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Impact of various maintenance strategies on unsealed road deterioration to achieve an acceptable maintenance budget & road performance

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Outline

- Introduction
- Unsealed road models
- Network & detailed data
- System setup – models, LOS, PCI, etc
- Results
- Summary
- Recommendations

Introduction - NT

NT Pop = 0.25 mill
NT area = 1.42 mill sq km

Texas Pop = 27 mill
Texas area = 0.7 mill

Introduction

- NTDoT wanted a PMS for their unsealed road network to
  - establish a long-term stable budget
  - have a sustainable road network
  - develop maintenance strategies to achieve above
- Existing PMS platform dTIMS

Unsealed road models

- Unsealed road models based on a local road deterioration study (LRDS) provided:
  - roughness (IRI) model (m/km)
  - gravel loss (GL) model (mm)
  - shape loss (SL) model (% change in X-fall)
- Above fit to data (r^2 = 0.09 to 0.59)
- Independent variables statistically significant

Network and detailed data

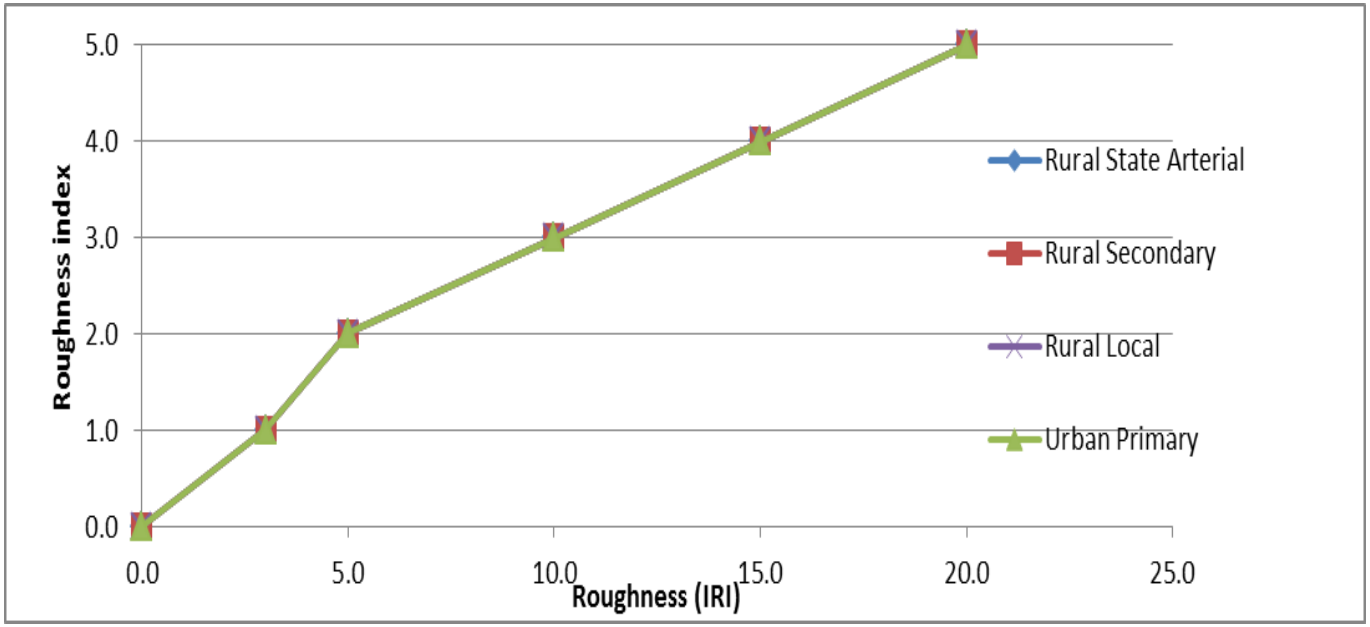
`Road Class’	Unsealed surface type			Total (km)
	Flat bladed (km)	Formed (km)	Gravel (km)	
Rural - Local	516.60	869.69	535.31	1921.59
Rural - Secondary	1069.33	2400.26	2345.62	5815.22
Rural - State Arterial	5.87	361.12	595.03	962.03
Urban - Local	6.34	3.20	0.82	10.36
Urban - Primary Arterial		2.28		2.28
Total	1598.14	3636.55	3476.78	8711.48

