

Semi-Automation of Period Permit and Single Trip Permit Vehicle Bridge Assessments

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ABSTRACT

The volume of heavy vehicle permit applications has continued to increase at approximately 8% per annum in Western Australia, requiring more engineering assessment time and pressure to maintain agreed permit turnaround times.

To make the permit assessment process more efficient, Main Roads Western Australia (MRWA) has recently developed a Heavy Vehicles assessment module as part of its corporate, electronic Bridge Management System (BMS) to semi-automate the permit assessment process. Period permits and single trip permits for floats and platforms are now completed.

The completion of this application has halved load assessment time, ensured consistency in permit assessment, improved response to the transport industry and minimised risk for litigious situations. In addition, by storing all previous permits electronically within BMS, the full history of permit assessments enables quick and consistent assessment of comparable future permit applications.

This paper describes the approach adopted by MRWA to develop software that is used for all bridge load assessments for heavy vehicle period permits and single trip assessments. It also details the assessment methodology and shows the solutions adopted within BMS.

1. INTRODUCTION

In 2009 MRWA commenced the development of its own custom built BMS to ensure it would have a comprehensive corporate system that supported and facilitated all of the bridge management activities so they could be performed in a consistent, effective and efficient manner with all activities being transparent and based on reliable data.

The BMS has been developed in five modules – Program Management, Bridge Enquiry, Heavy Vehicles, Inspections, and Bridge Inventory. The Heavy Vehicles (HV) module of the BMS is the corporate working tool, developed to help with the assessment of heavy vehicle movement permits and bridge load rating management. It provides a number of key benefits, including:

- Elimination of repetitive work when assessing permits;
- Improvement in efficiency of the process of assessing permits;
- Collection and storage of information to provide information on previous assessments and performance of the network; and
- Promotion of consistency in the completion of bridge assessments.

The HV module sources bridge inventory data directly from the corporate Integrated Road Information System (IRIS) bridge database and semi-automates the permit assessment process for period permits and single trip permits for floats and platforms. The semi-automation of single trip permits for all other vehicle types is currently under development, and is planned to be completed this financial year.

This paper provides background on the types of permits, types of vehicles, the assessment philosophy and methodology, the scope of the BMS semi-automation, and provides two detailed examples for the semi-automation of platform vehicle single trip assessment and crane period permit for bridges on the WA road network.

2. WESTERN AUSTRALIAN AND MRWA'S HEAVY VEHICLE PERMIT SYSTEM

All types of travel permits for movement of over size and over mass vehicles on public roads within Western Australia (WA) are issued by the Heavy Vehicle Services (HVS) directorate of MRWA.

This is a point of differentiation between WA and other states of Australia, in that MRWA assesses the movement of vehicles on bridges on all public roads, regardless of bridge ownership.

Within MRWA, Structures Engineering (SE) branch is responsible for undertaking the detailed condition inspections to inform the assessment of the load rating for all bridges on public roads in the State, so as to be able to meet this permit assessment obligation.

3. PERIOD PERMITS

Period permits are issued for annual operation for Special Purpose Vehicles (SPVs, i.e. cranes, drill rigs, concrete pumping trucks etc.) and multi-combination 4-Tyre vehicles (standard width vehicles at vehicle standard regulation (VSR), concessional or full loads). These permits are usually issued for movement within nominated areas, often including the potential crossing of hundreds of bridges.

Period permits cannot be issued with additional bridge conditions to control vehicle movement or speed, so it becomes a yes or no decision for each requested bridge.

MRWA bridge engineers assess approximately 45 period permits each month. These permits are required to be assessed within a 2 week period.

4. SINGLE TRIP PERMITS

As the name suggests, single trip permits are issued for travel from origin to destination along a specified route on a once-off single trip basis. They are generally issued for the larger vehicles carrying indivisible loads (floats and platforms) but can be issued for any vehicle type, particularly where bridge capacity precludes the issue of a period or network permit.

MRWA bridge engineers assess approximately 25 single trip bridge permits each day. These permits are required to be assessed within a few hours of receiving the permit from HVS for a less than 24-hour total turnaround to the transport operator.

5. ASSESSMENT PHILOSOPHY

The assessment philosophy used by MRWA for the different types of permits and vehicles complies with the requirements of Standards Australia Bridge Design Code¹ or modified Code approaches as outlined in MRWA's Bridge Branch Design Information Manual².

In general terms, the assessment of requested vehicles for bridge transit is based on the load rating equation (refer Equation 14.2(2) in AS5100.7¹). This equation, noted below, is expressed for moment but comparable equations are also applicable for shear and reaction:

$$\% \text{ Rating} = \frac{\phi M_U - (\gamma_G M_D + \gamma_{GS} M_{DS} + M_P + M_S + \gamma_T M_T)}{\gamma_L \times (1 + DLA) \times M_L} \quad (1)$$

where:

ϕ	=	Capacity reduction factor
M_U	=	Calculated ultimate moment capacity
γ_G	=	Load factor for dead load
M_D	=	Moment due to dead load
γ_{GS}	=	Load factor for superimposed dead load
M_{DS}	=	Moment due to superimposed dead load
M_P	=	Moment due to parasitic effects of prestress
M_S	=	Secondary moment due to differential settlement
γ_T	=	Load factor for differential temperature
M_T	=	Secondary moment due to differential temperature
γ_L	=	Load factor for live load
DLA	=	Dynamic Load Allowance
M_L	=	Moment due to live load incorporating multiple lane modification factors or accompanying lane factors as appropriate

The bracketed numerator component represents the permanent effects (PE). This equation can then be simplified to:

$$\% \text{ Rating} = \frac{\phi M_U - PE}{\gamma_L \times (1 + DLA) \times M_L} \quad (2)$$

