Central Otago District Council

Seal Extension Strategy

September 2004

Quality Assurance Statement	
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Central Otago District Council

Seal Extension Strategy

Contents

1. Executive Summary

The purposes of this strategy are to:-

- formalise a method of prioritising seal extension projects that balances the economic, environmental and social needs of Central Otago
- ensure the processes of procurement of services, design and construction are carried out in a cost effective manner
- ensure projects are environmentally acceptable
- provide the basis for preparing a long term programme of upcoming seal extension projects

This strategy builds on the documentation already produced from previous studies and local experience within Central Otago and surrounding areas. The existing Transfund economic evaluation procedures have been considered along with the social, economic, environmental considerations for undertaking seal extensions and provide a strategy and ranking procedure for determining priorities.

Other Council documents which are currently being developed and which should be read in conjunction with this strategy are:

- Roading Activity Plan
- Blue Print Study
- Development Contributions Policy
- Safety Management System
- Walking and Cycling Strategy
- CODC Addendum to NZS 4404:2003
- District Plan

2. Seal Extension Strategy

Central Otago District Council has developed a seal extension strategy that:

- Provides the most cost efficient means of carrying out seal extension works;
- Prioritises roads to have seal extended;

The reasoning behind the strategy has been explained in more detail within the body of the document.

1. Strategy Review

This strategy will be reviewed from time to time as network demands change or legislation dictates.

2. Long Term Council Community Plan (LTCCP)

This strategy is consistent with Council's LTCCP. It is an operating document designed to assist Council in achieving targets set in the LTCCP.

3. Budget

The LTCCP contains the long term financial plan for funding seal extension projects.

4. Cost Effective Procurement

All services required for seal extensions shall be undertaken by a cost effective procurement method. Where Transfund New Zealand subsidy is obtained, procurement must meet Transfund requirements. The method should take into account the current market environment and capabilities of those able to carry out the work.

The procurement method will encourage competition and have an element of price tension.

5. Prioritising of Projects

Projects are to be prioritised so that they can be completed in an orderly fashion that matches the financial plan contained in the LTCCP. The priortisation methodology is more fully explained in Section 13.

The benefit cost ratio calculated in accordance with Transfund New Zealand's economic evaluation procedures forms the basis of the prioritisation process.

The following annualised tangible benefits are added to those allowed by Transfund New Zealand:

Tangible Benefit Description	Value	Reference
Horticulture		13.3
Cherries	\$19 700/km frontage	
Stonefruit	\$23 700/km frontage	
Pipfruit	\$9 700/km frontage	
Grapes	\$3 300/km frontage	
Pastoral		13.4
Beef and Sheep	\$50/km	
Diary	\$230/km	
Venison	\$100/km	
Dust Nuisance to Adjoining Properties		13.5
Residential	\$1 040/per house	
Commercial	\$2 600/per commercial operation	
Long Term Aggregate Supply	\$1.00/m^3 running course loss	13.6

The following intangible benefits are applied to the modified tangible benefit cost ratio.

Intangible Benefit Description	Value	References
Strategic Importance		13.7
Local road with little or no through traffic	0	
Local road with through traffic and alternative sealed route	0.1	
Link road between two small communities	0.3	
Link road between small community and large community	0.5	
Tourist Route	0.5	
Collector road from several small communities to large communities	1.0	
Heavy traffic route	1.0	
Urban Social Value	0.0 - 0.5	13.8
Health Residential Amenity Value	0.1/house	13.9
Equity	0.0 – 0.5	13.10
Safety	0.0 – 0.3	13.11
Road Oiling Environmental Effects	0.0 – 0.5	13.12

6. Forward Works Programme for Seal Extensions

With projects prioritised and the long term financial plan defined in the LTCCP, a forward programme of seal extension candidates is produced.

Maintenance activities are reviewed and coordinated to match the seal extension programme. Routine maintenance activities shall continue but be carried out in a manner that is consistent with the proposed seal extension.

7. Pavement Design

Pavements shall generally be designed for a 25 year design life. An alternative life may be accepted on a case by case basis where it can be shown to be of benefit to Council.

Past experience has shown some local materials that do not fully comply with Transit New Zealand specifications perform satisfactory. Where these local materials provide an economic alternative then they will be accepted.

8. Geometric Design

It is important to provide a safe road network for the travelling public. Geometric design includes seal widths. Generally all geometric design will conform to accepted design standards and codes of practice. Where it is not economically viable to seal full width the following table of minimum seal widths will be used when the criteria of section 8.3.3 of this document are met.

Recommended Narrow Seal Widths			
Vehicles per day*	**Seal Width (m)**	**Unsealed Shoulder**	**Total Pavement Width**
Less than 50	4.5	0	4.5
50 – 150	5.5	1.0	6.5
150 – 300	6.0	0.5	6.5
300 - 500	6.5	0.5	7.0

* the vehicles per day value is the estimated number of vehicles at the end of the design life

9. Management of Data Collection

Council has an annual programme of traffic counting and road roughness collection. There is flexibility within these programmes to accommodate data collection for upcoming seal extension projects.

Each road within the seal extension forward programme requires an annual classified traffic count. These counts should continue until two years after sealing so records of traffic generation due to sealing can be obtained. Traffic counts will require seasonal adjustment to be converted to an Average Annual Daily Traffic Volume. The adjustment factors may be obtained from the Transit New Zealand Guidelines for Estimating AADT or based on data collected from local control sites.

There will be 3 one week traffic counts carried out at 4 month intervals annually.

Roughness or unsealed roads can vary considerably during the grading cycle. Biennial roughness counts are required on those roads included on the forward programme for seal extensions. The roughness counts may need to be adjusted to reflect district-wide grading and weather cycles.

10. Supplementary Funding

Council will allow any supplementary funding to reduce the capital cost used to calculate the benefit cost ratio under Transfund economic evaluation procedures.

The amount of supplementary funding required to obtain Transfund subsidy is to be identified for each road and the Community Board invited to contribute this amount either through unsubsidised Community Board funding or private contributions. Where this contribution is provided these roads *will receive priority. Alternative lesser amounts will not be considered in determining priority for unsubsidised seal extensions.*

11. New Ventures on Gravel Roads

Through the resource consent process, new ventures will be encouraged to establish their activities on the site in a manner which considers the adverse effects of dust on workers health and machinery.

3. Introduction

3.1 Project Background

Central Otago District Council (CODC) has approximately 1,400km of unsealed roads. In 2004 approximately 18km of these roads are estimated to have an Average Daily Traffic (ADT) in excess of 150 vehicles per day, and 50km has an ADT in excess of 100 vehicles per day.

Increases in lifestyle block development, horticulture, viticulture and tourism are placing increased pressure on these unsealed roads. Public expectation is that CODC should seal many of these roads. CODC has previously budgeted a local share of $175,000 per annum for seal extensions.

The high construction cost of seal extensions surpasses any other consideration in undertaking this work and has proven to be a major hurdle in CODC obtaining Transfund funding for this work. At present funding cannot meet ratepayer's demands using the local share available.

The Local Government Act (2002) and the Land Transport Management Act (2003) require Road Controlling Authorities (RCA's) such as CODC to consider the social, environmental, economic and cultural implications of sealing unsealed roads and the relative impact of these. Transfund will now include these considerations when prioritising work under the National Land Transport Programme (NLTP).

This seal extension strategy should identify a process for measuring inputs, determining standards for different situations and CODC's priorities need to be consistent, clear and able to be audited.

As part of this project, a Workshop was held on 15 March 2004 in Alexandra between the Roading Hierarchy Sub-committee, the CODC Roading Manager and MWH representatives. The purpose of this workshop was to define the problem and objectives, identify the issues, generate alternative approaches for seal extensions and develop an action plan.

3.2 Study Objectives

The objectives have been defined in the Request for Tender and they include:

- Identify social, economic and environmental implications of sealing gravel roads and the relative impact of these.
- Identify the process for determining priorities based on social, economic and environmental implications.
- Identify parameters under which narrower seal widths would provide cost effective options.
- Identify subbase conditions where alternative pavement design would be appropriate.
- Identify local materials that could be used as alternatives to standard specifications for materials for pavement construction.
- Identify the most cost-effective method of procuring seal design and construction.
- Set a programme of traffic and roughness counting required for roads to be considered for seal extension.

In conjunction with this project, CODC have requested that specific seal construction design parameters for Central Otago District be produced and benefit cost ratios and priorities could then be set using these parameters.

3.3 Brief Problem Summary

The problems that have been identified previously include:

- High cost of the traditional seal extension methodology.
- Risk associated with using design standards below the accepted industry standard.
- Changes to Transfund policy has and will continue to impact on ability to secure subsidy on seal extensions.

3.4 Terms of Reference

MWH New Zealand Ltd has been engaged by Central Otago District Council to prepare a Seal Extension Strategy for the Central Otago District.

This strategy builds on the documentation already produced from previous studies and local experience within Central Otago and surrounding areas. The existing Transfund economic evaluation procedures should be considered along with the social, economic and environmental considerations for undertaking seal extensions and provide a new policy and ranking procedure for determining priorities.

The purposes of this strategy are to:-

- formalise a method of prioritising seal extension projects that balances the economic, environmental and social needs of Central Otago
- ensure the processes of procurement of services, design and construction are carried out in a cost effective manner
- ensure projects are environmentally acceptable
- provide the basis for preparing a long term programme of upcoming seal extension projects

3.5 Report Outline

The remainder of this report is divided into the following chapters:

- **Section 4** is an overview of the Transfund existing and proposed ***funding framework***.
- **Section 5** describes the ***environmental and social impacts*** of unsealed roads versus sealed roads.
- **Section 6** details the ***economic evaluation impacts*** of unsealed roads versus sealed roads.
- **Section 7** is an ***overview*** of the existing seal extension methodology.
- **Section 8** discusses ***alternative design standards*** for seal extensions.
- **Section 9** gives an overview to the management and programming of the ***data collection***.
- **Section 10** discusses the ***procurement of design and construction*** works.
- **Section 11** discusses the **forward planning of maintenance works**.
- **Section 12** details the ***Long Term Council Community Plans (LTCCP)***.
- **Section 13** provides an outline to the ***draft prioritisation ranking procedure*** for seal extensions.

4. Transfund New Zealand Funding Framework

4.1 Proposed Framework

The Land Transport Management Act (LTMA, 2003) and the New Zealand Transport Strategy (NZTS, 2002) provide an integrated approach to land transport funding and management. The land transport programmes for all road controlling authorities and the NLTP are required to include long term financial forecasts setting out anticipated revenue and expenditure on activities over the next 10 years.

The government's vision is for a land transport system that is affordable, integrated, safe, responsive and sustainable. In moving towards this vision, the government is committed to an approach that is forward-looking, collaborative, accountable and evidence-based.

The NZTS sets out five key objectives**:**

- assisting economic development
- assisting safety and personal security
- improving access and mobility
- protecting and promoting public health
- ensuring environmental sustainability.

The LTM Act changes Transfund's statutory objective from requiring Transfund to:
"allocate resources to achieve a safe and efficient roading system"[1]

To one that requires Transfund to:
"*allocate resources in a way that contributes to an integrated, safe, responsive and sustainable land transport system".*

An initial assessment framework is being established and is detailed in Table 4.

Table 4: Transfund's Initial Assessment Framework

Objectives	**Typical Evaluation Factors (examples only)**
Economic Development	• *wider economic impacts* • *land use policies* • *travel delay between economic nodes* • *congestion* • *travel time reliability* • *energy efficiency*
Safety and Personal Security	• *fatalities* • *crashes* • *personal security* *effect on vulnerable users*

[1] Transit New Zealand Act 1989 – Section 3B outlined Transfund's principal objective (repealed).

