of Climate Change, Energy, the Environment and Water.

Infrastructure Australia would also like to acknowledge the generous contributions from hundreds of individuals representing businesses, industry and governments across the infrastructure industry who participated in surveys, workshops and one-on-one interviews. We thank each for their invaluable contributions.

Acknowledgement of Country

Infrastructure Australia proudly acknowledges the Traditional Owners and Custodians of Australia, and their continuing connections to the land, waters and communities. We pay our respects to them and to their Elders past, present and emerging. In preparing for the future of our infrastructure, we acknowledge the importance of looking beyond the immediate past to learn from Aboriginal and Torres Strait Islander peoples' unique history of land management and settlement, art, culture and society that began over 65,000 years ago.

As part of Infrastructure Australia's commitment to reconciliation, we will continue to develop strong, mutually beneficial relationships with Aboriginal and Torres Strait Islander partners who can help us to innovate and deliver better outcomes for Aboriginal and Torres Strait Islander communities, recognising their expertise in improving quality of life in their communities.



Note on the artwork

The artwork Moving Along Pathways was created by Kamilaroi/Gamilaraay artist Dennis Golding, specifically for Infrastructure Australia's first Reconciliation Action Plan. The artwork depicts examples of Australia's first infrastructure.

Pathways and river systems are prominent in the artwork and reference the pathways First Nations peoples formed on land and water for transport and communication of knowledge and stories. Images of waterholes, campsites and boomerangs within the artwork acknowledge First Nations cultural practices, technology and places for gathering that continue to be operated today.



Foreword

I am pleased to present the second edition of Infrastructure Australia's *Infrastructure Market Capacity* report, an analysis of the capacity of the market to deliver the projected major public infrastructure pipeline.

First debuted in 2021 and supported by the collaboration and timely data-sharing of state and territory governments, this report explains the factors impacting the capacity of the market in order to support decision making, help mitigate risks across sectors, and support value-for-money outcomes from future infrastructure investments.

12 months have passed since the first *Infrastructure Market Capacity* report was published. During this time, the ongoing effects of the COVID-19 pandemic, war in Ukraine and further escalation of local factors continue to challenge infrastructure industry capacity. Given the importance of major public infrastructure in Australia's economic ambitions, it has never been more important to understand the factors influencing supply and demand of skills and materials critical to project delivery, and the risks in planning and delivery.

New for this edition of *Infrastructure Market Capacity* is a more comprehensive review of supply-side capacity inhibitors, including valuable inputs from many industry representatives who graciously gave time to share their opinions. Also included is a summary of the opportunity to use recycled materials in roads construction, taken from the forthcoming Infrastructure Australia report, *Understanding the Market for Replacement Materials in Major Road Infrastructure Projects*.

Many of the implications and opportunities outlined in this report reaffirm those presented by Infrastructure Australia in both the *2021 Australian Infrastructure Plan* and *Delivering Outcomes: A roadmap to improve infrastructure industry productivity and innovation*. The reforms identified will have long-term consequences for services received by infrastructure users and the community that are reinforced by the industry views expressed in this *Infrastructure Market Capacity* report.

We look forward to collaborating across government further to enhance our understanding of market capacity, so that we may provide governments and industry with world-leading evidence for decision making well into the future.

Mark Balnaves



On behalf of the Infrastructure Australia Board

Independent expert statement

"The inaugural *Infrastructure Market Capacity* report of 2021 examined demand-side challenges and risks of the major public infrastructure pipeline. After its release, Infrastructure Australia expanded the scope and depth of its research to inform this 2022 edition, including sourcing better data with a finer degree of accuracy.

I was commissioned to provide independent expert advice to Infrastructure Australia's market capacity research team for their 2022 report. My role focused on testing the reasonableness of general cost and schedule assumptions underlying the report, in particular those for plant, labour, equipment and materials.

The methodology formulated by the research team assumes a novel approach with a high degree of rigor: detailed project resources and costs have been interrogated across market segments and jurisdictions; project typecasts contain a set of detailed cost breakdown assumptions developed by analysing actual cost data, using the International Construction Measurement Standards; significantly challenging assumptions and methods have been corroborated with real-world industry examples. As such, I am assured that inputs and outcomes have been thoroughly examined and discussed at every stage of the project's expansion.

I can confidently state that the program of work has been conducted with rigor and in a creditable manner, in keeping with the high standards of integrity expected by Infrastructure Australia. The culminating 2022 *Infrastructure Market Capacity* report is a comprehensive national view of the major public infrastructure pipeline which will provide considerable benefits to industry and government in the future decision-making."

— Professor Anthony Mills, Chair of Construction Management, Deakin University School of Architecture and Built Environment

Executive summary

At a glance

- **Demand-driven risks have increased over the last 12 months:** While demand for major public infrastructure projects has climbed by $15 billion in a year, so too has the breadth of construction demand coverage within Infrastructure Australia's Market Capacity Intelligence System. By ingesting more data sets, the scale of competition for scarce resources is now more evident than ever.
- **Supply side risks have surged in 2021—22:** The global economy continues to battle significant disruption to supply chains caused by the COVID-19 pandemic, volatile demand and more recently, the war in Ukraine. These factors are causing delays and cost escalations for imported items. Onshore, severe labour shortages present the greatest risk to capacity, according to industry.
- **Increasing project costs and complexities, plus truncated risk allocation and planning practices are driving insolvencies and consolidation, thus threatening capacity:** Exposure to fast-rising costs and dangerous levels of risk have proven too much for some businesses. Construction insolvencies have risen sharply in 2022, leaving fewer companies – many of which are operating at 90% capacity and above - to deliver the pipeline of work. Compounding this, the continued rise in complex mega-projects means the majority of public infrastructure projects are awarded to a few offshore Tier 1 operators. Such consolidation further diminishes industry's capacity to deliver, since only large operators are equipped with the resources and financial means to compete.
- **The market is arguably at capacity, so project slippage is now expected:** The pressure the industry is experiencing to supply labour and materials in step with demand creates unprecedented uncertainty on project outcomes, and the opportunities to adapt and pivot will take time to realise. As such, it is no longer a question of if a project will slip, but more likely when, by how long and at what cost.
- **Construction sector multifactor productivity has stagnated for 30 years:** Compared to other related industries such as transport and logistics, and manufacturing, the construction industry has a poor track record in achieving sustainable, strong productivity growth over time.

A rapidly-changing market is creating unprecedented uncertainty

An overheated construction market, characterised by escalating input costs, labour shortages and worsening productivity, continues to place extraordinary pressure on construction companies, suppliers and projects. These inflamed conditions were previously explored in the:

- *2019 Australian Infrastructure Audit*
- *2021 Infrastructure Market Capacity* report
- *2021 Australian Infrastructure Plan*
- *Delivering Outcomes: A roadmap to improve infrastructure industry productivity and innovation.*

The five-year infrastructure pipeline of major public projects has continued to grow by more than $15 billion in the last 12 months. As such, relevant recommendations and actions from the *Australian Infrastructure Plan* and *Delivering Outcomes* are reaffirmed in this report. There is increasing urgency to manage these risks and proactively sequence the major infrastructure pipeline. A focus on productivity improvements in planning and delivery, and more ambitious reform to sustainably expand the market's capacity through supply of labour and materials is increasingly critical for successful, timely and cost-effective delivery.

A once-in-a-generation opportunity for change

The current market capacity challenges present a rare opportunity for governments to steer industry towards sustainable supply and demand equilibrium. In summary, there are three key areas of opportunity:

- **Proactive demand management:** State and territory governments, alongside the Australian Government, can leverage the Market Capacity Intelligence System data to sequence their infrastructure pipelines and proactively manage resource demand in the construction market. This would involve strengthening coordination across jurisdictions and ensuring greater visibility of investment pipelines. Sequencing and reprofiling of the pipeline should be focused on projects that have not commenced construction, affording more time to focus on risk discovery in the planning phase of projects. See **Table 1**.
- **Expansion of market supply:** With supply constraints impacting construction markets globally, opportunities to expand local supply exists in growing the circular economy for construction materials (this report explores such opportunities in road construction), and in recruiting more women into the infrastructure workforce. See **Table 2**.
- **Productivity growth:** Given the difficulties in quickly increasing construction labour and capital inputs to meet demand, productivity improvements offer the critical link to minimising capacity and capability risks, improving outcomes, enhancing industry sustainability and lowering infrastructure costs. See **Table 3**.

Table 1: Recommendations to proactively manage infrastructure demand

Market capacity finding	Implications	Recommendation
Demand for major public infrastructure works has increased by $15 billion since 2021, equivalent to 6.7% growth.	Demand for infrastructure projects continues to outstrip supply, heightening the risks to overall value for money infrastructure delivery.	**Intermediate Outcome 3.1.1 *from the 2021 Australian Infrastructure Plan:*** ***Improve industry capacity and capability by prioritising procurement and portfolio management and increasing pipeline transparency, certainty and confidence.***
Due to time pressures, the risk discovery stage of a project is often truncated, leading to a convention in market behaviours where contractors are assuming higher levels of risk than is sustainable within the market.	Construction sector insolvencies are occurring at an increasing rate compared to other sectors since the onset of the COVID-19 pandemic.	**Recommendation 3.2a *from the 2021 Australian Infrastructure Plan:*** ***Improve value for money and reduce risk by consistently adopting appropriate best-practice front-end due diligence for projects.***

By applying best practice portfolio planning and management, governments can enhance sector stability, and thus drive greater capacity to meet Australia's infrastructure needs.

Having a stable pipeline will also facilitate the transformation of industry productivity through the adoption of production and manufacturing approaches to reduce cost volatility, lower overall prices and create a more sustainable industry.

Minimising or removing risks is critical to successful infrastructure delivery, an outcome that is achieved by using thorough and robust due diligence processes. These processes should occur before major commercial contracts are awarded - the optimal point being the earliest stage of a project - to ensure the best solution is identified and the right infrastructure is built.

Additionally, Australia's governments can play a key role in advocating for and driving best practice in due diligence through Front-End Engineering and Design (FEED), and by championing a 'go slow to go fast' mentality.

In terms of effective risk planning and management, the *2021 National Study of Infrastructure Risk* report offers an examination of risks common to the project lifecycle.[1] A supplement to the report is the interactive Infrastructure Risk Dashboard, which offers procurers, and contractors a valuable, data-driven tool for understanding risks relevant to their projects, with a library of common risks classified by project type and infrastructure sector.[2]

Table 2: Recommendations to expand supply of materials and labour

Market capacity finding	Implications	Recommendation
The demand for materials for use in road construction projects is expected to grow to a peak of $7.6 billion in 2023–24.	Based on current technology and standards, around 27% of conventional materials (i.e., materials that do not originate from or contain recycled constituents) used for road projects could be replaced with a range of recycled materials.[3] This would mean substituting approximately 54 million tonnes of conventional materials used in roads infrastructure with approximately 52 million tonnes of recycled materials.[4]	**Intermediate Outcome 9.1.3 from the *2021 Australian Infrastructure Plan:*** ***Build support for the circular economy and embed circular practices by developing a circular economy roadmap for the infrastructure sector, including annual progress reports.***
The construction industry is comprised of 12% women and 88% men (compared to an all-industry average of 47% women and 53% men).	An industry which has less than 1 in 8 positions held by women (less in private firms) cannot be said to be maximising potential labour participation.	**Outcome 3.1.3 from the *2021 Australian Infrastructure Plan:*** ***Ensure the industry is a sector of choice for employees and can meet current and future workforce demands by introducing cultural reform that embraces diversity and inclusion.***

An uptake in replacement materials can lessen the reliance on conventional materials and lead to an expansion of materials supply. In addition, a circular economy can reduce costs for business, support new industries and jobs, and enable the efficient use of natural resources.

The challenge of creating predictable demand and stable supply of replacement materials requires enduring and proactive leadership that seeks to: shift perceptions and take-up of replacement materials by educating users and manufacturers; challenge and evolve inhibiting standards, specifications and regulations, support new infrastructure in under-served areas and modernise existing material processing infrastructure to grow capacity for recycled material products.

In terms of cultural reform, commitments to affect cultural change should deliver greater workforce diversity and inclusion across the sector, along with better mental health and wellbeing outcomes.

The construction sector is one of Australia's largest employers, yet it also has the lowest levels of female workplace participation of any industry at only 12%.[5] Difficulties in attracting, recruiting and retaining female employees exacerbates industry's growing labour shortage, and leads to lost productivity benefits by overlooking the skills and capabilities of a large portion of the workforce.

Lifting female workforce participation has clear economic benefits, and also represents an opportunity to drive cultural change within an industry plagued by poor mental health, high rates of family breakdown and lack of diversity. There is evidence that employing more women can bring a diversity of skills and thought, and cultural benefits such as a reduction in bullying, improved attention to detail and improved communication.

Taking deliberate and meaningful action to understand and address the working needs of women and other under-represented groups, can unlock the potential for a more resilient ecosystem that is capable of delivering Australia's future infrastructure needs.

Adoption of the Culture in Construction standards is vital to securing the long-term sustainability of the sector. Failing to address cultural issues such as excessive work hours, fatigue and poor mental health will keep from attracting untapped workforces.[6]

NSW Government's forthcoming Culture Standard pilot provides a recent and laudable example. Here, an Australian-first Culture Standard will be piloted at two NSW construction sites to improve facilities, working conditions and ultimately boost the number of women in construction. [7]

Table 3: Recommendations to achieve sustainable productivity growth

Market capacity finding	Implications	Recommendation
Compared to other related sectors, the construction industry has not achieved sustainable, strong productivity growth over time) See **Figure 38**	Without productivity growth, more labour and capital will be needed to meet increased construction demand which, in times of scarcity, puts resources under pressure and heightens capacity and capability risks as well as construction costs.	**Implement the 7 focus areas of reform outlined in:** ***Delivering Outcomes: A roadmap to improve infrastructure industry productivity and innovation***

Delivering Outcomes - published in 2022 - is a roadmap for transforming today's infrastructure sector into one that is more productive, innovative and sustainable. With an emphasis on changing how projects are procured and delivered to ensure better outcomes for the community and businesses, this roadmap includes seven areas of reform (and 30 best practice principles). Like the preceding recommendations from Table 1, these 7 reform areas address how we plan infrastructure from the start of the construction lifecycle, so it is worth noting the productivity opportunity extends to projects already in flight by adopting an adaptive leadership approach across governments and industry in particular areas:

- **Collaboration** – long-term and collaborative relationships throughout the ecosystem are essential to creating a financially sustainable and high-performing infrastructure industry
- **Innovation** – delivery integration, digital techniques and other modern methods of construction enable increased productivity
- **People** – the wellbeing and resilience of people is the foundation of a flourishing infrastructure sector, and is brought about by the systemic pursuit of health, safety and wellbeing outcomes.

The evidence base that informs the findings, implications and recommendations above is laid out in the following sections of this *2022 Infrastructure Market Capacity* report:

- **Understanding demand** – an explanation of how the national infrastructure pipeline has changed year-on-year, plus a detailed profiling of material demands over time.
- **Industry confidence** - an exploration of supply-side constraints affecting the infrastructure market, from the point of view of builders and civil contractors.
- **Understanding non-labour supply** - a series of insights, quotes and improvement ideas from industry participants on non-labour inputs – including spotlights on steel, concrete and quarry products - plus a look at the market for using replacement materials in road construction.
- **Workforce and skills** - a quantitative analysis into the demand for and supply of labour in service of public infrastructure.
- **Implications and recommendations** - drawing meaning and relevance from the evidence base presented in preceding sections, recommendations are presented to address capacity constraints and risks.

Key market capacity findings

Infrastructure demand

There are now 5,500 construction projects listed in Infrastructure Australia's Market Capacity Intelligence System representing:

- a combined value of $647 billion from 2021—22 to 2025—26
- 57% of the total estimated construction market from 2021—22 to 2025—26 (67% in 2024-25)
- an increase of more than 4,800 projects in the last 12 months.

The five-year pipeline of major public infrastructure projects is:

- valued at $237 billion - an increase of $15 billion in the last 12 months
- mostly focused on transport (63% of spend)
- highly skewed to New South Wales, Victoria and Queensland (84% of spend).

Non-labour inputs

- Demand for plant, equipment and materials to service the five-year major public infrastructure pipeline is expected to more than double between 2020—21 and 2023—24.
- The Australian Bureau of Statistics reports a minimum 40% rise in the cost of reinforcing steel and structural timber between June 2021—22.
- Industry consolidation impacts on supply chains are evident, for instance through delays of up to 45 weeks in delivery of large diameter concrete pipe.
- A recycled alternative exists for 27% of conventional road construction materials.

Industry confidence

Industry surveys and interviews indicate that:

- labour scarcity is the single biggest issue faced by construction companies
- the cost of construction materials has risen by an average 24% in the last 12 months
- the cost of labour inputs has risen by an average 17% in the last 12 months
- a significant number of construction companies are operating at 90% or above capacity.

Workforce and skills

- As of October 2022, public infrastructure projects, including small capital projects, face a shortage of 214,000 skilled workers. This shortage is not comparable to findings from the 2021 *Infrastructure Market Capacity* report due to the expanded view of demand in 2022.
- In 2023, labour demand is projected to grow by 42,000 to a peak of 442,000. This is more than double the projected available supply.
- Every state and territory jurisdiction is experiencing a shortage in their public infrastructure workforce.

Many of the reforms identified from Infrastructure Australia's research are underscored by the new evidence-base provided in this updated *Infrastructure Market Capacity* report

2021 Australian Infrastructure Plan

Infrastructure Australia's *2021 Australian Infrastructure Plan* is a practical and actionable roadmap for infrastructure reform. It is intended to deliver infrastructure for a stronger Australia, and support our national recovery from the COVID-19 pandemic, bushfires, drought, floods and cyber-attacks that have tested our resilience in recent years.

The *2021 Australian Infrastructure Plan* outlines a vision for 2036 to have infrastructure that improves the sustainability of the country's economic, social, environmental and governance settings, builds quality of life for all Australians, and is resilient to shocks and emerging stresses.

The relevant reforms from the *2021 Plan* are reiterated in this *Infrastructure Market Capacity* report, in *Section 6: Implications and recommendations*.

Delivering Outcomes: A roadmap to improve infrastructure industry productivity and innovation

The *Delivering Outcomes* report provides a roadmap to improve infrastructure industry productivity, setting out a future where:

- outcomes provide the focus for infrastructure delivery
- partners are engaged earlier in developing delivery approaches
- integrated teams are brought together to innovate and collaborate to deliver outcomes for people and place
- digital transformation is used to develop intelligent solutions.

Infrastructure owners and delivery agencies must be able to clearly articulate the outcomes they seek in terms of the change experienced by customers, community and environment.

To achieve this step-change, seven focus areas of reforms are needed:

People and places: infrastructure investment is driven by delivering economic, social and environmental outcomes to enable people and places to flourish and prosper.

Systems: managing and planning infrastructure as a system drives more informed decision-making leading to higher quality, faster and cheaper infrastructure solutions that better align to the needs of people and places.

Digital: the adoption of digital tools can be transformative in driving increased productivity and innovation in infrastructure delivery.

Collaboration: with effective collaboration and integration across the sector, a financially sustainable, high performing infrastructure industry can emerge.

Commercial: alignment and optimisation of commercial goals and operations can unlock financial sustainability and sectoral innovation.

Innovation: the adoption of digital techniques enable increased productivity.

People: the wellbeing and resilience of people working in the infrastructure industry is the foundation for a flourishing sector.

Key infrastructure sector facts

- It takes 10 or more years for the approval, build and ramp-up of a new quarry, even those well outside metropolitan areas. This coupled with increasing difficulty in obtaining consent extensions for existing quarries is creating the real risk of a 'quarry gap' in Melbourne's infrastructure supply chain.
- Following widespread flooding in Queensland and New South Wales in February 2022, delivery of re-routed quarry freight throughout Australia incurred an additional $2.3 million in transport costs.
- Domestic steel production is unlikely to fulfill demand between 2021-22 and 2023-24.
- Western Australia has the highest demand-to-supply ratio for labour, with 2.7 workers demanded for every 1 supplied.
- The demand-to-supply ratio for labour New South Wales, Queensland, and the Northern Territory is 2:1.
- Australia is 'missing' almost half a million people in net overseas migration expected between 2019—2020 and 2021—22.
- Wages for public infrastructure roles are generally 5% lower in the public sector.
- Women participate at a higher rate in the public sector than the private sector across every public infrastructure occupation group.



1. Introduction

This *Infrastructure Market Capacity* report is the second report on this issue by Infrastructure Australia. These reports respond to a request made by the Prime Minister and First Ministers at the Council of Australian Government (COAG) meeting of 13 March, 2020:

> “Leaders considered analysis on the market’s capacity to deliver Australia’s record pipeline of infrastructure investment to support the country’s growing population. This analysis highlighted the importance of monitoring infrastructure market conditions and capacity at regular intervals to inform government policies and project pipeline development.
>
> Leaders agreed that Infrastructure Australia will work with jurisdictions and relevant industry peak bodies to monitor this sector.”
>
> *— COAG Communique, March 2020*

In meeting this request, Infrastructure Australia has worked collaboratively with state and territory governments, and industry across Australia and internationally. These partnerships continue to facilitate our ability to understand and analyse the pipeline of major public infrastructure projects through the Market Capacity Program established in 2021.

This report – the second of such following last year’s debut *Infrastructure Market Capacity* report – descends from challenges explained in the *2019 Australian Infrastructure Audit*. As asserted by states and territories, the increasingly complex risk environment for project delivery, plus constraints in the supply of skills and resources, market volatility, and inconsistent project and portfolio planning standards are all intensifying the risk of cost escalations and project delays across sectors. In service of this, the intent of the Market Capacity Program is to provide governments and industry with world-leading capability that supports investment decisions and industry policy-making.



A wider view of project activity

The Market Capacity Program is underpinned by a data-driven capability designed to comprehensively understand the capacity of the market to deliver the pipeline of major public infrastructure projects. A National Infrastructure Project Database aggregates and organises project data and a Market Capacity Intelligence System applies a comprehensive suite of analytical and system-based tools to interrogate and visualise capacity across sectors, by project type and resource inputs.

The breadth of data available for analysis by the Market Capacity Intelligence System has increased over the last 12 months to include a larger share of industry activity. By ingesting a broader set of project-level data, the ability of the system to quantify industry resource demands is increased, thereby providing a far-expanded view of demand.

The additional data ingested during this second phase of the Market Capacity Program includes: small capital public infrastructure projects (valued under $100 million in New South Wales, Victoria, Queensland and Western Australia, and $50 million in South Australia, the Australian Capital Territory, the Northern Territory and Tasmania); privately funded public infrastructure e.g., toll roads that are funded, delivered and operated by the private sector); private construction (i.e., residential and non-residential buildings), and road maintenance (i.e., resource demands for road maintenance projects). The total number of projects represented in the Market Capacity Intelligence System has grown from 634 to over 5,500 in the last 12 months.

A better understanding of supply-side capacity and constraints

This *2022 Infrastructure Market Capacity* report introduces a greater degree of supply-side analysis, that is, factors influencing the provision of key infrastructure input resources – i.e., materials, plant, equipment and labour – required to meet demand.

The sources used to provide supply-side insights include publicly-available production and/or import data for materials, plant and equipment, plus surveys and telephone interviews with builders, civil contractors and key industry suppliers. In combination, these inputs highlight potential pinch points in supply-side capacity and likely causes and consequences, plus the general confidence and latent capacity of builders and civil contractors in meeting infrastructure demand.

Finally, the *2021 Australian Infrastructure Plan* identified the acceleration of Australia's transition to a circular economy as a key reform to meet Australia's future infrastructure needs. In service of this, a summary of the market for replacement materials in roads construction is included in this report.

Plans for further capability for the next phase of the Market Capacity Program

Ongoing direct and complete data sharing by state and territory governments plus the provision of high-quality third-party data will continue to enhance the capability of the Market Capacity Program over time.

Data collection sources will remain consistent to this year's report to enable detailed analysis of year-on-year drivers of change. On the supply side, the aim is to collect third-party industry data that quantifies the available materials compared to demand. This will complement the workforce and skills supply-and-demand analysis.

2. Understanding demand

At a glance

Over the last year, the Market Capacity Intelligence System has ingested data for projects beyond those concerning major public infrastructure. This means better quantification of the market in which major public infrastructure projects compete for common resources.

There are now over 5,500 projects represented in the Market Capacity Intelligence System covering: major public infrastructure; small capital public infrastructure; privately funded public infrastructure private construction activity. This compares to last year's project total of 634.

The combined infrastructure pipeline is worth $647 billion over the five years from 2021—22 to 2025—26. Of this, major public infrastructure projects represent $237 billion – a growth of $15 billion in 12 months – and other infrastructure projects represent $410 billion.

Of the $237 billion five-year major public infrastructure pipeline, 63% is attributable to transport projects.

Of the $410 billion other infrastructure projects, roughly three in four dollars ($319 billion) are allocated to privately funded projects, such as residential and non-residential building activity, over the next five years.

This greatly expanded view of infrastructure demand effectively equates to a doubling of key resources at minimum, including plant, labour, equipment and materials.

Materials required to deliver the five-year pipeline of public infrastructure projects are valued at $75 billion, of which steel and concrete account for 34% and 33%, respectively. As explored in *Section 4: Understanding non-labour supply*, quantities of locally-produced steel will be insufficient for meeting demand between 2020—21 and 2023—24.

The culmination of today's difficult market conditions means that projects are being delivered in a reality that is vastly different than planned. The likely result is a dramatic slowing of progress, not by choice and therefore not by plan. The evidence supporting this assertion is a comparison of 2021's reported total investment for major public infrastructure projects during 2021—22 ($44.6 billion) with this year's total investment for the same period and same set of project types ($43.3 billion). This drop in total investment provides early signs that not all projects are being delivered to schedule, with some projects taking longer to complete than originally planned.



Broadening the view of infrastructure demand

Last year's *Infrastructure Market Capacity* report revealed that major public infrastructure projects listed in the Market Capacity Intelligence System represented almost 53% of all public infrastructure projects, and just 13% of the broader infrastructure project landscape in 2019—20, as indicated in ABS estimates of historical work done.

Major public infrastructure projects are defined as projects with a value higher than $100 million in New South Wales, Victoria, Queensland and Western Australia and more than $50 million in Tasmania, South Australia, the Northern Territory and the Australian Capital Territory.

This year, Infrastructure Australia has taken steps to enhance its commentary on market capacity, capability and potential risks, by importing significantly more project-level data into the Market Capacity Intelligence System, including:

Small capital public infrastructure, i.e., projects valued below $100 million in New South Wales, Victoria, Queensland and Western Australia, and below $50 million elsewhere.

Privately-funded public infrastructure, e.g., toll roads that are funded, delivered and operated by the private sector.

Private construction, e.g., residential and non-residential buildings.

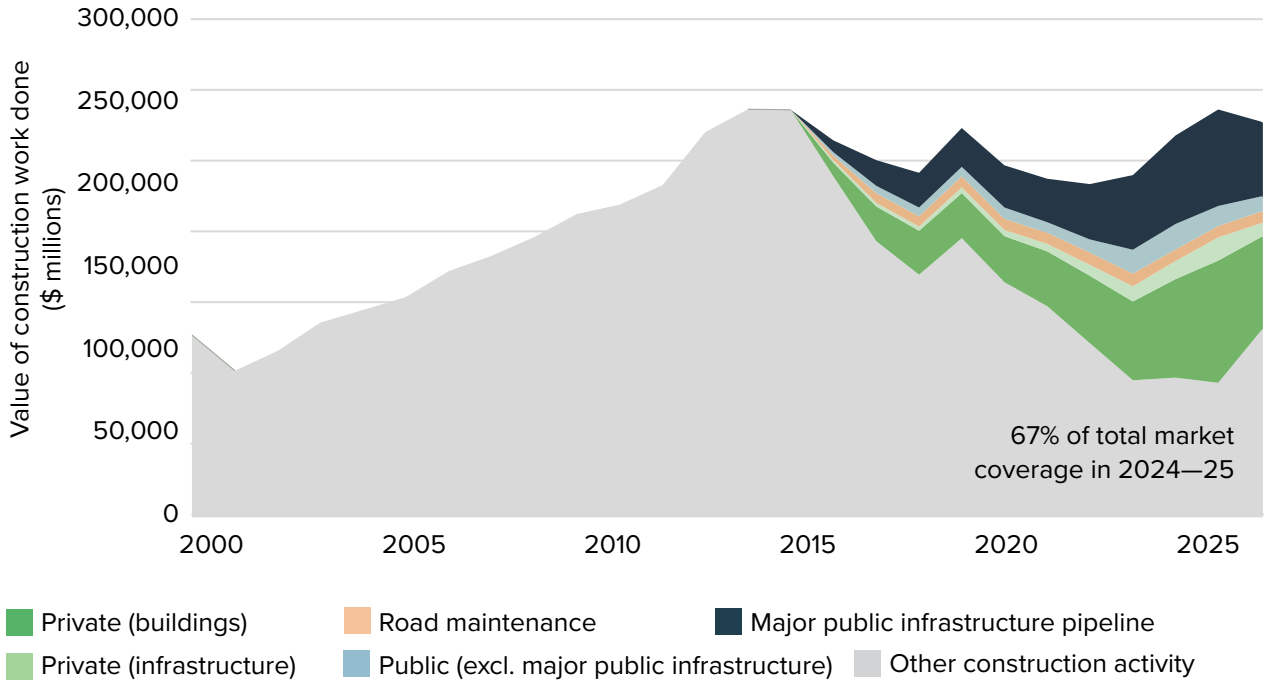
Road infrastructure maintenance i.e., resource demands for road maintenance projects.

Given every project is competing for the same set of limited resources, obtaining this wider view has been critical in ensuring:

- improved accuracy of demand quantifications
- better visibility of potential supply-side pinch points
- a clearer view of the findings on demand and supply in relation to capacity and costs
- provision of better-informed recommendations for infrastructure policy, further research and improvements.

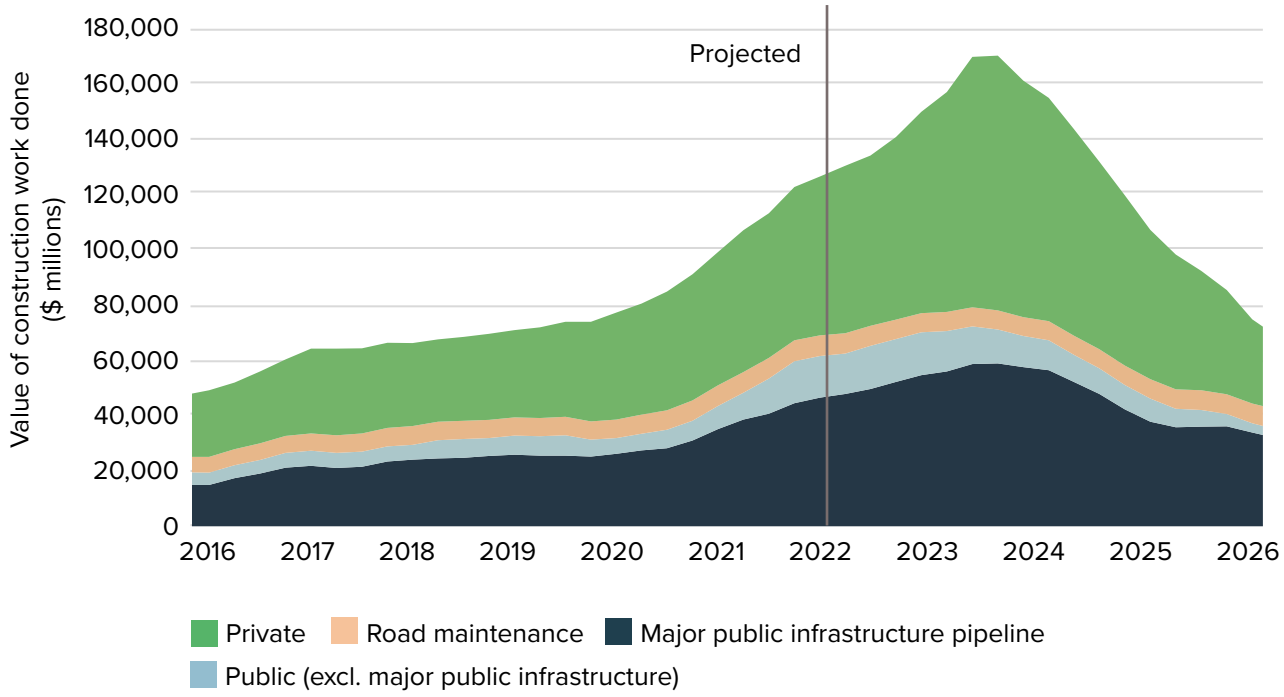
As a result of ingesting the additional project types listed above, the Market Capacity Intelligence System now houses detailed information for over 5,500 construction projects, compared to a year ago when 634 major public infrastructure projects were represented. This expanded view (shown in **Figure 1** and **Figure 2**) covers, on average, 57% of estimated construction demand per year (rising to 67% in 2024—25), compared to 13% just 12 months ago.

