Reducing Permit structural assessments with Heavy Vehicle Access Maps

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| **Abstract**  Over the last five years (2018-2023), the Department of Transport and Planning (DTP) has seen a 400 per cent increase in heavy vehicle permit applications requiring a structural assessment (from 681 per annum to 3405 per annum).  This growth has been fuelled by the Victorian Government’s major investment in infrastructure, the construction of windfarms and innovation in the freight industry, which has boosted the number of High-Productivity Freight Vehicles (HPFVs) on the road (30 and 36.5-metre combinations that are safer, more environmentally friendly, and carry more mass than conventional freight vehicles).  This growth has led to increased processing costs and up to four-month delays in transport operators obtaining permits from DTP.  As a result, DTP has expanded the pre-approved and gazetted networks on the National Heavy Vehicle Regulator (NHVR) National Network Map website, allowing streamlined, pre-approved access for larger, oversize vehicles, mobile cranes, and HPFV combinations. This paper will delve into the proactive measures taken by DTP to deliver this reform initiative. These include:   * Addressing the gaps and optimizing current engineering methodologies to pre-assess over 100 reference vehicles across most of the DTP bridges and major culverts (6000+). * Providing access to older structures or structures with condition deterioration issues on the network, especially those that are part of critical routes. * Explaining the criticality of the documentation for the future management of the networks. * Data capturing and management of over 300,000 data points for future network management. * Identification and implementation of uplift works to structures to support increasing access to Victoria’s arterial road network. * The impacts of this works resulted in the state uplift works of the state arterial network.   **Keywords:** keyword 1, keyword 2, keyword 3, keyword 4, keyword 5 |

# Introduction

In Victoria, the Department of Transport and Planning (DTP) manages the Victorian arterial road and freeway network. One of the functions that DTP undertakes is providing safe heavy vehicle access to over 6,000 road-carrying structures (bridges and major culverts) on the network. The demand for heavy vehicle access has grown significantly over the past decade. In the last five years, DTP saw a 400 percent increase in heavy vehicle permit applications requiring a structural assessment (from 681 per annum to 3405 per annum).

This growth has been seen across all vehicle classes. Most notably, permits for indivisible load (Class 1) vehicles have been driven by the Victorian Big Build, which includes the Level Crossing Removal Project, the West Gate Tunnel Project, the North East Link and other projects such as the construction of wind farms to meet the government’s commitments to renewable energy target of 95 per cent by 20351. Permits for for freight (Class 2) vehicles have been driven by innovation in the industry to meet the growing freight task and a boost in the number of HPFVs on the road. HPFVs are freight vehicles which are either greater than 26m or 68.5t, and are safer, more environmentally friendly and carry more mass than conventional vehicles such as B-doubles2.

The growth in permit applications requiring a structural assessment has led to increased processing costs and delays in transport operators obtaining permits from DTP of up to four months in some instances. In addition, when a permit application route includes structures with limited capacity due to age or condition deterioration issues, additional permits may be required for detour structures. This process can result in further costs and delays.

To meet the demand for heavy vehicle access permits, DTP proactively expanded the pre-approved and gazetted networks on the National Heavy Vehicle Regulator (NHVR) National Network Map website, allowing streamlined, pre-approved access for larger, oversize vehicles, mobile cranes, and HPFV combinations. This includes over 100 reference vehicles, 67 new maps developed over the past five years, and the expansion of existing maps to include new routes.

This paper provides an overview of the rollout of the heavy vehicle access map developed by DTP, including the steps undertaken to create and subsequently optimize their delivery.

# Rollout of Heavy Vehicle Access Maps

## Class 1

Class 1 access maps have historically been relatively smaller special purpose vehicles (SPVs) that have been assessed for most of the network. Load carrying combinations transporting indivisible items have been represented by the oversize and over-mass (OSOM) map, allowing for a range of low loader combinations up to 100.0.t. All-terrain cranes typically range between two and five axles with 12t per axle.

With the increase in movements associated with major projects from Victoria’s Big Build, there became a need for the road network to have capability to transport heavier indivisible loads. This has led to the development of new multiple-axle platform maps, ranging from a denser 100t low loader combination to a 206t dolly platform combination. Moreover, new crane maps have also been added with larger six-or-more axle cranes with 12t per axle (up to 108t), or with an additional dolly to better distribute the loading.

