TRACS TYPE SURVEYS FOR LOCAL ROADS SCOPING STUDY

by

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TRACS TYPE SURVEYS FOR LOCAL ROADS - SCOPING STUDY

Foreword by

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Project Director

TRAffic Speed Condition Surveys (TRACS) were introduced on the trunk road network in England in 2000. This Scoping Study has taken a hard look at the issues which relate to the introduction of TRACS Type Surveys (TTS) to the local road network in England. Information has been gathered from a variety of sources including highway maintenance practitioners, clients and survey contractors. We have drawn on the wide experience and knowledge of the Highways Agency from the introduction of TRACS and other implementations of TTS on the road network. A particularly valuable example has been the Scottish Road Maintenance Condition Survey.

Without doubt there is a need to provide objective and reliable data on road condition at both a local and a national level. Road condition is high on the political agenda and high in the pecking order of public dissatisfaction with public services.

Although the National Road Maintenance Condition Survey (NRMCS) has provided a valuable and generally reliable tool for many years there exists justified concerns at the overall consistency and reliability of present manual visual survey methods and there is a sensible aspiration to move towards one data source for local condition screening and for the generation of local and national performance indicators. The introduction of TTS on local roads is the means by which that can be achieved and it is clear that it needs to be available without delay. Extending the use of TTS to local roads in England offers the promise of the development of a UK wide set of road condition Performance Indicators (PIs).

There is considerable experience of using TRACS on the national trunk road network and from which lessons can be drawn. TRACS is also being used in London and elsewhere on principal roads providing further data. The success of the Scottish Road Maintenance Condition (SRMCS) is very encouraging and shows the need for an incremental approach to the introduction of TTS to local roads – and the need to base the project on sound technical developments.

There is a need to blend pragmatism and scientific diligence in a way that ensures that TTS is available for use on the English network as early as possible – but in a form that will yield quality data capable of use in UKPMS and which covers the range of defects which are important to local highway managers as well as to statisticians. SRMCS was introduced with high levels of pragmatism and has yielded large amounts of data on sub-principal roads and generated superficial but easily understood PIs. Further research is needed – and is being undertaken – to more securely ground the scientific base for the survey and its yield of data. Practitioners in England will want to see that TTS provides a working and affordable replacement for Coarse Visual Inspections (CVI), the main survey tool for sub-principal roads. CVI despite its acknowledged shortcomings is yielding working - and locally consistent - data at a local network level. TTS needs to be developed to the standard of a CVI substitute and then might also yield useful additional functionality.

The report presents options and in the recommended option builds on the work already started in Scotland whilst demanding some basic research to authenticate TTS for local roads. Further research will be needed but to refine TTS into a first class tool for condition data collection on local roads – capable of fully replacing CVI and eventually providing a higher level of functionality.

There are very real concerns among practitioners in England – and these are echoed by the concern expressed by the one Scottish authority that did not participate in SRMCS surveys in 2002. These concerns must be addressed by delivering TTS in a form which commands confidence and offers reassurance on issues such as funding and procurement and the issue of the continuing need for manual visual surveys on footways.

There will be a need for an extensive and comprehensive communications programme for local authority staff and managers supplemented by clear and purposeful statements from Government as to the future requirements for BVPIs and LTP funding bids.

The Scoping Study offers a way forward and sets out an implementation programme and a costed programme of research. Confidence in the recommendations and their implementation will be assisted if there is an opportunity for explanation and feedback for the wider constituency of the local highway authorities, government and the road condition survey industry. This process should be on the basis that the principles of the TTS project have been accepted but would afford an opportunity to test the detail of the recommendations before firming up the implementation plan and setting about its delivery with resolution.

One aspect of the recommendations needs to be actioned straight away and that is the appointment of a project manager with a full time commitment to the task of implementation. The project manager could, if appointed early enough, be involved with the information dissemination exercise.

In conclusion, the Scoping Study affirms the proposal to introduce TTS as the principal survey tool for assessing the condition of local roads in England, makes recommendation as to how this should be achieved and sets out a costed implementation plan to achieve this. We commend the report to the Roads Board.

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Project Director

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EXECUTIVE SUMMARY

This study was commissioned by the Roads Board following a proposal to the Roads Liaison Group that TRACS Type Surveys (TTS) should be extended to the non-principal local road network for the assessment of carriageway condition. The TTS will be based on the TRAffic Speed Condition Surveys (TRACS) introduced on to the trunk road network in 2000 but adapted to reflect the particular features and aspects of condition found on the local road network. The report considers the range and application of condition surveys, including TTS, and discusses the issues that relate to their application on non-principal roads. Recommendations are made for the way forward and implementation plans are included.

Since 1977, the National Road Maintenance Condition Survey (NRMCS) has gathered condition data from a random sample of roads in England and Wales by manual assessment methods. Broadly, the approach to assessing the visual condition, using manual CHART visual inspections, has not changed since the start of the Survey. This study considers the replacement of the visual surveys with TTS on local roads.

In 2000 the Government published "Transport 2010 - the 10 Year Plan", which introduced broad targets - to arrest the decline in the standards of local roads by 2004 and to eliminate the backlog of maintenance work by 2011. It has been agreed that the NRMCS should provide the means of assessing progress towards these targets.

In 2000, a review of NRMCS considered how the condition data for the Survey should be gathered. The study concluded there should be no data collection specifically for NRMCS and the Survey should use condition data collected by authorities for the local management of the network. It also concluded that the data collection approach for principal roads should be closely aligned with the data collection on the trunk road network. At that time it was therefore recommended that TRACS be implemented on principal roads and Coarse and detailed Visual Inspections (CVI and DVI) should replace the CHART surveys on the non-principal roads. Since that review the specification for TTS on principal roads has been produced and it has been agreed that the current visual surveys do not provide sufficiently reliable information to be used as a national indicator of condition.

Scottish roads have not been part of NRMCS but in 2002, Scottish local authorities agreed to jointly undertake a TRACS type machine survey of local roads. This survey, known as the Scottish Road Maintenance Condition Survey (SRMCS) includes measurement of the condition of all principal roads and a proportion of the non-principal roads. Initially the surveys measured surface texture and both longitudinal and transverse profile. The automatic measurement of cracking has now been included.

TTS have been carried out on the principal roads in London for 2 years and these have helped identify some of the problems on local roads. Following the work in London, the Best Value Performance Indicator for the condition of principal roads will, in 2004/05, be based on TTS. In 2003/04 some authorities have undertaken some TTS local road surveys in preparation for 2004/05.

The surveys in Scotland and London have shown the advantages of using TTS but have also highlighted the need for the surveys to be extended to include those aspects of condition that are not often seen on trunk roads but are more common on local roads (e.g. edge deterioration). The study has therefore identified areas of research that are needed before TTS can become a full replacement of the current CVI.

The research is in two parts. The first part is to make short-term improvements to the current TTS and introduce TTS to non-principal roads as soon as possible. This research will comprise 4 areas of work:

(i) A brief review of the TTS that have been carried out so far to get a full understanding of the immediate issues that can be addressed before applying the surveys more widely

(ii) An assessment and implementation of improvements to the current measuring techniques to yield more information about edge deterioration

(iii) Improvements to the analysis algorithms used for the transverse profile measurements to provide a better understanding of rut depths on local roads

(iv) A preliminary analysis of measurements from the existing TTS to derive a Defects Index based on the current capabilities of the TTS.

The second part of the research is to satisfy the longer term aim to enhance TTS so that it is a full replacement of the current CVI. To do this some areas of work have already been identified but others may arise from the review and data collection exercise to be carried out before the research into specific technical areas commences. The areas of work identified in the study are:

(i) Confirmation of the requirements for TTS and a collection of base data for the research

(v) The ability to measure edge deterioration and verge over-run

(vi) An updated method for measuring and analysing transverse profile to provi de a better representation of rutting on local roads

(vii) Extension of the cracking measurement and analysis systems to include other road surface types and take into account other aspects of the road (e.g. ironwork)

(viii) Increasing the capability of the systems to detect other visual surface defects required for the identification of maintenance need

(ix) Development of a method to use texture and other surface defects as a proxy for skid resistance

The study identified 3 implementation options that all take advantage of the work carried out so far in England and Scotland.

Option 1 is sufficient to continue the NRMCS as it currently exists but substitutes TTS for the visual surveys. It is based on the measurement of the condition of a random sample of sites in England. The sites would be identified by the Department for Transport (DfT) and the surveys would be managed centrally by DfT. The measurements would be provided back to DfT and the data would not be used locally by authorities to manage the road network.

Option 2 is based on an early introduction of TTS with its current capability, subject to the short-term research developments. To allow sufficient time for equipment development and procurement of the surveys, the earliest introduction of these surveys is 2005/06. While these surveys are carried out, the longer term research will progress and a revised TTS introduced in 2007/08 with the full capabilities of the current CVI. In this option, the TTS data is loaded into the UKPMS comparable pavement management system operated by the local authority. The surveys are managed locally by authorities but it is recommended that authorities get together to form consortia for letting the survey contracts.

Option 3 is based on option 2 but the introduction of TTS on to the local roads in England is delayed until the longer term research has been completed.

In addition to the 3 implementation options for the surveys, work programmes are presented to accompany options 2 and 3 for the development of a method for the calculation of the maintenance backlog. It was concluded in the study that a sufficiently reliable maintenance backlog calculation could not be carried out from the measurements and analysis made in option 1.

The study recommends the early appointment of a dedicated project manager for the selected implementation option. The associated management structure for the project manager and the NRMCS Technical Sub-Group is proposed. It was recognised in the study that it is important to keep the local authority users of the TTS data informed of progress with the implementation. A framework for a communication policy is provided that includes newsletters and regional workshops.

The study concludes that implementation option 2 is the recommended approach for introducing TTS on to non-principal local roads.

PART A: State of the Art

1 Introduction

This study was commissioned by the Roads Board following a proposal to the Roads Liaison Group that TRACS Type Surveys (TTS) should be extended to the non-principal local road network for the assessment of carriageway condition. The study has been undertaken by John Ekins as Project Director and Les Hawker, the TRACS Project Sponsor for the Highways Agency, as Project Manager. The report considers the range and application of condition surveys, including TTS, and discusses the issues that relate to their application to non-principal roads. Recommendations are made for the way forward and implementation plans have been prepared.

This report contains numerous acronyms and technical terms which, for convenience, are defined in the glossary in Annex 1. The work specifications for the Project Director and the Project Manager are shown in Annex 2.

2 Background

2.1 Monitoring Network Condition

Since 1977, the National Road Maintenance Condition Survey (NRMCS) has gathered condition data from a random sample of roads in England and Wales by manual assessment methods. Broadly, the approach to assessing the visual condition, using manual CHART visual inspections, has not changed since the start of the Survey. The major change to the Survey has been the inclusion of the results from machine surveys by Deflectograph, for the structural condition of trunk and principal roads, and SCRIM for the skidding resistance of the road surface.

In 1999, the Highways Agency (HA) introduced routine TRAffic-speed Condition Surveys (TRACS) on trunk roads in England to minimise the disruption to road users caused by slow-speed manual and machine surveys. The introduction of TRACS enabled the HA to adopt a survey strategy that is based on routine TRACS and SCRIM surveys. Only the lengths of road identified from these surveys, as likely lengths for maintenance, are assessed in more detail using the slower and more disruptive Deflectograph and visual surveys.

As part of the introduction in England of a Best Value Performance Indicator (BVPI) for the condition of local roads in 1999/2000, authorities could choose to determine the condition of principal roads by Deflectograph data, Coarse Visual Inspection (CVI) or Detailed Visual Inspection data converted to CVI for reporting purposes. More recently, new BVPIs have been introduced for non-principal local roads and for footways, based on Coarse or Detailed Visual Inspections (DVI). As part of the Best Value regime, local authorities must survey the entire network, although for the lowest hierarchies complete coverage may be achieved over 4 years. The current requirements for the BVPIs associated with road surveys are given in Annex 3.

Following the move to TRACS surveys on trunk roads and the use of new CVI and DVI techniques on local roads it was recognised that skilled resources for CHART inspections would soon become scarce and the reliability of the inspections would decrease. In 2000, a review of NRMCS considered how the condition data for the Survey should be gathered. The study concluded there should be no data collection specifically for NRMCS and the Survey should use condition data collected by authorities for the local management of the network. It also concluded that the data collection approach for principal roads should be closely aligned with the data collection on the trunk road network. At that time it was therefore recommended that TRACS be implemented on principal roads and CVI and DVI should replace the CHART surveys on the non-principal roads. This approach was also reflected in the recommended survey strategies included in the Code of Practice for Maintenance Management.

In 2000 the Government published “Transport 2010 - the 10 Year Plan” which heralded a significant increase in funding for highway maintenance. The need to improve the condition of local roads remains a key challenge in the Department for Transport (DfT) priorities for 2003/04 and the 10 Year Plan also introduced broad targets - to arrest the decline in the standards of local roads by 2004 and to have eliminated the backlog of maintenance work by 2010. It has been agreed that the NRMCS should provide the means of assessing progress towards these targets.

The Roads 2000 project, to collect the condition of principal roads in London, adopted TRACS surveys for the data collection but also carried out extensive trials to correlate TRACS condition data with CVI and DVI data. The approach adopted for TRACS in London was close to the approach already adopted by the HA on trunk roads and showed that the practical aspects of this type of survey could be overcome for this part of the network. Work to improve the understanding and interpretation of the measurements made as part of the principal road surveys is still ongoing. Nevertheless, the similarity of the surveys on principal roads to TRACS led to the adoption of the name TRACS Type Surveys (TTS) for these surveys on local roads.

The practical success with introducing TTS on roads in London was sufficient to instigate a change to the BVPI for principal roads (BV96). For 2003/04, TTS is the recommended survey for the collection of condition data for BV96 and it is known that a range of types and sizes of authorities are carrying out TTS on their roads. From 2004/05, TTS will be the only survey that can be used for BV96. Annex 4 contains the Advice Note for carrying out TTS on principal roads. A model specification for the surveys has also been produced and is available by downloading it from the DfT and UKPMS web sites.

Scottish roads have not been part of NRMCS but in 2002, Scottish local authorities agreed to jointly undertake a machine survey of their local roads with the aim of introducing surveys similar to those used on trunk and principal roads in England. This survey became known as the Scottish Road Maintenance Condition Survey (SRMCS). Initially, the surveys measured surface texture and both longitudinal and transverse profile. The automatic measurement of cracking was to be included in the future making the surveys more similar to the surveys carried out in England. The SRMCS includes measurement of the condition of all principal roads and a proportion of the non-principal roads. A fuller description of the SRMCS is given in Annex 5.

