Specification for state highway skid resistance management

1 Scope

This T10 Specification outlines the process for implementing the state highway skid resistance policy as part of NZTA safety management for the state highway network. It applies to all surfacing types, including existing surfacings and new surfacings. Surfacings that are under temporary traffic management for their whole life may be excluded.

The objective of this specification is to provide 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 tyre hysteresis are outside the scope of this specification but some comment is made in T10 Notes.

A glossary is included as appendix A.

A list of abbreviations is included as appendix C of the T10 Notes.

2 Status of specification and notes

The T10 Specification is a guideline in terms of the *Register process manual for network standards and guidelines*. However, compliance with the process in the specification is mandatory for all work on state highways, although variations may be approved by the NZTA National Pavements Manager.

The T10 Notes contain guidance for the implementation of the T10 Specification and the NZTA's skid resistance policy and it is important that the notes are read in conjunction with this specification.

3 Skid resistance measurement, investigatory and threshold levels

3.1 Measurement

Skid resistance on the state highway (SH) network is measured with a SCRIM+ (Sideway- Force Coefficient Routine Investigation Machine). This equipment measures both friction (the SCRIM reading) and macrotexture. The SCRIM reading is corrected for an SFC factor, survey speed and temperature to provide a SCRIM coefficient (SC). This is normalised for within-year and between-year seasonal variations in the SC to produce an equilibrium SCRIM coefficient (ESC)

3.2 Investigatory levels

The investigatory level for skid resistance (IL) and the investigatory level for macrotexture (ILM) are skid resistance maintenance priority levels set with two objectives:

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

2 To provide an economic balance between the cost of achieving the skid resistance and the crash savings.

3.3 Threshold levels

The threshold level for skid resistance (TL) and the threshold level for macrotexture (TLM) are skid resistance maintenance trigger levels set with the following criteria:

- the TL is a skid resistance level 0.1(ESC units) below the IL or 0.30, whichever is higher.
- TLMs are defined in section 5: Investigatory levels: macrotexture.

4 Investigatory levels: skid resistance

The investigatory levels for skid resistance (ILs) in units of ESC with associated site descriptions are set out in table 1.

The defaults ILs are the black areas for all site categories except for the rural curves shown in site categories 2b and 2c. The greyed boxes either side of the black area indicate alternative ILs that may be considered when amending ILs in accordance with section 14. For site categories 2b and 2c, the ILs have white letters (L, M and H) inside the greyed areas which represent the IL for low, medium and high-risk sites. Each 10m length of the state highway network has been allocated a default IL (units ESC) based on:

- the information in table 1
- data collected during the 2009/10 high-speed data collection survey
- the NZTA's curve risk analysis policy.

This has been entered into the Road Assessment and Maintenance and Management system (RAMM) in the tables 'Skid baseline event' and 'Skid baseline IL'. More detailed information on the curves can be found in the 'Curve context table.'

A link to an online paper on Curve Risk Analysis is included in the T10 Notes.

It is important that the default ILs are confirmed by investigation, see section 14.1 for more information.

Table 1 Skid resistance investigatory levels

Site category	Skid site description	Investigatory level (IL), units 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. One lane bridges: a) 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	L	M	H	
	a) Down gradients >10%. b) On ramps with ramp metering.						
3	a) State highway approach to a local road junction. b) Down gradients 5–10% c) Motorway junction area including on/off Ramps d) Roundabouts, circular section only.						
4	Undivided carriageways (event-free).						
5	Divided carriageways (event-free).						

Notes to Table 1:

- when using seasonally corrected data, ILs are for mean skidding resistance within the appropriate averaging length. This is referred to as the Skid Assessment Length (SAL). The SAL for each site category is detailed in table 2
- the curve risk rating on rural curves with radii 0-400m is shown as H, M or L (high, medium or low-risk curves) in the appropriate greyed IL band under site categories 2b and 2c. Two options are available for rural low-risk sites with radii between 250m and 400m. Urban curves with a radius less than 250m are site category 2a
- the units for IL in table 1 are ESC, being the average of the left and right wheelpaths. 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
- where the length of the feature is less than the SAL, the actual length shall be averaged and considered.

