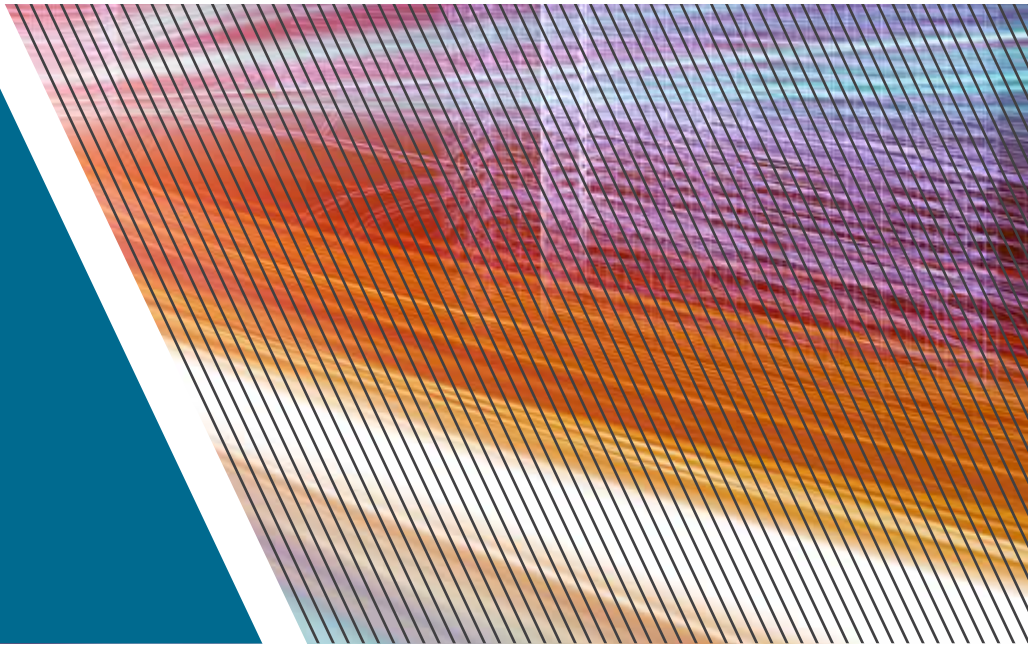


Victorian Digital Asset Strategy

Guidance

OFFICE OF PROJECTS VICTORIA

VICTORIA State Government

Office of Projects Victoria (OPV) recognises the departments and agencies of the Victorian Government that participated in the consultation for this work, the MelBIM Community, as well as AECOM as an alliance partner.

OPV also wishes to acknowledge the many individuals, companies, and organisations across the architecture, engineering, construction and operations (AECO) industry and supply chain.

There is a detailed list of acknowledgements at the end of this document.

Version	**Summary of changes**
1.00	Release
Owner:	Office of Projects Victoria
Authoriser:	Victorian Chief Engineer

Part A contents

Message from the Treasurer

‘The VDAS seeks to maximise every dollar of Victorian investment.’

The Victorian Government is embracing innovative processes and frameworks to plan, create and operate our State’s assets – and the *Victorian Digital Asset Strategy* (VDAS) is key to achieving this goal.

The VDAS is a consistent, integrated and repeatable approach to creating and managing Victorian assets and maximising the many benefits of our investments.

The VDAS embraces key technologies such as building information modelling and geographic information systems to enable better outcomes for all Victorians.

The move to adopt the VDAS is strongly supported by all stakeholders, including government, industry, academia, project teams and operators.

The VDAS is a key enabler for the future, setting the foundation for the use of smart construction platforms and integrated, real-time data collection and analysis, to help build digital twins and truly smart cities.

The VDAS will allow Victoria’s assets to be more cost effective, and it will enable us to deliver them safely and to make use of leading innovations that will add value to our State for decades to come.

I’m excited about what the VDAS means for Victoria today and into the future.

Tim Pallas MP
Treasurer of Victoria

Message from the Victorian Chief Engineer

‘Victoria is an engineering powerhouse.’

The Government of Victoria has set out a clear vision to transform the way we deliver, analyse, share and use data and information about our State’s infrastructure and built environment.

The vision harnesses the power of digital technology, data capture and analytics, for the public good.

The VDAS sets a strong agenda for how we can achieve this. It includes creating world-class assets with a whole of life philosophy and innovative approaches such as digital engineering.

The VDAS is guided by, and aligns objectives, policies, directions and priorities on state, Commonwealth and international levels.

These include the state Asset Management Accountability Framework, ‘Virtual Victoria’, and the Value Creation and Capture Framework, the Commonwealth Australian National Digital Engineering Policy Principles and the international Gemini Principles and United Nations Sustainable Development Goals.

The *VDAS Guidance* should be applied to all projects and assets to create a smarter built environment.

Dr Collette Burke
Victorian Chief Engineer

Executive summary

The *Victorian Digital Asset Strategy* (VDAS) is a step change in the way Victorian Government departments and agencies plan, deliver, operate and maintain the assets they manage on behalf of the people of Victoria.

In particular, it recognises that preserving the valuable data generated at each stage of an asset's lifecycle is critical, and that this data can and should be used for the public good. Preserving this data will enable future cities with improved data value and information management

Decisions for public good demand quality information. Quality information needs fit-for-purpose data. Any break in this chain erodes quality decision making.

The same applies to how Victoria creates, maintains and operates its infrastructure, such as transport, hospitals, education, parks and justice facilities.

Being able to know the location, condition and performance of our infrastructure assets, digitally and in real-time, allows us to use those assets more productively.

Importantly, it will enable us to create a 'Virtual Victoria' – a digital twin that supports integrated planning and the development of smart cities.

The VDAS builds on and supports Victoria's Asset Management Accountability Framework (AMAF), which was released in 2016 to help decision makers and operators to better plan and maintain these crucial systems.

Data-enabled infrastructure will generate significant value towards Victoria's future.

The VDAS sets out the vital process for safeguarding the digital systems that will allow us to monitor and improve the creation and management of infrastructure assets in Victoria.

The VDAS supports the government's objective to provide world-class public infrastructure, and it aligns with Victorian Government Acts, policies and initiatives, including the Department of Treasury and Finance's (DTF) Investment Lifecycle, Value Creation and Capture (VCC) Framework and the *Public Administration Act*.

It provides the framework for Victorian Government stakeholders to apply innovative approaches such as digital engineering to improve outcomes across the State.

Digital engineering aims to create an efficient flow of information across the lifecycle of an asset. It enables the Government to get more out of existing infrastructure by managing data in a systematic way, which leads to improved decision making and better productivity.

This work is supported by a common data environment (CDE) aligning digital information systems including drafting, geospatial information systems (GIS), building information modelling (BIM), electronic document management systems (EDMS), project controls (time, cost, risks, etc.), asset data and other related systems.

The VDAS will enhance Victoria's infrastructure outcomes through innovative approaches.

This *VDAS Guidance* document is the next step in adopting a consistent and modern approach to digital engineering and BIM. It is aimed at Victorian Government departments and agencies, and sets out the 'who', 'why, 'how' and 'when' of digital engineering and BIM adoption in major capital and renewal projects.

The *VDAS Guidance* is structured and designed to assist stakeholders and decision makers within their organisation.

The *VDAS Guidance* also includes templates, checklists and tools to assist you throughout the journey.

While the *VDAS Guidance* is not mandated, it has been developed through extensive stakeholder engagement, and it is aligned with relevant international, national and state best practice, standards and lessons learned. It also accounts for and aligns with applicable Victorian law, regulations, policies and frameworks.

The *VDAS Guidance* works as a system. It is highly recommended that executives, practitioners and managers do not pick and choose the parts of the guidance to adopt, but rather view it as a complete package where all parts work together to achieve maximum value.

To align with contemporary best practice in policy, technology and standards, the *VDAS Guidance* will be regularly updated through revisions and release of additional resources. Refer to www.opv.vic.gov.au for more information.

VDAS aims to enhance digital assets to inform their physical counterpart for the benefit of current and future Victorians.

Future cities

Future cities combine physical and digital systems in the built environment. An integrated and smart built environment means a sustainable, prosperous, and inclusive future for Victorians.

Future cities rely on 'enablers' such as digital twins, integrated planning, data being valued, automated worksites and virtual reality technologies.

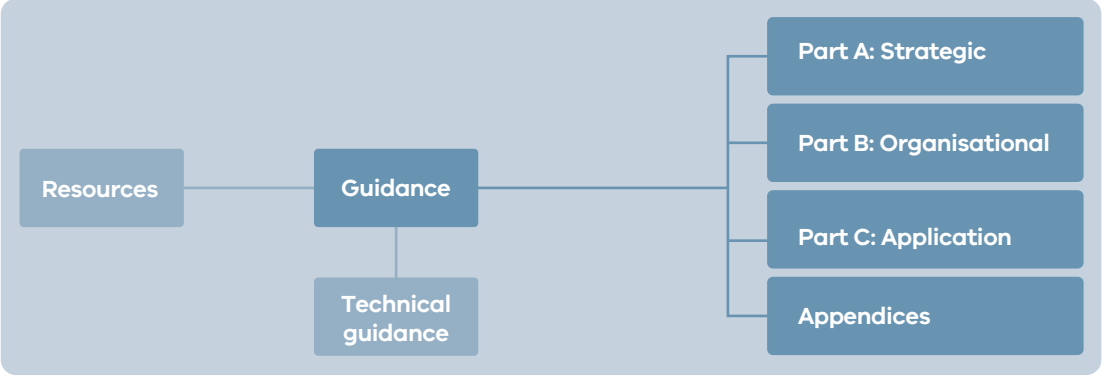
These enablers don't just 'happen' - they need an integrated and supported approach, such as VDAS, to get there.

The *VDAS Guidance* document is a key enabler for Victoria as a future city.

Future city enablers

Artificial intelligence	Driverless cars	Circular economy	Smart agriculture	Increased automation	Virtual reality
Integrated planning	Valued data	Automated worksite	Digital twins	Internet of things	

Victorian Digital Asset Strategy initiative



Purpose of this document

This *VDAS Guidance* document is for government stakeholders who plan, create and operate Victoria's assets. It provides detailed guidance on planning, implementing, managing and maintaining an effective digital asset strategy throughout the lifecycle of your organisation's asset base.

The *VDAS Guidance* outlines who is responsible for implementing and managing the VDAS within an organisation.

Across the project lifecycle, this includes:

- roles and responsibilities;
- governance of information;
- organisational requirements;
- procurement; and
- the people, processes and technology.

The audience for this document is:

- executive management;
- asset owners: Victorian Government departments, Victorian Government agencies, or those representing their best interests;
- client-side asset management professionals, including those responsible for asset-level decisions;
- client-side project delivery professionals, such as engineers, constructors, and commissioners; and
- client-side technology, finance and customer-focused departments.

The VDAS approach supports complex interfaces on major projects.

How to use this document

Part A: Strategic **Page A.1**

This section provides insights and direction for heads of departments, executives and others who plan, deliver, operate and maintain assets.

It articulates how the VDAS integrates, assists and improves on various policies, Acts and strategies that Victorian Government executives are required to follow.

Part A also highlights how the VDAS aligns with, and responds to, national and international principles and strategies, alongside other digital engineering frameworks.

Part B: Organisational **Page B.1**

This section provides organisational-level guidance and advice for asset owners, operators, project managers and mid-level management involved in the management, and direction of major assets and projects.

It captures key information about change management, the governance of information management, systems integration, organisational requirements and common data environments.

Part B also positions the organisation to manage digital information and data effectively throughout the life of an asset and explains how this integrates with structuring projects and managing capital investment.

Part C: Application **Page C.1**

This section provides detailed project-level advice articulated through the front-end, implementation and handover phases of the asset lifecycle. Part C is structured in seven phases:

- Phase 1 – Brief
- Phase 2 – Concept
- Phase 3 – Definition
- Phase 4 – Design
- Phase 5 – Build and commissioning
- Phase 6 – Handover and closeout
- Phase 7 – Operate and maintain

Appendices

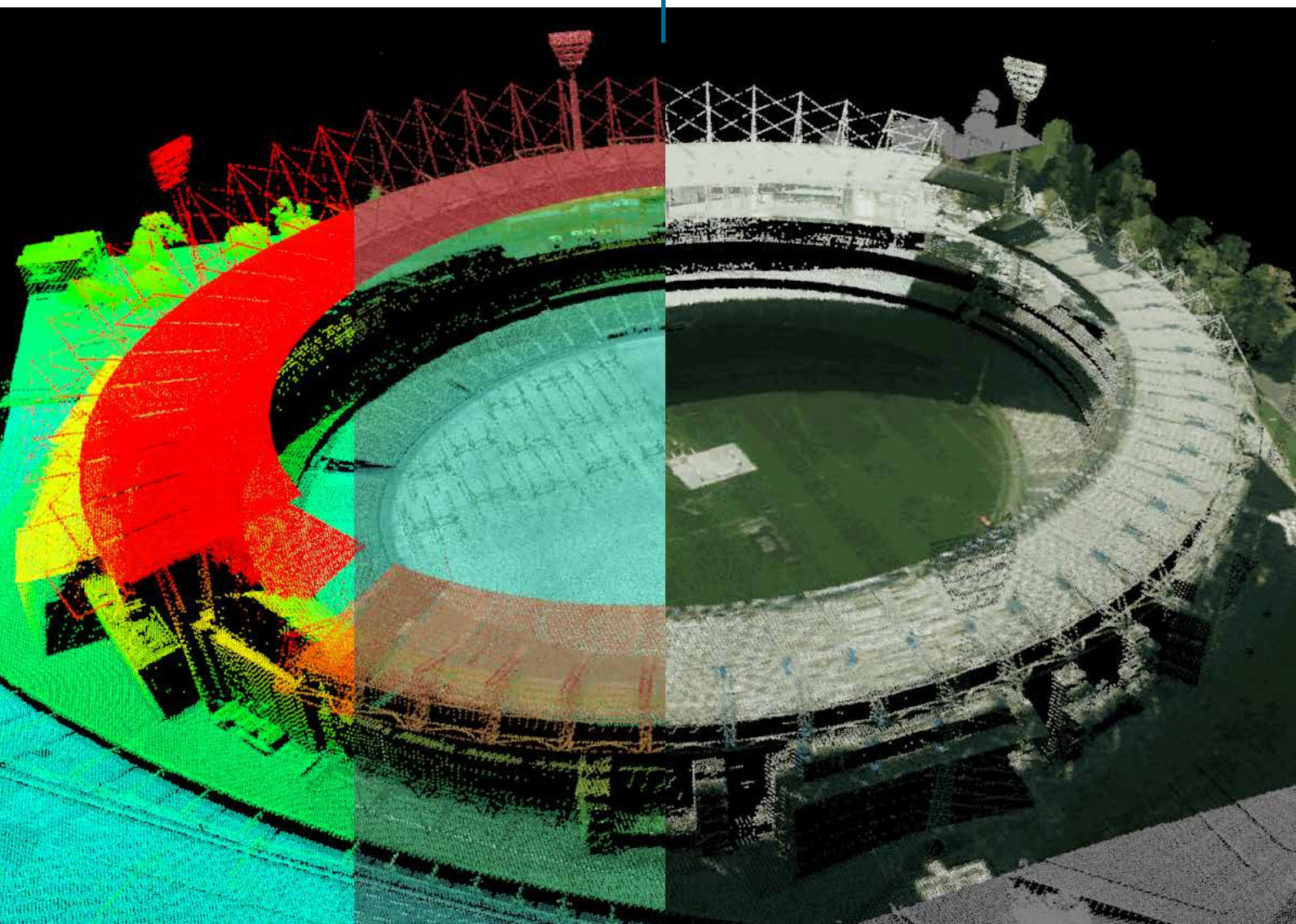
- Appendix 1: Organisational information requirements (OIR) template
- Appendix 2: Asset information requirements (AIR) template
- Appendix 3: Sample key decision points (KDP)
- Appendix 4: VDAS data dictionary (VDD)
- Appendix 5: Exchange information requirements (EIR) template
- Appendix 6: Digital engineering execution plan (DEEP) template
- Appendix 7: RACI/scope checklist template
- Appendix 8: Digital engineering execution response (DEER) template
- Appendix 9: Sample VDAS job descriptions
- Appendix 10: VDAS procurement workflows

While the VDAS is specifically aimed at the Victorian Government and its stakeholders who support planning, creating, operating and maintaining government assets, it is equally applicable to many other stakeholders in the architecture, engineering, construction and operations (AECO) industry. This includes supply chain, local government and councils, industry organisations and associations and individual practitioners.

The *VDAS Guidance* document is not exhaustive, nor is it a list of instructions on how to apply digital engineering to major assets and projects.

Each asset, organisation, context, and situation is unique. Applying the VDAS demands pragmatism and consideration at every point from all relevant stakeholders.

The VDAS has been developed in the Victorian context. Victoria is proud and excited to lead the way in developing clear and detailed guidance to the many stakeholders that deliver our important assets.



Part A
Strategic

About this section

Part A articulates how the VDAS integrates, assists and improves on various policies, acts and strategies that Victorian Government executives are required to follow.

It also highlights how the VDAS aligns with, and responds to, national and international principles and strategies, alongside other digital engineering frameworks.

Who this section is for

This section provides insights and direction for heads of departments, executives and those trusted by government to plan, deliver, operate and maintain assets.

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What is the VDAS?

The *Victorian Digital Asset Strategy* (VDAS) is an innovative way to improve the value and use of both physical and digital assets through digital engineering across the entire asset lifecycle. The VDAS applies to all asset types: built environment, linear infrastructure and systems.

At its core, the VDAS aims to:

- improve public infrastructure assets, public sector capability, promoting innovation and digital efficiencies;
- deliver effective and efficient public services; and
- drive more sustainable outcomes.

The VDAS provides a consistent, integrated and repeatable approach to creating, curating and managing information relating to Victoria's physical assets in a digital environment.

The digital environment maximises the benefits of making decisions about Victoria's many physical assets, such as hospitals, schools, railways and roads.

The VDAS employs digital technologies to help users better understand, visualise, consume and gain insight from asset information.

These processes include digital engineering, which encompasses building information modelling (BIM) and geographic information systems (GIS).

Digital engineering improves the value and useability of physical assets across their lifecycle.

The VDAS is not software nor a specific system. It is a shift in how we create and manage information across the asset lifecycle. It encompasses a collection of processes, frameworks, systems and technologies.

The VDAS aims to improve the transfer and the quality of information through each stage of the lifecycle.

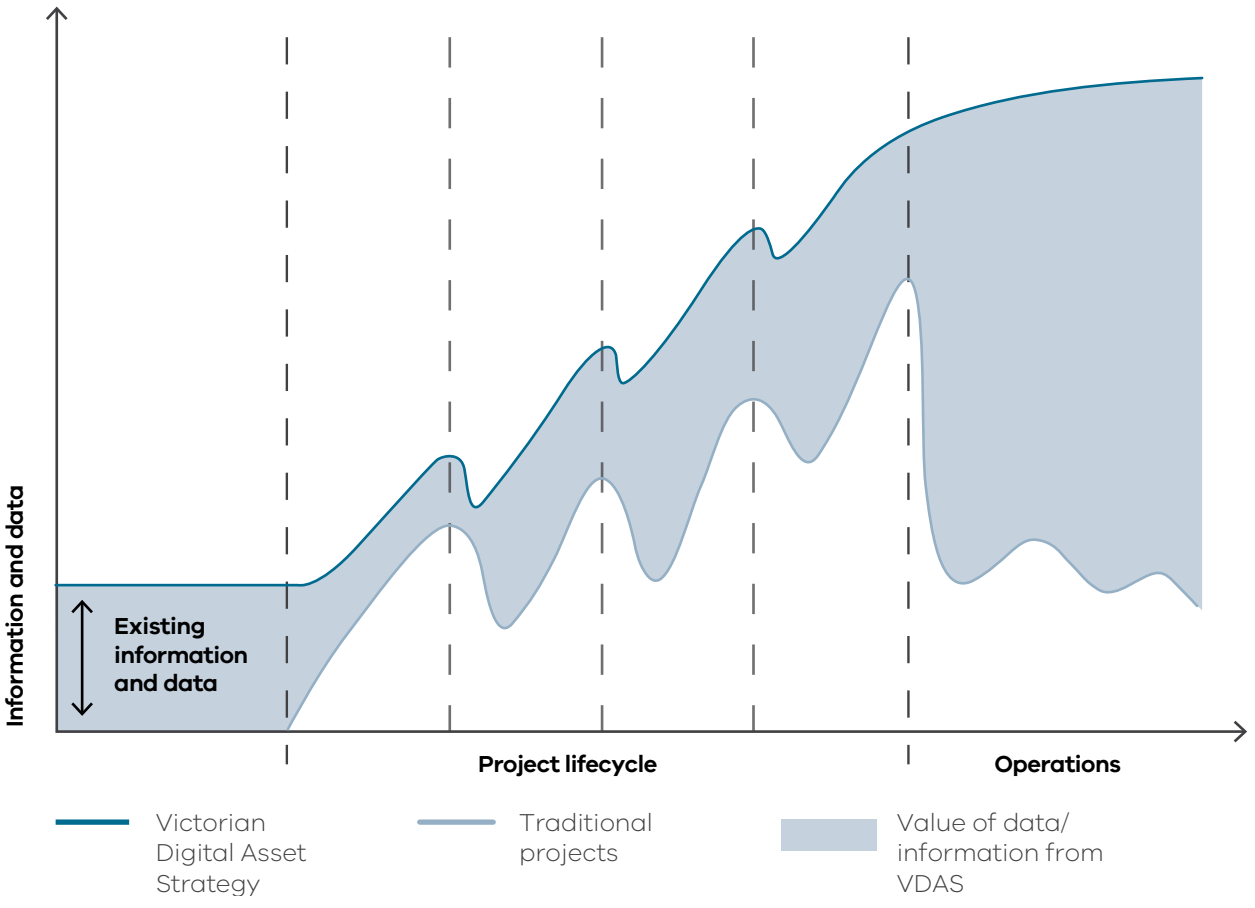
Managing information and data flow through the life of assets drives better decision making for operators and provides improved insights for operation, maintenance and future investment planning.

There are different approaches to infrastructure management – some of them more effective than others.

The current approach relies on analogue processes – printing, static versions and non-linked sets of information, data and documentation about the asset. In this approach, the lessons learned, and tacit knowledge are typically retained by individuals rather than the 'system'. When an individual leaves a project or an organisation, the knowledge is lost and it needs to be recreated at significant cost. This creates unnecessary risk, is inefficient, expensive to maintain, and it does not support balanced and effective decision making.

A better approach is to leverage digital information and systems. The VDAS uses a digital environment where systems interact and information, data and documentation are retained. Individuals thus spend less time searching for information, and save more time for making effective decisions.

In this way, information and data is better utilised, current and available to stakeholders and given inherent value.



The VDAS is a modern and best practice approach

It has been developed in collaboration with industry and is aligned with international standards and best practice, such as International Standard *ISO 19650: Organisation and digitization of information about buildings and civil engineering works* and the Centre for Digitally Built Britain's Gemini Principles.

It also harmonises with existing Victorian Government and Commonwealth policies.

Implementing the VDAS is a medium to long-term program that will support better asset management in the public interest – however, this work comes with inherent challenges.

Some of the perceived challenges and barriers are addressed in the table below.

Perceived barriers to VDAS implementation		Response from government and industry experts
'We don't need a new software or enterprise system, or a similar discrete solution.'	→	The VDAS is a best practice approach that values system and information interoperability. In most cases, existing systems can be retained.
'It will cost a lot and who's going to pay?'	→	Qualitative and quantitative studies support a high return on investment. In many circumstances, government is already paying for industry to apply these practices without receiving the full benefits.
'Why change? We've always done it this way and it seems to be working.'	→	Leveraging a best practice approach unlocks organisational efficiencies through digital workflows.
'It's not in the contract.'	→	There are very few contracts that preclude the use of effective practice. In most circumstances, contract parties are very willing for the State to move toward best practice approaches.
'It's not our responsibility – isn't this industry's problem?'	→	The State has been entrusted by the people of Victoria to develop, operate and maintain assets in line with best practice. Certainly industry has a role when its contracted on behalf of the State.
'It will be too hard to find and upskill people.'	→	There is a wide range of training and professional development material available within the Victorian context. Further support is available from the Office of Projects Victoria to assist with training, guidance and subject-matter expertise.

VDAS vision and priorities

The vision of the VDAS is:

To create, deliver and enhance digital assets that inform the delivery and whole-life management of world-class, effective and efficient physical assets across Victoria for the benefit of current and future Victorians.

The VDAS approach is underpinned by the following strategic priorities. These priorities are aligned with the Victorian Government's objectives, alongside broad objectives set out in the Gemini Principles, a UK framework on the value of data, information and effective decision making.

The VDAS priorities outlined below should be used by Victorian departments and agencies as a guide when compiling their own VDAS implementation roadmap.

Principles for applying the VDAS

International best practices in the management of information, digital assets and projects have established principles towards a collaborative culture relating to sharing and integrating data and information more collaboratively.

The *VDAS Guidance* has been developed in line with these principles – with a large emphasis on the value of data and information.

The principles set out here for applying the *VDAS Guidance* are not typical of the traditional AECO operating environment. Historically, the AECO industry can be susceptible to a commercially unproductive, litigious and 'siloed' environment.

This erodes potential organisational, asset and project value. Through collaboration and more transparent information exchanges during the asset lifecycle, the VDAS seeks to change this legacy.

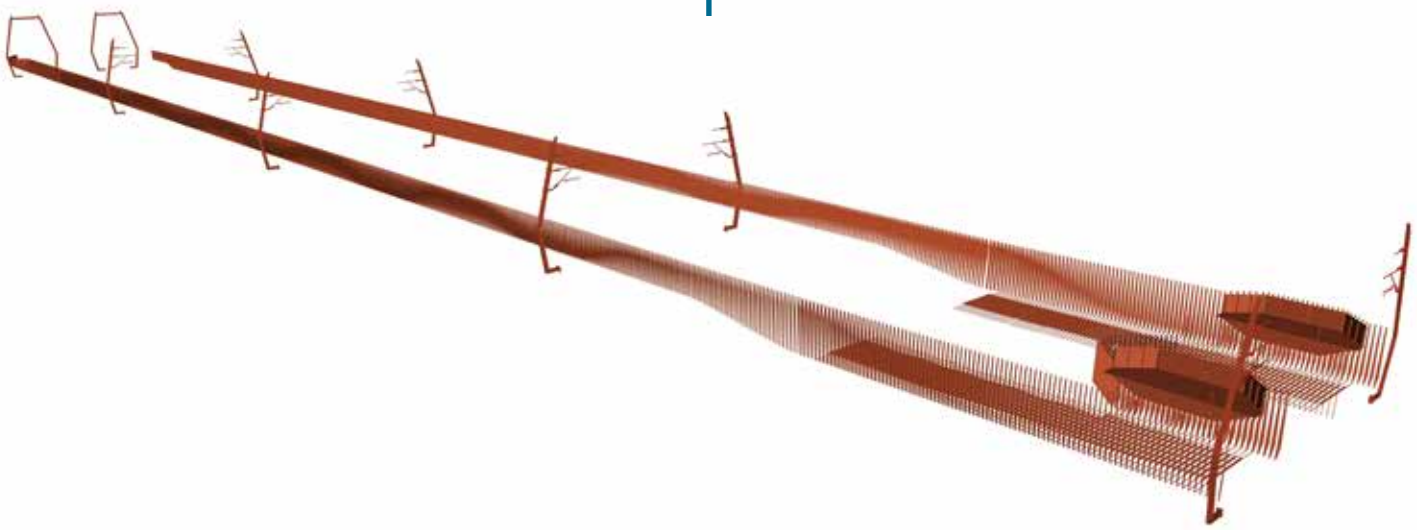
It aims for a new and more effective approach to developing Victoria's assets by improving collaboration and replacing unproductive workflows.

The VDAS principles should therefore be clearly established, articulated and instilled within the organisation.

The VDAS represents a future way of working; all stakeholders (whether in government or supporting government) who are adopting the VDAS should use these principles as part of their commitment to continuous improvement.

The 12 VDAS principles are explained in the next section.

The VDAS follows a set of 12 principles that inform better and more transparent project solutions earlier in the project lifecycle.



Clear requirements

Clear data and information requirements to an appropriate level of need

Better outcomes

Data to support the public good and enhance the lives of Victorians

Asset leveraging

Driving valuable outcomes for Victorians, asset users and stakeholders

Transparent

Enable more important and transparent decisions to be made

Secure

A holistic approach to securely share data and information

De-risk/ risk sharing

Using DE and digital management to mitigate and minimise risk

Whole of life

Using DE and data feedback loops to visualise lifecycle solutions

Capability and capacity

Increasing capability and capacity for DE and digital asset management

Open

An open and vendor-neutral approach

Integrated and repeatable

An integrated working practice, aligning OPEX and CAPEX in a repeatable manner

Innovative approach

Implementation of DE, BIM and digital asset management methodologies

Future enabled

Data and information that supports a virtual Victoria

The VDAS in the Victorian context

Executives and leaders within the Victorian Public Service (VPS) are responsible for setting the strategic direction for the organisations they represent, for ensuring that their assets and operations are sustainable, for delivering good value to the public, and for meeting all relevant regulatory requirements.

The VDAS can assist executives and leaders in the VPS to meet these responsibilities by providing the aligned enablers listed on the following page.

VPS executives and leaders should see the VDAS as an 'enabler' that assists with delivering and complying with the Government's legislation, policies and initiatives (see following table).

The VDAS can assist individuals within the VPS with greater depth and transparency of information and data – both of which drive better decision making and community engagement.

		VDAS enablers												
		Innovative responses	VDAS adoption	Cost certainty	Early creation of data	Common data environment	Enhanced accountability	Transparent data and workflow	Data and asset classification	Design re-use	Information exchange	Monitoring waste and utilisation	Trialling design optioneering	Using international best practice	Informed decision making
Public Administration Act 2004	Responsiveness	✓	✓												
	Integrity						✓								
	Impartiality						✓								
	Accountability							✓							
Financial Management Act 1994	Section 23C whereby Government must operate in accordance with principles of sound financial management			✓											
	Section 44B highlights the importance of asset information management								✓						
Section 44B highlights the importance of asset information management	Principle 1: Information is valued and governed as an asset				✓	✓					✓				
	Principle 2: Information is created and managed digitally					✓			✓		✓				
	Principle 3: Information is fit for its intended purposes and is easy to find, access and use					✓			✓		✓				✓
	Principle 4: Information is shared and released to the maximum extent possible					✓	✓				✓				✓
	Principle 5: Information management capability is fostered and embedded into how the government does its work					✓		✓	✓		✓				✓
Standing Directions 2018	Instruction 3.4: Internal control system							✓	✓						
	Instruction 4.2.1: Acquisition of assets, goods and services				✓				✓						

		VDAS enablers												
		Innovative responses	VDAS adoption	Cost certainty	Early creation of data	Common data environment	Enhanced accountability	Transparent data and workflow	Data and asset classification	Design re-use	Information exchange	Monitoring waste and utilisation	Trialling design optioneering	Using international best practice	Informed decision making
DTF Investment Management	Planning				✓		✓	✓				✓	✓		✓
	Delivery							✓		✓		✓	✓		✓
	Evaluation					✓			✓						✓
Value Creation and Capture (VCC) Framework	Increasing productivity and cost efficiency					✓									
	Increasing asset value and amenity								✓		✓				
	Unlocking commercial opportunities									✓					
	Improving accessibility												✓		
	Enhancing public safety												✓		
	Protecting and enhancing the environment											✓			
	Increasing social capital											✓			
DTF Investment Lifecycle	Stage 1: Conceptualise							✓							
	Stage 2: Prove								✓						
	Stage 3: Procure								✓					✓	
	Stage 4: Implement								✓		✓				
	Stage 5: Realise								✓			✓			
Asset Management Accountability Framework	Service delivery focused						✓								
	Integrated into planning frameworks							✓						✓	
	Whole of life cycle approach								✓		✓				
	Informed decision making								✓						✓
	Responsible and accountable												✓		
	Government policies and priorities													✓	

VDAS alignment

The *VDAS Guidance* has been established and developed to align closely with the following digital engineering policies, principles and frameworks, both global and local. This alignment is essential to enable future adoption across Australia. Operational data should feed back into future design opportunities to facilitate innovation.

One of the lessons learned from the UK Government mandating the use of BIM was the importance of clear guidance to departments and agencies beyond a national directive and technical standards.

The VDAS seeks to address this.

Australasian BIM Advisory Board: Australian BIM Strategic Framework

The *Asset Information Requirements Guide* is internationally recognised and aims to assist clients and consultants in defining information requirements using BIM to capture and deliver asset data.

The *BIM Process Consistency* document identifies a clear definition, the underlying principles, main elements and requirements for developing a common framework for BIM process consistency.

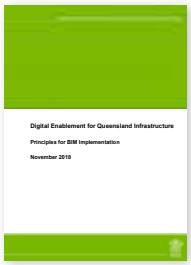
Asset Management Council

The *Framework for Asset Management* outlines the different types of information that can be useful for strategic, tactical and operational purposes.

Facilities Management Association

This association has developed a good practice guide for Facilities information outlining the key stakeholders and the importance of facilities information management.

Digital Enablement for Queensland Infrastructure



The principles for BIM implementation report aims to embrace a consistent approach to BIM adoption, and simultaneously provide certainty to industry for its future investment.

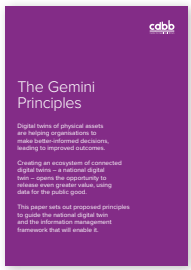
Transport for New South Wales

The *Digital engineering framework* is a unified and reusable approach to digital engineering for project management teams and individuals.

Victorian Digital Asset Strategy

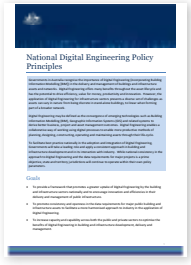
The *Victorian Digital Assest Strategy* (VDAS) aims to improve the way infrastructure projects are defined, delivered and maintained.

The Gemini Principles



As a global leader in the vision toward the 'digital twin' concept, the UK government created and embraced the Gemini Principles. At the heart of the principles is the value of data, information, and effective decision making.

National Digital Engineering Policy Principles



The principles were developed in recognition of the potential benefits that digital engineering and BIM can bring to the design, delivery, operation and management of infrastructure assets.

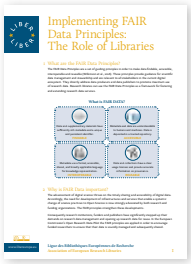
HM Government Construction Strategy

In 2011, the UK Government released a Construction Strategy to embrace the use of BIM. The government mandated the use of 'Level 2' BIM on all centrally procured government projects from April 2016.

New Zealand BIM Acceleration Committee

The New Zealand BIM Acceleration Committee was established in February 2014 to coordinate efforts to increase the use of BIM in New Zealand.

FAIR Data Principles

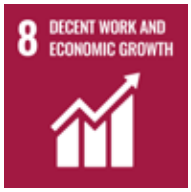


The FAIR Data Principles (Findable, Accessible, Interoperable, Reusable) were drafted at the Lorentz Center workshop in Leiden, the Netherlands in 2015.

Shergold Weir Report

Completed in 2018, the Shergold Weir report outlines 24 recommendations for the Australian building industry.

United Nations' Sustainable Development Goals



Industry innovation and infrastructure – targets quality, resilient, functional and sustainable infrastructure.

Decent work and economy growth – focused on improving individual, asset and societal productivity through informed and evidenced-based decision making;

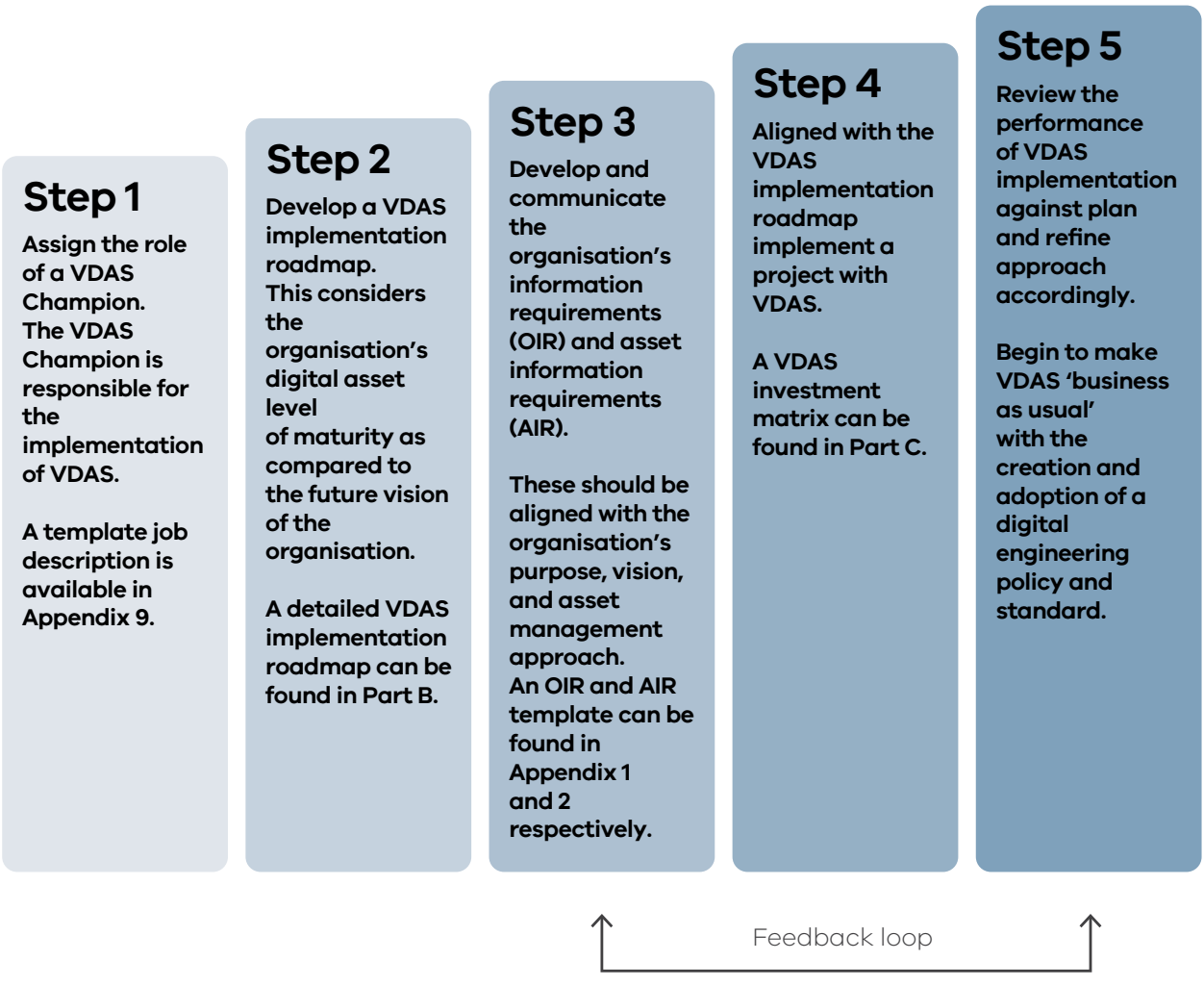
Sustainable cities and communities – explicitly targeting integrated planning for improved asset and land use.

Five steps to VDAS success in the organisation

The five steps to VDAS success outline how senior executives in the Victorian public service should deliver future projects and assets. For many organisations, this requires a change in the current way of working to move towards better practice.

For each department and agency, these five steps will vary in scale, timeframe and resourcing, including funding. Evidence shows that this resourcing commitment has a positive return on investment, with improved societal impacts, decision making, productivity, value for money, amenity/function and safety.

It is also important to note that the VDAS will evolve and incorporate continuous improvement. The VDAS implementation road map (step 2) must be contemporary and reviewed in line with lessons learnt, industry better practice and government policy.

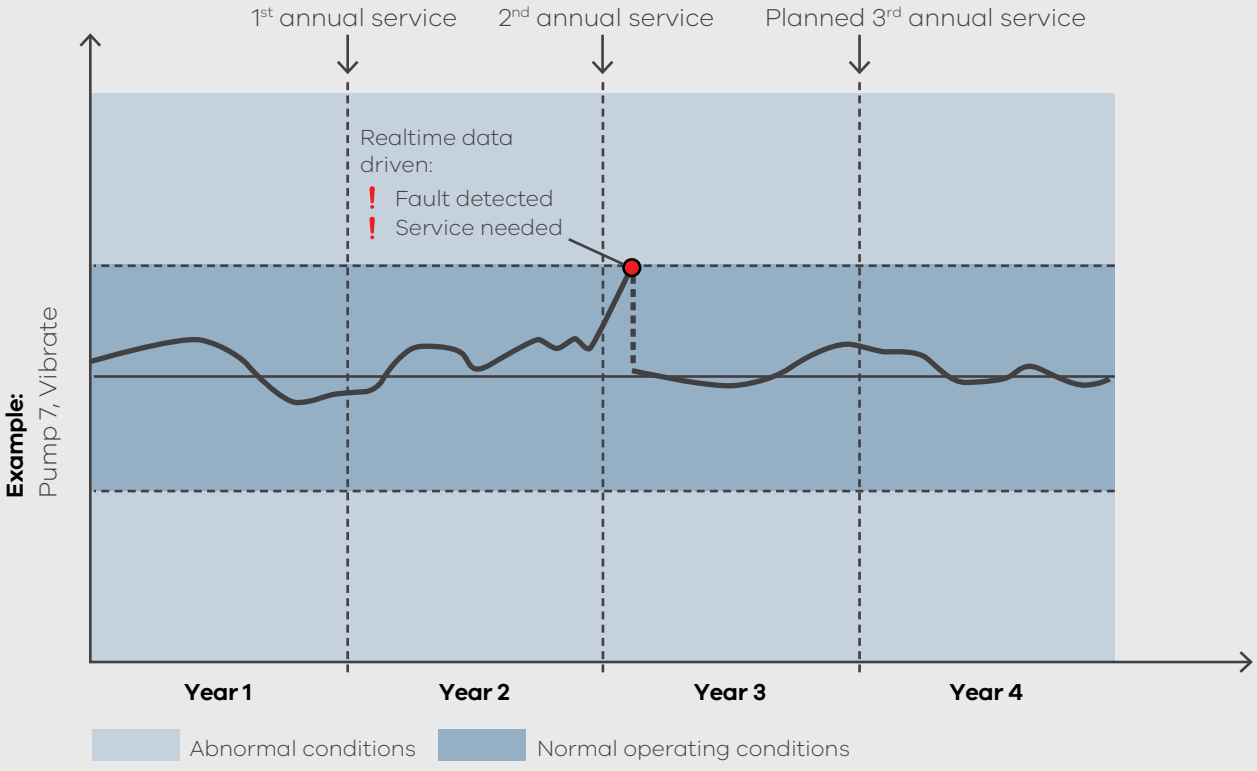


Data-driven asset management

Timely and high-quality information informs good asset management decisions. Digital engineering creates valuable information for custodians of Victoria's assets, such as asset managers, facilities managers and operators so they can make informed decisions to provide efficient, fit for purpose and effective services.

Custodians of Victoria's assets need to make strategic, tactical and operational decisions informed by key themes, such as:

- the type of asset and its role as part of a larger infrastructure/system;
- the location of the asset, and its geographic context;
- the current condition of the asset;
- the cost of repairs and maintenance;
- asset utilisation and leveraging opportunities;
- the current capacity and future demands on the asset;
- technical and financial asset performance;
- commercial and non-commercial service commitment;
- critical assets and risk minimisation; and
- asset portfolios resilience, asset interaction and interoperability.



Data-driven asset management (continued)

Many of these themes are now informed by data, both historical and in real-time.

For example, vibration sensors can be mounted to critical assets to measure movement as a proxy for condition. This information can be used to pinpoint exactly when maintenance is required.

Often this saves on additional servicing costs alongside unnecessary asset downtime. For even small assets, this can save tens of thousands of dollars a year, per asset.

Much of the information needed throughout ongoing operations and maintenance is generated during the project's development phases. This may include maintenance manuals, access to warranty statements, process flow diagrams, plot plans and wiring diagrams.

If this historical information is lost or not updated, it will need to be recreated and re-validated for both routine maintenance and more involved capital works programs.

Not only is this a risk to the organisation, but it also attracts a large cost and time commitment to refresh lost information.

There is also a high risk that data will not be able to be regenerated or recreated for asset components or elements that are no longer visible post construction, which means you may not be able to fully use an as-built data set.

The VDAS lays the foundations for best practice information management across the asset's lifecycle, which supports operators, asset managers and facilities managers with their strategic, tactical and operational goals.

In the figure on the previous page, without the introduction of sensor-based technology, the organisation would either experience asset failure or operate in an inefficient way for the next 11 months, increasing risk for the organisation.

Summary

Part A provides insights and direction for heads of departments, executive management and those trusted by government to plan, deliver, operate and maintain assets.

Executive management is essential in taking the next step towards a consistent approach to digital engineering, but organisational support and alignment is equally as important.

Part A articulates how the VDAS integrates, assists and improves on various policies, Acts, and strategies that Victorian Government executives are required to follow.

Part A also highlights how the VDAS aligns with, and responds to, national and international principles and strategies, alongside other digital engineering frameworks.

The next part, Part B, provides detailed guidance on positioning an organisation to manage digital information and data effectively throughout the life of an asset. It also provides advice for professionals responsible for implementing the VDAS.

The VDAS integrates, assists, and improves on various policies, Acts and strategies that Victorian government executives can realise benefits from following.

Part B
Organisational

About this section

Part B covers how to start implementing the VDAS on an organisational level. It establishes why leadership and governance is critical, the importance of asset management as a function, and how the VDAS applies to Victorian investment and asset management lifecycles, and ISO 19650 workflows.

It also covers how the VDAS integrates with technologies and systems already in use by the organisation.

Who this section is for

This section provides increasingly detailed guidance and advice for asset owners, operators, project and portfolio managers, and mid-level managers involved in the management, direction, and portfolio management of major assets and projects.

Version	Summary of changes
1.00	Release
Owner:	Office of Projects Victoria
Authoriser:	Victorian Chief Engineer

Part B contents

Part A - Setting up the strategy for success	
Part B - Implementing the VDAS in the organisation	
VDAS - Supporting better operational and asset-level outcomes	Establishing how the VDAS will benefit asset and facilities management outcomes.
Leadership, governance and implementation roadmap	Assigning key responsibilities within the organisation. Understanding the current state and future state.
The VDAS implementation roadmap	Establishing the importance and scope of an implementation roadmap.
People	Clarifying key roles and responsibilities to implement the VDAS.
Asset, project and investment lifecycles	Aligning asset, project, and investment lifecycles in the Victorian context.
Information management process	Best practice approach to manage asset information.
Technology and systems	The tools and technology required to develop an effective information management process.
Part C – Delivering VDAS success on a project level	

Supporting better operational and asset-level outcomes

Advances in built environment technologies, the impact of digitalisation and the growth of digital capability is transforming the way Victorian organisations plan, deliver and operate their infrastructure.

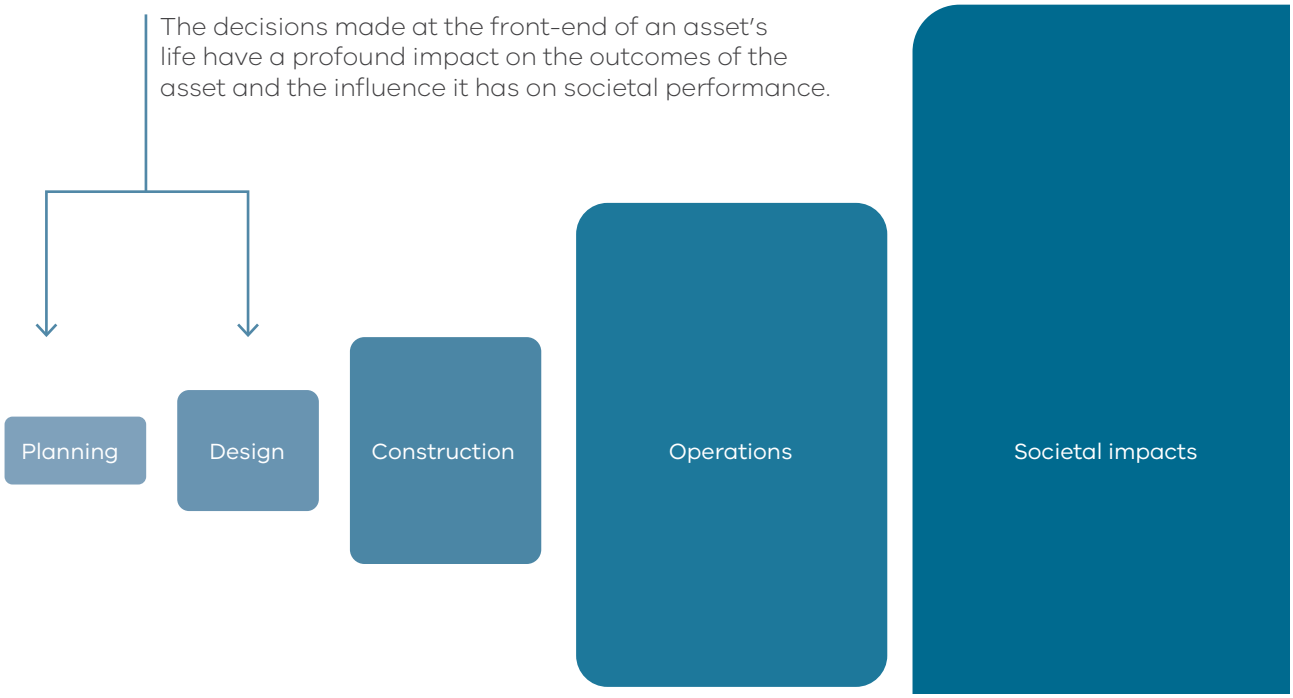
The VDAS ambition to deliver resilient and smarter built assets applies to both new project investments and existing assets.

Getting the most out of existing Victorian assets means improving how organisations produce, manage and use data. This is combined with integrated technologies and systems to inform strategic asset management and facilities management.

Typically, most costs associated with developing assets are incurred during the operations and maintenance stages, rather than during design, engineering and construction. This is largely because operations and maintenance phases often exceed 40 years.

Operational expenditure (OPEX) is often four to twelve times greater than the capital expenditure (CAPEX) incurred in the construction phase.

This is particularly true if we make sub-optimal decisions throughout planning, design and construction as these decisions will considerably erode productivity, usability, and service well into the asset's future.



The VDAS seeks to improve decision making by enhancing the way we develop, use and share information at the front end of a project to deliver maximum societal benefit at the end.

The disciplines, processes and practices in facilities management (FM) and asset management (AM) depend on high-quality and timely data and information. This information informs decision making about the health and operation of an asset.

To maintain an asset, we need access to the information that was used to build it.

For example, a bridge-widening project requires access to the original structural engineering drawings. The original structural engineering drawings are likely to date back several decades. This 'as-built' information would include specifications of member sections, steel and fixture specifications, bolting tolerances, loading calculations and general assumptions, such as the weight of the average car, average car speed or the applicable engineering standard used.

Historically, such information was lost, difficult to find or not in an easily retrievable format. Subsequently, it would need to be recreated at cost. This is not an uncommon occurrence.

For simple FM and AM activities, such as painting, the original structural drawings may be required to understand where the under-bridge scaffold can be fixed alongside any loading requirements.

What is facilities management?

Organisational function which integrates people, place and process within the built environment with the purpose of improving the quality of life of people and the productivity of the core business.
Source: ISO 41011:2017.

FM best practice follows ISO 41000.

What is asset management?

Asset management is the coordinated activities of an organisation, carried out over an asset's whole lifecycle, to realise full value from assets in delivering their service delivery objectives. Realisation of value will normally involve a balance of costs, risks and performance benefits.
Source: ISO 55000.

Best practice AM follows ISO 55000.

The VDAS addresses both these scenarios by improving handover and information management processes from the project into AM and FM. This reduces the cost and time by making data and information more available and valuable.

Ineffective information management can have a profound influence on the assets that Victorians depend on every day, by delivering efficient and comfortable public transport, parks and recreational facilities and police, justice and educational services.

To ensure these assets continue to function, we need reliable information for strategic decisions throughout the assets' lifecycle. In addition, the increasing integration between asset networks and the use of smart sensors and artificial intelligence (AI) will unlock new opportunities to enhance the performance of existing assets and future-proof the design of new infrastructure.

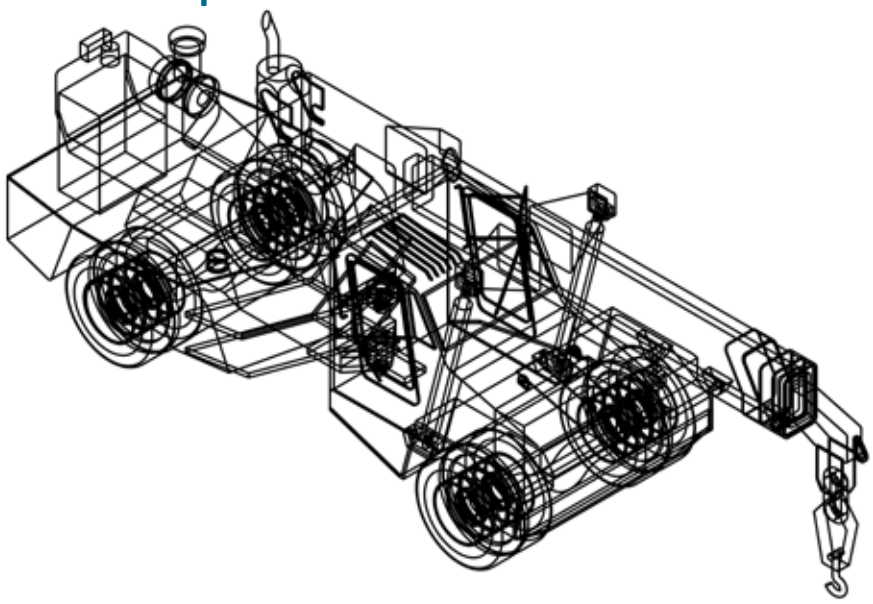
Adopting the VDAS will help organisations improve the business and societal performance of these assets and will allow us to improve asset planning including demand and prioritisation.

FM and AM in context

The Treasurer's *2018-19 Financial Report* identifies that the State of Victoria controlled a total of $273 billion of non-financial assets.

This amount is significantly greater than capital investment in the same period highlighting the value and importance of good FM and AM practices that underpin Victoria's assets.

Victoria's construction industry will be supported by constantly advancing digital technologies to change the way we design, build and operate.



VDAS-enabled benefits	Asset users and stakeholders					
	Asset occupants Employees, non-employees and members of the public	**Asset managers and owners** Government and public entities	**Facilities managers** Operators, and shared-service providers	**Contractors and services** MEP, security, IT, general contractors, emergency personnel, etc.	**Maintenance and capital projects**	**Third parties** Insurers, regulators, reporting entities, etc.
Wayfinding	✓		✓	✓	✓	
Operational efficiencies Innovation-ready systems, real time sensors, waste reduction, and integrated systems		✓	✓	✓	✓	
Complete informational access Single source of truth in assets, asset data, maintenance, maintenance data, and PIM	✓	✓	✓	✓	✓	✓
Confidence in decision making	✓	✓	✓	✓	✓	✓
Risk reduction and mitigation	✓	✓	✓	✓	✓	✓
Improved interfaces to third parties	✓	✓	✓	✓	✓	✓
Ongoing maintenance Asset performance data and predictive maintenance	✓	✓	✓	✓	✓	✓
Future projects	✓	✓	✓	✓	✓	
Regulatory requirements and reporting		✓	✓			✓
Internal asset reporting and dashboarding		✓	✓			✓
Future Victorian 'digital twin'	✓	✓	✓	✓	✓	✓
Asset disposal or handover	✓	✓	✓			✓

Virtual Building Information System

The Victorian Government's Virtual Building Information System (VBIS) assists with the seamless handover of asset information to asset managers.

VBIS is a freely available and system-agnostic standard that provides a means of classifying asset data. It integrates data sources across systems to provide a balanced asset view.

This data includes: equipment registers, asset registers, operation and maintenance procedures, technical data sheets, schedules of equipment, briefs, specifications, reports, commissioning, warranty information and real-time performance data.

At its core, the VBIS provides a public-domain syntax and asset-tagging structure that provides facilities and asset managers a consistent way to search, display, compare and interrogate key asset and maintenance information.

This makes it possible to integrate and compare information from a range of applications, including digital engineering, BIM and FM systems. VBIS has the following benefits for operators:

- provides standardised asset classification;
- can be applied to existing databases to provide a standard structure without disrupting any existing categorisation;
- leverages construction digitisation for operations;
- efficient information retrieval;
- supports AIR, OIR and EIR;
- VBIS syntax negates the need for the user to know how to access and use disparate applications;
- ability to transfer links between applications facilitating interoperability; and
- best practice data management.

For more information visit vbis.com.au.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Leadership, governance and implementation roadmap

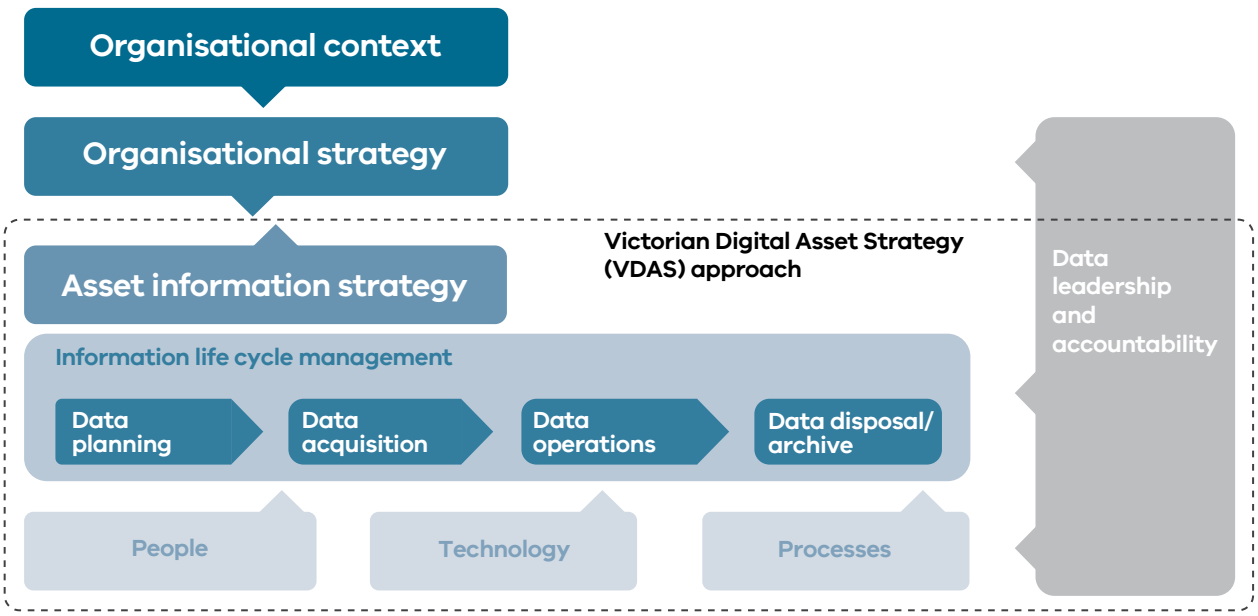
The leadership, governance and implementation of the VDAS is the responsibility of the VDAS Champion and the wider executive leadership team, including the Chief Information Officer, Chief Financial Officer, Chief Technical Officer, Strategic Asset Manager and the Strategic Operational Manager.