Network and detailed data

Inventory data provided	Condition and traffic data provided	Presumptive values to initiate analysis (when no data supplied)
Road Number	Gravel depth	110 mm
From	P075	-
To	MMP	70 mm
Region	ADT	500
Width	ADL	-
Road Class	PCT_COMM (% commercial vehicles)	30
Surface type	IRI	3
	Width	7.5 m
	Growth	10%
	Crossfall	3%
	Pct Shape Loss	0

System setup – Models and CI

- Models – GL, IRI and SL used to predict future conditions
- Condition Index (CI) produced by transformation of:
  - GD, IRI & SL to Index values, e.g. for IRI



System setup – Level of Service (LOS) settings

- Expressed as Index range from very good (0-1) to very poor (4-5) for GD, SL & IRI
- Use of Index for LOS connects community acceptability with condition measures
- Further refinement of Index range possible to match community's acceptance

System setup – LOS levels for Index values & Road Types

INDX_CI_Gdepth						
Index description	INDX value	Gravel depth (mm) for different road class				
		Rural State Arterial	Rural Secondary	Rural Local	Urban Primary	Urban Local
Very good	0-1	200-150	200-150	200-150	200-150	200-150
Good	1-2	150-125	150-125	150-125	150-125	150-125
Fair	2-3	125-100	125-100	125-100	125-100	125-100
Poor	3-4	100-50	100-50	100-50	100-50	100-50
Very poor	4-5	<50	<50	<50	<50	<50
INDX_CI_SL						
Index description	INDX value	Total shape loss (%) for different road class				
		Rural State Arterial	Rural Secondary	Rural Local	Urban Primary	Urban Local
Very good	0-1	0-5	0-5	0-5	0-5	0-5
Good	1-2	5-7	5-7	5-7	5-7	5-7
Fair	2-3	7-10	7-10	7-10	7-10	7-10
Poor	3-4	10-20	10-20	10-20	10-20	10-20
Very poor	4-5	>20	>20	>20	>20	>20
INDX_CI_IRI						
Index description	INDX value	Roughness (IRI) for different road class				
		Rural State Arterial	Rural Secondary	Rural Local	Urban Primary	Urban Local
Very good	0-1	0-3	0-3	0-3	0-3	0-3
Good	1-2	3-5	3-5	3-5	3-5	3-5
Fair	2-3	5-10	5-10	5-10	5-10	5-10
Poor	3-4	10-15	10-15	10-15	10-15	10-15
Very poor	4-5	>15	>15	>15	>15	>15

System setup – PCI Index

- Is a composite index by aggregating condition indicators (CI) Index value
- CIs used for gravel depth, roughness & shape loss

System setup – PCI Index

$$PCI = MAX(w_i \times Index_i) + p\left(\frac{SUM(w_i \times Index_i) - MAX(w_i \times Index_i)}{\sum(w_i) - Avg(w_i)}\right)$$

w_i = weight for individual condition criteria

= 1 or 0 (where surface type is not gravel) for gravel depth

= 1 for roughness

= 1 for shape loss

$Index_i$ = Index value for individual condition criteria for roughness, gravel & shape loss

p = condition factor (= 0.1)