The increase in size of these vehicles typically reduces the number of routes that are feasible, and therefore the new maps are limited to major highways, depots and other key areas where it is known that these vehicles will require access. Many of the heaviest combinations face structures where no access can be safely given, however this is important information to publish to allow for clear, proactive planning of indivisible loads. Figure 1 shows the heavy vehicle access map from a 12-axle platform weighing 205t, with conditionally approved structures marked as yellow and restricted structures marked as red.

Figure 1 Example Class 1 Heavy Vehicle Access Map - 12 axle platform - 205t maximum mass

A map of the united states

Description automatically generated

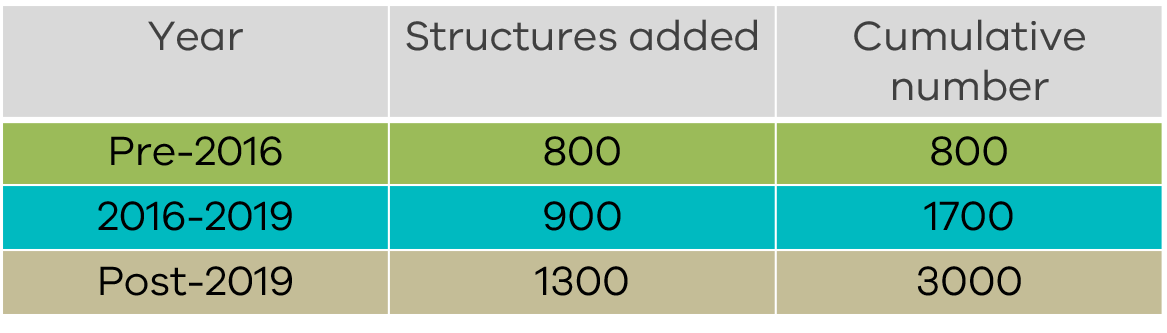
## Class 2

For Class 2 vehicles, DTP has maintained an active Higher Mass Limit (HML) and B-double network for nearly three decades. The introduction of the Performance Based Scheme (PBS) and HPFVs has resulted in the need to develop additional heavy vehicle access maps.

Figure 2 shows how HPFV access maps have been developed over many years. The first HPFV access maps were introduced in 2015, with access only on key corridors such as the Hume Hwy, Goulburn Valley Hwy, Western Fwy, and Monash Fwy. Interest in HPFVs led to other main routes being assessed between 2016 and 2019, with the goal of reducing the number of structures that needed assessment.However without the minor highways and other last mile access routes added after 2019, many applications still required an assessment (though reduced in scope).

In addition to growing the routes over recent years, DTP also significantly increased the number of reference vehicles to match the innovations by heavy vehicle operators. In 2015, the network maps consisted of a quad-quad B Double (77.5t) and A-doubles (85.5t). Since then, DTP has progressively introduced new reference vehicles including tri-axle dolly A-doubles (91t), B-triples (91t) and AB-triples (113.5t), as well as tanker variants for most vehicles.

Figure 2: Victoria's HPFV Network Expansion



# Creation of a Heavy Vehicle Map

When creating a heavy vehicle map following the five aspects are considered.

1. Data collection
2. Defining assessment methodology
3. Completing structural assessment
4. Publishing structural assessment outcome
5. Ongoing data management

## Data Collection

Data utilised in the creation of the heavy vehicle maps sets the baseline for all the subsequent works. Prior to commence of any works, the data must be validated. The validation is through any available information, such as drawings, inspection reports and the information provided on the reference vehicle and its operational conditions. Data utilised in the map creation can be categorised into two main areas: vehicle data and structure data.

### Vehicle data

This data related to the reference vehicle generally includes overall dimensions, axle group spacings including the individual axle spacings and individual axle masses. Axle spacings can vary producing multiple combinations of compliant vehicles. Other information such as trip type (whether single trip permit or period permit for Class 1), type of loading (general mass loading or volumetric loading for Class 2) are also required to determine the structural assessment parameters.

### Structures data

This data generally includes structure individual span length, continuity of the structure, design load of the structure, type of superstructure, type of substructure & condition of the structure. If any load ratings have been completed on the structure, the rating factors may be considered for use in assessment.

