System Design and Delivery Date of Issue: November 2018

2019/20 Annual Plan Instructions:

New and Improved State Highway Infrastructure

1. Purpose

This is the Manual Management Plan for the above System Design and Delivery Manual. [In accordance with the New Zealand Transport Agency's ISO 9001 Quality System, Manual Owners are expected to complete this form for all manuals].

2. Document Information

Manual Name	Annual Plan Instructions Manual
Manual No.	**SM 018**

3. Amendment and Review Strategy

All Corrective Action/Improvement Requests (CAIRs) suggesting changes will be acknowledged by manual owners.

	Comments	Frequency
Amendments (of a region nature)	To be forwarded to Manual Owner	Annually
Review (major changes)	Reviewed in March – June to reflect updates from NZ Transport Agency and internal procedural changes	Annually

4. Other Information

This manual reflects the process required to prepare an Annual Plan as required by the SH Professional Services Contract Proforma Manual (SM030).

Contents

KEY DATES:

WHEN	WHAT	WHO
30 November 2018	All low cost, low risk applications due (efficiency, safety, resilience, cycling improvements).	Local offices.
December/January	Submitted projects reviewed	Low cost, low risk improvement managers.
February 2019	All approved low cost, low risk applications submitted for funding.	Low cost, low risk managers.
April 2019	Low cost, low risk programme confirmed. Regions notified of approvals.	Low cost, low risk managers.
May 2019	Low cost, low risk managers notified of carryovers into 19/20.	Local offices.
July 2019	Approved projects loaded and approved in SAP.	Investment and Finance.

INTRODUCTION

The aim of these instructions is to inform the user on the process and requirements when applying for low cost low risk projects. The process for applying for low risk/, low cost projects (including small projects) and resilience improvement projects is explained in detail. Please note that this manual is not a step by step instruction on how to use SAP or Transport Investment Online (TIO), there are already sufficient manuals explaining this and your SAP/TIO champions should be contacted if you require support.

If you need any further information, please do not hesitate to get in touch with one of the contacts listed in this document.

EXPECTATIONS OF NETWORK TEAMS

System Managers are accountable via their teams for ensuring that project information is up to date and current in SAP and TIO. It is particularly important to make sure the date of economic transactions and the economics reported match. Also that the profile is up to date and has been assessed using the Investment Assessment Framework (IAF).

CAPITAL IMPROVEMENTS >$1M

Project managers are responsible for ensuring SAP is up to-date and supplying up to-date information to the Transport Planners to update TIO (until the automatic link is activated). This should be kept up to date for projects in their regions as part of our business as usual process. Where projects have yet to be allocated a project manager it is the responsibility of the Transport Planning Team for the region to ensure that SAP and TIO information is up to-date. This includes:

- Maintaining project background information including the primary outcome of the project;
- Update current project cash flows to match both the phase information and cash flow timing in TIO (note the National Office Programming Team will supply an un-escalated estimate of the information in TIO to assist – this should then reflect the likely baselines for the year – subject to the NLTP approval of course);
- Current financial forecast and actual expenditure;
- Project status: Current, complete;
- Uploading current project documentation to TIO.

Within the context of the 2019/20 Annual Plan however it is particularly important that SAP and TIO is up to date in February 2019 in order for the Annual Plan to be developed. We do not expect that this will be a major task since the majority of projects were entered into the system as part of the RLTP process.

WC341: LOW COST, LOW RISK ROADING IMPROVEMENTS <$1M

Low cost, low risk roading improvements **(Work Category 341)** is split into three activities: Efficiency, Safety and Resilience.

Each activity will be administered separately by the various activity managers. However, all projects will be combined into one single list and applied for together as one low cost, low risk programme. Please refer to the Key Dates section for delivery requirements for each activity.

All submitted projects will be moderated to determine if they qualify for funding. Then projects which qualify will be prioritised based on a number of factors, e.g.

- Score for the project (based on resilience, safety or efficiency metrics).
- Track record of region for delivering projects
- Reflection of strategic documents e.g. AMPs, Safety strategy

This will mean not all submitted projects are funded and may be pushed into the next year.

Building a realistic programme

It's important that when submitting individual programmes of work for safety, resilience and efficiency, that networks consider their overall programme and how realistic delivery will be within the financial year. It may be that some lesser priority projects need to be pushed out a year. Consultation with project delivery teams is recommended to ensure a realistic programme is submitted.

