



**WARRIP**

WESTERN AUSTRALIAN  
ROAD RESEARCH AND  
INNOVATION PROGRAM

2019

# Program Highlights





The Western Australia Road Research and Innovation Program (WARRIP) has been providing innovative solutions and cost savings opportunities for Main Roads WA since 2016.

Western Australia has one of the world’s most expansive road networks, crossing different climate zones and topographical areas. WARRIP helps to solve the unique challenges faced by those undertaking to maintain and improve the current network.

## PARTNERSHIP BOARD

“MAIN ROADS IS COMMITTED TO EMBRACING INNOVATIONS THAT PROVIDE BETTER SAFETY, RELIABILITY AND SUSTAINABILITY OUTCOMES FOR USERS OF THE WA ROAD TRANSPORT”



“We have partnered with ARRB to establish the WARRIP, a cooperative research initiative focused on improving practices and tackling challenges in delivering and maintaining WA’s vast road network. Main Roads encourages collaboration with relevant discipline specialists to develop implementable solutions. Creation and advancement of local technical expertise, in addition to building and strengthening relationships, are key objectives for the program. It’s our expectation that the WARRIP will continue to support Main Roads in delivering better social, environmental and economic outcomes into the future”.

– Peter Woronzow, Main Roads Western Australia.

“THE WARRIP PROGRAM REPRESENTS A GREAT STEP FORWARD FOR THE COMMUNITY OF WESTERN AUSTRALIA IN MEETING THE CHALLENGES FOR THE EVER CHANGING ..



“The research and practical outcomes that emanates from this program of dedicated work will genuinely *Shape the Transport Future* for all Western Australians. The partnership between Main Roads and ARRB the National Transport Research Organisation will craft the outcomes for the future in a range of fields from Pavement and Materials engineering, Safe Systems, Connected and Automated Vehicle implementation, Sustainable and Recycled materials and Asset Management all within a new enlivened mobility environment. Our partnership will deliver great outcomes, based on great work undertaken by great people.”

– Michael Caltabiano, ARRB.

## AGREEMENT MANAGERS

“THE JOINT APPROACH TO SELECTING PROJECTS, UNDERTAKING RESEARCH AND IMPLEMENTING OUTCOMES IS THE GREATEST STRENGTH OF WARRIP.”



“The focus on collaboration has been instrumental in building relationships, optimising solutions and advancing business-as-usual. ARRB provides nationally and internationally recognised expertise and Main Roads contributes history of practice and an appreciation of the local environment. Together with partners in Local Government, Industry and Academia, the WARRIP is delivering practical solutions that are improving the design, construction, maintenance and management of road infrastructure in WA.” – Jon Griffin, Main Roads Western Australia.

“THE WARRIP PROGRAM REPRESENTS A GREAT STEP FORWARD FOR THE COMMUNITY OF WESTERN AUSTRALIA IN MEETING THE CHALLENGES FOR THE EVER CHANGING TRANSPORT FUTURE.”



“**Collaboration, Innovation and Implementation** have been the tenets on which this program will be measured in the years to come. Innovation is the fruit of nurture and improvements which can only be achieved whilst working in collaboration. We at ARRB realise that we do not have a monopoly on great ideas, and when we collaborate with our partners at Main Roads along with members of the industry, that is when we can achieve great outcomes. We need to maintain sight that our offerings will add to the good of society and that our solutions can be implemented in a timely manner.” – Francois Finette, ARRB.

THE VISION OF WARRIP IS TO DELIVER ENGINEERING EXCELLENCE THROUGH THE CONDUCT OF LEADING ROAD TECHNOLOGY RESEARCH THAT WELCOMES INNOVATION AND PRIVATE SECTOR PARTICIPATION AND DRIVES MORE EFFICIENT ROAD MANAGEMENT PRACTICE THROUGH THE IMPLEMENTATION OF FIT-FOR-PURPOSE ENGINEERING SOLUTIONS.

