Procedure for the Management of Skid Resistance of Road Surfaces on the County Road Network
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GLOSSARY OF TERMS

The terms used within this report are defined in the Glossary below; this is not an exhaustive list.

**SCoRIM Coefficient (SC)**

A SCoRIM reading that has been corrected for all factors except seasonal effects.

**Investigatory Level**

The level of skid resistance at or below which a site investigation is to be undertaken.

**Equilibrium Correction Factor Area**

A group of road sections within a locality that is used to provide the Equilibrium Correction Factor.

**Mean Summer SCoRIM Coefficient**

The mean of three SC’s measured for the same length of road at reasonably well spaced intervals during the full summer testing.

**Equilibrium SCoRIM Coefficient (ESC)**

The ESC is the mean of the SC’s over three years.

**Equilibrium Correction Factor (ECF)**

The ECF is the ESC divided by the mean SC for an ECF area...

**Seasonal Adjustment Factor (SAF)**

The SAF is equivalent to the ECF except that it is obtained from the Seasonal Control sites rather than from the main run.

**Characteristic SCoRIM Coefficient (CSC)**

The skid resistance value that has been corrected for within year and between year seasonal variations and is obtained by multiplying the 10m SC’s by the appropriate ECF.
1.0 INTRODUCTION

Following the study to review the skid resistance intervention criteria for the Highways Agency Trunk Road Network by TRL, a revised list of Investigatory Levels (IL) and recommendations were proposed. The results from the study by WDM and TRL have been used to revise the section dealing with skid resistance in the Design Manual for Roads and Bridges, Volume 7, Section 3 referred to as HD28/04. The changes to HD28/04 are intended to meet the broad requirements of trunk road systems for England, Scotland and Wales but not to address the detailed procedures or methodology statements necessary to provide the level of guidance that will ensure consistency of application by agents outside of the organisations that manage the Trunk Road.

This document sets out to provide clear unambiguous procedures for the management of the skid resistance of the road surface for Cornwall County Council. Although this document is based on the new HD 28/04 and HD 36/06 documents, the results from a separate study that compared the wet accident rates against the skid resistance indicated that changes should be made to the investigatory levels specified in HD 28/04 to optimise the risks for the Cornwall local roads. In addition there are occasions where certain parts of the HD 28/04 standard are not considered appropriate for the Cornwall local roads, in these cases the areas of the standard that are considered inappropriate have been clearly identified and the rational for not following the standard has been provided. Nevertheless, the ultimate responsibility for the allocation of site category and investigatory level can never be identified from guidance documents but can only be decided from a risk assessment of the particular characteristics and information defining a particular location. This is discussed further in Section 5.

2.0 BACKGROUND TO SKID RESISTANCE

It has been known for a long time that improving the wet road skid resistance of a road can reduce the risk of certain types of accidents and many countries have a policy of measuring and setting minimum standards for the skid resistance of roads in the wet.

Almost all dry road surfaces where the aggregate is exposed have a relatively high skid resistance which is adequate for the frictional demands arising from the routine braking, accelerating and manoeuvring of vehicles which are driven within the speed limit of the road. However, the skid resistance can fall significantly when the road is wet and can be reduced to a level where there is insufficient friction generated to avoid skidding even during routine manoeuvring. In emergency situations where the frictional demand is much greater where, for example, a driver brakes sharply or swerves to avoid a collision, or where a driver attempts to negotiate a bend at too high a speed the risks of a skidding accident are far greater in the wet than the dry. However, when skidding does occur and an accident results, it can rarely be said that only low skid resistance is the cause of the accident. The primary cause is almost always a combination of factors – driver error, poor visibility, excessive speed, poor signing, etc. These factors increase the demand for high friction. A high skid resistance will not prevent the emergency braking situation from arising or improve driver judgment, but it can often alleviate the effects of driver error and reduce the risk of an accident occurring or at least reduce the severity of a collision. This will not
only reduce the amount of suffering but also save considerable costs to the community.

There are, therefore, compelling reasons for Local Highway Authorities to introduce a skid policy to ensure wet road skid resistance is adequate because, not only will it reduce accidents, but it also produces very high rates of return on funds invested.

2.1 Relationship between Wet Road Skid Resistance and Accidents

Research has shown that as the wet road skid resistance of a road surface decreases the rate of wet skidding accidents increase. It has also been found that different sites present different risks of accidents occurring in the wet. Consequently, to obtain a constant risk of wet skidding accidents across a road network, the skid resistance at a site needs to be aligned to the risk.

Using this approach, it was found possible to establish a number of site categories that described the range of situations found on a road network and to identify relationships between wet skidding accident risk and wet skidding resistance values at each of the site categories. These relationships were used to define an investigatory level below which the risk of wet skidding accidents could be expected to rise for each site category.

3.0 ROAD FACTORS INFLUENCING WET ROAD SKID RESISTANCE

While it is recognised that there are great many variables involved in skidding accidents only the road factors are dealt with in this document.

The principal surface related factors influencing wet-road skid resistance are the materials used in the road surface, the depth of surface water, vehicle speed and traffic intensity and the annual cycle of weather conditions (seasonal effects). An explanation of how these factors affect the wet road skid resistance is given in Appendix 1. An understanding of the information presented in the appendix is important in producing the most cost effective programme of treatments and will assist in implementing the skid policy.

4.0 IMPLEMENTATION OF THE CHANGES IN HD28/04

The introduction of HD28/04 has not changed the process described in its predecessor but it has provided a more structured approach and it does provide greater guidance on the decision making process. This document provides additional guidance and tailors the requirements to Cornwall County Council. In addition, the results from a study carried out on the Cornwall local road network to determine optimum default investigatory levels for each site category have been incorporated. The overall process is described in the following sections and is shown diagrammatically in Figure 1. The overview in Figure 1 outlines the cyclical nature of the process which involves annual surveys to identify sites requiring investigation, a procedure to ensure that an outcome is identified and implemented and, if the outcome is to do nothing until the next set of data is available the justification for that decision is documented.
5.0 SKID RESISTANCE INVESTIGATORY LEVELS

5.1 Background

The previous SCRIM Investigatory Levels specified in HD 28/94 in Volume 7 of the Manual for Roads and Bridges (DMRB) were established in the 1980's and included in the first publication of the HD, No15, in 1987.

