*International Public Works Conference*
*25 -29 August 2019*

# Hydro Tasmania Road Network Management

**N. Cribbin CEng (Civil), Dip PM, OMIE Aust[1*]**

[1] *Hydro Tasmania, Hobart, TAS*

[*] *Corresponding author. Email: norm.cribbin@hydro.com.au*

***ABSTRACT:*** *Hydro Tasmania owns and manages 588 km of roads, with some 386 km (66%) open to public access. The objective of Hydro Tasmania's roads programme is to maintain a safe and reliable road network for use by Hydro Tasmania employees and the public, established upon an acceptable level of organisational risk.*

*The management and maintenance of the road portfolio is governed by the corporation's asset management strategy to "Discharge all safety, duty of care, legislative and operational compliance obligations on a prioritised risk basis". This strategy is supported by the corporation's safety vision of "No harm to anyone at anytime." by providing safe access to staff and the public.*

*In order to fulfil the organisation's roads programme objectives, Hydro Tasmania engaged the capability of an experienced road maintenance contractor in 2009 to deliver road management and maintenance services safely and efficiently through a transparent value for money relationship based contract model.*

*Hydro Tasmania has developed a Road Risk Rating (RRR) system as a measure of exposure to Duty of Care (DoC) risk. The RRR system allows for targeted spending of operation maintenance funds where the highest return on investment is achieved.*

*Key components of Hydro Tasmania's roads asset management include:*

- *Assessment of Asset Management Capability*
- *Roads Classification system (Asset Hierarchy & inventory)*
- *Agreed Levels of Service and Intervention Timing*
- *Regular Network inspections appropriate to the various road classes*
- *Knowledge Management*
- *Programme Governance*

*This paper presents the development of Hydro Tasmania's (HT) roads asset management since 2008 to the present.*

**KEYWORDS:** Hydro Tasmania, road network management, road risk rating.

## 1 Introduction

Hydro Tasmania owns and manages 588 km's of roads, with some 386 km (66%) open to public access, as shown in Figure 1. The objective of Hydro Tasmania roads programme is to maintain a safe and reliable road network for use by Hydro Tasmania employees and the public, established upon an acceptable level of organisational risk.

The management and maintenance of the road portfolio is governed by the corporation's asset management strategy to "Discharge all safety, duty of care, legislative and operational compliance obligations on a prioritised risk basis". This strategy is supported by the corporation's safety vision of "No harm to anyone at anytime." by providing safe access to staff and the public.

Road management was undertaken in a spasmodic manner from individual power generation areas (6 no. exist within the state), resulting in annual expenditure variations of up to 300% year to year. The business held little or no roads expertise, and risk or service criteria were not primary drivers for expenditure.

In order to fulfil the organisation's roads programme objectives, Hydro Tasmania engaged the capability of Stornoway Maintenance Pty Ltd in December 2009 to deliver road management and maintenance services safely and efficiently through a transparent value for money relationship based contract model.

Developing around prudent service standards and a robust pavement management system (PMS), the programme has matured significantly and yielded a variety of benefits.

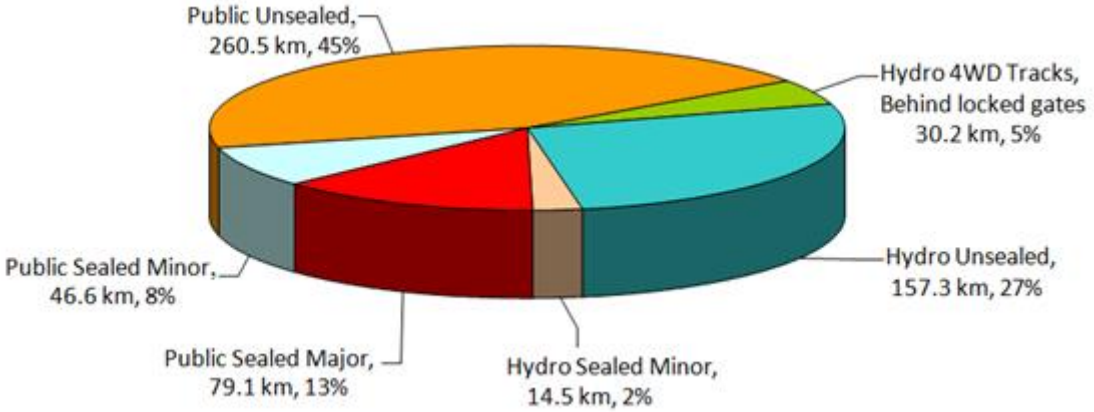


**Figure 1 - Hydro Tasmania categories**

## 2. Background

### 2.1 Business Case 2008

A business case approved by the Hydro Tasmania Capital Investment Allocation Team (CIAT) in December 2008 stated the following benefits for the implementation of a state-wide road safety maintenance and safety improvements programme of works;

"*The roads programme will provide the organisation with a reduction in risk exposure from both business and public use of our road network. The programme has been designed to maximise the productivity of Technical and Operations staff by addressing road issues on a state-wide portfolio approach. The programme has been structured to make better use of contractors and contracting methods to more efficiently discharge minimum standards of road maintenance."*

The Business Case recognised there is no single solution to address road network issues. Rather a number of interdependent elements – including a statewide portfolio approach, safety upgrades and performance based contract servicing - needed to be affected for successful delivery of effective road asset management and maintenance.

### 2.2 Asset Management Maturity Level

To assess Hydro Tasmania's performance in road asset management a self-assessment structured around the generic asset management framework developed in Australia by Austroads in 1999-2000 has been undertaken. The self-assessment kit was developed by Mihai, Binning & Dowling [1] with the view that the asset management planning process should be an integral part of a road management portfolio quality culture. The self-assessment kit consists of a list of 50 questions, scored 0-5, addressing seven key elements of asset management:

- Agency objectives & stakeholder requirements
- Strategy and planning process
- Data, information and Knowledge
- Business results
- People
- Leadership
- Audit and review.

An initial self-assessment was conducted in June 2008 prior to commencement of the contract with Stornoway Maintenance Pty Ltd (Stornoway) to deliver a state-wide road maintenance programme. The intention was to establish a baseline by which maturity over time in road assessment management could be assessed. The self-assessment was performed again (in 2008) with the assumption that a road network management plan (RNMP) [2] and pavement management system (PMS) had been implemented. Table 2 presents the scores of these two assessments.

Table 1 describes the interpretation of the total scores out of 250.

