T10: 2010
SPECIFICATION FOR STATE HIGHWAY SKID RESISTANCE MANAGEMENT

In this release:

The revised T10 reinforces a nationally consistent approach to the current policy for the management of skid resistance. The main changes are outlined below:

- Providing more detailed guidance for managing skid resistance on the State Highway Network.
- Providing more formalised responsibility for all skid resistance practitioners.
- Updating and including Curve Risk Analysis within the specification for rural curves 400m radius or less. They are assigned default ILs based on a driver's personal and collective crash risk.
- Including "hard wiring" of Investigatory Levels (ILs) in RAMM to enable more accurate location of data.
- Introducing a range of Investigatory Levels (ILs) for each site category to enable management of local risk factors
- Providing more detailed guidance on when to modify ILs to reflect local site conditions.
- Introducing a requirement to review ILs on a regular basis.
- Updating and including macrotexture requirements within the specification.
- Including full lane width Watercutting requirement within the specification.
- Improving the methodology for aggregate selection to achieve the design Investigatory Level for the life of the surfacing.
- Requiring assessment of aggregate performance and surfacing methodologies.
- Introducing training and experience requirements for practitioners.

Note: This page is not part of T10.

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SPECIFICATION FOR STATE HIGHWAY SKID RESISTANCE MANAGEMENT

1. Scope

This specification outlines the process for implementation of state highway skid resistance policy as part of the total Safety Management Strategy for the network. It applies to maintenance of existing surfacings, resurfacings and new construction. The specification covers action from philosophy and future policy direction by the Skid Technical Advisory Group (STAG) to details of regional action to maintain and plan future actions to ensure the network has adequate levels of skid resistance.

The objective is a nationally consistent and proactive approach to the management of skid resistance on the state highway network. Provision is included for local network managers to make changes to reflect local conditions.

Surface drainage, pavement shape, aquaplaning, spray, snow, ice and hysteresis are outside the scope of this specification but some comment is made in T10 Notes: Skid Resistance in New Zealand; A Best Practice Guide.

A Glossary and Definitions are included in Appendix 1. Further information and explanation of the policy is included in the T10 Notes.

2. Background

Numerous studies internationally have shown that a skid resistance policy with appropriate skid resistance at various locations on the network reduces crash rates and is a very economic, proactive, crash reduction tool. Reviews of the New Zealand policy confirm that it also has a high benefit cost ratio.
Most benefits occur on wet roads but increasing skid resistance usually reduces crash rates in dry conditions also.

3. Outline of Responsibilities

An outline of responsibilities for implementation of the skid resistance policy is:

a. STAG is responsible for developing and reviewing skid resistance policies and initiatives.

b. Highways and Network Operations (HNO), National Office is responsible for the High Speed Data Collection (HSDC) contract and management of the RAMM database.

c. HNO National office will manage general skid resistance issues including approval of changes to locational data and Investigatory Levels (IL's) as well as reviews of regions.

d. Regional offices are responsible for proactively maintaining adequate skid resistance in accordance with this specification throughout their network. It includes:

- Provision of adequate micro and macrotexture
- Action following release of the Exception Report
- Maintenance of existing surfacings
- Review of full RAMM database for skid resistance
- Construction of new surfacings
- Aggregate selection and monitoring
- Regional review of Investigatory levels (IL's).

4. Skid Resistance General

4.1 Microtexture, Macrotexture and Water (The Basics of Skid Resistance)

Microtexture is defined as the sub 0.5mm texture on the surface of individual aggregate particles (chips).
Macrotexture is defined as the texture greater than 0.5mm formed by the gaps between aggregate particles.
(Refer to Appendix 1 for a more detailed definition).

Skid resistance is primarily a function of the surfacing aggregate microtexture and macrotexture. It is lower when the road surface is wet. For wet road surfaces the loss of skid resistance progressively increases with increasing speed, at higher speeds and thicker water films a limit state of aquaplaning may occur. While aquaplaning lateral resistance is minimal but vehicle deceleration may be significant.

4.2 Other Factors

Other factors that influence skid resistance include vehicle tyres, vehicle suspension, aggregate polishing, surface contamination and hysteresis of vehicle tyres. The most important surface contaminants are bitumen, oil, grease, tyre rubber, mud, clay, and organic (plant) matter.

4.3 NZTA skid resistance general

The objective of the skid resistance policy is to provide a surface that will economically have appropriate high skid resistance for road vehicles in wet and dry conditions for a full range of water depths and vehicle speeds for legal vehicles in New Zealand. Appropriate skid resistance is determined by reference to Investigatory and Threshold Levels of skid resistance for a range of site categories. Low speed skid resistance is measured with the SCRIM methodology (Refer to Appendix 1 for a more detailed definition) The loss of skid resistance with increasing speed is managed by ensuring adequate macrotexture on the road surface and tread depth in vehicle tyres.

An annual survey is undertaken in most lanes measuring SCRIM Coefficient in both wheelpaths, together with macrotexture. As skid resistance varies with time

the data is normalised (seasonally corrected) for both within year and between year variations to produce Equilibrium SCRIM Coefficient (ESC). This is then used as a factor for prioritising surfacings maintenance for skid resistance via Investigatory and Threshold Levels (IL & TL) appropriate to the site category or risk of a skidding crash for the site.

