HEAVY VEHICLE ACCESS MANAGEMENT SYSTEM (HVAMS) - TASMANIA

M. ELISCHER
Director of ME Consulting,
Matt has worked in the heavy vehicle and freight industry for over 28 years, specialising in heavy vehicle technology, infrastructure-vehicle interactions, policy and regulation, and more recently on the development of HVAMS with government agencies.

Abstract

This paper will outline the approach, attributes and high-level architecture of a risk and evidence-based heavy vehicle access management system that uses infrastructure and network data to generate tailored networks for unique individual heavy vehicle configurations. Rather than the traditional approach of using broad-based classes or categories of vehicles, defined by prescribed mass and dimension thresholds, this approach can provide optimised and readily available network access for each and every vehicle configuration.

The Heavy Vehicle Access Management System (HVAMS) (DSG, 2023) is a system developed and implemented by the Tasmanian government, which improves safety and productivity through heavy vehicle operators having increased levels of access certainty, efficiency, transparency and flexibility when planning their operations; and through road managers having increased understanding, control and greater consistency over infrastructure management against heavy vehicle access demand.

HVAMS is an on-demand web-based application that provides a network-wide, real-time legal permission to heavy vehicle operators, allowing informed decisions to be made on where, and with which heavy vehicle, freight tasks can be undertaken. For road managers, HVAMS provides the platform do safely manage their assets and associated risks.

This paper will demonstrate that HVAMS optimises the heavy vehicle safety and productivity return on road transport infrastructure investment, through both time and change, by way of automation. It is noted that this paper encapsulates the current state of HVAMS, and that further development, functional improvements and implementation is ongoing.

Keywords: heavy vehicle access; road assessment; heavy vehicle networks; safety; productivity; network optimisation; automation.

1. Background

Heavy vehicles are a key enabler of the Australian economy, providing an essential service to many of its critical parts, including agriculture, communications, construction, defence, energy, manufacturing, mining, retail, and transport systems. The level of success achieved in enabling heavy vehicles to optimally navigate the road network, both safely and productively, is critical to economic development and critical to avoiding economic stagnation.

A modern road structure is designed to be in service for 100 years, and a road pavement is typically designed to be in service for 40 years. Vehicle engineering advances over these same timeframes have provided the ability to build and operate larger and heavier combinations. Much of the road network is not designed for, or constructed to accommodate this contemporary heavy vehicle fleet, its activity, and its demand for access. For structures, such as bridges and culverts, the load effects produced by modern heavy vehicles are often in excess of those produced by the original design vehicle. For roads, the cross section and junction arrangements can often be inadequate to properly accommodate modern heavy vehicle characteristics.

Jurisdictions cannot afford, nor would it be prudent, to continually reconstruct their roads and structures to match contemporary heavy vehicle access demand and fleet innovation. However, jurisdictions cannot afford not to safely facilitate this same access demand and fleet innovation. Therefore, it is vital that heavy vehicle access to the road network is managed in a way that maximises heavy vehicle productivity, without compromising safety, using the available infrastructure. It is also vital that limited resources are directed to identifying and addressing network 'deficiencies' that are impeding heavy vehicle productivity, and, in turn, are impeding economic return or recovery. It is important to note that this paper does not seek to comment on actual assessment methodologies, rather the focus of this paper is on the automation of heavy vehicle access.

2. The Challenge and opportunities with Heavy Vehicle Access Management

Heavy vehicles are critical to our economies and communities. There are very few products and services that do not rely upon heavy vehicles. For instance, the computer you are reading this paper on, the building that you are in, the electricity that charged or is supplying your device. Optimising the safe and productive movement of heavy vehicles can therefore drive productivity and efficiency improvements across a vast range of sectors and industries. However, there are a number of challenges.

2.1. Road Network Capacity/Capability

The benefits that can be realised from optimising heavy vehicle networks will be necessarily constrained by the capacity of the road network. A bridge, at any point in its life, will only be able to carry so much load. Furthermore, the investment in the bridge also needs to be optimised. Even though a bridge might be capable of carrying greater loads, its life may be shortened considerably, leading to increased maintenance and replacement costs.