Since that time, there have been significant changes in the levels of traffic flow, the composition of the type of vehicles included in the traffic flow and the speed that vehicles can achieve.

As discussed in the introduction, the two major reviews of the investigatory levels carried out led to one set of revised SCRIM Investigatory Levels, published in HD 28/04, that could be used for the Trunk roads in England, Scotland and Wales. Additional guidance, as outlined in this document, is required to appropriately apply the new standard to local roads.

5.2 Revised SCRIM Investigatory Levels (HD28/04)

The revised Investigatory levels for HD 28/04 are shown in Table 1

5.2.1 Generic Changes

There are two primary changes to the Investigatory Levels which are:

- the IL’s now cover a range for each category rather than single values plus a risk assessment rating;
- there are no longer IL’s for 20 km/h testing for roundabouts and bends with radii of less than 100m. The target survey speed for these sites is now 50 km/h.

5.2.2 Specific Changes

The specific consequences of the review of the Investigatory Levels are:

- Categories A (motorway), B (Dual non event), C (single non event), G1 (Gradients 5% -10%), G2 (Gradients > 10%) and corresponding ILs are unchanged.
- Categories H1 (Bends < 250m radius) and H2 (Bends < 100M radius) have been reassigned to new categories S1 (if dual c/way) or S2 (if single c/way), with default IL 0.55 and 0.55, respectively.
- Category L (Roundabouts @ 20 km/hr) have become new category R (Roundabouts @ 50 km/hr) with default IL of 0.50
- Categories D (Dual Minor Junctions), E (Single Minor Junctions), F (Major Junctions)
- J (Approach to Roundabouts) have become new category Q. The default IL is 0.50
- Category K (Approach to crossings and other high risk situations etc). The default IL is 0.55
The comparison between the previous and the revised IL’s are shown in Table 2

<table>
<thead>
<tr>
<th>Site category and definition</th>
<th>Investigatory level at 50km/h</th>
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<tr>
<td></td>
<td>0.30</td>
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<tr>
<td>A  Motorway class</td>
<td></td>
</tr>
<tr>
<td>B  Dual carriageway non-event</td>
<td></td>
</tr>
<tr>
<td>C  Single carriageway non-event</td>
<td></td>
</tr>
<tr>
<td>Q  Approaches to and across minor and major junctions, approaches to roundabouts</td>
<td></td>
</tr>
<tr>
<td>K  Approaches to pedestrian crossings and other high risk situations</td>
<td></td>
</tr>
<tr>
<td>R  Roundabout</td>
<td></td>
</tr>
<tr>
<td>G1  Gradient 5-10% longer than 50m</td>
<td></td>
</tr>
<tr>
<td>G2  Gradient &gt;=10% longer than 50m</td>
<td></td>
</tr>
<tr>
<td>S1  Bend radius &lt;500m – dual carriageway</td>
<td></td>
</tr>
<tr>
<td>S2  Bend radius &lt;500m – single carriageway</td>
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5.2.3 Changes to the Investigatory Levels for Cornwall CC

The investigatory levels in Table 1 have been developed for the trunk road & motorway network, consequently Cornwall commissioned a study to compare the wet accident rate at various skid resistances at different site categories. The results from this study provided the information to set investigatory levels for each of the site categories for the local road in Cornwall. The revised IL’s are shown in Table 2. It was found from the study that the accident rates were higher:

- on approaches to roundabout than on approaches to junctions
- for bends with radii < 100m than for bends with larger radii

To accommodate these findings the Investigatory Level table for Cornwall has been expanded. The site category Q has been separated into Q1, which refers to approaches to Junctions, and Q2, which refers to approaches to roundabouts. The Bends on single carriageways have been separated into bends that have radii < 100m which are coded S2<100 and bends that have radii >=100m and <250m coded S2>100<250 and bends that have radii >=250m and <=500 coded S2>250<500.
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<tr>
<td>Q1 Approaches to and across minor and major junctions,</td>
<td></td>
</tr>
<tr>
<td>Q2 Approaches to roundabouts</td>
<td></td>
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<tr>
<td>K  Approaches to pedestrian crossings and other high risk situations</td>
<td></td>
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<tr>
<td>R  Roundabout</td>
<td></td>
</tr>
<tr>
<td>G1 Gradient 5-10% longer than 50m</td>
<td></td>
</tr>
<tr>
<td>G2 Gradient &gt;=10% longer than 50m</td>
<td></td>
</tr>
<tr>
<td>S1 Dual carriageway bend radius &lt; 500m</td>
<td></td>
</tr>
<tr>
<td>S2&lt;100 Single carriageway bend radius &lt;100m</td>
<td></td>
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<tr>
<td>S2&gt;100&lt;250. Single carriageway bend radius &gt;100m &lt;250m</td>
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<tr>
<td>S2&gt;250&lt;500. Single carriageway bend radius &gt;250m &lt;500m</td>
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The defaults in the PMS database have been changed to account for the revised IL bands. The same rules have been used for selecting the default values i.e. sites that have a band covering 2 IL’s the lower IL value in the dark band should be used as a default and for sites that have dark bands covering 3 IL’s the middle value should be used as the default.

However, all IL values have been reviewed to determine that the default value reflects the appropriate level of risk for the site. Further IL reviews should be undertaken on a regular basis but not less that every 5 years.

The IL’s for the bends that have radii less than 100m and the IL for roundabouts appear to have been set to reduce the level of skid resistance required but this is not the case. These sites were previously surveyed at 20 km/h resulting in a higher measured SCRIM reading than would be obtained if measured at 50km/h. It has been
estimated that the measurements at 20kph will give values of 0.1 SCRIM Coefficients higher than if measured at 50kph, and this has been taken into account in the revised IL’s.

5.3 Additional Variations to the HD 28/04 Standard

It is suggested that a number of variations to the rules are applied to Cornwall’s site categories to address local interpretation, these are as follows:

- Mini Roundabouts will be treated as junctions.
- School location defined by signed school crossing patrol sites with amber flashing lights will be treated as pedestrian crossings.
- At sites where multiple categories overlap the highest category applies
- The minimum length of bend will be 50m
- In 30mph speed restricted areas where there is a combination of bends and gradients, gradients will take precedence over bends when setting the IL.