As seasonal correction cannot be completed until the end of summer an Exception Report is produced following the survey to enable prompt programming of treatment to address the most important skid resistance issues. The Exception Report details sections of the network with lower SCRIM Coefficient or macrotexture.

Initial assessment and programming of treatments is made at Exception Report stage. Assessment of the full network for further treatments and surfacings and aggregate performance is undertaken when the RAMM database is available populated with seasonally corrected data.

5. Segmentation of the Network

The network is divided into 10m lengths, for each lane, with the beginning and end of each length accurately defined by GPS co-ordinates and given a linear label. The High Speed Data Collection (HSDC) contractor allocates a site category (see Table 1) from site descriptions and hence a default IL (and ILM) to each 10m section of lane surveyed. The site categories are calculated from a combination of manually entered data and other measurements made during the survey.

In future surveys the reports will be based on fixed RAMM data given to the survey contractor. It is the responsibility of the region to ensure this is accurate. To assist in identifying new features a crosscheck will be performed by comparison of fixed RAMM data with data entered by the survey contractor.

A continuous length with a single site description is referred to as a skid site. These sites are normally not less than 50m long but can be several kilometres or more.

6. Investigatory Levels

Plots of crash rates versus skid resistance show increasing skid resistance reduces crash rates. While the general shape of the curve is the same for all sites, the actual crash risk may vary significantly between different types of sites.

The Investigatory Level (IL) is a skid resistance maintenance priority level set with two objectives:

a. To equalise the risk of a wet road or skidding crash across the state highway network.

b. An economic balance between the cost of achieving the skid resistance and the crash savings

In Table 1 (below) each skid site has an associated site category, and a range of ILs to allow for variations in risk:

i. The black shaded area in Table 1 details the default Investigatory Level (IL, Units ESC) for the Site Category.

ii. The alternative ILs in the greyed areas adjacent to the black area shall be considered by regions where the crash risk for the site under consideration is different from the national average for the Site Category. Where the crash risk is lower, construction and maintenance savings may be made by selecting the lower IL. Where the crash risk is higher than the national average the higher IL should be selected or other safety measures implemented to reduce the probability of a wet road crash to the national average for the Site Category. More detail on changing ILs is included in section 8, Appendix 2 and T10 notes.

iii. Only one site category can be assigned to any one section of a lane on the network. If more than one category is applicable choose the site category with the higher default IL. Where two events occur consideration should be given to the use of an even higher IL to reflect the combined risk.

Site descriptions with associated ILs are set out in Table 1.

Table 1: Skid Resistance Investigatory Levels

Site Category	Site Description	Investigatory Level (IL,ESC)					
		0.35	0.40	0.45	0.50	0.55	0.60
1	Approaches to: a) Railway level crossings. b) Traffic signals. c) Pedestrian crossings. d) Stop and Give Way controlled intersections (where State Highway traffic is required to stop or give way). e) Roundabouts (approaches only) One lane bridges: Approaches **and** bridge deck.						
2	a) Urban Curves <250m radius.						
	b) Rural Curves <250m radius			L	M	H	
	c) Rural Curves 250-400m radius		L		M	H	
	d) Down Gradients >10%. e) On Ramps with ramp metering						
3	a) Approaches to road junctions (on the State Highway or side roads). b) Down Gradients 5-10%. c) Motorway junction area including On/Off Ramps.						
4	• Undivided carriageways (event-free)*						
5	• Divided carriageways (event-free)*						

Notes to Table 1:

- The units for IL in table 1 are ESC. Where seasonally corrected data is not available SCRIM Coefficient (SC) may be used as an approximation to ESC with further checks undertaken when seasonal corrections are available.

- Event-free: where no other geometrical constraint, or situations where vehicles may be required to brake suddenly, could increase the skid resistance requirements.

- The curve risk rating on all rural curves with radii between 0-400m is shown as H, M or L in the appropriate IL band under site category 2b & 2c. Urban curves were not included in the Curve Risk Analysis procedure.

6.1 Site Category 2 curves less than 400m

Rural Curves less than 400m radius (Site category 2b & 2c) are subject to a Curve Risk Analysis procedure to rank curves based on personal and collective crash risk. High Risk Curves are assigned a default IL of 0.55, Medium Risk 0.5, Low Risk <250m radius 0.45 and Low Risk ≥250m radius 0.4. (See T10 Notes for further information)

7. Threshold Level

For the purposes of state highway skid resistance management the Threshold Level (TL) is defined as a skid resistance level 0.1(ESC units) below the Investigatory Level or 0.30 whichever is highest. This is the level that triggers high priority for treatment as outlined in Table 3.

8. Modifying Investigatory Levels

8.1 Reasons to modify IL's

Investigatory levels may be modified for two general reasons:

i. The location for the site category is wrong.