The VDAS Champion is a key role as they are accountable for the organisation's approach to the VDAS. With the support of the executive leadership team, the VDAS Champion will ensure the VDAS vision and implementation remain in step with other organisational strategic objectives and initiatives.

The VDAS implementation roadmap provides the organisation with a suggested approach to adopting the VDAS.

The VDAS implementation roadmap helps organisations understand how to adopt and embrace digital asset information.

The VDAS implementation roadmap is managed by the VDAS Champion. Appendix 9 provides more information on the role and responsibilities of the VDAS Champion.



The VDAS implementation roadmap

Organisations seeking to improve their digital asset information practices are recommended to begin by developing a 'roadmap' that establishes a vision, key success criteria and benchmarks the current IM approach against best practice.

The VDAS implementation roadmap leverages the progressive steps taken to date by Victorian Government departments and agencies required under the Asset Management Accountability Framework (AMAF).

The AMAF details mandatory requirements such as asset management strategies, governance frameworks, performance standards and processes to regularly monitor and improve asset management.

The VDAS harmonises these requirements with an emphasis on digital assets, information flow between asset lifecycle phases and creating quality information during capital investment phases to benefit later phases.

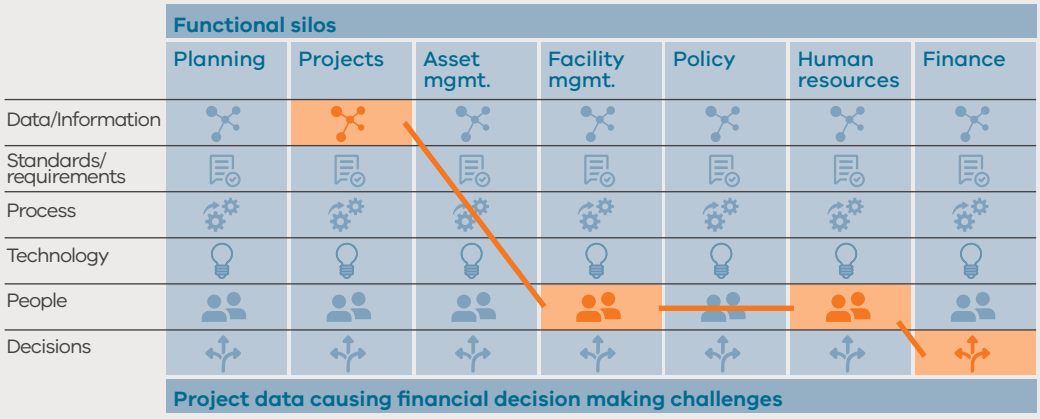
The AMAF also includes requirements for establishing systems to maintain assets and processes for identifying and addressing performance failures. Similarly, the VDAS harmonises with these requirements, again with an emphasis on consistent data and accurate information, to inform more effective and efficient decision making.

Like the AMAF, the VDAS implementation roadmap works on a supported but devolved accountability model. This allows public sector bodies to manage their digital assets in a manner that is consistent with industry best practice, alongside their own specific operational circumstances and the nature of their asset base.

To assist Victorian Government departments and agencies, the following table contains pertinent areas to support the development of a roadmap. This should be overseen by the VDAS Champion.

The following table details the VDAS implementation roadmap basic outline and scope of works.

VDAS implementation roadmap: basic outline and scope of works

Area	Sub-area	AMAF alignment
Part 1: Governance	**Establish the VDAS Champion role within the Executive Leadership Team**	
	Executive leadership	3.1.2
	Responsible persons	3.1.2
	Communication and stakeholder management reporting	3.1.2
	Identify preliminary opportunities and risks to the organisation	3.2
	An organisational vision for digital asset data and information integration, responding to: • 'What does good look like?' • 'What does success look like?' • 'How will we know when we are there?' • 'How will departments do this?'	3.1.2 and 3.2.2
	Defined implementation roadmap key success criteria: capability, returns, IM system efficiency, reduced rework, fewer errors etc.	3.1.2 and 3.2.2
	Data quality control to achieve better accuracy and compliancy	3.1.4, 3.2.2, 3.3 and 3.4.1
		
Part 2: Organisational-wide 'current state' assessment	**Define organisational information requirements (OIR) including a 'current state' assessment**	
	Asset lifecycle activities: organisational need for data and decision-making processes	3.1.4, 3.2.2, 3.3 and 3.4.1
	Identify alignment between capital expenditure and operational expenditure	3.1.5
	Capability and capacity of the organisation	3.1.1
	Capability and capacity of the organisation's supporting supply chain	3.3.2
	Current information management, project management and asset management processes	3.1.4, 3.2.2, 3.3 and 3.4.1
	Asset classification and hierarchies	3.4.3
	Parallel digital initiatives and progress	3.1.4
	Current technologies and systems in use by the organisation	3.1.4 and 3.2.2
		

Part 3: Organisational-wide 'future state' assessment (short to medium-term: two to three years)	**Define a 'future state' that aligns with organisational vision, KSC and objectives**	
	Identify future benefits to the organisation	3.1.2 and 3.2.2
	Forecast capability and capacity of people, processes and technology systems	3.1.1 and 4.2.1
	Forecast capability and capacity of the organisation's supply chain	3.3.2
	Future organisational need for information, data and decision making	3.1.4, 3.2.2, 3.3 and 3.4.1
	Asset information classification and hierarchy management	4.5
	Proposed digital initiatives and progress	3.1.4, 3.2.2 and 4.2.1

Part 4: Implementation roadmap actions	**Detailed gap analysis (moving from current state to future state)**	
	Pilot projects and demonstrators	
	Tools and technology enablers	
	Digital engineering workflow embedment	
	VDAS training	
	Commercial – embed VDAS in tenders and contracts	
	VDAS implementation roadmap response: • one, three and five-year responses and initiatives	
	Resources and investment requirements	
	Seek endorsement from the Executive Leadership Team	

Review and continuously improve

The remaining sections of Part B provide high-level guidance to the VDAS Champion, strategic asset managers, facilities manager, head of assets, and other similar roles.

Part B is divided into four sub-sections:

1. people;
2. asset, project and investment lifecycles;
3. information management processes; and
4. technology and systems.

Guidance on project-specific implementation of the VDAS approach is provided in Part C.

A quick start guide to establishing the VDAS on a project is provided in Part C.

VDAS is organised to support a range of professionals who deliver Victoria's complex infrastructure and built environment assets.

People

Despite its emphasis on technology and digital-centric processes, the VDAS is enabled by people and the culture they work in.

People are at the heart of driving and realising digital innovation and change.

It is critical to understand the organisation's culture and motivation to change, as well as its capability and capacity.

Key people-focused considerations include:

- key roles and responsibilities, such as the VDAS Champion and data and information custodians;
- organisational capability and capacity, including workforce planning; and
- training, support and mentoring.

Understanding these elements will enable a more seamless VDAS implementation process.

Tip

The Victorian Government is committed to driving innovation and improved ways of working. The *Public Sector Innovation Strategy,* released in July 2017, provides helpful tips for leaders of government departments and agencies to adopt more innovative practices in their workforce. These tips are also applicable to private industry.

Roles and responsibilities

Implementing the VDAS at an organisational level requires clearly defined roles and responsibilities.

Departments and agencies may already employ people with roles and responsibilities that overlap with key VDAS roles.

These roles include:

- Chief Technology Officer (CTO);
- Chief Information Officer (CIO);
- Chief Financial Officer (CFO); and
- department-specific executive roles involving innovation, technology and assets.

If your organisation does not have the budget to support new roles, you can align the accountabilities and responsibilities of the VDAS roles with existing roles.

Two key VDAS roles discussed in detail below are the VDAS Champion and data custodians.

For more information on organisational-level roles, please contact the Office of Projects Victoria (OPV).

The VDAS Champion

The VDAS Champion has executive responsibility for the establishment and delivery of the VDAS vision.

Specifically, the VDAS Champion works to ensure a digital approach to information management (IM) on Victorian Government assets.

The executive role requires a complementary set of skills to succeed, including:

- executive leadership – stakeholder engagement, reporting, financial management, executive management, strategic and policy direction of technology, systems, and processes;
- technology – a solid foundation in technology and how it is employed on projects and AM;
- organisational design – understanding of the business, commercial, technical, asset, and project matters. An understanding of how a project and asset is developed;
- continuous improvement – a commitment to implementing large asset and IM change exercises with a focus on transforming AM processes; and
- team and capability development – identification of workforce gaps, opportunities and seeking improvement in terms of staffing, resourcing, skills development, and organisational effectiveness toward the strategy.

This role relies on organisational-wide stakeholder engagement to realise 'best-in-class' outcomes for digital engineering and digital asset management.

The role is accountable for the development of key deliverables, such as the organisational information requirements (OIR) and the asset information requirements (AIR).

Ideally, this role should not be undertaken by a contractor or a consultant, but rather by someone employed by the State. However, finding a person with this skillset may be difficult, and the role may initially be assigned to an external or contracted appointee.

Appendix 9 provides a role description for a VDAS Champion.

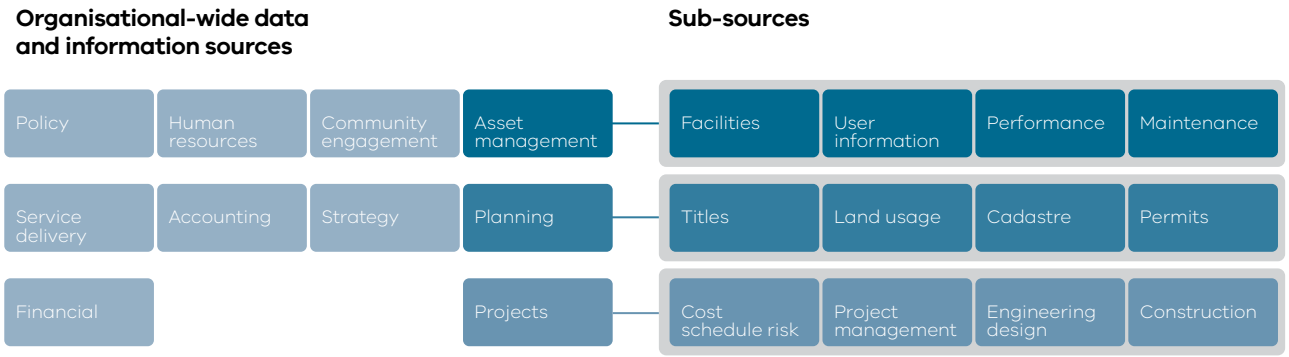
Custodians of data and information

A pivotal part of best practice IM is a well-defined data and information custody and stewardship model with clearly articulated roles and responsibilities. Without data custodians, individuals, users and organisations all lose confidence in data-based decision making.

This is not just best practice – it is also a requirement set out in the Victorian Government *Information Management Governance Standard: Information Management Framework*.

In these requirements departments must:

- establish a custodianship model that clearly establishes key accountabilities and responsibilities for the management of information, records and data; and
- assign a custodian to ensure key Victorian Government data and information is managed through its lifecycle.



Tip

A data custodian is tasked with responsibility for data and information across its lifecycle including: transport, storage, use and access.

Tip

A data steward is responsible for specific data and information content and context.

Data and information custodians are likely required across the organisation. These include: operations, accounting, human resources, projects, planning, and engineering.

It is important to note that each of these sources of information are likely to be made up of many sub-sources. It is important to recognise that these responsibilities extend to how data and information is shared and how it is represented to other custodians and users.

For example, 'projects' are likely to include information sub-sources such as costs, risks, engineering, and schedules.

For each of these areas and sub-areas a data custodian should be established that is accountable for the ownership, management and quality of the data and information.

Data custodians are critical stakeholders in the implementation of the VDAS.

Capability and capacity assessment

Each department or agency is made up of many stakeholders. These stakeholders create, manage, access, modify, and dispose of digital asset information daily.

To enable the VDAS approach it is critical to understand the organisation's capability and capacity with respect to digital maturity and literacy.

This is particularly critical as departments and agencies begin to transition towards integrated working approaches as outlined in the Victorian Government's IM policy and framework.

A way to determine the capability of the organisation is to review user's digital maturity, as pictured below.

The assessment will provide the organisation with a clear understanding of ability to service Part 3 of the VDAS implementation roadmap – the organisation's desired future state.

With results from the assessment the organisation has a better understanding of training, mentoring, and support required to enable the implementation of the VDAS.

For more information, including resources for capability assessments, contact OPV.

Tip

Digital literacy is a measure of a person's capability to engage, live, learn and drive value in today's digital society.

Part of digital literacy is to follow the Victorian Government IM framework and policy.

Information and data users have an obligation to follow the IM framework's five key principles:

- Principle 1: Information is valued and governed as an asset;
- Principle 2: Information is created and managed digitally;
- Principle 3: Information is fit for its intended purposes and is easy to find, access and use;
- Principle 4: Information is shared and released to the maximum extent possible; and
- Principle 5: IM capability is fostered and embedded into how the government does its work.

Key organisational maturity and literacy questions:

Is the balance of individuals with user maturity within the organisation appropriate given the current (and future) needs of the organisation?

Does the organisation value key datasets and information containers?

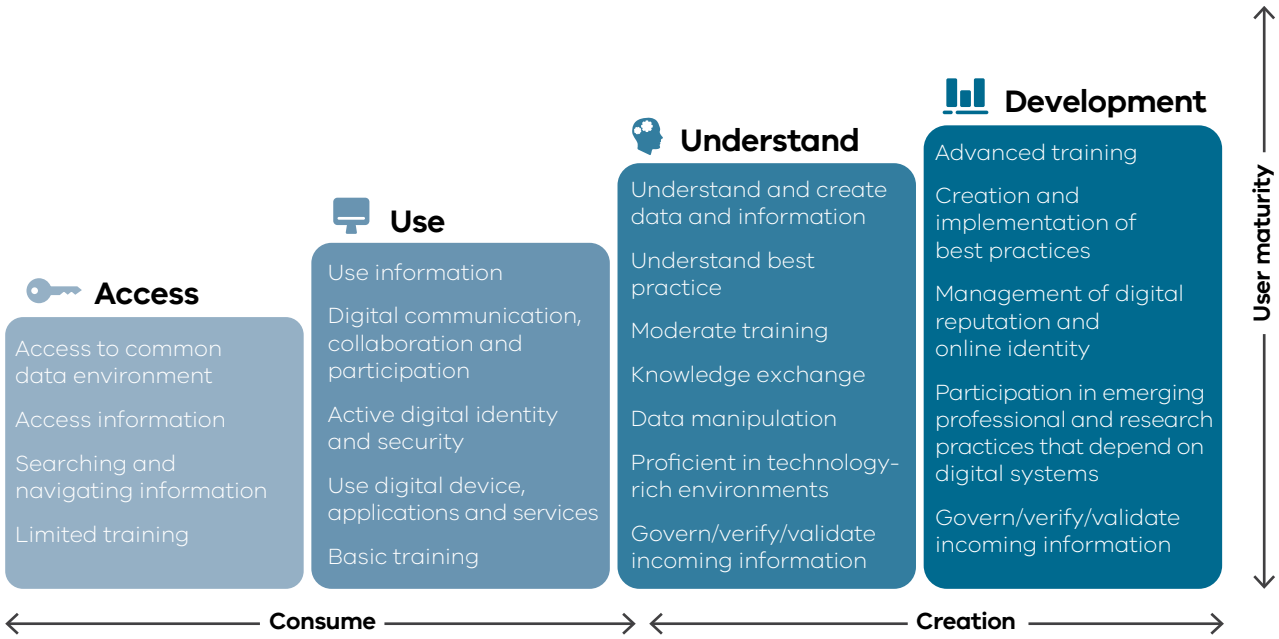
Has the organisation assigned data custodians and stewards to key data and information?

Do individuals within the organisation have a clear understanding of the origin, processes, and destination of data and information they handle?

Does information and data routinely get discarded, wasted, or archived?

Are datasets developed, managed, and maintained with security considerations at the fore?

Does the organisation have confidence that their supply chain has similar skills?



Training, support and mentoring

Your organisation should carefully consider the IM training, support and mentoring needs of your staff and supply chain, as these are vital for the adoption of good IM processes.

As part of developing the VDAS implementation roadmap, the VDAS Champion should assess, articulate, plan and implement the required skills, training, support and mentoring requirements.

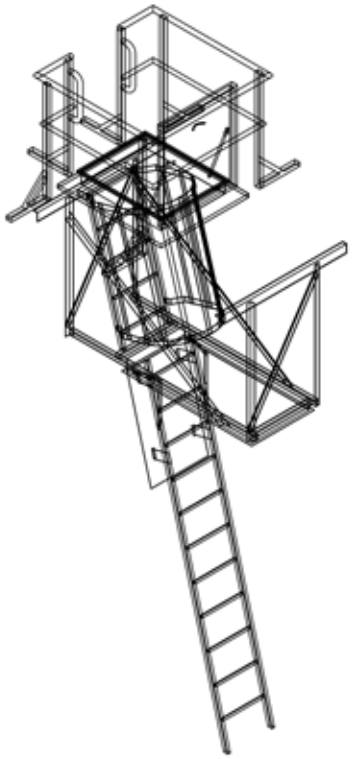
It is advised that training, support and mentoring programs are informed by digital maturity assessments.

OPV will provide the necessary support and is available to assist with the implementation of the VDAS in Victorian Government departments and agencies. If you have any questions, please contact OPV.

OPV can assist with:

- application of VDAS in line with current workflow, assurance and practices;
- VDAS awareness and basic training;
- measurement of capability and capacity;
- review of key documentation;
- maturity assessment and 'future state' development;
- identification of challenges and opportunities within the organisation; and
- access to subject-matter expertise.

People are the key to change, the VDAS champion will lead the implementation within their organisation.



Heating Ventilation and Air Conditioning Centre of Excellence

The Heating, Ventilation and Air Conditioning (HVAC) Centre of Excellence was established through a collaborative partnership between Holmesglen TAFE and the Air Conditioning and Mechanical Contractors' Association (AMCA). The centre is purpose-built to upskill and train the next generation of climate-control technicians and mechanical professionals.

Beyond offering training outcomes, the Centre supports the 12 VDAS principles including transparency, open, asset focused and whole of life.

With a focus on cutting-edge commercial and residential HVAC technologies, the Centre features a modern mechanical services laboratory and a BIM and asset data laboratory, reflecting leading contemporary industry practices.

The Centre features technologically advanced and enhanced learning tools, such as augmented reality, which allows students to use their mobile devices over a piece of equipment to explore its use, installation date and the last date serviced.

The Centre has created a 'digital twin' acquired using laser scanning. This provides users with the ability to 'fly' through the facility and to access detailed asset information by selecting equipment on the screen.

Contemporary training approaches utilising valuable technologies will greatly support Victoria's future leaders.

Asset, project and investment lifecycles

The Victorian Government is home to a number of asset and investment lifecycles and frameworks. These include:

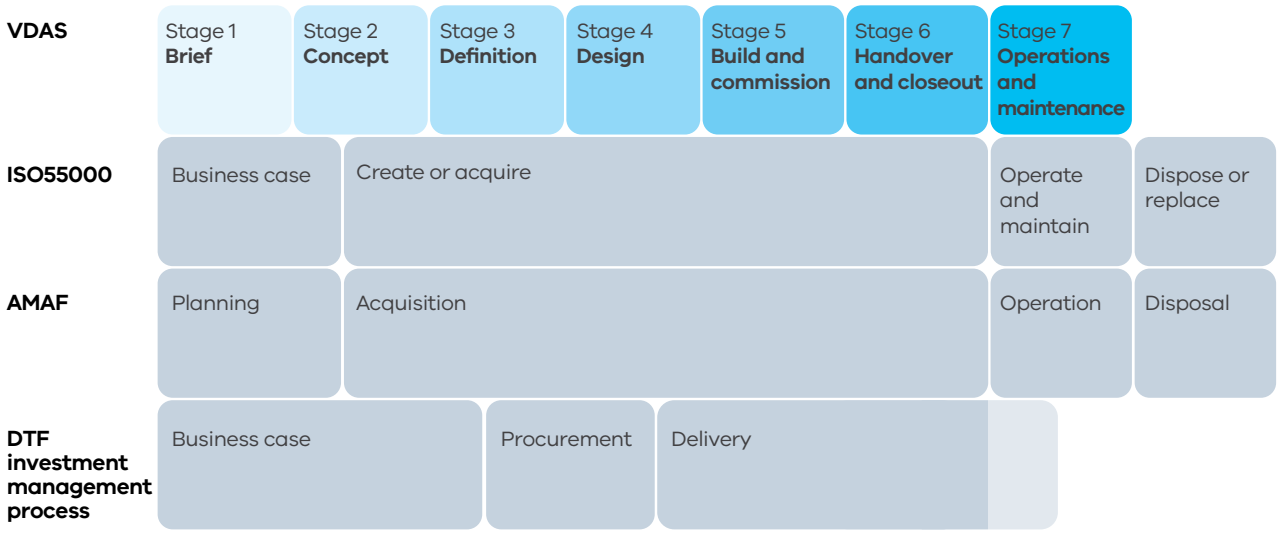
- Department of Treasury and Finance (DTF) Investment Lifecycle and Gateway Review Process;
- AMAF (following ISO 55000); and
- public private partnership (PPP) and market-led proposal guidance from Partnerships Victoria.

It is important to distinguish between investment lifecycle and project lifecycle. There is no formal whole of Victorian Government project lifecycle.

An investment lifecycle involves engaging the market, procuring the asset and realising the benefits, whereas a project lifecycle takes into account the maturity of the project's design alongside its stage and progress.

To aid practitioners working between the various lifecycles the VDAS lifecycle has been aligned with ISO 55000 and 19650 series, DTF Investment Lifecycle and the AMAF (see diagram below). This contextualises the VDAS lifecycle, alongside investment and asset lifecycles.

Further information on how the VDAS lifecycle is applied on various contracting approaches in line with ISO 19650 is provided in Appendix 10 and discussed in the 'Procurement and VDAS lifecycle' section below.



AMAF and ISO 55000

The VDAS aligns with the AMAF, which was developed to adhere to international best practice, ISO 55000.

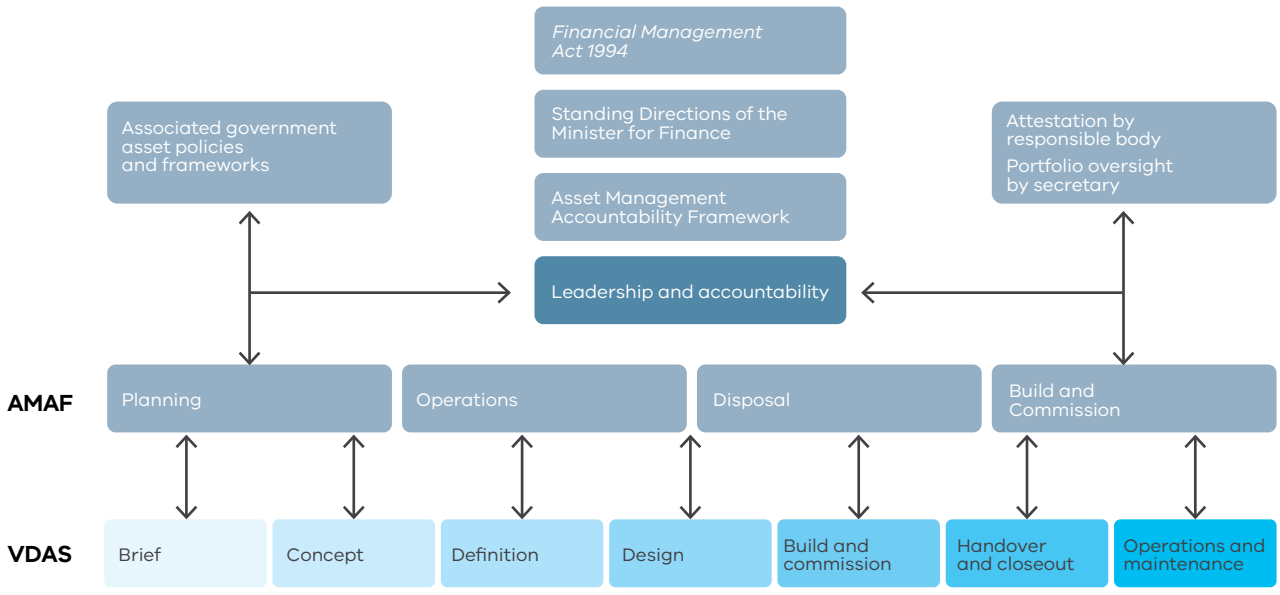
AMAF details mandatory AM requirements and general guidance for agencies responsible for managing assets. It emphasises best practice AM, including reporting, transparency and accountability.

The ISO 55000 series consists of three international standards that provide the terminology, requirements and guidance for implementing, maintaining and improving asset management systems. The ISO 55000 series is widely used by utilities, transport, mining, process and manufacturing industries worldwide, enabling them to streamline their expenditure, strengthen their credentials and future-proof their facilities and assets.

As seen in the graphic below, the VDAS supports the AMAF. The VDAS empowers strategic asset managers and the CFO with correct, timely, structured and accurate information from major projects.

In this fashion, data and information from major projects can be seamlessly integrated with your organisation's asset register, which minimises rework.

Aligning the VDAS lifecycle with the ISO 55000 series and AMAF ensures that Victorian public infrastructure assets benefit from the use of best in class standards and processes to provide consistent and sustainable outcomes.



The VDAS builds on the AMAF landscape through:

- an IM approach to developing and creating assets;
- clear articulation of roles and responsibilities;
- a suite of templates that can assist AM and FM stakeholders to articulate requirements;
- alignment with key procurement methodologies;
- assurance and quality control of digital asset information;
- promoting a project and asset classification and hierarchy system; and
- development and management of project information, and integration of this with other organisational systems.

VDAS addresses each of these items to add strength to the AMAF.

The VDAS lifecycle

Victorian Government assets and projects require a large volume of information to enable effective decision making across all phases of the project and asset lifecycles.

The VDAS lifecycle spans seven stages – from early planning and strategic decision making, through to project optioneering, scope selection, scope development and engineering, into construction, commissioning and handover, and through to operations, maintenance and disposal of the asset.

The VDAS lifecycle promotes early and effective decision making.

The VDAS lifecycle promotes the seamless transfer of data and information from one stage of the lifecycle to the next. This increases the value and re-use of data and information.

To aid practitioners, each stage of the VDAS lifecycle includes clear guidance articulated toward specific stakeholders, checklists, key decision points and deliverables as defined in ISO 19650.

The VDAS lifecycle has also been linked to the various procurement methodologies employed in Victorian Government projects, alongside the project development and due diligence process.

VDAS enables digital models to be developed in line with key decision points and deliverables.

Completed: ✓
In progress: 🛠
Planned: 🗓

	Brief	Concept	Definition	Design	Build and commission	Handover and closeout	Operations and maintenance
	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5	Stage 6	Stage 7
	Stage 1 checklist + KDP	Stage 2 checklist + KDP	Stage 3 checklist + KDP	Stage 4 checklist + KDP	Stage 5 checklist + KDP	Stage 6 checklist + KDP	Stage 7 checklist + KDP
VDAS workflows							
OIR	✓	✓	✓	✓	✓	✓	✓
AIR	✓	✓	✓	✓	✓	✓	✓
EIR (RACI / scope checklist)	🗓	🛠	✓	✓	✓	✓	✓
DEEP	🛠	🛠	🛠	✓	✓	✓	✓
DEER	🗓	🗓	🛠	✓	✓	✓	✓
PIM	🗓	🛠	🛠	🛠	🛠	✓	✓
AIM	🗓	🗓	🗓	🗓	🛠	🛠	✓
VDAS use cases							
Asset management		✓	✓	✓	✓	✓	✓
Capacity/disruption modelling			✓	✓	✓	✓	✓
Constructability		✓	✓	✓	✓		
Cost estimation	✓	✓	✓	✓	✓	✓	✓
Design authoring		✓	✓	✓			
Design review		✓	✓	✓			
Digital fabrication		✓	✓	✓	✓		
Digital twins	✓	✓	✓	✓	✓	✓	✓
Emergency planning	✓	✓	✓	✓	✓	✓	✓
Engineering analysis		✓	✓	✓			
Evacuation simulation				✓	✓	✓	✓
Existing conditions modelling	✓	✓	✓	✓			
Reality capture	✓	✓	✓	✓	✓	✓	✓
Risk minimisation	✓	✓	✓	✓	✓	✓	✓
Scheduling	✓	✓	✓	✓	✓	✓	✓
Scope reuse	✓	✓	✓	✓			✓
Site analysis	✓	✓	✓	✓			
Site utilisation planning	✓	✓	✓	✓	✓		
Solution reuse	✓	✓	✓	✓			
Space management and tracking		✓	✓	✓	✓	✓	✓
Spatial analysis	✓	✓	✓	✓			
Sustainability	✓	✓	✓	✓	✓	✓	✓
User movement monitoring		✓	✓	✓	✓	✓	✓
Visualisation		✓	✓	✓	✓	✓	✓
3D control and planning				✓	✓	✓	
3D coordination		✓	✓	✓	✓	✓	

Procurement and the VDAS lifecycle

Procurement and contracting are pivotal parts of a project.

Selecting the appropriate procurement model requires considerable attention.

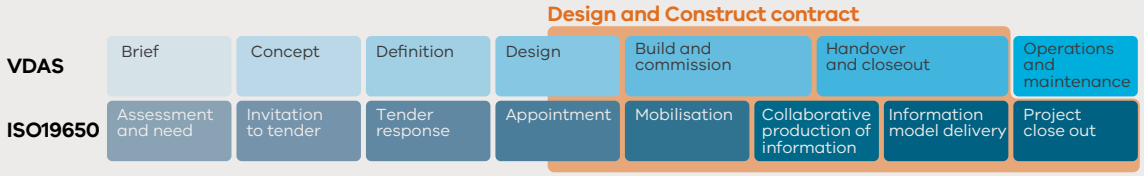
There is no 'one size fits all' approach to procurement. Different procurement methods suit the specific needs and complexity of individual projects.

The VDAS can apply to any procurement methodology.

Digital engineering should be independent of any contracting philosophy: it should be used in all circumstances.

The information below sets out the alignment of VDAS lifecycle phases with ISO 19650 and each main procurement methodology utilised in Victoria.

Design and construct (D&C)



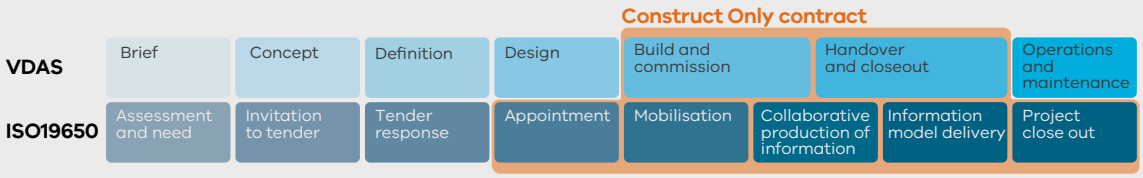
In a D&C contract the 'owner' or 'state' (Appointing Party) defines information requirements before appointing a 'head contractor' (Lead Appointed Party) to complete both the design (stage 4) and construction (stage 5).

The majority of D&C contracts also include cold and hot commissioning activities, as well as handover through to operations and maintenance (stage 6).

D&C contracts in Victoria typically include warranty periods into operations (stage 7).

The Lead Appointed Party is likely to engage other subcontractors and consultants as needed. The Lead Appointed Party should employ ISO 19650 processes as part of those engagements.

Construct only (CO)

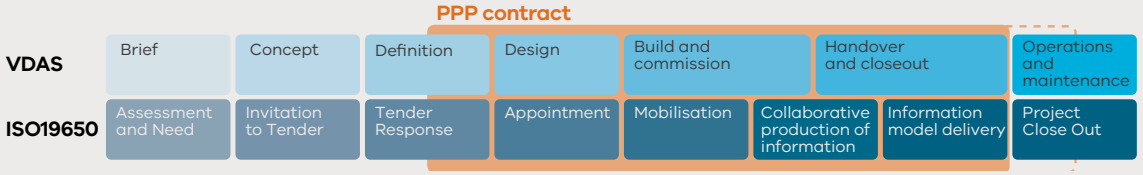


In a CO, the 'owner' or 'state' engages one or more design or architect team/s for a contract for stages 2, 3 and 4 to define project options, project designs, information requirements and engineering drawings. Beyond warranties and post-contract support, these contracts typically have limited involvement into stage 5 and beyond.

The CO contract refers to a separate contract between the 'owner' or 'state' (as the Appointing Party) and a contractor (as the Lead Appointed Party) for construction activities (stage 5). Construct only contracts are also likely to include commissioning activities as well as handover through to operations and maintenance (stage 6).

The Lead Appointed Party in a CO is likely to engage other subcontractors and consultants as needed. The Lead Appointed Party may employ ISO 19650 processes as part of those engagements.

Public private partnership (PPP)



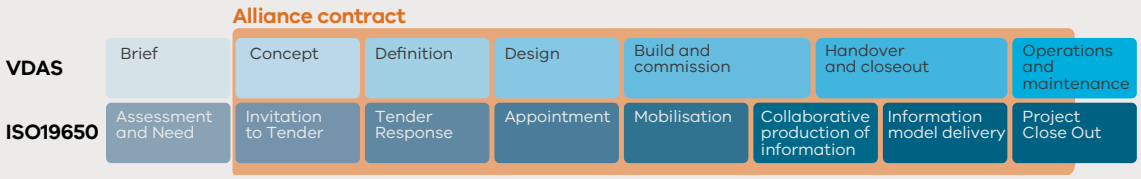
In a PPP, the 'owner' or 'state' typically engages with one or more design or architect team/s in a contract for stage 2 and perhaps stage 3 to define potential project options and designs, key project and information requirements, and perhaps some basic site analysis.

The 'owner' or 'state' (as Appointing Party) also typically engages a Special Project Vehicle ('consortium', 'project co' or 'Lead Appointed Party') for stages 4 through to 6 for an 'Availability PPP', and stages 4 through to 7 for a 'Concession PPP'.

The Lead Appointed Party ('project co') in a PPP is likely to engage its constituent companies as contractors and consultants. In this circumstance, the Lead Appointed Party is likely to employ ISO 19650 processes for those engagements.

For more information about PPP, refer to www.dtf.vic.gov.au/ppp-resources/partnerships-victoria-excellence-public-private-partnerships

Alliance



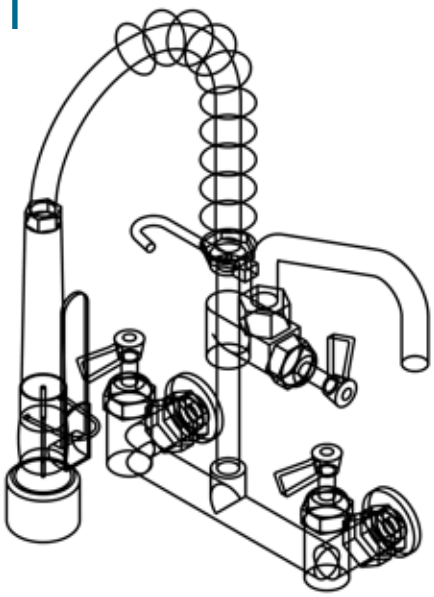
In an alliance procurement model, a 'joint venture' between the 'owner' or 'state' is formed with an alliance partner. This is likely to occur in stage 1 or 2 of the lifecycle.

In this circumstance, the 'Alliance team' (made up of 'owner' personnel and industry personnel is created. Here, a soft delineation is created between the Appointing Party and the Lead Appointed Party – whereby typically the 'Alliance team' becomes the 'Appointing Party' and the alliance partner's constituent companies form the 'Appointed Party'. An alliance contract is likely to form over stages 2 through to 6 of the VDAS lifecycle.

Appendix 10 provides detailed workflows for each of these four common procurement methodologies.

For any other procurement methodology not covered here, contact OPV for support.

The VDAS lifecycle aligns with different procurement routes to apply across major contract models.



Project assurance during the project lifecycle: project development and due diligence

The magnitude of Victoria's infrastructure program requires a strong focus on effective front-end information management processes such as planning, design and engineering. These collectively ensure timely and cost-efficient delivery of our major projects. Rushing this process or getting elements of this process wrong erodes a project's outcomes.

A project's success depends heavily on the quality of its early development and due diligence activities. This process is driven by the project development and due diligence (P3D) guidelines.

P3D is the basic, initial engineering and design undertaken for a project, usually following a conceptual exploration or a feasibility study.

It defines the specific technical requirements for a project, identifies key issues including technical, contextual and environmental matters, resolves them where possible and enables the cost of the investment to be estimated.

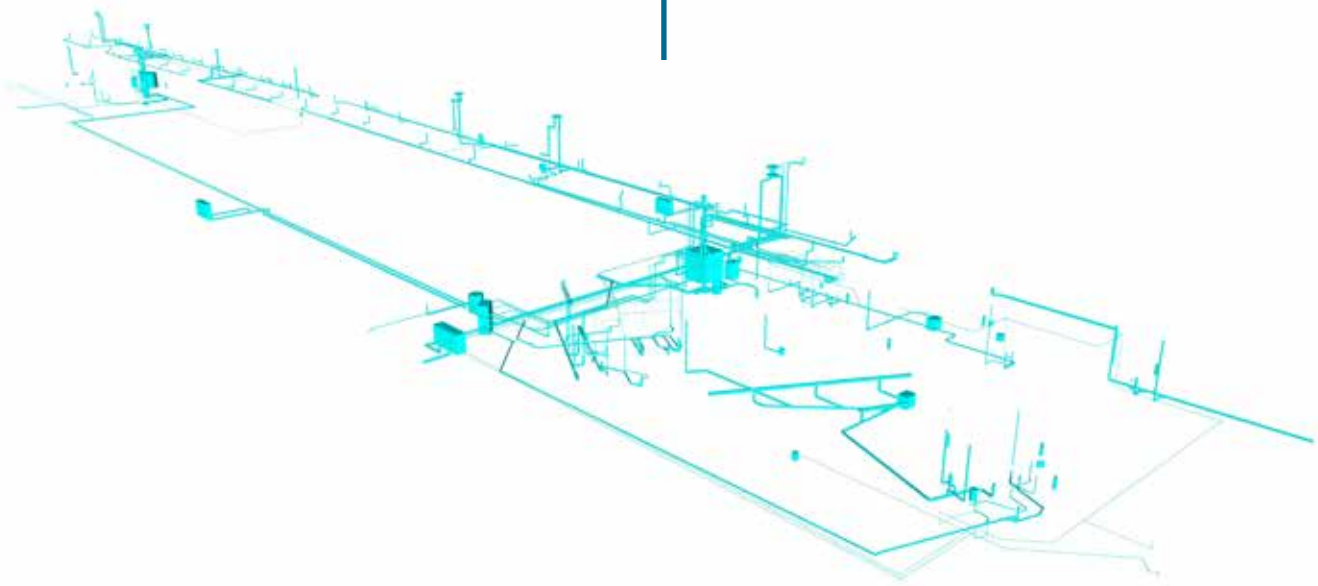
These processes unearth technical elements and challenges early in the project lifecycle, which allows risks to be identified, quantified, managed and properly allocated for future stages.

P3D bolsters the DTF Gateway Review process from a technical review perspective.

The P3D covers 75 separate technical project 'elements', including 'information management plan', 'digital engineering' and 'information requirements'.

The VDAS is integrated with and supports the P3D.

Virtual design processes support P3D assurance processes to minimise and mitigate risk.



Project practitioners can gain confidence, and support executive decision makers, through the VDAS process. Further, the VDAS is an ideal process to increase the overall technical maturity of the project. In the table below, the DTF Gateway Review Process (GWR), and the P3D process are presented in combination with how the VDAS can support decision making throughout the project lifecycle.

DTF Gateway Review			
Process		**P3D Process**	**How VDAS can support P3D and DTF Gateway Review Process**
Gate 1	Concept and feasibility	Test critical assumptions that affects business case purpose and determine feasibility	✓ Clear articulation of what, why, how, when digital asset information is wanted ✓ Framework to integrate stakeholders ✓ Tools and environment to collate and integrate existing information ✓ Clear framework for roles and responsibilities ✓ Solution and design reuse friendly
Gate 2	Business case	Gather critical information that will reduce risk and costs	✓ Easily reuse information from prior phase ✓ Generate feasible project options ✓ Holistically review project and asset risk ✓ Quickly identified preferred option ✓ Provide confidence and assurance to stakeholders ✓ Visualisation of project solution(s) ✓ Integration of scope, cost, schedule, and risks
Gate 3	Market readiness	Ensure that the responsibility balance between the State and the Head contractor is appropriate	✓ Easily reuse information from prior phase ✓ Efficiently and effectively design the project 'virtually' ✓ Gain deeper stakeholder and supply-chain buy-in ✓ Support DfMA processes ✓ Visualisation of project solution(s) ✓ Integration of scope, cost, schedule, and risks
Gate 4	Tender decision	Allow for market forces to work appropriately and for the State to maintain control where market is improperly positioned	✓ Easily reuse information from prior phase ✓ Review maturity of 'virtual project' prior to award ✓ Visualisation of proposed project solution(s) ✓ Ability to proposed information management process ✓ Review comprehensiveness of supply-chain engagement ✓ Integration of scope, cost, schedule, and risks
Gate 5	Readiness for service	Are the essential items closed out by the project prior to handover	✓ Easily reuse information from prior phase ✓ Visualisation of project solution(s) ✓ Process for information handover ✓ Support for structured data ✓ Ability to reuse information in the future ✓ Confidence from FM and AM that scope is aligned to expectations
Gate 6	Benefits analysis	Lessons learned for P3D process	✓ Easily reuse information generated in phase prior ✓ Scope integration with CAPEX and OPEX ✓ Design reuse friendly ✓ Ability to search and review existing content

For more information about P3D, please email OPV at enquiries@opv.vic.gov.au.

Solution Reuse in Victoria's Level-Crossing Removal Project

The Level Crossing Removal Project (LXRP) was established by the Victorian Government to eliminate 75 level crossings across Melbourne by 2025. Other rail network upgrades involved in this project include new train stations, track duplication and train stabling yards. The LXRP is one of the largest rail infrastructure projects in Victoria's history.

The Solution Reuse project was developed to reduce the amount of time and effort needed to reach design milestones. It identifies a previously completed design, with its accompanying artefacts, and uses this data as the basis for the next design.

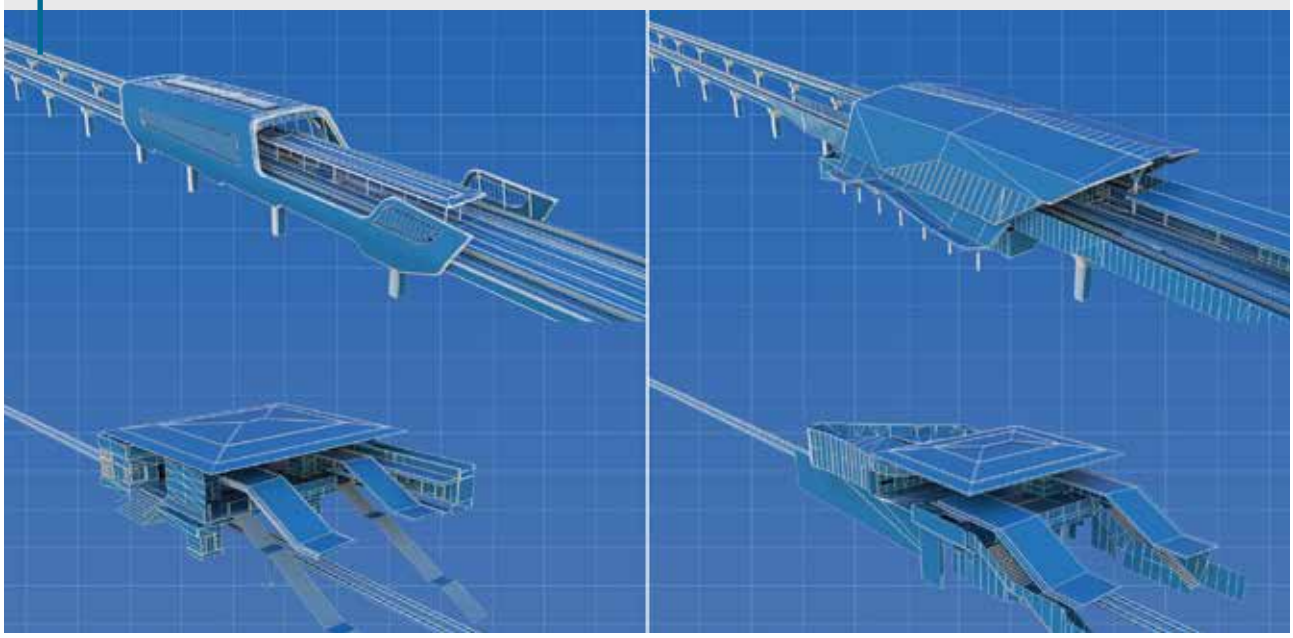
Digital engineering is a key enabler for solution reuse. LXRP is developing digital engineering platforms, capability and processes aligned with the VDAS to facilitate the sharing of digital design artefacts across the program. This includes a common data environment accessible by all participants, a Uniclass 2015-based common classification system and consistent project requirements to ensure interoperability.

The VDAS supports innovative efforts in complex digital engineering such as the LXRP.

'LXRP has invested significant resources identifying innovative methods for delivering these critical projects for the benefit of all Victorians. Our Solution Reuse program saves us time, cost and improves quality, all of which is underpinned by a digital engineering process.'

John Dyer, Project Manager,
Standardised Design Solutions and Digital Engineering

VDAS supports innovative efforts in complex digital engineering such as the LXRP.



Information management processes

Information management details how organisations manage their data and information to inform decision making. This includes the way the organisations plan, identify, create, receive, collect, organise, govern, validate, secure, use, control, issue, exchange, maintain, preserve and dispose of their data and information.

The primary aim of IM is to ensure that the right people have the right information at the right time.

Good IM practices lead to greater productivity, as information can be retrieved faster and more easily and with a greater level of confidence.

IM is everyone's responsibility – all in the Victorian Public Service (VPS) can improve the way information is created, transferred, managed, consumed and governed.

Information management is not just good practice – it is a key part of Victorian Government policy. At the core of the policy is the fact that:

- information is valued and governed as an asset;
- information is created and managed digitally;
- information is fit for its intended purposes and is easy to find, access and use;
- information is shared and released to the maximum extent possible;
- there is better consistency and accuracy of data; and
- there are better informed decisions on CAPEX and OPEX and any associated trade-offs.

Digital counterparts can be interrogated to find specific information at a specific time.

Once IM policy objectives are addressed, IM supports organisations through:

- an improvement in processes and decision making;
- reduced costs for information storage and application management;
- compliance with freedom of information; privacy and security requirements; and
- the preservation of vital and historical records.

It's also important to note that IM processes are improved when:

- data and information are structured in line with industry standards;
- data is timely, and managed in a meaningful way to be used as information;
- information is the basis for effective decision making;
- the sum of decisions drives effective decision making about an asset; and
- the collective decisions about assets and projects ultimately defines the outcomes of the organisation.

Governance

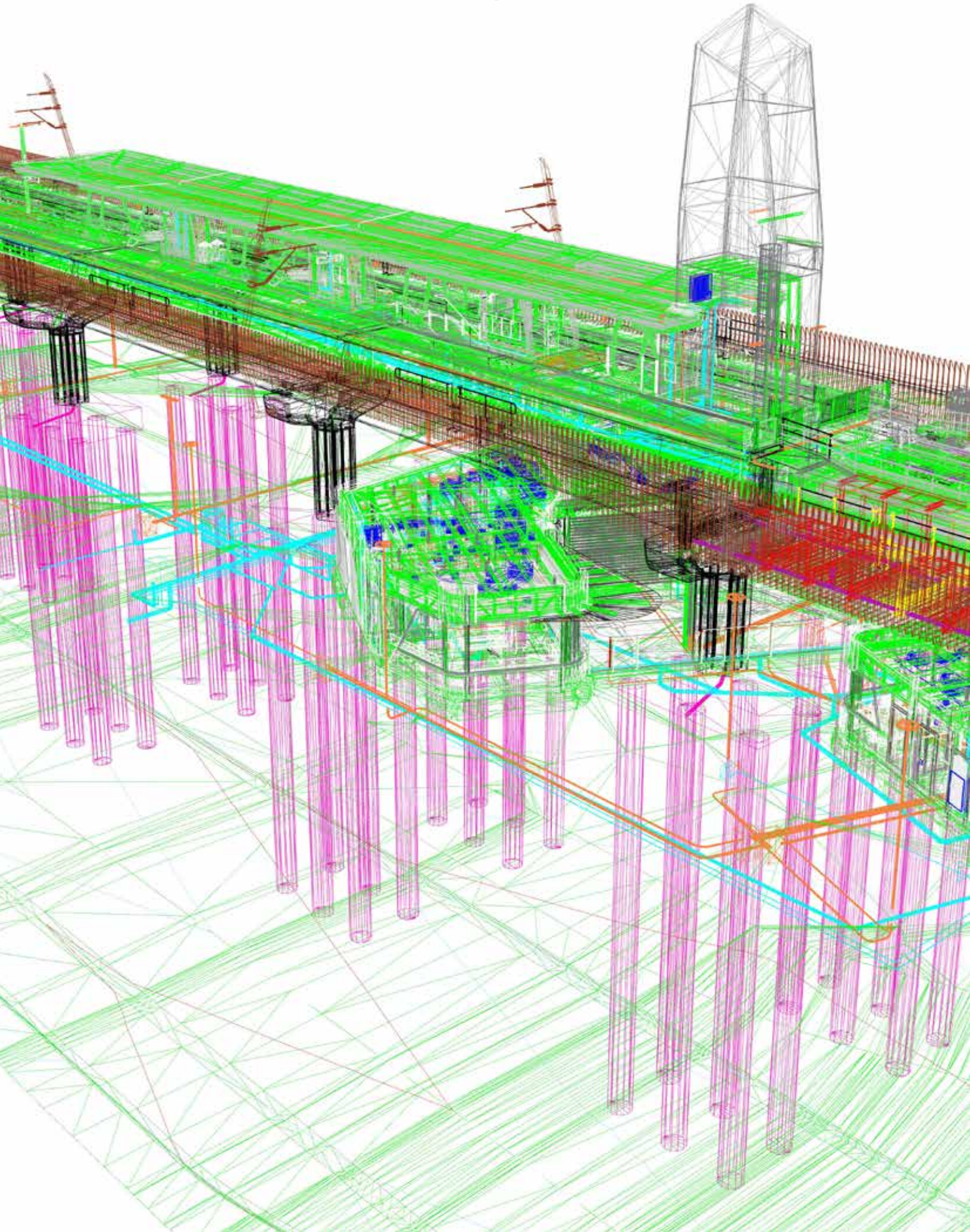
Victorian Government departments and agencies must follow the Department of Premier and Cabinet *Enterprise Solutions Information Management Framework*. VDAS follows the *Victorian Public Service Information Management Policy,* endorsed by the Victorian Secretaries Board.

For more information about the *Victorian Information Management Framework,* refer to www.vic.gov.au/information-management-whole-victorian-government

Developing data relationships

Developing data relationships is important for better asset management of your organisation's digital portfolio and to support statutory compliance with portfolio-level queries. It is also important that system integration is tested outside the project environment before being launched.

Effective IM allows us to quickly model and interact with highly specific information from complex assets.



Asset complexity

Information management needs to be applied in a pragmatic, consistent and functional way. As a result, complex assets demand more from IM systems, while simpler assets demand less.

IM should be appropriate to the size, complexity and essential nature of the asset.

The Victorian Government requires departments, agencies and organisations to demonstrate that they have appropriate IM arrangements, as well as systems and processes for asset planning, auditing and decision making.

Individual organisations should validate their AM complexities, and define an appropriate IM strategy that supports effective asset and organisational performance in line with the IM hierarchy.

Greater need for VDAS →

Simple asset

Low value to Victoria
Limited number/volume
Not an essential service
Low level of technicality
Low downstream impact
Low demand and use
Not a Victorian critical asset
Simple upgrades

Complex asset

High value to Victoria
Multiple assets/sites
Essential service
High level of technicality
High downstream impact
High demand and use
Victorian critical asset
High cultural significance
Upgrades are High Value
High Risk (HVHR)
Prolonged asset use

Information management perspectives

At its core, IM is about people and the needs of users.

There are many ways to do IM – the approach taken must depend on the organisation's needs and perspectives, decision-making requirements, legacy frameworks and the regulatory environment.

Effectively understanding users' perspectives throughout the lifecycle will ensure efficient and effective IM processes.

IM perspectives should be defined on a case by case basis.

The table below sets out an example set of IM perspectives. It shows the suggested owners, supporting stakeholders and update frequency for each deliverable and model as defined in ISO 19650.

Example perspective	Purpose	Example of deliverables
Asset owner	To establish and maintain the purpose of the asset or project. To make strategic business decisions.	• Business plan • Strategic asset portfolio review • Lifecycle cost analysis • Organisational information requirements (OIR)
Asset user	To identify the true requirements of the user and make sure the asset solution has the right qualities and capacities.	• Asset information model (AIM) • Asset register • Product documentation • Operational information
Project delivery or asset manager	To plan and organise work, mobilise the right resources, and to coordinate and control development (depending on circumstances).	• Project brief • Plans, for example digital engineering execution plans • Organisational charts • Function definitions • Project information model (PIM)
Data custodian and steward	Data management practices, including how the information collected, managed and disclosed while in their care.	• Intended use statements • Letters of intent • EIR and the level of information need
Public	To make sure the community's interest is taken care of during the asset's lifecycle (in planning, delivery and operation).	• Policy decisions • Area plans • Building permits and concessions

BIM MEP^{AUS} data standards

Asset owners' asset information needs are predominantly non-geometrical: performance, uptime, pressure ratings, operating temperatures, set points, manufacturer, asset tag number, operating limits and costs. For asset owners and managers, this information is more valuable than having geometrically accurate 'twins' of their assets.

To improve the consistency of non-geometrical parameters of critical and expensive equipment, the BIM-MEP^{AUS} has developed an industry-recognised, structured and consistent approach to digital modelling and data management for mechanical, electrical and plumbing (MEP) services.

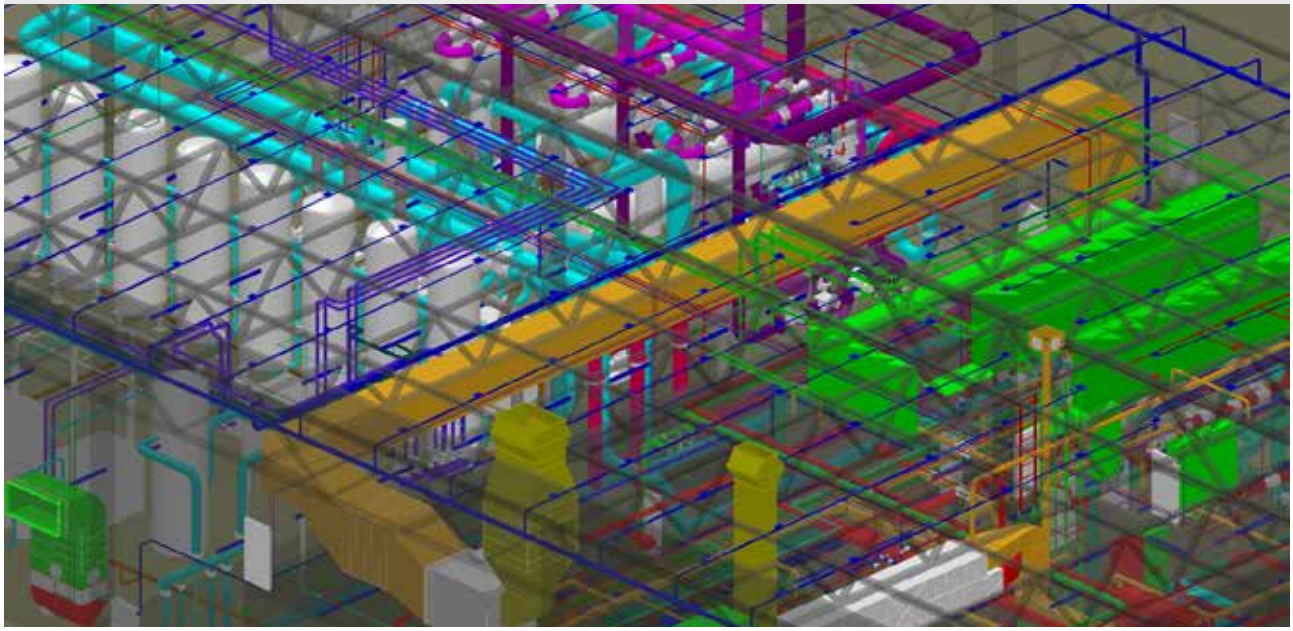
BIM-MEP^{AUS} allows stakeholders throughout the supply chain to develop and operate assets with confidence. Non-geometric parameters are applied consistently, and accurately supporting the decision-making process.

BIM-MEP^{AUS} content is globally recognised and has been developed with advice and support from many of Australia's leading BIM practitioners, including designers and engineering consultants, contractors, specialist contractors, manufacturers and suppliers.

All guidelines, specifications, product data templates and the online parameter manager are free to use and access. They have been developed to align with other relevant standards, such as:

- Uniclass 2015;
- openBIM formats;
- the National Construction Code and relevant Australian Standards;
- VBIS; and
- NATSPEC National BIM Guide and Specifications.

For more information visit www.bimmepaus.com.au



The VDAS information processes

Existing IM frameworks establish a clear set of expectations for operating assets and established organisations.

Although these expectations exist for operating assets, there is a lack of information and structure provided for assets that are being defined, engineered and constructed, that is, stages 1 through 6.

Arguably, most of the information that will assist the operations and maintenance phases (stage 7) is created in stages 1 through 6.

To assist asset and project stakeholders with information management during these important stages of asset development, the VDAS leverages the globally accepted IM process ISO 19650.

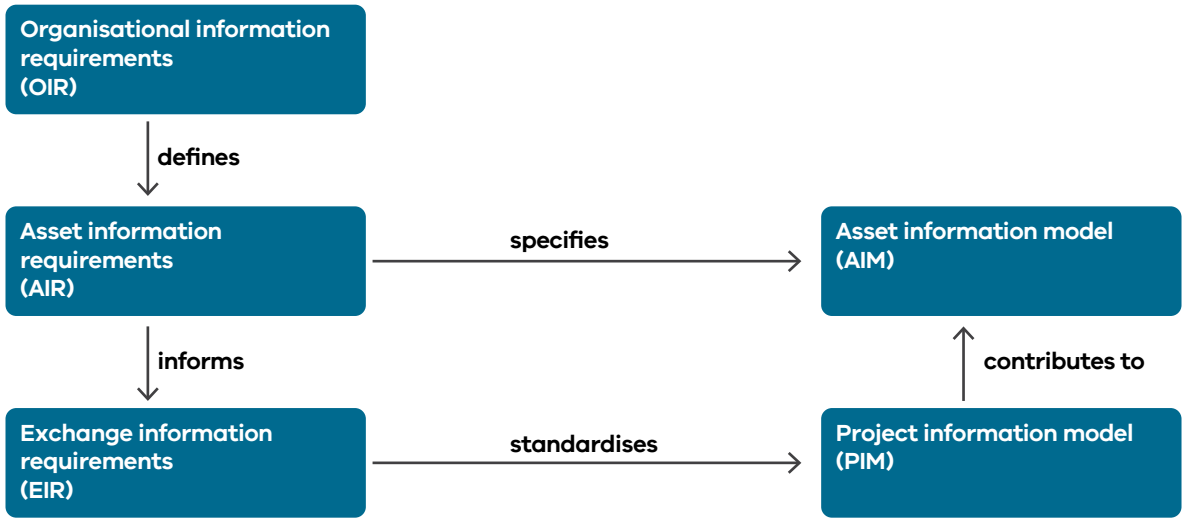
The VDAS complements and is aligned with the Victorian Government's IM Framework.