System setup - treatments

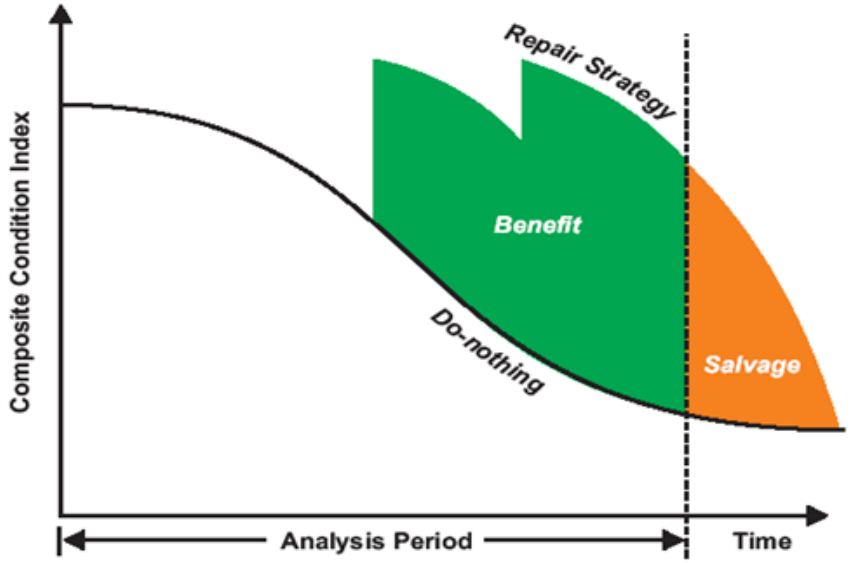
- Rural State Arterial
  - 1 × full maintenance grade (FMG)
  - 1 × between batters (Half Maintenance Grade, HMG)
  - 2 × carriageway (Running Surface Grade, RSG)
- Rural Secondary
  - 1 × full maintenance grade (FMG)
  - 2 × carriageway (Running Surface Grade, RSG)
- Rural Local
  - 1 × between batters (Half Maintenance Grade, HMG)
  - 1 × carriageway (Running Surface Grade, RSG)

System setup - treatment triggers

- Annual composite re-gravelling: FMG to HMG and 1 – 2 RSG when gravel depth (GD) is < 100 mm
- Annual composite reshape treatments: FMG to HMG and 1 – 2 RSG when total shape loss (SL) is > 10%
- Annual grading: combination of varying frequencies of FMG to HMG and RSG applied yearly except when re-gravelling and reshaping triggered

System setup – works effects

- Works effects (WE) – impact on conditions from treatments
- Impact of WE improvement is area between ‘do-nothing’ and new performance due to treatment



