Executive Summary

As the Local Highway Authority responsible for maintaining around 1,300km of roads, Milton Keynes Council has a duty under the Highways Act 1980 to maintain the highway in a condition that is safe and fit for purpose. Although ensuring safe levels of skid resistance is not a specific legal requirement for local authorities, the Council wishes to manage the skid resistance in accordance with relevant standards and best practice. This Skid Resistance Strategy sets out the Council’s approach to managing skid resistance across its highway network, outlining the purpose and benefits, and providing detailed descriptions of principles and processes.

The overriding aim of our Skid Resistance Strategy is to ensure acceptably safe skid resistance conditions for all road users. It forms part of the Local Highway Authority’s wider remit of highway asset management and maintenance of all its public highways.

This Strategy is based on relevant standards and guidance, in particular the provisions of the national standard within the Design Manual for Roads and Bridges (DMRB), 7.3.1 HD28 on Skidding Resistance. The Strategy takes a risk-based approach to managing skid resistance through monitoring of skid resistance on a defined network of classified and grid roads, and use of appropriate materials to achieve required skid resistance levels depending on the risk profile of the section of road.

This document has been produced by the Council’s Highway Asset Management team with the assistance of Yotta’s Infrastructure Asset Management Consultancy team.
## Document History

<table>
<thead>
<tr>
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<th>Reviewer(s)</th>
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</table>

*NB: This Skid Resistance Strategy will be reviewed on a three-yearly basis, or when HD28 is amended by the Department for Transport, whichever occurs more frequently.*
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Introduction

Milton Keynes Council (MKC) is responsible for some 1,300km of roads. The Skid Resistance Strategy and Operational Guidance sets out MKC’s approach to maintaining skid resistance levels of road surfaces across our highway network. It outlines the purpose, benefits, and provides detailed descriptions of processes. This document is based on guidance provided in the national Design Manual for Roads and Bridges (DMRB) 7.3.1 HD28: Skid Resistance, with variations to account for local factors.

Skid resistance is a measure of the frictional properties between the tyre of a moving vehicle and the road surface, which directly affect the ability of a driver to slow / stop the vehicle. As such, it is a key component of road safety. In this document, skid resistance is considered in wet conditions, since the skid resistance of a wet or damp road surface can be substantially lower than the same surface when dry.

The skid resistance of a surface decreases over time due to the effects of traffic and weathering. Routine monitoring of skid resistance is carried out annually across the network using a Sideways-force Coefficient Routine Investigation Machine (SCRIM) to provide an average deficiency measurement known as the Characteristic Skid Coefficient (CSC), and combined with other data to determine areas for further investigation and potential treatment.

This Skid Resistance Strategy provides the framework, processes and guidance for the management of skid resistance, with the aim of ensuring that the frictional properties of road surfaces are appropriate for their expected use and safety risk.

The operational guidance describes the detailed processes to:

- Define the roads/sections to be surveyed for skid resistance (the SCRIM network)
- Define the framework for assessing skid resistance risk
- Measure skid resistance on the SCRIM network
- Analyse skid resistance data to identify sites at which skid resistance risk may be unacceptable
- Investigate selected sites to determine/confirm skid resistance risk
- Determine remedial actions in cases where skid resistance is found to be unacceptable.

This Skid Resistance Strategy will be reviewed on a three-yearly basis, or when HD28 is amended by the Department for Transport, whichever occurs more frequently.

This document has been produced by Milton Keynes Council’s Highway Asset Management team with the assistance of Yotta’s Infrastructure Asset Management Consultancy team.
Benefits

The safety benefits of effective skid resistance management are:

- Preventative: reduced likelihood of wet skidding accidents
- Mitigatory: improved safety outcomes in cases where wet skidding accidents do occur.

Additionally, there are ancillary benefits of effective skid resistance management which include:

- extending the life of a road surface by implementing skid resistance improvement works
- reducing the risk of claims against the Council due to wet-skidding incidents
- providing a cost-effective opportunity to address other identified highway condition deterioration, such as rutting, crossfall, etc.
- economic and environmental advantages from use of quick and repeatable treatments.

Legal Basis

Ensuring safe levels of skid resistance is not a legal requirement on local authorities, but is considered good practice, supporting legal and national requirements for safe operation and to maintain the road network. This includes the Council’s duties under the Highways Act 1980, such as:

- s41 to maintain adopted highways, accepting what is reasonably practicable on applying differing standards the network based on its use and operational speed.
- s58 defence to counter legal actions of negligence to take “such care” considering highways and traffic, standard of maintenance, state of repair, highway condition and expectation of repair.

A Risk-Based Approach

In line with the general principles of the Well-Maintained Highways Code of Practice, its successor Well-Managed Highway Infrastructure, and HD28, this Strategy applies a risk-based approach to the management of skid resistance to our highways network, including:

- The surveyed portion of the highway network, such as traffic types, densities, speeds, relevant accident statistics, and expertise
- Location factors, such as road layout/geometry, driver visibility, etc.
- Departures from HD28 to take better account of local road circumstances.
### Strategy Overview

Figure 1 below provides an overview of the process behind the Council's Skid Resistance Strategy. Each of these steps is detailed further in the *Operational Guidance* section.