Access and Mobility	• *access to transport system* • *transport interchange* • *severance*	
Public Health	• *physical fitness* • *walking effects* • *cycling effects*	
Environmental Sustainability	• *landscape/townscape* • *heritage of historic resources* • *biodiversity* • *noise and vibration* • *air quality* • *greenhouse gasses* • *water environment* • *effect on non-renewable resources*	
Efficiency	*Costs ($000)*	
	Benefits ($000)	
	Benefit to cost ratio (BCR)	
	rate of return (%)	

Table 4 highlights that the BCR analysis will become one of six criteria that will be assessed for each project and will not be the overall governing factor. The first five criteria will be assessed qualitatively by Effectiveness (positive, neutral or negative) and the Level of Confidence (high, medium or low). However, if a quantitative measure is available such as congestion costs these can be used instead.

With regards to seal extension projects, the environmental sustainability and economic development criteria could be assessed highly depending on the surrounding land use. Overall safety will improve by sealing unsealed roads and can be assessed using this framework even if there is only anecdotal evidence and no crashes reported along the road.

Transfund New Zealand is considering accepting supplementary funding as a mechanism to reduce project costs and improve benefit cost ratios. This change in policy will have a dramatic effect on Local Authority roading. It has opened by way for seal extensions projects to be “bought” by local residents contributing towards the capital costs.

A more detailed report on the changes to Transfund policy has been submitted to Council. A copy is appended to this document.

Council will allow any supplementary funding to reduce the capital cost used to calculate the benefit cost ratio under Transfund economic evaluation procedures. Details regarding supplementary funding are contained in 13.13.

5. Environmental & Social Impacts

Road systems in rural areas are an essential component of the infrastructure as they provide access to social, economic, educational and other opportunities. While rural roads are often gravel, they still have an important role to play as they connect locations of economic and social importance such as towns, agricultural and forestry areas, and tourist centres. These links ensure that social interaction is possible and while these roads contribute to the wellbeing of the community at large, there are a number of social and environmental effects associated with unsealed roads.

Social and environmental effects generally acknowledged as being associated with unsealed roads, and discussed more fully in the following sections, are:

- Dust nuisance
- Amenity values
- Human health
- Visibility
- Dust suppression
- Change in rural character
- Effects of mud, gravel migration and rough road surface.

5.1 Effects of Dust

Gravel roads in Central Otago require 6-10% by weight of clay and silt particles to act as the binder to hold the larger aggregates in place in the dry summer conditions. This fine material is easily disturbed by vehicles, grading operation and strong winds.

Vehicles travelling on gravel roads can pulverise surface particles, which are then lifted and dropped from the turning wheels. In dry weather, the road is exposed to strong air currents as a result of the movement between the wheels and surface thereby creating a wake of dust behind the moving vehicles. This can be a nuisance to people and animals, and can impact on adjoining land uses. Due to the dry climatic conditions of Central Otago, dust nuisance is a frequent occurrence.

Given that the effects of dust are dependent largely on the sensitivity of the receiving environment, the nuisance effects of dust are often subjective and difficult to measure objectively, especially given the dispersed area over which the nuisance occurs.

Dust modelling of emissions can be undertaken and various studies have been conducted to evaluate the impacts of dust on the environment. Of particular importance are studies relating to the productive losses to farming systems adjacent to unsealed roads, caused by road dust emissions.

5.1.1 Effects on Plants

Dust deposit has the potential to have significant effects on plant life. A detailed coverage of effects of dust on plants is given in a report by the Agricultural Economics Research Unit (McCrea, 1984). This report gives estimates of the potential losses in crop productivity for various rates of dust deposition. The main focus of the report is on horticultural crops grown alongside unsealed roads, which is of particular importance in this strategy.

It was found that the losses were significant within approximately 200 metres of the source, with the main area of impact being up to 7 metres from the road verge. There is little impact of dust beyond 200m from the road.

The effects of dust on plants can include:

- Reduced photosynthesis due to reduced light penetration through the leaves. This can cause reduced growth rates and plant vigour. It can be especially important for horticultural crops, through reductions in fruit setting, fruit size and sugar levels.

- Increased incidence of plant pests and diseases. Dust deposits can act as a medium for the growth of fungal diseases. In addition, it appears that sucking and chewing insects are not affected by dust to any great extent, whereas their natural predators are affected.

- Reduced effectiveness of pesticide sprays due to reduced penetration.

- Rejection and downgrading of produce which is of particular significance for horticultural crops, e.g. the European Union does not accept crops where the crop was grown adjacent to an unsealed road. Note pip fruit tends to trap the dust below the stork and this dust is not washed off by rainfall.

5.1.2 The Effects on Amenity Values

The most noticeable nuisance issue is the soiling of clean surfaces and visual impacts. The visual soiling of clean surfaces affect residents living in close proximity to unsealed roads associated with dust. Effects include dust deposition on cars, household washing, windowsills, and effects on the paintwork on the outside of the houses. Depending on the prevailing wind direction dust will enter house if the windows or doors are left open. Dust can also effect people's enjoyment of outdoor activities, such as sporting events and social gatherings.

The importance of the effects depends largely on human perceptions since the level of tolerance to dust deposition can vary significantly between individuals. Related to this is the perceived value of the activity producing the dust, for example, people living in rural areas may have a high level of tolerance for dust produced by ploughing, but a much lower tolerance to the dust from gravel roads. Furthermore, the frequency of dust deposition and other factors such as rainfall also has an effect on the tolerance level.

In considering the loss of amenity value as a result of dust, for most people the main effects of dust is annoyance at the increased requirement for cleaning and loss of ventilation because doors and windows cannot be left open in the direction of the road

5.1.3 Effect on Visibility

The loss of visibility due to the presence of heavy dust is a safety concern on unsealed roads.

Otherwise, visual effects from dust is mainly an issue of aesthetics, since it is only a concern in the immediate vicinity of road and is short lived.

5.1.4 Human Health Effects

Potential health effects of dust are closely related to particle size, with human health effects mainly associated with particles of less than about 10 microns, which are small enough to be inhaled. These effects are specifically covered under the New Zealand Ambient Air Quality Guidelines (MfE, 1999), and can be obtained from this report.

Nuisance effects can however, be caused by particles of any size, but are usually associated with particles larger than 20 microns. This can cause minor health effects, such as eye and nose irritation. Indirect stress-related health effects could also arise, especially if dust problems are allowed to persist for a length of time. This is unlikely to occur as a result of dust caused by gravel roads, but if combined with other dust sources, this could compound the problem.

Some nuisance dust containing specific biologically active materials may also have the potential to cause other types of health effects. For example, the presence of waste oil in dust may have a detrimental effect on human health. This is discussed below.

5.2 Effects of Suppression of Dust

There are control methods for the management of dust, the most common being the use of waste lubricating oil, due to its low cost, ease of availability and effectiveness. In the Otago Region, the use of waste oil as a road dust suppressant is permitted without the need to gain resource consent, subject to certain conditions (Rule 6.6.2 of the Regional Plan: Waste). Conditions relate to the lead concentration and runoff (refer to section 9.2 of this report).

Wet suppression using a water cart and fixed sprinklers is also used mainly during the construction and maintenance of unsealed roads, particularly during dry windy periods. Chemical stabilisation can also be used in conjunction with water and involves the use of chemical additives that form a crust and thereby bind the dust particles together. The treatment methods used vary according to the aggregates present in the road surface and the binding ability of the chemicals. Chemical stabilisation is expensive and is only applied under certain circumstances that warrant the expense. The use of chemical additives would require a discharge permit from the Otago Regional Council.

The effects of using additives can however be detrimental to the environment and the use of waste oil is considered to be of most concern. The Ministry for the Environment commissioned a report from Woodward-Clyde (February 2001) on the environmental impacts of using waste oil and spreading it on roads. Unsealed roads using used oil as a dust suppressant are usually oiled once per annum during the summer at a rate of 2 litres of oil per square metre of road surface. The potential emissions from the use of waste oil are associated with the concern that the oil may cause either contamination of the environment or health effects in people who come in to contact with the dust.

There are various contaminants present in the dust, these include heavy metals (copper and lead) and a number of organic compounds. Furthermore, one of the concerns that have been raised is that there may be emissions of volatiles from the road during the oiling process.

Generally the same areas are oiled each year and over a period of time this can lead to a build up of contaminants. While not only considered harmful to the environment in New Zealand they can also cause difficulties with seal extension work.

5.2.1 Dust Deposition

Contaminant dust from the oiled road surface has the potential to impact on soil quality and may settle in a watercourse, impacting on both surface water quality and the sediment in the stream bed. Once in the soil, the contaminants may be absorbed by root crops and grazing cows, and the milk produced by cows is also potentially affected.

The dust also has the potential to settle on pip or stone fruits, although there is the potential for rain to wash the dust off.

5.2.2 Runoff from the Road

Runoff laden with dust as a result of a storm event may enter the grass verge adjacent to the road and enter a nearby watercourse. Run off which includes contaminants can effect surface waterways and groundwater by causing silting and damage to vegetation and fish breeding grounds.

5.2.3 Accumulation of Contaminants

A risk assessment has been used to estimate the accumulated concentrations of contaminants in the food chain. There are many different exposure pathways by which the contaminants in waste oil on roads could enter both the environment and the food chain. The three main food chain receptors identified were root crops grown containing deposited dust, dust settling on apples while growing on trees and grass uptake of contaminants from soil, the subsequent consumption of grass by cows and the excretion into milk. The risk associated with exposure over long periods of time resulting in the accumulation of carcinogenic compounds was considered to be a concern.

5.2.4 Health Risks

In undertaking the risk assessment, Woodward-Clyde (2001), assumed that all the potential human exposures are cumulative and in addition to the risks associated with the food chain, the following pathways are also identified:

- Skin contact with soil, which is impacted by deposition of contaminated dust, during vegetable gardening.
- Inhalation of contaminated dust while travelling along or living close to an oiled road.

The emissions of volatiles from the road during the oiling process may have potential health risks for people involved in the oiling process.

5.3 Effects of Mud

While the effects of dust are usually associated with gravel roads, the problem of mud during rainy periods is also an effect associated with unsealed roads.

Gravel roads, particularly those with high clay content, if not maintained regularly, have the potential to get churned up by heavy vehicular traffic. This may lead to slippery and dangerous driving conditions. It can also cause damage to the road surface and once dry becomes difficult to negotiate.

Mud carry-out from vehicles leaving gravel surfaces onto sealed roads can create slippery conditions on sealed roads causing a potential danger to traffic.

5.4 Effects of Gravel Migration

As with mud carry-out from vehicles, gravel migration from unsealed roads at the intersection of sealed roads, may cause potentially dangerous driving conditions.

As a result of gravel migration, on-going application of gravel is necessary which adds to the frequency and cost of maintenance.

5.5 Noise

Traffic noise increases with increased volumes, speed of traffic, road surface, road gradient and increasing numbers and sizes of commercial vehicles. Given the number of factors that effect noise, it is difficult to determine what the effect unsealed roads would have on traffic noise.

Noise may be generated from road works during maintenance of unsealed roads. This can have adverse effects on the adjacent landowners, particularly when residences are located close to the road. Given that maintenance works are usually of short duration, this noise should not be unreasonable.