Table 2 Skid assessment length

Site category	Skid site description	Skid assessment length (SAL) metres
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 One lane bridges: a) Approaches and bridge deck.	60
2	a) Urban curves <250m radius b) Rural curves <250m radius c) Rural curves 250–400m radius d) Down gradients >10%. e) On ramps with ramp metering	50
3a	State highway approach to a local road junction.	60
3b and 3c	Down gradients 5 – 10% Motorway junction area including on/off ramps	50
3d	Roundabouts, circular section only.	10
4	Undivided carriageways (event-free).	100
5	Divided carriageways (event-free).	100

5 Investigatory levels: macrotexture

Macrotexture is required for two reasons:

1. To minimise the progressive loss of skid resistance with increasing speed on wet roads. This applies to all surfacings.
2. To prevent or minimise the loss of skid resistance due to contact between vehicle tyres and bitumen. This applies primarily to chipseal surfacings.

Table 3 combines these two aspects of skid resistance. The variables are surfacing type (chipseal or asphaltic concrete) and vehicle speed, where the permanent speed limit is used as the indicator of vehicle speed.

Table 3 Minimum macrotexture requirements

Minimum macrotexture – mean profile depth (MPD mm)				
Permanent speed limit	**Chipseal**		**Asphaltic concrete**	
	ILM	**TLM**	**ILM**	**TLM**
50km/h and less	1.0	0.7	0.5	0.5
Less than or equal to 70km/h but >50km/h	1.0	0.7	0.7	0.5
Greater than 70km/h	1.0	0.7	0.9	0.7

Notes to Table 3

- for existing asphaltic concrete in urban areas, judgement (see definition in appendix A) should be exercised before maintenance is undertaken to increase the macrotexture (see T10 Notes for guidance)
- for new surfacings in urban areas, the target should be to achieve the requirements of table 3. Where material costs to achieve the specified macrotexture are high, judgement should be exercised when considering a lower macrotexture level to ensure the surfacing achieves an acceptable safety level over its life
- on curves where the advisory speed limit is 45km/h or less, consideration may be given to the use of ILM and TLM (as per table 3) for asphaltic concrete where the permanent speed limit is 50km/h and less
- the TLM for chipseals is set at 0.7mm MPD. In urban areas, where the surveyed macrotexture is equal to or higher than required for asphaltic concrete (ie 0.5mm MPD), maintenance to improve the macrotexture may be delayed provided that:
  - the ESC is above TL
  - ESC levels are stable, ie they have not reduced by more than 0.05ESC since the previous annual survey
  - inspections are programmed and resources are available to ensure prompt treatment is undertaken, should macrotexture levels continue to drop.

6 Survey of existing surfacings

An annual survey will be undertaken to measure the SC, macrotexture and other factors via the High Speed Data Collection contract. Seasonal correction factors will be calculated for SCs with all information entered into the RAMM database.

6.1 Assessment of sections of network not surveyed

The annual survey will not cover all sections of the network. By default the outer lane (furthest from centreline or median) only (excluding slow vehicle bays) is surveyed.

Where sections of the network are not surveyed, the ESC and macrotexture shall be assessed by comparison of data from adjacent lanes taking into account the surfacing aggregate, surfacing type, surfacing stress, heavy traffic numbers and any surfacing contamination. Where the un-surveyed lanes are not comparable to the adjacent surveyed lanes this assessment should be confirmed by another skid resistance measurement tool (see the T10 Notes, section 11.1: Methodology for confirming the SC or ESC).

7 Exception report

To enable prompt consideration of sections which may have priority for treatment to improve the skid resistance, an exception report will be issued. This lists sections where the SC and/or macrotexture are less than the TL or TLM. The report should be used to consider sites for investigation.