## THE PROJECTS

|  |   |   |
|--|---|---|
| <p>HIGH MODULUS ASPHALT<br/>EME2</p>                         | <p>STONE MASTIC ASPHALT</p>                         | <p>BEST PAVEMENT PRACTICE</p>                 |
| <p>COST EFFECTIVE THICKNESS<br/>DESIGN</p>                   | <p>FUTURE TECHNOLOGIES</p>                          | <p>ERN9 UPDATE</p>                            |
| <p>TRAFFIC SPEED<br/>DEFLECTOMETER</p>                       | <p>ASPHALT TEMPERATURE<br/>MONITORING</p>           | <p>INVESTIGATION OF TRIAL<br/>SECTIONS</p>    |
| <p>CRUMB RUBBER ASPHALT</p>                                  | <p>WARM-MIX ASPHALT</p>                             | <p>RECYCLED ASPHALT</p>                       |
| <p>HCTCRB INVESTIGATION</p>                                  | <p>FATIGUE AT ELEVATED<br/>TEMPERATURES</p>         | <p>BEST PRACTICE ASSET<br/>MANAGEMENT</p>     |
| <p>DYNAMIC LOAD EFFECTS OF<br/>HEAVY VEHICLES</p>            | <p>OPTIMISED ANRAM USING<br/>TSD DATA</p>           | <p>LIGHT EMITTING LANE<br/>DEMARCATIION</p>   |
| <p>NON DESTRUCTIVE DENSITY<br/>TESTING</p>                   | <p>BOND STRENGTH TEST<br/>REVIEW</p>                | <p>MEASURING CAPILLARY RISE</p>               |
| <p>EVALUATING NANOSILICA IN<br/>ASPHALT</p>                  | <p>DENSITY COMPLIANCE<br/>SYSTEMS</p>               | <p>IMPROVED WORKS PROGRAM<br/>DEVELOPMENT</p> |
| <p>CRM RECYCLABILITY</p>                                     | <p>TRANSFERING CRM BINDER<br/>TO GGA TECHNOLOGY</p> | <p>OPTIMISING PROFILOMETER<br/>DATA</p>       |
| <p>REHABILITATION<br/>SUPPLEMENT TO<br/>AUSTROADS PART 5</p> |   |   |

Safety Improvements 
 Savings in Materials 
 Recycled Materials 
 Reduced Emissions 
 Noise Reduction 
 Reduced User Costs 
 Time Savings 
 Construction Cost Savings

## ACCOMPLISHMENTS

We live in the information age, but we are ready to usher in a new era of implementation. A time where the WARRIP can measure its successes not on the statistics of achievements as contained hereafter but, on its ability to disseminate the findings for ease of adoption and implementation. Our team of innovators through their work on scientific and industry development projects are committed to successful outcomes. There have been many, with 35 projects completed and the program achieving BCR of between 7.7 and 13.3, with improvements made in the design and adoption of new material for our road system resulting in significant savings to our community.

## OUR RESEARCH



### Recyclable Materials

Sustainable solutions that are cost effective, improve performance and are beneficial to the environment ensure that available resources are well utilised. WARRIP explored a crumbed rubber modified binder for its' potential application in open-graded asphalt. This long term project aims to update specifications to increase the utilisation of this product in WA.

Similarly, applying this crumb rubber modified binder in gap-graded asphalt will further extend the use of this recycled material. A supplementary project has been initiated to investigate this application.

In response to some industry concerns to the recyclability of pavements with crumb rubber modified binders, WARRIP has partnered with industry to investigate. To date such a pavement has been profiled and crushed, with samples currently being tested in the laboratory. This project is ongoing and should provide industry with some confidence in whether rubber modified pavements have the ability to be used as recycled asphalt materials.

Crumb Rubber Modified binder - OGA with 18% Yard Trial



Recycled asphalt pavements are not new to WA but investigations to maximise the opportunity for recycling pavements has been beneficial. It has provided better understanding of the recycled material and set the scene to remove barriers to the greater utilisation of this material.

The soon to be released Guide to Pavement Technology Part 5: Pavement Evaluation and Treatment Design provides guidance for the investigation of existing surfaced road pavements, the selection and design of pavement strategies or treatments. There is a need for WA to capture the state specific learnings and practices.



### Reduced Emissions

A key sustainability consideration is reducing the impact of pavement construction and maintenance by reducing the emissions during those actions. Key projects delivering lower emissions are warm mix asphalt and crumb rubber asphalt.

Crumb rubber asphalt has been successfully trialled with our industry partner, Fulton Hogan, in open grade asphalt, opening the door to increase the use of old rubber tyres previously sent to landfill. Not

only does this technology have environmental benefits but it also improves the performance of pavements offering increased durability and crack resistance.



