PLEASE NOTE:
An error in the length of Horsnell Road was identified in the Improving the Productivity of the Mango Industry in Litchfield Municipality report.
Horsnell Road is 3.4km in length instead of 1.74 as previously stated.
The total road length for all four roads equates to 15.2km, as a project.

Version 2 - 26 June 2018

matters more
economic analysis

Improving the Productivity of the Mango Industry in Litchfield Municipality

Upgrade and seal gravel roads to mango farms and packing sheds
Business Case

Disclaimer

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economic analysis

Geografia

Executive Summary

- The Northern Territory mango production accounts for 45% of Australian output. Darwin region accounts for 24% of Australian production, almost all from Litchfield.
- Over the last 40 years, the mango industry has consolidated from small individual hobby farms into larger farms with packing sheds and with a focus on high quality product.
- The poor state of key mango industry roads is constraining productivity.
- Product is sent to markets in South Australia, NSW and Victoria. A proportion of product is sent to new and growing markets in South East Asia and in the Middle East.
- The sealing of 15.2 kms of gravel road in Litchfield municipality in the Northern Territory has emerged as a high priority for the agriculture and horticulture industry to improve domestic productivity and quality and to expand in emerging international markets.
- The project is a partnership with NT Farmers and has the support of the Northern Territory Government and Regional Australia Development NT.
- The project is to seal the following roads:
  - Chibnall Road between Old Bynoe and Leonino Road
  - Mocatto Road between Whitstone and Acacia Gap Road
  - Horsnell Road between Elizabeth Valley Road and Alverly
  - Kentish Road between Hopewell Road and end of seal.
- The intention of the project is to address fundamental problems that are undermining the capacity of the mango industry to deliver more, high quality fruit to growing markets.
- The methodology for assessing the economic benefit of this project follows federal government guidelines for transport project assessments to demonstrate alignment to key policy objectives. Assessment guidelines specify the use of 4% and 7% as discount rates.
- This economic appraisal assesses the financial and economic viability of the project. It is based on a construction estimate of $20.1 million and NPV benefits of $35.1 million (4% discount rate) and $25.0 million (7% discount rate). This gives benefit cost ratios of 1.75 and 1.24 respectively, indicating that it is a good investment as the ratio is over 1.0.
- In conclusion there is a very strong positive return on investment of 9.3%, making this project an attractive investment for stimulating economic activity in the Northern Territory.
- Further analysis shows that the project will provide overall benefits to the agricultural industry and the municipality through productivity gains, employment and financial returns.
- Sensitivity testing of the impact of input cost changes (±10%) on the benefit cost ratio show that it remains over 1.0 for all discount rates.
- In summary, even with input cost changes, the project benefits are robust; with a quantified return on investment of 9.3%, the project is a wise investment for Northern Territory.

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1. Introduction

- ✓ The sealing of 15.2 kms of gravel road over four roads in Litchfield municipality, NT has emerged as a high priority for the agriculture and horticulture industry.
- ✓ The project is a partnership with NT Farmers and has the initial support of the Northern Territory Government and Regional Development Australia.
- ✓ The methodology for assessing the economic benefit of this project follows federal government guidelines for transport project assessments.

1 Introduction

This business case provides the rationale for the sealing of four gravel roads in Litchfield municipality, NT.

This project ('the project') emerged as a high priority through workshops and consultation with the agriculture and horticulture industry in Litchfield municipality, with Territory Government and Regional Development Australia.

A business case study was commissioned by Litchfield Council to analyse the feasibility of the project to seal roads servicing mango growers and packing sheds. The development of the business case was carried out with the assistance of NT Farmers and the Mango Growers Association. This report summarises these findings.

1.1 NT STRATEGIC INVESTMENT FRAMEWORK

Prior to proceeding to the business case, the project was considered against the identified priorities of the Northern Territory Government, and agency-level strategic priorities.

The project then progressed to this strategic business case, which outlines the high-level benefits of the project and the opportunities to encourage and leverage investment by the mango farmers themselves into increased productive capacity and high-quality production.

1.2 THE PROJECT

This report presents the business case for sealing the following roads and lengths in Litchfield municipality (see Figure 1):

1. Chibnall Road between Old Bynoe and Leonino Road 5.4km;
2. Mocatto Road between Whitstone and Acacia Gap Road 3.2km;
3. Horsnell Road between Elizabeth Valley Road and Alverly 3.4km; and
4. Kentish Road between Hopewell Road and the end of seal 3.2km.

The intention of the project is to address three fundamental problems that are undermining the capacity of the mango industry to deliver more, high quality fruit to growing markets. These problems are:

1. The corrugations and potholes on the unsealed roads damage the mangoes, reducing their market value.
2. The dust from traffic on the unsealed roads is impeding pollination and encouraging the proliferation of mites, both of which reduce tonnes/hectare.

3. The roads are also increasing equipment failure and damage, as well as risking driver and worker safety.

1.3 OBJECTIVE OF THIS REPORT

This business case has been prepared to assist Council with funding applications for contributory funding from the Northern Territory and Federal Government.

1.4 METHODOLOGY

To assess the project and develop the business case, we used a process that drew on the Australian Transport Assessment and Planning (ATAP) Guidelines and Investment Management standards.

The methodology included the following steps:

1. Site visit.
2. Development of a problem definition and investment logic map.
3. Facilitation of a benefits assessment workshop with industry, local government and other relevant stakeholder participation.
4. Preliminary analysis of key benefits identified in the benefits map to establish whether benefits are sufficient to proceed with business case.
5. Development of business case.
6. Benefit cost analysis.
7. Estimation of economic impacts and benefits[1].

Through the process, we consulted with mango growers, Litchfield Council infrastructure department, NT Farmers Association, Regional Development Australia Northern Territory (RDANT), and Australian Mango Industry Association. Furthermore, Council consulted with NT Department of Infrastructure Planning and Logistics General Manager Transport and Civil Services Division and other potential funding contributors.

The study area for the business case is Litchfield municipality. The roads covered by the project are in Litchfield's south. The map shows the road locations (Figure 1).

A workshop was held on 2 March 2018 to refine the Investment Logic Map[2] (Figure 2) and develop the Investment Benefits Map (Figure 3).

[1] To ensure transparency in the analysis, we used the University of Adelaide's WISER input output model to estimate direct and indirect benefits of the project.

[2] The Investment Logic Map (ILM) is a one-page, flowchart style map of the logic behind the investment in the project. It specifies the problems that will be solved, the benefits of doing so and the strategic interventions necessary. The ILM is a part of the Victorian State Government's investment management standards and has been used around Australia to guide business case development. See dtf.vic.gov.au/infrastructure-investment/investment-management-standard for more information.