8 Prioritising and investigating sites

8.1 Exception Report prioritisation

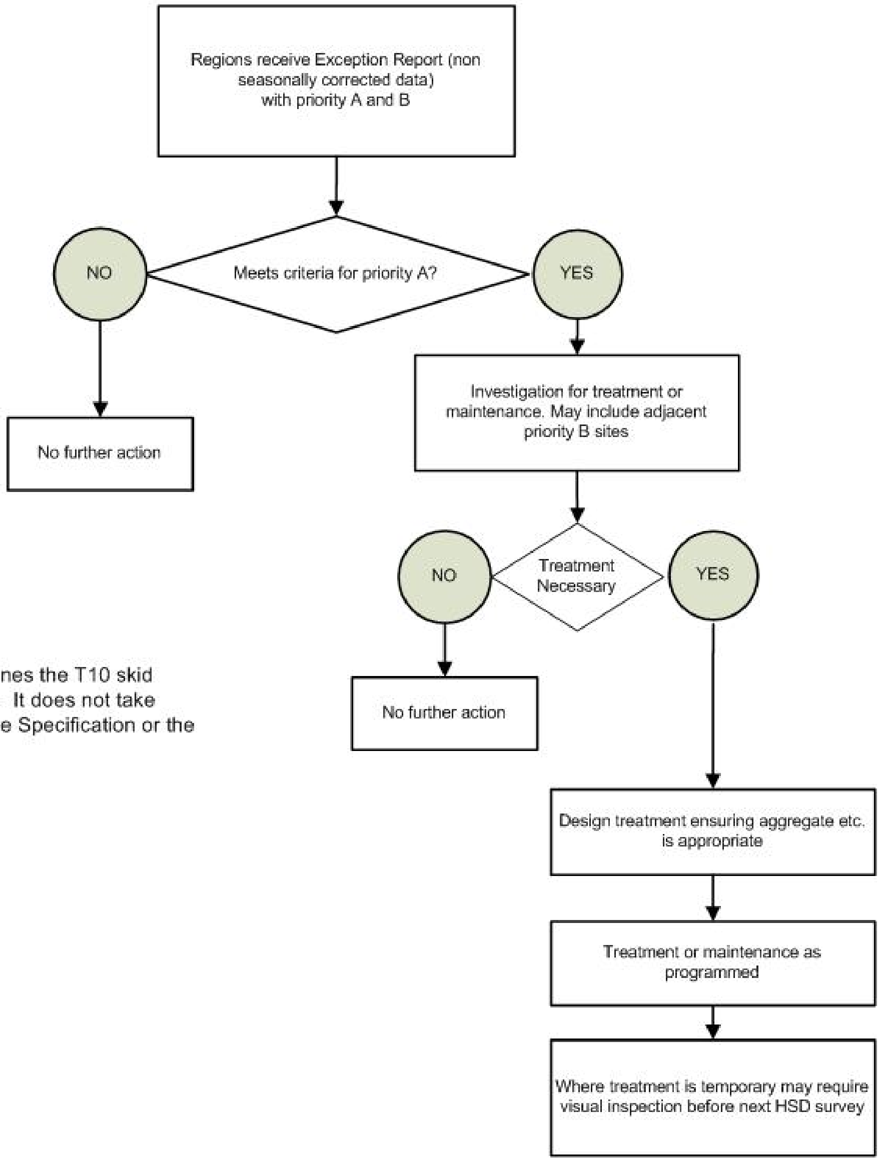
The exception report provides details of 10m sections that are ≤TL or ≤TLM, or both. Each 10m length will be assigned to priority A or B for investigation using the following criteria.

Priority A sites are those that meet at least one of the following criteria:

- sites that are below the TL or the TLM and have had at least two wet skid crashes in the previous five years (any wet crash within 250m of the site, see section 8 in the T10 Notes)
- sites that are flushed (see section 8 in the T10 Notes)
- sites where the SC is low (see section 8 in the T10 Notes).

All other 10m lengths will be assigned to a Priority B.

Skid Resistance Flow Chart:
Exception Report Process



Note:
This flow chart outlines the T10 skid resistance process. It does not take precedence over the Specification or the Notes.

8.1.1 Investigating priority A sites

All sites that are in priority A shall be investigated and where treatment is necessary it shall be designed and programmed. A list of features that should be recorded is included in the T10 Notes.

Some sites may be of a high priority for treatment in which case the treatment should be undertaken as soon as is practicable. On these sites, if the selected treatment is weather dependent, such as sealing, it is important that the treatment is carried out in appropriate weather conditions. This may require the treatment being delayed until the next sealing season. Actions such as the removal of excess binder, eg water blasting and rejuvenating the microtexture eg scabbling or signage, do not tend to be weather dependent.