## Defining Assessment Methodology

Based on the operational requirements and the vehicle information provided, the following assessment criteria and the relevant assessment parameters must be defined:

1. Live load factor for reference vehicle
2. Width distribution factor
3. Dynamic load allowance
4. Applicability of the volumetric loading
5. Multi-presence factors
6. Applicability of the past performance
7. Comparative Assessment and whether to use load rating factors.

## Completing Structural Assessment

DTP adopts two tiers when conducting structural assessment for creating network maps in line with AS 5100.73 parameters otherwise covered by approved internal DTP policy positions.

1. Tier 1 – comparative assessment on a 1D model.
2. Tier 2 – rating factor comparative assessment model.

### Tier 1 - Comparative assessment on a line-beam model

The first tier is based on comparative assessments on a 1D line model. DTP facilitates this process through software including the Vehicle Assessment Tool (VAT). The load effects for both superstructure (moments and shear) as well as substructure (reactions) are assessed. The capacity is represented by a preapproved load model and is compared to effects from the subject vehicle, that is the reference vehicle for the maps being created. The capacity load model for Class 1 assessments is most frequently the design load model of the existing structure (eg: A26, A36, HS20, T44 or SM1600). For HPFV assessments, based on a past performance criterion, a similar type of freight vehicle may be used as the capacity load model. These load models include existing approved full mass HPFVs and the Austroads Bridge Assessment Guidelines (ABAG) Semi and B-Doubles.

### Tier 2 - Rating Factor comparative assessment model

The second tier is based on a rating factor assessment, defined by AS 5100.73 as the ratio between the available bridge capacity for traffic load effects against the traffic load effects of the nominated rating vehicle. This tier is conducted when access cannot be granted via comparative assessment and the structure being considered is on a critical route. This option is less frequently utilised due to increased complexity, cost per structure, and time to complete the assessment.

### Condition Assessment

Additionally, the condition of the structure is considered when granting access to a heavy vehicle. The condition assessment is conducted via a desktop review of the relevant inspection reports available at the time for the structure. These could be Level 2 reports, monitor inspection reports, or other Level 3 investigation reports. Based on the severity of the defect and the type of the vehicle class, access is determined accordingly.

The geometric restrictions already posed on Class 1 vehicles (due to their height, length and width), mean that “positioning” can be used when granting access (see Table 1 below).

In contrast, “positioning” is not an available option for Class 2 due to the frequency of these combinations and the high speed at which they operate at. As such, access beyond the structure’s capacity is not considered.

## Publishing Structural Assessment Outcome

Access requirements over structures are based on structural assessments. However, operational requirements vary based on the vehicle class and the nature of the vehicle loading. A summary of the different access conditions is provided in Table 1 below.

Table 1 Access Conditions Per Vehicle Class

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| --- | --- | --- |
| Access Categories | Class 1 Vehicles | Class 2 Vehicles |
| Approved | No travel restriction | Travel at full mass |
| Conditionally Approved. (Travel With operation restriction) | * A position to travel, e.g: Straddle centreline of bridge, * A speed restriction e.g: Slow to 5/10kph * Or a combination of both. | Given an Approved Mass Allowance (AMA), vehicle able to operate at a reduced mass, e.g: 80t for an A-double (where the maximum mass of the combination is 85.5 tonnes). |
| Restricted | No access given (No Go) | 68.5t if structure approved for HML Loading, otherwise rescind access |

These operating requirements with vehicle information are published on the NHVR website via Freight Victoria.

## Ongoing data management

Documenting the entire process of how the maps are generated is crucial. This documentation includes background information, parameters used, and assumptions made in the decision-making process. This serves two purposes:

1. If the network is expanded or modified in the future, supporting documents are available beyond spreadsheets.
2. This can be provided as guidance material to deliver permit applications for vehicles not covered by these maps.

In the past, work of this type was captured in project-based spreadsheets. This, however was unwieldly to store, utilise and control. As such, a major effort was conducted to transition the data into a database, where each row is a single structure assessment for an individual reference map conducted at a single point of time. This forms a point in time reference for the following attributes:

* Dates for when an assessment was completed.
* The strength and condition-based outcomes of assessment.
* Date for most recent condition data used for condition outcome.
* The result to be published.