2.2. Gap between design and demand vehicle

Structures are built to a particular design code, which is relevant and fit-for-purpose at that time. Structures, however, are built to last decades, over which time heavy vehicles have, and will likely continue to adapt and change. A structure built in the 1970's in Australia will have been built to carry a design vehicle of 44 t. Today's standard workhorse combination is in the range of 44 - 68.5 t, with specialised vehicles weighing in at over 200 t.

3. Current approach for managing heavy vehicle access

In Australia, heavy vehicles comprise of any single vehicle, or combination, that weighs 4.5 t or more. Heavy vehicles are then split into two broad categories, those that enjoy 'general access' – access to all roads (unless signposted otherwise); and 'restricted access vehicles' (RAVs) – those vehicles that require a special permission to access a network, likely under certain conditions. RAVs can include anything from longer freight vehicles such as road trains, to oversize/overmass (OSOM) vehicles, to mobile cranes and agricultural vehicles. This paper outlines the automated approach for managing RAVs.

Figure 1 - Examples of RAVs in Australia

Most countries provide a 'permit' mechanism to manage the particular and additional risks of individual RAV movements. Australia also provides a permit mechanism, of which the nation's largest heavy vehicle regulator issued 143,231 in 2021-22 (NHVR, 2022). Permits require an operator to request permission to travel on a specific route(s) using a specific heavy vehicle. Road managers and regulators will assess these requests and approve (with appropriate conditions) or deny access. This is, fundamentally, a reactive approach to managing access. A more pro-active approach, in Australia, is the 'gazette notice' mechanism which permits vehicles of certain categories to travel on specified networks (with appropriate conditions). HVAMS provides tailored, approved networks, on-demand, for operators' unique vehicle configurations.

3.1. Assessments

Decisions on whether a particular vehicle can access a road/infrastructure are taken by the road manager responsible for that road. In Australia, road owners and managers are largely state and local governments, although other entities such as ports can also be road owners and managers. Regardless, all road mangers are required to undertake an assessment to inform their decision on access.

Assessments can take many forms, and use different methodologies based on the policy and risk settings of the road manager. Bridge and structural assessments form the main challenge for most Australian road managers due to their complexity, and a lack of resources and expertise (particularly local governments). However, geometric, pavement, amenity and other specific network element related (e.g., level crossings) assessments are also undertaken.

Assessments are usually the most time-consuming and costly aspect of making an access decision, particularly if there are many structures on the route or network being requested. Over time, this has led to 'worst-case' scenarios being used for broad categories of vehicles, which means that many vehicles may be afforded access they are currently missing out on.

A move towards automation has allowed more assessments to be carried out by more road managers, and a tailored approach to be utilised that assesses actual vehicle configurations (not 'worst-case') against individual structures. It should be recognised that in of itself, automation does not produce a 'better' assessment, as it is simply a codification of an existing methodology that was manually undertaken previously. However, automation vastly decreases time, and therefore allows more assessments to be undertaken (within a given time). When considered in the context of a computational system, this allows impacts from individual vehicle configurations to be assessed directly against individual structures/bridges (and other network factors) in near real-time.

4. HVAMS - Heavy Vehicle Access Management System

HVAMS is a government system that automates the road and structure assessment functions of road managers in making heavy vehicle access decisions. It builds upon concepts developed in earlier tools such as that described in Elischer et al. (2012). The Tasmanian Department of State Growth initially developed HVAMS throughout 2014-15, with it being launched for the OSOM industry in 2016 (Elischer, 2016). The next, enhanced, version was launched for Special Purpose Vehicles (SPV) such as mobile cranes in 2019, with the third version under development.

Whilst HVAMS has legal effect under Australia's Heavy Vehicle National Law (HVNL), it has been designed to operate under other legislative frameworks (of which Australia has three). New South Wales and Queensland have already begun working together with Tasmania to roll out HVAMS across all roads in their states (including local government), and all Infrastructure and Transport Ministers in Australia (excepting Western Australia) have now committed to implementing HVAMS through a national approach (HVNL Reform Implementation Steering Committee, 2023).