Priority A sites selected for treatment should be programmed for the following season, if the treatment cannot be carried out in the current survey season.

8.2 Prioritising sites for investigation after seasonal correction

After the skid data has been seasonally corrected, sites that are below the IL or ILM shall be prioritised for investigation using the scoring system in table 4. The ESC and the macrotexture should be averaged over each SAL.

Table 4 Scores for investigation priority, after seasonal correction

Parameter	Scores and criteria
Number of wet skid crashes	One crash zero points, two or more crashes 80 points for each crash.
SCRIM difference (averaged over the SAL)	4 points for each 0.01 between IL and IL-0.05. 10 points for each 0.01 between IL-0.06 and -0.1 15 points for each 0.01 below IL-0.1
Texture difference (averaged over the SAL)	5 points for each 0.1 between ILM-0.1 and ILM-0.3 10 points for each 0.1 when less than ILM-0.3
Annual average daily traffic (AADT)	1 point for each AADT/1,000

The score for each parameter shall be summed for each SAL under consideration, and given a priority from the highest score to the lowest.

The NZTA Regional Operations Manager or their nominee within the NZTA shall confirm the sites to be investigated and these sites should be selected from the highest scoring SALs.

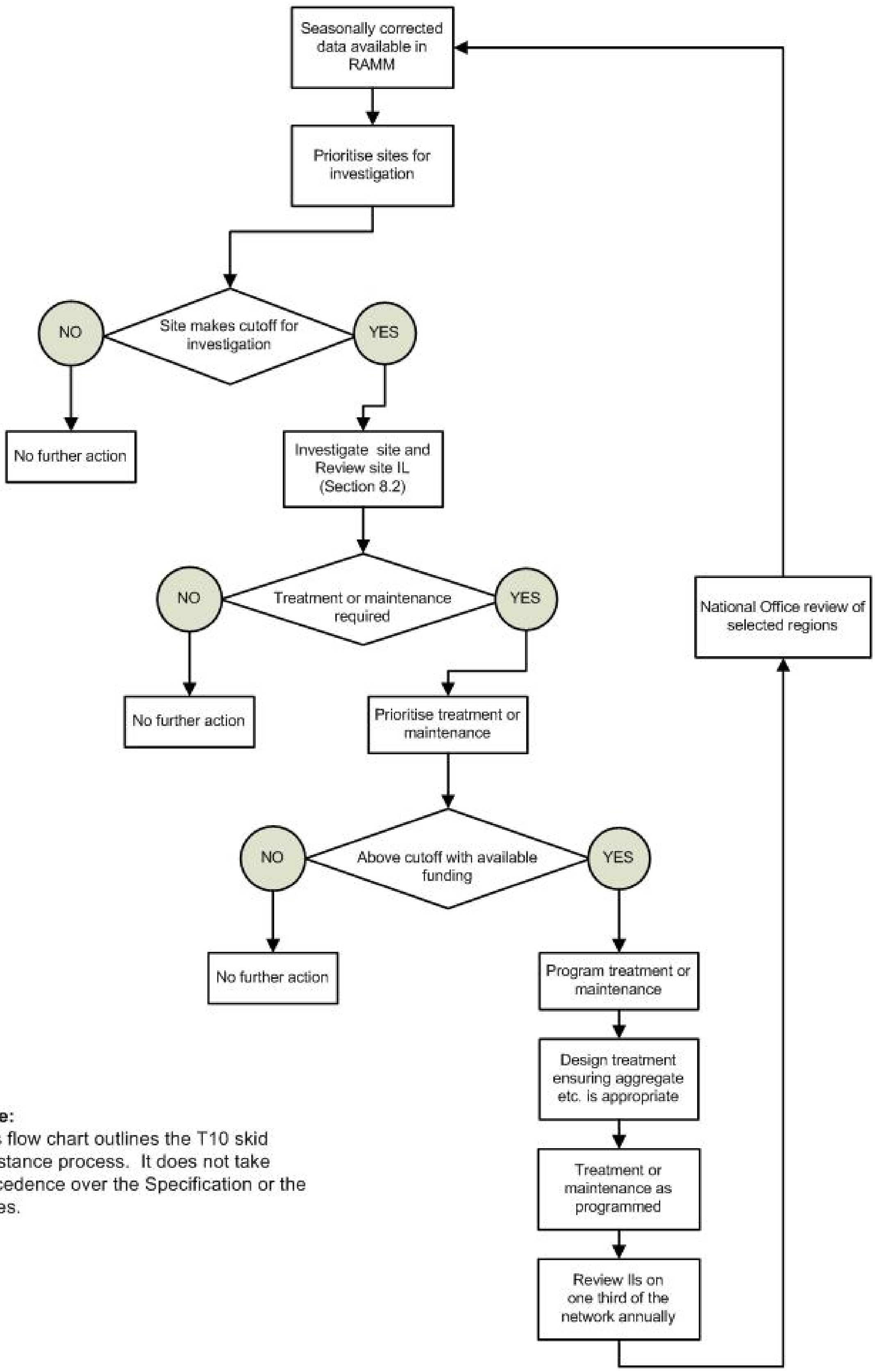
8.3 Investigating sites after seasonal correction