**Table 1:** Self-assessment of total scores

| *Overall score* | *Description* | *Interpretation* |
|---|---|---|
| 200-250 | Best practice, continuous improvement phase | Excellence |
| 150-199 | A good system in place but can be improved | Competence |
| 100-149 | Undergoing development with knowledge of the correct process | Systematic approach |
| 50-99 | Still developing | Development |
| 25-49 | Basic understanding only | Awareness |
| 0-24 | Lack of understanding | Innocence |

**Table 2:** Initial 2008 Initial Scores

| *Element* | *Description* | *Possible score* | *Initial assessment June 2008* | *Assessment assuming RNMP & PMS in place* |
|---|---|---|---|---|
| 1 | Agency objectives and stakeholder requirements | 30 | 4 | Individual element scores unavailable |
| 2 | Strategy and planning process | 65 | 26 | |
| 3 | Data, information and Knowledge | 65 | 33 | |
| 4 | Business results | 30 | 8 | |
| 5 | People | 20 | 7 | |
| 6 | Leadership | 20 | 17 | |
| 7 | Audit and review | 20 | 7 | |
| Total | | 250 | 102 | 154 |

The initial assessment indicates the organisations maturity in road assessment management in June 2008 had barely achieved 'Undergoing development', indicating *"…a systematic approach to asset management, the organisation is in the process of developing the process and there are several good initiatives, however not fully deployed*".

Repeating the self-assessment assuming a road network management plan (RNMP) and pavement management system (PMS) had been implemented, the score improved to borderline 'Competence', indicating *"…competence in asset management, a good process is in place, but audits and reviews are required to identify areas for improvement*".

The above step change in road asset management maturity supported Hydro Tasmania's decision to enter a contract with Stornoway to deliver a state-wide road maintenance programme, thus engaging technical competency.

## 3. Strategy & Programme Development

### 3.1 Road Safety Improvements

In late 2009 a business case paper was submitted to, and approved by, CIAT for the delivery of year one of the four year programme of works to deliver state-wide road safety improvements.

Using a risk evaluation report prepared by external consultants in 2006, identifying 1276 issues totalling $10.9 million, a parcel of work was selected and issued for pricing and delivery methodology through a closed tender process targeted at companies known to Hydro Tasmania. The evaluation criteria were weighted essentially on cost and time with the successful Tenderer eventually selected on the basis of being the most cost effective. Stornoway worked closely with Hydro Tasmania and successfully completed the parcel of works on time and on budget.

## 3.2 Review of Road Management Capability

On commencement of year one of the safety improvement programme of works it became apparent the original report (External Consultants 2006) used for the tender process was out of date and there was a need to re-evaluate the roads on a prioritised risk basis.

This initial re-evaluation process, using Hydro Tasmania risk evaluation criteria [3], was undertaken on a collaborative basis between Stornoway and Hydro Tasmania.

Stornoway developed a keen understanding of Hydro Tasmania's requirements and, as well as utilising their own core experience, has proven to Hydro Tasmania that they can successfully meet Hydro Tasmania's requirements.

The road safety improvements project highlighted the value of establishing an open and trusting relationship with an experienced vendor, capable of working independently in often remote locations; a contractor willing to learn, understand and align with all Hydro Tasmania safety, environmental, sustainability, and quality requirements and, a vendor wanting to enter into a relationship with Hydro Tasmania and align goals and outcomes.

Hydro Tasmania recognised road maintenance is not a core activity, and that establishing a relationship with a road maintenance company was the most efficient way of assuring legislative and duty of care requirements and demonstrating due diligence.

## 3.3 Road Management Strategy - 2010

Following learnings from the Road Safety Improvements tender process, the strategy was revised to combine road maintenance and safety improvements into a single programme.

To allow the successful vendor to establish sound road management strategies and to become thoroughly familiar with the Hydro Tasmania's road network, strategies, policies, legislative and compliance requirements a minimum contract period of three years was nominated.

Procurement adopted a 'Relationship Contract' which allowed a collaborative approach in scope development for the delivery of the programme of works. Given the lack of expertise within Hydro Tasmania, this approach was important to ensure the desired outcomes were enabled by the Contract structure and documentation.

Using best estimates Hydro Tasmania adopted a fixed annual budget for road maintenance ($1 million), capital works ($500 000), and the safety improvements programme of works ($3 million over 3 years) making the budget and schedule known quantities.

Key elements of the road management programme strategy are listed below:

- No harm to anyone at anytime
- World Class Asset Management (WCAM)
- To deliver a fully managed road maintenance program that discharges all Hydro Tasmania's 'Duty of Care' and legislative obligations
- To deliver a road network that is fit for purpose at the lowest Life Cycle Cost
- To implement a program of works to address identified road safety improvements on the Hydro Tasmania owned road network.

## 3.4 Road Management Programme Contracts

In December 2009 Hydro Tasmania entered a contract with Stornoway Maintenance Pty Ltd to deliver a state-wide road maintenance programme. The initial term of the contract was 3 years, with a further 2 year option.

The initial contract term with Stornoway Maintenance Pty Ltd to deliver a state-wide road management and maintenance programme matured in December 2012. The option to extend for a further term of 2 years was exercised and the contract expired on 31 December 2014.

In September 2014, Stornoway was assessed as likely to remain the best placed Contractor to provide road maintenance and management services for Hydro Tasmania. They are a locally established business, focussed heavily on the relationship and solving problems to suit our needs. In a memo to the Manager Asset Strategy & Risk the following recommendations were made and subsequently endorsed.

- A Contract be pursued for a period of up to five years, with an option for a further 5 years
- A basic EOI be undertaken to determine market interest in this Contract proposal.

In October 2014 the Hydro Tasmania Supply Chain Manger, after conducting the basic EIO, made the following statements:

"*I support the recommendation that the direct negotiations with Stornoway be pursued for a new 5+5 year contract from 2015 – 2019*

*inclusive (to align with the state governments contract term)*.

*I also recommend that an EOI / Tender process be fully considered and evaluated in another four years' time, when the proposed contract with Stornoway still has 12 months remaining. The review of the contract at the start of 2019 can take into account any decision by the state government to renew or tender their own 5+5 contract."*

In December 2014 the Formal Instrument of Agreement for the initial term of 5 years was signed.

Currently a memorandum has been prepared to recommend that Hydro Tasmania exercise the option extend the existing contract for a further 5 years (2020 to 2024).

# 4. Asset Management Capability

## 4.1 Introduction

Since inception of the initial contract both Hydro Tasmania and Stornoway have co-operatively worked together to develop and refine the Road Network Management Plan (RNMP) [4]. Considerable improvement has been made in addressing the 7 elements of road asset management described in section 2.2.