Where the location data is changed, measurements must be made to a similar accuracy to the original survey. Generally ± 2m will be adequate.

ii. Where the crash risk for the site under consideration is different from the national average for the Site Category. In these cases, similar situations on the regions network must also be considered and the IL increased or decreased where justified in terms of a total strategy for a substantial length or a number of similar situations.

In both situations the region shall ensure the new site category, location and IL etc are entered into the RAMM Database together with the reason for the modification.

8.2 Examples of Reasons to modify IL's

Examples where modification of the IL is justified for any site category include the following: (for additional details see Appendix 2).

i. Multiple wet road crashes should prompt consideration of increasing the IL.

ii. Multiple risk factors (such as those included in Table 1 under "Site Description") occurring at the same location should prompt consideration of increasing the IL.

iii. Experience gained in assessing risk of crashes from undertaking site investigations over multiple sites or substantial lengths has highlighted a need for modification, either up or down.

iv. High traffic volumes with an associated high number of crashes or conversely low traffic volumes with an associated very low number of crashes may indicate IL should be modified.

v. An unforgiving roadside environment with associated high severity crash outcomes should prompt consideration of increasing IL.

In general addressing skid resistance will be an economic crash reduction tool but other safety actions should also be considered as an alternative or may be included as part of a total strategy.

9. Review of Investigatory Levels and Site Categories

9.1 Regional Review

Investigatory Levels shall be reviewed, amended or confirmed for all sections of the network on a three year cycle. This process shall address approximately a third of the network each year.

Records shall be kept to enable the programme and decisions to be reviewed.

Before entering changes or confirming current data the decisions shall be approved by the senior operations person following consultation with the regional principal Safety Engineer and local STAG member. It shall receive final approval from the Operations Manager, HNO National Office.

9.2 National Office Review

HNO National office will review a sample of all networks to confirm that the process, programme and allocation of IL's are appropriate.

10. Macrotexture

Macrotexture is required for three reasons:

a. To provide for drainage of water from under vehicle tyres to minimise the progressive loss of skid resistance on wet roads at increasing speeds.

b. Macrotexture is also required to minimise contact of vehicle tyres with bitumen between chipseal aggregate. The mechanism is; vehicle tyres deflect around individual chips in the surfacing and some of the normal force is taken on bitumen rather than the higher microtexture aggregate. This factor is well modelled by the SCRIM methodology. Hence, if the surfacing has an adequate ESC (or SC) it is assumed the macrotexture is adequate to minimise contact of vehicle tyres with bitumen. Contact of vehicle tyres with bitumen may become a significant problem at an MPD of 1.5mm for larger grade chipseals, but for grade 5 chipseals and asphaltic mixes adequate ESC may be obtained at lower macrotexture levels.

c. Macrotexture also contributes to skid resistance through hysteresis. Tyres

designed to maximise hysteresis skid resistance are not suitable for general use on New Zealand roads. This factor will not be considered further in this specification.

10.1 Macrotexture Terminology

It is considered appropriate to apply Investigatory and Threshold Levels to macrotexture as well as microtexture for prioritising treatment actions.

In order to differentiate between the two, the terms Investigatory Level Macrotexture (ILM) and Threshold Level Macrotexture (TLM) will be used to indicate the macrotexture requirement. These can be abbreviated to ILM and TLM.

10.2 Macrotexture Requirement

Adequate macrotexture shall be maintained throughout the life of surfacing as required by this specification and detailed in Table 2.

10.3 Modifying ILM and TLM

ILM and TLM may be reduced by up to 0.2mm MPD using the principles and approval processes outlined in Section 8 Modifying Investigatory Levels.
The modified ILM etc shall be entered in RAMM and used for future maintenance decisions.

10.4 Macrotexture Treatment

Where macrotexture levels are below the ILM actions to minimise the risk of macrotexture falling below TLM shall be included in the annual programme.

Where macrotexture levels are below the TLM actions to increase the macrotexture shall be included in monthly maintenance programmes and frequent inspections programmed.

10.5 Watercutting

Where watercutting of the surfacing is the selected maintenance it shall be undertaken over the full width of the lane and shoulders unless the following criteria are met:

- Either; after watercutting the macrotexture of the areas not watercut are equal to or more than the areas watercut.
- Or; the macrotexture outside the area watercut exceeds 2.0mm MPD for grade 2 & 3 chipseals and 1.5mm for smaller chips (For two coat chipseals etc the chip size refers to the larger chip).

Table 2: Minimum Macrotexture Requirements

Minimum Macrotexture MPD (mm)				
Legal Speed Limit	**Chipseal**		**Asphaltic Concrete**	
	ILM	TLM	ILM	TLM
50 kph and less	1.0	0.7	0.5	0.5
Less than or equal to 70 kph but >50 kph	1.0	0.7	0.7	0.5
Greater than 70 kph	1.0	0.7	0.9	0.7

Notes to Table 2

- The macrotexture requirements for asphaltic concrete are to minimise the progressive loss of skid resistance at higher speeds. The requirements for chipseals, where they are higher, are also to minimise the risk of low skid resistance due to vehicle tyres running on bitumen.
- For existing AC surfacings (laid prior to 1st October 2010) where the legal speed limit>70 kph judgement shall be exercised and the TLM may be reduced to 0.5mm MPD until maintenance is required for other reasons (see glossary for definition of Judgement).
- For asphaltic concrete in urban areas (50kph or less) judgment should be exercised before maintenance is undertaken solely to increase the macrotexture. For new surfacings in these locations the target should be to achieve the requirements of Table 2 but if economic material constraints dictate that this cannot be achieved judgement shall be exercised to ensure any surfacing achieves an acceptable safety level.