The assumption is then, that for a particular bridge at a given location (i.e. sag or hog) that, $(\phi M_U - PE)$ is a constant, and thus:

$$\% \text{ Rating} \times (\gamma_L \times (1 + DLA) \times M_L) = \phi M_U - PE = \text{Constant} \quad (3)$$

and

$$\% \text{ Rating}_1 \times (\gamma_{L1} \times (1 + DLA_1) \times M_{L1}) = \% \text{ Rating}_2 \times (\gamma_{L2} \times (1 + DLA_2) \times M_{L2}) \quad (4)$$

MRWA has developed a comprehensive IRIS database containing detailed location, geometry, condition and load rating information for all 2,500+ vehicular bridges on public roads for which it is responsible for issuing heavy vehicle permit access (including bridges owned by others). The detailed load rating information contains percentage rating values (%Rating) for 12 standard MRWA defined Group 1 (standard width) and Group 2 (float and platform) rating vehicles, as well as T44/M1600 design vehicles. All ratings are based

on detailed assessments completed using appropriate structural analysis modelling in accordance with AS5100¹.

By using a similar rating vehicle to the requested vehicle, Equation 4 can be further refined. Assuming that the vehicles have similar overall width of axles and thus similar transverse load distribution factors, and assuming the same movement conditions and thus the same DLA and γ_L factors for both vehicles, the equation is further simplified:

$$\% Rating_1 \times M_{L1} = \% Rating_2 \times M_{L2} \quad (5)$$

Knowing % Rating₁ it is possible to then derive % Rating₂ by running a simple linebeam program to derive M_{L1} and M_{L2} (given the assumption of similar transverse distribution factors).

This is the assessment philosophy MRWA has adopted from inception of heavy vehicle permit assessments and for the development of its BMS.

If transverse ratings control the bridge load rating or if they are less than 100% then care needs to be taken as various programs for assessment or linebeam comparisons cannot accurately assess this transverse effect. The detailed bridge model should be used where possible.

6. DETAILED EXAMPLE 1: ASSESSING PLATFORM VEHICLE SINGLE TRIP PERMITS

Platforms represent the larger mass single trip permit vehicles and equate to approximately 45% of all single trip permit assessments requiring specific engineering assessment. These vehicles and the single trip permit assessment of these vehicles is a focus of this paper, but the same assessment philosophy and similar approach within BMS is adopted for the single trip assessment of other vehicle types.

Multiple axle platforms permit up to 18t per axle under supervision with 8-tyres per axle, up to 27t per axle under supervision with 12-tyres per axle (3-file), and up to 36t per axle under supervision with 16-tyres per axle (4-file). They vary significantly in their overall width of axles, from 3.0m to 4.5m for 8-tyres and from 6.2m to 7.5m for 16-tyres.

As laden platform vehicles can only travel using single trip permits, these vehicles can be controlled with additional bridge supervision conditions (e.g. central movement on the bridge at 10km/h with video supervision) if required to limit the effects on the bridges.



