2nd International Surface Friction Conference

The Centaur – Cheltenham, England, 11 - 14 May 2008

A Management Plan for Skid Resistance on the Queensland State-Controlled Road Network

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ABSTRACT

This paper describes the approach of the Queensland Department of Main Roads (QDMR) to managing skid resistance on the State-controlled road network, as a means of improving road safety and reducing trauma associated with road crashes.

Queensland's road traffic is concentrated in high rainfall sub-tropical and tropical Pacific coastal areas. QDMR developed a skid resistance management plan (SRMP) in response to studies of traffic crash histories around the world that have consistently found that, for wet road surfaces, a disproportionate number of crashes occur where the road surface has low surface friction.

Risk management is an integral aspect of the QDMR strategy for managing skid resistance. The QDMR strategy is based on a rational analytical methodology supported by field inspections and integration with related asset management decision tools. The aim is to make the probability of a crash with skid resistance or surface texture as a contributing cause uniform across the network, having regard to local circumstances such as traffic patterns and climate.

The QDMR SRMP defines the Department's overall objective and central strategy for managing skid resistance, describes a corresponding suite of performance indicators, and describes specific actions including research and development necessary to achieve the overall objective.

The paper explains the SRMP in detail, and concludes that skid resistance should be a central aspect of asset management and performance reporting, and that implementation of the SRMP will reduce the incidence of crashes with low skid resistance as a contributory cause.

1. INTRODUCTION

To understand the Queensland Skid Resistance Management Plan (SRMP), it will firstly be helpful to broadly describe the Queensland road network and how it is managed, particularly the road safety and asset management functions, because road safety is the driver for managing skid resistance, and managing skid resistance is part of asset management.

Of Australia's 6 States and 2 Territories, Queensland is the second largest in area (1,727,200 sq km, bigger than most nations, and similar to Iran, Libya, Mongolia and Mexico), the third most populous (4,120,000 at 30 June 2007), the least centralised, has the fastest population growth rate (about 1,500 persons per week), the greatest increase in vehicle registrations, and the greatest increase in travel (vehicle-kilometres) (Reference 1). Queensland's total road network is approximately 180,000 km long (with approximately 360,000 lane-km). Nearly 40% of the State's road network has a bituminous or concrete surface.

The population and travel is concentrated in the south-east corner of the State, and along the eastern seaboard. These areas coincide with areas of highest rainfall, and so they are the areas with the greatest risk of skidding accidents and the greatest potential for benefits from a rational and proactive approach to managing skid resistance.

Long-term traffic data indicate continuing statewide growth in travel at annual rates of around 3% for light vehicles and around 6% for heavy vehicles. Actual growth in travel will depend on economic conditions and is likely to be high because, for example, during 2006, Queensland's Gross State Product grew by 5.3%, which was over three times the rest of Australia's growth of 1.7%.

2. THE QUEENSLAND STATE-CONTROLLED ROAD NETWORK

Queensland Department of Main Roads (QDMR) is the State's primary road authority, with responsibility for delivering the government's social, economic and environmental objectives through stewardship of the State-controlled road network.

The 33,500 km State-controlled network contains the roads that carry the major traffic and provide the major links through the State. State-controlled roads carry approximately 80% of the State's road traffic. With a capital value of A$34.9 billion at 30 June 2007, the State-controlled road network is the State's single largest built asset.

QDMR is responsible for managing the Queensland State-controlled road network, which comprises:

- the Auslink national road network (the critical travel links, 5,040 km);
- the balance of the State's strategic roads (4,150 km in six strategic corridors); and
- regional and district roads (24,340 km).

QDMR's total expenditure in 2006/07 was A$2,059,515, including A$1,626,970 capital.

2. THE QUEENSLAND AND AUSTRALIAN NATIONAL APPROACHES TO ROAD SAFETY

The Queensland government regards safer communities as one of five key long term priority objectives (Reference 2). Recent estimates of the social cost of road crashes to the Queensland community are of the order of A$3.6 billion or 2.8% of Queensland's Gross State Product (Reference 1, page 81). QDMR has adopted safer roads as one of its top four key outcomes (Reference 3, page 12).

In Queensland there was a 40% reduction in the road fatality rate from 13.73 fatalities per 100,000 population in 1992 to 8.19 per 100,000 in 2003. This downward trend has not been maintained in recent years, with 330 road-related fatalities in 2005 (8.32 per 100,000) and 335 fatalities in 2006 (8.30 per 100,000).