5.6 Change in Rural Character

Unsealed roads have a distinct rural character and the sealing of a road has the potential to change the character of the area. People’s perception of rural areas may be one of isolation or one of peace and quiet. By improving road conditions, an increase in traffic can be expected with the associated increase in signage and activities. New opportunities may be created with the exposure of more through traffic and the benefits that this may have to businesses. This in turn has potential spin-offs for increased tourism activity and associated developments and amenities. By improving linkages between areas, there is greater ease of access and the potential for change.

The threat of change, is often a key cause for conflict. People’s expectations vary and the reality of “progress” may meet with differing responses. The reality for many areas is that the environment is not static and is constantly changing as a result of people seeking to fulfil their social, economic and cultural needs.

5.7 Aggregate Pits

Each year Central Otago excavates some 75,000m^3 from pits through the district to replenish the aggregates lost to the environment as dust and runoff.

These pits generally have been on low cost agricultural land. However this is changing as Central Otago becomes more popular for tourism and recreation.

These pits in the past have not been reinstated and the true cost of aggregate needs to recognise the environmental cost of pits and their reinstatement.

5.8 Effect of Rough Road Surface

The generally rough surface of unsealed roads can be inconvenient to the driver in terms of discomfort, dust, and lower speeds resulting in longer driving time and the increased safety risks. Damage to vehicles (broken or cracked windscreens, chipped paintwork, suspension etc) and the associated wear and tear can be inconvenient and in cases could lead to increases in operating costs. Fuel consumption is generally higher on an unsealed road due to the rolling resistance of the loose metal surface.

Tourism may be affected in areas where hired cars or campervans are discouraged due to poor road conditions.

There is also the potential for damage to fruit during cartage due to the roughness of the road.

5.9 Environmental and Social Issues

Given the subjective nature of environmental and social issues, it is not always possible to quantify or allocate a rank for the purposes of priority. In determining the different approaches to the treatment of unsealed roads in this strategy, the following measures may be applied to mitigate, avoid or reduce the impacts on the environment:

- Where existing horticultural activities occur within 100 metres of the road and there is reported dust nuisance, consideration may be given to sealing a section of road alongside the activity.

- Alternatively, if a decision is made to retain an unsealed road, consideration may be given to minimise dust emissions by applying the following measures:
  1. Limiting vehicle speeds. A speed limit of 10 – 15 km/hr is commonly applied. This not generally feasible.
  2. Placing screens and/or shelterbelts alongside unsealed roads where horticultural products may be effected.
  3. Apply a suitable dust suppressant. It should be noted that if waste oil is used, the Regional Plan: Waste for Otago has rules controlling the use of oil as a dust suppressant. Under Rule 6.6.2 the discharge of oil or substances containing oil is a permitted activity provided that *"the dust suppressant has a lead concentration of less than 100mg/l; and the dust suppressant is applied to the road at a rate and manner whereby there is no runoff from or ponding on the surface of the road"*. If these conditions cannot be met, it becomes a discretionary activity requiring resource consent.
  4. In assessing a discretionary activity associated with the use of oil as a dust suppressant, the following conditions are recommended:
     - used oil should be applied at a rate of less than 2 litres per square metre of road surface;
     - the oil should not be applied within 10 metres of a watercourse to protect both the water and sediment quality;
     - cows should not be permitted to graze within 10 metres of an oiled road;
     - to minimise runoff, oil should be applied to a dry road when 2 to 3 days of fine weather is forecast;

Water content in the oil should be minimised as far as possible.

6. Economic Impacts

6.1 Review of Existing Transfund Economic Evaluation Process

There are four tangible benefit categories, identified by Transfund New Zealand, associated with sealing roads including:

- Productive gains on adjoining properties;
- Ameliorating driver and passenger discomfort (including improved ride quality);
- Vehicle operating cost savings due to reduced roughness; and
- Travel timesavings due to increased speed.

The procedures developed for Transfund's Project Evaluation Manual (PEM) are based on previous research into the benefits of the sealing unsealed roads. Refer to Appendix A7 of the PEM.

From previous research projects into tourism benefits from sealing unsealed roads, the following conclusions were found:

- The Milford Road Study (Travers Morgan, Report No. 45) – It was confirmed that sealing the road made the journey faster, more comfortable and safer for all road users including tourists but there had been no significant increase in traffic volumes once the road was sealed.
- The Waipoua Forest Road Study (Booz Allen & Hamilton, Report No. 86) – There was a significant growth in traffic volumes using the road once it was sealed. Road condition (i.e. whether it was sealed) was a major factor in route choice and approximately 37% of the survey respondents used the road more frequently once the road was sealed. Also tourists preferred sealed roads to unsealed roads.

Particularly in Central Otago, there are a large number of tourists visiting the region and there is an increase in significant developments such as viticulture that will attract more visitors. The tourists are more likely to visit attractions such as wineries if the road access is sealed. At present there are no studies available that could assist in predicting the suppressed demand for unsealed roads if they were to be sealed.

6.1.1 Productive Gains on Adjoining Properties

Transfund's PEM states that "*the resource gain resulting from dust reduction should be based on the increase in profit, or increase in receipts assuming no change in expenditure. It is the difference between the profit the farmer or grower would make if the road was sealed and there was no dust damage to the pasture or crops, and the profit the farmer or grower would make if the road was left unsealed and pasture or crops were damaged by dust (all factors of production taken into account).*"

There is scope to use alternative values other than those given in the PEM for agricultural and horticultural land. However, they shall only be used if they are based on estimates of increases in profits as a result of sealing, assuming the affected farmer or grower adopts all reasonable management practices to minimise the effects of dust while the road is unsealed.

Animal Production

The effects of dust on animal production include worn teeth, lower weight gain due to ingestion of dust, depressed pasture yields, reluctance of stock to eat contaminated pasture, and contaminated wool. Research indicates that most of these effects have minimal economic consequences. The following values for the effect of dust from unsealed roads on adjoining farmland have been established from the Lincoln College Agricultural Economics Research Unit (McCrea, 1984) report:

- Beef and Sheep Farms: $50 per kilometre per annum
- Dairy Farms: $150 per kilometre per annum

Crop Yield

The effects of dust on crop yield can be significant, particularly for high value horticultural crops such as apples, pears, other stone fruit, berryfruit, grape vines and cut-flowers. The main consequences of dust are reject product and reduced crop yield as discussed in Section 4.1.1. The European Union will not accept crops where the crop was grown adjacent to an unsealed road

The effect of dust on plant yield is dependent on factors such as the amount of dust, ambient temperature and plant species. In some circumstances dust can be beneficial such as for grapes. In the event of low average temperatures the effect of dust increasing leaf temperature can be desirable. Also, in drought conditions the lower evapo-transpiration due to dust on the plants can be beneficial. However dust adversely affects horticultural production, much of which is stone fruit in the Central Otago area.

The PEM recommends a value of $300 per kilometre per annum for the effects of dust from unsealed roads on horticultural land.

6.1.2 Ameliorating Driver and Passenger Discomfort

The primary factors of concern to users of unsealed roads, as highlighted in previous road user surveys, are dust, road roughness, safety concerns due to lack of grip, and safety concerns and vehicle damage due to loose stones.

Research by Transfund (2002) has determined a road user willingness to pay value for ride quality (i.e. road roughness). This willingness to pay value has been combined with the vehicle operating cost values for different levels of road roughness (in Appendix A5 of the PEM) to provide composite values for road roughness.

Road user comfort has been valued at **10 cents per vehicle per kilometre**, can be used in the evaluation of seal extension projects. This considers the other benefits associated with avoiding unsealed roads (excluding ride quality). This value was previously valued at 16 cents per vehicle per kilometre but was amended in Amendment 6 of the PEM, dated 1 September 2002, to reflect the outcomes of the most recent research undertaken. This value of discomfort for unsealed roads already includes an amount for the increased risk (i.e. site specific discomfort) that users perceive on unsealed roads.

6.1.3 Travel Time Savings Due to Increased Speed

Travel timesavings for sealing unsealed roads are generally derived from increased mean speeds. The default values that can be used to estimate the increase in mean traffic speed and the travel time reduction between the unsealed do minimum and the sealed road option are shown in Table A7.1 in the PEM which is shown below.

The speed increase between the unsealed do minimum and the sealed road option can be lower than those shown in the table but must not exceed those shown in the table unless there is justification for a greater speed increase. To obtain justification, mean speeds should be measured for a road before and after seal extension and then similar roads (in terms of hierarchy, seal width, traffic volumes, land development and terrain) can be compared to this data to determine whether the greater speed increase maybe justified.

Table 3: PEM Table A7.1 – Increase in Mean Speed for Seal Extension Works

Unsealed Section Mean Speed of Light Vehicles	Sealed Section Increase in Mean Speed (km/h) for Increase in Carriageway Width (m)		
	No increase (seal as is)	Increase of 1 metre	Increase of 2 metres
> 60 km/h	0	5	10
45 to 60 km/h	5	10	20
35 to 45 km/h	10	15	25
< 35 km/h	15	20	30

Note: Any inconsistencies in the post sealing speed environment over the length of the project shall be taken into account in the project design and in the project benefit calculations.

The difficulty in Central Otago is that many busier unsealed have an unsealed width greater than the proposed seal width and based on TFNZ research the benefits form sealing are minimal.

Our experience and estimates of speed changes on recent seal extensions are as follows:-

Road	Speed Before	Speed After
Conroys traction seal	35	55
Felton Road	75	90
Pearson Stage 1	85	95
Burn Cottage Stage 1	75	85

These assessments of speed were based on following another car to determine speed.
Follow up speed classification of these roads would provide additional information.

Road such as Pearson Road with Dennison's Pit material that were straight and wide had a pre-existing high speed environment. These roads did corrugate in summer and this reduced the speeds significantly.

Similarly the worst period of corrugations on Conroys Road hill section dropped the speed in summer to crawl speed.

In summary:-

- were the existing unsealed road is wide, the aggregate provides a good ride without corrugations or loose aggregate, then average speed increase with 6m seal and widening on corners, is estimated to be 10-15km per hour.
- for hill sections where corrugation or loose aggregate is present the speed increase from sealing has been 10-20km per hour for a similar width of carriageway

6.1.4 Vehicle Operating Cost Savings

The reduced road roughness from sealing unsealed roads will result in reduced vehicle operating costs. These are calculated in accordance with the procedures in Appendix 5 of the PEM and/or the Simplified Procedures. From Transit's research report No. 37 (Travers Morgan), it was calculated that there is a 5% reduction in vehicle operating costs from sealing unsealed roads. Vehicle operating costs include fuel/oil consumption, tyre wear, vehicle depreciation, repairs and maintenance.

The vehicle operating costs are reliant on a substantial change in roughness (NAASRA counts) from an unsealed to a sealed pavement and also the base costs which are related to the mean speed and the gradient for that section of road. More often than not, the mean speed will increase due to sealing the road while changes in gradient are less likely to occur unless the seal extension is combined with major geometric improvements.

6.1.5 Crash Costs

Crash cost savings can be justified if LTSA's CAS database has a reported crash history for the road/seal extension site. The presence of a reported crash history is rare for low volume local authority roads, such as Central Otago, where the majority of low severity and damage only crashes are not reported. Generally, all fatal and most serious injury crashes will be reported with the local Police attending the incident.

However, in rural communities, particularly in the more remote areas, crash reporting does not occur. This has been confirmed in CODC's previous seal extension economics where there are no reported crashes and hence no crash savings for sealing.

Even if there are reported crashes present, there are no recommendations in the PEM for crash reductions due to sealing unsealed roads. A crash reduction of 30% has been used in the Queenstown Lakes District Council seal extension evaluations. This value has been accepted at the peer review stage. However, a further study similar to gathering mean speeds is required to obtain more accurate crash reductions for before and after a seal extension projects.