## 4.2 Assessment Tool

A framework to assess organisational maturity in road asset management was documented by Mihai, Binning and Dowling (2001) [1]. The assessment tool is structured around the generic asset management planning framework developed in Australia by Austroads in 1999-2000. The concept of this tool is aligned with the Australian Business Excellence Framework, Balridge Award and the 2000 ISO 9000 series and consists of fifty (50) questions that address seven elements of road asset management.

**Table 3:** Assessed Maturity Score over time

| *Year* | *Assessed Maturity Score* | *Descriptor* | *Interpretation* |
|---|---|---|---|
| 2008 | 102 | Undergoing development with knowledge of the correct process | Systematic approach |
| 2008* | 154 | A good system in place but can be improved | Competence |
| 2011 | 209 | Best practice, continuous improvement phase | Excellence |
| 2012 | 188 | A good system in place but can be improved | Competence |
| 2014 | 202 | Best practice, continuous improvement phase | Excellence |
| 2017 | 205 | Best practice, continuous improvement phase | Excellence |

* Reassessment assuming road network plan in place.

An internal assessment in 2008 using this tool produced a score of 102 out of 250, indicating a *'Systematic Approach'* existed. This status was a key indicator of the need for change.

In early 2011 this assessment was repeated by an independent road asset management consultant, with the output being a much improved score of 209 or *"Excellence".* Such a result indicates best practice asset management elements are in place, and the continuous improvement phase has been reached.

An internal re-assessment was conducted in August 2012 by Portfolio Risk Manager Civil – Daryl Polzin and Civil Technical Specialist – Norm Cribbin, with the output being a score of 188. This score aligns to the descriptor *'Competent'* and also demonstrates that the requisite asset management elements are in place, though improvements can be made. The variation between 2011 and 2012 assessment scores is attributed to scoring granularity and interpretation of the questions by the individual assessors, as shown in Table 4.

The current Hydro Tasmania road asset management maturity score of 205 shows that the systems established have been sustained and can be described as *"Best practice, continuous improvement phase"*.

**Table 4: Self-assessment scores**

| *Element* | *Description* | *Possible score* | *2008 score* | *2012 score* | *2014 score* | *2017 score* |
|---|---|---|---|---|---|---|
| 1 | Agency objectives & stakeholder requirements | 30 | 4 | 22 | 22 | 22 |
| 2 | Strategy and planning process | 65 | 26 | 51 | 52 | 56 |
| 3 | Data, information and Knowledge | 65 | 33 | 52 | 58 | 57 |
| 4 | Business results | 30 | 8 | 20 | 22 | 19 |
| 5 | People | 20 | 7 | 15 | 15 | 16.5 |
| 6 | Leadership | 20 | 17 | 19 | 19 | 19 |
| 7 | Audit and review | 20 | 7 | 9 | 14 | 15.5 |
| | Total | 250 | 102 | 188 | 202 | 205 |

### 4.3 Continuous Improvement

Whilst the recent self-assessment demonstrates the asset management elements are in place to deliver the business benefits of prudent and cost effective risk management of our roads portfolio, there are aspects that can be refined and embedded to improve value for money and business outcomes.

## 5. Description of Assets

### 5.1 General

Roads in general fall into a hierarchy of functional classes ranging from major arterial to local access. Austroads (1989) defined a system of functional classifications for both urban and rural roads.

The entire Hydro Tasmania road network of roads fall into Rural Class 5 roads and are defined as 'Those roads, which provide almost exclusively for one activity or function which, cannot be assigned Classes 1 to 4' [5]**.**

### 5.2 Road Classification System

A functional based classification system has been adopted based on the Austroads classification system to comply with classifications systems adopted by State and Local Government road authorities throughout Australia.

The Hydro Tasmania road assets comprise of roads that have been consolidated into five (5) operational categories based on class type, service function and road type description as described in ARRB Roads Classifications, Geometric Designs and Maintenance Standards for Low Volume Roads - Appendix C [5], namely;

- 5A Primary Road
- 5B/5B1 Secondary Road
- 5C/5C1 Minor Road
- 5D/5D1 Access Track/Road
- 5E Rough Tracks

A suffix of 1 has been added to each class for that portion of the network that is only accessible to authorised Hydro Tasmania personnel ie restricted access behind locked gates.

With each road classification a daily traffic volume has been included as a guide to the range of traffic likely to be carried by each road class. This volume is expressed as the Average Daily Traffic (ADT) and represents a guide to the traffic over the peak season. Also included is a description of the road type envisaged for each road class.

A schematic diagram of the various road classifications is illustrated in Figure 2. The intent of the diagram is to depict the relative function of the road classifications in terms of the main road through an area and the various collector/distributor roads. This is a generic diagram and should be adapted to suit requirements.

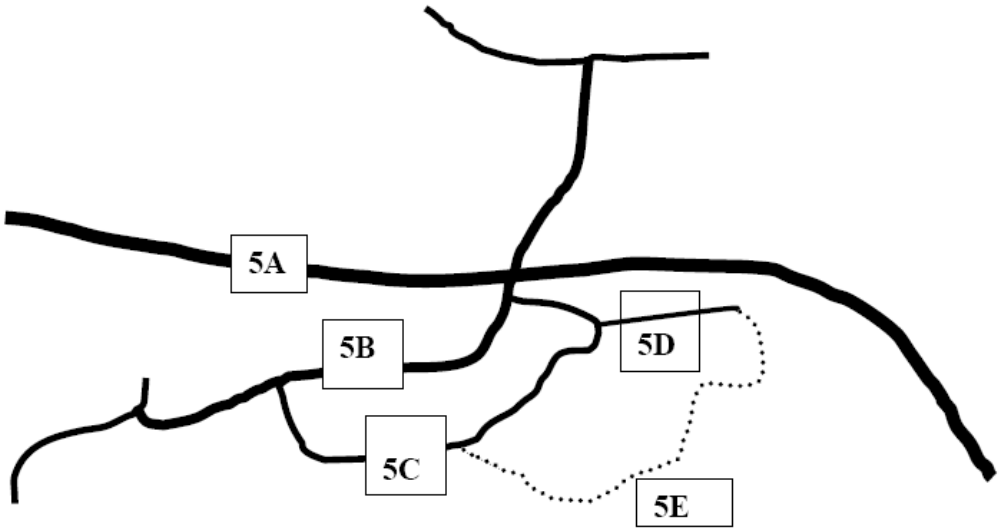


**Figure 2:** Schematic Diagram of the Road Classification System adopted by Hydro Tasmania

In the description of the road type, the notion of a quality of service has been included to highlight the characteristic of the road class, which could be linked to the desired levels of service. The quality of service is a qualitative term based on the concept of providing varying levels of convenience, comfort and safety to a driver. Convenience can be associated with the travel time taken for a journey, (ie travel speed) comfort can be associate with ride quality (ie road profile), and safety related to the consistency of road standards (ie no surprises).