5.4 Changes to the Standard that are not Recommended for the Cornwall Local Roads

There are some additional changes related to where the standard applies which are not considered appropriate for the Cornwall local roads. Specifically, it is recommended that the 50m approach to bends and gradients are not included within the policy.

On county roads in areas such as the south west of England a significant proportion of the length of the network surveyed by SCRIM will be categorised as less than 500m radius and or gradient at or above 5%, compared with the proportion on the motorway and trunk road network. The approaches to the bends and gradients will not therefore be so much of a surprise to a driver and unless there is evidence of accidents it is not considered that the approach to bends or gradients present a high risk of wet road skidding. It is also recommended that uphill gradients on dual carriageways should not be classified as category G1 or G2 and that unless there are other events on the site they be classified as category B. It is not considered that there will be an increased risk of a wet skidding accident when a vehicle is travelling up hill on a divided carriageway.

6

6.0 REVIEW OF THE SITE CATEGORIES AND INVESTIGATORY LEVELS

6.1 General

It is stipulated in HD 28/04 that the IL’s should be reviewed on a 3 year rolling programme. However, Cornwall County Council has decided to review on a 5 yearly cycle. Therefore, on average 1/5 of the site categories on the road network need to be reviewed every year. This 1/5 can include all sites that have been investigated during that year. It is important that the review considers increasing, maintaining and decreasing the IL value.
Every part of the network should be assigned to a site category. These site categories may require changing as the network evolves. The Maintenance Assessment Engineer is responsible for establishing the initial site categories and assigning the default IL’s. These will then be reviewed as part of the 5 year rolling programme. The Network changes will be published through GIS and held on the PMS.

A review of site categories will be an essential part of the 5 yearly rolling programme of reviewing the investigatory levels. The review of non-event sites could be carried out using the SCANNER survey videos rather than a site visit to confirm they remain non-event sites. If there is any doubt a site visit should be undertaken. Each site will generally be allocated an Investigatory Level from within the range shown in Table 2. A lower Investigatory Level may be assigned if this is justified by the observed accident record and local risk assessment. It is not recommended that an IL lower than the bottom range be assigned for any site unless there is exceptional and substantial justification. All changes made to either the site category and/or the Investigatory Level shall be recommended by the Highway Asset Manager and signed off by the Head of Policy and Assets. The recommendations and the decisions made will be documented and filed to provide an audit trail justifying the decisions made. In all cases, a site visit is always required to collect the necessary information to justify any change in the IL.

6.2 Reducing the Investigatory Levels

The initial IL’s as implemented by the bulk update are discussed in Section 5.2.3. A reduction in the IL may be warranted depending on overall risk of the site. There will be a number of factors that will influence the choice, some of which are discussed below.

- Low traffic levels.
  Roads carrying say an average daily flow of less than 1000 vehicles per day should, as a guide, be considered as low flow. However, it is also important that rush-hours are taken into account hence the vehicles volume should also be less than 300 vehicles in any one hour. Also, holiday traffic should be considered, and if the volumes increase to greater than 1000 vehicles per day in the holiday period this could be a good reason not to lower the IL since the increase traffic will be occurring when the skid resistance is at its lowest (i.e. in the summer)

- Clear Signing and Reduced Speed Limits.
  If a site is clearly signed and the speed limit has been reduced to mitigate the risk of a hazard then a reduction in the IL may be considered.

- Good visibility
  Where an approach to a hazard is clearly visible within the minimum stopping distance for the appropriate speed limit.

- Secure Layouts.
  Where an approach of a site category has been designed to mitigate the risk, such as an approach to a junction having a separate turning lane for right turning traffic.
If a site is investigated because the skid resistance is below the IL and it is concluded that the IL for the site should be lowered it is important that this happens or the site will be flagged for investigation every year. The wet accident rate at all sites where the IL is lowered should be monitored to ensure the revised risk is warranted and action taken to revise upwards if accidents start to increase or there is evidence of increased risk. To facilitate easy identification of sites under review such sites will initially be assigned a temporary monitoring site category.

6.3 Increasing the Investigatory Level

A number of factors, as listed below, should be taken into account when considering increasing the Investigatory Levels. However, these factors should not be used as absolute rules to increase the IL. If the overall level of risk is judged to be low, e.g. because of low traffic flow or speed, or because the risk has been mitigated by other means, then a higher Investigatory will not be justified.

The factors which may lead to an increase in the IL are:

- High accident rates.
  The most convincing evidence for increasing the Investigatory Level is a history of disproportionately high accident rates for the particular site category. In this case, the information from the accident records should be evaluated to ensure that there is some link between the accidents and the skid resistance to ensure that the appropriate treatment is applied.

- High traffic flows.
  Particularly in high speed areas (50 mph +) where the traffic capacity creates queuing hazards.

- Bends with radius < 500m where traffic speed is high and there are other hazards such as poor geometry.

- Two or more events in proximity, e.g. bends on gradients with junctions etc.

- Roads with busy accesses onto the main carriageway, (e.g. garage entrance/exit), even though garages are not considered site categories they should be taken into account when assessing the overall risk of the area.

- Poor visibility on the approach.

- For non-event categories A-C: approach to slip road leaving main carriageway or downstream merging area following slip road joining main carriageway, may present a hazard except if low traffic flow means that the slip road gives rise to little added conflict between road users, compared with the mainline.

- Roads that have poor geometry.
• For roundabouts: high speed of circulating traffic or high incidence of cyclists or motorcyclists.

7.0 IDENTIFYING AND PRIORITISING SITES FOR INVESTIGATION

7.1 SCRIM Data

All the 2a, 2b and rural 3a hierarchy roads in Cornwall are surveyed each year. In addition, the seasonal control sites are monitored 3 times each year to provide information to allow the main survey data to be corrected for seasonal changes and produce Characteristic SCRIM Coefficients. This data is processed in the PMS for viewing and interrogation.

7.2 Accident Data

The Accident manager module within the PMS allows the user to import accident data, summarise data, perform cluster analysis, and calculate accident rates. The location of the accident data can be linked with location of the skid resistance data.

7.3 Prioritising the Site Investigations

The skid and the accident data can be used to identify sites for investigation by using the SQL query function in the PMS.