6.1.6 Intangible Benefits

Intangible benefits are the benefits that do not have a standard monetary value at present. This is due to it being inappropriate or that further research is required to establish a standard value.

Typical intangible benefits relating to unsealed roads include:

- Air Quality (which is included in the vehicle operating costs).

- Water Quality.
- Special Areas (such as cultural, spiritual, historic, archaeological, ecological, aesthetic and amenity sites).
- Ecological Impact.

Section 4 discusses these intangibles in greater detail.

6.1.7 Capital and Maintenance Costs

The capital cost for a seal extension is the construction cost including associated engineering fees to implement the design.

The maintenance costs for the higher volume unsealed roads are usually greater than the maintenance costs for sealed roads over a 25 year period, particularly if the unsealed roads are oiled to suppress dust. This gives a reduction (or saving) in maintenance costs.

6.1.8 Metal Loss

The two highest costs of maintaining an unsealed road are grading and replenishing the metal course.

Over time the metal course breaks down and is either last as dust or stones are thrown to the verge by passing vehicles. The table below shows typical metal loss rates.

Typical Metal Loss Rates (per annum)		
Vehicles per Day	***Soft Aggregate***	***Hard Aggregate***
<50	25 – 30mm	10 – 15mm
500 – 100	40 – 55mm	15 – 25mm
100 – 200	50 – 70mm	20 – 30mm

Replenishing the lost metal has a financial and environmental cost to the district.

Further information on metal loss can be found in the Unsealed Pavement Strategy that was prepared by MWH in 2004.

6.1.9 Benefit Cost Ratio

The benefit cost ratio is the sum of all the benefits (travel time, vehicle operating costs, comfort benefits, dust nuisance and crash savings) divided by the capital costs less the reduction in maintenance costs required for a sealed road.

6.2 Improvements to the Existing Evaluation Process

The existing seal extension economic evaluation can be improved by gathering more reliable data for traffic counts and road roughness (both of which are discussed further in Section 8). In conjunction with before and after studies for mean speed (from classified counts), traffic volume growths and crash reductions on like sections of roads within the local authority area, the benefit cost ratio could be improved to a level which attracts Transfund funding. Refer to Section 6 for details on the funding framework.

Without undertaking an intensive economic study into updating the values that are used in the dust nuisance benefits, it is best to refer to the McCrea (1984) report which gives ranges of costs for the effects on animal production and crop yield.

- Beef and Sheep Farms: $50 to $250 per kilometre per annum
- Dairy Farms: $150 to $710 per kilometre per annum
- Horticulture: $100 to $20,000 per kilometre per annum (varies greatly depending on the type of horticulture)

As discussed in Section 8.1.1, the Transfund PEM has assumed the lower values of these ranges. It therefore prompts the question to whether higher values can be used considering the issues with not being able to export crops cultivated adjacent to unsealed roads to the European Union.

The economic impact on horticulture appears to be considerably higher than that allowed for under Transfunds Project Evaluation manual. Export quality produce attracts premium prices so any loss of produce has significant economic impact. It has been suggested by one Orchardist that costs could be as high as $100 000.00 per kilometre for cherry production. The table below illustrates suggested costs compared to the default values adopted by Transfund.

Suggested costs for orchards*				
Crops	**Value per hectare**	**Order of cost from dust at 10m of orchard affected on one side of road only per km**	**Estimated % loss***	**Economic loss**
Cherries	$100,000	$100,000	20	$20,000
Stonefruit	$30,000	$30,000	80	$24,000
Pipfruit	$50,000	$50,000	20	$10,000
Grapes (7t/ha)	$18,000	$18,000	20	$3,600

* Further study is required to confirm the values used in this table. That study is considered outside the scope of this study. Considering the suggested magnitude of the economic impacts it will be worth pursing this matter further.

6.3 Feedback from Dust Questionnaire

Questionnaires were sent to six people for comment. Some of the issues raised were:

- dust through houses
- dust effect on fruit and vines
- road safety
- oiling not acceptable under the “Sustainable Winegrowers” code of practice (E.U. Requirement)
- unable to have barbecues or eat outside
- stock dusty and were down graded when sold to meat works
- washing gets dirty on clothesline
- affects asthma

These issues have been considered when preparing the methodology for priortising seal extension projects.

7. Existing Seal Extension Methodology

7.1 Issue Summary

Unsealed roads are less desirable to the public than sealed roads. Dust nuisance and driver safety account for the majority of complaints about unsealed roads.

As areas around the district have developed both residentially and commercially, Council has received more requests to have roads sealed. There were thirteen submissions to the 2003 Annual Plan requesting seal extensions. Some of these were submitted on behalf of groups of ratepayers so the number of people involved in the submissions is considerably more than thirteen.

At the workshop held between CODC and MWH in March 2004, the issues associated with unsealed roads and/or seal extension projects were identified in a brainstorming session. This is not an exhaustive list but highlights the major issues for CODC and how they can manage and maintain unsealed roads and implement seal extension improvements.

The issues identified, in no specific order are:

- Conflicts between the road and adjoining land uses and/or changing land uses. A specific example is the impacts of dust etc on horticulture and/or viticulture crops when located alongside unsealed roads. (Note – the European Union (EU) will not accept crops where the crop was grown adjacent to an unsealed road. Oiled unsealed roads are included in this ban).
- Nature of vehicles using the unsealed roads – heavy commercial vehicles, light vehicles, school buses.
- Traffic volumes along the unsealed roads and future growth predictions based on land use development.
- Number and density of residences including distance back from the road.
- Current place within the road hierarchy and potential future place in road hierarchy (i.e. acknowledging change, growth etc), relationship of road to the network or what should be the "back bone" or key routes to develop.
- Safety and public health of all users (e.g. pedestrians, cyclists, equestrian riders).
- Travel comfort and extent (distance) of "discomfort".
- Nuisance e.g. plumes of dust.
- Maintenance Costs of unsealed versus sealed roads.
- Growth – implications of strategic direction and future land use development.
- Environmental Effects on water bodies, soil etc, for example from run off.
- Affordability, including access to funding options and associated implications.
- Sustainability in terms of resource use and other implications.
- Vehicle maintenance costs/implications.
- Road materials – nature, availability, costs and use.
- Nature of community and associated expectations.
- Rural versus urban community pressures.
- Funding issues – funding availability such as Development Levies.
- Visual Effects – roads, quarries etc.

7.2 Existing Design Standards & Specifications

In New Zealand the generally accepted design standards and guidelines for roading works are:

- Austroads Rural Road Design – Guide to the Geometric Design of Rural Roads
- NZS 4404:2004 Land Development and Subdivision Engineering
- ARRB Sealed Local Roads Manual
- Transit New Zealand Standard Specifications
- TNZ Pavement Design and Rehabilitation Manual

These documents define geometric and pavement strengths parameters relative to the road use, materials and environmental condition. The parameters minimise the risk of vehicle accidents and pavement failure.

To date not all seal extensions carried out in Central Otago have fully complied with the above standards and guidelines. Where appropriate use of the local aggregates, that do not meet Transit New Zealand specifications, have been accepted as an economic alternative.

For similar economic reasons in some instances lesser geometric standards than those recommended in the above guidelines and standards have been accepted where deemed appropriate. It is important to note that Transfund may refuse subsidy or decline to subsidise maintenance on roads that it considers were not designed to an appropriate standard.

A brief history of seal extension strategies has been appended for further information.

8. Alternative Design Standards

8.1 Aggregate Design

Many studies have been carried out over the years on aggregates and pavement design.

Aggregates have several key properties that need to be considered when assessing their suitability for road construction. These include:

- Strength – ability to withstand traffic loading, measured by crushing strength
- Weathering – ability to maintain its strength when exposed to the elements
- Plasticity – susceptibility to water, determines if an aggregate will hold water or drain freely
- Grading – the size distribution of the particles

When determining the suitability of an aggregate, the above properties need to be considered against the type of roads being constructed. Unsealed roads have different requirements to sealed roads. Environmental factors will affect how aggregates behave. Traffic loads dictate the minimum strength of a pavement.

The strength of an aggregate is measured by its crushing resistance of the parent rock. The stronger the aggregate the greater the traffic loading it will be able to withstand before failing. Therefore if follows that a road with low traffic loading does not require aggregate to be as strong as that of a road with high traffic loading. Those roads with low traffic loadings offer more scope to use alternative aggregates.

When assessing traffic loadings it is very important to design for likely future development. Using low strength aggregates on a road that will be subject to significant traffic loadings in the future will result in a road that has very high maintenance costs.

Weathering is the ability for an aggregate to maintain its properties over time when exposed to the elements. There is a standard method for measuring and classifying the weathering properties of aggregates.

Central Otago is renown for its extreme temperatures. Frosty areas are prone to freeze/thaw situations. Moisture trapped within road pavement layers during freeze/thaw cycles can cause rapid deterioration of the road. The moisture expands during the freezing phase and will cause separation between the aggregates particles. When the moisture thaws it reduces in volume leaving voids in the pavement. The loss of strength causes differential settlement and pavement failures.

It is important to use aggregates very low plasticity or water retentions to avoid the affects of freeze/thaw. For some aggregates with higher plasticity it is possible to modify this characteristic by stabilisation with lime, cement, asphalt or organic enzymes. To assess the effectiveness of stabilisation a series of laboratory tests are required for each source of materials.

Grading is the method of describing the size distribution of particles within the aggregates. While strength determines the performance of individual particles it is the size distribution that influences how the pavement performs as a whole. A well-graded material has a range of particle sizes that interlock for greater pavement strength.

Transit NZ in Research Report No. 51 titled "Freeze Thaw Effects in NZ Pavements" examined the requirements to avoid freeze thaw problems and recommend the following criteria:

1. Average heave displacement of four CBR sample after four days of freezing to be less than 14mm
2. Sand equivalent value to exceed 50
3. Crushing resistance in kN greater than 300
4. Fines content smaller than 0.075mm shall be less than 5% by weight
5. Cracks should be sealed to retain water proofing
6. Basecourse thickness should exceed the penetration depth of the frost if the subgrade is frost sensitive (Note in Central Otago frost penetration to 400mm is common except in the Teviot Valley area.)
7. Surface and subsurface drainage should ensure the watertable is below the frost penetration depth

In Central Otago District there have been no recorded instants of M4 aggregate pavements being damaged by frost only subbase or subgrade materials. The requirement above need to be considered but generally aggregates meeting M4 specification have performed adequately. Table 1 below compares a local material from Roses Pit to standard aggregate specifications.