**Figure 1: Overview of MKC’s Skid Resistance Strategy processes**

<table>
<thead>
<tr>
<th>Define roads/sections to be surveyed for skid resistance (see page 10)</th>
</tr>
</thead>
<tbody>
<tr>
<td>- These roads/sections are known as the SCRIM Network</td>
</tr>
<tr>
<td>- The SCRIM Network will be defined based on a pre-assessment of likely skidding risk</td>
</tr>
<tr>
<td>- The SCRIM Network will be divided into Site Categories (SCs) based on risk factors</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Establish skid resistance assessment framework (see page 12)</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Assess the relative skid risk of each site on the SCRIM Network</td>
</tr>
<tr>
<td>- Set Investigatory Levels (ILs) for each site based on the Site Category and relative risk</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Measure Skid Resistance (see page 14)</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Skid resistance will be measured using a Sideways-force Coefficient Routine Investigation Machine (SCRIM)</td>
</tr>
<tr>
<td>- Use the Single Annual Skid Survey approach, as defined in HD28 (Annex 2)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Analyse skid resistance data (see page 14)</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Analyse SCRIM survey data to check skidding resistance against relevant IL’s</td>
</tr>
<tr>
<td>- Risk assess sites with skid resistance below the IL and prioritise for further investigation</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Investigate high-risk sites (see page 16)</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Investigate sites identified in the previous step in situ on a prioritised basis</td>
</tr>
<tr>
<td>- Gather and record detailed information about the site using a pre-defined process</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Determine remedial actions (see page 17)</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Identify appropriate remedial actions based on the site investigation</td>
</tr>
<tr>
<td>- Pass to the appropriate team for implementation</td>
</tr>
<tr>
<td>- Incorporate identified remedial works into maintenance/improvement works plans</td>
</tr>
</tbody>
</table>
All processes, guidance, etc. are based on HD28 where relevant, with deviations where necessary to account for local factors. The strategy should be operated in accordance with relevant national guidance and codes of practice, such as:

- DMRB as amended:
  - HD28 - Skid resistance
  - HD36 - Surfacing materials for new and maintenance construction
  - HD37 - Bituminous surfacing materials and techniques
  - HD38 - Concrete surfacing and materials

- Road Liaison Group Codes of Practice – Well-Maintained highways and its successor Well-Managed Highway Infrastructure
- Road Surface Treatments Association – Skid Policy Guidance
- British Horse Society / ADEPT guidance – Horses and highway surfaces
- Institute of Highway Engineers Guidelines for motorcycling
- Department for Transport - Traffic Signs Regulations and General Direction
- British standards BS EN1097-8:2009 – Tests for mechanical and physical properties of aggregates. Determination of the polished stone value
- TRL - Surface Treatment Measurement on Local Roads.

Any significant changes to any relevant guidance should be accounted for in updates to this Strategy document.

Records of surveys, data analysis and site investigation will be retained in accordance with the Operational Guidance.
Operational Guidance

The analysis of skid resistance is the responsibility of the lead officers from Highway Maintenance, Traffic Management and Road Safety. Figure 2 below shows how we conduct the process to accord with national guidance and best practice.

**Figure 2: Skid resistance management process**
The SCRIM Network

The SCRIM Network is that part of the highway network on which it is considered advisable to manage the risk of wet skidding accidents. The current SCRIM Network is shown in Figure 3 below, and consists of:

- All classified A- and B-roads, and grid roads
- Specific C-roads and unclassified roads determined to have a high skid risk.

Skid resistance surveys will not be undertaken routinely on other parts of the network. Other specific assessments may be undertaken when requested by the maintenance engineer as a result of reported incidents. Where possible, such sites will be included in the annual SCRIM survey programme, and will be reviewed to determine whether they should be included in the SCRIM Network.

The SCRIM Network is divided into sections, called Site Categories (SC’s), based on the characteristics of the section in relation to wet-skidding incident risk, considering both the likelihood and potential consequences of a wet-skidding incident. We determine SC’s by reference to HD28 or updated guidance, accident history data, and local knowledge of the highway network. A full list of SC’s is given in Investigatory Levels below.
Figure 3: Current MKC SCRIM network

2017/18 SCRIM Network

Legend

SCRAM Network

SCALE 1:40000
DATE 07/02/2018
DRAWN BY P
CHECK P

Milton Keynes Council

Yotta
From Data to Decisions

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The SCRIM Network will be reviewed regularly on a three-year cycle with major changes updated annually, and in the following specific cases:

- After significant changes to the network.
- Sites at which the number of year-to-year reported accidents changes.
- Sites for which relevant incidents / complaints are reported. Such cases may include:
  - damage to street furniture
  - near-misses
  - complaints from police or the public
  - loss of control incidents
  - relevant incidents involving horses.

Details of the SCRIM Network, including SC’s are maintained by the Highways Asset Management Team.

**Investigatory Levels**

Investigatory Levels (IL’s) are a pre-defined limit of minimum acceptable skid resistance. Measurements greater than the limit are considered satisfactory, while those equal to or less than the limit will trigger further investigation.

IL’s are applied to specific sections of carriageway on the SCRIM Network based on their SC. IL’s for each SC are set according to the wet-skidding incident risk, so that higher-risk SC’s have higher IL’s, i.e. more stringent skid resistance requirements.

Risk levels may vary within SC’s. For this reason, a range of applicable IL’s has been determined for each SC, based on whether the risk at the specific site is considered to be Low (L), Standard (S), or High (H). Sites will be defined as Standard (S) risk except in the following circumstances:

- **High (H) risk sites:**
  - sites where one or more Killed or Seriously Injured (KSI) wet skidding incident has occurred within the preceding three years, OR three or more non-KSI wet skidding incidents have occurred within the preceding three years
  - sites which are an approach to a hazard, AND where the speed limit ≥50 mph.

- **Low (L) risk sites:**
  - unclassified roads with a speed limit of ≤30mph, AND where analysis of accident data has shown that the site is generally less prone to wet skidding accidents
  - sites with no history of wet skidding accidents or reports of wet skidding incidents within the preceding three years.

Site risk classification may be subject to review.

