INTERIM ADVICE NOTE 42/05

TRAFFIC-SPEED CONDITION SURVEYS (TRACS): REVISED ASSESSMENT CRITERIA

SUMMARY

This Interim Advice Note provides guidance on the condition data collected by the TRACS survey vehicle, as presented in **Confirm**, and on the interpretation of this data

INSTRUCTIONS FOR USE

This edition of IAN 42/05, supersedes IAN 42/02 issued April 2002

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Interim Advice Note 42/05 (IAN 42/05)

Traffic-speed Condition Surveys (TRACS): Revised Assessment Criteria

1. Introduction

1.1. For the trunk road network in England, surveys carried out under the Highways Agency (HA) TRAffic-speed Condition Survey (TRACS) contract replaced the previous High-speed Road Monitor (HRM) surveys in the summer of 2000.

1.2. TRACS surveys are carried out using survey vehicles equipped with lasers, video image collection and inertial measurement apparatus to enable surveys of the road surface condition to be carried out whilst travelling at variable speeds, of up to 100 km/h, to match prevailing traffic, and hence cause minimum disruption to other road users.

1.3. In the 2000/2001 financial year, TRACS surveys were carried out over both lanes of single carriageways and lane 1 of the main carriageway on dual carriageways. From the spring of 2001, the surveys were expanded to include annual surveys of lane 2 of dual carriageways, and lane 1 of slip roads. Roundabouts are excluded from TRACS surveys.

1.4. TRACS surveys are controlled by an end result specification for the survey equipment and a detailed Quality Audit procedure for the surveys includes regular independent checks to maintain quality assurance.

1.5. This Interim Advice Note provides guidance on the condition data collected by the TRACS survey vehicle, as presented in **Confirm**, and on the interpretation of this data.

1.6. Previous advice with regard to the use of TRACS data was provided in Interim Advice Note 42/02. This document supersedes Interim Advice Note (IAN) 42/02. The key changes described in this Interim Advice Note are:

- Changes to the Investigation Levels for Texture Depth, see Table 3.1
- Changes to the interpretation of Longitudinal Profile, specifically the replacement of Moving Average Longitudinal Profile Variance with Enhanced Longitudinal Profile Variance, and new Investigation Levels for the assessment of Enhanced Longitudinal Profile Variance, see Table 3.2
- Revised advice and guidance levels for Cracking, see Table 3.3
- Advice and guidance levels for the use of Fretting data on Hot Rolled Asphalt surfaces, see Table 3.4
- Advice and guidance levels for the use of Noise data, see Table 3.5
- Advice for the use of Surface Type data
- Advice on the availability of Geometry data
- Advice on the availability of Video records

1.6 Table 1.1 summarises the advice provided in this Interim Advice Note in relation to previous guidance provided for the use of TRACS data in Interim Advice Note 42/02.

1.7 This Advice Note is for the assessment of TRACS data only, and should not be applied to the assessment of HRM data, which has not been used in the measurement of condition of the Trunk Road network since 1999.

Table 1.1: Status of this Interim Advice Note (IAN)

Parameter	Status of this Interim Advice Note (IAN)
Texture Depth	Supersedes the advice in IAN 42/02 for all TRACS data
Rut Depth	Supersedes the advice in IAN 42/02 for all TRACS data
Ride Quality	Enhanced Longitudinal Profile Variance (LPV) supersedes Moving Average LPV for all TRACS data collected after 1st June 2004. This IAN provides new thresholds for the assessment of Enhanced LPV. Appendix A provides advice concerning the assessment of Moving Average LPV data provided by TRACS before 1st June 2004.
Cracking	Supersedes the advice in IAN 42/02 for all TRACS data
Fretting	Fretting data is provided for TRACS data collected after 1st June 2004. This IAN contains new advice and guidance levels not previously provided for the assessment of Fretting data and cannot be applied to TRACS data collected before 1st June 2004.
Noise	Noise data is provided from TRACS data collected after 1st June 2004. This IAN contains new advice and guidance levels not previously provided for the assessment of noise data.

1.8 The TRACS survey vehicle measures:

- Texture Profile in the nearside wheel-track at approximately 1mm longitudinal intervals
- Transverse Profile across a 3.2m width at approximately 0.1m longitudinal intervals
- Longitudinal Profile in the nearside wheel-track at approximately 0.1m longitudinal intervals
- Cracking over a width of 3.2m (continuous monitoring)
- Vehicle geographical position (Northing, Easting and altitude) as well as Road Geometry (gradient, crossfall and curvature) at discrete 5m intervals
- A forward-facing video record of the road being surveyed

1.9 All data collected by the TRACS survey vehicle is referenced to the start of network referencing Sections to a longitudinal accuracy of ± 1m.

1.10 The TRACS survey data is delivered in raw form as TRACS Raw Condition Data (RCD). The Highways Agency's Machine Survey Pre-processor (MSP) software, developed as part of the Highways Agency Pavement Management System (HAPMS) programme, is used to process the RCD to generate the TRACS Base Condition Data (BCD), which contains:

- Rut Depths in the nearside and offside wheel-tracks calculated from the measured Transverse Profile, over 10m lengths
- 3m, 10m and 30m Enhanced Longitudinal Profile Variance calculated from the measured Longitudinal Profile, over 10m lengths
- Intensity of Cracking calculated from the crack map, over 10m lengths
- Intensity of Wheel-track Cracking calculated from the crack map, over 10m lengths
- Sensor Measured Texture Depth (SMTD), calculated from the measured Texture Profile, over 10m lengths
- Crack map
- An estimate of the level of Fretting present on the pavement, calculated from the measured Texture Profile, over 10m lengths
- An estimate of the level of road/tyre noise, calculated from the measured Texture Profile, over 10m lengths
- An estimate of the Surface Type, over 10m lengths
- The road Geometry (gradient, crossfall and curvature), over 10m lengths

1.11 The TRACS BCD is loaded into **Confirm**, the main database/application for HAPMS.

1.12 **Confirm** provides maintenance engineers with access to the condition data collected from their network, and enables them to identify potential maintenance schemes and to monitor the network performance. The TRACS BCD can be queried in **Confirm** and reported on using the database facilities, and can be displayed against a map background. **Confirm** also provides reports and information in support of the development of the Road Renewals maintenance programme. The on-line facilities in **Confirm** provide a fuller guide to the presentation of project information.

1.13 TRACS survey data is reported within **Confirm** in relation to the Sections defined for network referencing, but there may be gaps in the data. These gaps arise for a variety of reasons (e.g. where the survey vehicle drove out of lane due to obstructions or road works, or where the survey data has been identified as Unreliable).