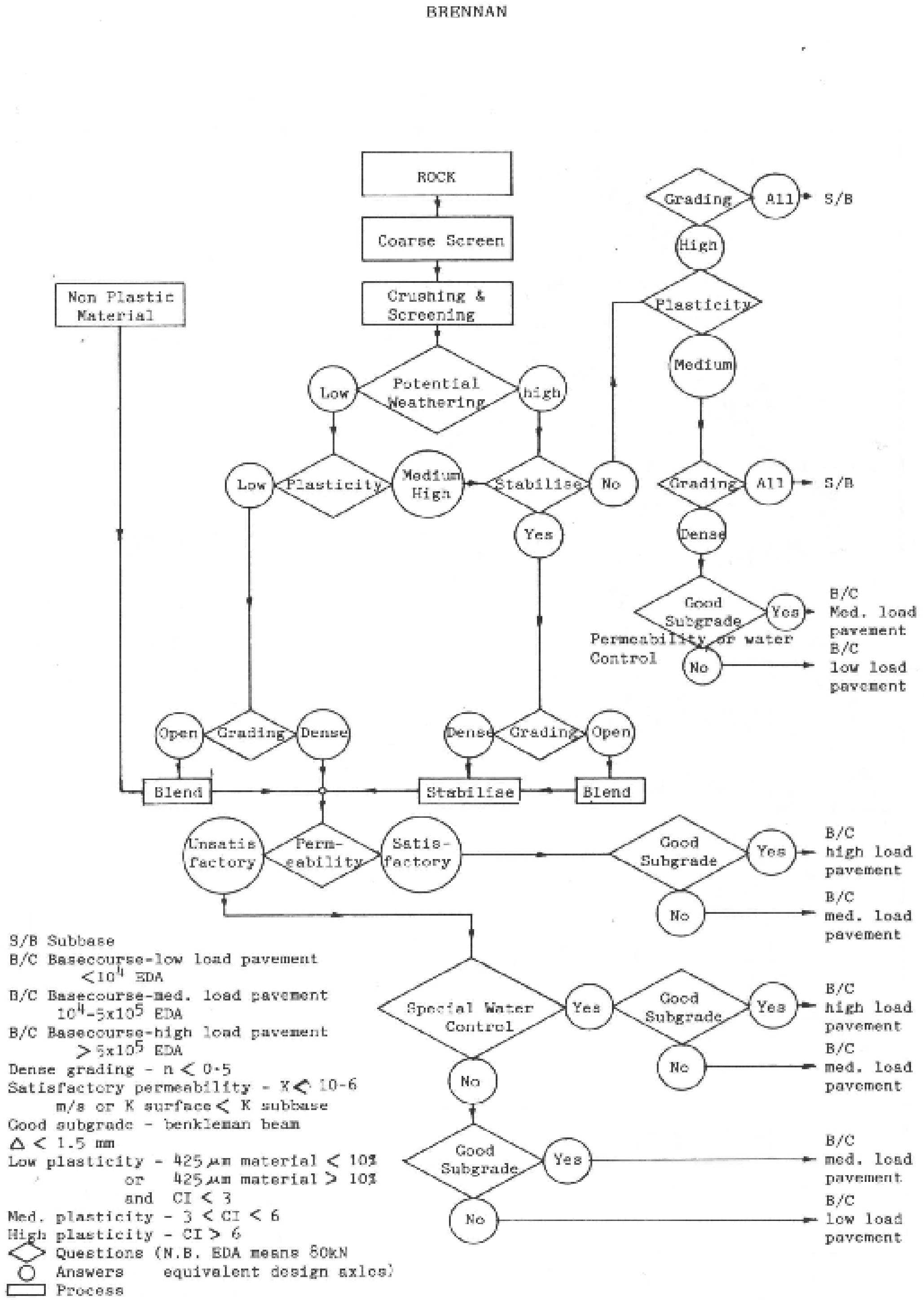
Table 1: Comparison Between Aggregate Specifications

Parameter	Roses Pit M5	M4	TNZ Tec Pub No 51
Weathering	BA	AA, AB, AC, BA, BB or CA	As per M4
Sand equivalent	10	Greater than 40	Greater than 50
Crushing resistance kN	Not measured	Greater 130	Dependant on % less than 75micron.
% fines less than 0.075mm	5% in stockpile 9% in pavement	Less than 7% AP40 Less than 8% AP20	Less than 5%
Clay index	Not measured	Less than 3	As per M4
CBR soaked	150%	Greater than 80%	As per M4
Plasticity Index	Not plastic	Less than 5	As per M4

Note M4 specifications allows material than has sand equivalent of down to 20 where the clay index is less than 3 or the plasticity index is less than five.

In 1984, and later in 1987, Bartly and Brennan set out the key requirements for selecting alternative aggregates in the appended papers. Figure 1 below provides a good guide when designing alternative aggregates.

Figure 1: Roading Aggregate Selection Chart (Brennan)



Trials have been carried out using local materials that do not fully comply with Transit New Zealand standards. To date they have generally performed well. In Central Otago the cost of producing M4 materials is very similar to producing the alternative materials. The difference in cost is mostly associated with any transportation costs saving if the alternative quarry material is closer to the seal extension site.

When trials of alternative pavement designs are carried out Council needs to record the trial sections and carry out monitoring on an annual basis. The data collected on these roads can be used when considering alternative pavement design on future roads.

8.2 Pavement Design

Pavement design is determined by:

- subgrade strength
- aggregate properties
- traffic loading

Subgrade is the material beneath the road end may include material up to 1.5 metres below the road surface. The stronger the subgrade the less pavement depth required.

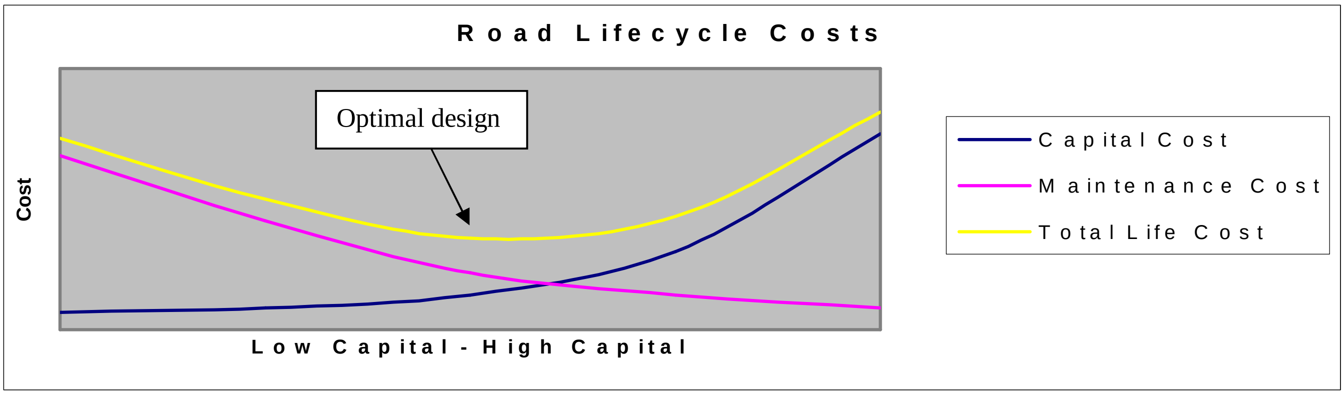
Generally for seal extensions the existing unsealed road is the foundation. A layer of aggregate is placed over the existing road and sealed.

Aggregate properties were discussed in Section 6.1.

Traffic loading is sensitive to the number of heavy vehicles travelling the road. One heavy vehicle may cause as much damage as five hundred cars. The greatest load is at the point of contact between tyre and road. Stronger aggregates are therefore required in the top layer of pavements compared to deeper layers.

Designing pavements that meet the guidelines and standards listed in Section 6.1 provide roads with minimal risk of failure. To reduce capital cost the pavement depth can be reduced but the risk of failure increases. The result can be higher maintenance costs for the life of the road. The graph below illustrates the relationship between capital and maintenance costs. The optimum design is the lowest lifecycle cost.

Figure 2: Road Life-Cycle Costs



It is recommended that Council takes a flexible approach to pavement design and each project is considered on its merits.

The initial starting point should be a twenty-five year design life based on appropriate design standards and guidelines. The pursuant designer is to provide a design statement outlining options and associated risks with alternative pavement designs for Council's consideration. Where alternatives are economically attractive Council may accept the alternative pavement and revised risk profile.

8.3 Seal Widths

The width of a sealed road is generally determined by:

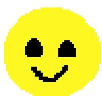
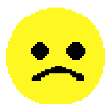
- Traffic volumes
- Topography

Roads with higher traffic volumes generally have higher incidences of vehicles meeting opposing traffic. The exception to this is where there may be highly directional traffic flows i.e. a morning flow of traffic into the CBD area and an evening flow back to residential areas.

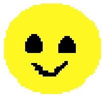
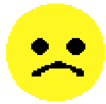
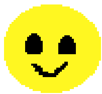
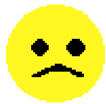
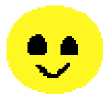
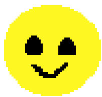
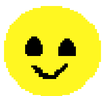
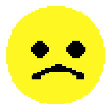
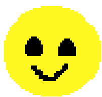
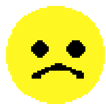
Where seal widths are too narrow for opposing traffic to safely pass at least one vehicle will need to drive on the unsealed shoulder. When vehicles drive across the seal edge there are both safety risks and risk of edge break damage. The safety risks increase significantly where topography limits sight distance around horizontal curves.

8.3.1 Road Width and Accident Rates

The literature on road accident rates is illustrated with the following Table.

Factor	Higher Value	Lower Value	Comment on literature
Sealed road width			The literature on sealed width indicates; 1. Increasing seal width from 4m to 6m, accident rate per million vehicle km (AR mvkm) drops form 2.0 to 1.2. However the AR does not decrease so significantly as the seal width increases beyond 7m[1] 2. Adding 600mm of sealed shoulder per side decreases accident rate by 16%[2] 3. Sealed roads with 3.4m lanes had significantly less accidents than 3.0m lane widths[3]

[1] Rural Road Design standards and value for money, W H Rahman p 773-779, NZ Road Sym. 1987 Vol 4
[2] What's That Extra Two Feet of Land or Shoulder Worth, W T Sunley, www.lib.niu.edi/ipo/im900419.html
[3] Roadway Widths for Low Volumes Roads, www.hsisinfo.org/pdf/94-023.htm

Factor	Higher Value	Lower Value	Comment on literature
Unsealed shoulder width			Adding 600mm of shoulder each side decreases accident rate by 13%[4] Adding 600mm of sealed shoulder decreases accident rate by 17%[5]
Clear way off road			General agreement this has major influence on road safety, allows vehicle to run off the road without hitting a major obstacle
Road gradient			Over 6.5% safety decreases
Road curvature radius in m			For tight radius curves safety is reduced and roads need to be wider
Sight distance			Good sight distance allows time for drivers to identify hazards and take action
Uni-direction of traffic			Where traffic is all one way in morning and visa versa in the afternoon (such as for a ski field) the passing opportunities are reduced and road width can be narrowed without compromising safety

The risk of accidents increases with narrow seals. The table below provides an example of the effects on a 3km section of road carrying 100 vehicles per day with 3% growth over 25 years.

Seal Widths	Accident Rate per million vehicles km's	Expected No. Accidents over 25 years (Rahman)	No. Accidents Compared to 5.5 Seal	Cost of Accidents*
4.0	2.0	8.0	+2.8	+ 6,440
4.5	1.8	7.2	+2.0	+ 4,600
5.0	1.5	6.0	+0.8	+ 1,840
5.5	**1.3**	**5.2**	**0**	**0**
6.0	1.2	4.8	-0.4	-920
6.5	1.1	4.4	-0.8	- 1,840

- The costs are based on non-injury accident costs from the Transfund Economic Evaluation manual. In reality the costs will be higher because it is likely there will be injury accidents.

Where ever there is significant cycle traffic then accident rates on narrow seals will increase significantly.

4 Sunley
5 Rahman

8.3.2 Maintenance Costs

Narrow sealed roads are generally prone to edge break where vehicles cross over the edge of seal. The extent of edge break is relative to both traffic volume, traffic mix and the nature of the traffic flows.

Widening a narrow sealed road results in a road prone to rutting along the construction join. This area cannot be compacted to a standard matching the original pavement that would have received years of traffic compaction. Further rut filling treatment will be required during the road lifecycle that will increase the maintenance cost in comparison to a road originally constructed to the full width.