The ISO 19650 establishes a clear workflow – made up of organisational information requirements (OIR), asset information requirements (AIR) and project or exchange information requirements (EIR). It also establishes two conceptual information models, the AIM and the project information model (PIM).

The VDAS follows, and builds on, the globally accepted ISO 19650 standard with information in the Victorian context, example templates, and greater tie-in with AM and FM activities.

Detailed information is provided on the OIR, AIR, EIR, AIM and PIM in Part C: Application.

The VDAS information process is aligned to ISO 19650. Adapted from ISO 19650.



Deliverable/ model	Suggested 'owner' or custodian	Suggested supporting stakeholders	Suggested update frequency
Organisational information requirements	VDAS Champion	• Secretary • Deputy Secretary • CIO, CTO, CFO • Head of Risk and Compliance • Head of Assets • Head of Projects	Annually
Asset information requirements	VDAS Champion	• Asset Manager • Facility Manager • DE Project Manager(s)	Annually (or as needed based on the complexity of the asset)
Exchange information requirements	DE Project Champion	• VDAS Champion • Project Director • Engineering Manager • Project Manager • GIS Lead • Procurement • Legal • Operations Lead • Maintenance Lead	Per project
Asset information model	Asset Manager/ Facility Manager	• VDAS Champion • DE Project Manager(s) • Operations • Maintenance	Simple assets: annually Complex assets: quarterly
Project information model	DE Project Champion	• VDAS Champion • Project Director • Engineering Manager • Project Manager • GIS Lead • Procurement • Legal • Operations Lead • Maintenance Lead	Ongoing through project (depending on contracting approach and assurance requirements)

ISO 19650

This international standard supports the organisation's digitisation of information about building and civil engineering works, including BIM, and information management using BIM.

ISO 19650 has been widely acknowledged as a step-change in how data and information should flow through the asset or project lifecycle.

It defines clear roles and responsibilities independent of project type, procurement approach, project size and complexity.

ISO 19650 is embedded in to the VDAS approach.

VPS employees can now gain free access to ISO 19650-1 and ISO 19650-2 through the Victorian Government Library Service (VGLS).

For more information about ISO 19650 and to gain access refer to opv.vic.gov.au

VDAS aligns with ISO19650 to plan and deliver assets with specific attention to, and control of, information.

Organisational information requirements

Organisational information requirements (OIR) underpin how your organisation translates data and information into decisions to support the organisational vision, purpose and objectives.

The OIR needs to be defined according to your organisation's mission statement and vision, and alongside IM and AM Acts and policies, strategies and plans.

Defining OIR without a clear understanding of your organisation's vision is an inefficient and wasteful process.

Within the Victorian Government context the OIR may capture information or deliverables established under current policies or acts, such as the AMAF *(ISO 55000:2014 Asset management — Overview, principles and terminology)*, the *Public Records Act* or the *Information Management Framework*.

The OIR sets out the:

- the organisation's functional groups and stakeholders;
- how information 'flows' between the organisation's functional groups;
- key decisions needed to be made by each functional group;
- decisions, information and data required by legislation, reporting, etc.;
- time and path taken for raw data to be processed, adapted, consumed, and returned into information then to key decisions; and
- where information is discarded between functional groups/users.

The OIR also provides confidence to executives that the organisation can fulfil its legal and regulatory responsibilities, such as safety, security, individual information freedoms, and freedom of information.

Getting the OIR right is critical.

The OIR depends on data and informational 'inputs' from organisational stakeholders, such as: asset management, policy, operations, regulation, customers, finance, procurement, projects and strategy.

The OIR uses these inputs to show how data and information flows into, within and out of functional groups within or outside the organisation.

While the overall structure of the OIR remains consistent the contents are unique for every organisation.

Each department, agency or organisation will have a different purpose, area, asset base, and level of service to the community.

An OIR should be considered a 'live' document — one that is reviewed and updated regularly and continuously reflects your organisation's current context. It is an input to the AIR and the EIR but is generally not issued as part of a project's tender documents.

A complete and well-structured OIR will detail the information required to successfully operate individual assets and asset management systems.

Appendix 1 provides an OIR template.

Asset information requirements

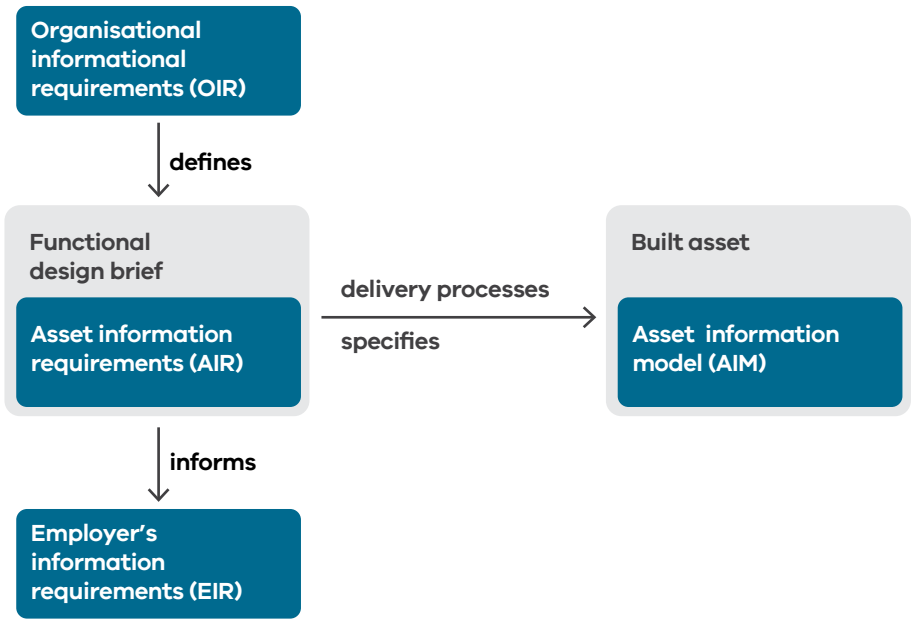
The AIR explains what asset-level data and information is required to meet the organisation's objectives and purpose.

The AIR enhances the quality and consistency of asset information throughout an asset's lifecycle.

It also determines the structure, contents, graphical and non-graphical data of the AIM.

The AIR demands input from key asset stakeholders, including: asset managers and asset operators, facilities management and projects that are specific to that asset. The executive sponsor of the AIR is the VDAS Champion.

Like an OIR, an AIR is a live document that should be updated in accordance with changes to the asset base. The AIR will be used to develop the project EIR, which forms part of the tender documents.



The AIR typically includes:

- asset register;
- data schemas/standards;
- confirmation of how many information fields are required as a minimum in the asset register;
- costs associated with each item;
- whether a parent and child breakdown is required, and to what extent;
- managerial information – unique asset identification numbers, asset location (via spatial referencing or geographical information systems, or location codes), replacement periods, warranties and guarantee periods;
- financial information – data relating to an asset's whole-life-costs, including the cost of historical planned maintenance, depreciation schedule, estimated replacement value, original purchase or leasing cost, and cost to replace;
- commercial information – such as descriptions of assets and the systems they serve, as well as functions of assets and vendor data (details of the organisation that supplied the asset);
- technical information – such as engineering data and design parameters, and operational data, including performance characteristics and design limits; and
- legal information – such as asset-related contractual information, task risk assessments and control measures.

An AIR forms an important part of the exchange information requirements (EIR).

Appendix 2 provides an AIR template.

Essential asset-level data is defined early to ensure the built asset has all the required embedded data to inform operation and maintenance phase.

Exchange information requirements

The EIR establishes the related managerial, commercial and technical aspects to produce and consume information and data throughout the project and asset lifecycle.

The EIR clearly defines the owner's data and information requirements throughout the life of the project.

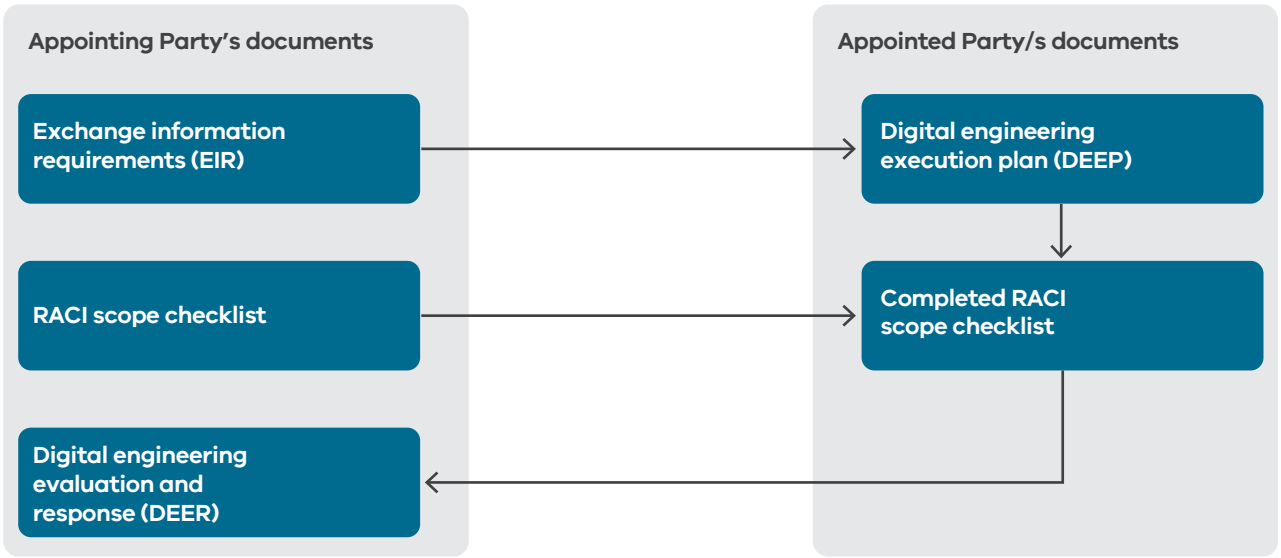
Two of the key managerial aspects of the EIR are the responsible, accountable, consulted and informed (RACI) scope checklist and the level of information need. These two tools articulate the information you want and its purpose. Level of information need is discussed in the next section.

The technical aspects of the EIR specify the detailed data and information needed to achieve the high-level strategic objectives. This includes information security requirements.

The EIR is issued to bidders as part of the tender process.

Bidders 'respond' to the EIR in the form of a digital engineering execution plan (DEEP).

The DEEP demonstrates how, if successful, the bidder will work with their supply chain to deliver and manage data and information in line with the Appointing Party's requirements.



It is important to allocate time and resources to prepare a quality and tailored EIR for every project.

This includes the definition of a complete and comprehensive set of information requirements that are synchronous with the AIR and OIR.

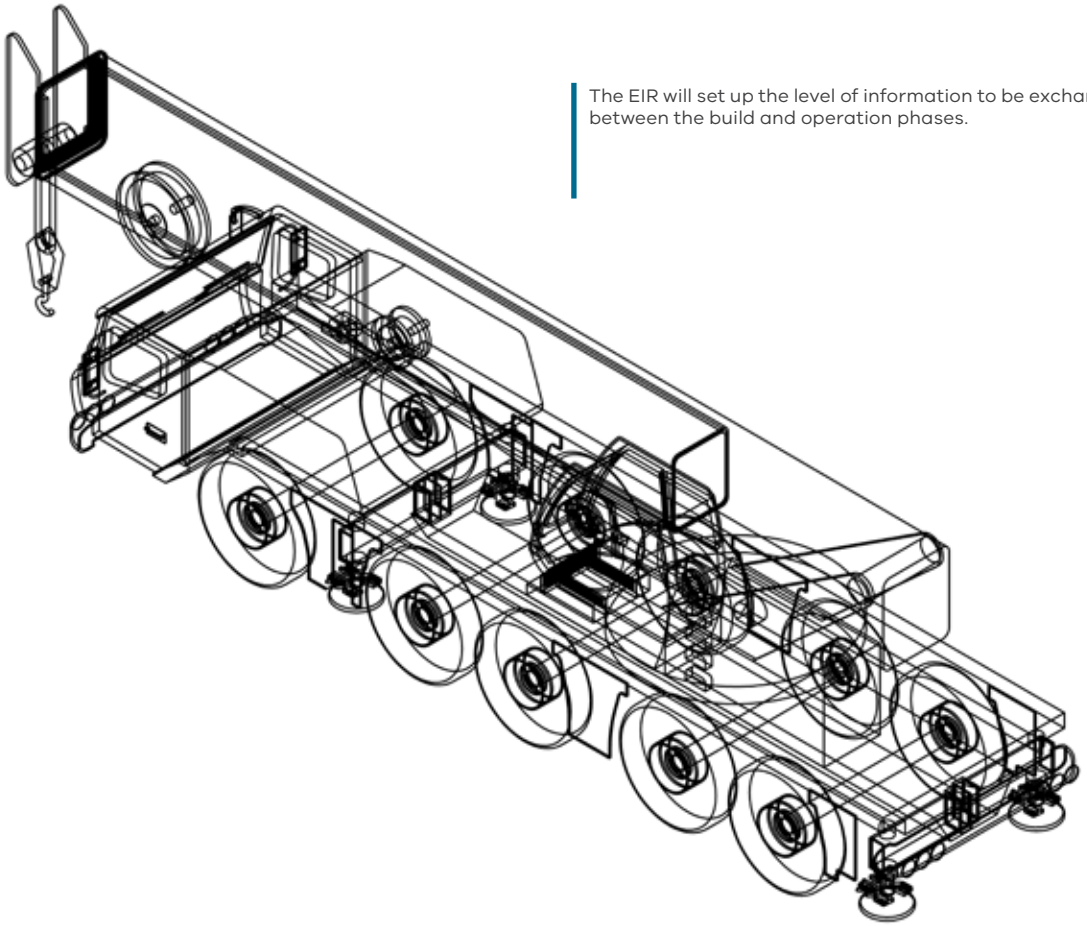
Appendix 5 provides an example EIR template.

Tip

EIR is known by other names, such as: employer information requirements or project information requirements or 'client' information requirements.

In the context of the VDAS, these documents all drive similar outcomes: to define the information and data procurement and 'ways of working' between the Appointing Party (Government) and the Appointed Party (the Contractor).

It's worth noting that the Appointed Party is also likely to create their own EIR, and it is highly beneficial if they are aligned. To minimise confusion, these sub-EIR are not referred to in this document



The EIR will set up the level of information to be exchanged between the build and operation phases.

Level of information need

ISO 19650-1 introduces the concept of level of information need in response to onerous (often over) specification of modelling detail.

Defining the level of information need provides all stakeholders with a clear way to articulate the purpose of the requested data and information. It is the basis for a conversation, and acts as the ideal framework to determine the appropriate level of development (LOD).

Level of information need complements LOD; it does not replace the need to specify LOD.

Instead, level of information need contextualises LOD. Project team members (designers, suppliers, manufacturers and constructors) always require clarity on 'what' to design, supply, manufacture and construct. LOD assists with defining their information requirements.

It is the DE Project Champion's and the VDAS Champion's responsibility to articulate the level of information need and LOD.

By doing so, the project team and contractor will not incur costs and losses in productivity to 'back capture' information or unnecessarily capture too much information.

The digital engineering execution plan (DEEP) should be developed as a response to the Appointing Party's level of information need. This ensures information is created for a purpose and that purpose is defined.

Appointing Parties may struggle to articulate their level of information need and LOD. A good way to determine level of information need within the organisation is to use plain language questions (PLQ).

PLQ are simple 'prompts' for the Appointing Party that can be used throughout the asset lifecycle to verify the organisation is receiving the right information, in the right format, at the right time.

Appendix 5 provides an example EIR which includes a basic level of information need template. Appendix 3 provides example PLQ.

Digital engineering execution plan

The digital engineering execution plan (DEEP) articulates how prospective bidders plan to develop the PIM and align with the Appointing Party's systems and requirements. It is populated by the prospective project tenderers.

The DEEP outlines a response to the EIR and includes a proposed IM delivery approach throughout the contract period.

The DEEP has multiple purposes and benefits.

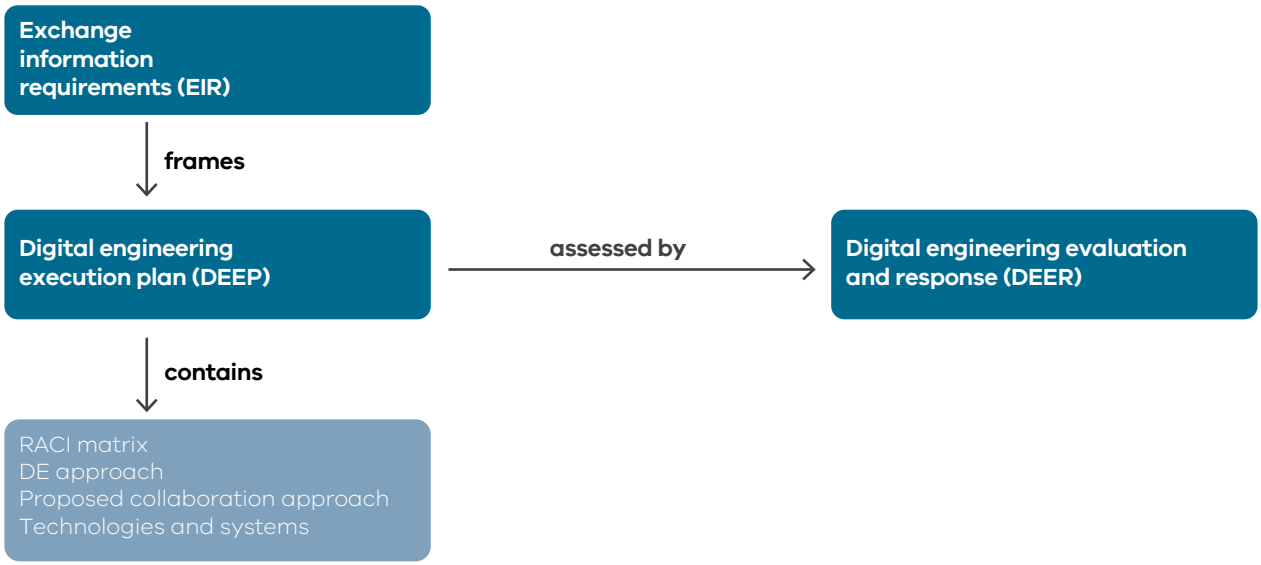
First and foremost, the DEEP is a key document that enables the prospective tenderers to highlight their capabilities, that they understand the owner's requirements, and the depth of conversations within their organisation and their supply chain.

Another benefit is that it provides the Appointing Party with a means to comparatively assess prospective tenderers with respect to DE. It also enables a 'conversation' between the Appointing Party and any prospective tenderer.

To be of value it is recommended that the Appointing Party must review and customise the DEEP template in line with the project and organisation's needs. Further, it is recommended that the DEEP be structured in the same way as the EIR following the commercial, managerial and technical sections.

Detailed information on the DEEP and the recommended approaches can be found in Part C.

Appendix 6 provides a DEEP template.



Digital engineering evaluation and response

The digital engineering evaluation and response (DEER) is a standardised template that allows the Appointing Party to assess the bidder's DEEP in a consistent and transparent manner.

The DEER provides the Appointing Party with a checklist of IM criteria that should be highly valued throughout the project or asset lifecycle. Valued criteria include: shared vision/objectives, people, training, approach, visual bidding, standards, alignment with AIR and OIR, etc.

This can help the Appointing Party to understand if the proposed tenderers have thought about, and documented, their approach to digital engineering and whether it is aligned to the AIR and EIR and their scope of services.

A sample DEER can be found in Appendix 8.

It is highly likely that tenderers are developing detailed object-based project information models as part of internal 'business as usual' scoping and bidding processes.

In these circumstances prospective bidders could use this information to convey: design intent, function, performance, aesthetics, or value creation and capture objectives.

Asset information model

The AIM is the centralised source of validated and approved information that supports your strategic and day-to-day AM and FM processes.

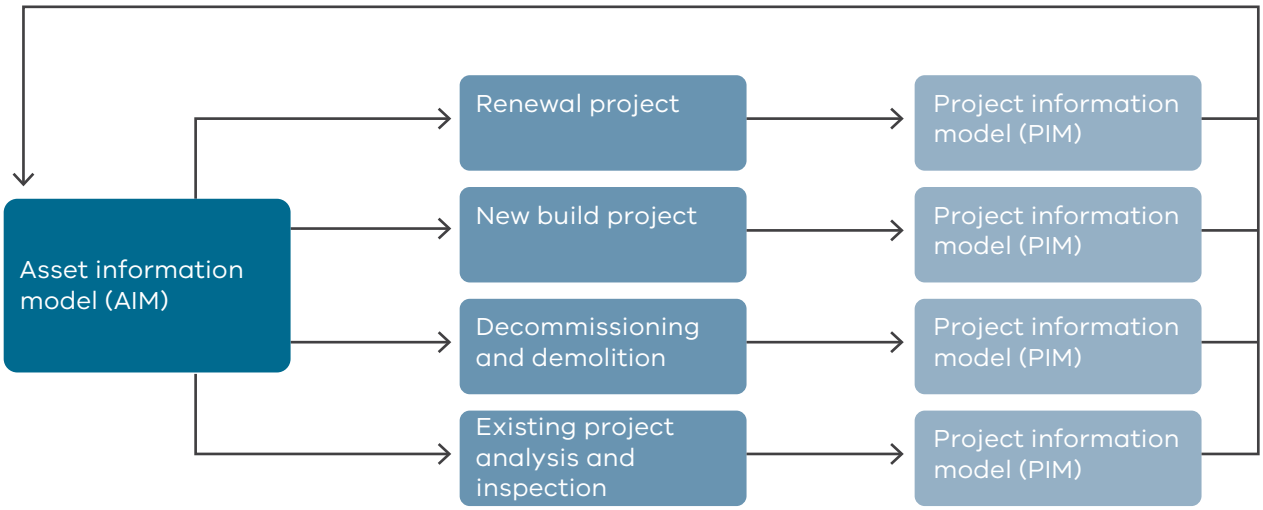
The AIM includes relevant data and information generated from as-built PIM which is integrated with other asset-management tools and systems. The contents of the AIM are specified by the AIR.

The AIM is used daily by the organisation's operators, asset managers, end users and facility managers.

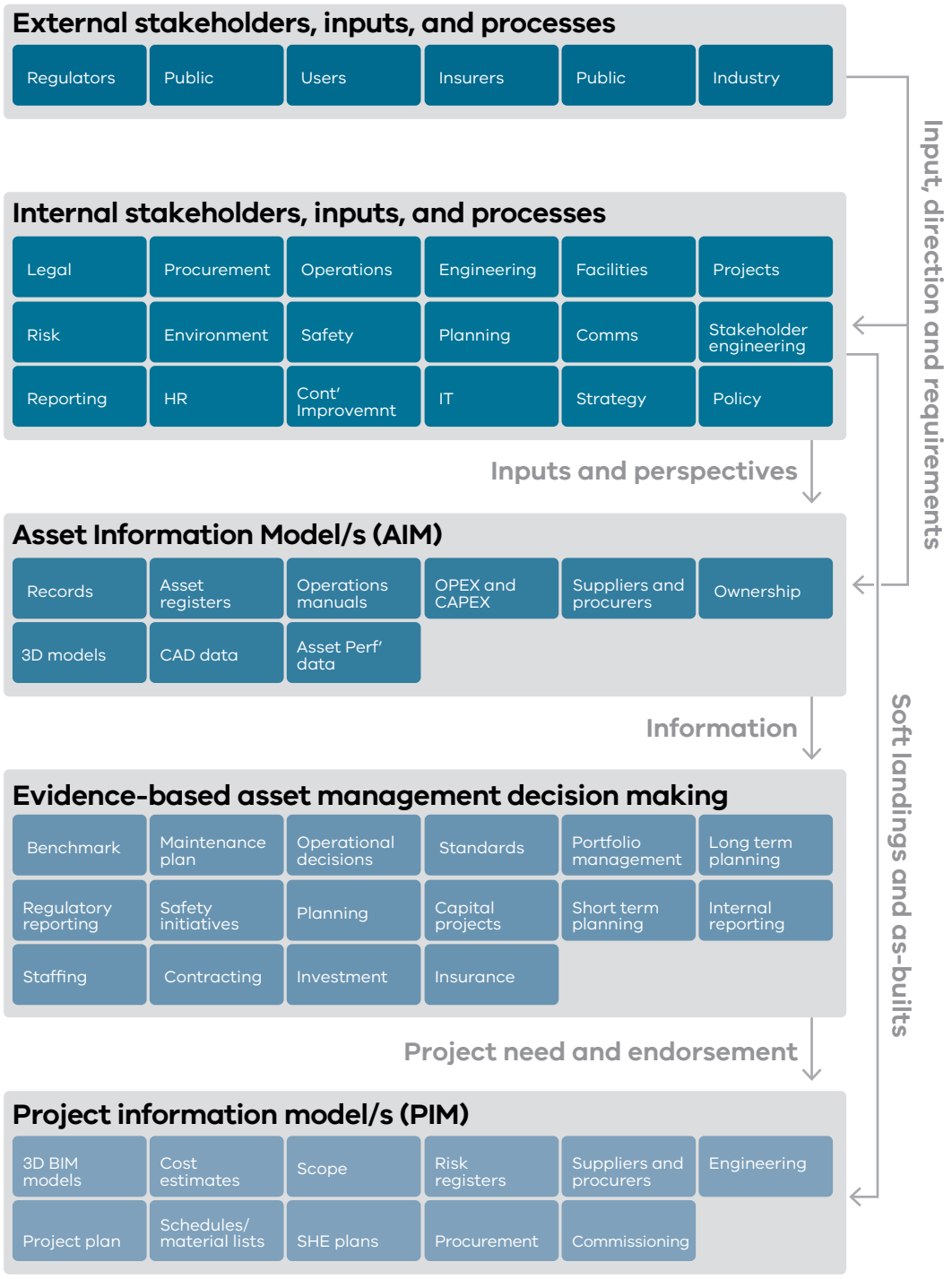
The AIM also informs new projects, renewal projects and maintenance programs. The information captured as part of these projects is then fed back into the AIM – keeping it current.

The AIM includes:

- integrated view of information and data from existing organisational systems, such as finance, procurement, assets, maintenance and operations;
- capital portfolio models;
- operation manuals;
- key resources;
- records;
- design intent;
- ownership details;
- survey work undertaken;
- operational performance details;
- costs;
- 3D models;
- common data environment of information;
- the location of all assets;
- ability to generate the primary list of all parent and child assets (items for asset register); and
- single point of truth for all information.



The AIM is housed within the asset information management system (AIMS) as outlined in the AMAF, and typically includes information contained within the asset register, CAFM, GIS, BIM information, e-plan rooms, building management systems, or distributed control systems.



Asset register

As part of the AMAF, Victorian Government departments and agencies must maintain a current asset register and an asset risk register that is commensurate with the asset's or organisation's complexity.

The asset register and asset risk register form the basis of the AIM.

The VDAS approach supports the development and ongoing maintenance of asset registers as required by the AMAF.

For Victorian Government departments and agencies, the asset register should include requirements as established by the Victorian Managed Insurance Authority (VMIA).

These include:

- asset classification;
- asset performance or condition (to meet service delivery objectives);
- function and performance;
- responsibility/ownership/governance;
- lifecycle cost by asset or program;
- asset-tagging and naming conventions;
- information required to meet financial or regulatory requirements;
- level and frequency of asset maintenance program;
- transactions and financial information affecting the assets;
- parent and child requirements;
- the minimum number of information fields required within register to meet financial or regulatory requirements;
- actual asset item cost;
- actual supplier and manufacturers details;
- test and commissioning; and
- warranties.

VDAS also recommends that assets within the register are spatially referenced as well as classified, hierarchically managed and location referenced as per Uniclass 2015.

Victorian Department of Transport Asset Condition and Investment Modelling

The Victorian Department of Transport (DoT) Asset Condition and Investment Modelling (ACIM) project is a leading example of how analytics and modelling can inform integrated planning and investment.

It contextualises the Asset Investment Framework, AMAF and VDAS within the transport context.

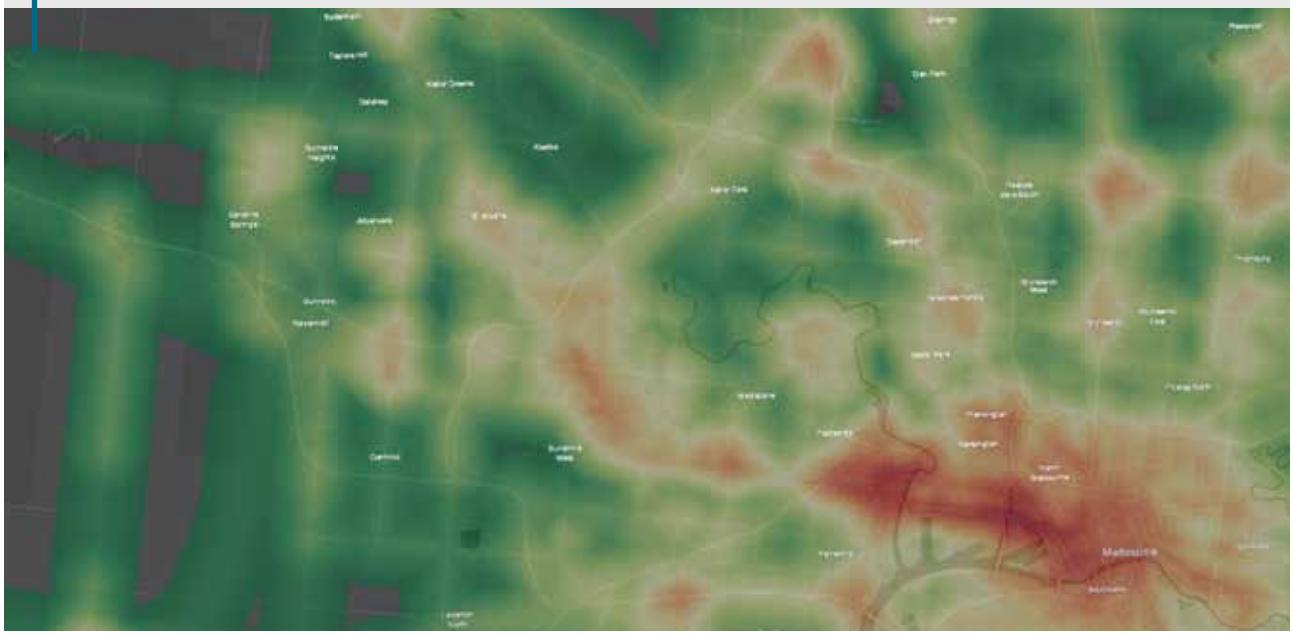
The ACIM project seeks to integrate information on asset condition, risks, utilisation and operating investment of the DoT asset base to inform decision making on asset utilisation, investment productivity and whole of life costs.

Once completed, the ACIM will be a key input to DoT's service delivery planning, strategic asset management plans (SAMP), network strategy, modal plans and timetable modifications.

Key benefits of the ACIM project include:

- understanding key asset risks, asset availabilities, and opportunities;
- providing objective and data-based evidence for investment and decision-making for both existing and new assets;
- provides real time data about whole-of-life asset costs;
- targeted investment to asset capacity and productivity by matching investment decisions to service delivery and user outcomes; and
- creating a sustaining asset IM capability to secure ongoing, continuously improving and repeatable outcomes.

Data is informing future investment strategies in Victoria – seamlessly integrating key information to inform decision making.



Project information model

The PIM is a federated collection of information 'containers' created during planning, design and construction. The production of the PIM is developed within the project's CDE.

The PIM is made up of information containers from multiple sources, systems, software and locations. It typically contains connected information and data sources such as survey, CAD, BIM, and GIS, and cost, schedule, safety and other project-related data.

The PIM can be made up of many different software, systems, networks and user groups.

The goal and core of the PIM is that these systems, software, networks and user groups are organised and synchronous with one another.

In practice, this means:

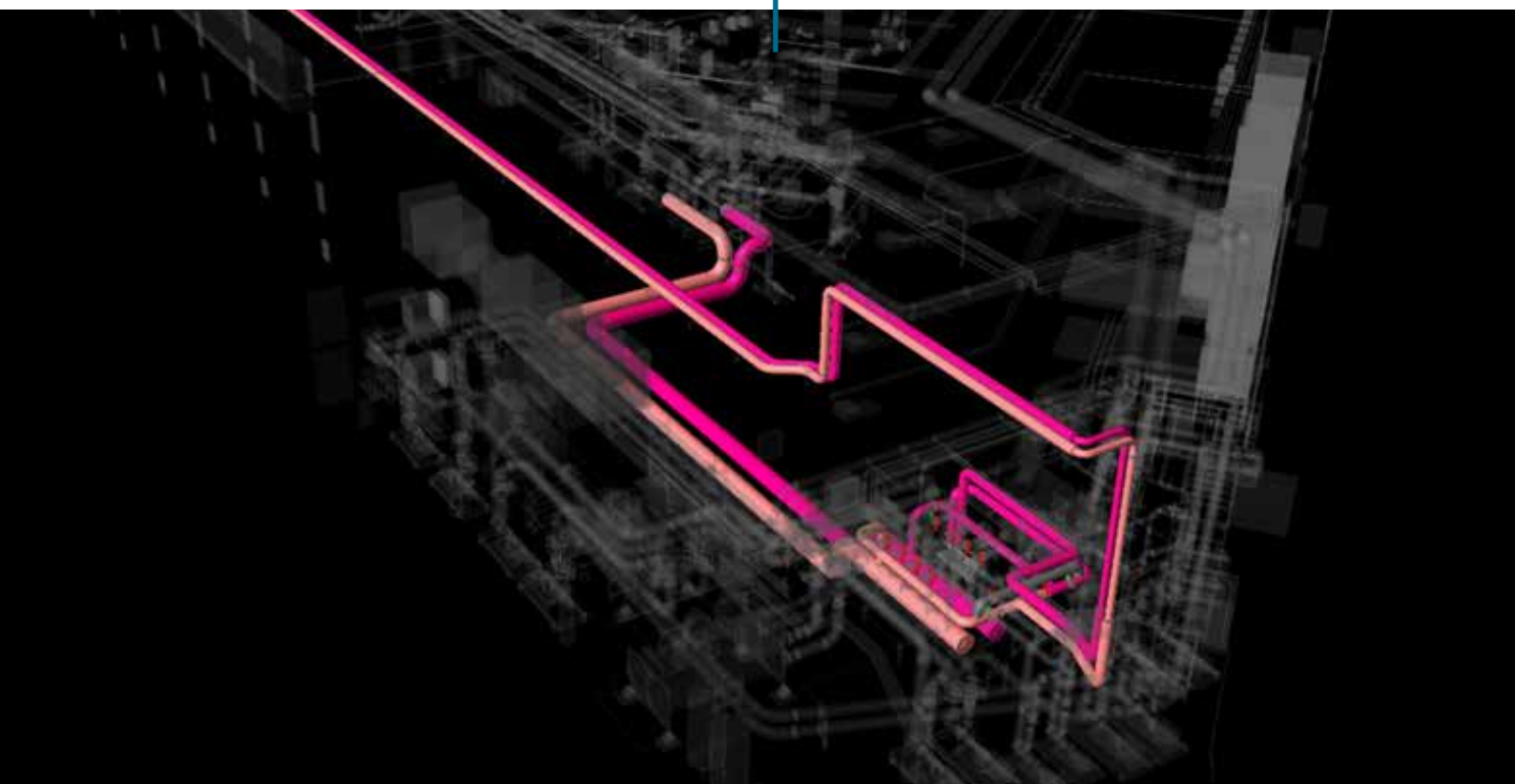
- fewer locked PDFs, emails with bespoke information in them and repeatedly collecting the same information and data; and
- systems can 'interact' with one another – i.e. capital costs contained within a cost estimate can be linked to an 'object' within a model authoring tool.

Information between systems and containers may interface in many ways: through application programming interfaces, structures/schemas, naming conventions, cost breakdown structure, work breakdown structure and procurement codes.

It is important that the data structures of the PIM aligns with the AIM, the AIR and EIR. This simplifies the transfer and integration of data and information throughout the lifecycle.

Further, it is highly recommended that departments and agencies begin to move toward including as-built drawings and asset registers that are, where possible, handed over on a 'for-reliance' basis.

The PIM will enable extraction of specific information at a specified level of detail.



Data quality

At the core of the VDAS is trusted high-quality data that enables confident decision making, informs policy development, promotes data reuse and supports service delivery. This data should be verified and validated at key points in the asset lifecycle.

Data quality standards provide a consistent approach to measuring and communicating among stakeholders.

Data quality is at the forefront of organisations being more productive and making better decisions.

The Victorian Government approach to data quality has been established by the Information Management Framework.

All Victorian Government departments and agencies should follow IM-FMW-01 and IM-STD-07. It is recommended that they also follow IM-GUIDE-09.

This standard requires all critical data across the Victorian Government to follow seven data-quality dimensions.

The seven data quality dimensions are shown below. It is important to note that improvements in data quality need to be commensurate with the information and decision they inform. Needlessly spending money to increase the 'currency' element of a specific data source is wasteful if the decision doesn't depend on 'up to the minute' information. Data quality should be measured across the seven dimensions outlined in IM-STD-07.

Legal and procurement

There are several evolving legal issues with the rise of digital engineering. The purpose of this section and supporting sections in Part C aim to clarify certain legal aspects.

All projects require a high degree of focus on legal and procurement matters. The introduction of the VDAS does not mitigate that need.

The VDAS has been developed using lessons learnt from past projects, and it is informed by advice on how to navigate digital engineering in the complex legal and commercial environment associated with major capital investment.

VDAS does not introduce new legal and commercial risks to projects but seeks to mitigate emerging digital engineering risks.

Instead, digital engineering changes the way we approach existing risks related to traditional paper-based approaches to IM.

Part C of this document includes a detailed discussion of commercial and legal matters at a project-specific level.

At the organisational level, however, it is the VDAS Champion's role to consider commercial matters, together with the Chief Legal Counsel and the Chief Procurement Officer.

Data standards

Data standards are documented agreements on the consistent format, representation, definition, use and management of data.

Data standards are essential in creating high-quality information that informs decision making.

The following section details specific data types, sources, standards and classifications.

Wherever possible, the VDAS supports open data formats.

Data standard	VDAS applicable formats
Asset classification	Uniclass 2015
Asset hierarchy	Uniclass 2015 with a suggested approach as outlined in Part C.
File formats	*See below note*
Proprietary data formats	
Survey and titles	LandXML
Datum	GDA2020
Geospatial data formats	Open Geospatial Consortium (OGC), ISO 19100 series
ISO	19650, 16739, 12006

Note: The VDAS supports the following:

- Data Vic access policy Principle 4 'Government data will be easy to find (discoverable) and accessible in formats that promote its reuse';
- the National Digital Engineering Policy Principles; and
- the Gemini Principles.

The VDAS supports BIM formats in the following order of preference: Industry Foundation Classes (IFC), including COBie, followed by native or proprietary.

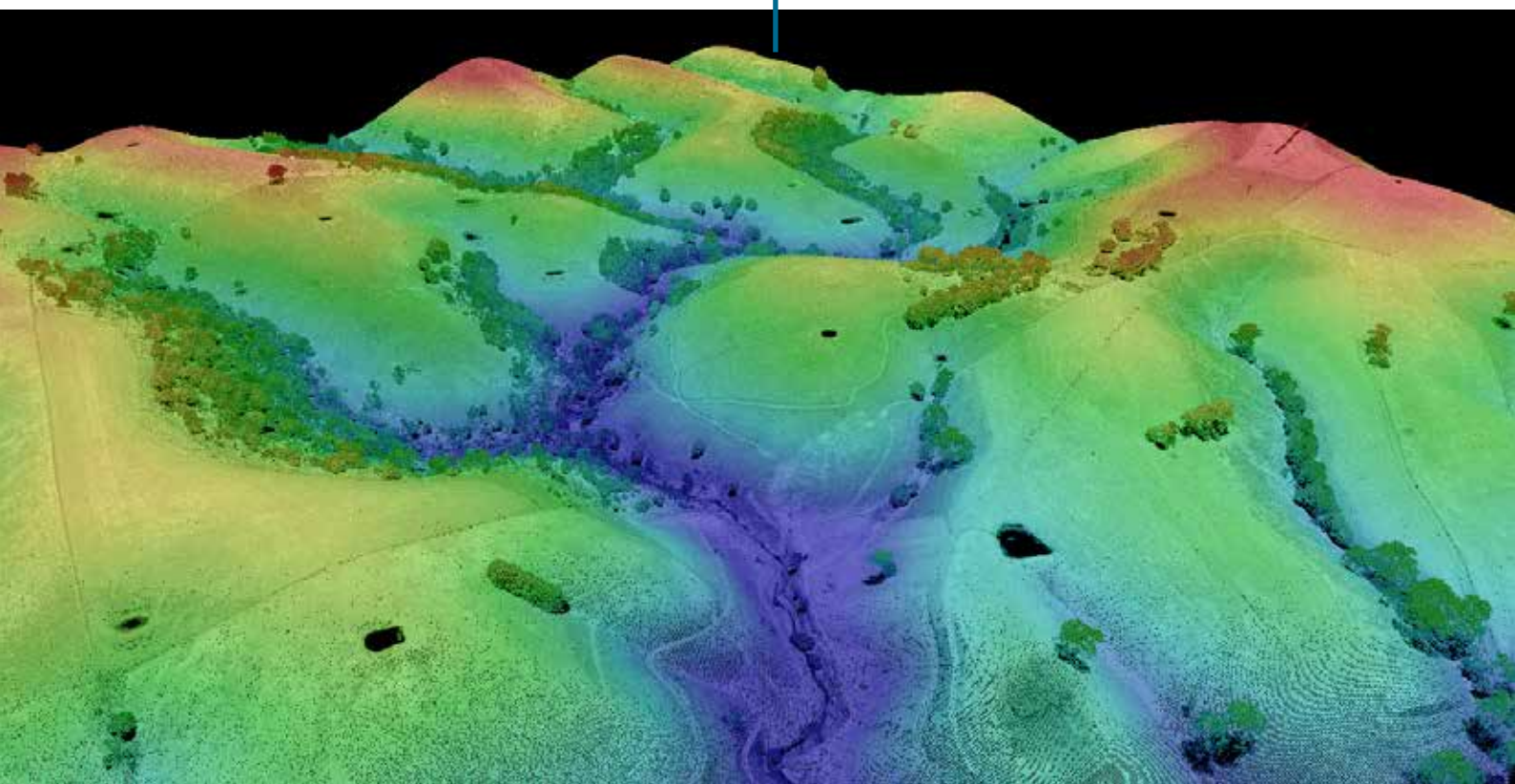
VDAS acknowledges that openBIM formats may not serve all use cases.

In these circumstances, native or proprietary formats may be used. However, it must be recognised that there are many challenges associated with using proprietary formats, such as:

- schema of proprietary formats are generally not transparent – this practice impedes reasonable and non-discriminatory sharing between stakeholders;
- proprietary data formats tend to favour the incumbent organisation – by design, many proprietary formats are difficult to translate to future platforms and formats. This presents itself as an implied 'barrier to exit';
- data formats that are not supported in perpetuity – some of the data and information generated for/by the State may need to be maintained and read later; and
- proprietary formats are often patented – corporations maintain patents and intellectual property associated with their own formats and format structure. Accessing and maintaining data in this format carries an inherent cost.

It is the responsibility of the DE Project Champion, in alignment with the VDAS Champion, to understand and communicate the process, IM workflows and IM challenges (such as file formats) to be undertaken by the project team.

Many different data sources can be integrated to inform better decision making.



Asset classification

Asset classification is one of the most important parts of establishing and maintaining assets.

Historically, asset classification schemas have been inconsistent for each stage, project, asset and department or agency. Getting a consistent asset classification system is paramount.

Asset classification is the 'common language' – the one source of agreement among all asset stakeholders.

The VDAS supports the use of Uniclass 2015 as it is a widely accepted and unified classification and hierarchy system for both buildings and infrastructure covering the asset lifecycle that supports a wide range of stakeholders.

Uniclass 2015 complies with ISO 12006-2:2015, is mapped to RICS NRM1, VBIS, OBOS and various common object databases available.

Uniclass 2015 is a unified classification system that is flexible enough to accommodate future classification requirements, is free to use, and is owned and maintained by the United Kingdom's National Building Specification (NBS) on behalf of the global construction industry.

Where Uniclass 2015 does not fulfill a specific classification need, the Appointed Party should work with the client to develop an appropriate standardised classification system.

Part C has more information on Uniclass 2015 including a proposed asset classification hierarchy.

Example

Project cost data can (and should) be allocated into a cost breakdown structure (CBS) that is common across the organisational (and other departments and agencies).

Similarly, using an asset classification system (such as Uniclass 2015 and VBIS) allows for a common alignment of scope and nomenclature.

Aligning a common CBS with common asset classification system enables:

- best practice cost benchmarking;
- enhanced transparency of capital costs and scope; and
- rapid cost options assessment in a BIM environment.

When the project's work breakdown structure (WBS) is linked with the CBS and the asset classification system, the value of project information exponentially increases.

Data formats

Industry Foundation Classes (IFC)	IFC is an open-data format managed and maintained by BuildingSMART International that is published freely without limitation. As the schema is freely available, the data can be accessed by anybody willing to recognise and implement the schema. It provides and promotes interoperability. IFC schemas are published as an ISO standard. IFC provides a global consensus on a comprehensive suite of objects including attributes and relationships through the entire lifecycle of a project. Where possible, VDAS recommends the use of IFC (in any version) to promote interoperability.
Proprietary formats	A data format with a structure and contents that are protected. The company or body that owns this data format controls the access and use of their data through a commercial application or web service that generates revenue. Consumers storing data within a proprietary data model can be locked out of their data if the controlling organisation folds (for example, due to insolvency, a sale of the company or changes to the services it provides). Proprietary models have limited compatibility and interoperability, encouraging monopolies and dependency. Proprietary models may be more flexible due to being directly funded by an owner, and they may make it easier to reach consensus on standards.
Geospatial data formats	The Commonwealth Government's policy on public data requires, where they exist, the use of agreed open standards when making data available. The VDAS recommends the use of domain standards that are openly available to provide a common language for communication and provide consistency of meaning for the data collected, and for products created in a construction project. There are two global organisations in charge of creating and maintaining GIS standards that are applicable to VDAS: The Open Geospatial Consortium and ISO. The OGC represents an international, voluntary consensus on standards, where more than 500 commercial, governmental, non-profit and research organisations worldwide work together by consensus to encourage the development and implementation of open standards for geospatial content and services, 'internet of things', GIS data processing, and data sharing.

Technology and systems

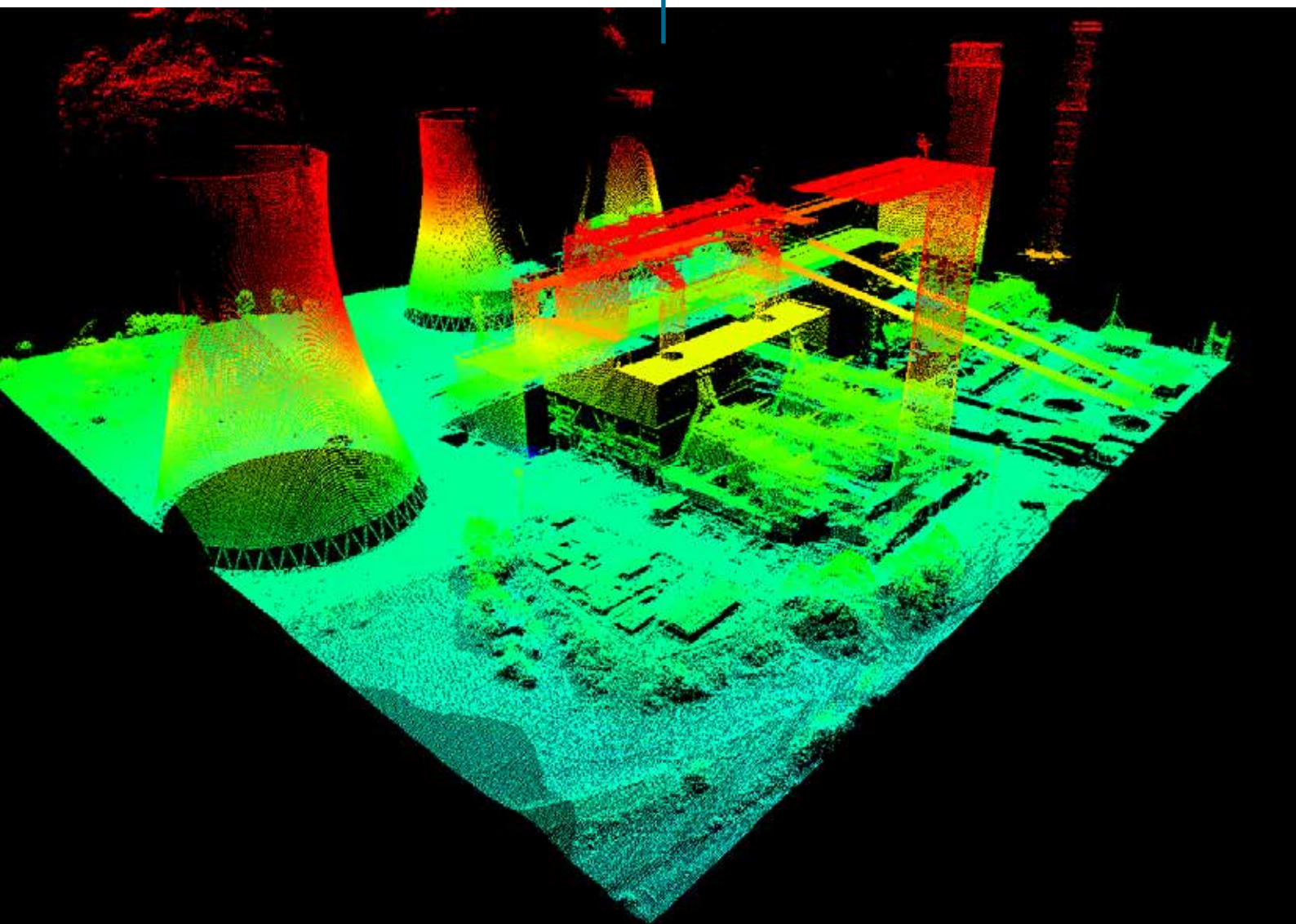
It is common for different functional groups and users within an organisation to need and use many different technologies and systems.

For example, maintenance teams rely on CMMS, finance departments rely on financial asset information systems, engineering teams rely on BIM (and CAD) systems, while surveyors, planners and spatial professionals are likely to rely on a planning tool, such as GIS.

Implementing the VDAS does not imply decommissioning legacy systems or make these technologies or systems redundant.

Instead, the VDAS, ISO 19650 and ISO19100 value system interoperability.

Drone-captured high quality LiDAR datasets are invaluable to capture existing conditions.



These technologies and systems should continue to be used where they:

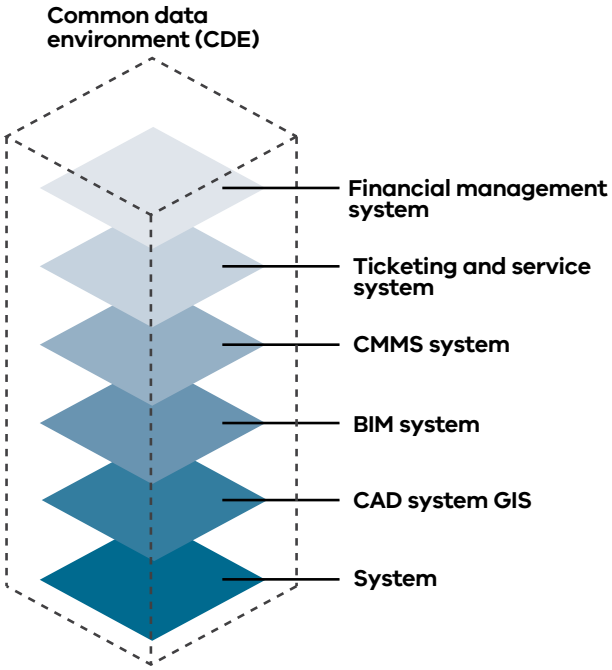
- fit a functional purpose;
- are productive; and
- integrate with other data sources within the PIM.

For any organisation to remain efficient, an integrated information strategy is required. This means that all information systems need to communicate with each other in a structured way.

The collection of systems and technologies that service an organisation and its user groups is called the operational CDE.

In this CDE, the value of data and information within each system is increased when systems share data between one another.

Part C provides a detailed discussion of each of the technologies and systems required to implement the VDAS approach.



Schedule data, when integrated with BIM data, becomes an incredibly powerful information source for sequencing complex work. Integrating these data sources means a better understanding of the worksite over time, which leads to fewer traffic disruptions, higher site productivity, increased safety and fewer costs.

BIM and GIS integration

BIM and GIS integration allows the creation of 'digital twins' and virtual environments that mirror the physical world. Combining these two systems helps to integrate 'micro-level' information with 'macro-level' information. Combining these two can generate significantly powerful insights and deliver value on a range of use cases.

Integrating BIM and GIS has limitless application in urban and regional planning, crisis and disaster simulations and risk management. Decision making in these areas is increasingly complex in an environment where space, land-use and natural resources are becoming more and more valuable.

GIS increases the value of BIM by enhancing locational contextual clarity (i.e. including specific locations and elevations, and connecting this to ambient temperatures, legal boundaries, and shadows etc.) around objects.

Despite the upside BIM and GIS integration is not without challenges. The biggest challenge is understanding 'which' information needs to be transposed and integrated.

These challenges are not insurmountable with rapid progress being made by Land Use Victoria and Office of Projects Victoria to integrate BIM and GIS at a state level to enable Victoria's digital twin.

In the interim and at a more local level the VDAS Champion is responsible for integrating these two systems in line with requirements and use cases established in the OIR and AIR.

Example

The many decisions we need to make about how to operate an asset rely on much of the same information that was generated during the delivery of that same asset. This data is itself an asset of value and should be managed accordingly.

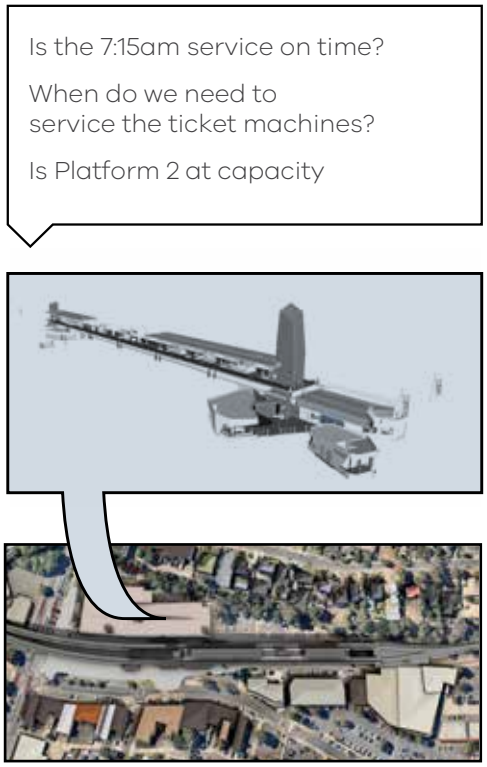
For example, if we wish to know the original manufacturer of a specific piece of equipment to identify replacement costs, location of spares and maintenance provisions, without easy to access digital information we may be forced to make sub-optimal decisions.

The VDAS Champion must consider the following:

- status and comprehensiveness of existing (BIM and GIS) information;
- purpose of integration;
- use of non-proprietary formats;
- use and consistency of model view definitions (MVD);
- consistency of asset classification schema (i.e. adoption of Uniclass 2015);
- aligning project coordinates with real world spatial coordinates;
- how sub-surface and utilities information is captured within the integrated model; and
- understanding how cadastral and legal ownership boundaries also affect the underlying objects – such as access requirements.

For more information about GIS and BIM integration within the Victorian context contact OPV.

GIS and BIM integration is the key to 'digital twins' and integrating valuable micro- and micro-level information for holistic decision making.



Types of BIM-GIS integration

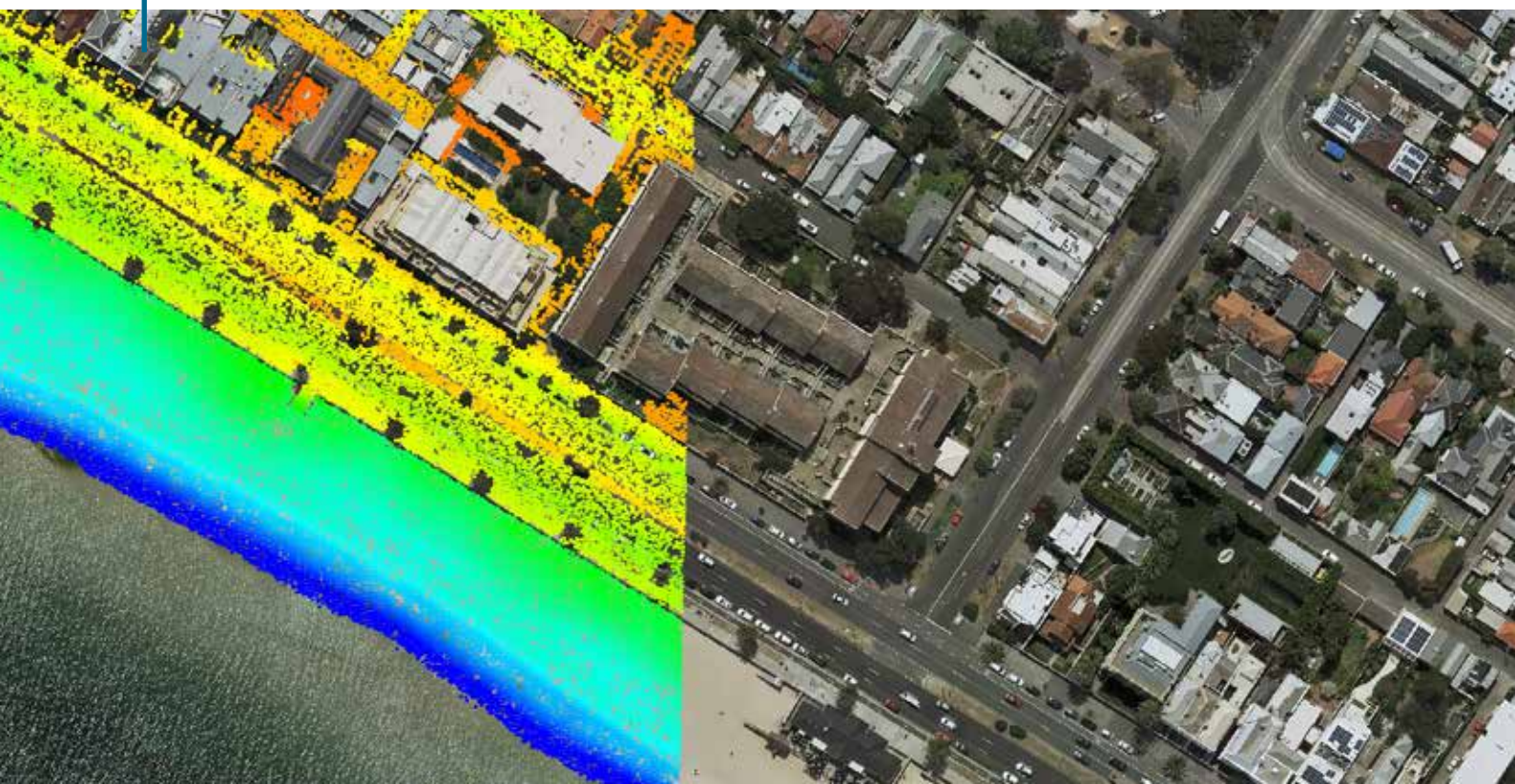
Integration of BIM and GIS is complicated by the fact that both technologies were originally created with different purposes in mind.