Table 1 on the following page sets out the full list of IL’s to be applied for each SC. These IL’s are consistent with the lower levels set out in HD28. The part of the table coloured red is critical, representing the highest risk.
### Table 1: Investigatory Levels by Site Category and relative risk

<table>
<thead>
<tr>
<th>Site Category Code &amp; Description</th>
<th>Investigatory Level (L/S/H risk)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.3</td>
</tr>
<tr>
<td>B Dual carriageway/one-way non-event.</td>
<td>L</td>
</tr>
<tr>
<td>C Single carriageway non-event.</td>
<td>L</td>
</tr>
<tr>
<td><strong>G1</strong> Gradient 5-10%, longer than 50m. Not applicable to uphill gradients on dual/one-way sections.</td>
<td>L</td>
</tr>
<tr>
<td><strong>G2</strong> Gradient &gt;10%, longer than 50m. Not applicable to uphill gradients on dual/one-way sections.</td>
<td>L</td>
</tr>
<tr>
<td>Q Approaches to and across minor and major junctions. Approaches to roundabouts and traffic signals.</td>
<td>L</td>
</tr>
<tr>
<td>K Approaches to pedestrian crossings and other high-risk situations.</td>
<td>S</td>
</tr>
<tr>
<td><strong>R</strong> Roundabouts</td>
<td>S</td>
</tr>
<tr>
<td><strong>S1</strong> Bend Radius &lt; 500m &amp; speed limit &gt;=50mph. Dual carriageway/one way.</td>
<td>L</td>
</tr>
<tr>
<td><strong>S2a</strong> Bend Radius &lt; 500m &amp; speed limit &gt;=50mph. Two-way traffic.</td>
<td>L</td>
</tr>
<tr>
<td><strong>S2b</strong> Bend Radius &lt; 250m &amp; speed limit &gt;=40mph. Dual or single carriageway.</td>
<td>L</td>
</tr>
<tr>
<td><strong>S2c</strong> Bend Radius &lt; 100m &amp; speed limit &gt;=30mph. Dual or single carriageway.</td>
<td>L</td>
</tr>
</tbody>
</table>
Measuring Skid Resistance

Skid resistance will be measured using a SCRIM to survey the defined highway network. The entire SCRIM Network will be surveyed annually, in accordance with the Single Annual Skid Survey (SASS) approach defined in HD28 (Annex 2). Appendix 1 explains the background.

As Skid resistance varies from year to year, and within a year, surveys of the SCRIM Network are undertaken in a controlled manner at different times within the survey season of 1 May to 30 September when the road surface is expected to be drier and more susceptible to polishing from dust and detritus. At such times skid resistance tends to fall. This provides an annual coverage of 100% of the SCRIM Network and a consistent dataset. The survey programme is scheduled on a rotating 3-year rolling basis:

- Year 1 – early season
- Year 2 – mid season
- Year 3 – late season.

Other relevant specifications applied to SCRIM surveys are:

- Provision of evidence from the survey contractor that the survey machine has passed its annual calibration testing
- The standard test speed of 50 km/h (30mph)
- Testing of the leftmost lane in both directions of travel unless otherwise specified by the engineer. This lane carries the most traffic and is subject to greater surface wear
- Measurements shall be carried out with the test wheel in the nearside wheel path
- Measurements shall not be undertaken where the air temperature is below 5ºC
- Road surface contamination shall be recorded by the SCRIM operator
- The test line to be followed at roundabouts shall be agreed by the SCRIM operator and the engineer.

Additionally, routine monitoring of the texture depth for classified roads shall be undertaken, as collected for the annual UKPMS surveys using the Surface Condition Assessment National Network of Roads (SCANNER) Machine. This allows calculation of the Characteristic Skid Coefficient (CSC), which is an estimate of the skid resistance accounting for the effects of seasonal variation. Where data was collected below or above 55km/h, the measured values will be corrected to a speed of 55km/h to obtain CSC’s in accordance with HD28.

The Council’s asset management system CONFIRM is used to store and process the survey data from SCRIM and other surveys for a period of five years.

Identification of Sites for Investigation

All locations on the SCRIM Network where the CSC is equal to or below the corresponding IL shall be considered for in-situ investigations. These sites will be prioritised based on hazard attribute risk factors, including the magnitude of skid resistance deficiency.
The process for analysis of SCRIM survey data is as follows:

1. Import/update SC and IL data in UKPMS system.
2. Import CSC data into UKPMS and determine SCRIM Deficiency.
3. Import three-year accident data into the relevant GIS software.
4. Undertake data analysis by desktop study of all sites at which the CSC is at or below IL to allow identification and prioritisation of sites at which a more detailed site investigation is warranted.
5. Rank sites using a risk-based scoring system as set out below in Table 2 to allow prioritisation of sites to be investigated.

Table 2: SCRIM site investigation scoring matrix.

<table>
<thead>
<tr>
<th>Weighting Factor</th>
<th>Criteria</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of wet skidding KSI accidents</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>10</td>
</tr>
<tr>
<td>Number of wet skidding accidents (slight)</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td>SCRIM deficiency</td>
<td>&gt; 0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>≤ 0 AND &gt; -0.1</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>≤ -0.1 AND &gt; -0.2</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>≤ -0.2</td>
<td>10</td>
</tr>
<tr>
<td>Texture Depth</td>
<td>&gt; 0.6mm</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>≤ 0.6mm</td>
<td>6</td>
</tr>
</tbody>
</table>

Note: Table 2 is based on HD28 Table A.7.1, with some modifications to account for differences in application to the Council’s highway network and to improve usability.

Identification of sites at which there is a SCRIM deficiency will be undertaken within six weeks of receipt of all relevant processed SCRIM survey data, accident and traffic data.

For sites with a texture depth less than 0.6mm, a review of available works history records should be undertaken to identify sections where materials have low or negative texture by design.

To account for possible inaccuracies in the recording of collision locations, analysis will extend over a length of road extending 100m in each direction from recorded collision locations. Inaccuracies may arise due to:
• Vehicle locations are often recorded where the vehicle(s) came to a stop, and it may therefore not be possible to accurately locate the point of collision.
• Vehicles may have been moved before the recording of the collision so that an approximation of the location has to be made.
• Damage-only collisions are not recorded by the Police and so locations may be approximate.