Due to the repeatability and reproducibility of the SCRIM survey only sites that have been identified as > 0.05 deficient will be investigated. These sites will be sorted by deficiency level and the number of accidents. Once these lengths of the network have been identified, they should be programmed for site investigation. The site investigation should be prioritised initially on the basis of how much the skid resistance is below the investigatory level but this list should be refined to take into account accident data. Sites where wet or skidding accidents have occurred within a 3 year period should be given priority.

8.0 SITE INVESTIGATION

8.1 Timing

A site investigation will normally be flagged by the skid resistance being at or below the IL but could also be prompted by high accident rates or even anecdotal information from the Police or road users of a possible problem. Sites requiring investigation should be identified as soon as practicable after receipt of the skid resistance survey data or other information.

The site investigations need to be performed in a timely manner and all investigations should ideally be complete prior to the next SCRIM season.

8.2 Carrying out the Site Investigation
The reason for the site investigation is to determine if the existing skidding resistance is causing or is likely to cause a skidding accident problem. It is important to note that site investigations instigated by the operation of a skid policy are not intended to fulfill the same role as accident analysis. The former is attempting to maintain a safe network in an asset management sense while the later is involved with trying to understand the factors that have contributed to a specific accident and what can be done to mitigate those risks at the particular location.

8.3 Preliminary Investigation

All site investigations should be carried out by experienced pavement engineers. An initial (preliminary) investigation should be carried out before a decision is made to perform a secondary investigation. The preliminary assessment should confirm that the conditions of the site fit the data from the PMS. There are many reasons why sites may not require treatment even though the PMS evaluation indicates that the skid resistance is deficient, these include:

- **The skid resistance appears to be incorrect**

  This may be because there was a temporary reduction in the skid resistance not due to the road surface condition but by contamination of the road surface from agricultural usage, clay washed onto the road from the verge, spillages, binder on the surface of the aggregate ‘fatting’ etc. This can become apparent if a section of road is deficient yet a site in the same area with the same category using the same aggregate is above the IL. Further evidence of either a temporary reduction in the skid resistance or possibly the SCRIM data being affected by site conditions i.e. testing in slow moving traffic, temporary roadwork delays is that the skid resistance has been above the IL for many years previously and no significant changes to the traffic has occurred. In these cases, obtain a repeat SCRIM survey of the road as soon as practicable and review the data as a priority.

- **The site category is incorrect**

  The site has been misclassified e.g. the site is listed as an approach to a pedestrian crossing but there is no crossing within 50 metres.

- **The accidents are due to poor geometry or visibility and improving the skid resistance is not likely to affect the accident rate significantly.**

  In this case treatment may be considered to increase the skid resistance but since the skid resistance is not considered the primary cause the benefits are likely to be marginal.

- **The investigatory level of the site should be reduced and once it is, the skid resistance will be above the investigatory level**

  For the situations stated above, a video review may be sufficient to decide on the course of action. If there is any doubt then a site visit should be undertaken.
If there are any concerns noted about a site during the preliminary investigation it must be identified for a secondary investigation. Any suggestion for a change in the IL will automatically prompt a secondary investigation.

8.3.2 Report Requirements from the Preliminary Investigation

The information from the Preliminary Investigation should be recorded by the Site Investigator as part of a site investigation report. The report should include the following details:
- surface characteristics i.e. surface type, age, PSV, etc
- accident records
- does not require further investigation and state the reason
- requires a secondary investigation because:
  - treatment may be required
  - it is believed that the IL should be reduced
  - require a revised site category

All completed preliminary reports will be reviewed by the Highway Asset Manager

8.4 Secondary Investigation

If it is found from the preliminary investigation that the SCRIM data is validated and that treatment may be warranted, then the site will require further assessment to provide the information required for treatment selection and to be able to prioritise the site for maintenance treatment. The information obtained during the secondary investigation should include:

- General condition of the road at the site:
  - Does low skid resistance also coincide with low levels of texture?
  - Are there extreme levels of rut depth that could make ponding of water likely?
  - Do the surface characteristics comply with original design criteria?
  - Is the structural condition adequate to provide a reasonable life for any surface treatment?

- Volume and type of traffic including vulnerable road users:
  - Are the observed traffic speeds appropriate to the nature of the site?
  - What are the types of manoeuvring made at the site and the consequences of not completing them successfully? e.g. potential for head-on or side impact at speed;
  - Is there a need to redesign junction areas to control manoeuvres?
  - Are other road users vulnerable? i.e. pedestrians, cyclists & motorcyclists.

- Road layout:
  - Does the road layout deviate significantly from the current standards for geometric design?

- Visibility:
  - What is the general visibility for the road user?

- Pavement markings:
  - Are the warnings and direction signs appropriate and effective?
  - Are the marking clearly visible?
• Is there reason to increase the IL as indicated in section 6.3?

8.4.1 Outcome from the Secondary Investigation

Sites that are flagged for maintenance will normally require a surface treatment to improve the skid resistance. However, if the site investigation identifies any characteristic of the site or road user behaviour that suggests other road safety measures could be appropriate then the Traffic and Safety Section should be contacted.

Some form of skid resistance treatment is likely to be required if either:-

i) based on an accident analysis, the number of accidents observed is higher than average for the type of site and these accidents are likely to be caused by the skid resistance being too low, or

ii) the nature of the site and the demands of road users mean that a higher accident risk might be expected with the skid resistance at its current value or if it were to fall further before the next measurement. In this case, a preventative treatment can be justified to reduce accident risk.

If it is also found that there is a need for other types of routine maintenance such as reapplication of road markings, cleaning/re-positioning of signs or additional road sweeping, then this should also be addressed.

8.4.2 Report Requirements from the Secondary Investigation

The information from the Secondary Investigation should be included in a report form. The completed form will include the information from the secondary investigation and a list of sites that:

• Recommend a change in the investigatory level, with justification;
• Require treatment to improve the skid resistance, with details of what is required e.g. minimum PSV;
• Require treatment other than for the skid resistance, include reasons why and to whom this information will be communicated to ensure the necessary action is taken;
• Do not require treatment, include reasons why.

There should be a completed assessment form for each site that has been investigated.

8.5 Approval

All forms for Preliminary and Secondary site investigations should be completed and checked by the Highway Asset Manager.

An overall report will be compiled together with a list of recommended actions. This report will be reviewed by the Head of Policy & Assets in conjunction with the Highway
Asset Manager and the Maintenance Assessment Engineer. Any changes to IL’s will be signed off by the Head of Policy and Assets.