A list of features that should be recorded during the investigation is included in the T10 Notes.

The information from the site investigation and a decision made by the inspector will be recorded. The decision will include recommending one or more of the following:

- a change in the IL, with justification (see section 14: Review of investigatory levels and site categories, and appendix B)
- treatment to improve the skid resistance, with details of what is required and when
- treatment other than for the skid resistance, including reasons why and to whom this information will be communicated to ensure the necessary action is taken
- no treatment, including the reason why.

Skid Resistance Flow Chart:
Seasonally Corrected Data Process



Note:
This flow chart outlines the T10 skid resistance process. It does not take precedence over the Specification or the Notes.

9 Prioritisation of skid resistance maintenance

The sites selected for treatment from the investigation of priority A sites shall be programmed for treatment as soon as is practicable.

For seasonally corrected data the priority should take into account the score achieved from the process in section 8.2, the site features, life of the treatment and the cost.

10 Water blasting and scabbling

Where waterblasting of the surfacing is the selected maintenance, this shall normally be undertaken over the full width of the lane. If only the wheelpaths are waterblasted, the untreated sections of the pavement must be above the ILM and be expected to remain above the TLM.

The assessment of macrotexture may be visual unless the NZTA region requires measurements to be undertaken.

Where scabbling of the surface is the selected maintenance, it shall be undertaken over the full width of the lane.

11 Skid resistance investigations: general

Where skid resistance investigations are undertaken the following shall apply:

- **Staff experience**

  staff carrying out investigations should be experienced in skid resistance, pavement and surfacing engineering

- **Effectiveness of maintenance**

  to ensure the most effective maintenance is chosen, decisions should take into account skid resistance data, previous surfacing history and performance of maintenance undertaken elsewhere.

12 New surfacing

12.1 Surfacing aggregate general

New surfacing design shall include an estimation and recording of the expected life. Records shall be kept of maintenance undertaken, the expected life of the maintenance and actual life.

The fundamental requirement for new surfacing aggregate selection is:

- aggregates should be selected with the objective of maintaining the skid resistance at or above the IL for the design life of the surfacing. Where this is not cost effective, alternative aggregates may be used (see the T10 Notes section 12.6)

12.2 Selection of surfacing aggregate

Surfacing aggregate may be selected by one of two methods:

- aggregate Performance method
- polished Stone Value (PSV) method.

The preferred method for aggregate selection is the aggregate performance method. However, if sufficient information is not available, the PSV method may be approved for use by the NZTA Regional Operations Manager or their nominee within the NZTA.

12.3 Aggregate Performance Method

This method entails the following steps:

1. Using data on the polishing of aggregate (SC or ESC achieved over the life of the surfacing) from the survey data produce a matrix of aggregate performance in a variety of polishing stress situations normalised for heavy traffic. It may include aggregates from other regions.
2. Produce a list of aggregates commonly used in the region, ordered by their resistance to polishing and use the list to select aggregate(s) that meet the requirements of table 1.
3. For a new alignment, assess the traffic and polishing stress and select appropriate aggregate(s).