Figure 1: The infrastructure pipeline for 2022 *Infrastructure Market Capacity*, in the context of full construction activity



Source: Turner & Townsend and BIS Oxford Economics commissioned by Infrastructure Australia (2022)

Figure 2: Infrastructure pipeline – split by component



Source: Turner & Townsend and BIS Oxford Economics commissioned by Infrastructure Australia (2022)

A combined infrastructure pipeline worth $647 billion over five years

Infrastructure projects in the Market Capacity Intelligence System represent $647 billion in total estimated capital investment for the duration of the project between 2021—22 to 2025—26, in nominal terms at time of estimation. This equates to an annual expenditure forecast of $129 billion each of the five years.

Major public infrastructure projects reflect $237 billion over five years

Figure 2 shows that major public infrastructure projects represent $237 billion (37%) of the $647 billion five-year pipeline. This is an increase of $15 billion in the last 12 months.

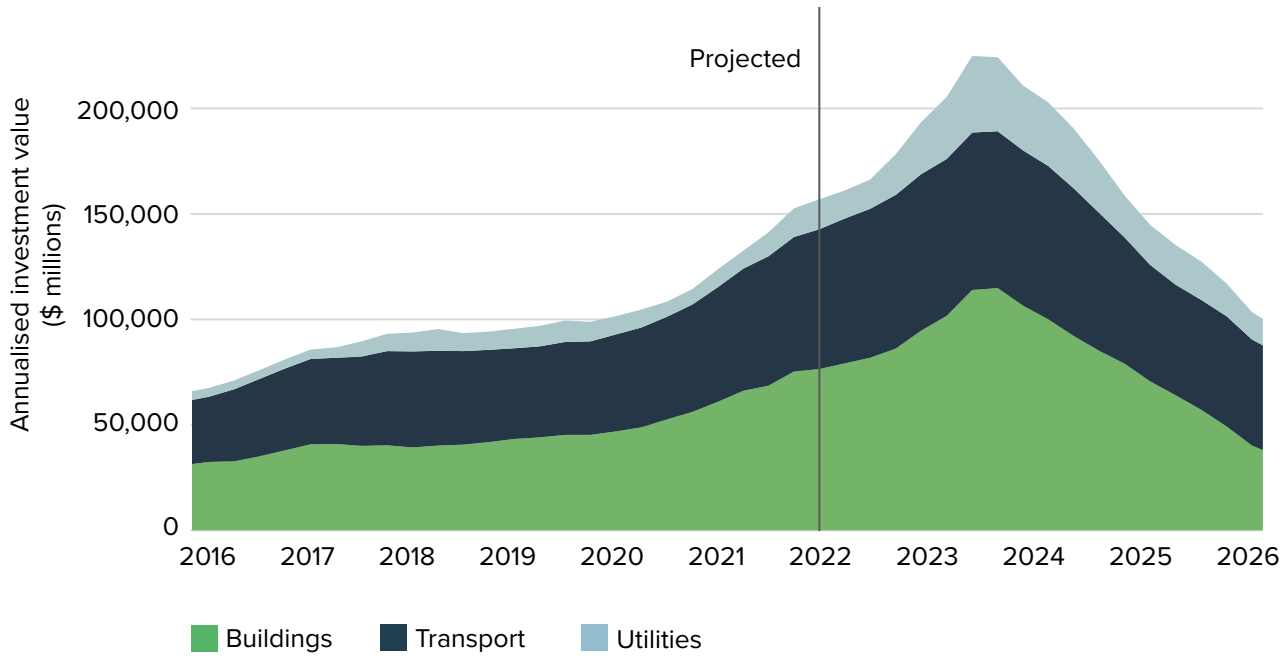
Other infrastructure projects (small capital, privately funded for public use, private, and road maintenance) combine to form a $410 billion pipeline over five years.

Private construction projects represent 78% of newly-ingested projects

Of the $410 billion expenditure that excludes major public infrastructure activity, private construction projects represent the bulk of demand with a forecast expenditure of $319 billion (78%). Of this, $271 billion is attributed to private building projects of which $183 billion is private residential activity.

Having a greater view of upcoming construction projects changes the proportional sizes of the three sectors. Where transport projects represent the greatest proportion of the major public infrastructure pipeline, building projects represent the greatest proportion of the wider infrastructure pipeline, as illustrated in **Figure 3**.

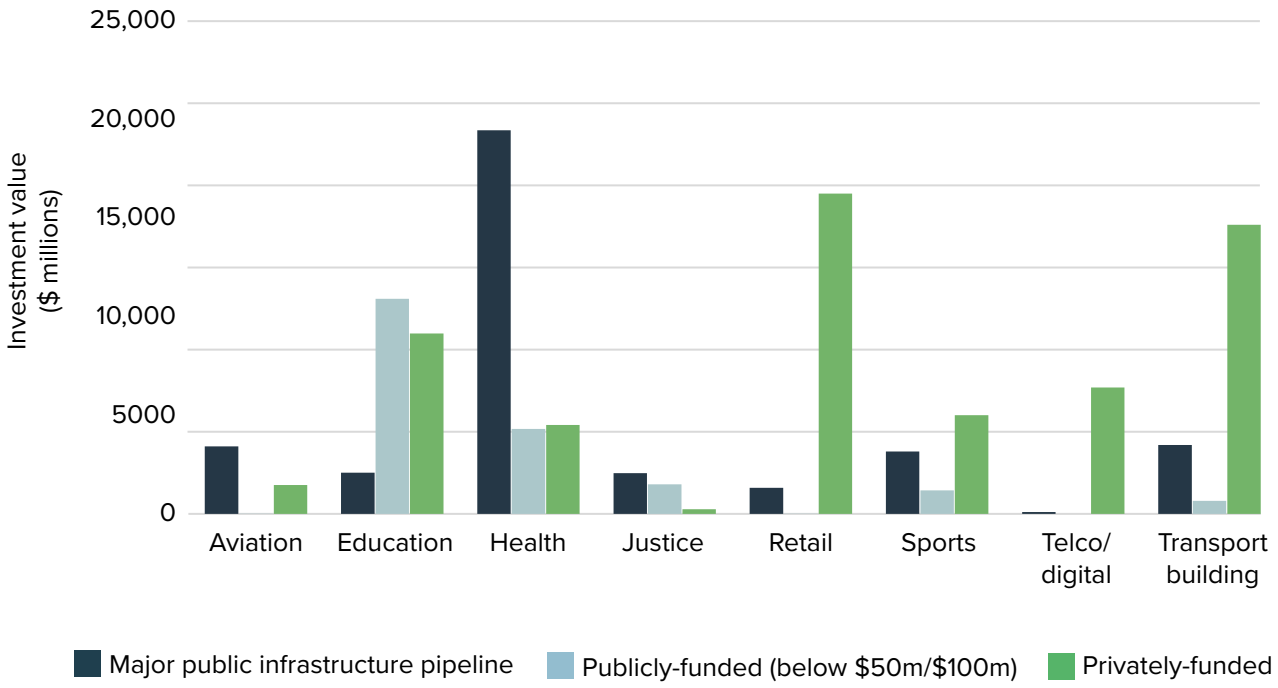
Figure 3: Infrastructure spend – split by sector



Source: Turner & Townsend and BIS Oxford Economics commissioned by Infrastructure Australia (2022)

Projects valued below the threshold of $100 million in New South Wales, Victoria, Queensland and Western Australia, and below $50 million elsewhere represent a small proportion of building activity. $11 billion is planned for small-capital education infrastructure over the next five years (compared to $2.1 billion in major education infrastructure in the same timeframe), which is likely to be the combined value of construction projects occurring across multiple schools – see **Figure 4**.

Figure 4: Infrastructure pipeline – building sector funding comparison, 2021—22 to 2025—26

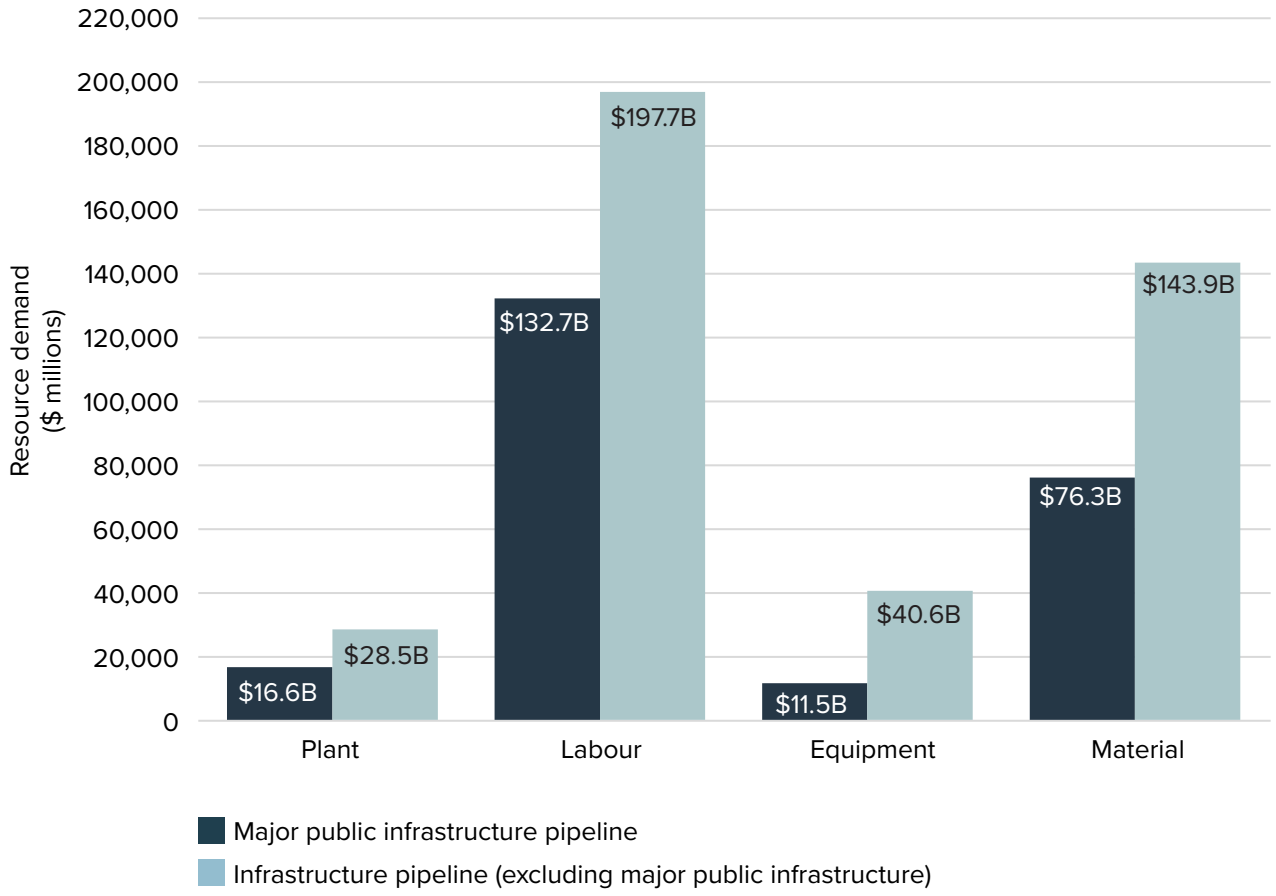


Source: Turner & Townsend and BIS Oxford Economics commissioned by Infrastructure Australia (2022)

A three-fold increase in resources

Almost three times as many resources are demanded by the broader infrastructure pipeline than major public infrastructure projects alone. As depicted in **Figure 5**, the proportion of additional demand is different by resource. For example, the increased proportion of building activity in the infrastructure pipeline drives a proportionally larger increase in resources used intensively by the building sector.

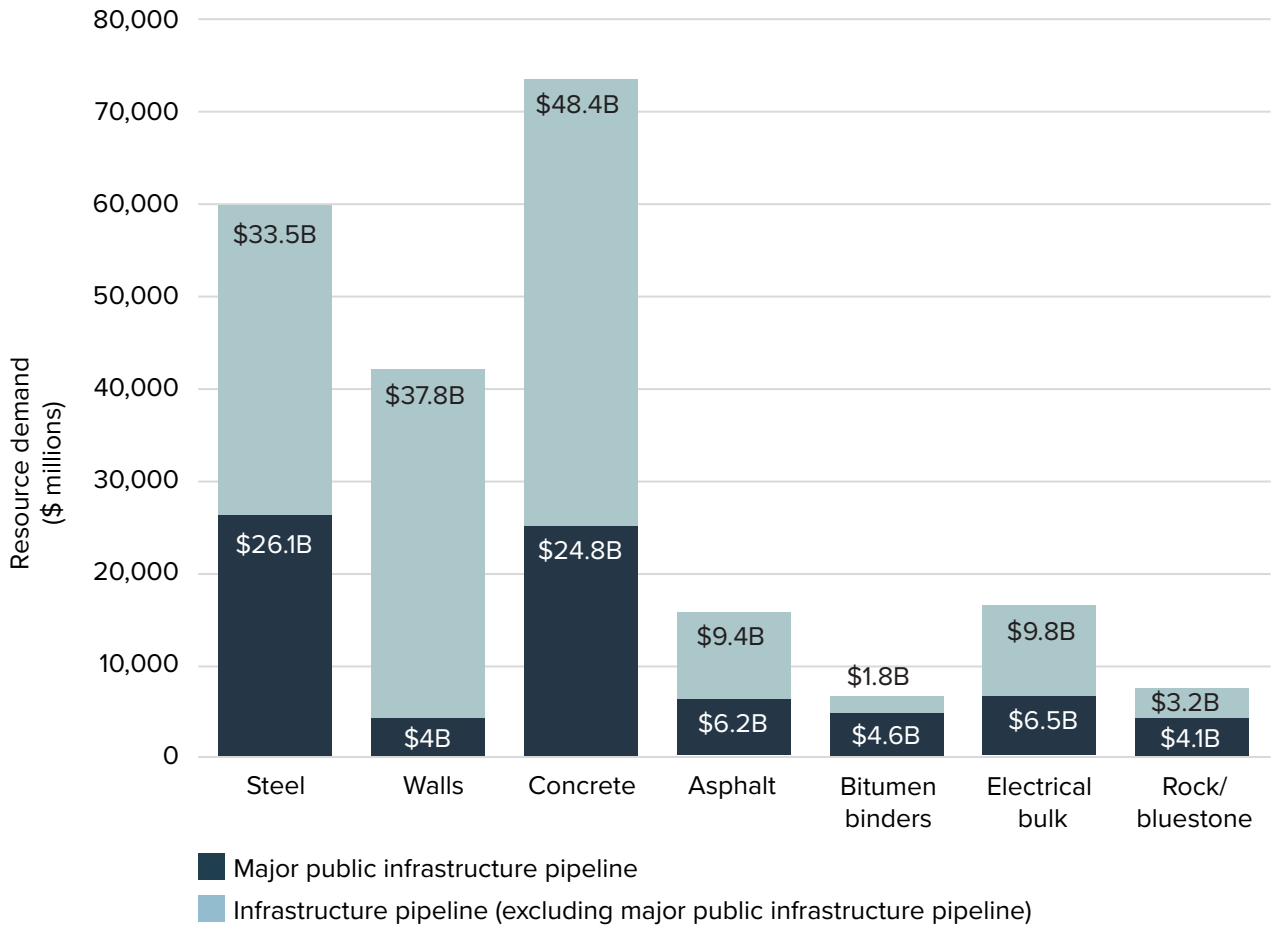
Figure 5: Additional plant, labour, equipment and materials demand of the infrastructure pipeline (2021—22 to 2025—26) alongside the major public infrastructure pipeline



Source: Turner & Townsend and BIS Oxford Economics commissioned by Infrastructure Australia (2022)

The inclusion of private sector building activity provides a clearer view of demand for those materials of which infrastructure projects require less. For example, walls are the third most demanded material of the broadened infrastructure pipeline yet the least demanded material of major public infrastructure projects – see **Figure 6**.

Figure 6: Material classification resource demands – 2021—22 to 2025—26

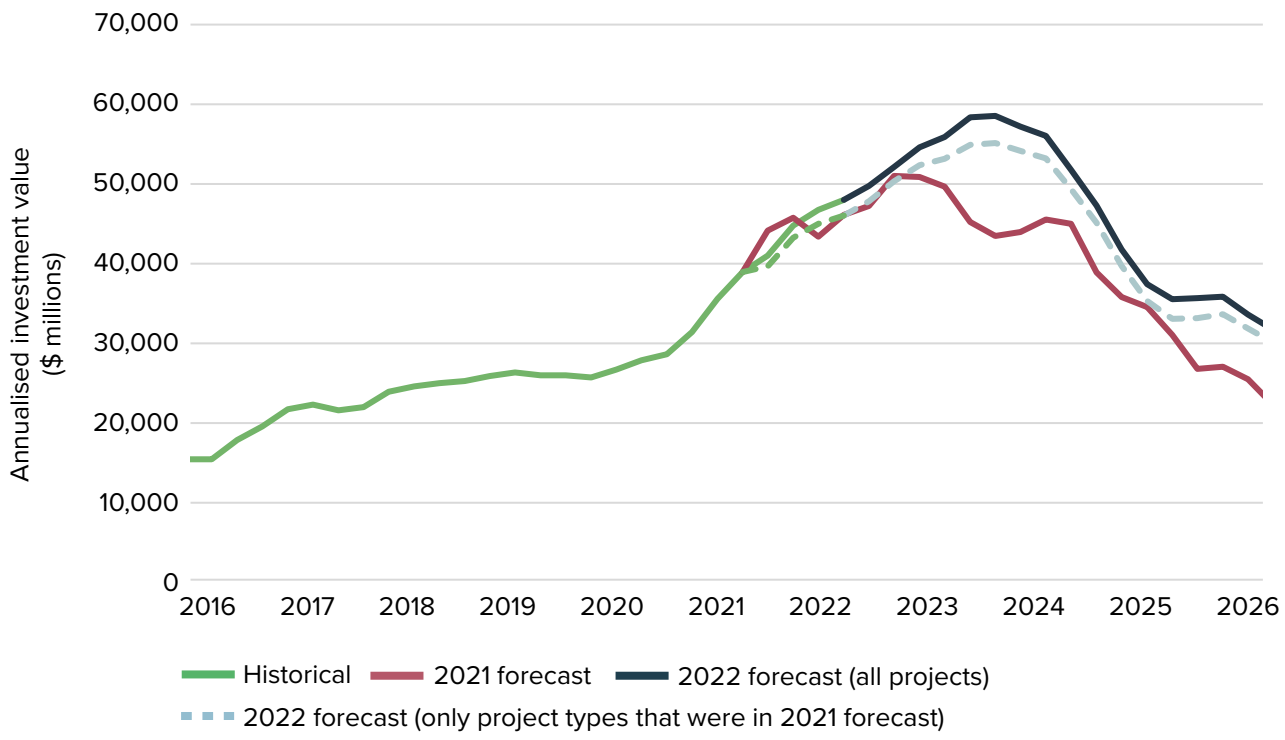


Source: Turner & Townsend and BIS Oxford Economics commissioned by Infrastructure Australia (2022)

Five-year demand for major public infrastructure has grown more than $15 billion in the last year

The projected demand for major public infrastructure over the next five years has grown by $15 billion in the past 12 months. **Figure 7** shows the difference in 2021 and 2022 five-year pipeline valuations.

Figure 7: Total demand for major public infrastructure has increased since the 2021 *Infrastructure Market Capacity* report



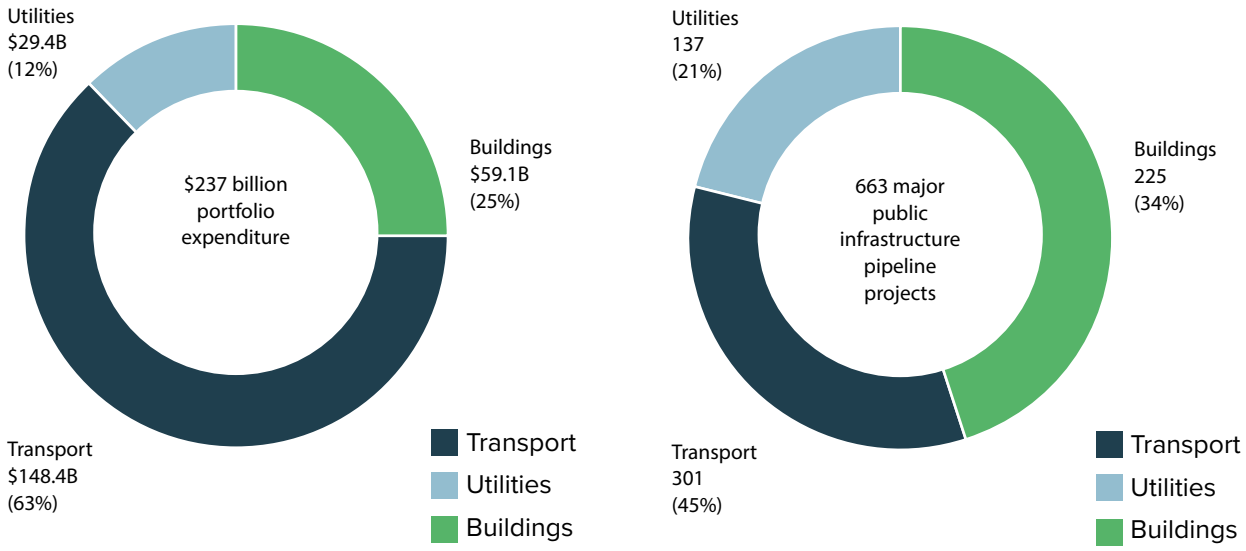
Note: Available data for the period beyond forward estimates is limited. Actual spend beyond 2026 will depend on future project announcements. The dashed 2022 forecast line allows for a direct comparison to the project types that were in scope in the 2021 *Infrastructure Market Capacity* report, excluding new project types for 2022 (such as residential, retail and data centres).

Source: Turner & Townsend and BIS Oxford Economics commissioned by Infrastructure Australia (2022)

Transport projects account for 63% of five-year major public infrastructure spend

Over the next five years, major public infrastructure project activity is estimated at $237 billion, 63% of which is attributable to transport sector projects – see **Figure 8**.

Figure 8: Major public infrastructure pipeline (5-year total)

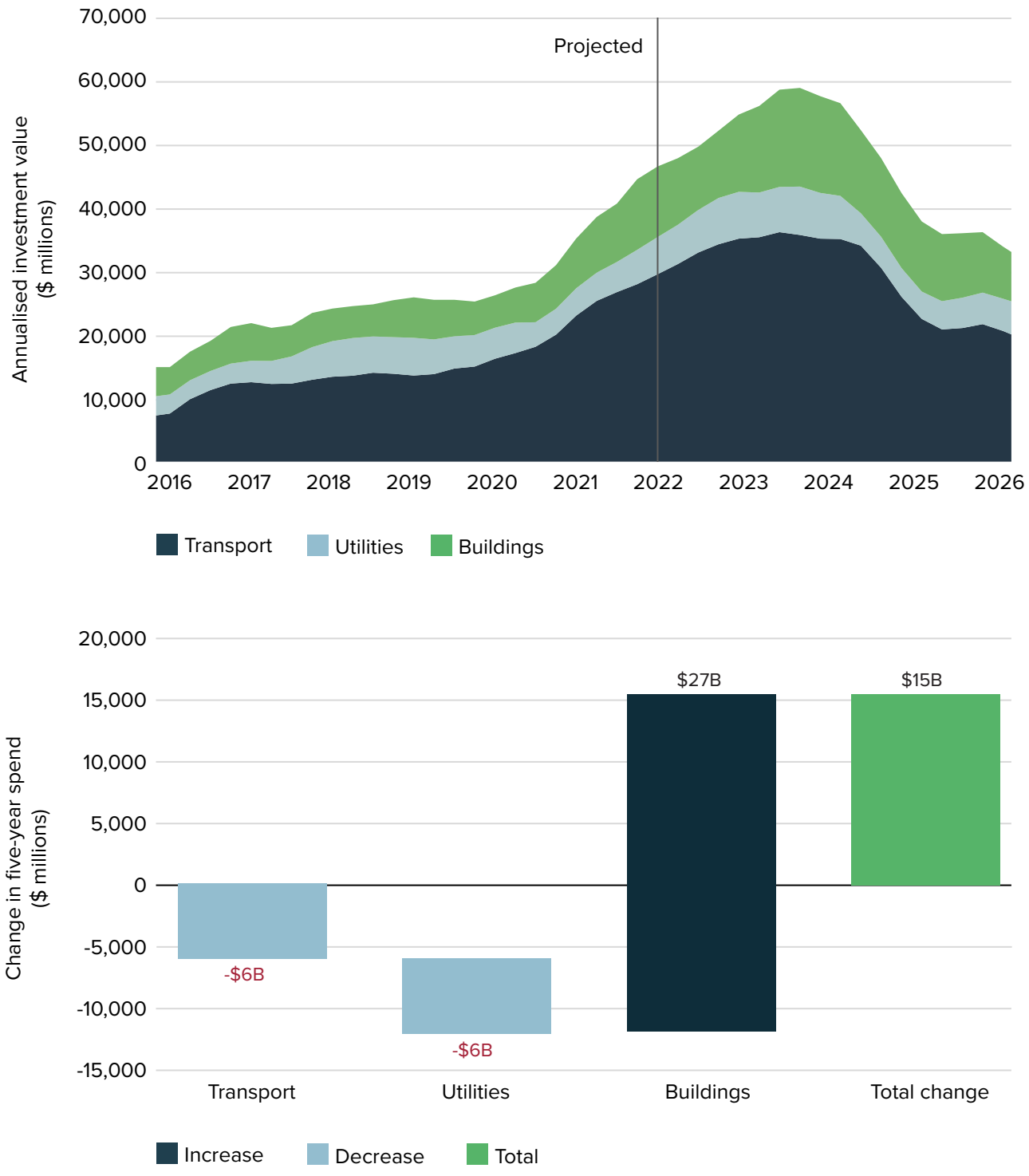


Source: Turner & Townsend and BIS Oxford Economics commissioned by Infrastructure Australia (2022)

Five-year spend on major public buildings increases while transport and utilities fall

The transport sector continues to represent the bulk of major public infrastructure spend despite a small drop in five-year spend ($154 billion in 2021—25 down to $148 billion in 2022—26). The spend on buildings is the only category to have grown in the last 12 months, from $32 billion in 2021—25 to $59 billion in 2022—26, see **Figure 9**.

Figure 9: Major public infrastructure expenditure profile and change in five-year spend since the 2021 *Infrastructure Market Capacity* report

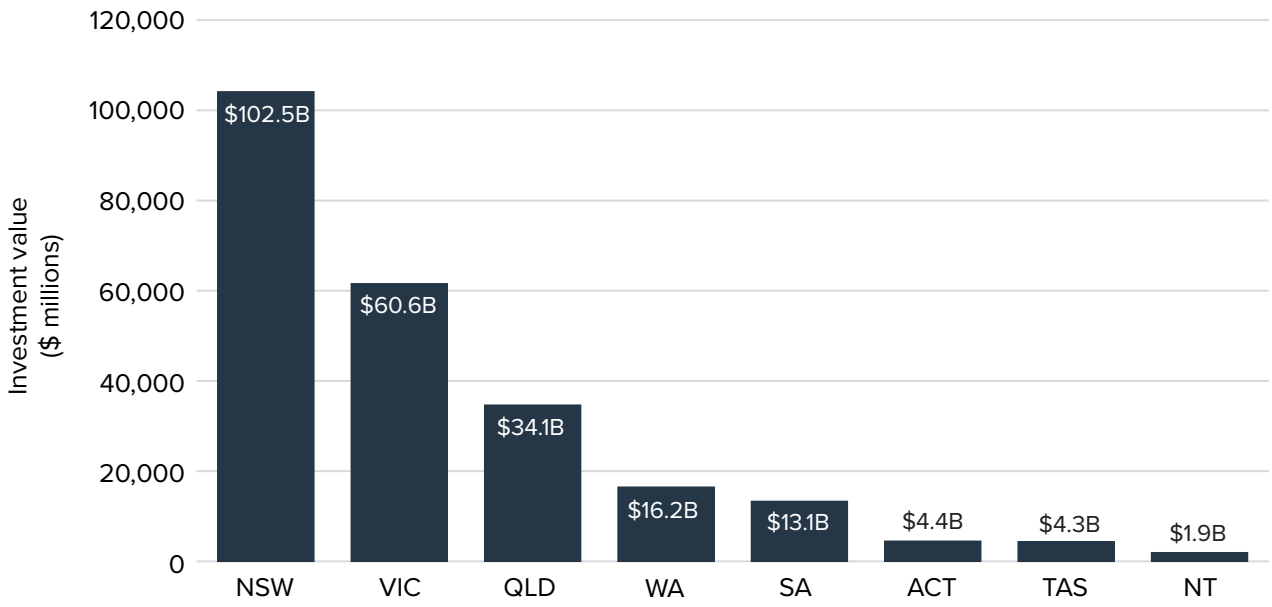


Source: Turner & Townsend and BIS Oxford Economics commissioned by Infrastructure Australia (2022)

East coast jurisdictions make up 84% of five-year demand

New South Wales and Victoria together account for 70% of the five-year major public infrastructure budget, and the addition of Queensland lifts the east coast share to 84%. Per **Figure 10**, the three states together represent $197 billion of the $237 billion five-year total. In keeping with transport sector dominance, each state plans to spend the highest proportion of its budget on major transport infrastructure.

Figure 10: State and territory pipeline comparison – 2021–22 to 2025–26



Source: Turner & Townsend and BIS Oxford Economics commissioned by Infrastructure Australia (2022)

Regional spread of work is likely to create supply side challenges

During the pandemic, there was relatively stronger growth in construction activity and population growth in regional Australia vis-à-vis metropolitan areas, particularly across Australia's east coast states.

Construction activity has been spurred by a number of programs aimed at rebuilding and restimulating regional economies following a succession of natural disasters as well as stimulatory measures following the COVID-19 pandemic lockdowns. On top of these programs, regional infrastructure activity was driven by very large projects such as sections of Inland Rail, Snowy Hydro 2.0, and an increasing number of regional roads, bridges, water, and energy projects.