Sites identified for treatment will be prioritised as part of the annual surface treatment maintenance programme. Sites not included within the next annual programme and showing a level of deficiency greater than 0.1 will be signed with Slippery Road Signs.

9.0 TREATMENT SELECTION

The treatment selection will be driven by the condition of the road and the current surface. For example, a surface dressing would not be an appropriate treatment for a site that is heavily rutted or for a site where the substrate and adjacent surface is porous asphalt. Section HD 36 of the Design Manual for Roads and Bridge (DMRB) provides a summary of surfacing options available for use on flexible and rigid pavements and advises on the current requirements for surface treatments.

It is important that the treatments are cost effective so the likely design life and the cost for treatments should be considered, as should the probability of success of the selected treatment. The information of the structural and functional life will be available from the PMS and should be considered at each site selected for treatment to ensure that the road will not require other forms of treatment before the end of the design life of the skid resistance treatment, or at least before the benefits of the skid resistance treatments can be realised.

The properties of the aggregate should also be considered, as there is no point in using the same aggregate that was used previously if the site fell below the IL prematurely even if the PSV of the aggregate met the requirements.

9.1

9.2 Polished Stone value

Where sites are to be treated the specified PSV shall be derived from the Guidance note on the selection of aggregates contained in appendix 2.

10.0 PRIORITISATION OF TREATMENT

Since not all treatments can be done at once and there is likely to be insufficient budget to include all deficient sites in the annual maintenance programme, there is a need to prioritise treatments so that the higher risk sites are treated first.

Sites should be given priority for treatment if:

- The accident history indicates there is a disproportionate number of skidding and/or wet accidents.
- The skid resistance is substantially below the Investigatory Level (e.g. >0.05 units below the IL);
- The skid resistance is below the IL and the site has low texture (e.g. <0.6mm)
Factors Affecting the Skid Resistance of the Road Surface

The factors affecting the wet road skid resistance include:

- Microtexture and macrotexture
- Water film thickness
- Seasonal variation
- Aggregate properties
- Vehicle speed
- Age of road surface
- Traffic intensity

A 1.0 Microtexture and Macrotexture

Wet-road skid resistance is the coefficient of dynamic friction between a tyre and the road surface. It is influenced by texture on two scales macrotexture, and microtexture.

- Macrotexture is the overall texture of the road surface and is given by the spaces in-between the stone aggregate. Macrotexture is often referred to as the texture depth.
- Microtexture refers to the small texture on the surface of each of the stones

This is shown diagrammatically in Figure 1.

Figure 1. Diagrammatic Picture of Macrotexture and Microtexture

Figure 2 shows the interface between a moving tyre and a wet road. When a vehicle is running on a wet road surface it is necessary for the layer of water between the tyre and the road to be dispersed before dry contact can be established and adhesive forces developed. There are three distinct regions at the tyre/road interface. In zone 1, at the leading edge of the tyre, the bulk of the water is...
dispersed, leaving a thin film which can be penetrated in zone 2 by some of the surface asperities, with substantially dry contact being achieved in zone 3. It is the microtexture that is most effective in breaking through thin water films to achieve dry contact.

**Figure 2. Tyre Interface on a Wet Road**

At slow vehicle speeds the bulk water is readily dispersed, zone 3 (the area of dry contact) is large and the maximum adhesive force can be developed. As the vehicle speed increases, there is less time available for the removal of the water and zone 3 becomes smaller, with a consequent reduction in adhesive force. The reduction can be minimised by providing drainage channels to facilitate the removal of bulk water. One way of doing this is to provide drainage grooves in the tyre tread. A more effective way is to provide high macrotexture which not only provides drainage paths, but also produces greater tyre deformations. Vehicle tyres are not perfectly elastic therefore some energy is dissipated between the tyre being deformed by the macrotexture and the rebounding back. This imperfect elastic recovery is known as hysteresis and helps to reduce braking distances in both wet and dry conditions.

At all vehicle speeds, the influence of microtexture is important. At low speeds (up to about 50km/h) it is the predominant influence. As the vehicle speeds increase the macrotexture becomes increasingly important. If a vehicle increases its speed from 50km/h to 130km/h on a conventional bituminous surface with texture depth of 0.5mm, there is a reduction of about 30% in skid resistance, whereas for a texture depth of 2.0mm there is very little reduction. This is illustrated in Figure 3.
A 2.0  Vehicle Speed

Since the removal of bulk water between the tyre and the road is a time-dependent process, the area of dry contact decreases as the vehicle speed increases, with a consequent decrease in the effective skid resistance. The rate at which the skid resistance reduces with increasing speed depends mainly upon the macrotexture.

A 3.0  Water Film Thickness

When a road surface passes from a dry to a slightly wet condition, there is a sharp reduction in the skid resistance because of the presence of the water film. As the thickness of the water film increases, the skid resistance decreases further, but at a much less rapid rate. In measuring skid resistance, a water film of thickness of about 0.5mm is used for SCRIM.

A 4.0  Age of Road Surface

Almost all new road surfaces constructed with crushed aggregate have a high skid resistance because the exposed aggregate particles have good microtexture and sharp edges. However, under the polishing action of vehicle tyres microtexture is reduced, the edges become worn and the skid resistance falls. Eventually the skid resistance stabilises at an equilibrium level as shown in Figure 4, thereafter only small fluctuations occur, providing the traffic level remains constant and there is no structural or other deterioration of the surface. The time to reach the equilibrium state is related to the amount of traffic and can range from 6 months to several years to reach equilibrium. There is also a steady deterioration in macrotexture on road surfacings as aggregate particles are either embedded or worn away due to the abrasive action of the traffic.
A 5.0 Seasonal Variation

Once a surface has polished to an equilibrium level the skid resistance, usually within 12 months, the skid resistance fluctuates due to seasonal effects and tends to increase in the winter and decrease in the summer.

UK studies have shown that the variation is due mainly to seasonal changes in the grading of the abrasive material lying on the road or embedded in vehicle tyres. During the summer months, particularly during long dry spells the small chips of aggregate are continually ground down to produce very fine flour and it acts as a polishing agent. During times of prolonged rain (winter months) the very fine material is leached away leaving the coarser grit which provides an abrasive rather than a polishing action and consequently increases the skid resistance of the surface by replenishing the microtexture. Natural weathering of the aggregate particles due to prolonged wetting and frost action also contributes to the improvement in microtexture during the winter months. Seasonal variation has been reported to occur to a greater degree on the more heavily-trafficked roads.