Figure 1: Study Area Map

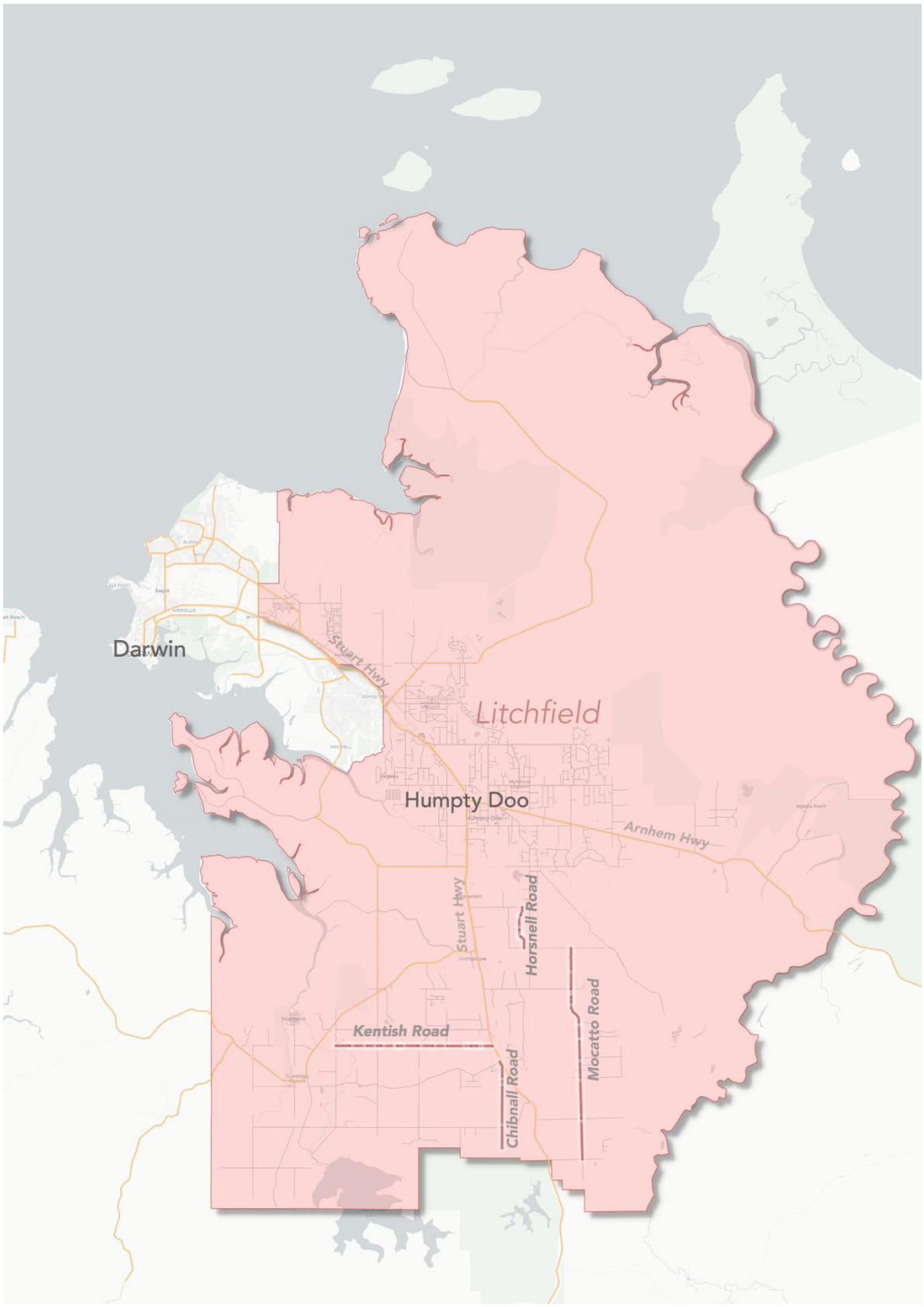


Figure 2: Investment Logic Map

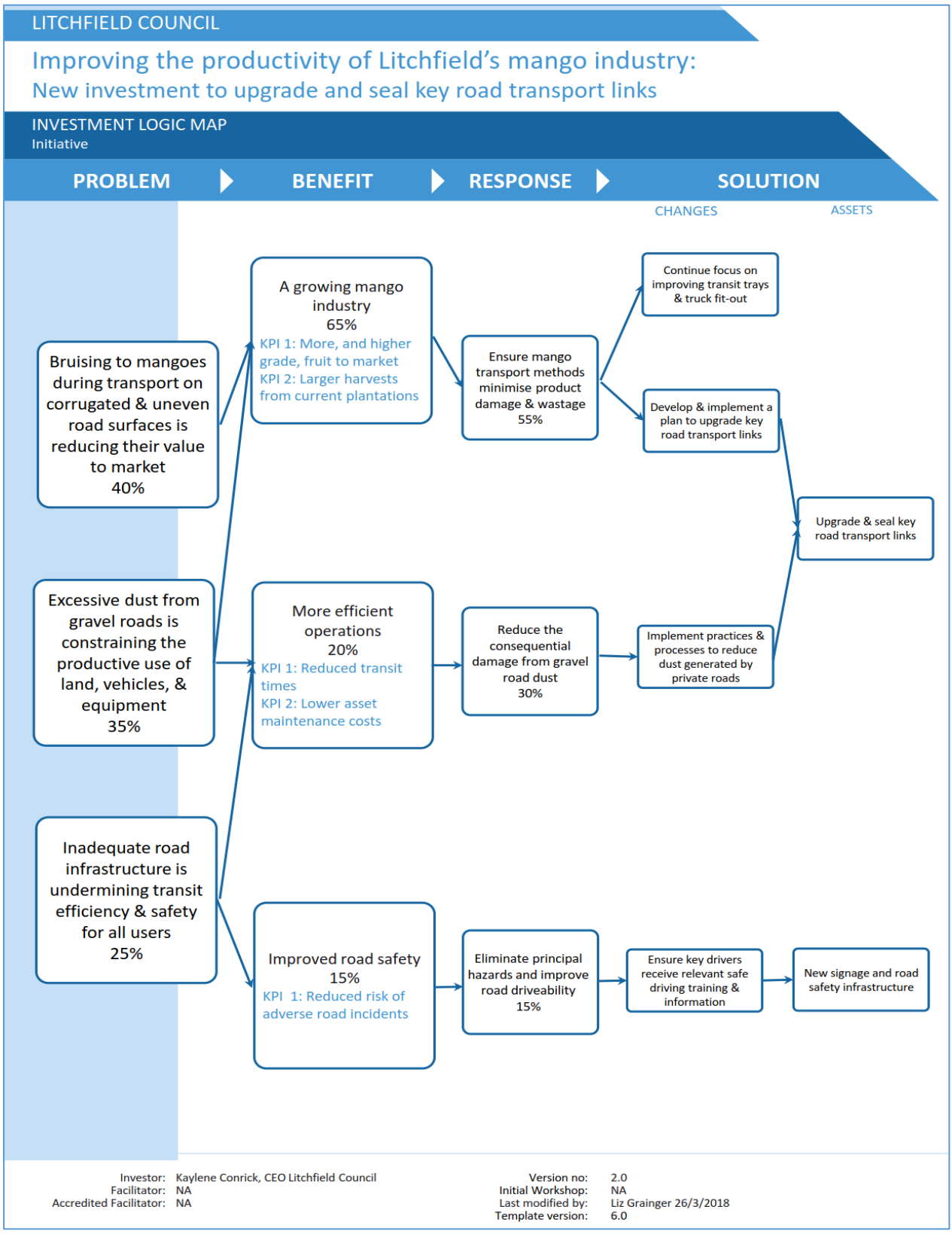
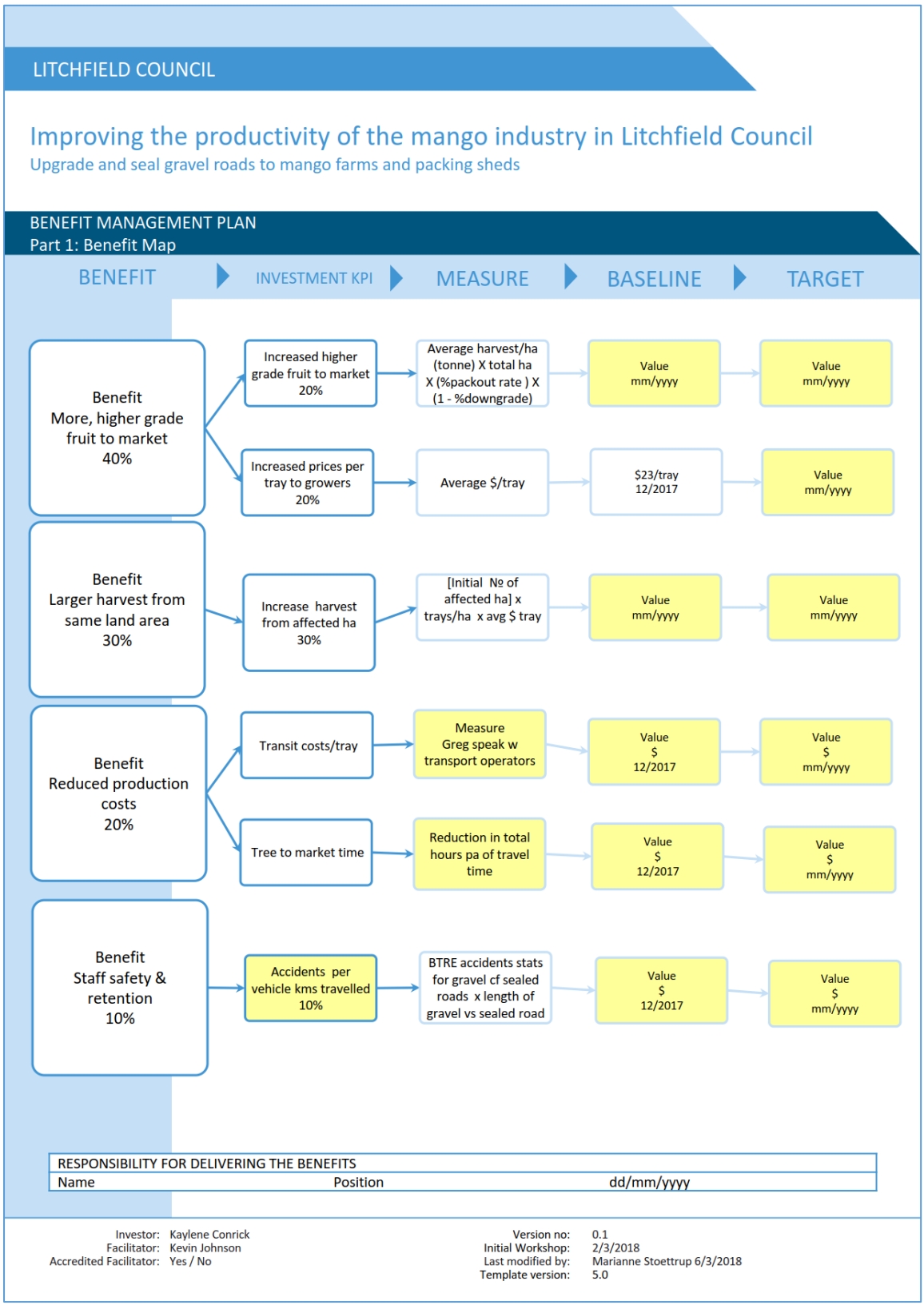
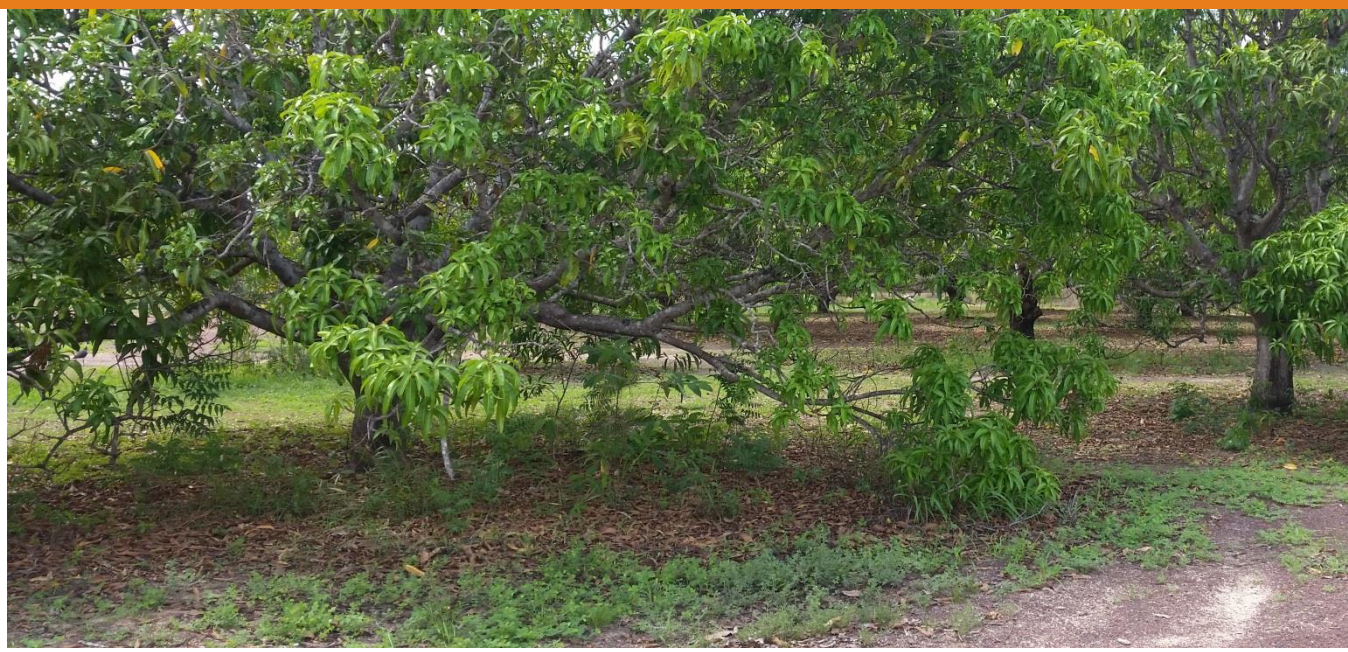


Figure 3: Benefits Management Plan



2. The Strategic Context



- ✓ Over the last 40 years, the mango industry has consolidated from small individual hobby farms into larger farms with packing sheds and a focus on high quality product.
- ✓ Product is sent to markets in South Australia, NSW and Victoria. A proportion of product is sent to new and growing markets in South East Asia and in the Middle East.
- ✓ Northern Territory mango production accounts for 45% of Australian output. Darwin region accounts for 24% of Australian production, almost all from Litchfield.

2 Strategic Context

The strategic context for the project considers the potential value of the industry to Australia and the impetus to encourage agribusiness activity in the NT.

2.1 INDUSTRY FOCUS

The mango industry in Australia produces some 50,000 to 65,000 tonnes of fresh mangoes each season. Total Australian production volume has increased by an average of 10.5% per annum over the last 3 years (Table 1).

Industry forecasts are for the value of the mango production in Australia to grow from $153 million in 2013 to $280 million by June 2022. This is an average annual growth rate of 7%, making it a very important growth industry for Australian agriculture. Although a growth industry, the domestic market is very profitable, and therefore there has been little incentive for the industry to seek export markets. Currently only about 10 per cent is exported (going to markets in Hong Kong, New Zealand, Singapore and the United Arab Emirates[3]), but proactive growers are exploring direct sales channels for higher quality product in export markets.