To achieve a realistic delivery schedule, funding for projects can be split across two years. This allows for investigation, design and consenting work to be completed in the first year, and physical works to be completed in the second.

Changes to programme throughout year

Beyond the initial submission date, any projects applied for will undergo the same scrutiny as applied to previous applications. Any subsequent additions/ deletions to the approved programme shall be agreed with the relevant activity manager and the low cost, low risk template updated and attached to TIO, thereby providing an audit trail. Note that local offices who are not delivering on their already approved programme **will not** have additional projects approved. Project delivery will be monitored through SAP and frequent performance reports will be sent to network offices throughout the year.

Note: Beyond initial project submissions in November, new applications will only be considered after April the following year once funding commitment is clarified.

Forecasting in SAP, overspend and end of year carryovers

As mentioned, project delivery will be closely monitored in SAP, and regions held to account for poor performance. It is therefore critical that Project Managers update forecast and accruals in SAP. It is perfectly acceptable for projects to be forecast over 18 months or two years.

If a low cost, low risk improvement project is going to exceed its original allocation by more than 10%, then the respective programme manager will need to be notified. An overspend will require a Price Level Adjustment (PAA5) form as justification. If a low cost, low risk improvement project is going to exceed $1M, the project will need to be put on hold, and applied for in the appropriate work category.

Where projects were not forecast to run over two financial years, regions will need to indicate the amount of money required to be carried over for these projects. If carryovers are not indicated, the region will lose out on this amount from their next year's allocation.

Note: Projects can be carried over from 18/19 into 19/20. The process for this will be provided toward the end of the financial year.

Low cost, low risk improvement – Safety

Regional Safety teams are responsible for populating the Safety Works Investment Prioritisation Process Database (SWIPP) tool with the proposed low cost, low risk safety projects and required supporting information.

Note that:

1. The projects being submitted shall reflect the Regional SH Road Safety Strategy.
2. It is expected that the programme will include a number of projects to be designed in 2019/20 followed by construction in 2020/21.
3. The focus of the safety programme is on reducing risk by using Deaths and Serious Injuries (DSI) saved/10 years/ $100m spent on the proposed intervention as the main metric.
4. Alternative risk metrics may be used when DSI's saved/10 years/ $100m spent on the proposed intervention do not readily illustrate the risk, e.g.
    a. Level of service reduction from D to B on a road carrying 15,000 vpd.
    b. BCR > 2 for low cost projects

5. Projects for the 2019/20 programme must be added to SWIPP and submitted for assessment no later than **30 November 2018**.
6. **Appendix 2 of the SWIPP Manual outlines the checks that Regional Users should undertake prior to submitting their projects for assessment.**

Low cost, low risk improvement – Efficiency

The System Optimisation team (CDD) are responsible for collating and populating the low cost, low risk improvement (Optimisation) tool and required supporting information. We expect that the expenditure will be targeted to mainly urban areas (i.e. towns and cities with a population over 30,000 people), with only a very limited number of exceptions outside these areas made on a case by case basis.

CDD System Optimisation team is responsible for:

- Coordinating the local and TOC ideation phase (as above);
- Reviewing and moderating the low cost, low risk improvement (Efficiency) programme.

All regional applications for Low cost, low risk efficiency projects will require:

- A Low cost, low risk improvement spreadsheet which lists all Efficiency projects for that region.
- All projects to be be submitted in draft into Hapai no later than **30 November 2018.**

For further information contact: **oliver.postings@nzta.govt.nz**

Low cost, low risk improvement – Resilience

All regional applications for low cost, low risk resilience (<$1M) will require:

- A low cost, low risk improvement spreadsheet which lists all low cost, low risk resilience projects for that region (see **low cost, low risk improvement template** on HIP – link below).
- An individual application form for each project (see **low cost, low risk resilience application form <$1M** on HIP – link below).
- https://www.nzta.govt.nz/roads-and-rail/highways-information-portal/processes/strategic-activity-management/annual-planning/
- An NPV which supports investment in the project.
- A detailed schedule of pricing is required for all resilience projects, and for projects >$300k, including the split of
  - Investigation & design
  - Construction & MSQA
- All projects must be submitted in Infohub (https://infohub.nzta.govt.nz/otcs/cs.dll?func=ll&objId=10036793&objAction=browse&viewType=1) no later than **30 November 2018.**

This information will be used to rank all low cost, low risk resilience projects across the country. Notification of approved projects will be given in February 2019 when all low cost, low risk improvement projects are submitted for funding.