To enhance integration, VDAS recommends reviewing the following to optimise BIM to GIS coordination:

- using industry foundation classes (IFC) formats;
- adopting Uniclass 2015 for asset classification and hierarchy tables;
- aligning the coordinate reference frame for the project with the one adopted by the Victorian Government – GDA 2020 (datum), MGA (X/Y coordinates) and AHD (height);
- aligning 'transfer' points (i.e. stage 3 for a defined solution, and stage 6 for 'as-builts');
- adopting ISO 19100 series standards;
- aligning Uniclass 2015 'complexes' or 'entities' tables with base classes (buildings, bridges, vegetation etc.);
- linking sub-BIM elements to GIS elements, such as rooms, spaces, systems etc; and
- defining complex 2D and 3D geometry such as planes, vertices, loops etc.

In Victoria, there are ongoing and significant developments to integrate cadastral, geospatial and BIM information. For more information, contact OPV or Land Use Victoria.

Innovative technologies can capture existing conditions with high accuracy forming a strong basis for BIM and GIS data integration.



Asset information management system

An AIMS maintains the necessary information, tools, applications, processes and interfaces required to support the strategic, tactical and operational management to support the asset.

In line with the AMAF, organisations must maintain an AIMS that is defined by the AIR, asset complexity and regulatory requirements.

The AIMS must effectively and efficiently manage the AIM. It must maintain and provide current asset information and historical financial records over the asset's life for the purposes of:

- asset planning;
- asset performance monitoring and reporting; and
- accountability, transparency, record keeping in line with VPS and PROV requirements.

The functional requirements of an AIMS will depend on the size, nature and complexity of the organisation's operations and asset portfolio. For an AIMS to fully support effective and efficient asset decision making, it should:

- be comprehensive and include all assets under the control of the organisation;
- manage assets to a detail or specificity that enables effective strategic asset management;
- be classified in line with Uniclass 2015;
- capture details of all transactions affecting the assets as they occur;
- have associated procedures, controls and audits trails to maintain the integrity of the information;
- include financial information that supports effective financial decision-making;
- act as a single 'source of truth' that users can rely on for effective decision-making;
- remain 'live' and support 'as needed' inputs from projects (via the PIM); and
- maintain the asset information model.

The OIR and AIR should provide the VDAS Champion with a detailed perspective of how the AIMS integrates with other asset and organisational-level systems.

Computerised maintenance management system (CMMS)

A CMMS is software designed to maintain a maintenance and operations database. CMMS are used to manage assets, schedule maintenance and to track work orders.

Typically, a CMMS will run as a standalone system that will integrate with the AIMS.

Best practice IM highlights a necessity to integrate CMMS with the overall asset management system. The benefits of an AIMS-integrated CMMS include:

- reduced equipment downtime;
- increased productivity;
- lower maintenance costs;
- enhanced work order management;
- increased equipment life;
- ease of scheduling preventive maintenance;
- improved inventory management;
- customisable reports;
- enabling data-driven maintenance decisions; and
- ease of complying with safety and other standards.

Emphasis should be on the OIR and AIR where the CMMS and the overall AIMS is concerned. This interface is the responsibility of the VDAS Champion in concert with the strategic asset manager, facilities management, CTO and CIO.

An integrated AIM and CMMS environment more effectively supports decisions from maintenance planning down to work order management.

Building management system (BMS) and distributed control system

A BMS is a computer-based system that controls and monitors the building's mechanical and electrical equipment, such as ventilation, lighting, power systems, fire systems, lifts and security systems.

The distributed control system (DCS) is a computerised control system for several automated control loops that can be overseen by a central operator.

Both the BMS and DCS provide valuable information about the state of an asset (e.g. a tram's current location or the flow rate of an air handling unit – AHU). More advanced systems provide this information as a function of time, such as a tram's operating hours or the uptime of the AHU.

How BMS and DCS can save service costs

Service costs for aging air handling units (AHU) are around $10 to $15 per m^2 in buildings. For a 2,000 square metre building in Melbourne's CBD this would cost over $20,000 per service. With an integrated CDE, AHU services would happen when the service is needed, rather than at a set service frequency. This might represent a saving of $4,000 per year – but this is expanded to other critical assets in the building this represents a notable saving.

Connecting real-time BMS and DCS data to a CMMS can provide critical information needed to make predictions that influence decisions about maintenance.

For example, this would include the duration of time since the last repair of an AHU as a function of the historical benchmark of an AHU's 'uptime failure rate'. Combined with a current and voltage sensor, a bearing sensor or a thermocouple, this would inform the operator with a high degree of confidence when the AHU will need to be serviced.

Object-based operation and maintenance management systems can be used to efficiently address problems such as:

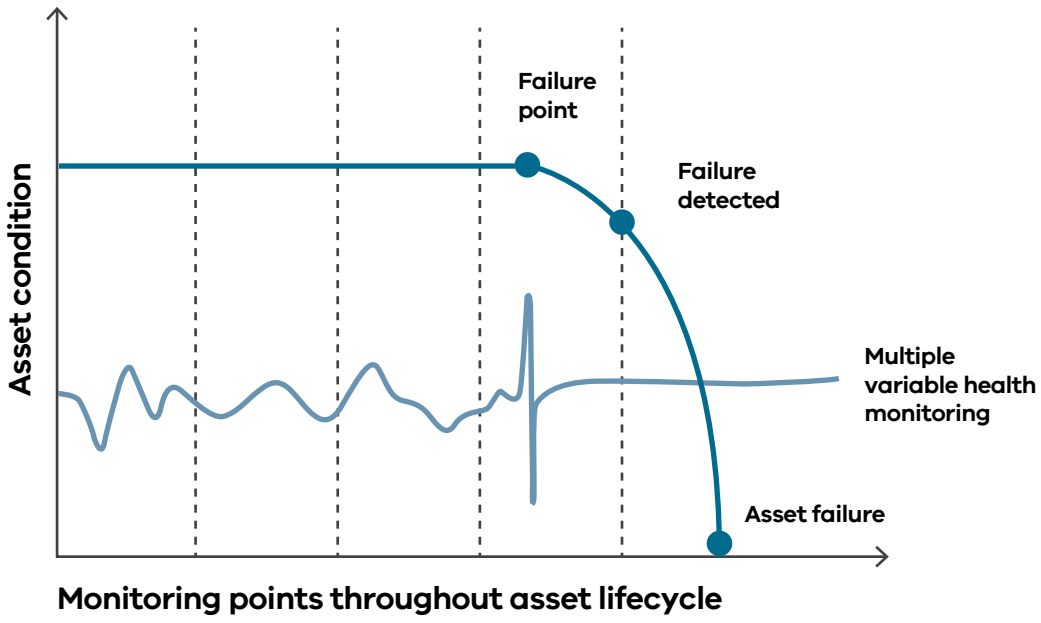
- the lack of standardisation and continuity of monitoring, analysis and control;
- poorly documented building information and poor IM practices;
- greater control of the facility (i.e. fine tuning of HVAC systems for comfort);
- lack of equipment maintenance;
- a lack of indexing in any of the recorded logs, memory limits of sensors in building management systems or building automation systems;
- redundancy in database structuring;
- location of all assets;
- index/ link/ single source of truth to all asset information; and
- future data analysis of CAPEX and OPEX activities within the actual asset.

In an object-based operation and maintenance management system the BIM is connected to the BMS, which contains sensors, Wi-Fi, RFID, etc.

These integrated information sets can prove exceptionally useful.

In one example, sensors could isolate an earth fault on a motor controller, and the object-based operation and maintenance management system could pull up location, service history, power-quality data from the last 24 hours and the maintenance manual, as well as order a replacement part and even provide the electrician a wayfinding route to the specific asset.

Further, this information can be rigorously analysed to provide insights. For example, analysis of power-quality data could show that a specific motor controller is prone to failure under circumstances that occur in summer periods after 5.30 pm. In turn, this can inform future procurement choices or decisions to improve power quality on site.



Summary

Part B provides key information about how a Victorian Government department or agency should, at an organisational level, manage the transition toward the VDAS approach.

Part B covers how to get started on VDAS, why leadership and governance is critical, how VDAS integrates with Victorian investment and asset management, lifecycles, the governance of information management processes, ISO 19650 workflows, and how VDAS integrates with technologies and systems already in use.

The goal of Part B is to position your organisation to manage digital information and data effectively throughout the life of a physical asset.

Further, it emphasises the importance of best practice asset management and its ability to set up each project for success, as well as being the ultimate 'home' for all information relating to the project.

This section provides increasingly detailed guidance and advice that is valuable to asset owners, operators, project and portfolio managers, and mid-level management involved in the management, direction, and portfolio management of major assets and projects.

Part B: Organisational Guidance established a consistent approach to digital asset management in line with best practice and the Victorian context.

The next section articulates in greater detail how to implement the VDAS on a project throughout its lifecycle.

As Victoria continues to grow so does our asset base. The importance of effective and efficient management of digital asset information and data will only continue to increase.

Part C
Application

What's in this section?

Part C covers the end-to-end implementation of digital engineering on a project in Victoria. Read Parts A and B before undertaking a project especially in relation to governance, accountability, roles and responsibilities including the roles of VDAS Champion and DE Project Champion.

Who should read this section?

VDAS Part C is for the VDAS Champion, the DE Project Champion and parties engaged by the Victorian Government to deliver capital works projects.

Before reading this section, make sure you have a sound understanding of the terminology used in ISO 19650, 'Part 1: Concepts and principles' and 'Part 2: Delivery phase of the assets'.

ISO 19650 is available to download, for Victorian public servants. Visit the OPV website to find out how to access it.

Version	Summary of changes
1.00	Release
Owner:	Office of Projects Victoria
Authoriser:	Victorian Chief Engineer

Part C contents

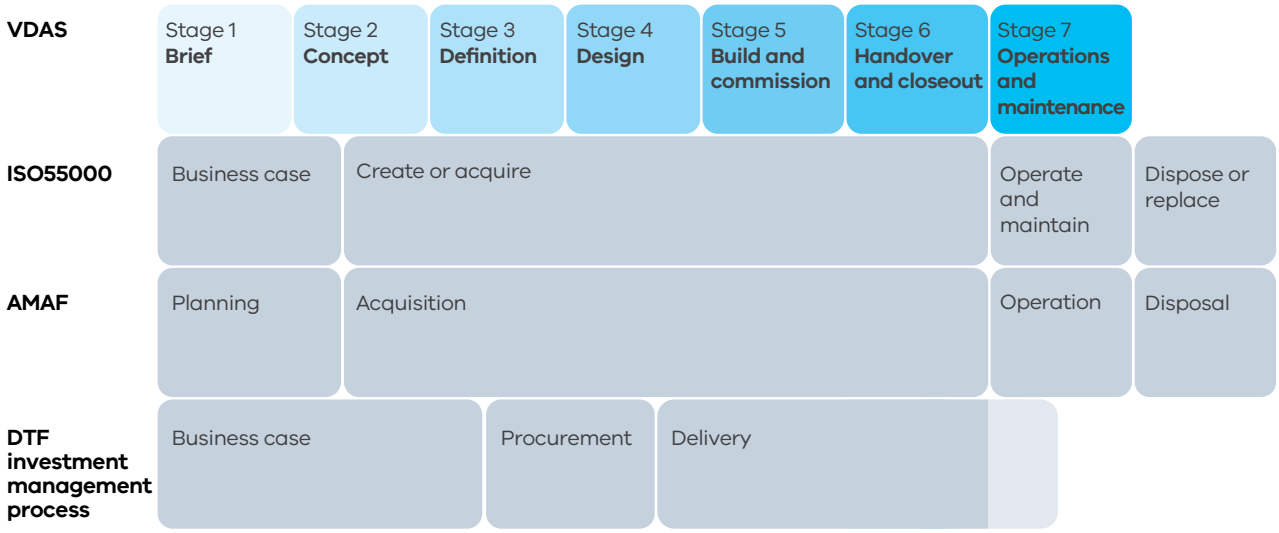
Digital engineering within the asset information lifecycle

Part C was developed to align with the stages and process defined in DTF's AMAF, ISO 55000, and DTF's investment lifecycle.

It establishes seven major stages, shown below. A summary of each stage can be found on the following page.

It is important to recognise that VDAS is an enabler for effective information management practices. The earlier in an asset lifecycle that it is adopted the more value will be delivered.

Each of the stages is divided into four subsections: people, information management, information models, and technology and systems. Each of these subsections clearly articulates deliverables, responsible parties and tasks based on best practice, international standards and lessons learned.



Stage 1 **Brief**	The purpose of this stage is for the Appointing Party (the owner, State Government or those contracted on their behalf) to understand and clearly articulate the problem statement into a project opportunity statement, and gather existing contextually relevant information to inform various concepts developed in stage 2.
Stage 2 **Concept**	The purpose of this stage is to assess a wide range of options that meet the business case and project objectives, as well as gather and develop data and information requirements, and consider critical legal and security elements. The stage is marked by selecting the preferred procurement route.
Stage 3 **Definition**	The purpose of this stage is to develop the selected option from stage 2 further. Development of this option informs a final business case. It is the stage where a large volume of information is gathered, and it is likely where the procurement of a head contractor or contractor (the Appointed Party) commences.
Stage 4 **Design**	The purpose of this stage is to begin detailed design and engineering activities. This development occurs in step with community engagement, commercial reviews, onboarding, pre-works, and the development of a digital engineering execution plan including a responsibility matrix to inform construction and site activities.
Stage 5 **Build and commission**	The purpose of this stage is to translate the drawings, design and intent from stage 4 and physically construct and commission the project. This occurs in line with the project's business case and objectives. The Appointed Party and its supply chain take a pivotal role in the project.
Stage 6 **Handover and closeout**	The purpose of this stage is to complete the project in line with the project objectives and plan, and developing handover material to the Asset Owner. The handover includes all designs to as constructed or as built, transferring relevant and agreed information from stages 1 to 6 of the project to the asset information model.
Stage 7 **Operations and maintenance**	The purpose of this stage is to operate the facility or asset in line with expectations set by the organisation and business case. It is important that the asset delivers benefits for Victorians, the asset information model is maintained in line with the organisation's digital asset objectives and the AMAF.

VDAS workflows and use cases

Completed: ✓
In progress: 🛠
Planned: 🛅

	Brief	Concept	Definition	Design	Build and commission	Handover and closeout	Operations and maintenance
	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5	Stage 6	Stage 7
	Stage 1 checklist + KDP	Stage 2 checklist + KDP	Stage 3 checklist + KDP	Stage 4 checklist + KDP	Stage 5 checklist + KDP	Stage 6 checklist + KDP	Stage 7 checklist + KDP
VDAS workflows							
Organisation information requirements	✓	✓	✓	✓	✓	✓	✓
Asset information requirements	✓	✓	✓	✓	✓	✓	✓
Exchange information requirements (RACI/scope checklist)	🛅	🛠	✓	✓	✓	✓	✓
Digital engineering execution plan	🛠	🛠	🛠	✓	✓	✓	✓
Digital engineering execution response	🛅	🛅	🛠	✓	✓	✓	✓
Project information model	🛅	🛠	🛠	🛠	🛠	✓	✓
Asset information model	🛅	🛅	🛅	🛅	🛠	🛠	✓
VDAS use cases							
Asset management			✓	✓	✓	✓	✓
Constructability		✓	✓	✓	✓		
Cost estimation	✓	✓	✓	✓	✓	✓	✓
Design authoring		✓	✓	✓			
Design review		✓	✓	✓			
Digital fabrication		✓	✓	✓	✓		
Digital twins	✓	✓	✓	✓	✓	✓	✓
Emergency planning	✓	✓	✓	✓	✓	✓	✓
Engineering analysis		✓	✓	✓			
Evacuation simulation				✓	✓	✓	✓
Existing conditions modelling	✓	✓	✓	✓	✓		
Network capacity/disruption modelling			✓	✓	✓	✓	✓
Reality capture	✓	✓	✓	✓	✓	✓	✓
Risk minimisation	✓	✓	✓	✓	✓	✓	✓
Scheduling	✓	✓	✓	✓	✓	✓	✓
Scope reuse	✓	✓	✓	✓			✓
Site analysis	✓	✓	✓	✓	✓		
Site utilisation planning	✓	✓	✓	✓	✓	✓	
Solution reuse	✓	✓	✓	✓		✓	
Space management and tracking		✓	✓	✓	✓	✓	✓
Spatial analysis	✓	✓	✓	✓			
Sustainability	✓	✓	✓	✓	✓	✓	✓
User movement monitoring		✓	✓	✓	✓	✓	✓
Visualisation		✓	✓	✓	✓	✓	✓
3D control and planning		✓	✓	✓	✓	✓	
3D coordination		✓	✓	✓	✓	✓	

The seven stages of the VDAS lifecycle follow workflows and deliverables established by ISO 19650 and ISO 55000 series:

- The Appointing Party develops the organisation information requirements (OIR), asset information requirements (AIR) and exchange information requirements (EIR).
- The Appointing Party issues the EIR to the market. Prospective bidders respond to the EIR through a digital engineering execution plan (DEEP) and RACI/scope checklist.
- The Appointing Party reviews the DEEP with the assistance of the digital engineering execution response (DEER) and awards the project to the most appropriate party (the Appointed Party).
- The implementation of the project commences, and the Appointed Party develops the project information model (PIM).

The VDAS has many benefits and use cases in each of these stages. These include cost-schedule integration, sustainable design, risk minimisation, scope and solution reuse, as well as visualisation.

Improving structured information and data will increase in value as your organisational approach to the VDAS matures.

Tip

Part C uses terms such as Appointing Party and Appointed Party.

As per ISO 19650:

Appointing Party
Refers to the client, owner or procurer of the information and contract. The term is applied to many different project circumstances and procurement approaches. In the case of the VDAS, the Appointing Party refers to the State Government, the owner-led project team, or those contracted by the State to act on behalf of their best interests.

Appointed Party
Typically refers to the entity or organisation on the project delivery side – typically an architect, lead consultant or contractor engaged by the Appointing Party to manage a delivery team.

Within the delivery team, there are multiple task teams – such as designers, cost planners, engineers and subcontractors.

VDAS getting started

Getting started with the VDAS on an individual project or asset isn't difficult, but it does require planning.

Many organisations begin a change process with a pilot. Undertaking a pilot allows you to develop shared learning and improved processes, capability, capacity and systems within a controlled environment.

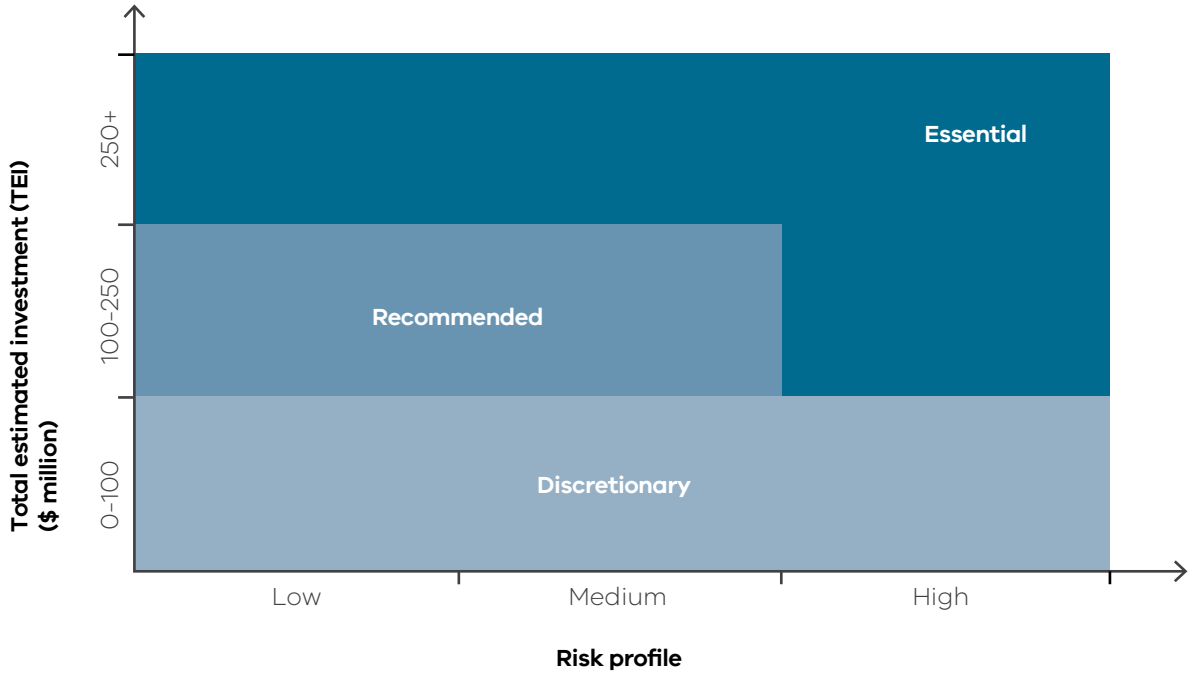
The VDAS is not mandatory for Victorian Government departments, agencies and their associated projects or assets. It does, however, provide many benefits, which are outlined in Part A.

Step 1: Select a project

The earlier in an asset lifecycle you can implement VDAS, the better the outcome will be. As a project or asset increases in complexity, so does the value of digital engineering.

The list below provides some considerations to determine the need for implementing VDAS:

- process or technical complexity;
- location;
- schedule and timelines;
- level of scope definition;
- site conditions;
- distance from supply chain;
- cost targets;
- asset type and existing information;
- opportunities for repeatability in the design and construction of the asset; and
- organisational experience.



Step 2: Executive sponsorship

Parts A and B of this document establish the need for executive sponsorship and appointment of a VDAS Champion within an organisation. This person should be sourced and empowered by the head of the organisation to foster an environment for the VDAS principals to succeed.

Step 3: Governance and vision

It is critical to clearly communicate the vision for the VDAS, set a governance approach and establish critical success factors. This allows stakeholders within your organisation to articulate what VDAS success looks like, and it empowers people to make consistent decisions.

Step 4: Understand how information management currently works within the organisation

Consider your current approach. How does it currently work? Is it documented? Is it repeatable? Who is responsible? Does each process step add value? Is data and information valued?

Understanding your current situation, stakeholders and processes will form the foundation of future improvements. Ensuring good stakeholder engagement and strong processes will embed long-lasting change. Digital engineering aligns information management practices and processes with people and technology, such as BIM and GIS.

Step 5: Assemble and empower the team

Creating a change management team is an important part of the transition. The team should report to the VDAS Champion, and it should undertake a process to articulate the needs of the organisation, including its vision, people, processes and practices. The team's makeup should be balanced with internal appointments and external consultants, and it should represent a wide range of experience, roles, functions and backgrounds. It is important to also consider equality and diversity within the team. Provide the team with training and support, and enable them to help others adapt to the change.

Step 6: Communicate the intention

Executive sponsors, the VDAS Champion and the DE Project Champion should clearly communicate the intent of the VDAS implementation process. This includes ensuring your organisation understands the vision, goals, objectives, use cases, risks assessment and anticipated benefits. Continuous improvement on what is/isn't working are vital to support people through the change.

Step 7: Execute and document

Existing ways of working will be challenged as the VDAS is applied, affecting stakeholders, existing processes and practices. During implementation, important decisions about how information is used and managed throughout the asset's lifecycle will arise. Key decisions may include the following:

- Who needs this information?
- Why do we routinely ask for this – where does this information go?
- Who is responsible for validating this data?
- Who is responsible for the upkeep/management and security of this data?

These decisions are part of a valuable change management process. Your organisation may not be able to answer these questions yet, and the process may initially be confronting. However, it will unearth many new and more efficient ways of working, and it will provide a more comprehensive understanding of how information flows across your organisation. It is important to support stakeholders to address these key decisions and find answers in a timely fashion. The VDAS Champion should also document progress against the plan.

Step 8: Review, correct and improve

Throughout implementation of the VDAS, monitor progress and modify plans if necessary. It is imperative your organisation collectively documents and communicates challenges, lessons learnt and successes. The VDAS Champion should be the custodian of these. This feedback is a key part of improving the feedback loop and increasing the likelihood of success in the future. This process connects to the beginning of stage 1.

Complex assets require support on many different levels. The quick start guide assist in developing this network.

Stage 1

BRIEF

The purpose of this stage is for the Appointing Party to understand and articulate the OIR in a project opportunity statement. Stage 1 establishes the governance and framework around information, data and decision making throughout the project.

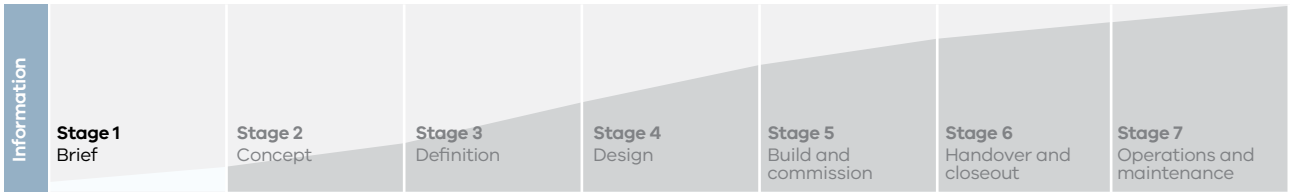
Key outputs of this stage include a draft business case, VDAS brief, preliminary procurement approach, basic project requirements and objectives.

If you miss steps from stage 1, it is unlikely they will be resolved later, when more parties are involved and the capital intensity and risks are higher.

Stage 1

BRIEF

Stage	Brief	
People	• VDAS Champion • DE Project Champion • Asset and Facility Manger • Maintenance Manager	• Head of Engineering/Engineering Manager • Project Director • Senior Responsible Owner (sponsor) • Data custodians and stewards
Information management	• Review and update OIR and AIR • Clear articulation of vision, benefits realisation, and KPIs. • Understanding of organisational wide digital initiatives • DE governance structure and organisational chart defined	• Basic procurement approach, incl. legal and commercial review • Assessment of asset criticality • Review of lesson learnt • Existing data and information review and capture • Quality assurance/quality control (QA/QC)
Data information models	• Establishment of a PIM • Incorporate relevant AIM and existing data and information into PIM • Functional data and information requirements established • Key data and information inputs defined	• Data models updated • Changes to data models defined and budgeted • QA/QC • Assurance
Technology and systems	• Internal CDE/EDMS/CAFM/CMMS/GIS • Asset data system requirements and access requirements	• Model and drawing viewer implementation • Systems, tools, integrations defined and budgeted
Deliverables	• Updated OIR and EIR • Preliminary EIR • Preliminary DE Strategy, including: training, upskilling program, mentoring, communication strategy, IM and systems	• Report to executive on project progress/ challenges • Stage 1 checklist • Information from stage 1 transferred into stage 2



Tip

The diagram above provides a summary of the actions associated with the current stage. This introductory indicator is supported at the end of the stage by a checklist of items to be addressed before continuing to the next stage.

People

Securing the engagement and ongoing support of executives and sponsors is critical for success. The project will also require input from a range of functional areas and stakeholders within the organisation.

Key stage 1 stakeholders include strategic asset planners, business case authors, data custodians or stewards, asset and facilities managers, procurement, legal and project managers.

Development and clear articulation of these roles, responsibilities and accountabilities will greatly increase the likelihood of success.

In addition to these traditional roles, the VDAS introduces the roles of VDAS Champion (explained in more detail in Part B), and the DE Project Champion. These two roles are jointly responsible for VDAS implementation and digital asset information throughout the project's lifecycle. The VDAS Champion is responsible on an organisational level and the DE Project Champion on a project level. Appendix 9 provides VDAS-specific position descriptions.

If the organisation or project is new to digital engineering and digital asset management, or has little internal capability or capacity, consider engaging an experienced digital engineering consultant.

It is also important to focus on personnel development throughout the project's lifecycle. People will require ongoing support and mentoring. Increasing digital engineering capability should be included in individual staff professional development plans.

VDAS Champion

To ensure digital engineering is applied appropriately across the organisation, a VDAS Champion role should be created.

The VDAS Champion is accountable for implementing the VDAS. They must be across parallel initiatives in the organisation, and have a deep understanding of digital engineering, digital and traditional asset management, BIM, GIS and CAD.

The VDAS Champion is tasked with understanding the organisation's digital engineering capability and maturity, as well as integrating traditional information silos throughout the organisation.

The VDAS Champion should play a supportive role in setting up the front end of the project. This includes selection and support of the DE Project Champion, timely development and issue of the OIR and AIR, functional team integration, assistance with the EIR and guidance on lessons learnt.

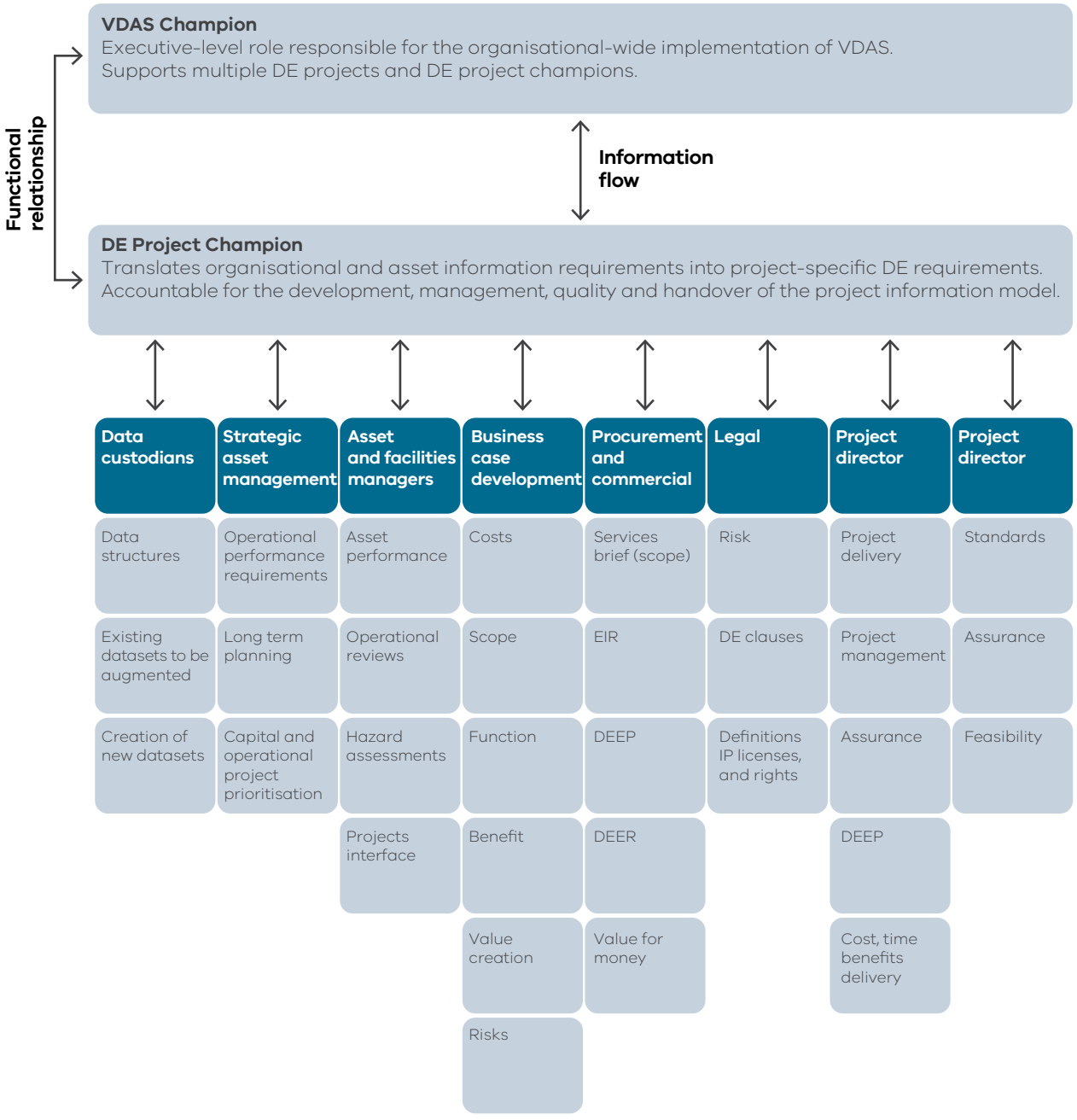
The VDAS Champion should consider the following questions:

- What does 'good' look like at the end of the project (i.e. starting with the end in mind)?
- How are we going to get from here to there, and what are the likely risks?
- Do we have the capability and resources?
- Do we have agreement, throughout all project stages, of all stakeholders on the first three questions?
- What lessons can we take from others to avoid making the same mistakes?

The following graphic provides an example of how key stakeholders interact with the DE Project Champion and the VDAS Champion. Job descriptions for these role is provided in Appendix 9.

Stage 1

BRIEF



Stage 1
BRIEF

	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5	Stage 6	Stage 7
Asset/Facilities management staff	0.20	0.40 - 0.75	0.75 -0.90	1	1	1	1
VDAS Champion	0.75 - 1	0.50 - 0.75	0.40 - 0.50	0.20 - 0.40	0.20 - 0.50	0.50 - 0.80	0.80 - 0.90
DE Project Champion	0.90 - 1	0.45 - 0.90	0.25 - 0.45	0.25 - 1	1	1	1
DE Lead	0.05	0.05	0.05 - 0.15	0.15 - 1	0.90 - 1	0.20 - 0.90	0.20 - 0.25

The diagram above indicates the level of full time equivalent commitment from each key role on the project or asset. Note it will differ depending on specific asset/project type and procurement method.

DE Project Champion

The DE Project Champion is the organisation's lead role for implementing digital engineering on a specific project.

The role reports functionally to the VDAS Champion and directly to the Project Director.

The DE Project Champion should be defined and onboarded during stage 1. The role:

- can be shared between multiple parties;
- is accountable for managing the project-level implementation of the VDAS; and
- supports the VDAS Champion with the wider integration of digital engineering into the organisation.

The role must work in collaboration with other organisational and project functions, including legal and commercial, engineering, planning, corporate, facilities management, technology and asset management.

On a project, the DE Project Champion is accountable for:

- collating information requirements;
- defining the project's approach to digital engineering;
- provide support and mentoring;
- internal and external stakeholder engagement;
- assessment and management of digital engineering deliverables; and
- digital engineering contract management.

Appendix 9 provides a DE Project Champion job description template.

Data custodians and data stewards

While the DE Project Champion is responsible for digital engineering on a project, they are not the ultimate custodian or steward of information and data.

A data custodian is tasked with responsibility for data and information across its lifecycle including transport, storage, use and access. A data steward is responsible for specific data and information content and context.

It is important that this nuance is understood, and that DE Project Champion knows who manages and maintains data and information for the long term.

The roles of data custodian and steward are not specific to the VDAS. They also appear in the Office of the Victorian Information Commissioner (OVIC) policies and principles, the Victorian Protective Data Security Standards (VPDSS) and various federal Acts.

Data custodians and stewards need to be identified and nominated early in the project lifecycle – preferably during stage 1, with additional data custodians and stewards onboarded in stages 2 and 3.

Key information management roles will manage asset information on different scales.

Stage 1

BRIEF

Asset and facilities managers

Asset and facilities managers are among the most critical functions to be introduced early into a project.

While it may seem counterintuitive to introduce this role when there is no asset to manage, research shows that early involvement of this function is necessary and valuable. Asset and facilities managers help to deliver better cost, schedule, operational and safety outcomes over the entire asset's lifecycle.

Asset and facilities managers are responsible for the asset from end-to-end, including whole of life costs, function, output, usability, safety (design, construction and operation), maintenance and disposal. It is difficult to recreate this accountability for project-only functions.

During stage 1, it is imperative that empowered asset and facilities managers are onboarded to shape the project objectives and business case from a whole-of-life perspective. These roles may not be required full-time.

Asset and facilities managers should introduce lessons learnt from similar assets or facilities whether that is from within the portfolio or locally, nationally or internationally. It is likely the asset about to be created will be similar to one elsewhere in the world, which can inform decisions about this project.

In addition, assets and facilities managers should also review the OIR and AIR in the context of this project or opportunity statement.

Asset managers and facilities managers should be continuously involved in project decision making during stage 1.

Legal and procurement

Digital engineering triggers several important legal considerations. Based on lessons learnt and industry engagement, the following section provides advice on how to navigate digital engineering within a legal and commercial environment.

Digital engineering approaches tend to work best under more collaborative types of contract arrangements.

Nonetheless, there is no 'best' approach to commercial, procurement and legal matters on a project. Each project is different and must be considered according to its own needs.

Digital engineering across procurement models

The VDAS is not limited by or to a specific procurement method.

It can be used on the full spectrum of contracts, from construct only, design and construct, public private partnerships (PPPs), to alliances.

Due to the collaborative nature of various types of contracts, some contract types favour digital engineering, including early contractor involvement, PPP and alliancing.

For any procurement method you should map and align:

- expected milestones of the project;
- DTF investment lifecycle;
- appropriate planning process;
- the VDAS and AMAF workflows;
- the 'hold' and 'key decision' points affiliated with the expected contracting method; and
- stage deliverables.

The information requirements (AIR, EIR and DEEP) are key parts of the procurement model. More information on these is provided in later stages.

The responsibility for this mapping and alignment exercise remains with the project leadership team, with key inputs provided by authors of the business case, executive sponsors, the VDAS and DE Project Champions, strategic asset managers, project directors, commercial, procurement and legal.

In the context of the VDAS, BIM, CAD, GIS and digital engineering more broadly, there are no new legal or commercial risks as part of projects, asset delivery and asset maintenance.

Instead, the VDAS changes the way we must approach existing legal and commercial risks compared with traditional paper-based approaches to information management.

Legal and commercial considerations

The most common claim contractors on major projects make is payment for extra work or variations, and the associated time consequences of that additional work. The VDAS promotes two practices known to reduce claims on projects:

Practice 1: Enabling earlier access to information and data during decision making before awarding a contract and assigning risk (i.e. 'front-end loading' a project). This minimises the chance of surprises throughout delivery of project (midway through a contract) that could have been identified earlier.

Practice 2: Providing a platform that enhances collaboration through the visualisation and sharing of data and information with the right party at the right time , potentially avoiding any issues that would have been created through previous approaches.

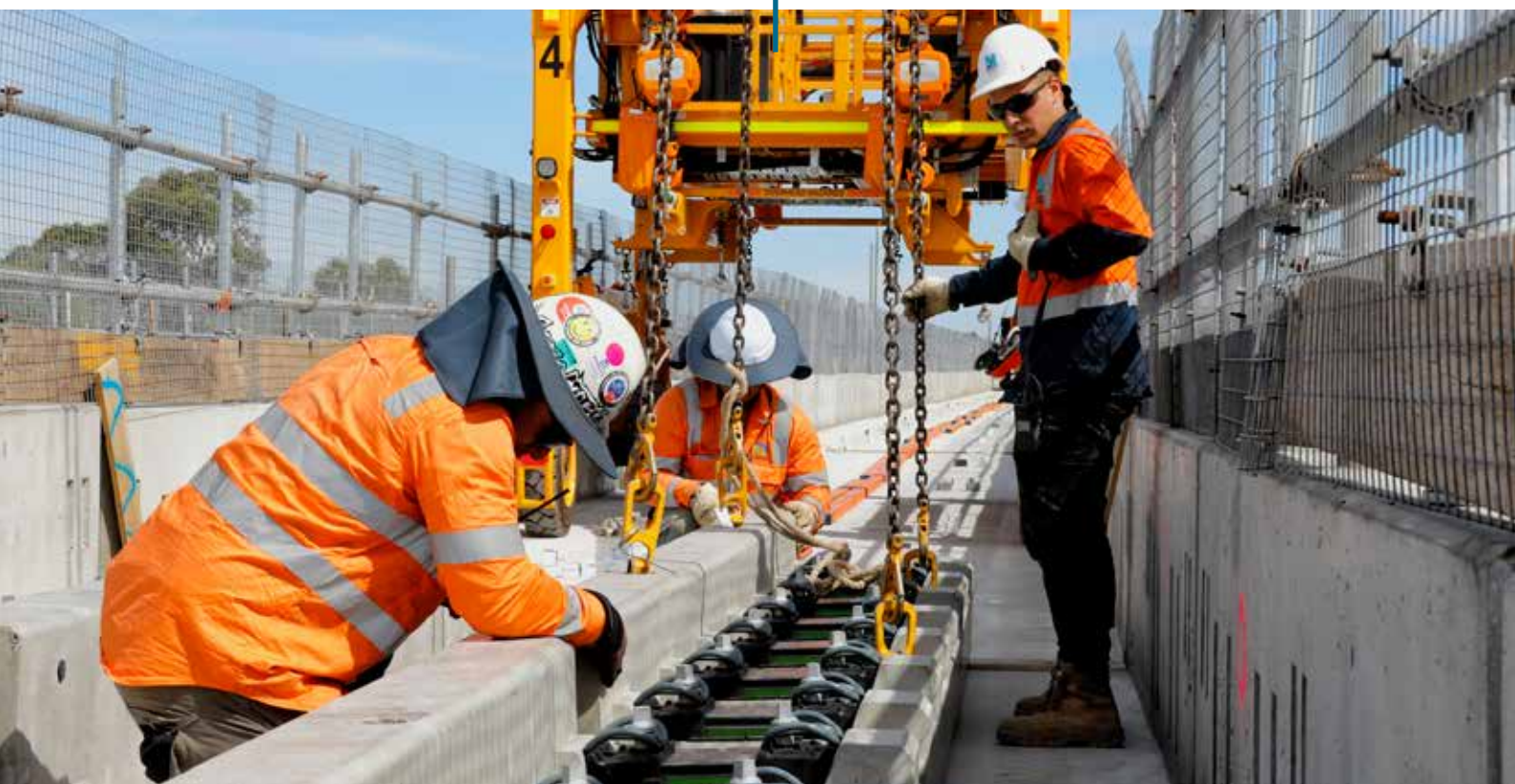
(Notwithstanding the above, the VDAS will not mitigate all claims, commercial disputes or legal issues encountered on major projects but aims to reduce the overall risk profile of projects utilising digital engineering / BIM.)

At an early stage of the project, informed legal and commercial discussions should include:

- intellectual property and ownership;
- confidentiality and privacy;
- licensing;
- data sovereignty and critical assets;
- data security and integrity;
- critical asset requirements; and
- liability and information reliance.

The VDAS recommends that the most appropriate way to address legal and commercial matters is through early and structured conversations, by better understanding stakeholder positions and through best practice project management.
A second-order response is through specific legal terms and clauses that provide certainty regarding contractual requirements.

Effective digital engineering and information management will ease information across complex interfaces when delivering major assets.



Stage 1

BRIEF

Intellectual property and ownership

Intellectual property (IP) in the context of the VDAS is a priority topic for early discussion and resolution.

Digital engineering enables a more seamless flow of information and data. Without proper consideration, one party's IP could be transferred to another party as part of a federated model or within the project's common data environment (CDE). There is an increased risk of IP infringement as sensitive information is more easily transferred between parties.

In light of this, the VDAS recommends that all Victorian Government procurement activities for all infrastructure projects follow Victorian Government IP policy. The policy clearly articulates the following:

- The State in an agreement defines data, foreground and background IP rights applicable to the procurement.
- By default, the State seeks to gain a licence for foreground IP. The terms and duration of this licence must be applicable to the needs of the project and wider organisation.
- The State by default may need to gain a licence to background IP, similarly the terms and duration of this licence must be applicable to the needs of the project and wider organisation.
- Victorian Government IP policy cautions against the practice of owning IP. There are clear circumstances and cases where practice diverge from standard Victorian Government IP policy. An example of where this may be required is reusing project solutions across different procurements.
- In general, IP licenses can be established broad enough to have similar rights as ownership.
- IP rights should not be assigned to the State for the purpose of preventing commercial parties from further leveraging those intellectual property rights.
- Joint ownership of intellectual property should generally be avoided.
- Legal matters should be considered by their appropriate party. For third-party IP, such as IP of subcontractors or subconsultants, the VDAS Champion, Chief Legal Counsel and the DE Project Champion must consider which information and data requires specific IP assignments and licences.

Blanket provisions or policies that promote state ownership of all content, information and data are priced accordingly by industry, erode the confidence of project stakeholders, and in some instances remove third parties' competitive advantage.

The VDAS Champion, in concert with the Chief Legal Counsel and the DE Project Champion, must consider all facets of informational and data pertinent to the project including designs, scripts, model elements, process technology and code. Restricting access to certain data may also be considered when dealing with sensitive information.

For State-based IP, all State investments must follow the Victorian IP policy. The policy sets a framework of IP ownership and management and for its use of IP belonging to other parties.

Tip

Foreground IP is the new IP created under the contract. It might also include data gathered during the project.

Source: IP Australia

Tip

Background IP refers to work created prior to, or independently of the particular contract and may be used in the collaboration project.

Source: IP Australia

Stage 1

BRIEF

The VDAS recommends the asset owner and project practitioners follow the IP policy. IP policy direction in the context of the VDAS are provided in the worked examples below:

IP policy direction	VDAS worked example
The State manages its IP in ways that are consistent, transparent and accountable	Be clear with stakeholders as part of the EIR about state-owned IP, its sources, quality, applicability and timeliness. Transfer existing relevant and allowable IP (and broadly information and data) to parties for the purposes of letting a new contract or project. Ensure the EIR and RACI scope checklists include a clear delineation and definition between foreground and background IP to assist in defining the scope of the IP assigned, owned and licensed to the State.
The State grants rights to its IP with the fewest possible restrictions	Do not withhold information 'owned' by the State that can reduce stakeholder and contract risk, and in turn, raise risk premiums allocated to the project by parties.
The State exercises restriction to IP for reasons of privacy, public safety, security, law enforcement, public health, commercialisation and compliance with the law	Understand that others' IP may be their competitive advantage, and blanket contract clauses that seek to secure the entirety of the party's IP are not good practice and likely to drive perverse outcomes. These include the State: • 'paying' for IP for which they do not seek to maintain; • being responsible for IP for which they have no expertise to maintain; and • removing a party's competitive advantage by takeover. Understand that various Victorian assets are subject to conditions set by the Victorian Critical Infrastructure Resilience Framework. In this case, IP (State or private) may have specific conditions associated with it.

Stage 1

BRIEF

Reviews of completed projects highlighted the following IP lessons learnt:

- **Learning 1:** the Appointing Party must consider which IP rights created as part of a project must be 'owned' by the Appointing Party. IP ownership must be tailored to the project-specific circumstances and typically precludes includes a cost premium from the Appointed Party.
- **Learning 2:** IP rights created as part of the project should only be 'owned' by the Appointing Party if a licence is not adequate in the circumstances. IP licences can be established for broad use cases – including future re-use.
- **Learning 3:** IP should not be assigned to the Appointing Party for the purpose of preventing other parties from leveraging their own IP.
- **Learning 4:** it is preferred that project participants retain ownership of their respective data, background IP and foreground IP, with a broad licence granted to the Appointing Party in respect of both, with specific exceptions agreed on a case-by-case basis. This can include future re-use.
- **Learning 5:** joint ownership of IP should generally be avoided.

In stage 1, the VDAS recommends that the VDAS Champion, Chief Legal Counsel, and the DE Project Champion discuss and seek alignment on the lessons learnt noted above.

These parties should discuss and be able to answer the broad IP questions specific to the project, including the following:

- What IP does the Appointing Party have access to, what IP can be issued, and under what terms, licences and assignments?
- What IP does the Appointing Party need to procure, and for what purpose/use case?
- What IP does the Appointing Party want to provide/issue to other parties, and for what purpose?
- What definitions are required for the project, including 'data', 'background IP', 'foreground IP', 'for reliance', and 'for information'?
- Where are there departures from the Victorian Government IP policy, and are there cases of 'joint IP'?
- What are the contract terms for digital engineering software (both the tools used and the data created), including usage rights, IP rights for submitted material, access control, confidentiality, privacy, data protection obligations and conditions associated with data formats?

Consultants will retain the sole responsibility for amendments to their design data.

Licensing

During stage 1, your organisation should consider how information will be used post-project and, if relevant, how that information may be used by, or disclosed to, other State Government departments and agencies or the public.

In stage 1, the VDAS Champion, DE Project Champion, legal counsel and asset managers should agree on post-project licensing of information. This team should also consider how to apply the 'licensing-specific' lessons learnt from other completed Victorian projects:

- **Learning 1:** most organisations' approach to and general policies about information licensing were insufficient for projects being implemented in a contemporary context. At stage 1, projects must review how licensing was approached on previous projects, and what can be applied to this project in terms of IP licensing and contract clauses.
- **Learning 2:** contractors and other Appointed Parties should clarify which information that they generate will be shared upstream (i.e. within the Appointing Party project team) and downstream (i.e. third parties engaged by the Appointing Party).
- **Learning 3:** if information is going to be shared with third parties or other government departments, either provide a liability waiver or ensure the purpose of that use is well understood by the third party. At present, the State does not indemnify Appointed Parties against third-party claims. Projects are beginning to shift towards more open licensing arrangements for digital engineering data, such as creative commons.

Appointed Parties may not have the right to use model information for unlimited use cases.

The creator and receiver of information should clearly understand how the information was created, its intended current/future uses and any limitations, thus minimising disputes. It is the responsibility of the user of others' information to confirm with the author that it is suitable for that user's purpose (i.e. using others' information for a purpose that was not foreseen or approved by the author is poor information management practice, and it will likely result in poor decision making).

The Appointed Party should also review the material and information being requested as part of the procurement and secure a licence for the information. The scope of the licence must consider purpose or purposes, duration, inclusions and conditions. Future use cases for purposes of securing a licence may be able to be identified. In this circumstance, seek a broad licence that conveys a broader intent.

For example, the Appointing Party may identify benefits from being able to use the foreground IP information from a specific part of the design (such as a structure or a modular building) on future or adjacent projects. In these circumstances the Appointing Party may seek a licence for this specific use case.

Alternatively, it may be beneficial for the Appointing Party to transfer specific information about critical equipment from the PIM into the AIM for the purposes of maintenance, real-time dashboards or future modifications. In this circumstance, the Appointing Party may seek a licence for this use case and clearly establish this in tender documentation.

To avoid disputes and ensure that the desired outcomes are achieved, the State should clearly define the permitted uses of the model at the start of the project rather than seeking additional rights at a later stage. Note that this is stage specific, and it should be considered with regard to the IP scope of each party involved.

The EIR and RACI scope checklist should include a clear and definition of, and delineation between, data, background IP and foreground IP to assist in defining the scope of IP assigned and licensed to the State.

The scope of licences granted to the State should be carefully defined to ensure that all desired future uses are permitted (including future use in relation to separate projects if required by the State).

The VDAS encourages licensing arrangements that cater for all intended future uses of the data and information.

Privacy

Digital engineering information, data and information containers are unlikely to contain substantial amounts of personal information.

Nonetheless, if information, data and models do contain any personal information (including that of contributors), all parties with access to that information will need to ensure they comply with Commonwealth and State privacy laws and data security requirements.

In Victoria, the relevant authority and policy on this is the Victorian Protective Data Security Framework and Standards, as well as the *Privacy and Data Protection Act 2014*. Federal rules and regulation on data privacy are within the *Privacy Act 1988*. Data custodians should be responsible for maintaining their own data.

When creating a digital copy of an asset, legal and commercial issues are equally important to consider in the digital version.

Data sovereignty and critical assets

Data sovereignty is the idea that data is subject to the laws and governance structures within the nation it is collected and stored.

In the context of the VDAS, consideration must be given to how information and data will be transferred to/from the project delivery team and international partners. This includes any Appointed Party's international partners (such as international design/documentation offices), as well as any subcontractor's international partners.

These considerations are particularly important in the context of the Victorian *Emergency Management (Critical Infrastructure Resilience) Regulations 2015*.

The VDAS Champion, DE Project Champion, project director and project risk lead must assess the delivery of the project against the criticality assessment methodology discussed below.

In the context of digital engineering, this group must consider:

- stakeholders (local or otherwise);
- location of stored information for supporting software;
- flow of information;
- access to information;
- obligations of disclosure for information breaches;
- reporting; and
- escalation processes.

The criticality assessment methodology is an approach to categorising the importance of your project to the community. This process categorises an asset according to one of four categories: vital, major, significant or local.

Assets assessed as 'vital' must, at a minimum, consider the following additional resources:

- *Critical Infrastructure Resilience Ministerial Guidelines*;
- *Victorian Protective Data Security Standards*; and
- *Security of Critical Resilience Act 2018 (Cwlth)*

All the above require a data security and integrity framework or approach consistent with the VDAS. Suggested frameworks are provided in the following section.

Data security and integrity

Data security and integrity are important parts of any project or digital asset workflow.

To ensure each Appointed Party retains the value of its data, data and information transactions should be secure and follow relevant Victorian policies. The correct source for this is the *Victorian Protective Data Security Framework* (VPDSF) and the *Victorian Protective Data Security Standards* (VPDSS), as established under the *Privacy and Data Protection Act 2014*.

Both the VPDSF and the VPDSS provide clear direction to Victorian public sector agencies and bodies on their data security obligations.

While the VPDSF and VPDSS do not specify data security obligations specific to the VDAS and digital engineering workflows, they articulate a clear need for Victorian Government departments and agencies to undertake a security risk profile assessment (SRPA) and develop a protective data security plan (PDSP).

In the VDAS context, a number of resources can be leveraged to meet obligations, including the SRPA and PDSP under the VPDSF and VPDSS.

These resources include:

- PAS 1192-5 (soon to be superseded by ISO 19650-5);
- ISO 27001 or ISO 27002;
- ISO 27017; and
- ISO 27018.

These standards contain security assessment and planning frameworks that can be applied in the VDAS context. These frameworks create a logical sequence of security considerations.

Topics include:

- relevant stakeholders (local or otherwise);
- location of CDE/hosting services;
- flow of information;
- access to, and control of information;
- track and trace of contribution; modification and deletions of information and data;
- obligations of disclosure for information breaches;
- reporting; and
- escalation processes.

Liability and information reliance

In any major project, information must be transferred from one party to another, as well as from one stage to another. Information handover to tenderers allows them to prepare a proposal with an informed price. It can be used to avoid informational waste, reducing the need to recreate information, designs, models, etc.

This raises a potential issue around information dependency and liability for information that has been relied on.

The current approach within Victorian Government projects is to transfer information from one party to another on an 'information only' basis – i.e. non-reliance. This can help with alleviating disputes regarding liability for data.

While this reduces risk for the State, it does require the receiving party to:

- question the merit and validity of the data being provided to them;
- potentially re-create the information and data;
- verify the information and data; and/or
- proceed and bear the risk of the validity of the data and information being provided to them.

In most cases the risk/uncertainty will be priced accordingly and paid for by the State.

Given the above, the State is transitioning towards a reliance and transfer model that supports partial or full reliance of information. Examples of where information could be transferred from one party to another and reasonably relied upon are: geotechnical, utilities location and flood modelling.

In this case, the 'reliance' only extends to the incoming party if the information makes reasonable sense.

The following learnings are provided in the context of liability:

Learning 1: 'fitness for purpose' warranties in the context of digital engineering require specific clarification. The concern of third-parties is that digital engineering enables a wider range of potential applications and future uses for purposes well beyond the scope of the immediate design/construction of the project.

Learning 2: the UK CIC BIM Protocol (2018) has sought to address the concern of consultants and contractors being liable for future unknown uses of the permitted model. The protocol expressly excludes liability arising out of any modification, amendment transmission copying or use of the digital engineering information other than for the permitted purpose.

Learning 3: private industry commonly seeks to negotiate an exclusion of liability for all indirect or consequential losses in major projects. One protocol developed in the USA for BIM (ConsensusDOCS 301) is a multiparty document that seeks to deal with this issue. It recognises that the contract between Appointing Party and Lead Appointed Party should govern the treatment of consequential losses. This leaves the parties free to include (or not) a regime that applies to both.

As part of stage 1, the VDAS Champion, DE Project Champion, legal counsel, project director and project risk lead must have a clear strategy on information liability on a stage-by-stage basis for the project. This same group should also articulate how they have considered the lessons considered on the project in the context of information flow throughout the lifecycle.

Information should be open by default and secured as required.

Insurance

Insurability of parties has become a particularly contemporary and poignant topic. Contractors, subcontractors, consultants and subconsultants are increasingly reviewing their insurance policies in line with their business engagements.

A comprehensive legal and commercial stakeholder engagement process has highlighted the following learnings about insurance:

Learning 1: the collaborative nature of digital engineering can potentially complicate traditional liability-based insurance arrangements, as the model can make it difficult to attribute information to a particular party..

Learning 2: contractors, subcontractors, consultants and subconsultants hold insurance policies that warrant them to a specific level of design that is commensurate with their role and the maturity of the project.

Learning 3: contracts can be appropriately divided in line with industry stakeholders' insurance and risk appetites.

Clearly defining the information purpose will add confidence to the Appointed Party.

Information management

Stage 1 is a critical time for the project.

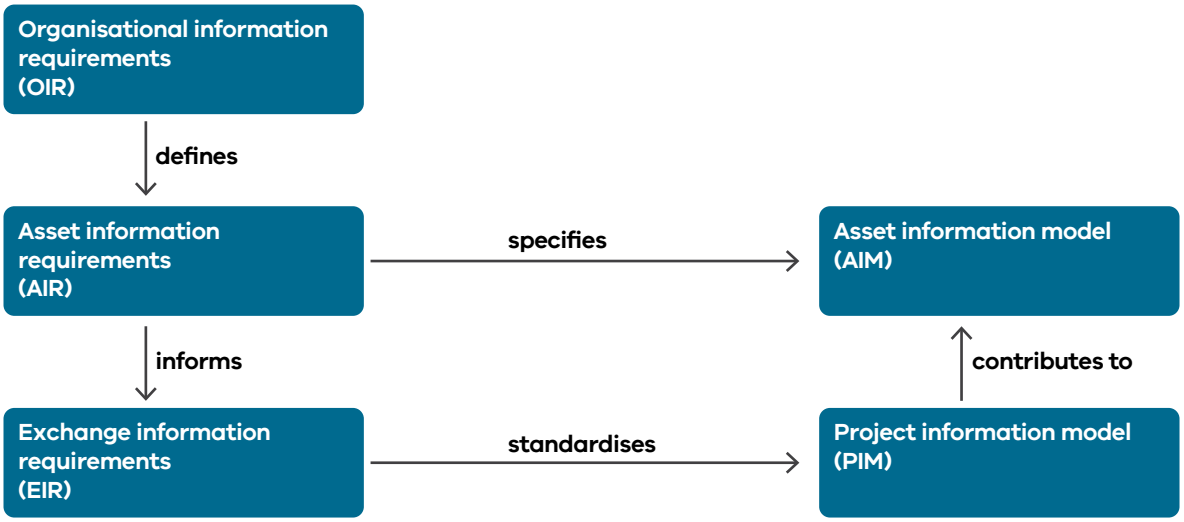
At the earliest possible time, i.e. the front-end of the project, the Appointing Party must have a clear understanding of organisational information requirements (OIR) as well as the asset information requirements (AIR). This needs to align with the Appointing Party's key decision points, and level of information need at these points, to adequately define, create and manage the asset – from planning, design to construction, operations and decommissioning.