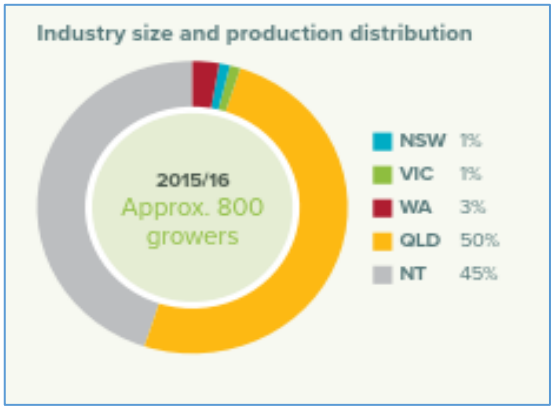
Table 1: Fresh Mango Production and Export

Year ending	2013	2014	2015
Production (tonnes)	54,090	51,069	66,087
Production value ($ million)	138	146	190
Export volume (tonnes)	4,604	5,275	7,012
Export value ($ million)	16	20	25

Source: Mango Strategic Investment Plan

The NT's 125 mango growers produce 45% of Australian mangoes[4] (Figure 4).

Figure 4: Mango Industry in Australia



Source: Mango Strategic Investment Plan

[3] According to the NT Farmers' Federation this equates to 4 million trays per annum. Increasing exports through collaboration 2016

[4] HortInnovation Mango Strategic Investment Plan 2017-2021.

Major producing areas in the Northern Territory include Darwin (54% of NT's production), Katherine and Mataranka. Litchfield accounts for almost all of the Darwin area production.

2.1.1 Complementary harvests

Mango growing is highly seasonal. Most of the mangoes in the NT are harvested between October and December, with a small proportion coming to market earlier in August and September.

The Western Australian season is slightly later, the Queensland season later again (high yields in November, December and January), while NSW and Victoria come to market in January and February. Having mango production across several states ensures availability for an extended period, which improves domestic demand and creates the potential for more exports.

2.2 INDUSTRY STRATEGIC PLAN

The Mango Strategic Investment Plan 2017-2021 (SIP) is funded by an industry-led levy of 1.893cents per kg of harvested mangoes.

The SIP focuses on four key outcomes:

8. Increased industry productivity through increased yields and reduced costs per hectare.
9. Increased grower profitability through increased consumer demand for Australian mangoes.
10. Increased R&D and extension capacity and resources supporting industry development.
11. Improved sustainability and management of risks.

Several strategies sit under these four objectives. They support the delivery of one or several of the desired outcomes. Among other areas, the strategies focus on:

1. Grower productivity;
2. Tree management;
3. Disease management; and
4. Development of export markets.

2.2.1 Gentle fruit handling

One of these strategies (and a particularly relevant one for this project) is the implementation of best practice supply chain management throughout the industry. The objective is to achieve greater consistency in handling and transport of mangoes to ensure high quality product.

As stated in the SIP:

> ***Harvest and postharvest handling of a mango crop is labour intensive and complex because of the fragile nature of the fruit leading to losses from disease and blemishes. Careful postharvest handling throughout***

the supply chain is critical to maintaining fruit quality.

Maintaining fruit quality contributes both to grower productivity and to the development of export markets.

2.2.2 Other relevant issues

The SIP also mentions the following challenges:

1. Ageing industry
2. Poor quality fruit at times
3. Climate variability and weather impact on production and marketing cycle
4. High production costs
5. Access to skilled labour and seasonal pickers for harvest

These challenges are noted because the project has the potential to address at least of a couple of the challenges for the Litchfield mango growers.

2.2.3 Export prospects

In recognition of the need to develop exports markets, in 2014, the five-year Australian Mango Export Plan was developed by the Australian Mango Industry Association (AMIA). The Northern Territory, Queensland and Western Australian governments assisted.

Currently some 43% of exported mangoes go to Hong Kong, with most of the rest to one of four other countries (Table 2).

Table 2: Mango Exports by Country 2014-16 (tonnes)

Market	2014	2015	2016
Hong Kong	2,360	2,707	3,010
Singapore	784	953	869
New Zealand	469	886	834
UAE	596	813	805
Lebanon	193	422	423
Other	873	1,231	1,064
Total	5,275	7,012	7,006

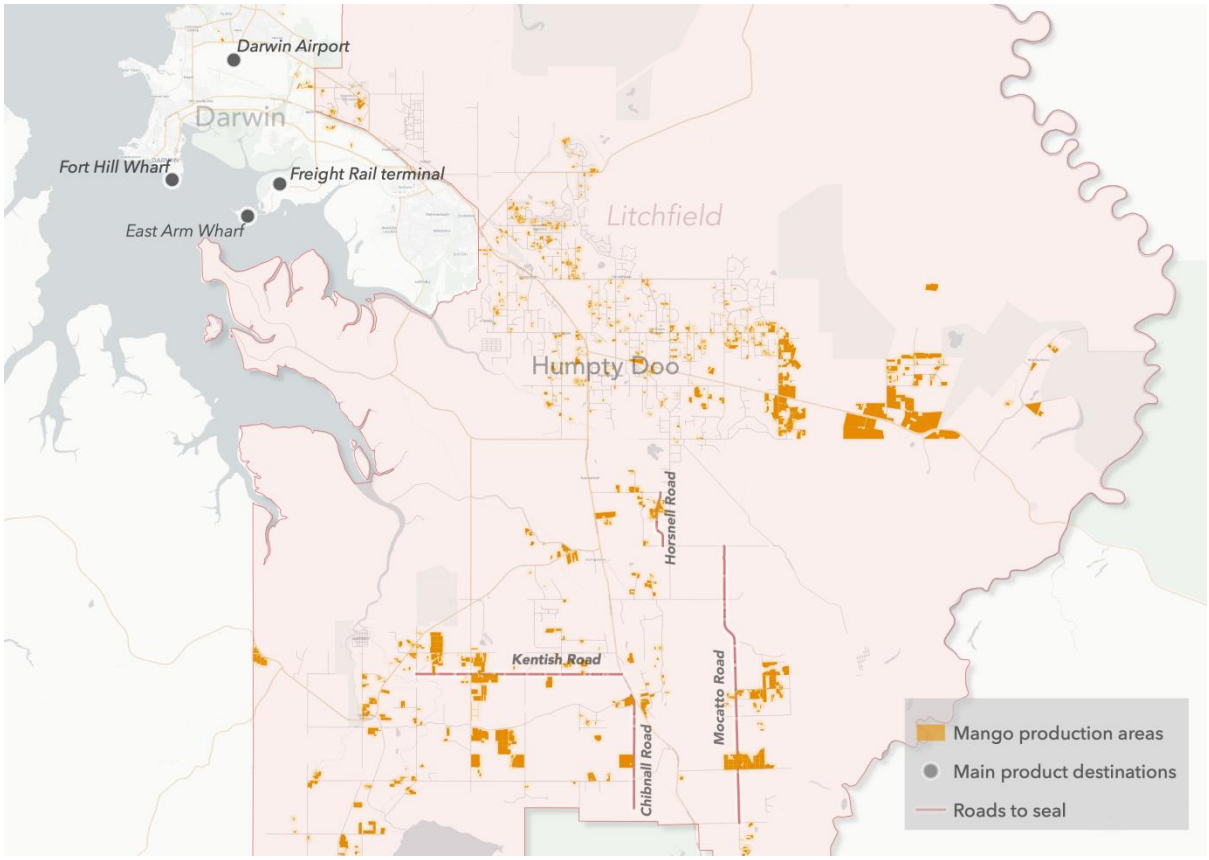
Source: Mango Strategic Investment Plan

There is industry consensus that these and other markets (e.g. the USA) can grow significantly as the freight capacity is expanded, export channels are developed and market connections and supply chains are strengthened.