## 6. Levels of Service (Intervention Levels)

### 6.1 Maintenance Criteria

The key maintenance criteria for both sealed and unsealed road pavements are given in Table 5 and 6, and are based on three (3) key performance criteria of safety, serviceability and structural requirements.

***Table 5 Maintenance Criteria for Pavements***

| ***Sealed Road*** | | | ***Unsealed Road*** | | |
|---|---|---|---|---|---|
| Type of Issue | Road Defect | Priority Group | Type of Issue | Road Defect | Priority Group |
| Safety | Edge Defect | 1 | Safety | Rutting | 1 |
| Safety | Edge Break | 2 | Safety | Loose Material | 1 |
| Safety | Rutting | 2 | Serviceability | Corrugations | 2 |
| Structural Capacity | Cracking | 1 | Serviceability | Channels & Scouring | 2 |
| Serviceability | Roughness | 2 | Serviceability | Course Texture or Roughness | 2 |
| Serviceability | Potholes & Patches | 2 | Serviceability | Potholes | 3 |
| Structural Capacity | Shoving | 3 | Structural Capacity | Gravel Depth (wearing and base course) | 1 |

***Table 6 Maintenance Criteria on Roadsides***

| *Type of Issue* | *Road Defect* | *Priority Group* |
|---|---|---|
| Serviceability | Table drains | 2 |
| Serviceability | Batters | 2 |
| Serviceability | Roadside vegetation | 3 |
| Structural | Culverts | 1 |

The criteria listed in Table 5 are based on a review of local road conditions in Australia (Austroads 2001) and Hydro Tasmania's experiences as applied to low volume roads. The priority Groups are included as a guide only and have been modified to best suit specific local conditions and the extent of resources available to collect condition data.

Table 6 lists other roadside factors outside of the pavement that require maintenance attention.

The road defect items selected, Table 14 are based on those considered essential in monitoring existing road conditions and can be collected readily by visual means while driving along a road. The selected road defect and rating system attempts to arrive at a workable set of criteria that depicts the condition of a road section without the need to collect too much data and requiring a higher use of staff resources.

## 6.2 Levels of Service (Intervention Levels)

The Levels of Service (LoS) for each road class are based on the selection of the key defect elements for sealed and unsealed roads, mentioned in Table 5 and 6, taking into account minimal life cycle cost considerations. The intervention levels provided indicate the level of severity and extent of road (by % length) when routine maintenance should be undertaken and the typical actions applied. The collective impact of all defects observed on a given road segment is presented in Table 7.

The intervention values given in Tables 8 & 9 are based on current experiences and on user expectations and the impact on existing budgetary considerations.

To assist in the identification of defect type a Hydro Tasmania – Road Condition Assessment Manual has been developed. This manual includes photographs giving examples of typical road defects.

**Table 7:** Condition Rating Descriptive

| *Rating* | *Collective impact of all defects observed* |
|---|---|
| 1 | Nil |
| 2 | Negligible |
| 3 | Minor |
| 4 | Moderate |
| 5 | Extreme |

Target minimum LoS criteria are presented in Tables 8 and 9.

**Table 8:** Hydro Tasmanian Road Network - Public Access Level of Service

| *Road Class* | *Class Type* | Sealed Roads Level of Service (Minimum acceptable Rating) | Unsealed Roads Level of Service (Minimum acceptable Rating) |
|---|---|---|---|
| 5A Public Access | Primary Road | 2.3 | N/A |
| 5B Public Access | Secondary Road | 3.0 | 2.7 |
| 5C Public Access | Minor Road | 3.3 | 2.7 |
| 5D Public Access | Access Track or Road | N/A | 3.7 |
| 5E Public Access | Rough Tracks | N/A | 5.0 |

**Table 9**: Hydro Tasmanian Road Network - Restricted Access Level of Service

| *Road Class* | *Class Type* | Sealed Roads Level of Service (Minimum acceptable Rating) | Unsealed Roads Level of Service (Minimum acceptable Rating) |
|---|---|---|---|
| 5A1 Restricted Access | Primary Road | N/A | N/A |
| 5B1 Restricted Access | Secondary Road | 3.7 | 3.0 |
| 5C1 Restricted Access | Minor Road | 4.2 | 3.3 |
| 5D1 Restricted Access | Access Track or Road | N/A | 4.3 |
| 5E1 Restricted Access | Rough Tracks | N/A | 5.0 |

## 7. Network Inspections

The network is systematically inspected to ensure identification of existing defects and other hazards and to identify opportunities for network improvements that will reduce risk to users and or minimise maintenance effort over time. The frequencies for network inspections are to be in accordance with the following table, or as varied from time to time.

**Table 10:** Inspection Frequencies

| *ARRB Road Class Type* | *Inspection Frequency* | |
|---|---|---|
| | Public Access | Restricted Access |
| 5A | Fortnightly | N/A |
| 5B | Monthly | 3 Monthly |
| 5C | 3-6 Monthly[1] | 6 Monthly |
| 5D | 6 Monthly – Annual[1] | Annual |
| 5E | Not Inspected | Not Inspected |

[1] Inspection frequency based on public usage.

## 8. Response Times

Response Times for the repair of identified defects, refer Table 13, have a requirement to be rectified between 7 days and 6 months depending on the road hierarchy and defect type. Several examples are shown below.