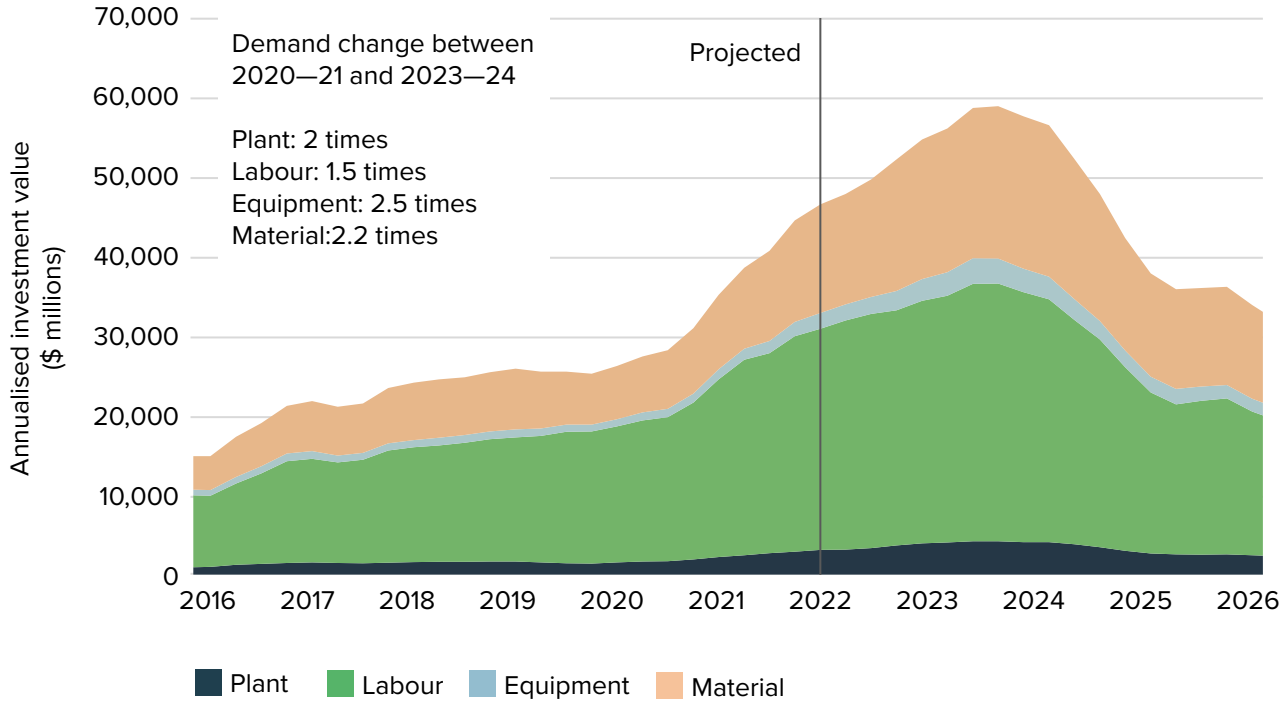
Building activity in regional Australia has also been impacted by stronger population growth in regional areas relative to cities, combined with the Homebuilder stimulus program, which has seen greater regional impact on housing activity. During 2020—21, the population of regional Australia grew by over 70,000 persons, representing growth of 0.9%. The relatively lower cost of regional housing and combinations of amenities, and the increased ability for professional to work from home, may see higher than usual growth in Australia's regional populations sustained in coming years.

The greater regional spread of infrastructure spending is likely to place pressure on local supply chains, which are typically configured to service steady levels of demand. Additionally, it will also require more skills than can be supplied locally and increase demand for local housing and accommodation for construction workforces.

Demand for all non-labour inputs will at least double over the next three years

Per **Figure 11** the demand for non-labour inputs (i.e., plant, equipment and materials) required to deliver the major public infrastructure project pipeline is expected to more than double between 2020—21 and 2023—24.

Figure 11: Major public infrastructure expenditure profile – plant, labour, equipment and material demands



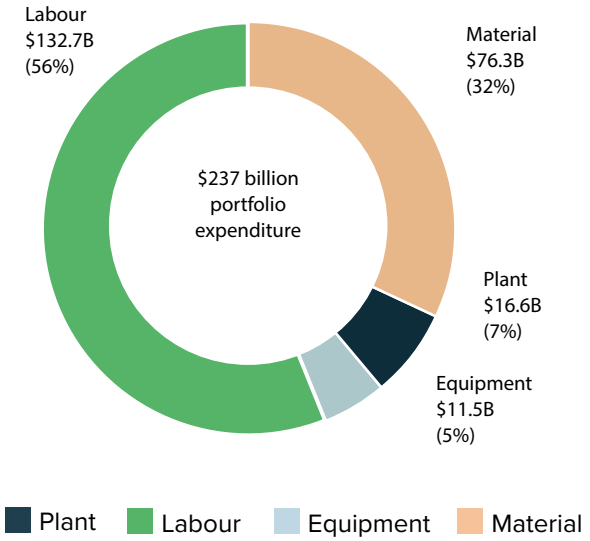
Source: Turner & Townsend and BIS Oxford Economics commissioned by Infrastructure Australia (2022)

Labour demanded by major public infrastructure activity over the next five years is valued at $133 billion, which is the largest share of total expenditure at 56%. However, labour experiences the 'weakest' growth, rising from 165,000—222,000 to 247,000—331,000 annual FTE employment between 2020–21 and 2023–24 (+48%). Demand growth for labour is more spread out than the other sectors, with consecutive gains in demand in the years prior to 2020–21. This wider growth profile is mainly driven by the labour-intensive transport sector and the higher proportion of labour demand in the pre-construction phase of projects.

Figure 12 illustrates the projected proportion and spend of each resource category, including labour.

A deeper analysis of the demand and supply of infrastructure workforce and skills is covered in Section 5: Workforce and skills. Also included are some key facts about the public sector public infrastructure workforce – i.e., those employed by governments to deliver and maintain public infrastructure projects.

Figure 12: Plant, labour, equipment and material share of demand ($billions) – 2021–22 to 2025–26



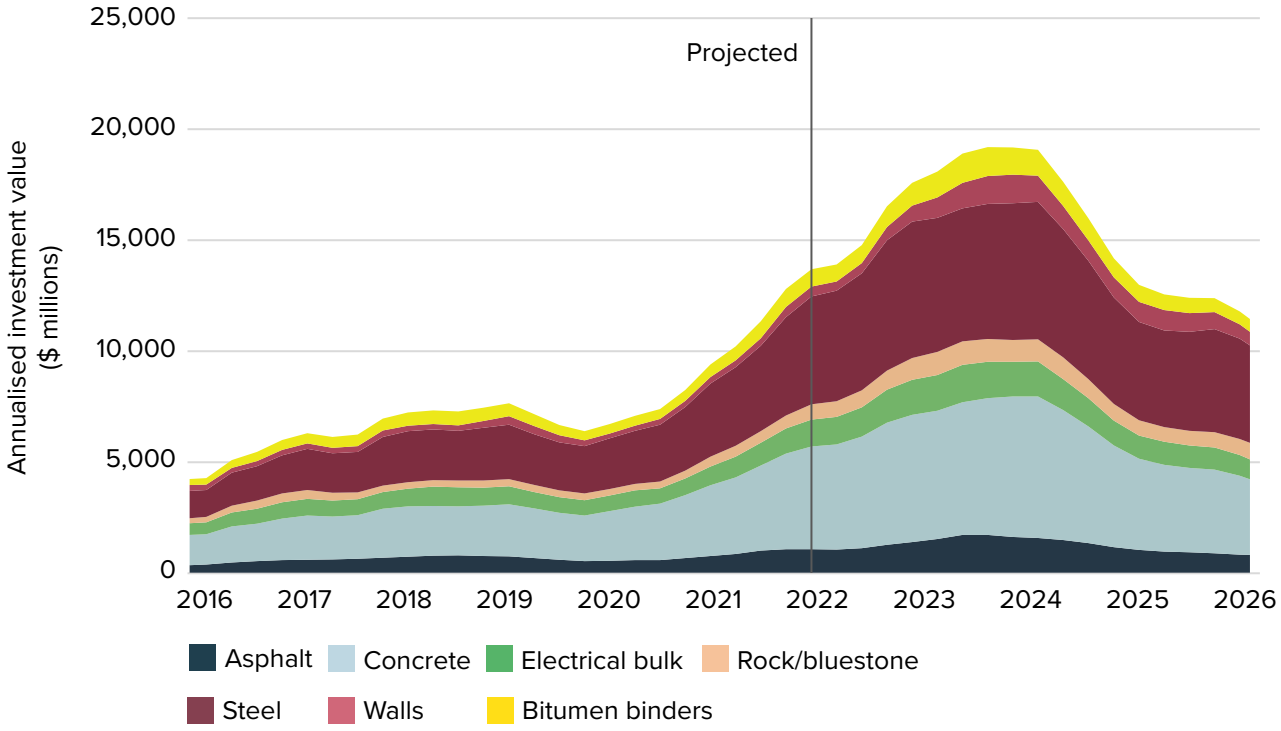
Source: Turner & Townsend and BIS Oxford Economics commissioned by Infrastructure Australia (2022)

Demand for steel and concrete is highest among materials

In total, **materials** account for the second largest proportion of projected expenditure, estimated at approximately $76 billion over the next five years.[8] As illustrated in **Figure 13**, the largest materials sub-categories are steel and concrete in expenditure terms. Over the next five years, these categories represent approximately 34% and 33% of overall material demand, which is a yearly average demand of 32—44 million tonnes of concrete and 2.4—3 million tonnes of steel.

Concrete and rock/bluestone represent almost 89% of total volume, equating to yearly average demand of 42—56 million tonnes over the next five years, with peak demand of 52—71 million tonnes of material in 2023–24.

Figure 13: Major public infrastructure expenditure profile – materials



Source: Turner & Townsend and BIS Oxford Economics commissioned by Infrastructure Australia (2022)

Demand volumes of the remaining materials sit well beneath concrete and rock/bluestone. The second largest category is asphalt (and bitumen binders) for which major public infrastructure projects will require an annual average of 5.1—6.9 million tonnes over the next five years. The demand peak of 6.8—9.2 million tonnes is forecasted for 2023–24.

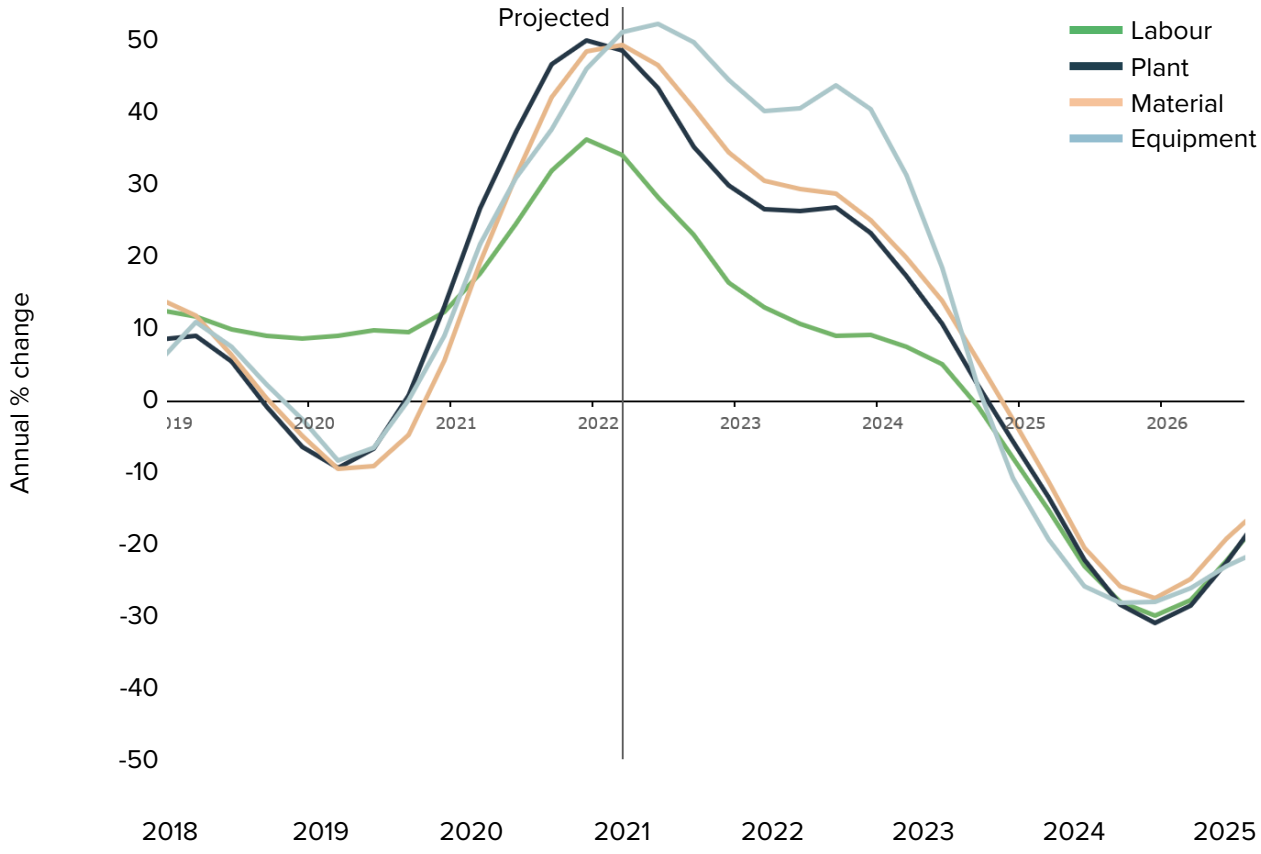
Finally, despite the high demand for steel in expenditure terms, it accounts for only a small proportion of volume. Annual average demand is estimated at 2.4 to 3.0 million tonnes over the next five years.

Plant is the second smallest resource classification in value terms, but expects $2 billion growth from $2.1 billion in 2020—21, to $4.1 billion in 2023—24. The transport sector uses a higher proportion of plant than the other sectors, such that the relatively lower growth in transport activity limits growth relative to equipment and materials.

Plant accounts for 7% ($16.6 billion) of total resource spend over five years (2021—22 to 2025—26).

Equipment – despite being the smallest resource category in value terms (5% over five years), equipment is set to experience the fastest growth in demand of all non-labour resource categories – as shown in **Figure 14**. This is due to its intensive use by the fast-growing building sector.

Figure 14: Major public infrastructure – plant, labour, equipment and material demand growth



Source: Turner & Townsend and BIS Oxford Economics commissioned by Infrastructure Australia (2022)

Market constraints make project delivery less predictable

The analysis presented in this section demonstrates that Australia continues to pursue an ambitious pipeline of public infrastructure investment. As explained in *Section 3: Industry confidence*, the view from constructors and suppliers is that their order books are filling up while lead times are extending as they contend with labour shortages and logistical constraints. The assertion is that projects are being delivered in a reality that is vastly different than anticipated, and as a result progress is slowing dramatically, not by choice and therefore not by plan. In this way, the infrastructure market appears to have reached the limit of its ability to adjust.

Using schedule slip modelling to investigate if projects are progressing as planned

Reviewing historical project data confirms a P50 (portfolio average) project slippage rate of 9%, giving a good indication of the average slip rate for projects under normal market conditions. Given today's difficult operating conditions, a P75 indicator offers a more realistic context for current demand, and as such shows that 75% of major public infrastructure projects could take up to 53% longer to complete than their schedule targets at final business case – see **Figure 29** in *Section 6: Implications and recommendations*.

To illustrate this point, the 2021 *Infrastructure Market Capacity* report projected total investment for major public infrastructure projects during 2021—22 to be $44.6 billion. One year on, with more recently-updated project schedule and investment data in nominal terms at time of estimation and therefore not counting the cost of subsequent price escalations, the total investment for the same period (and same set of project types) reduced slightly to $43.3 billion. This provides early signs that not all projects are being delivered to schedule, with some projects taking longer to complete than originally planned – see **Figure 7**.

This analysis is based on historical project slippage rates, the accuracy of which can be improved in future versions of this report by collecting and analysing actual project expenditure data from states and territories for contemporary projects within their jurisdiction, for both recently completed and in-flight construction projects.

P50 and P75 explained

To conduct this analysis, all historical projects analysed are sorted in order from the one that was delivered earliest relative to planned schedule, through to the one that was delivered latest relative to schedule.

P50: From this ranking, the project that is ranked in the middle of the list provides us with the mid-point for project delivery relative to schedule, which in this analysis averages out across Transport, Utilities and Buildings to be a 9% overrun relative to planned schedule.

P75: The project that is ranked three quarters of the way through the project listing, which therefore must be worse than an average 9% overrun. In this analysis, it averages out to be 53% across transport, utilities and buildings.

3. Industry confidence

At a glance

New to the *Infrastructure Market Capacity* report, this section provides insights from industry gleaned from surveys and telephone interviews. The views shared here highlight key supply-side challenges that pose risk to infrastructure market capacity, along with potential solutions.

The key insights from industry engagement are:

- Supply-side risks have increased markedly over the last two years as a consequence of the COVID-19 pandemic, disruptions to local and international supply chains and transport, and more recently, from the war in Ukraine.
- International supply chain challenges threaten market capacity, especially in the areas of steel, oil products and construction equipment.
- Imbalances in supply and demand mean the cost of key inputs has increased over 20% in 12 months, a near-record increase.
- There is a broad consensus that the way projects are planned and procured (notably tendering costs, contract complexity, risk identification and allocation) are the greatest addressable threats to industry capacity.
- Many industry respondents attest to operating at 90% or more capacity, which leaves little-to-no room for extra work. Smaller firms that claim latent capacity may in fact be referring to growth aspirations – healthy and expected for businesses – rather than an actual ability to ramp-up to meet incremental demand in the short-term.
- When reviewing potential solutions, larger firms see more efficient risk allocation and innovation-friendly procurement as having the greatest potential benefits. For smaller and medium sized firms, greater industry capacity is desired by de-bundling projects.



Industry point to risk allocation, project pre-planning and supply chain factors as key threats to market capacity

To better understand the supply-side constraints affecting the infrastructure market, Infrastructure Australia commissioned a series of surveys to gather insights from builders and civil contractors:

2022 Tier 1 industry survey. Conducted over March and April, 2022, this survey consisted of 30 minute telephone interviews with individual Tier 1 industry participants. These were builders and civil contractors with the ability to deliver larger infrastructure projects – including 'megaprojects' valued over $1 billion – with a greater likelihood of operating across multiple state jurisdictions.

2022 Civil Contractors Federation Tier 3 survey. In May 2022, the National Branch of the Civil Contractors Federation, at the behest of Infrastructure Australia, coordinated a survey of its own member base. The Civil Contractors Federation is the peak body for Australia's civil construction industry, representing approximately 2,000 contractors and associates nationally. The Civil Contractors Federation is formed of smaller and medium sized contractor businesses predominantly, located throughout metropolitan and regional Australia. 80% of Civil Contractors Federation Tier 3 survey respondents reported that their maximum contract size was under $20 million and over half reported a maximum contract size of under $5 million.

2022 Tier 3 industry survey. Conducted online in July 2022, Infrastructure Australia surveyed 190 decision-makers in Tier 3 construction companies, defined as companies offering civil and construction services on contracts up to $100 million in value. A range of company sizes was engaged, with carpentry, licensed building, engineering, electrical and plumbing being the main services represented.

Risk allocation and pre-planning practices

According to Tier 1 respondents, the main factors impacting infrastructure market capacity and capability is the way projects are planned, developed and procured. As captured in **Table 4**, respondents ranked two factors above all else in terms of detrimental impact on market capacity and capability:

- The allocation of risk in contracts (total mean score of 8.3/10).
- Insufficiency in pre-construction project development and risk identification (7.4/10).

Table 4: Factors impacting industry capacity and capability

		Geographies of operation									Areas of operation				Current capital value of projects			Segment	
	Total	NSW	VIC	QLD	SA	WA	TAS	NT	ACT	NZ	Syd, Melb, Bris, Perth	Smaller cities/ towns >10,000	Small regional remote <10,000	Northern Australia	Up to $100m	$101M to $1B	More than $1B	Builder	Civil contractor
Availability of insurance																			
Mean score/10	6.5	6.6	6.7	6.5	7.1	6.9	8.0	7.4	7.1	6.7	6.7	6.4	6.7	7.2	4.3	6.5	7.6	5.0	7.9
Cost of tendering/bidding for work																			
Mean score/10	5.7	5.9	6.0	5.7	6.1	5.9	6.6	6.3	6.4	6.8	5.9	5.9	5.6	6.1	4.0	6.2	6.2	4.4	6.9
Type of procurement model used																			
Mean score/10	6.4	6.4	6.1	6.4	6.3	6.1	6.9	6.6	5.7	6.8	6.7	6.7	6.7	6.4	6.8	6.0	6.6	5.6	7.2
Complexity of contracts used																			
Mean score/10	6.3	6.4	6.1	6.3	6.1	6.4	5.9	5.9	5.9	6.5	6.4	5.9	6.3	5.7	6.3	4.8	7.2	5.2	7.2
Allocation of risk in contracts																			
Mean score/10	8.3	8.3	8.1	8.3	8.1	8.1	7.7	7.6	7.6	8.2	8.4	8.1	8.3	7.4	8.5	7.3	8.8	8.2	8.3
Insufficient pre-construction project development and risk identification																			
Mean score/10	7.4	7.3	7.3	7.4	7.4	7.4	7.6	7.5	7.5	7.5	7.6	7.7	7.6	7.3	7.3	7.2	7.6	7.6	7.2
Delays in obtaining planning and environmental approvals																			
Mean score/10	6.3	6.2	6.2	6.3	6.4	5.9	6.4	6.1	6.2	5.2	6.1	5.9	6.7	6.0	6.5	5.0	7.0	6.8	5.8
Dealing with 3rd party asset owners																			
Mean score/10	6.5	6.4	6.4	6.5	6.4	6.5	7.3	7.4	6.1	5.8	6.3	6.7	6.5	7.2	6.8	5.7	6.9	5.7	7.2
Timelines for delivering the work																			
Mean score/10	6.5	6.7	6.7	6.5	6.6	6.4	7.0	6.5	6.3	7.0	6.6	6.6	6.2	6.2	6.3	6.7	6.4	6.2	6.7
Uncertainty over the infrastructure pipeline or funding																			
Mean score/10	4.8	4.9	4.9	4.8	5.0	4.6	5.3	5.2	5.3	5.0	4.9	5.2	5.2	5.1	4.5	4.3	5.2	4.2	5.3

Note: Scale of 1 to 10; where 1 = no threat/not an issue and 10 = major threat/critical issue

Source: Infrastructure Australia industry survey (2022)

Civil Contractors Federation Tier 3 members corroborate this finding, indicating that risk allocation and pre-planning practices are a sector-wide concern, a likely reflection of the industry's interconnectedness. Transfer of risk from large contracts onto smaller subcontractors and suppliers can have negative downstream effects, and similarly, poor pre-construction planning and risk identification has ramifications for smaller contractors when risks crystallise within large projects.

Other high risk factors identified by segments of the industry included:

- the availability of insurance (particularly in smaller jurisdictions and for large civil projects)
- dealing with third party asset owners (particularly utilities)
- timelines for delivering the work.

By contrast, uncertainty over the infrastructure pipeline or funding, as well as the cost of tendering for work were considered 'lower-order' concerns in terms of risk to market capacity. This may reflect improvements in the way state and territory governments and the Australian Government now communicate their pipelines, and/or how 'higher order' factors – such as risk allocation in contracts – are driving overall capacity and capability risk in the market.

Risk transfer and sharing

Research undertaken by Infrastructure Australia's Market Capacity Program in 2021 points to differing perspectives across the government and private sector on who is best placed to bear critical risks during a project's delivery.[10] Currently, the default approach sees government project owners transferring risk to the private sector, in an attempt to increase certainty in outturn cost. This leads to procurement models that are often imbalanced, and higher levels of risk and uncertainty being priced into tenders. Moreover, commercial strategy and risk allocation often happens in isolation, and risks are often pushed further down the line to sub-contractors, who have limited integration into the delivery team and are less informed to manage risks effectively.

A better approach would involve early collaboration to ensure that risks are owned by the parties best able to manage and bear them. This needs to be underpinned by a best practice risk management process that is aligned to desired outcomes, which allocates risk based on the capability required to manage identified risk.

Supply chain disruptions

Industry feedback also indicates that disruptions to the provision of non-labour resources pose a threat to market capacity and capability.

Steel – as explored in *Section 4: Understanding non-labour supply*, producing sufficient quantities of local steel and steel products is difficult due to the time it takes to ramp up production. Importing steel may provide a solution to this though is accompanied by risks associated with quality and disrupted international supply chains. [11]

Fuel and other oil products – Australia's reliance on fuel and bitumen products has increased since 2012 following the closure of five local oil refineries during this time. While access to these materials remains relatively stable, full exposure to global supply risks has resulted in strong cost escalation pressures.

Quarry products and sand – although the industry is relatively optimistic about the supply of quarry products and sand, deeper soundings suggest that large construction companies and governments may be unaware of emerging capacity risks in local markets where quarry closures may precede the opening of greenfield sites. Producers themselves note that approvals for new quarries and or extensions of consents at existing facilities are very difficult, taking up to 10 years in some cases. Due to such extended timelines, there is currently a real risk of a quarry 'gap' occurring in Melbourne's infrastructure supply chain.

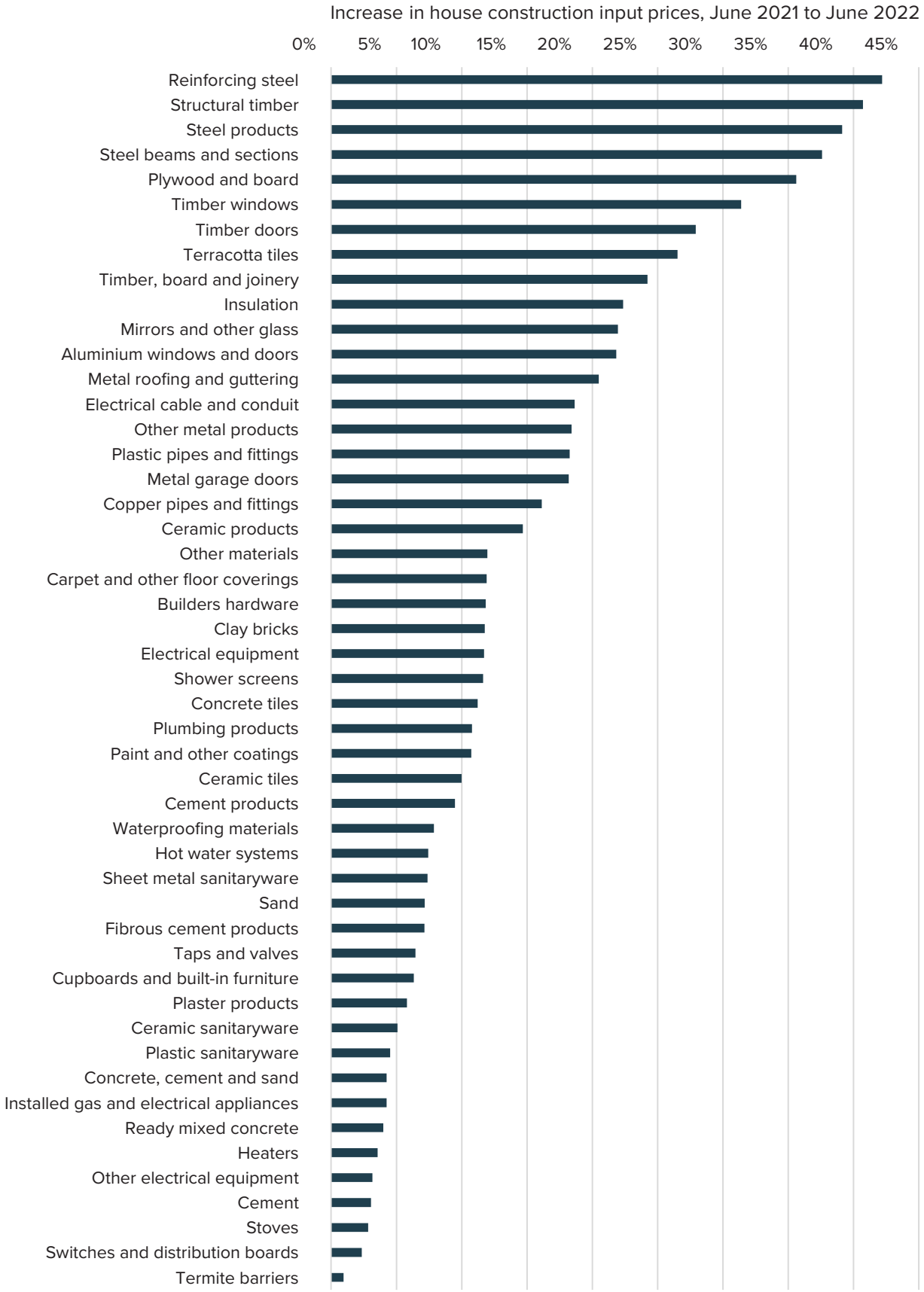
Precast concrete products – surging demand plus the exit of a major local producer (Rocla) has significantly reduced and slowed the supply of large diameter concrete pipes. Rising energy costs and ongoing risks to energy supply in the National Electricity Market add further pressure due to the energy-intensity of concrete product manufacturing. These factors likely explain why survey respondents cited relatively higher capacity risks for precast concrete products.

Construction equipment – industry respondents assigned a relatively mild risk rating for construction equipment, although some suppliers of plant and equipment point to increasing risks. For example, disruptions from international supply chains are creating longer wait times for key items including trucks and materials handling equipment.

Very large cost escalations

Survey responses indicate that rising cost pressures are impacting all construction businesses regardless of size and operating location(s), with well over half of respondents saying the price of non-labour inputs has risen more than 20% in 12 months. The largest of cited increases are steel, timber, oil and oil products (plastic pipes and fittings) and copper-based products (copper pipes, electrical cable), which is congruent with ABS Producer Price Index data collected across Australia's six largest capital cities, as shown in **Figure 15**.

Figure 15: Construction input cost growth, year to June quarter 2022



Note: Values are weighted averages for six capital cities.

Source: Australian Bureau of Statistics (2022)[12]

Efficiency in risk management and contracting, plus labour boosts are key

Among Tier 1 companies, the highest rated solutions to improving market capacity and capability revolve around efficiency in risk management and contracting. This is to be expected given the shared view that the way projects are planned, developed and procured are the main drivers of market capacity and capability. By contrast, Civil Contractors Federation Tier 3 members rated pipeline coordination and sequencing as key actions that could improve industry capacity and capability.

As observed in **Table 5**, the highest rated solutions among Tier 1 companies are:

- a more efficient allocation of risk in contracts
- greater standardisation of contracts across sectors, government departments and jurisdictions
- more innovative procurement models
- reduced cost of tendering
- government policies regarding skilled migration.