These two key elements (OIR and AIR) set the basis for what information is required to be documented in the exchange information requirements (EIR).

The project delivery team respond to the EIR through a digital engineering execution plan (DEEP) and create the project information model (PIM).

Without a clear understanding and articulation of the OIR and the AIR in the EIR – the expectations about what, who, how and when of digital information will erode progress in further stages of the project.

The VDAS information process is adapted from ISO 19650.



Organisational information requirements

The purpose of the OIR is to articulate the information, decisions, data, reporting and stakeholders required by your organisation to effectively and efficiently run its day-to-day business activities. Part B provides a full explanation of the OIR.

The responsibility for the format, completeness and quality of the OIR remains with the VDAS Champion. This collection of documents must be contemporary and should be complete prior to commencing a project. Stage 1 of the project should not be dedicated to developing the OIR.

Instead, stage 1 should review the OIR in the context of the project. This process is led by the DE Project Champion and the VDAS Champion. It should also be repeated with the project leadership team.

Inputs must be sought from business case authors, executive sponsors, engineering, operations, strategic asset managers, project directors, commercial, procurement and legal.

Key project items for discussion with reference to the OIR include:

- key decision points;
- asset identifiers and classification;
- data standards/policies and procedures;
- handover of information during project implementation;
- handover of information post project delivery;
- reporting and regulatory requirements;
- capital investment financial data;
- asset information requirements; and
- quality control and data validation.

An OIR template is provided in Appendix 1.

Efficient operation of an organisation relies on easy access to information.

Asset information requirements

The AIR is an asset-specific document that articulates and documents information, decisions, data, reporting and stakeholders required for assets to effectively and efficiently support their function and the wider organisation on a day-to-day basis. Refer to Part B for full explanation of the OIR.

It is important to note the following about the AIR:

- it is much more granular than the OIR;
- the AIR feeds into the OIR; and
- an organisation could have more than one AIR (if managing different assets).

For the project, the AIR remains a key input as it sets out the expectations for how information is gathered, used, processed and acted on. It articulates the processes for how information should be handed over during project stages (soft landings) and at stage 6.

The AIR remains a co-responsibility of the VDAS Champion and the strategic asset manager. The document must remain contemporary and should be established prior to the commencement of the project.

The DE Project Champion is the key accountable person to:

- engage the appropriate stakeholders for the AIR;
- assess the quality of the AIR and seek clarification and update (where applicable); and
- lead conversations with the project leadership team around the AIR in the context of the key decision points on the project.

Key topics for the DE Project Champion to lead with the project leadership team, include:

- level of information need;
- level of development (LOD);
- key decision points when information is required;
- the current status of the existing AIM and its ability to support the project development process;
- asset classification;
- asset location referencing;
- asset attributes and data schemas;
- performance data;
- maintenance data;
- relevant commercial information;
- asset register, parent and child extents;
- data collaboration strategy (CDE); and
- quality control/validation.

Level of information need

Data and information costs money to create and maintain. Managing unnecessary data and information is not financially sustainable.

In stage 1, the Appointing Party should consider information needs across the asset's lifecycle. The VDAS Champion, supported by the DE Project Champion and strategic asset manager, is responsible for this.

Level of information need requires consideration and balance. Capturing too little information will mean you will have to recapture information at greater cost, or it will make later operational decisions difficult. Capturing too much information or capturing information and data in a poorly structured format will result in wasted capital investment.

During stage 1, the level of information need process must be integrated with key stakeholders such as operators, maintainers and managers of the future asset. Stakeholders are tasked with articulating what information is needed upon completion of the project.

The output of the level of information need process should support the OIR, AIR and will inform the development of the EIR.

Effective level of information requirements will greatly assist in attaching valuable data to the asset.

Key decision points

The VDAS Champion should determine the key decision points related to project delivery, i.e. information necessary to support business decision making aligned with project milestones.

The VDAS Champion will define the digital engineering use cases to support the organisation's key decisions. These use cases will be implemented by the DE Project Champion in later stages.

Combined with the level of information need, this will determine the staged approach to information management and delivery. This enables the organisation to have efficient access to project and asset information at the time it is needed, supporting business decisions.

Early definition of key decision points and level of information need can create opportunity for innovative construction methodologies such as offsite and modular.

Existing information

Every project starts with some level of information. Existing information about an asset, site or project is often overlooked yet remains a key information source.

Victorian assets are supported by much existing information to assist decision making about a project and future asset. This includes, but is not limited to, data and information relating to:

- weather;
- ground conditions;
- monitoring information;
- existing site conditions;
- topographical survey data;
- point clouds from laser scanning and UAV, aerial LiDAR and photography, title and cadastral information;
- utilities and subsurface utility information (SUI) plans, permits, engineering drawings;
- existing CAD (2D/3D), BIM and GIS data or original hardcopy drawings;
- timetables, existing assets, upcoming projects; and
- publicly available information.

Most of this information can be sourced at very little cost. Leveraging existing information allows the project leads to make informed decisions.

It is the responsibility of the DE Project Champion, alongside responsible functional leads within the project team, data custodians and stewards of existing asset information, to broadly capture and make available as much of this existing information as early as possible.

Project stakeholders should collaborate to build up a reliable understanding of existing site conditions.

It is important to recognise that the presence of information doesn't confirm its accuracy; information and data can quickly become out of date. In this regard, existing information may need to be assessed, validated, aggregated or supplemented with additional field verification.

Highly valuable sources of existing information are:

- Dial Before You Dig (DBYD);
- point clouds from laser and image scanning;
- topographical and feature surveys; and
- Aerial LiDAR and photography.

A brief description of how these data sources can inform the early stages of project planning are provided in the next section.

To support project teams within the Victorian context, VDAS provides a data dictionary in Appendix 4. The VDAS data dictionary includes more than 40 links to freely available information and data.

Dial Before You Dig (DBYD)

DBYD is a free referral service for information about the location of underground services and utilities. It provides users with access to plans and information direct from the individual asset owners of subsurface utilities and infrastructure. This includes water, gas, power, sewerage, drainage, telecommunications and signalling authorities and organisations.

Knowing this information early is critical, as it provides a better and more comprehensive understanding of the location and depth of subsurface assets. This allows for better planning around (and isolating) assets, reduced safety risks for site personnel, and avoidance of services/ utilities damage and disruption.

While DBYD information is incredibly useful, it is classified as a 'low quality' source of information (per AS 5488). This classification is due to difficulties in discerning true (X, Y and Z coordinate) locations of buried assets and the poor reporting of as-builts (works as completed) data to the responsible authority.

These challenges can be overcome by contacting the responsible asset authority and confirming subsurface assets on site.

The DE Project Champion should adopt best practices associated with underground services location quality (AS 5488.1-2019), as it specifies how:

- location data should be captured;
- information on subsurface asset types should be captured; and
- subsurface asset data should be stored and made available to relevant parties.

Existing data sets available can inform projects in early asset stages. See Appendix 4.

Topographic surveys, laser scanning, point cloud surveys and aerial photography

Knowledge of the existing built environment, latent conditions and associated information can be bolstered using topographic surveys, laser scanning, image scanning and reality-capture systems to generate point clouds from which 3D BIM models and surfaces can be generated. Such data sets have a major application in:

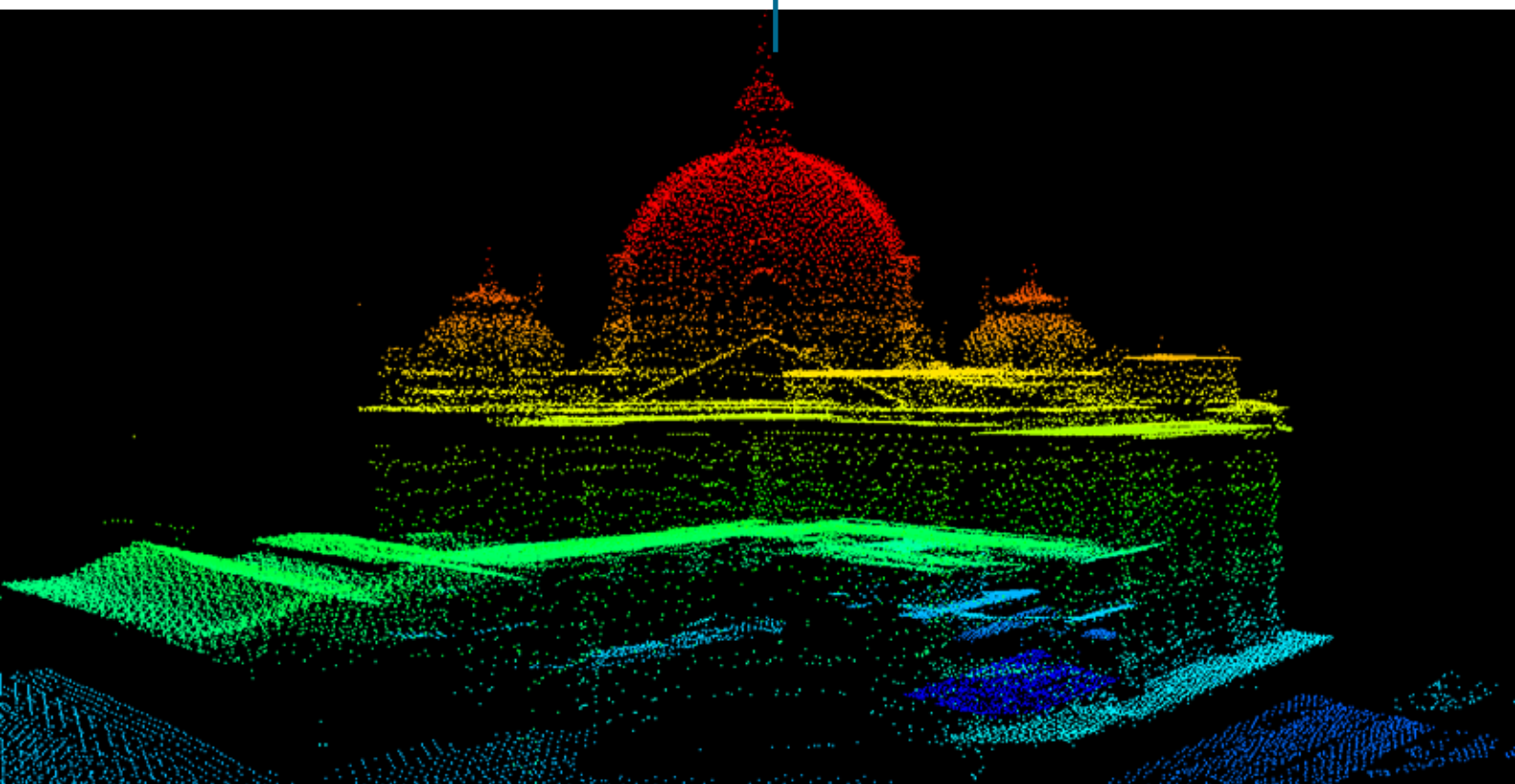
- stage 1: location investigation;
- stage 2: contextual planning;
- stage 3: establishing existing conditions;
- stage 4: design validation;
- stage 5: for construction progression, clash detection, and earned value (EV);
- stage 6: for as-built verification and design handover; and
- stage 7: for wayfinding, predictive maintenance, and maintaining a digital twin.

This information can easily be leveraged in digital engineering environments and can improve the certainty of proposed designs against existing conditions.

The DE Project Champion should be empowered to seek and integrate existing condition data from a wide range of sources.

Where information and data has been determined as low value or low quality, the DE Project Champion should be empowered with resources to improve accuracy of the information.

Existing conditions can be captured rapidly and accurately using innovative scanning and capture technologies.



Victoria's authoritative spatial information source

Spatial information helps locate, connect and deliver projects and services. Spatial information describes the geographical location of both natural features and the built environment such as roads, property boundaries and other important attributes.

With the advancement of computing technology, spatial information has moved beyond the static surface description of a location, to digital mapping and three-dimensional data modelling. Modern systems to acquire and process spatial information include satellite-based global positioning systems and imagery sensors, 'big-data' computing technology and software that enables layering digital information and 3D visualisations and modelling.

This shift in technology and digitisation has resulted in an increasing reliance on spatial imagery data – high-resolution digital photography and light detecting and ranging (LiDAR) data. This underpins many digital tools and technologies that support more intelligent, efficient and accurate decisions about infrastructure including digital twins and advanced 3D models.

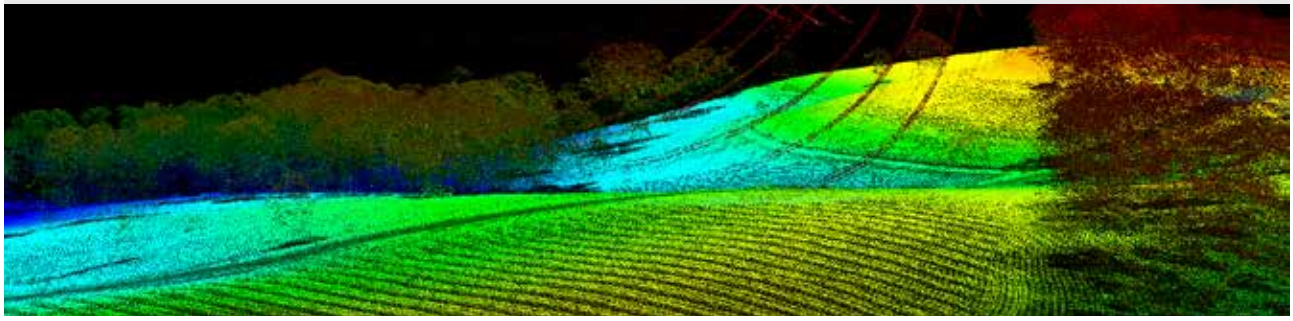
Vicmap™ offers highly valuable Victorian spatial data and information, and it is the State's authoritative source for spatial information. Managed by the Department of Environment Land Water and Planning (DELWP), Vicmap's™ portfolio of spatial data and products includes high-resolution spatial imagery and LiDAR data with coverage across the State. It provides easy self-service access to wide range of State Government organisations and partners.

The Vicmap™ program provides specialist spatial imagery and LiDAR data knowledge and expertise to ensure the acquisition high-quality, fit-for-purpose data and products are acquired for government. Established data specifications, data sharing and storage systems and networks ensure streamlined access to data to undertake a range of service and project delivery activities, including monitoring urban growth changes, modelling major infrastructure projects and undertaking asset condition and management tasks.

Vicmap™ data is invaluable for the early stages of project planning, and it should inform a more comprehensive understanding and better decision-making around in-situ conditions (vegetation, natural and non-natural features, shading) and siting conditions (orientation, topography, boundaries, land parcels).

The data can be used for real-time transport decision making, land use planning and integration, journey management, safety management, asset management, information sharing, location intelligence analytics and business case development.

For more information about Vicmap™ go to https://www2.delwp.vic.gov.au/maps



Model review approach

The VDAS Champion should, in consultation with the DE Project Champion, define how model-based reviews will occur within the organisation and across all projects.

The goal is to improve stakeholder engagement and reduce coordination issues – improving collaboration.

Digital model review can be used to:

- model and visualise different design options and alternatives in real-time during design review, based on construction, end users' or owner's feedback;
- create shorter and more efficient design workflow and review processes;
- evaluate the effectiveness of design in meeting construction schedule criteria and owner's needs;
- enhance the health, safety and welfare performance of projects and assets. For example, BIM can be used to analyse and compare fire-rated enclosures, egress routes and alternative stair layouts;
- easily communicate the design to all decision makers including the owner, construction team and end users;
- get instant feedback on schedule performance, owner needs and building or space aesthetics;
- greatly increase coordination and communication between different parties;
- eliminate costly and time-consuming traditional construction mock ups; and
- enhance design quality and minimise hazards by scenario planning interactions with construction, maintenance and operation teams.

The following resources will be required:

- design review software;
- interactive review space (i.e. cave automated virtual environment etc.);
- hardware capable of processing large model files;
- an individual with the ability to manipulate, navigate and review a 3D model; and
- quality control and validation.

It is important to remember that digital engineering is as much a behavioural change as it is about technology.

Effective collaboration is key to achieving the aims and outcomes of digital engineering and therefore setting up the right environment, either physical or virtual, is vital.

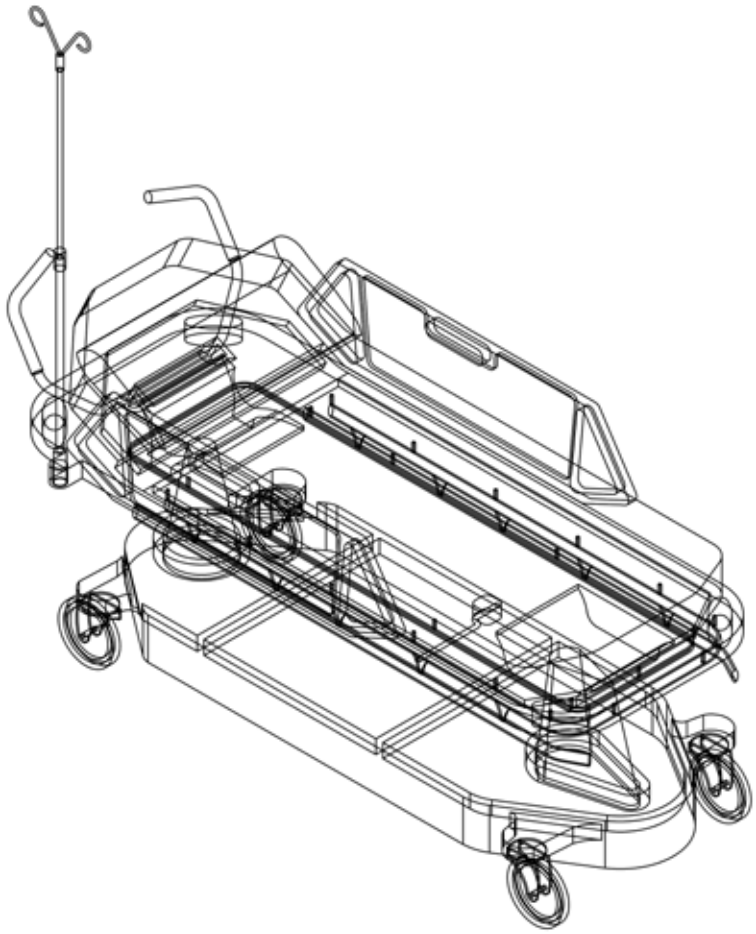
Soft landings - data drops

Infrastructure assets may look the same, but the assets that form them can be vastly different. Each building, bridge, roadway or train line must respond to its site, environment and the occupants who use it.

Many parties are involved in the creation of these assets. Often by the time construction is finished, many of the original project team members are not involved anymore. This creates problems for the asset owner and users, as the tacit knowledge departs with the project team.

Operations and maintenance manuals aim to address these issues, but the end user is best supported through the handover process.

Organisations should adopt a 'soft landings' approach to all projects. Further detailed guidance can be found in the *Soft Landings Framework Australia and New Zealand document* with a revised UK version *Government Soft Landings* (aligned with ISO 19650).



Technology and systems

The VDAS and digital engineering are not software. They are a combination of frameworks, processes and workflows that use valuable data and information, leveraging spatial, object-based design, modelling and use.

They are underpinned by innovative and rapidly changing technologies and systems.

In this context, the DE Project Champion, VDAS Champion, CIO/CTO should agree on the current and proposed technologies and systems and integrations that will exist between them for your organisation.

Projects are inherently dependent on the technologies and systems they use, and these technologies and systems develop and change over time.

The CDE is established during stage 1. The CDE could contain GIS, BIM and CAD systems, and enterprise-level drawing/document management and other solutions as well as workflow management.

Constantly changing technologies and systems have significant impact on projects and the complex interfaces or networks they connect to.

Common data environments

A CDE is the collection of data and information repositories. It is used to collect, manage and disseminate all relevant approved project documents for multidisciplinary teams in a managed process. The CDE is the single source of information for any given project.

A CDE is not one piece of software, system, cloud platform or shared network drive. It is the environment and process of moving data between systems that enable users to store, collaborate and exchange structured information and data.

The ISO 19650 series recommends the Appointing Party establish the CDE. For the VDAS, this is termed the organisational CDE. In practice, this is usually left up to the lead Appointed Party to administer. For the VDAS, this is termed the project CDE.

It is the responsibility of the DE Project Champion to specify the CDE for the project in consultation with the lead Appointed Party. The DE Project Champion should collaborate to ensure suitability aligns at the organisational level.

Tip

The benefits of having a CDE include:

- reducing the time and effort required to validate and reissue information;
- reducing error rates from working on outdated information or unapproved data;
- reducing the time and cost of producing coordinated information;
- reducing the number of coordination checks required;
- reusing information to support construction planning, cost planning and asset management;
- improving consistency in the usage of datasets on projects;
- improving project data security and user control; and
- system interoperability and data sharing.

Tip

The CDE could contain the following functionalities:

- project management system;
- 2D and 3D Information;
- BIM, GIS, CAD;
- scheduling information;
- cost information;
- enterprise content management (ECM); and
- electronic document management system (EDMS).

Stage 1

BRIEF

CDE workflow

Contractors, owners and supply chain create information on projects. The workflow of how this information is generated, shared, approved, published and archived is of great importance.

In the Victorian Government infrastructure project context, information is usually created by the Head Contractor (Lead Appointed Party) in their own in-house/proprietary CDE.

The following best practice approach workflow should be used throughout the asset's lifecycle.

Information and data is generated by the Appointed Party (e.g. designer) or the Appointed Party's supply chain (e.g. subcontractor/ consultant). During this generation and creation stage, the data is labelled 'work in progress'. This status within the CDE denotes that data and information is controlled, and not for use or released until quality checks and assurance have been completed.

Once the data has been approved via assurance and quality checks, it gains the CDE status of 'shared'.

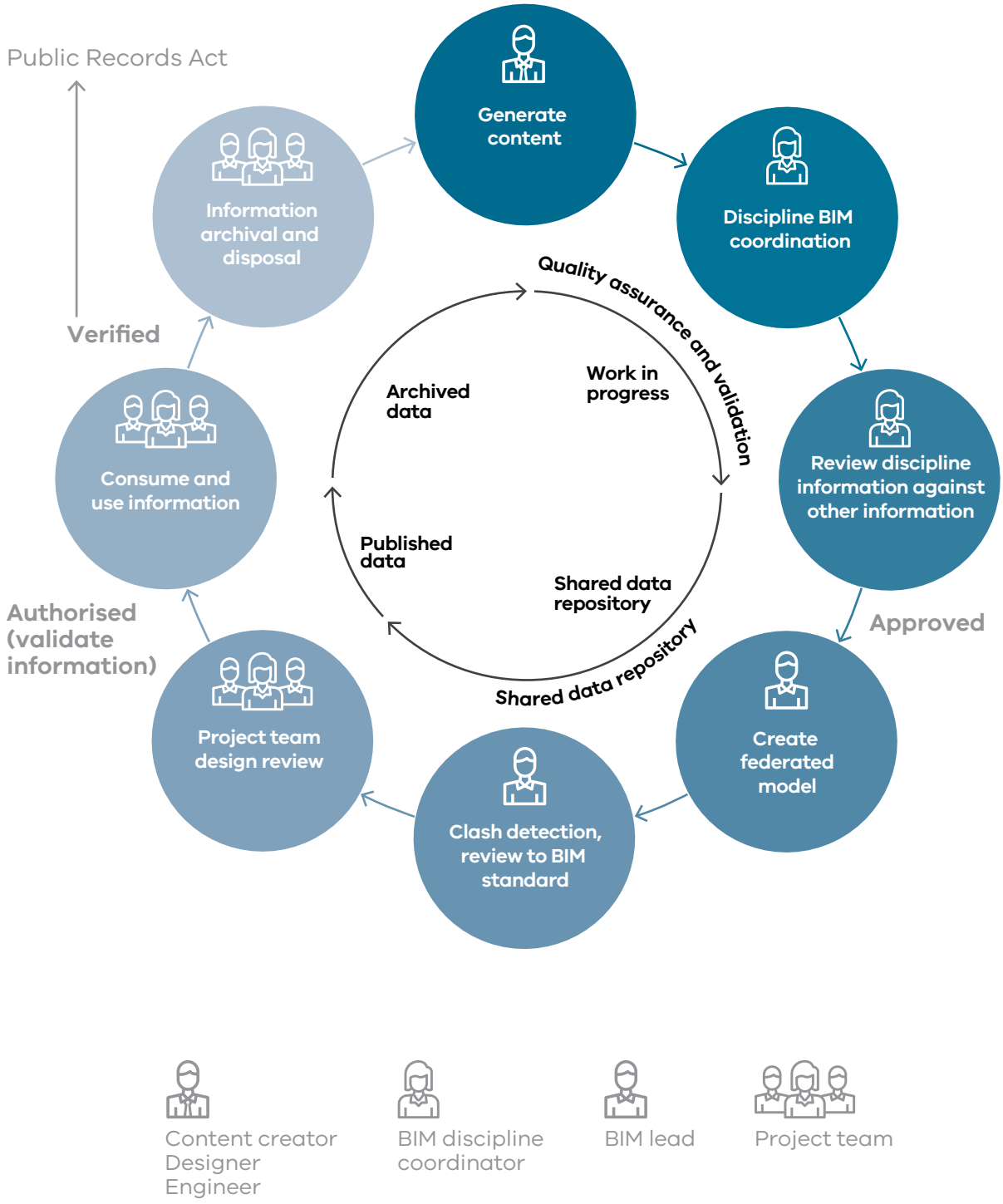
With this status, data and information can be freely shared between authorised parties as per the EIR. Shared data and information is typically not released to all parties on the project, depending on the procurement route chosen.

Once information is agreed as approved, it gains the status of 'published' within the CDE. With this status, digital engineering and digital asset information is now authorised for use for a specific and clearly articulated purpose, such as cost estimating, construction, handover, etc.

Given the iterative and contemporary nature of data and information on projects, it is necessary to provide an 'archived' status. This denotes data and information that is outdated, of a previous revision, or not for use. Archived data can be generated from all three states – work in progress, shared and published.

Stage 1

BRIEF



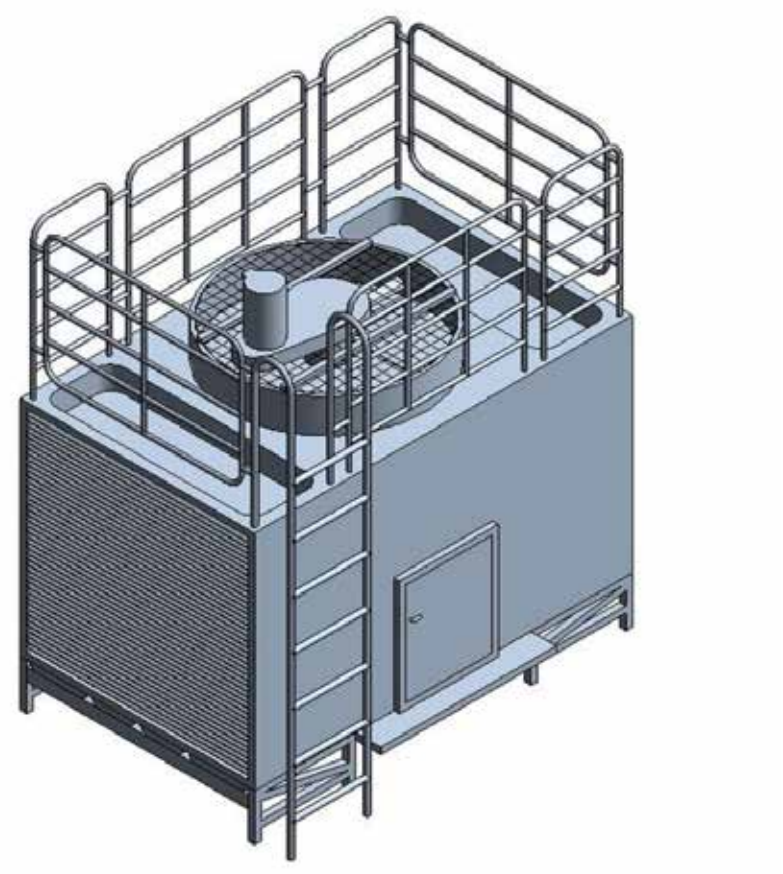
Common data environment requirements

As part of stage 1, and prior to engaging the Lead Appointed Party, the DE Project Champion should determine the CDE requirements and approach for the project.

Elements to consider by the DE Project Champion include:

- security requirements (see 'Data security and integrity');
- legacy systems (such as GIS, BIM, CAD, EAM, CMMS, etc.);
- user access rights;
- hardware and software;
- data quality and information management requirements;
- reporting requirements;
- user and organisational outcomes;
- how the project CDE will adapt throughout the lifecycle;
- how the project CDE will translate and novate through contracts (with emphasis on the Lead Appointed Party); and
- the OIR, AIR, and AIM.

The CDE will control how project stakeholders engage with complex asset information.



Geographic information system

Many organisations maintain and operate a comprehensive GIS system. GIS is a powerful and valuable tool in the digital engineering and CDE workflows.

The VDAS and digital engineering benefit greatly from the versatility of GIS.

Existing GIS adds value through spatial analysis, geolocated and cadastre aligned representation of information and overall collaboration. In some circumstances, GIS systems are integrated with asset registers, as well as financial performance data to provide project decision makers with a comprehensive picture of how existing (and similar) assets perform and can be leveraged.

A prime example of this may be having deeper insight into the location of service conduits to inform decision making, which saves capital investment.

Key questions for the DE Project Champion, Project GIS Lead and System GIS Lead to consider as part of stage 1 include:

- How will the current GIS data be integrated into the project?
- How is the project GIS integrating back into the enterprise GIS?
- What are the basic spatial and GIS-based requirements, including coordinate reference frame (datum, projection, height datum), spatial accuracy requirements, metadata and attribute structures and schemas?
- What is the relationship between the organisations GIS, CMMS, finance, BIM and CAD systems?
- Do legacy GIS systems require proprietary file formats and protocols?
- Are any major changes anticipated to the GIS over the project lifecycle?
- How should project stakeholders reference coordinates?
- What is the verification process for integrating spatial data into the CDE?
- What is the maturity and currency of the existing GIS data?

GIS lays the foundations for digital assets. These assets will be placed in an environment with embodied existing information.

Building information modelling systems

Existing BIM systems, data and information are powerful if leveraged effectively during stage 1.

Many departments and agencies already have access to legacy BIM systems, data and information, but may not be aware of it.

An example of this may be from prior projects. In these circumstances, the following could be re-used and leveraged:

- object libraries – which would likely not need to be re-engineered or assured to the same extent, e.g. Australasian Health Facility Guidelines project resources;
- non-graphical data – such as performance, cost, manufacturer, etc.;
- generative scripts, automation scripts, existing designs and historical decisions; and
- product manufacturer libraries should be used (even if not actual – but equal or equivalent).

It is important for the DE Project Champion to understand existing context of any BIM systems, including:

- proprietary file formats;
- BIM data structures and schemas;
- versions of schemas;
- versions of software;
- model view definitions;
- classification of asset data,
- difference between design and fabrication specific tools;
- common data environment; and
- collaboration requirements.

In line with NDEPP, VDAS recommends that BIM collaboration occurs using OpenBIM formats such as IFC – except where IFC is favourable in all circumstances of the asset lifecycle, and proprietary formats may be more beneficial.

The DE Project Champion must also consider how information, data and systems will interact throughout the asset lifecycle, as well as how other BIM-related platforms will interact.

The DE Project Champion should collaborate with the organisation's CTO to enable digital engineering model viewers for selected personnel on the proposed project, with the view to a broader roll-out strategy.

Stage 1

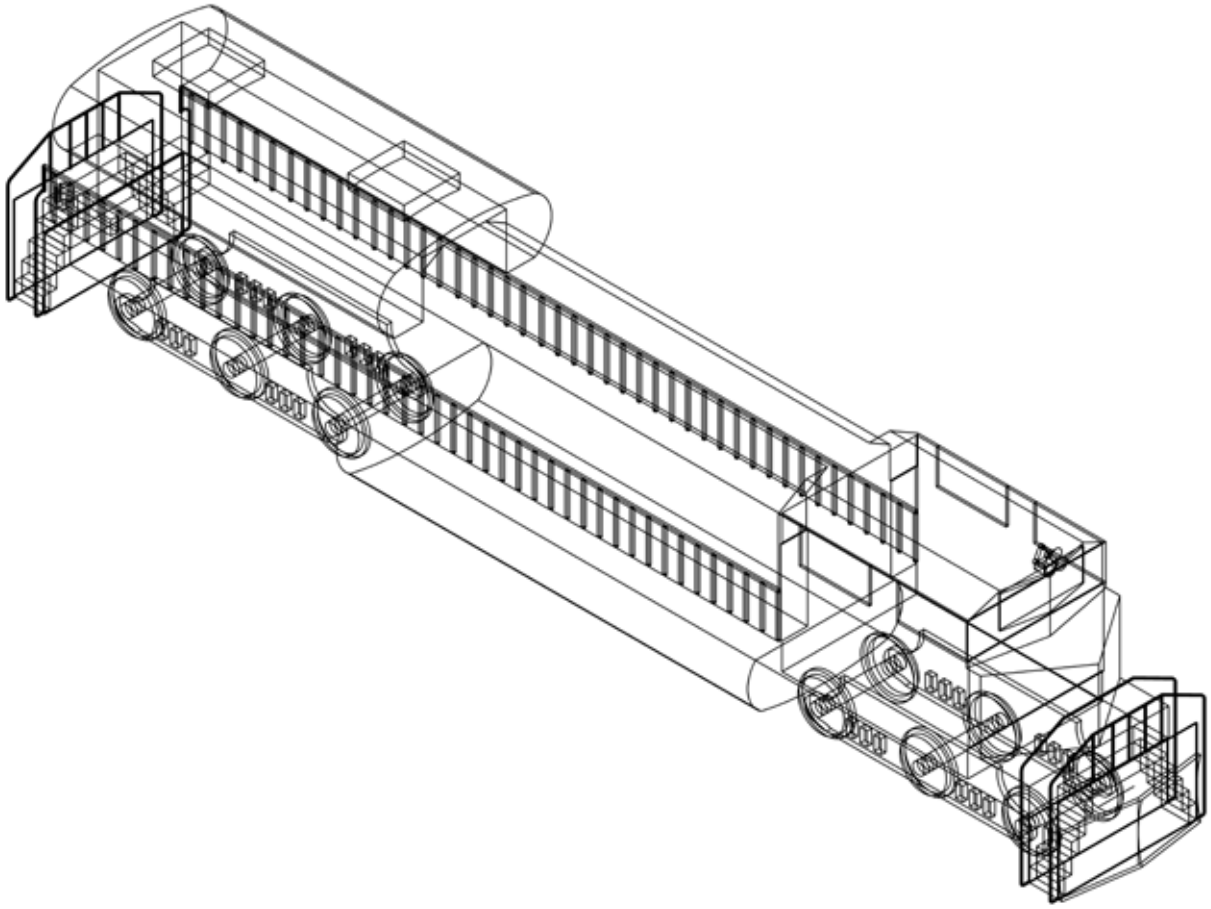
BRIEF

Computer-aided design systems

CAD systems create, house and visualise computerised drawings and models defined by 2D and 3D vectors, arcs and circles that contain geometric parameters and attributes.

Key questions for the DE Project Champion and engineering manager to consider include the following:

- How will data in the CAD system be integrated into the project and CDE?
- How will the project CDE provide output back to the organisational-level CAD system throughout the lifecycle?
- What are the basic CAD requirements, including standard drawings, vectors, thicknesses, layers/levels, file formats and drawing numbers?
- Is there an opportunity to automate the generation of drawings from models in line with the specific requirements of asset owners?
- What is the relationship between the CAD, CMMS, finance, BIM and GIS?
- Are any major changes to the CAD system anticipated over the lifecycle?
- How should project stakeholders reference existing drawings in the CAD system?
- What is the verification process for CDE to CAD re-integration?



Enterprise asset management and computer maintenance management system

An EAM system or CMMS is generally an enterprise-level system that maintains information about an organisation's assets and maintenance operations.

This information is highly valued in the context of effective whole-of-life decision making. An example of this may be information and data on a HVAC system. Access to EAM or CMMS may highlight that one system is considerably more unreliable or expensive to run than another. This is essential information to know as part of very early project decision making.

The DE Project Champion, in collaboration with the asset manager and the maintenance manager, must consider how asset-centric information from the project (the PIM) will be handed over to the AIM throughout the project lifecycle via data drops.

As per the following table, there is a spectrum of how PIM can integrate back into the AIM.

VDAS project-to-asset handover spectrum

Undesirable	Minimal	Moderate	Exceptional	Best in class
No handover Remaking the asset-centric information after project completion Handing over information in paper-based systems for manual transfer	Asset data/ information transfer supported by paper-based transfer of drawings, manuals and schematics Using existing proprietary formats to review as-builts	Defined asset data-loading spreadsheets supplied to project team for population Some integration of project CAD, BIM, GIS with the organisations systems and standards	Defined asset information model requirements articulated to inform PIM creation PIM progressively loaded and validated into AIM throughout project delivery	Seamless CDE to CMMS, EAP, and BMS handover Paperless transfer Scope attributed with unique IDs to aid IoT and real-time sensors

Other systems

Organisations typically operate and maintain many other existing systems that are pivotal 'inputs' and 'outputs' to the CDE and digital engineering workflow throughout the project lifecycle. These should be articulated as part of the EIR.

As part of stage 1, the DE Project Champion must capture and consider an integration or interface approach with these systems.

Key business systems that digital engineering information is likely to integrate with may include:

- procurement systems;
- financial management systems;
- electronic document management systems;
- enterprise-level systems (Microsoft Office and email clients); and
- other web-based collaboration platforms.

The DE Project Champion should work with these system leads to drive the best outcomes for the project.

If data was as standardised as shipping containers, the flow of information internationally would be seamless, consistent and reliable.

Stage 1

BRIEF

Stage 1 checklist

Check	Description	Role	Page
☐	VDAS Champion and DE Project Champion onboarded to the project	Appointing Party	C.12
☐	Key decision points for information transfer identified	DE Project Champion	C.34
☐	Preferred procurement routes identified and aligned with key decisions	DE Project Champion	C.34
☐	OIR currency checked and updated	Data custodians	C.31
☐	AIR currency checked and updated	Asset/facilities managers	C.32
☐	Asset classification system agreed upon	Asset/facilities managers	C.16
☐	Operations and maintenance representative engaged	Asset/facilities managers	C.16
☐	Completed project statement of intent	Appointing Party	n/a
☐	Data dictionary consulted – naming conventions collated and validated	Project director	C.32
☐	Existing asset information model validated and required data collated	Asset/facilities managers	C.32
☐	Existing site information collated	Asset/facilities managers	C.35
☐	Site constraints understood and documented	Project director	C.35
☐	Existing model/drawings (graphical and non-graphical data) handed over to parties in stage 2	DE Project Champion	C.35
☐	Lessons learnt relayed back to the VDAS Champion for inclusion in future projects/approaches	VDAS Champion	C.12
☐	Clarify and check user access rights	DE Project Champion	C.18
☐	Review stage 1 key decision points	VDAS Champion	C.34
☐	Prompt and answer stages 2 and 3 key decision points in collaboration with key project and asset stakeholders	VDAS Champion	n/a

Stage 2

CONCEPT

The purpose of this stage is to gather the project information requirements, consider the legal and security implications of digital engineering and define the preferred procurement route.

During this stage, the Appointing Party will begin to engage designers, architects, and external consultants begin creating the best scope 'option' for the project, that meets business case objectives.

Project options include:

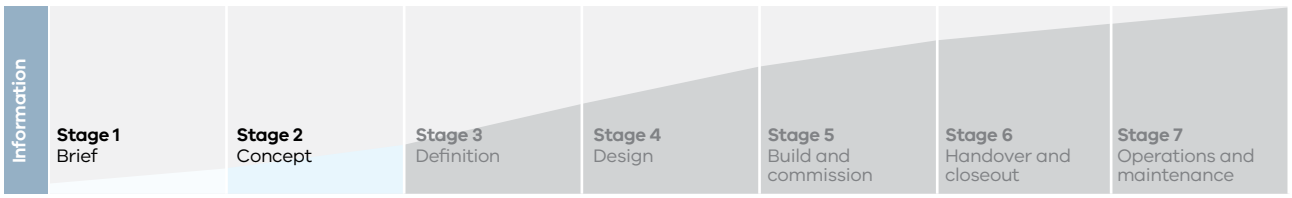
- site locations;
- preliminary plot plans and routes;
- basic in-situ conditions;
- basic massing diagrams (volumes);
- order of magnitude cost estimates;
- preliminary schedules;
- key stakeholder consultation; and
- understanding of project risks

Digital engineering information is immensely valuable during this stage. It informs early design development, rapid options assessment, site analysis, risk analysis, cost estimating, traffic modelling and assurance, as well as aligning internal and external expectations through graphical visualisation tools.

The completion of this stage is marked with a preferred design option that balances business and project objectives (such as value for money, functional outcomes and community expectations) as outlined in the preliminary business case.

Stage 2
CONCEPT

Stage	Concept	
People	• VDAS Champion • DE Project Champion • Asset and Facility Manager • Maintenance Manager	• Head of Engineering/Engineering Manager • Project Director • Senior Responsible Owner (Sponsor) • Data custodians and stewards
Information management	• OIR and AIR agreed/locked for the project • DE vision, benefits realisation, and KPIs agreed and locked • Draft EIR developed in line with OIR and AIR • DE governance structure and pre-contract org. chart locked • Near final procurement approach, incl. legal and commercial review	• Asset/location classification, and asset hierarchy agreed • Asset criticality status finalised and requirements agreed • Data/information and lessons learnt review and capture • QA/QC
Data information models	• Stage 1 information reviewed • Relevant AIM and existing data and information transferred and vetted into PIM • Functional groups alignment of DE requirements • Data custodians defined	• Data models reviewed • Changes/updates to data models defined and budgeted • QA/QC • Assurance
Technology and systems	• Internal CDE/EDMS/ • CAFM/CMMS/GIS • System requirements and user access established	• Org. model and drawing viewer implementation (reduce 2D) • Systems, tools, and integrations defined and budgeted
Deliverables	• Finalised OIR and EIR • Draft EIR, incl. RACI/Scope Checklist • DE strategy • Training/upskilling program • Mentoring/support program	• Communication strategy • Report to executive on project progress/ challenges • Stage 2 checklist • Information from stage 2 transferred into stage 1



People

By stage 2, the project delivery team is beginning to form and collaboration is pivotal to successful project outcomes. Leveraging data and information from stage 1 enables the VDAS Champion and DE Project Champion to take a lead role in meeting the project's goals and objective.

VDAS Champion

In stage 2, the VDAS Champion's obligations shift to the DE Project Champion. The VDAS Champion must still be readily available to provide the DE Project Champion with support, information and oversight.

The VDAS Champion will also be required to maintain stakeholder alignment within the organisation's functional areas, with the goal to understand and integrate with parallel initiatives, other VDAS enabled projects, including their respective DE Project Champions.

The VDAS Champion should have already led an organisational-level capability assessment that seeks to understand the organisation's readiness to consume and leverage digital engineering information across the asset lifecycle.

This also includes how the organisation expects digital engineering information will be migrated from the project information model (PIM) into the existing asset information model (AIM). The PIM and AIM should be made available to the DE Project Champion, with associated reviewed project documents.

It is important that the VDAS Champion enables your organisation to be an informed client.

The above also extends to supporting the DE Project Champion's assessment of which data custodians and stewards will be responsible and accountable for the management of information when the assets are in service.

Stage 2
CONCEPT

DE Project Champion

From stage 2, the organisational-level digital engineering objectives are translated to project-level objectives and 'owned' by the DE Project Champion.

Accountability for system or organisational-level digital engineering objectives remains with the VDAS Champion.

For this transition to occur seamlessly, the DE Project Champion must clearly understand the organisation's information management maturity, with project-level gaps beginning to be filled and addressed.

The DE Project Champion should establish the governance structure, including roles and responsibilities of the project delivery team and any RACI matrices.

These must be informed by capability and capacity assessments undertaken as part of the VDAS implementation roadmap.

Many of the capabilities and capacity may not be able to be filled immediately from within the VPS. In this case, the DE Project Champion will appoint external resources to represent the Government's best interest as the owner's representatives. For more information or assistance in staffing your project, contact OPV.

For all intents and purposes, these parties must be engaged with independence and without conflict.

People are pivotal to stage 2, as they provide the key inputs to the EIR, which should be nearly in final draft form upon completion of this stage.

The DE Project Champion must take ownership of the EIR, and guide development of the PIM and how it integrates back into the AIM.

A digital engineering evaluation and response (DEER) document will assist the DE Project Champion assessing the delivery team digital engineering plan (DEEP). See Appendices 6 and 8.

A thorough and quality DEEP will assist the DE Project Champion in delivering an smart asset.

Stage 2

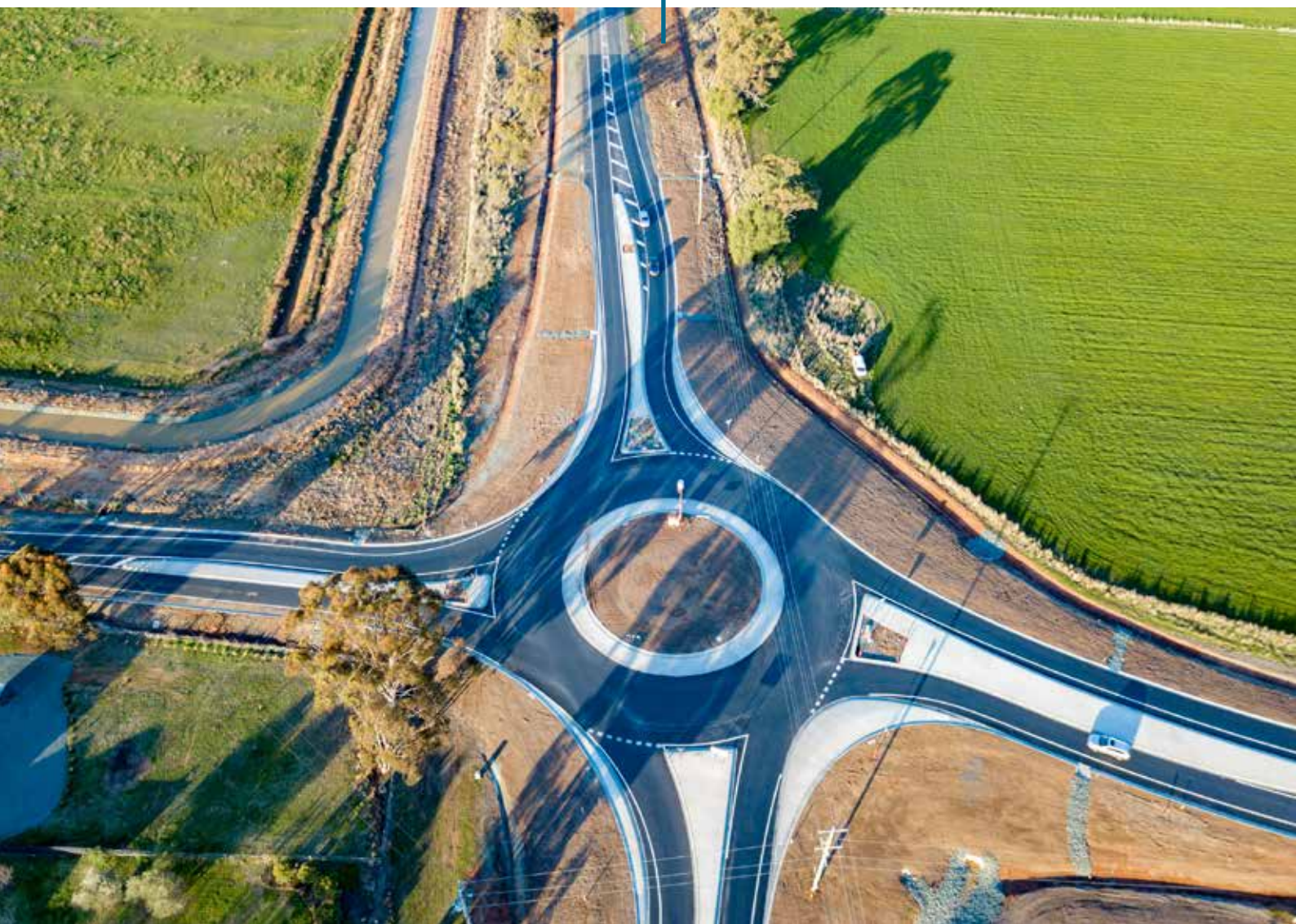
CONCEPT

Data custodians and data stewards

Most data custodians and stewards identified in stage 1 will be onboarded during stage 2. The DE Project Champion and VDAS Champion should focus on assigning responsibility for the remaining datasets and information sets without an 'owner'.

The stage 2 workflow for data custodians and stewards involves working with the DE Project Champion to ensure all the relevant organisational and asset information requirements for the project have been addressed and included in the EIR prior to appointing any party.

Roles focussed on data and information are highly important to facilitate the delivery of high quality assets.



Asset and facilities managers

Asset and facilities management teams should be actively involved with stage 2 activities and should support the DE Project Champion. Ensuring their commitment and time may often require buy-in from the organisation's leadership or the Project Sponsor.

Operational representatives or champions should have clear roles and responsibilities for asset and facilities management. Ideally, the project team will secure the engagement of people who see the project through from these initial capital works stages, to commissioning, handover and in-use stages, where they will use the information models to deliver their functional activities.

At this stage, much of their involvement will be in assisting establishment of explicit asset information requirements (AIR) for incorporation into the project EIR. All their operational data/ information use cases, requirements, schemas and exchange formats should be fully catalogued. Their early involvement will help ensure there is a smooth transition of data into the various asset and facilities management systems on handover.

It is also important to understand what the asset and facilities management teams will use the information models for during the design and construction stages, for example as digital maintainability reviews or soft clash detection on plant room maintenance zones.

The asset and facilities managers can also help define clear, measurable targets for facility performance outcomes and simulation requirements to test during the design development.

Appointed Party

Most projects will engage a designer or architect for the discrete scope of developing the project's pre-feasibility, reference or concept design package during stages 2 and 3. With respect to VDAS and ISO 19650, the successful party of this contract is termed the lead Appointed Party.

The lead Appointed Party/Appointed Parties (collectively called the delivery team) are contracted to assist in the development of the concept design. They are also the best-placed party to develop digital engineering and BIM data and information. For best results, and aligned with best practice, the stage 2 Appointed Parties should be engaged through a contract with a defined Appointing Party EIR. Typically, this EIR is only for the duration of this design-focused contract (i.e. stages 2 and 3). The clearer the requirements for a design-focused contract, the better.

Typically, there is a lead Appointed Party (e.g. lead consultant or head contractor) that manages the inputs/outputs of all Appointed Parties.

For digital engineering and BIM workflows, data and information, the DE Project Champion is the client-side accountable stakeholder for this contract.

The DE Project Champion should ensure, from a digital engineering perspective, that the lead Appointed Party:

- sets the project up to succeed;
- understands the vision and asset data needed on completion/handover;
- has enough capability and capacity to meet the project's digital engineering objectives;
- understands the owner's needs for information management (i.e. OIR, AIR, level of information need, and draft EIR) throughout the entire asset lifecycle;
- knows what is likely required of future appointed parties (e.g. the migration of information from stage 2, to 3, to 4 and onwards);
- understands the owner's proposed high-level digital engineering approach; and
- is capable of documenting the information they will be generating for the term of the contract and beyond stages 2 and 3.

Information management function

The DE Project Champion is the key information management functional role required on the organisation's side of the project. A similar role is needed on the delivery team to ensure information is developed by all parties in line with the requirements. This role is often termed the digital engineering/CAD/GIS/BIM lead or information manager. This role's function is usually performed by the lead Appointed Party. The DE Project Champion should consider the project scale/complexity and capability of the delivery team with respect to creating new roles.

Typically, the DE Project Champion role would:

- articulate the Appointing Party information requirements (AIR/EIR) to the entire delivery team;
- collate the individual task information delivery plans (TIDP) into a master information delivery plan (MIDP) and determine the information management workflows;
- collate the CAD/GIS/BIM approach into a draft DEEP;
- manage the project approach and relevant technologies and systems used including the CDE;
- review the digital engineering deliverables for quality/compliance to the AIR/EIR, scope and milestone deliverables;
- provide support/training to the delivery team and define/demonstrate workflows; and
- collate discipline-specific information into a federated environment and lead coordination reviews.

Competence

Competence, skills, experience and knowledge of digital engineering and BIM (both internal and externally) must be regularly evaluated by the DE Project Champion.

Two commonly used competence assessment tools are:

- ACIF's *BIM Knowledge and Skills Framework*; and
- BuildingSMART's *BIMCreds*

Developing competence within the team is a crucial step in delivering quality and data driven assets.

Information management

Stage 2's information management no longer focuses on synchronising the project EIR with the OIR and AIR, which should be completed in stage 1.

In stage 2, the DE Project Champion must ensure that the EIR is available, current and relevant to the project's context.

This also involves synchronising the digital engineering and BIM elements with the traditional concept stage workflows of the project.

Digital engineering workflows and information management must align with key project milestones for this stage, including:

- finalising and locking the project site location/ coordinates;
- developing preliminary plot plans and/or routes;
- understanding existing conditions;
- developing and analysing basic massing diagrams (volumes);
- developing order of magnitude cost estimates;
- finalising preliminary schedules;
- understanding basic material take-offs;
- understanding and engaging with key internal and external stakeholders; and
- understanding, documenting and visualising project risks.

This stage 2 information management section sets out key focus areas for the DE Project Champion.

Stage 2
CONCEPT

Exchange information requirements

A draft EIR should be completed by the end of stage 2.

The responsibility for the quality, timeliness, completeness, effectiveness and performance of this document remains with the DE Project Champion.

The EIR's value cannot be understated. It will be the product of many internal and external conversations, and is pivotal to the success of the project.

The EIR articulates exactly what digital asset information is required during each stage and upon completion of the project.

The EIR is a succinct commercial document that outlines the Appointing Party's information needs throughout the project and asset lifecycle.

The EIR is:

- the backbone of how information should flow between stages;
- a tool the Appointing Party can use to integrate stakeholders such as operations and maintenance;
- a clear articulation of commercial expectations between the Appointing Party, lead Appointed Party and subsequent Appointed Parties;
- what the Appointed Party's subsequent EIR (within the supply chain) will be developed against; and
- what the lead Appointed Party supply chain will respond to.

Tip

The Appointing Party may wish to consider rolling up all EIR documents into a single document.

EIRs are easily confused with project information requirements (PIR), as these documents are very similar. With respect to the VDAS, EIR and PIR are nearly interchangeable because most Victorian Government infrastructure contracts span across the project lifecycle.

Stage 2

CONCEPT

The completion of stage 2 should be marked with a near-final EIR.

The stage 2 EIR should include the following:

- clear alignment with the OIR and AIR;
- clarity on level of information needed at each major stage in the project lifecycle such as concept, design, build and commissioning handover and closeout;
- current operating information management systems/software;
- current organisational-wide information management initiatives/projects;
- input from current facilities/asset management (if brownfield/operating asset);
- input from facilities/asset management subject matter expert (if greenfield project);
- expectations around asset classification, location and hierarchies;
- preferred formats for use/exchange;
- preferred meeting and information exchange schedule;
- timing of project key decision points;
- existing information to be exchanged;
- consideration of current policies, standards and procedures around IP, data sovereignty, data security, access control; and
- a preliminary RACI/scope checklist in line with the preferred option at stage 2.

The VDAS Champion, the Project Director, Project Sponsor and organisational asset management team must review the EIR as part of stage 2 assurance processes.

The EIR enables powerful communication across the project team to support them in making improved decisions.

Stage 2
CONCEPT

RACI matrix/scope checklist

Clarity of roles, responsibility and authority are an essential aspect of effective information management.

A RACI matrix/scope checklist clearly sets out the responsibility to produce information and models for each defined project stage, aligned with the level of information need.

The RACI matrix/scope checklist is a pivotal attachment to the EIR. These two items should always be cross-referenced.

At stage 2 of the project the RACI matrix/scope checklist should set out generic roles and responsibilities aligned with the level of information need or preliminary scope of the project. As stages 2 and 3 of the project progress, the scope will mature, project participants will develop, and specialist organisations and supply chain will be added.

If the Appointing Party's digital engineering skills and capability are not well advanced, the EIR and RACI matrix/scope checklist should be independently reviewed. These are to be reviewed against ISO 19650 as well as the project maturity.

Security and access rights

The project EIR must consider security and user access rights. These are developed and defined for every single project and asset. From a security perspective, the DE Project Champion must apply outcomes from the data security and integrity section in stage 1.

Information and data will be created in multiple systems across a broad range of stakeholders, irrespective of who 'owns' the CDE. It is important to note that ultimate accountability for asset, data and information security must remain with the State.

In practice, the lead Appointed Party typically provides the CDE. In this circumstance, the EIR must articulate security and user access requirements.

Stage 2
CONCEPT

Elements to consider as part of stage 2 include the following:

- Which users need access and why?
- What is the protocol for access control?
- What are the system requirements with respect to up-time and usage?
- What is the escalation process in terms of a security breach?
- Can required team members access the CDE software/systems/networks?
- Upon project completion, do the Appointing Party or stakeholders require access?
- How do specific datasets/layers get protected?
- How will user access and control be moderated throughout the lifecycle of the contract (and beyond)?

The DE Project Champion is accountable for seeking a response to these questions and articulating the response in the EIR (where required).

Built assets have varying levels of security and access, the same applies to the CDE used to build its digital counterpart.

Interoperable and connected teams

System and software interoperability are a large part of enabling seamless information digital engineering workflows.

In some instances, software and software systems lack harmonisation, particularly around native formats and backwards compatibility.

As part of stage 2, the digital engineering lead must map the intended delivery team systems and software for the project. This includes versions, tasks and interfaces between anticipated contracted and subcontracted parties.

In a similar vein, hardware must be appropriate for the software. Exceptions should be highlighted in the DEEP along with minimum hardware specifications.

Authoring and reviewing software platforms as outlined in the EIR must be documented, including versions that will be used in the DEEP.

This should be approved by the DE Project Champion before starting the project, including testing of any new software applications, or testing software upgrades during the project, within specific timeframes.