1.14 From an examination of the TRACS condition data in **Confirm**, lengths of road with deteriorating surface condition can be identified. Examples of the use of TRACS condition data include:

- Rut Depths can be used to evaluate safety and structural aspects of the pavement surface condition
- The Longitudinal Profile Variance can be used to assess Ride Quality
- Texture Depth data can be used to indicate a potential loss of skid resistance, in connection with SCRIM data, or provide warning of some modes of surface failure
- The Cracking and Fretting data, together with the Surface Type data can be used to evaluate the condition of the surface
- The Noise and Surface Type data can be used to aid investigations of the noise levels generated by the road/tyre interaction on the pavement

2. Assessment of Road Condition using TRACS Data

2.1 An overview of the condition, or the trend in condition, of road pavements is required to give an indication of the scale of possible maintenance requirements and to identify changes in the general level of service provided over a period of time. At a more detailed level, lengths of road requiring further investigation need to be identified and prioritised.

2.2 The results of an analysis of the TRACS survey data may be used as a coarse sift to identify lengths of road in need of further investigation or to supplement other road condition data to provide a robust road maintenance proposal.

2.3 To undertake the assessment, the TRACS condition data (with the exception of TRACS Surface Type) should be obtained from **Confirm** using the most recent TRACS Combined Length Weighted (LW) Averages data source.

2.4 The TRACS Surface Type may be obtained using the **Confirm** TRACS – Base Surface Type data source.

2.5 Section 3 of this Interim Advice Note provides assessment criteria for the evaluation of TRACS data.

2.6 For Texture Depth, Rut depth and Ride Quality, the TRACS survey data can be assessed by means of four Condition Categories, as shown in Table 2.1. These Condition Categories are defined by threshold values applicable to each parameter measured by the TRACS survey vehicle, which are set out in Section 3.

2.7 For any 100m length in Condition Category 4, a more detailed investigation should be carried out at the earliest opportunity and the need for maintenance assessed.

2.8 Similarly, where two or more 100m lengths in Condition Category 3 fall within any 1km, the cause of the deterioration should be investigated to determine if maintenance or other actions are necessary.

Table 2.1: Condition Categories

Category	**Definition**
1	<u>Sound</u> – no visible deterioration
2	<u>Some deterioration</u> – lower level of concern. The deterioration is not serious and more detailed (project level) investigations are not needed unless extending over long lengths, or several parameters are at this category at isolated positions
3	<u>Moderate deterioration</u> – warning level of concern. The deterioration is becoming serious and needs to be investigated. Priorities for more detailed (project level) investigations depend on the extent and values of the condition parameters
4	<u>Severe deterioration</u> – intervention level of concern. This condition should not occur very frequently on the motorway and all purpose trunk road network as earlier maintenance should have prevented this state from being reached. At this level of deterioration more detailed (project level) investigations should be carried out on the deteriorated lengths at the earliest opportunity and action taken if, and as, appropriate.

2.9 Priority for treatment will depend on the type, extent, distribution and severity of deterioration and the strategic objectives for road maintenance.

2.10 For the assessment of Cracking, Fretting and Noise, this Interim Advice Note provides guidance levels, specified in Section 3, which may be used as an aid in the interpretation of the Cracking, Fretting and Noise values reported in **Confirm**. For these measures, it is not appropriate to apply the classification system defined in Table 2.1.

2.11 When carrying out the assessment it is recommended that reference be made to the detailed descriptions and further guidance concerning the TRACS measurement of the Texture Profile, Transverse Profile, Longitudinal Profile, Cracking, Fretting and Noise given in Appendix A of this Interim Advice Note.

2.12 In particular, when determining the cause of significant levels of Cracking, it is recommended that the crack map be examined to determine the distribution and type of cracking present. Guidance on the interpretation of the crack map is given in Appendix A.

2.13 The Highways Agency should be contacted if more information is required about the interpretation of data collected under the TRACS contract.

3. Assessment Criteria

General

3.1 This Section describes the interpretation of each of the condition parameters measured by the TRACS survey vehicle and gives threshold levels or assessment criteria for evaluating the extent of pavement deterioration, as detailed in Section 2. The assessment criteria are based on experience gained from the HA's ongoing research and development programme, and are currently considered to be the most appropriate criteria for condition assessment. However, they may change in the future as a result of further research.

3.2 All the threshold values and guidance levels given in this Interim Advice Note are based on characteristic values associated with 100m lengths.

3.3 The thresholds specified in Table 3.1 and Table 3.2 are for the assessment of current TRACS data collected from in-service roads, as opposed to newly constructed roads.

Texture Depth

3.4 Texture Depth values in the TRACS Combined Length Weighted (LW) Averages data source in **Confirm** are calculated using the Sensor Measured Texture Depth (SMTD) method.

3.5 The threshold values for TRACS LW Average Texture Depths are given in Table 3.1. These values differ from the threshold values given in Interim Advice Note 42/02.

3.6 Table 3.1 shows that lengths of the network having lower values of Texture Depth are placed in the higher (worse) condition categories.

3.7 Changes in the Texture Depth of the road surface can indicate a potential loss of skid resistance or some modes of surface failure, e.g. Fretting (resulting in a high Texture Depth) or Fatting-up or embedment of chippings (resulting in a low Texture Depth). Advice on the interpretation of Texture Depth data in connection with skid resistance is given HD28/04. Specifically, HD28/04 requires the Investigatory Level for skid resistance to be increased for surfaces (except High Friction Surfacing materials - HFS) with Texture Depth below 0.8mm SMTD (Category 3). Therefore, any location where the Texture Depth (except for HFS) triggers Category 3 or above must be reviewed in the context of HD28/04.

3.8 Locations where the Texture Depth (except for HFS) triggers Category 4 will require urgent intervention if the nature of the surface condition means that further loss of texture can reasonably be expected, e.g. Fatting-up of a surface. Conversely, no action may be required if the Texture Depth is stable and a risk assessment undertaken in the context of HD28/04 does not indicate an elevated level of risk. Therefore, a more detailed investigation will be needed to determine the appropriate response.

3.9 Different thresholds are applied to High Friction Surfaces because of the different ways in which texture is provided by these materials. For these materials, the SMTD value is not an appropriate means of defining Condition Category 2 or higher. In this case, maintenance decisions should also take account of SCRIM results and the results of visual surveys.

Rut Depth

3.10 **Confirm** stores Rut Depth information as the average Rut Depth for each wheel-track over a 10m length. This base data is then used to calculate representative values of rutting for the required reporting lengths.

3.11 **Confirm** uses the stored rut information to calculate the following LW Average values:

- Left Rut (using the left wheel-track values only)
- Right Rut (using the right wheel-track values only)
- Average Rut (using both wheel-track values)
- Maximum Rut (using the maximum wheel-track values from each 10m)

3.12 Table 3.1 shows threshold values for the TRACS LW Average Maximum Rut measurements. Note that concrete surfacings should give negligible Rut Depths.