8.3.3 Use of Narrow Seals

While it is ideal to construct sealed roads to the widths suggested in generally accepted design standards and guidelines it is not always economically viable to do so. Whenever considering a narrow seal the risks should be assessed for each individual site. The designer must assess both benefits and risks if using a narrow seal. These will be reported to the Council for consideration.

Where the following criteria apply to a section of road then a narrow seal is worth considering:

- Not economically viable to seal normal width
- Generally flat gradients
- Large radius horizontal curves
- Good sight distance
- No cycle traffic
- Minimal number of heavy commercial vehicles

The minimum recommended seal widths have been provided in the table below. These seal widths have been based on the references in Section 8.3.1 and those adopted by several road controlling authorities in New Zealand and Internationally.

Recommended Narrow Seal Widths			
Vehicles per day*	**Seal Width (m)**	**Unsealed Shoulder**	**Total Pavement Width**
Less than 50	4.5	0	4.5
50 – 150	5.5	1.0	6.5
150 – 300	6.0	0.5	6.5
300 - 500	6.5	0.5	7.0

* the vehicles per day values is the estimated number of vehicles at the end of the design life

8.4 Roadside Safety Zones

In conjunction with sealing unsealed roads and possibly widening them, consideration should be given to assessing the hazards that exist on the roadside and removing, relocating or mitigating them where possible. Where a road is sealed, this may attract additional traffic and it is almost certain that travel speeds will increase therefore increasing the severity of crashes along the road. During 2002 and 2003, Transfund commissioned MWH to undertake an investigation into roadside safety zones (or clear zones). Refer to the draft "Proposed Guidelines for Establishing and Maintaining Roadside Safety Zones on Rural Local Roads".

8.4.1 Roadside Safety Zone Widths

Table 2 shows recommended widths for roadside safety zones on New Zealand rural Local Roads.

Table 2: Recommended Minimum Desirable Roadside Safety Zone Width by Transfund Rural Volume Classes*

Transfund Road Groups for Maintenance	AADT (vehicles per day)	Roadside Safety Zone Width (m) (Minimum)
B	>5,000	6.0
C	1,000 – 5,000	5.0
D	200 – 1,000	3.0
E	50 – 200	3.0
F	<50	No Set Value (NSV)

* Compiled from "Guidelines for Establishing and Maintaining Roadside Safety Zones on Rural Local Roads" October 2003 (Draft).

These are minimum guidelines only. It is desirable that a greater width should be provided where economically achievable.

A minimum width of 3.0 metres is recommended. Below this value a roadside safety zone has limited effect and hazards present within this distance can adversely effect within the traffic lane.

It is recommended that this width be doubled on the outside of low radii curves.

In areas with flat, open terrain, the implementation of roadside safety zones will be much easier when compared to roads in rolling and mountainous terrain.

8.4.2 Roadside Safety Zone Lengths

Although no research appears to be available on recommended roadside safety zone lengths, it is suggested that Local Authorities aim to provide roadside safety zones where economically feasible, noting that:

- Continuous lengths of roadside safety zones are preferred over short isolated lengths but safety benefits are gained with the removal of single hazards; and,

- Consideration should be given to providing a transition between sections of roads that have roadside safety zones and those that do not.

8.4.3 Implementation of Roadside Safety Zones

The extent to which roadside safety zones can be established will be closely linked to funding capability. Where economically achievable, retrofitting a roadside safety zone should follow the stepped selection process of the Hazard Management Plan in the Transfund guidelines.

Where a new road or upgraded road is being designed and constructed, the minimum standards for roadside safety zone widths and lengths, should be considered as the first option. Only if this is uneconomic or physically unachievable should lesser measures described in the hazard management table be applied.

9. Management of Data Collection

9.1 Traffic Counting Programme

The traffic count programme has three main objectives:

- Measure traffic loads on roads due for pavement work.
- Measure traffic growth across the district.
- Measure seasonal variations in traffic volumes.

The existing traffic counting programme has the ability to meet the above objectives. However to fully meet the recommendations below the number of counts should be increased by forty per year.

Traffic counting is currently carried out on 200 sites throughout the CODC network each year. Forty of these counts are classifier counts that give a breakdown of vehicle speed, direction of travel and vehicle type.

Classifier counts are taken at specific project sites to collect speed data for traffic calming areas and HCV use for pavement design on potential seal extension or AWPT sites.

The programme is prepared on a 6 monthly cycle. The programme is flexible to enable urgent counts to be taken when required. Routine counting on sealed roads is programmed where deficiencies in data on RAMM are identified.

Unsealed local roads are targeted for counting to provide base and peak counts as well as an indication of growth. Traditionally CODC experiences a peak traffic volume increase of up to 100% over the December to February period on sections of the network. Counts during this period enables better definition of this peak period and volumes.

A representative sample of roads should be used as control sites programmed for several classified counts per year to provide a basis for measuring seasonal variations. The sample will need to cover local roads, tourists routes and horticultural areas. These counts should be repeated at the same times each year to provide a measure of traffic growth rates.

The data collected from these sites can be compared to the default adjustment factors provided by Transit New Zealand Guidelines for Estimating AADT. Council may require five years of data to establish alternative adjustment factors that will be accepted by Transfund.

Until seasonal traffic adjustment factors that fit Central Otago can be established, it is recommended that the roads likely to have seal extensions in the next three years have up to three one-week traffic counts carried out annually. These counts must be carried out at various times of the year that reflect the seasonal variations. Transfund correction factors should be applied to each count and the average of the adjusted counts can be used as the best estimate of the AADT.

9.2 Predicting Future Traffic Volumes

Data collected from the traffic counting programme will provide a good basis for predicting traffic growth rates across the district. Some roads may not follow steady growth patterns but be subject to sudden increases of traffic associated with development. For example, a new rural subdivision will significantly increase the traffic between the subdivision and places of work and shopping centres.

To predict roads where traffic volumes are likely to experience sudden increases it will be necessary to study the District Plan for areas designated for development. The magnitude of the sudden increase in traffic volumes is dependant on the type of development. The table below has some suggested traffic volumes estimated by month to reflect expected seasonal traffic fluctuations.

Predicted Traffic Volumes					
Road	**Residential property**	**Per hectare of grapes**	**Per hectare of fruit**	**Per room tourist accommodation**	**Tourist Attraction**
Month					
Jan	7.0	1.0	3.5	4.0	To be considered
Feb	7.0	1.0	1.0	4.0	on case by case
Mar	7.0	1.0	0.2	2.0	basis
Apr	7.0	2.0	0.2	4.0	
May	7.0	0.7	0.2	4.0	
Jun	7.0	0.7	0.2	2.0	
Jul	7.0	0.8	0.2	4.0	
Aug	7.0	0.8	0.2	2.0	
Sep	7.0	1.0	0.2	4.0	
Oct	7.0	1.0	0.2	2.0	
Nov	7.0	1.0	0.8	4.0	
Dec	7.0	1.0	1.5	4.0	
Average Daily vehicle count	7.0	1.0	0.7	3.3	

For seal extension projects that will be subject to increased traffic volumes the above table and information supplied by the developer, if any, will be used in conjunction with expected growth rates to estimate future traffic volumes.

Reference should be made to the Blue Print Study for guidance on future land use and growth patterns.

9.3 Roughness Data Programme

Sealed roughness counting is undertaken biannually. Unsealed roughness counting is undertaken annually on 20km of roads.

It is ideal to undertake these counts at the same time each year to ensure consistency of results. The ideal time to undertake these counts is after the post winter maintenance has occurred. It would be beneficial to repeat these counts during a dry mid-summer to enable a maximum count to be realised. This is particularly beneficial on hilly sections or those with high traffic volumes.

10. Procurement of Design and Construction

10.1 Objectives

The preferred method of procurement should:

- be acceptable to Transfund New Zealand
- not prevent any players in the market having the opportunity to price work
- encourage competition
- be cost effective
- share risk appropriately

For any work that is subsided by Transfund New Zealand, the method of procurement must conform to the Transfund New Zealand Competitive Pricing Procedure Manual. However Transfund may approve alternative methods of procurement on a case by base basis.

The local market is the largest driver to be considered when choosing procurement options and should be tailored to the market.

The method of procurement should not prevent capable contractors from pricing the work. For instance if there are small contractors in the market, it is advised not to let all the projects in one large package for which they cannot adequately resource.

Encourage competition by going to the market for prices rather than negotiating with preferred contractors.

The procurement process should be cost effective for both Council and contractor. Bear in mind that a contractor has to recoup their costs for tender preparation. If several similar contracts are to be let then it may be more cost effective to have attributes submitted once and a register of interested contractors created. The register will require annual updating to meet Transfund requirements.

The most effective method of procurement apportions risk to the party with the most control over the risks. This allows that party to take steps to mitigate the risk because it is in their interest to do so.

10.2 Design Build

Design and build contracts allow the contractor scope to come up with innovative solutions. The more complex the project the more opportunity for an innovative solution.

For design and build projects to be successful it is important that the players in the market have access to appropriate design skills.

Generally design and build is let on a lump sum basis. This provides price certainty and eliminates the risk/reward scenario for Council. With the risk placed on the contractor this will be reflected in the lump sum price.

Design and build is only recommended for large, complex projects that have opportunities for innovative solutions.

10.3 Multi-Year Contracts

Multi-year contracts reduce the procurement costs but can place more risk on the contractor.

If the programme of work is defined for the duration of the project then contractor risk is reduced because they can source materials and calculate appropriate cartage. To carefully define the work in a conventional contract, Council would need to have the designs complete at the tender stage.

With recent fluctuations in fuel prices not being reflected accurately in cost fluctuation formulae, the contractor will need to cover the risk of fuel increases. This can be overcome by separate cost fluctuation to cover fuel costs.

Cost benefits can be realised by the Council if there is some flexibility in the construction timing. This allows the contractor to better utilise resources.

11. Forward Planning of Maintenance Work

11.1 Maintenance Costs Included in Capital Costs

The capital cost of carrying out seal extensions often includes work that could have been carried out during routine maintenance activities. This is detrimental to securing Transfund subsidy. These maintenance activities need to be carefully planned so that they match the long-term plans for each road.

11.2 Drainage

Drainage channels and culverts should be cleaned and maintained on a routine basis.

When culverts are replaced or repaired it should be done in a manner that will fit in with any future seal extension.

Side drains should be positioned far enough from the unsealed carriageway to allow for any future widening.

11.3 Metalling

Unsealed roads lose aggregate over time and require metalling on a regular basis. The aggregate used for metalling will be different to that required for a seal extension. By programming the seal extension to coincide with the metalling programme, the last metal run will not be required. The cost saved by not carrying out the metal run can help offset the capital cost.

11.4 Minor Safety Improvements

Where roads on the seal extension programme require minor safety improvements these can be carried out prior to the seal extension. Provided any crash cost reduction for the minor safety improvements is not included in the economic analysis for the seal extension then both can attract Transfund subsidy.

12. Long Term Council Community Plan (LTCCP)

The community's view will set the outcomes that the Council will strive to meet as part of the requirements in the Local Government Act 2002.

One purpose of this strategy is to provide improved information to better allow the community to identify and chose their outcomes. Council can then incorporate those outcomes in their Long Term Council Community Plan (LTCCP) and long term financial strategy (LTFS).

The decision to increase the quantum of seal extensions has implications years before the tendering of a contract for seal extension.

In particular, sealing a road need to be integrated with:

- existing unsealed maintenance strategies
- improvement works to a five to ten year programme of critical operations such as drainage, metalling, traffic services and safety improvements
- financial programmes
- financial contributions
- growth trends with development and subdivisions

Critical questions to ask and answer are:

- Why are we doing it this way?
- What are the alternatives, their benefits, costs and sustainability?
- What processes are required to better identify community outcomes?
- How do we provide an audit trail of how and why these decisions are made?