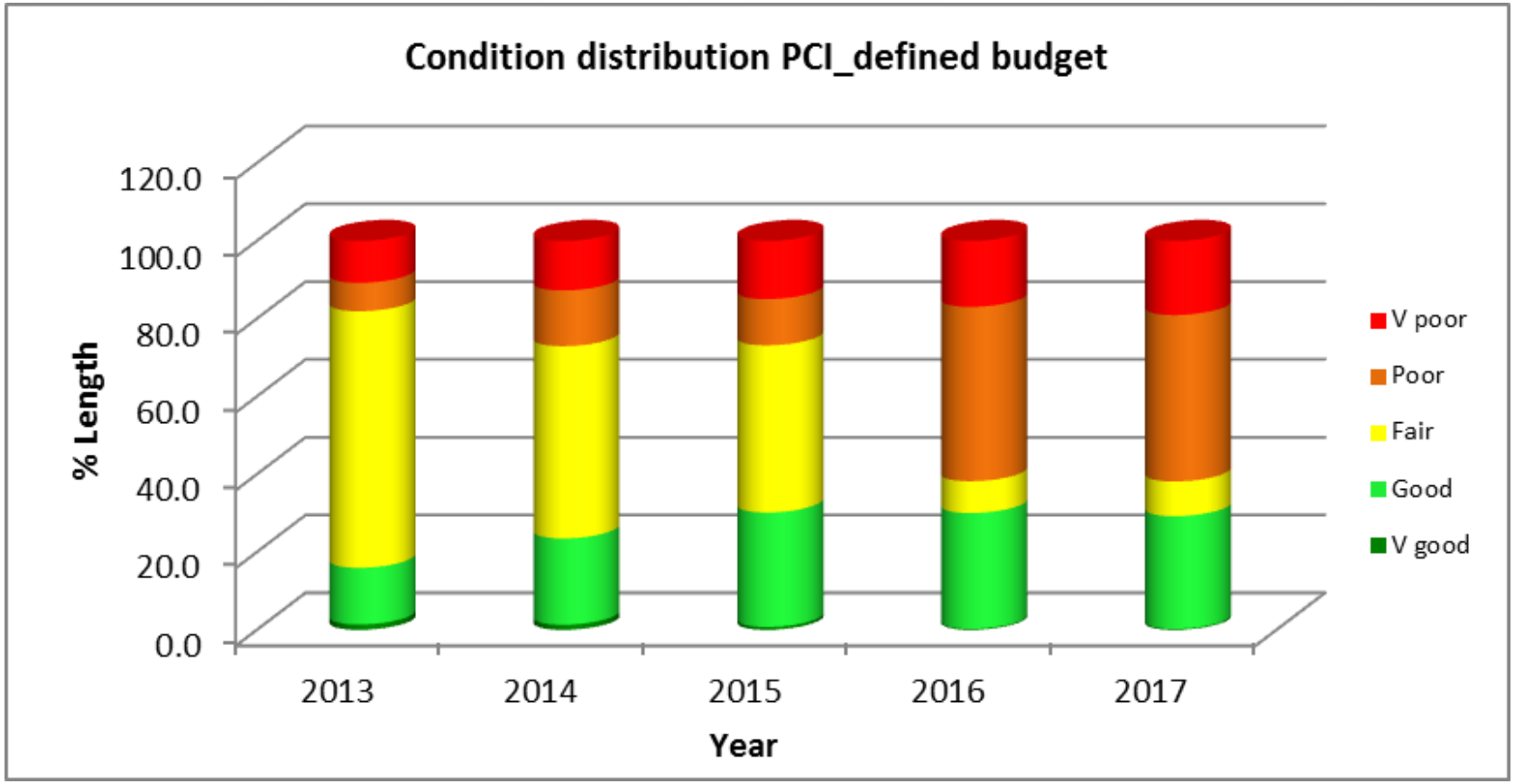
Results – budget scenarios

- Treatment options varied with road class – each class analysed separately with separate budget scenarios
- Large number of treatment options limited analysis period to 5 years
- Unrestricted annual budget used showed existing annual budget did not meet required LOS on all road classes
- Annual $20 m network budget with optimised scenarios showed not all sections were treated annually