3.13 The threshold values for Rut Depth in Table 3.1 of this Interim Advice Note are unchanged from those specified for use with TRACS measurements in Interim Advice Note 42/02.

3.14 It is recommended that, where any length has been identified for further investigation as a result of high levels of rutting, comparison be made between the Left Rut and Right Rut LW Average values contained within **Confirm** as a check on the self-consistency of the rut measurements – see Appendix A.

Table 3.1: Rutting and Texture Depth Criteria for TRACS measurements (100m lengths)

Category →	1	**Threshold Value** ↓	2	**Threshold Value** ↓	3	**Threshold Value** ↓	4
Maximum Rut (mm)		6		11		20	
Texture Depth (mm):							
Anti-skid surfacing (HFS)		0.6		N/A		N/A	
All other surfaces		1.1		0.8		0.4	

Ride Quality

3.15 From the commencement of the fifth year of TRACS surveys on 1st June 2004, Enhanced Longitudinal Profile Variance (LPV) replaced Moving Average Longitudinal Profile Variance for the assessment of Ride Quality. A description of Enhanced LPV is provided in Appendix A of this Interim Advice Note.

3.16 The assessment of Ride Quality is carried out using three Enhanced Longitudinal Profile Variance values, that indicate the level of profile unevenness within wavelength ranges less than or equal to 3m, 10m and 30m. It has been found that measurements within these wavelength ranges may be broadly related to levels of ride comfort.

3.17 The Enhanced Longitudinal Profile Variance data is therefore reported within the TRACS Length Weighted Averages data source in **Confirm** as LPV 3m, LPV 10m and LPV 30m.

3.18 The threshold values for the assessment of the TRACS LW Average Enhanced LPV measurements within the three wavelength ranges are given in Table 3.2, and should be applied for all TRACS Enhanced LPV data reported in **Confirm** for surveys carried out since 1st June 2004.

3.19 Note that different threshold values are specified within Table 3.2 for different road classifications (which can be abstracted from **Confirm**), e.g. a Motorway requires a better standard of Ride Quality than an urban single carriageway, where traffic is generally travelling at a lower speed.

3.20 When assessing the Enhanced LPV data it should be noted that:

- The Ride Quality measurements provided by TRACS surveys prior to 1st June 2004 were reported as Moving Average Longitudinal Profile Variance, which are also reported in **Confirm** as 3m, 10m and 30m LPV. To distinguish between Moving Average LPV and Enhanced LPV the TRACS Length Weighted Average LPV data source in **Confirm** provides an additional label for the LPV data called "Enhanced".
- The threshold levels for Enhanced Longitudinal Profile Variance in Table 3.2 differ from those applied for the assessment of Moving Average Longitudinal Profile Variance given in Interim Advice Note 42/02. Reference should be made to Appendix A for the assessment of TRACS Moving Average Longitudinal Profile Variance data (collected before 1st June 2004).

Table 3.2: Ride Quality criteria for roads of all types of construction for TRACS measurements (Enhanced Longitudinal Profile Variance, 100m lengths)

Category →	1 **Threshold Value** ↓	2 **Threshold Value** ↓	3 **Threshold Value** ↓ 4
1. MOTORWAYS AND RURAL DUAL CARRIAGEWAYS(†)			
Enhanced Variance (mm²)			
3m	0.7	2.2	4.4
10m	1.6	6.5	14.7
30m	22	66	110
2. URBAN DUAL CARRIAGEWAYS (†)			
Enhanced Variance (mm²)			
3m	0.8	2.2	5.5
10m	2.8	8.6	22.8
30m	30	75	121
3. RURAL SINGLE CARRIAGEWAY ROADS (†)			
Enhanced Variance (mm²)			
3m	0.8	2.2	5.5
10m	2.8	8.6	22.8
30m	30	75	121
4. URBAN SINGLE CARRIAGEWAY ROADS (†)			
Enhanced Variance (mm²)			
3m	1.4	3.8	9.3
10m	6.1	18.3	36.6
30m	48	97	193

(†)Based on the road classifications in **Confirm**

Cracking

3.21 Guidance levels for the TRACS LW Average Whole Carriageway Cracking intensities are given in Table 3.3 The guidance levels have been derived from on-going research into the TRACS measurement of cracking and should be used as guidelines for identifying lengths having higher relative levels of Cracking.

3.22 The guidance levels defined in Table 3.3 should be applied in the assessment of all Whole Carriageway Cracking derived from TRACS surveys (i.e. for all survey years).

3.23 As described in Appendix A, the TRACS survey vehicle relies on crack identification software to automatically identify cracks in the road surface. Research has shown that the measurement and the interpretation of the types of Cracking made by the crack identification software may differ from that made by the inspector carrying out a manual visual survey over the same site. As a result of this the intensities of Cracking measured by the TRACS survey vehicle are generally lower than those recorded by the visual inspector. This behaviour is reflected by the low magnitudes for the guidance levels given in Table 3.3.

3.24 It has also been shown that, on Hot Rolled Asphalt (HRA) surfaces, the sensitivity of the TRACS crack identification software is higher than on other, finer textured, bituminous surfaces. To cater for this difference in sensitivity, higher guidance levels are specified for HRA surfaces in Table 3.3.

3.25 As separate guidance levels are defined in Table 3.3 for Hot Rolled Asphalt surfaces and other bituminous surfaces, the correct Surface Type must be known for the assessment of Cracking data.

3.26 Monitoring of the behaviour of the TRACS Cracking intensities recorded on the network has shown that they can be affected by variations in the survey conditions, which thereby influence the relative intensities of cracking reported. As a result, the intensities recorded in surveys carried out in consecutive survey years can vary and, when applying analyses based on threshold levels, the categories within which the Cracking measurements fall may change from survey year to survey year. Therefore:

- As the variability in the TRACS cracking intensities can introduce a degree of uncertainty in the cracking measurements the thresholds defined in Table 3.3 are provided for guidance only, to aid in identifying lengths in need of further investigation.
- It is not recommended that the intensities of cracking be used in the trending of pavement condition.
- It is essential that, where any length has been identified for further investigation, examination be undertaken of the crack map data contained in **Confirm** for the length under investigation before further action is taken
- Further advice regarding the assessment of the cracking data is provided in Appendix A.