If the result is no longer valid due to new defects or the structure being uplifted, the original assessment is marked as no longer valid, given a change date and reason, but the other data is maintained, and a new assessment is established on a new row. This transition makes asset management tasks easier, as all the data is kept in a single repository , is easy to extract, track, and can be updated in a consistent format.

# Optimizing Network Map Creation Process

The recent rollout of access maps required efficiencies within the overall process to meet project timelines. For example, if no efficiencies were found for the rollout of Class 1 Access Maps for Platforms and Cranes, engineers on the project team would have needed to undertake over 150,000 individual structural assessments.

Achieving the efficiencies were focused on the following areas.

* Pre-population of assessment results and travel condition
* Grouping of similar vehicles to reduce the number of similar types of maps.

## Pre-population of assessment results

Existing structural assessment practice requires an assessor and a reviewer to assess and review the structure for each comparative analysis conducted. On average this process takes approximately 15 minutes per structure to complete. Therefore, it was investigated if this process could be streamlined to avoid any unnecessary duplication when the same type of vehicle is being assessed over the same list of structures.

Based on the outcomes of the initial investigation, it was determined that the most onerous vehicle or the vehicles that governs using a one-to-one assessment via VAT must be assessed first. By utilising this approach where the structures were cleared for most onerous vehicles, these structures were determined to be cleared for the rest of the vehicles within that group. This removed the need for the assessor or reviewer to undertake additional works for the cleared structure.

This approached was further refined where additional data fields and basic logic were captured to enable pre-population of assessment results.

### Example

As a basic example of the process, if a T44 bridge has a HLP400 lane, then the assessment can be simple to logically encode for a platform – if the T44 comparative assessment fails, then only a positioning restriction would apply, and there would be no requirement for slow-down restriction.

## Grouping vehicles for mapping

When creating access maps for a multitude of vehicles, there is a trade-off between maximizing access for individual vehicles against the rollout and ongoing management requirements that determine the final number of access maps created. If individual maps are created for each vehicle, then the rollout of these maps becomes much slower, and the ongoing management more cumbersome to verify and update. If too few maps are created, then the maps are unlikely to be useful for vehicles as access can be unfairly restrictive.

### Example

As an example, during the creation of 6+ axle crane network maps, a list of 39 cranes with varying axle counts (between 6 and 11) and axle masses (either 12t per axle or reduced through removing weight or sharing with a dolly) were submitted. In the past, when this type of scenario occurred, maps were created based on the axle spacing ranges. Further investigations revealed that using a range would create vehicle combinations so onerous that, in reality, they would never exist. Therefore, the approach of comparing loading impact of each individual crane was considered. Comparison was done against two key design loads on the arterial network (HS20 and T44). These were then grouped into ranges by what restrictions would apply. An example is shown in Figure 3 with the final reference groups split into different colours. With this approach, the 39 vehicles could be grouped into 8 categories resulting in only 8 maps compared to 39 individual maps. The alternative would have been 50 vehicles for 11 maps.

Figure 3 Fully Loaded Cranes compared to example design load (T44)

# Organisation Benefits

## Asset Management

While road-carrying structures are critical assets that maintain the connectivity of Victoria’s arterial road network, they are also the most likely impediment to the movement of heavy vehicles. Access maps for heavier vehicles give a broader picture of the network including identifying bottlenecks caused by structural inadequacies.

The availability of funding often determines the approach to uplifting a corridor. The access map information can be useful tool for prioritising structures along a corridor, targeting those with lower access to ensure that benefits can be realised as projects are completed.

As more structures are uplifted, the benefits of uplifting additional structures can be greater due to the ability to open a key corridor.

# Conclusions

By the end of 2024, Victoria has developed over 100 networks maps to facilitate heavy vehicle movement across the state. These network maps include both Class 1 and Class 2 reference vehicles. The biggest challenge moving forward is the ongoing data maintenance of these network maps as the road network keeps expanding as new structures are introduced and old structures are rehabilitated or replaced.

The creation of these access maps has demonstrated the potential for DTP to move towards an automated permit system for heavy vehicle network access. Until that opportunity arrives, these maps will serve as a beneficial tool for the industry and DTP in processing demand for structural assessment for permits and asset management.

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