All low cost, low risk resilience applications must be less than $1M and include all investigation, design, consent and physical work. Applications for design or investigation work only **will not** be accepted. However, investigation/design and physical work can be split across 2 years.

Deterioration of Guardrail and Terminal End Replacement Projects

If the region has deteriorating guardrail that needs renewal then it should be submitted through the annual plan process. This will require justification of poor condition and costs.

If there are 'Texas Twist' or 'BCT' terminals to be replaced then include these as resilience applications (not small projects). These applications can be made using the resilience application form (sections 1-4 only). These will then be considered and prioritised nationally. The terminal replacement may require design to validate the length of need and transition parameters.

These end treatments will need to still pose a level of risk to the commuters. If it is hidden behind another obstacle or barrier then it will not be a risk.

Replacement of end treatments will not include replacing the rail between the terminals.

Instruction for completing the Low cost, low risk improvement spreadsheet:

- Each project within a region should be entered into the low cost, low risk improvement spreadsheet with each required column filled in using the descriptors and examples provided.
- On the far right column, indicate the resilience classification as well. This will assist in processing the application.

For further information contact: **Tristan.Hook@nzta.govt.nz**

Note: Resilience improvements over $1M will need to be applied for as a capital project through the regular RLTP/NLTP process. WC357: Resilience Improvements is no longer available.

SMALL PROJECTS

Background

A number of small, worthwhile projects have been identified around the country, which do not qualify for funding under Low cost, low risk improvements. NZTA wants to make funding available for these projects as it recognises that there are still a number of benefits to be achieved, despite projects not managing a high safety, efficiency or resilience score.

Detail

- Each NOC region will be able to apply for 3 projects per year. It is expected that each type of low cost, low risk improvement type is covered within the 3 activities (safety, efficiency, resilience) but this will be up to each region.
- Each project should be no more than $50k in value.
- Projects would not generally be able to generate a risk metric that would qualify it for funding under low cost, low risk safety, efficiency or resilience.
- It is expected that regions prioritise these projects themselves and only put forward the highest priority projects.
- Projects will be reviewed and approved every few weeks (see application dates below) by the low cost, low risk managers.
- Regional Safety Engineers, Network Managers, MCMs and Journey Managers should work together when selecting/submitting projects. This will promote consistency and awareness in each region.
- Regions need to confirm with their delivery teams/suppliers that projects are able to be delivered.

Application process

- Complete a Small Project application form – available on HIP:
  https://nzta.govt.nz/roads-and-rail/highways-information-portal/processes/strategic-activity-management/annual-planning

- Submit application (using naming conventions as outlined below) to the following folder in **Infohub**:
  – Small Project Applications 18.19
  https://infohub.nzta.govt.nz/otcs/cs.dll/properties/27412822
- **Note**: there will be a folder set up for 19/20 at the start of the financial year.
- Create a phase for the project in SAP under the low cost, low risk improvement project for your region.

Application Dates

Projects will be reviewed every few weeks with final submissions accepted no later than 14 February 2019 for 18/19 applications and 13 February 2020 for 19/20 applications. Once reviewed and approved, projects will be funded about one month later.

Review dates:

18/19	19/20
16 August 2018	15 August 2019
27 October 2018	17 October 2019
6 December 2018	5 December 2019
14 February 2019	13 February 2020

Naming conventions:

The naming convention for applications:
Region>low cost, low risk type>Project name.

Example:

- The region name needs to be a NOC region i.e. Central Waikato
- The Low cost, low risk type will be safety, efficiency or resilience.
- The name should reference the project and/or location:

So the filename will be: Central Waikato_Safety_SH1 Seal widening Turangi.

WALKING AND CYCLING

The TAIP has set out walking and cycling programmes for the 6 year period. For the Annual Plan and final TAIP we would like to undertake a programming exercise to match the TAIP/NLTP cycling programme with the aspirations of those responsible for delivering walking and cycling improvements in SD&D. If there are projects that have not yet been incorporated into the TAIP/NLTP then discussions should be held with each region on how to progress the project or integrate walking and cycling improvements into other projects.

The SD&D Op3 team is responsible for overseeing the programme of low cost, low risk safety improvements that improve the level of service for people walking and cycling in both rural and urban settings. It will work with the SD&D system managers and safety engineers in planning and delivering these improvements.