See the T10 Notes for further guidance.

12.4 Polished stone value method

Using this method, the PSV of the surfacing aggregate shall be equal to or greater than the value calculated from the following equation:

$$PSV = 100*SR + 0.00663*HCV + PSF$$

SR = investigatory level for the site (table 1)

HCV = estimated heavy commercial vehicles per lane per day at the end of the surfacing life

PSF = polishing stress factor selected for the site in accordance with table 5

PSV = polished stone value

Table 5 Polishing stress factors

Polishing stress factor	Site description
3	Site category 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 category 4, straight level road, less than 5,000VPD, very seldom any congestion and few low-volume access points.
4	Site category 4, greater than 5,000VPD, very seldom any congestion, grades < 3%, Site category 3a, state highway approach to a local road junction. Low-risk curves.
5	Site category 4, where congestion may occur or grades ≥ 3% Site category 3b, down gradients 5–10%. Site category 3c, including 200m before off ramps. Urban site category 2 curves.
6	Site category 1, with average approach speeds and infrequent emergency braking. Rural site category 2, curves medium risk.
7	Site category 1, with average braking Rolling country with frequent curves requiring frequent acceleration and deceleration.
8	Site category 1, with frequent heavy braking Site category 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 steeper down grade (≥8%).

The NZTA Regional Operations Manager or their nominee within the NZTA may amend table 5 following discussion with the National Pavements Manager.

12.5 Specification of surfacing aggregate

Where the aggregate has been selected on the basis of the PSV method, the required PSV shall be specified.

Where the aggregate has been specified on the basis of the aggregate performance method, a prioritised list of aggregates based on performance (resistance to polishing) together with the locations where their use will be acceptable will be issued with each surfacing contract.

12.6 Site sampling and testing of surfacing aggregate

Where the quarry PSV of an aggregate is 57 or more, or where the calculated PSV is 57 or more, using the formula in 12.4, sample(s) of surfacing aggregate shall be taken by an NZTA-appointed person independent of the surfacing contractor and aggregate supplier. Note that the PSV test requires aggregate passing a 10mm sieve and retained on a 7.2mm sieve. This can be obtained from aggregate within the grade 4 size range or at the extremes of grade 3 and 5. For asphaltic concrete, the aggregate for PSV testing should be sampled before mixing with bitumen.

- the sampling rate shall be:
  - a minimum of one sample for each surfacing contract where the length of surfacing in a contract does not exceed 10km
  - a sample from each aggregate used in the contract
  - where the length of surfacing in a contract exceeds 10km, total sampling should be at a rate of one sample per 10km, both lane kilometres
- samples shall be tested for PSV and at least one sample in three should be tested for PSV12, see the T10 Notes, appendix B for method
- the NZTA Regional Operations Manager or their nominee within the NZTA shall be responsible for ensuring the data is analysed to compare quarry quoted PSVs with those from samples taken independently, and the data is stored in a systematic manner

The data should be used, together with information on the skid resistance of various sections of the network, to allow informed decisions to be made regarding selection of future surfacing aggregates.

12.7 PSV values from site samples

Should the PSV results from the site sampling provide significantly different values to those shown on the certificate provided by the quarry, this shall be discussed with the quarry and details forwarded to the National Pavements Manager, HNO, National Office.

13 New alignments

Capital projects and road reconstruction shall stipulate an appropriate IL and ILM for both the first coat and any subsequent surfacing. The design ILs and associated aggregates shall be subject to approval by the NZTA Regional Operations Manager or their nominee within the NZTA.

14 Review of investigatory levels and site categories

14.1 Regional review

ILs and site categories shall be reviewed for all sections of the network on at least a three-year cycle. This review will either confirm the IL or identify the reason to amend it. Records shall be kept to enable the decisions to be reviewed.

14.2 Reasons to amend ILs

There may be reasons why ILs should be amended, for example:

- an error in location data – where there is an error in the location data and the relevant site category does not occur at that location
- varying crash risk – ILs may be amended where the current IL is not appropriate for the site under consideration
- a longer length of higher or lower skid resistance is required. Eg long queues at traffic signals or insufficient braking length exists before 800m radius on sharp curves.