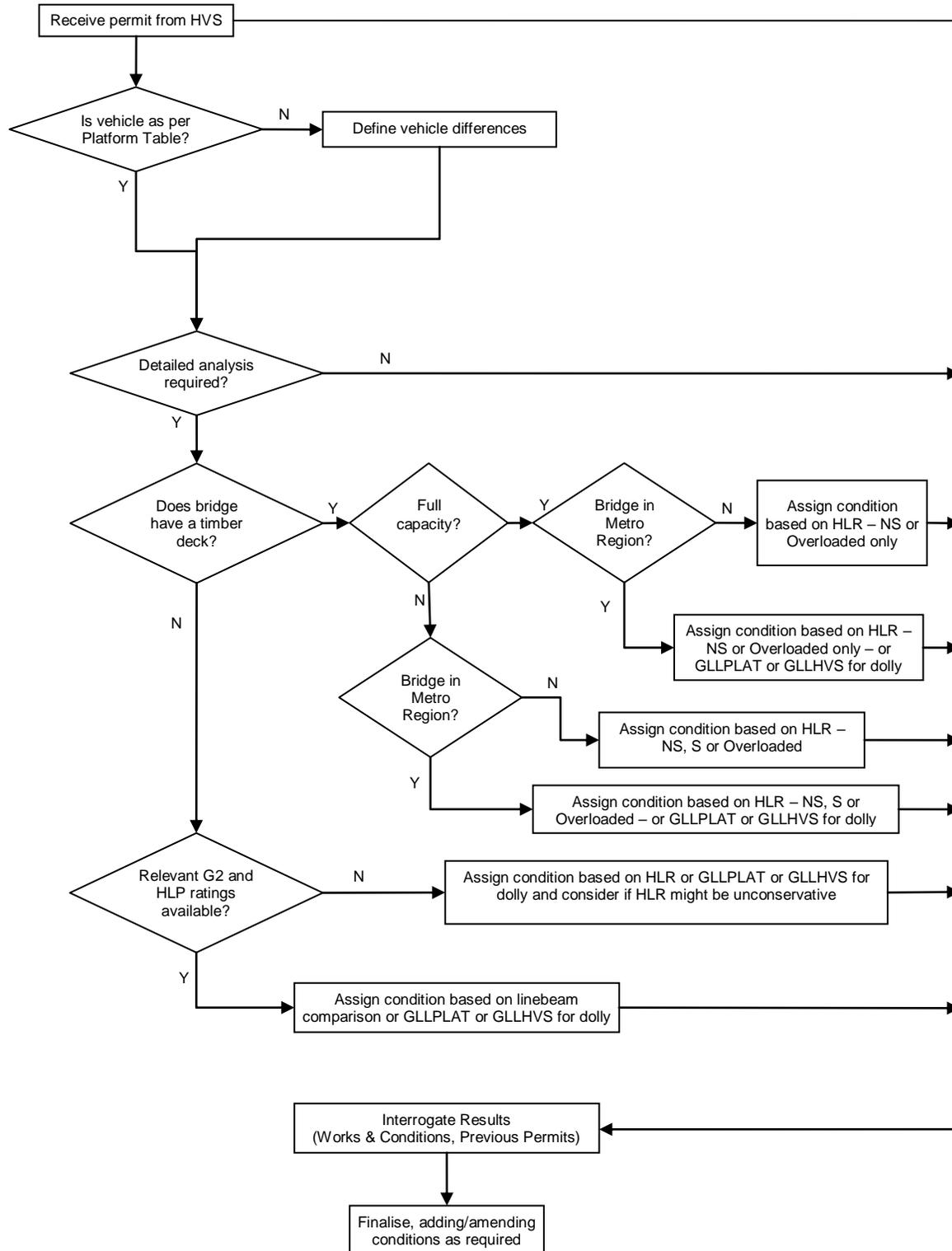
Figure 1 – Platform Vehicle Examples

Given the large number of requests for platform vehicles with similar configurations, MRWA's SE bridge engineers have developed a 'Platform Table' to assist in the individual assessment of platform vehicles of defined various spacings and overall width of axles, for the more common transport routes. This is a guiding tool only and SE must approve the movement of all laden platform vehicle single trip permits.

The Platform Table summarises the rating for standard vehicles with a prime mover (single steer) and platform (6 to 16 axles) with axle spacings of either 1.55m or 1.80m at no supervision (NS) and supervision (S) limits for different overall widths of axles. The majority of NS and S values are controlled by generic lower-bound NS and S limits set by HVS (GLLHVS and GLLPLAT) to protect the State's assets and are not generally controlled by the bridge capacity.

If the bridge being assessed is covered by the Platform Table but the vehicle differs, the difference in vehicle needs to be assessed by the MRWA bridge engineer. The difference may be insignificant, for example, if the spacing difference is only in the prime mover or if the spacing difference is only small. However, if the spacing change is considered significant or if a dolly is present in the requested vehicle, then full structural assessment is warranted.

The general assessment steps are represented diagrammatically in the flow chart in Figure 2.



* Full Capacity refers to minimum ratings of at least 18t tandem-axle, 27t tri-axle, 36t quad/484quad-axle and 100% T44.

* MRWA's G2 vehicles have overall width of axles/tyres per axle of 3.0m/8, 3.7m/8, 4.81m/12, 6.22m/16 for comparison to similar width vehicles².

* HLR³ refers to the Heavy Load Routing software program used for the assessment of vehicle crossing bridge structures.

Figure 2 – Single Trip Assessment Steps for Platforms

The Single Trip Permits screens of the HV module include a streamlined process for the single trip permit assessment of bridges by:

- Directly interrogating IRIS for bridge data;
- Retrieving previous single trip permits for similar vehicles and routes from stored history;
- Identifying changes to bridge ratings;
- Semi-automating the assessment process to improve efficiency and consistency of results;
- Providing seamless integration with the structural analysis software (Heavy Load Route (HLR³) Analysis System) and MRWA's permit system (RAVS);
- Allowing the user to review and amend assessment results;
- Automatically assigning additional bridge supervision conditions; and
- Automatically saving the details of the deficient bridges and assessment records for use in future single trip permit assessments.

The Single Trip Permits screens represent the working area for the SE bridge engineers to manage and assess single trip permits.

6.1 Single Trip Permit List General Screen

The opening screen of the Single Trip Permits section lists all outstanding single trip permits (for all vehicle types). The user can also tick the box to “Show completed permits and assessments only” to report the history of single trips completed using BMS.

All data is automatically retrieved from HVS's RAVS permit database. The transport operator requests a permit from HVS and all details are then entered into RAVS. BMS extracts the relevant information from RAVS to enable bridge assessment of the single trip permit.

The Single Trip Permits screenshot (for completed permits) is shown in Figure 3.