  The most significant factor is the operating speed. Reduction of available skid resistance (on wet roads) is progressive with increasing speed. Skid resistance is a maximum at around 20kph. It reduces continuously with increasing speed. At a speed of 50kph the reduction in skid resistance is small; at 70kph loss of skid resistance is significant.

  Hence, where operating speed is low, eg busy built up areas that are frequently congested, to maintain the surfacing solely to increase macrotexture is inappropriate. But at the outskirts of the urban area where a significant number of vehicles may exceed the 50kph speed limit maintenance to achieve 0.5mm macrotexture is normally justified.

  Other factors to consider are:

  - How far below 0.5mm is the macrotexture.
  - Crash rate compared to similar sections of SH (However, increasing microtexture as well may be more effective when crash rates are higher).

- The TLM for chipseals is set at 0.7mm MPD. Where the macrotexture is equal to or higher than required for asphaltic concrete maintenance to improve the macrotexture may be delayed provided;

    - ESC is above TL
    - Inspections are programmed and resources are available to ensure prompt treatment is undertaken should macrotexture levels continue to drop significantly.
    - ESC levels are stable. Ie have not reduced by more than 0.05ESC since the previous annual survey.

- For site categories 1 & 2 additional visual inspections should be undertaken and earlier maintenance programmed when macrotexture falls below Investigatory Level (ILM).

- Survey data is the average of readings over the 10m survey length. Hence a short length of flushing (or low SCRIM Coefficient) may be masked by higher values over the rest of the 10m length. Short lengths of network that are obviously flushed shall be maintained within the monthly maintenance programme. Greater priority should be given to:

    - Flushed patches on curves.
    - Flushed patches that may bleed in hotter weather.

- Surfacings may be constructed with low macrotexture (0.5mm MPD) on high stress curves where the side thrust gauge readings, before rounding, indicate an advisory speed of 45kph or less. This dispensation excludes the approaches (The spiral that may be recorded as part of the curve.)

- Asphaltic concrete also includes cape and slurry seals.

11. Survey of Existing Surfacings

HNO National Office will complete an annual survey of skid resistance, macrotexture and other factors via the High Speed Data Collection contract. Seasonal Correction factors shall be calculated for SCRIM coefficients with all information entered into the RAMM database for access by regions.

The annual survey will not cover all sections of the network. The lanes to be surveyed may be amended on request, however, for economic reasons the whole network cannot be surveyed. Any request must be forwarded to National Office prior to 1st August.

12. Assessment of Sections of Network Not Surveyed

Where sections of the network are not surveyed the ESC and macrotexture, shall be assessed during inspections by comparison of data from adjacent lanes taking into account surfacing date(s) of each lane, surfacing aggregate, surfacing type, surfacing stress, heavy traffic numbers and any surfacing contamination.

Note:
Since most flushing occurs during summer the critical period for assessment may be before receipt of the Exception Report.

13. Exception Report

To enable prompt consideration of sections with lower skid resistance HNO National Office issue an Exception Report. This details sections where SCRIM Coefficient (SC) and/or macrotexture are less than the Threshold Level (TL or TLM) and therefore high priority for treatment (see Table 3).

The Exception Report process is:

a. Following the survey of each network the data is checked and an Exception Report forwarded to the relevant region by HNO National Office through the HSDC Contractor and Consultant.

b. The Exception report details SC and macrotexture for each 10m section where either SC and/or macrotexture is below the Threshold Level together with location and survey time.

c. On receipt of the Exception Report, regions shall promptly investigate and programme treatment of sections identified in accordance with this specification on the assumption that SC is the same as ESC (see Table 3).

d. Records shall be kept of all inspections and treatment programmed. Progress for both inspections and treatment shall be compared to the treatment programme monthly.

e. Generally treatment is carried out within the annual maintenance programme rather than waiting until the following summer. However where resurfacing or pavement rehabilitation is the most economic treatment seasonal weather restraints may require temporary action (e.g. signage or water cutting/ blasting) followed by construction the following summer.

f. Further explanation of action required is contained in T10 Notes: Skid Resistance in New Zealand; A Best Practice Guide.

14. Existing Surfaces

The priority for investigation and programming of treatment or maintenance for low microtexture (Low ESC) depends on the ESC value relative to the IL (& TL).

Following the annual High Speed Data Collection survey existing surfaces shall be investigated, treated and maintained in accordance with the measured skid resistance (ESC) and priorities given in Table 3.

Notes:

- **Treatment** in the context of this specification is the action following

consideration of skid resistance to ensure the road is adequately safe. The action may include addressing factors other than skid resistance and may include a documented justification to do nothing.