The NT accounted for 690 tonnes ($3.3 million) of total exports in 2015/16. Queensland, in comparison, exported 5,465 tonnes of mango to the value of $23.2 million. Given the proximity of Darwin to most of the current markets, export prospects for the NT are particularly promising. Given the proximity of Litchfield growers to Darwin, they would greatly benefit from developing NT export prospects.

The strategic locational advantage of Litchfield's mango industry is shown in Figure 5.

Figure 5: The Strategic Locational Advantage of Litchfield's Mango Industry



2.3 POLICY RELEVANCE

2.3.1 10 year Infrastructure Plan

The project is most relevant to the NT Government's 10-year Infrastructure Plan. This sets out the priority projects for 2017-2026. The plan notes that *"regional economic development is constrained by a lack of infrastructure, which affects development costs, contributes to project risk and impacts the ability to get products to markets."*

Two key points to note from the Plan are:

1. Secure and reliable supply chains are critical to economic growth; and

Mangoes are the major horticultural crop in the NT, worth a combined annual total of about $88.5 million.

The relevant investment needs for the agribusiness sector identified in the Plan are:

1. Maintain and improve the regional road network to support industry; and
2. Develop processing, cold chain infrastructure and logistics support for key agriculture industries including mangoes, other fruit, fish and seafood.

2.4 THE LITCHFIELD MANGO STORY

The mango industry in Litchfield has grown and consolidated over the last 40 years. Initially, mangoes were grown on small holdings as a side crop, but over this period farming practices have improved and become more sophisticated and through consolidation, larger irrigated properties account for a large share of the municipality's production.

Darwin region with 2.1 million trays accounts for24% of Australian production, and Litchfield accounts for almost all of Darwin's production.

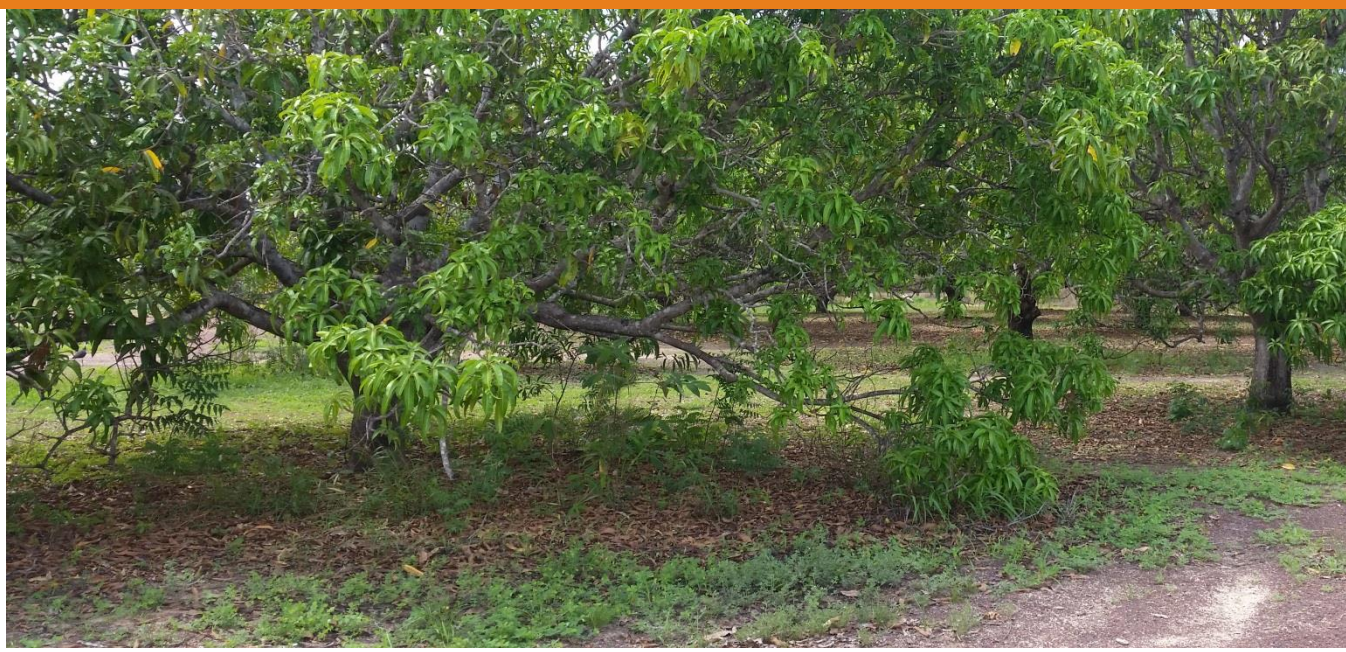
2.4.1 How it works in Litchfield

Mango production is concentrated in areas east of Humpty Doo and in the southern part of Litchfield. Mangos are trucked from farms to local, large on-farm packing sheds, where they are graded and then road freighted directly to Australian markets or transhipped by rail through Darwin. Quality mangoes are shipped by trays and the rest is pulped for juice or other products.

Product is sent to markets in South Australia, NSW and Victoria. A proportion of product is sent to new and growing markets in South East Asia and in Middle East.

To maximise returns and respond to market demand growth, the focus of the local industry has shifted to higher quality product. This requires a more controlled production process, particularly for transport, as mangoes easily sustain damage during transport.

3. The Project



- ✓ The project is to seal the following roads:
  - Chibnall Road between Old Bynoe and Leonino Road
  - Mocatto Road between Whitstone and Acacia Gap Road
  - Horsnell Road between Elizabeth Valley Road and Alverly
  - Kentish Road between Hopewell Road and end of seal.
- ✓ The intention of the project is to address fundamental problems that are undermining the capacity of the mango industry to deliver more, high quality fruit to growing markets.

3 Description of the Project

The project is to upgrade and seal four lengths of unsealed road in the south of Litchfield municipality. Along these roads there are substantial mango farms and packing sheds where own and neighbouring producers' fruit is packed for market. The unsealed roads are used either to move fruit from orchards to the packing sheds, or from the sheds to market. The roads are also the access routes for staff and supply chain inputs.

An Investment Logic Map was prepared to summarise the priority problems caused by the unsealed roads; the strategic interventions necessary to address these problems; and the benefits of doing so (see Figure 2).

3.1 PROBLEMS FOR THE LOCAL MANGO INDUSTRY

The key problems the project is intended to address are outlined below. Each problem is described in terms of the cause and consequence.

3.1.1 Gravels roads corrugations and potholes are reducing the value of mangoes to market

Transportation of mangoes to and from packing sheds occurs along 15km of unsealed roads. As with most unsealed roads in the NT, vehicle impact and weathering creates potholes and corrugations. Notwithstanding costly and carefully designed packing trays, transport along these roads, therefore, damages the fruit.

Bruising is usually not apparent until the fruit is unloaded at the market and results in a downgrade of the fruit to a lower price point. However, by this stage, producers have often already committed significant sums to harvest and deliver what should be class 1 fruit to market. By contrast, class 2 fruit often does not warrant delivery to distant market. The regrading, therefore, can represent a significant loss to the producer, both financially and reputationally.