4.1. Overview

HVAMS currently works by providing legal networks for heavy vehicles through a gazette notice, which is a legal instrument made under the HVNL. Networks are tailored for individual vehicles based upon their impacts and interactions with the road network and infrastructure and, therefore, optimised access can be provided for that vehicle. No permits are needed for access provided under HVAMS.

HVAMS is a modular platform that connects a heavy vehicle's configuration, and infrastructure geometry and capacity data with the assessment methodologies used for access decision making. Currently, HVAMS covers structural and road geometry-related assessments, however, it is anticipated that future assessment modules will cover pavement, environmental and amenity related factors.

Significantly, HVAMS allows road manager decision making processes and tools to be automated and provides access decisions in a consistent format that can be used in a variety of ways. Primarily this will be in the form of an interactive map but will also readily support other technologies to aid industry compliance (e.g., "voice in cab" technologies).

By providing flexibility in assessment approach, HVAMS accommodates the needs of any participating road manager. This avoids the pitfalls of a 'one size fits all', or inadequately granulated, assessment approach. It also allows for different assessment modules/approaches to be seamlessly connected to provide an end-to-end network, without being limited by state and local government boundaries. Each road manager has discretion, and the obligation, to apply their most appropriate assessment (which will incorporate risk management and economic considerations), to suit each individual asset within their network.

Although HVAMS is premised on infrastructure and asset data being available up front, access assessments can be based on basic or detailed data for any given network element (road, bridge, etc.). As with manual assessments, the more detailed data that is available generally leads to a more precise assessment outcome.

HVAMS provides industry with the ability to test and iterate on a specific vehicle's characteristics, e.g., axle spacing and mass distribution, to determine the most productive combination for a particular freight task, based on the specific structures and constraints on that network (or route). Each additional tonne of payload on a vehicle travelling over the course of a day delivers productivity gains in the form of less heavy vehicle movements on the network. Such iteration is only feasible using an automated assessment approach, with real time feedback to transport operators and vehicle designers.

4.2. System approach

A high-level outline of HVAMS is provided in Figure 2. HVAMS has two core inputs:

1) the heavy vehicle configuration – this includes details on vehicle configuration, axle spacings, axle group masses, load type, overall dimensions and may include information particular to the vehicle type;

2) network asset information – this comprises two parts:
   a) base spatial data set – this data set describes the network spatially and includes road segmentation
   b) detailed road/asset data – this data set includes attributes on the road segments and assets that are required for assessments to be undertaken, and can include elements such as:
      - lane widths
      - bridge span information

- clearance heights
- specified assessment module(s)

At the centre of HVAMS is the Analytics Engine that contains a processing pipeline. This collects relevant information from the core inputs and undertakes the actual processing and assessment of these data.

The core output of HVAMS is a spatial data set representing the network where the input vehicle is permitted access (including the conditions of access). This output is usually presented on a map to allow the user to visualise where access is allowed and to also clearly identify and understand what the specific conditions of access may be.