- **Maintenance** in the context of this specification is an action to improve skid resistance of the surfacing.

Table 3: Treatment Priority for Existing Surfaces

Treatment Priority	Definition	Action
High	Values of ESC at or below TL	These sites must be investigated promptly on receipt of the Exception Report. An on-site inspection made, the cause of the low skid resistance assessed and appropriate treatment designed and programmed as soon as practicable as part of routine highway maintenance. Any maintenance should, as a minimum, be expected to increase the skid resistance to a level above the TL for a period of at least 12 months. An inspection as detailed below shall be undertaken 6 months after maintenance or treatment where: ▪ Maintenance of the surfacing is estimated to retain the ESC above TL for 12 months or less. ▪ Treatments are implemented that do not increase the skid resistance of the surfacing. At this inspection the safety of the site shall be assessed: • The reports of any crashes shall be reviewed. • The effectiveness of the treatment shall be reviewed. • An assessment shall be made of future deterioration and a further inspection programmed before the site may become unsafe. Records shall be maintained during each inspection.
Medium	Values of ESC between IL and TL	Inspect and programme future maintenance and subsequent inspection. Maintenance shall be programmed with the objective of minimising the risk of skid resistance falling below TL. Where skid resistance may fall below TL prior to completion of programmed maintenance, or the next High Speed Survey, an earlier inspection shall be programmed as for sites with high treatment priority.
Low	Values of ESC at or above the IL	Monitor performance of surfacings to assist with future programming of maintenance.

Notes to Table 3:

- Where a site inspection is undertaken for high or medium treatment priority it is

recommended that the Inspection Assessment Sheet included in T10 notes is completed to record site details and decisions taken.

- Where treatment decisions are made on the basis of SC (e.g. Exception Report data) and subsequent seasonal correction calculations show that ESC is numerically less than SC then an additional assessment of sites shall be made (see Section 15.1 for more details).

- Site investigations should also be prompted by knowledge of a high proportion of wet or wet skid accidents, or where information from the Police or members of the public suggest a possible skidding problem.

14.1 Site Investigations (General)

Requirements for carrying out site investigations:

i. Staff Experience

1. Staff carrying out site investigations must be appropriately experienced in skid resistance; pavement and surfacing engineering and the leader on site shall have received appropriate training at least in skid resistance.

ii. Effectiveness of Maintenance

1. To ensure the most effective maintenance is chosen decisions shall take into account previous surfacing history and performance of maintenance undertaken elsewhere with similar traffic, surfacings and substrate.

iii. Design Life of Maintenance

1. Maintenance design shall include assessment of the design life.

2. Where maintenance (or treatment) does not increase the skid resistance to above the IL maintenance of the surfacing should be programmed to occur within 12 months.

iv. Temporary Traffic Management

1. The NZTA's temporary traffic control requirements must be complied with for the safety of staff and road users.

15. Full Survey Data & RAMM Database

Following checking of survey data and calculation of skid resistance seasonal corrections National Office shall advise regions when fully checked data is available in the RAMM database.

15.1 Seasonal Correction Factors Less than One

As noted under Table 3, where seasonal correction data shows that ESC is numerically less than SC an additional assessment of all sites shall be made. Generally this will be a desk exercise, based on available records and inspections. Where sites have moved from medium to high treatment priority, each site shall be inspected, assessed and treated as for all sites originally having ESC values at or below TL.

Where seasonal correction data shows that there are sites which were programmed for treatment following release of the Exception Report which are now of higher priority the programme should be reviewed.

15.2 Network Performance and Annual Planning

Following issue of the full RAMM database regional practitioners shall:

i. Complete the assessment of all data in accordance with Table 3 and other sections of this specification.

ii. Review Annual Plans for surfacings and Area Wide Treatments

iii. Analyse surfacing performance to better understand the success of all maintenance for skid resistance including:

- Aggregate polishing due to heavy vehicle's in a full range of stress conditions.
- The cost of maintenance.
- The life of maintenance in a variety of situations.

This analysis should ensure appropriate aggregates are used for new surfacings and more economic maintenance options are selected.

16. New Surfacing

New surfacing includes all new asphaltic concrete and chipseals but excludes any surfacing under Temporary Traffic Management for its full life. It includes new surfacing for projects and resurfacing of existing surfaces.

New surfacing design shall include an estimation and recording of an expected design life.

New surfacing shall be constructed by a method and with an aggregate expected to maintain skid resistance (microtexture and macrotexture) at or above the appropriate IL and ILM for the design life of the surfacing.

The microtexture requirement may be met by one of two methods set out below:

- Compliance with the PSV and associated requirements.

- Selection of an aggregate with good performance in similar traffic and polishing stress conditions. (Aggregate Performance Method)

16.1 Polished Stone Value (PSV) Method

a. The PSV of the surfacing aggregate shall be equal or greater than the value calculated from the following equation.

PSV = 100*SR + 0.00663*CVD + PSF

SR = Investigatory Level for the site
CVD = Commercial vehicles per lane per day, see Appendix 1
PSV = Polished Stone Value, see Appendix 1
PSF = Polishing Stress Factor selected for the site in accordance with Table 4 and notes below.