Estimates of the higher revenue for producers, through class 1 fruit reaching the markets are based on commercial-in-confidence data provided by the producers located adjacent to the roads covered by the project. The percentage of fruit that is bruised on sealed roads has been used as the comparison.

Annual increase in revenue to the producers is shown in Table 3.

In summary, sealing of these roads would reduce bruising sufficient to increase revenue for the relevant producers by an estimated $1.115 million p.a.

Table 3: Revenue Increase to Producers from Reduced Quality Downgrade

Damage	Estimated loss pa
Bruising appearing at market	$488,633
Bruising to fruit to be packed entering the packing shed over unsealed roads	$517,750
Part loads of other growers' fruit travelling over unsealed roads	$109,593
Total	$1,115,976

Source: NT Farmers

3.1.2 Gravel road dust is reducing mango farm productivity

Dust from unsealed roads affects mango tree pollination to a depth of 60m from the roadside. Not only does the dust reduce pollination, it also increases the incidence of mites in the fruit. Producers tend not to harvest fruit from the first 60m adjacent to the unsealed roads. Trees bear insufficient volume or quality of fruit to cover harvesting costs.

An estimate of the increase in revenue to the producers from increasing their productive area (i.e. harvesting from this 60m wide strip) on currently owned orchards is provided in Table 4.

Table 4: Revenue Increase from Increased Productive Area

Damage	Estimated loss pa
Loss of production due to dust from unsealed roads	$308,155

Source: NT Farmers

3.1.3 Gravel roads are reducing safety

There are a range of other consequences across the supply chain. These can be broadly described as efficiency losses.

Firstly, mango producers on unsealed roads are compelled to use freight contractors with special air suspension on the vehicles in lieu of the standard spring or coil suspension[5].

The need to use transport companies with air suspension vehicles reduces the choice in transport providers for the mango producers and reduces competition. While, there are no direct cost savings, the decreased supply of freight contractors limits the choice of mango producers located on unsealed roads.

It is not possible to quantify the impact to mango producers, but any reduction in market competition is likely to have a negative impact on the end freight costs.

[5] Air suspension is a system of rubber and polyurethane bags, inflated by a compressor, which substitute for other suspension. Fragile loads suffer less damage when air suspension is used.

Another efficiency loss is the safety of workers accessing the farms and packing sheds. Unsealed roads have a higher rate of traffic accidents and this is particularly concerning given that many of the farm workers are backpackers with limited experience driving in Australia.

Table 5 shows the average number of accidents per year 2011 to 2015 in Litchfield. Accidents have been attributed to sealed and unsealed roads using GIS data and assuming that Northern Territory roads are sealed.

Table 5: Average Accidents per year 2011 – 2015 Litchfield

Accidents	Sealed	Un-sealed
Annual fatalities per year	4.2	0
Annual serious injury per year	70	1.2
Annual injury per year	7	1
Annual no injury per year	102.8	2.75

Source: Litchfield and Geografia

Table 6 shows the parameter values associated with serious injury accidents. The data does not enable the calculation of a benefit from a reduction in accident rate between sealed and unsealed roads. However, anecdotal evidence from local residents indicate the accident rate on unsealed roads is significantly higher. It is speculated that the remoteness of the area and access to local assistance lead to underreporting of non-fatal accidents.

Table 6: Serious Injury Accident Costs – 2013 values

Cost Component	Costs
Total Human Cost	$335,078
Total Vehicle Costs	$13,241
General Costs	$151,632

Source: ATAP (Note; General costs cover travel delays, insurance administration, police, property and fire)

Anecdotally, sealing the roads has the potential to reduce road accident rates equating to a reduction in cost for staff, deliveries and farmers.

Finally, there is additional wear and tear of vehicles and equipment[6] because of the unsealed roads (due to both vibration from travel and the dust produced). This is based on the experience of farmers and residents using unsealed roads, that the lifespan of a vehicle used on unsealed roads is one third of that for vehicles only used on sealed roads.

The combined revenue loss from these problems caused by the unsealed roads cannot be quantified due to lack of quality data.

[6] This includes staff vehicles, farm machinery and transport vehicles.

4. Analysis

- ✓ The economic appraisal assesses the financial and economic viability of the project.
- ✓ The appraisal is based on a construction estimate of $20.1 million and net present value (NPV) benefits of $35.1 million (4% discount rate) and $25.0 million (7% discount rate).
- ✓ This gives benefit cost ratios of 1.75 and 1.24 respectively.
- ✓ There is a very strong positive return on investment of 9.3%, making this project an attractive investment for stimulating economic activity in the Northern Territory.

4 Analysis

This section assesses the financial and economic viability of the project. The methodology follows the Australian Transport Assessment and Planning Guidelines, which outline best practice for transport planning and assessment in Australia. Guidance is provided on the monetised and non-monetised potential benefits and costs to include in the cost benefit analysis. The guidelines also identify what can be considered secondary economic impacts. The appraisal is undertaken in real terms, using the recommended discount rates.

4.1 METHODOLOGY & ASSUMPTIONS

4.1.1 Methodology

The components required for the economic appraisal were identified in the Investment Logic Mapping, where the stakeholders identified and estimated the major benefits that could be attributed to the project.

Costs and benefits are calculated using discount rates to estimate the net present value of future dollar values. The sum of the annual discounted present values of the stream of benefits or costs is called the 'present value' of that stream. The net present value (NPV) of a project is the difference between the discounted stream of benefits and the discounted stream of costs[7]. The NPV is given by:

$$NPV=\sum_{t=0}^{n} Bt-OCt-ICt(1+r)t$$

where:

- t is time in years
- n is number of years during which benefits and costs occur
- r is the discount rate
- B_t is benefits in year t
- OC_t is infrastructure operating costs in year t
- IC_t is investment costs in year t.

Dividing the NPV of benefits with the NPV of costs gives the cost benefit ratio. Although Cost Benefit Analyses (CBAs) are normally undertaken from the point of view of society as a whole, this appraisal is undertaken from the point of view of NT, given the relatively low interdependency of the NT economy with other States and Territories.

4.1.2 Assumptions

The economic appraisal of these benefits and costs is undertaken using the following

[7] ATAP, Cost Benefit Analysis 10.4

parameters, which have been adopted through discussion with Litchfield Council and regard to NT standard practice[8]:

- Price year – the year in which all monetary values e.g. construction costs are presented. This is usually 4th Quarter of the previous year in which the assessment is based and in this case is 4Q2017;
- Construction year – construction is estimated to take up to 12 months and to occur in 2019;
- Road opening year – the construction is assumed to be completed for road reopening to traffic at the start of 2020;
- Evaluation period – this is usually 30 years for road projects. This enables the results of the CBA to be directly compared with other road CBAs for funding purposes;
- Discount rate – these are currently set at real rates of 4% and 7% for transport related projects, which provides a range in NPV[9].

A positive NPV means that the project represents an improvement in economic efficiency compared with the existing conditions.

To then calculate the benefit cost ratio (BCR) the present value of net benefits is divided by the present value of costs.

A BCR greater than one implies a positive NPV.

4.1.2.1 Road construction costs

Construction cost of the project has been estimated at approximately $20.1 million (Table 7).