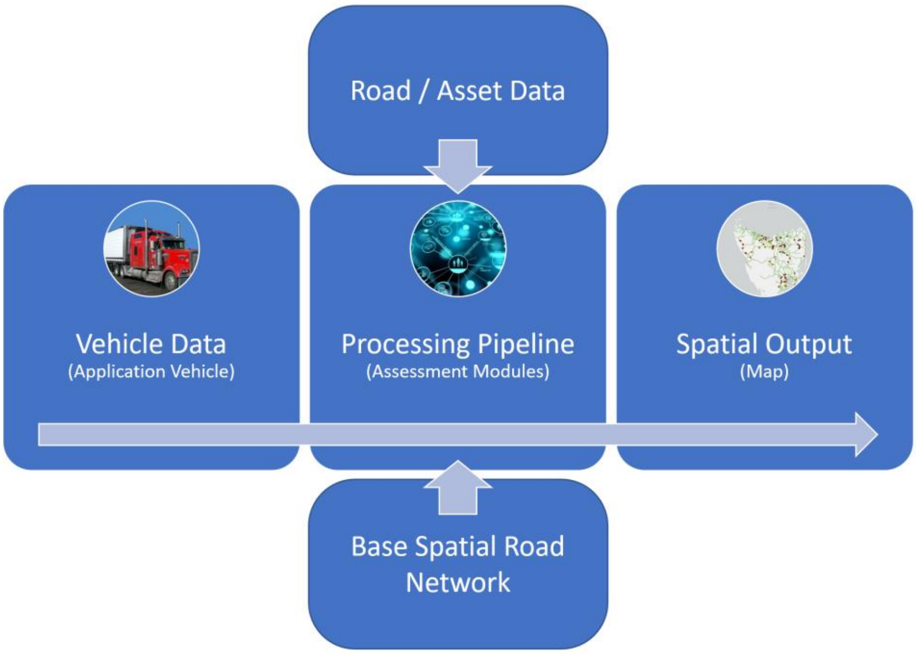

Figure 2 – The HVAMS approach

4.3. Assessment modules

A key element of automating access through HVAMS is the assessment module. HVAMS provides a platform for 'plugging in' any modules developed or selected by the road managers for each relevant asset or part of their network. Modules are codifications of existing assessment methodologies and can be applied to multiple assets and infrastructure that form the broader network. The codification of an assessment module involves documenting a road manager's approach and methodology and coding that into HVAMS. The accuracy and repeatability of assessment results is crucial, and consequently robust testing and approval workflows are in place to provide the necessary assurances that HVAMS is delivering the expected outcomes for the road manager. Figure 3 displays a cross-section of modules that HVAMS can utilise (with more expected to be developed in future versions).

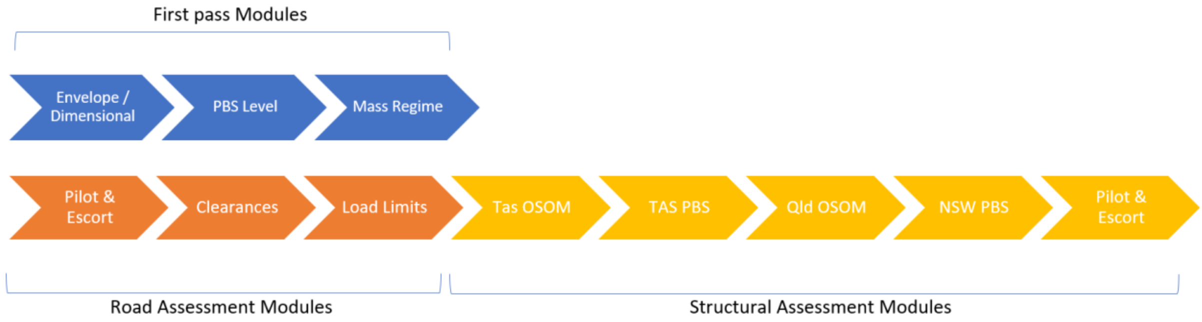

Figure 3 – HVAMS module library (example)

Modules are constructed to reflect specific road managers' risk and policy settings, as they would apply when a manual assessment is undertaken. Assessment modules may also be created for specific types of heavy vehicle. An OSOM vehicle could be assessed differently to a more standard freight vehicle. There may also be different input parameters for an assessment module. For example, an assessment for an OSOM vehicle would likely include ground contact width (the transverse distance between outer tyres on an axle group), whereas this is not usually a variable for freight vehicles.

Whilst HVAMS allows for this flexibility, in Australia many local governments face resource and capability challenges when assessing heavy vehicles. The implementation strategy taken by the Tasmanian state government has been to offer their assessment modules for local government use which addresses these challenges, and provides for a more consistent end-to-end network across the whole state. Although HVAMS operates under an opt-in model, all 29 local governments in Tasmania have, and continue to use the system in close collaboration with the Tasmanian state government.

4.4. The Road User and Road Manager Interfaces

There are two main components to the system, those being:

- the Road User Interface (RUI) – which comprises both the vehicle input logic and the presentation of the output onto a mapping interface; and
- the Road Manager Interface (RMI) – which allows road managers to input detailed road and infrastructure data for their assets.