**Table 11:** Response Times for

| *Routine Maintenance Items* | *IL Code* | *Intervention Level* | *Response time* | | | | |
|---|---|---|---|---|---|---|---|
| | | | *Class* | | | | |
| | | | *5A* | *5B* | *5C* | *5D* | *5E* |
| **1.0 Unsealed Roads** | | | | | | | |
| **1.1** Pothole Maintenance on Unsealed Roads | UR01 | Pothole with depth of 50mm - 100mm and area < 10m2 | 1 mth | 1 mth | 3 mth | 3 mth | 3 mth |
| | UR02 | Pothole > 100mm depth | 7 day | 1 mth | 1 mth | 3 mth | 3 mth |
| **1.2** Repair of General Pavement Defects on Unsealed Roads | UR03 | Scouring, rutting or corrugations >75mm depth and length < 20m. | 1 mth | 2 mth | 3 mth | 3 mth | 3 mth |
| **1.3** Management of Loose Material on Unsealed Roads | UR04 | Loose material >100mm depth at any location on the pavement and <20m2 | 1 mth | 2 mth | 3 mth | 3 mth | 3 mth |

# 9. Condition and Performance

## 9.1 Road Risk Rating (RRR)

Road defect data collected during routine inspections is evaluated against a set of criteria to determine the Road Risk Rating (RRR) score. Individual road link RRR scores are summed to provide an overall RRR score for the entire road network.

The RRR score is used as a point in time indicator on the condition of individual road link(s) and when summed, the entire network. The RRR score is a measure of exposure to Duty of Care (DoC) risk. The target RRR scores for both individual road links and the entire network are presented in Table 12.

**Table 12:** Target RRR scores for Roads Links and entire Network

| *Link/Network* | *Target RRR score* | *Maximum RRR score* |
|---|---|---|
| Individual Road Link (<2 km length) | < 20 | < 40 |
| Individual Road Link (>2 km length) | < 50 | < 100 |
| Entire Road Network | < 500 | < 1000 |

The RRR score is highly influenced by deterioration resulting from significant weather events, increased heavy vehicular movements such as log trucks and reduced operational maintenance.

The RRR score is not related to the Pavement Condition Index (PCI) or the Surface Condition Index (SCI) which are used to determine Capital and Operational planning and expenditure.

RRR scores are updated as defects observed and recorded during routine network inspections. The frequency of RRR score update is therefore the same as presented in Table 10 – Inspection Frequencies.

The criteria to determine the RRR score are as follows:

- Road hierarchy (Table 13)
- Defect type and severity (Table 14).

Each of these criteria is sub-defined into five and nine categories respectively. Category 1 is less severe than Category 2 and so forth. When the information has been evaluated against these two (2) criteria, the numerical values for each category are transposed into **Equation 1** and the output is the Road Risk Rating (RRR) for the hazard identified. The road link RRR score is determined by **Equation 2** and the network RRR score by **Equation 3**.

**Equation 1 – Determination of RRR Defect score**

RRR score per defect = Road Hierarchy Score (Table 13) x 2 + Defect Severity Score (Table 14)

**Equation 2 – Determination of RRR Link score**

Link RRR score = sum of all RRR scores for all defects on the link

**Equation 3 – Determination of RRR Network score**

Total RRR score = Sum of all link scores for all roads

**Table 13:** Road Hierarchy Risk Score

| *Hierarchy* | *Inspection Frequency* | *Risk Score* |
|---|---|---|
| 5A | Fortnightly | 5 |
| 5B | Monthly | 4 |
| 5B1 | 3 Monthly | 3 |
| 5B1 | 6 Monthly | 2 |
| 5C | 3 Monthly | 3 |
| 5C1 | 6 Monthly | 2 |
| 5C1 | Annual | 1 |
| 5D | 6 Monthly | 2 |
| 5D1 | Annual | 1 |
| 5E | Annual | 1 |
| 5E1 | Annual | 1 |
| 5E1 | Not Inspected | 1 |

**Table 14:** Defect Type Severity Score

| *Defect ID* | *Defect Type (Description)* | *Severity Score* |
|---|---|---|
| DR01 | Isolated (<10 m &/or <5 $m^3$) blockages that prevent free flow of water | 7 |
| DR02 | Isolated blockages <5 m in length >30% of cross sectional area | 7 |
| DR03 | >50% of cross sectional area blocked | 7 |
| DR04 | Clear culvert | 7 |
| DR05 | Minor damage to culvert structures | 7 |
| DR06 | Install new culvert | 7 |
| DR07 | Sub Soil Drains | 7 |
| SR01 | Pothole repair >75 mm depth | 7 |
| SR02 | Pothole with depth >40 mm & dimension of 350 mm in any orientation | 7 |
| SR06 | Stripping <5 $m^2$ | 6 |
| SR07 | Edge break with a deviation from seal edge of >250 mm | 6 |
| SR10 | Accumulation of aggregate, soil or debris, hazardous to vehicles, cyclists or pedestrians | 8 |
| SR11 | Deformation / depression >75 mm under 1.2 m straight edge | 7 |
| SR12 | Pavement failure repair | 7 |
| TF01 | Guidepost replacement | 9 |
| TF02 | Guidepost straightening | 3 |
| TF03 | Delineator replacement | 2 |
| TF04 | Sign straightening | 2 |
| TF05 | Sign cleaning | 3 |
| TF06 | Sign post/footing replacement | 6 |
| TF07 | Sign replacement | 6 |
| TF08 | Safety fence repairs | 3 |
| UR01 | Pothole with depth 50 – 100 mm <10 $m^2$ | 7 |
| UR02 | Potholes, rutting, scouring >100 mm depth | 9 |
| UR03 | Rutting, scouring or corrugations >50 mm depth & length <20 m | 8 |
| VG01 | Sight distance to signs | 6 |
| VG02 | Litter, debris & dead animals | 9 |
| VG03 | Removal of vegetation encroaching onto verge | 2 |
| VG04 | Remove any encroachment of lateral vegetation into the portal | 2 |

Defects are identified and recorded in accordance with the Road Condition Assessment Manual, and all defects are included in RRR calculations, with the output being an overall assessment of the RRR for each individual road link and the network overall.

Figure 3 presents the shift in the network RRR score between July 2013 and May 2019, clearly demonstrating the impact funding changes to Programmed Operational expenditure has on the RRR score. The 10 point end of month (EoM) RRR score is used to evaluate RRR Score trend.