Table 7: Road Construction Costs

Road Name	Cost Estimate (Mar 2018)
Horsnell Road	$5,526,677
Kentish Road	$3,692,672
Mocatto Road	$5,814,980
Chibnall Road	$5,041,504
Total	**$20,075,833**

Source: Litchfield Council. Note: all costs inclusive of GST

The costs are based on road design and survey work undertaken by Byrne Consulting. The design and survey work has been completed for all four roads. There are no additional permit requirements as there will be no land acquisition in connection with the road works. All works are within the existing road reserve. The project is therefore ready to commence construction when capital funding has been granted.

[8] ATAP, Cost Benefit Analysis Section 10.3

[9] A discount rate of 7% is clearly higher than current real interest rates. If the NPV is positive at that level, it clearly demonstrates the value of the project.

4.1.2.2 Road maintenance costs

The saving in road operation and maintenance has been included in this economic appraisal as a benefit. This is because the ongoing maintenance costs of unsealed roads are higher by a ratio of some $4.5:$1 over a 30 year period.

Maintenance costs for sealed roads vary more between individual years and are quite high in years that require a new bitumen seal, which is necessary every 10 to 15 years.

Maintenance costs have been estimated over the full 30 year period and then annualised to provide an average figure that is comparable between the sealed and unsealed road sections.

Table 8 summarises the maintenance cost estimates for 15.2km of unsealed roads and Table 9 for the equivalent length of sealed road.

Table 8: Maintenance Cost Unsealed Road

Maintenance Task	Frequency	Cost
Grading	6 weeks	$250/km + mobilisation costs
Grade and Water Roll (where produce is grown adjacent to the road)	quarterly	$1500/km
Pre-wet season full maintenance grade	Annual	$450/km + mobilisation costs
Corrugation fix (Rip, Reform, Recompact)	Yearly	$5500/km
Regravel with top up of subbase, gravel top up and compact	Every 5 years	$19/m2
Estimated total for 15.2km of road over 30 year period		$22.1million

Source: Litchfield Council & Matters More

Table 9: Maintenance Cost Sealed Road

Maintenance Task	Frequency	Cost
Renewal of line marking2	2 years after completion, then every 5 years	$5-$7 per metre
Shoulder and drainage	Every 3 – 5 years	$1400/km of road side
Bitumen seal	Every 10 – 15 years	$$9.90 - $15/m2 + mobilisation and demobilisation costs
Estimated total over 30 year period		$4.9 million

Source: Litchfield Council & Matters More

The maintenance cost estimates indicate that the approximate annual maintenance cost saving would be in the order of $573,000pa over a 30-year period.

4.2 ECONOMIC APPRAISAL

4.2.1 Net present value

Table 10 summarises the full suite of costs and benefits to be evaluated.

Net present value calculations are done with two discount rates to provide results that are robust in case of a real interest rate increase. Assessment guidance specifies use of the 4% and 7% discount rates. It is worth noting that both of these discount rates are higher than the current cash rate in Australia.

NPV (7% discount rate) of benefits;

= $25,027,675 or $25.0 million (rounded)

NPV (4% discount) of benefits:

= $35,126,526 or $35.1 million (rounded)

Table 10: Summary of Costs and Benefits

	Components of the costs benefit analysis	Period it occurs	Costs & Benefits 2018 dollars
Cost	**Capital costs**	Year 0	-$20,075,833
Benefit	**Increased revenue to producers from reduced fruit bruising**	Every year from Year 1 to 30	$1,115,976
Benefit	**Increased revenue from increased production**	Every year from Year 1 to 30	$308,155
Benefit	**Benefit of reduced maintenance to roads covered by the project**	Every year from Year 1 to 30	$573,000
Benefit	**Value of staff safety through reduced road accidents**	Every year from Year 1 to 30	Not quantifiable

4.2.2 Benefit Cost Ratio

The benefit cost ratio (BCR) is calculated by dividing the total discounted value of the benefits by the total discounted value of the costs.

BCR @ 4% = $35.1 mio/$20.1 mio

= 1.75

BCR@ 7% = $25.0 mio/$20.1 mio

= 1.24

A BCR ratio over 1.0 indicates that the net present value of the sum of the project benefits is greater than the sum of costs, and that it is therefore a good investment.

4.3 ECONOMIC IMPACT ASSESSMENT

Economic impact assessment differs from a cost benefit analysis in that it is focused on the changes in the wider economy that results from the project. In this case, it looks at the impacts on the industry that is involved in the delivery of the project (the construction industry), and on the industry that is the main benefactor of the project (the agricultural/horticultural industry). It also takes flow-on effects through the wider economy into account[10].

4.3.1 The economic impact model

The University of Adelaide economic impact model[11] was used to estimate the impact of construction and operational phases on Litchfield's economy. The results of this are documented below.

To quantify the impact at the national level, a national Input Output model was constructed. In view of the fact that the NT economy is relatively self-contained (particularly with respect to road construction activity), it can be assumed that most of the economic impact occurs within the NT.

Key inputs for the model are:

1. A one- year construction phase with a total estimated expenditure of $20.1million.
2. Ongoing operational benefit to the mango industry of $1.42million (see Section 4.2.1).

4.3.2 Impact on Litchfield

Table 11 and Table 12 summarise the impact results for Litchfield for both construction and operational impacts. For the latter, this is a result of improved productivity in the mango

[10] The economic impact assessment focuses on the effect on the mango production industry and not indirect effects, such as fewer traffic accidents.
[11] See http://eiat.aurin.org.au/#/eiat/impact. This model was used to ensure a transparent process.

industry enabling additional employment. Key findings are:

- A total impact on local GRP[12] of $12.3m from construction and $1m for operational impacts; and
- A total impact on employment of 109 full time equivalent (FTE) jobs during construction and 10.5 FTEs ongoing.

Table 11: Litchfield Construction Economic Impact Estimates

	Direct	Indirect	Total
GRP	$6.3m	$6.1m	$12.3m
FTEs	59	50	109

Source: WISeR Economic Impact Analysis Tool

Table 12: Litchfield Operational Economic Impact Estimates

	Direct	Indirect	Total
GRP	$0.6m	$0.4m	$1.0m
FTEs	7	3.5	10.5

Source: WISeR Economic Impact Analysis Tool

In 2016, Litchfield's GRP was estimated at $2.22b (NIEIR) and the total local FTE count, 11,686. This makes the construction impact equivalent to 0.55% of the Shire's GRP and 0.9% of all FTEs (or 33% of heavy and civil engineering construction FTEs[13]).

The ongoing operational impact equates to 0.05% of the Shire's economy and 0.09% of all jobs (or 2% of all agriculture FTEs).

These findings are corroborated by independent forecasts by the NT Farmers Association. The expectation is that there will be increased investment and employment on farm and in the packing sheds over the 30-year horizon of the project.

On farm permanent employment is forecast to increase by 6–10 staff, and harvest workers by 28 staff (4.7FTE) during the harvest period. The model output (10.5 FTEs) is more conservative than this market intelligence.

The improved profitability of the harvests is also expected to induce new investment in orchard areas. Two existing farms have the capacity to expand orchards by 40,000 trees (320 ha in total). This would increase the value of the mango crop by approximately 5,800 trays or $136,000 per annum once trees reach maturity seven years after planting. The other farms will be looking at expanding their area under cultivation by buying or leasing existing farms or greenfield developments (subject to water availability). This information has not

[12] Gross Regional Product.
[13] This only refers to direct FTEs in construction.

been factored into the model to reduce the risk of double counting.