Permit Type	Permit Subtype	Permit Number	Permit Received Timestamp	Completed Timestamp	Allocated To	Assessment Outcome	Origin	Destination	Company Name	Reason Assigned
SPV	Permit	5738918	23/10/2017 12:13	23/10/2017 12:30	ISLAM Syed (SE)	Permit Approved			FREO GROUP PTY L...	Permit to be assessed. SPV Single... Crane Rego: 1DIV719 GCW = 2.70
Platform	Permit Application	5738532	23/10/2017 11:59	23/10/2017 12:19	ISLAM Syed (SE)	Permit Approved	South Guildford	Welshpool	HEVI HAUL AUSTR...	Permit Application to be assessed...
Platform	Permit	5738378	23/10/2017 11:20	23/10/2017 11:52	LU Chin (EBL)	Permit Approved			HEVI HAUL AUSTR...	Permit to be assessed. Structures...
Platform	Permit	5738663	23/10/2017 10:25	23/10/2017 10:49	ISLAM Syed (SE)	Permit Approved			W.A. SPECIALISED...	Permit to be assessed. Structures...
SPV	Permit	5738882	23/10/2017 10:12	23/10/2017 10:38	ISLAM Syed (SE)	Permit Approved			AUSTRALIAN CON...	Permit to be assessed. SPV Single... Crane Rego: 1G/P584 GCW = 2.80
Platform	Permit Application	5738856	23/10/2017 09:29	23/10/2017 10:17	ISLAM Syed (SE)	Permit Approved	Waroona	Boddington	CHARLES HULL CO...	Permit Application to be assessed...
SPV	Permit	5738860	23/10/2017 08:54	23/10/2017 09:31	ISLAM Syed (SE)	Permit Approved			ANGEN NOMINEE...	Permit to be assessed. SPV Single... Crane Rego: 1EOR436 GCW = 3.05
SPV	Permit	5738858	23/10/2017 08:46	23/10/2017 09:13	ISLAM Syed (SE)	Permit Approved			ANGEN NOMINEE...	Permit to be assessed. SPV Single... Crane Rego: 1EOR436 GCW = 3.05
Float	Permit Application	5738435	23/10/2017 07:22	23/10/2017 07:51	ISLAM Syed (SE)	Permit Approved	WA/NT Border	Roy Hill Mine	NATIONAL HEAVY...	New WEB permit application requi...
Platform	Permit	5738832	20/10/2017 17:19	20/10/2017 18:14	PARVIN Jewely (SA...	Permit Approved			W.A. SPECIALISED...	Permit to be assessed. Structures...
Platform	Permit	5738831	20/10/2017 17:18	20/10/2017 18:12	PARVIN Jewely (SA...	Permit Approved			W.A. SPECIALISED...	Permit to be assessed. Structures...
Platform	Permit	5738664	20/10/2017 17:17	20/10/2017 17:57	PARVIN Jewely (SA...	Permit Approved			W.A. SPECIALISED...	Permit to be assessed. Structures...
Platform	Permit	5738833	20/10/2017 17:16	20/10/2017 17:48	PARVIN Jewely (SA...	Permit Approved			W.A. SPECIALISED...	Permit to be assessed. Structures...
Platform	Permit Application	5738368	20/10/2017 16:13	20/10/2017 16:59	PARVIN Jewely (SA...	Permit Approved	Kailis Mine Site	Bald Hill Mine Site	TOLL TRANSPORT...	Permit Application to be assessed...
Platform	Permit Application	5738369	20/10/2017 16:12	20/10/2017 16:56	PARVIN Jewely (SA...	Permit Approved	Kailis Mine Site	Bald Hill Mine Site	TOLL TRANSPORT...	Permit Application to be assessed...
Float	Permit	5738427	20/10/2017 14:34	20/10/2017 14:54	PARVIN Jewely (SA...	Permit Approved	RAVENSTHORPE	PEAK HILL	DTMT LOGISTICS P...	Permit to be assessed. Roads not...

Figure 3 – BMS Single Trip Permits Screenshot

To begin the bridge assessment of a single trip permit, the user simply clicks on the BMS Permit Number hyperlink.

After opening a single trip permit the user is presented with eight standard screens – Permit Details, Route Details, Vehicle Details, Previous Permits, Selected Bridges Report, Assessment, Summary Report and Finalise. These screens are viewed as a series of tabs, located across the top of the screen to enable the user to easily go from one to another. The screens are ordered in the typical work sequence to input, review, assess and finalise the results of the single trip assessment. The content of each of these screens and the general workflow are detailed in the following sections.

6.2 Single Trip Permit Details Screen

All basic data for the permit including permit number, permit type, transport company, and date the permit is received, are automatically retrieved from HVS’s RAVS database but the user has the option to amend the permit type (if required) before starting the assessment of this permit.

6.3 Single Trip Route Details Screen

The route data is automatically retrieved from HVS’s RAVS permit database but the user has the option to amend the route (if required). The routes are built using IRIS road names and intersection data to ensure that there are no gaps in the requested outgoing or return route.

The Single Trip Route Details Screen is shown in Figure 4.

Sequence	Road Number	Road Name	Local Road Name	LGA	From	To
1	H006	Great Northern Hwy	Great Northe...		Yandi Mine Access Rd	Roe Hwy & Great Northern Hwy & Reid Hwy
2	H018	Roe Hwy	Roe Hwy		Great Northern Hwy & Reid Hwy	Great Eastern Hwy Bypass
3	H019	Great Eastern Hwy...	Great Eastern...		Roe Hwy	Abernethy Rd
4	1092053	Abernethy Rd	Abernethy R...	Kalamunda, Swan (C)	Great Eastern Hwy Bypass	Abernethy Rd & Adelaide St
5	1020997	Abernethy Rd	Abernethy R...	Kalamunda, Swan (...)	Abernethy Rd & Adelaide St	Grogan Rd
6	1021148	Grogan Rd	Grogan Rd (...)	Kalamunda, Belmo...	Abernethy Rd	Grogan Dr (Federal)
7	H065	Horrie Miller Dr	Horrie Miller...		Horrie Miller Dr (Federal)	Kewdale Rd
8	1130048	Kewdale Rd	Kewdale Rd	Belmont (C), Canni...	Horrie Miller Dr	Kewdale Rd
9	1140014	Kewdale Rd	Kewdale Rd (...)	Belmont (C), Canni...	Kewdale Rd	Orrong Rd
10	H027	Rivervale Wattle Gr...	Orrong Rd (C...		Kewdale Rd	Orrong Rd on to Leach Hwy (Westbound) & Leach H...
11	H793	Orrong Rd on to L...			Leach Hwy (Westbound) off to Orrong Rd & Orrong...	Leach Hwy
12	H012	Leach Hwy	High St (Fre...		Orrong Rd on to Leach Hwy (Westbound)	Welshpool Rd
13	1140585	Welshpool Rd	Welshpool R...	Canning (C), Victori...	Leach Hwy	Adams Dr

Figure 4 – BMS Single Trip Route Details Screen

6.4 Single Trip Vehicle Details Screen

The vehicle data is automatically retrieved from HVS's RAVS permit database and cannot be amended. The vehicle data is summarised and displayed for easy reference to the user.

The Single Trip Vehicle Details Screen is shown in Figure 6.