The condition of roads in Wales is addressed in the NRMCS but Northern Ireland conducts its own study of the condition of the road network. Both the National Assembly for Wales and the Department of Regional Development (Northern Ireland) have expressed interest in adopting TTS for national studies of the condition of the road network.

In England, results from CVI and DVI on all classes of roads have been variable and the reliability of these surveys for national and local reporting has been questioned. Although procedures have been introduced to improve the quality of the condition data from these surveys, the need to consider a more objective survey for all parts of the network has been agreed. The Roads Board has proposed that TTS be extended to classified non-principal roads for the collection of carriageway condition data in 2004 and to unclassified roads in 2005. TTS machines for use on local roads will be derived from TRACS but will require further development if they are to meet the current survey capabilities provided by CVI. The surveys to be adopted on local roads may not be the same for all road types but currently they are all referred to as TTS.

As the introduction of TTS for all local roads will take time, it has been agreed that in the meantime, for NRMCS, random CHART surveys should continue, at least until 2004/05, to provide statistical continuity.

2.2 Objectives of the Study

This Scoping Study has been set up by the Roads Board to examine the proposed timetable for the introduction of TTS on non-principal roads and prepare a delivery plan.

In considering the need for improved condition surveys the Roads Board has identified four objectives:

i. To ensure consistent **reporting in the short term** – to be met by continuing to use CHART surveys for NRMCS whilst more tightly specifying CVI/DVI to improve consistency.

ii. To **ensure consistent reporting in the long term -** by building on current expertise in machine and visual surveys in the light of experience and research.

iii. To **ensure that data collection meets the range of needs for monitoring road conditions nationally and locally as cost effectively as possible** - by developing TTS as a cheaper and reliable means of screening the whole network leaving more expensive visual surveys to be targeted on sites needing further investigation.

iv. To develop a strategy for a UK indicator of condition for all trunk and local roads - by introducing TTS across the UK network, comparisons will be possible between road classes and regions.

This Scoping Study considers the introduction of TTS for local roads in England and considers the costs of extending the surveys to Wales and Northern Ireland. Information on the TTS in progress in Scotland is also provided.

3 Current Position

3.1 The UK Road Network

The local road network consists of different categories of road. Principal roads (A class roads) are at the top of the hierarchy with non-principal classified roads – “B” and “C” being used for less important routes. There is also a large proportion of local roads which are publicly maintainable, but which are not classified, serving as minor cross-country routes or access roads to development in urban areas.

The formal classifications of the road network do not necessarily correlate well with a practical hierarchy derived from function or traffic load - many principal roads are lightly trafficked and some unclassified roads carry high volumes of traffic. The Code of Practice for Maintenance Management recommends the adoption of a functional hierarchy for maintenance purposes. However, for the purposes of this report and for consistency with NRMCS, the road categories are used to describe the road network. A summary of the lengths of road categories is shown in Table 3.1, for England, Scotland, Wales and Northern Ireland. Although the Scoping Study is initially addressing the local roads in England, the long-term aim is to produce a condition index for the whole of the UK.

Table 3.1 The UK road network

Road Categories	Road Types (England, Scotland, Wales)	Road Types (Northern Ireland)	England[1]	Wales[1]	Scotland[1]	Northern Ireland[2]	Total
			Kilometres				
National Network							
Trunk Roads	Motorways and some A roads	Motorways	14,053	1,681	3,258	110	15,263
Local Network							
Principal (built up)	A-roads in urban areas	Class I Dual and Single Carriageway	180,358	796	1,003	2,270	37,095
Principal (non built up)	A-roads in rural areas		**59,457**	1,790	6,416		
Classified	B and C roads	Class II and III roads	84,519	12,804	17,632	7,570	122,525
Unclassified	Unclassified	Unclassified	180,358	15,924	31,148	14,830	242,260
Total			**299,911**	**32,995**	**59,457**	**24,780**	**417,143**

[1] UK Department for Transport – Transport Statistics Great Britain – 2002 Edition
[2] Central Statistics and Research Branch - Northern Ireland Transport Statistics 2001-02

Footways form an important part of the local road network but they are outside the remit of this study. However, a consequence of the introduction of TTS on carriageways may be a change to the approach to surveys on footways. For BVPI 187, DVI surveys are required on Category 1, 1a and 2 footways. This requirement may change in future years. Currently some authorities carry out DVI on the footways while others carry out CVI on the footways and carriageways at the same time. If TTS remove the need for

CVI on the carriageways, the inspectors will still have to walk down the road for the footway inspection and this may result in more DVI surveys on footways or other developments in survey technology for use on footways. Breaking this link of doing surveys on carriageways and footways at the same time is not necessarily a problem. The hierarchies of carriageway and footway are not always aligned (busy roads do not always have busy footways). The introduction of TTS will mean that both the carriageway and the footway can be surveyed at a frequency, and using a technique, appropriate to their hierarchy. This Scoping Study has not constrained carriageway surveys to retain any association with footway surveys.

3.2 Road Data

Pavement condition surveys are carried out on all road types for a variety of reasons (e.g. assess what maintenance is needed and to report against performance targets) with the overall aim of improving the management of the road network. For all networks, the data can have a range of different uses. Figure 3.1 shows a pyramid that represents the levels of detail in the condition data.

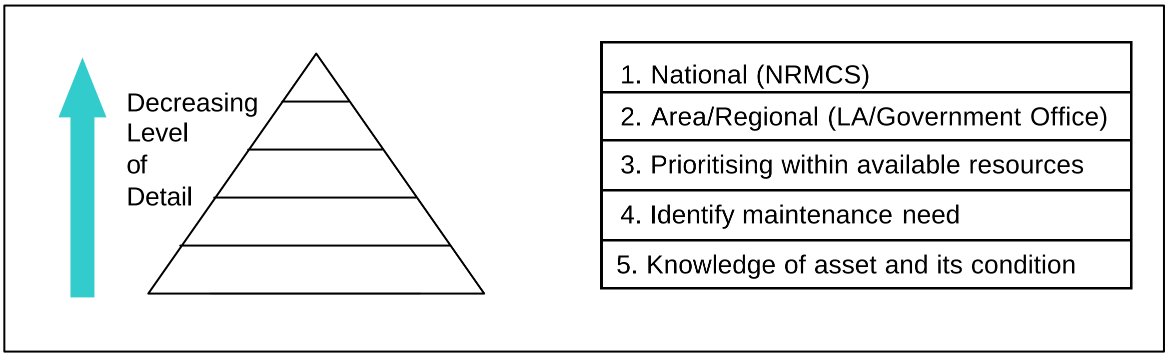

Figure 3.1 Use of condition data

Level 5 <u>Knowledge of the asset</u>

The most detailed information collected and held about the asset. This may include the structure of the road, condition, traffic, maintenance history, inventory and other aspects of the road (e.g. noise) that helps to describe its performance. Not only is this the most detailed in terms of types of data but also the most detail for each aspect of the data. For example, deflections are held as measured (i.e. at approx. 3m intervals for each wheel track).

Level 4 <u>Maintenance Need</u>

Not all of the information held at Level 5 is used to identify maintenance - a subset of the data may be used and the actual condition data may be aggregated to a length more suitable for representation as a uniform condition length (e.g. 10m may be considered for some aspects of condition as more detail adds little value to the maintenance decision process). In practice, the data at Level 4 may identify a need for further investigation, and the collection of more information at Level 5. Only when this supplementary information is available is the Level 4 data used to identify maintenance need.

Level 3 <u>Prioritisation</u>

This level of detail applies in a number of ways:

(a) When assessing overall budget need, the condition data used may be at less detail over the whole network than data considered for specific lengths (i.e. project level). An analysis at the network level with aggregated data can be used to estimate budget need. The estimated or allocated budget is then considered with data at Level 4 for individual lengths in the network to select the maintenance option to adopt.

(b) Using the data from Level 4, all the maintenance identified can be prioritised against the available budget to determine what maintenance can be carried out. This may not require all the detail of the maintenance identified with data from Level 4 (e.g. long lengths of apparently uniform treatment are used rather than the varying treatment along the maintenance length).

(c) Rather than collecting data at its most detailed level over the whole network, the data collected at one level (say Level 4) may be sufficient to identify (prioritise) where on the network more information is needed to specify the maintenance (e.g. a CVI may identify where to carry out a DVI or Deflectograph survey). TRACS and TTS work in this way; the machine survey replacing CVI will show where more detailed surveys are needed.

Level 2 <u>Area/Regional</u>
At this level, the detail is needed only to compare and report at area/regional levels. An example of the use of the data at this level is for BVPIs and performance reports for Managing Agents for the HA. The use of data at this level is similar to Level 1 but the extra detail allows reliable comparisons on smaller networks.

Level 1 <u>National</u>
At the top of the pyramid, the data is at its least detail but it may have originated from data collected at a higher level of detail, rather than have been collected at the aggregated level. National data is used for reporting (e.g. NRMCS) but has little direct use in the day-to-day management of the network. An example of data at this level is the typical 100m lengths of carriageway used by the HA and local authorities to calculate PIs and demonstrate overall performance.

It is possible to collect data at different levels of detail using different types of survey on different parts of the network as shown by the different cells in Table 3.2. At present, for those defects measured by TRACS, the HA satisfies all the levels of detail for trunk roads using these surveys and the same will be true for principal roads when TTS are introduced in 2004/05. In general, both cost and time increase as more cells are completed in the direction of the arrow in Table 3.2. Currently CVI and DVI are used on the classified and unclassified roads. The aim of this study is to show how the 'V' cells can be changed to 'TT' in Table 3.2, but not to improve the capabilities of TTS beyond those provided by the current visual surveys.

Table 3.2 Survey type and the variation in detail of data on the road network

Road Type	Level of detail of data - (1) is lowest detail				
	(1)	(2)	(3)	(4)	(5)
National (Trunk)	T	T	T	T	T
Principal	TT	TT	TT	TT	TT
Classified	V	V	V	V	V
Unclassified	V	V	V	V	V*

Notes:

T = TRACS, TT = TTS, V = CVI/DVI (assuming TTS are implemented on principal roads)

At the higher detail, additional surveys may be carried out to supplement the data from the network surveys.

* represents the aim of the NRMCS Review in 2000 (i.e. use data collected by local authorities for the local management of the network).

The Code of Practice for Maintenance Management (DETR, 2001) acknowledged the different levels of detail of data and different levels of cost to provide that data in recommending a choice of survey strategies. In the Code, CVI is the recommended survey for non-principal roads with TTS recommended for principal roads in the minimum and enhanced survey strategies shown in the Code. For CVI, it is recommended that only 50% of classified roads and 25% of unclassified roads are surveyed each year. The Code (the survey strategy from the Code is shown in Annex 6) shows a range of strategies for road networks, including the use of TTS on classified roads. All strategies adopt the same proportion of the network to be surveyed annually.

Table 3.3 shows the defects currently recorded by CVI on the local road network, as given by the UKPMS Visual Inspection Guide, and the defects recorded by TTS as currently implemented. In some cases, a defect may have the same name in the 2 types of survey but this does not mean it is recorded in the same way, merely that the aspect of condition is recorded by both survey methods. The coverage by TTS suggested by Table 3.3 is low but it should be noted that concrete and block paved surfaces form a small proportion of the overall network length (estimated at less than 5%). In terms of defects on bituminous pavements, the omission of edge deterioration is the main concern in the TTS capabilities.

Table 3.3 Defects currently recorded as part of CVI and TTS

Feature	Pavement Type	Defect Description	CVI Current	TTS Current
Carriageway	All	Longitudinal Evenness		✓
		Texture		✓
	Bituminous	Whole Carriageway Cracking	✓	✓
		Wheel Track Cracking	✓	✓
		Wearing Course Deterioration	✓	
		Edge Deterioration	✓	
		Surface Deterioration	✓	
		Settlement/Subsidence	✓	
		Transverse/Reflection Cracking	✓	✓
		Rutting	✓	✓
	Concrete	Concrete Cracking	✓	
		Transverse Defective Seal	✓	
		Longitudinal Defective Seal	✓	
		Defective Surface Dressing	✓	
		Transverse Joint Defectiveness	✓	
		Longitudinal Joint Defectiveness	✓	
		Bituminous Patching	✓	
		Concrete Surface Deterioration	✓	
		Settlement	✓	
	Block paving	Block Deterioration	✓	
		Minor Block Deterioration	✓	
		Rutting	✓	✓
Footway	(1)	Major Deterioration	✓	
		Minor Deterioration	✓	
Kerb		Kerb Deterioration	✓	
		Inadequate Upstand	✓	
Verge (Paved)	(1)	Major Deterioration	✓	
		Minor Deterioration	✓	
Cycle track[(2)]	(1)	Major Deterioration	✓	
		Minor Deterioration	✓	

Notes

(1) Defects occur for each pavement type (bituminous, concrete/flagged and block)

(2) Cycle tracks not forming part of the carriageway

✓ = May include a measure that represents the type of defectiveness (i.e. not necessarily the current CVI defect definition)

Not all ✓ are of the same weight. Some carriageways and defects are more common than others.

The aim of this Scoping Study is not to produce a plan for the introduction of surveys to improve the quality of data collected by experienced and motivated inspectors from visual surveys. It is to produce a plan for the introduction of routine machine surveys that will replace the subjective variation that accompanies nearly all visual surveys on non-principal roads. In time the quality of the machine surveys will improve further and this will lead to better information that will enable aspects of condition, not considered in current surveys, to be used in the management of the local road network.

As part of the TRACS contract on trunk roads, the condition measurements are located on the network with the aid of studs marking the start of each referenced network section. These studs are not available on the local road network but for TTS on principal roads, authorities provide OSGRs for the ends of sections where they are available. As more OSGRs are added each year, so the location referencing of the condition measurements improves. It is possible that analysis algorithms, for use with the condition measurements could be improved if the pavement surface type is known. For BVPIs, authorities need to process the condition measurements in a UKPMS comparable pavement management system (PMS). As the authorities continue to improve the network inventory held in their PMS, in time, the quality of the pavement type information will improve.