Table 5: Solutions to improve market capacity and capability

		Geographies of operation									Areas of operation				Current capital value of projects			Segment	
	Total	NSW	VIC	QLD	SA	WA	TAS	NT	ACT	NZ	Syd, Melb, Bris, Perth	Smaller cities/ towns >10,000	Small regional remote <10,000	Northern Australia	Up to $100M	$101M to $1B	More than $1B	Builder	Civil contractor
Respondents	***19***	***18***	***16***	***19***	***14***	***14***	***7***	***10***	***11***	***6***	***17***	***15***	***12***	***9***	***4***	***6***	***9***	***9***	***10***
Greater visibility of the public and private sector project pipeline and implied demands																			
Mean score/10	6.7	6.6	6.6	6.7	6.2	6.5	5.7	6.3	6.7	6.3	6.5	6.9	6.6	6.2	8.0	6.3	6.3	7.6	5.9
Reducing cost (and time in) gaining government approvals																			
Mean score/10	7.6	7.6	7.6	7.6	7.4	7.1	7.0	6.7	7.5	6.7	7.5	7.6	7.2	6.9	8.5	7.7	7.2	8.4	6.9
Government policies regarding construction training and apprenticeship																			
Mean score/10	6.4	6.7	6.4	6.4	6.5	6.9	6.1	6.4	6.8	6.3	6.3	5.9	6.7	6.4	5.3	5.8	7.3	6.2	6.6
Government policies regarding skilled migration																			
Mean score/10	8.2	8.2	8.0	8.2	8.3	8.4	8.3	8.3	8.1	8.0	8.2	7.9	8.3	8.2	8.0	7.2	9.0	7.6	8.8
Better coordination of State and Commonwealth construction programs																			
Mean score/10	7.4	7.3	7.1	7.4	7.1	7.0	7.6	7.4	6.8	6.0	7.2	7.5	7.3	7.3	8.0	7.0	7.3	7.2	7.5
Reducing cost of tendering																			
Mean score/10	8.2	8.2	8.3	8.2	8.1	8.0	8.7	8.5	8.6	8.3	8.4	8.9	7.9	8.3	8.5	8.5	7.9	8.1	8.3
Use of innovative procurement models																			
Mean score/10	8.4	8.3	8.3	8.4	8.4	8.2	8.3	8.5	8.1	8.5	8.2	8.5	8.3	8.6	9.3	8.5	7.9	8.3	8.4
More efficient risk allocation in contracts																			
Mean score/10	9.1	9.1	8.9	9.1	9.1	9.1	9.0	9.1	8.9	8.3	9.1	8.9	9.4	9.1	9.0	8.5	9.6	9.0	9.2
Standardisation of contracts, laws and practices across agencies and states																			
Mean score/10	9.0	8.9	8.8	9.0	8.9	8.9	8.4	8.6	9.0	8.7	8.9	8.7	9.0	8.7	8.8	9.0	9.0	9.2	8.7
Contractual enforcement throughout the supply chain																			
Mean score/10	6.0	5,8	5.7	6.0	5.5	5.9	5.9	5.7	5.6	5.7	6.1	6.0	5.9	5.7	5.8	5.8	6.1	5.6	6.3

Note: Scale of 1 to 10; where 1 = would have no impact at all and 10 = would have a major/positive impact

Source: Infrastructure Australia industry survey (2022)

Both Tier 1 and Civil Contractors Federation Tier 3 members agree that strategies to boost labour access would alleviate capacity and capability constraints. Now that Australia has reopened its international border, contractors of all sizes observed that prioritisation of skilled migration is a critical step for improving industry capacity.

Better identification of skills gaps is also cited by respondents as an important tool to unlock capacity, along with an overhaul of construction occupation definitions from the Australian Bureau of Statistics (unchanged since the early 2000s), to better reflect current and emerging roles. In parallel, ongoing and improved industry training initiatives are needed, as well as workplace flexibility and diversity practices that encourage greater participation from existing and potential workforces.

Confidence to deliver projects in short-term is lower than delivering projects over 2 years away

When asked to rate their confidence to deliver infrastructure projects over (i) the next 12 months, (ii) the next 2-4 years, and (iii) beyond 5 years, construction companies generally indicated reasonable, but not high, certainty. By time period, firms were least confident of delivery over the next 12 months and most confident of delivery over the next 2-4 years, overall. Only smaller projects more than 5 years away were rated as highly likely to achieve successful delivery overall, the highest confidence rating of all – see **Table 6**.

Table 6: Industry confidence to deliver infrastructure projects

		Geographies of operation									Areas of operation				Current capital value of projects			Segment	
	Total	NSW	VIC	QLD	SA	WA	TAS	NT	ACT	NZ	Syd, Melb, Bris, Perth	Smaller cities/ towns >10,000	Small regional remote <10,000	Northern Australia	Up to $100M	$101M to $1B	More than $1B	Builder	Civil contractor
Next 12 months	7.0	7.0	7.3	7.0	7.4	7.4	6.3	7.6	7.6	7.8	6.8	6.7	7.3	7.7	5.5	6.7	7.9	6.2	7.7
Next 2 to 4 years	7.7	7.7	7.7	7.7	7.7	7.7	7.0	7.6	7.9	8.2	7.7	7.5	8.0	7.7	7.5	7.3	8.1	7.9	7.6
More than 5 years	7.3	7.2	6.9	7.3	6.7	6.7	6.6	6.1	6.3	7.0	7.7	7.3	7.3	6.0	8.5	6.3	7.4	7.1	7.5

Note: Scale of 1 to 10; where 1 = successful delivery highly doubtful and 10 = successful delivery highly likely

Source: Infrastructure Australia industry survey (2022)

The majority of firms are operating at 90% or above capacity

In terms of latent capacity, most Tier 1 survey respondents reported a high degree of confidence in being able to scale up to achieve 5% growth. The same respondents were only slightly confident in achieving growth of 10% and mostly not confident in being able to achieve growth of 25% or more. Builders are generally less confident than civil contractors in their ability to scale up at all three potential growth rates and are not confident of scaling up to achieve 25% growth, whereas civil contractors are unsure.

Contrasting this, the Civil Contractors Federation Tier 3 members are generally more positive in their responses, with two thirds of survey respondents reporting sufficient capacity to take on 20% more work, and nearly 20% reporting latent capacity for over 50% more work. Furthermore, more than 70% of the Civil Contractors Federation members report they can scale up within the next six months to meet this demand, with 35% saying they can scale up within the next 3 months.

Tier 3 confidence to ramp up is likely a growth aspiration, versus a reflection of spare capacity

Given the widespread perception that contractor order books are full at least for the short-term, Infrastructure Australia sought to better understand the current and future capacity of Tier 3 companies. As such, 190 decision makers in Tier 3 civil and construction companies with contract values up to $100 million were surveyed.

The findings show four in ten (42%) of construction companies are operating at 90% or above capacity, (indicating 10% or less latent capacity), while roughly one in four (26%) are operating at 75% to 90% capacity (indicating 25% or less latent capacity). In sharp contrast, the vast majority (79%) of respondents report a total confidence in their ability to ramp up to meet further demand.

It is difficult to reconcile the idea that 68% of respondents claim to have 25% or less latent capacity with the idea that 79% claim confidence in scaling up to meet demand. These conflicting responses suggest that confidence in the ability to scale up and meet demand may in fact reflect growth aspirations (expected and healthy for any business) instead of an actual capacity to grow. As this report highlights, growth requires additional resources which are currently, to varying degrees, in short supply.



4. Understanding non-labour supply

At a glance

New to this year's *Infrastructure Market Capacity* report, this section includes:

- industry commentary and quotes on the market's capacity to supply steel, concrete and quarry products, based on interviews with a range of each industry's suppliers
- a summary of Infrastructure Australia's *Replacement Materials* report, which investigates the potential for using recycled materials for roads construction
- an introduction to TraNSIT – CSIRO's freight-planning tool – including a use case that quantifies the extra cost of freight deliveries that were rerouted as a result of Queensland and New South Wales flood-related road closures in February, 2022.

Key findings of this section are:

- Australia faces a severe shortage of steel fabrication capacity, as well as plate steel production, which may constrain local benefits from new energy investment.
- Challenges in planning and approving new quarries may see a capacity gap in the Melbourne market within 5—10 years as existing quarries close.
- Road infrastructure is very well-suited for the use of recycled materials and around 27% of conventional material in road infrastructure could be replaced with recycled alternatives.
- Following flood events on 28 February, 2022, 68,959 tonnes of freight did not reach destinations across 353 supply chain paths. In addition, 2,167 construction supply chains were forced to seek alternative detours, equating to 244,609 tonnes of redirected freight at an extra transport cost of $2.3 million.

All infrastructure inputs are experiencing supply constraints, some at critical levels

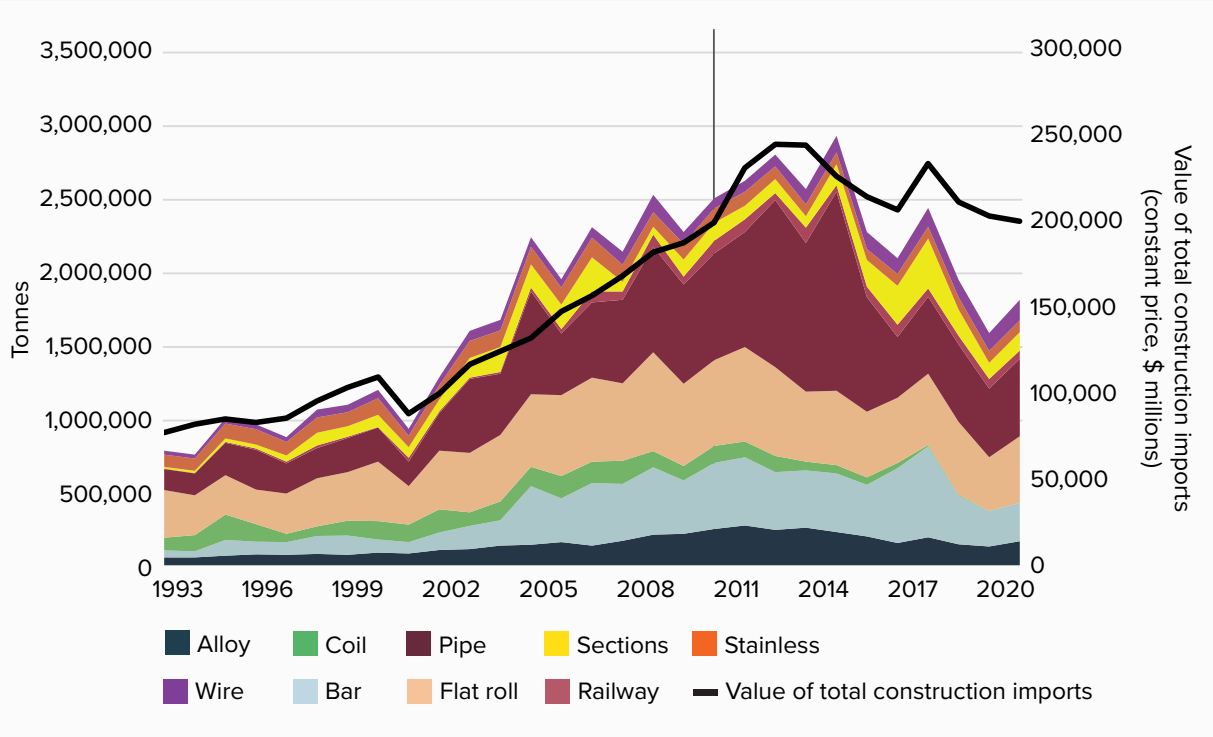
To better understand supply-side challenges impacting the infrastructure industry's ability to meet demand, telephone interviews were conducted with key industry suppliers, including: steel and steel fabrication representatives; concrete and quarry products suppliers, plant and equipment suppliers.

Spotlight on steel

Steel is a key ingredient of Australia's infrastructure ecosystem. Supply is served by two major domestic players – Infrabuild and Bluescope – and augmented with imports as illustrated in **Figure 16**. While lower-costing imports triggered the decrease of domestic production of recent decades, their proportion to total supply declined in 2014—2015, and again in 2019—20 and 2020—21. To augment steel shortfalls, Australian producers have, as best they can, ramped up production towards their respective capacities.47888

The need for steel is growing, with transport engineering construction – especially rail and road projects – fuelling much of current demand growth. In the coming years, residential and non-residential building construction will push demand up further. Given the construction industry's historical appetite for flat steel products (it consumed 70% of demand in 2017—18 and 80% in 2019), an adequate supply of steel will be critical to support future construction levels.

Figure 16: Australian steel imports by type

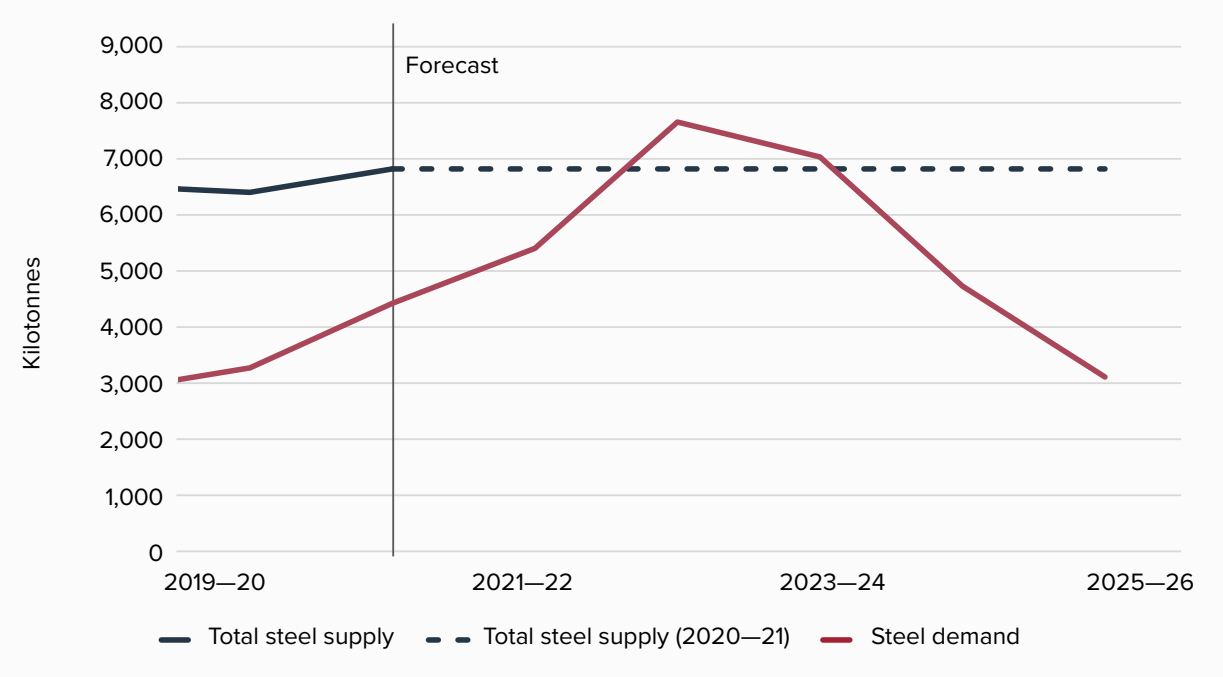


Source: Department of Foreign Affairs and Trade (2022)[13]

Domestic steel supply unlikely to meet demand from 2022—23 to 2023—24

A key challenge is the ability of the local steel market to meet public infrastructure demand. Domestic production will not satisfy construction demand between 2022—23 and 2023—24. While a respite in demand is forecast for 2024—25 and 2025—26 it is likely due to the completion of existing known projects and a lack of longer-term pipeline visibility than a genuine drop in demand – see **Figure 17**.

Figure 17: Estimated construction industry steel supply (domestic + imports) and demand



Source: Department of Foreign Affairs and Trade (2022)[14]

Several factors are limiting steel capacity growth

Meeting upcoming steel demand will require either increasing local production capacity, increasing import volumes, or a combination of both.

As indicated in industry interviews and explained below, growing local production capacity is difficult for many reasons but is crucial to secure supply chains and support long-lived, high-quality infrastructure investment. It is also seen as critical for industry to service increasing renewable energy investment, which will likely involve steel-intensive onshore and offshore wind projects.

Ongoing collaboration is required between governments and contractors

Representatives from the steel industry who participated in consultations observed that they are not engaged early enough in the project lifecycle by project proponents and contractors. In many cases, there is little or no engagement with steel suppliers when developing business cases and construction plans for major projects. Resultingly, capacity issues emerge, particularly with plate steel products due to their use in several infrastructure sectors, including energy. As one major Australian steel producer noted:

> “There are some projects – and they can be significant projects – where we get a phone call eight weeks out to say, ‘Hey, we’re delivering this project and we need X amount of steel in eight weeks time.’ Now that just does not work.”

Severe labour shortages

Skilled migrants, who have historically been instrumental in meeting demand, are in extremely short supply. This is mostly because Australia is 'missing' almost half a million people in net overseas migration between 2019—2020 and 2021—22 due to international border closures. According to one respondent:

> "The most pronounced thing we found from COVID was … the reliance on migration for the construction industry… The lack of migration over the last couple of years has put a squeeze on. And even when migration was around, there still aren't as many kinds of visa classifications available in construction for coming work. There are some, like some of the PMs and engineers, but I don't think there is a classification for visas for drivers… Historically it's been the white collar forces where they've allowed it to come and go, well you need engineers or tunnel engineers and so forth. We say, "No, we actually need labourers and drivers."

Respondents noted that skilled local workers are hard to find. Steel trades (such as boilermakers and steel fabricators) were cited as being particularly difficult to source, which one steel supplier put down to steel being a less-desirable career choice than plumbing, electrical or carpentry. As explained during a telephone interview:

> "I know it'll probably sound old-fashioned, but boiler making as a trade is … I mean, most of the kids out my way want to be plumbers or electricians or carpenters. Right? No one wants to be a boiler maker. You might find the occasion when there wants to be a welder, but those metalworking trades… Our workforce is ageing, big time. And so how do we attract kids, effectively, into those trades that we're probably going to need?"

Unskilled local workers, according to industry, are a depleted pool having been lured into other industries on the promise of higher wages and training. Truck drivers are in especially short supply, with many opting for 'less difficult' jobs with flexible, work-life-friendly hours such as ride-share or taxi driving. As a major steel producer said:

> "Transport is the big issue, not manufacturing… We've got so much inventory here at the moment, just ridiculous, we just cannot get enough trucks and drivers to get the product to market."

Boom-bust losses

Decades of boom-bust investment cycles have inhibited the local steel fabrication industry's investment in its own capacity. In interviews for this report, fabricators pointed to the boom in wind tower construction during the mid-to-late 2010s that quickly turned to bust, leading to employment losses in local industry and fabrication businesses. As one local steel fabricator explains:

> "So we gear up, we spend a lot of money on capital and training people. Last time around, we employed 60 guys. Only two years later we have to let some of those guys go. So we went through redundancies. Once they were finished, we let go of 40 people."

Compressed spending patterns

In many cases, infrastructure spending follows an annual pattern, whereby little is actually spent until the last few months of the financial year. Trying to then compress activity into just a few months of the year, when fabrication capacity is already tight, creates unnecessary supply challenges.

Early engagement is the key to opening up steel capacity

Industry participants concur that early engagement with the steel industry is critical, as noted by a major Australian steel producer:

> "Early engagement between project proponents and suppliers is absolutely critical in this space, particularly now when demand is very tight. I think sometimes people, and indeed governments and major project proponents, just make an assumption that there is X capacity and capability domestically. And in six months' time when our project's been further developed, we'll be able to ring up [a steel producer] or ring up a fabricator and just get everything we need. And that's not necessarily the case. Don't assume, don't make assumptions."

Progress exists in this area, with the New South Wales Renewable Energy Sector Board providing a positive exemplar of upfront collaboration. Here, the *Electricity Infrastructure Investment Act 2020 (New South Wales)* requires the Board to be established by the Minister for Energy and the Environment in relation to the operation of the sector and the manufacture and construction of infrastructure in the sector.[15]

The Board is responsible for developing a plan for the renewable energy sector, setting out how in a cost-effective way to maximise the following in the construction of generation, storage and network infrastructure carried out under the Act:

- Use of locally produced and supplied goods and services.
- Employment of suitable qualified local workers.
- Opportunities for apprentices and trainees.

In fulfilling these tasks, local steel producers note they have been engaged as key stakeholders in the planning of energy infrastructure in New South Wales and are hence able to better plan and advise on their ability to deliver local steel products.

Another positive example exists in Victoria, where steel industry roundtables have been established with suppliers and fabricators to discuss upcoming publicly funded infrastructure projects across all sectors. Organised through the Office of the Local Jobs First Commissioner, the objective of these roundtables include identifying improvements to increase the use of local steel in government projects. As one major Australian steel producer explained in recent soundings:

> “In Victoria, there is actually a steel industry roundtable... I believe it’s about to be expanded to fabricator representation as well. And the heads of the government agencies responsible for major projects come along regularly to that meeting. And they present about the projects. And there’s an engagement process with all of the players, including us, the fabricators, and anyone else in the supply chain. That’s absolutely invaluable. The Victorian roundtable is pretty unique in covering a broad range of government projects.”

Spotlight on concrete and quarry products

Quarrying involves extracting raw commodities to make construction materials such as concrete and asphalt. Quarries tend to be located relatively close to end users since transport costs are high compared to the low unit value of the sand and rock extracted. As such, capacity risks are highly-localised and variable by region.

Data on quarry production (and therefore demand) is published by Victoria and Queensland only. As it does not indicate total or spare quarry capacity, Infrastructure Australia augments this knowledge gap with qualitative feedback from industry. As such, it can be gleaned that Sydney and Brisbane (pending an understanding of Brisbane Olympic requirements) has sufficient capacity to meet upcoming quarry demand, while Melbourne and Adelaide may face capacity challenges in 5 years and 10+ years, respectively.

Several factors are limiting concrete and quarry capacity growth required for infrastructure investment

Difficulties with new quarry approvals and existing consent extensions

Obtaining approval for a new quarry – even those well outside metropolitan areas - is becoming increasingly difficult, as are consent extensions for existing quarries. This is generally because noise and vibration, truck movements, dust and loss of visual amenity receive pushback during community consultation. One major quarry materials producer explained:

> "For Melbourne, the challenge is the rock is still there, but they don't want to have the fight with communities around expanding the quarry network."

As an example, it is predicted that extension consents for metropolitan Melbourne quarries may not be renewed in the next five years. This is likely to cause project delays and or cost escalations in major infrastructure projects. Given a quarry takes 10+ years to build and ramp up, there is a real risk of a 'quarry gap' occurring in Melbourne's infrastructure supply chain. According to one major materials supplier, the capacity risk is clear:

> "For us, it's about five years away. For us, internally we can service our underlying base business and we could service North East Link. The risk for us is that depletes probably two of our quarries in Melbourne, to service those two.... So then as a business, that means obviously we've got to find replacement quarries for those within five years. And we expect just from previous experience, a new quarry is a decade long exercise. So there's a gap there."

Constrained planning processes

According to industry, access to quarry materials is often not validated during the design and development phases of major projects. This can lead to supply issues (project delays and/or increased costs) further along.

In the case of planning for higher capacity limits – which are often reached early – approval processes are unhelpfully long. This is even the case for short duration capacity increases required to meet particular infrastructure needs. A producer in Queensland said:

> Take our Glasshouse Mountains quarry in the Sunshine Coast. We have a rolling three-year capacity limit that we can't exceed for any two years out of three. Now for the last five years, we've been trying to get it extended from 650,000 tonnes a year to a million. And it's a five-year process that we aren't even close to closing out because of council, because of local community, and because of state government as well. So you can't just quickly turn on extra volume out of a quarry if you require it, the hurdles and the red tape you've got to get through are immense.

Industry consolidation impacts supply chain, for instance large diameter concrete pipes

Locally, concrete pipe manufacturing capacity has been significantly curtailed by the closure of Rocla's large pipe manufacturing facility in Emu Plains in March 2020, leaving Humes (owned by Holcim) and Reinforced Concrete Pipes Australia (RCPA) as the only suppliers of concrete pipe. The absence of Rocla's production capacity has been keenly felt in the NSW infrastructure market, particularly. New manufacturing capacity is difficult and time consuming to bring onstream, usually requiring long lead times to purchase and bring in critical machinery from overseas as well as a long period (usually 2—3 years) from planning, development approvals and construction to establish a manufacturing site.

Extreme labour scarcity, especially in concrete product-making

A dearth of workers to operate the concrete pipe-making machines is one of the industry's biggest immediate problems. The closure of Australia's international border during the COVID-19 pandemic has considerably hindered the industry's ability to secure additional labour. According to one major concrete pipes producer:

> In the 20 years I've run concrete businesses, I don't think it's been this hard. And I managed a concrete pipe business in Mackay, in the mining boom, and it wasn't this hard. There were always people. They might not have stayed, but there was always enough people. It's just, there's not enough people right now. And everyone in the industry that I speak to, it's always same message.

And another:

> Labour. Number one challenge that is wholly and solely the biggest challenge my business faces at the moment.

Shortages of trucks and truck drivers

An absence of available trucks and truck drivers presents another capacity risk for concrete and quarry product producers. The commonly-held view is that wait times for new vehicles is almost one year, presenting logistical delays to infrastructure projects. As explained by one of several suppliers interviewed for this report:

> [Truck drivers] are getting tight. During the downturn before COVID hit, there was a lot of labour supply and people were happy to work casually. But now that's all gone away. You can't employ casuals anymore. It's only full-time people. They'll only take full-time jobs.

> Drivers is a big one. We're in the same squeeze as everyone else when it comes to labour and for us that's drivers. So yes, we have people operating batch plants in quarries, but the labour pool is really tight, and we're feeling it now. Experienced quarry operators is a pinch point. But you'd have to say drivers is our biggest issue.

> Trucks are a problem. We had 1,000 on order. The last one was due in April last year. And then they were all due sort of February, March, April, and they didn't start til March, and then the last one didn't arrive until I think March this year.... 11 months late. Yeah. They just blame supply chain problems.

Spotlight on replacement materials

This section summarises Infrastructure Australia's *Replacement Materials* report that investigates the potential to unlock new supply chains of recycled materials for infrastructure construction.[16]

The *Replacement Materials* report is the culmination of collaboration between the partners listed below. The collaborative approach and support from government agencies, departments and key individuals has been critical to developing the analysis, as has industry support and engagement.

Collaborating partners

- Australian Government Department of Climate Change, Energy, the Environment and Water (project sponsor)
- Victorian Major Transport Infrastructure Authority
- ecologiQ Victoria
- Australian Road Research Board
- EY
- EY Sweeney

A recycled alternative exists for 27% of conventional road construction materials

From 2015–31, approximately 200 million tonnes of conventional materials are needed to deliver 998 road projects from across the country. Over 95% of the mass is made up of five key materials: aggregates (29%), asphalt (27%), rock/bluestone (16%), sand (15%) and cement (9%).

Road infrastructure is very well-suited for the use of recycled materials. Based on current technology and standards, around 27% (54 million tonnes) of conventional material tonnage could be replaced with 52 million tonnes of recycled alternatives. As shown in **Table 7**, the largest quantities of replaceable conventional materials are asphalt (32% of 54 million tonnes) and concrete (also 32%).

Table 7: Opportunity for replacing conventional materials by replacement scenario

Conventional materials replacement opportunity, total (million tonnes)	Current	Future	Blue-sky
Asphalt	17.6	29.8	41.7
Concrete (aggregate component)	8.8	17.7	26.5
Concrete (cementitious component)	8.8	12.3	15.9
Steel	3.5	3.5	3.5
Rock/bluestone	15.6	23.4	31.2
Total	**54.3**	**86.6**	**118.7**

The modelling in this section on replacement materials adopts a top-down approach to estimate the potential for their use in infrastructure projects:

Forecasting demand: Starting with demand forecasts of conventional materials, a range of replacement rates are applied to estimate the tonnage of suitable recycled materials required to meet demand. To account for future demand uncertainties, three scenarios for conventional materials demand – low, central, and high– are the basis for forecasting demand for recycled materials.

Forecasting future replacement rates: In anticipation of higher adoption rates of replacement materials by industry practitioners, coupled with updated standards and specifications, two forward-looking scenarios - future and blue-sky - were developed to supplement current practices:

a. **Current** – based upon: existing science and technology; regulation; product allowable limits within state and territory standards and specifications, and; modelling assumptions from Victorian Government's ecologiQ initiative which seeks to integrate recycled and reused content across Victoria's transport infrastructure projects.[17]

b. **Future** – assumes advancement in technology and corresponding changes to standards.

c. **Blue-sky** – a more bullish set of assumptions assuming further technical improvements and standards updates.

Details of these forecasting scenarios are in the technical notes in the *Replacement Materials* report appendix[18].

Table 8: Potential demand for recycled materials by replacement scenario

Replacement materials demand, total (million tonnes)	Current	Future	Blue-sky
Crushed concrete	9.3 (18%)	7.8 (10%)	18.6 (16%)
Crushed bricks	1.5 (3%)	3 (4%)	4.4 (4%)
Reclaimed asphalt pavement	13.5 (26%)	28.7 (36%)	39.3 (34%)
Recycled crushed glass	12.5 (24%)	19.2 (24%)	20.5 (18%)
Crumb rubber	0.6 (1%)	0.6 (1%)	0.6 (1%)
Fly ash	2.6 (5%)	4 (5%)	5.3 (5%)
Ground granulated blast furnace slag	4.8 (9%)	6.4 (8%)	8 (7%)
Granulated blast furnace slag (slag aggregate)	2.6 (5%)	5.3 (7%)	12 (10%)
Plastic	0.9 (2%)	1.2 (2%)	2.2 (2%)
Steel	3.5 (7%)	3.5 (4%)	3.5 (3%)
Total	**51.9 (100%)**	**79.6 (100%)**	**114.3 (100%)**

Referring to **Table 8**, the largest quantities of recycled materials that could replace conventional materials are reclaimed asphalt pavement (26% of 52 million tonnes), followed by recycled crushed glass (24%) and crushed concrete (18%).

Replacing 43% of conventional materials is viable in an optimal supply chain

The scale of replacement materials adoption relies wholly on the technology, standards, market appetite and processes across the supply chain.

With advancements in technology and updates to standards, the tonnage of conventional materials replaced could rise to 43%, replacing 87 million tonnes of conventional materials with 80 million tonnes of recycled products, approximately.

43% has the potential to rise to 59% with further technological advancements and updates to standards. This would see 119 million tonnes of conventional materials replaced with 114 million tonnes of recycled materials.

Material cost savings from recycled material applications

Recycled materials have been used in roads and rail infrastructure for a long time as a cost-effective way to reduce waste and emissions and to deliver safe, sustainable and reliable infrastructure. Comparative analysis by Australian Road Research Board for the Australian Government, which compared the indicative unit costs of virgin and recycled materials used in the same infrastructure application, found that cost savings can range from 2% to 83% across different materials.[19] However, given that material costs are project specific the economic impact of using recycled materials is subject to significant variation over geography, time, suppliers, market maturity and quantity. For example, material cost estimates can be significantly impacted by factors such as the distance between the project site and material processing locations, and price changes as underlying market conditions evolve over time. Moreover, cost efficiencies and economic impacts of using recycled materials should be viewed from a whole of life perspective, since whole of life material costs are likely to differ after accounting for material demand from maintenance activities over the asset's lifecycle.

The increased adoption of recycled materials in infrastructure projects can be expected to generate additional employment opportunities in Australia. Research shows that adopting greater quantities of recycled materials would lead to employment growth, with 9.2 jobs created for every 10,000 tonnes of recycled waste, compared with only 2.8 for sending waste to landfill.[20]

Several barriers prevent significant uptake of recycled materials

Despite the obvious and sizeable opportunity, barriers exist throughout the supply chain that impede the consideration (and therefore adoption) of replacement materials.

Industry perceptions

There is a low familiarity of recycled products and their benefits, as well as the market opportunities available from the resource recovery and recycling industry. At the same time, uncertainty, negative perceptions and a risk aversion culture are key barriers to uptake.

Regulatory systems

The absence of a strong regulatory system that drives industry advancement and protects against adversity continues to block significant progress. Also, environmental regulations are falling behind community and industry expectations which prevents user uptake and industry growth.

Geographic reach

Access to replacement products can be hindered by the location of a project in relation to the location of supply. Certain replacement products are not readily available throughout the country, and the concentration of facilities in metro areas has led to constraints for regional and rural areas. The difficulty of achieving economies of scale can make manufacturing costs higher and limits throughput, which ultimately presents a barrier to improving the availability of facilities in regional and rural Australia.

Capacity inconsistences

The effective provision of replacement materials depends on demand-side and supply-side factors. Patchy and irregular demand means producers have little visibility of when and what replacement materials are required, leaving little inclination to produce anything without a ready buyer.

A number of capacity constraints impede predictable and steady supply, including: declining feedstock volumes; geographic mismatch between demand and supply; high capital costs, lack of demand and competing demand from other industries.

As depicted in **Table 9**, some replacement materials themselves are in limited supply, with recycled crushed glass and ground granulated blast furnace slag having the greatest chance of future shortages.