The RMI is currently under development and will enable road managers to input data on specific network elements through an interface. Currently a manual process exists where data can be loaded into the system by a dedicated team. The RUI comprises a number of screens for the user to 'build' their vehicle, starting with configuration type (Figure 4), and working through more detailed data (Figure 5). The RUI provides a high degree of validation, to ensure the input vehicles and their details are within valid ranges and also to provide feedback to the user as to what other requirements there may be to access the network (e.g., telematics devices may need to be installed).

Figure 4 – HVAMS screenshot showing selection of a Special Purpose Vehicle type

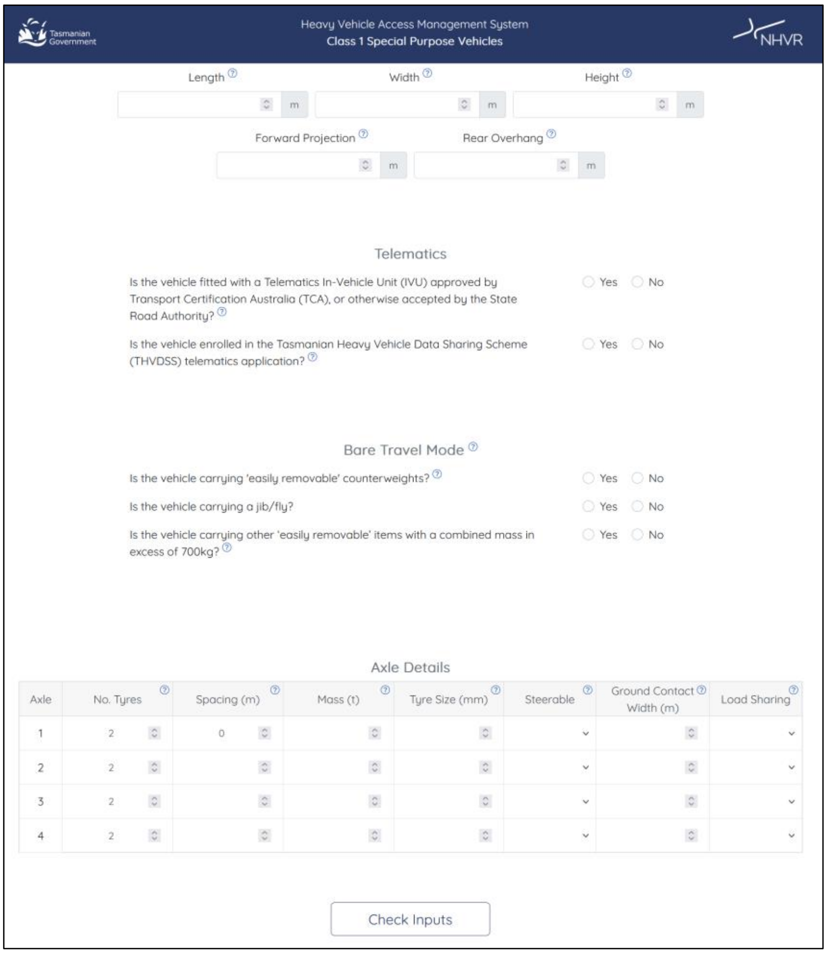

Figure 5 – HVAMS screenshot showing vehicle details page

Once all details have been entered, the user is taken to the output/map screen and provided with a unique vehicle code. This code can be entered the next time a user visits the system so they don't need to re-enter vehicle data. It is also used by enforcement officers to check where a particular vehicle is permitted to travel and under what conditions.

Figure 6 displays the output and map presentation screen (for a 4-axle all terrain crane in this case). There are a number of features on this screen including:

- map legend (e.g., green lines are unrestricted access, orange dots indicate conditional access, red dots indicate no access allowed, purple dots are load limited structures)
- standard map manipulation and search functions
- a route planner
- a route card which can be printed and given to the driver. It displays turn-by-turn information for a particular route including conditions of access
- a description of the vehicle, and the ability to go back and modify parameters