4 What Is Available?

4.1 Trunk Roads

The requirements for TTS, in terms of the provision of the appropriate information for use within the five broad categories, range from the provision of a national indicator such as the NRMCS Defects Index, through the identification of need for maintenance investigation, and on to the detailed knowledge of asset condition. The minimum level of data required to satisfy the requirements of each of these categories may include survey data and "network" data such as the construction types. However, there is no agreement on the specific individual data parameters required to satisfy the needs of each category over all road types (in terms of providing an accurate measure of, for example, maintenance need).

A structure designed to meet the needs of the five categories already exists for the national (trunk) road network and is described in detail in Table 4.1

The basis of the approach on the trunk road network is that the distribution of construction types on these roads is such that the pavement is generally well constructed and may be regarded as a "long life" pavement. Therefore, visual distress (surface distress from TRACS) and low friction (skid resistance from SCRIM) are the key initial indicators of maintenance need. Once further investigation is triggered by the measurements from TRACS or SCRIM then the additional surveys using slower and more expensive techniques enable the proposed maintenance treatments to be refined. The trunk road methodology for representing the condition of the trunk road network is shown in Table 4.2.

The detailed knowledge of a given asset is that which is sufficient to establish whether any selected length is in need of maintenance, and the likely maintenance required. This may include information from sources other than condition surveys (e.g. noise levels may be from pass-by measurements, "standard calculations" or Close Proximity measurements). Table 4.2 shows that on the trunk road network the primary data source for the categories requiring a lower level of detail is TRACS and SCRIM. More detailed information on both the condition of the road and its construction and use is required to make maintenance decisions.

4.2 Local Roads

The fundamental capabilities of TRACS surveys are to be maintained as TRACS moves to the principal road network under TTS. It is important to note at this point that TRACS and TTS, although fundamentally very similar, do not represent exactly the same surveys and further differences may be introduced as TTS are added to other parts of the local road network. Whilst the fundamental principles of TTS on principal, classified and unclassified roads may remain the same, it is almost certain that technical differences will exist between them.

Table 4.1 Characteristics of condition surveys on the trunk road network

- Routine TRACS and SCRIM surveys are carried out over the whole network.

  TRACS equipment used on the trunk road network measures the transverse and longitudinal profile, and the texture profile in the nearside wheel track, crack maps, the road geometry, and the Ordnance Survey grid co-ordinates of the surveyed lane.

  The measurements are used to derive a number of parameters to assess the need for maintenance investigation. These include measures of longitudinal evenness in the form of moving average variances over 3m, 10m and 30m average lengths, measures of wheel track deformation in the form of rutting in the nearside and offside wheel tracks, measures of texture depth in the form of Sensor Measured Texture Depth values, and crack intensity values expressed in percentage terms. The TRACS measurements are usually reported over 10m lengths but can be aggregated over longer lengths.

  TRACS data accuracy is controlled by detailed acceptance testing and regular quality assurance checks of the systems carrying out the surveys. Accurate location referencing is achieved through the use of the distribution of node markers that physically mark the locations of Section start and end points. Regular checks are made to ensure that the system carrying out the surveys has located these points accurately.

  Routine SCRIM surveys are carried out on one third of the network each year. For each survey, three measurements provide the Mean Summer SCRIM Coefficient (MSSC) and this is compared with the site Investigatory Level.

- Targeted Ground Penetrating Radar, Visual Condition, and deflection (Deflectograph and/or potentially FWD) surveys that are typically carried out on sites already highlighted by the TRACS or SCRIM surveys as needing further attention.

- TRACS data is fundamental to the identification of lengths in need of maintenance investigation. However, the data is also used in combination with other condition data to propose maintenance schemes and to evaluate solutions on a whole life cost basis. Therefore it is important that the data be accurate and well located on the network.

Table 4.2 Collecting and using road condition information on trunk roads

Level of detail of data				
(1) National (e.g. NRMCS)	(2) Regional (e.g. Regional PI)	(3) Prioritising within Resources	(4) Identification of need for Maintenance Investigation	(5) Detailed Knowledge of Asset
TRACS Rut Depth over 100m SCRIM friction coefficient over 100m (nominal) Residual Life[1]	As (1)	As (2) plus Resource Data Route Priority Traffic Levels	As (3) but TRACS condition data aggregated over 10m lengths Location Referencing TRACS "ride" (3m, 10m, 30m Variance) TRACS Texture Depth TRACS Wheel Track Cracking Construction Data[2]	As (4) Plus TRACS Road Geometry Historical Data Deflection
Future Developments: TRACS Cracking Intensity over 100m			Future Developments: (e.g. Noise levels from condition, other defects)	Future Developments: (e.g. Noise levels from condition, other defects)

[1] From deflection and construction data.
[2] From construction records, coring and possibly Ground Penetrating Radar (GPR)

As the principal road network contains a range of road types (in terms of widths, environments and geometries) it is likely that the systems developed to operate on this network would also be practicable for the collection of survey data on many parts of the non-principal network. It follows, therefore, that it should be possible to obtain TTS data on the principal and on a proportion of the non-principal road networks using the same survey vehicles. However, although the TTS used on principal roads may also be suitable for the non-principal road network, this does not imply that the data collected using TTS on principal roads would be suitable for assessment of the condition and maintenance need of the non-principal road network.

TTS data should provide a key input for the lowest level of detail of condition information (e.g. NRMCS) and also for the other categories requiring higher levels of detail. Whereas there is a structure already in place to utilise the TRACS and SCRIM data on the trunk road network, it is necessary to consider the differences between the trunk road network and the principal and non-principal road networks to determine whether the data that is available from principal roads will meet the needs on these roads and on non-principal roads. Currently CVI and DVI are used to measure the network condition but TTS do not record all the defects measured in visual surveys. There is, therefore, a need to consider which aspects of condition need to be measured, to satisfy the requirements of each of the road categories.

It can be assumed that for all road categories, the aspects that reflect the condition of the road can be divided into three main groups:

- Structural condition (e.g. construction, deflection, surface visual distress and in-depth distress)
- Functional condition (e.g. surface evenness, longitudinal evenness, transverse evenness and tyre/road noise and road usage - traffic)
- Safety (e.g. slow and high-speed skid resistance, surface profile, longitudinal evenness and transverse evenness)

For the trunk road network, as shown in Table 4.2, the Performance Indicator (or PI) encompasses rut depth, skid resistance and currently residual life to cover the main aspects of road condition to obtain a national condition measurement. Further structural and functional measurements are necessary to provide a sufficient level of information to meet the needs of the more detailed categories such as maintenance need. It is likely that a similar approach will meet the needs of the principal road network, as shown in Table 4.3. Therefore, for principal roads, at the national level, the majority of the information should be provided by the current TTS, the main exception being the measurement of skid resistance, which requires a SCRIM survey. The other missing data element on principal roads is the measurement of the deflection. Routine measurement of deflection has been phased out on the trunk road network as the “long life” nature of the majority of pavements means that surface condition is now the primary measure of condition. Significant lengths of the principal road network may have similar structural characteristics to the trunk road network, meaning that surface condition would also be the key trigger of maintenance investigation on those roads. When developing a condition indicator it may therefore be acceptable for the measurement of deflection to be absent from the indicator, as this measure would not be strongly linked to the need for maintenance expenditure.

Although the combination of rutting, cracking and skid resistance (where available) is likely to be considered appropriate for obtaining an indicator on the trunk road and principal road networks under TRACS and TTS, the non-principal road network is likely to contain a wider distribution of road types, geometries, constructions and environments than that found on the trunk and principal road networks. Therefore, although these parameters may provide some insight into condition on parts of the non-principal road network, they may be unsuitable for the calculation of a PI for all parts of this road network.

The reasons for this can be considered in terms of the:

- Effect of the nature of the non-principal road network on the measurement system itself
- Suitability of the parameters derived from the measurements
- Suitability of a PI based solely on TTS measurements in describing the condition of the non-principal road network

For example, the transverse profiles recorded on these roads may be subject to large errors caused by survey conditions and the limitations of the measurement systems used on TTS vehicles. It is also possible that the skid resistance measurement would be subject to error on parts of the non-principal road network as a result of the road geometry and surface types. Additionally, the range of vehicles using non-principal roads, combined with the variation in road widths is likely to make the basic rut measurement, obtained by TTS, less useful in indicating the structural and safety condition on the non-principal road network. Furthermore, for the calculation of a PI for non-principal roads, the structural condition of the pavement may need to be included to obtain a realistic indicator of condition, as that aspect of condition may be more strongly linked to the triggering of maintenance than on the principal and trunk roads.

Work in Scotland, for the SRMCS, has attempted to compensate for the non-availability of SCRIM measurements and deflection measurements on the Scottish road network by including the TTS measures of ride quality and texture in the PI. Current reports on this work suggest that this approach may be successful in obtaining an appropriate PI on the principal road network. It is not yet clear if the friction information is essential for identifying sites in need of investigation or if the profile data offers an acceptable alternative in the absence of a measure of structural condition on the non-principal roads. On the lower classes of road it is also not clear whether the rut data is accurate or if the defects not currently recorded by TTS make a big contribution to identifying maintenance treatments. Also, for the lower road hierarchies, unrepresentative values are likely to arise as part of the measurement of the longitudinal profile, which is reported as longitudinal profile variance. This is due to the effects of survey condition and road geometry on the measurement and interpretation of the profile data.

Although it is clear that TTS on non-principal roads should be capable of delivering data which would contribute to both the calculation of an indicator and the estimation of the need for maintenance investigation, the specific requirements for these surveys cannot be fully defined without further investigation. It is likely that the interpretation of the transverse and longitudinal profile data could require development beyond that used on the principal and trunk road networks, the exact nature of this development has yet to be determined.

Justification of the structural and safety measures provided by deflection and friction surveys on the local road network has yet to be confirmed. Therefore, a possible approach for the classified and unclassified road networks is summarised in Table 4.3. However, in order to define the requirements of Table 4.3 in more detail it will be necessary to consider which structural, functional and safety measurements are most suitable to reflect the condition of the roads found on those parts of the local road network. The measurements must realistically describe that part of the local road network, and condition measurements should also have the potential to aid the local engineers in determining maintenance need. When these factors have been addressed, it should be possible to propose the key elements required from TTS for all road types and how these may be met by current and future developments.

In addition to monitoring condition, the aim for the TTS data is to provide sufficient information to calculate the maintenance backlog on the local road network. No agreed method is yet available for the calculation of the backlog based on TTS measurements although the SRMCS is initiating work in this area. Further research is required in this area to develop and test the calculation method on all road types.

To determine the key condition parameters to be derived for classified and unclassified roads, and to decide whether these can be addressed by the current or future TTS or by alternative methods, some questions require answers:

- How can the edge deterioration of pavements, including verge overrun, be measured with TTS?
- Is the current method of measuring transverse profile adequate?
- Is the current method of summarising transverse profiles by rut depth adequate?
- Is the current nearside longitudinal evenness measurement sufficient?
- Is the current method of interpreting longitudinal evenness adequate?
- Is the current measurement coverage of texture adequate?

Table 4.3 Simplified representation of condition data collection on local roads

Road Category	Key	Level of detail of data – (1) is the lowest detail				
		(1) National (e.g. NRMCS)	**(2) Regional**	**(3) Prioritising within Resources**	**(4) Identification of need for Maintenance Investigation**	**(5) Detailed Knowledge of Asset**
Principal	A	TTS Rut Depth TTS "ride" (3m, 10m, 30m Variance) TTS Texture Depth TTS Cracking Intensity	As (1)	As (2) plus Resource Data Route Priority	As (3) Plus Location Referencing TTS Wheel Track Cracking	As (4) plus Historical Data
	B					
	C					Other Surface Distress
	D	SCRIM friction coefficient		Traffic Levels	Construction Data	Structural Condition Noise Levels
Classified	A	TTS Road Geometry	As (1)	As (2) plus Resource Data Route Priority	As (3) Plus Location Referencing TTS Wheel Track Cracking	As (4) plus Historical Data
	B	TTS Texture TTS Cracking Intensity TTS Transverse Profile TTS Longitudinal Evenness		As (2)	As (3)	As (4)
	C	TTS Visual Distress (Friction Measure)		As (2)	Other Surface Defects	As (4)
	D	(Structural Condition)		Traffic Levels	Construction Data	As (4)
Unclassified	A	TTS Road Geometry	As (1)	As (2) plus Resource Data Route Priority	As (3) plus Location Referencing	As (4) plus Historical Data
	B	TTS Texture TTS Cracking Intensity TTS Transverse Profile TTS Longitudinal Evenness		As (2)	As (3)	As (4)
	C	TTS Visual Distress (Friction Measure)		As (2)	Other Surface Distress	As (4)
	D	(Structural Condition)		Traffic Levels	Construction Data	As (4)

Key

A Data currently provided by TTS or provided from another source that should be available
B Data that could be obtained from TTS with suitable new processing methods
C Data unobtainable from current TTS, and requires developments to the TTS survey device
D Data available from another existing source but may not be provided under the current survey regime

Notes

Some aspects of condition are shown as Category A (data is currently provided). This does not mean that further development is not necessary. The Table shows what can be achieved now but the measurements and analysis may be significantly improved by further research.

- Is the current TTS crack system adequate for all road classes and surface types?
- What other visual defects are important and how can these be measured and interpreted by TTS?
- Is a measurement or representation of skid resistance required?

In addition, constraints may be caused by weather conditions, the more frequent occurrence of traffic calming measures on local roads and vehicle speed requirements. TTS can be implemented on non-principal roads before these questions are answered and may provide valuable information on the condition and maintenance need of the local road network. Only when research has been carried out to answer the questions, however, will TTS provide the capability required to support the maintenance management of local roads.

It is not, however, sufficient only to provide answers to these questions. There are not sufficient TTS vehicles currently available to survey a large proportion of the local road network. In any development plan, time must, therefore, be available for manufacturers to increase the number of vehicles suitable for carrying out surveys. Experience to date has shown that this time must be at least 6 months in advance of the proposed survey year.

PART B: Way Forward

5 Research and Development

5.1 Types of Research

In recent years, significant advances have been made in the capabilities of machine surveys of road condition. In England, the HA introduced the first significant change in technique for more than 10 years with the use of TRACS. London and local authorities in Scotland and England have since shown the value of these types of survey by introducing TTS on their local roads. All of the TTS currently adopted by local authorities are closely based on the development of the condition measurement and analysis techniques for high-speed trunk roads, and the survey strategy adopted by the HA.