All SD&D system and design managers and safety engineers should consider the opportunities to improve the level of service for all modes as part of any capital or low cost, low risk improvement.

These improvements may be in urban centres, or connecting smaller settlements, to improve mode neutral access along, or across the state highway network.

A particular focus signalled in the 2018-21 GPS is the New Zealand Cycling Network (map available on the Transport Agency website), and the Te Araroa Trail (particularly where it is in the State Highway corridor).

For technical information refer to design considerations which can be found at:

The cycle network guidance at: www.nzta.govt.nz/cng

The Pedestrian Planning Guide at https://www.nzta.govt.nz/resources/pedestrian-planning-guide/pedestrian-planning-guide-index/

The NZCT Design Guide at: https://www.nzcycletrail.com/public-resources/

APPENDIX A: PRIORITISING LOW COST, LOW RISK RESILIENCE PROJECTS

Resilience Improvements can be broadly defined as "maintenance which will prevent or mitigate an incident or event impacting on the serviceability of the carriageway".

Resilience Improvements schemes are funded nationally on a prioritised needs basis to ensure the most beneficial schemes are progressed. Therefore, in order to obtain a consistent approach to ranking these schemes a common assessment methodology is required. These guidance notes aim to outline the criteria for assessing the priority of each scheme to achieve this goal.

Much of the information to assist in prioritising a scheme is located on the Resilience Improvements application form (but each team will also need to assess whether they agree with the assumptions in the submission).

In the event of no supporting information having been provided the team will need to note this as an improvement action and decide whether they support the submission for funding and if so prioritise accordingly using these guidelines.

The prioritisation methodology is based on **two** criteria, firstly the likelihood of the event or incident actually occurring and secondly the consequences of the event or incident if it does occur.

First Criteria – Likelihood

Each scheme is to be ranked as High, Medium, Low or "not supported". These are based on the likelihood of the event or incident happening and impacting on the carriageway using the following measures which can also be aligned to **probability (B)** on the application form:

High (H) – The event is extremely likely to occur within the next 12 months **(B=0.8).**

Medium (M) – The event will probably occur in the next 12–24 months **(B=0.5).**

Low (L) – The event will possibly occur but not immediately **(B=0.2).**

Schemes which are not considered to fulfill the criteria for preventive maintenance funding will be assessed as "not supported".

Second Criteria – Consequences

Within each of the above bands (H, M, L) there is further numerical ranking **(1 to 5)** based on the consequence of the event or incident occurring. This consequence is considered in terms of the following three factors:

- **Benefit Cost** – the cost of doing the work now against the cost of doing the work at time when the failure/event occurs.
- **Safety Risk** – the risk to the safety of the road user presented by the potential failure/event happening.
- **Disruption** – the disruption to route security that would be caused by the failure or event happening.

Benefit Cost or Maintenance Priority Index (C/D)

The Maintenance Priority Index (C/D) on the application form can be used as a guide to the relative cost benefit of undertaking the scheme now against reinstatement at any failure/event.
The higher the index the higher the ranking using the following guidelines:

High Ranking = C/D is greater than or equal to 4.

Medium Ranking = C/D is greater than 1.2 but less than 4.

Low Ranking = C/D is less than 1.2

Safety Risk

This criterion considers the potential for the failure/event to present a safety risk issue to the road user before a maintenance response can be made. Factors to consider include, the remoteness of the site, the level of traffic using the road and the ability of approaching traffic to be aware of any problem (road environment). These will be assessed as follows:-

High Ranking = Certain that one or more of these factors will present a risk.

Medium Ranking = Possible that one or more of these factors will present a risk.

Low Ranking = Unlikely that one or more of these factors will present a risk.

Disruption

This criterion considers the disruptive effect on the road user of any failure/event. In determining the ranking of this, use can be made of the Route Security Factor in section 6 on the PM application form. This disruption should be assessed using the following guidelines:-

High Ranking = Security Factor is greater than 5 million.

Medium Ranking = Security Factor is greater than 1 million but less than 5 million.

Low Ranking = Security Factor is less than 1 million.

Ranking of Consequences

The overall final numerical ranking will take account of the individual ranking of all three of the above consequences and is best considered using a typical "decision making matrix" as shown below:

RANKING	Consequence 1	Consequence 2	Consequence 3
1	H	H	H
1	H	H	M
2	H	H	L
2	H	M	M
3	H	M	L
3	H	L	L
3	M	M	M
4	M	M	L
4	M	L	L
5	L	L	L

The ratings shown are "an illustration only" for ranking purposes and all consequences carry **equal weighting** in the ranking process.