A 5.1 The Effects of Seasonal Variations on Measuring Skid Resistance

As discussed wet road skid resistance varies throughout the year, with the lowest values occurring towards the end of the summer and the highest values during the winter. To minimise this seasonal effect, skid testing is limited to the summer months each year.

Nevertheless, this within year, or more correctly within summer, variation means that parts of the highway tested at different times during the summer can record different levels of wet road skid resistance even if, had they been tested on the same day, the values would be identical. The “within year” variation could therefore lead to an inefficient use of maintenance resources because those sections tested towards the
end of the summer would be more likely to be identified for treatment than those tested early or late in the summer.

A 5.2 Mean Summer SCRIM Coefficient

The skid resistance of a surface varies within the year. To minimise the “within year” variation control sites have been established on the A390.

The control sites are tested three times each summer and the measurements used to give a Mean Summer SCRIM Coefficient for each site. The three surveys are spread across the summer season. The procedure is shown diagrammatically in Figure 5.

Figure 5. Mean Summer SCRIM Coefficient

![Diagram showing Mean Summer SCRIM Coefficient](image)

The results from the seasonal sites allow network measurements to be corrected to an equivalent Mean Summer SCRIM Coefficient regardless of when the network was tested.

A 5.2.1 Problems Associated with the MSSC Method

The results from the seasonal sites allow network measurements to be corrected to an equivalent Mean Summer SCRIM Coefficient regardless of when the network was tested.

However, the MSSC method does not take into account the variation between the years. Figure 6 shows the results of skid resistance measurements taken on a monthly basis for 11 years. This figure shows quite clearly that the skid resistance not only varies within the year but also between years. This variation between years tends to be caused by variations in the climate. For example, 1959 has a low MSSC and would be caused by an atypically dry year whereas 1963 has a high MSSC and would represent an atypically wet year.
If the variation between the years is not taken into account, the following problems occur:

- In a year when MSSC levels are exceptionally low (dry years), some sites will be wrongly identified as Deficient and will be resurfaced unnecessarily;

- In a year when the MSSC is exceptionally high, some sites would not be treated when, on a typical year they would. This is a critical condition because under these circumstances sites will not be identified that in a normal year could fall below the investigatory levels established. If the following year were a normal or dryer than normal year, road users would be exposed to a higher risk of wet road skid resistance than is considered acceptable.

- It is extremely difficult to determine reliable trends in skid resistance, or to assess the effectiveness of the general skid resistance management procedures, because of the between-year variation.

A.5.3 Equilibrium SCRIM Coefficient

The HA has been aware of this between year variation for a number of years and has used a strategy to overcome the problems associated with between year variations referred to as the Equilibrium SCRIM Coefficient (ESC) method.

The ESC procedure provides correction factors to account for seasonal variations for both within year and between years. The correction factor is called the Equilibrium Correction Factor (ECF). The ESC’s are obtained from using the seasonal correction sites. The average MSSC is calculated each year and the ESC is the mean of the three previous annual MSSC’s. This ESC is used to produce an ECF for the fourth year. The fourth year MSSC’s are corrected for between year variations by multiplying by the Equilibrium Correction Factor. This is shown diagrammatically in Figure 7.
Figure 7. CSC Procedure

NEW STRATEGY (CSC METHOD)

Characteristic SCRIM Coefficient is the MSSC value multiplied by an Equilibrium Correction Factor

The equilibrium correction factor is calculated for each seasonal site and is applied to individual 10-metre SC values

<table>
<thead>
<tr>
<th>SCRM COEFFICIENT</th>
<th>0.20</th>
<th>0.30</th>
<th>0.40</th>
<th>0.50</th>
<th>0.60</th>
<th>0.70</th>
</tr>
</thead>
</table>

The advantages of using the ESC method include the following:

- both the within year and between year seasonal variation will be corrected;
- the greater accuracy in the targeting of deficient sites for investigation and treatment will lead to better use of maintenance funds;
- CSC will be a more stable performance parameter than MSSC and will enable more accurate year-on-year comparisons of proportion deficient to be made;

A 6.0 Traffic Intensity

The extent to which a road surface becomes polished is directly related to the traffic intensity. Consequently, a transverse profile of skid resistance will reveal lower levels in the wheel tracks and, on an otherwise uniform surface, a longitudinal profile will show that levels are lower where there are additional stresses due to vehicles braking or turning. As might be expected, heavy commercial vehicles have a greater polishing action than other vehicles. It has been shown that on bituminous surfacings there is a highly significant correlation between commercial vehicle traffic flow and equilibrium skid resistance. Figure 8 shows the change in skid resistance of a road surface resulting from a by-pass which reduced the numbers of commercial vehicles per day.
A 7.0 Aggregate Properties

For bituminous surfacings, the polishing resistance of the aggregate particles exposed at the surface of the road is the most important factor influencing the microtexture and hence the skid resistance. The exposed aggregate requires a good resistance to polishing. Resistance to abrasion is also important since macrotexture will be lost if an aggregate wears away too rapidly under the grinding action of vehicle tyres.

A 7.1 Polished Stone Value

The propensity of a stone to polish is assessed in the UK by the Accelerated Polishing Test which produces Polish Stone Values (PSV).

The PSV has been related to the required skid resistance with known commercial vehicle volumes and is given in HD 36 Table 3.1. The PSV is an important characteristic of an aggregate but it should be remembered that the relationship between the PSV and the on road skid resistance is far from exact and knowledge gained from experience on how aggregates react in-service is more important than the PSV. The local knowledge gained from monitoring the performance of aggregates on the County Road network has been used to produce a guidance note on aggregate selection. This note sets out the Accepted PSV for a range of commonly used aggregate sources together with the appropriate level of accepted PSV for various road hierarchies required to achieve the IL’s set out in the Cornwall County Council Skid Policy. A copy of this guidance note is included at appendix 2.
Guidance Note on Aggregates for Surfacing & Surface Dressing

Introduction

The control of skidding resistance on the highway has traditionally been achieved by the specification of Polished Stone Value (PSV). This is a laboratory test which gives an indication of the resistance or otherwise of a particular aggregate to polishing under the action of traffic. To achieve a long-term durable surface PSV must also be specified in conjunction with some measure of durability, traditionally Aggregate Abrasion Value (AAV) and Magnesium Sulphate Soundness which measure the wear resistance and resistance to chemical degradation by de-icing salts respectively. Guidance on the appropriate PSV to achieve the desired level of skidding resistance for a particular site category and traffic loading is contained in the Highways Agency Design Manual for Roads & Bridges Volume 7 – HD36/06 with a proviso that local knowledge may be needed when dealing with certain aggregate/site category combinations.