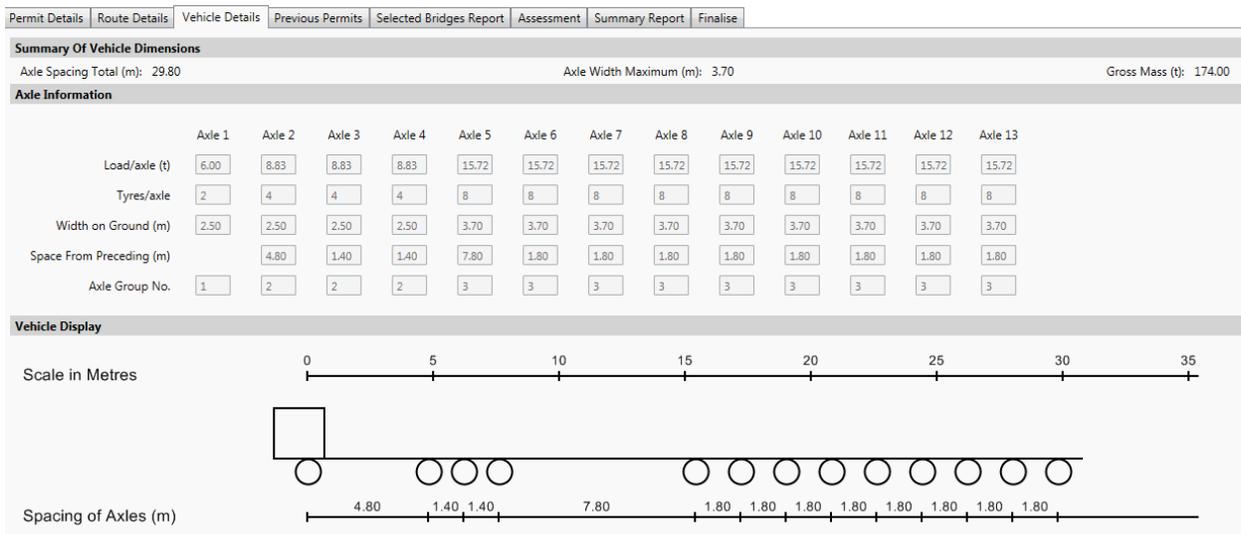


Figure 6 – BMS Single Trip Vehicle Details Screen

6.5 Single Trip Previous Permits Screen

BMS automatically retrieves previous single trip permit assessments for similar vehicles and routes from stored history. A permit is deemed 'similar' if the difference in bridge list (i.e. the bridges crossed by the requested vehicle) is less than ten, the vehicle is of the same type with the same number of axles and tyres per axle, with axle masses within 2%, spacings within 5% and overall width of axles within 3%.

It may be that the current single trip permit is identical to a previous permit and no further assessment is required. At the least, the similar previous permit will give some history of the conditions applied and any restrictions imposed, promoting consistency in bridge assessments.

6.6 Single Trip Selected Bridges Report Screen

This screen displays all the bridges on the selected route(s) and their rating values and other specific attributes. In some instances, for an experienced engineer, this information will be sufficient for finalisation of the permit without completing a full assessment. For less experienced engineers, this report provides a good check for assessment results.

6.7 Single Trip Assessment Screen

This screen displays a summary of the information from the preceding screens and determines the information to be used in the semi-automated BMS bridge assessment. Any differences in vehicle dimensions from the standard Platform Table vehicles are highlighted to the user, for judgement by the engineer as to whether these are significant or not for this particular single trip permit vehicle.

The user can choose a partial or full assessment. A partial assessment assumes that the Platform Table values are appropriate. A full assessment undertakes full comparative assessment – comparing the load effects of the requested vehicle to the allowable rating values using the rating values for a similar width vehicle, or using HLR analysis if no relevant detailed ratings are available. BMS uses the assessment philosophy outlined in Section 5. The determination of the relevant rating vehicle, the type of assessment and the generic lower limit values are all automatically determined and reported in BMS.

6.8 Single Trip Summary Report Screen

Following successful assessment, the summary report screen is populated with the results for each bridge on the route. A bridge is either assessed using 'HLR' (if no relevant MRWA Group 2 (float or platform)/HLP rating vehicles exist) or 'linebeam' with a comparative approach as per the assessment philosophy outlined in Section 5.

By default, only those bridges with movement or weight restrictions are shown on the summary report screen. The user can also tick the box to "Show all structures" to report the results for all bridges.

From this screen, the user can also easily upload the load rating summary information, any special conditions, outstanding critical repairs, or upcoming bridgeworks that may affect the bridge assessment.

The user has the ability to override the condition and provide comments before the final condition is assigned in BMS. The associated special movement condition or bridge video supervision condition (if applicable) is automatically determined in BMS ('BVS Code' in the screen example below).

The Single Trip Summary Report Screen is shown in Figure 7.