When combined together the final prioritised list will therefore consist of an alpha numeric ranking from the most need **(H1)** all the way down to the lowest need **(L5).**

Process for funding low cost, low risk Resilience projects:

- All projects with Resilience rating of H3 or higher funded.
- Rockfall projects with a RHRS ranking of >500 funded (regardless of resilience rating).
- Rockfall projects with high resilience rating (i.e. H4/M1, 2, 3) and a RHRS score >350 were funded.
- Rockfall projects are assessed by John Jarvis/Stuart Finlan.
- Scour projects are assessed by Nigel Lloyd.
- Projects deemed to have great enough scour need are funded regardless of resilience rating.
- Projects on a particularly vulnerable route (i.e. lifeline to community, lack of reasonable alternate route) given special consideration.
- Regular meetings to discuss progress and assessment of projects.
- Asset Integrators may be consulted on certain projects.

APPENDIX B: ROCKFALL RATING SYSTEM

Introduction

The Rockfall Hazard Rating (RHR) System (see standard check form attached) which we recommend be adopted nationally was originally developed by Pierson et al (1990) for the Oregon State Highway Division to rapidly classify rockfall hazards. It was subsequently adopted by several states in America and Canada and is internationally recognised as state of the art for quick ranking of hazardous rockfall sites. We made slight adaptations to the system to better suite New Zealand conditions based on our experience.

We have presented the framework of the system here and highlighted in boxes useful notes which may help in implementing and running the system in any area.

What is important is that all parties are using the same system the same way and there is a measure of consistency nationwide. The RHR system is intended as a proactive hazard management tool creating a quick, easy to use first cut prioritisation rather than a definitive assessment.

Opus International Consultants Ltd for Transit New Zealand introduced this system for the Central Otago state highway network as part of the slope check prioritisation work to determine levels of risk. It is used as the primary management tool for hundreds of sites.

The work was carried out by experienced geotechnical engineers combined with the local NM consultant and contractor. It has proved an effective method of obtaining a first cut of relative site risk to the motorist. We have found that it is a manageable process to implement and use in the course of our hazard monitoring program.

Our experience has shown that although the system is relatively simple it does have certain technical aspects related to geotechnical conditions.

It is therefore essential that proper geotechnical support is used for the implementation of the system and for review. We would recommend that at least 10% of all sites should be checked by an experienced geotechnical engineer.

The first stage in using the RHR system is identifying the sites to be included in the database. The NM staff will play a major role by supplying historical rockfall information, and should accompany the Geotechnical staff on the initial network drive over.

The RHR system is intended as a proactive hazard management tool rather than a complete assessment guide. Using the RHR should be seen as a first cut analysis that is useful to allow resources to be directed towards the higher risk sites for further assessment and/or physical works.

It is a semi-quantitative system that allocates points to the sites depending on,

1. Road features
2. Geological characteristics
3. Event characteristics and history

The scores for each site are then categorised. We have used our experience of conditions in Central Otago to establish the following categories,

<275 no action needed, continue to check 6 monthly

>325 should be inspected in closer detail by an experienced geotechnical engineer

>500 is likely to be a serious hazard and remedial work is almost certainly required soon.

Our experience has been that all sites should be generally checked every 6 months and formally reviewed annually.

The work is kept in a manual quite separate to all other NM activities and controlled by the geotechnical engineer who covers the area.

Road features

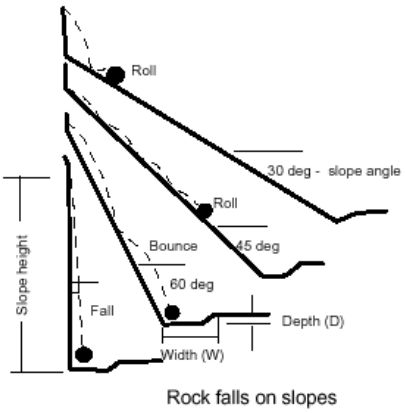
Slope Height

Rocks on higher slopes have more potential energy, so have higher risk scores. The slope height measurement should be taken to the highest point from which rockfall is expected either from within the cut or from the greater natural slope above the cut.

Estimating height can be quite difficult. A good method is to take a survey measuring staff out into the field with you and stand it up against the slope to help gauge approximate height.