In summary, while this is a technical document it must be readable to assist the community in making informed choices.

13. Prioritisation Methodology

When prioritising seal extension works there are many factors to consider. The various factors may place different priorities on different roads. To be fair to all stakeholders any prioritisation system should be consistent across the district. The methodology must be made as objective as possible.

The objective of this seal extension strategy is to maximise the length of seal extensions Council many construct within its budget. To this end it is important that the projects qualify for Transfund subsidy where ever possible.

Existing factors included in TFNZ BCR system include the following:

Road Costs	Included in TFNZ BCR
Roughness	Yes
Speed change	Yes
Maintenance costs	Yes
Metal loss	Yes
Grading costs	Yes
Additional drainage costs	Yes
Road user discomfort costs	Yes
Vehicle maintenance costs	Yes
Time savings	Yes
Oiling	Yes
Heavy vehicle use	Yes
Seal and reseal costs	Yes
Economic	**Included in TFNZ BCR**
Dust on horticulture	Yes
Dust on pastoral	Yes
Safety	Yes

To include the economic, social and environmental factors, we propose to include a raw estimate of these costs which are then weighted by the Working Party to best reflect community values and outcomes.

These factors are as follows:

Road Costs	Considered in TFNZ BCR	Comment	Tangible/ Intangible
Environmental			
Road runoff	No	Unsealed roads have dust and silt in their runoff but sealed roads have higher concentration of hydrocarbons. Where road runoff goes directly into a small creek or stream effect can be significant.	Intangible

Road Costs	Considered in TFNZ BCR	Comment	Tangible/ Intangible
Long term quarrying	No	There is a cost to reinstate the land that is not currently included in the metal costs	Tangible
Road oiling environmental effects	No	Oil has a detrimental effect on the environment	Intangible
Social			
Dust on people and facilities	No	Dust increases the amount of cleaning required for both residential and commercial Dust reduces the amenity value on residential properties i.e. unable to have barbecues – keep windows closed	Tangible
Safety	Yes	Transfund economic evaluation bases it's safety costs on accident history. There is an additional safety factor from risk to other road users.	Intangible
Economic Development			
Strategic	No	The importance of a road to the network both now and in the future	Intangible
Land use	Yes	Values used on the Transfund Economic Evaluation procedures do not reflect actual cost to Central Otago business	Tangible
Equity	No	Changes in land use in one area may affect traffic volumes through another area	Intangible

Our approach has been:

1. that we recommend a cost where we can sensibly calculate a cost
2. factors have been suggested for intangible items
3. that CODC discuss and adopt appropriate values
4. CODC weighting applied and ranking BCR calculated

The advantage of this approach is that time values of funds are compared and this method retains the core of BCR analysis.

13.1 Objective

At the workshop held on 15 March 2004, approximately twenty factors that influence seal extension priorities were identified. Many of the factors discussed are used in the Transfund Economic analysis and should not be double counted as local factors. A table in Appendix ….. lists the factors considered and identifies those already incorporated in the Transfund economic evaluation.

The local social, environmental and economic factors that have been considered to prioritise projects as described above and have been grouped into two categories:-

Tangible – those factors that can be quantified in monetary value
Intangible – those factors that cannot be quantified in monetary value

Where factors are tangible the values have been treated in a similar way to benefits included in the Transfund benefit cost analysis. Intangible factors have been given a score that is added or subtracted to the modified benefit cost calculation.

Tangible: horticulture
pastoral
dust nuisance to adjoining properties
long term aggregate supply effects

Intangible: strategic importance
urban social values
health and residential amenities
equity
safety
road oiling – environmental effects

All tangible factors have been calculated on a per annum basis.

13.2 Ranking Methodology

The methodology for prioritising seal extension projects uses the Transfund economic evaluation procedure to obtain a benefit cost ratio. Supplementary funding is deducted from the capital cost of the project within the benefit cost ratio calculation. Local tangible benefits are then added into the Transfund Benefit Cost ratio calculation. Intangible factors are then applied to the revised benefit cost ratio. The weighting on local factors can be either positive or negative.

13.3 Horticulture

The Transfund economic evaluation process has an allowance of $300 per kilometre for the effects of dust on horticultural operations. The feedback from local horticultural business has suggested that this figure is significantly lower than the actual cost to horticultural businesses.

The following assumptions have been made in assessing the horticultural cost factors:-

1. Only the first 10m of crop is affects
2. This factor will not be applied where oiling is used to reduce dust. The cost of oiling is included in the unsealed maintenance costs of Transfund's economic analysis.
3. The factor applies to the length of horticultural land fronting onto the project. The length for each side of the road are added together.

4. The standard value of $300 per km will be included in the B/C analysis so the factors have been reduced by this amount to avoid double counting
5. The table in Section 6.3 has been used as the base value for calculation.

Suggested Horticultural Factors

Crop	Factor per km of frontage to project
Cherries	$19 700
Stone fruit	$23 700
Pipfruit	$9 700
Grapes	$3 300

13.4 Pastoral

The Transfund economic evaluation process has an allowance of $100 per kilometre for the effects of dust on pastoral operations. Research carried out by McCrea (1984) suggests that this value is lower than the average costs incurred.

The following assumptions have been made in assessing the pastoral factors:

1. This factor will not be applied where oiling is used to reduce dust. The cost of oiling is included in the unsealed road maintenance costs of Transfund's economic analysis.
2. The factor only applies to the length of pastoral land fronting onto the project. The length on each side of the road are added together.
3. The adjustment factor is based on the average value from McCrea's report with the Transfund allowance deducted to avoid double counting.

Suggested Pastoral Factors

Pastoral Use	Factor per km of frontage to project
Beef & sheep	$50
Diary	$230
Venison	$100

13.5 Dust Nuisance to Adjoining Properties

Properties near unsealed roads suffer the nuisance of dust accumulating on surfaces. This increases the amount of cleaning required to maintain a tidy house or commercial operation.

The following assumptions have been made in assessing the dust nuisance factor:

1. The factor only applies to residences and commercial buildings within 100m of the road
2. Residences will require an additional two hours of cleaning per week
3. Commercial operations will require an additional five hours per week
4. The hourly rate for cleaning is $10.00
5. This factor will not be applied where oiling is used to reduce dust. The cost of oiling is included in the unsealed road maintenance costs of Transfund's economic analysis.

Property Type	Dust Nuisance Factor
Residential	$1,040
Commercial	$2,600

The above default value for commercial premises will be reviewed based on the type and function of the commercial use. A higher value will be considered on a case by case basis for premises processing high value produce.

13.6 Long Term Aggregate Supply

There is a cost involved in aggregate supply over a long period of time. Quarries requiring re-establishment. Often quarried areas are no longer useful for other activities. With property development occurring at a fast rate in Central Otago more pressure is being put on land being made available for development.

Quarry reinstatement costs can vary considerably depending on level of reinstatement, size of operation, topography, method of quarrying, etc. A rough estimate of reinstatement costs is $1 per cubic metre of material quarried.

For ease of calculation it is assumed that the subsurface pavement layers of both the unsealed and sealed roads will incur similar costs and will negate each other. Therefore this cost need only be applied to metal loss on unsealed roads.

Historical data will be used to assess metal loss for each unsealed road. The factor applied will be $1 per m^3 of running course applied on an annual basis.

13.7 Strategic Importance

A road's strategic importance to the network is often difficult to quantify in monetary terms. Link roads are more important than cul-de-sacs and arterial roads are more important than link roads.

The following table lists several levels of strategic value and associated factors in use in prioritising seal extension projects. The factors have been kept in context with the economic analysis benefit-cost ration, i.e. a B/C of 2.0 may receive Transfund subsidy.

Road Description	Strategic Factor
Local road with little or no through traffic	0
Local road with through traffic and alternative sealed route	0.1
Link road between two small communities	0.3
Link road between small community and large community	0.5
Tourist route- to provide positive experience for tourists	0.5
Collector road from several small communities to large community	1.0
Heavy traffic routes	1.0

13.8 Urban Social Values

There is a general expectation that urban streets should be sealed. The expectation is that urban, with 70 km/hr zones, road should be sealed because of safety, expected level of service, children's health and safety, etc. For whatever reasons there is the perception among most ratepayers that urban streets should be sealed before rural roads are sealed. This needs to be considered in Council's weighting system. An arbitrary value has been placed on urban social values.

Urban Social Value Factor = 0.0 - 0.5

13.9 Health and Residential Amenity Value

Residential properties beside unsealed roads lose some of the amenity value that residential properties on sealed roads have i.e. unable to eat outside because of dust, clothes hanging on the clothes line get dirty, windows need to be kept closed to reduce dust nuisance, effects of dust on health etc.

This factor only applies to those residential properties within 100m of an unsealed road that do not use oiling to reduce dust.

Residential Amenity Factor = 0.1

13.10 Equity

The equity or fairness factor is only considered where a significant change in traffic pattern contributes to an increase detrimental effect on an existing operation or residence. An example would be the opening of a quarry that generated additional significant traffic. The effects of this traffic would be evaluated on existing operations and residences. Operations and residences established after the quarry would be excluded form any equity factor because they were aware of the effects prior to establishing.

The equity factor will be assessed at Council's discretion but will be within the range 0 to 0.5.

13.11 Safety

The Transfund economic evaluation process uses accident history to predict any cost savings that may occur due to a decrease in the accident rate once a road is sealed. Generally the history is based on the number of accidents reported to police and scaled by a factor to reflect that not all accidents are reported. Typically these accidents are vehicular accidents.

Accidents can also be caused by stones being propelled by vehicle tyre. Often these are not reported as road accidents. Examples of stone accidents could include:-

- horse bolting and dislodging rider
- pedestrian injury – especially near schools or work areas close to road
- broken house windows

For projects that may have additional safety risks due to activities close to the road a safety weighting factor should be supplied. The factor should be small to avoid double entry in the accident cost reductions already, incorporated into the Transfund economic evaluation procedure. The factor should be considered on a project by project basis.

Where roads are regularly used by vulnerable road users, these will be given a higher score. These roads will typically be used by higher than average numbers of cyclists and pedestrians.

Recommended Safety Factor range 0.0 – 0.3

13.12 Road Oiling Environmental Effects

The Transfund economic evaluation process includes the cost of road oiling as a maintenance item but does not consider the environmental effects of oil run off into watercourse.

Oil contains heavy metals and other substances that have a detrimental effect on the environment. Where road runoff enters directly into a small creek the potential for environmental damage is at its greatest. The higher the proportion of road oiled the greater the environmental effect.

This factor will only be applied where road oiling is used. Each site will be assessed individually on the significance of the environmental effects from oiling.

Recommended Road Oiling Factor range 0.0 – 0.5

13.13 Supplementary Funding

The issue of supplementary funding or private contributions which may be made to reduce the cost of the project to Council and leverage priority was considered. There were three issues raised.

1. that without any guidelines the result could be a "Dutch auction" where increasing offers would be made between residents on different roads, and by Community Boards, to buy priority. The programme would be ever changing and benefits in having a forward programme of work would be lost.

2. the priority system proposed is considered to provide a fair means of establishing priority to the wider community, and Council. "Buying" priority could result in the roads which were not considered to be high priority for economic, social and cultural reasons being sealed and those that are high priorities not being sealed.

3. Transfund are considering the issue of supplementary funding and have indicated that they may allow private contributions to be made to projects. By not allowing contributions, Council would be restricting the ability to attract Transfund subsidy.