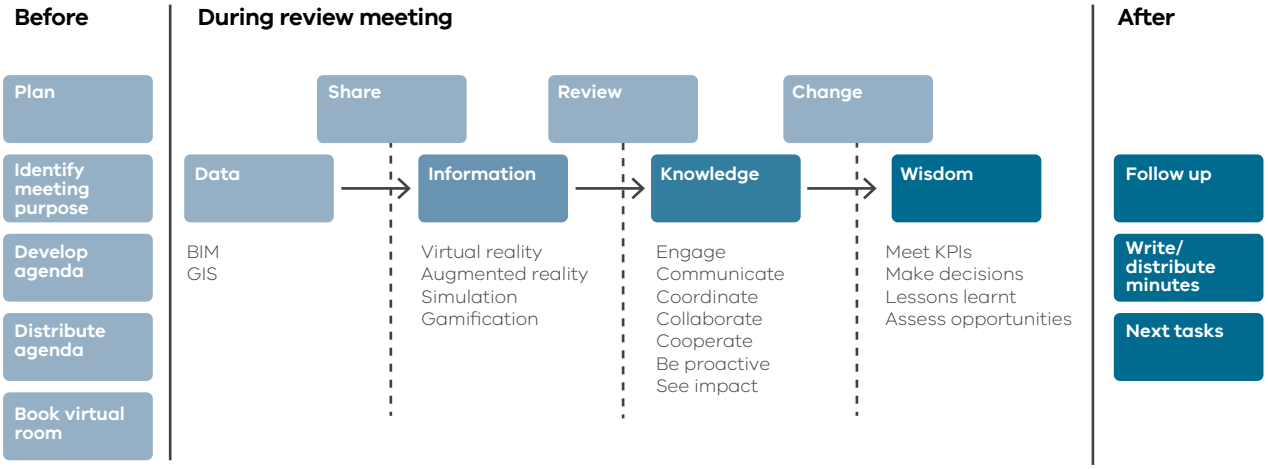
Model review approach

The DE Project Champion should develop the minimum model review requirements in consultation with the digital engineering lead. These meetings allow key stakeholders to determine, understand, analyse and review the PIM and other information outputs, provide their feedback and validate the stage against the key decisions. Ideally there should be three key stages to the process:

1. before review meeting;
2. during review meeting; and
3. post review meeting.

This workflow allows the team to develop proactive behaviour while collaborating and sharing key projects/asset data and information.

Stage 2
CONCEPT



Information models

The concept stage of a project is marked with the beginning of a PIM.

The DE Project Champion must ensure that the PIM is appropriately specified by the EIR.

It is important to recognise that PIM content increases rapidly as Appointed Parties generate data and information. This is continually being developed as part of the project's concept design.

The EIR being developed as part of stage 2 specifies the PIM structure. A high-quality EIR will ensure the PIM provides value during project delivery as well as upon project completion.

A poor-quality PIM will inhibit opportunities to automate or semi-automate asset information management.

Recognising that the EIR specifies the PIM, the DE Project Champion must focus on the following PIM elements within the EIR:

- location references;
- data schemas;
- data formats (e.g. file formats, versions, etc.);
- data classification and hierarchy (e.g. Uniclass 2015);
- data translation (e.g. between the Appointing Party, lead and other Appointed Parties, and other stakeholders); and
- data integration (e.g. asset information held in BIM to the CMMS).

Stage 2
CONCEPT

Location reference

A location reference identifies a unique location in either the real or digital world.

Documenting a location reference using a standard, explicit and consistent method is a fundamental part of effective asset management.

It is paramount to have a standardised and universal approach within the organisation that caters to complexities and differences across asset classes.

It is common to see significant rework in digital engineering due to poor specification of the chosen location reference. Stage 1 highlighted the value of this discussion early with the organisation's spatial experts or GIS leads. In stage 2, these discussions must be finalised prior to any Appointed Party commencing design activity.

The following are provided for the DE Project Champion to complete immediately:

- clear understanding of the organisation's current spatial, location and coordinates requirements;
- clear understanding of the organisation's future spatial, location and coordinates requirements;
- agreement and alignment with Asset Managers, GIS leads, and spatial experts on the common location requirements (e.g. coordinates) set and to be used on digital engineering or BIM authoring tools; and
- clear communication on common location requirements to all stakeholders within the delivery team, documented spatial and location requirements in the EIR and highlight the need to comply with these in the DEEP.

Victorian Digital Cadastre Modernisation Project (DCMP)

Maps have been in use for centuries, from the time of the early navigators and explorers to the current day where maps are used at work, on holidays and to assist people in need. Although convenient and easy to use, they frequently need to be updated to reflect changes to our cities. Older versions of maps can sometimes lead to problems in locating services and utilities or responding to people in need.

In some parts of rural Victoria, our current digital map of property boundaries is mis-located by many metres.

The Victorian Government is investing $45 million to update to update the authoritative map of property boundaries in (or throughout) Victoria, making it more accurate and accessible. All Victorians will benefit from this modernisation, as will the industries that rely on spatial information, including surveying planning, construction, agriculture, transport, emergency services, communications and research. This investment will ensure our digital maps are ready for Victoria's future.

The DCMP will ensure one of Victoria's most important datasets is more accurate, modern and easily accessible.

The DCMP provides an accurate system and complements existing Government initiatives such as Smart Planning and ePlan, and it will enhance the accuracy of Vicmap, the state's authoritative property/parcel/cadastral map base. The DCMP is broken into four stages, which will be delivered in partnership with a wide range of stakeholders. It is a key project to support the delivery of the Government's technology agenda.

Project data schemas

The EIR must articulate which data schemas will be used by which area of the project.

Schemas should be articulated early and compiled throughout delivery. This enables asset and project information to be accessed, analysed and maintained consistently.

Ideally, data schemas are specified for a purpose or a stage of the project, including:

- coordination;
- handover/transfer; and
- retention and archival of information.

The EIR template provided in Appendix 5 sets out a basic reference table that should be modified by the DE Project Champion

Effective data schemas can help seamlessly assemble a complex digital model from parts of different origins, just like its physical counterpart.

Industry foundation classes (IFC)

IFC is a standardised, digital description of the built environment, including buildings and civil infrastructure. IFC is 'open', follows international standards (ISO 16739-1: 2018), is vendor neutral, platform agnostic and usable across a wide range of hardware devices, software platforms and interfaces for many different use cases. The IFC schema specification is the primary technical deliverable of buildingSMART International.

IFC is used in BIM authoring and viewing applications to exchange 3D geometry and data (through property sets) from one party to another, for a specific business transaction. For example:

- an architect may provide an owner with a 3D model of a new facility design;
- an owner may send that 3D building model, with quantities/volumes/counts to a contractor to request a bid; and
- a contractor may provide the owner an as-built 3D model with details describing installed equipment and manufacturer information.

IFC can also be used as a means of archiving project information, whether incrementally during the design, procurement and construction stages, or as an as-built collection of information for long-term preservation and operational purposes. The IFC data can be encoded in various formats (XML, JSON and STEP), and can be transmitted over web services, imported/exported in files, or managed in centralised or linked databases.

The DE Project Champion must consider how the IFC schema will be implemented within the project. Questions that the DE Project Champion should answer as part of stage 2 include the following:

- Will IFC just be used for archival and geometric purposes?
- Are the embedded IFC schema (property sets) to be aligned to the existing AIM?
- Who will align property sets, exercise and advise delivery team members that the IFC property sets are to be used in of lieu of proprietary, or custom created attributes?
- Which version of IFC is most applicable?
- Is customisation required of the IFC version?
- Which MVD are applicable and to be used?

Asset classification

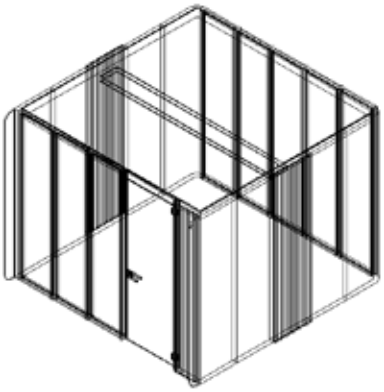
The value of consistent asset classification cannot be overstressed. Alongside location, it is one of the single-most valuable specifications that the DE Project Champion can articulate on a project or asset.

Many organisations and projects maintain their own asset classification systems and hierarchies. However, it is very rare to see consistency in the specification or use of these systems. Each department or agency uses their own, each project within the same department or agency uses their own, and there is rarely consistency between each stage of the same project.

Put simply – a consistent agreement on asset classification is a major priority as part of implementing digital engineering.

The VDAS recommends using Uniclass 2015, as it is ISO certified and a globally recognised and consistent system. The below asset tag/label, adapted from TFNSW, illustrates how an asset can be basically identified.

Uniclass 2015 is made up of 11 tables based on ISO 12006-2:2015 *Building construction – Organization of information about construction works*, 'Part 2: Framework for classification'. It is designed to distinguish different classes of information, as tabulated below. These tables are free to use, consistent, constantly being refined for specific sectors and allow for the addition of new classification codes as needed, in consultation with OPV and the UK's NBS.



Asset	**Classification**	**What type of asset is it?**
	Reference	**How is it named?**
	Hierarchy	**What is it related to?**
Location	**Classification**	**What type of location?**
	Reference	**Location name?**
	Hierarchy	**How to locate it?**

Uniclass 2015	Description (ISO 12006-2:2015)	Transport example	Building example
Co Complexes	Aggregate of one or more entities intended to serve at least one function or user activity	Rail networks, road network, interchanges, facilities, ports and fleets	University campus, airport precinct, mixed use site, private house with a garden
En Entities	Independent units of the built environment with a characteristic form and spatial structure, intended to serve at least one function or user activity	Structures (including buildings, stations, bridges, tunnels), corridors, roads, cars, vessels	Buildings, bridges, restaurant, public toilet block, swimming pool
SL Spaces / locations	Space defined by built or natural environment or both, intended for user activity or equipment	Lanes, lines, stops, and concourses	Rooms, hall, kitchen, sports hall, toilets
EF Elements / functions	Constituent of an entity with a characteristic function, form or position	Structural elements and high-level functions.	Main components of a structure, walls, columns, floors
Ss Systems	Interrelated products that together perform a defined function	HVAC, security, communications, ticketing, FF&E, fire, control and constructions (pavement, walls, floors, ceilings, roofs and structures)	HVAC, security, communications, FF&E, fire, control, ceiling, walling, roofing
Pr Products	Product intended to be used as a construction resource	All products at a maintenance managed item level	All products at a maintenance managed item level
Ac Activities	Things that are happening or being done in a space or location	Cleaning, maintenance, construction	Sleeping, eating, working, exercising
FI Form of information	Information of interest in a construction process	Mapped for use in project document management metadata	Mapped for use in project document management metadata
PM Project management	Control activity on as construction process by one or more construction agents	Mapped for use in project management metadata	Mapped for use in project management metadata
TE Tools and equipment	Asset and construction resource intended to assist in carrying out a management process	Mapped for use in asset construction management metadata	Mapped for use in construction management metadata
Zz CAD	Naming for all drawing related requirements, related to element/ function of the system titles	Used by DE for CAD layer naming	Used by DE for CAD layer naming
Ro Roles	Types of roles in an organisation, project, asset	name of roles i.e. Asset Manager, contractor	name of roles i.e. architect, cost manager

Each of the Uniclass 2015 tables features a four-level classification hierarchy, with each level providing a greater level of detail. See table below.

The DE Project Champion should review the Uniclass 2015 tables in collaboration with the VDAS Champion, and asset and facilities management.

The VDAS Champion should take a lead role in these organisation-wide conversations to ensure agreement.

Uniclass level	Format
Level 1: Group	Xx_00
Level 2: Subgroup	Xx_00_00
Level 3: Section	Xx_00_00_00
Level 4: Object	Xx_00_00_00_00

Asset hierarchy

Uniclass 2015 does not specify how systems, elements and products can or should be combined. Users may define their own conventions to determine how these are consistently combined.

VDAS recommends the following hierarchy conventions:

- Systems (Ss) are always at the top of the asset configuration hierarchy. Systems may be subsystems of a parent system.
- All elements (Ef) and products (Pr) must be associated with a system (Ss). Ef and Pr should not be 'stranded' assets (i.e. not connected).
- Complex assets should be hierarchically broken down in alignment with how the item would be managed and maintained (MMI).

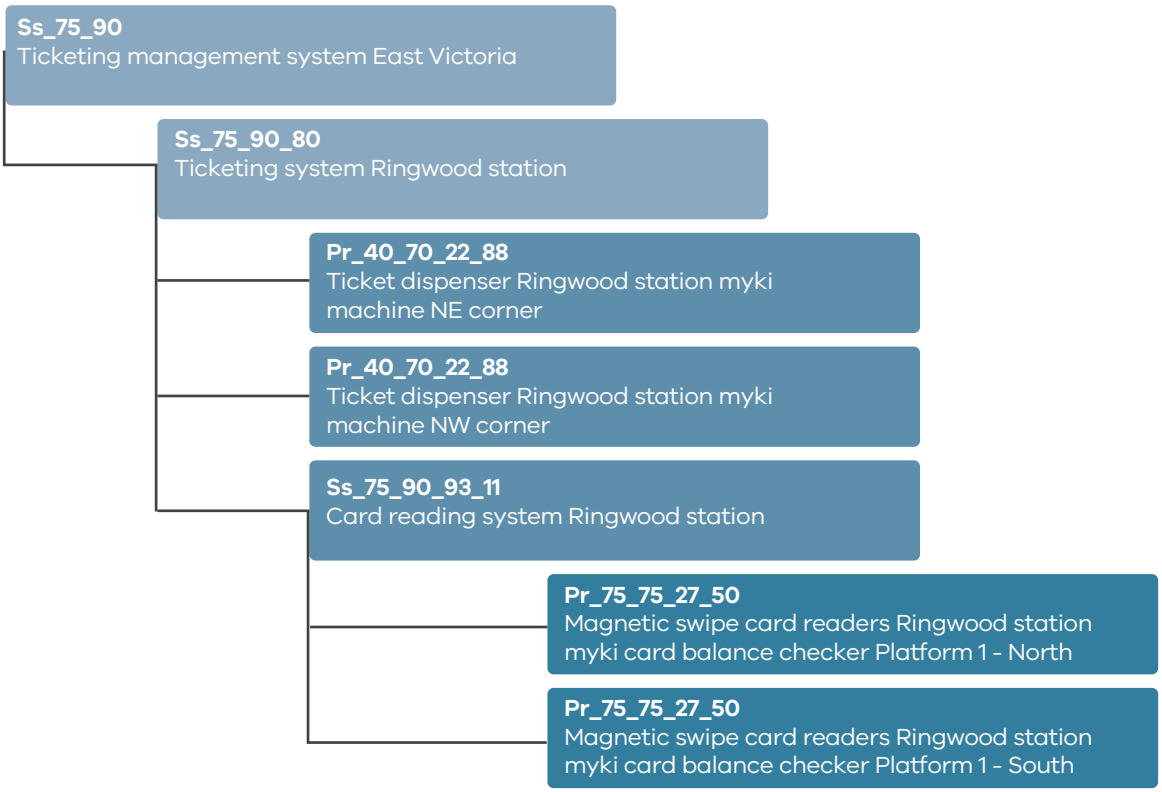
The maintenance managed item (MMI) is an asset or component that exists generally at the lowest level in the asset hierarchy. For each MMI, the owner will make key decisions on, including to repair, rehabilitate or replace.

It is important to consider the MMI when considering asset hierarchy and classification. In many cases, several scope items are typically installed: i.e. two myki card readers will be placed within the same space. In this case, a reference is required to distinguish individual objects using the same classification (e.g. myki machine-1, myki machine-2).

Asset classification has an impact at every level of the asset. From the train station and broader context to the myki machine on the platform.

Asset hierarchy example

Asset references must be unique within an asset hierarchy.



This approach ensures that large organisations, running many concurrent projects can use a common asset classification nomenclature.

The organisation is then able to aggregate these discrete projects into a single AIM.

The above may require mapping between Uniclass 2015 and the existing AIM.

Technology and systems

Prior to stage 2, the DE Project Champion and VDAS Champion will have consulted with the CTO. The defined technology approach for the project should be largely in place and communicated to the delivery team at stage 2. The focus now turns to the implementation of the chosen technologies and systems on the project.

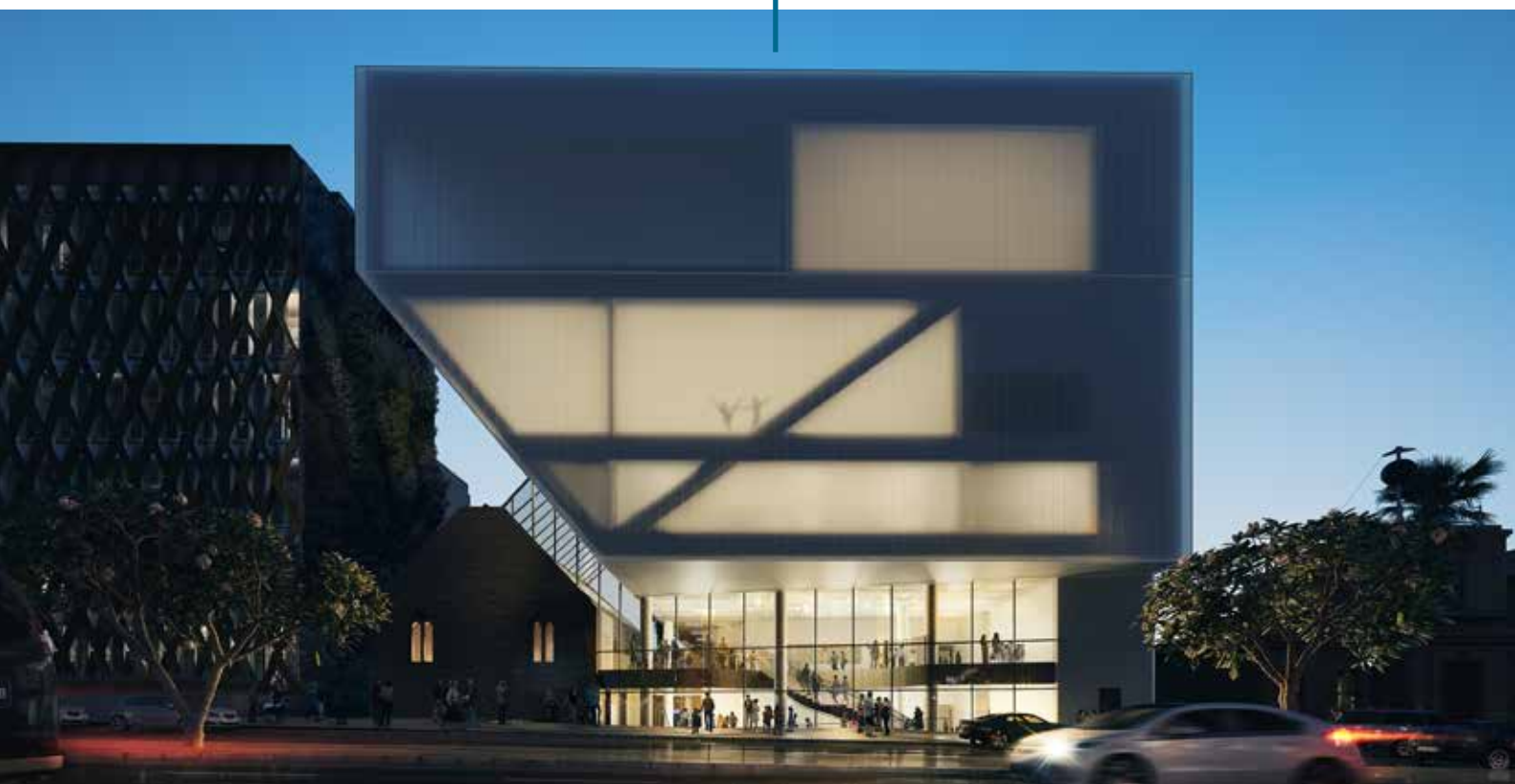
In this context, stage 2 will have defined technologies and systems including the following:

- CDE approach;
- GIS environments approach;
- BIM platform approach;
- CAD platform approach;
- viewing and assessment digital engineering model platforms (IFC, 3D, 2D and data);
- EAM and CMMS platform approach; and
- Interface between systems and technologies.

The systems architecture of the organisation should be well understood at stage 2, including any proposed future enhancements that may impact the VDAS approach.

Typically, the implementation of digital engineering requires an uplift in computer hardware. The VDAS Champion together with the DE Project Champion and CTO will plan any future requirements. This conversation must extend to the VPS IT outsourcing contractor.

The technology and systems being used should be capable of communicating and delivering an output with the required level of information.



Common data environments

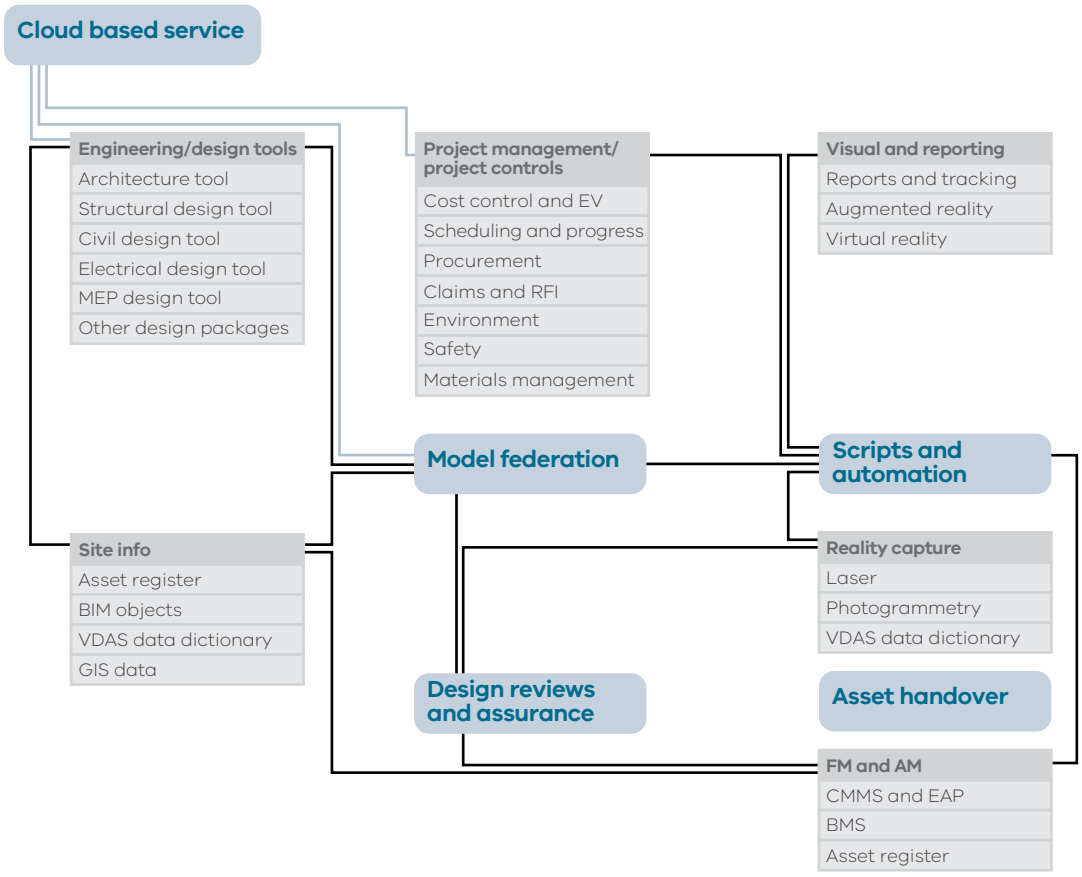
ISO 19650 recommends the Appointing Party establishes the common data environment (CDE) for the project.

This ensures the Appointing Party maintains information throughout the asset's life. Further, the Appointed Party is unlikely to remain engaged with the asset after stage 6, and, unless directed, will archive or destroy vital asset information generated in stages 1–6. This information will likely need to be recreated by the Appointing Party at significant cost.

Some organisations do not yet have the technical capability to establish and manage a CDE. Therefore, the lead Appointed Party is likely to fulfil this function on behalf of the organisation.

In this situation, the DE Project Champion will collaborate with the lead Appointed Party to address:

- a documented naming convention;
- establishing information containers;
- ongoing management and status of information containers;
- the classification system used (see approaches described in ISO12006-2); and
- the information container unique reference based on the documented convention.



Geographic information system

Similar to the CDE ownership as noted above, the custodianship of the GIS will be defined.

The DE Project Champion, in collaboration with GIS Lead and spatial expert, will seek agreement on whether a GIS environment will be provided by the Appointing Party, the lead Appointed Party, or another third party.

The DE Project Champion, GIS Lead and spatial expert must consider:

- access rights;
- security;
- what information is to be displayed;
- what information is needed;
- stakeholders (internal and external);
- visualisation;
- CAD and BIM data alignment;
- system performance/requirements; and
- database scheme defining attributes and metadata.

By the completion of stage 2, the EIR should have a detailed understanding of the GIS requirements.

Projects grounded in an accurate spatial environment will be a useful decision making tool throughout the stages.

Building information modelling systems

During stage 2, BIM may be limited to producing a massing or volumetric model.

This model is useful to understand overall scale, functional relationships between spaces, and to provide stakeholders with a visualisation of the proposed project.

Where possible, it should be informed by rapid options assessment and generative designs, as well as previously used objects and designs.

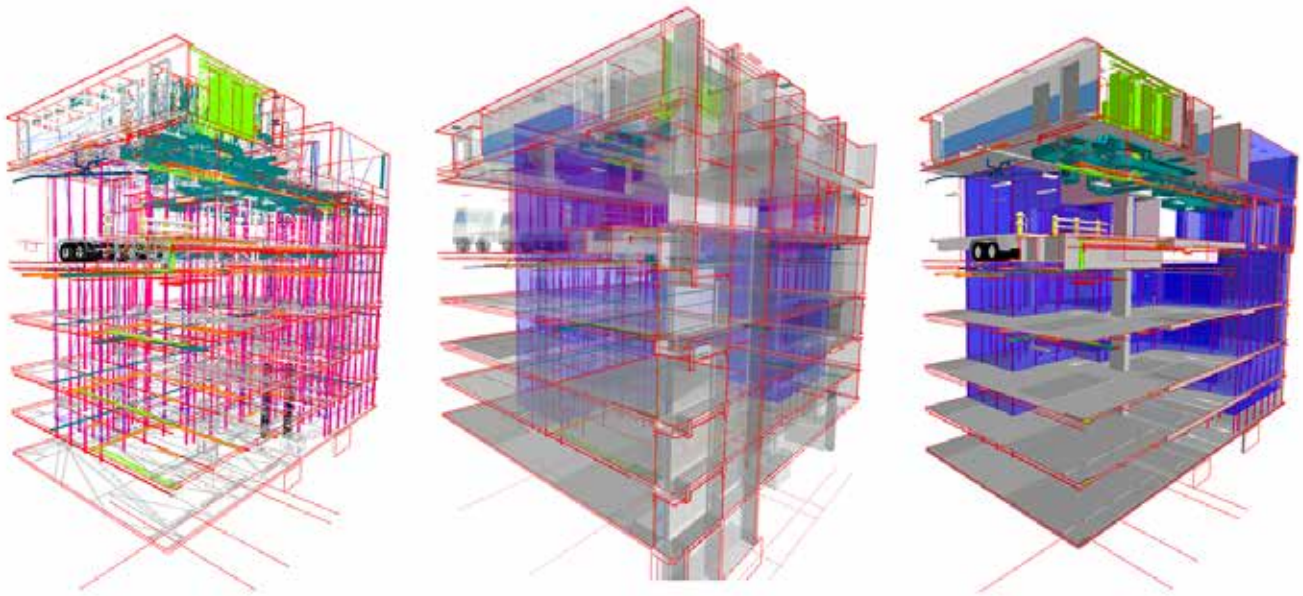
Further, the BIM should be, where possible, aligned with the project's schedule (via the work breakdown structure), and the project's cost estimate (via the cost breakdown structure).

The Appointing Party should have access to these early concepts to improve understanding of the project constraints and opportunities within the broader site context and to reduce the need for 2D drawing production. The integration, assurance and communication of this BIM information data, and models within the Appointing Party remains the sole responsibility of the DE Project Champion.

In addition to non-graphical and graphical BIM data being generated as part of the project's concept design, the DE Project Champion will need to specify the BIM systems (if applicable) for the main implementation contract.

The EIR must convey any BIM system requirements, including any provisions as to how existing BIM data will be supplied by the Appointing Party, as well as the use of IFC.

A BIM model will develop across the stages to create a federated model combining input from multiple relevant parties that reflects the built asset.



Digital engineering model viewers

To enable integration and improved understanding of digital engineering, the department or agency must have the ability to view digital information being developed by the delivery team.

BIM files and point clouds can typically exceed many hundreds of megabytes. Consideration should be given to the hardware required to manage these files in line with job functions and use cases.

Model and point cloud viewers are typically lightweight or browser-based and are able to optimise content for viewing on standard PCs/laptops.

Certain hardware upgrades may be required; these should be provided to staff who need them.

Over time, these viewers should integrate with many users' workflows and form part of the standard operating environment.

Contact OPV for more information of recommended viewers for the VPS.

Model viewers offer an instant deep insight into the asset environment, they are a powerful communication tool.

Computer-aided design

Many asset owners still use 2D or 3D CAD and associated drawings. These processes still retain value, but they are slowly being replaced by object-based modelling, as used in BIM.

These older and existing approaches and datasets need to be considered when implementing newer approaches to information management.

During the concept stage of the project, CAD deliverables are still likely to be generated. Development of these must follow your organisation's CAD standard (if applicable). Given the rapid design iterations in this stage, data standards and compliance may be difficult to manage. Where possible, you should plan for this accordingly.

Assurance of these deliverables should remain with the project's CAD lead or the engineering manager.

It is also likely that during this stage, existing CAD information will be available for developing the project's concept design. This could include:

- as-built CAD schematics and drawings of the site in question; and
- CAD schematics and drawings of other designs which may be applicable in the context of the project in question.

Focus-in

One of the many advantages of BIM is that once a 3D model is created, data and information can be translated into any number of 2D drawings. This is typically easier than converting existing 2D drawings into BIM data.

Neither of these data sources should be overlooked. However, the quality of the existing CAD information must be evaluated for completeness and correctness.

If existing CAD information is of poor quality or cannot be found, a physical resurvey will be required. This could be achieved by laser scanning (LiDAR/scan to BIM) or using traditional surveying techniques. The UK Government provides valuable guidance on this matter in its *Clients guide to 3D scanning and data capture*.

This process of reviewing existing CAD systems, as-built CAD drawings and CAD drawings and information from other projects remains the shared responsibility of the DE Project Champion, CAD lead and engineering manager. Another important part of stage 2 is the need to specify CAD requirements and CAD to BIM integration. This allows the development of a standard process.

These specifications can be integrated with the EIR or left as a standalone requirement.

The specifications should not be onerous and must be aligned with future-ready engineering processes, such as BIM.

Enterprise asset management and computer maintenance management systems

EAM or CMMS are systems that enable elements of the AIM and help facilities and AM to more effectively and consistently manage physical assets and equipment. The objectives of these systems are to:

- maximise the entire asset's lifetime;
- reduce costs;
- improve quality and efficiency;
- increase equipment uptime;
- schedule downtime in line with usage;
- optimise reporting; and
- improve safety and environmental outcomes.

For both greenfield and brownfield projects at stage 2, it is critical that the CMMS operational uses are clearly understood.

It is also critical that the CMMS input requirements are clearly articulated for ease of handover upon project completion. The system's inputs must be referenced in the EIR.

Finally, any proposed upgrades or changes to the CMMS must be recognised and prepared for.

Frequently, midway through project delivery, new EAM or CMMS systems will be rolled out, or existing systems will be upgraded.

Specifically, for brownfield projects there is likely an existing CMMS. This should contain a contemporary asset register and schema that must be used as a source of information and integrated into the EIR.

In either case, the VDAS Champion and DE Project Champion should consult with the asset and facilities managers to align the requirements of the EAM or CMMS as part the broader AIM.

Stage 2
CONCEPT

Stage 2 checklist

Check	Description	Role	Page
☐	OIR currency checked and updated	DE Project Champion	C.60
☐	AIR currency checked and updated	DE Project Champion	C.60
☐	Design and modelling process planned	DE Project Champion	C.54
☐	Location and orientation defined, consult with Land Use Victoria (LUV)	Delivery team	C.77
☐	EIR currency checked and updated	DE Project Champion	C.61
☐	DEER checked and updated	DE Project Champion	C.60
☐	Draft DEEP developed	DE lead	C.59
☐	Detailed digital asset created	Delivery team	C.61
☐	RACI matrix/scope checklist checked and updated	Appointing Party	C.63
☐	New deliverables validated	DE lead	C.61
☐	Authorisations for data security agreed, and user access rights clarified and checked	DE Project Champion	C.63
☐	Software version and information exchange agreed	DE Project Champion	C.75
☐	Technologies agreed (CAD, GIS, BIM, CDE) and viewers installed	DE Project Champion/ delivery team	C.75
☐	Existing model (graphical and non-graphical data) handed over to parties in stage 3	DE Project Champion	C.61
☐	Lessons learnt relayed back to the VDAS Champion for inclusion in future projects/approaches	VDAS Champion	n/a
☐	Clarify and check user access rights	DE Project Champion	C.63
☐	Review stage 2 key decision points	VDAS Champion	n/a
☐	Prompt and answer stage 3 and 4 key decision points in collaboration with key project and asset stakeholders	VDAS Champion	n/a
☐	Review quality control process	DE Project Champion/ lead Appointed Party	n/a

Stage 3

DEFINITION

Stage 3 is one of the most intense periods of the project. During this stage, a large volume of information is gathered, procurement of a lead Appointed Party commences, and the project transitions from a business case into a reality.

The objectives of stage 3 are to:

- take the preferred project or scope option from stage 2 and define this option to a greater level of maturity;
- align the project plan and targets with that of the business case;
- seek buy in from executive decision makers; and
- engage the market.

The success of stage 3 depends on the success of stage 2. It will be less effective if project options or scope remain uncertain.

The Appointing Party will likely continue a contract with designers, architects and external consultants to continue developing the PIM and further define the selected project or preferred option.

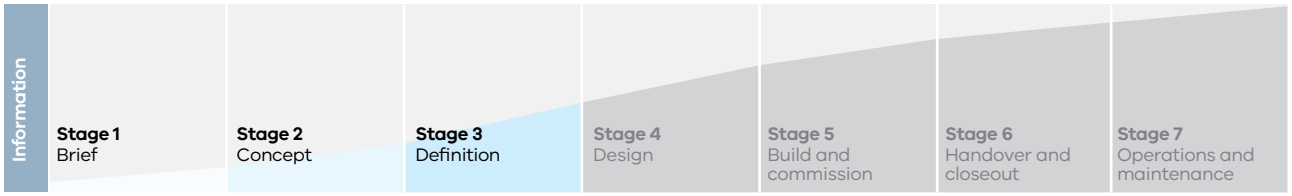
Considering the required deliverables, the completion of stage 3 will coincide with the finalisation of the Appointing Party's EIR and engagement with the market. The EIR will be the key digital engineering document for conversation.

The VDAS is critical during this stage, as the PIM becomes the basis of a 'go' or 'no-go' decision – the point at which a head contractor is engaged.

Project executives should be empowered to see the value and benefits of the PIM, including visualisation outputs to confirm the maturity of the project, the assessment of risks and the likelihood of project outcomes being achieved on time and on budget.

Stage 3
DEFINITION

Stage	Definition	
People	• VDAS Champion • DE Project Champion • DE Leads • Others (i.e. Project Director, Asset Manager, Ops Manager, Maint.)	• Appointed Party • Appointed Party's supply chain
Information management	• Development of final EIR, internal review and submission to market • DEEP review, clarification sought and aligned to key decisions • DEER/response to market	• Receipt of EIR • Clarification sought • Development of DEEP (including RACI/scope checklist) • Supply chain engagement
Data information models	• Stage 2 PIM reviewed • Stage 3 PIM reviewed • Receipt and assurance of data drops/ Soft landings • Organise data standards implementation on project	• Stage 3 PIM developed existing information (VDAS data dictionary) • Data standards • CAD, BIM, GIS • Data drops/soft landings
Technology and systems	• Owner CDE (CAFM/CMMS) • Appointed Party's CDE • Model and drawing viewers	• DE viewing, authoring and interoperability tools (CAD and BIM and GIS) authoring • System requirements and user access issues resolved
Deliverables	• Final EIR, including RACI/scope checklist • Final DE strategy • DEER and Executive feedback • Stage 3 checklist • Handover of stage 3 PIM	• Receipt, assurance of stage 1-2 PIM • Development of stage 3 PIM • DEEP and RACI scope checklist • Handover of PIM, drawings, cost estimate, project schedule, CAD and GIS deliverables, data and schedules



People

Irrespective of the project's proposed procurement approach, stage 3 should mark the completion of all major Appointing Party digital engineering workflows, documents and approaches. The DE Project Champion is responsible for this.

This is a critical stage of the project, as tendering parties will be basing their approach, resources and fees on the digital engineering requirements of the project.

In stage 2, the VDAS Champion's daily project responsibilities will have transitioned to the DE Project Champion.

Nevertheless, the VDAS Champion still has an important role to play in assuring the project deliverables, process and systems used by the DE Project Champion, as well as the project's harmonisation with the OIR, AIR (including AIM), other projects within the organisation, alongside other improvement initiatives across the organisation.

VDAS Champion

By stage 3, the VDAS Champion will largely have reduced daily project-specific digital engineering activities and will return to overseeing the portfolio of digital engineering projects. In this sense, the VDAS Champion drives consistency and best practice.

The DE Project Champion should now focus on resolving any project-specific VDAS obligations and commitments.

The VDAS Champion should maintain a high-degree of contact with the DE Project Champion. This will be for deliverable assurance, in a mentoring capacity, as a subject matter expert or for clarification.

In line with driving digital engineering consistency and best practice, the VDAS Champion should:

- communicate changes to the OIR, AIR and AIM, or templates for project delivery;
- communicate project-specific issues back to executive management;
- oversee ongoing socialisation and governance of VDAS;
- build and maintain relationships between functional areas of the organisation to improve information management and reduce 'knowledge silos';
- document and support the organisation's subject-matter specialists, data custodians and stewards;
- uplift VDAS, digital engineering and BIM capacity and capability;
- support mentoring initiatives;
- develop lessons learnt; and
- share lessons learnt and adopt best practices from other departments and agencies, including OPV.

DE Project Champion

In stage 3, the DE Project Champion remains responsible for key project-level resources and is accountable for digital engineering implementation on the project.

All VDAS and digital engineering challenges will be identified, actioned or, where required, escalated by the DE Project Champion.

Key obligations for the DE Project Champion throughout stage 3 include:

- accountability for the approach and delivery of the PIM, which is aligned with key decision points for the project;
- clearly defining information management roles, functions and responsibilities;
- finalising the project's EIR;
- conducting market-sounding exercises with the shortlisted tenderers;
- assessing VDAS-specific documents from the shortlisted tenderers, including DEEP, RACI scope checklist, TIDP/MIDP and tender-generated digital engineering documentation;
- completing the DEER and providing feedback to successful and unsuccessful tenderers;
- assessing the shortlisted tenderers' (and their supply chain) capability; and
- collaborating with the Appointed Party's information exchange processes and systems (e.g. CDE, collaboration/review tools).

Digital twins for tenders

To assess the vast amount of information produced in tender submissions, it is now common for tenderers to produce a digital twin to assist in articulating the delivery methodology to the client.

Most designers, head contractors, and tender joint ventures will use digital engineering technologies to develop and assess the Appointing Party's opportunity.

These technologies help the Appointing Party to review project risks, and develop cost estimates, project schedules, preliminary bills of materials, preliminary quantities, margins and assess challenging project interfaces.

The opportunity exists for the Appointing Party to leverage the format and maturity of this information.

The Appointing Party, led by the DE Project Champion, should encourage the tenderers to submit digital engineering information as part of the tender process. This should also be accompanied by a presentation from the tenderers on their proposed project solutions.

The presentation could be through traditional renders of digital engineering information to physical models of the project solution, or preferably providing access to immersive environments such as VR/AR demonstrations of construction methodology.

The VDAS approach should account for expectations of quality regarding IP and risks that exist on the tenderers' side at this early stage.

The VDAS Project Champion and wider Appointing Party must be aware that:

- tenderers may limit the certainty around the intended use of this information, model or data;
- tenderers are likely to oppose conditions and owner requirements around 'taking' information, data and objects from one solution and providing it to another party; and
- there may be a difference in the BIM or digital engineering visualisation as compared to the schematics, plot plans and project deliverables issued by the tenderer.

Functional information management roles

At stage 3, pivotal information management functional roles within the Appointed Parties must be defined by the lead Appointed Party in collaboration with the VDAS Project Champion and VDAS Champion.

These roles include digital engineering, BIM, GIS and CAD leads.

Given the integral nature and commonality between CAD, GIS and BIM information, oversight from a digital engineering lead will be warranted on larger projects. Similarly, there would be a clear need for separate CAD, GIS and BIM lead roles.

Typically, these roles are employees of the lead Appointed Party to ensure they are acting in the best interests of the state. Notwithstanding, it is understood that these roles may be filled by a third party or consultant.

The Appointing Party may need similar roles depending on the stage of maturity of digital engineering in the organisation and whether it intends to improve its use of digital engineering information.

In either case, the DE Project Champion must provide confidence to the project's executive leadership team that there are enough owner-led individuals to support information management functions, including defining, validating, managing and quality checking deliverables.

Lead Appointed Party digital engineering, BIM, GIS and CAD leads should perform the following tasks and functions during stage 3:

- author the relevant DEEP sections and relevant workflows between Appointed Parties, systems and technologies to ensure tenderers can appropriately respond to the EIR;
- provide expert review and opinion on the relevant sections within the tenderers' DEEP;
- provide expertise in software and systems, including support, development, integration and customisation;
- provide internal training, mentoring and capability building; and
- reviewing discipline and contractor information for compliance to the EIR, AIR, AIM and any relevant OIR.

Asset and facilities managers

As the preferred option matures, the asset and facilities managers should assist with developing a handover and facilities management strategy. This strategy should also consider digital needs such as mobile model viewing and highlight any particular requirements for the EIR.

Asset and facilities managers should also analyse early information models to see whether they align with operational objectives and maintainability criteria. They should also review all digital construction details and scope to highlight anything that will negatively affect performance.

Asset and facilities managers should also have appropriate access to the project CDE so they can undertake structured reviews of the developing information models.

Continual and constant engagement with asset and facilities managers will enable effective operation and maintenance for decades to come.

Information management

Stage 3 is one of the most critical phases of the project and the asset's life.

For most contract types, stage 3 is the point at which decisions must be made about whether the project will deliver the expected benefits and whether the investment should proceed.

Stage 3 can be broken into four major information management tasks. These four tasks are to be led by the DE Project Champion:

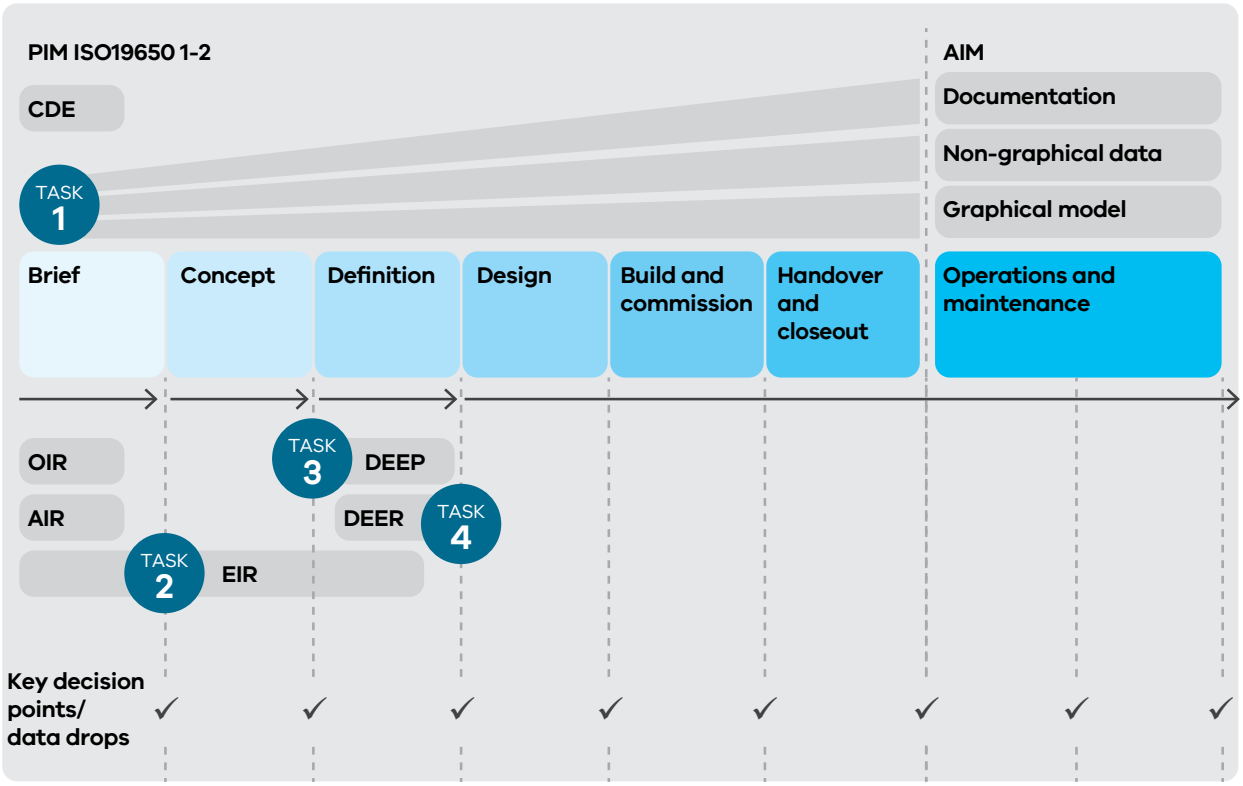
Task 1: Collate all previous stages' information and distil this information into a package for executives making the decision about whether the project should proceed.

Task 2: Finalising the EIR (including RACI/scope checklist, level of information need, MIDP/TIDP) in line with the business case, the OIR and the AIR.

Task 3: Engaging the market with the EIR and subsequently reviewing tenderers' submissions. The DEEP informs the digital engineering component of the tender submission process. This includes supporting executives with contract award decision making.

Task 4: Respond to the market on their digital engineering approach through the DEER to drive lessons learnt and continuous improvement.

The ideal information management process is detailed below.



Exchange information requirements

In stage 3, the EIR must be finalised by the DE Project Champion, prior to engaging the lead Appointed Party. The EIR is critical to successful information flow on the project.

The lead Appointed Party can then use this defined EIR to complete their information management approach in a returnable DEEP.

This defined EIR also informs the lead Appointed Party information management approach and other parties in the supply chain (i.e. other Appointed Parties).

The EIR should be structured with sections, such as 'Commercial', 'Managerial' and 'Technical'. The stage 3 EIR must capture:

- the needs of the OIR and AIR;
- relevant regulatory information requirement;
- project-specific information requirements (e.g. procurement approach, safety in design, delivery schedule requirements);
- required information and deliverables (e.g. drawings, models, schedules, specifications, data and reports) aligned to key decision points and project delivery stages;
- security requirements, including the flow down of these to the entire delivery team;
- standards to be used when creating information (e.g. internal CAD standard, file formats, object libraries, AS5488 etc);
- Appointing Party operating information management systems/software;
- development of the post-project aftercare (PPA) plan;
- articulation of information management in line with federal, state and organisational policies, standards and procedures around IP, data sovereignty, data security, access control; and
- technologies, software and systems to be used (e.g. model viewers, collaboration platforms, CDE, specific in-house platforms, GIS).

The EIR will also contain a subset of the OIR and AIR, such as:

- project location and asset location referencing (e.g. geospatial reference, space/room naming conventions, linear/point referencing);
- asset hierarchies, classification and attribution (e.g. Uniclass 2015, make, model, serial number); and
- commissioning and operational information (e.g. date tested, tested by, O&M manuals).

Appendix 5 contains an example EIR template for the Appointing Party.

Digital engineering execution plan (DEEP)

The draft DEEP should be developed by prospective tenderers in stage 3, articulating their approach to digital engineering on the project. It is an early indicator for the Appointing Party of the whether the proposed tenderers can meet the information requirements. It is also an opportunity for the tenderers to identify additions/ amendments or challenges of the Appointing Party EIR.

After the contract has been awarded, the DEEP will be collaboratively updated with the DE Project Champion and successful lead Appointed Party. The EIR will inform the lead Appointed Party's response, including their supply chain.

A pre-contract DEEP will contain initial:

- RACI matrix of responsibilities and accountabilities, the composition of the delivery team, including the information management functions;
- digital engineering approach for each delivery stage, the likely information to be created and quality checks to be performed;
- likely risks/opportunities and any assumptions used in the development of the draft DEEP;
- proposed approach to collaboration, federation of information, coordination and the processes to define the status of information; and
- likely technologies/systems that will be used to manage information including authoring, collaboration and CDE.

Appendix 6 contains a DEEP template to assist with this process.

Stage 3
DEFINITION

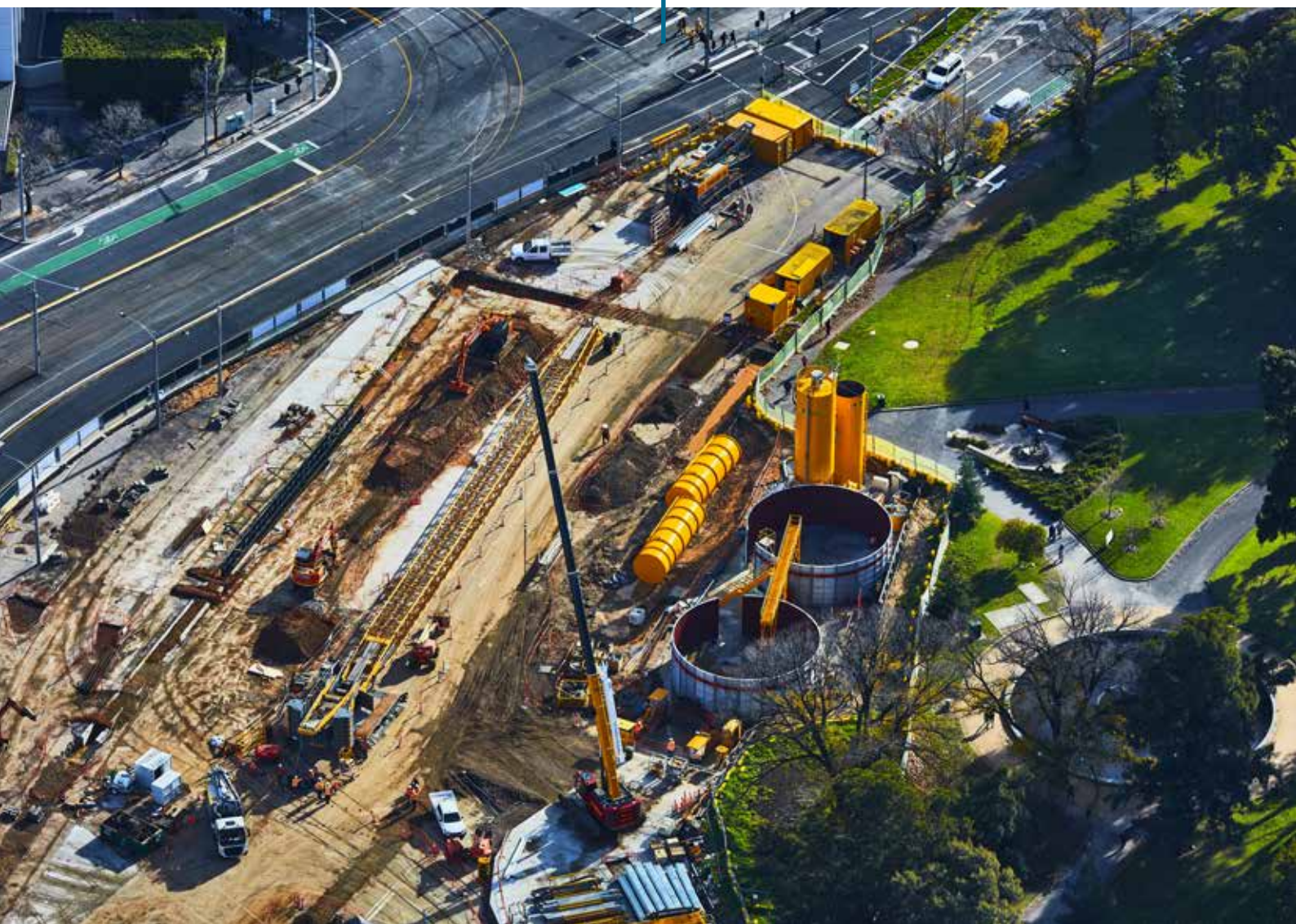
Task information delivery plans (TIDP)

TIDPs enable a structured way of defining what information will be created, at what stage and by each Appointed Party. It is typically the responsibility of each DE/CAD/BIM/GIS lead to compile their own TIDP which then assist in the development of the MIDP and DEEP.

Each task should have a corresponding milestone that aligns to the overall design and construction program, taking into consideration any sequencing requirements to produce information.

Each task should also detail the responsibility and show how the preparation of project documents may transfer from one task team to another.

By effectively defining the TIDP, specific tasks within large and complex projects can be tracked in detail.

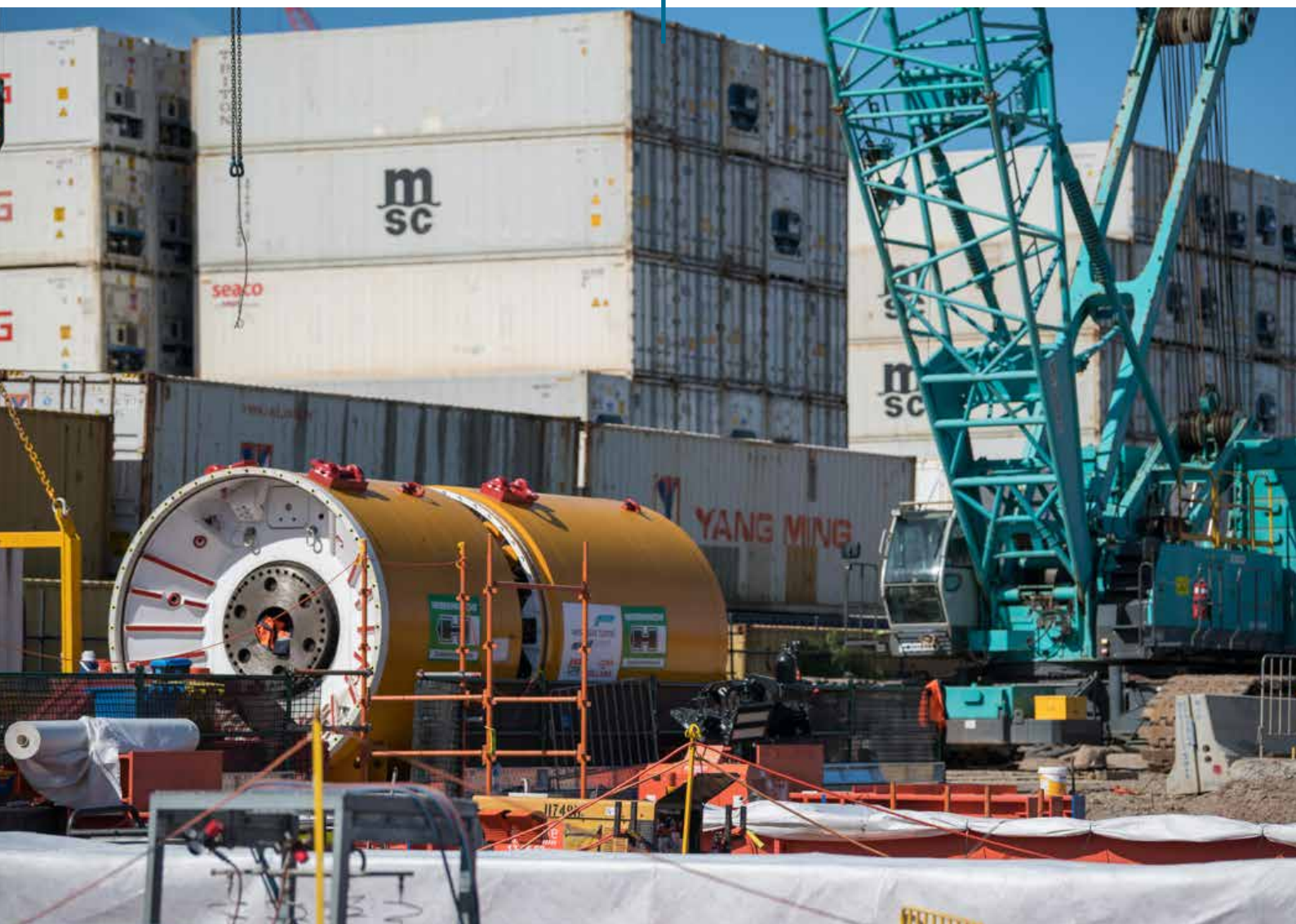


Master information delivery plan (MIDP)

The MIDP is used to manage the overall delivery of information during the project lifecycle. It is typically developed by the digital engineering lead in collaboration with other task team leads (CAD, GIS, BIM leads). A process flow diagram, showing the information containers should support the MIDP.

The MIDP is used by the lead Appointed Party to ensure project information is developed by the respective delivery team members in line with project stages and key decisions. This enables clear accountabilities and transparency on information creation, management and delivery timeframes. The TIPD and the MIDP form part of the DEEP, which is explored in greater detail in Appendix 6.

As a combination of all TIDP, the MIDP will lead the overall information delivery of the broader operation.



Digital engineering execution and response (DEER)

The VDAS Champion and DE Project Champion should develop a DEER to assist in the tender selection and award process.

The DEER should be structured according to the DEEP template and it should provide useful guidance to the Appointing Party's representatives on whether the tenderer has understood and can comply with the EIR/AIR, broader information management requirements and other scope of works documents.

Critical assessment criteria should include the:

- digital engineering capability of the tenderer, including the role of information management;
- capacity of the proposed delivery team to meet the information requirements;
- assessment of the draft RACI matrix;
- draft approach to digital engineering information production, including processes to be employed across all project stages the delivery team is appointed for;
- alignment of the key decisions with the proposed information delivery program;
- approach to information management and collaboration including the use of a CDE;
- security, access rights and distribution of information; and
- delivery team alignment with any key technologies in use by the Appointed Party.

The DE Project Champion is the key resource to support the use of this document during tender assessments. Appendix 8 provides an example.

The completed DEER should be provided back to prospective tenderers to highlight any concerns of the Appointing Party.

Data compliance against EIR/AIR/DEEP

The DE Project Champion will be responsible for assessing the delivery team digital engineering deliverables and compliance with the information requirements. The approach should be determined prior to stage 4 and aligned with key decision points.

This includes:

- assessing discipline and federated models for coordination issues;
- undertaking assessment of data quality checks, i.e. classification, location, attribution;
- documentation compliance to required standards (e.g. AS 1100, AS 5488);
- alignment with EIR/AIR and any other project's EIR; and
- assessing AIM outputs from the PIM for compliance with the AIR.

Information sign-off and publication

After the contract is awarded, the DEEP should be finalised between the DE Project Champion, the Project Director and the awarded delivery team.

The DEEP, along with any EIR/AIR and other OIR shall be referenced in all appointments to ensure all delivery team members are aware of their obligations for information delivery and management.