Table 4: Polishing Stress Factors

Polishing Stress Factor	Examples
3	Site Cat 5, Event-free: where no other geometrical constraint, or situations where vehicles may be required to brake suddenly, could increase the skid resistance requirements. Site Cat 4 straight level road, less than 5,000VPD, very seldom any congestion and few low volume access points.
4	Site Cat 4 greater than 5,000VPD very seldom any congestion, grades less than 3%, Site Cat 3a, Approaches to road junctions (on the State Highway or side roads).
5	Site Cat 3b, Down Gradients 5-10%. Site Cat 3c including 200m before off ramps.
6	Site Cat 1with average approach speeds and infrequent emergency braking. Site Cat 2 curves medium risk.
7	Site Cat 1 with average braking Rolling country with frequent curves requiring frequent acceleration and deceleration
8	Site Cat 1 with frequent heavy braking Site Cat 2 curves that are High Risk Any site with frequent heavy braking, eg curve requiring braking at end of down grade.
9	Sections of the network with highest stress due to braking or cornering. Eg curve requiring braking at end of down grade.

b. Where aggregate with an acceptable PSV is not available within 400km radius of the site to be resurfaced an analysis of options to achieve the required ESC shall be undertaken in terms of the Aggregate Performance Method, below.

c. NZTA Regional Offices may extend table 4 above following advice to the Operations Manager, NZTA HNO National Office.

d. Should an aggregate polish to below its TL full details shall be reported to the Operations Manager, NZTA HNO National Office.

e. In general regions should be aware of aggregates that polish to below the IL. Care should be exercised in use of these aggregates and where significant lengths polish to below the IL a report written and forwarded to the Operations Manager, NZTA HNO National Office.

16.2 Sampling of Surfacing Aggregate etc

Where the quarry PSV of an aggregate is 55 or more, or where the calculated PSV is 55 or more using the formula in 16.1, sample(s) shall be taken by a consultant or other NZTA appointed person independent of the contractor:

a. The samples shall be tested for PSV.
b. The details shall be stored in a systematic manner in the region.
c. Records of PSV testing shall be retained for review and details of sample reference, probable location aggregate used, aggregate source (quarry and producer), quoted PSV and tested PSV forwarded to the Operations Manager, NZTA, HNO, National Office.
d. The region shall analyse the data to compare quarry quoted PSV's with those from samples taken independently.
e. The data shall be used, together with information on the skid resistance of various sections of the regions network, to ensure better decisions are made regarding selection of future surfacing aggregates. This data shall be shared with other regions on request.
f. The rate of sampling shall be;
   - A minimum of one sample for each surfacing contract.
   - Where the contract is for more than 1km, an additional sample per 5km of surfacing or part thereof.
g. An attempt shall be made to collect aggregate samples from that to be used in the higher polishing stress areas and the probable (or general) location where the aggregate was laid recorded.
h. National office may allocate an assessed PSV to aggregate from a quarry following assessment of ESC obtained at a variety of locations. Where the assessed PSV is in excess of 55 it shall have been trailed in situations requiring the higher PSV.

16.3 Aggregate Performance Method

This method may be used where aggregate with an acceptable PSV is not available within 400km radius of the site, or where a full analysis of the historic performance of the aggregate indicates it will perform adequately in the proposed location.

The analysis shall include skid resistance performance for all sites where the aggregate has been used on state highways. Experience from use on local authority roads may be included provided full data including ESC and heavy traffic is available.

For aggregates where there is limited experience with use on state highways, and particularly in high stress areas, the Contractor may guarantee the performance of the alternative aggregate. The agreement will include replacement of the surfacing with a better aggregate should the surfacing not meet agreed conditions. This shall be backed up with an appropriate bond. Conditions shall include no more than 10% of the length having an ESC below the IL or ILM and no 10m section falling below TL or TLM. This process shall be subject to final approval by the Operations Manager, HNO National Office.
(Further guidance on selection of aggregate is included in T10 Notes: Skid Resistance in New Zealand; A Best Practice Guide).

16.4 Surfacing Design

The surfacing shall be designed to maintain the surfacing integrity, without flushing (Macrotexture above ILM), for the design life of the surfacing.

16.5 New Alignments

Capital Projects and road reconstruction shall have assessment of an appropriate IL & ILM included in the design process. The design IL's and associated aggregates shall be subject to approval by the senior operations person following consultation with the regional Principal Safety Engineer and local STAG member. It shall receive final approval from the Operations Manager, HNO National Office.

16.6 RAMM Inventory Data for New Alignments

Inventory data for new alignments that are open to traffic must be entered in RAMM prior to 1 September. If this is not done data collected may have significant errors. Network openings programmed after 1 September must be discussed with National Office before 1 September and final data entered as a matter of urgency.

The first HSDC survey after the project or reconstruction will re-measure the displacement and GPS Co-ordinates for the full reference station (RS) length in both directions.