In view of these three factors, the sub-committee have determined that an appropriate mechanism to allow the opportunity for private and Community Board contributions, provide a policy on the amount required, while ensuring that the outcome is in the best interests of the wider community is:

The amount of supplementary funding required to obtain Transfund subsidy is to be identified for each road and the Community Board invited to contribute this amount either through unsubsidised Community Board or private contributions. Where this contribution is provided these roads will receive priority. Alternative lesser amounts will not be considered in determining priority for unsubsidised seal extensions.

14. References

The following references were used during the course of the investigation.

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- Works Consultancy Services Ltd (1993), *Economic Disbenefits of Dust from Unsealed Roads,* Transit New Zealand Research Report No. 16, Wellington.

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- Booz Allen & Hamilton (NZ) Ltd (1997), *Tourism Benefits from Sealing Unsealed Roads: Survey of Users of Waipoua Forest Road*, Transfund New Zealand Research Report No. 86, Wellington.

- MWH (NZ) Ltd (2003), *Proposed Guidelines for Establishing and Maintaining Roadside Safety Zones on Rural Local Roads (Draft Only)*, Transfund New Zealand, Wellington.

Appendix A: Seal Extension Historical Background in Central Otago

1. Brief History of Seal Extension in Central Otago

The following section was developed from interviewing Mr Bruce Cull previously with Vincent County (VCC) and Central Otago District Council and Roadex, and MWH staff experience in Central Otago.

1.1 Narrow Seals

Narrow seals were widely constructed in the period from 1960 through to the mid 1980s.

In the Maniototo, seals that were initially constructed to 3.05m(10 foot) were too narrow for truck and trailer units and edge break of the seal occurred. Where seals were constructed to 3.66m(12 foot) width this was less of a problem on long straight section with good visibility.

Historically there were many problems with edge break and these did require regular maintenance grading and re-metalling. Truck and trailer units require a minimum lane width of 3.25m as the trailer unit tends to follow the truck in a meander pattern outside of the path of the truck.

Since 1985 through to 2000 most of the narrow seals in the Maniototo and Manuherikia area have been widened to minimum of 6.5m seals due to traffic growth and associated maintenance problems.

Since these roads have been widened there has been a decrease in edge break and low shoulder repairs. These shoulders were frequently graded prior to 2000 but since 2000 they have been grassed progressively and maintenance costs have decreased. Mowing now replaces spraying and this turf provides additional binding strength to help retain the shoulder aggregate.

A seal width of 5.5m has been adequate for straight sections of road where there are low traffic volumes and low heavy traffic use.

Where seals have been widened there is a weakness between the existing pavement and the widening. At the join the pavement can not be compacted as well and settlement and rutting with ponding of surface water has caused maintenance and safety problems. This is evident on roads such as large sections of the Ida Valley Road.

This has been repaired by asphalt or slurry/drag seal prior to a reseal. If asphalt is used bleeding and flushing is a common problem that then requires pressure water cutting such as used on the Earnscleugh road. This rutting at the join of seal widening of narrow seals is a common problem throughout New Zealand.

1.2 Alternative Aggregates

In 1978 Vincent County Council were achieving only short sections of seal extensions each year and most of what was being done was to National Roads Board standards and Ministry of Works S4 pavement design.

Methods to reduce seal extension cost including consideration of different standards and effect of those alternative pavements on performance were reviewed by VCC.

1.2.1 Risk

VCC knew from experience that other non TNZ M/4 materials behaved reasonably well and they undertook trials with Roses Pit material in 1983 on Airport Road. In terms of performance and cost, it was obvious that cheaper non M/4 aggregates which were closer to seal extension areas could be used provided these were constructed at a greater depth.

Pitrun was typically used as a sub base with the top 50mm being crushed aggregate to provide a mosaic surfacing for sealing. Also the surface of the Roses pit material was sometimes mixed with 20mm down scalpings from chip production to provide a mosaic aggregate surface prior to sealing.

The VCC accepted that there was a risk and a reward formula with potential for a higher failure rate of pavements constructed to the alternative standard. Their premise was "If no roads are failing the standard is too high".

During the 1980s there was blame directed at the 'old timers' for previous poor quality aggregates but Mr Cull noted what was overlooked was that most of these pavements were 30 years of age and had traffic loadings many times the original design assumptions.

1.2.2 Trials

During the 1980s the National Roads Board through the liaison engineer at Ministry of Works and Development insisted on M/4 specification for base course aggregates. VCC Engineering Consultant Duffill Watts and King (DWK) set out a methodology which received NRB research funding and undertook trials with lime stabilisation and alternative aggregates.

Following from the trials the VCC had standard approach consisted of minimum of 180mm of pit run sub base and 80mm of M/4 or M/5 over good subgrade with modifications for increased design axles.

1.2.3 Paerau Road Trials

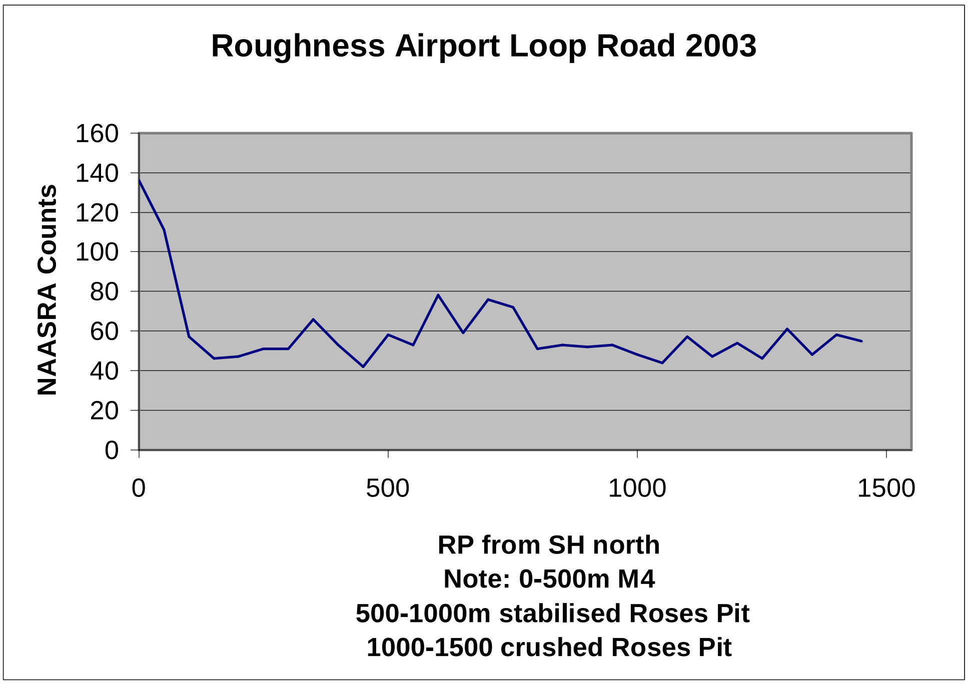
Lime stabilisation trials were undertaken in Paerau under an NRB Research Unit project.

Neville Jelley supervised that work. This indicated lime stabilisation was effective for unsealed and sealed roads that rutted badly during spring freeze thaw through binding the clay fraction. If the aggregate did not contain clay but silt, cement modification was also used at low percentages.

1.2.4 Airport Loop Road Trials

For Airport Road three alternatives aggregates, (refer attached paper) were used; TNZ M/4, stabilised Roses Pit and crushed Roses Pit.

AIRPORT LOOP ROAD-ROSE'S PIT TRIALS 1983- PHOTO 2004



ROUGHNESS COUNTS 2003 TWENTY YEARS ON

The higher roughness from the first 100m of Airport Road is due to trenching and the rail trail crossing.

For more detail on this trial please refer to the attached paper. This road carries light traffic with an ADT of 180 vehicle per day in 2004.

1.2.5 Freeze Thaw

In the early 1980s period there were significant rutting problems on sealed roads during freeze thaw periods within the Ida Valley and Maniototo areas.

Historically these roads were constructed with high clay aggregates with insufficient structural depth of clean aggregates. During freezing these aggregates adsorbed water as ice from capillary action from subgrades, and through seals that had lost their surface water proofing. This resulted in frost heave as ice lenses form causing cracking of the surface seal.

On thawing after being frozen for some weeks, this ice was released as water, decreasing the strength of the aggregates resulting in deep rutting in extreme cases or pumping of clay through the surface of the seal in moderate cases.

To solve the problem adding and blending of materials was undertaken with Huddleston's Pit material from Omakau and also from Omakau River to mechanically stabilise the pavements.

Sections of Ida Valley Road were lime stabilised and overlaid with 70mm of crushed Huddleston's pit or Omakau River aggregate. Huddlestons Pit was on the other side of Glassfords at Racecourse Road.

These aggregates were similar to M/4 aggregate standard being clean, hard, well graded (densely packed) aggregate with larger stone choked with finer aggregate and sands.

Where surface moderate damage occurred without rutting, the road was resealed with an emulsion fog coat to restore water proofing. These seals normally performed adequately provided the water proofing was retained.

For lime stabilising the road was ripped, bags of lime spread out and evenly distributed with the grader and then stabilised with a rotary hoe.

1.2.6 St Bathans Loop Road

In 1997 sections of the St Bathans Loop Road were sealed by grading, compaction and dressing the existing river terrace gravel prior to sealing directly.

1.2.7 Vincent County Standard Approach

Following these trials Vincent County adopted a minimum standard of 180mm of pit run and 80mm of M/4. This approach was used on Letts Gully Road stage 2 in 1998 where there was little risk of frost damage beyond the initial tree shaded valley.

For the shaded Stage 1 length a more conservative approach was used of 140mm of M/4 basecourse over the subbase due to frost risk.

1.3 Programming and Funding Criteria

A significant area that Mr Cull commented on was that Planned Maintenance (drainage, minor safety and metalling) needs a programme well in advance for planning purposes if there was to be a substantial programme of seal extensions.

This needs to be at least a five year to ten year programme so that the pre-works under maintenance can be done well in advance and ensure that there is no conflict with Transfund NZ criteria. This required a commitment from Council.

1.4 Summary

From the history of seal extensions and behaviour of existing pavements we can conclude that:

1. Narrow seals of 5.5m on straight sections of road with low traffic volumes and little heavy traffic have performed adequately.
2. Truck and trailer units require minimum sealed width of 6.5m to avoid edge break and erosion of the unsealed shoulder.
3. Where narrow roads have been widened, rutting at the join is a common problem requiring drag slurry seal prior to resealing.
4. Pavements constructed with an adequate depth of well-graded, hard, pit run aggregates without plasticity have performed well. These materials while not meeting M/4 criteria did meet TNZ M/5 classification.
5. Pavements typically comprised 180mm of good quality (Roses type) pit run with 80mm of M4 or M5 material and were used in the Ranfurly and Ida Valley areas with softer subgrades.
6. Pavements constructed with aggregates with plasticity exceeding TNZ guidelines behaved poorly during period of freeze thaw and should be avoided.
7. Lime stabilisation was effective to modify clay aggregates in conjunction with cement if the clay is not reactive. An overlay of 70mm of M4 type material was used over the stabilised pavement and these pavements have performed adequately since the 1980s.
8. In freeze thaw conditions where pavements heave and during thawing pump clay through cracks in the surface of the seal. These should be resealed to retain water proofing on drying out as a cost effective option provided no permanent deformation of the pavement has occurred.
9. Forward planning and commitment from Council was required to optimise maintenance activities and ensure no conflict with the funding criteria of Transfund NZ.

Appendix B: Draft Prioritisation Spreadsheet

Appendix C : Feedback Questionnaires