All road traffic collision incident data will be validated before being used in analysis to ensure there is no duplication.

Other factors which relate to risk such as speed limit, road classification and traffic levels are considered when defining SC’s and IL’s, as detailed in the corresponding sections above.

Site Investigation

Investigation will take place at all sites with a risk-ranking score of 10 or greater, as determined by the system set out in Table 2 above, this being the minimum risk score for all sites with at least one wet-skidding KSI accidents, or where SCRIM deficiency is ≤ -0.2. All other sites flagged for potential investigation, i.e. with a CSC lower than the IL should be investigated on a prioritised basis, as far as resources will allow, in descending order of risk-ranking, i.e. higher risk sites have a higher priority for investigation.

Site investigations must be undertaken by a competent person in highway maintenance, using the Site Investigation Form in Appendix 2 which is designed with reference to HD28 Annex 4, and making reference to the detailed guidance notes. Initially, this will be part of a desktop exercise.

Once on site the remaining parts of the form should be completed, noting any inconsistencies between machine survey data and on-site assessment, and taking photographs of the site to provide:

• an overview of the location, illustrating site characteristics such as gradient, bends, visibility across junctions, etc.
• the road surface, defects and other important features which could contribute to determining the required remedial action.

If at all possible, a camera with geo-referencing should be used.

The site investigation will include an assessment of the SC / IL for each site to determine if a revision is required.

Records of all site investigations will be retained for five years. These will include sites at which remedial works are required, sites where other action is required, and sites at which no further action is considered necessary. Sites at which no further action is required will be reviewed the following year to monitor the performance of the road surface and to review the level of risk.
Identification and Prioritisation of Remedial Actions

The following are some possible actions after completion and review of the Site Investigation:

- Surface treatment works
- Resurfacing Works
- Other Actions, such as cleaning/replacing signs, increasing routine verge maintenance, etc.
- Review site after next survey
- Reduce / Increase Risk Rating
- Review visibility splays, road alignment or road markings
- No further action required

Sites requiring resurfacing works must be immediately added to the works programme and Slippery Road Warning Signs should be erected along the extent of the sites in accordance with signing requirements. Signs must be immediately removed once works are completed.

Any resurfacing works must be designed with reference to HD37 and HD38 and specifications. Refer Appendix 3 for more details.

Sites at which surface treatments are required to improve skid resistance will be added to the programme of works for the current year and prioritised according to the associated risk.

The prioritisation will take account of:

- The level of skid deficiency (see Table 3 below)
- Site Category
- Accident history, where there is a disproportionate number of wet skidding related collisions
- Reported incidents and complaints
- Carriageway condition, including loss of texture, rutting, and adverse profile.

Table 3: Surfacing works priorities

<table>
<thead>
<tr>
<th>Priority</th>
<th>Skid Deficiency IL (CSC)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>≤-0.1</td>
</tr>
<tr>
<td>2</td>
<td>≤-0.5 and &gt;-0.1</td>
</tr>
<tr>
<td>3</td>
<td>≥0 and &gt;-0.5</td>
</tr>
</tbody>
</table>

A record of any works instigated due to Site Investigations must be archived along with the related Site Investigation forms.
Use of Warning Signs

“Slippery Road” warning signs to Traffic Signs Diagram 557 with additional plate, Diagram 570, shall be erected to warn road users of sites for which remedial works have been determined to be necessary to improve skid resistance to acceptable levels.

Signs shall be erected as soon as is practicable after the need for remedial treatment is identified, and removed as soon as possible once maintenance engineers are satisfied that skid resistance levels have been returned to an appropriate level after completion of works.

At sites at which the skid resistance is considerably below the IL (≥0.1 differential), Slippery Road signs should be erected as a matter of urgency. Priority will be given to sites at which the Investigatory Level is 0.45 or greater.

An inventory of Slippery Road signs shall be maintained. This will include details of sign locations, date of erection, date of removal, and details of related works orders. The inventory will be retained for five years.

Considerations for Other Road Users

This strategy is predominantly intended to manage the risks of wet skidding incidents involving motor vehicles. However, any reports of incidents involving horses and possible slippery road surfaces will be investigated in order to determine any further action with reference to guidance produced by the British Horse Society in conjunction with ADEPT.

Additionally, for cases involving motorcycles, the IHE guidance will be referenced.

Programming of Works

Treatment of skidding related sites is seen as one consideration when developing the overall programme of surface treatments. Those sites rated highly for early treatment where the assessed sites are below the IL and where there is significant risk of collision are to be given priority with the remainder entering the longer term planned programme.
Improving Skid Resistance

Early-Life Skid Resistance

Newly laid asphalt surfaces exhibit lower skid resistance than the same surface after a few months of carrying traffic. To address such a short-term drop in skid resistance, a site-specific risk assessment will apply. A particular example is Stone Mastic Asphalt (SMA) surfacing. The high binder content of SMA materials, and the presence of significant amounts of bitumen at the surface of the carriageway after laying, result in skid resistance values in wet conditions that are significantly below the values required. Where such materials are to be used, initial specifications and checks on laying will apply.

High-Friction Surfaces

High Friction Surface (HFS) systems can be highly effective when used to increase the skid resistance of a site with a high skid incident risk. Its use will apply at locations specified within Table 3.1 of HD 36, or Table 4 of this Strategy, if the required traffic flows for the site are not available. In appropriate circumstances, the use of HFS may be targeted at other specific sites where there is a demonstrably high skid incident risk.

HD36 requires a minimum HFS treatment length of 50m on the approach to a hazard, however, this standard has been developed for use on Trunk Roads. In Milton Keynes, our non-trunk roads generally carry lower levels of traffic travelling at lower speeds. Where this is the case, HFS lengths shorter than 50m may be considered where justified by a specific assessment.