Table 9: Potential supply concerns

Replacement materials		Future demand level	Current supply issues	Potential supply concern
Crushed concrete		Medium	No	Low
Reclaimed asphalt pavement		High	No	Moderate
Recycled crushed glass		High	Yes	High
Crushed bricks		Low	No	Negligible
Crumb rubber		Low	Yes	Moderate
Slag	**Ground granulated blast furnace slag**	Medium	Yes	High
	Granulated blast furnace slag (slag aggregate)	Low	Yes	Moderate
Fly ash		Low	Yes	Moderate
Plastic		Low	Yes	Moderate
Steel		Low	No	Negligible

Workforce limitations

A limiting perception of the resource recovery and recycling industry thwarts the attraction and retention of talent. The term ‘waste management’ perhaps carries negative connotations in the minds of prospective workers, whereas ‘product manufacturing’ may have more favourable associations, thereby increasing interest rates among jobseekers.

Spotlight on freight planning

Around 160 million tonnes of quarry materials such as stone, gravel and sand are transported around Australia each year, making them some of the country's most-transported commodities. The most common freight path for quarried material is urban roads.

Freight planning for quarry materials depends upon yearly variances in: government infrastructure project investments; the locations and material requirements of construction sites; quarry capacity limits, quarry capacity for different aggregates used in cement, concrete, bitumen, rail track ballast etc.

TraNSIT: A strategic investment tool for governments and industry

The Transport Network Strategic Investment Tool (TraNSIT) is a freight analysis and capacity planning tool. Developed by CSIRO, it provides mapping of construction material freight along road and rail networks across Australia, from point of extraction or production to processing facilities, through to construction sites.

The TraNSIT platform is a powerful tool for both government and industry, with the ability to inform infrastructure investment evaluations and supply chain investment decisions, such as decisions regarding road upgrades and where to build new facilities such as batching plants. In addition, TraNSIT can report on the impact of unexpected freight disruptions – for example, extreme weather events – to help with scenario planning and risk mitigation strategies.

The core engine of TraNSIT simulates the number of vehicle trips per month between origin and destination enterprises. Its goal is to optimise transport route and vehicle selection along the transport network for each trip (from origin to destination), and then calculate the cumulative impacts at the enterprise or regional scale. Cumulative impacts can also be calculated for other data dimensions such as commodity, sector or network.

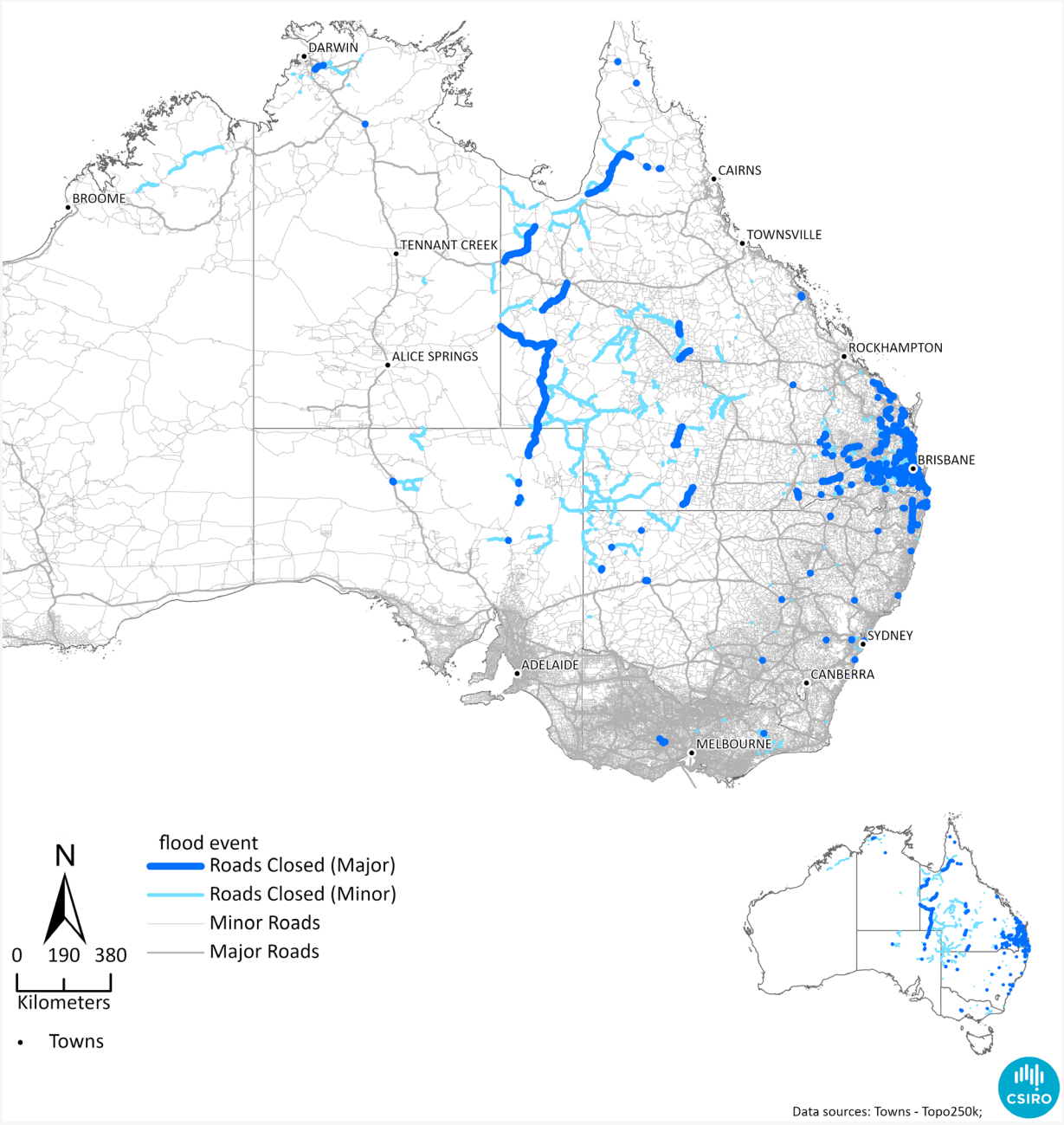
To determine the optimal road route, the analysis considers parameters such as costs, vehicle access and vehicle type according to the regulatory road class. TraNSIT will select/default to the lowest-cost vehicle combination based on heavy vehicle access restrictions throughout the journey from origin to destination. The optimal route selected may not necessarily be the actual route taken by the driver but rather the route that would be taken should the driver be seeking a least-travel-cost option.

Measuring the impact of severe weather events on freight movement and cost

When used in conjunction with applications such as the Australian Climate Service, TraNSIT can be used to report on capacity impacts of major weather events, in terms of delays and costs. This provides supply chains with the opportunity to build resilience, while reminding those involved in the delivery of infrastructure projects that risks can eventuate beyond state and territory borders.

The severe flood events of 28 February, 2022 delivered over 800mm of rain in a few days across much of south-east Queensland and northern New South Wales. The rains caused major flooding of waterways, including Brisbane River and Wilsons River. As shown in **Figure 18**, this resulted in the closure of many roads and major freight routes including the Bruce Highway, which starts in Brisbane and passes through coastal areas on its way to Cairns in Far North, and the Warrego Highway that connects Queensland's east-coast centres to south-western areas of the state.

Figure 18: Road closures following the severe flood event of 28 February, 2022, including some pre-existing road closures in western Queensland from previous flooding.



Source: CSIRO commissioned by Infrastructure Australia (2022)

Using the TraNSIT platform, the impact of road closures on the movements of freight and construction materials is measurable in the following ways:

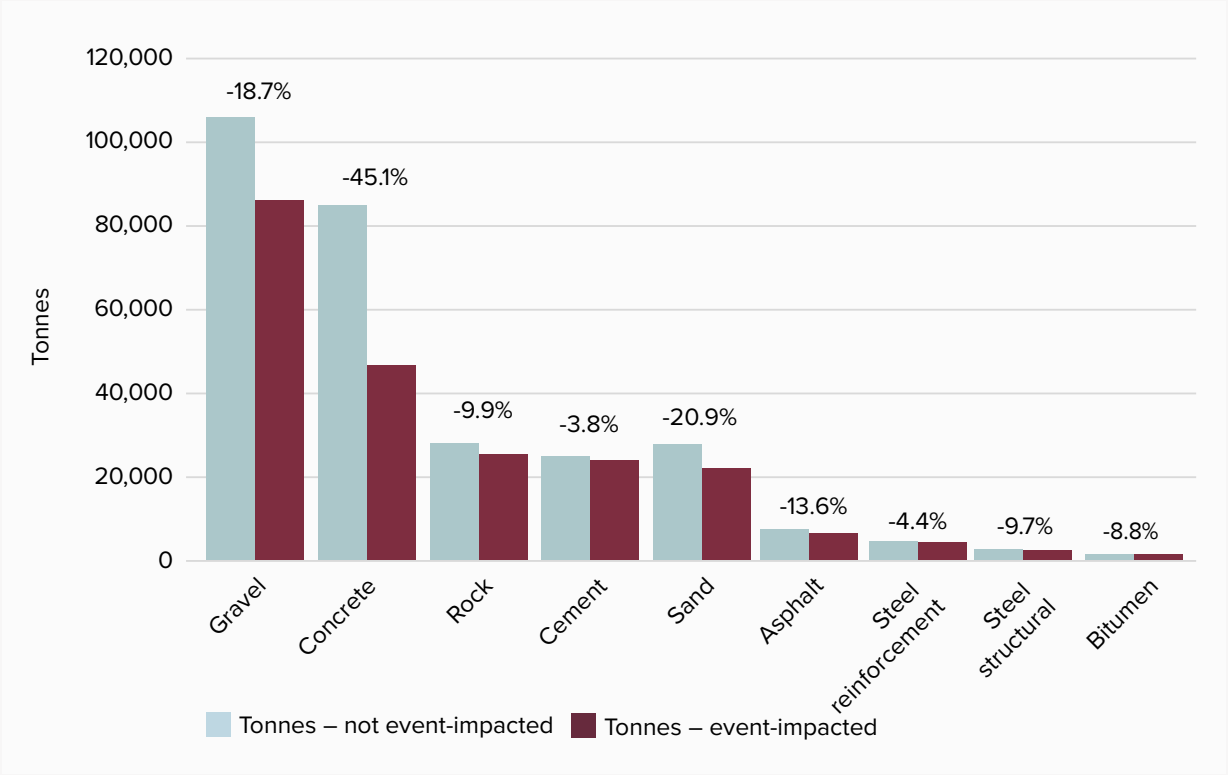
- Freight **unable** to reach its destination due to there being no available detour, which typically occurs when origin exit point and/or destination entry point is inaccessible.
- Freight **able** to reach its destination due to there being an available detour, thereby incurring additional transport costs and travel time.

Freight detours following the floods cost an additional $2.3 million

Following flood events on 28 February, 2022, TraNSIT reports that 68,959 tonnes of freight could not be delivered to destinations using 353 impacted supply chain paths. Conversely, 2,167 supply chains used detours to deliver 244,609 tonnes of freight, at an additional cost of $2.3 million.

Figure 19 shows the volume of the freight tonnage not impacted and freight tonnage impacted via detour in the seven days after road closures on February 28, 2022. Concrete was the worst-impacted commodity with 45.1% of freight unable to reach its destination at all, and 54.9% of freight reaching its destination via detour, thereby incurring further cost and time.

Figure 19: Freight tonnes reaching market



Source: CSIRO commissioned by Infrastructure Australia (2022)

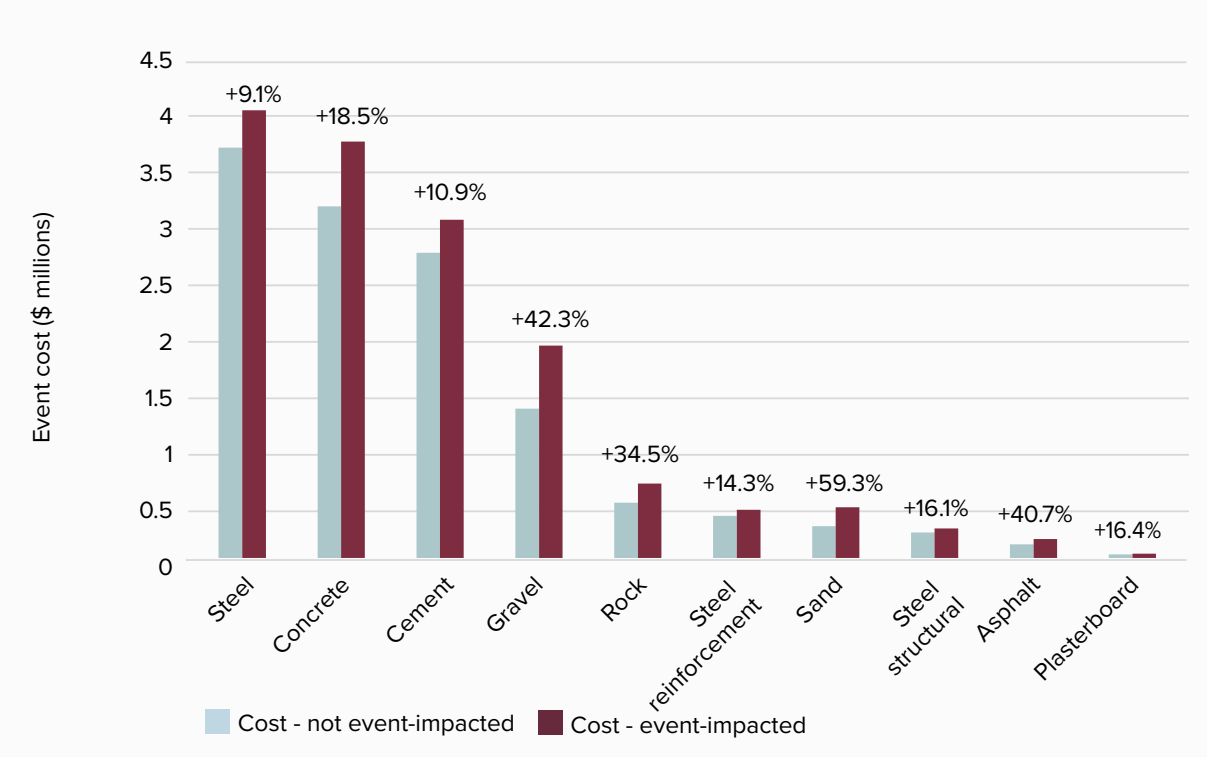
Enterprises that did not receive freight due to road closures were mostly based in south-east Queensland, although a handful of northern Queensland businesses were impacted too. The total cost of undelivered freight (due to lack of available detour) was $681,795, as shown in **Table 10**.

Table 10: Cost of freight tonnage unable to reach its destination

Commodity	Origin state	Destination state	Event tonnes	Baseline event cost
Asphalt	QLD	QLD	992	$39,024
Total asphalt			**992**	**$39,024**
Bitumen	QLD	QLD	113	$27,487
Total bitumen			**113**	**$27,487**
Cement	NSW	QLD	248	$33,893
	QLD	QLD	699	$54,122
Total cement			**947**	**$88,015**
Concrete	QLD	QLD	38,213	$211,218
Total concrete			**38,213**	**$211,218**
Gravel	NSW	QLD	563	$13,722
	NT	QLD	23	$277
	QLD	NSW	113	$885
	QLD	QLD	19,051	$190,793
Total gravel			**19,749**	**$205,676**
Rock	NSW	QLD	90	$2,051
	QLD	NSW	23	$171
	QLD	QLD	2,638	$49,057
Total rock			**2,751**	**$51,279**
Sand	QLD	QLD	5,748	$44,092
Total sand			**5,748**	**$44,092**
Steel Reinforcement	NSW	QLD	18	$903
	QLD	QLD	176	$4,392
Total steel reinforcement			**194**	**$5,295**
Steel structural	NSW	QLD	41	$6,621
	QLD	QLD	212	$3,089
Total steel structural			**253**	**$9,710**
Grand Total			**68,959**	**$681,795**

Figure 20 shows the additional cost of freight delivered via detour in the seven days after February 28, 2022. Gravel deliveries cost almost $575,000 more during this time, equivalent to a 42.3% jump compared to freight costs that are not event-impacted. Of this, $110,000 in excess freight costs were incurred detouring gravel from New South Wales to sites in Queensland.

Figure 20: Delivery cost of freight

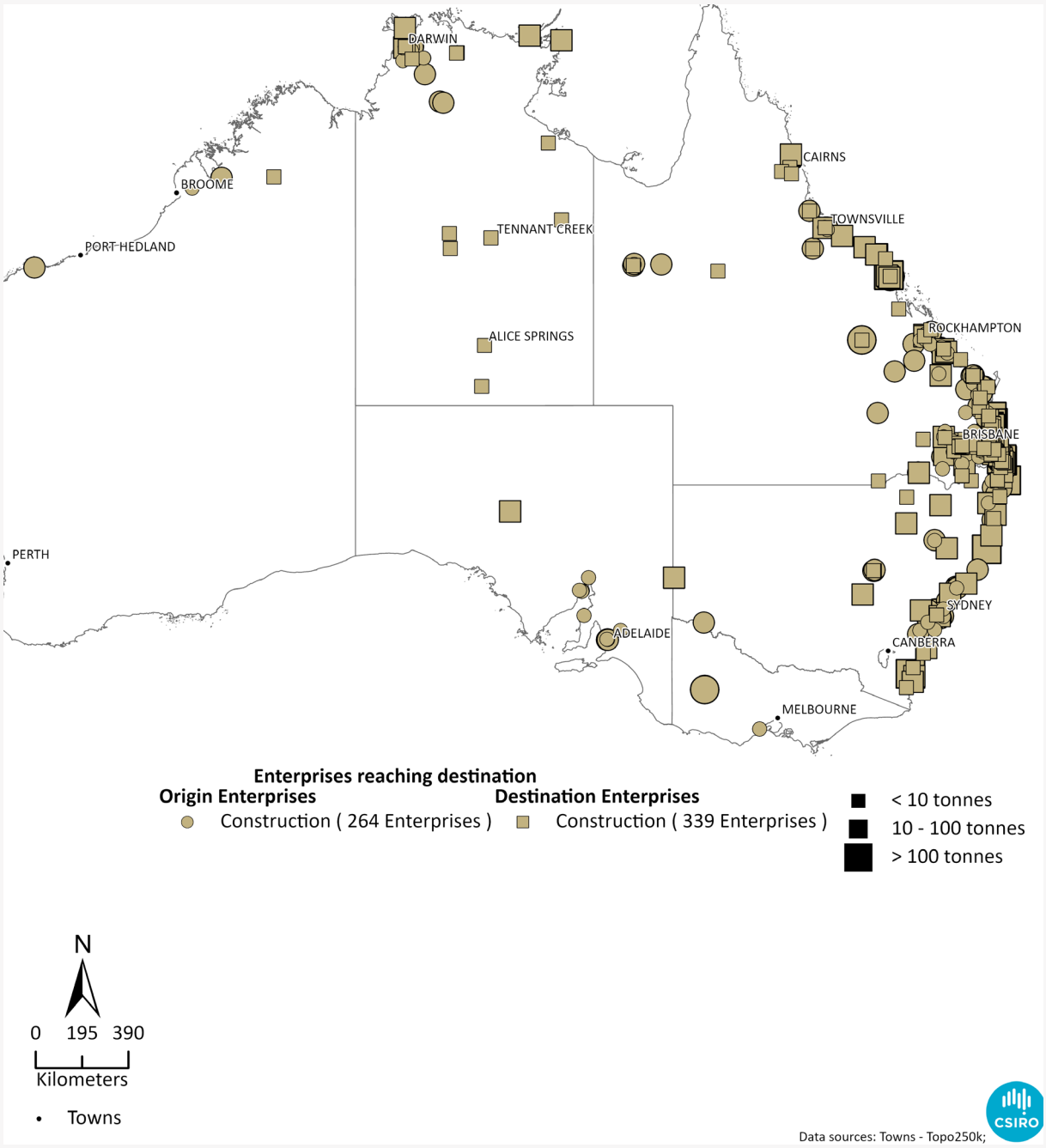


Source: CSIRO commissioned by Infrastructure Australia (2022)

Although the flood event of 28 February, 2022 occurred in south-east Queensland and northern New South Wales, ripple-effects were felt by construction projects elsewhere, either through increased transport costs or undelivered materials. By way of example, total concrete freight from South Australia to Victoria cost $124,000 more than the average over the seven days following 28 February, 2022. All such cross-jurisdictional impacts can be seen in **Figure 21**.

Infrastructure Market Capacity

Figure 21: Impacted origin and destination enterprises requiring a detour at additional transport costs



Source: CSIRO commissioned by Infrastructure Australia (2022)

5. Workforce and skills

At a glance

This section provides quantitative analysis on the demand for and supply of labour in service of public infrastructure. It includes suggestions to address capacity constraints and risks, as well as key facts on the public infrastructure government workforce.

Key findings include:

- Demand for public infrastructure now substantially exceeds the capacity of the existing workforce.
- As of October 2022, public infrastructure projects, including small capital projects, face a shortage of 214,000 skilled workers. This shortage is not comparable to findings from the *2021 Infrastructure Market Capacity* report due to the expanded view of demand in 2022.
- Workforce shortages for the total public infrastructure pipeline (including major projects and smaller projects) are visible in all jurisdictions.
- Engineers, scientists, and architects are acutely scarce, accounting for nearly half of the total workforce needs.
- Australia will continue to face severe shortages in the workforce available for public infrastructure until at least early 2026.
- There are extremely limited short-term opportunities to address this challenge. Demand-side solutions are the only realistic short-term solution, including data-driven, proactive demand management via intelligent pipeline sequencing.
- Significant action is needed both in public infrastructure planning and workforce training and supply to ensure Australia can meet its infrastructure ambitions.
- State and territory governments have grown their public infrastructure workforces by 30% since 2016.
- 12% of public sector public infrastructure workers are aged 15-29 years (compared to 27% in the private sector) and 50% of public sector public infrastructure workers are over 45 years (compared to 35% in the private sector).
- Women participate at a higher rate in the public sector than the private sector across every public infrastructure occupation group.
- 27 new skills have emerged in relevant public sector public infrastructure job advertisements since 2016, most of which are digital-related.

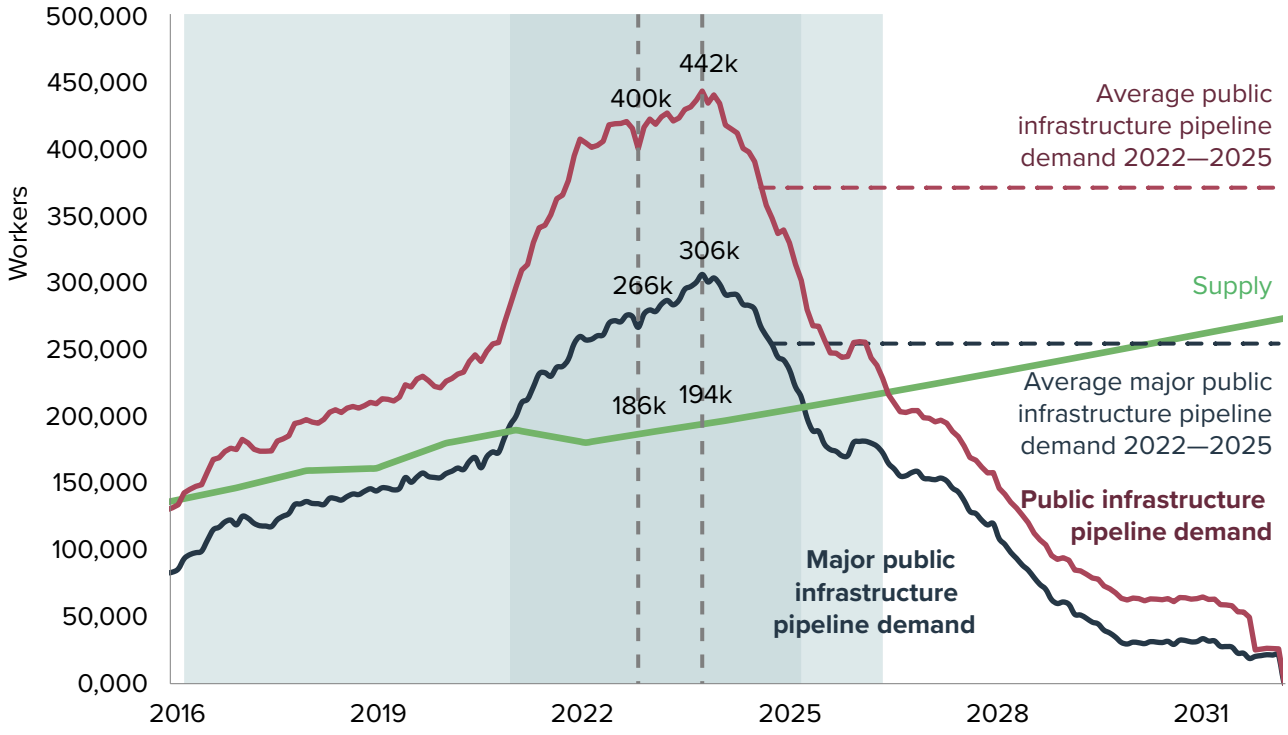
The Australian infrastructure sector is facing an unprecedented workforce shortage

A sufficiently skilled and available workforce is critical for realising Australia's ambitious public infrastructure investment. However, the rapid expansion of public infrastructure means demand is substantially exceeding existing supply.

Figure 22 shows that, as of October 2022, public infrastructure projects (including small projects) face a shortage of 214,000 skilled workers. This is projected to grow to a peak shortage of 248,000 people in 2023, 128% of the projected available workforce. These figures are not comparable to findings from the 2021 *Infrastructure Market Capacity* report, due to the methodological changes in 2022 that enable an expanded view of demand across the construction sector (see *Section 2: Understanding demand* for a more detailed explanation of the changes).

The consequences of this unprecedented workforce shortage will affect every public infrastructure project in the coming years.

Figure 22: National supply and demand for workers engaged in major public infrastructure projects, historical (2016-2022) and projected (2022-2032)



Note: Public infrastructure pipeline demand includes major public infrastructure projects, non-major public infrastructure projects, road maintenance projects and privately funded infrastructure for public use. The definition for each element is available in *Section 2: Understanding demand*. The shaded periods indicate when major public infrastructure projects (darker) or public infrastructure (lighter) demand exceeds supply.

Source: Nous Group commissioned by Infrastructure Australia (2022)[21]

In 2023 alone, demand is projected to increase by 42,000 workers to a peak of 442,000. This is more than double the projected available supply, which will grow by just 8,000 individuals during the year. Meeting this demand will be very difficult given Australia's tight labour market and historically low unemployment rate of 3.5%.[22]

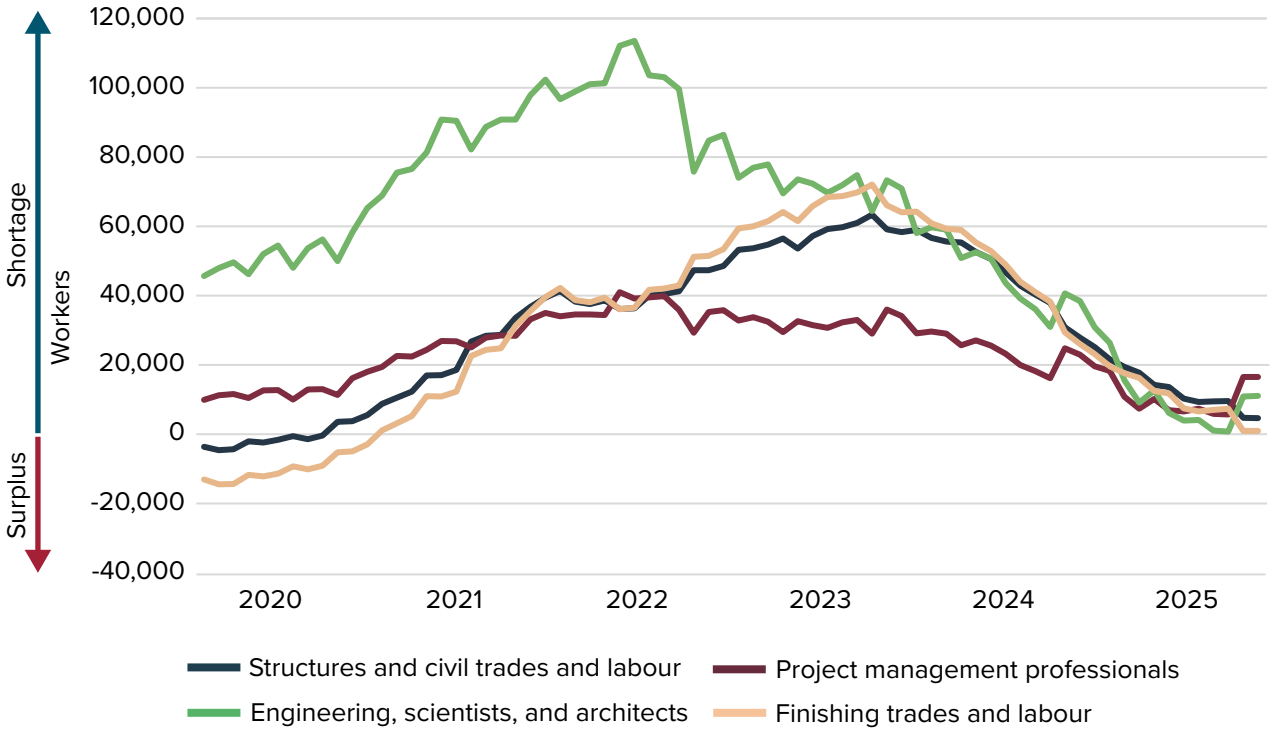
The projected demand growth is primarily driven by major projects, which make up about 70% of demand. The workforce demand for the major public infrastructure will peak at almost 306,000 in 2023, close to double the demand in 2020 and triple the demand in 2016. This is exacerbated by smaller public infrastructure projects; these usually require about 70,000 workers, but will require between 120,000 and 140,000 for the next two years, pushing public infrastructure pipeline demand up to a peak of 442,000.

Every occupational group now faces significant shortages

Key changes in the skills required across the job market include a growth in skills focused on client engagement, management and logistics. This reflects that many projects are in their planning stages, and it indicates that engineers are being asked to do work outside their specialisation. Rapid growth in digital skills that enable these generalist and technical tasks could also create skills shortages resulting from a mismatch of project needs with workers' skills.

Figure 23 shows that every occupational group involved in public infrastructure now faces significant labour shortages. Engineers, scientists, and architects face particularly broad and severe shortages, followed by finishing trades and labour, and structures and civil trades and labour, which will worsen as projects begin construction. Already the scarcity among engineers, scientists, and surveyors has expanded to include significantly more roles, many of which are senior roles that will be difficult to fill. Many environment-focused roles have entered into shortage too.