Ditch Effectiveness

This is determined by the depth and size of the ditch in conjunction with the slope angle (i.e. the expected particle motion) and the expected size of the falling material. Any



Rock falls on slopes

Figures taken from FHWA Manual 'Rock Slopes' November 1991. USDOT Chapter 12 Page 19.

features on the face which will launch rocks out from the face will reduce the effectiveness of the ditches, so don't just look at the ditch width but consider its ability to actually catch rocks given the slope profile above. The figure shows probable trajectories of falling rocks, and it can be seen that falling rocks (i.e. from a vertical face) will need significantly smaller ditches than rapidly rolling rocks (i.e. from faces at around 45^0).

In NZ we don't often have an actual ditch as such as these can be a hazard in themselves. Assessment will therefore need to be based on verge or shoulder. Grass or gravel shoulders can be effective in absorbing energy from rockfall. Small bunds on verges or shoulders have also proved effective in operating like a ditch. Useful information about ditch effectiveness can be gained from the local NM staff.

Average Vehicle Risk

This is a function of the speed environment of the road, the amount of traffic on the road and the length of the feature. It determines the amount of time that any vehicle is in the hazard area. It is important to ensure that only the length of the slope where rockfall is likely to occur is used to calculate AVR.

Please be aware that the formula requires hourly traffic (AAHT), not just AADT which is what we are most used to using.

We have used AAHT = AADT/24

Then,

AVR = AAHT (cars/hour) x slope hazard length (km) x 100%/posted speed limit (km/h)

Also note that the posted speed limit should be used not the advisory.

Percent of decision sight distance

This determines the likelihood of a vehicle hitting a rock that has already fallen onto the road. The measured sight distance is the distance from which a 150mm object on the edge of the road can be seen with an eye level 1.3m above the roadway. The decision sight distance is the average distance that is needed for a driver to react to a hazard and stop their vehicle.

It is important to remember that the formula is based on the posted speed limit rather than any advisory speed for example as we commonly see in NZ on tight bends etc.

Percent of decision sight distance = Actual site distance x 100%/Decision site distance

Posted Speed Limit (km/h), Note: this is not the advisory limit	**Decision Sight Distance (m)**
50	135
60	180
80	230
100	300

Roadway Width

This influences the risk at a site because it affects the likelihood of a vehicle impacting a fallen rock. On a wide roadway there will be space for a vehicle to avoid a rock without risking a collision with oncoming traffic. Narrow roadways will reduce the chance of a vehicle being able to avoid a fallen rock.

Geological Characteristics

There are two cases within the geological characteristics of the rockfall, either defect or erosion driven events.

At this point it is well worth consulting with a geotechnical engineer and deciding on the overall classification of typical exposures in the region. Consistency is more important than necessarily being technically correct.

Case 1: Events that are defect driven

For the defect dominated sites, the presence and orientation of defects and the friction available to resist sliding are the two controlling factors on failure. The following two tables show the point values associated with different conditions.

Defect Presence and Orientation

3 points	*Discontinuous Joints, Favourable Orientation* Jointed rock with no adversely oriented joints, bedding planes, etc.
9 points	*Discontinuous Joints, Random Orientation* Rock slopes with randomly oriented joints creating a three-dimensional pattern. This type of pattern is likely to have some scattered blocks with adversely oriented joints but no dominant adverse joint pattern is present.
27 points	*Discontinuous Joints, Adverse Orientation* Rock slope exhibits a prominent joint pattern, bedding plane, or other discontinuity, with an adverse orientation. These features have less than 3m of continuous length.
81 points	*Continuous Joints, Adverse Orientation* Rock slope exhibits a dominant joint pattern, bedding plane, or other discontinuity, with an adverse orientation and a persistency greater than 3m.

Continuous joints are defined as being greater than 3m long.

Friction Available to resist sliding.

3 points	*Rough, Irregular* The surface of the joints is rough and the joint planes are irregular enough to cause interlocking. This macro and micro roughness provides an optimal friction situation
9 points	*Undulating* Also macro and micro rough but without the interlocking ability.
27 points	*Planar* Macro smooth and micro rough joint surfaces. Surface contains no undulations. Friction is derived strictly from the roughness of the rock surface.
81 points	*Clay Infilling or Slickensided* Low friction materials, such as clay and weathered rock, separate the rock surfaces negating any micro or macro roughness of the joint planes. These infilling materials have much lower friction angles than a rock on rock contact. Slickensided joints also have a very low friction angle and belong in this category.