Alternatives to High-Friction Surfaces

Alternatives to HFS include:

- Road safety measures, such as improvements to road markings, signage, or street lighting
- The use of surface dressing materials with a highly skid-resistant natural aggregate bonded with a binder capable of withstanding the braking forces generated at the site
- Speed reduction or traffic-calming measures.

Additionally, there may be a limited number of sites where the use of HFS is not warranted, but it is recognised that there may be advantages to be gained by the use of a surfacing that provides the material properties required for the site together with a visual impact similar to that provided by HFS. In these cases, options include:

- The use of a surface course material containing a coloured aggregate or coloured pre-coated chippings. The binder of this material may additionally contain a coloured pigment;
- Application of a surface dressing containing coloured chippings.
- Application of a surface dressing containing a 70+ PSV natural aggregate at high risk / high stress sites, using a polyurethane resin binder to ensure that the bond between the road
surface and the dressing is of sufficient strength to prevent the dressing being stripped from the road surface;
• Installation of a Surface Course containing a 70+ PSV natural aggregate.

Materials and Workmanship
Requirements for the use of specialised HFS systems, and surface courses and surface dressing containing 70+ Polished Stone Value (PSV) aggregates, must be included within Appendix 7/1 of any Contract documentation produced for new or maintenance works on our highway network, and this information must be forwarded to the Asset Management Section.

Although Highways Authorities Product Approval Scheme (HAPAS) approval is not required for the use of specialised HFS systems on local authority-maintained highways, we specify that the systems used on our highways adhere to the requirements of the Manual of Contract Documents for Highway Works (MCHW), Clause 924; High Friction Surfaces. This requires the system to have a current British Board of Agreement (BBA) HAPAS Roads and Bridges Certificate, and to be installed by a contractor approved by the BBA and the Certificate Holder.

Natural aggregate that has a PSV over 60 is regarded as a highly skid resistant aggregate, but aggregates with a PSV over 65 are needed for particularly high stressed sites.

HFS is a term that describes the specialised group of road surface treatment systems that are applied as a topping to the road surface and utilise calcined bauxite as the aggregate that provides the specified minimum 70+ PSV.

The calcined bauxite aggregate used in specialised HFS systems exhibits very high PSV and very low Aggregate Abrasion Value's (AAV), although the PSV does alter according to the source.

There are several sources of calcined bauxite on the market with densities varying from 2.6 to 3.4, dependent upon source. Density is a good indication of the PSV of the calcined bauxite, with high density indicating a high PSV. Test certificates should be requested to ensure that the calcined bauxite used has an appropriate PSV.

Milton Keynes does not specify an 'end product' Skid Resistance Value (SRV) for specialised HFS systems because it is considered unlikely that a currently certified system, installed by an Approved Contractor, will not be fit for purpose.
Appendices
Appendix 1: Background to the Measurement and Interpretation of Skid Resistance

Wearing of road surface materials caused by weathering and commercial vehicle damage can significantly reduce the skid resistance performance when the road is wet or even damp. By managing the risk of skidding accidents in wet conditions we equalise the risk across the road network. This is achieved by providing a level of skid resistance to a section of road based on a risk analysis using accident records, road layout and engineering experience.

Dry, clean road surfaces achieve a high and generally consistent skid resistant level whereas the same surface when wet or damp can produce a significantly lower skid resistance level. For this reason, measurements of skid resistance are made on wetted road surfaces.

Research by TRL demonstrated that the risk of a wet-road skidding accident increases as skid resistance decreases. However, the secondary nature of skid resistance as an accident factor means that the relationship between skid resistance and accident risk is not a precise one.

Road Surface Parameters

The level of skid resistance is dependent on two road surface parameters: the micro-texture, which is the surface roughness of the aggregate in the road; and the macro-texture, which is the surface texture as shown in Figure A.1 below.

*Figure A.1: Macro- and micro-texture of a road surface (reproduced from HD28)*

Micro-texture is the main contributor to skid resistance at low speeds of less than 50 km/h (30mph) whilst macro-texture generates friction by deforming the tyre and providing a drainage route between tyre and road surface helping to prevent aquaplaning. Macro-texture is a more important factor for wet skidding resistance at speeds of greater than 65 km/h (40 mph).
Seasonal Variation of Skid Resistance

Skid resistance fluctuates through seasonal weathering and polishing cycles. During the winter period, October to March, the roads are often wet, and gritty road detritus roughens the micro-texture, causing the skid resistance to rise. In the summer period, April to September, the roads are generally dry and road detritus is mainly dusty, so the road surface becomes polished and the skid resistance falls. In practice, the minimum skid resistance will vary from year to year and within a year depending on weather conditions.

As skid resistance varies during the year, a method of measurement has been developed to allow for this effect, known as the Single Annual Skid Survey (SASS) approach as per HD28 Annex 2.

Relationship to Accident Risk

Within normal ranges, low skid resistance may be a significant contributory factor to collisions. The level of skid resistance, even on a polished surface, will generally be adequate to achieve normal acceleration, deceleration and cornering manoeuvres on sound surfaces that are wet, but free from other contamination. However, higher skid resistance can allow manoeuvres that demand higher friction to be completed, e.g. to shorten stopping distance or to turn sharp corners. Higher skid resistance can therefore reduce accidents in cases where drivers need to complete a more demanding manoeuvre in order to avoid an accident.

Accident analysis reveals that there are relationships between measured skid resistance and accident risk. These relationships are not precise; the influence of skid resistance on accident risk is significantly different for roads with different characteristics. For this reason, site categories have been defined to group roads with similar characteristics.

For some site categories, the relationship between accident and skid resistance is tenuous. For these sites the level of skid resistance can be lower. For other site categories progressively more accidents are observed as the skid resistance falls. For these categories there are clear benefits in maintaining a higher level of skid resistance.