In-service performance of road surfaces is measured using the Sideways force Coefficient Routine Investigation Machine (SCRIM) and the criteria for assessment is set out in Highways Agency Design Manual for Roads & Bridges Volume 7 – HD28/04.

It has always been recognised that PSV and SCRIM are measuring fundamentally different properties and whilst there might be some loose correlation between the two it is by no means certain that two aggregates with the same PSV will achieve similar in-service SCRIM values even when subjected to the same traffic loading and site conditions. Thus the choosing of PSV is an indistinct “science” which can and does lead to skidding deficiencies even when all appropriate national guidance has been followed.

In addition, changes to HD28 have resulted in the SCRIM deficiencies of our Principal Road Network (PRN) rising from 17% in 2004 to 38% in 2005. In response to this we have commissioned WDM to carry out a detailed study on our network which looks at the relationship between accidents and skidding resistance based on Cornish data. The output of this study has resulted in a revised skidding policy which sets different IL's for the principal and non-principal networks and also revises some of the site categories contained in HD 28/04.

The aim of this guidance note is to clarify the situation and give specific guidance on which aggregates will perform in which given situations. To make things easier for the specifier/designer indicative PSV's are given next to the SCRIM IL in Table 1 overleaf. Table 2 shows known sources of aggregate that will achieve the prescribed IL levels/indicative PSV's. Any aggregate source not quoted in this guidance note will need clarification and authorisation from the Asset Management team at Bodmin before it is used.
## Table 1

<table>
<thead>
<tr>
<th>Site Category</th>
<th>2a/2b Strategic Routes</th>
<th>3a Distributor Routes</th>
<th>3b - 6 Other Routes</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>SCRIM default</td>
<td>SCRIM default</td>
<td>SCRIM default</td>
</tr>
<tr>
<td></td>
<td>Investigatory Level/</td>
<td>Investigatory Level/</td>
<td>Investigatory Level/</td>
</tr>
<tr>
<td></td>
<td>Indicative PSV</td>
<td>Indicative PSV</td>
<td>Indicative PSV</td>
</tr>
<tr>
<td>B</td>
<td>Dual carriageway</td>
<td>0.35 (57)</td>
<td>0.35 (55)</td>
</tr>
<tr>
<td></td>
<td>Non Event</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>Single carriageway</td>
<td>0.40 (57)</td>
<td>0.40 (57)</td>
</tr>
<tr>
<td></td>
<td>Non Event</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Q1</td>
<td>Approach to &amp;</td>
<td>0.50 (65)</td>
<td>0.50 (60)</td>
</tr>
<tr>
<td></td>
<td>across minor &amp;</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>major junctions</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Q2</td>
<td>Approach to</td>
<td>0.50 (68 or Antiskid*)</td>
<td>0.50 (68 or Antiskid*)</td>
</tr>
<tr>
<td></td>
<td>roundabouts</td>
<td></td>
<td></td>
</tr>
<tr>
<td>K</td>
<td>Approach to</td>
<td>0.55 (Antiskid)</td>
<td>0.55 (Antiskid)</td>
</tr>
<tr>
<td></td>
<td>Pedestrian Crossing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>R</td>
<td>Roundabouts</td>
<td>0.5 (65)</td>
<td>0.5 (60)</td>
</tr>
<tr>
<td>G1</td>
<td>Gradients 5 – 10%</td>
<td>0.45 (65)</td>
<td>0.45 (57)</td>
</tr>
<tr>
<td>G2</td>
<td>Gradients &gt; 10%</td>
<td>0.5 (68)</td>
<td>0.5 (65)</td>
</tr>
<tr>
<td>S1</td>
<td>Dual Carriageway</td>
<td>0.45 (65)</td>
<td>0.45 (60)</td>
</tr>
<tr>
<td></td>
<td>Bends &lt;500m radius</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S2/1</td>
<td>Single Carriageway</td>
<td>0.55 (68 or Antiskid*)</td>
<td>0.55 (68)</td>
</tr>
<tr>
<td></td>
<td>Bends &lt;100m radius</td>
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<td></td>
</tr>
<tr>
<td>S2/2</td>
<td>Single Carriageway</td>
<td>0.5 (68)</td>
<td>0.5 (65)</td>
</tr>
<tr>
<td></td>
<td>Bends 100m to 250m</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>radius</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S2/3</td>
<td>Single Carriageway</td>
<td>0.5 (68)</td>
<td>0.5 (60)</td>
</tr>
<tr>
<td></td>
<td>Bends 250m to 500m</td>
<td></td>
<td></td>
</tr>
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</table>