17. Reviews of Regions

HNO National office will undertake reviews of individual Network Management Areas to confirm compliance with policy and make recommendations for improvements, both in the region and nationally. All reviews will be conducted according to a methodology advised prior to the review commencing. Team members may include regional STAG members or others with appropriate expertise.

Appendix 1
GLOSSARY AND DEFINITIONS

Bleeding: A pavement surface defect where the viscosity of the binder on the road surface is low, resulting in pick up of bitumen by vehicle tyres (See Flushing below).

Curve Risk Analysis: A risk rating procedure for rural horizontal curves (≤400mm radius) based upon a crash prediction model that takes into account the curve geometry, approach gradient and the out of contextness of the curve speed with the approach speed.

Equilibrium SCRIM Coefficient (ESC): SCRIM Coefficient, SC, adjusted for within year and between year variations.

Flushing: A pavement surface defect in which the binder is near or above the uppermost surface of aggregate particles (See bleeding above).

Global Positioning System (GPS): is a space based satellite location referencing system.

High Speed Data Collection (HSDC): The Contract to collect annual pavement condition data at near traffic speed.

Investigatory Level (IL): The level of microtexture (SC or ESC) at or below which a site investigation is to be undertaken, and the information used as a priority indicator for programming treatment.

Investigatory Level Macrotexture (ILM): The level of macrotexture at or below which a site investigation is to be undertaken, and the information used as a priority indicator for programming treatment.

Judgement: Where judgement is required in this specification the decision(s) shall be documented and then approved by the senior operations person following consultation with the regional principal Safety Engineer and local STAG member. It shall receive final approval from the Operations Manager, HNO National Office.

Macrotexture: is a surface characteristic related to potential channels for water drainage between the vehicle tyre and road surface, which has a wavelength range of 0.5mm to 50mm.

Maintenance: In the context of this specification is an action to improve skid resistance of the surfacing (Also see Treatment).

Mean Profile Depth (MPD): This is a measure of macrotexture based on the height of the highest peaks above the mean depth, calculated over a 100mm line. For the HSDC these values are averaged over the reporting length, typically 10m.

Mean Summer SCRIM Coefficient (MSSC): is the mean SCRIM Coefficient, SC, over the summer period.

Megatexture: is a surface characteristic related to pavement defects and "waviness" having wavelength components from 50mm to 500mm.

Microtexture: is a surface characteristic having wavelength components less than 0.5mm, formed by the irregularities on the surface particles exposed at surface level. It is measured with SCRIM methodology in New Zealand.

New Zealand Transport Agency (NZTA): The crown agency responsible for, amongst other functions, the management and maintenance of the State Highway network.

Polished Stone Value (PSV): is a measure of the level of polishing resistance of surfacing aggregate under standard laboratory conditions. It is designed to indicate the ultimate state of polish for in situ road surfacing aggregate. It is only an indicator of future microtexture of a road surface.

Polishing: An action in which the uppermost faces of aggregate lose microtexture, or become smooth, as a result of the abrasion effect of traffic, reducing the available friction between road surface and vehicle tyre.

Polishing Stress: The tractive braking or cornering forces that influence the rate of polishing of a surfacing aggregate.

Road Assessment and Maintenance Management System (RAMM): A computer based system to manage the maintenance and rehabilitation of pavements and other roading features.

SCRIM (Sideway-force Coefficient Routine Investigation Machine): A machine which provides a reliable method of measuring skid resistance of roads under wet conditions. The New Zealand machines are capable of testing both wheelpaths of long lengths of road at highway speeds and are designated SCRIM+. The + referring to additional instrumentation to measure macrotexture, roughness, rutting, gradient, curvature and GPS location.

SCRIM Coefficient (SC): It is the SCRIM measured low speed skid resistance or microtexture at the time of measurement. It has been corrected for normal load, temperature and travel speed.

Site Category: A generic description of a consistent length of road feature or type against which an Investigatory level can be assigned.

Skid Resistance: The coefficient of friction between the road surface and a vehicle tyre, normally measured with a wet road surface.

Skid Technical Advisory Group (STAG): The group responsible for developing and reviewing skid resistance initiatives within NZTA.

T10: NZTA Specification for State Highway Skid Resistance Management.

T10 Notes: T10 Notes: Skid Resistance in New Zealand; A Best Practice Guide.

Threshold Level (TL): A term used to describe a trigger level of microtexture for determining priority for programming treatment.

Threshold Level Macrotexture (TLM): A term used to describe a trigger level of macrotexture for determining priority for programming treatment

Treatment: In the context of this specification is the action following consideration of skid resistance to ensure the road is adequately safe. The action may include addressing factors other than skid resistance and may include a decision to do nothing (Also see Maintenance).

Watercutting: Also called waterblasting. A process where very high pressure water is sprayed in very small quantities to remove bitumen from between the surfacing aggregate.