Mobilisation of the delivery team

To ensure the delivery team has the best possible chance of success, the lead Appointed Party should, before stage 4:

- determine the IM and other roles and responsibilities with a RACI matrix;
- determine any further EIR that need to flow down to other/future delivery team members;
- initiate the delivery team to develop the individual TIDP and collate the MIDP including any RACI matrix;
- test the information creation (authoring) and management processes;
- test the integration of systems and tools including collaboration processes and determine any technology gaps;
- determine the delivery team CDE, information status/coding, security requirements and transfer/access to the Appointing Party CDE/ systems/stakeholders; and
- determine any shared resources (object libraries, templates, training and materials, support staff) for the project.

The DE Project Champion should assist, where possible, in helping the delivery team to better understand the EIR during the mobilisation phase. This will reduce re-work and potential future costs.

Security and access

The project must employ a security-minded approach defined by the DE Project Champion. The security requirements must be well documented throughout the EIR and the appointed delivery team should provide compliance/evidence that secure access and appropriate controls are in place, proportionate to the project circumstances. It is particularly important that subcontractors also understand their obligations in this respect.

The flow of information should be clearly understood by all relevant parties to ensure the final asset achieves the AIR.

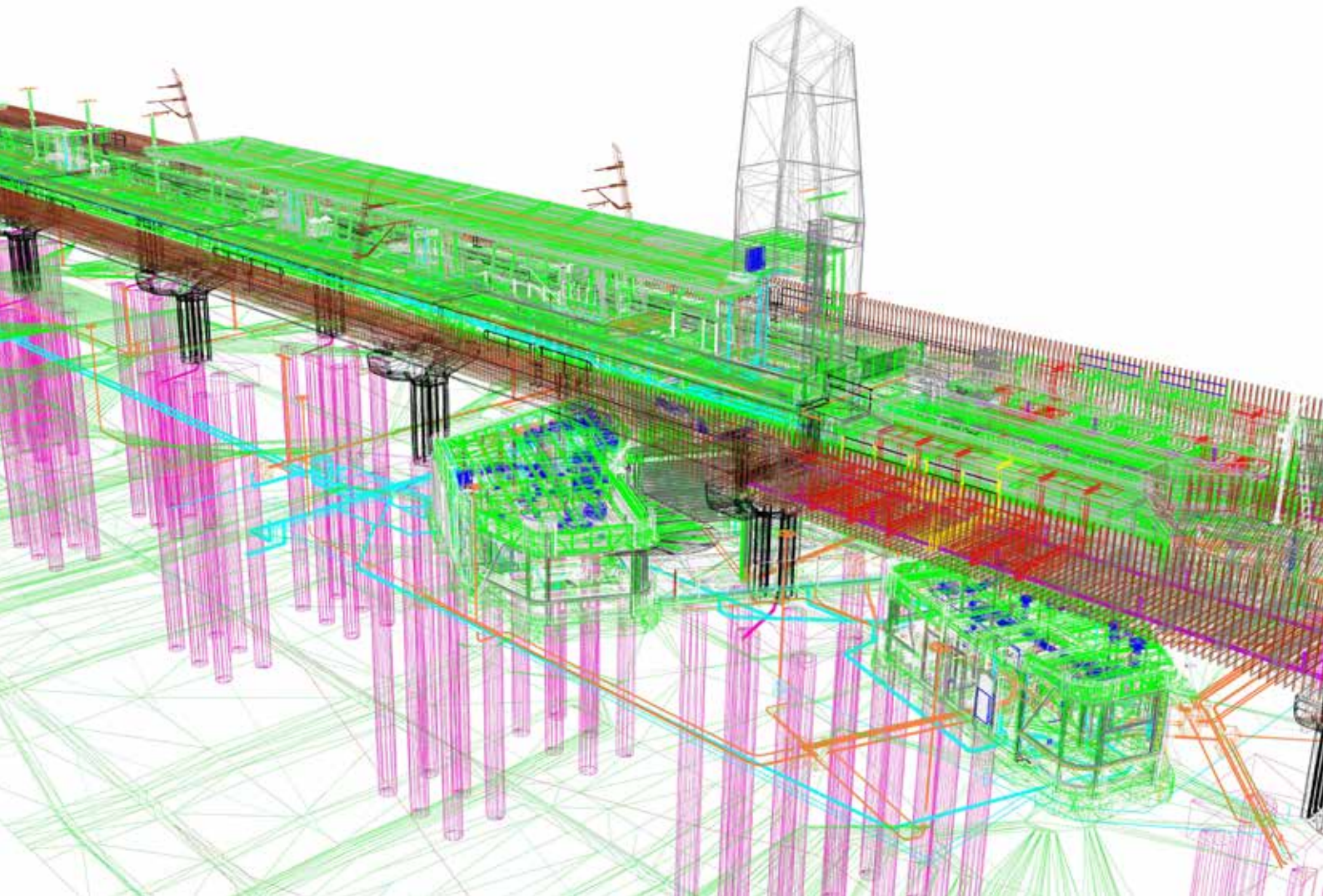
Stage 3
DEFINITION

Information models

Stage 3 sees further enhancement of the PIM. The PIM, currently in development from previous stages, should be provided to any prospective tenderers through controlled and secure access. The authors of the early PIM shall define the intended uses and limitations so subsequent users are well informed. This early PIM is a valuable source of information for tenderers to develop their approach, scope and fee for future stages.

For brownfield projects, the existing AIM can be supplied using secure and controlled access. The owners of the information that makes up the AIM should also define the intended uses and limitations. This is important, as it is the most current known asset information of the existing asset. The quality/confidence level of the AIM should be articulated by the DE Project Champion after consultation with the Appointing Party's asset/facilities management stakeholders.

The PIM will act as a source of truth for the project team, easily accessible, current and controlled.



Asset information model (AIM)

Typically, there is always some level of information about an organisation's existing asset. For brownfield projects, the existing AIM, residing in the CMMS and other AIM systems, is a useful source of information.

During stage 4, the DE Project Champion and digital engineering lead can review this asset information. This information can be crosschecked against the actual physical assets to enhance the AIM.

This quality assurance process will improve the confidence within the Appointing Party, designer and constructor teams regarding:

- last known updated 2D drawings of the assets (as built, works as executed);
- historic information about underperforming assets, which can provide the delivery team with information about the new assets and the proposed solution;
- how the proposed design solution will integrate with the existing assets;
- verifying existing assets, and whether the currency of the existing asset information model can be improved; and
- operational activities on existing assets that need to be performed during delivery of the new project.

These processes can improve safety and reduce costs and risks across the lifecycle.

The AIM should ideally reflect the current site conditions. No project starts in a vacuum.

Project information model (PIM)

Stage 3 sees the rationalisation of the existing AIM and PIM to a single or series of defined options to take forward into stage 4. Prior to stage 4 starting, all relevant PIM created, including any relevant information from the AIM, should be supplied, where possible, to the awarded delivery team.

The DE Project Champion and relevant Appointing Party stakeholders will collaborate with the lead Appointed Party digital engineering lead to ensure PIM validity, completeness and quality. Any security requirements must be articulated by the VDAS Champion, DE Project Champion and Delivery Team. They will ascertain if any new spatial or other information models need to be sourced (i.e. additional topographical survey data, laser scans, subsurface utility survey) or existing information models need to be field verified.

The following PIM should be provided to the delivery team:

- current survey with 3D points, including a triangulated irregular network (TIN) of the topology;
- any known and field-validated subsurface utility information (SUI), as aligned with the quality levels (QL) detailed in AS 5488.1:2019;
- existing conditions – 3D modelled with existing attribution in the objects to identify them from proposed works;
- proposed cost plan and historic decisions made that will affect costs;
- proposed likely schedule and any historic decisions made that will affect the schedule;
- any reports created that could improve comprehension of constraints and opportunities, e.g. environmental impact statements, community consultation;
- proposed concept design – generically 3D modelled to show the volumetric extents of the project; and
- any defined object libraries, symbology standards or templates that must be used.

Model viewers are a powerfully effective tool in offering an instant and basic level of project understanding.

Technology and systems

Stage 3 sees the rollout of the chosen Appointing Party digital engineering technologies and systems to be used for the project.

This will be coordinated by the DE Project Champion.

The DE Project Champion will oversee all user acceptance testing, including training and user support. This will include, but not be limited to:

- CDE including GIS, BIM and CAD platforms;
- viewing and assessment platforms (IFC, 3D, 2D and data);
- EAM and CMMS platforms; and
- interoperability processes documented between systems and technologies.

The Lead Appointed Party should assemble resources and implement the mobilisation plan including the setup of any technologies and systems.

It is critical that any technologies proposed by the delivery team (in the DEEP) are assessed by the DE Project Champion for suitability and aligned with the organisation's environment and formats (as specified in an OIR or AIR). This includes the security and access to the developing PIM.

Any security/access requirements that the Appointing Party has should be passed on to all delivery team participants.

The selected digital engineering technologies and systems should be appropriate to the scale and complexity of the asset.

Common data environment (CDE)

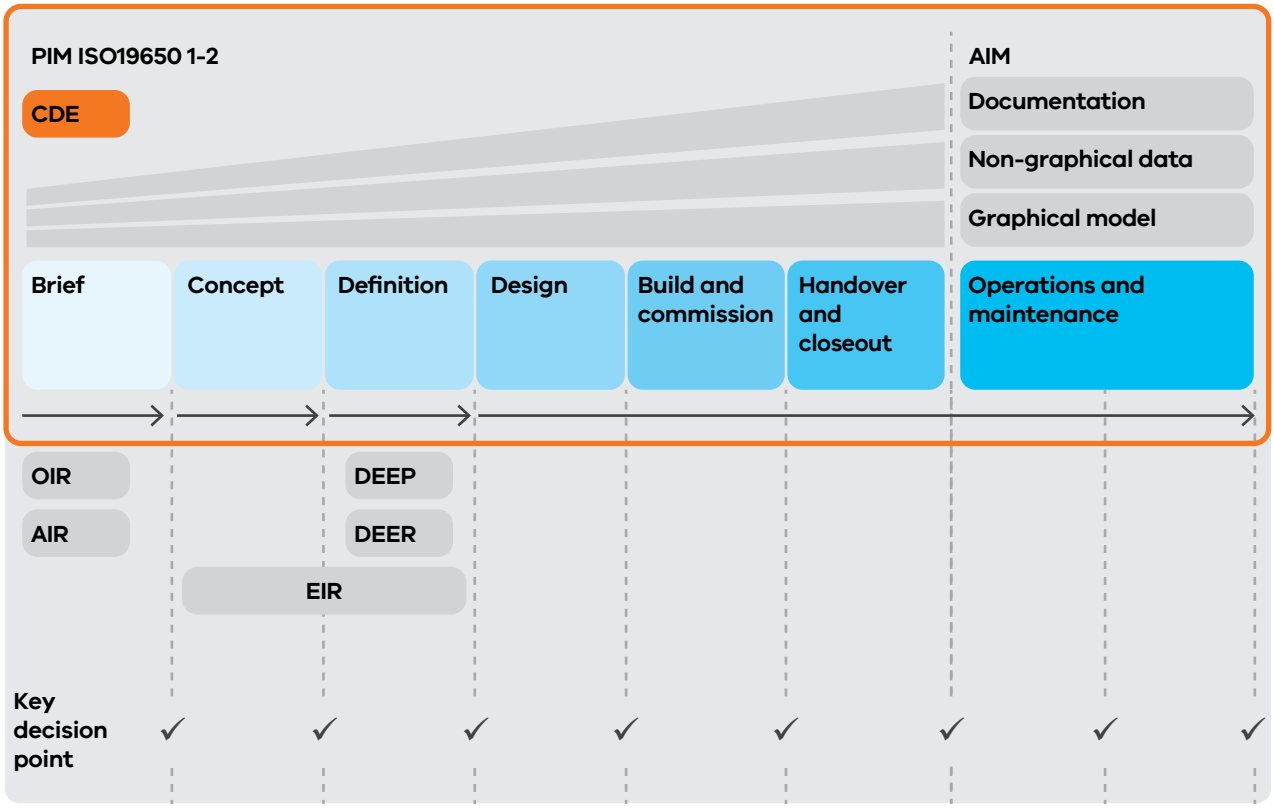
By stage 3, the VDAS Champion and DE Project Champion will have defined the organisational CDE that internal stakeholders will use on the project. This organisational CDE could well be different systems compared with the project CDE being used by the delivery team through stages 1–6 with the ability to manage data to ISO 19650.

It is critical that information management approaches, in both the organisational and project CDE, are agreed between the DE Project Champion and lead Appointed Party. The processes for transferring the relevant information containers of the PIM to the AIM must be agreed prior to stage 4 and documented in the DEEP. This will be based on the CDE and security requirements and approaches defined in stage 1 and tested in stage 2 and 3.

The CDE is at the core of the delivery process, ensuring that the production of information is managed and exchanged in a consistent manner.

The diagram below illustrates the information evolution across the VDAS lifecycle and how deliverables support the investment and gateway decisions.

The processes, procedures and responsibilities should be established to validate the data received at each of the stage gateways, including accuracy, compliance with standards, integrity, continuity and completeness. These requirements should be set out in the EIR along with validation procedures for the CDE gateways.



Geographic information system (GIS)

The administration, hosting and access approach of the GIS environment must be documented in the draft DEEP. The DEEP should outline how GIS information will be used across the lifecycle and, most importantly, how it will be exchanged back to the Appointing Party in stage 6.

Building information modelling systems (BIM)

If BIM requirements exist within the Appointing Party's organisation, including shared resources (object libraries, templates, information transfer processes such as COBie), these will be defined in the EIR by the DE Project Champion. This will include if, and how, BIM is developed and made available to tendering parties.

As the adoption of BIM develops over time, this will include any relevant BIM information from previous projects. The proposed lead Appointed Party, in consultation with the broader delivery team, will define the approaches and systems in the DEEP for how BIM will be utilised on the project in stage 3 and beyond.

The DE Project Champion will have liaised with the CTO to ensure relevant model viewers are installed prior to stage 4 commencing.

This may require training to be initiated by the DE Project Champion. This will target the specific key decision points/uses cases defined in stage 1.

Computer-aided design (CAD)

Any CAD requirements of the Appointing Party must be included as part of the EIR by the DE Project Champion. This will ensure any existing CAD drawings, information, templates, standards etc. are made available to the proposed delivery team. If and how CAD is to be integrated with GIS/BIM and implemented on the project shall be documented in the draft DEEP by the lead Appointed Party. Assurance and delivery of any CAD deliverables should remain with the CAD lead or the engineering manager.

Enterprise asset management and computer maintenance management systems (CMMS)

The Appointing Party EAM and CMMS requirements will be finalised by stage 3. This will be in the EIR, managed by the VDAS Champion in alignment with asset and facilities managers.

Critical to the successful transition of information from the PIM to the AIM, information structures, such as classification/location will be documented in the EIR. The asset and maintenance information transfer process throughout the lifecycle will be defined in the EIR and overseen by the DE Project Champion. This may include:

- existing organisational 'data loading' spreadsheets or templates;
- COBie spreadsheets;
- the use of application programming interfaces (APIs); and
- any custom-developed approaches.

Stage 3
DEFINITION

Stage 3 Checklist

Check	Description	Role	Page
☐	Nominated DE Project Champion for the project	VDAS Champion	C.85
☐	EIR/AIR finalised including security requirements	VDAS Champion/Appointing Party Organisation stakeholders	C.85
☐	DEEP template developed (if applicable) and DEER defined	DE Project Champion	C.92
☐	Draft DEEP developed by prospective tenderers	Lead Appointed Party/delivery team	C.92
☐	Delivery team roles and responsibilities defined and confirmed	Lead Appointed Party/delivery team	C.88
☐	Information management roles defined and confirmed	Lead Appointed Party/delivery team	C.88
☐	Regular model review meetings undertaken	Delivery team	C.88
☐	Information received complies with EIR/AIR	DE Project Champion/Appointing Party Organisation stakeholders	C.85
☐	Processes in place for sign-off information and request publication	DE Project Champion/Appointing Party Organisation stakeholders	C.96
☐	Mobilisation plan and testing underway	Lead Appointed Party	C.85
☐	CDE/DE viewers accessibility and suitable hardware implemented	DE Project Champion/lead Appointed Party	C.101
☐	Existing asset information model (graphical and non-graphical data) handed over to Appointed Parties in stage 4	DE Project Champion/Appointing Party Organisation stakeholders	C.98
☐	Lesson learnt relayed back to the VDAS Champion for inclusion in future projects/ approaches	DE Project Champion/VDAS Champion	C.85
☐	Clarify and check user access rights	DE Project Champion	C.85
☐	Review stage 3 key decision points	VDAS Champion	n/a
☐	Prompt and answer stage 4 and 5 key decision points with key project and asset stakeholders	VDAS Champion	n/a
☐	Review quality control process	DE Project Champion/ lead Appointed Party	n/a

Stage 4

DESIGN

During stage 4, there is a considerable increase in project resources, engagement and effort.

The PIM rapidly grows in size, complexity and value for the selected and awarded project concept.

As the contract is likely now awarded, the project delivery team expands and mobilises. Individual task teams begin to work together, developing designs to achieve the Appointing Party's brief in compliance with the Building Code of Australia (BCA).

The data and information containers that constitute the PIM should be developed and constructed in line with the EIR and the DEEP. A considerable volume of data and information will begin to transition through the CDE workflows, as defined in stage 1.

The early phases of stage 4 will also involve finalisation of the DEEP and RACI/scope checklist. These should be completed as early as possible as they inform later and critical conversations relevant to the project budget.

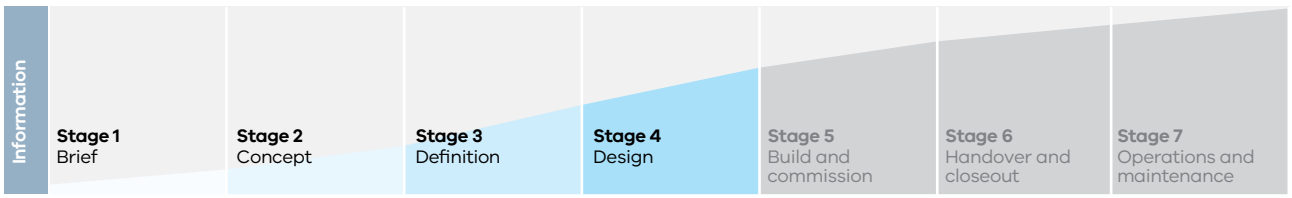
Another key element of stage 4 is the TIDP, MIDP and the use of 'soft landings – data drops'. These information management handovers and reviews should be subject to audits and assurance reviews.

By the end of stage 4, the PIM should be mature enough to articulate the design intent of construction. It should start to incorporate specialist subcontractor models in order to support construction and site activities (not including early works or enabling works).

A detailed construction methodology, and construction-specific risk management plan should be developed by the most appropriate party to undertake such tasks in stage 4, based on information from the PIM.

Stage 4
DESIGN

Stage	Design	
People	• VDAS Champion • DE Project Champion • DE Leads • Others (i.e. Project Director, Asset Manager, Ops Manager, Maintenance)	• Appointed Party • Appointed Party's supply chain
Information management	• Ongoing audit and assurance of PIM against EIR, DEEP (and RACI/Scope checklist) • QA/QC • Ongoing integration of functional stakeholders within organisation	• Soft landings/data drops • Supply chain engagement • DE design reviews (30%, 60%, and 90%) • Field/site integration
Data information models	• Stage 3 PIM reviewed • Stage 4 PIM reviewed • Receipt and assurance of data drops/ soft landings • Org. data standards implementation on project	• Stage 4 PIM developed, incl. multi-disciplinary reviews • Data standards • Integration with CAD, BIM, GIS, cost estimate, and project schedule • Data drops/Soft landings
Technology and systems	• Owner CDE (CAFM/CMMS) • Appointed Party's CDE • Model and drawing viewers	• DE viewing, authoring and interoperability tools (CAD and BIM and GIS) authoring • System requirements and user access issues resolved swiftly
Deliverables	• Audit review checklists • Responsive DE (30%, 60%, 90%) review notes and feedback • Ongoing mentoring, support, and training • DE reporting/progress • Stage 4 checklist • Handover of stage 3 PIM (if applicable)	• Receipt, assurance of stage 3 PIM • Development and handover of Stage 4 PIM, engineering drawings, cost estimate, project schedule, CAD and GIS deliverables, and data and schedules



Stage 4
DESIGN

People

At this point in the lifecycle, the DE Project Champion will still be engaged and remain committed to the project. Turnover (planned or otherwise) of this role is not recommended.

This individual will be complemented by the digital engineering lead from the lead Appointed Party. In sync, these two roles are responsible for the delivery of the PIM in line with agreed expectations and deliverables.

These two roles must provide ongoing input and oversight to ensure that the PIM acts as a 'single source of truth'. It is important that the PIM informs decision making throughout stages 4 and 5 and exchanges via 'soft landings', and ultimately integrates with the AIM in stage 6.

VDAS Champion

In stage 4, the VDAS Champion has limited project-specific daily responsibilities.

Instead, the VDAS Champion must oversee the DE Project Champion so that the project's PIM is being developed in line with organisational needs.

To achieve this, the VDAS Champion must work closely with the DE Project Champion to ensure that internal organisational stakeholders information needs (as mapped out in the OIR, AIR and EIR) have been considered and are being actively implemented on the project by the delivery team.

In addition, the VDAS Champion must maintain visibility on project-level capability and capacity. This may be informed through assessments or through informal communication with project team members.

Finally, the VDAS Champion must continue to support the project via:

- communicating changes to the OIR, AIR and AIM, or templates for project delivery (noting changes may incur additional costs, post award);
- communication of project-specific issues back to executive management;
- build and maintain relationships between functional areas of the organisation to improve IM to, reduce 'knowledge silos';
- supporting the organisation's subject-matter specialists, data custodians and stewards; and
- sharing lessons learnt and adopting best practice from other departments, agencies. This will be led by OPV.

DE Project Champion

In stage 4, the DE Project Champion maintains their role as the key project-level resource responsible and accountable for digital engineering implementation.

One of the key obligations of the DE Project Champion is to build a cohesive and working relationship based on mutual trust with the digital engineering lead.

Furthermore, the DE Project Champion, in collaboration with the digital engineering lead, must form an internal working group made up of key internal stakeholders, including digital engineering/BIM/GIS leads, project manager, project director, engineering manager, functional leads, and the integration manager. This working group addresses IM-related matters. It must be chaired by the DE Project Champion.

Additional obligations for the DE Project Champion during stage 4 include:

- delivery of the PIM in alignment to project key decision points;
- clear definition of information management roles and responsibilities;
- review of the project's progress in line with the EIR and DEEP;
- acting as the interface manager for complex internal and external stakeholders;
- continuous improvement of internal and the Appointed Party's information exchange processes and systems (e.g. CDE, collaboration/review tools); and
- ongoing development of lessons learnt and feedback of progress to the VDAS Champion.

Upskilling and training

VDAS is a process and cultural transition for many organisations. Change management is a critical part of adoption of any major and innovative technology. Often, it's not the technology which requires the greatest level of commitment but the people behind the technology and their behaviour.

The DE Project Champion in concert with the VDAS Champion should define how individuals will be upskilled and trained with digital engineering and VDAS processes.

Upskilling and training should include but not limited to:

- a clear articulation of shared vision including the 'why' and 'how';
- use cases by function;
- ISO 19650 and VDAS terminology in the context of the project;
- CDE and information management workflows; and
- how information will be passed from the PIM to the AIM and the ongoing AIM maintenance.

The DE Project Champion and VDAS Champion may also wish to conduct supporting training on VR/AR, PIM to AIM handover, as well as other niche topics relevant to the organisation and project.

Digital engineering lead

The digital engineering lead's role in stage 4 is to coordinate the information generated by all parties within the delivery team. They are typically resourced by the lead Appointed Party and shall be a contractually required role in all projects where the VDAS approach is implemented. This is aligned to ISO 19650 series and the need for an information management function within the delivery team.

The digital engineering lead works with and functionally reports to the DE Project Champion. They are accountable for the following:

- collation and federation of information containers in line with the EIR, DEEP, and RACI/scope checklist;
- delivering the MIDP and TIDP;
- maintaining clear roles and responsibilities;
- ensuring information management is delivered in line with the delivery team's resource availability;
- acting as the conduit for information management between delivery team members;
- maintenance of the project CDE, including workflows and metadata;
- testing, audit and verification of Appointed Party project CDE;
- engagement with IT subject-matter experts in relation to software and hardware;
- maintenance of shared resources (object libraries, templates, standards, coordination tools); and
- Delivery of any required training or skills uplift of the delivery team.

On larger projects the digital engineering lead role may also be supported by:

- BIM lead;
- CAD lead;
- GIS lead;
- CDE lead;
- technology lead; and
- document controller/s.

Note: If the lead Appointed Party (or Appointing Party) has low capability, then the services of an external digital engineering adviser should be considered. This is particularly useful in the first few pilot projects, when understanding the detail held with the information models is of paramount concern. The digital engineering adviser can also support the implementation of the project, assisting the DE Project Champion.

Stage 4
DESIGN

Asset and facilities managers

Asset and facilities managers play a pivotal role in stage 4. They are the guiding voice and input on 'what', 'how' and 'why' things are being designed in a specific manner.

In stage 4, Asset and facilities managers should focus on integration and collaboration between themselves and the delivery team.

For brownfield sites asset and facility managers will have invaluable experience and knowledge on how the asset operates and its challenges. This experience and knowledge should not be overlooked, and should inform all decisions by the delivery team to ensure that what is being proposed meets the service requirements.

Asset managers and facilities managers should be continuously involved in design and PIM reviews. This environment enables them to gain confidence that the PIM is being developed in line with the AIR for AIM integration.

Asset and facilities managers have a crucial role. Early engagement will foster their long-term vision.

Information management

During stage 4, a well-established information management process will yield considerable dividends.

An information management process that is aligned with VDAS and ISO 19650, will support major decisions throughout stages 4, 5, 6 and 7.

Effective information management practices are based on two major focus areas:

1. maximising existing and efficient design processes; and
2. minimising error rates, information recapture, rework and poor decisions.

Suboptimal IM practices will result in a PIM that does not inform effective decision making.

In turn, this can result in poor scope, costs, schedule and quality decisions.

It will also mean that the PIM is more difficult to integrate with the AIM, and stage 7 stakeholders may lose confidence in the project.

Task information delivery plans (TIDP)

During stage 4, all design-related TIDP are to be finalised. This involves appointed delivery team members developing information in line with the EIR and DEEP.

The TIDP should be checked and audited by the digital engineering lead. Then, they should be reviewed by the DE Project Champion to ensure that information is:

- being developed in line with the agreed project timeline;
- synchronous with the broader project development;
- shared and integrated with other project task team members (such as cost engineers and schedulers) and engineering disciplines; and
- developed to the appropriate quality.

Approval must be sought from the DE Project Champion prior to any adjustments to the agreed TIDP.

If approved by the DE Project Champion, the digital engineering lead should update the MIDP.

Stage 4
DESIGN

Master information delivery plan (MIDP)

The MIDP provides a project-wide view of how information will be created and managed across the lifecycle. It must be aligned with the project timeline and associated key decision points.

The digital engineering lead, in consultation with the DE Project Champion, must ensure that the MIDP is finalised within weeks of stage 4 commencing.

During stage 4, all design-related MIDP are to be finalised and delivered as per the EIR and DEEP.

The MIDP must be checked and audited by the digital engineering lead first, then by the DE Project Champion to ensure that information is:

- being developed in line with the agreed project timeline;
- synchronous with the broader project development; and
- aligned with the project approval process.

Approval must be sought from the DE Project Champion prior to any adjustments to the agreed MIDP.

Finalisation of the EIR and DEEP

In most circumstances, the commencement of stage 4 will align with the award of the delivery contract.

As part of this process, attention must be dedicated to the post-contract award process. All contractual documentation between the Appointing Party and Lead Appointed Party must be completed.

Most importantly, the post-contract award review must cover the contractual requirements of the EIR, DEEP, RACI/scope checklist, and the TIDP and MIDP.

This review should be led by both the DE Project Champion and the digital engineering lead.

Coordination and clash avoidance

Stage 4 includes the creation of volumes of technical information that will need to be coordinated.

Depending on the nature of the contract, roles and responsibilities, the digital engineering lead will facilitate the coordination of models. This includes information coordination and collaboration, as well as clash detection and avoidance.

The process of model federation and coordination extends beyond software – it must involve dedicated coordination meetings to facilitate progressive reviews and assurance of the designs. This can improve project quality, progress and staged information transfer and compliance.

Design model coordination meetings must address the following:

- overall coordinated model progress to date and snapshot of input models and data;
- technological/formatting concerns/issues;
- clear identification of disciplines/stakeholders;
- issues identified and issue tracking;
- major clash resolution process;
- minor clash resolution process;
- how the requirements of any non-geometric data will be met and tracked;
- delivery of level of information need and LOD requirements;
- adherence to the required collaboration process; and
- ensure that all decision makers are kept informed of the federated model progress.

It is recommended that design-model collaboration and coordination meetings are held frequently and not missed by stakeholders.

To optimise decision making it is recommended that 'clashing' disciplines address issues offline.

The digital engineering lead must review how the coordinated model is leveraged on site and in their supply chain.

It is recommended that, where feasible, the Appointed Party allocate a site-based resource in stage 5 to provide model access to work crews and site personnel. The use of these dedicated site resources make site tasks more productive, clearer, effective and safer.

It is important to note that a 'clash free' federated model is highly unlikely prior to stage 5. The goal of stage 4 is to reach a point where:

- the elements within each discipline model are of the required quality, and the model itself reflects all required systems that need to be coordinated with other discipline models, with major and moderate issues resolved;
- the elements that have the largest spatial and cost impact (such as structure and MEP) are the focus, and are well coordinated prior to construction; and
- elements that can be routed onsite are not given the same clash priority as elements that would create significant time and cost delays.

> **Tip:**
>
> On D&C, PPP and alliance contracts, the early engagement of specialist subcontractors to work up their discipline's details should be considered as early as possible. This will avoid abortive work by the design team and reworking by the subcontractors later.

Information container metadata

The approach for how project information will be classified, categorised, named and status coded (including revisions) must be clear to all parties. This includes both metadata (data about data) and object property/attribute data within each of the proposed digital engineering environments.

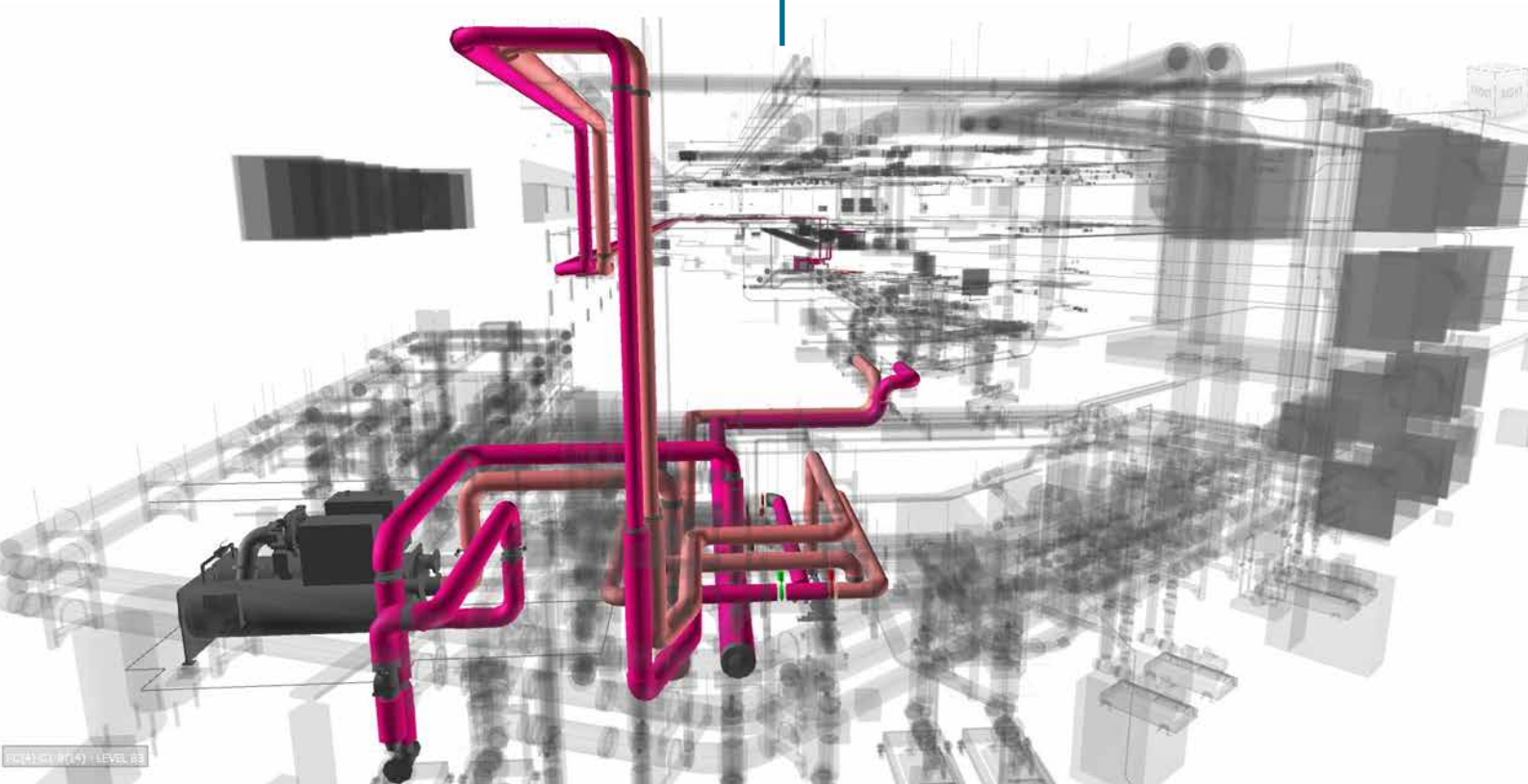
By stage 4, the digital engineering lead and DE Project Champion will have established the project's metadata and property/attribute data approach. This information should be updated in the DEEP for approval by the DE Project Champion.

The metadata and property/attribute data approach must suit the project stakeholders as well as asset managers and facilities managers.

Security and access

In stage 4, security compliance spot checks should be carried out by the digital engineering lead and DE Project Champion and other relevant parties to report on compliance with the EIR.

Digital assets need security controls similar to their physical counterparts which allow different access for different stakeholders.



Stage 4
DESIGN

Critical infrastructure resilience

The Minister for Emergency Services has approved guidelines under section 74W of the *Emergency Management Act 2013*. These guidelines provide further detail in relation to the criticality assessment methodology that can assist with the assessment of 'vital' infrastructure.

The guidelines also provide detail in relation to emergency risk management planning, exercises, audits and sector resilience plans.

Responsible entities, i.e. owners and/or operators of 'vital' critical infrastructure, must develop, conduct and evaluate an exercise to test their emergency planning, preparedness, prevention, response or recovery capability.

The PIM is the ideal tool that can be used by the responsible entity to conduct such testing.

Vital infrastructure assets should be assessed and tested using the PIM to conduct modelling of certain situations/use cases.

Stage 4
DESIGN

Compliance with AIR, EIR and DEEP

A regular review of the PIM and associated stage 4 deliverables by the Appointing Party is a key aspect to ensuring information management success.

It is expected that the DE Project Champion will drive compliance review activities in line with the EIR and DEEP.

It is important to note that for most circumstances – compliance should be approached as early as possible, collaboratively and in a no-blame environment.

With this approach, remediation activities associated with compliance reviews are fewer, less adversarial and less costly in the long-term.

The VDAS Champion has a bespoke compliance role. The role must ensure that the PIM is being delivered in line with the EIR/AIR and that the PIM seamlessly integrates with the AIM.

Information models

The individual design intent models that make up the PIM should be developed throughout stage 4, so that they inform:

- functional objectives of the project (in line with the project objectives and business case);
- estimating and project scheduling;
- organisational and project-wide risk reviews and tolerances; and
- construction activities.

The information models should be aligned with the agreed key decision requirements of the project, procurement strategy and proposed work breakdown structure.

Project information model

Stage 4 will see the continued development of the PIM, with the aim of enabling construction activities.

This will include:

- a schedule of accommodation, room data sheets and spatial information;
- individual BIM files from all disciplines such as architecture, structural, civil, mechanical etc. aligned to Uniclass 2015 classification;
- drawings of the proposed design by each discipline;
- spatial data held within the GIS environment;
- federated BIM model – combining above discipline models, clash and compliance reports;
- schedules such as door, window, finishes, FFE etc.;
- cost plan linked to BIM files;
- proposed construction schedule linked to BIM files;
- reports such as environmental impact statements and safety in design; and
- specifications with alignment to Uniclass 2015 classification.

Stage 4
DESIGN

Soft landings – data drops

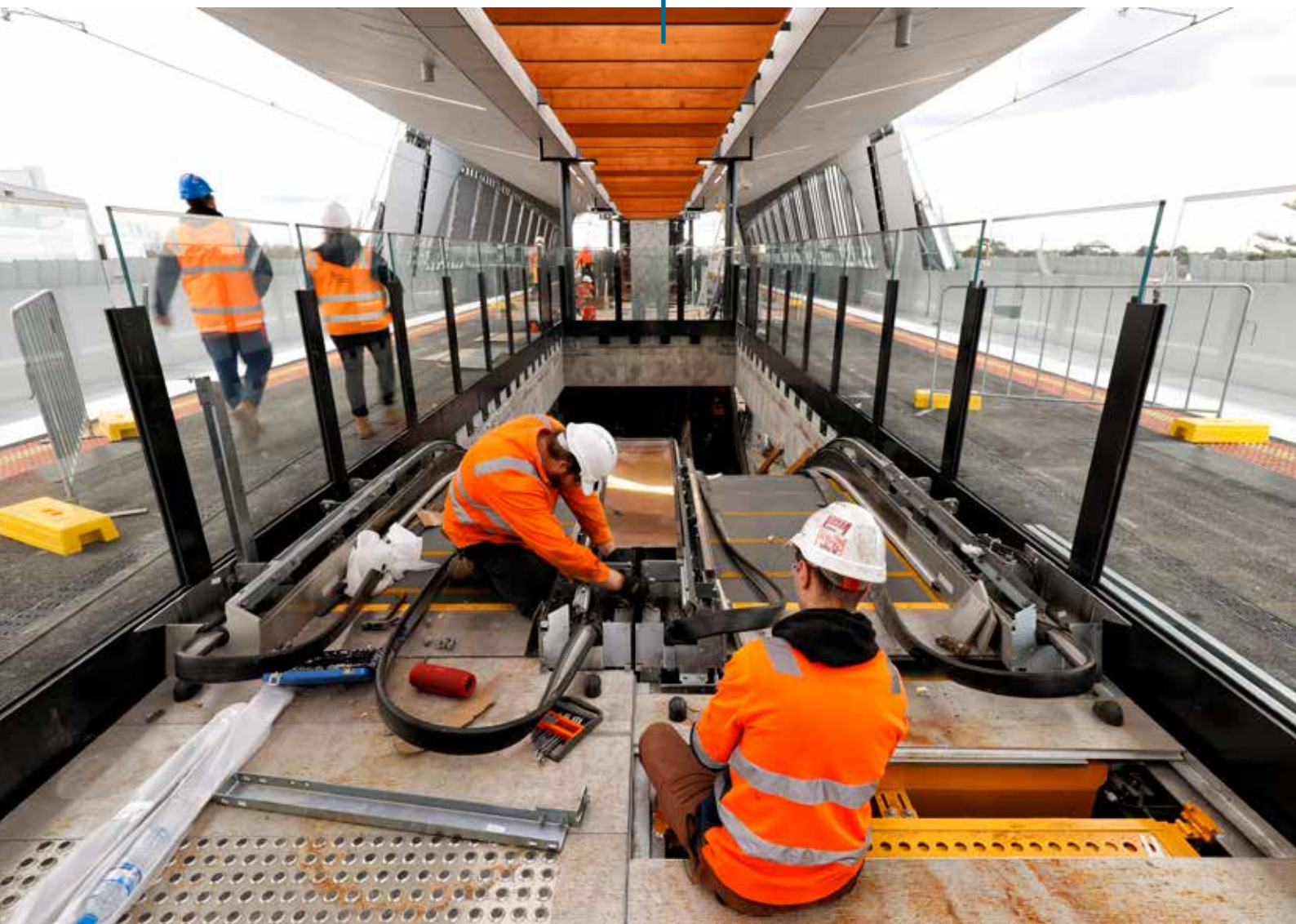
To facilitate understanding and buy-in, asset and facility managers should be engaged early (stage 1) and be consistently updated throughout the project via 'soft landings – data drops'.

Soft landings involve 'trial' exchanges of PIM data (as defined in the AIR/EIR) to inform the key decision points and facilitate improved and staged handover processes. Soft landings enable progressive validation and loading into the CMMS/AIMS to reduce the effort during handover and closeout in stage 6.

Moreover, these processes increase buy-in and collaboration between the project team and the ultimate asset custodians.

The soft landings approach should be championed by the DE Project Champion.

Gradual sharing of information will enable a smooth accumulation of valuable data driving towards high attention to detail.



Technology and systems

During stage 4, there will be a rapid increase in technologies and systems that support the development of the PIM.

These technologies and systems form the organisational CDE and must be in place and operational as early as possible.

The DE Project Champion, VDAS Champion and the CTO must endeavour to reach a prompt consensus on how to integrate systems using open forms of data exchange.

Furthermore, the DE Project Champion must also focus on the development of the PIM from stage 4 to 5 as part of soft landings.

PIM to AIM integration testing

On the first few VDAS enabled projects, a test environment should be set up to enable the trial the transfer of information from the PIM to the AIM. Stage 7 information management processes must be considered as part of PIM to AIM integration testing, including:

- ability to extract structured and unstructured PIM data meaningfully;
- ability to append existing spreadsheets and databases in the AIM with PIM data;
- applicability of common data transfer schemas, such as COBie;
- relationships between design, construction, and operational attributes;
- how asset identifiers from the CMMS will be passed (or not) to the PIM;
- testing third-party applications or plugins;
- integration of the PIM with middleware applications that bi-directionally link to the CMMS (and other AIMS);
- data storage and management requirements of accepting the PIM (i.e. point clouds, BIM, and GIS);
- processes for what information shall reside in BIM, GIS, drawings or the CMMS and other related AIMS;
- how information will be updated and governed as part of the transition;
- how the elements of the AIM will be used by future projects, e.g. how will part of the BIM be updated in a future refurbishment;
- how AM and operations users will access information both on the desktop and in the field; and
- what information will be passed to the organisational CDE/CMMS versus what design/construction information will be archived at stage 6.

Once the approach is defined, the MIDP can be updated with alignment with key asset managers and facilities managers.

Stage 4 PIM to AIM integration testing is complete when the integration approach has been unanimously agreed among stakeholders. Not all asset information will be available in stage 4, however the processes and required data for exchange will be well defined.

Digital engineering model viewers

The DE Project Champion will continue to deliver training and support services on the chosen digital engineering model viewers to the Appointing Party stakeholders throughout stage 4.

Collaboration platforms

In line with the security and access protocols for the project, collaboration must occur and is important. Online collaboration platforms should be used to address these protocols. The DE Project Champion should assess these platforms on a case by case basis to reduce miscommunication and other risks. This assessment will consider security, access, asset criticality and IT infrastructure.

These tools can greatly increase real-time collaboration, coordination, accountability between team members and reduce coordination challenges, reducing conflicts.

It is noted that many online collaboration tools do host information on servers that are certified in line with Victorian Government information security requirements. Nonetheless, for assets deemed 'critical', caution needs to be taken regarding the hosting server's location in line with data sovereignty and agreed access controls.

Stage 4
DESIGN

Stage 4 checklist

Check	Description	Role	Page
☐	Model coordination strategy defined and confirmed	DE Project Champion	C.117
☐	Regular model review meetings undertaken	Delivery team	C.116
☐	Data security strategy reviewed regularly	DE Project Champion	C.112
☐	Critical resilience self-assessment conducted	Delivery team	C.114
☐	Integration of digital engineering information with operational CDE tested	DE Project Champion/ lead Appointed Party	C.117
☐	Data drops conducted, PIM to AIM integration testing	DE Project Champion	C.117
☐	Existing model (graphical and non-graphical data) handed over to parties in stage 5	DE Project Champion/ Appointing Party Org. Stakeholders	C.110
☐	Lesson learnt relayed back to the VDAS Champion for inclusion in future projects/approaches	DE Project Champion/ VDAS Champion	C.108
☐	Clarify and check user access rights	DE Project Champion	C.112
☐	Review stage 4 key decision points	VDAS Champion	n/a
☐	Prompt and answer stage 5 and 6 key decision points in collaboration with key project and asset stakeholders	VDAS Champion	n/a
☐	Review quality control process	DE Project Champion/ lead Appointed Party	n/a

Stage 5

BUILD AND COMMISSION

Stage 5 is the most capital-intensive phase of the project. In stage 5, considerable resources are allocated to physically construct the asset in line with the contractual scope, AIR/ EIR and BCA.

The success of stage 5 is fully reliant on stages 1 to 4 being finalised and being of high quality.

From a digital engineering perspective, stage 5 includes translating the design PIM (created in stage 4) to information and decisions that inform site construction and commissioning activities, including the creation of a construction PIM. This construction-enabled PIM will leverage many existing design models, and the approach/ processes must be documented in the DEEP.

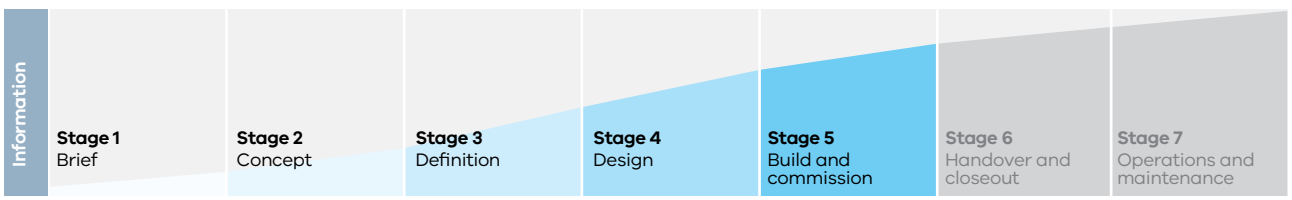
Sound information management practices become critical in stage 5. Key stage 5 tasks include:

- model and information federation and review for work-pack creation and management;
- seeking alignment with designers and engineers;
- supply chain engagement;
- daily site briefings coordinated through 3D model usage;
- quality control;
- construction sequencing and scheduling;
- cost management;
- progressive asset information commissioning;
- quality control; and
- health and safety planning.

Stage 5

BUILD AND COMMISSION

Stage	Build and commission	
People	• VDAS Champion • DE Project Champion • DE Leads • Others (i.e. Project Director, Asset Manager, Ops Manager, Maint.)	• Appointed Party • Appointed Party's supply chain
Information management	• Ongoing audit and assurance of PIM against EIR, DEEP (and RACI/scope checklist) • QA/QC of as-builts • Ongoing integration of functional stakeholders within organisation	• Soft landings/data drops • Supply chain engagement • Construction readiness reviews • Field/site integration (technical clarifications from site) • Hot and cold commissioning reviews
Data information models	• Stage 4 PIM reviewed • Stage 5 PIM reviewed • Receipt and assurance of data drops/soft landings • PIM to AIM integration test • Org. data standards implementation on project	• Stage 5 PIM developed, incl. multi-disciplinary reviews • Data standards • Integration with CAD, BIM, GIS, cost estimate, and project schedule • Data drops/soft landings • Capture of as-built information
Technology and systems	• Owner CDE (CAFM/CMMS) • Appointed Party's CDE • Model and drawing viewers • DE viewing, authoring and interoperability tools (CAD + BIM GIS)	• Lidar + Site scanning • O&M capture system • System requirements and user access issues resolved swiftly
Deliverables	• Audit review checklists • Responsive clarifications from site • Ongoing mentoring, support, and training • DE reporting/progress • Stage 5 checklist • Handover of stage 5 PIM	• Receipt, assurance of stage 4 PIM • Development and handover of stage 5 PIM, including update of drawings, schematics, cost estimate (actuals), project schedule, CAD and GIS deliverables, data and schedules



Stage 5

BUILD AND COMMISSION

People

At this point in the lifecycle, the DE Project Champion will remain fully committed on the project. Turnover (planned or otherwise) of this role is not recommended.

Additional individuals such as subcontractors and specialist trades will be on-boarded as part of stage 5. These people will need to be engaged and trained in the methodology articulated in the EIR and DEEP. This may change the responsibility of, or introduce a new, digital engineering lead with a build and commissioning focus for construction.

The digital engineering lead must be a member of the decision-making team.

As the team expands in stage 5, all parties must understand and acknowledge the development of the PIM to date and what is required to develop the PIM into stage 5 and stage 6.

It is imperative that the DE Project Champion convenes a stage 5 'kick off' meeting with stage 5 and 6 stakeholders.

Any contractor-required EIR will be tabled at this meeting and alignment sought between all parties.

VDAS Champion

At stage 5, the VDAS Champion has limited daily project-specific responsibilities. However, the VDAS Champion must gain assurance that the project has been optimised for stage 5 activities. The responsibility for this remains with the DE Project Champion.

The VDAS Champion and DE Project Champion will work closely to ensure that all internal stakeholders' information needs have been considered and implemented for construction and commissioning activities.

Finally, the VDAS Champion must continue to support the project via:

- communicating changes of the OIR, AIR and AIM, or templates for project delivery;
- communicating project-specific issues back to executive management;
- building and maintaining relationships between functional areas of the organisation to improve information management to reduce knowledge silos;
- supporting the organisation's subject matter specialists, data custodians and stewards; and
- sharing lessons learnt and adopting best practices from other departments, agencies, including OPV.

DE Project Champion

In stage 5 the DE Project Champion maintains a key role as project-level resource that bears responsibility for the Appointing Party's requirements. They must continue to foster and maintain communication and relationships with the digital engineering lead, internal departments, asset and facilities managers and applicable external agencies.

The DE Project Champion must continue to chair the internal working group noted in stage 4. They must include new stage 5 stakeholders as quickly as possible. This integration will drive achievement of the project's digital engineering objectives and realisation of associated benefits.

In stage 5, the role of the DE Project Champion will now shift toward ensuring the contractor translates the stage 4 'Design PIM' into a 'construction PIM'.

The construction PIM typically includes critical information to inform construction and commissioning activities and work pack development and implementation.

Digital engineering lead

The digital engineering lead's role in stage 5 is to coordinate the information generated by all parties within the delivery team.

It is highly likely that during this stage, there will be a BIM, GIS and CAD lead. These individuals are to be integrated into the project team digital engineering working group.

These leads maintain structured information handover between the Appointed Parties to ensure continuity of the PIM in line with the EIR.

These leads must also be available to their respective delivery teams to ensure the EIR are understood and delivered. During stage 5, the roles and responsibilities of the digital engineering lead include:

- training, mentoring, supporting and capability building;
- validating and identifying discrepancies in design and construction information, data and documentation; and
- manage the execution of tasks as outlined within the DEEP.

Stage 5

BUILD AND COMMISSION

Asset and facilities managers

Stage 5 (and into stage 6) is a key time for asset and facilities management stakeholders. These stakeholders must remain steadfast in their perspectives to ensure the asset operable and maintainable.

The key task of asset and facilities management stakeholders is to ensure the delivery team is creating, managing and delivering the PIM in line with the EIR, and that the EIR relates to the AIR.

It is highly likely that this complex process will require fine-tuning and will demand stakeholder collaboration.

It is the responsibility of the DE Project Champion to broker these conversations.

In addition to PIM handover – the AM and FM stakeholders may seek to implement the PIM for the following operational readiness purposes:

- visualisation;
- scenario planning;
- operational on boarding and effectiveness;
- emergency response;
- commissioning/decommissioning assets; and
- asset information transfer.

Valuable modelling and simulation can be tested across the asset network to optimise performance and visualise the impact of events.

Lead Appointed Party

The lead Appointed Party (in most cases referred to as the contractor) plays a significant role in ensuring information is managed and coordinated during construction and commissioning. During stage 5, the contractor will likely engage a large delivery team. This wider delivery team (which may include subcontractors) must maintain the digital engineering vision and requirements outlined in the EIR and be contractually obligated to deliver these.

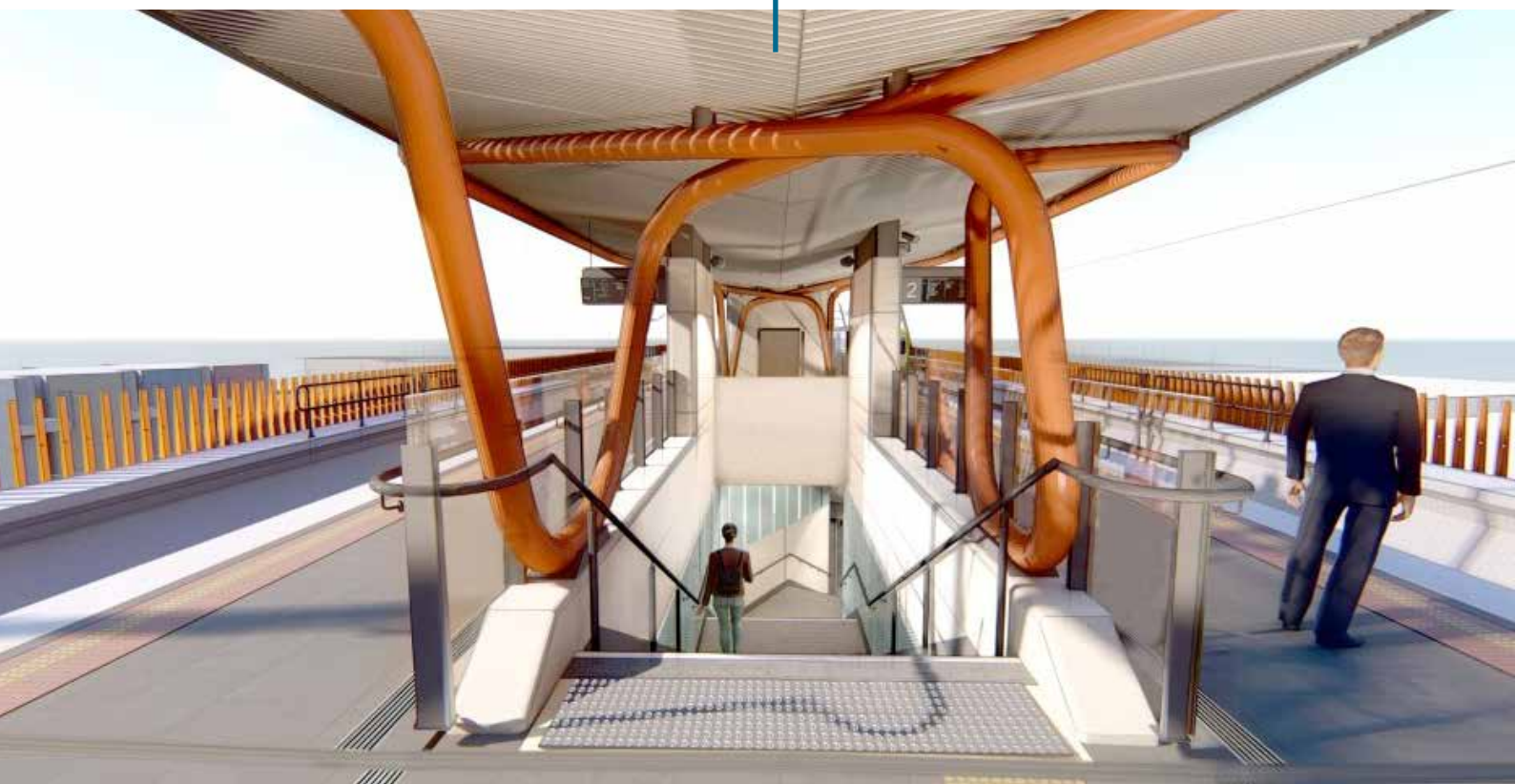
During stage 5, the contractor will dedicate individuals and resources to further develop the design PIM to a construction PIM. The construction PIM is likely to include:

- project information, such as drawings, schedules, models, etc.;
- counts of components, area, volumes of spaces, material and quantities from the digital model to inform cost estimates, bills of quantities, and procurement;
- product-level and asset information;
- information and data to support project reporting;
- information and data to inform a project schedule to drive efficient site decision-making; and
- supply chain/manufacturer-led information such as operating manuals, installation manuals, warranties, operating limits, etc.

Upon completion of stage 5, the contractor should be responsible for:

- the creation and handover of an 'as-built' PIM that reflects the actual physical construction in line with the EIR; and
- integration of the 'as built' PIM into the AIM as specified in the EIR and AIR.

The as-built PIM will be a valuable resource for asset and facilities management roles in stages 6 and 7



Appointed parties

Contracted by the lead Appointed Party, other appointed parties known as subcontractors play a pivotal role in stage 5 of the project. They are responsible for site works and should have a thorough understanding of the design PIM and their contractual obligations to develop the construction PIM alongside the physical construction.

The contractor bears the responsibility of making these parties aware of any contractual EIR prior to commencing any work on site. At a minimum the subcontractor must:

- develop information and data in line with defined TIDP; and
- ensure that information and data developed integrates into the PIM.

The contractor is typically responsible for the performance of its subcontractors, both from a digital and physical asset delivery viewpoint.

Information management

During stage 5, the well-established information management processes developed in stages 1 to 4 will yield considerable dividends.

Effective stage 5 information management practices are based on three major focus areas:

1. maximising the design PIM to inform construction and commissioning activities;
2. in collaboration with supply-chain and subcontractors, continue developing the PIM in line with the EIR and DEEP; and
3. maintaining interfaces with asset and facilities managers through the VDAS Champion and soft landings approach to improve the efficiency of the PIM to AIM handover.

Parties responsible for any stage 5 information management must maintain visibility on the EIR and the DEEP.

Task information delivery plans (TIDP)

During stage 5, construction-related TIDP are to be finalised. The contractor should direct its subcontractors to update their respective TIDP in line with the Appointing Party EIR/AIR.

The TIDP should be checked/audited by the DE Lead and then by the DE Project Champion to ensure that information is:

- being developed in line with the agreed project timeline;
- synchronous with the broader project development;
- shared and integrated with other project team members (such as cost engineers and schedulers) and engineering disciplines; and
- developed to the appropriate quality.

Master information delivery plan (MIDP)

The digital engineering lead will create a construction MIDP combining the construction TIDPs from all awarded delivery team members.

Subsequently, the digital engineering lead for construction should update the construction DEEP and issue it to the DE Project Champion for approval.

Coordination and clash avoidance

Stage 5 involves the coordination of technical information that informs decisions and sequencing of trades and works.

The process of model federation and coordination extends beyond software – it must involve dedicated coordination meetings.

Model collaboration and coordination meetings should be continued from stage 4, be held frequently, and be attended by all stakeholders.

One of the core benefits of coordinated models is the ability to reduce trade-level conflicts on site.

The DEEP should articulate how the PIM will be used to facilitate coordination and clash avoidance strategies. If this is not included, the DE Project Champion must seek clarification from the digital engineering lead.

A coordination and clash avoidance process may include:

- the required tolerances and elements needed to inform construction coordination;
- the approach for continuing development of the design models or substitution of fabrication models to avoid duplication of information and effort;
- the embedded information needed to facilitate coordination (model discipline/trade, classification, asset attributes); and
- early adoption of fabrication or manufacturers' models.