Figure 23: Projected shortages in the public infrastructure workforce by occupational group, 2020 to 2025



Source: Nous Group commissioned by Infrastructure Australia (2022)[23]

A drop in VET inflows has lowered labour supply projections

The main cause of reduced supply growth is a reduction of vocational education and training (VET) inflows in 2020 during the COVID-19 pandemic, with VET inflows down by 61,000 in 2020.[24] This reduction does not appear to be permanent, as early evidence suggests that VET has bounced back in 2021, with commencements for apprenticeships for construction trades workers up by 60.8% compared to 2020 (5,525 individuals).[25]

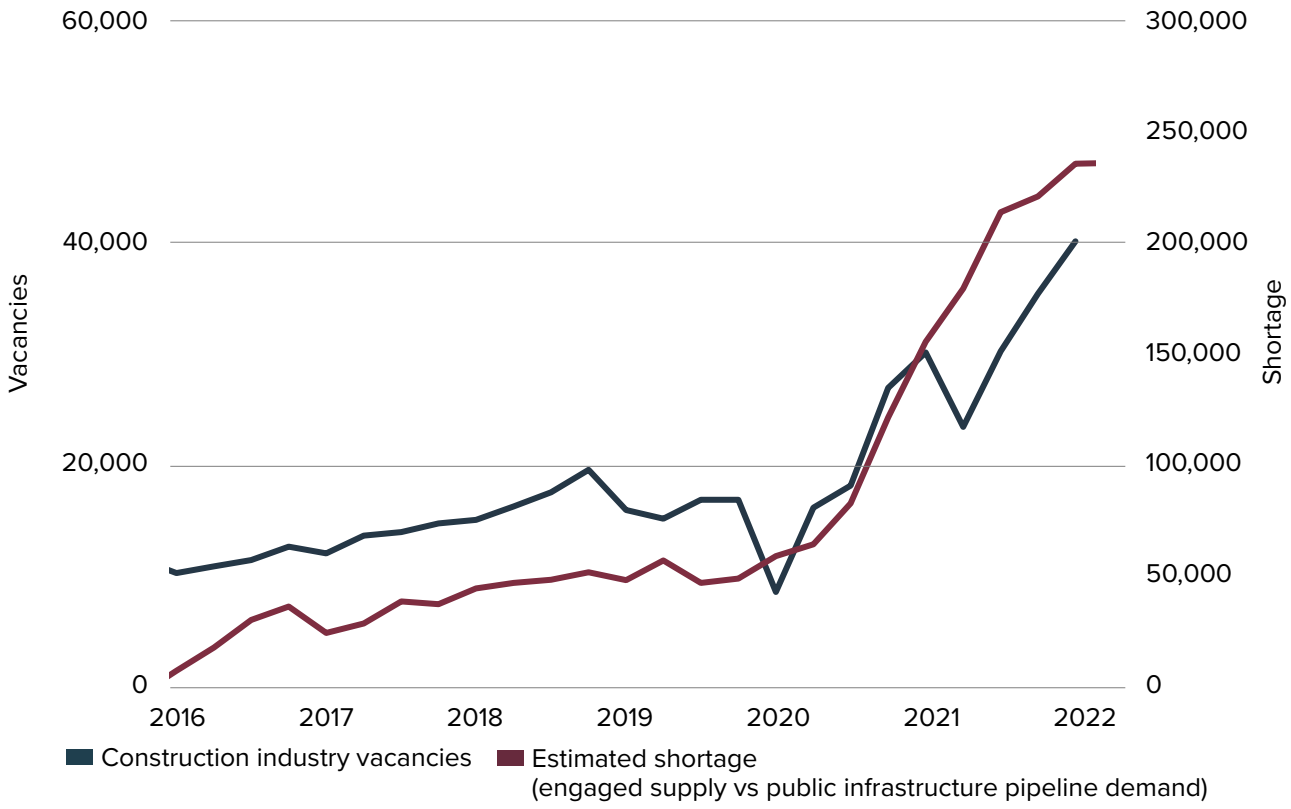
Industry is at its limit responding to the market shortage

The infrastructure labour market seems to be at the limit of its ability to adjust. Existing vacancies are not being filled, existing workers are already working as many hours as they can, and wages are rising well above the Australian average. There is also little growth in education activity.

Employers are advertising for new staff as quickly as they can. Job vacancies typically track with unmet demand, which shows that the market is responding to the shortage.

Recruitment efforts are limited in their impact. **Figure 24** shows ~40,000 job vacancies across the entire construction sector in the second quarter of 2022. Of these, only ~8,000 are likely to be in public infrastructure (assuming that vacancy rates in public infrastructure are similar to the construction industry overall), or 1.8% of total projected demand in June 2022.[26] This seems much lower than the projected shortage, but is actually within a normal range: across all industries, vacancies have ranged from 1.6% at the start of the pandemic to 2.8% in March 2022.[27] The construction industry does have the largest sampling error of any industry in the ABS Job Vacancies data, but even at the high end of estimates the vacancies would still be within this normal range.

Figure 24: Historical construction industry job vacancies (2016—2022) with estimated shortage overlay (2016—2025)



Source: Australian Bureau of Statistics (2022)[28]



Another standard response to shortage would be for the existing workforce to work more hours, effectively increasing the labour supply. However, total hours worked in construction has declined since 2018.[29] This is probably an effect of the COVID-19 pandemic, which has caused project delays, and also caused more people than usual to take annual leave.[30]

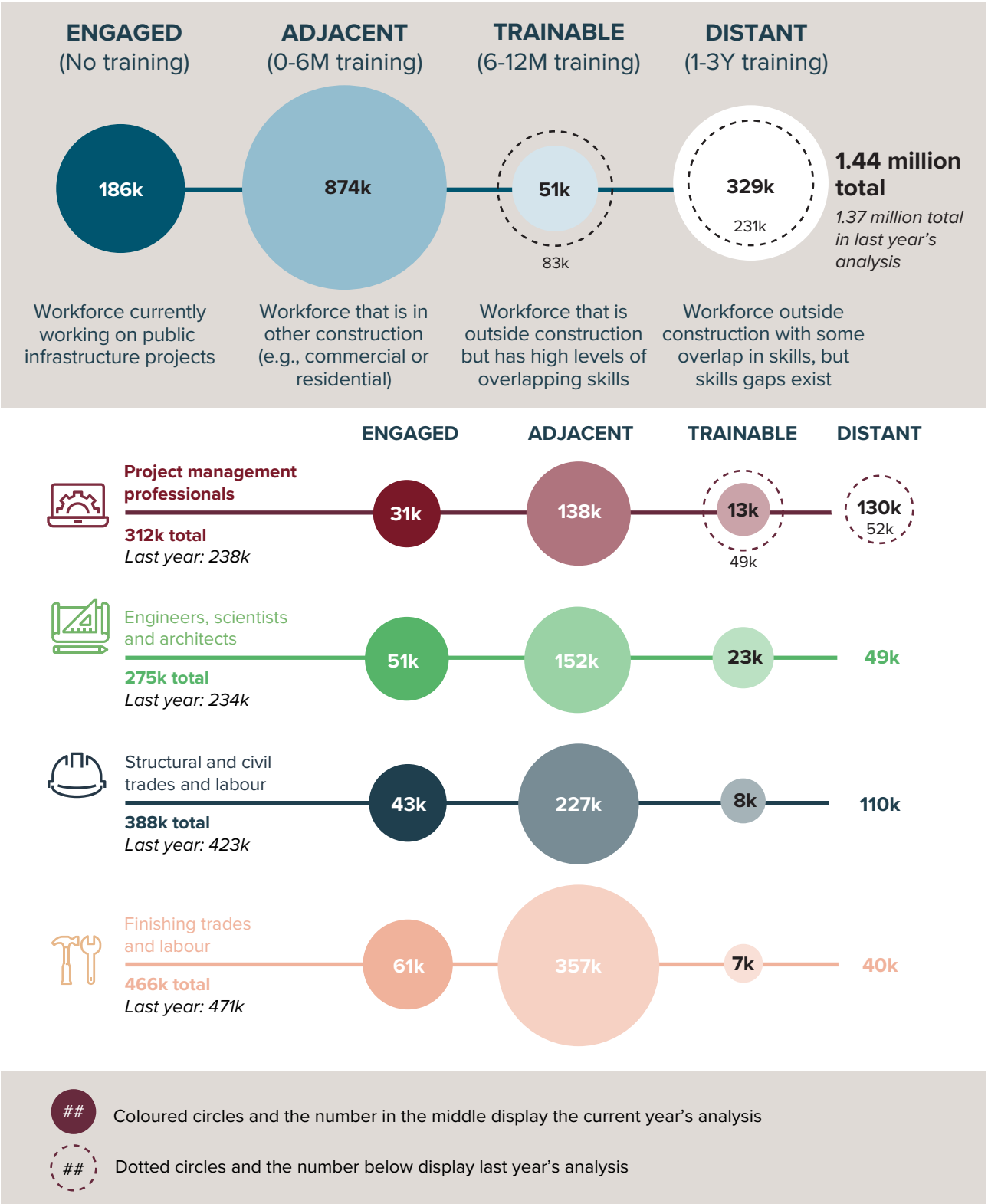
Training activity continues to lag demand and opportunities for migration have been limited. Even if upcoming increases in the workforce are not yet captured by data, the level of shortage is so high that inflows from training or migration cannot solve immediate shortages. Even if inflows from training or migration were at pre-COVID-19 pandemic levels, shortages would persist for some time.

The adjacent workforce is not equally distributed, so cannot ease urgent shortages

With reference to Figure 25, one possible opportunity is the adjacent workforce of 874,000 individuals working in similar roles in other construction sectors. However, while many workers in this “adjacent” workforce may be quickly trained (or re-trained) for public infrastructure employment, they are likely already employed in private sector construction. “Adjacency” also does not factor in willingness to move, relative compensation, and contractual obligations which could prevent timely transition. It may also be unrealistic in rural and remote areas where there are fewer adjacent workers and in regions where there is more competition from other industries, such as mining, that potentially draw individuals from public infrastructure works.

The “distant” workforce is sizeable, but these workers would only finish their training or reskilling after the peak of the shortage in 2023.

Figure 25: Snapshot of the workforce relevant to public infrastructure in 2022



Source: Nous Group commissioned by Infrastructure Australia (2022)[31]

The number of adjacent workers also varies by workforce category. In particular, the demand for engineers, scientists and architects remains significant across private and public projects, highlighting that the adjacent workforce may not be able to fill pressing shortages. Transitioning workers from the adjacent workforce to the engaged workforce is most viable when a small proportion of the adjacent workforce is required to fill shortages.

Generalist and technical skills are more easily transferable than specialist skills

Knowing what skills workers need is critical to understanding the changes in roles over time, particularly where rapid change can lead to skills shortages that may not appear in aggregate labour shortage data. Skills data also shows where workers in different occupational groups and industries are difficult to substitute, and how focused the industry is on specialist skills for each occupation. Engineers are relatively specialised, and therefore hard to substitute with workers from other occupational groups or industries; but they are being used by industry for generalist and technical skills in spite of a shortage. Increased use of paraprofessionals may help reduce the burden on engineers and other specialised occupations in the future.

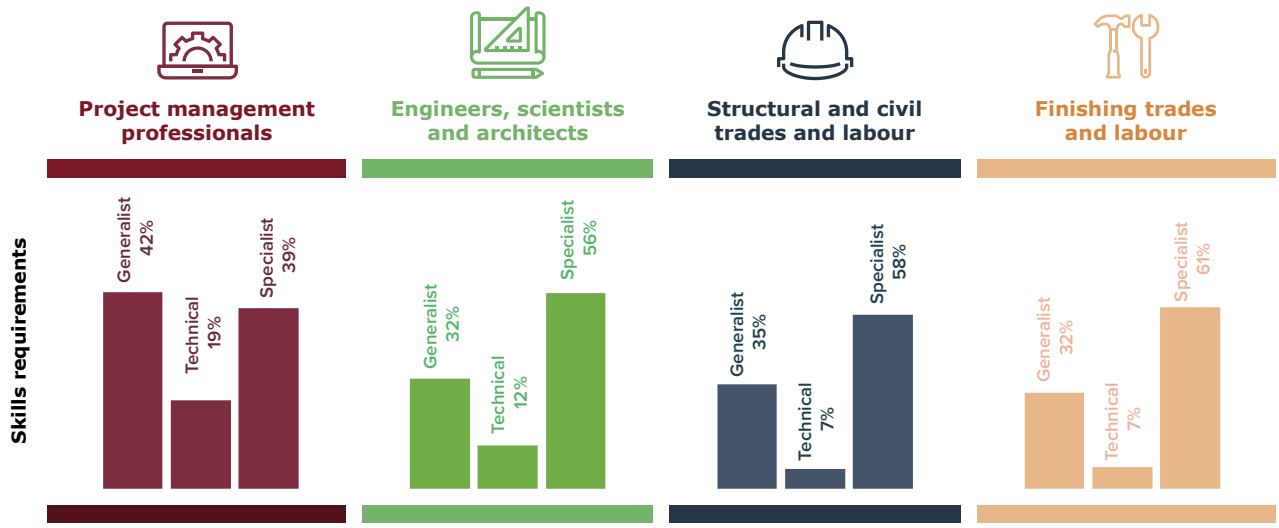
Classification of skills

General and technical: easily transferable skills that are developed throughout a career

Specialist: skills that are developed early through vocational training and occupation-specific job experience, and have limited relevance in adjacent occupations and industries

Figure 26 shows the emphasis placed on each category of skills in job advertisements in the public infrastructure sector. Generalist skills such as communication, problem solving, and teamwork are required throughout a person's career. Specialist skills are developed through vocational training and on-the-job experience early on in a career. Technical skills are generally built when workers become project managers and team leaders; workers are expected to develop these on the job.

Figure 26: Proportion of skill mentions in 2021 job advertisements that are generalist, technical or specialist, by occupational group



Source: Nous Group commissioned by Infrastructure Australia (2022)[32]

Note: Each bar chart shows the mentions of a skill of a given type (generalist, technical or specialist) in job advertisements as a percentage of the total mentions of skills in all job advertisements for each occupational group.

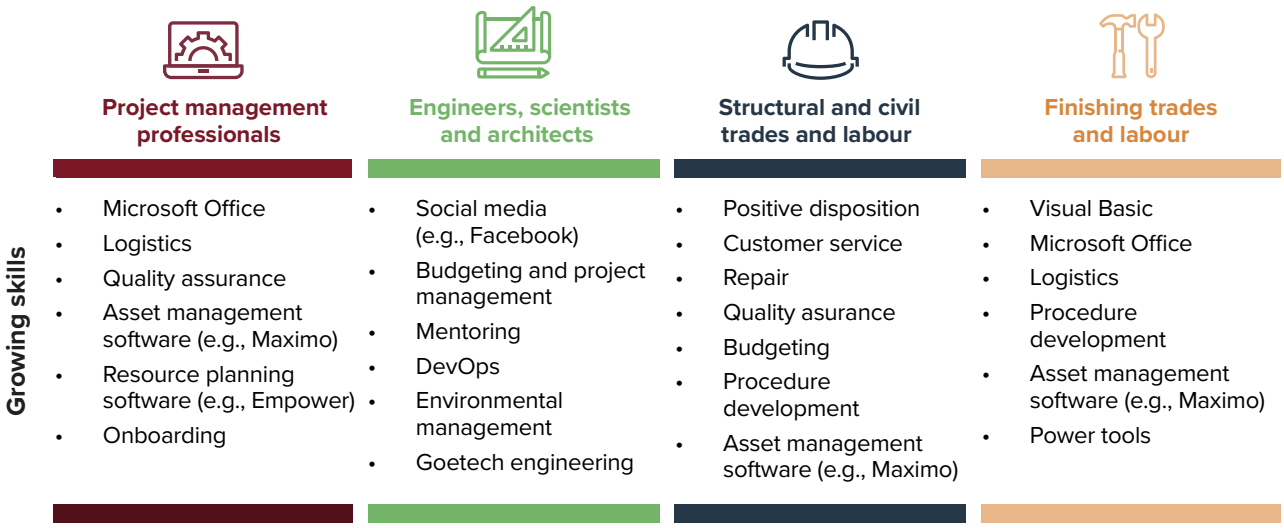
After grouping skills this way it can be seen that engineers, scientists, and architects are highly specialised and are difficult to train from other occupations. **Figure 26** also indicates that project managers are easier to retrain because the skills employers need are usually generalist or technical.

The skills that the public infrastructure sector needs are changing as the result of new processes, standards, equipment or technology. When enough of the workforce find their skills are out of date, employers can struggle to find staff with the right skills even if there are apparently enough people in an occupation. This mismatch in skills may not appear in analyses of aggregate shortages at a workforce or occupational level.

Engineers and other specialists are being asked to develop generalist skills that much larger workforces already possess

Analysis of job advertisement data in **Figure 27** shows the skills that have seen the largest increase in how often they appear in job advertisements over the 2015 to 2021 period. Most of these are technical and project management skills such as logistics, scheduling, and quality assurance, along with the ability to use the software that enables these activities. While these emerging skills are not necessarily in shortage, they present a potential challenge where the need for these skills outstrips workers' ability to develop them on the job and through training.

Figure 27: Emerging skills by occupational group



Source: Nous Group commissioned by Infrastructure Australia (2022)[33]

In particular, there has been a rise in the number of engineering, science, and architecture positions requiring social media skills for community and client engagement, and budgeting and project management skills. This indicates that these workers are being asked to do work outside of the specialisation – work that could be done by project managers, marketers and other occupations with smaller shortages.

This accords with stakeholder feedback that a litigious industry environment and the use of engineering specialists (often senior) for contract management is lowering productivity and exacerbating labour shortages because senior engineers are spending time on contracts, clients, and engagement rather than specialised engineering work.

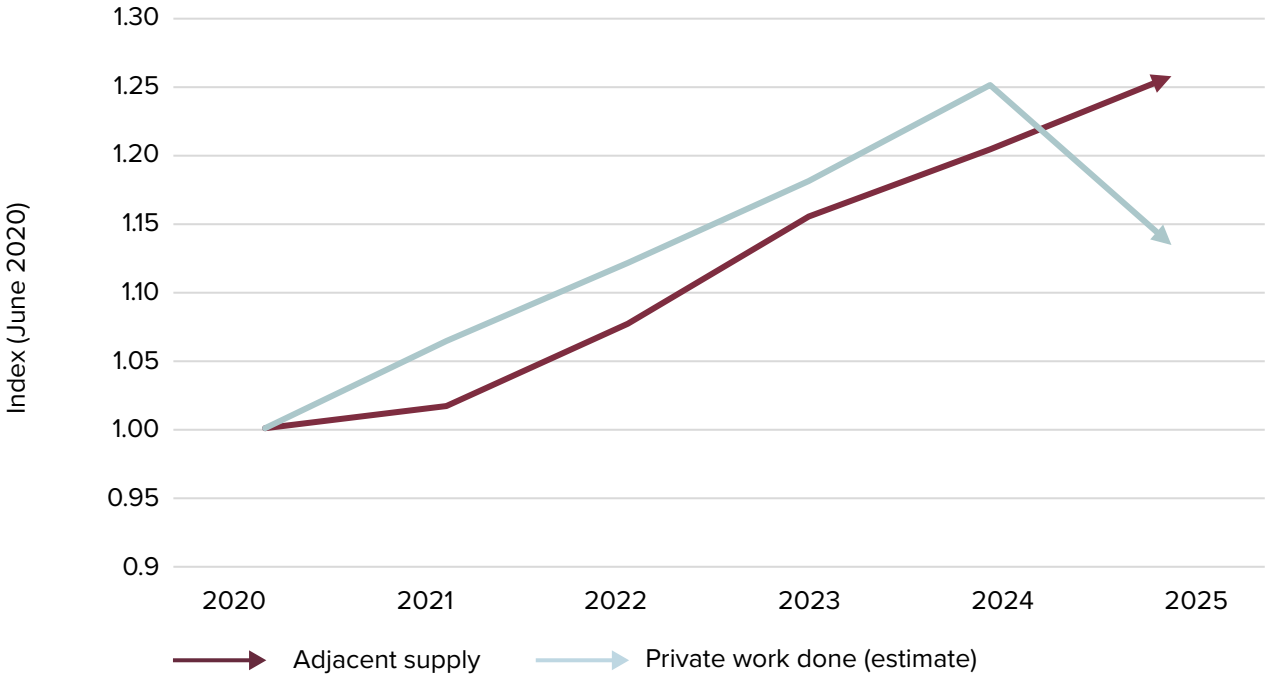
Consultations also indicated that the industry is beginning to adjust in other areas, particularly by looking to paraprofessionals to assist engineers with work that can be done with skills that are transferable or specialised but easily trained. Expanding efforts to hire paraprofessionals will be a key piece for enabling the existing engineering workforce to be used effectively and giving them experience in their specialisation quickly.

The adjacent workforce faces its own private sector demand pressures

The availability of the adjacent workforce to fill public infrastructure demand is also limited by the separate, conflicting private demand for workers with the necessary skills. Some shortages across public infrastructure are simply too large to fully address through transitioning people from the adjacent workforce. The significant growth in private sector demand suggests that it may be difficult to attract many workers at all.

Figure 28 projects the growth of private sector demand for labour based on incomplete data on the total private sector demand for labour (with adjustments made to account for that incompleteness). Much like demand for public infrastructure labour, demand for labour in the private sector is growing at a significantly faster rate than the relevant supply (the adjacent workforce) needed to meet that demand. Importantly, while this does not show the actual equilibrium or shortage, the different growth rates clearly show that labour availability in the private sector position will not start improving until at least 2023. This suggests that the private sector is experiencing substantial workforce pressure, which has been corroborated through stakeholder feedback.

Figure 28: Projected growth in private demand for construction labour against projected growth in the adjacent workforce supply (2020—2025)



Source: Nous Group commissioned by Infrastructure Australia (2022)[34]

Likely private sector shortages will make it difficult for the public sector to attract enough workers from the adjacent workforce to address public infrastructure shortages, even where the adjacent workforce is large. At best, it would transfer the workforce pressure into the private sector. This would create further challenges with project timelines and inflating wages, driving up costs across the industry.

Key public sector workforce facts

The public sector is a critical component of Australia's public infrastructure workforce. It supports the delivery of public infrastructure from scoping and planning major projects, engaging communities, supporting delivery, and then maintaining developed infrastructure.

These key facts outline the current state and recent trends for this workforce:

1. The number of individuals employed in public sector organisations in support of public infrastructure activity:
   - Local government: 38,000 employees
   - State and territory government: 34,000 employees
   - Australian Government: 13,000 employees
   - Total: 85,000 employees
2. The number of individuals employed per occupation group:
   - Project management professionals: 35,000
   - Engineers, scientists and architects: 26,000
   - Structures and civil trades and labour: 10,000
   - Finishing trades and labour: 8,000
   - Policy and regulation: 6,000
3. The total number of individuals employed by state and territory governments has increased by 9,700 individuals since 2016.
4. The total number of individuals employed by local governments has decreased by 2,800 individuals since 2016.
5. The proportion of individuals employed by local governments in structures, civil trades and labour and finishing trades and labour roles is 39%.
6. 69% of public sector employees in structures, civil trades and labour roles are aged over 45 years, compared to 32% in the private sector.
7. 71% of public sector employees in finishing trades and labour roles are aged over 45 years, compared to 31% in the private sector.
8. Across all public infrastructure occupation groups women are employed at a higher rate in the public sector than the private sector. The share of individuals aged under 30 years in public infrastructure roles is 15% lower in the public sector than the private sector.
9. The share of individuals aged over 50 years in public infrastructure roles is 15% higher in the public sector than the private sector.
10. Five-year growth across public sector infrastructure has been greatest among engineers, scientists, architects and project management professionals.
11. Wages are generally 5% lower in the public sector.
12. Advertised public sector salaries increasing 1.4% since 2018 while private sector equivalents fall.[35]
13. There is between 80% and 85% similarity in skills requested by the public and private sectors in support of public infrastructure delivery across occupational groups.
14. 37 new skills have emerged in relevant public infrastructure job advertisements since 2016. Of these, 27 appear exclusively or overwhelmingly in the public sector, the majority being digital skills.[36]

6. Implications and recommendations

At a glance

This section presents the implications of the demand and supply analysis detailed in sections 2—5 of this report. Any recommendations are reiterations of what has been presented in the *2021 Australian Infrastructure Plan* or the *2022 Delivering Outcomes* report.

Demand-driven risks have increased over the last 12 months: Demand for major public infrastructure projects has climbed by $15 billion in a year. At the same time, a much broader view of project demand has been achieved by ingesting other types of project data into the Market Capacity Intelligence System. This allows for better quantification of demand and therefore more understanding of the scale of competition for scarce resources.

Supply-side risks have surged in 2021—22: The global economy continues to battle significant disruption to supply chains caused by the COVID-19 pandemic, volatile demand and more recently, the war in Ukraine. These factors are causing delays and cost escalations for imported items. Onshore, severe labour shortages present the greatest risk to capacity, according to industry.

The interaction of demand and supply-side risks are causing construction cost escalations and insolvencies: Rising input costs threaten the financial viability of construction firms and supply chain businesses. Adding to this, project planning and risk allocation practices expose construction firms to dangerous levels of risk, especially smaller operators further along the supply chain. These factors are driving up insolvency rates within the construction sector. Further compounding the issue of reduced industry capacity, the majority of constructors report that they are operating at 90% capacity or more.

The market is at its limit of responding to such highly-inflamed conditions, so projects slippage is now expected: It is no longer a question of *if* a project will slip, but more likely when, by how long and at what cost.

A rapidly-changing market creating unprecedented uncertainty

An overheated construction market – characterised by escalating input costs, labour shortages and stagnating productivity – is placing extraordinary pressure on project timelines, cost and scope, therefore escalating risks for projects and programs.

There is increasing urgency to manage these risks and proactively sequence the major infrastructure pipeline. A focus on productivity improvements in planning and delivery, and more ambitious reform to sustainably expand the market's capacity through supply of labour and materials is increasingly critical for successful, timely and cost-effective delivery.

Delays

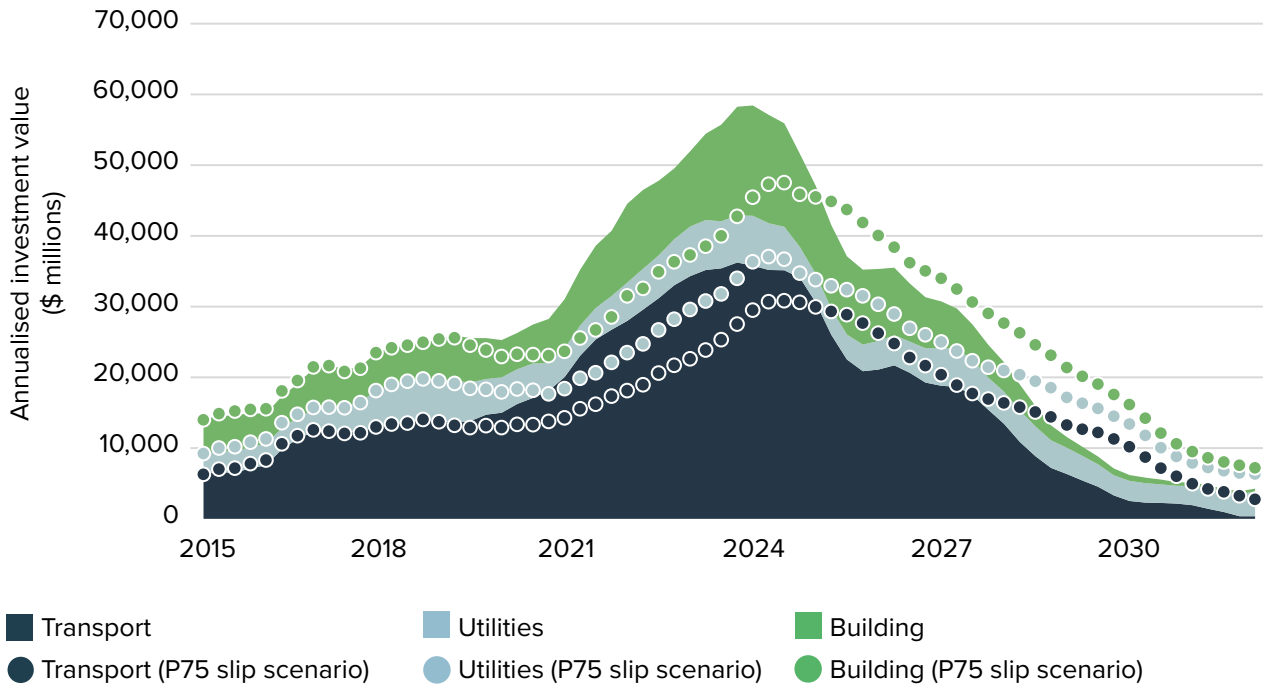
Project delays: No longer *if*, but *when* and by *how long*

The complex interplay among heated market dynamics means it is no longer a question of *if* a project will slip, but more likely *when* and by *how long*.

Governments are well placed to lead the market to a sustainable supply and demand balance by proactively managing demand to minimise future delays. Slip scenarios like those captured in **Figure 29** provide a foundation to understand both the risks of project slippage created by limitations in market capacity, but also the opportunity to proactively coordinate and reschedule pipeline activity to manage these risks.

A review of historical project data since 2015 indicates a P50 project slippage rate of 9% (i.e., the historical market average slip rate under normal conditions). In today's challenging market the historical average may not be applicable, and it is therefore prudent to consider what might occur using a P75 indicator. In doing so, **Figure 29** reveals the effect of P75 project slippage on major public infrastructure projects, assuming they take up to 53% longer to complete than their schedule targets at final business case.

Figure 29: The effect of P75 project slippage on the building, utilities and transport major public infrastructure project pipelines



Source: Infrastructure Australia (2022)

P50 and P75 explained

To conduct this analysis, all historical projects analysed are sorted in order from the one that was delivered earliest relative to planned schedule, through to the one that was delivered latest relative to schedule.

P50: From this ranking, the project that is ranked in the middle of the list provides us with the mid-point for project delivery relative to schedule, which in this analysis averages out across Transport, Utilities and Buildings to be a 9% overrun relative to planned schedule.

P75: The project that is ranked three quarters of the way through the project listing, which therefore must be worse than an average 9% overrun. In this analysis, it averages out to be 53% across Transport, Utilities and Buildings.

Increasingly, project investment commitments across both the public and private sector are subject to greater demand for resources. This in turn is escalating project risks and compromising the ability of the market to meet the needs of certain projects.

Greater visibility of the pipeline and resultant industry demands – as per this report – provide infrastructure agencies with information that can help coordinate demand and avoid the extreme volatility inherent in a boom period. A steadier, known and funded long-term pipeline, can provide construction companies with the confidence to invest over the long term and plan for sustained growth.

Recommendation: 3.1.1 from the *2021 Australian Infrastructure Plan:*

Improve industry capacity and capability by prioritising procurement and portfolio management and increasing pipeline transparency, certainty and confidence.

Developing a long-term view of the infrastructure pipeline should be an objective of all infrastructure delivery agencies. The recent delivery of Tasmania's 10 Year Infrastructure Pipeline and the Northern Territory 10 Year Infrastructure Plan are important examples of the critical importance of this planning for jurisdictions of all sizes.[37] A longer-term view allows for refinement and re-sequencing in response to industry capacity considerations. This was evident in 2022 in NSW through the reprioritisation of the Beaches Link and other projects. The reprioritisation was in response to industry capacity considerations where the Infrastructure NSW State Infrastructure Strategy recommends to reconsider the timing and sequence of future megaprojects to diversify the State's investment program and mitigate delivery risks.[38] A longer-term view also supports longer-term planning for productivity and innovation where a long-term, sustained pipeline of construction projects provide confidence for industry.