The Queensland *Road Safety Action Plan 2006-2007* is based on the government's response to recommendations from a Summit convened in 2006 in response to the recent adverse road safety trend, and on community consultation. It supplements existing and ongoing road safety initiatives.

The Australian *National Road Safety Strategy (2001-2010)* identifies four areas for action, viz, safer speeds, roads, drivers and vehicles. Under roads, the national strategy specifically mentions skid resistance in one of seven priority actions, viz "Increase the number of intersections and approaches assessed for skid resistance and treated where resistance levels are low."

Responsibility for road safety in Queensland is shared between QDMR, the Queensland Police, and Queensland Transport, along the following lines:

- The Queensland Police have primary responsibility for the delivery of a range of proactive and reactive traffic activities centred on law enforcement and including random breath testing, speed management and traffic camera operations.
- QDMR has primary responsibility for keeping the State-controlled road network safe and trafficable. QDMR includes road safety in economic evaluations of all capital investment proposals for roads. Almost all road projects have a positive road safety outcome.
- Queensland Transport (QT) is the lead agency responsible for developing, managing and coordinating land, air and sea transport in Queensland. QT promotes road safety, and works closely with QDMR and other government departments, local governments, industry and the community to ensure a coordinated, consultative and integrated approach to addressing transport challenges.

3. QUEENSLAND'S APPROACH TO ROAD ASSET MANAGEMENT

QDMR accepts the Austroads, OECD and PIARC definitions of strategic asset management, viz:

- A comprehensive and structured approach to the delivery of community benefits through management of road networks (Reference 4); and
- A systematic process of effectively maintaining, upgrading and operating assets, combining engineering principles with sound business practice and economic

rationale, and providing the tools to facilitate a more organised and flexible approach to making decisions necessary to achieve the public's expectations (OECD and PIARC 1999).

QDMR recognises that effective road system planning should focus on the long term. Planning therefore considers the current and future needs of road users, with the overall objective being to identify and prioritise needs for the long-term preservation and efficient use of existing infrastructure, and for new infrastructure that will support efficient travel, and existing, new and emerging industries, and the community in general.

To ensure that its responsibilities are carried out consistently across the State, QDMR has adopted a comprehensive 'cradle to grave' iterative framework for asset management of its road network. Principles such as risk management, fit-for-purpose design, affordability and project management are embedded within this framework, which defines seven phases covering strategic direction setting, development of policy and strategy, program development, delivery and operations, performance review and feedback. The framework includes stakeholder engagement as an integral aspect of each phase and activity.

In recent years QDMR has issued a series of internal documents setting out the details of its approach and processes, etc for asset management, chiefly:

- *Strategic Framework for Road System Asset Management,* based on the 2002 Austroads *Integrated Asset Management Guidelines for Road Networks* (Reference 5);
- *Road System Manager – Framework Process Map* (2005); and
- *Road System Manager – Guide to the Framework* (August 2005).

In accordance with the strategic framework, the management processes for each of 34 activities, of which skid resistance is one, are compared with current QDMR policies and procedures to identify gaps. The gaps are given priorities to assist in developing new policies and procedures. Because of resource constraints it is important to focus development work on areas that are expected to have the best impact on achieving an overall efficient and effective chain of processes. The overall process is only as strong as the weakest link. Therefore, rather than refining areas that have already been developed, greater returns can be achieved by directing resources to under-developed areas. Although some processes are still being developed, the framework is helping to identify this focus.

In summary, QDMR practice in road asset management at both the network and project level is proactive, has a long term focus, responds to agency and road user costs and stakeholder perspectives, uses rational assessment methods, and relies on automated capture of data on inventory, condition and use of the major asset components (notably pavements, bridges, delineation devices, and road reserves).

QDMR uses prioritisation software developed in-house, notably "SCENARIO" for pavement management and "WhichBridge" for bridge structure management. These programs aim to achieve over a long term consistent fit-for-purpose standards across the State, in terms of road configuration and condition. Similarly, the QDMR method for prioritising remedial treatments where skid resistance is low aims to equalise the risk of crashes (measured in terms of crash rates per vehicle kilometres travelled) across the State. To date software for this method has not been developed.