Appendix 2
Criteria for Modifying Investigatory Levels

SITE CATEGORY 1

Site Cat	Definition	Initial Criteria for changing IL from default value
1a	Railway level crossings	Increase: • No barrier arms. • No warning lights. • Poor visibility of tracks within stopping distance. • Curvature less than 500m within stopping distance calculated from legal speed limit. Decrease: • Very few trains. • Low speed limit approaches e.g. less than 60kph. • Train visible from long distance away. • Train always crosses road slowly.
1b	Traffic Signals	Increase: • Speed limit is greater than 50kph. • Increase length of higher IL where queue lengths plus stopping distance regularly exceeds the default of 50m. • Higher than average fatal & serious crash record. • Multilane approaches.
1c	Pedestrian Crossings	Increase: • Higher traffic or pedestrian volumes. • Intermittent high pedestrian volumes e.g. near schools, preschools, colleges, hospitals etc. • Multi-lane approaches Decrease: • Traffic volumes and pedestrian volumes are low, with good approach visibility.
1d	Approaches to Roundabouts Note; A default IL of 0.55 applies to the approaches to roundabouts. The circulating portion of the roundabout should generally be a low risk curve.	Increase: • Speed limit is 70kph or more. • Low approach deflection deviation angles and hence high speed entry possible. • Two lanes on approach and circulating section of roundabout where drivers may be tempted to drive straight through cutting across the lanes. Decrease: • Speed limit and operating speed is 50kph or less.
1e	Stop and Give Way controlled intersections	Note: The default IL applies where the state highway traffic is required to stop or give way. Where the state highway authority is also maintaining the other approach

Site Cat	Definition	Initial Criteria for changing IL from default value
		legs a similar criteria should be applied to the side road, regardless of whether the side road is controlled or not. Where the traffic volumes are higher or the approach is on a curve consideration should be given to increasing the length of site cat 1a. Increase IL: • Speed limit approaching control greater than 60kph • Lower sight distance for approach to control. Decrease: • Very low traffic volumes on side road approach leg
1f	One lane bridges Notes: Default IL applies to both approaches and the bridge deck. The length of IL for one lane bridges depends on the speed limit, the operating speed and sight distances.	Increase: • Sight distance is less than stopping distance for legal speed limit on approaches or operating speed on the bridge. Decrease: • Longer one lane bridges, where a central section has adequate distance for both vehicles on the bridge to stop safely. • Very low traffic volumes and reasonable geometry.

SITE CATEGORY 2

Site Cat	Definition	Initial Criteria for changing IL from default value
2a,b,c	Curves < 400m radius	Curves less than 400m radius have been rated as high, medium or low based upon their crash risk due to a combination of curve radius, geometry, speed and approach speed (out of contextness). Default IL values of 0.55 (high), 0.5 (medium) & 0.45/0.4 (low) have been assigned. Increase: • High predicted crash numbers (collective risk) **Due to a combination of the predicted crash rate and high traffic volumes** • Above expected crash numbers. • High traffic flows. • Poor sightlines i.e. a good proportion of the curve is hidden by bank or vertical curve. • A difficult and unforgiving roadside environment. Decrease: • Low predicted crash numbers (collective risk) **Due to a combination of a low predicted crash rate and low traffic volumes** • Low crash record over a long period.

		• Very low traffic flows. • Low traffic volumes and a forgiving roadside environment with low risk of serious injury. • Low speed environment of ≤50kph
2b	Down gradients greater than 10%	Increase: • Longer down gradients. • Combined down gradients and curves up to 500m or more. Decrease: • Very short lengths of down gradient not significantly greater than 10%.

SITE CATEGORY 3

Site Cat	Description	Initial Criteria for changing IL from default value
3a	State highway approach to side road junction, where side road is required to give way to state highway traffic.	Increase: • Where traffic volumes on side road are high. • A history of Intersection crashes. Decrease: • Where traffic volumes on side road are very low.
3b	Down gradients 5 – 10%	Judgement should be used to select a default IL between 0.4 and 0.5 depending on the actual grade, length and curvature. Also refer 2b, down gradients greater than 10%.
3c	Motorway junction area including On/Off ramps	Detailed investigation of motorways shows that high stress movements occur at some typical locations. For example through lane immediately before an off ramp. Detailed investigation should be undertaken to identify features common to the motorway network in the region i.e. queuing traffic and treat all similar areas to a consistent standard.

SITE CATEGORY 4

Site Cat	Description	Initial Criteria for changing IL from default value
4	Undivided carriageways, event free.	This is the largest site category on the State Highway network. The curve analysis methodology modifies the required IL over some sections. Generally IL should not be reduced to below the default value of 0.40, regions should be vigilant to ensure appropriate safety treatments (including increasing IL) are undertaken as soon as crash rates rise above a threshold minimum. Increase: • Large radius or long curves with a crash record.

		• High levels at intersections result in the need for braking or a record of rear end crashes.

SITE CATEGORY 5

Site Cat	Description	Initial Criteria for changing IL from default value
5	Divided carriageways, event free.	1. See earlier note that TL shall not be below 0.35. The consequences of this requirement is that any section with an ESC (or SC for Exception report) below 0.35 will require prompt treatment in accordance with Exception Report instructions. 2. Where traffic volumes are higher or congestion may occur a default IL of 0.40 is appropriate. Where traffic volumes are high or congestion occurs regularly the IL should be increased above 0.45.