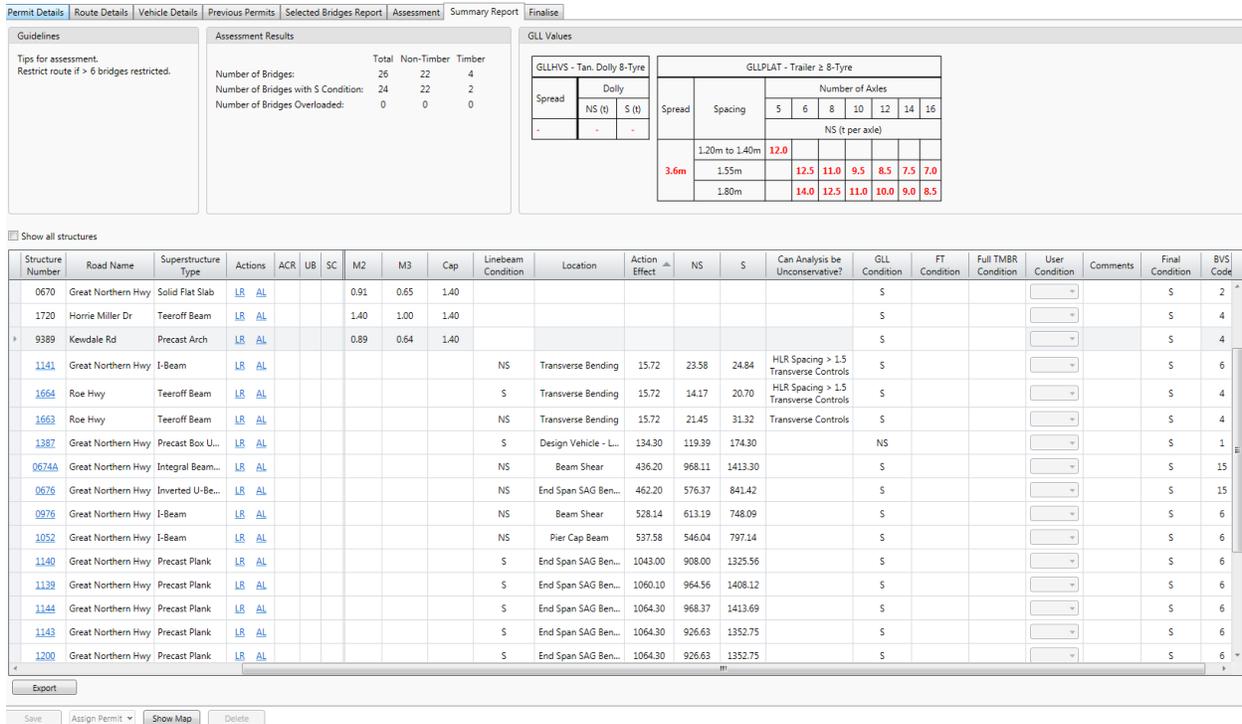


Figure 7 – BMS Single Trip Summary Report Screen

6.9 Single Trip Finalise Screen

Following completion of all conditions in the summary report screen, the finalise screen is used to automatically save the details of any deficient bridges and save the full assessment records for use in future single trip permit assessments.

Further, these assessment results are automatically and seamlessly sent back to HVS through their RAVS permit system to enable collation with additional permit conditions prior to issue of the permit to the transport operator.

7. DETAILED EXAMPLE 2: ASSESSING CRANE PERIOD PERMITS

Cranes permit up to 12t per axle on 20” (500mm) tyres. They are generally close to 3.0m width on ground and can move within a marked lane. All special purpose vehicles are weighed when licensed and there is reduced risk of overloading.

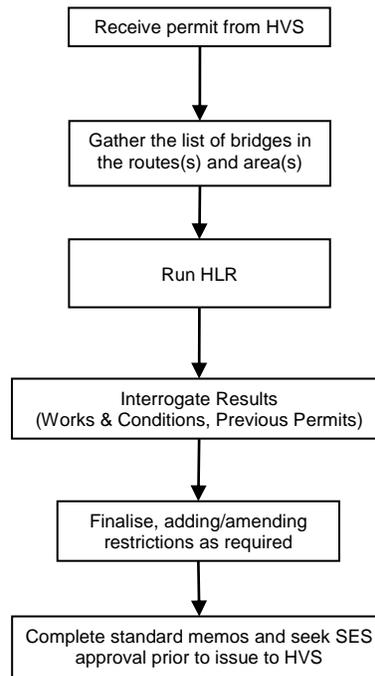
As cranes are generally lighter vehicles, they normally operate using period permits.



Figure 8 – Crane Examples

Given the large number of requests for crane permits, MRWA has some common crane configurations covered under the network access permit system, whereby some crane period permits can be self-assessed by the transport operator for predefined vehicle configurations operating on restricted networks. Only those cranes that are not covered by these network access permits need specific engineering assessment and are assessed and recorded in BMS.

The general assessment steps are represented diagrammatically in the flow chart in Figure 9.



* HLR³ refers to the Heavy Load Routing software program used for the assessment of vehicle crossing bridge structures.

Figure 9 – Period Permit Assessment Steps for Cranes

The Period Permits screens of the HV module include a streamlined process for the period permit assessment of bridges by:

- Directly interrogating IRIS for bridge data;
- Retrieving previous period permit assessments for similar vehicles and routes from stored history;
- Identifying changes to bridge ratings;
- Semi-automating the assessment process to improve efficiency and consistency of results;
- Providing seamless integration with the structural analysis software (Heavy Load Route (HLR³) Analysis System);
- Allowing the user to review and amend assessment results;
- Preparing memos of assessment outcomes, with documented approval provided to HVS; and
- Automatically saving the details of the deficient bridges and assessment records for use in future period permit assessments.

The Period Permits screens represent the working area for the SE bridge engineers to manage and assess period permits.

7.1 Period Permit List General Screen

The opening screen of the Period Permits section lists all outstanding period permits. The user can also tick the box to “Show completed permits” to report the history of period permits completed using BMS.

At this stage of development, all data is manually entered but there are plans to automatically retrieve this data in the future from HVS’s RAVS permit database. The Period Permits List screenshot is shown in Figure 10.