Costs

Construction costs have surged over the last 12 months

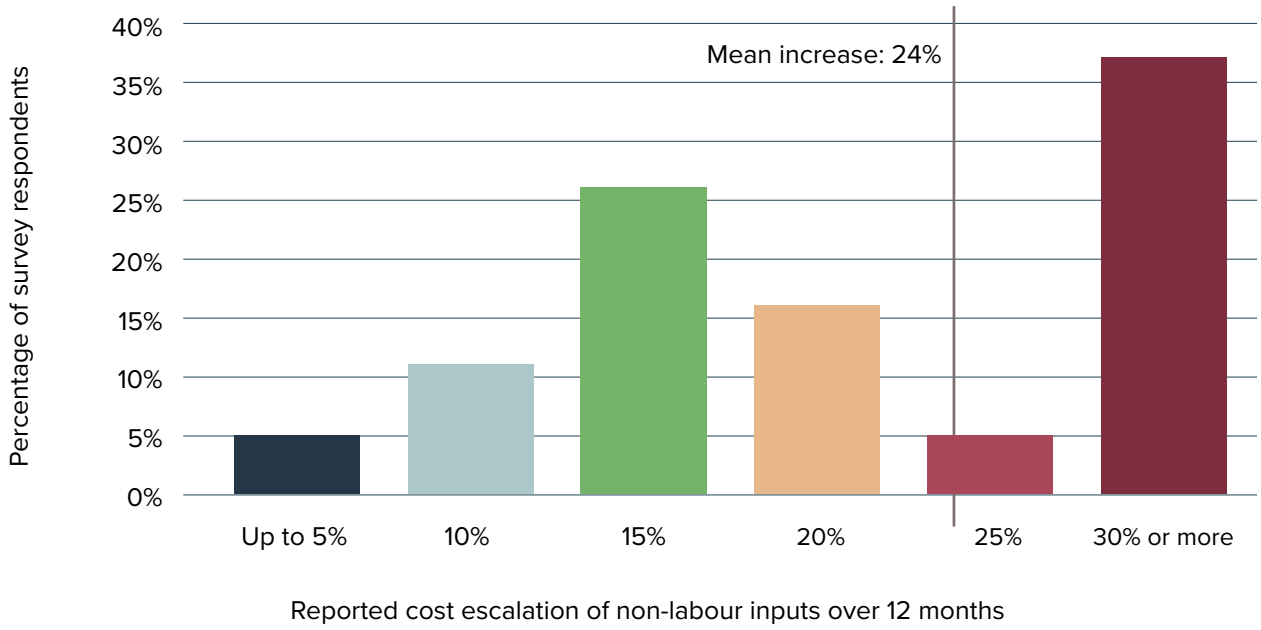
Internationally, the crystallisation of risk is observed through steep price rises for globally-produced commodities (steel, timber and oil products), heightened global transport and logistics costs, plus supply chain disruption caused by the COVID-19 pandemic and the war in Ukraine.

Locally, risks are manifesting as evidenced by rising wage costs driven by severe labour shortages and an increase in materials demanded by the growing construction pipeline.

Industry reports non-labour inputs are 24% more expensive than a year ago

According to interviews and surveys conducted with infrastructure industry representatives between March—May 2022, the price of non-labour inputs has risen on average 24% in the last year, with 58% of respondents reporting over 20% growth. See **Figure 30**.

Figure 30: Reported cost escalation for non-labour inputs over past 12 months



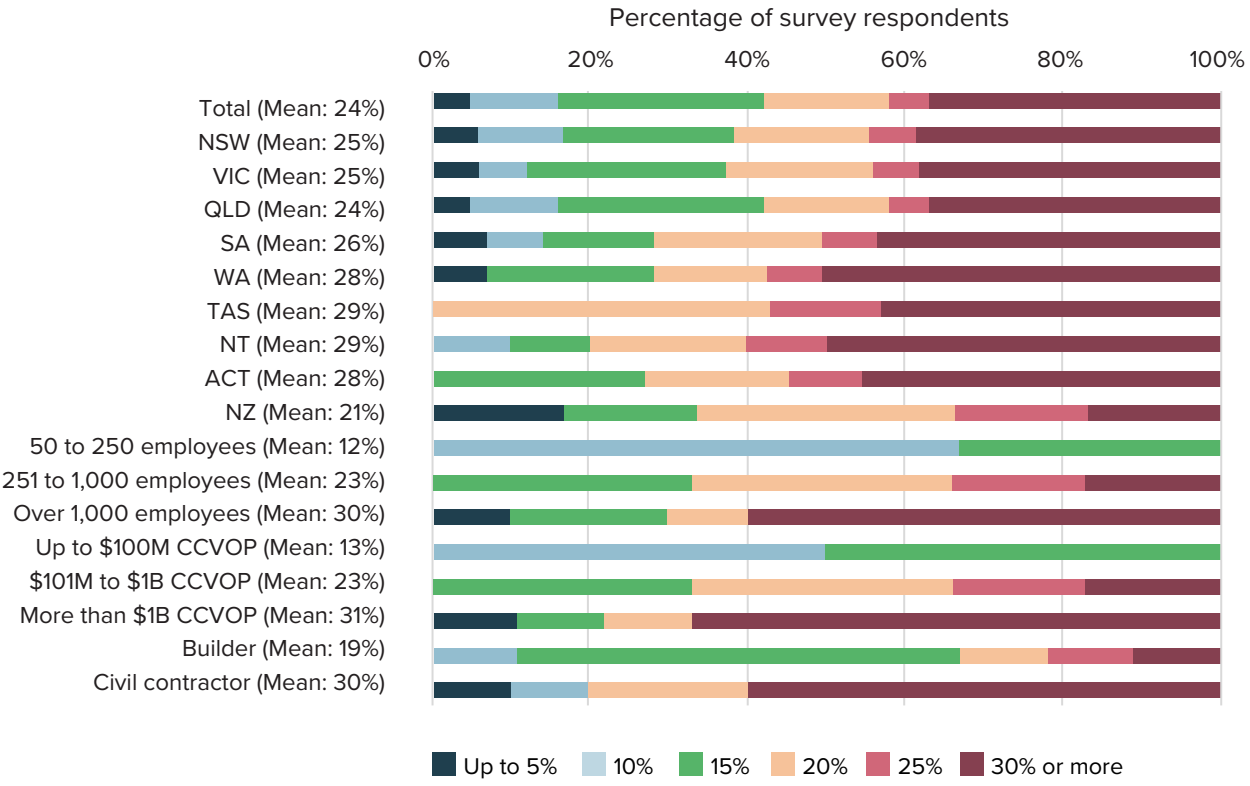
Source: Infrastructure Australia industry survey (2022)

Figure 31 breaks down this reported cost increase by state, company size (based on employee count), current capital value of projects, and company type (i.e., builder or civil contractor).

Compared with the 24% average increase in non-labour costs over 12 months as reported by industry:

- companies in Western Australia and the Australian Capital Territory report a 28% rise, and Tasmania and the Northern Territory report 29%. New Zealand is the only jurisdiction below the 24% average with 21%
- companies with over 1,000 employees report a 30% rise, while smaller companies of 50—250 employees report 12%
- construction companies with a total project value exceeding $1 billion report an average 30% rise, whereas companies with a total project value under $100 million report 13%
- civil contractors report a far higher average increase of 30% compared to builders, amongst whom a 19% rise is reported.

Figure 31: Reported cost escalation for non-labour inputs over past 12 months, by type of organisation



Note: CCVOP refers to current capital value of projects.
Source: Infrastructure Australia industry survey (2022)

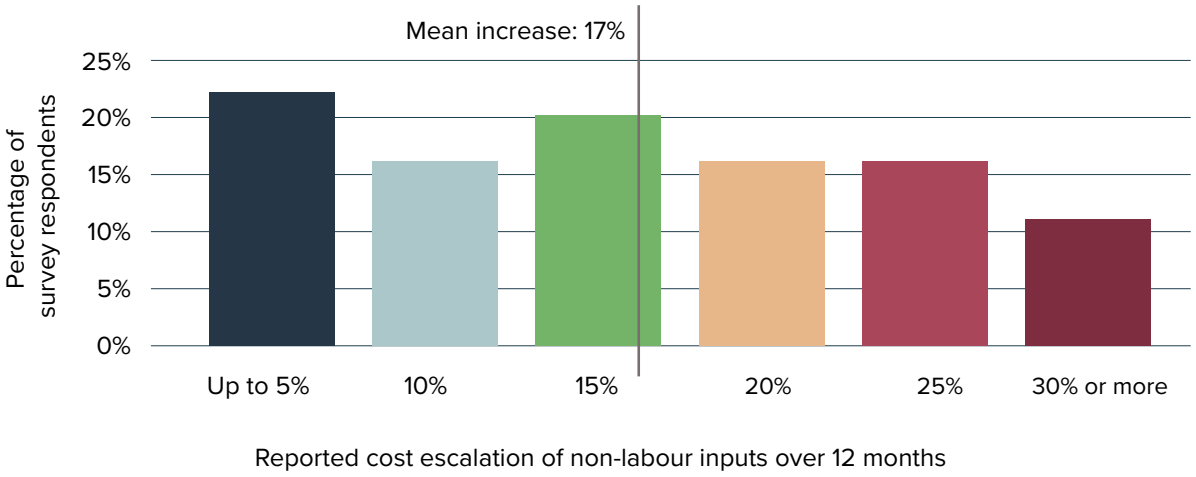
The largest cost increases are identified in steel, timber, oil, oil products (plastic pipes and fittings) and copper-based products (copper pipes and electrical cable), according to ABS Producer Price Index data collected from Australia's six largest capital cities.

For more on the factors impacting steel and quarry materials (including concrete) capacity, read *Section 4: Understanding non-labour supply.*

Industry reports labour costs are 17% higher than a year ago

The cost of labour within public infrastructure and construction has grown on average by 17% over the last 12 months – see **Figure 32**. This demonstrates that escalating project demand is driving employers to compete on price for scarce labour.

Figure 32: Reported cost escalation for labour inputs over past 12 months



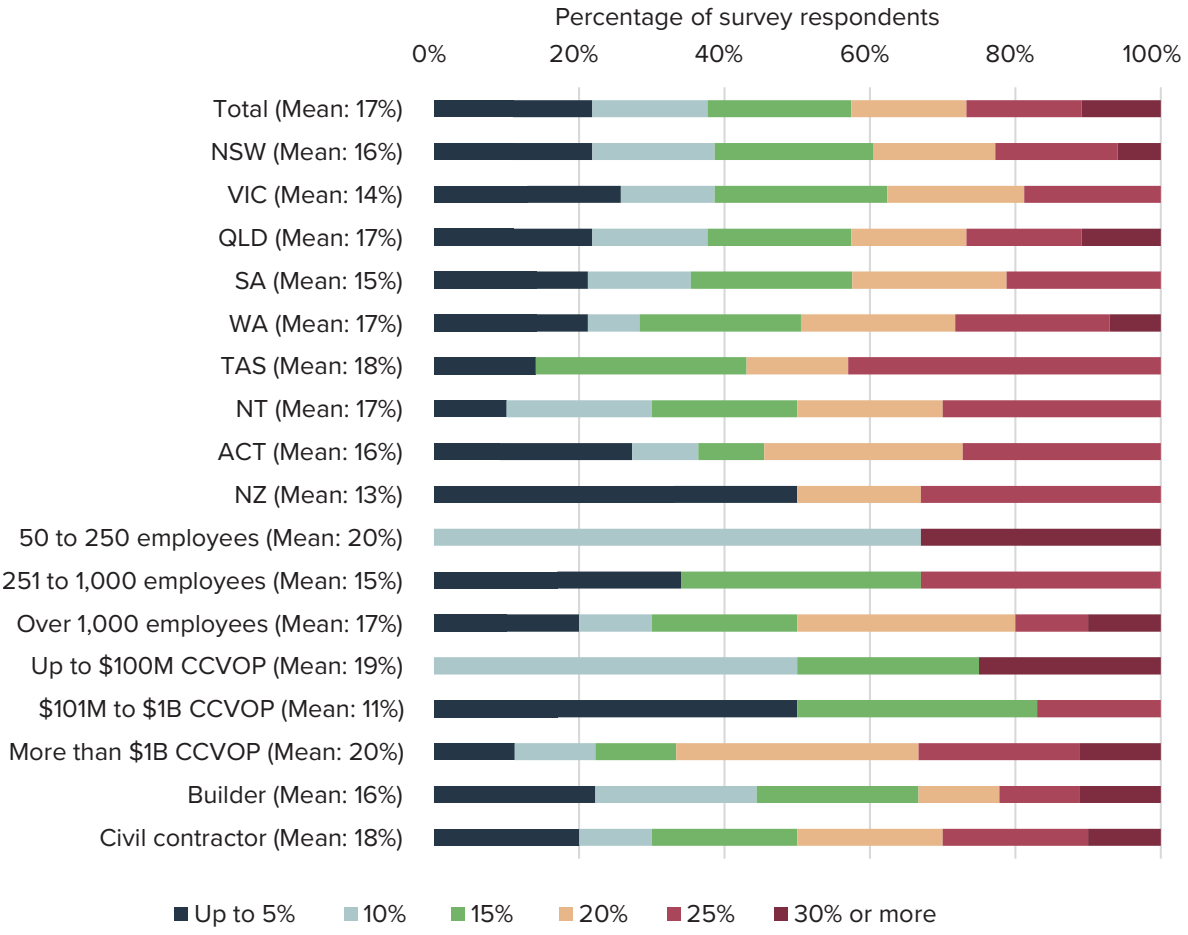
Source: Infrastructure Australia industry survey (2022)

Looking a little further, **Figure 33** reports on the average reported cost increase for labour in the last 12 months. As with non-labour inputs above, this is presented by state, company size (based on employee count), current capital value of projects, and company type (i.e., builder or civil contractor).

Compared with the 17% average increase in labour costs over 12 months as reported by industry:

- Tasmanian construction companies report an average rise of 18%, while New Zealand, Victoria and South Australia report 13%, 14% and 15% respectively. All other jurisdictions align with the average reported increase of 17%.
- companies with over 1,000 employees report the smallest rise (15%), while smaller companies of 50—250 employees report the biggest rise (20%). Interestingly, this is opposite to non-labour costs increases, where larger companies reported the greatest rise, and smaller companies reported the smallest.
- construction companies with total project value under $100 million report 19% rise, and those over $1 billion report 20%. Conversely, companies with total project value between $101 million and $1 billion report a markedly-lower rise of just 11%.
- there is very little difference between the increase in labour costs reported among builders and civil contractors, the former indicating 16% and the latter indicating 18%.

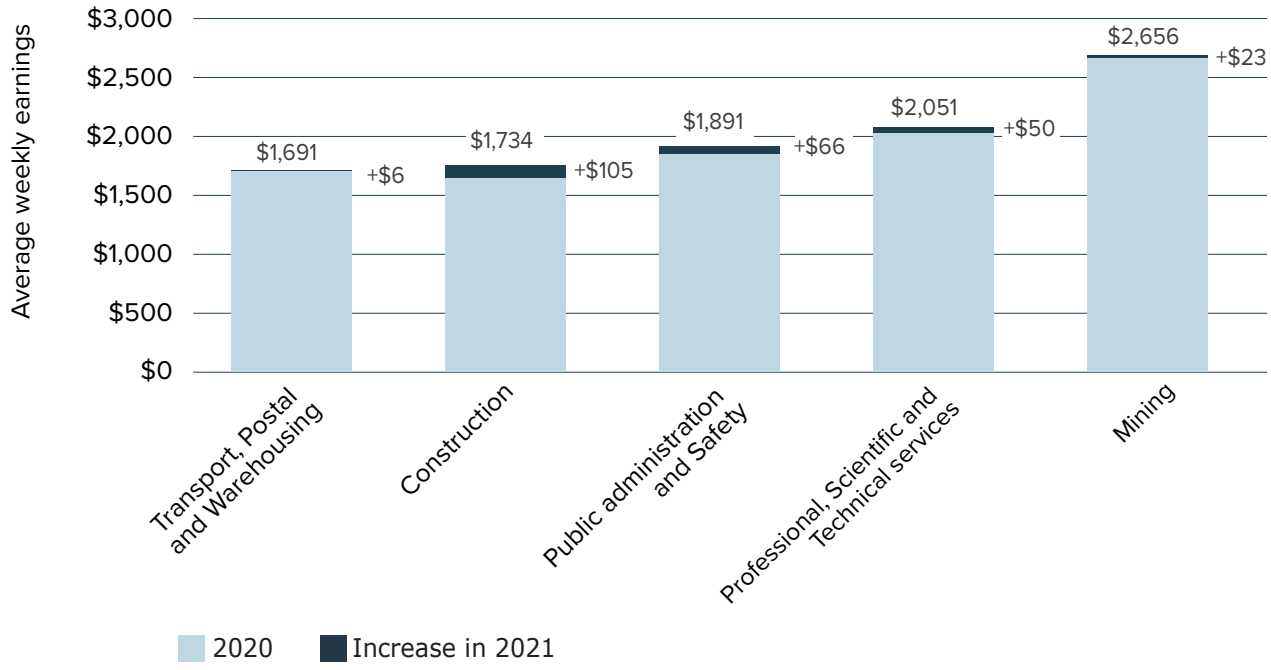
Figure 33: Reported cost escalation for labour inputs over past 12 months, by type of organisation



Note: CCVOP refers to current capital value of projects.
Source: Infrastructure Australia industry survey (2022)

Despite wages increasing for those roles directly engaged in infrastructure and construction, adjacent industries remain competitive and continue to pay more (see **Figure 34**). This indicates that while wage increases are driving up the cost of labour, the underlying supply constraints persist.

Figure 34: Average weekly earnings for most common industries among relevant occupations



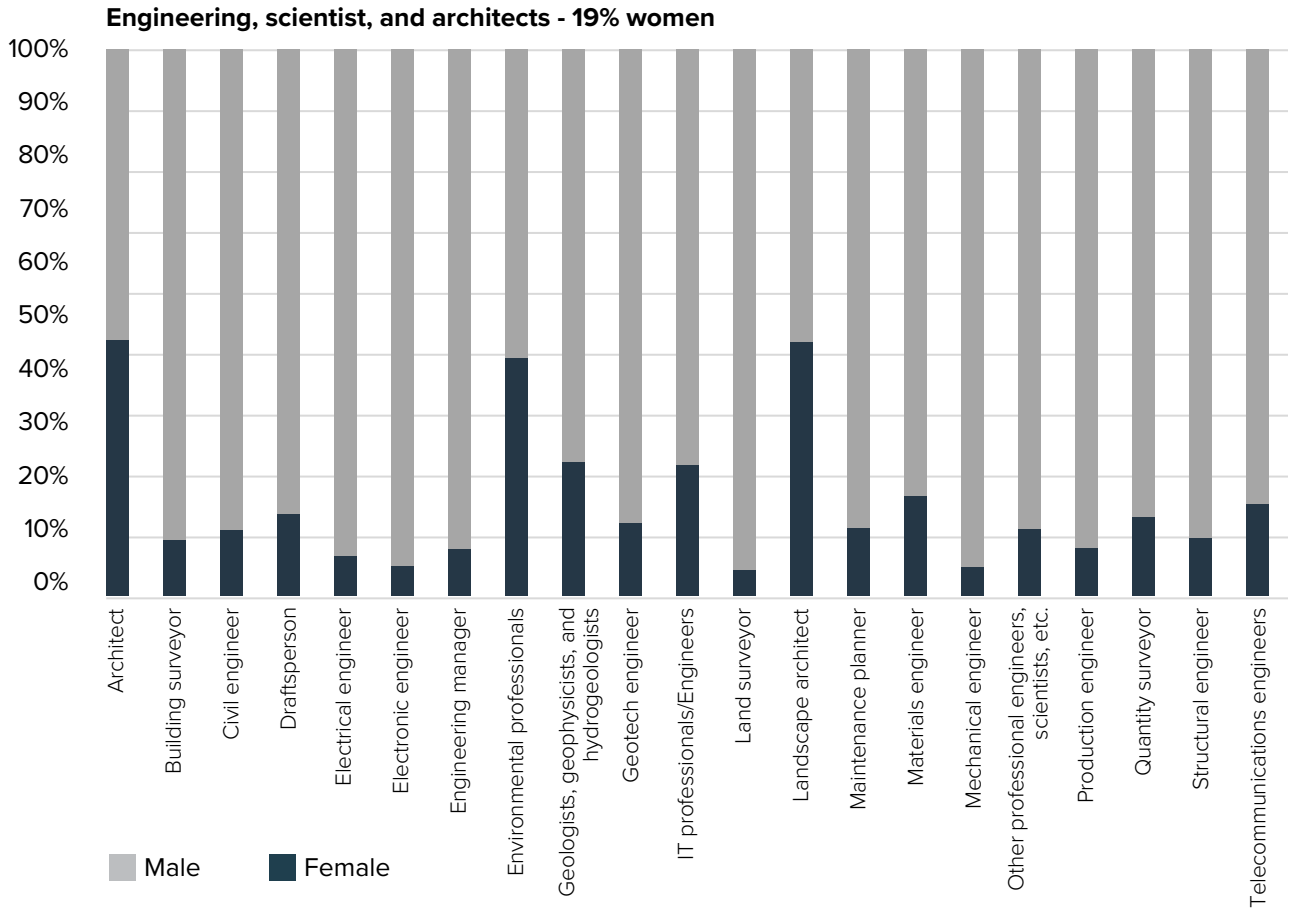
Source: Australian Bureau of Statistics (2021)[39]

Rather than rely on adjacent industries for transferable talent (and leave a bow-wave of vacant roles in incumbent industries) options exist to increase the size of the public infrastructure workforce:

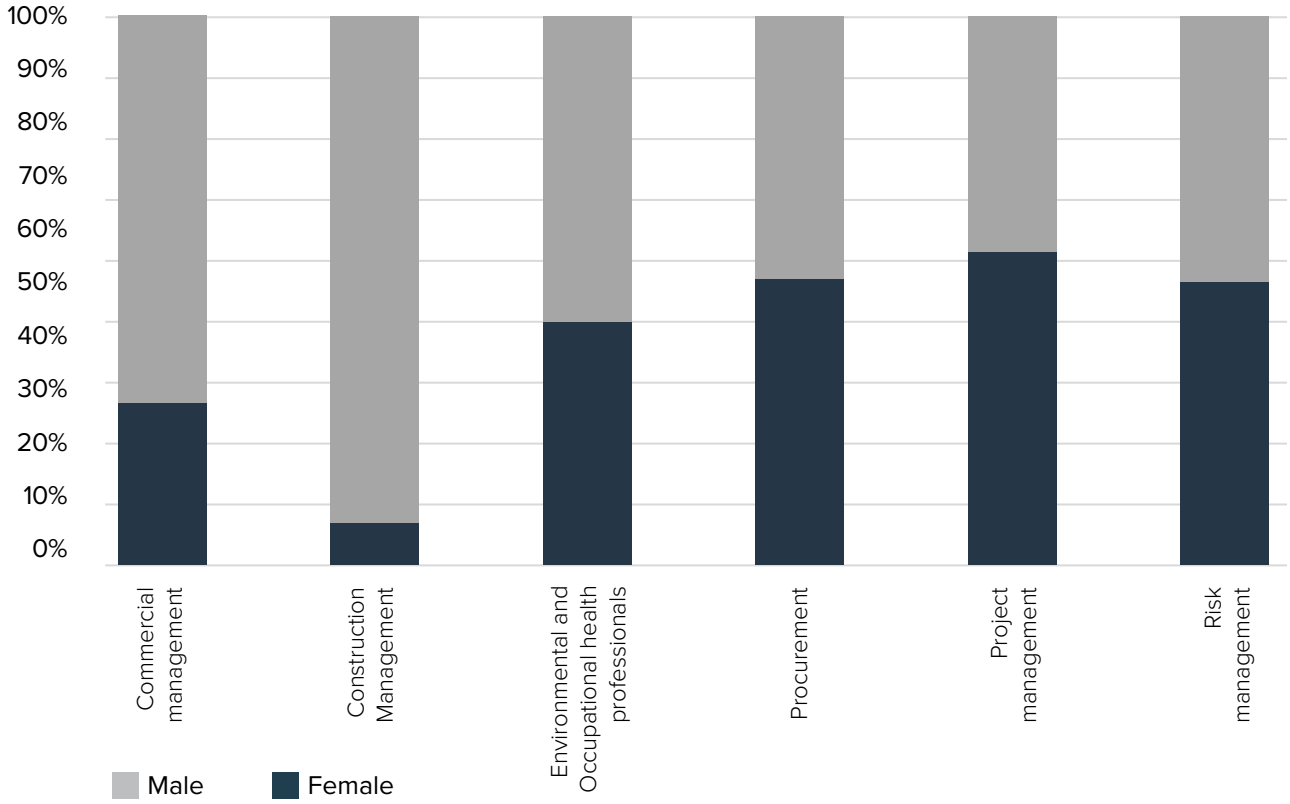
Industry requires measures that target increased participation from under-represented groups, particularly in regional areas. As recommended by the *Delivering Outcomes* report, this means ensuring senior leaders are responsible for establishing equality, diversity and inclusion objectives and for demonstrating continuous improvement against stated targets.[40]

The need for improvement is particularly acute regarding gender diversity. Australia's construction industry remains heavily male dominated, with approximately 12% women in 2020.[41] As detailed in **Figure 35**, breakdown of the distribution of full-time female construction employees across occupations reveals a preference towards project management professionals (36% women), followed by engineering, scientists and architects (19% women) and a distinct under-representation in finishing trades and labour (3% women) and structures and civil trades and labour (2%). Despite a greater shift towards manager and professional positions in recent years, industry is still well behind other non-construction sectors in terms of female representation.[42]

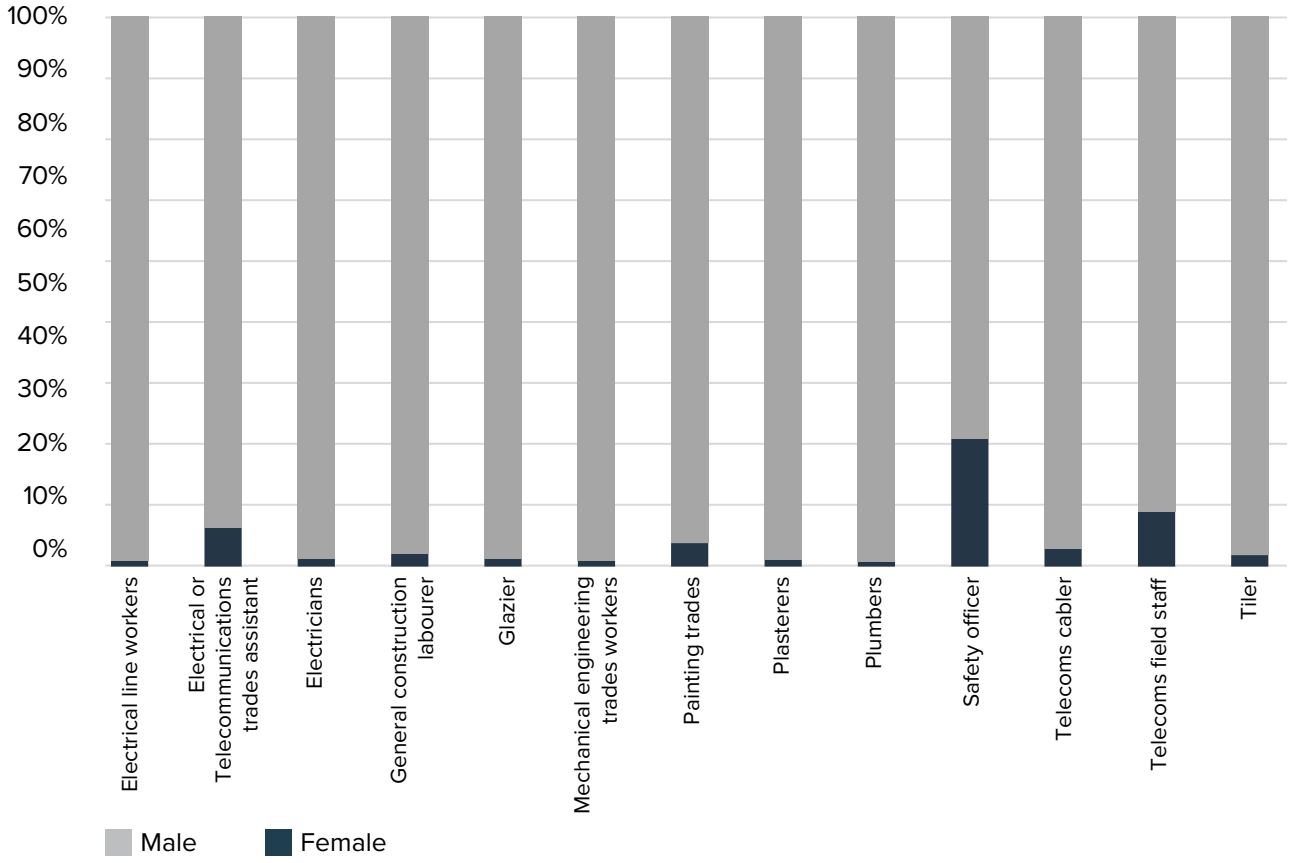
Figure 35: Gender breakdown by occupational group

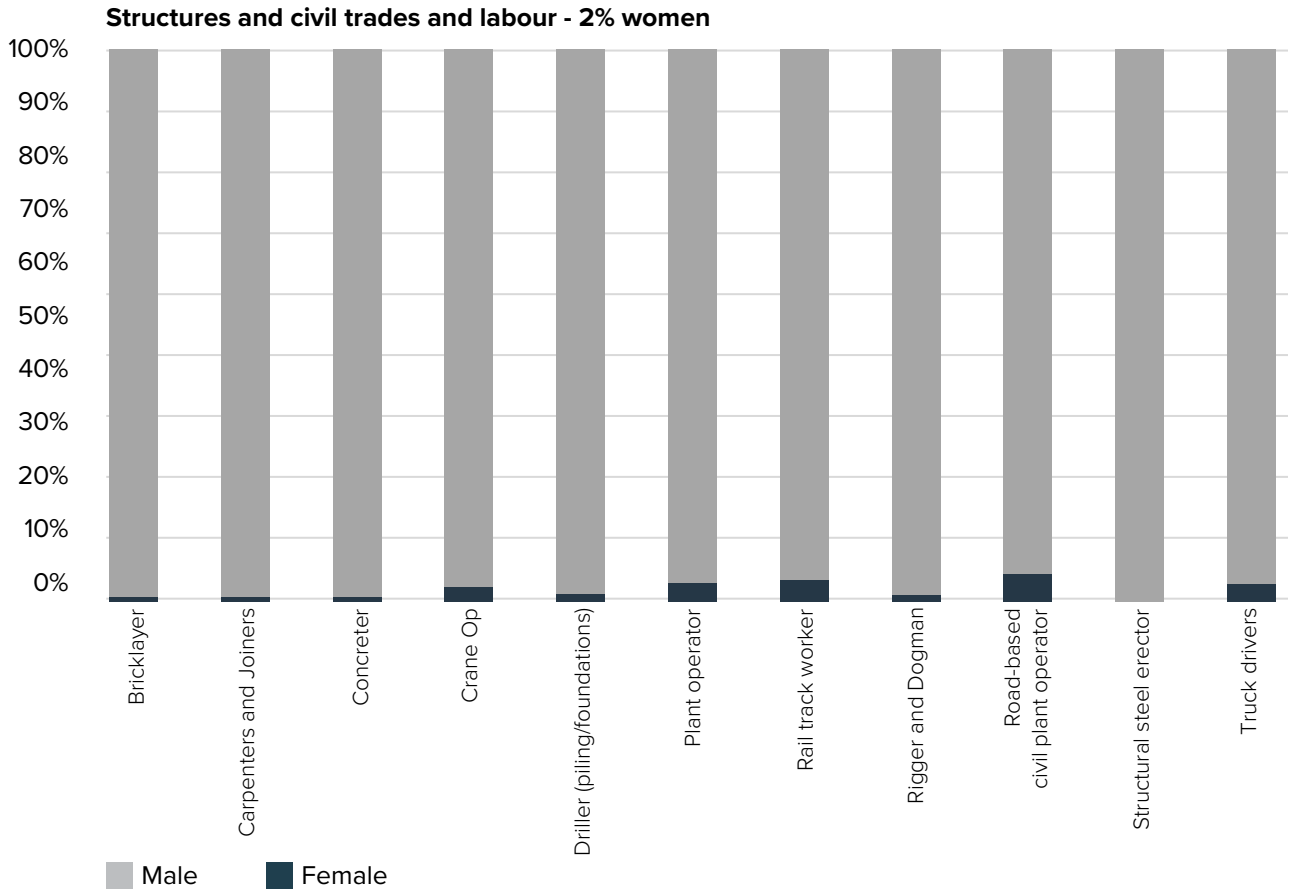


Project management professionals - 36% women



Finishing trades and labour - 3% women





Source: Infrastructure Australia Public Infrastructure Workforce Supply Dashboard (2022)

While lifting female workforce participation in the construction industry has a clear benefit in terms of ameliorating the current workforce shortage, it can also bring other improvements. In 2018, KPMG modelling estimated that halving the gap between men and women's workforce participation could produce an additional $60 billion in GDP by 2038, and households would be better off by an estimated $140 billion.[43] Additionally, evidence shows that employing more women can bring greater diversity of skills and thought, and deliver improvements to workplace culture such as a reduction in bullying, improved attention to detail and improved communication.[44]

Delivering Outcomes has highlighted several factors which contribute to industry's inability to attract, recruit and retain female employees. These include: a general lack of understanding on diversity and inclusion issues, particularly those specific to the infrastructure sector and the case for change, a lack of ownership and accountability for bringing about meaningful change, recruitment practices that are too ambiguous or informal, long working hours and working practices that create barriers to productivity, the lack of women in construction oriented education and training at the tertiary level; and poor perceptions of workplace culture. Other research points to issues such as gendered assumptions about femininity and women's work; the lack of female construction role models; the existence of employer bias and cultural fit; recruitment practices; a failure to build support of gender equality throughout the workforce; gendered violence; failure to provide adequate equipment and other infrastructure to minimise health and safety hazards in the workplace and rigid workplace practices.[45]

Given these insights, more needs to be done earlier in the education process to promote construction-related skills, and broader STEM skills to women. A shift in culture is also necessary to allow for a better work/life balance, more flexible working arrangements and improved health and safety outcomes to maximise potential labour participation.