In addition, the four existing packing shed operators are committed to substantial further investment subject to the road sealing. This includes:

- More harvest machines;
- Investment in new technology for digitising traceability, cool chain monitoring, increased use of NIR[14] maturity testing and reporting, colour system graders; and
- Integrated pest management systems.

These flow-on effects have not been monetised but indicate the results of this analysis are very likely to underestimate the benefits to the economy (in Litchfield municipality and beyond).

4.3.3 Impact on Australia

Table 13 and Table 14 summarise the total impact results for Australia. Key findings are:

- A total impact on GDP of $31m from construction and $1.2m for operational impacts; and
- A total impact on employment of 139 FTEs during construction and 5 FTEs ongoing.

Table 13: National Construction Economic Impact Estimates

	Direct	Indirect	Total
GDP	-	-	$31m
FTEs	39	100	139

Source: Geografia, 2018[15]

Table 14: National Operational Economic Impact Estimates

	Direct	Indirect	Total
GDP	-	-	$1.2m
FTEs	4	1	5

Source: Geografia, 2018

4.3.4 Other impacts

The CSIRO Futures research on agribusiness (CSIRO, 2017) suggests this sector is one of only a few major growth drivers for Australia. This is not (as previously thought) as a food bowl producing at volume, but as a niche producer with a focus on high value products. Mangoes are part of this landscape.

As explained in Section 3, road sealing is directly related to the quality of product. As there is a delay before bruising appears, downgrading can occur upon delivery to the

[14] Near Infrared analysis is a cost-effective, non-invasive spectroscopic technique to test food samples (e.g. for ripeness).
[15] The Geografia inter-industry model used for this does not provide separate direct and indirect impact results.

buyer, thereby risking reputational damage for the growers.

4.4 RISK ASSESSMENT

Since the values that are part of the cost benefit analysis are forecasts, they are associated with a level of uncertainty. That is, there is a risk they may be higher or lower than forecast for the analysis.

As part of the risk assessment, a sensitivity analysis was undertaken to determine whether the project would be feasible with different cost and benefit assumptions.

4.4.1 Sensitivity analysis

Sensitivity analysis has been undertaken on the following components:

1. Construction cost
2. Benefits of reduced bruising
3. Benefits of increased productive area
4. Benefits of reduced road maintenance costs

4.4.1.1 Construction cost

Although the construction costs are based on detailed design, there is the risk that construction cost may have increased if there is some lengthy delay before construction eventuates. Construction costs have been tested at a sensitivity of 10% increase in costs. Under this assumption, the BCR at both 4% and 7% discount rate remains above 1.0.

4.4.1.2 Reduced bruising

The value of the project has been assessed in the event that the benefits of reduced bruising during transport to packing sheds and/or markets are lower than estimated. This could occur if the overall production from the farms located on the roads decline (e.g. a grower or packing shed goes out of business), or if fire or disease impacts on the orchards and thereby reduces the production. The impact on the BCR has been measured at a 10% decline in benefits achieved, under both discount rate scenarios, the BCR remains above 1.0.

4.4.1.3 Increased productive area

The sensitivity of benefits from the increased production area (the area that is no longer affected by dust from the unsealed road) has also been measured. It is possible that there could be a delay in realising the benefits. For example, if it takes longer than expected for the trees to fully recover from the dust (in year 3 or 4 instead of year 1). Again, a 10% in benefits achieved from increasing the productive area still returns a BCR above 1 for both discount rates.

4.4.1.4 Reduced road maintenance costs

Table 15 summarises the results of the sensitivity analysis at 10% change for the four scenarios outlined in Section 4.4.1.

Sensitivity of the BCR result to different assumptions about the reduced road maintenance costs is estimated.

Table 15: Sensitivity Analysis at 10% Change

Component	Current value	Sensitivity	BCR @4%	BCR @ 7%
Construction Cost	$20.1 million	+10%	1.6	1.1
Benefits of reduced bruising (from year 1)	$1,115,976 pa	-10%	1.6	1.2
Benefit of increased production area (from year 1)	$308,155 pa	-10%	1.7	1.2
Road maintenance cost savings not realised to full extent (from year 1)	$573,000 pa	-10%	1.7	1.1

There is a risk that the cost to maintain sealed roads increases more than expected. For example, if it becomes difficult to source the aggregate that is used to reseal roads or other inputs. The BCR impact is again tested if the maintenance costs savings are reduced by 10%. BCRs remain above 1 for both discount rates.

The sensitivity analysis shows that at 10% increase in costs or decline in benefits, the BCR of the project remains greater than 1 in all cases.

The project is most sensitive to:

- increases in construction costs; and
- reduction in achieved benefits from reduced bruising to the fruit.

4.4.2 Risk management

Risk management strategies to ensure a successful outcome of the project should be focused on controlling the construction costs tightly to ensure there is no overrun. Council's engineering department should be consulted on the best strategies for managing the construction process. This includes gauging views on:

- The least risky time of year for the construction where weather events are will have a minimal impact on the construction period; and
- Negotiating a fixed cost construction contract with the preferred provider.

5. Conclusion

- ✓ Analysis of the sealing of four roads in Litchfield shows that it will provide overall benefits to the agricultural industry and the municipality.
- ✓ The benefit cost ratio of the project at a discount rate of 4% is 1.75. At a 7% discount rate, it is 1.24.
- ✓ Tests of the impact of input cost changes (±10%) on the benefit cost ratio show that it remains over 1 for all discount rates.
- ✓ This project provides an attractive 9.3% p.a. return on investment
- ✓ In summary, even with input cost changes, the project benefits are robust and, therefore is a wise investment for Northern

5 Summary and Conclusion

5.1 THE MANGO INDUSTRY

The mango industry has grown over the last 40 years. During this time, it has consolidated into larger farms with packing sheds and focused on higher quality product, primarily for the domestic market.

The Darwin region accounts for 24% of Australian production, and Litchfield accounts for almost all of Darwin's production.

The CSIRO Futures research (CSIRO, 2017) suggests agribusiness is one of only a few major growth drivers for Australia. This is not (as previously thought) as a food bowl producing at volume, but as a niche producer with a focus on high value products. As a high value, in-demand product, mangoes are clearly part of this future.

Sealing four roads in Litchfield Shire will have significant benefits for the mango industry in Litchfield. Currently, bruising that appears at delivery of packaged product to market as a result of transport on unsealed roads, is reducing the quality of the product. A downgrade from grade 1 to grade 2 effectively halves the value of a tray of mangoes and this affects the reputation of growers in Litchfield and NT generally.

The cost to seal four roads totalling 15.2kms is estimated at $20.1million. Survey and design of the road improvements were completed by Litchfield Council at a cost of approximately $272,000, so works could commence immediately and deliver benefits for the mango harvest in late 2018 and early 2019.

5.2 THE ANALYSIS

The analysis shows that the project will provide overall benefits to the agricultural industry and the municipality.

The benefit cost ratios of the project are:

1. **1.75 at a discount rate of 4%.**
2. **1.24 at a 7% discount rate.**

Analysis was undertaken to test the robustness of the benefit cost ratio to increases in costs and decreases in benefits. Cost increases of 10% and benefit decreases of 10% were tested. In all instances, the benefit cost ratio remained over 1.0 for both 4% and 7% project discount rates, indicating that the project benefits are quite robust.

The internal rate of investment is 9.3%, which is very attractive in the current low interest environment.

5.3 CONCLUSION

The project will bring significant benefit to Litchfield and provide impetus for further growth of the mango industry, generating employment and GDP for the municipality and the NT.

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