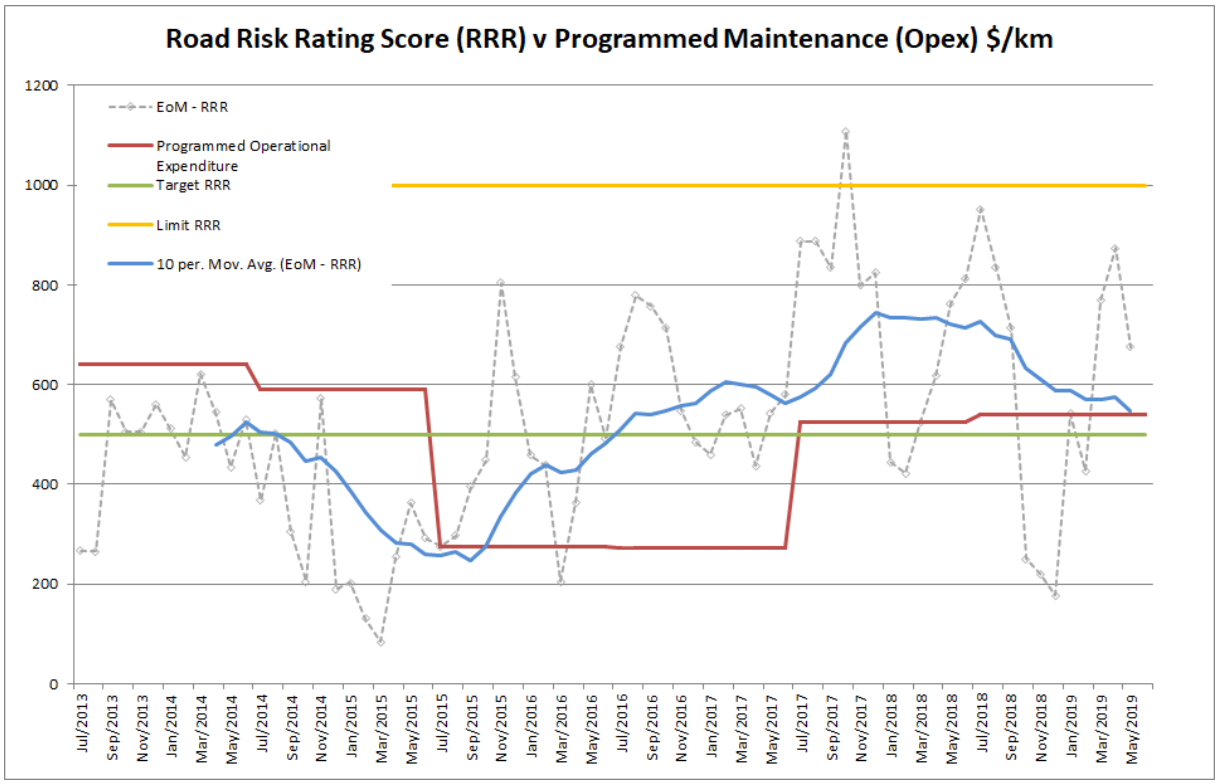


**Figure 3:** Relationship between Network RRR score & Discretionary Operational Expenditure v Time

Table 15 presents a summary of all Network RRR and Programmed Maintenance Opex $/km data collected since 2010. The Programmed Operational $/km that should be budgeted for to achieve the target network RRR score of 500 is $540/km which equates to an annual expenditure of $317 k (2019 $AU).

Note: Capital expenditure, programme management and contract costs are not included in this in this assessment.

**Table 15:** All Network RRR and Programmed Operational $/km data

| *Financial Year Ending (FYE)* | *2010* | *2011* | *2012* | *2013* | *2014* | *2015* | *2016* | *2017* | *2018* | *2019* |
|---|---|---|---|---|---|---|---|---|---|---|
| Opening RRR Score | 20973 | 4580 | 2856 | 326 | 267 | 368 | 275 | 667 | 887 | 935 |
| Year Ending RRR Score | 4580 | 2856 | 885 | 267 | 529 | 292 | 492 | 580 | 813 | **562*** |
| Programmed Opex $/km | $2,658 | $1,388 | $1,346 | $960 | $640 | $590 | $274 | $272 | $524 | **$539*** |

*Values as of May 2019

## 9.2 Pavement Management System (RoadWise)

### 9.2.1 General

RoadWise produces a condition driven model of the budgetary and condition consequences of applying a given management strategy to the pavement network. The network is represented as an ensemble of asset elements (road segments), each consisting of two components:

- Underlying pavement
- Surface

In the most general terms, the inputs required for RoadWise cover the following aspects:

Model Description – via input file (Excel)

- Segment definitions, pavement types & current condition/age
- Class hierarchy
- Anticipated deterioration characteristics of the assets
- Management models
- Commitments/budget streams

Scenario Description – via interactive inputs, saved & recalled scenarios

- Budget restrictions & horizon
- Treatment overrides

The following is a description of key inputs provided via the input file.

### 9.2.2 Segment Definitions

Segmentation of the network is made such that each segment is, from a management point of view, uniform (i.e. has a uniform “Pavement Type” and “Class”). There may exist in the final segmentation, segments which vary along their length (e.g. partial seal of an otherwise unsealed segment, or an asphalted intersection within a spray sealed segment). Such segments are characterized in RoadWise by the type representing the major part of the segment. Any small discrepancies cause by the non-uniform segments fall within the anticipated tolerance of the model.

For Hydro Tasmania, the segmentation generally consists of 500 m sections of roadway, full width. Sections less than 500 m typically occur at the end of each road, as the remainder after 500 m divisions.

### 9.2.3 Pavement Types

Pavement types represent the management regime which applies to any particular segment; thus construction characteristics (e.g. surface type) are essential factors in determining pavement type. The management regime encompasses the available treatments (e.g. “Potholing/Grading”, “Mill & Fill”, “Rehabilitation”), the conditions under which the treatment is undertaken (triggered), the consequence of the treatment (condition reset, change in available subsequent treatments, cost of treatment). The pavement type also incorporates the anticipated rate of deterioration of the pavement, both surface and underlying pavement.

Within each pavement type, provision is made for variation in the management parameters (triggers, resets, costs) and the notional rate of deterioration, according to a hierarchical (class) structure.

### 9.2.4 Condition

The condition, the actual level of service being delivered by a road segment, is represented on an inverted 0 to 5 scale, in which 0 represents a perfectly acceptable condition, and 5 represents the worst anticipated condition (i.e. the condition at which the asset no longer serves its purpose). Deterioration beyond the extreme is still represented as 5, and improvement better than zero is still represented as 0. It is generally accepted that, on such a scale, the major available treatment would be triggered at a condition of around 4. That is, at condition 4 or worse, if budget permits, a major replacement treatment (rehabilitation) would be undertaken. Typically, budget restrictions prevent most such treatments occurring exactly at condition 4, and a worsening condition (beyond the ideal rehabilitation condition) is thus represented in the model.

While condition is derived from measured parameters (roughness, rutting, visual assessment, etc.), it is aspirational in nature, and takes into account the intended usage (i.e. the class structure).