14.3 Recording of amended ILs

In both the above situations the NZTA Regional Operations Manager or their nominee within the NZTA should arrange for the correct data to be entered into the RAMM database together with the reason for the amendment. Further guidance on the process for recording changes to ILs is given in the T10 Notes.

14.4 Scope for amending ILs

The current ILs may be amended within the greyed bands indicated in table 1 of this specification and the value may be moved up or down, within these limits. For rural curves the risk may be amended which will change the IL. Additional guidance is given in appendix B.

When considering increasing the IL above 0.55, the full costs and benefits of this strategy must be taken into account.

14.5 Approval of amendments

Before entering changes or confirming current data the decisions shall be approved by the NZTA Regional Operations Manager or their nominee within the NZTA, following consultation with the regional principal Safety Engineer.

15 National Office review

HNO National Office will review a sample of all networks to confirm that the skid resistance process, programme and allocation of ILs are appropriate.

Appendix A: Glossary

AADT: Average annual daily traffic.

Asphaltic concrete: A mixture of bituminous binder and aggregate with or without mineral filler produced in a mixing plant. It includes cape, slurry seals etc.

Bleeding: Bleeding occurs on a flushed surface where the viscosity of the binder is low, resulting in pick up of bitumen by vehicle tyres (see also Flushing).

Curve Risk Analysis: A risk rating procedure for rural horizontal curves (≤400m radius) based on a crash prediction model that takes into account the curve geometry, approach gradient, the degree to which the curve speed is out of context with the approach speed, the AADT and the curve length.

Equilibrium SCRIM coefficient (ESC): SCRIM coefficient (SC) adjusted for within-year and between-year variations.

Flushing: A pavement surface defect (or end of life condition) in which the binder is near or above the uppermost surface of aggregate particles resulting in contact between vehicle tyres and the bitumen (see also Bleeding above).

Global positioning system (GPS): A satellite-based location referencing system.

High-speed data collection: The contract to collect annual pavement condition data at near maximum traffic speed.

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

Judgement: In this specification, where judgement is required the decision(s) should be briefly documented.

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

Maintenance: In the context of this specification, maintenance is an action to improve the skid resistance of the surfacing (see also 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): The mean SCRIM coefficient (SC) over the summer period.

Microtexture: An aggregate surface characteristic having wavelength components less than 0.5mm, formed by 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, among other functions, the management and maintenance of the state highway network.

Polished stone value (PSV): A measure of the level of polishing resistance of surfacing aggregate under standard laboratory conditions. It is designed to indicate the resistance to polishing for road surfacing aggregate.

PSV12: An extension of the standard PSV test where emery flour polishing (fine polishing) is continued up to 12 hours. The test method is described in appendix C of the T10 Notes.

Polishing: An action in which the uppermost surface of aggregate loses microtexture, or becomes smooth as a result of the abrasion effect of traffic, reducing the available skid resistance between the road surface and a 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 record 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 the skid resistance of roads under wet conditions. The New Zealand machines are capable of testing both wheelpaths of long lengths of road at near maximum traffic speed and are designated SCRIM+. The '+' refers to additional instrumentation to measure macrotexture, roughness, rutting, gradient, curvature and GPS location.

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

Sideway-force coefficient (SFC): The ratio of the force developed at right angles to the plane of the test wheel (the sideways force) to the load on the wheel.

SFC factor: A correction factor to convert the readings collected by the latter day SCRIM to those of the early machines, which collected sideways force measurements. The SFC factor is 0.78.

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

Skid assessment length (SAL): A length of lane over which ESC data may be averaged to assess priority for investigation using seasonally corrected data.

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

Skid site: A section of network that has a uniform demand for skid resistance and a single investigatory level (see table 1).

Skid site length: The length of a single skid site.

Skid Technical Advisory Group (STAG): The group responsible for providing technical advice on skid resistance policies and initiatives within the NZTA.

T10 Specification: Specification for state highway skid resistance management.