4. THE QUEENSLAND APPROACH TO MANAGING SKID RESISTANCE

4.1 WHY MANAGE SKID RESISTANCE ON THE QUEENSLAND ROAD NETWORK?

Studies of traffic crash histories have consistently found that a disproportionate number of crashes occur where the road surface has a low level of surface friction and/or surface texture (macrotexture), and particularly when the road surface is wet. In addition to skid resistance and surface macrotexture, there are many influences on the level of risk of crashes, such as driver behaviour, traffic conditions, travel speed, road geometry and condition, and vehicle characteristics (eg, tyre type, pressure and condition, and suspension type and condition). Of these physical influences, experience suggests that drivers are least able to perceive the level of surface friction.

Managing skid resistance and surface texture is therefore an essential part of the QDMR response to its responsibilities for traffic safety.

4.2 WHAT IS SKID RESISTANCE?

QDMR defines skid resistance as a condition parameter characterising the contribution that a road makes to the friction between a road surface and a vehicle tyre. A quantitative measure of ‘skid resistance’ refers to the frictional properties of a road surface measured using a specific device under standard conditions. These measurements are used to characterise the road surface and assess the need for maintenance, but cannot be related directly to friction available to a vehicle executing a particular manoeuvre at a particular time and location.

The new QDMR approaches to road safety and to road network asset management, as outlined above, have led to a sharper focus on a number of key road surface condition parameters, notably roughness, rutting, cracking, surface texture and skid resistance. As a result and in response to the Key Output and Outcome in *Roads Connecting Queenslanders* (Reference 3), of “safer roads to support safer communities” and supported by the 2005 Austroads *Guidelines for the management of road surface skid resistance* (Reference 6), QDMR has expanded its traditional project-level interest in skid resistance by undertaking network level surveys, analysis, and planning.

The 2005 Austroads guidelines (Reference 6) list 16 key elements to be considered in the development of a road authority’s strategy for managing skid resistance. QDMR considered these elements in developing the SRMP, which tabulates the position of QDMR for each element as at February 2006. For example, for the element “Setting levels for skid resistance and surface texture”, the QDMR position was “To be developed further after research. Investigatory Levels have been set for skid resistance. Intervention and threshold or minimum levels will be considered in future skid resistance management strategies.”

Within the QDMR organisation structure, the SRMP describes the responsibilities for managing skid resistance and for providing support to those managers.

4.3 SKID RESISTANCE MANAGEMENT PLAN (SRMP)

4.3.1 Scope of Skid Resistance Management Plan (SRMP)

Introduction of the new emphasis on skid resistance prompted QDMR to compile a *Skid Resistance Management Plan* (SRMP) (Reference 7), which:

- defines QDMR's **overall objective** and **central strategy** for managing skid resistance;
- establishes a corresponding suite of **Key Performance Indicators** (KPIs);
- describes action necessary to **achieve** the overall objective and to **implement** the central strategy for skid resistance; and
- identifies QDMR's **processes** for managing skid resistance.

The SRMP also serves as an interim depository for technical guidelines on skid resistance, such as the measurement regimes for skid resistance and surface macrotexture, pending completion of sufficient research and development to warrant issuing QDMR guidelines.

4.3.2 Structure of Skid Resistance Management Plan (SRMP)

The SRMP is structured around the generic asset management framework used by QDMR, and comprises a six-step process of:

- Consistent **measurement** of skid resistance and surface texture (Chapter 5);
- Consistent **management of data** on skid resistance and surface texture (Chapter 6);
- Consistent **analysis of data** on skid resistance and surface texture (Chapter 7);
- Consistent use of data in reaching **decisions about remedial actions** (Chapter 8);
- Consistent **design, construction and maintenance practices** (Chapter 9); and
- Quantified **performance targets, regular reviews and feedback** (Chapter 10).

In addition, Chapter 11 in the SRMP suggests 38 future actions for QDMR that are likely to support further improvements in the management of skid resistance. Many of these are listed later in this paper.

4.3.3 Overall Objective, Central Strategy, and Key Performance Indicators

The SRMP defines QDMR's overall objective in managing skid resistance is to **reduce the incidence of crashes** on the State-controlled road network with low skid resistance as a contributory cause.

QDMR's central strategy in managing skid resistance is to provide **appropriate levels of skid resistance and surface texture throughout the State-controlled road network**.

The proposed new **Key Performance Indicators** in the SRMP are:

- '**number of wet-weather mid-block crashes per 100 mvkt per year**'
  (where mvkt is million vehicle kilometres of travel); and
- '**number of wet-weather intersection crashes per year**'
  disaggregated for 'mid-block' and 'intersection', and by
  'urban area' (speed limit at or below 80 km/h) and
  'rural area' (speed limit above 80 km/h).