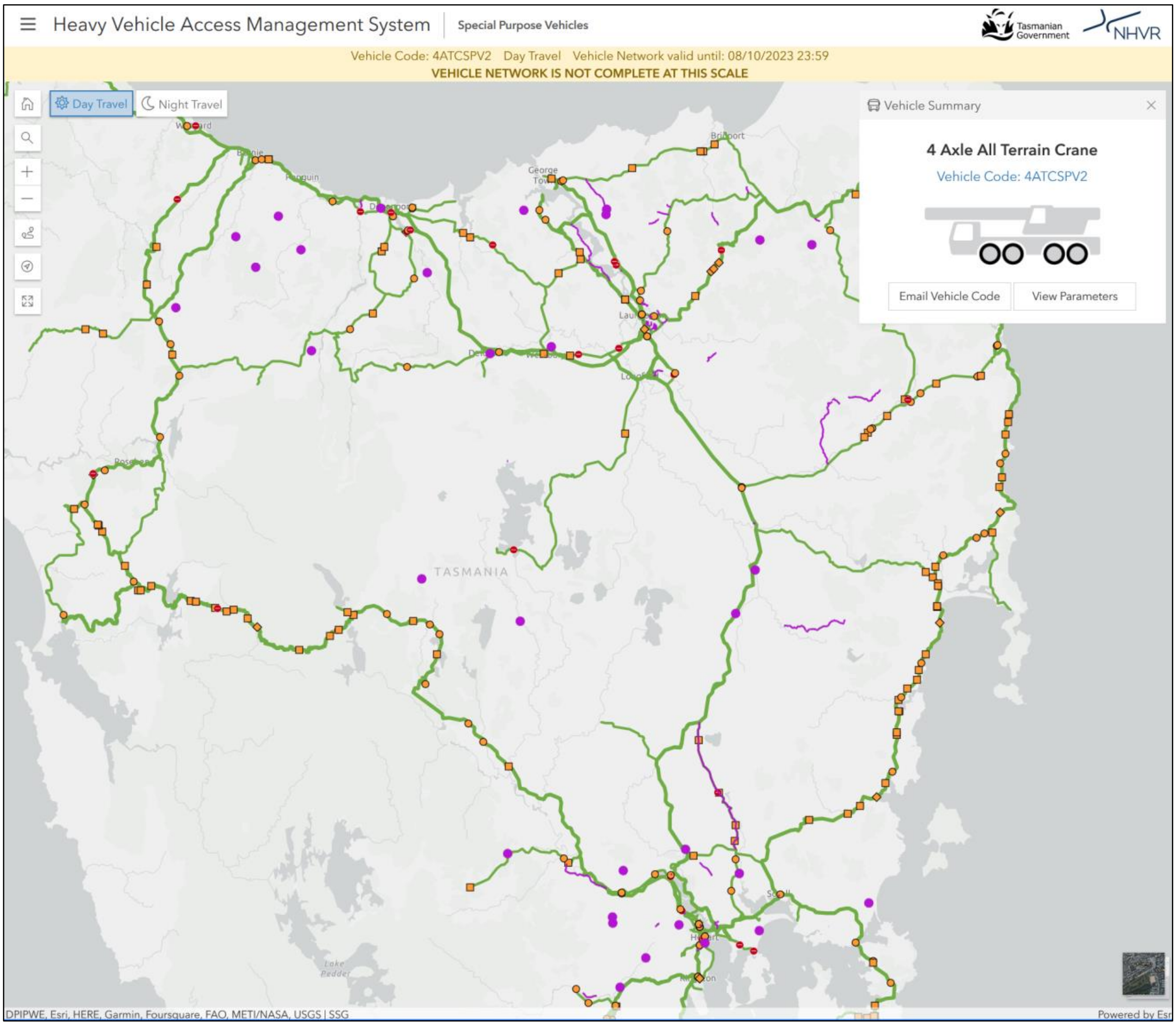

Figure 6 – HVAMS screenshot showing output and map page

4.5. Road Network Data

HVAMS is a data-driven system. In particular, the spatial road data set needs to be segmented in a way that allows the network and access decisions to be managed at the right granularity. This is managed through the on-boarding processes and initial data ingestion processes. An example of this is in highlighted in Figure 7. The image on the left shows the on- and off-ramps extending over the east-west road running under the main thoroughfare, however, the image on the right which depicts the road segmentation shows the on- and off-ramps merging before the overpass.