There are some clear examples (e.g. edge deterioration) where defects rarely found on trunk roads play a key part in identifying the condition of local roads. Although the defects currently measured by TRACS and TTS do reflect some aspects of the condition of local roads, the measurement of other defects and changes to the analysis algorithms, used with the current measurements, are likely to provide significantly better information for the management of local roads.

Current capabilities for TTS allow machines to travel at high-speed (traffic speed) when surveying. On local roads, the traffic speed is likely to be significantly lower than on trunk roads and survey speeds will also be lower. There is, however, little to be gained from the slower speed, in terms of equipment development. The potential for slow speed TTS slower speed machine surveys has not been considered.

This study has undertaken a review of a research programme is needed to consider the increase in the capabilities of TTS to provide a range of condition measures to fully support the management of the local road network. It is recognised, however, that the aim of this study is to show how to introduce a level of TTS that will provide an objective measure of the condition of the network in advance of further detailed investigations on lengths highlighted by TTS as being in need of investigation. This is in much the same way as CVI is currently used on non-principal roads and it is the more detailed surveys (e.g. DVI) that identify the full maintenance need.

Before commencing any research to improve the current TTS approach for local roads, a review should be undertaken of current research activities and those surveys that have already been introduced (i.e. London, Scotland and other local authorities). The review should also include the results from the TRACS contract since there are some aspects of these surveys that may aid the development of TTS on local roads.

Following this initial review and consultation, specific research tasks can be carried out to develop the new capabilities needed for TTS. The types of research required can be classified under two main headings:

Measurement - Improving/developing measurement methods (i.e. modifying or developing new equipment)

Measurement research is likely to involve much practical development work and corresponding pavement trials. This type of work requires reference measurements that can often only be provided by manual assessments and past research (e.g. crack detection systems) has shown that significant areas of the road surface must be examined to provide meaningful results.

Interpretation - Improving/developing interpretation methods (i.e. the processing and analysis of the measurements)

Interpretation research can be carried out on existing data and is largely a desk top exercise for the development of analytical methods of interpretation rather than practical trials.

The means of carrying out these different tasks involve different resources but both types can be broken down into a number of common stages:

- Confirmation of the exact need

  This may not be just a simple desk exercise. As a minimum it should involve interviews with a number of practising highway maintenance engineers and consideration of the views of road users. For some parameters (e.g. edge deterioration) different maintenance treatments may result from separate components of an overall defect. For example, breaking up of the edge of the carriageway and vehicle overrun on the verge are often both recorded as edge deterioration. The introduction of the new surveys is an appropriate time to confirm what aspects of condition it would be best to record, and use the research to develop techniques for the automatic measurement and interpretation of relevant properties of the defect. Further investigation of, for example, maintenance records may also be necessary to provide robust information to support the research.

- Review of existing techniques for each aspect of condition

  If no satisfactory techniques exist, new potential techniques that can be developed or adapted will be explored

- Developing the new technique
- Obtaining reference measurements and analysis results
- Testing the new technique against criteria for accuracy, repeatability and reproducibility as well as practicality and robustness
- Validation of the new method

5.2 Current Research

5.2.1 Developments overseas

The state of road monitoring has been directly and indirectly reviewed by a number of European and non-European studies over the past few years. In 1997, the European COST (Co-operation in the field of Scientific and Technical research) Action 325 reported on “New road monitoring equipment and methods”. At that time the conclusion was:

“In the case of the collection of surface distress data, visual inspection and subjective evaluation is the current practice. Although, in some cases, the evaluation is carried out at the office based on images of the road surface collected at high-speed, visual inspection on site carried out on foot or in slow moving vehicles is still the general rule.”

The conclusions further state:
“The COST325 …..Committee is aware of the fact that the development of automated high-speed systems for ……. data collection are very costly and time consuming. …… With good support, co-ordination and co-operation between research institutes, industry and road authorities it should be possible to realise a payable, fully automated data collection system within a period of eight years.”

Within six years after the time of this publication, progress has been made towards the stated goal (e.g. the TRACS contract in the UK), but much has still to be done even on the national road networks. In Germany, in 1997, the autobahns and federal highways were regularly surveyed for surface condition using multi-function machines and image collection equipment. However, as at that time, the key defects are still detected by manual analysis of the images on a routine basis.

In 1997 the Netherlands reported the acquisition of an image collection vehicle for the development of automated crack detection. From recent personal communications with the users and developers of this condition monitoring equipment, the lack of robustness of the automated systems means manual analysis is still the preferred approach for interpretation of the defectiveness.

A recent interim report from the ongoing European Commission funded project, FORMAT (Fully Optimised Road MAinTenance) (February 2003), entitled “Optimisation of pavement monitoring procedures” contains a review of the state of the current monitoring techniques in Europe. It concludes that for surface distress surveys:

"Manual surveys of surface distress are still widely used in spite of several disadvantages (e.g. monitoring staff and road user safety, traffic disturbance, reliability of data, speed of survey, low survey capacity). However, it seems that Western European countries are in the middle of a transition to more automated processing methods and Eastern European countries are just beginning this transition."

The evidence and reporting on the current use of automated surface condition monitoring covers mainly the national road networks in Europe. There are extremely few reports on its use on the minor road networks.

The recent draft report of surface distress detection systems by Working Group A of PIARC Technical Committee C1 - Road Surface Characteristics, to be reported at the next World Congress in Durban in October 2003, includes a world-wide survey of such systems. The survey concentrated on the identification of cracks, since this seemed the only surface distress parameter that, at present, is measured automatically. The study placed emphasis on the systems being routinely applied and found only the TRACS contract fitted this requirement in Europe. In the USA, there were a number of applications that showed varying degrees of success. Most were applied to just the major networks but some also to 'county' roads. However, these roads in the USA are very different from those in the UK with the same name and the techniques do not readily apply to the non-principal roads in the UK. Single applications have also been found in Japan and Australia. The introduction to the report states that:

"Many companies and road authorities have made efforts and invested money to develop systems that automate the measurement and analysis of roadway data. However, after years of research and experimentation, some limited initiatives notwithstanding, most authorities still measure cracking manually. Some of their experiments with automated equipment for measuring pavement cracking seem conclusive, and others less so."

The report of COST Action 325 (1997) referred to the high cost of research to develop automated condition monitoring systems and a recent telephone survey of some European surveying and research organisations in Sweden, Germany and the Netherlands, has confirmed this. These organisations came from both the public and private sectors and suggested that although some research contracts were small, a worthwhile contract in which a problem is thoroughly examined, alternatives properly considered and evaluated and a comprehensive report produced, would cost between 50,000 and 100,000 Euro. The development of new items of prototype monitoring equipment, such as those for crack detection or high-speed deflection measurement, would cost at least 1 to 2 million Euro. There are current examples of the development of new equipment in Sweden, Denmark and the USA, for pavement deflection measurement at high-speed (traffic speed) and the costs of these developments already easily exceed 1 million Euro and a machine is yet to be implemented. The TRACS concept was developed from the production of a research prototype survey vehicle, HARRIS (Highways Agency Road Research Investigation System). Although it is difficult to isolate the development cost to the HA of HARRIS (Ferne et al, 2003), this is also likely to have been in excess of £1m.

5.2.2 Research activities in the UK

There are ongoing research activities in the UK that may assist with the improvements that can now be made to TTS and, potentially, encourage the provision of resources for the new research. For example, the HA has an ongoing research programme to further develop the measurement and analysis techniques currently in the TRACS contract. This research will extend the defects detected in the current surveys and these advances may shorten the development work for TTS.

As part of the surveys for London and Scotland, extra activities have been included or are planned for inclusion (e.g. development of condition indicators and inclusion of extra measurements, or modification of current measurements, to improve the detection of edge deterioration). As much use as possible should be made of these developments, before embarking on new research for TTS.

In 2002, the Roads Liaison Group (RLG) recommended 21 research projects for funding (Category A). These projects included two that are specifically associated with TTS on local roads:

(x)	Local road machine surveys	[Ref: NR1	Duration - 12 months	Cost - £200k]
(xi)	Edge deterioration	[Ref: UK9/TL17	Duration - 18 months	Cost - £100k]

Another project titled “Machine Collected Rutting” [Ref. UK280, Duration 12 months, Cost £80k] was also recommended but was assumed to be included in project NR1. A project, “Improved Condition Index” [Ref: BV1/CB14, Cost £20k] was also recommended and could cover some of the analysis of measurements required to develop the new NRMCS Defects Index. These 3 projects have not been specifically included in the cost estimates for the new research identified. It has, however, been assumed that their funding could be used for research identified for 2003/04 and the first half of 2004/05 and allow the work to start without the need to wait for further funding approvals. The current funding could also be set against the total funds needed for research. Time has been allowed for funding approvals to be obtained before the later research work continues.

5.3 Initial New Research Activities

Some research activities could start relatively soon (e.g. September 2003) after agreement to proceed with the implementation of TTS, if the funding approved by the RLG, or other funding, is available. None of these initial research activities associated with measuring condition is expected to last more that 6 months and all of these activities could proceed in parallel. The preliminary development of the Defects Index would follow the activities to measure condition.

Scotland has already introduced TTS on local roads. The National Assembly for Wales and the Department for Regional Development (Northern Ireland) have expressed an interest in adopting TTS. A formal commitment from these Administrations will enable any particular aspects of the road networks in all parts of the UK to be considered in the initial research activities.

Table 5.1 summarises the cost and duration of each of the initial activities and Figure 5.1 shows a simple work programme to complete the research prior to starting more extensive research in 2004/05.

5.3.1 Review of current surveys

Before specific aspects of condition and their analysis are considered, the first research activity should aim to identify the requirements for the new surveys and review the lessons learned from the surveys undertaken to date. Measurements from the trunk road network, principal roads in London and all roads in Scotland and other authorities will be examined to assess the:

- Use of these types of measurements in measuring condition and identifying the maintenance need on local roads
- Effect of other analysis techniques on the same TTS measurements
- Potential for modifying the current measurement techniques
- Need for measurement and analysis of defects/pavement types not currently considered
- Potential for improvements in maintenance management using TTS measurements with changed business processes

It has been assumed that the data from the current surveys would be readily available to the research team, no costs have been allocated for obtaining this data.

This activity is relatively short and will include a brief consultation exercise with a small number of experts on local roads, to confirm the initial requirements from TTS. This is not the same scale of review and consultation that will be carried out as part of the long-term research, although this short exercise may form an introductory part of the long-term Task.

5.3.2 Edge deterioration

It is acknowledged that one of the biggest disadvantages of applying the survey techniques developed for trunk roads, is the inability to detect edge deterioration that commonly occurs on the local road network. Ongoing work to investigate the feasibility of detecting deterioration of the pavement edge and overrun of the verge has shown that substantial further research and system development will be needed to provide the capability.

Rather than wait for this capability to be fully available, this initial activity will aim to improve the information available to represent the condition of the edge of the pavement, while the more extensive research project is in progress. The early representation could, for example, be based on measuring some of the components of edge deterioration that make up the overall defect, rather than measure all of the defect characteristics.

5.3.3 Transverse profile analysis

At present TTS equipment measures transverse profile using a number of discrete non-contact laser sensors mounted across the measuring vehicle. The TRACS contract for trunk roads and the TTS specification for local roads requires that the measuring equipment needs at least 20 non-contact height sensors, equally spaced over a 3.2m width. This has been found to be adequate for the normal geometry of most of the trunk road network and the principal roads measured so far. However, the dimensions of non-principal local roads are rather more varied. A study of exactly what range of dimensions are encountered on the various parts of such networks, and how frequently they occur, will be needed together with an investigation of what the optimum measuring configurations for such roads are.

A more comprehensive review of the approach to measuring transverse profile on local roads is identified for one of the research projects to be undertaken before the full TTS is implemented. However, so that more useful information can be collected from the start of the surveys on non-principal roads, a smaller scale study could examine how limited changes to the current configuration and analysis algorithm could improve the quality of the information collected.

5.3.4 Defects Index – preliminary analysis

The early implementation of TTS will provide a set of condition data from which the overall condition of the local road network can be reported. The current NRMCS uses a defects index based on the visual condition, so a new index will be needed to represent the new condition measurements on principal and non-principal roads. A short study could take existing TTS measurements and propose one or more indicators of road condition based on those measurements, for the road types in the local road network.

The indicator(s) may need to change when the defects collected by TTS change, in particular, when the full surveys are introduced. A more comprehensive study is therefore suggested as one of the research projects for further in the future, when all the defects are known. This initial study, however, carried out in the first half of 2004/05 after completion of the other initial research activities, will be able to make use of the TTS measurements made up to that time.

Table 5.1 – Initial Research Activities

Research Activity	Estimated Cost (£k)	Estimated Elapsed Duration (months)
Review of current surveys	20	3
Edge deterioration	45	6
Transverse profile analysis	30	6
Defects Index – preliminary analysis	25	6
Total	**120**	**12**

5.4 Longer Term Research

The need for longer term research can be considered in terms of different aspects of pavement condition and research on each aspect undertaken as a separate Task. All of the Tasks will require the collection of sample data using current equipment and techniques. These collections may be more efficiently carried out at the same time (all measurements made using the same traffic management arrangements) but for the purposes of this study, a data collection activity is shown in each Task (i.e. for each aspect of pavement condition). The first task, Task 0, does, however, consider all the aspects of condition and is aimed at confirming the long-term requirements for TTS.