Results – network condition

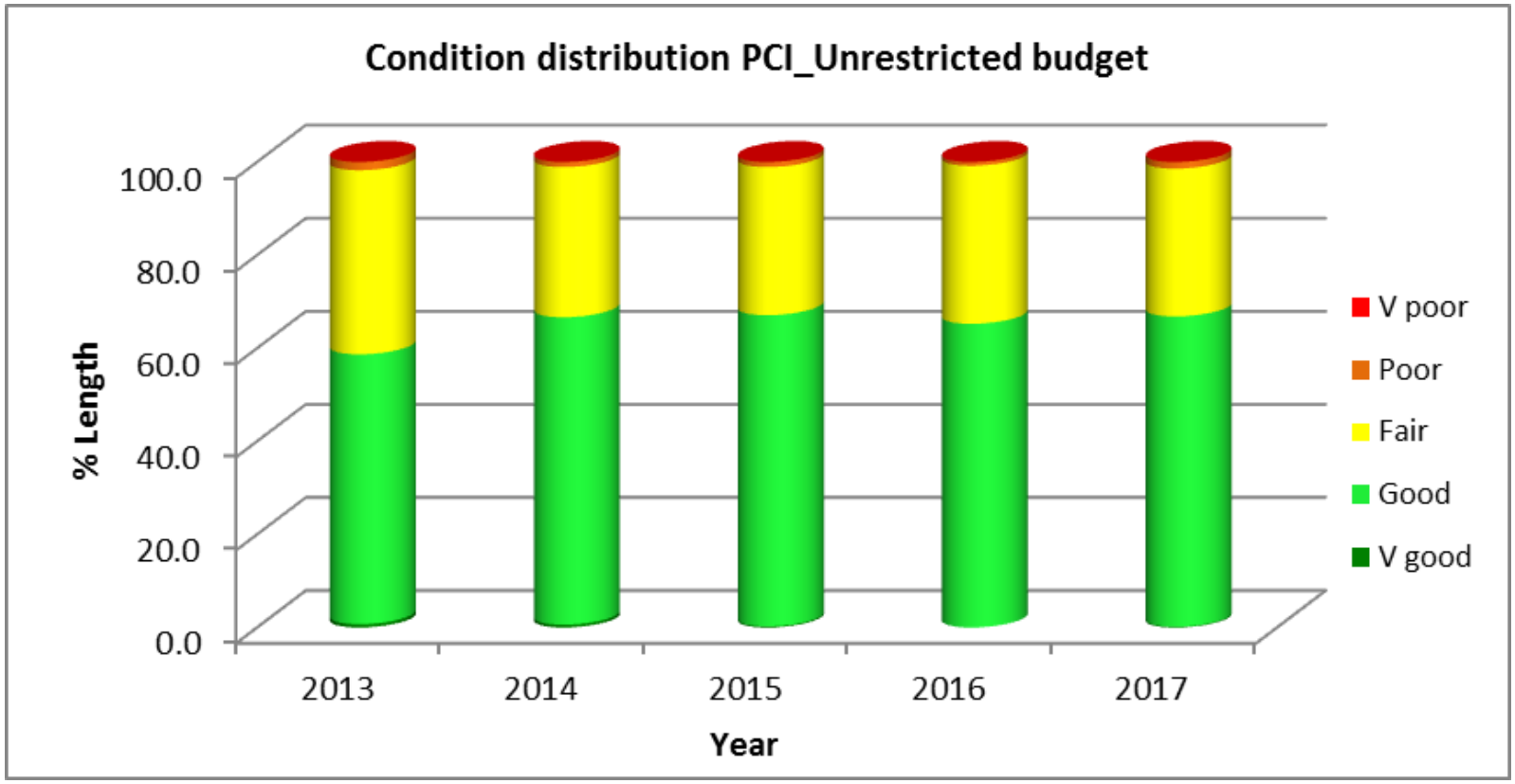
- Some input data was assumed – actual funding needs could vary
- Network condition can change between condition data collection and analysis
- Results are indicative of potential achievements
- Examination of conditions (PCI) over analysis shows distribution of conditions with time

Results - network PCI distribution



PCI distribution for defined $20 m annual budget

Results - network PCI distribution



PCI distribution for unrestricted annual budget

Results – network funding

- Defined budget annual $20 m - most treatments were grading with different types and frequencies
- Unrestricted annual budget – more renewal and re-gravelling work
- Unrestricted annual budget $60 m – may have over-estimated unit rates or treatment regimes were not fully executed (annualised composite treatments)

Summary

- PMS developed for NTDoT unsealed road network
- Further PMS refinements recommended

Recommendations

- Review network database to combine short sections (< 100 m)
- Review annual composite treatments to make a wider range of choices for annual budget
- Adopt different treatments for different regions
- Refine calibration of models to reflect ‘wet’ and ‘dry’ regions
- Review unit cost rates to reflect regional differences
- Review triggers to closely reflect current practice
- Provide separate budgets for each region