The image on the left also includes yellow sections that indicate an access condition is placed on the on- and off-ramps, with unrestricted access on the main thoroughfare which is the desirable outcome. If the segmentation was not corrected and remained as shown in the image on the right, the access conditions would need to be placed on the main thoroughfare. This would result in either an access condition that applies to heavy vehicles that it doesn't need to, or an access condition that would need to be worded such that it only applied to certain vehicles (i.e. those travelling on the on- or off-ramps), which would be confusing to operators and less likely to be understood or complied with.

Figure 7 – Example of road segmentation not allowing access to be optimised

5. Realised benefits from HVAMS implementation

The state of Tasmania has realised significant and real benefits since HVAMS was first implemented in 2016 as outlined below.

5.1. Sustainable Network Management for Road Managers

The state of Tasmania used to spend a large amount of time processing requests for applications. With the implementation of HVAMS, the number of permits were reduced substantially, allowing officers of the state to re-focus work on improving the sustainability and management of the road network. Figure 8 below outlines the permit reduction for Special Purpose Vehicles from 2017-18 to 2021-22, a reduction of 98% from the peak of 700 applications. HVAMS for SPVs commenced in 2019.

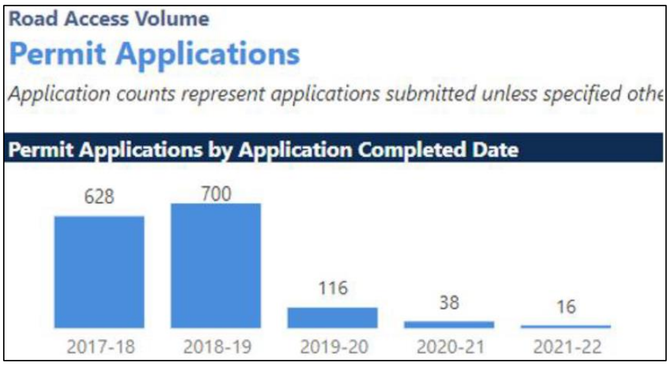

Figure 8 – Tasmanian SPV permit applications from 2017-18 to 2021-22

Since HVAMS can provide tailored networks for specific vehicles, it is also possible for road managers to obtain insights into network 'deficiencies'. Figure 9 highlights the number of strengthened bridges on the state road network from 2015-16 to 2021-22. There have been 80 bridges strengthened for approximately $40 million which, from 2019 has been a much better targeted investment approach utilising information from HVAMS and informed feedback from industry, who now have visibility of available networks.

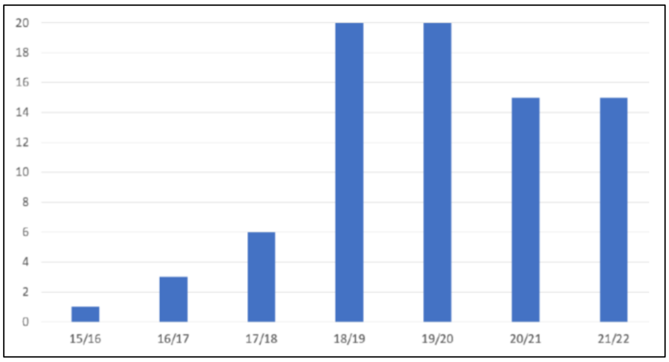

Figure 9 – Number of state bridge strengthening sites

5.2. Certainty of Access for Industry

HVAMS gives industry full certainty of where they can travel as well as the conditions of access. Prior to HVAMS, the process for industry would be to submit a permit application for a particular route and wait up to 28 days (or more) for a response. The response may be a permit, but may also be to decline the access request, in which case, industry would need to re-submit another request for a different route (or a different vehicle). The SPV industry is highly reactive, and rarely experiences long lead times to plan a task. Being available 24/7, allows HVAMS to provide industry with end-to-end networks on demand, and provides support and benefit across the following areas:

- Vehicle design/innovation – networks are provided for vehicles on the drawing board
- Fleet management – networks understood prior to investment into fleets and equipment
- Ease of compliance
- Responsive to unforeseen and/or short notice client requests and changes
- Visibility and certainty through continual network approval in advance (subject to unplanned emergencies such as land slips, structure failures, etc.)