HD28 states that not all sites within a single category are equivalent in terms of their accident risk. Judgement of the relative accident risk and appropriate level of skid resistance for different sites within the same category forms a key part of the effective operation of this strategy. Guidance in determining SCs and allocating ILs is provided on pages 10-14 of this document.

Economic Benefits

Skid resistance improvements can be implemented at relatively low cost by using methods such as surface dressing, retexturing etc. These can produce very substantial benefits to the community in terms of reduced personal injury and accidents costs.

The monetary value of fatal road crashes has been estimated by the Department of Transport as £1,953,783 (2013) and is updated annually. The values take into account medical costs, police and
administration costs, damage costs and lost output; they also include a value for the human costs such as loss of earnings, pain, grief and suffering.

Various studies have shown that expenditure on compliance with skid resistance standards has been cost effective. This is particularly noticeable at high stress sites such as those at approaches to traffic signals and pedestrian crossings since crash densities are potentially higher at these locations. Achieving the appropriate skid resistance requirement has produced a high cost / benefit ratio (1:20) particularly in urban areas.
### Appendix 2: Site Investigation Form

<table>
<thead>
<tr>
<th>Milton Keynes Council</th>
<th>SCRIM Survey Year:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site Ref</td>
<td>Road Number</td>
</tr>
<tr>
<td>Pavement Condition data</td>
<td></td>
</tr>
</tbody>
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| Site Location and Use |

| Visual Assessment |

| Road Users |

| Road Layout |
### Markings, Signs and Visibility


### Any Other Information


### Assessment of Accidents


<table>
<thead>
<tr>
<th>Accident Analysis for the last three-year period</th>
<th>Control Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length of site</td>
<td>Site Data</td>
</tr>
<tr>
<td>Number of accidents in analysis period</td>
<td>Route Data</td>
</tr>
<tr>
<td>Accident/year</td>
<td>Similar Sites</td>
</tr>
<tr>
<td>Accidents/100km</td>
<td></td>
</tr>
<tr>
<td>Accidents/10^9 vehicle – km</td>
<td></td>
</tr>
<tr>
<td>Accident severity ratio</td>
<td></td>
</tr>
<tr>
<td>% Wet</td>
<td></td>
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<td>-------</td>
<td>---</td>
</tr>
<tr>
<td>% Skid</td>
<td></td>
</tr>
<tr>
<td>% Wet Skid</td>
<td></td>
</tr>
</tbody>
</table>

**Actions/Recommendations**

<table>
<thead>
<tr>
<th>Name/Position</th>
<th>Signature</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
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<td></td>
</tr>
</tbody>
</table>

**Accompanying guidance notes:**

The following guidance is provided to assist the highway maintenance engineer or equivalent in undertaking SCRIM Site investigation and completing the SCRIM Site Investigation Form. During site investigation photographs should be taken to provide a record and overview of the site and to provide context to information summarised on the form.

**SCRIM Survey Year:** The year of the SCRIM survey that prompted the SCRIM Site investigation.

**Site Ref:** Unique Site reference assigned to Site; this is the Year / Route / Site Number, e.g. 2015/A509/001.

**Road Number:** Road or Route Number, e.g. A509; if the road is unclassified, the street name & town or Street Gazetteer number will suffice.

**Location:** Description of the location using permanent features such as house numbers. Additionally, Ordnance Survey Grid Reference or Longitude and Latitude coordinates for the start and end of the site.

**Pavement Condition Data:** Summary of the SCRIM and SCANNER data; areas of focus are:

- Data consistency: If SCRIM data (i.e. CSC) is variable this can be indication of a localised problem in the left wheel path, such as a smooth inspection chamber cover.
- Macro-texture Depth: Macro-texture (texture depth measured by SCANNER) generates friction by physically deforming the tyre surface and also provides rapid drainage routes between the
tyre and road surface. Macro-texture depth becomes increasingly significant at speeds greater than 65 km/h (40 mph).

- 3m and 10m Longitudinal Profile Variance (LPV): Stopping distances can increase due to poor LPV.
- Rut Depth: Rutting can prevent water from draining from a carriageway surface, therefore increasing the risk of aquaplaning.

**Site Location and Use:** Notes should be made regarding the following:

- Nature of Site, e.g. whether site is on a bend and/or gradient, is an approach to a junction or potential high-risk location such as pedestrian crossing, level crossing, traffic signals, etc.
- Likelihood of Vulnerable Users, such as cyclists, pedestrians, motorcyclists, children. Mainly assessed by proximity to hospitals, care homes, schools, etc.
- Where relevant, note whether there are facilities to allow vulnerable users to cross safely, e.g. pedestrian crossings, footway bridges, footway subways, etc.

**Visual Assessment:** Assess the road surface condition, noting any inconsistencies with survey data relating to:

- Road Surface Condition, especially: homogeneity, fretting/stripping, polished aggregate, visible depressions/rutting, potholes
- Presence of utility trenches
- Evidence of reactive maintenance (patches, etc.)
- Presence of surface detritus
- Blocked/damaged drainage
- Presence of inspection chambers, and their condition – smooth, damaged, etc.

**Road Users:** Assessment of the type of traffic that uses the route, noting the following:

- Observed traffic speed, and relation to speed limit
- Traffic type and levels
- Evidence of vehicles going off-carriageway, e.g. tyre tracks in verge, damaged kerbs, etc.

**Road Layout:** Description of the road layout, including junctions, road width, suitability for traffic levels, types and speed, etc.

**Markings, Signs and Visibility:** Note any relevant observations, including:

- Visibility: anything which reduces road user visibility, e.g. vegetation
- Street furniture: condition, visibility, suitability, number, potential for confusion, etc.
- Road Markings: condition, visibility, suitability, potential for confusion, etc.
- Junctions: visibility, potential for queues forming, provision for right turning vehicles, etc.