3.27 No guidance levels are currently specified for the intensity of Wheel-track Cracking.

3.28 It can be seen that no thresholds are specified in Table 3.3 for the intensities of Whole Carriageway Cracking measured on concrete surfaces. Although the TRACS survey vehicle provides a measure of the extent of Cracking present on concrete surfaces it has been found that the system may falsely record the presence of joints or grooves in concrete roads as cracks. These false cracks are added to the Cracking area and lead to a higher level of Cracking being reported on this Surface Type. Therefore it is recommended that Cracking intensities derived from the TRACS crack data are not used to directly assess the condition of concrete surfaces within Condition Categories. However, for concrete surfaces the crack map may be utilised to aid in the assessment of the condition of the pavement.

Table 3.3: Guidance levels for TRACS Whole Carriageway Cracking intensities (100m lengths). Reference should be made to the advice given in Appendix A when assessing the Cracking data

Category →	Low	**Threshold Value** ↓	Moderate	**Threshold Value** ↓	High
Whole Carriageway Cracking (%)					
Bituminous Surface – Hot Rolled Asphalt		0.45		1.5	
Bituminous Surface – Other		0.15		0.5	
Concrete Surface		N/A		N/A	

Fretting

3.29 Ongoing research into the use of TRACS condition data has shown that the Texture Profile data can be used for the estimation of the intensity of Fretting present on Hot Rolled Asphalt surfaces. From 1st June 2004 algorithms to estimate the intensity of Fretting were included in the MSP for the provision of Fretting data within **Confirm**.

3.30 The application of the automated Fretting measure should be considered with the knowledge that the use of such data is in its infancy. Therefore in this Interim Advice Note thresholds are provided for guidance only. The guidance levels for the TRACS LW Average Fretting data are presented in Table 3.4.

3.31 As the Fretting measure applies only to Hot Rolled Asphalt surfaces, for the assessment of Fretting the correct Surface Type must be known.

3.32 The Fretting measure can be used to assess the presence of minor deterioration and in particular aid in the assessment of Cracking. Guidance on the use of the Fretting measure is given in Appendix A.

Table 3.4: Guidance Levels for Fretting (100m lengths)

Category →	Low	**Threshold Value (%)** ↓	Moderate	**Threshold Value (%)** ↓	High	**Threshold Value (%)** ↓	Severe
Bituminous Surface – Hot Rolled Asphalt		0.20		1.15		1.80	
Bituminous Surface – Other		N/A		N/A		N/A	

Noise

3.33 Further research into the use of TRACS condition data has shown that the Texture Profile data can be used to estimate the intensity of the noise generated at the tyre/road interface. From 1st June 2004 algorithms to estimate tyre road noise were included in the MSP for provision of Noise data within **Confirm**.

3.34 The TRACS Noise data can be used to provide an indication of the potential benefit of providing lower noise surfacings for sites where noise levels have been identified as an issue. However, the implementation of the TRACS Noise measure is still being developed and the noise prediction algorithms may be improved in future enhancements of the system. Furthermore, the intensity of tyre/road noise predicted does not correlate directly with the roadside noise level, which is influenced by the volume, type and speed of traffic; nor does it indicate the noise experienced at nearby properties, which is influenced by their distance from the road and the presence of natural or man made barriers. Therefore, in this Interim Advice Note, Noise thresholds are provided as an initial classification of the surface noise properties. Where the noise benefits of a proposed maintenance scheme form a key part of the justification for carrying out the works, the TRACS LW Average Noise measure must be supplemented by more detailed project level investigations.

3.35 The guidance levels for the TRACS LW Average Noise measurements are presented in Table 3.5. Pavements exhibiting higher levels of Noise are placed in higher Categories with Category G having the highest noise level.

Table 3.5: Guidance levels for Noise (100m lengths)

Category→	A	**Threshold Value**	B	**Threshold Value**	C	**Threshold Value**	D	**Threshold Value**	E	**Threshold Value**	F	**Threshold Value**	G
All Surface Types (dB(A))		101.5		102.3		103.8		104.8		105.2		105.6	

3.36 As the noise prediction algorithm in MSP relies on the correct identification of the Surface Type in the TRACS predicted Surface Type (see paragraphs 3.38 - 3.42), the TRACS Noise measure must not be used in cases where the TRACS predicted Surface Type data disagrees with the actual Surface Type. Therefore for the assessment of the TRACS Noise data the correct Surface Type must be known.

3.37 In particular it should be borne in mind that:

- If the TRACS predicted Surface Type is incorrect for a significant proportion of the length under investigation then the TRACS Noise prediction is likely to be inaccurate. Therefore, the TRACS predicted Surface Type data must be reviewed before using the corresponding TRACS Noise data.
- The TRACS Noise data can only be generated for the range of Surface Types that can be identified by the TRACS predicted Surface Type algorithms. Where the actual Surface Type is not contained within the range of Surface Types that the TRACS predicted Surface Type algorithms can distinguish, the TRACS Noise measure is likely to be in error. In particular, porous surfaces may be misclassified by the system.

Predicted Surface Type

3.38 Developments undertaken in the processing of the TRACS data have provided methods to estimate the Surface Type from the TRACS Texture Profile data, within four categories:

- HRA
- Thin Surfacing Systems
- Brushed Concrete
- Grooved Concrete

3.39 The TRACS predicted Surface Type information may be obtained from the **Confirm** TRACS - Base Surface Type Data data source in **Confirm**.

3.40 It should be noted that the TRACS predicted Surface Type is an estimate obtained from the Texture Profile and may therefore be subject to error. It should be noted in particular that the TRACS predicted Surface Type algorithms will always generate a predicted Surface Type, even when the true Surface Type does not fall within the four categories listed in paragraph 3.38. For example, it has been observed that the TRACS predicted Surface Type often reports High Friction Surfaces (which are not contained within the current list of identifiable surfaces) as brushed concrete.

3.41 The TRACS predicted Surface Type information is used as the basis of the tyre/road noise estimate. Therefore where the TRACS predicted Surface Type is incorrect, the noise estimate will also be inaccurate.

3.42 Users may consider using **Confirm** to plot the surface layer of the construction data alongside the TRACS predicted Surface Type to assist in the assessment of the accuracy of their construction records within **Confirm,** which will remain the primary source of surface type information.

Road Geometry

3.43 The TRACS survey vehicle records the instantaneous gradient, crossfall and radius of curvature of the pavement at intervals of 5m.

3.44 The geometry data can be obtained from **Confirm** using the TRACS – Base Geometric Data data source.

3.45 The data values contained in the TRACS – Base Geometric Data are reported in units of percent (for gradient and crossfall) and metres (for radius of curvature). There are no thresholds specified for the assessment of geometric data.

Video Record

3.46 The TRACS survey vehicle is equipped with a digital forward-facing video camera that collects a video record of the road being surveyed. The record collected by the forward-facing video camera during the TRACS surveys carried out in 2003/4 was loaded on to a server for use by HA Regional Offices.