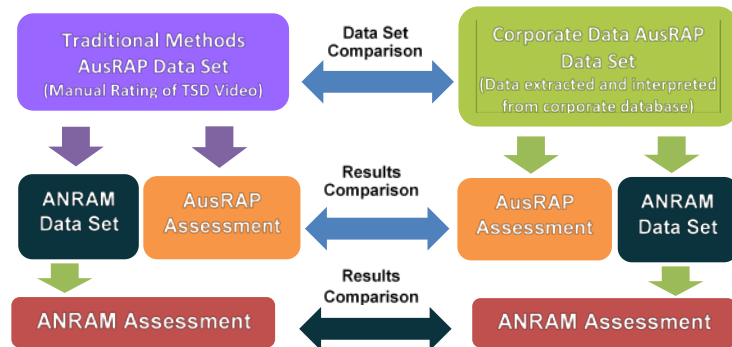
Sasobit® Pellets, source [www.engineeringnews.co.za](http://www.engineeringnews.co.za) Aug. 2015

Warm mix asphalt uses additives to allow asphalt to be produced at lower temperatures. These lower temperatures have the benefits of reducing emissions, saving on energy and assisting operators to extend hauling distances and extend construction seasons. Trials to date have offered considerable learning's, which will inform the next stage of testing and development of specifications for WA's application of the technology.

Other materials with environmental benefits were studied in our future technology project such as nanotechnology, recycled plastics and solar roads. Nanotechnology is not yet commercially viable at this stage, but research shows the technology may result in self-sensing, self-cleaning, and self-healing concrete. The recycled plastic industry was found to be a competitive market. Government support would be required to drive recycling initiatives to the point where the industry could support the volume of plastic that would be required to construct roads. Solar roads, although well suited to the Australian climate, are still being developed to a point where they could be used in Western Australia. Solar charging stations and lighting options are recommended for further investigation.

### Safety Improvements

WARRIP projects with a safety benefit have focussed on safer more efficient data collection methods, applying that data collection for safety assessments and optimal use. A comparison study was undertaken of corporate and traditional data sets to explore the suitability and applicability of using data extracted from the Main Roads WA corporate database for use in producing AusRAP and ANRAM data sets. Being able to assess roads for potential safety concerns quickly and efficiently using existing datasets would support Main Roads WA in ensuring the network is safe for users.



Allowing greater use of profilometer data will lead to a reduction in unsafe working conditions that can be created through alternative test methods. A review of current test methods and proposed revisions are provided through WARRIP.



Solar-powered roads studs, source TRL (2006)

Potential light emitting lane demarcation, that could improve visibility for our road users, providing safer driving conditions was reviewed. Initial studies into available technology show this industry is still in its infancy with potential in the future to provide some enhanced safety.



## Time Savings

Updating test methods to include new technology results in time savings. The TSD has been a game changer, allowing roads to be surveyed at speed making it quicker and safer to survey. The specialised lasers and cameras simultaneously capture pavement condition data obtaining deflection, roughness, rutting and cracking data in a single pass at up to 80km/h. After an initial review of this technology Main Roads have proceeded to assess their entire network in 2018 in this way.



Other examples of where test methods result in time savings include non-destructive density testing, alternative density compliance systems, bond strength tests and measuring capillary rise. Non-destructive testing reduce the amount of core samples taken to determine compaction compliance, using alternative equipment to check density. An investigation into alternative density compliance systems for subgrade and embankment construction to provide quicker, safer alternatives to current test methods was undertaken and field trials are planned for some of the alternatives identified.

Currently there is no standard bond strength test specified by Main Roads WA. These tests will be able to predict pavement performance at asphalt layer interface and reduce time required for repairs on inadequately bonded pavements. Similarly, having a better understanding and standard test method to measure capillary rise, will lead to a consistent way to estimate capillary rise height, resulting in better designs and fewer failures when constructing on sand.



## Reduced User Costs

Improving the road and riding quality can ensure the road user benefits too; less wear and tear on vehicles, less damage to goods in transit and improved travel time. We investigated the dynamic load effects of heavy vehicles on the road pavement, as they are a major contributor to pavement deterioration. This initial research focussed on collating the current understanding of dynamic load, its impact on the vehicle and effects on the pavement. Knowledge gaps were identified that might be addressed in order to better design and cater for the impacts of these loads on the road.



WARRIP also reviewed best practice in asset management to assist in assessing current asset management strategies and made recommendations for areas that could improve. Main Roads WA has implemented and maintained high standards for asset management but strives for continuous improvement and development of capability. Overcoming challenges faced by regional teams and ensuring capability levels are maintained and improved upon, will strengthen the ability of decision makers to make informed and best practice decisions. This will improve the network for road users through the whole-of-life cycle of pavements.