T10 Notes: T10 Notes to: Specification for state highway skid resistance management

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Threshold level (TL): A trigger level of skid resistance for determining priority for programming treatment.

Threshold level macrotexture (TLM): A trigger level of macrotexture for determining priority for programming treatment

Tracking: Temporary contamination caused by the deposition of binder on the road surface from a source of bleeding (see also bleeding).

Treatment: In the context of this specification, 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 (see also Maintenance).

Treated (same) direction: For passing lanes etc, the treated direction is the direction of travel when using the passing lane. Untreated is the opposite direction. Upstream and downstream refer to the location relative to the passing lane etc, when using the passing lane and may refer to pavement on both sides of the centreline.

Urban and rural: Sections of the network where the legal speed limit is 70km/h or less are designated urban. The remainder of the network is rural.

Waterblasting: A process where very high pressure water is sprayed in small quantities to remove bitumen from between the surfacing aggregate. This process is also often known as watercutting.

Wet skid crash: Any crash occurring on a wet road where increasing the skid resistance may have reduced the probability of the crash occurring or reduced the severity of the crash. In the context of this specification, it refers to a crash within 250m of the site being considered.

Appendix B: Guidance for amending investigatory levels

Site category 1

Site cat.	Definition	Guidance for amending 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 and train is visible from long distance away • Low speed limit approaches, eg less than 60km/h and train is visible from long distance away • Train always crosses road slowly.
1b	Traffic signals	Increase: • Speed limit is greater than 50km/h • Higher than average fatal and serious crash record • Multilane approaches. Decrease • No pedestrians • Where the crash risk has been mitigated.
1c	Pedestrian crossings	Increase: • Higher traffic or pedestrian volumes. • Intermittent high pedestrian volumes (eg near schools, preschools, colleges, hospitals) • Multilane 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 for the approaches to roundabouts. The circulating portion of the roundabout is site category 3 with a default IL of 0.45	Increase: • Speed limit is 70km/h 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 50km/h 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 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 category 1. Increase IL: • Speed limit approaching control greater than 60km/h • Lower sight distance for approach to control. Decrease: • Very low traffic volumes on side road approach leg.

Site cat.	Definition	Guidance for amending IL from default value
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.

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Site category 2

Site cat.	Definition	Guidance for amending 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). 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 • Curve not readily readable, ie 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 • A forgiving roadside environment with low risk of serious injury • Low speed environment of ≤50km/h • The curve is very readable and self explanatory • The crash risk is successfully mitigated by other safety measures • The estimates for approach speed or curve speed are clearly incorrect. (Noting the curve speed is the same for both directions and is the higher value. Also the approach speed used is the higher value.)
	Curves located near to works/features that alter the downstream and/or upstream speed environment (as an alternative to improved signs and markings).	Consider increase for the following situations: • Climbing lanes and passing lanes (both fitted to existing road alignment (tack-on) and within larger realignment works): – up to 2km downstream of merge taper end for both directions of travel – 2–4km downstream of merge taper end in the treated (same) direction of travel – up to 2km upstream of diverge taper start in the untreated (opposite) direction. • Slow vehicle bays (SVBs) – up to 2km downstream of end of merge taper end in same direction. • Lengths of diagonally marked shoulders used for passing (not for corner widening/accesses) – up to 2km downstream of end of markings in same direction. • Realignments with increased overtaking opportunities (not passing lanes, slow vehicle bays (SVBs) or marked shoulders) – up to 2km downstream after the end of the straight in each direction of travel.
2d	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	Guidance for amending 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, eg through lane immediately before an off ramp. Detailed investigation should be undertaken to identify features common to the motorway network in the region, ie queuing traffic and treat all similar areas to a consistent standard.

Site category 4

Site cat.	Description	Guidance for amending IL from default value
4	Undivided carriageways, event free.	This is the largest site category on the state highway network. Generally the IL should not be reduced to below the default value of 0.40. The NZTA Regional Operations Manager or their nominee within the NZTA 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 traffic volumes at intersections result in the need for more braking or a record of rear-end crashes.

Site category 5

Site cat.	Description	Guidance for amending IL from default value
5	Divided carriageways, event free.	See earlier note that TL should not be below 0.30. 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.