3.47 The digital video was also transferred to hard disks (separate Areas being stored on separate disks), and the disks were distributed to each MA/MAC. The TRACS Forward Facing Video system, provided with the video images, should be used to view the digitised video record. (N.B. this is not within **Confirm**).

3.48 The provision of updates to the digital video data for surveys carried out after 2003/4 is under review.

4. References

4.1 Design Manual for Roads and Bridges, Volume 7 Section 3, Part1, HD28/04 "Skidding resistance"

4.2 Design Manual for Roads and Bridges, Volume 7 Section 3, Part2, HD29/94 "Structural assessment methods"

4.3 Interim Advice Note IAN 42/02, Highways Agency

Appendix A Further Description of the Condition Data Collected by the TRACS Contract.

A1 Texture Depth

A1.1 The surface Texture Depth measured by the TRACS survey vehicle is the coarser element of macrotexture and the finer element of megatexture formed by aggregate particles in the surfacing material, e.g. the chippings rolled into an asphalt mortar, or by brushing or grooving on a concrete surface. Texture Depth contributes to skidding resistance, primarily at medium and high speeds, in two ways. Firstly, it provides drainage paths to allow water to be removed rapidly from the tyre/road interface. Secondly, the projections, which contribute to hysteresis losses in the tyre, are an important factor in the braking process.

A1.2 MSP calculates Sensor Measured Texture Depth (SMTD) from the raw Texture Profile measurements collected by the TRACS survey vehicle and averages them over 10m lengths for storage as Base Data within **Confirm**.

A2 Rut Depth

A2.1 To measure Rut Depth, the TRACS survey vehicle records the Transverse Profile of the road surface over a width of 3.2m using 20 laser sensors. The Transverse Profile measurements are processed in MSP, which uses an algorithm to simulate placing a notional 2m straight edge on the recorded Transverse Profile, and measuring the largest deviation from the straight edge to the Transverse Profile. This calculation is carried out for each wheel-track. MSP calculates the average of the individual Rut Depths for each wheel-track over 10m lengths for storage within **Confirm**.

A2.2 The Transverse Profile measurement method of Rut Depth determination used by the TRACS vehicle has been shown to be highly comparable with the measurements made using a conventional straight edge and wedge.

A2.3 TRACS Rut Depth measurements can sometimes be affected by variations in driving line. When the survey vehicle drives to the nearside of the traffic lane the lane edge marking may be included in the Transverse Profile measurement, giving rise to nearside Rut Depths that are higher than those actually present on the pavement. Similarly, driving to the offside can result in lower nearside Rut Depths.

A2.4 It is recommended that, where any length has been identified for further investigation as a result of deep Rut Depths, that comparison be made between the Left Rut and Right Rut LW Average values contained within **Confirm** as a check on the self-consistency of the Rut Depth measurements.

A3 Ride Quality

A3.1 The parameter used for the assessment of Ride Quality, or Profile Unevenness, is the Longitudinal Profile Variance of individual deviations of the profile relative to a datum obtained by removing (or filtering) longer wavelengths from the measured longitudinal profile.

A3.2 Until 1st June 2004 this filtering was achieved using a moving average, to derive the Moving Average Longitudinal Profile Variance. Research has shown that the use of the moving average method can result in features remaining in the profile that can give rise to high levels of variance as a result of the underlying geometry of the pavement (gradient, crossfall and curvature), which is noticeable, in particular, when assessing Ride Quality on roads having changes in geometry and, for example, at the approaches to roundabouts. By applying more sophisticated filters it is possible to reduce the occurrences of such falsely high levels of variance. These more sophisticated methods deliver values referred to as Enhanced Longitudinal Profile Variance.

A3.3 The Enhanced Longitudinal Profile Variance value reflects the unevenness associated with profile features that are equal to or less in wavelength than the length of the filter used to calculate the Enhanced Longitudinal Profile Variance. For example, the variance of deviations from a 3m filter reflects the unevenness of profile features with wavelengths equal to or less than approximately 3m.

A3.4 The measurement of Profile Unevenness can be used to investigate the Ride Quality of the pavement. The short, medium and long wavelength features found to relate with the perceived effect on vehicle ride are represented by variance from 3m, 10m and 30m filters respectively. The 3m, 10m and 30m Enhanced Longitudinal Profile Variance values are calculated from the TRACS longitudinal profile measurements by MSP and averaged over 10m lengths for storage within **Confirm**.

A3.5 As for Moving Average Longitudinal Profile Variance, high values of 3m Enhanced Longitudinal Profile Variance may arise from short wavelength features such as potholes, poor reinstatements and faulting (in concrete roads) that cross the nearside wheel-track. Extremes of 10m Enhanced Longitudinal Profile Variance may arise from poor reinstatements along the wheel-track, the presence of high and/or variable levels of rutting, and bay length irregularities (in concrete roads). High levels of 30m Enhanced Longitudinal Profile Variance may be associated with subsidence. However, the 30m Enhanced Longitudinal Profile Variance may also be affected by changes in crossfall and/or gradient along the length.

A3.6 It should be noted that high levels of Profile Unevenness do not only affect Ride Quality. High levels of Profile Unevenness, particularly in the 3m and 10m wavelength ranges, have been shown to contribute to increased dynamic loading of the pavement, hence accelerating the deterioration of the road pavement. Extremes of Profile Unevenness can also lead to increased stopping distances, and can have an adverse effect on vehicle manoeuvrability.

A3.7 The values of 3m, 10m and 30m Enhanced Longitudinal Profile Variance calculated from TRACS Longitudinal Profile measurements should not be compared directly with values of 3m, 10m and 30m Moving Average Longitudinal Profile Variance, as provided by TRACS surveys carried out prior to 1st June 2004, or with the values of Moving Average Longitudinal Profile Variance provided by HRM surveys, as there are significant differences in the scaling of the data (the Enhanced Longitudinal Profile Variance measure generally reports lower values, as reflected by the decreased threshold levels given in Table 3.2 of this IAN in comparison with IAN 42/02). However, the Moving Average Longitudinal Profile Variance and Enhanced Longitudinal Profile Variance methods are well correlated. On lengths where there is little variation in the geometry they will, in general, agree with regard to the locations at which higher values are reported. On lengths containing variations in the geometry the Enhanced Longitudinal Profile Variance is likely to report lower values.

A3.8 Further research carried out on TRACS measurements has shown that the TRACS survey vehicle may provide Longitudinal Profile data having lower levels of accuracy when surveying at slow speed, or under conditions of significant acceleration or (more commonly) deceleration. To reduce the occurrence of low accuracy data, limits have been specified for the TRACS surveys for speed and acceleration/deceleration beyond which the data is considered invalid. Where these limits have been exceeded the data is marked as Unreliable in the TRACS Base LPV Data. The presence of a significant proportion of Unreliable values within any 100m length will result in missing values when the data is expressed as 100m Length Weighted Averages in **Confirm**.