5.3. Economy and community

The state's economy and the community have also benefitted from the introduction of HVAMS. The state of Tasmania undertook a cost-benefit analysis (Chow and Hickey (2022)) which concluded that the benefits of apply HVAMS to SPVs significantly outweighed the costs. Figure 10 summarises the analysis stating that the benefit-cost ratio is between 16 and 46 for net present value of benefits and costs between 2017 to 2039. The state invested approximately $5 million to cover system development and data collection and ongoing management costs, with benefits being realised across four broad areas:

- Major events – the ability to send SPVs to major events quickly due to HVAMS (e.g., major plant failure at processing facility or factory)
- Avoided delays – project delays due to the need to wait for a permit
- Operational flexibility – certainty of network wide access and the ability to send a different vehicle if other vehicles are unavailable
- Administration savings – permit processing time savings for operators and road managers

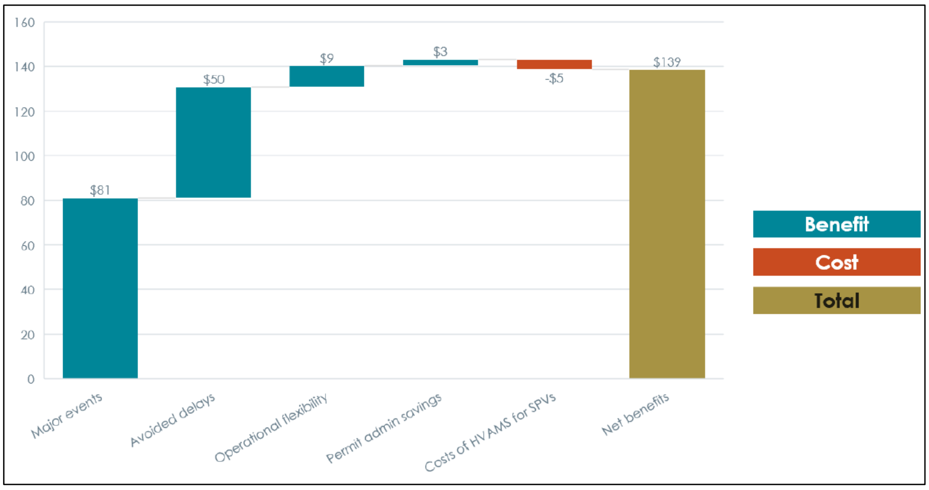

Figure 10 – Present value of benefits and costs from 2017 to 2039 by category

6. References

- Chow, M. and Hickey, L. (2022), "Cost-benefit analysis of HVAMS", Department of State Growth, Tasmania. Viewed on 18 Sept 2023 – https://www.transport.tas.gov.au/__data/assets/pdf_file/0012/405003/HVAMS_CBA_Final_Report_16_Nov_22.pdf
- Department of State Growth, Tasmania (DSG) (2023), HVAMS on-line tool, Viewed on 23 Oct 2023 - https://hvams.stategrowth.tas.gov.au/
- Elischer, M., Ai, U., Ritzinger, A. and Hense, D. (2012), "Assisting Local Governments - Online Route Assessment Tool", HVTT12
- Elischer, M., Buxton, S. and Percy, A. (2016) "Access Management Framework for Oversize-Overmass (OSOM) vehicles in Tasmania", HVTT14
- HVNL Reform Implementation Steering Committee (2023), 24 July 2023 meeting statement, Viewed on 15 October 2023 - https://www.infrastructure.gov.au/department/media/publications/statement-24-july-2023-hvnl-steering-committee-meeting
- National Heavy Vehicle Regulator (NHVR) (2022), Annual Report 2021-22, National Heavy Vehicle Regulator, Brisbane, Australia. Viewed on 26 Sept 2023 - https://www.nhvr.gov.au/files/media/document/98/202210-1270-nhvr-annual-report-2021-22.pdf