Permit Type	BMS Permit No.	RAVS Permit No.	Permit Received Date	Allocated On	Allocated To	Status	Route Summary	Vehicle Type	Vehicle Registration	Company Name	Comments
CLS	PP17-0624		31/08/2007	5/09/2017	LU Chin (EBL)	In Progress	Additional Bridges...	MRWA17801	MRWA17801	BIS INDUSTRIES	
VSR	PP17-0636		4/01/2017	7/09/2017	LU Chin (EBL)	In Progress	Additional Bridges...	Road Train	Max Mass - Narrows	HVS REQUEST	
CLS	PP17-0420		16/06/2017	16/06/2017	LU Chin (EBL)	In Progress	Additional Bridges...	Triple Road Train	QUBE 2 Test	XVZ TEST COMPANY	
CLS	PP17-0419		16/06/2017	16/06/2017	LU Chin (EBL)	In Progress	Additional Bridges...	Qube 42m Roa...	QUBE1	RICH BAIN	
CLS	PP17-0622		1/09/2017	1/09/2017	LU Chin (EBL)	In Progress	Additional Bridges...	road train	aa	HVO REQUEST	
SPV	PP17-0659		5/09/2017	22/09/2017	PARVIN Jewely (S...	In Progress	Regions: Goldfields...	Crane	Test		
VSR	PP17-0657		12/09/2017	20/09/2017	ZHUANG Anna (...)	In Progress	Additional Bridges...	Containerised...		HVO REQUEST	Narrows Bridges
SPV	PP17-0648		12/09/2017	19/09/2017	PARVIN Jewely (S...	In Progress	Regions: South West Local Government...	Liebherr LTM 1...	1EXX771	LEYBURN NOMINEE...	
VSR	PP17-0655		20/09/2017	20/09/2017	ISLAM Syed (SE)	In Progress	Additional Bridges...	Theoretical Vehi...	ASVR	TEST	TEST ASRV
VSR	PP17-0687		2/10/2017	2/10/2017	ZHUANG Anna (...)	In Progress	Additional Bridges...	RAV 4	RAV 4	HVO REQUEST	
CLS	PP17-0689		2/10/2017	2/10/2017	ZHUANG Anna (...)	In Progress	Additional Bridges...	AAMS Concessi...	AAMS 2.3	HVO REQUEST	
VSR	PP17-0709		3/10/2017	12/10/2017	ZHUANG Anna (...)	In Progress	Additional Bridges...	RAV 4	RAV 4	HVO REQUEST	
CLS	PP17-0693		3/10/2017	3/10/2017	LU Chin (EBL)	In Progress	Additional Bridges...	road train		HVO REQUEST	
CLS	PP17-0721		13/10/2017	13/10/2017	ZHUANG Anna (...)	In Progress	Additional Bridges...	Qube 42m Roa...		QUBE PTY LTD	PP17-406 Vehicle 2
CLS	PP17-0724		13/10/2017	24/10/2017	LIM Adam (SES)	Awaiting Approval	Additional Bridges...	Qube 42m Roa...		QUBE PTY LTD	PP17-406 Vehicle 1
VSR	PP17-0732		16/10/2017	16/10/2017	ZHUANG Anna (...)	In Progress	Additional Bridges...	RAV 4	RAV 4	HVO REQUEST	4150 & 4034 RAV 4
VSR	PP17-0728		16/10/2017	16/10/2017	ZHUANG Anna (...)	In Progress	Additional Bridges...	RAV 10-V1	RAV 10-V1	HVO REQUEST	799 & 798 RAV 10 V1
VSR	PP17-0729		16/10/2017	16/10/2017	ZHUANG Anna (...)	In Progress	Additional Bridges...	RAV 10-V2	RAV 10-V2	HVO REQUEST	798 & 799 RAV 10- V2
VSR	PP17-0731		16/10/2017	16/10/2017	ZHUANG Anna (...)	In Progress	Additional Bridges...	RAV 3	RAV 3	(NONE)	4150 & 4034 RAV 3
VSR	PP17-0730		16/10/2017	16/10/2017	LU Chin (EBL)	In Progress	Additional Bridges...	RAV 10-V3	RAV 10-V3	NONE	798 & 799 RAV 10 - V3

Figure 10 – BMS Period Permits List Screenshot

To begin the bridge assessment of a period permit, the user simply clicks on the BMS Permit Number hyperlink.

After opening a period permit the user is presented with nine standard screens – Permit Details, Route Details, Vehicle Details, Previous Permits, Selected Bridges Report, Single Trip Check, HLR Assessment, Summary Report and Memo. These screens are viewed as a series of tabs, located across the top of the screen to enable the user to easily go from one to another. The screens are ordered in the typical work sequence to input, review, assess and finalise the results of the period permit assessment.

The content of each of these screens and the general workflow are similar to those for the single trip permits, refer Section 6 for details. Only the screens with major differences will be outlined in the following sections.

7.2 Period Permit Route Details Screen

On this screen the user enters the route details to enable extraction of all bridges that may be crossed under the use of the requested period permit vehicle. The Period Permit Route Details Screen is shown in Figure 11.

Selected Bridges Report	Single Trip Check	HLR Assessment	Summary Report	Memo
Permit Details	Route Details	Vehicle Details	Previous Permits	
<input checked="" type="checkbox"/> Region(s)	<input checked="" type="checkbox"/> Gascoyne <input checked="" type="checkbox"/> Goldfields - Esperance <input type="checkbox"/> Great Southern <input type="checkbox"/> Kimberley <input checked="" type="checkbox"/> Metropolitan <input type="checkbox"/> Mid West <input type="checkbox"/> Pilbara <input type="checkbox"/> South West <input type="checkbox"/> Wheatbelt North <input type="checkbox"/> Wheatbelt South			
<input type="checkbox"/> Local Government Area(s)	<input type="checkbox"/> Albany (C) <input type="checkbox"/> Armadale (C) <input type="checkbox"/> Ashburton <input type="checkbox"/> Augusta - Margaret River <input type="checkbox"/> Bassendean (T) <input type="checkbox"/> Bayswater (C) <input type="checkbox"/> Belmont (C) <input type="checkbox"/> Beverley <input type="checkbox"/> Boddington <input type="checkbox"/> Boyup Brook <input type="checkbox"/> Bridgetown - Greenbushes <input type="checkbox"/> Brookton <input type="checkbox"/> Broome <input type="checkbox"/> Broomehill - Tambellup <input type="checkbox"/> Bruce Rock <input type="checkbox"/> Bunbury (C) <input type="checkbox"/> Busselton (C) <input type="checkbox"/> Cambridge (T) <input type="checkbox"/> Canning (C) <input type="checkbox"/> Capel <input type="checkbox"/> Carnamah <input type="checkbox"/> Carnarvon <input type="checkbox"/> Chapman Valley <input type="checkbox"/> Chittering <input type="checkbox"/> Christmas Island <input type="checkbox"/> Claremont (T) <input type="checkbox"/> Cockburn (C) <input type="checkbox"/> Cocos Island <input type="checkbox"/> Collie <input type="checkbox"/> Coolgardie <input type="checkbox"/> Coorow <input type="checkbox"/> Corrigin <input type="checkbox"/> Cottesloe (T) <input type="checkbox"/> Cranbrook <input type="checkbox"/> Cuballing <input type="checkbox"/> Cue			
<input type="checkbox"/> Additional Bridges	<input type="text"/>			
<input type="checkbox"/> Pre-defined	<input type="checkbox"/> Bounded Area in SWR <input type="checkbox"/> Standard Metro			
Route Summary	<p>⚠ Do not forget to update the Route Summary below as selections above have changed.</p> <p>Regions: Gascoyne, Goldfields - Esperance, Metropolitan.</p>			<input type="button" value="Update"/>
<input type="button" value="Save"/>	<input type="button" value="Correspondence with HVO"/>	<input type="button" value="Assign Permit"/>	<input type="button" value="Delete Permit"/>	