A3.9 Ride Quality measurements provided by TRACS surveys prior to 1st June 2004 were reported as Moving Average Longitudinal Profile Variance. As the TRACS Length Weighted Averages data source in **Confirm** reports the most recent TRACS data, the data source may contain data collected prior to 1st June 2004.

A3.10 To distinguish between Moving Average LPV and Enhanced LPV, the TRACS Length Weighted Averages data source in **Confirm** provides an additional label for the LPV data called “Enhanced”. Where the label is not present this indicates that the value reported in the Confirm TRACS Length Weighted Averages data source is Moving Average Longitudinal Profile Variance

A3.11 Where it is required that an assessment be made of TRACS measurements of Moving Average Longitudinal Profile Variance (for TRACS surveys carried out before 1st June 2004) it will be necessary to apply the thresholds specified in Interim Advice Note 42/02, that were applicable to the assessment of Moving Average Longitudinal Profile Variance. These thresholds are reproduced in Table A3.1.

Table A3.1: Ride Quality criteria for roads of all types of construction for TRACS measurements obtained before 1st June 2004 (Moving Average Longitudinal Profile Variance, 100m lengths)

Category →	1 Threshold Value ↓ 2	Threshold Value ↓ 3	Threshold Value ↓ 4
1. MOTORWAYS AND RURAL DUAL CARRIAGEWAYS(†)			
Variance (mm^2)			
3m	1.3	4	8
10m	4	16	36
30m	55	165	275
2. URBAN DUAL CARRIAGEWAYS (†)			
Variance (mm^2)			
3m	1.5	4	10
10m	7	21	56
30m	75	187	300
3. RURAL SINGLE CARRIAGEWAY ROADS (†)			
Variance (mm^2)			
3m	1.5	4	10
10m	7	21	56
30m	75	187	300
4. URBAN SINGLE CARRIAGEWAY ROADS (†)			
Variance (mm^2)			
3m	2.5	7	17
10m	15	45	90
30m	120	240	480

(†)Based on the road classifications in **Confirm**

A4 Cracking

The TRACS crack identification system

A4.1 The measurement of Cracking by the TRACS survey vehicle is made using four downward facing video cameras that continuously collect images of the road surface over a transverse width of 3.2m. The video images from each camera are passed to a data processing system on-board the TRACS survey vehicle that automatically interprets the images to detect Cracking.

A4.2 The TRACS image collection system has a transverse and longitudinal resolution of approximately 2.5mm (the "pixel size"). The system is therefore unlikely to detect cracks in the road surface having widths less than 2.5mm.

A4.3 Cracking is reported as a "crack map" which describes the transverse and longitudinal position of each crack (reported as a straight line), the length of each crack and the angle of each crack relative to the direction of travel of the survey vehicle. The crack map can be viewed using facilities in **Confirm**.

A4.4 Crack maps are processed by MSP to obtain the intensity of Cracking over each 10m length, for storage within **Confirm**. To obtain the intensity of Cracking, MSP simulates the placing of a grid, made up of 0.2m squares, over the crack map. The percentage of grid squares containing at least part of one or more cracks is then evaluated over 10m lengths to give a value of Cracking (in %).

A4.5 Crack maps are also processed by MSP to obtain a measure of the intensity of Wheel-track Cracking over 10m lengths in both the left and right wheel-tracks. To calculate the intensity of left Wheel-track Cracking, MSP simulates the placing of a grid 0.8m wide over the left wheel-track, made up of 0.2m by 0.8m grid rectangles. The percentage of grid rectangles containing at least part of one or more cracks along the 10m length is evaluated to give a value of Wheel-track Cracking intensity (in %). The procedure is repeated for the right wheel-track.

A4.6 TRACS survey vehicles use crack identification software to identify the cracks present within each image collected. The software relies on the inherent darkness of the crack features within the images to enable the detection of the cracks. However, this darkness can also be associated with texture and chippings, which can give rise to the detection of "false positives", i.e. the reporting of cracks that were not really present in the image. It is recognised that there is a need to minimise the reporting of false positive cracks as these could lead to lengths being falsely reported as defective. Therefore, before commencing network surveys TRACS survey vehicles were assessed against the results of manual crack surveys, and calibrated to meet the needs of the Highways Agency road network. The calibration included the adjustment of the sensitivity of the system to minimise the reporting of false-positive cracks. However, reducing the sensitivity of the system to minimise false positives also affects the detection of "real" cracks. With reduced sensitivity, the system is likely to miss some cracks, and to only detect parts of other cracks. Therefore the total intensity of Cracking recorded by the TRACS survey vehicle will be lower than that recorded by an inspector in a manual crack survey.

A4.7 Furthermore, where a manual inspection will estimate the extent of the Cracking by placing a theoretical frame around the Cracking and recording the area within the frame, the MSP software will only record the total area of grid squares that contain cracks in the crack map. Since the grid squares are relatively small, the TRACS measurement will not tend to "fill-in" between cracks, as is the case when an inspector estimates an area of Cracking. It has been found that this contributes to an additional reduction in the area of Cracking recorded by the TRACS survey vehicle, in comparison with the results of a manual survey, regardless of the Surface Type.

A4.8 Research has shown that the sensitivity of the TRACS crack detection system is lower on finer textured surfaces, such as thin surfacing systems and surface dressing. It has been found that the intensity of Cracking on these Surface Types is reported at a level that is proportionately lower than Hot Rolled Asphalt (HRA) surfaces, and in particular fretted HRA surfaces. Therefore separate guidance levels for the assessment of Cracking data are specified for HRA and other bituminous surfaces in Table 3.3 of this Interim Advice Note.

Initial assessment of TRACS crack data

A4.9 As stated in paragraph 3.26, the TRACS measurement of cracking is subject to a degree of variability that can result in changes in the intensities of cracking reported over individual 100m lengths from survey year to survey year, even when the actual surface condition (cracking) has not changed significantly. Reasons for these changes in intensity include:

- Variations in driving line can result in the identification of road edge features that contribute to the cracking intensity recorded in one survey year, but not the next.
- Changes in surface appearance (e.g. darkness, detritus etc) may affect the sensitivity of the crack identification system to different types of cracks.

A4.10 Although variability has been identified in the TRACS crack measurements, research has shown that the system reports, with a reasonable level of reliability, locations on the network that are cracked.

A4.11 However, because of this variability, it is essential that a careful approach be taken when assessing the TRACS Cracking data. Specifically, it should be noted that the use of the Cracking Intensities to trend the changes in cracking from year to year is not considered a reliable method to assess the crack data.