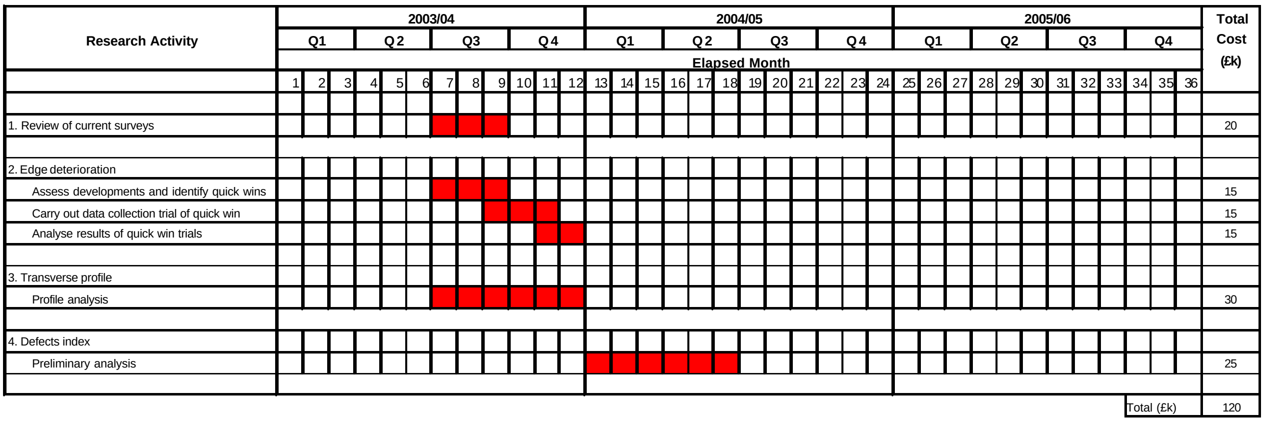

Figure 5.1 Work programme for the initial research activities

All of the Tasks for improved condition measurement aim to develop measurement and analysis techniques that are sufficient to provide a machine capability equivalent to the current manual CVI. For each aspect of condition, part way through the Task, there is also an assessment of the interim solutions identified, to confirm the need for further development or acceptance that the interim solutions are sufficient to meet the needs of a network survey. New funding will be needed for these research tasks. To start the research soon after June 2004, action must be taken to put funding in place. The funding requirement should be considered at the Roads Board meeting in October 2003.

To derive the costs of the Tasks, it has been assumed each Task is carried out independently. Combining Tasks may lead to a reduction in the costs shown. A more detailed breakdown of each research Task after the initial consultation and collection of base data is given in Annex 7.

5.4.1 Task 0: Confirmation of requirements and base data

For TTS to have the measurement and analysis capability for non-principal roads that will provide information for the same purpose as the current CVI, a better understanding of the principal features of the condition of these roads is required. This includes reaching agreement on what characteristics are important on these roads for maintenance need or the requirements for road users and safety. This better understanding could be obtained by consultation with engineers from different types of local authorities. This consultation supplements the short activity proposed as part of the initial research activities but for this long-term research a much wider consultation is envisaged.

To undertake these activities separately for each aspect of condition would be inefficient. Therefore, from the review of existing TTS survey information and consultations with highway engineers familiar with local roads, carried out as part of the initial research activities, and consultation on the perceptions of road users list of those aspects of condition to be considered in the longer term research projects could be prepared.

In addition, to further develop the necessary measurement and analysis techniques, each aspect will require further information about the local roads in the network. For example, for transverse profile measurement and analysis, what range of dimensions are encountered on the various parts of the local road network and how frequently as they occur?

It would also be more efficient if, for all of the aspects of condition to be considered, an information collection exercise is undertaken for the network information to be used in all of the research projects (e.g. range and frequencies of road widths, edge types and geometries). Based on the information currently available, the aspects of condition to be included in the longer term and, therefore, in this data collection Task, are:

- Edge deterioration
- Transverse profile
- Longitudinal evenness
- Cracking
- Other visual defects (e.g. fretting, fatting-up)
- Skid resistance

It is estimated that this data collection and consultation exercise could be completed in 3 months and could commence in January 2004. The estimated cost of £50k could be funded from the current RLG projects.

5.4.2 Task 1: Edge deterioration

Based on a literature search using the International Road Research Database (IRRD) of completed and ongoing research, no significant studies on the automatic measurement of edge deterioration have yet been published world-wide. Specialist studies, for example on the problem of measuring rut depths close to the edge of country roads in Sweden have been carried out but no work that replicates the environment where edge cracking and overrunning are prevalent, as seen on much of the non-principal rural local roads.

Research is ongoing at TRL (Wright et al, 2003) to develop techniques for the automatic detection of edge deterioration but these are not yet sufficiently robust and practical for full implementation.

A timetable for the research to develop the full capability for the measurement of edge deterioration is shown in Figure 5.2 and the cost and duration of the work is summarised in Table 5.2.

5.4.3 Task 2: Transverse profile

Recent work assessing the quality of the results obtained from the TRACS contract for trunk roads and from the SRMCS has illustrated, under certain conditions, the limitations of existing algorithms for the interpretation of rut depths from transverse profiles. More comprehensive profile measurement devices, in combination with enhanced algorithms, are needed for a fuller understanding of transverse profile. The initial research activities will start to examine the changes needed to current measurement and analysis methods but this Task is a more comprehensive study.

The optimum arrangement of sensors for measuring the transverse profile has been considered many times in the past. A recent Forum of European Highway Research Laboratories (FEHRL) study, entitled FILTER (FEHRL, 2002), considered this objective in Tasks 1 and 3, and was reported by Descornet et al (2000) and Willett et al (2000). They considered the range of existing equipment and its performance in practical trials as well as a semi-theoretical examination but no unique solution was identified. Most of the work concentrated on the derivation of rut depths from the measured transverse profile, but some research has questioned the appropriateness of this analysis on certain road classifications. For example, some countries use estimates of the potential for the depth of water ponding as an alternative parameter (Descornet et al, 2000) but as this is based on only a 2-dimensional calculation, its reliability is limited. A 3-dimensional model would improve the analysis but this is a much more complex algorithm and has yet to be fully developed.

A timetable for this research Task is shown in Figure 5.2 and the cost and duration of the work is summarised in Table 5.2.

5.4.4 Task 3: Longitudinal evenness

The measurement of longitudinal evenness has 2 purposes. Firstly, as a measure of comfort for users of the length of road, noting that the requirements may vary with road type and level of use. Secondly, to predict the structural condition of the road. This may mean use of the longitudinal evenness in association with other defects and may require the analysis of the difference between longitudinal evenness measures from different surveys (e.g. the difference between the current and previous year's values). This, of course, means the surveys must be sufficiently aligned (located accurately) to enable measurements from the same length of road to be compared. It is understood that the SRMCS is attempting to achieve the second purpose during the current contract.

Current TTS vehicles measure longitudinal evenness in one wheel track. Recent work in New Zealand and Australia has suggested that representing evenness by an index based on just one wheel track is inadequate due to possible out of phase effects between the profile in the two wheel tracks. This is less likely to occur with low levels of rutting. However, where there is significant rutting or there is variable construction across the width of the pavement, then such effects may be significant.

Research for the HA has shown that longitudinal profile measurements can be affected by a number of operational procedures and road geometry including, survey speed, acceleration, deceleration and road curvature. It has been shown that different types of measuring equipment respond to these problems in different ways. Also, different summary indices, derived from analysis of the profile measurements, can have very different sensitivities to these effects (Willett et al, 2000). The effects of these parameters are likely to be even more significant in the environments encountered on local roads.

Past research by Jordan et al (1989) has shown that, under research conditions, there can be a relationship between road evenness and structural condition. Some of the early results from the SRMCS surveys have suggested a link between high levels of unevenness and serious surface deterioration. It is therefore suggested that the potential for using the longitudinal evenness as a proxy for pavement condition on certain types of local road should be further explored.

The cost and duration of the work is summarised in Table 5.2, based on the timetable for the research shown in Figure 5.2

5.4.5 Task 4: Cracking

There is a limited number of crack detection systems available world-wide and few that are in regular network use. A recent world-wide survey by PIARC (PIARC, 2003), to be published in October 2003, has highlighted the difficulties of calibrating such systems for the range of different surface types existing on the UK road network. TRL research (Pynn et al, 1999) and the acceptance tests and subsequent quality assurance tests carried out for the TRACS contract show the same conclusion. No published information has been found on how the systems cope with surface contaminants and street furniture, common problems on local roads. On concrete surfaces, distinguishing joints from cracks has proved very difficult to solve with sufficient reliability.

A timetable for this research is shown in Figure 5.2 and the cost and duration of the work is summarised in Table 5.2.

5.4.6 Task 5: Other visual defects

The current TTS surveys monitor only cracking that is traditionally referred to as a visual defect. The current CVI includes other defects (see Table 3.3) and research will be needed to further develop the measurement and analysis techniques although this may not be by direct image analysis. Defects not currently measured may also be considered as technology develops.

Research has already looked at monitoring some of these additional defects. For example, Vos et al (1999) has reported on methods of interpreting texture profiles to measure the ravelling of asphalt surfaces and the University of Birmingham, some years ago, explored the potential of stereoscopic images to determine the dimensions of potholes. These methods have not yet reached the implementation stage and many of the parameters still remain to be determined on these and other defects.

The timetable for the research, shown in Figure 5.2, includes the time taken to reach agreement on the other defects to be included. The cost and duration of the work is summarised in Table 5.2.

5.4.7 Task 6: Skid resistance

The Code of Practice for Maintenance Management (DETR, 2001) recommends that "Authorities should develop a strategy for managing the skidding resistance of running surfaces based on the principles defined in this Code and include this in the Highway Maintenance Plan. The strategy should provide for regular measurements of skidding resistance ....." (see Annex 6).

The UK is, in general, ahead of other European countries in the design and use of skidding resistance policies. Few other countries have such well-defined policies even on the national road network. Thus, there is little to learn from Europe for this aspect of maintenance. However, an assessment of measurement techniques as part of the 1st PIARC International Experiment on the measurement of Friction and Texture (PIARC, 1995) did examine alternative measuring techniques, one of which, the Grip Tester, has been adopted by some local authorities.

The current TTS does not include the measurement of skid resistance directly (e.g. by SCRIM or Grip Tester) but the texture depth measurement may provide a proxy. Research by Roe (1998) has questioned the traditional view that texture depth is only important on high-speed roads. This confirmed earlier work by Roe et al (1991) that showed that texture depth can have an influence on accident rates even at relatively low speeds on dry surfaces. In order to predict satisfactory skid resistance performance of roads in all conditions it is necessary, as a minimum, to measure both slow speed skid resistance (e.g. with SCRIM) and the texture depth of the road surface (e.g. SMTD by laser sensor). However, on some local roads it may be justifiable to measure just texture depth as an early warning for inadequate skid resistance. Research is needed to further understand this possibility and the risks inherent in such an approach.

A timetable for this research is shown in Figure 5.2 and the cost and duration of the work is summarised in Table 5.2.

Table 5.2. Summary of research topics, timescales and costs

Task	Topic	Elapsed time (months)	Estimated cost (£k)
0	Confirmation of requirements and base data	18	50
1	Edge deterioration	18	90
2	Transverse profile	18	110
3	Longitudinal evenness	18	155
4	Cracking	18	125
5	Other visual defects	18	90
6	Skid resistance	18	115
	Total	**18**	**735**

5.5 Defects Index

Part of the initial research activities identified for 2003/04 and 2004/05, included a preliminary analysis for the development of a Defects Index based on TTS measurements. As the capabilities of TTS are extended, the Defects Index will need to be redefined to take advantage of the new defects, noting that, as part of the later developments, it must be possible to also calculate the earlier Index, to preserve continuity.

As part of the long-term research activities, it is therefore necessary to include activities to develop one or more Defects Index that can be used to represent the road condition across the UK. Following the preliminary analysis, a further research Task could be carried out on completion of the survey and analysis research Tasks in 2005/06 and 2006/07, to assess the likely changes in the Index. In the work plan in Figure 5.3, this is referred to as the interim analysis.

It is expected that there will be a period of more than one year between the completion of the long-term research activities and the start of the full network surveys and a further year before the results are available for the network. When all the results are available, the final analysis of the Defects Index could be carried out to produce the final version for use in future years.

The cost and duration of each stage of the development of the Index is summarised in Table 5.3. It must be noted that, as shown in Figure 5.3, there is a period of 15 months between the preliminary and the interim analyses and a period of 18 months between the interim and final analyses during which the TTS will collect condition data for use in the analyses but resulting in a long elapsed time for the overall development of the Index.

Table 5.3. Calculation of the Defects Index

Development Stage	Elapsed time (months)	Estimated cost (£k)
Preliminary analysis	6	25
Interim analysis	6	20
Final analysis	9	25
Total[1]	**54**	**70**

[1] Includes 33 months for data collection

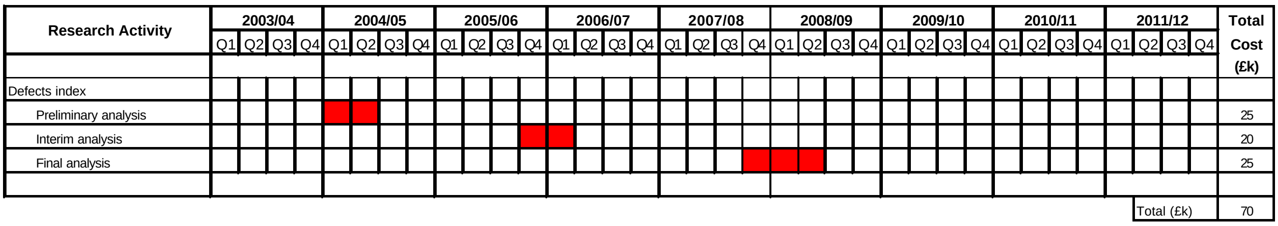

Figure 5.3 Work programme for the derivation of a new defects Index

5.6 Calculation of the Maintenance Backlog

One of the main uses of the data from the network TTS is to form the basis of the calculation of the maintenance backlog for the local road network and show how the backlog is changing over time. The second objective of the 10 Year Plan is to remove the maintenance backlog on the local road network by 2011 and the analysis developed as part of this study will be used to assess if this has been achieved. However, the calculation must be carried out some time before 2011 to enable the extent and type of maintenance carried out to be changed if it appears to be necessary.

There is currently no agreed method for the calculation of the backlog for any part of the local road network. A study to investigate how TTS data can be used to derive the level of backlog in maintenance for the local road network is therefore needed. It is also suggested that the derivation of the approach for the analysis for principal roads is included with this study, to enable a consistent approach to be developed for all the local road network. The calculation for principal roads using the information available from the London and Scotland surveys could be included in the same study or carried out as a separate study, in parallel with the study for non-principal roads.

With the ongoing development of TTS, it is likely that the defects measured in the future will differ from those to be measured for the next few years and the calculated backlog will also inevitably change. Nevertheless, a brief preliminary analysis could be carried out in 2003/04 using some of the RLG funding, to review methods used elsewhere and possible alternative methods for the calculation of the backlog that could be used on local roads throughout the UK. Inevitably, the method will be modified as the type and extent of the available condition data changes.