4.3.4 Causes of low skid resistance

The SRMP identifies the common causes of low skid resistance on the Queensland State-controlled orad network, as a variety of surface defects such as stone polishing, bleeding, stripping, flushing, and contamination, as well as pavement markings, manhole covers, and crack sealants with low friction. However, the available surface friction also depends on vehicle speed, surface texture, water depth, tyre characteristics and condition, vehicle suspension and distribution of mass, temperature, seasonal influences, and road geometry.

Standard methods of measuring skid resistance are therefore necessary to 'isolate' the contribution of the road surface itself to the level of friction available.

4.3.5 Measuring skid resistance and managing data

For measuring skid resistance, QDMR has used the portable British Pendulum Tester at a project level for many years, and Norsemeter ROAR (variable slip mode) and SCRIM devices at both network and project levels. For measuring surface macrotexture, QDMR has used the sand patch method at a project level for many years, and multi-laser profilometer at a network level. We recognise that the values of skid resistance and surface macrotexture from the different device types are different parameters and cannot be directly compared.

For each of skid resistance and surface macrotexture, the SRMP includes two measurement regimes – one for network level monitoring, and one for project level assessments. The QDMR network level regime for skid resistance is broadly consistent with the proactive approach described in the 2005 Austroads guidelines (Reference 6), and the QDMR project level regime is broadly consistent with a reactive approach. The four measurement regimes cover aspects such as responsibilities for initiating measurements, selection of carriageway, lane and wheelpath, survey frequency (time interval), time of survey, sample and reporting intervals (length), equipment and test method, and data audit requirements.

The survey frequency (time interval) in the network level (proactive) measurement regime for monitoring skid resistance was derived having regard to the typical average life of around 8 years for surfacing on the strategic network, and the need for a balance between:

- the cost of skid resistance testing;
- the need to be aware of and to monitor locations with low skid resistance; and
- the need for quality data on skid resistance to establish relationships between skid resistance and the incidence and severity of crashes and to establish trends in skid resistance over time.

The more detailed project level (reactive) measurement regime for monitoring skid resistance recognises the relatively low cost (except possibly for site establishment, depending on the proximity of the site to Brisbane or to other concurrent skid resistance test locations), and the need for greater confidence in the results. QDMR intends to review the measurement regimes (particularly for network level measurement of skid resistance) as experience is gained in their application.

Skid resistance data is managed in the corporate pavement database (ARMIS PAVCON). Automation of identifying and presenting 'Skid Resistance Site Categories' (high, intermediate and normal, depending mainly on geometry, advisory speeds, the presence of pedestrian or rail crossings, intersections, merges, etc) is intended, bearing in mind that 'Skid Resistance Site Categories' are unique, viz, not the same as any other categorisation within ARMIS.

4.3.6 Risk-based approach to analysis of data on skid resistance and crashes

Management of risk is an integral aspect of the QDMR strategy for managing skid resistance. Low skid resistance and surface texture can increase the risk of traffic crashes. The central strategy of providing **appropriate levels of skid resistance and surface**

texture at all locations throughout the State-controlled road network is intended to broadly equalise the risk across the network of crashes with low skid resistance as a contributory cause.

Because of the reality of finite budgets, competing priorities, the consequential preference for a risk-based approach, and the inherent statistically variable nature of skid resistance data, QDMR has not adopted a set of absolute minimum levels (sometimes referred to as threshold or intervention levels) for skid resistance at this stage. A set of minimum levels for skid resistance may be appropriate after further research. The SRMP sets out a probability-based approach as a basis for decisions on remedial treatments.

The QDMR risk-based approach to managing skid resistance:

- is consistent with the Department's broad approach to asset management, and the 'fit-for-purpose' concept in *Roads Connecting Queenslanders* (Reference 3);
- is based mainly on proactive network monitoring rather than reactive assessment of crash sites; and
- aims to provide a level of skid resistance that is appropriate to the road environment at each location on the network.

The risk-based approach relies heavily on analysing skid resistance and crash data side by side. However, the SRMP lists a number of significant difficulties in this, including:

- Crash numbers within a specific road length and time period are typically low, and though they may be historically accurate, they may not be statistically significant.
- The period for crash data may be a number of years, during which the skid resistance may have changed as a result of traffic and other factors, such as maintenance.
- It is often necessary to consider data on resurfacing and other maintenance to understand changes in skid resistance within a time period.
- QDMR relies on data from QT and the Police for planning analysis and for reviewing and reporting on progress with the proposed Key Performance Indicators.
- Possible low accuracy of location data for crashes on a road segment.
- Crash data may identify the location of impact, but not of the cause of the crash.
- Skid resistance data captured in different seasonal conditions from a given site may not be comparable.
- Skid resistance and macrotexture data from network surveys may not be obtained from the same lane as the cause of the crash.
- Skidding or slippery conditions in crash data may not be relevant to the cause.
- It is difficult to assign reliable traffic volumes to a specific section of road, because of the relatively large spacing between traffic counting stations.