A4.12 Therefore, it is advised that detailed investigations are targeted at locations where consistently high Cracking intensities are observed in TRACS data from successive survey years. The assessor may consider averaging the Cracking intensities obtained over two or more years for this comparison. For example, obtaining averages of the 2003 and 2004 datasets, and considering these values in terms of the guidance levels provided in Table 3.3. Note that this method is only applicable for lengths where no maintenance has been carried out during the averaging period.

A4.13 This approach should enable more reliable identification of lengths with high levels of cracking present. Further investigation of these lengths shall begin with the examination of the crack map data contained in **Confirm.** This should be carried out using the most recent survey year and, where available, at least two preceding survey years.

Using crack maps to complete the assessment of TRACS crack data

A4.14 The following paragraphs provide guidance in the use of crack maps to aid in the assessment of the crack data. Reference should be made to the two example crack maps obtained from **Confirm,** presented in Figure A1, when following this guidance. Each of these crack maps has lengths highlighted and marked from A to I.

A4.15 The crack maps in Figure A1 show each detected crack as a single line plotted on a pseudo road background (traffic lane 1 (top) and traffic lane 2 (bottom) are shown in each example). Each traffic lane contains two dark strips marking the locations of wheel paths. These crack maps were obtained from TRACS surveys carried out on Hot Rolled Asphalt surfaced Motorways. The crack maps show the cracks identified in the 2001, 2002 and 2003 survey years, which are shown as red, green and blue cracks respectively.

A4.16 As the TRACS survey vehicle is able to distinguish between joints and cracks these features are also displayed using different colours in the crack map (see the **Confirm** documentation for further guidance on the graphical capabilities of the crack map display). However, for the purposes of this guidance, there are no joints included on the crack maps of Figure A1.

A4.17 Each of the crack fragments contributes to the total intensity of cracking reported in **Confirm**. When the 100m lengths encompassing the example segments shown in Figure A1 (for Lane 1) were assessed in terms of the guidance levels of Table 3.3, it was found that, for crack map 1, survey years 2001 and 2002 fall below the guidance category for low levels of cracking, whereas survey year 2003 falls in the moderate category. For crack map 2, years 2001 and 2002 fall within the moderate category, and 2003 falls within the high category.

A4.18 However, this numerical analysis provides a reasonably low level of information regarding the condition and does not address any possible variability. By examination of the crack map it may be possible to identify the types of cracking that lead to the categories obtained in the numerical analysis, and determine whether the category is appropriate.

A4.19 Crack maps covering road lengths containing cracking often contain many short features distributed across the width of the traffic lane. This is a characteristic of the TRACS crack identification system. Due to the texture of the road surface, the crack identification system often breaks-up, or "fragments", cracks. It is these fragments that are viewed on the crack map display system. It is likely that parts of individual cracks will be missed, and the crack may appear as a series of disjointed fragments.

A4.20 However, it is also possible that some fragments will be reported as a result of deep texture or minor fretting, which will appear as random cracks, and will not be indicators of the presence of real cracks. Lengths A and B in crack map 2 illustrate how such fragments may appear. The general presence of cracking has been reported in all survey years over these lengths, but the cracking appears random, and has not been reported at a consistent location in any one survey year. Some variation may also be observed from year to year. For example the 2003 survey has reported a higher number of these random cracks in length B.

A4.21 Further examination enables such fragments to be isolated from locations in the crack map where it is likely that significant levels of true cracking are being reported. Crack map 2 contains two specific lengths over which the cracking is grouped (lengths C and D). Such grouping of the crack fragments is an indicator of the presence of cracking. Over lengths C and D this is further confirmed by the consistent reporting of groups of cracks over more than one survey year.

A4.22 The grouping of cracks, and consistency in the reporting of the cracking in the crack map over time are, therefore, useful indicators of the presence of cracking. The assessor may find that reducing the scale of the crack map to show longer lengths (several hundred metres) aids in identifying such groups of cracks, which can then by investigated further by increasing the scale to a similar level to that shown in Figure A1.

A4.23 It should be noted that, on pavements having heavy textures with large chip size, such as Hot Rolled Asphalt (the surface type present in the examples of Figure A1), severe Fretting (loss of stone from the surface) may be reported as Cracking. This results in the reporting of lengths containing Cracking that, in a visual survey, may have been reported to contain high levels of minor deterioration. Typically the crack map from such sites will show a large quantity of very short cracks distributed in random pattern over the pavement, and may be similar to that shown over lengths C and D in crack map 2. The Fretting measure described in Section 0 can be used to aid in the distinction between Fretting and Cracking on HRA surfaces. Knowledge of the pavement surface type is therefore required when assessing the cracking data.

A4.24 Localised cracking, such as transverse reflective cracks, can also be identified using the crack map. However, fragmenting and the presence of random cracks described above can make the identification of such cracks more difficult. Both crack map 1 and crack map 2 show examples of such cracks - at E, F and G. These can be seen as cracks that, although fragmented, extend across the traffic lane.

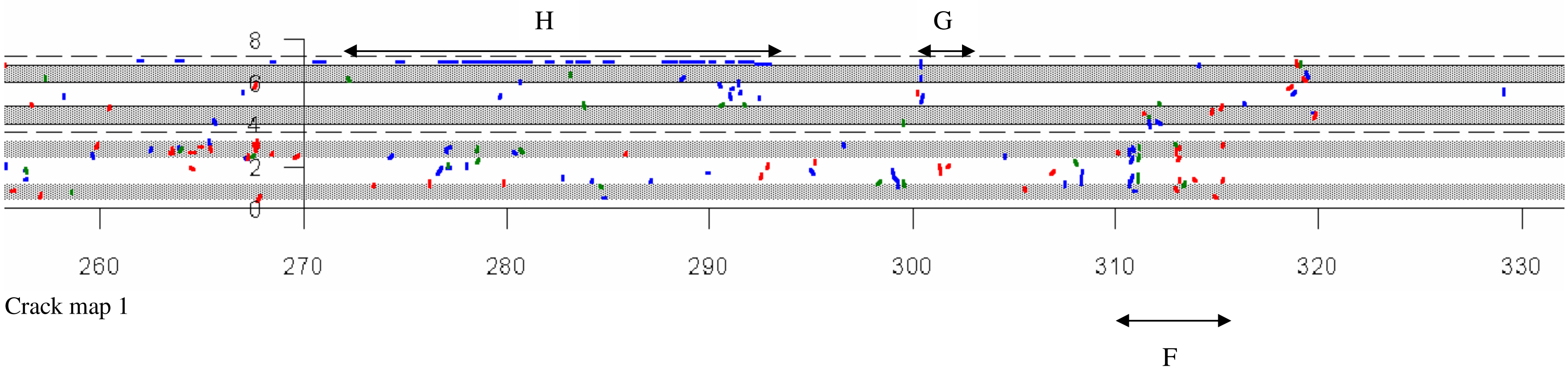
A4.25 Knowledge of the pavement construction combined with crack map data from consecutive survey years can aid identifying, and assessing the extent, of such cracks. However, it should be noted that small errors in location referencing can lead to a crack being recorded in slightly different positions in successive survey years. For example, at point E one crack has been reported in each survey year. However, this appears as three cracks. Visually, the result is that the crack map may appear more cracked than it actually is when, successive survey years are compared.