The final development of the backlog calculation can be undertaken when full surveys are introduced over all the local road network and at least one year of data is available. The timing of the calculation is therefore dependent on the implementation plan for TTS and is considered further as part of the implementation options in Section 6.

Research Activity	2003/04												2004/05												2005/06												Total Cost (£k)
	Q1			Q2			Q3			Q4			Q1			Q2			Q3			Q4			Q1			Q2			Q3			Q4			
	Elapsed Month																																				
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	
0. Confirmation of requirements and base data																																					
Acquire information on the networks										■	■	■																									25
Consult (maintenance need, user and safety req'mnts)										■	■	■																									25
1. Edge deterioration																																					
Identify long term needs																■	■	■																			10
Develop long term solutions																			■	■	■	■	■	■	■	■	■	■	■	■							60
Assess interim solutions																						■	■	■													10
Develop long term implementation plan																															■	■	■				10
2. Transverse profile																																					
Collect measured transverse profile samples																■	■	■	■	■	■																20
Assess current equipment and analyses																			■	■	■																20
Assess interim solutions																						■	■	■													15
Develop long term solutions																						■	■	■	■	■	■	■	■	■							50
Develop final specification																															■	■	■				5
3. Longitudinal evenness																																					
Collect measured three dimensional profile samples																■	■	■	■	■	■																20
Assess current equipment and analyses																			■	■	■																30
Assess interim solutions																						■	■	■													20
Develop long term solutions																						■	■	■	■	■	■	■	■	■							80
Develop final specification																															■	■	■				5
4. Cracking																																					
Collect measured crack detection sample surveys																■	■	■	■	■	■																20
Assess current equipment and analyses																			■	■	■																25
Assess interim solutions																						■	■	■													15
Develop long term solutions																						■	■	■	■	■	■	■	■								40
Implement and retest																													■	■	■						20
Develop final specification																															■	■	■				5
5. Other visual defects																																					
Collect survey samples of selected defects																■	■	■	■	■	■																20
Assess current equipment and analyses																				■	■	■															25
Investigate and develop monitoring solutions																						■	■	■	■	■	■	■	■	■							40
Develop final specification																															■	■	■				5
6. Skid resistance																																					
Basic skid resistance measurement																																					
Collection of skid resistance and texture data																■	■																				10
Analysis and recommendations																		■	■																		15
Adequacy of texture depth coverage																																					
Collection of sample texture data																■	■	■	■																		10
Assess interim solutions																				■	■	■															20
Develop long term solutions																						■	■	■	■	■	■	■	■	■							50
Develop final specification																															■	■	■				10
																																			Total (£k)		735

Figure 5.2 Work programme for the longer term research activities

6 Implementation Options

Three survey options for implementation have been identified. The timescales, resources and costs are discussed for each option in association with the expected timetable for the surveys and data analysis for principal roads. The options take into account the different measurements that will be made on the network and the use that can be made of those measurements. The Options are based on 2 timetables for implementation. Either the surveys are introduced as soon as possible, with small improvements to the current TTS capabilities based on short-term research or the surveys are not implemented until the results of the long-term research are available and the full proposed capability of TTS, to replace CVI, can be adopted. For the Options based on the early implementation, it is assumed the TTS capabilities are upgraded when the results of the long-term research are available. Table 6.1 shows the TTS capabilities for each of the 2 timetables for implementation. The capabilities are shown in terms of the defects measured as part of the current CVI. The results of the research may show that other measurements are needed instead of, or in addition to, those shown in the Table. However, the Table shows the relative expected capabilities of the different implementations of TTS compared with the current CVI.

All of the options take into account the lessons learned from the operation of TRACS and TTS by the Highways Agency, London and the SRMCS in Scotland, since all options include a review of these surveys as one of the initial research activities.

The implementation programmes for the survey options are shown in Figures 6.1 to 6.3. The programmes acknowledge that the implementation of new surveys must be carried out at the start of each survey year, rather than part way through the year. To complete the picture of TTS on local roads, Figure 6.4 shows, as a baseline for the other options, the expected implementation programme for TTS on principal roads. The development and implementation of the agreed method for the calculation of the Maintenance Backlog is considered separately from the survey options. The work programme for the backlog calculation is shown in Figure 6.5.

For each option, the costs of implementation are summarised with each work programme. The survey costs are based on an average survey rate of 150 km/day. All costs exclude VAT. Full details of the costs are given in Section 9.

For all options, resources are shown for project management of the implementation. It is assumed in each programme that all surveying contracts are tendered through the Official Journal of the European Community (OJEC) procedures and the necessary timescales for these procedures have been included in the work programmes together with the timescales needed for DfT approvals for funding and contract awards.

6.1 Quality Assurance of the Surveys

All of the Options will result in the use of more survey vehicles on the network than are currently available. There will, therefore, be a need for an acceptance procedure to confirm the additional vehicles make the necessary measurements in a way that are of sufficient quality and consistency with the existing machines and methods. The specification for the use of TTS on principal roads includes a Quality Assurance procedure and, to maintain consistency on all road categories, it has been assumed the same procedure will be extended to TTS on non-principal roads. However, it should be noted that as new defects are introduced, new procedures may be needed. At this stage, it has been assumed the current procedures will be adopted. The main parts of the procedure are:

- Initial Acceptance Tests

  These comprise a series of tests of the initial performance of the survey equipment against the requirements of the TTS Specification. Survey equipment would need to pass the tests each year. In the specification for principal roads, partial acceptance of equipment is possible, to allow the survey of some defects. The consequence of this on the calculation of BVPIs has not been considered in this study.

Table 6.1 TTS capabilities and CVI defects

Feature	Pavement Type	Defect Description	CVI Current	TTS Current	TTS Interim Solution	TTS Final Specification(2)
Carriageway	All	Longitudinal Evenness		✓	✓	✓
		Texture		✓	✓	✓
	Bituminous	Whole Carriageway Cracking	✓	✓	✓	✓
		Wheel Track Cracking	✓	✓	✓	✓
		Wearing Course Deterioration	✓			✓
		Edge Deterioration	✓		(✓)	✓
		Surface Deterioration	✓			✓
		Settlement/Subsidence	✓			✓
		Transverse/Reflection Cracking	✓			✓
		Rutting	✓	✓	✓	✓
	Concrete	Concrete Cracking	✓			✓
		Transverse Defective Seal	✓			✓
		Longitudinal Defective Seal	✓			✓
		Defective Surface Dressing	✓			✓
		Transverse Joint Defectiveness	✓			✓
		Longitudinal Joint Defectiveness	✓			✓
		Bituminous Patching	✓			✓
		Concrete Surface Deterioration	✓			✓
		Settlement	✓		✓	✓
	Block paving	Block Deterioration	✓			✓
		Minor Block Deterioration	✓			✓
		Rutting	✓	✓	✓	✓
Footway	(1)	Major Deterioration	✓			
		Minor Deterioration	✓			
Kerb		Kerb Deterioration	✓			✓
		Inadequate Upstand	✓			✓
Verge (Paved)	(1)	Major Deterioration	✓			✓
		Minor Deterioration	✓			✓
Cycle track(3)	(1)	Major Deterioration	✓			
		Minor Deterioration	✓			

Notes

(1) Defects occur for each pavement type (bituminous, concrete/flagged and block)

(2) Research aimed at developing the capability to record the equivalent of CVI for carriageways but the actual defects recorded may be different to those currently recorded in TTS and CVI

(3) Cycle tracks not forming part of the carriageway

(✓) An interim implementation to measure some of the components of edge deterioration

✓ May include a measure that represents the type of defectiveness (i.e. not necessarily the current CVI defect definition)

Not all ✓ are of equal weight. TTS will aim to address the common problems on the network first.

- Ongoing Quality Assurance

  This specifies a number of regular checks that the survey contractor must undertake and record the results from, for inspection by the client authority and Quality Assurance inspector.

- Independent Advice and Arbitration

  An essential part of the Quality Assurance procedure is the provision of independent, expert advice on the collection, quality, interpretation and application of TTS data. This role, which may be described as the Auditor, will be available to provide independent advice and support to both local authorities and survey contractors and to act as an arbiter in case of any disagreements or disputes.

6.2 Option 1: TTS On A Sample of Sites

This Option is based on a survey of a sample of sites measuring a sub-set of the defects currently collected with CVI. The main aim of this option is to continue with the NRMCS in England and Wales, but introduce TTS as soon as possible for non-principal roads.

To survey the same length of the network that is currently surveyed in NRMCS will require more survey vehicles than are currently available. Also, with no specification for the surveys yet available, and the agreed way forward for TTS on local roads not expected until mid-2003, there is insufficient time for the industry to provide the required survey capability until 2005/06.

Allowance has been included so the initial research activities described in Section 5 can be adopted to improve the current TTS capabilities for edge deterioration and transverse profile. The study will use measurements made as part of the TTS work carried out in London, Scotland and for the HA. The preliminary analysis for the Defects Index can also be undertaken in advance of the surveys. It is expected this research will be provided under the projects already recommended by the Roads Liaison Group for funding in 2003/04.

The longer term research is not required for this option but could be carried out and the surveys upgraded when the results are available.

The implementation programme for Option 1 is shown in Figure 6.1.

The main features of Option 1 are:

- Centrally managed surveys

  The surveys and analysis in this option are funded and organised centrally by the DfT, although regional contracts (e.g. by Government Office) could be let for the surveys. This option can be carried out with or without one of the other options being adopted.

- Survey of a random sample of sites

  The DfT provides the random sample of sites to be surveyed each year. The survey contractor would provide the processed results for the sample lengths, with a site identifier but not located on the network (e.g. the results could be a set of values in a database or spreadsheet).

  As with the current NRMCS, some of the sites would change each year. The sample size would need to be at least as large as the current sample. There is however a difference in that TTS cannot be used to survey 100m lengths as currently used for NRMCS. With a minimum survey length of 500m, this increases the length surveyed and also limits the roads that may be included in the survey (many local roads are not 500m long).

  If this option is adopted for a short time, the sample survey should continue to provide an overlap of the 2 surveys.

- Phased introduction of new defects prior to 2007/08

  Sample survey can be introduced on non-principal roads in 2005/06, but initially using less defects than CVI – the Defects Index would be based on the subset of defects. It would then be possible to improve the capabilities if new techniques become available. The costs of the long-term research have not been included in this option.

- Data Usage

  The Defects Index would be based on the sub-set of defects measured rather than all the current CVI defects. The Index is for national reporting only, not for local use. For this option, authorities would not receive the survey or processed data, it would be for national reporting only but will not provide data for the BVPI unless the definition of the BVPI is changed significantly.

  Maps showing the ‘condition’ across the network will not be produced for local usage (since a sample of sites used) and the survey data will not be loaded into local (UKPMS) systems.

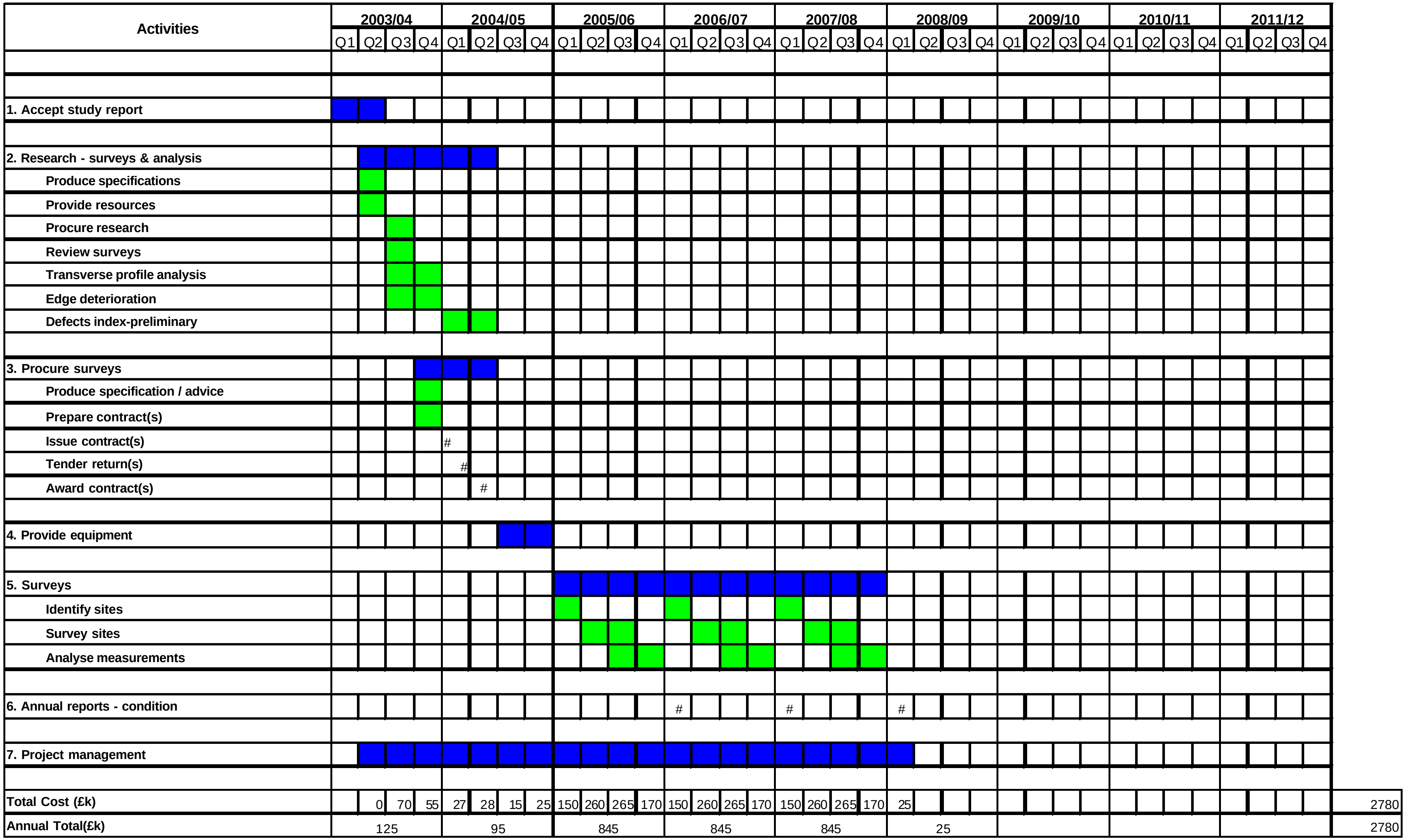

Figure 6.1. Option 1: Work programme for implementation

- Procurement

  Although centrally managed, there could be more than one survey contract (e.g. could be in 3 or more regions). The surveys would be centrally funded and organised by the DfT, so authorities need not be involved at all.