Figure 11 – BMS Period Permit Route Details Screen

The main difference for period permits is the selection of the route by area (region and/or local government area) as opposed to a defined route from origin to destination.

BMS determines the bridges that are crossed and thus need assessment, for the selected route details.

7.3 Period Permit Assessment Screen

This screen displays a summary of the information from the preceding screens and determines the information to be used in the semi-automated BMS bridge assessment.

BMS performs an analysis of the permit using the Heavy Load Route Analysis System (HLR³) program, comparing the requested crane to the HLR recorded T44 rating values for each bridge. BMS uses the assessment philosophy outlined in Section 5.

7.4 Period Permit Memo Screen

The final step in the period permit assessment process and the last tab in BMS for each period permit is for the creation of the standard memo, approval and reporting back to HVS.

Permit Details | Route Details | Vehicle Details | Previous Permits | Selected Bridges Report | Single Trip Check | HLR Assessment | Summary Report | Memo

Prepare Memo

Download Memo Use this button to Edit / View Memo

Upload Memo to BMS

Approved

Send Approval to HVO

Vehicle Details

	Axle 1	Axle 2	Axle 3	Axle 4	Axle 5
Load/axle (t)	11.55	11.70	12.35	12.20	12.15
Width on Ground (m)	2.75	2.75	2.75	2.75	2.75

Scale in Metres 0

Axle Number 1 2 3 4 5

Spacing of Axles (m) 2.60 1.65 2.00 1.65

Route Details

Regions: Gascoyne, Goldfields - Esperance, Kimberley, Mid West, Pilbara.

Assessment Results

⚠ This Period Permit contains LGAs with too many restricted structures.

Number of Bridges: 294
 Number of Bridges with YES Condition: 260
 Number of Bridges with Restrictions: 34

Figure 12 – BMS Period Permit Memo Screen

A standard memo is created by BMS from the vehicle and route input data, and incorporates the outcomes of the assessment. Once this memo has been approved it is automatically and seamlessly sent back to HVS to enable collation with any additional permit conditions prior to issue of the permit to the transport operator.

8. BENEFITS AND OUTCOMES

The completion of the BMS period permit application and single trip permit application for floats and platforms has halved load assessment time, ensured consistency in permit assessment, improved response to the transport industry and minimised risk for litigious situations. In addition, by storing all previous permits electronically within BMS, the full history of permit assessments enables quick and consistent assessment of comparable future permit applications.

The seamless integration with HVS for permit documentation and issue to the transport industry has provided improved business process linkages and removes human error in the transfer of data between load assessment outputs and permit conditions that are applied to the transport operator's permit.

Period permit assessment and single trip permit assessment within MRWA SE previously required 2 engineers full time. It is anticipated that with the completed BMS single trip permits (still to implement semi-automation for special purpose vehicles, 4-tyre and mixed vehicles) MRWA will only require 1 engineer for this work. This equates to significant savings and refocus of a valuable full time resource for other asset management tasks.

9. CONCLUSIONS

Despite the economic downturn, MRWA continues to issue approximately 18,000 single trip permits every year, an 8% increase per annum, with approximately 25 each day requiring specialist bridge engineering input for assessment. In addition, specialist bridge engineering input is required for the assessment of approximately 550 period permits every year. The industry and political pressure to maintain agreed permit turnaround times and the increase in requested permit loads prompted MRWA to develop custom built BMS software capable of structural assessment of these vehicles. The assessment process adopts long-serving and Australian Standard Bridge Design Code supported philosophies, interrogating detailed load rating data for various overall width of axles to compare to the effects of each requested vehicle.

Detailed statistics are readily available from within BMS to report on the total number of period permits and single trip permits completed within a period of time, the number approved, not approved or those that required further input, and the average time taken to complete the permits.

The completion of this semi-automated process has halved load assessment time, ensured consistency in permit assessment, improved response to the transport industry and enables the full history of permit assessments to be available for quick and consistent assessment of comparable future permit applications.

The significant savings has permitted refocus of a valuable engineering resource for other asset management tasks.

MRWA has commenced development to complete the single trip assessment within BMS enabling semi-automation of 4-tyre per axle vehicle, special purpose vehicle and mixed vehicle bridge assessments. This will complete the heavy vehicle semi-automation of period permit and single trip permit vehicle bridge assessments within BMS.

10. REFERENCES

1. Standards Australia, "AS5100 Bridge design", 2017, Australia.
2. MRWA, "Bridge Branch Design Information Manual", Document 3912/02, Perth, Australia.
3. Heavy Load Route Analysis System (HLR) program, Transport SA.

11. ACKNOWLEDGEMENTS

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