4.3.7 Remedial actions

QDMR recognises the need to ensure that decisions about remedial actions and their priorities are supported by rigorous objective analysis, and are appropriately documented. The first step in this is to identify road sections where skid resistance data from the most recent network survey is at or below the relevant Investigatory Level. The challenge then is to prioritise remedial actions for these locations. A risk-based approach is used to determine the appropriate remedial action and treatment for each location and its priority. The main criteria influencing the appropriate remedial actions and priorities are the historical crash rate, traffic volume, skid resistance demand category, and other asset management inputs (eg, priority for resurfacing based on influences such as oxidation and brittleness or age of surfacing, roughness, rutting, macrotexture, stripping, flushing, cracking, etc). Priority is given to locations where probability of failure to comply with the skid resistance Investigatory Level exceeds 30%, and extra attention is given where this probability exceeds 50%.

A site inspection and investigation is necessary before a final decision is reached on a remedial action resulting from low skid resistance. The SRMP specifies the details of the conduct of site inspections and investigations, and stresses the importance of co-ordinating site inspections with similar inspections that aim to assist in selecting treatment options and priorities for surface treatments that are driven by considerations other than skid resistance.

The SRMP also emphasises that a surface treatment is not the only option for responding to inadequate skid resistance – it identifies remedial actions for sites with low skid resistance as potentially comprising geometric, surfacing, and traffic engineering options. For example:

- **Geometric options** include increasing curve radius, increasing superelevation, modifying the geometry to reduce water flow depth and ponding, segregating traffic flow, etc.
- **Surfacing options** include resurfacing, using durable (non-polishing) aggregates that retain their microtexture, or high friction aggregate (calcined bauxite), using open-graded asphalt, heating and rolling new stone into asphalt surfacing.
- **Traffic engineering options** include reducing travel speeds, improving delineation (signs, lines, etc), and installing crash barriers.

4.3.8 Reviews

The SRMP calls for three levels of review, viz:

- Reviews of progress in implementing the SRMP – an effective management level steering committee has been established for this purpose, with the aim of ensuring changes are introduced to QDMR practices as a result of progress with and findings from the research and development proposed in the SRMP;
- Annual monitoring of the numerical skidding crash indicators described above; and
- A 20 year vision and a 5 year milestone for skid resistance and surface macrotexture, shown in Table 1.

Element measure	20 year vision	5 year milestones
Skid resistance	Ensure that sites identified as having skid resistance below the relevant Investigatory Levels have been investigated and remedial works programmed if required.	Ensure that sites identified as having skid resistance below the Investigatory Levels and with above average crash rates have been treated.
Texture depth	The high speed chip sealed network has a macrotexture depth of greater than 1 mm (sand patch equivalent).	Ensure that less than 3% of the non-skid tested chip sealed length has a macrotexture depth of less than 1 mm (sand patch equivalent).

Table 1: – QDMR Performance targets for skid resistance and surface texture

4.3.9 Further research and development

As mentioned above, the SRMP highlighted 38 areas where research and development was considered worthwhile. Work has commenced on some of these areas, co-ordinated by a Working Group comprising QDMR personnel with expertise in skid resistance, pavement surfacings, and road infrastructure asset management. The research and development areas suggested in the SRMP include:

- Analysis and review of crash data to test whether 800 mm rainfall per annum is the appropriate threshold for determining the frequency of skid resistance testing.
- Establish the correlation on the Queensland State-controlled road network between crashes, skid resistance, and texture depth, covering a wide range of local circumstances. Also review the recent UK standards (Reference 8), and consider the need for a set of minimum or threshold levels for skid resistance to replace the probability approach being adopted now.
- Review the skid resistance Investigatory Levels, using the results of the above work.
- Review the suitability of 1 mm (sand patch equivalent) as the investigatory level for macrotexture of sprayed seal surfacings, and consider specifying target levels for macrotexture on new asphalt surfacings.
- Record experience with the use of and then review the four measurement regimes for skid resistance and surface texture, and incorporate the resulting measurement regimes in an updated QDMR *Pavement Condition Data Collection Policy*.
- Conduct and report on parallel testing of skid resistance on the QDMR network, using the ROAR (owned and operated by QDMR) and a SCRIM (owned and operated by RTA NSW).
- Formally document and publish the current informal test methods for measuring skid resistance at the network and project levels, and for measuring macrotexture depth using non-contact (mainly laser) techniques.
- Examine the feasibility of and, if appropriate, develop and introduce processes for confirming 'skid resistance site categories' while measuring network and project level skid resistance.
- Establish field calibration sites throughout Queensland, to complement those recently established at Townsville and at the Gateway Arterial (SMA surfacing) in Brisbane.
- Establish a central mechanical calibration facility in Brisbane, for use with the skid resistance measurement process.
- Automate in ARMIS the current manual practice of identifying and presenting 'skid resistance site categories'.
- Develop systems that facilitate early recognition and notification of sections found to have poor crash rates, low skid resistance, or inadequate surface texture.
- Formalise the format for uploading skid resistance data to ARMIS, and include in training programs to assist District personnel in understanding data on skid resistance.
- Develop and formally document procedures for audits of network level data on skid resistance and surface macrotexture including data quality audits by the ARMIS group, and higher level network audits.
- Establish a QDMR position on making skid data available outside QDMR, and implement the resulting process.

- Develop a standard presentation style in CHARTVIEW for data on skid resistance.
- Establish a set of 'investigation sections' throughout the SCR network, covering a range of traffic, climatic and aggregate circumstances, for capture of more intensely detailed data on skid resistance and surface texture, to enable long term monitoring at a research (as distinct from an operational) level.
- Establish target levels for skid resistance on new surfacings (a longer term task).
- Finalise a site inspection process, and relate it to existing inspection processes for asset management and safety auditing.
- Further develop the risk-based decision methodology as a tool for use at the project level for prioritising responses to identified skid resistance problems. The needs include identifying available treatments and their effectiveness by examining circumstances in which treatments are successful and not successful (eg, various stone sizes from the same source).
- Introduce guidelines for monitoring sites with low skid resistance, pending corrective treatment.
- Develop and implement guidelines for reviewing the continued need for "Slippery" and similar signs after resurfacing or other corrective treatment.
- Expand current guidelines and specifications for road surfacing:
    - ♦ to cover skid resistance issues for new surfacings, possibly by specifying performance criteria including a range of values for PAFV, macrotexture and skid resistance (cooperative work with a panel of experts from some of the other Australian State Road Authorities proved helpful in deciding on target values for PAFV and macrotexture);
    - ♦ to respond to the phenomenon of low early skid resistance, including practicality of resourcing testing; and
    - ♦ to review the QDMR standard specification for construction of unbound pavements, specifically considering increasing density from standard to modified compaction density, providing more cohesive fines, and introducing a maximum embedment requirement and a standard Test Method.
- Develop a Technical Note on linemarking that includes skid resistance criteria.
- Develop a Technical Note on crack sealing to include skid resistance criteria.
- Define and specify in detail a small suite of skid resistance KPIs based on wet weather crashes, (eg, define terms such as mid-block, wet weather crash, etc and provide sample calculations of each KPI). Establish current values for the KPIs. Introduce the skid resistance KPIs within the framework of other QDMR KPIs.
- Develop detailed procedures to enable consistent monitoring and reporting over time of progress in achieving the 5 year milestone and 20 year vision for skid resistance and surface macrotexture.
- Develop and deliver skid resistance management training (the initial training in 2007 prompted a call from District personnel for more training on the technical and management aspects of skid resistance, and this is now planned for 2008).

5. CONCLUSIONS

QDMR has developed a management plan for skid resistance (the SRMP).

QDMR has begun managing skid resistance as a central aspect of asset management and performance reporting on the State-controlled road network, and is confident that implementation of the SRMP will reduce the incidence of crashes with low skid resistance as a contributory cause.

The purpose of the management plan is to describe QDMR's overall objective and central strategy for skid resistance, and to introduce a small suite of new Key Performance Indicators on road safety, which is one of the most important responsibilities of QDMR.

The SRMP outlines a risk-based approach to the management of skid resistance as part of the overall asset management of the road surfacings on the Queensland State-controlled road network.

The SRMP identifies a number of needs for further research and development, which are being progressed by QDMR.

The effectiveness of the SRMP will be readily assessable in the future by reviewing a time series of data on the rates of wet-weather crashes on the Queensland State-controlled road network.

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