  With a sample based survey, there are procurement options that are not generally available on current contracts. The contractor could be asked to survey the sites and tender for the length of time needed to complete the surveys and provide the processed results, at a fixed rate per day, subject to a maximum value.

- Machines

  The programme includes 6 months for survey contractors to provide new quality assured survey equipment.

  On the extent of surveys proposed, it is anticipated that 2 survey vehicles will be required for non-principal roads but this can only be confirmed when the survey contracts are tendered.

- Coverage

  Coverage would be determined by the sample size required. It is estimated that to provide a sample size equivalent to the current NRMCS, 3 survey machines would be needed. To achieve the required sample size, each survey vehicle could be expected to have to travel over approximately 50% of the network.

- Timetable

  An early statement of intention to proceed is required if time is not to be wasted. There is not a lot of spare time if the initial research activities are to start in 2003/04 and the surveys are to start in 2005/06. An early award of contracts is needed to provide time for building sufficient machines to do a large enough sample size.

- Surveys

  After supply of sites by the DfT, the survey contractor is responsible for the surveys and provision of analysed data back to the DfT.

- Other options

  Option 1 can be run in association with the other options although it is expected that option 1 would only be adopted if it was decided that the full surveys are not to be adopted..

- Project management

  A project manager will be required from mid-2003, provided under a contract for the duration (5 years) of the implementation. Initially, in 2003/04 and the start of 2004/05, the requirement will be for only 3 or 4 days a week but from 2005/06, the job would be full-time. The RLG funding would enable the project manager to start in 2003, without waiting for further funding approvals.

6.3 Option 2: TTS On All The Network - Early Introduction

This option makes the maximum use of the experience gained from the surveys in London and Scotland and on trunk roads. The initial review of those surveys will show the best way of implementing similar surveys on the local roads in England although the surveys would not measure all the defects collected as part of a CVI. TTS will be introduced with the capabilities derived from the initial research activities and the long-term research will provide the full capability to survey all the defects in 2007/08.

To survey the same length of the network that is currently surveyed for BVPIs will require more survey vehicles than are currently available. Also, with a specification for surveys on non-principal roads not yet available, and the agreed way forward for TTS on local roads not expected until mid-2003, there is insufficient time for the industry to provide the required survey capability, and introduce any TTS on non-principal roads until 2005/06.

The implementation programme for Option 2 is shown in Figure 6.2.

The main features of Option 2 are:

- Locally managed surveys

  The surveys and analysis in this option are funded and organised by local authorities, although regional contracts (e.g. by Government Office) could be let for the surveys by consortia of authorities. The surveys will provide data that is loaded into UKPMS and will be used to support the local management and operation of the network.

- Surveys make use of experience gained from earlier surveys

  While preparation for the start of the surveys and the actual surveys are taking place, research will be undertaken to review the work undertaken in Scotland, London and for the HA to assess the successes and weaknesses of the techniques and analysis carried out. This will lead to defining more precisely the approach to be adopted on non-principal roads in England.

- Introduction of new defects in 2007/08

  Following the research activities described in Section 5, the surveys will be enhanced to provide a full replacement for the current CVI in 2007/08. The Defects Index will be developed to represent all the defects measured in the survey.

- Data Usage

  Colour coded maps of ‘condition’ (of the network surveyed) can be produced for local use. Survey data will be loaded into local (UKPMS) systems from 2005/06 for the defects included in the surveys (i.e. the information loaded from the early surveys is different to that loaded from the full surveys).

  The data will be suitable for BVPI reporting. New BVPI definitions will be needed for 2005/06 and again for 2007/08.

- Procurement

  It is expected that the surveys could be funded and managed locally by authorities or consortia of authorities in the same way as advised for the surveys on principal roads (e.g. by Government Office area or by a lead authority acting on behalf of a group of authorities).

  This option should result in co-ordinated survey regimes for authorities that will provide organisational benefits.

- Machines

  The programme includes 6 months for survey contractors to provide new quality assured survey equipment. A second 6 month period is allowed for modifications to the equipment after completion of the long-term research, prior to the full surveys in 2007/08.

  On the extent of surveys proposed, it is expected that 3 survey vehicles will be required for non-principal roads in England but it will be up to the survey contractors to offer the appropriate number of vehicles as part of the tender process.

- Coverage

  The same coverage has been assumed for this option as that currently required for the BVPIs (i.e. 50% of classified roads and 25% of unclassified roads). The proportion surveyed could be increased over time as more vehicles come available but it is unlikely that there would be significant reductions in the survey cost with extra survey vehicles as it is a large network that is currently surveyed.

  No allowance has been made for increasing the survey coverage, and therefore increasing the number of survey vehicles needed, over time. It is estimated, however, that full coverage of the non-principal road network, each year, could be achieved by increasing the coverage each year for 4 years:

2007/08	Classified roads – 50%	Unclassified roads – 25%
2008/09	Classified roads – 75%	Unclassified roads – 50%
2009/10	Classified roads – 100%	Unclassified roads – 75%
2010/11	Classified roads – 100%	Unclassified roads – 100%

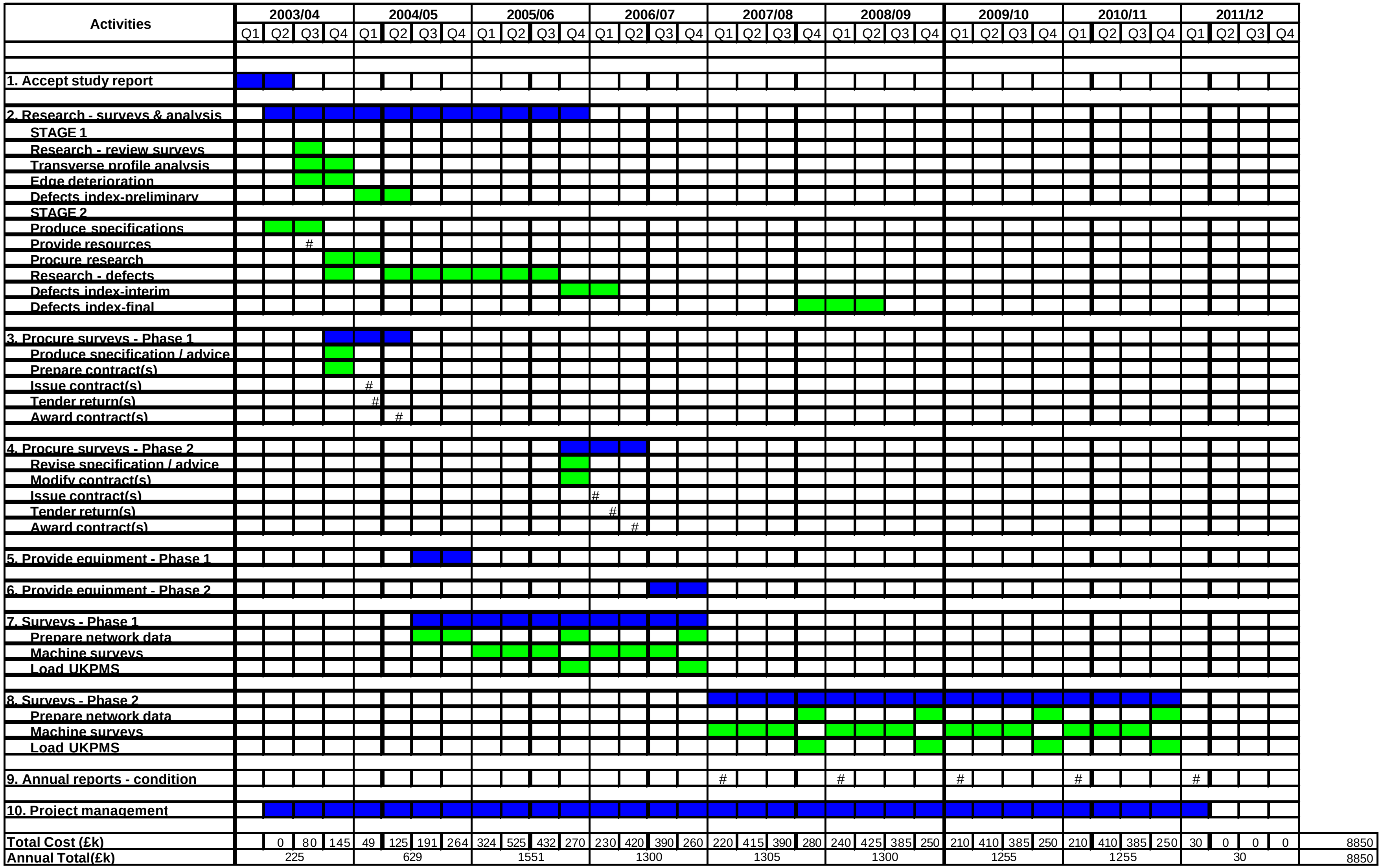

Figure 6.2. Option 2: Work programme for implementation

- Timetable

  An early statement of intention to proceed is required so that the activities shown for 2003/04 can be started. To allow time to build sufficient machines the earliest the surveys can start on the network is 2005/06 using a sub-set of the current CVI defects.

  Early award of contracts is needed to provide time for building sufficient machines for the surveys and carrying out research to improve the measurement and interpretation of condition of each road type. It is unlikely that survey contractors will start to build new equipment until a firm commitment to the new surveys is given.

- Surveys

  The surveys comprise 3 operations by the local authority and the survey contractor. Firstly, the authority provides the information on the parts of the network to survey and, where available, the locations of the start and end of the sections in the network. This is not a random selection and not the lengths in best or worst condition. Generally, a geographical area would be selected. After carrying out the surveys and preliminary analysis, the survey contractor loads, or passes to the local authority to load, the data into UKPMS. In the programme, the load data operation is shown for the last quarter of the year, in time for the annual condition report to be processed at the start of the year after survey. This may, however, be a gradual process through the survey period.

- Defects Index

  An initial Defects Index will be developed as part of the early research activities in 2004/05 and a revised version, based on the results of the surveys carried out with the first version of TTS equipment. The final version of the Index will be developed from the survey data collected from the full surveys in 2007/08.

- Project Management

  A full time project manager will be required from mid-2003, provided under a contract for the duration of the implementation (e.g. 3 + 1 + 1 or 3 + 2 years).

6.4 Option 3: TTS On All The Network - When Full Capabilities Are Available

This option describes the implementation of 'full' TTS on non-principal roads when research has been carried out to identify the aspects of condition to measure and provided methods for making and analysing the measurements. It is expected that the research needed to provide these capabilities can be completed such that the surveys can start in 2007/08. This timescale is not affected by the adoption, or not, of Option 1 but will overlap with Option 1 if the sample survey goes ahead. It is assumed that a visual survey will be used for NRMCS until 2007/08 but no specific actions are shown to implement those surveys.

The implementation programme for Option 3 is shown in Figure 6.3.

The main features of Option 3 are:

- Before the start of the surveys, the review of the current surveys and the long-term research described in Section 5 will be undertaken.

  These research activities include:

  Review of the work undertaken in Scotland, London and for the HA to assess the successes and weaknesses of the techniques and analysis carried out, prior to defining more precisely the approach to be adopted on non-principal roads in England.

  Provide the capability to measure and analyse the defects from TTS to represent the condition of each (non-principal) road type (i.e. a replacement of CVI surveys)

  Development of the Defects Index based on measurements of the full set of defects.

- Locally managed surveys

  The surveys and analysis in this option are funded and organised by local authorities, although regional contracts (e.g. by Government Office) could be let for the surveys by consortia of authorities. The surveys will provide data that is loaded into UKPMS and will be used to support the local management and operation of the network.

- Data usage

  Colour coded maps of ‘condition’ (of the network surveyed) can be produced for local use. Survey data will be loaded into local (UKPMS) systems for the defects included in the surveys (i.e. the full surveys).

  The data will be suitable for BVPI reporting. A new BVPI definition will be needed for 2007/08.

- Procurement

  It is expected that the surveys could be funded and managed locally by authorities or consortia of authorities in the same way as advised for the surveys on principal roads (e.g. by Government Office area). This approach has been successfully adopted in London, where Hammersmith and Fulham was the lead authority, and in Scotland, where Perth and Kinross are taking the same role. In some areas, consortia already exist for purchasing and these groups could take on the same role for TTS.

- Machines

  The programme includes 6 months for survey contractors to provide new quality assured survey equipment prior to the start of the surveys in 2007/08.

  On the extent of surveys proposed, it is anticipated that 3 survey vehicles will be required for non-principal roads in England but this can only be confirmed when the survey contracts are tendered.

- Coverage

  The same coverage has been assumed for this option as that currently required for the BVPIs (i.e. 50% of classified roads and 25% of unclassified roads in one direction on each road). It is estimated that 4 survey vehicles could complete this level of survey but it would be up to the survey contractors to offer the appropriate number of vehicles as part of the tender process. The proportion surveyed could be increased over time as more vehicles come available but it is unlikely that there would be significant reductions in the survey cost with extra survey vehicles as it is a large network that is currently surveyed.

  No allowance has been made for increasing the survey coverage, and therefore increasing the number of survey vehicles needed, over time. It is estimated that full coverage of the non-principal road network, each year, could be achieved by increasing the coverage each year for 4 years:

2007/08	Classified roads – 50%	Unclassified roads – 25%
2008/09	Classified roads – 75%	Unclassified roads – 50%
2009/10	Classified roads – 100%	Unclassified roads – 75%
2010/11	Classified roads – 100%	Unclassified roads – 100%

- Timetable

  An early statement of intention to proceed is required so that the research activities shown for 2003/04 can be started and the funding for the long-term research can be arranged.

- Other options:

  Option 1 can be run in association with Option 3. This will provide surveys earlier and maintain the NRMCS. If Option 1 is adopted with Option 3, surveys for both options will be needed in 2007/08 to provide the overlap.

- Surveys

  For this option, the surveys comprise 3 operations by the local authority and the survey contractor. Firstly, the authority provides the information on the parts of the network to survey and, where available, the locations of the start and end of the sections in the network. This is not a random selection and not the lengths in best or worst condition. Generally, a geographical area would be selected. After carrying out the surveys and preliminary analysis, the survey contractor loads, or passes to the local authority to load, the data into UKPMS. In the programme, the load data operation is shown for the last quarter of the year, in time for the annual condition report to be processed at the start of the year after survey.