### Construction Cost Savings

Significant indirect savings can be achieved by improving the efficiency of the methods used to construct roads, especially in light of the vast network maintained across the whole of Western Australia. One of the first projects executed under WARRIP involved engaging industry expertise to identify improvements in our pavement practices; from pavement design alternatives to contract types to contractual matters such as defects liability periods. Common practices across other states related to the identified issues were compared. Various emerging technologies such as EME2 were identified for further research. These were covered by projects across the 2015-19 program.



Improving asphalt thickness designs through improved characterisation of the stiffness and fatigue behaviour of typical WA asphalt mixes at high weighted mean annual pavement temperatures are being investigated. As our Western Australian pavements are designed for higher temperatures in the northern areas, a saving in pavement thickness in full depth asphalt pavements with high traffic could have great cost savings. Initial results are varied, and further research are recommended to clarify design approaches, testing methodology and laboratory-to-field shift functions.

The performance of granular pavement trial sections on the Tonkin, Reid and Kwinana freeways have exceeded expectations. Three WARRIP projects focussed on analysis of these sections' performance and how learnings could lead to reduction in conservatism during design for granular pavements. The results to date have been promising and the next step will be a comparison study to further validate the findings.





## Savings in Materials

One of the key objectives of WARRIP is to identify potential cost savings for Main Roads WA, in order to pass on those savings to ensure the investment in the network achieves the best possible outcomes for Western Australia. The initial focus in this area considered pavement thickness and the reduction thereof as a means of saving on material costs. Many potential changes were highlighted through this research and have been considered by Main Roads.

The current WA specification for Stone Mastic Asphalt was assessed identifying potential savings through consideration of air void content, compaction, test methods, binder content. Main Roads is now reviewing the recommendations for feasibility in context of Western Australian applications.

Historically HCTCRB was developed in response to heavily trafficked or moisture affected areas requiring treatment to improve performance. Due to perceived performance risks HCTCRB construction has had limited use in recent years and requires a review to improve confidence in this method.



EME2 was developed in France and industry experts came to assist our research into this heavy duty pavement material in Western Australia. Using a strong, durable material that can handle heavy loads with a reduced thickness provides dual benefits of material savings and time savings. Initial trials again provided many learning's and has provided an interim specification.

As part of ensuring Main Roads ERN9 is current and reflect best practice regular reviews and updates are undertaken. WARRIP has been comparing and considering the latest best guides to update this Engineering Road Note.

Gathering data on asphalt temperature across the diverse climatic conditions in WA has been a long term focus of WARRIP. Understanding the conditions and stresses pavements are under will inform designs and provide thinner solutions with better understanding of the relationship between temperature and asphalt fatigue.

WARRIP has partnered with Curtin University to better understand the potential of nanosilica in asphalt, having a better understanding of the characteristics and performance of these extremely fine particles is the first step to validating the material.

Last but not least WARRIP considered how best to take advantage of both the review of their asset management systems and enhanced data collection to develop an improved works program that maximises the use of the available data and expertise.



PROGRAM PERFORMANCE



**Expertise**

**23% Applied**  
**49% Potential**  
**66% Innovative**  
**Applied Projects**

**7:7-13:3**  
**BCR**



**30 Activities**  
**490 Attendees**  
**43% MRWA**  
**Knowledge Transfer**



**55% on time**  
**82% on budget**  
**67% Good/Excellent**  
**Delivery**

## INDUSTRY

With the advent of new disruptive technologies which have at their core offer healthy mobility, cleaner and safer modes of transportation, WARRIP will be critical to the process of discovery, validation and adoption as part of this innovation program.

WARRIP realises that new technologies and practices emerge constantly, with their potential to enhance performance and safety and improve the sustainability and durability of existing and new roads and networks. WARRIP can draw upon industry experts across programs such as Austroads and NACOE, and importantly industry experts so that we may access global best practice for design and construction, with access to the latest research and techniques.

Ultimately our road users benefit from this knowledge, as we help make an objective assessment of technologies that will deliver real value and future benefits in roadway design and usability.

## ACKNOWLEDGEMENTS

We would like to acknowledge and thank the board, the management team, the project teams and our industry partners for their efforts in making this a successful program.