Site planning

One of the key benefits of object-based modelling is that it can visualise the project over time. This can assist construction managers and decision makers with decisions to enhance productivity and safety on site, and reduce costs.

Use of the PIM for site planning and integrated scheduling is recommended by the VDAS.

The integrated scheduling approach should consider:

- the embedded object information needed to facilitate site planning (i.e. lifting classification, weight, centre of gravity, crane slews, etc.);
- linking the federated model to the construction schedule (i.e. asset classification via the WBS);
- use of augmented and virtual reality to simulate installation planning and sequencing;
- cutover/shut down planning and sequencing;
- trade work package planning and scheduling;
- location of lay-down yards and 'time on tools' assessments;
- planning complex crane lifts;
- difficult working environments (multiple cranes, working at heights, confined spaces, etc.); and
- design vs reality checks.

Site planning and integrated scheduling is complemented with the use of laser scanning, point cloud surveys and photogrammetry.

Site operations can be tracked with high accuracy to provide improved data-driven decision making.

Stage 5

BUILD AND COMMISSION

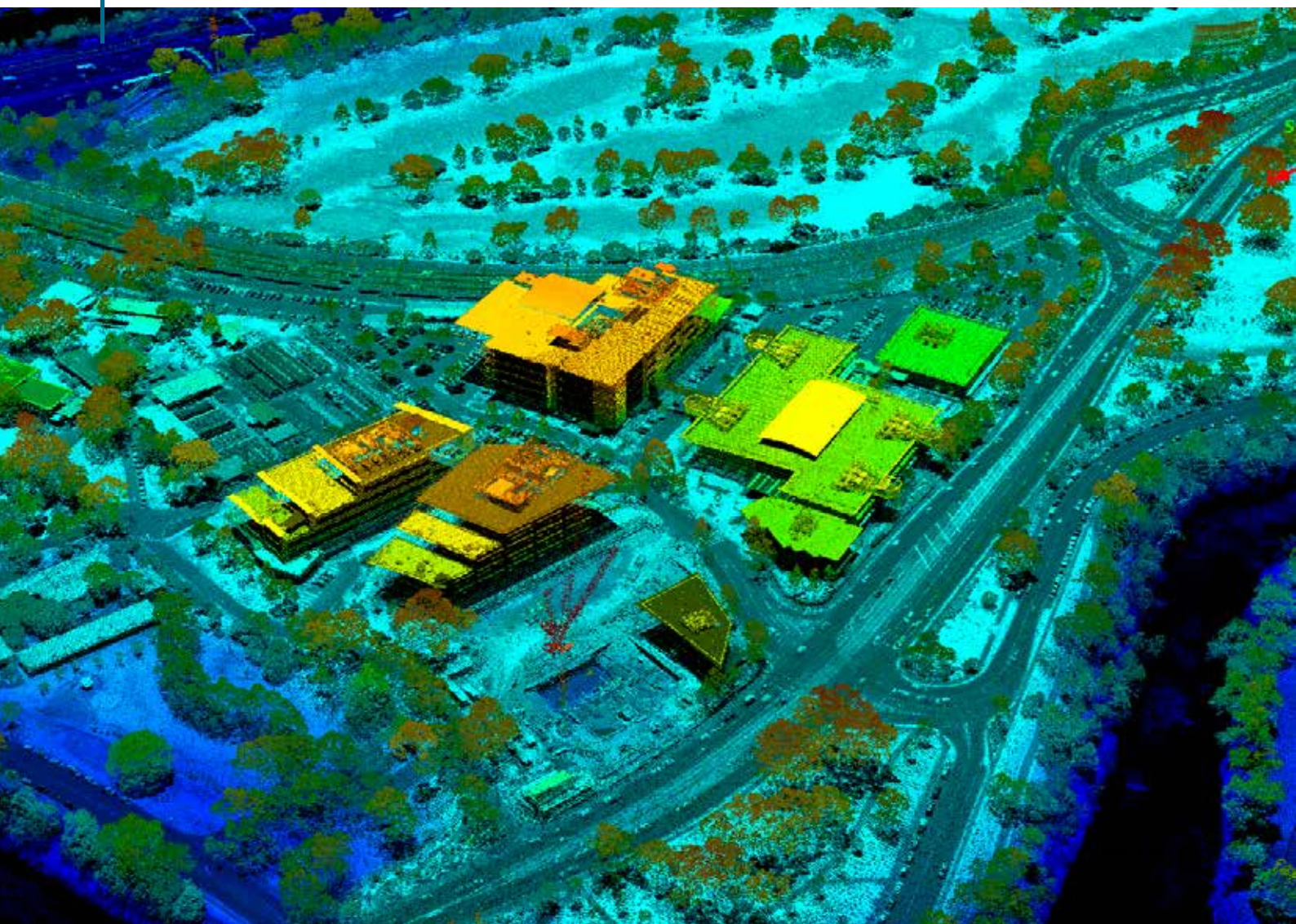
Laser scanning and reality capture

Laser scanning, UAVs, reality capture systems or a combination of these approaches can be used to create point clouds, aerial imagery and models that can provide stakeholders with a cost-effective approach to better understanding how the project is being delivered over time. These approaches can be employed at any time in the project lifecycle when improved spatial information is sought.

These tools can greatly assist project stakeholders with a comprehensive understanding of how the project is progressing against the plan, and involves:

- avoiding costly downtime caused by components built off-site not fitting the design intent;
- ensuring components that are built off-site will fit when delivered, without rework on-site;
- facilitating clash detection by testing between existing structures and new design components; and
- reviewing actual installation versus planned cost, schedule and earned value, assisting with virtual construction or simulation.

Innovative scanning and capturing approaches can collect large amounts of data very rapidly.



Stage 5

BUILD AND COMMISSION

As-built capture

Stage 5 is a critical opportunity to capture as-built information and update the construction PIM when it is the least costly.

In many cases, works are installed in places that are concealed once fully constructed.

A prime example of this may be utilities services in a wall or under a floor. The best time to confirm the location of these soon-to-be-obscured services is during installation and prior to concealment.

Point cloud scans and photos of obscured works assists the as-built update process, particularly in stage 6.

This approach can greatly benefit asset and facilities management stakeholders and future refurbishment projects that may need to understand existing and obfuscated works.

The DE Project Champion, in coordination with the digital engineering lead must consider how the project will utilise these technologies and approaches, at what stage and to what level of detail.

This should be documented in the contractually binding construction DEEP and communicated to all project stakeholders. These approaches must include how this information can be updated in later stages and ultimately retained.

Data captured in previous stages will make the as built capture process highly efficient.

Security and access

Security and compliance spot checks should be carried out by the DE Project Champion and to ensure EIR compliance during stage 5.

All security and access requirements should flow down to subcontractors.

Where possible, the stage 4 project CDE should be continued into stage 5 to maintain security and access consistency.

Stage 5 will likely include the onboarding of many people. This process will require the establishment of user access controls in line with the security-minded approach outlined in the EIR.

Compliance with AIR, EIR and DEEP

The regular review of the construction PIM and associated stage 5 deliverables by the Appointing Party is a key aspect to ensure IM success.

The lead Appointed Party is responsible for reviewing the constitute elements of the PIM (such as BIM, 2D drawings, schedules, etc.) in the CDE 'shared' status in line with the EIR and DEEP.

From an assurance perspective, the PIM should be reviewed by the lead Appointed Party prior to releasing the information to a 'published' status (i.e. visible to the owner) in the CDE.

Information models

Data information models that constitute the PIM must continue to be developed during stage 5 in accordance with the MIDP, EIR, and DEEP.

At defined points during stage 5, the delivery team will provide information exchanges in the required formats.

Project information model

Stage 5 will see the continued development of the construction PIM. In stage 5, the PIM is used by the delivery team to physically construct the project's assets, but it must also be appropriately handed over to the Appointing Party, as well as integrated with the AIM.

With respect to the stage 5 PIM, the lead Appointed Party will:

- review and deliver as-built conditions documentation (preferably digital data capturing methods such as laser scanning);
- generate all 2D CAD design drawings from the coordinated construction discipline and/or trade-level models;
- coordinate a 3D model providing evidence that coordination is continuing throughout stage 5;
- perform clash-detection on the federated model to inform site tolerances;
- develop, implement, and maintain model data validation process, and provide a Model Validation Report prior to each data drop outlining the results from this process; and
- deliver CAD, BIM and GIS spatial datasets and associated data in accordance with department/agencies' CAD, BIM and GIS requirements and standards as defined in the EIR;
- maintain and deliver information in the agreed (and aligned) project information structures (such as WBS, CBS, asset classification and location referencing – Uniclass 2015); and
- ensure the PIM can append to the AIM and relevant asset information system(s).

Ultimately, stage 5 is about developing the PIM to meet the integration requirements of handover and close out in stage 6.

Soft landings – data drops

To facilitate understanding and buy-in, asset and facility managers should receive project updates through soft landings – data drops.

The soft landings approach should be championed by the DE Project Champion.

Technology and systems

Stage 5 demands the use of appropriate construction technologies and systems to support the physical build as well as enhancing the information within the PIM.

This stage of the project requires clear alignment of the technology and systems in use, supporting information transfer from the delivery team to asset and facilities management stakeholders in stage 6.

These technologies and systems must be documented in the DEEP and aligned with critical stakeholders such as the construction manager and the DE Project Champion.

PIM with AIM integration approach

Following stage 4 PIM to AIM integration testing, stage 5 focuses on finalising the integration approach.

The VDAS Champion maintains ultimate accountability from an organisational interface perspective.

The DE Project Champion maintains project-level accountability in ensuring the project is delivering the PIM in line with the EIR, AIR, and ultimately, that it can append to the AIM.

Outstanding issues from stage 4 integration testing must now be completed and addressed.

Common data environment

Given the complexities of IM between engineering design activities and the site, it is recommended that the stage 4 CDE is transferred to stage 5.

If the Appointing Party has not supplied the CDE, the DE Project Champion must begin to consider transition from a project CDE to the organisation CDE. The DE Project Champion is responsible for this transition.

As part of the transition, the DE Project Champion must consider:

- naming, coding, classification and location;
- drawing and document management;
- asset information transfer;
- what information will be retained by the delivery team and what information is to be supplied to the Appointing Party; and
- how design/construction cross referencing will occur in the organisational CDE (Xrefs, federated model links, GIS maps etc).

Stage 5
BUILD AND COMMISSION

Stage 5 checklist

Check	Description	Role	Page
☐	Data exchange reviewed and validated against key decision points	DE Project Champion	n/a
☐	Construction model coordination strategy defined and confirmed	DE Project Champion/ Lead Appointed Party	C.127
☐	Model review meetings undertaken	Delivery team	C.126
☐	Data security strategy reviewed	DE Project Champion	C.131
☐	As-constructed/as-built model begun to be captured	Lead Appointed Party	C.130
☐	Asset information migration strategy prepared	DE Project Champion	C.126
☐	Delivery management process defined	DE Project Champion	C.126
☐	Project information model updated	DE Project Champion	C.131
☐	Construction stage report completed	DE Project Champion/ Lead Appointed Party	C.130
☐	As constructed models, data and documentation delivered	Lead Appointed Party	C.130
☐	Existing PIM (graphical and non-graphical data) handed over to parties in stage 6	DE Project Champion/ Lead Appointed Party	C.130
☐	Lesson learnt relayed back to the VDAS Champion for inclusion in future projects/approaches	DE Project Champion/ VDAS Champion	C.124
☐	Clarify and check user access rights	DE Project Champion	C.131
☐	Review stage 5 key decision points	VDAS Champion	n/a
☐	Prompt and answer stage 6 and 7 key decision points in collaboration with key project and asset stakeholders	VDAS Champion	n/a
☐	Review quality control process	DE Project Champion/ Lead Appointed Party	n/a

Stage 6

HANDOVER AND CLOSEOUT

Stage 6 culminates in the completion of project construction activities and the commencement of an efficient and effective transition towards operations and maintenance.

At this stage, the as-built project information model is delivered to the client (appointing party) and relevant information transferred from the project information model to client asset and facility management systems.

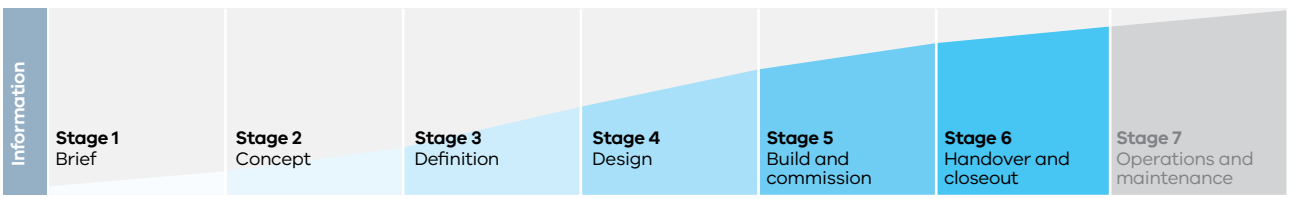
Key stage 6 tasks include:

- identifying safety-critical testing and commissioning workflows to ensure the asset cannot go live and be accepted into use (such as a railway or staged temporary commissioning) before these workflows are certified as completed;
- all commission data logged and reviewed against performance targets;
- end-user orientation and training completed;
- asset and facilities management familiarisation with primary operating systems such as BMS and SCADA;
- updating all construction information and any relevant design information to 'as constructed' or 'as built' status;
- finalise all laser scanning surveys and reality capture surveys and associated point cloud datasets linked with BIM, GIS, and CAD systems;
- alignment of the as-built model with the 'as constructed' asset;
- transfer of relevant PIM information into the AIM;
- store and/or archive the PIM as required;
- review the EIR and finalise delivery and handover of data and information in line with the AIR; and
- complete the project in line with EIR and DEEP.

Stage 6

HANDOVER AND CLOSEOUT

Stage	Handover and closeout	
People	• VDAS Champion • DE Project Champion • Project Director, Asset, Operations, Maintenance and Facilities Managers	• Appointed Party • Appointed Party's supply chain
Information management	• AIM integrated with PIM • Integration issues addressed • Final audit and assurance of PIM against EIR, DEEP (and RACI/scope checklist) • Lessons learnt • QA/QC of as-builts • Retention of the PIM	• Finalising data drop/model and digital asset information handover (incl. ongoing access) • Integration of PIM into AIM • Conduct lessons learnt
Data information models	• Stage 5 PIM reviewed • Stage 6 PIM reviewed • Oversight of AIM update • Capture of critical data (families, objects, designs, etc.) • Retention and maintenance of the PIM	• Validation of PIM (as-builts) • Completion of PIM and handover of PIM/data exchange/COBie/etc.
Technology and systems	• Owner CDE (CAFM/CMMS) • Novating agreed information from party's CDE to owner's CDE	• Providing agreed access to PIM, digital engineering viewing, authoring and interoperability tools (CAD and BIM and GIS) • O&M capture system
Deliverables	• Lessons learnt report (to VDAS Champion) • Appointed Party feedback • Updated digital engineering reporting/progress • Final AIM and final PIM (Handover to DELWP)	• Update and handover of handover of PIM, including drawings, cost estimate, project schedule, CAD and GIS deliverables, and other requested data and schedules • 360 degree digital engineering lessons learnt feedback • Digital engineering lessons learnt feedback to supply chain



People

During stage 6, the delivery team finalises PIM deliverables for handover to asset and facilities management stakeholders. If the VDAS has been followed, these stakeholders have been consulted and kept up to date with the PIM progress, they will be extremely familiar with the digital (and now physical) project.

Stage 6 will have significant resource requirements. It is likely that the project has been in motion for a number of years with large volumes of information generated throughout.

Project stakeholders must understand that while their personal responsibilities to the project may be ending, their responsibilities to the asset over its entire lifecycle are only just beginning. Extended after care should be considered to assist in initial stages on preparing for stage 7 and post-occupancy evaluation.

As such, it is critical to understand how PIM is transferred.

If the *VDAS Guidance* has been followed, with an emphasis on soft landings and frequent working group meetings, the rapport between the delivery team and asset and facilities management stakeholders should be well established. This will inform a sound understanding of handover requirements.

This rapport will greatly improve stage 6 and reaching final completion and commencing asset operations.

VDAS Champion

In stage 6, the role of the VDAS Champion gains more importance. The VDAS Champion takes a lead role in ensuring that, in line with the EIR and AIR, the internal stakeholders' digital asset information needs have been met.

The VDAS Champion must also lead collaboration activities, documenting benefits and challenges and capturing and sharing lessons learnt to inform future project delivery approaches and OPV.

Stage 6

HANDOVER AND CLOSEOUT

DE Project Champion

The DE Project Champion maintains accountability as the key project-level resource.

The key task in stage 6 for the DE Project Champion is to address gaps between the information and data contained in the PIM, and the requirements of stakeholders (such as AM and FM) as outlined in the EIR and AIR.

Simultaneously, the DE Project Champion must maintain accountability for the transition of the PIM to the AIM – as well as the safe storage and archival of the PIM.

To address data and information gaps, the DE Project Champion must work with the digital engineering lead to validate information requirements. Consistent validation and reporting during the construction stages will help mitigate these gaps.

The DE Project Champion should review the information model in accordance with the project's information production methods and procedures.

Finally, it is the core responsibility of the DE Project Champion to oversee the accuracy and detail of the as-built PIM.

This responsibility is pivotal to having current and as-constructed information that can support future AM activities.

Digital engineering lead

In stage 6, the digital engineering lead plays a critical role in coordinating the final PIM delivery, integration and validation with the broader AIM.

The digital engineering lead will work closely with the DE Project Champion, AIM users, the wider delivery team and other relevant stakeholders to finalise any amendments to the PIM.

Any amendments to the PIM should rest contractually with the lead appointed party. The digital engineering lead should maximise the use of automated validation tools as part of the PIM to the AIM transition.

This reduces the need for manually handling information and should limit errors.

The digital engineering lead shall collaborate with asset and facilities management stakeholders as part of this PIM to AIM transfer process.

All issues and challenges arising from the PIM to AIM process should be reported to the DE Project Champion and escalated to the VDAS Champion for future refinement of the VDAS approach.

Stage 6

HANDOVER AND CLOSEOUT

Asset and facilities managers

In stage 6, asset and facilities managers are the primary stakeholders ensuring the final elements, attributes and associated information within the PIM has been developed to facilitate integration with AIM and associated systems. In combination, AM/FM stakeholders, DE Project Champion and VDAS Champion should act as the primary approval entity of the Appointing Party.

Once the PIM is approved and relevant information transferred to the AIM, the Appointing Party should archive the PIM, considering:

- the information to be retained for day-to-day access versus archived, which can be achieved by locking down the archived PIM and creating a simplified version for day to day activities within the AIM;
- potential future access/use requirements, re-use, upkeep and data governance; and
- *Victorian Public Records Act 1973* and the Records Management Standards.

Lead appointed party

As the contractor is engaged as the party to physically construct the project, they are generally the best-placed entity to understand, document and communicate any changes that have occurred on-site during stage 5.

As part of that role it is recommended that the contractor (and its subcontractors) perform and provide documented evidence to support the following tasks:

- as installed, as constructed and as-built information on the location of assets aligned with tolerance requirements;
- document (or provide to others) any changes/ updates to the PIM post stage 5 and 6 to ensure the PIM reflects what is physically installed;
- creation, management and transfer of operations and maintenance manuals;
- finalisation of an as-built PIM that has been reviewed and approved by the DE Project Champion; and
- final Appointing Party acceptance that all information deliverables have been delivered to the required level of information needed.

Information management

Information management within the project CDE and timely transfer of the final information models is a key tenet of stage 6.

During stage 6, the Appointing Party will become the information custodians of the information created by the delivery team.

This may be a large and complex undertaking, as the delivery team is demobilising.

Stage 6 IM processes must maintain focus on the EIR, DEEP and AIR and the stakeholders that can support the transition.

As-built confirmation and verification process

Once an asset has been completed, the as-built design, drawings and models are the resource of what was delivered. This information must be continually assessed during stage 6 by the lead Appointed Party, DE Project Champion and the organisation stakeholder to validate and verify that what is digitally created reflects the needs of physical asset and complies with the scope, AIR/EIR and BCA.

This information is pivotal for any future capital investment or maintenance.

A high-quality and robust as-built verification and updating process is vital. At its core, VDAS seeks to maintain the circularity of this information, as it is guaranteed to be needed later.

The Appointing Party must take ultimate accountability for the as-built process being completed to a high quality. In doing this the Appointing Party should consider:

- MIDP deliverables;
- the EIR; and
- the level of information need and criteria for each information requirement.

If the review is successful, the Appointing Party will accept the information model as a deliverable within the project CDE. If an unsuccessful review occurs, the Appointing Party is to request amendments to be made from the lead Appointed Party for resubmission.

Not doing so will erode future decision making and will ultimately require future investment by the owner to recapture information.

A quick and cost-effective way to collect this information and verify 'issue for design' drawings and models is through the use (or a combination) of point clouds or 3D meshes generated using, laser scanning, and other reality capture solutions such as UAV and photogrammetry.

Laser scanning and point cloud information can efficiently capture and update information models to 'as-built' status by checking against this as-built point cloud.

It is the responsibility of the DE Project Champion, in coordination with the project director, digital engineering lead and engineering manager to champion the as-built process in collaboration with the delivery team.

Information validation

Each task team should submit their information to the lead Appointing Party for authorisation within the project CDE. The lead Appointed Party undertakes the review and authorisation before submitting to the appointing party for their review and acceptance.

Information acceptance

The Appointing Party needs to gain assurance that the validated information from each delivery team member has complied with the EIR/AIR and the MIDP/TIDP plus any regulatory requirements.

To facilitate continuous coordination of the information across the information mode, the delivery team will review each element to in accordance with the asset information requirements.

Where possible, validation and acceptance tools should be utilised to minimise error rates and ensure the accuracy.

Longer-term users of information should be consulted in this final acceptance process. If acceptance is not achieved, the lead Appointed Party shall manage the rectification of any deliverable, then resubmit for acceptance. The DE Project Champion will manage these processes.

Model handover and data transfer

Stages 1 to 6 generate considerable volumes of valuable information.

If the VDAS approach has been followed, information has been progressively developed and delivered to the Appointing Party in a staged manner through soft landings. Stage 6 marks the completion of this transfer process whereby final, verified and approved information models must be transferred as defined in the EIR/DEEP. This is not just good practice but is a key component of the *Victorian Public Records Act 1973* and the Records Management Standards.

All PIM data should be handed over and stored as a record of development. However, not all of this information will be required in stage 7 operation and maintenance. Each department and agency needs to define what information is required within their AIM.

> **Tip**
>
> An exciting digital twin initiative is being trialled in Fishermans Bend. If your project is within this precinct area, please contact OPV.

Example

Asset management is the lifecycle management of physical and non-physical assets to achieve the stated outputs of the organisation across the entire asset lifecycle.

AM best practice follows the ISO 55000 series and is aligned to and supported by the VDAS approach and ISO 19650.

Information is captured within Stages 1 to 6 of the project lifecycle, and should be included in the PIM:

- engineering designs, schematics, and plans;
- plot plans, general arrangement drawings;
- spatial data;
- federated BIM and digital engineering models;
- process flow diagrams;
- original project assumptions and models – traffic surveys, patronage, consumption;
- equipment manuals, drawings;
- asset registers (and asset systems);
- licences to applicable software and systems (as needed);
- maintenance philosophy, registers, permit to work systems, etc.;
- capital budgets and benchmarking data;
- operating budgets and benchmarking data;
- operating systems (business as usual as well as through fault conditions – fire evacuations, etc.);
- security systems;
- project documentation – such as contracts, project schedules, management plans, decision trees throughout the lifecycle, equipment warranties, lessons learnt, defects, compliance certificates, occupancy certificates, licences (gases, groundwater permits, ESD), and variations;
- monthly project reports;
- training manuals and material;
- commissioning data reports and tests (lifts, escalators, lifting equipment, boilers, pressure vessels, MEP systems, HVAC, etc.);
- material safety data sheets, hazard identifications, HAZID/HAZOP reviews;
- design, construction and operational risk registers; and
- legal boundaries and owners.

Information retention

It is likely that information generated throughout the lifecycle will need to be retained as set out by internal policies or the Public Records Office of Victoria (PROV).

The Appointing Party-led CDE is the ideal mechanism to support the above requirements. It is highly recommended that the VDAS Champion collaborate with the Appointing Party information management stakeholders/resources to confirm existing procedures relating to retention requirements are in place. If there are unknowns, the VDAS Champion should consult with PROV to review the department's policy on PIM retention.

The approach must be communicated to the DE Project Champion and the delivery team.

Lessons learnt

In collaboration with the lead Appointed Party the DE Project Champion and VDAS Champion shall conduct a comprehensive lesson learned process.

The lessons learnt process seeks to integrate the digital engineering learnings from stages 1 to 6. From there, the VDAS Champion and DE Project Champion must:

- evaluate the project approach from stage 1 (what was expected) vs. what was achieved (stage 2-6);
- assess how the project delivered outcomes, what was the value vs. shortcomings;
- review how information was managed and whether the quality of data was achieved;
- assess the team's and contractor's capability/ capacity;
- determine what processes, technologies and practices should be brought forward into future projects;
- review what learnings should be widely communicated;
- define what elements need careful consideration before applying them again; and
- review stakeholders' perceptions of whether information requirements were met, if they were satisfied with the outcome and the way it was achieved.

The DE Project Champion will record the outcomes in a suitable knowledge store, providing a record and insight into any augmentation/future VDAS approaches on upcoming projects.

The VDAS Champion should communicate any benefits realised to the broader Appointing Party organisation to improve understanding and build internal capability and support for the VDAS approach.

Stage 6

HANDOVER AND CLOSEOUT

Information models

Stage 6 represents the final transition of asset information (held within the PIM) to the operational AIM.

To manage this interface of data models, the DE Project Champion must work closely with the delivery team and asset and facilities management stakeholders to ensure the appropriate formats are delivered at the appropriate time.

Information containers

The PIM traditionally comprises many information containers. These containers may include drawings, cost plans, visualisation, discipline BIM files, BIM element/objects, point clouds, etc.

All information set out in the EIR and MIDP should be transferred to the Appointing Party. This means the as-built PIM will sit within the AIM CDE as an archive.

The DE Project Champion will work with the digital engineering lead to ensure only the relevant and current information containers are transferred from the PIM to the AIM.

Critically, an assessment of what information needs to be archived within the Appointing Party's systems must be performed by the DE Project Champion.

Project information model (PIM)

In stage 6, the PIM will be finalised, providing the information required by the Appointing Party in stage 7.

It is the digital engineering lead's responsibility to ensure information in the PIM has been created, validated, quality assured and exists in the appropriate formats as per the EIR and AIR.

The DE Project Champion will audit the PIM for compliance to the EIR/AIR prior to integration with the AIM.

Stage 6

HANDOVER AND CLOSEOUT

Asset information model (AIM)

Once the Appointing Party has validated, approved and accepted the remaining PIM data, it is transferred to the AIM.

If the VDAS approach has been followed, this information should include the relevant information generated from stages 5 and 6.

To effectively manage assets during stage 7, this process needs to occur with limited manual re-coding ensuring no data loss, corruption or missed fields are present in the AIMS.

The Appointing Party shall confirm that the requirements of the AIM have been satisfied prior to releasing the lead Appointed Party.

Tip

The AIM is an extremely valuable resource. It typically costs many hundreds of thousands of dollars to create. Stage 6 and 7 require the Appointing Party to continue to manage the AIM as changes to the physical assets occur.

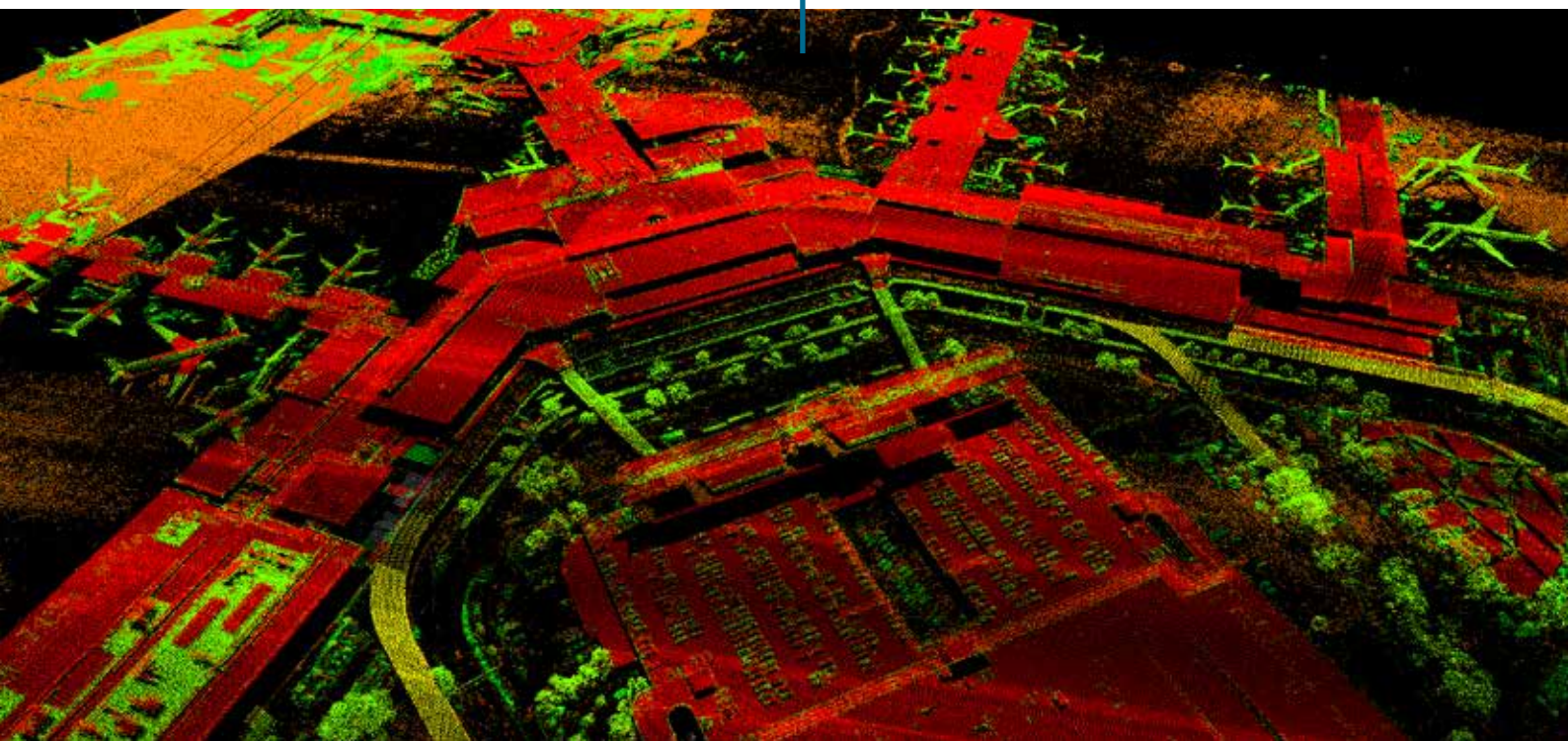
Handover formats

As part of the EIR, the Appointing Party should have well-established, defined and well-supported asset information exchange formats for each information deliverable.

In circumstances where the exchange formats have not been articulated in the EIR or DEEP, alignment should be sought as soon as possible with an emphasis on open data formats to reduce the possibility of marooning information in proprietary formats.

Schemas such as COBie can be used as an interim approach if an Appointing Party schema is not yet fully developed.

Information captured in the PIM will be transferred into the AIM, adding significant value in stage 7.



Technology and systems

In stage 6, the delivery team prepares for the transition of all project data within the PIM to the operations and maintenance stage.

The critical factor at this stage is to ensure the data and information being exchanged into stage 7 is in a format that can be read by the asset management technologies and systems.

It is recommended that the DE Project Champion, with support from the VDAS Champion, transitions or archives all information (in line with the EIR and DEEP) prior to any contractual release of any of the delivery team members.

Common data environment

Stage 7 marks the final transfer of information between the project CDE and the organisational CDE.

The onus of responsibility for transfer remains with the DE Project Champion in collaboration with the digital engineering lead.

The CDE transfer should have the ability to connect or link information held in different systems together.

This could be through an asset identifier that is independent of each system but the same across all systems.

In the situation where there is no organisational CDE, it is recommended that this system functionality include:

- drawing and document management (EDMS);
- asset information upkeep and management (i.e. CMMS, CAFM, and AIS);
- financial, accounting and procurements systems (ERP, CRM);
- visualisation of information containers (i.e. digital engineering model viewers, spreadsheets, PDF, etc);
- spatial environments (i.e. GIS, BIM, CAD, and point clouds);
- scenario-modelling environments (planning tools, financial modelling);
- system control environments (SCADA, IoT, BMS etc);
- mobility and field solutions that connect back to master data stores; and
- customer and community-focused systems (website, mobile app, portals).

Stage 6

HANDOVER AND CLOSEOUT

Training

If specialised technologies or systems were used on the project, the lead Appointed Party must allow enough time to provide training and support to the Appointing Party end users.

This is also true of physical equipment and the environments they operate in. Considered handover of the physical assets to the ultimate users and maintainers will improve the ongoing use, care and maintenance – improving the life and associated maintenance cost of the assets.

Decommissioning of systems

As the project moves into operational phases, some systems used in previous design and construction stages may need to be decommissioned or archived with access limited.

The DE Project Champion will work with the Appointing Party information management stakeholders/resources and the lead Appointed Party to confirm existing procedures relating to retention requirements are in place. If there are unknowns, the VDAS Champion shall consult with PROV ensure appropriate retention policies and guidance is in place.

Stage 6
HANDOVER AND CLOSEOUT

Stage 6 checklist

Check	Description	Role	Page
☐	Compliance with EIR checked by the Lead Appointed Party and DE Project Champion	DE Project Champion/ Lead Appointed Party	C.137
☐	As-constructed/as-builts captured and PIM updated	DE Project Champion/ Lead Appointed Party	C.143
☐	Defects identified and rectified by the delivery team	Delivery team	C.139
☐	As-constructed/as-built PIM verified for completeness and accuracy	DE Project Champion/ Lead Appointed Party	C.139
☐	Conducted training/briefing as needed for operational requirements	DE Project Champion	C.146
☐	Lessons learnt during the project captured	DE Project Champion/ VDAS Champion	C.142
☐	Information for soft landing activities completed	DE Project Champion	C.143
☐	Clarify and check user access rights	DE Project Champion	C.137
☐	Project information model verified by the Lead Appointed Party	DE Project Champion	C.169
☐	Project information model data approved by the Appointing Party	DE Project Champion	C.137
☐	Project information model data integrated into the asset information model	DE Project Champion	C.143
☐	Identification and maintenance of pertinent digital engineering information flagged for solution re-use on future projects	DE Project Champion	C.142
☐	Conduct project closeout meeting with all asset stakeholders to ensure asset information matches EIR requirements and the built asset	DE Project Champion	C.139
☐	Answer stage 6 and review all key decision points	VDAS Champion	n/a
☐	Review quality control process	VDAS Champion	n/a

Stage 7

OPERATIONS AND MAINTENANCE

At this stage of the lifecycle, the asset will have moved into an operational phase. The works delivered will be assigned ownership and put under the operational control of a government department, agency, operator or franchisee.

The VDAS improves the efficiency and management of Victorian assets throughout each stage of the lifecycle.

This stage can span multiple generations. The recurrent cost savings are significant.

The AMAF has introduced a significant shift in the expectations, practice and approach of new and existing public asset financial management.

All Victorian Government departments and agencies are implementing significant changes to how they manage their assets.

The VDAS is intended to be key enabler of the AMAF, as it can improve information management practices from projects to operating assets.

It links the volumes of valuable information created during the asset development to existing AIMS, accounting packages and financial management systems.

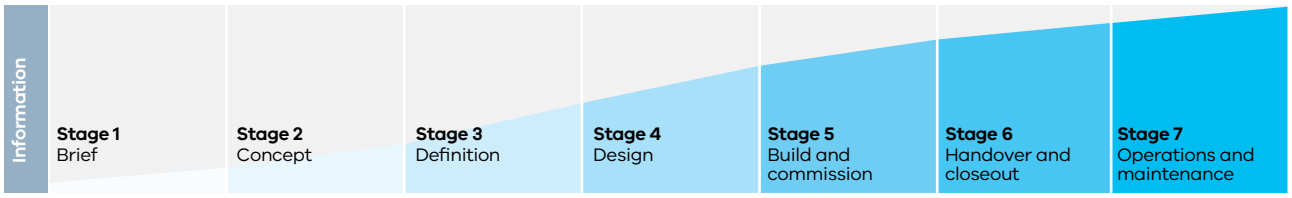
In the operational stage, the AIM helps manage, maintain and operate the asset using data and information. This will be integrated with and aligned to the organisation's AIMS.

The purpose of the AIM is to be the single source of approved and validated information related to the asset. This includes data and information such as geometry, performance, specification, maintenance manuals, usage data and health and safety information.

Stage 7

OPERATIONS AND MAINTENANCE

Stage	Operations and maintenance		
People	• VDAS Champion	• Data custodians and stewards	• Asset and maintenance managers/users
Information management	• Use of digital asset information for future developments • Implementation of lesson learnt • Relevant DE documentation revised	• Use, cleansing, upkeep, valuation and updating of asset data	• use of DE information within the CMMS • Information update process (laser scanning, point cloud, new projects, etc.)
Data information models	• AIM management with clear roles and responsibilities • Processes for AIM updates	• AIM and PIM as needed	• AIM and CMMS as needed
Technology and systems	• Internal CDE (CAFM/ CMMS/GIS/EDMS/AIM) and asset data systems	• Model and drawing viewers support • O&M capture system	
Deliverables	• Executive project report incl. challenges and opportunities • Ongoing feedback and engagement with OPV • New systems, tools, integrations defined and budgeted	• Updated data and asset information as needed	• AIM updates • Training, upskilling, mentoring, and support • Report to VDAS Champion on project progress and challenges



Maintaining an AIM

Documented processes and procedures to maintain an AIM are critical. It is important that the ultimate asset owner has a strategy and resources to maintain their AIM during stage 7. This should consider the capability of resources, timeliness and software systems being put in place to maintain the AIM effectively.

Changes to the AIM will generally be in response to a trigger. This includes planned or unplanned events, major works, refurbishment project etc These triggers may require changes to the AIM—typically non-geometric data.

Roles, responsibilities and authorities should be established to maintain the AIM to ensure high-quality information and data continue to support organisational needs.

The organisation should also establish, document, implement and maintain an information management process. This should cover the operational lifecycle of the asset, including but not limited to:

- handover from design and construction;
- daily operation of the asset;
- planned and reactive maintenance;
- minor works;
- major works;
- decommissioning;
- dismantling or demolition;
- linking into AIM additional plant sensor data;
- predictive maintenance; and
- ensuring asset register is synced with AIM updates.

Stage 7 information management processes will need to cover all asset data and information systems, not just the AIM. This ensures that all aspects of asset management – strategic through to operational – have access to the necessary data and information in the format that is needed, at the time it is needed.

All assets should be classified and contain a reference to an asset class, asset function and asset type.

Each asset in the asset register should have a specification, i.e. construction type. The asset should inherit the properties listed for its function, type and specification.

Document, graphical and spatial data should be linked directly to the asset in the asset register.

The figure below illustrates the information associated with the asset in the asset register in relation to its classification and specification.

Post-project aftercare (PPA)

PPA focuses on the concept that the Appointing Party and the lead Appointed Party have a responsibility to continuously monitor and review how an asset is performing throughout stage 7 in line with users' needs.

The PPA process improves the project-operations feedback loop by ensuring those who define, develop and engineer our infrastructure and built environment assets witness and validate how it performs post practical completion.

The Appointing Party reviews PPA through post-occupancy evaluations (POE). These should occur within pre-defined time periods of the asset's early operating life.

The PPA element of soft landings is about fine-tuning and de-bugging systems and ensuring operators understand their environment better. Following stage 6, the lead Appointed Party should engage asset and facilities management stakeholders and end users to:

- familiarise end users with the general operation of the asset or facility;
- provide training and technical support; and
- identify any operational issues and develop an action and communications plan to resolve.

The POE should be recorded in a report considering all the performance targets determined for the project, with particular emphasis on:

- operational management;
- durability and serviceability;
- performance of systems;
- end-user experience; and
- lessons learnt.

The lead Appointed Party's responsibilities for PPA also extend to monitoring the performance of the systems in collaboration with the appropriate stakeholders. Asset performance should be recorded and shared with the appropriate stakeholders, including the VDAS Champion and DE Project Champion.

Consequent troubleshooting and fine-tuning of the services and engineering systems should be carried out by the Appointed Parties in collaboration with the operator, asset managers or facilities managers. Outcomes should be reported back to the Appointing Party.

By the end of year one, a detailed understanding of the asset's structures, operations and control management systems will have a clear baseline.

By the end of year two, stable operation should have been achieved. This should include a stable baseline on asset condition, asset performance, power and energy consumption and cost data.

Year three onwards should involve ongoing reviews and POE in line with expectations set in the PPA of the EIR defined at stage 3.

Stage 7

OPERATIONS AND MAINTENANCE

Lessons learnt

In collaboration with the lead Appointed Party, the DE Project Champion and VDAS Champion should conduct a comprehensive lesson learned process.

The lessons learnt process seeks to integrate the digital engineering learnings from stages 1 to 6. From there, the VDAS Champion and DE Project Champion must:

- evaluate the project approach from stage 1 (what was expected) versus what was achieved (stage 2–6);
- assess how the project delivered outcomes, what was the value versus shortcomings;
- review how information was managed, and whether the quality of data was achieved;
- assess the team's and contractor's capability/ capacity;
- determine what processes, technologies and practices should be brought forward into future projects;
- review what learnings should be widely communicated;
- define what elements need careful consideration before applying them again;
- define whether the project solved the problem it was designed to address; and
- review stakeholders' perceptions of whether information requirements were met, if they happy with the outcome and the way it was achieved.

The DE Project Champion will record the outcomes in a suitable knowledge store, providing a record and insight into any augmentation/future VDAS approaches on upcoming projects.

The VDAS Champion should communicate any benefits realised to the Appointing Party organisation to improve understanding and build internal capability and support for the VDAS approach.

Customer/user and stakeholder benefits

Assets are created to service needs the Victorian community has. Stages 1 to 6 position asset management, facilities management and operations and maintenance activities to succeed, and ensure these needs are met.

Moreover, many users and stakeholders will use the asset. These users and stakeholders will create a volume of data and information that has considerable value. The VDAS and the AMAF have been designed to improve asset data and information systems to reduce inefficiency and costs across the entire spectrum of AM activities across all government departments and agencies. The VDAS offers several exciting possibilities in terms of uplifting how public assets are managed and utilised. VDAS also enables a digital twin or virtual Victoria.

The table below shows how VDAS benefits asset users and stakeholders.

Stage 7

OPERATIONS AND MAINTENANCE

VDAS-enabled benefits	Asset users and stakeholders					
	Asset occupants Employees, non-employees and members of the public	**Asset managers and owners** Government and public entities	**Facilities managers** Operators, and shared-service providers	**Contractors and services** MEP, security, IT, general contractors, emergency personnel, etc.	**Future maintenance and capital-project teams**	**Third-parties** Insurers, regulators, reporting entities, etc.
Ability to service future projects	✓	✓	✓	✓	✓	✓
Complete informational access Single source of truth in assets, asset data, maintenance, maintenance data, and PIM	✓	✓	✓	✓	✓	✓
Confidence in decision making	✓	✓	✓	✓	✓	✓
Enable a future Victorian 'digital twin'	✓	✓	✓	✓	✓	✓
Improved interfaces to third parties	✓	✓	✓	✓	✓	✓
Ongoing maintenance Availability of asset performance data, predictive maintenance	✓	✓	✓	✓	✓	✓
Operational efficiencies Innovation-ready systems, real time sensors, waste reduction, and integrated systems	✓	✓	✓	✓	✓	✓
Risk reduction and mitigation	✓	✓	✓	✓	✓	✓
Timely and comprehensive asset reporting	✓	✓	✓	✓		✓
Wayfinding	✓		✓	✓	✓	✓

Divestment and decommissioning

The current costs of divesting or decommissioning assets at the end of their useful life is significantly higher than it should be.

This is due to the lack of sufficiently detailed information for the structure, fittings, mechanical and electrical components, fire prevention systems, etc. that provide confidence to the incoming asset stakeholders.

The incoming asset stakeholders can gain even more confidence if the AIM is connected to operational, performance and cost data.

A well-maintained AIM will significantly reduce the safety and cost risks associated with divestment or demolition. It also opens up the possibility of repurposing and recycling assets or driving system-wide performance initiatives.

Adopting best practice information management processes allows the Appointing Party to safely and responsibly divest the asset and extract maximum value.

Stage 7

OPERATIONS AND MAINTENANCE

Stage 7 checklist

Check	Description	Role	Page
☐	Asset information model updated	DE Project Champion	C.150
☐	Appoint individuals to undertake the information management function for maintaining and auditing the AIM	DE Project Champion/VDAS Champion	C.150
☐	Information management process reviewed to ensure that the AIM can be adequately maintained	DE Project Champion/VDAS Champion	C.152
☐	Conducted training where required	DE Project Champion	n/a
☐	Performance-in-use assessed	Appointing Party/lead Appointed Party	C.150
☐	Create stage 7 post occupancy lessons learnt and collate with stages 1–6	DE Project Champion/VDAS Champion	C.152
☐	Review stages 1–7 Lessons Learnt and debrief with responsible party for portfolio management and continuous improvement	DE Project Champion/VDAS Champion	C.152
☐	Post-occupancy evaluation conducted and review of post occupancy as built data accuracy	Appointing Party/lead Appointed Party	C.151
☐	Clarify and check user access rights	DE Project Champion	n/a
☐	Answer stage 7 and review all key decision points	VDAS Champion	n/a

Summary

Part C has covered the implementation of digital engineering on a project.

This section also positioned the organisation to manage digital information and data effectively across the seven stages of the VDAS lifecycle.

Part C guidance shapes a consistent approach to managing digital engineering information on a project.

We all have a responsibility to continuously improve the way we create, manage and use information for the benefits of Victorian assets and the Victorian public that use them every day.

More information

For more information about the VDAS contact OPV:

Email: enquires@opv.vic.gov.au

Phone: 03 7005 9130

'We want to maximise the outcomes for Victorians – VDAS can help us make better decisions throughout design, construction, asset management and operation.'

Dr Collette Burke

VDAS strategic partners

The Office of the Victorian Chief Engineer would like to thank the following organisations, individuals, and companies.

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Golder

Gray Puksand

GRIMSHAW

Hansen Yuncken

HASSELL

Hatch

Hayball

Hendry

Hickory Group

Hive Engineering

Honeywell

IGS Group

Infrastructure Victoria

Irwinconsult

Jacobs

John Holland

John Wardle Architects

Johnstaff

Jon Mirtschin

Julian Watts

KBR

KPMG

Laing O'Rourke

Land Surveys

Land Use Victoria

Lendlease

Level Crossing Removal Project

Luke Belfield

Macdonald Dow

Major Road Projects Authority

Major Transport Infrastructure Program

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Meinhardt

Melbourne Airport

Melbourne City Council

Melbourne Water

MEMKO

Metamoto

MIA Consulting

Monash University

Mott MacDonald

Multiplex

Mushan Architects

NATSPEC

NBS

Nearmap

Neil Greenstreet

Nettleton Tribe

New South Wales Health Infrastructure

NH Architecture

Norman Disney & Young

North East Link Project

NZ BIM Acceleration Committee

Office of Projects Victoria

Oracle Construction & Engineering

Oskar Casasayas

OVGA

Pacific Partnerships

PCSG

PharmOut

Pitt & Sherry

PJM Engineering Services

Plenary Group

PLP Building Surveyors & Consultants

Plus Architecture

Position Partners

Powercor

Priya Ananthanarayana

Probuild

Public Transport Victoria

PwC

Rail Projects Victoria

Redbike

Reece Group

Revizto

Richard Syme

Rider Levett Bucknall

RMS

Roads and Maritime Services

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VicRoads

Victoria Police

Victoria University

Victorian Asbestos Eradication Agency

Victorian Building Authority

Victorian Centre for Data Insights

Victorian Planning Authority

Victorian School Building Authority

VicTrack

Water Services Association of Australia

Waterman AHW (Vic)

Watpac

West Gate Tunnel Authority

WestonWilliamson

WGE

Willow Inc. / Ridley

WOLF Architects

Wood and Grieve Engineers

Woods Bagot

WoodSolutions

WT Partnership

XiaoXiao Xu

Yarra Trams

Ynomia

Glossary

Appointed Party	Provider of goods or services to an Appointing Party. *Source: ISO 19650-1:2018.*
Appointing Party	See Employer/Client.
Asset	Defined as an 'item, thing or entity that has potential or actual value to an organisation'. Assets can be tangible or intangible through physical and non-physical (digital) assets. Data and information should be considered digital asset. Victorian major infrastructure assets are referred to large-scale infrastructure assets owned by the Victorian Government. *Source: ISO 55000.*
Asset management	Asset management is the coordinated activities of an organisation to realise value from asset(s). Asset management is a suite of activities that enable physical and non-physical assets to deliver the value they were designed to deliver. Asset management typically involves an asset management system. The system will ensure resources, competence, awareness, communication, information requirements and documented information are all enabled and focused on enabling the value that asset management delivers from the assets. *Source: ISO 55000.*
Asset information	Information is defined as data. *Source: ISO 22263:2008 and ISO 19650-1:2018.* In the context of assets, information relates to the reinterpretable representation of asset-related data in a formalised manner suitable for communication, interpretation or processing. Asset information is a key requirement for the successful creation and management of any physical asset. The value of asset information is enhanced when specified and considered early by the client/asset owner/operator. Digital engineering enables and facilitates the integration and sharing of asset information and data requirements across all phases of the asset lifecycle.
Asset information requirement (AIR)	Data and information requirements by the Appointing Party in relation to the operation of an asset. *ISO 19650-1:2018.*
Asset owner	The individual, entity or organisation responsible for asset management policy, strategy, planning and decision making for optimising the cost, risk and performance of assets over their life cycle. Note that ownership of physical and non-physical assets may differ over the life cycle of the asset.

Building information modelling (BIM)	Use of a shared digital representation of a built or to be built asset to facilitate design, construction and operation processes to form a reliable basis for decisions. *Source: ISO 29481-1:2016, 3.2.* BIM is a subset of digital engineering that integrates technology, process improvements and digital information to radically improve client and project outcomes and asset operations. BIM is a strategic enabler for improving decision making for both buildings and public infrastructure assets across the whole life cycle. It applies to new-build projects, and supports the renovation, refurbishment and maintenance of the built environment. *Source: EU BIM Task Group Handbook, 2018.*
Client	Individual or organisation named in an appointment or project contract as the Client/owner. Receiver of information concerning works, goods or services from a Lead Appointed Party. *Source: ISO 19650-1:2018.* Note that for Victorian Government projects, this is the project team or asset owner representing the Victorian Government, the Victorian Government department or agency. Also known as Appointing Party.
Computer-aided design (CAD)	A geometric/symbol-based computer drawing system that replicates hand-drawing techniques. CAD software can prepare 3D lines, surfaces or solids that are suitable for presentation on hardcopy plots of drawings, and/or as background data for other 3D data or BIM.
Common data environment (CDE)	Agreed source of information for any given project or asset, for collecting, managing and disseminating each information container through a managed process. *Source: ISO 19650-1:2018, 3.3.15*
Construction operations building information exchange (COBie)	Structured facility information for the commissioning, operation and maintenance of a project, often in a neutral spreadsheet format, that is used to supply data to the asset owner or operator to populate decision-making tools, facilities management and asset management systems. *Source: PAS1192.2-2013.* COBie can facilitate transformation from document-centric to information-centric handover processes to facility and asset operators post-construction.

Data	Information represented in a manner suitable for automatic processing. *Source: 701-01-11.* Reinterpretable representation of data in a formalised manner suitable for communication, interpretation or processing. Information can be processed by human or automatic means. *Source: ISO/IEC 2382-1.* Also known as digital information.
Digital engineering (DE)	A contemporary and collaborative approach to working on assets that allows for a faster and more efficient approach to delivering projects and managing physical assets. It is a convergence of emerging technologies such as building information modelling (BIM), geographic information systems (GIS) and other related systems for deriving better business, project and asset management outcomes. Digital engineering can contain additional digital information systems including drafting, electronic document management systems (EDMS), project controls (time, cost, risk etc.), asset data and other related systems. Digital engineering enables a collaborative way of working using digital processes to enable more productive methods of planning, designing, constructing, operating and maintaining assets through their life cycle. The core elements of digital engineering include a standardised classification system, open data format, object-based models, spatially located data and common data environment across all asset phases.
Digital engineering execution plan (DEEP)	A plan that delivers and explains how the digital information management aspects of the appointment will be carried out by the appointed parties prior to and during contract award. For Victorian Government major projects, a DEEP may be integrated with other execution plans, such as project execution plans, detailed contractor's activity proposal and activity execution plan. The DEEP is commonly referred to as the digital engineering execution plan (DEXP) and contains elements of a BIM execution plan (BEP).
Digital model	A three-dimensional representation in electronic format of infrastructure elements representing a combination of solid objects and specially located data with true-to-scale spatial relationships and dimensions. A model may include additional information or data. *Source: ConsensusDocs 301 BIM Addendum, 2008* Also known as digital twin, BIM model or data-rich 3D model.

Employer	Individual or organisation named in an appointment or project contract as the employer. Receiver of information concerning works, goods or services from a lead Appointed Party. *Source: ISO 19650-1:2018* Note that for Victorian Government projects, this is the project team or asset owner representing the Victorian Government, the Victorian Government department or agency. Also known as Appointing Party.
Exchange information requirement (EIR)	Specification for data and information by the Appointing Party that the Appointed Party is expected to meet during the appointment. *Source: ISO 19650-1:2018, 3.19.* An EIR provides guidance and pre-qualification documentation for appointed parties and forms the basis of appointment and tender documents on a project using digital engineering. An EIR defines which information is produced at each asset stage – together with the required level of detail and definition. For Victorian Government major projects, an EIR may integrate with other traditional contract documents, such as project scope, technical requirements, and the project agreement. Also known as employer's information requirements and owner's information requirements.
Fit for purpose	Data is considered fit for purpose when it is appropriate for its intended use. *Source: IM-GUIDE-09.*
Geographic information system (GIS)	A system used for the design, capture, storage, management and analysis of geographic data. *Source: Commonwealth Government.*

Industry foundation classes (IFC)	A specification for a neutral data format to describe, exchange and share information typically used within building and facility management industry sectors. An IFC data model consists of definitions, rules and protocols that uniquely define data sets, which describe capital facilities throughout their lifecycles. IFC is the only non-proprietary, open global data model specification available. *Source: BuildingSMART* IFC is defined by *ISO 16739:2018 – IFC for data sharing in the construction and facility management industries.* Note: In some circumstances where there is a concern about lack of data readability or interoperability with some specific tools or purposes, the native files can also be shared together with IFC files.
Information	Knowledge concerning objects, such as facts, events, things, processes or ideas, including concepts, that within a certain context, have a particular meaning. *Source: ISO/IEC 2382-1*
Information model	Set of structured and unstructured information containers. This can relate to the operational phase or the delivery phase of a built asset i.e. a project information model or an asset information model respectively. Information models may include geometrical models, schedules, databases, etc. Unstructured information containers may include documentation, video clips, sound recordings etc. *Source: ISO 19650-1: 2018.*
Intellectual property (IP)	The results or output of intellectual activity and creative effort. IP assets are intangible, and their economic value exists largely in the set of exclusive rights that an owner has in the asset. IP may be protected through copyright, trademarks, patents, designs, circuit layouts and plant breeder's rights. *Source: Department of Treasury and Finance IP Policy, August 2012.*
Level 2 BIM	BIM Level 2 is a level of maturity in BIM, which is distinguished by collaborative working. It involves developing asset information in a collaborative data-rich 3D environment, but created in separate discipline models. The collaboration is in the form of information exchange processes specific to a project and coordinated between different systems and project participants.
Organisational information requirement (OIR)	Specification for what, when, how and for whom information is to be produced in relation to organisational objectives. *Source: ISO 19650-1:2018.*

Responsible, accountable, consulted and informed (RACI matrix)	A matrix that clearly sets out the roles and responsibility for elements (such as scope, interfaces, information etc.) of the project at various points of the project's life cycle. Roles and responsibilities of individual team members as well as the schedule of responsibilities for deliverables of the overall team should be defined. The RACI matrix should be a core element of the contractual obligations for all parties. With respect to digital engineering, roles and responsibilities of data, interfaces, information, intellectual property and assumptions should be clarified early, prior to contract award. Note: Victorian Government major projects may use existing systems and frameworks to define roles and responsibilities more broadly for the project. The RACI matrix for the digital component of works may fall under those existing systems and frameworks.
Uniclass 2015	A UK classification system. Uniclass 2015 is a classification scheme for the construction industry. It is intended for organising library materials and for structuring product literature and project information. Uniclass 2015 comprises tables, each of which represents a different classes of construction information and deal with different scale of information. Each table can be used as a standalone table for the classification of a particular type of information, but, in addition, terms from different tables can be combined to classify complex subjects. *Source: Uniclass 2015.*

Abbreviations

ABAB	Australasian BIM Advisory Board
AIR	Asset information requirements
AMAF	Asset Management Accountability Framework
BIM	Building information modelling
CAD	Computer aided design
CAFM	Computer-aided facility management
CDE	Common data environment
CFO	Chief Financial Officer
CIO	Chief Information Officer
COBie	Construction operations building information exchange
COO	Chief Operating Officer
CTO	Chief Technology Officer
D&C	Design and construct
DE	Digital engineering
DEEP	Digital engineering execution plan
DELWP	Department of Environment, Land, Water and Planning
DET	Department of Education and Training
DPC	Department of Premier and Cabinet
DTF	Department of Treasury and Finance
ECI	Early contractor involvement
EIR	Exchange information requirements
EPCM	Engineering, procurement and construction management
FEED	Front-end engineering and design
GIS	Geographic information system
HVHR	High Value High Risk
IFC	Industry foundation classes
INSW	Infrastructure New South Wales
IoT	Internet of Things

IP	Intellectual property
IPEP	Infrastructure projects experts panel
ISO	International Organization for Standardization
LXRP	Level Crossing Removal Project
NBS	National Building Specification
NDEPP	National Digital Engineering Policy Principles
NELP	North East Link Project
OCG	Office of the Coordinator General
OPV	Office of Projects Victoria
PPP	Public private partnership
PTV	Public Transport Victoria
PROV	Public Records Office Victoria
RACI	Responsible, accountable, consulted and informed
RPV	Rail Projects Victoria
SMES	Survey Mark Enquiry Service
TfNSW	Transport for New South Wales
UAV	Unmanned aerial vehicle
VCC	Value creation and capture
VCIRA	Victorian Critical Infrastructure Resilience Arrangements
VDAS	Victorian Digital Asset Strategy
VDASSC	Victorian Digital Asset Strategy Steering Committee
VGRMF	Victorian Government Risk Management Framework

The Secretary
Department of Treasury and Finance
1 Treasury Place
Melbourne, Victoria 3002
Australia

Telephone: +61 3 9651 5111
Website: dtf.vic.gov.au

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1 Treasury Place, Melbourne, 3002

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Email: enquiries@opv.vic.gov.au
Telephone: 03 9651 1690

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