Case 2: Events that are erosion driven or are over steepened slopes

Erosion dominated sites are scored in two categories, the presence of erosion features, and the difference in erosion rates. The presence of erosion features scores 3 points for few, Low cost, low risk differential erosion features and 81 points for major erosion features, including overhangs or severely oversteepened talus slopes. The difference in erosion rates is the other category, and covers the rate at which new erosion features develop. A small difference in erosion rates (i.e. a slope that is near equilibrium) scores 3 points, while a slope with erosion features developing rapidly (multiple times per year) scores 81 points.

Note that this category also includes sites which are simply overstep irrespective of their tendency to erode.

Climate and presence of water on slope

The hydrological characteristics of the area are also important causal factors in rockfalls, so the presence of water, ice jacking and freeze thaw activity is given points. 3 points are assigned for sites with no freezing periods, no water flows, and little precipitation. 27 points are assigned for slopes with either a high precipitation, long freezing periods or water on the slope. 81 points are scored when the site has long periods of freezing and either continual water on the slope or high precipitation.

We have modified the values for the rainfall to reflect NZ conditions. The brackets that we have created are intended to reflect mountainous areas (high rainfall, >1250mm/yr), very dry areas such as Central Otago (<450mm/yr).

Event Characteristics and History

Block Size

The maximum block size expected in an event is included in the hazard rating. Large rocks do more damage than multiple small ones, so carry a higher risk rating.

Quantity of Rockfall per event

The size of the event also affects the severity of the event.

These values have been modified to create greater differentiation between sites and avoid score clustering. It is based on our experiences of using the system and consideration of risk to take account of typical rockfall sizes we have experienced in Central Otago and take account of both block size and volume (rather than either/or).

Rockfall History

This can be obtained from the NM team responsible for the area. In some cases there may not be any history of rockfall events, such as new slopes or in areas where rockfalls have been cleared up without any reporting being carried out. If there are no records, the maintenance costs for rock clearing in the area in general may give an indication of the rockfall history.

The table below shows the points assigned for the different categories within rockfall history.

3 points	*Few Falls* Rockfalls have occurred several times according to historical information but it is not a persistent problem. If rockfall only occurs a few times a year or less, or only during severe storms this category should be used. This category is also used if no rockfall history data is available.
9 points	*Occasional Falls* Rockfall occurs regularly. Rockfall can be expected several times per year and during most storms
27 points	*Many Falls* Typically rockfall occurs frequently during a certain season, such as the winter or spring wet period, or the winter freeze-thaw, etc. This category is for sites where frequent rockfalls occur during a certain season and is not a significant problem during the rest of the year. This category may also be used where severe rockfall events have occurred.

81 points	*Constant Falls* Rockfalls occur frequently throughout the year. This category is also for sites where severe rockfall events are common.

Overall Sites Ranking

Once all the sites have been ranked they should be collated into a ranking sheet as shown below (example from Central Otago network, SH8). The sheet also includes our landslide assessment, which is calibrated to align with the rockfall risk levels but is not currently part of this work.

		SLOPE CHECK RANKING SHEET			**Updated 10/5/04**		
		Location SH: 8			Alexandra to Raes Junction		
		Previous Score			Current Score		
RP	Site	Rockfall	Landslide	No. of events in last 6 mths	Rockfall	Landslide	Rank
328/7.3	Lye Bow	357	357		249		1
350/6.65		198	198		198		2
343/2.2	Miners Monument	276	276		189	D V.Low	3
343/0.1		219	219		189		3
343/3.7	Gorge Creek	228	228		147		4
381/16.3		120	120		120		5
350/5.5		147	147		117		6
381/16.7		114	114		114		7
328/1.7		186	186		111		8
350/2.8	LHS					D Low to Mod.	9
	RHS					D V.Low to Low	10
350/5.3					96		11