* Risk assessment required based on accident history and site context
APPENDIX 2

Table 2

Accepted PSV’s* for Aggregates in common usage in Cornwall

<table>
<thead>
<tr>
<th>Source</th>
<th>Accepted PSV*</th>
</tr>
</thead>
<tbody>
<tr>
<td>CEMEX - Dean</td>
<td>53</td>
</tr>
<tr>
<td>ARAM – West of England</td>
<td>53</td>
</tr>
<tr>
<td>ARAM - Carnsew</td>
<td>55</td>
</tr>
<tr>
<td>LAWER Bros - Chywoon</td>
<td>55</td>
</tr>
<tr>
<td>Aggregate Industries - Melbur</td>
<td>55</td>
</tr>
<tr>
<td>Wainwrights – Moons Hill</td>
<td>55</td>
</tr>
<tr>
<td>Hanson - Hingston Down</td>
<td>55</td>
</tr>
<tr>
<td>Castle Granite – Castle-an-Dinas</td>
<td>57</td>
</tr>
<tr>
<td>Aggregate Industries - Greystone</td>
<td>57</td>
</tr>
<tr>
<td>TARMAC - Lean</td>
<td>57</td>
</tr>
<tr>
<td>TARMAC - Blackhill</td>
<td>57</td>
</tr>
<tr>
<td>Cap Frehel – imported French aggregate</td>
<td>57</td>
</tr>
<tr>
<td>HANSON - Brayford</td>
<td>60</td>
</tr>
<tr>
<td>TARMAC Dolyhir(Nash Rocks)</td>
<td>60</td>
</tr>
<tr>
<td>HANSON - Cashel</td>
<td>60</td>
</tr>
<tr>
<td>Aggregate Industries - Venn</td>
<td>65</td>
</tr>
<tr>
<td>Aggregate Industries - Millom</td>
<td>65</td>
</tr>
<tr>
<td>CEMEX - Quartzite</td>
<td>65</td>
</tr>
<tr>
<td>TARMAC Bayston Hill</td>
<td>65</td>
</tr>
<tr>
<td>White Mountain – Ballystockart</td>
<td>65</td>
</tr>
<tr>
<td>Aggregate Industries – Cwm Nant Lleici</td>
<td>68</td>
</tr>
<tr>
<td>Aggregate Industries - Cribarth</td>
<td>68</td>
</tr>
<tr>
<td>HANSON - Gelligaer</td>
<td>68</td>
</tr>
<tr>
<td>HANSON - Craig-yr-hesq</td>
<td>68</td>
</tr>
<tr>
<td>CEMEX - Gilfach</td>
<td>68</td>
</tr>
<tr>
<td>TARMAC - Penhill</td>
<td>68</td>
</tr>
</tbody>
</table>

* Accepted PSV based on in service data and performance

N.B. blending of coarse aggregates to achieve a specified PSV will only be permitted up to and including 57 PSV. Any proposed blend must be authorised prior to supply.
APPENDIX 3

Wet/Dry Accident Investigation

The wet/dry accident investigation procedure is intended to supplement the SCRIM procedure and the local safety scheme programme.

1. This programme supplements the SCRIM investigation procedure for the principal road network and provides a method of prioritising sites for treatment on those roads where routine monitoring of skidding resistance is not undertaken.

2. The accident database is interrogated to identify sites where at least four accidents (injury and damage only) have occurred within a 250m radius on a wet road surface during the last three years.

3. The total accident record for these sites is assessed and compared to the wet accident record. The number of wet weather accidents as a proportion of the total number is assessed and compared to the norm for Cornwall. This is currently 40%, however the percentage may change year to year as accident details change. This will identify those sites where there are a significant number of wet weather accidents.

4. The specific site details are then analysed to determine:
   - Sites where investigation of the skidding resistance is required.
   - Sites where treatment has already been undertaken or other proposed works will resolve the accident problem.
   - Sites where other factors are contributing to the accident problem.
   - Sites where a site inspection is required.

5. Having assessed the sites based on accident records and arranged for any further testing necessary to determine the skidding resistance, a priority list of sites for treatment will be drawn up. The priority rating will reflect the number of wet accidents and the length of site. This list will be incorporated into the prioritisation process for surface treatments.

6. On completion of treatment monitoring of the before and after records will be undertaken to review the effectiveness of remedial action and provide data to improve the wet/dry investigatory procedure in the future.
### SCRIM Deficiency - Preliminary Investigation

#### Survey Details

<table>
<thead>
<tr>
<th>Date of SCRIM Survey:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Is the survey data representative of the site:</td>
</tr>
</tbody>
</table>

#### Investigatory Levels

<table>
<thead>
<tr>
<th>Are They Appropriate:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Changes To Road Layout:</td>
</tr>
</tbody>
</table>

#### General Site Description

<table>
<thead>
<tr>
<th>Surface Type, Age &amp; PSV (if known)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Junctions:</td>
</tr>
<tr>
<td>Lighting:</td>
</tr>
<tr>
<td>Speed Limits:</td>
</tr>
<tr>
<td>Lane Widths:</td>
</tr>
</tbody>
</table>

#### Existing Programmes of Work

#### Accident Record (over last 5 years)

<table>
<thead>
<tr>
<th>Total Accidents</th>
</tr>
</thead>
<tbody>
<tr>
<td>No of Wet Accidents</td>
</tr>
<tr>
<td>No of Wet Accidents where skidding appears to be a factor</td>
</tr>
<tr>
<td>Traffic Flow (AADT)</td>
</tr>
<tr>
<td>Accident Rate (per 100m vehicle km)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Outcome (✓ appropriate ☐ )</th>
</tr>
</thead>
<tbody>
<tr>
<td>No further Investigation/ monitor site (give reason) ☐</td>
</tr>
</tbody>
</table>

| Secondary Investigation (give reason) ☐ |
### SCRIM Deficiency - Secondary Investigation

#### Site Description

**Reported SCRIM Deficiency:**

#### Road Alignment & Site Geometry

Does Site deviate from current design standards, are site lines good? (record details)

#### Pavement Markings

Are they appropriate and effective?: (record details)

Are they visible?

#### Drainage

Is there standing water?(record details)

Is drainage functional & fit for purpose (record details)

#### Surface Characteristics

Is the texture depth adequate (record value from SCANNER)

Is the surface rutted (SCANNER)

What is the Structural Condition of the Road (Trenches/Patches etc)
Detritus / Contamination

Is there any evidence?

Traffic

Are the observed traffic speeds appropriate for the nature of the site? (record comments)

What types of manoeuvring are taking place (record details)

What are the consequences of failure to complete manoeuvring described above (ie potential impacts/collisions)

Is there a need to re-design junction areas?

How does the site accommodate vulnerable road users (eg pedestrians, cyclist, motor cyclists)

Investigatory Levels

Is there justification for altering the current investigatory levels? (record comments)
### APPENDIX 4

**Outcome** (✓ appropriate □)

- Erect Slippery Road Signs □
- Undertake Additional Scrim Survey To Verify Results □
- Recommend Revision To Investigatory Level □
- Investigate Other Engineering Measures (E.g. Road Signs & Markings) □
- Recommend Surface Treatment (record details) □
- No Further Action Is Required (record details) □

**Comments:**

<table>
<thead>
<tr>
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**Procedure for the Management of Skid Resistance**

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