In RoadWise, condition is represented by two primary Condition Indices, Surface Condition Index (SCI), and Pavement Condition Index (PCI). It also allows for any number of extra indices, if required, for treatment triggering purposes, but most reporting is made in terms of SCI and PCI. The progression of the condition index is represented as a function of

time (years) or traffic "consumption" (see Deterioration, below).

In addition, the actual age of the asset components (surface and pavement) may be used as "pseudo condition indices" (SAG and PAG) for triggering purposes, but of course their scale is in years, rather than 0 to 5.

For Hydro Tasmania, given the paucity of measured data, it was decided that the simple approach of using SCI and PCI alone, as functions of time, was the only realistic option.

SCI and PCI condition scores are updated annually, typically over a two (2) week interval.

### 9.2.6 Management Models

The management regime for each pavement type is represented as the combination of the available treatments to be considered for that pavement type, the condition indices by which the treatments are to be triggered, the actual trigger values, the degree to which the condition indices are anticipated to respond to the treatments (resets), the costs of the treatments, and the anticipated manner of deterioration in condition with time. They also obey "work diaries", which dictate which of the available treatments may actually be considered, and in what progressive order, given the preceding work history of any network segment.

### 9.2.7 Treatments

In the RoadWise model, at most one actual treatment may be undertaken for any given segment in a year, thus the treatments must be formulated as a *"year's worth of treatment"*. The costs and conditional benefits of the treatment must be gauged on that scale.

For Hydro Tasmania, this consideration applies particularly to such activities as potholing and grading, where it is reasonable to expect some roads to undergo a multiple combination of these treatments within a year.

The following suites of treatments were defined for the Hydro Tasmania model. Note that the treatments are shown in order of severity; minor treatments appearing first, major treatments last. This order is important; minor treatments are generally triggered at lower condition ratings than major treatments.

**Table 16:** RoadWise Treatment Hierarchy for Sealed Roads

| *Pavement Type* | *Treatment* | *Description* |
|---|---|---|
| ACG Asphalt Seal | Mill & Fill (Patching) 1 | Low degree of patching, mainly surface with some pavement repairs, as anticipated in the earliest years of the pavement's life |
| | Mill & Fill (Patching) 2 | Higher degree of patching, both surface and pavement repairs |
| | Mill & Fill (Patching) 3 | Degree of patching and pavement repairs anticipated in the later years of the pavement's life |
| | Reseal | Complete surface renewal, with associated pavement repairs |
| | Rehabilitate | Complete base and surface replacement |
| STG Spray Seal | Mill & Fill (Patching) 1 | Low degree of patching, mainly surface with some pavement repairs, as anticipated in the earliest years of the pavement's life |
| | Mill & Fill (Patching) 2 | Higher degree of patching, both surface and pavement repairs |
| | Mill & Fill (Patching) 3 | Degree of patching and pavement repairs anticipated in the later years of the pavement's life |
| | Reseal | Complete surface renewal, with associated pavement repairs |
| | Rehabilitate | Complete base and surface replacement |

**Table 17:** RoadWise Treatment Hierarchy for Unsealed Roads

| *Pavement Type* | *Treatment* | *Description* |
|---|---|---|
| GRG Unsealed | Grading / Potholing | The combination of potholing and grading anticipated in one year of maintenance |
| | Top Dress | Some grading with partial addition of new gravel; must include all other Grading / Potholing which may also occur within the year |
| | Re-Sheet | Addition of a surface layer of gravel |
| | Rehabilitate | Renewal of pavement structure |
| GRG1 Unsealed – behind locked gates | Grading / Potholing | The combination of potholing and grading anticipated in one year of maintenance |
| | Top Dress | Some grading with partial addition of new gravel; must include all other Grading / Potholing which may also occur within the year |
| | Re-Sheet | Addition of a surface layer of gravel |
| | Rehabilitate | Renewal of pavement structure |

### 9.2.8 Deterioration

The conditions are modelled to deteriorate as a function of time (years) or "consumption" (accumulated traffic). Linear deterioration functions between "upper and lower breakpoints" are used, as shown:

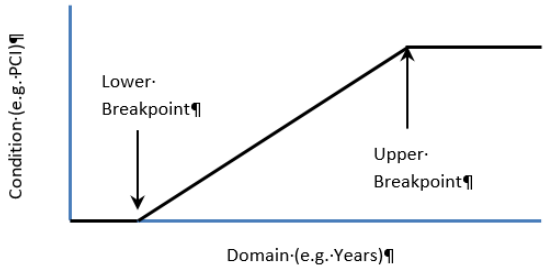


**Figure 4:** Linear deterioration functions between "Upper and lower breakpoints"

For Hydro Tasmania, deterioration was modelled as a function of years, and the lower breakpoints were all set to year 0. Setting the deterioration rates for Hydro Tasmania was fairly complex. As described previously, the effects of routine work, not captured by the treatment regimen, needed to be taken into account. A degree of juggling was required to estimate the effect of aging against the effect of improvement from treatments. No definitive rates could be estimated from available data, but *"in the ball-park"* numbers were obtained using past work histories from both Hydro Tasmania and Stornoway. With future collection of condition data and work records, these estimates should improve.

### 9.2.10 Triggers & Resets/Condition Indices

Every treatment (for every class of road) requires a trigger value of at least one of the condition indices in use. Normally only one index is used for any single treatment. Thus indices may be entirely devoid of triggers for any single treatment. Furthermore, it is not necessary for every index to have triggers; indices may exist purely for examining their response to the treatment life-cycle.

The effect of each treatment is registered as a reduction in at least one of the indices. Indices may be left unaffected. E.g. a purely surface treatment may reset the SCI, but not necessarily the PCI. The reset may be specified in various fashions, e.g. as a fixed value (less than the trigger value), or as a fixed reduction (i.e. amount to be subtracted from the original value), or as a proportional reduction.

The pseudo indices (SAG and PAG) can only be reset to 0 (i.e. renewal of the surface or pavement).

For Hydro Tasmania, only SCI and PCI are used for triggering. For some treatments, namely the *"Mill & Fill (Patching)"* treatments of sealed roads, and the *"Rehabilitation"* treatment of the unsealed roads, both indices are employed. For all other unsealed road treatments, and for the *"Reseal"* treatments for asphalt and spray sealed roads, SCI alone is used. PCI is used as the sole trigger for *"Rehabilitation"* of the sealed roads. Setting the trigger values has been achieved by a convoluted (incremental) process of advice from Stornoway, and matching the life-cycle characteristics to match what is thought to represent the current network management.