APPENDIX C: ROCKFALL RATING FIELDSHEET

Rockfall Hazard Rating Fieldsheet					
SH:		**RP:**	**Area:**	**RHS/LHS**	**Length**
Category		**Rating Criteria and Score**			
		Points 3	**Points 9**	**Points 27**	**Points 81**
Slope Height		7.6m	15.2m	22.9m	30.5m
Ditch effectiveness		Good catchment: all or nearly all of falling rocks are retained in the catch ditch	Moderate catchment: falling blocks occasionally reach the roadway	Limited catchment: falling rocks frequently reach the roadway	No catchment: no ditch or ditch totally ineffective
Average vehicle risk		25%	50%	75%	100%
% of decision sight distance		Adequate sight distance, 100% of low design value	Moderate sight distance, 80% of low design value	Limited sight distance, 60% of low design value	Very limited sight distance, 40% of low design value
Roadway width including paved shoulders		13.4 m	11.0 m	8.5 m	6.1 m
Calculated Road width Pts					
Geological Character	**Case 1**	CASE 1: for slopes where discontinuities are the dominant structural feature			
		Structural condition	Discontinuous joints, favourable orientation	Discontinuous joints, random orientation	Discontinuous joints, adverse orientation	Continuous joints (joint persistency >3m), adverse orientation
		Rock Friction	Rough, irregular	Undulating	Planar	Clay infilling, slickensided or low friction mineral coating
	Case 2	CASE 2: for slopes where differential erosion or oversteepened slopes is the dominant condition that controls rockfall. Common slopes that are susceptible to this condition are: layered units containing easily weathered rock that erodes undermining more durable rock.			
		Structural Condition	Few differential erosion features	Occasional erosion features	Many erosion features	Major erosion features
		Difference in Erosion Rates	Small difference; erosion features develop over many years	Moderate difference; erosion features develop over a few years	Many erosion features; erosion features develop annually	Major erosion features; erosion features develop rapidly
Block size		300 mm	600 mm	900 mm	1500 mm
Quantity of rockfall/event		1 m^3	1.5 m^3	2.5 m^3	3.0 m^3 or greater
Climate and presence of water on slope (adjusted for NZ conditions)		Low to moderate precipitation eg<450mm /year; no freezing, no water on slope	Moderate precipitation 450-2m/yr or short freezing (<1 week) periods or intermittent water on slope (seasonal or in response to rainfall)	High precipitation >2m/yr or long freezing periods (>1 week frozen) or continual water on slope	High precipitation >2m/year and long freezing periods or continual water on slope and long freezing periods (>1week frozen)
Rockfall history		Few falls; rockfall only occurs a few times a year or less	Occasional falls; rockfall can be expected several times a year	Many falls; frequent rockfalls during a certain season, e.g. winter freeze-thaw	Constant rockfalls; rockfalls occur frequently throughout the year
AAHT = AADT/24		**Posted Speed Limit km/h**	**Measured Sight Distance m**	**Decision Sight Distance m**	**Total**

APPENDIX D: SCOUR INFORMATION

Introduction

Potential bridge scour protection works are to be identified using the same process used for identifying "Waterway risks" in the regional *State highway bridges and major culverts life cycle management plans*. Whilst the procedures are written for bridges, other structures such as culverts and retaining walls may also be considered.

The prioritisation process that will then be used by National Office will take account of the likelihood and consequences of any bridge failure by considering the following factors:

- likelihood of any failure
- route importance (from the One Network Road Classification)
- traffic volume
- bridge size
- the length of an available bypass to the bridge.

Bridge scour protection works

The table in the application form shall be completed for all bridge scour sites being promoted. The following details are required:

- region, state highway, RP and bridge name
- assessed risk level (H/M/L)
- description of the risk
- details of the recommendations or strategy for the bridge for which funding is being sought
- assessed likelihood of failure in next 12 months (certain/probable/possible)
- estimated costs for any investigation, design or physical works
- estimated costs for work for which funding is being sought.

The bridge scour sites shall be listed in the order of priority assessed by the bridge consultant.

Note: Reference may be made to the reports produced for the National Scour Screening. Risk shall be categorised broadly as low, medium or high. To assist in this qualitative assessment, examples of consequence in a moderate flood (1/20 Annual Probability of Exceedance) are provided below:

- Low – Total scour risk rating in excess of 41. Low cost, low risk scour damage. E.g. localised re-construction of scour protection. No road closures. Repair cost less than $100k. Not to be included in this report.
- Medium – Total scour risk rating in excess of 50. Moderate scour damage. E.g. undermined abutments/piers, abutment approach wash-out. Road closure for up to 3 days. Repair cost $100 – 500k
- High –Total scour risk rating in excess of 60. Extensive scour damage. E.g. lost abutments/piers/spans, substantial approach re-construction etc. Road closure for several weeks. Repair cost greater than $500k.