A4.26 The crack map can also aid in identifying particular features that may be peculiar to a particular survey year, and that result in changes to measured Cracking intensities that are not associated with a real change in pavement condition. For example, in the 2003 survey a very distinct longitudinal feature was identified over length H (crack map 1). This feature is clearly a lane edge feature arising from the lane edge marking or a construction joint being reported as Cracking. It is noted that such features can also be accompanied by the presence of features in the crack map that have been labelled as joints, and may be observed in either side of the traffic lane.

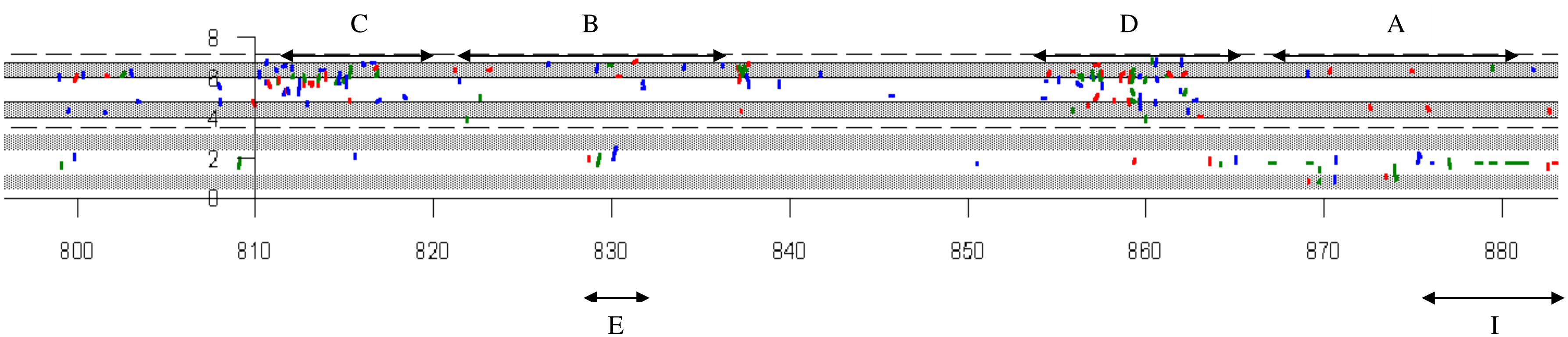
A4.27 This edge feature, which has not been identified in other survey years, contributes to the TRACS Cracking intensity reported over length H in 2003. As stated in paragraph A4.17, the effect of this feature has been to place the overall Cracking intensity for the 100m length into higher category than the previous year. It can be implied that a failure to identify this feature in the next survey year will result in a reduction in the category for this 100m length.

A4.28 Crack map 2 shows a similar longitudinal feature, reported in the centre of lane 2 over length I. This appears only in the 2002 data. This may arise from a construction joint identified only in the 2002 survey. However, localised repairs could also result in such behaviour. For such cases knowledge of the construction and maintenance history of the pavement under review is valuable.

A4.29 The TRACS crack identification system is able to distinguish between cracks and joints on concrete surfaces, and these features are displayed separately in the crack map when viewed using the facilities in **Confirm**. However, note should be taken of the advice given in paragraph 3.28 of this IAN when considering the crack data provided from concrete road surfaces.



Crack map 1



Crack map 2

Figure A1: Example crack maps, showing both lanes 1 and two, combined over three survey years: Red (2001/2), Green (2002/3), Blue (2003/4).

A5 Fretting

A5.1 Research has shown that on pavements having heavy textures with large chip size, such as Hot Rolled Asphalt (HRA), the presence of severe Fretting (loss of stone from the surface) may be reported as Cracking by the TRACS survey vehicle. This can lead to lengths reported as containing high levels of Cracking that, in a visual survey, may have been reported as containing high levels of minor deterioration.

A5.2 Research has shown that an estimate of the extent of Fretting can be derived from the Texture Profile by identifying characteristic shapes resulting from missing surface aggregate. Algorithms have been developed on this basis and incorporated into the MSP software to provide an indication of the presence of Fretting.

A5.3 The Fretting algorithms are currently optimised for the identification of Fretting on HRA. On other Surface Types the algorithms will in general report levels close to zero. Therefore, the Fretting data reported in **Confirm** should only be used in the assessment of HRA surfaces.

A5.4 The Fretting algorithm reports the intensity of Fretting as a percentage value. The guidance levels for the assessment of Fretting have been obtained by undertaking manual surveys of fretted HRA pavements and comparing the reported levels of Fretting with those reported by the Fretting algorithm. It can be seen that the threshold levels have reasonably low absolute values. This is a result of the Fretting calculation process and its relationship to the identification of missing aggregate particles. The values should not be compared directly with measures obtained from manual visual condition surveys.

A5.5 The Fretting data is, in particular, intended for use when assessing the condition of HRA pavements that have been reported to contain high levels of Cracking. Where both the Fretting and Cracking report high levels it is probable that the crack measurements are actually reporting the presence of Fretting. The intensity of the Fretting data can be used to estimate the severity of this Fretting.

A5.6 The crack map may be also used to show the presence of Fretting in the crack data.

A6 Noise

A6.1 The TRACS Noise measure utilises the TRACS Texture Profile to estimate the intensity of the noise generated at the tyre/road interface. The algorithms used in the calculation of Noise provide an estimate of the noise recorded using Close-Proximity (CPX) methods and subsequently adjusted to take into account the effect of the speed difference between the CPX measurement (which is typically carried out at a relatively low speed) and more realistic traffic speeds. However, at the current stage of development the values reported by the noise measure should be treated as approximations for use in general noise assessment.

A6.2 As the TRACS Noise measure is derived from the Texture Profile it is related only to the noise generated by the interaction of a typical tyre with the road surface. This measure is not weighted for traffic levels or fleet composition, or any other external conditions that would influence the average noise level recorded at the edge of the road.

A6.3 In particular, the TRACS Noise measure is likely to overestimate roadside noise levels in the case of porous surfaces.