Recommendation: 3.1.3 *from the 2021 Australian Infrastructure Plan:*

Ensure the industry is a sector of choice for employees and can meet current and future workforce demands by introducing cultural reform that embraces diversity and inclusion.

In tandem, adoption of the *Culture in Construction* standards is vital to securing the long-term sustainability of the sector. Failing to address cultural issues such as excessive work hours, fatigue and poor mental health will keep from attracting untapped workforces. [46]

Various efforts to encourage gender equality and create safe, fair and productive workplaces are already underway, complemented by support from the Australian Government. In 2019, the *Women in STEM Decadal Plan* was published to create a 10-year roadmap for achieving sustained increases in girls and women's STEM participation and retention. Led by the Australian Academy of Science and the Australian Academy of Technology and Engineering, this framework set out the government and sector's respective commitments to improving gender equity in Australia. Together with the Australian Government's *Advancing Women in STEM strategy*, the Decadal Plan sets the foundations for a national, coordinated approach to achieving sustained increases in gender equity in STEM.

Following the Jobs and Skills Summit held in September 2022, the Australian Government has also committed to a number of actions to promote equal opportunities, reduce barriers to employment and promote a better skilled, better trained workforce. These include actions such as:

- establishing, with states and territories a $1 billion one-year National Skills Agreement that will provide additional funding for fee-free TAFE in 2023, while a longer-term agreement that drives sector reform and supports women's workforce participation is negotiated
- accelerating the delivery of 465,000 additional fee-free TAFE places, with 180,000 to be delivered in 2023 and with costs shared with the states and territories on a 50:50 basis
- establishing Jobs and Skills Australia, based on tripartite governance and in consultation with all jurisdictions and stakeholders to address workforce shortages and build long-term capacity in priority sectors
- increasing the permanent Migration Program planning level to 195,000 in 2022-23 to help ease widespread, critical skills shortages
- widening the remit of the National Housing Infrastructure Facility to make up to $575 million available to invest in social and affordable housing
- strengthening existing reporting standards to require employers with 500 or more employees to commit to measurable targets to improve gender equality in their workplaces
- requiring businesses with 100 employees or more to publicly report their gender pay gap to the Workplace Gender Equality Agency.
- Providing additional funding to the ABS to strengthen information on the barriers and incentives to work through Labour Force Survey.
- Establishing a tripartite National Construction Industry Forum to constructively address issues such as mental health, safety, training, apprentices, productivity, culture, diversity and gender equity.
- Strengthening the Respect@Work Council by giving businesses and unions a permanent seat at the table, along with government and civil society to support women's safety and respect at work.

Increasing risks for project planning

With costs on the rise, there is increased chance that project scopes are being revised to help mitigate costs increases. This is likely to be true both for projects in planning as well as delivery and contains broader ramifications for overall project business cases and outcomes sought for the end user and community.

Industry remains concerned about inadequate risk management planning. Due to time pressures, the risk discovery stage of a project is often truncated, leading contractors to blindly assume higher levels of risk. When unforeseen risks on complex infrastructure projects crystallise, contractors then must approach project proponents with variations to absorb the extra cost of unexpected work.

The large number of concurrently-planned state road and main line rail projects for 2023 need urgent attention. There are 39 state road (highway/freeway) projects entering the planning phase in 2023. Based on a study of historic projects for this asset class, projects of this type are likely to carry one common and critical risk pertaining to geotechnical conditions which, if different from those originally planned, are likely to manifest in schedule delays and cost overruns during construction.[47]

Compounding the risk relating to state road projects, New South Wales, Victoria, South Australia and Queensland have, in combination, scheduled 18 main line rail works for concurrent planning in 2023. Again, based on a study of historic projects for this asset

class, projects of this type are likely to carry seven high-level risks, one of which is likely to occur with major impact. This project risk encompasses the impacts of poor management of the complex interfaces that exist between work packages and/or other projects with concurrent time frames. Impacts include: work progressing at various paces, and/or; doubling-up of work across projects, and/or; misalignment between work package and project commissioning milestones, and/or; community dissatisfaction, and/or; schedule delays.[48]

Recommendation: 3.2a *from the 2021 Australian Infrastructure Plan:*

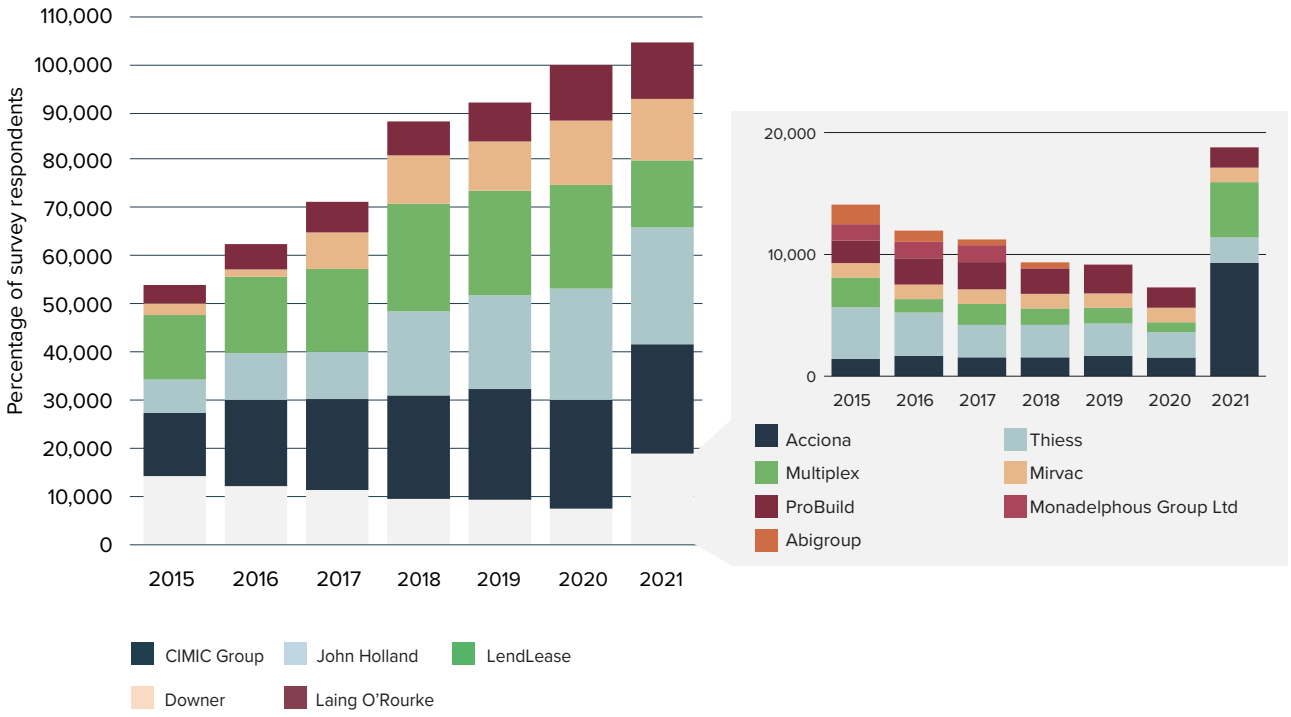
Improve value for money and reduce risk by consistently adopting appropriate best-practice front-end due diligence for projects.

Industry consolidation threatens capacity and competition

As of June 2021, the construction industry comprised 410,000 businesses, the majority being small- and medium-sized specialist firms with 20 employees or less. The high volume of small, competitive firms means that, for smaller capital works there is enough competition, labour and capital to meet the needs of the buyer.

In contrast, very large, complex infrastructure projects often require a range of competencies, highly-specialised skills, access to global supply chains for materials and equipment, and large balance sheets to absorb potential and/or crystallised risks. Given this, very large infrastructure projects tend to be undertaken by a handful of very large 'Tier 1' businesses. **Figure 36** reveals that in 2021, 82% of public and/or privately funded public infrastructure projects were awarded to just five Tier 1 companies. Here the risk for infrastructure procurers is whether there are enough Tier 1 businesses to bid for and deliver projects competitively, to ensure value for money for infrastructure procurers, users and communities.

Figure 36: The Tier 1 market is highly concentrated by five companies



Source: Infrastructure Australia (2022)[49]

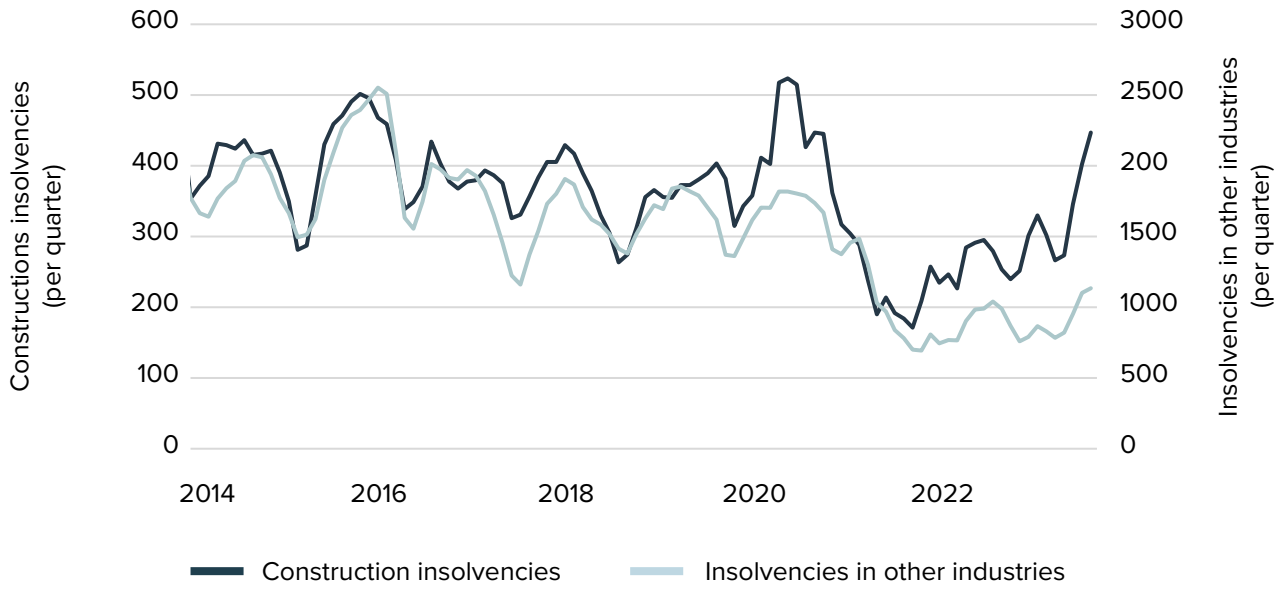
At the same time, the average value of a contract undertaken by Tier 1 firms has grown almost 50% to $600 million since 2015, an increase that is in step with the increasing complexity of infrastructure projects.

Australia finds itself facing a situation where our largest and most important projects are increasingly being allocated to large, offshore companies. If one of these large foreign-owned contracting companies were to exit the Australian market, the damage would be twofold: further concentration of the market, and loss of capability in terms of project delivery expertise and fiscal capacity.

Increasing insolvency rates in construction

Looking at **Figure 37**, Australian Securities & Investments Commission (ASIC) data shows that while most industries enjoyed low insolvency rates throughout 2019, the number of construction firms entering administration rose significantly. While JobKeeper payments helped support vulnerable businesses through 2020, administrations and insolvencies are rising again.[50]

Figure 37: Construction sector insolvencies are increasing faster compared to other sectors



Source: ASIC (2022)[51]

Several very large firms have moved into liquidation in 2022, including Probuild and Condev, while residential builders such as Next and Home Innovation Builders have also entered administration.

Whether these collapses result in broader, more systemic capacity challenges in the industry is yet to be seen. In most cases, the contractual obligations of collapsed businesses are taken over by other firms and projects are completed, albeit often later than expected and at a higher overall cost. However, more prominent project cancellations and business collapses can sometimes have a more widespread impact on industry capacity, particularly where the inability to pay creditors and subcontractors sets off a cycle of further business failures.

In some instances, the closure of key segments of the supply chain – such as the exit of Rocla from the concrete pipes market in 2019 – can have longer-lasting impacts on industry capacity because it takes time for new businesses to invest in new capital to bring capacity back to 'pre-failure' levels. Meanwhile, persistently low levels of project profitability, as claimed by some Tier 1 contractors, may lead some firms to exit the market or not participate in tenders for riskier projects. [52]

The opportunity to use replacement materials in road construction

Project data from Infrastructure Australia's Market Capacity Intelligence System indicates that the demand for materials for use in road construction projects is expected to grow to a peak of $7.6 billion in 2023–24. Consistent with the earlier recommendation to proactively manage demand by prioritising procurement and portfolio management, a localised analysis of demand (and resultant supply needs) for road materials will assist with managing the expected uplift in demand in coming years.

In the longer term, it is critically important to understand the opportunities for expansion of market supply. Based on current technology and standards, around 27% of conventional materials (i.e., materials that do not originate from or contain recycled constituents) used for road projects could be replaced with a range of recycled materials.[53] This would mean substituting approximately 54 million tonnes of conventional materials used in road infrastructure with approximately 52 million tonnes of recycled materials.[54]

For more information regarding the constraints and opportunities for using replacement materials in road infrastructure construction and maintenance, see *Section 4: Understanding non-labour supply*.

Recommendation: 9.1.3 from the *2021 Australian Infrastructure Plan*:

Build support for the circular economy and embed circular practices by developing a circular economy roadmap for the infrastructure sector, including annual progress reports.

Opportunities and actions to increase uptake of recycled materials in road infrastructure, from *Replacement Materials*:

Improving awareness, understanding and confidence to use recycled materials

All levels of government with support from industry groups to:

- educate businesses on the range of recycled materials through educational collateral, case studies and a database of products and their applications
- provide suppliers with communications, materials and knowledge that promote the environmental credentials and lifecycle cost benefits of recycled materials compared with products made from virgin materials
- develop, update and harmonise fit-for-purpose performance-based specifications and standards, and provide guidance on the application across jurisdictions
- support practical, application-focused research to translate the latest knowledge to local settings and conditions, and showcase trials and demonstrations to recognise and reward innovation.

Addressing regulatory issues

Environmental regulators with recycling industry representatives to:

- shift the negative perception of waste as a hazard and find opportunities to optimise environmental and commercial outcomes
- reform the environmental regulations of recovered and recycled materials, including removing or amending regulatory requirements that inhibit efficient business operations, create market uncertainty, and lead to adverse outcomes, such as valuable recovered materials being sent to landfills.

The recycling industry to work with all levels of government to:

- develop product certification rules and processes to manage the quality and consistency of recycled materials for use in road applications.

Improving and modernising recycling infrastructure and workforce capacity, and expanding geographic reach

All levels of government with support from industry groups and individual businesses to:

- increase the geographic reach of replacement products by using existing material processing infrastructure to accept waste streams and produce replacement products
- increase the attractiveness of the resource recovery and recycling industry to the workforce by modernising facilities and implementing incentives for school leavers or young people to enter the industry.

The productivity opportunity

As did last year's *Infrastructure Market Capacity* report, this report indicates that the sheer scale of growth in demand for skills and resources to support infrastructure delivery is likely to exceed normal capacity increases in the market. Given the difficulties in quickly increasing construction labour and capital inputs to meet demand, productivity improvements offer a critical opportunity to minimising capacity and capability risks, improving outcomes, enhancing industry sustainability, and lowering infrastructure costs.



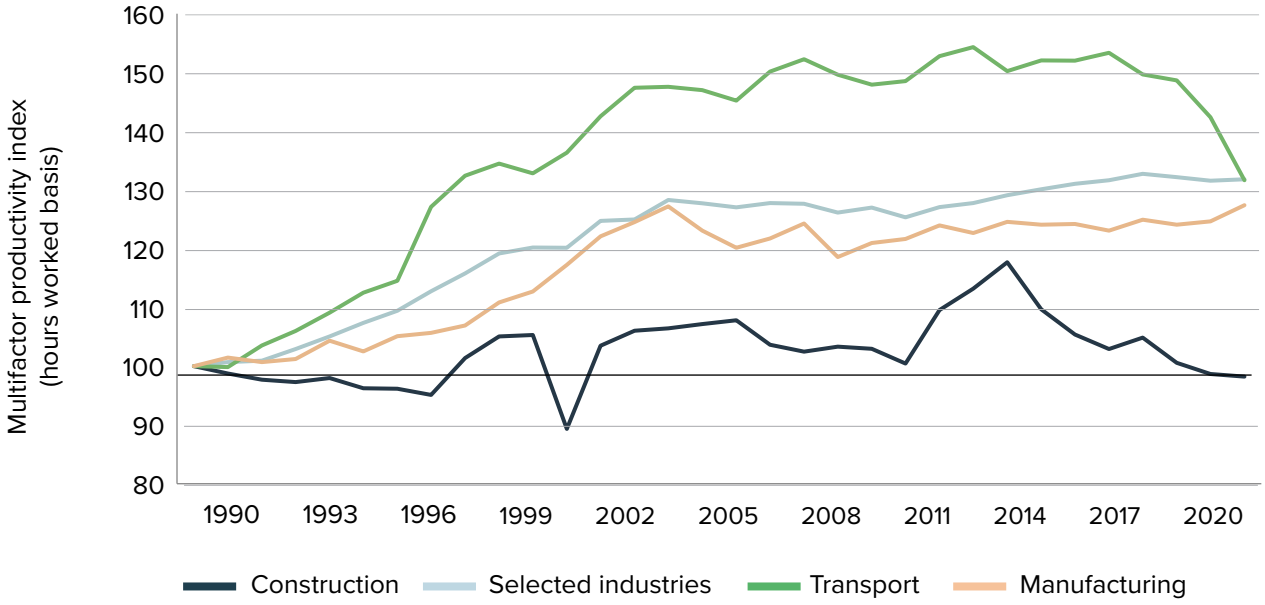
Compared to other related industries, the construction industry has a chequered history in achieving sustainable, strong productivity growth over time. Since 1990, multifactor productivity in the industry has fallen an average of 0.1% per annum, while transport, manufacturing, and other selected industries have experienced average productivity growth of 0.8-0.9% per annum over this period (**Figure 38**). Relatively slower growth in productivity, compared to the rest of the economy means that more labour and capital is needed to meet increased construction demand. In times of scarcity, this can put resources under more pressure and heightens capacity and capability risks as well as construction costs.

The industry's flagging productivity, its drivers and the opportunities this presents are well documented. The *2019 Australian Infrastructure Audit* observed that low levels of productivity have been linked to levels of capital investment, such as plant and machinery and likely exacerbated by high rates of workforce turnover, low workforce morale, low levels of investment in training and education and other cultural factors. Construction is also currently one of the least digitised industries in Australia.[55] Despite the adoption of labour-saving technologies, investment in technology and innovation has been comparatively low.[56] Moreover, efforts to drive systematic improvements are hampered by a lack of knowledge sharing and best practice. For example, as identified in *Delivering Outcomes*, post-completion reviews are not consistently undertaken and rarely shared publicly, limiting industry's capacity for continuous learning and improvement.[57]

Australia's construction industry is not alone in experiencing relatively weak productivity growth, with evidence pointing to similarly poor productivity performance in the construction industry globally. McKinsey Global Institute estimates the average annual growth in construction sector labour productivity averaged 1% over the past two decades, compared to broader economic growth of 2.8% for the total global economy.[58]

Regardless, there are sharp opportunity costs associated with sustained poor productivity performance. It has been estimated that a 1% increase in construction sector efficiency would result in an approximately $500 million saving to taxpayers, however this is dependent on industry activity at the time.[59]

Figure 38: Multifactor productivity indexes by industry, 1990—2021



Note: Selected industries includes the following: Agriculture; Forestry and Fishing; Mining; Manufacturing; Electricity; Gas; Water and Waste Services; Construction; Wholesale Trade; Retail Trade; Accommodation and Food Services; Transport, Postal and Warehousing; Information, Media and Telecommunications; Financial and Insurance Services; Arts and Recreation Services.

Source: Australian Bureau of Statistics (2021)[60]

Whilst getting productivity back on track will take time, research by Infrastructure Australia has identified a suite of opportunities for achieving productivity improvements through cultural, planning and process reforms.

The *2021 Australia Infrastructure Plan* and the *2022 Delivering Outcomes* report, in advancing a vision for a highly productive, effective and efficient industry, each present a suite of reforms to minimise capacity and capability risks, improve project outcomes, enhance industry sustainability, and lower infrastructure costs. In particular, *Delivering Outcomes* provides a roadmap for industry reform focused on changing the way that projects are procured and delivered, with consequences for how an asset is managed, operated, and maintained across its lifecycle.

- Outcomes for people and places – infrastructure investment is driven by delivering economic, social and environmental outcomes to enable people and places to flourish and prosper.
- Systems – managing and planning infrastructure as a system drives more informed decision making leading to higher quality, faster and cheaper infrastructure solutions that better align to the needs of people and places.
- Digital – digital transformation will drive productivity and innovation in infrastructure delivery.
- Collaboration – integration across the ecosystem will drive a financially sustainable and high performing infrastructure industry.
- Commercial – financial alignment and optimisation drives industry sustainability and enables innovation.
- Innovation – innovative, digitally-enabled techniques enable increased productivity.
- People – wellbeing and resilience is the foundation for a flourishing sector.

Recommendation:

Implement the 7 focus areas of reform outlined in Delivering Outcomes: A roadmap to improve infrastructure industry productivity and innovation

For a detailed review of industry interview and survey insights, please read *Section 3: Industry confidence.*

7. Next steps

- This *Infrastructure Market Capacity* report investigates the infrastructure industry's capacity to deliver the five-year major public infrastructure pipeline.
- The recommendations included in *Section 6: Implications and recommendations* are reiterations of those presented in Infrastructure Australia's *2021 Australian Infrastructure Plan* - an actionable roadmap for reform through to 2036 – and *Delivering Outcomes: A roadmap for improving infrastructure productivity and innovation.*
- Following publication of this report, Infrastructure Australia will continue pursuing the successful delivery of Australia's infrastructure ambition by:
  - working closely with jurisdictions to maintain data-sharing agreements and ensure that insights gleaned are actionable
  - continuing to expand the scope and depth of this analysis in order to help governments plan and execute infrastructure priorities. Key opportunities include:
    - quantifying and comparing the availability of key infrastructure materials against demand
    - quantifying embodied carbon emissions of projects listed in the forward-looking infrastructure pipeline.
  - providing knowledge and insights to governments that supports the leadership and policy transformation required to improve industry productivity
  - championing for collaboration between cross-governmental departments on macro-level pipeline sequencing as a critical enabler of achieving the nation's infrastructure goals.

Summary of key methodologies

This section summarises the main methodologies used to gather, analyse and prepare the information for this report. The 2021 *Infrastructure Market Capacity* Report - Supporting Appendices[61] contains full methodologies for all information presented in this report, including and supplemented by those summarised below.

Summary of key methodologies

Demand-side analysis

Analysis concerning the demand of major public infrastructure is based on the aggregation of project-level data to create a combined view of Australia-wide infrastructure, with data current as at March 2022. This combined view comprised identifiable publicly funded infrastructure projects which met certain criteria for inclusion. Projects were considered major if the investment value was above a threshold capital cost (over $50 million for South Australia, Tasmania, the Northern Territory and the Australian Capital Territory, and over $100 million for all other Australian states). The periods covered were between 2015–16 and 2025–26 – that is, projects were included on the basis that there was (or would be) a non-zero amount of construction activity across those ten years. The investment value is a measure of total estimated capital investment for the duration of the project, in nominal terms at time of estimation. Estimates vary over time.

The majority of data on public infrastructure is sourced from states and territories infrastructure agencies (as opposed to private industry sources). This also extends to a partnership with the Australian Department of Infrastructure, Transport, Regional Development and Communications (DITRDC) – the Department have provided budgeted transport infrastructure project expenditure from 2017–18 onwards. The exception to this is the energy and fuels sector, wherein activity has been estimated by projected upgrades to generation capacity as specified by the Australian Energy Market Operator (AEMO) in their Integrated System's Plan (ISP). With regard to transmission activity, the 2021 dataset on transmission line projects collated by the University of Technology Sydney has been retained in this report.

Furthermore, the collation of project-level data has expanded during the development of this report. Identifiable projects that are privately funded across all value ranges have been added to the project database. While these projects are not reported in the five-year pipeline of major public infrastructure projects, the entire project database is examined in *Section 2: Understanding demand*.

For each project, the database includes information, where available, on the following fields:

- location (including jurisdiction)
- investment cost (or megawatts for energy projects)
- project stage (preconstruction stages, under construction or completed)
- project schedule
- funding source (public, private, mixed)
- project type (project classification).

Supply-side analysis: non-labour

There is no single source of quantitative 'truth' for the supply capacity of critical non-labour infrastructure inputs. This includes concrete and quarry products, other construction materials or construction plant and equipment. Because quantifying supply is challenging, Infrastructure Australia has combined published production and trade data with industry surveys and interviews obtained as follows:

Detailed surveys of builders and civil contractors

2022 Tier 1 industry survey. Conducted over March and April, 2022, this survey consisted of 30 minute telephone interviews with individual Tier 1 industry participants. These were builders and civil contractors with the ability to deliver larger infrastructure projects – including 'megaprojects' valued over $1 billion – with a greater likelihood of operating across multiple state jurisdictions.

2022 Civil Contractors Federation Tier 3 survey. The National Branch of the Civil Contractors Federation, at the behest of Infrastructure Australia, coordinated a survey of its own member base. The Civil Contractors Federation is the peak body for Australia's civil construction industry, representing approximately 2,000 contractors and associates nationally. The Civil Contractors Federation is formed of smaller and medium sized contractor businesses predominantly, located throughout metropolitan and regional Australia. 80% of Civil Contractors Federation Tier 3 survey respondents reported that their maximum contract size was under $20 million and over half reported a maximum contract size of under $5 million. This survey was conducted online in May, 2022.

2022 Tier 3 industry survey. Conducted online over June and July 2022, Infrastructure Australia surveyed 190 decision-makers in Tier 3 construction companies. These were defined as companies offering civil and construction services on contracts up to $100 million in value. A range of company sizes was engaged, including carpentry, licensed building, engineering, electrical and plumbing being the main services represented.

Deeper industry interviews with the wider supply chain

These industry soundings, conducted over April and May 2022, allowed more time and discussions for deeper probing of challenges with major infrastructure industry suppliers. These soundings helped pinpoint where capacity challenges were already apparent or at risk, their potential causes as well as possible solutions that would help mitigate capacity risk. For this report, these interviews were held with:

- suppliers of quarry materials, concrete and related products
- steel producers and fabricators
- distributors of plant and construction equipment.

Workforce and skills

The fundamental question addressed by this report is to what extent the current and projected supply of labour can support Australia's proposed investment in public infrastructure. To understand this, it was necessary to clearly define the occupations and skills that underpin this workforce and to estimate the numbers of workers available at different points in time, including projections for the future. The broad approach was:

- To estimate numbers of workers in or near the infrastructure workforce as determined by official statistics and our own forecasts or modelling based on those statistics
- To confront these estimates with additional data (such as job advertisements) that provides extra information on variables (such as skills) not covered by the official statistics, and extra granularity (such as estimates down to the level of 'roles', below existing ANZSCO unit groups) on variables which required further detail than official statistics provided.

The analytical work has two elements: developing classifications and making estimates. The two elements overlap, as we used data-based estimates to define our classifications, but it is useful to understand the steps separately.

Two key classifications were developed for this work and are used throughout the report. These classifications build on the standard classifications used for occupation and industry: the Australian and New Zealand Standard Classification of Occupations (ANZSCO) and the Australia and New Zealand Standard Industrial Classification (ANZSIC). Using data to categorise, combine (and in some cases add) our final occupational classifications added additional granularity to the standard measures. The two classifications are:

- Which occupations and roles are relevant to public infrastructure?
- Which parts of the workforce in relevant occupations are engaged in, adjacent to, trainable for or distant from public infrastructure?

These classifications were developed to capture the full range of occupations that contribute to public infrastructure in a single streamlined taxonomy. They also support a more nuanced view of the labour force that recognises the portability of skills across and between sectors. Finally, the addition of roles provides a level of granularity which is not present in ANZSCO but which is critical to understanding skill needs.

There were six key pieces of data analysis that built on those classifications, seeking to estimate:

- historical and current labour supply
- anticipated workforce attrition
- future labour supply
- workforce shortages
- skill profiles
- demographics.

The methods used for these two classifications and six pieces of analysis are outlined in more detail in the 2021 *Infrastructure Market Capacity* report - Supporting Appendices.[62]

The most important data sources across the project were the 2016 Census and the ongoing Labour Force Survey, to quantify where supply matched demand until 2036; and job advertisement data from Burning Glass as an indicator of demand. Each of these data sources has its own strengths and weaknesses, which limits the conclusions that can be drawn:

- The Census is comprehensive but infrequent; it is self-completed and depends on respondents identifying their own occupation and industry.
- The Labour Force Survey is carefully calibrated to definitive population totals and has higher quality consistent use of classifications, but it is based on a sample.
- The job advertisements are also a sample, but of a varying and unknown proportion of the full quantum of demand – varying not just over time but also by occupation and industry.
- The classification of job advertisements to industry and occupation is done by a statistical / machine learning algorithm based on analysis of the original text, introducing its own statistical noise.

Key limitations of the analysis can be understood in several categories:

- Measurement noise – such as Census respondents misclassifying their industry or occupation in a way different to any misclassification that takes place in the Labour Force Survey.
- Processing noise – such as the Burning Glass Technologies machine learning algorithm misclassifying the occupation of a job advertisement.
- Analytical assumptions – such as assuming that the proportions of detailed job titles within an ANZSCO unit group in the workforce reflect the proportion of those titles appearing in job adverts for that ANZSCO unit group; or that the proportion of people in each industry working in each occupation at the time of the Census (the best source at that level of granularity) has not changed materially since.

Every effort has been made to control for these problems, but significant uncertainty and limitations are inevitable.

Infrastructure Australia analysis of contract values

Contract value is calculated based on project investment and contract type, sourced from GlobalData's Construction Intelligence Center.

The following assumptions were adopted in contract value calculation:

1. Main contractors take up 82.5% of total project value unless if no other contractors are identified, in which case the full project investment is assigned to the main contractor.
2. Companies identified as being of the same contract type (either main or otherwise) are assigned equal shares of the contract value.
3. Companies identified on a project are assumed to be active throughout the project's lifecycle.
4. In an event of acquisition, remaining active contracts from the acquired company are moved under the acquiring company.

The subset of projects analysed is limited to projects matched with or sourced from GlobalData's Construction Intelligence Center.

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Revision	page
Key finding for cost of labour inputs brought forward from page 14 to better contextualise its derivation	12

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