**Any Other Information:** Any other relevant information not recorded elsewhere on the Site Investigation Form.

**Assessment of Accidents:** Assessment of the accidents along the route, noting:
• Evidence of relationship between accidents and skidding resistance.
• Any significant changes to the site or traffic over the analysis period that could have an impact on the number of accidents.

**Actions/Recommendations:** Any actions arising from the site investigation should be agreed between the lead officers for Highway Maintenance and Traffic Management and Road Safety or their appointed representative. All actions must be signed off by both lead officers. Additionally, before assigning an action or recommendation, all data must be reviewed and assessed to determine if the road surface condition is a contributory factor to an increased risk of wet skid traffic incidents. If the road surface condition is deemed deficient, the following actions could be considered:

• Surface Improvement
• Retexturing
• Micro-surfacing
• Resurfacing

If the condition of the road surface is not considered to be a contributory factor to the increased risk of wet skid accidents, the site information should be reviewed to determine if recommendations are required to reduce the risk of incidents occurring. Examples of recommendations which may be considered, include:

• Improving Signage by removing confusing / redundant signs, cleaning / replacing signs, etc.
• Improving Road Markings by removing old visible road markings, renewing/refreshing markings, etc.
• Improving road user visibility by adapting verge maintenance regime, removing street clutter, adding sign-/wall-mounted mirrors, etc.
• Reducing traffic speeds, e.g. change / remove road markings to reduce lane widths, reduce speed limits, reduce visibility at approaches to roundabouts, providing vehicle activated speed display signs, etc.
• Improving crossing facilities, e.g. pedestrian crossings, pedestrian barriers, etc.
• Reducing SCRIM Investigatory Level, if skid incident risk is deemed low.

If it is deemed that no actions or recommendations are required, "No Action / recommendations required" must be written in the box and signed by both lead officers.
Appendix 3: Aggregate Specification for Pavement Surfacing

The correct aggregate for road surfacing works is vital in the role of providing safe roads, meeting road users’ needs, reducing environmental impact and providing value for money.

HD37 and HD38 provide a summary of the different types of bituminous and concrete surfacing materials and techniques, providing advice and recommendations regarding the appropriate material for each situation. Use of this guidance is required when designing schemes.

Aggregate is graded depending on size and Polished Stone Value (PSV); an aggregate with a low PSV will polish quicker when compared to an aggregate with a higher PSV. PSV testing must be carried out in accordance with BS EN 1097-8:2000.

Due to the nature and risk of the road network, different PSV aggregates can be used in different locations. Table 4 on the following page is based on guidance from HD36 and gives the minimum PSV requirements depending on SC’s, risk factors and daily traffic flows.

HFS surfacing will be used, where warranted, following a risk assessment of the site. As a general rule, due to the lower traffic speeds and volumes on the Milton Keynes highway network aggregate with a high PSV will be applied.

Notes on Table 4

- SCs are grouped according to their general character and traffic behaviour. ILs for specific SCs are defined in Table 1 (page 13).
- The IL to be referenced here must be that which has been allocated to the specific site on which the material is to be laid.
- Dual carriageway slip roads may fit in a number of groups depending on their layout. Use the most appropriate group depending upon the SC that was used to determine the IL.
- Where ‘68+’ PSV material is listed, none of the three most recent results from consecutive PSV tests relating to the aggregate to be supplied must fall below 68. See HD29 paragraph 3.21.
- HFS incorporates calcined bauxite aggregate and conforming to Clause 924 of the Specification, MCHW 1. Where HFS is required on the approaches to a hazard, the minimum treatment length recommended is 50m. This relates specifically to high-speed roads, in particular trunk roads and motorways. For local roads, on which traffic volumes and speeds are lower than on the Highways England’s network, a site investigation should be undertaken to determine the suitability of HFS.
- For site categories G, S and R, any PSV in the range given for each traffic level may be used for any IL and should be chosen on the basis of local experience of material performance. In the absence of this information, the values given for the appropriate IL and traffic level must be used.
- Where designers have the necessary expertise and experience of particular site conditions, an alternative PSV value may be specified, with justification.
- Site categories K and Q should not be applied to the circulatory parts of a roundabout.
Table 4: Minimum required PSV for chippings/aggregate in bituminous surfacing.

<table>
<thead>
<tr>
<th>Site Category</th>
<th>Site Description</th>
<th>IL</th>
<th>Minimum PSV required for given IL, traffic level and type of site</th>
<th>Traffic (cv/lane/day) at design life</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0-250</td>
</tr>
<tr>
<td>B</td>
<td>Dual carriageway non-event</td>
<td>0.35</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.4</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>C</td>
<td>Single carriageway non-event</td>
<td>0.4</td>
<td>55</td>
<td>50</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.45</td>
<td>60</td>
<td>60</td>
</tr>
<tr>
<td>G</td>
<td>Gradient 5% or greater and longer than 50m</td>
<td>0.45</td>
<td>55</td>
<td>60</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.5</td>
<td>60</td>
<td>68+</td>
</tr>
<tr>
<td>K</td>
<td>Approaches to pedestrian crossings and other high-risk situations</td>
<td>0.45</td>
<td>68+</td>
<td>68+</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.5</td>
<td>65</td>
<td>65</td>
</tr>
<tr>
<td>Q</td>
<td>Approaches to and across minor and major junctions; approaches to roundabouts (where speed limit is 40mph or below)</td>
<td>0.45</td>
<td>60</td>
<td>65</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.5</td>
<td>65</td>
<td>65</td>
</tr>
<tr>
<td>Q</td>
<td>Approaches to and across minor and major junctions; approaches to roundabouts (where speed limit is above 40mph)</td>
<td>0.5</td>
<td>65</td>
<td>65</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.55</td>
<td>68+</td>
<td>68+</td>
</tr>
<tr>
<td>R</td>
<td>Roundabout (where speed limit is 40mph or below)</td>
<td>0.45</td>
<td>50</td>
<td>55</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.5</td>
<td>68+</td>
<td>68+</td>
</tr>
<tr>
<td>R</td>
<td>Roundabout (where speed limit is above 40mph)</td>
<td>0.5</td>
<td>68+</td>
<td>68+</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.55</td>
<td>68+</td>
<td>68+</td>
</tr>
<tr>
<td>S</td>
<td>Bend Radius &lt;250m (where speed limit is 50mph or above)</td>
<td>0.5</td>
<td>68+</td>
<td>68+</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.55</td>
<td>HIGH</td>
<td>PSV/HFS</td>
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## Glossary of Acronyms