For example, the following diagram shows the RoadWise life-cycle for a fully funded (i.e. no budget restrictions) road of Type STG, Class 5A. The red line represents the progress of PCI, and the blue line that of SCI. In this example it

is assumed that the road begins in *"as new"* condition. The surface condition is seen to respond to each of the three levels of Mill & Fill (Patching), and culminate in reseal every 30 years. The condition of the underlying pavement responds to a small degree to the Mill & Fill (Patching) treatments, and to a greater degree to the reseal (as a result of associated repair work, and improved durability from the improved weather seal). However the pavement condition achieves a semi-stable condition (a perpetual pavement) that does not reach the rehabilitation condition.

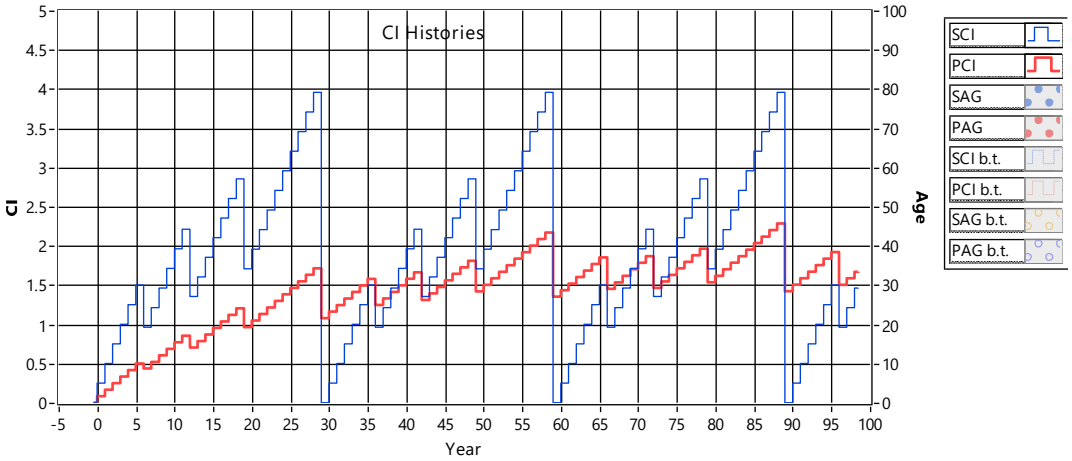


**Figure 5:** RoadWise life-cycle for a fully funded, no budget restrictions) road of Type STG, Class 5A.

## 10 Conclusion

Hydro Tasmania's road network is integral to the efficient and effective management of the state's major energy generating assets. The road network comprises 588 kilometres of roads, of which around 130 kilometres is sealed and 386 kilometres (66%) of the road network accessible to the public.

In comparison to other road managers in Tasmania, the Hydro Tasmania road network is relatively small but is dispersed over a large geographical area, Figure 6, of some 17,000 km$^2$.

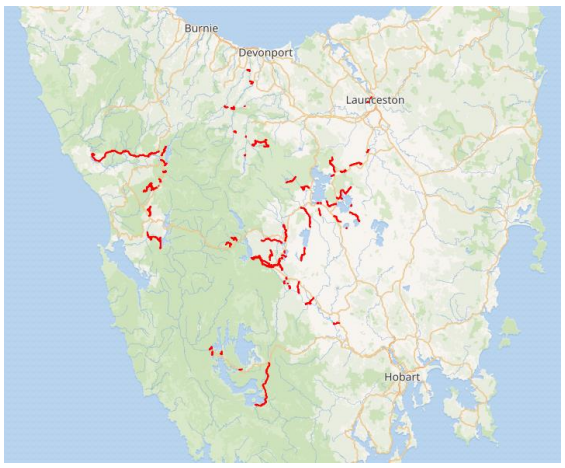


**Figure 6:** Geographical distribution of the Hydro Tasmania road network.

With the road network distributed across the north, west and south of the state of Tasmania, Hydro Tasmania benefits from the scale efficiency of its contractor Stornoway, which also undertakes works for various councils, mining operations and maintenance of the State roads network managed by the Department of State Growth.

Hydro Tasmania has entered into a long term collaborative contract with Stornoway for provision of capital and maintenance works on the road network. The contract is structured such that there is a fixed component for the contractor to cover administration, inspection and operational functions and variable components to cover capital and maintenance works to meet level of service and Duty of Care obligations.

A business case is presented to the Board of Hydro Tasmania on a 3 yearly basis for approval of the works program. There is an additional layer of scrutiny with an external audit of the maturity of the asset management practices of both the contractor and Hydro Tasmania undertaken biennially.

A predictive pavement management model (RoadWise) is used to inform the road spend. The model involves Hydro Tasmania setting a desired Level of Service for roads of differing types, from publicly accessible sealed roads to

closed to the public gravel roads. Stornoway complete a condition criticality/duty of care assessment, Road Risk Rating (RRR) score, at a frequency based on the road hierarchy. The RRR score assists both Hydro Tasmania and Stornoway to adjust the programme of works to address emerging Duty of Care risks on the road network.

Roads are not the core business of Hydro Tasmania but play an integral part in the management of our power generating assets. Past processes around road management meant that funding was not allocated on a strategic and fit for purpose basis and levels of service did not match operating requirements. The decision to outsource the road management and maintenance functions to an external provider has allowed Hydro Tasmania to focus more heavily on core functions but have the confidence that this essential ancillary asset class is being managed and works delivered effectively with adequate controls and accountabilities in place.

## Acknowledgements

The author would like to acknowledge the support of GR Webb Consulting in providing an overview of the Pavement Management System (RoadWise) used by Stornoway and Hydro Tasmania to plan annual works programmes.

## References

1. Mihai, Binning and Dowling 2001, “A Framework for Assessing Asset Management Performance in Australia” *Main Roads Western Australia*, pp 1-6.
2. N. Cribbin, 2018, “Roads – Asset Type Management Plan”, *Hydro Tasmania Standard*, Hobart, Australia, pp 5-59.
3. N. Cribbin, 2004, “Road Maintenance Risk Management Procedures” *Hydro Tasmania Standard*, Hobart, Australia, pp 1-10.
4. “Road Network Management Plan (RNMP), 2014” *Hydro Tasmania Standard & Contract,* Hobart, Australia, Sect. 1-13
5. G. Giummarra, 2001, “Road classifications, geometric designs and maintenance standards for low volume roads”, *Research Report AAR 351,* Vermont South, Australia, pp 1-2, Appendix C.