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADEPT</td>
<td>Association of Directors of Environment, Economy, Planning &amp; Transport</td>
</tr>
<tr>
<td>BS</td>
<td>British Standard</td>
</tr>
<tr>
<td>CSC</td>
<td>Characteristic Skid Coefficient: an estimate of the skid resistance accounting for the effects of seasonal variation.</td>
</tr>
<tr>
<td>DMRB</td>
<td>The Design Manual for Roads and Bridges</td>
</tr>
<tr>
<td>GIS</td>
<td>Geographic Information System: a system designed to capture, store, manipulate, analyse, manage, and present all types of geographical data.</td>
</tr>
<tr>
<td>HE</td>
<td>Highways England: the authority responsible for managing and maintaining the Trunk Road network.</td>
</tr>
<tr>
<td>HAPAS</td>
<td>Highways Authorities Product Approval Scheme</td>
</tr>
<tr>
<td>HD28</td>
<td>DMRB 7.3.1: Skidding Resistance. The current version dates from 2015</td>
</tr>
<tr>
<td>HD29</td>
<td>DMRB 7.3.2: Data for Pavement Assessment, 2008</td>
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<td>HD36</td>
<td>DMRB 7.5.1: Surfacing Materials for New and Maintenance Construction, 2006</td>
</tr>
<tr>
<td>HD37</td>
<td>DMRB 7.5.2: Bituminous Surfacing Materials and Techniques, 1999</td>
</tr>
<tr>
<td>HD38</td>
<td>DMRB 7.5.3: Concrete surfacing and Materials, 2016</td>
</tr>
<tr>
<td>HFS</td>
<td>High Friction Surfacing material: road surfacing material with high skid resistance properties.</td>
</tr>
<tr>
<td>IHE</td>
<td>Institute of Highway Engineers</td>
</tr>
<tr>
<td>IL</td>
<td>Investigatory Level: pre-defined limit of minimum acceptable skid resistance, applied to specific sites.</td>
</tr>
<tr>
<td>KSI</td>
<td>Killed or Seriously Injured; in relation to accidents.</td>
</tr>
<tr>
<td>LPV</td>
<td>Longitudinal Profile Variance</td>
</tr>
<tr>
<td>Abbreviation</td>
<td>Definition</td>
</tr>
<tr>
<td>--------------</td>
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</tr>
<tr>
<td>MCHW</td>
<td>Manual of Contract Documents for Highway Works</td>
</tr>
<tr>
<td>PSV</td>
<td>Polished Stone Value: provides a measure of the resistance of road aggregates to polishing under the action of vehicles and other effects.</td>
</tr>
<tr>
<td>SASS</td>
<td>Single Annual Skid Survey: a method of programming SCRIM surveys and processing their results to account for seasonal variations of skid resistance.</td>
</tr>
<tr>
<td>SC</td>
<td>Site Category: categorisation of a site on the SCRIM network based on the characteristics of that site in relation to wet-skidding incident risk.</td>
</tr>
<tr>
<td>SCANNER</td>
<td>Surface Condition Assessment National Network of Roads – machine survey which collects data on a range of items contributing to a road condition index for classified roads.</td>
</tr>
<tr>
<td>SCRAM</td>
<td>Sideways-force Coefficient Routine Investigation Machine, used to perform skid resistance surveys.</td>
</tr>
<tr>
<td>SMA</td>
<td>Stone Mastic Asphalt: durable road surfacing material.</td>
</tr>
<tr>
<td>SRV</td>
<td>Skid Resistance Value</td>
</tr>
<tr>
<td>TRL</td>
<td>Transport Research Laboratory</td>
</tr>
<tr>
<td>UKPMS</td>
<td>United Kingdom Pavement Management System (the UK national standard for pavement management systems)</td>
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## References

<table>
<thead>
<tr>
<th>Document</th>
<th>Publisher and Retrievable Location</th>
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</table>
| The Design Manual for Roads and Bridges       | Department For Transport  
www.gov.uk/guidance/standards-for-highways-online-resources#the-design-manual-for-roads-and-bridges                                                             |
| HD28 on Skidding Resistance                   | Department for Transport  
http://www.standardsforhighways.co.uk/ha/standards/dmrb/vol7/section3.htm                                                                                 |
| Well-Managed Highway Infrastructure           | Roads Liaison Group  
| Horses and Highway Surfaces                   | British Horse Society/ADEPT (formerly County Surveyors Society)  
| Guidelines for Motorcycling                   | Institute of Highway Engineers  
http://www.motorcycleguidelines.org.uk/the-guidelines/3-0-road-design-traffic-engineering/3-4-road-design/                                                          |
| Manual of Contract Documents for Highway Works| Department For Transport  
www.gov.uk/guidance/standards-for-highways-online-resources#the-manual-of-contract-documents-for-highway-works                                                        |
| Surface Treatment Measurement on Local Roads PPR148 | TRL  
https://trl.co.uk/reports/PPR148                                                                                                                                  |
| Traffic Signs Regulations and General Directions | Department for Transport  

NB: all HDs referenced in this document may be retrieved from the location provided for the Design Manual for Roads and Bridges. The direct location is provided for HD28/15 only given its significance for this document.