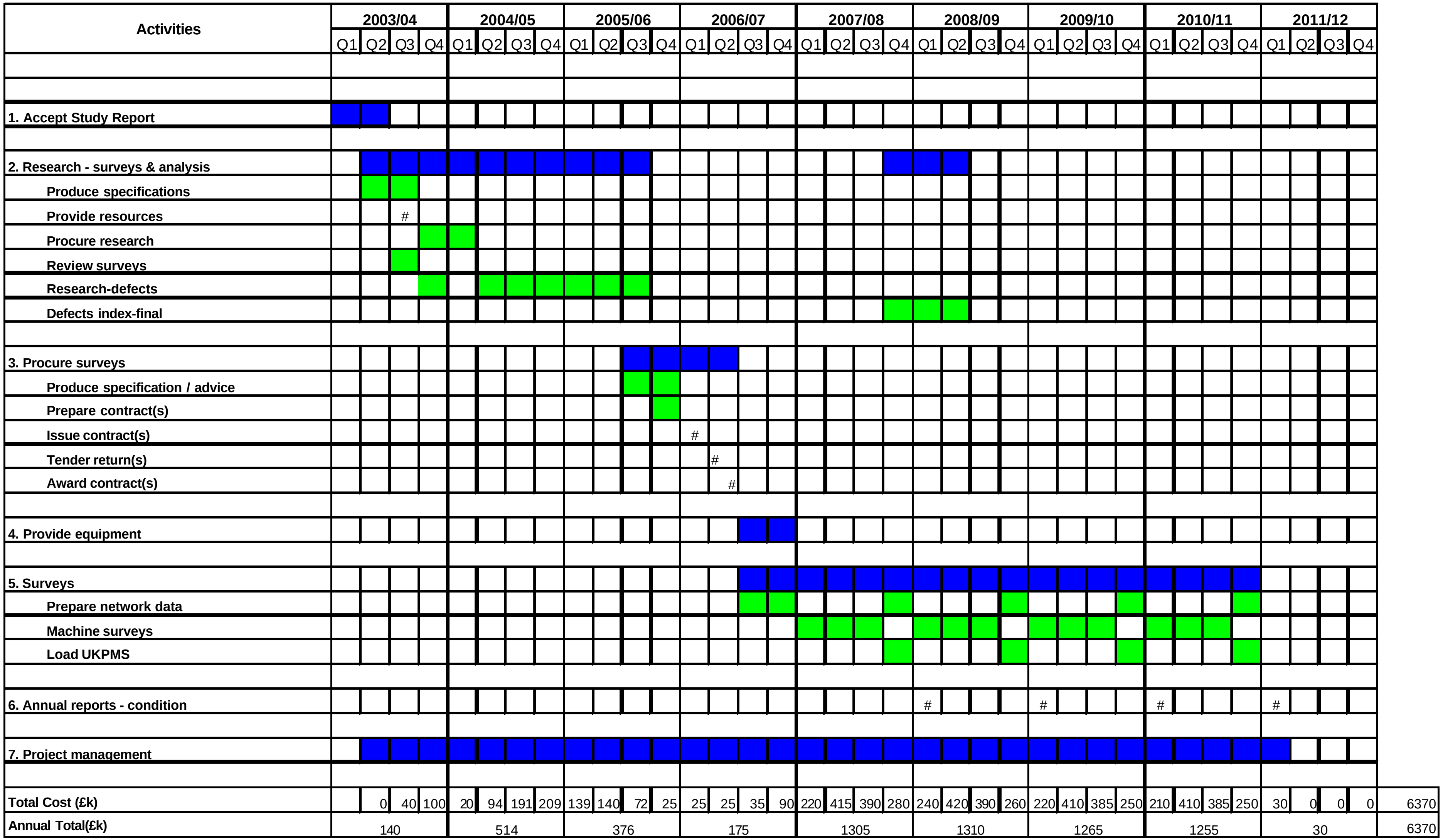

Figure 6.3. Option 3: Work programme for implementation

- Defects Index

  With this option, the Defects Index will be developed from the results of the surveys carried out with the TTS equipment in 2007/08.

- Project management

  A project manager will be required from 2003/04, provided under a contract for the 5 year period to the start of the surveys. A project management team of up to 2 people will be needed for much of the duration of the implementation. There may be some overlap in project management requirements with other options.

6.5 TTS on Principal Roads

A programme for TTS on principal roads is shown for completeness, to act as a baseline and to show the interaction between the activities for principal roads and the different implementation options for non-principal roads. The programme for principal roads is based on the specification for TTS as issued in May 2003 for surveys in 2003/04 and 2004/05. These principal road surveys could be changed when increased functionality is available in 2005/06 (based on research for the phased implementation on non-principal roads) and in 2007/08 with the full implementation of TTS on non-principal roads. These changes have not altered the timings of activities in each year of the programme. It is proposed that TTS on principal roads are managed locally (authorities are advised to form consortia) and paid for directly by the authorities. Data from the principal road surveys is stored locally by each authority. The expected implementation programme for TTS on principal roads is shown in Figure 6.4.

6.6 Backlog Study

As part of the overall objectives for the study, there is a need to define and adopt a definition of 'Backlog' to show the objective from the 10 Year Plan, to eliminate the backlog, has been met.

Figure 6.5 shows the implementation programme for the backlog study, using the condition data available from the surveys. It has been assumed that the information from the sample surveys in Option 1 will not be sufficient for a robust backlog calculation for non-principal roads. The choice of Option 2 or 3 for the implementation of surveys will affect how the backlog is examined.

A calculation method is developed for each stage of the surveys. For both Option 2 and 3, there is a preliminary analysis prior to any new surveys, based on knowledge gained from earlier surveys in London, Scotland and on trunk roads.

For Option 2, an interim analysis based on data from the early implementation of surveys can be carried out in 2005/06. The final analysis is carried out using data from the full surveys in 2007/08. It is expected that the experience gained from the interim analysis will avoid the need for a further change to the analysis method after the second year of full surveys in 2008/09.

For Option 3, there is no change to the preliminary analysis until the data from the first year of full surveys is available in 2007/08. The calculation will be further developed in 2008/09 when a second set of survey data is available.

The backlog analysis will need a small project management involvement. This is costed separately but it is expected that the resources can be found from the project management resources for the surveys.

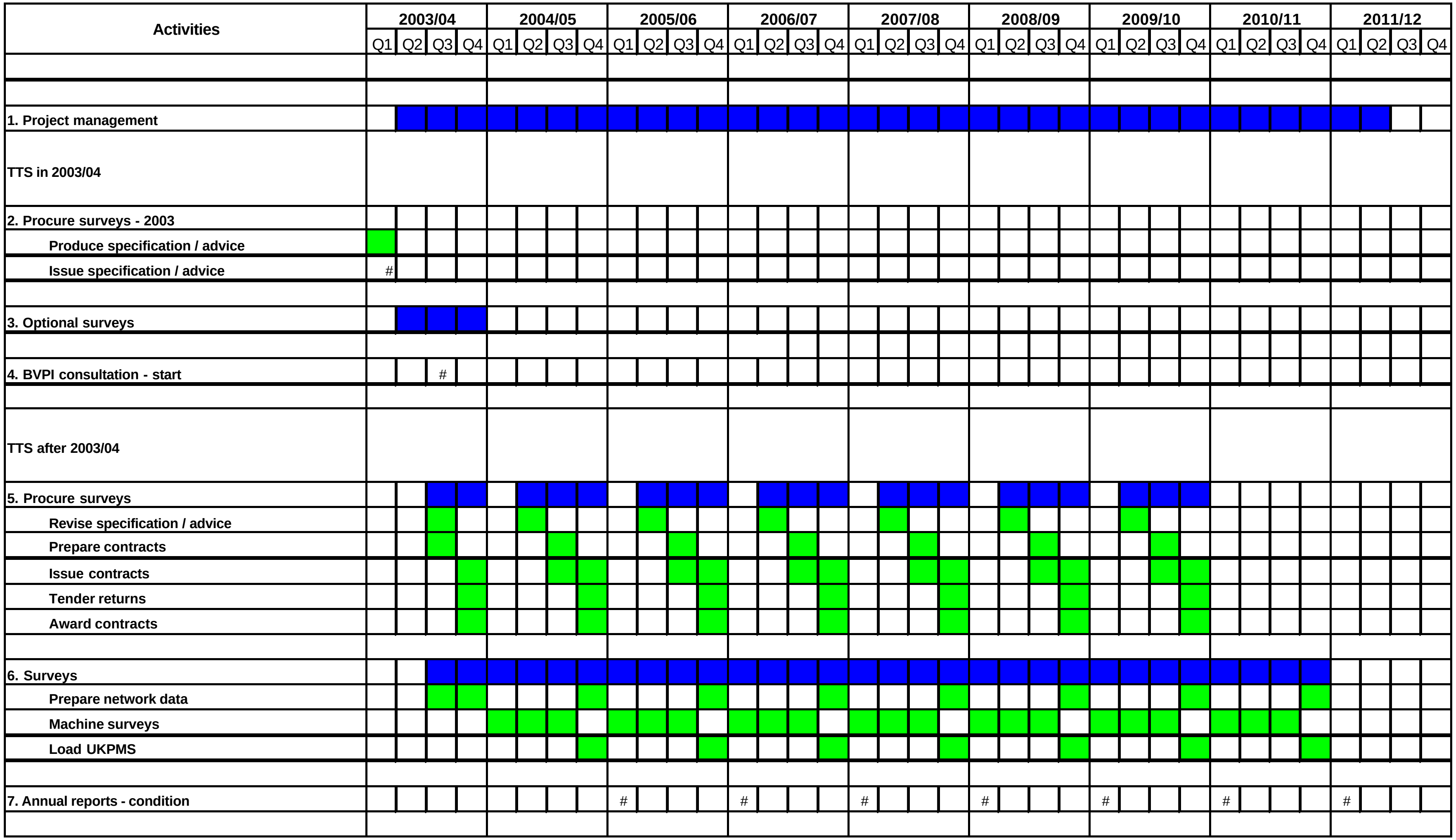

Figure 6.4 Implementation programme for TTS on principal roads

Activities	2003/04				2004/05				2005/06				2006/07				2007/08				2008/09				2009/10				2010/11				2011/12				
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	
1. Accept Study Report	■	■																																			
2. Research - Principal Roads (1)				■	■	■	■	■	■																												
Produce specifications				●																																	
Provide resources					#																																
Procure research							●																														
Analysis-preliminary				●																																	
Analysis-interim								●	●																												
3. Research - Principal Roads (2)												■	■	■	■	■	■	■	■	■	■																
Produce specifications												●	●																								
Provide resources													#																								
Procure research														●																							
Analysis-final															●	●	●	●	●	●	●																
4. Research - (for Option 2)				■				■	■	■	■	■	■	■	■	■	■	■	■	■	■	■															
Produce specifications								●	●								●																				
Provide resources									#									#																			
Procure research										●	●								●																		
Analysis-preliminary				●																																	
Analysis-interim												●	●	●																							
Analysis-final(1)																				●	●	●															
5. Research - (for Option 3)																■	■	■	■	■	■	■	■	■	■												
Produce specifications																●	●																				
Provide resources																	#																				
Procure research																		●	●																		
Analysis-preliminary				●														●	●																		
Analysis-final(2)																				●	●	●	●	●	●												
6. Annual reports																																					
Principal Roads									#				#				#				#				#				#				#				
Non-Principal Roads (Option 2)													#				#				#				#				#				#				
Non-Principal Roads (Option 3)													#				#				#				#				#				#				
7. Project management		■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■				
Total-Option 2		0	0	30	0	0	0	15	15	5	5	15	15	15	10	15	15	10	10	25	25	15	5	5	5	5	5	5	5	5	5	5	5	0	0	0	295
Total-Option 3		0	0	30	0	0	0	15	15	5	5	5	5	5	10	15	15	10	10	25	25	10	10	15	15	5	5	5	5	5	5	5	5	0	0	0	285
Annual-Option 2	30				15				40				55				60				50				20				20				5				295
Annual-Option 3	30				15				30				35				60				60				30				20				5				285

Figure 6.5 Work programme for derivation of the maintenance backlog

7 Project Management

Each of the implementation options described in Section 6 show a requirement for a project management team throughout both the research and implementation periods.

It is expected that this would be a dedicated resource for the period of the implementation and the start of the surveys, with responsibility for the delivery of analysed condition measurements for a centrally managed contract, and for delivery of draft contract documentation if locally run contracts are to be used.

The NRMCS TSG is made up of representatives from DfT, local highway authorities, the HA, National Assembly for Wales, Society of Chief Officers for Transportation in Scotland, Department for Regional Development (Northern Ireland), Transport for London, CSS, SRMCS, TRL and Chris Britton Consultancy. Implementation of TTS on local roads is, currently, the responsibility of the NRMCS TSG reporting to the Roads Board. A Sub-Group of the NRMCS TSG has been responsible for the introduction of TTS on principal roads. The effects of introducing TTS on all local roads will be wider than NRMCS and a revised structure is proposed to reflect the implications of these effects on the management of the local road network. In addition, the NRMCS TSG already addresses issues other than NRMCS and it is proposed that this TSG is re-named the Performance Management Group to reflect these wider responsibilities. It is expected that a new TTS Implementation Group will be needed and the TTS project management team will report to that Group. However, the Performance Management Group will also be involved in related issues and it is proposed both the TTS Implementation Group and the Performance Management Group report to the Roads Board. Figure 7.1 shows the relevant parts of the proposed organisational structure to deliver TTS.

The new TTS Implementation Group would need to include representatives from central and local government in England and the devolved administrations and those responsible for the introduction of TTS throughout the UK (e.g. project managers for TTS in England and the SRMCS). The TTS project management team would provide the secretarial support for the TTS Implementation Group. Specialist consultants and other representatives from local authorities could attend appropriate parts of TTS Implementation Group meetings by invitation.

The size of the TTS implementation project management team depends on the implementation option adopted and the tasks to be managed and the size may vary over the total implementation time period. Option 1, the centrally managed option involving sample surveys would require the largest management team for the surveys but there is no long-term research to be managed with that option.

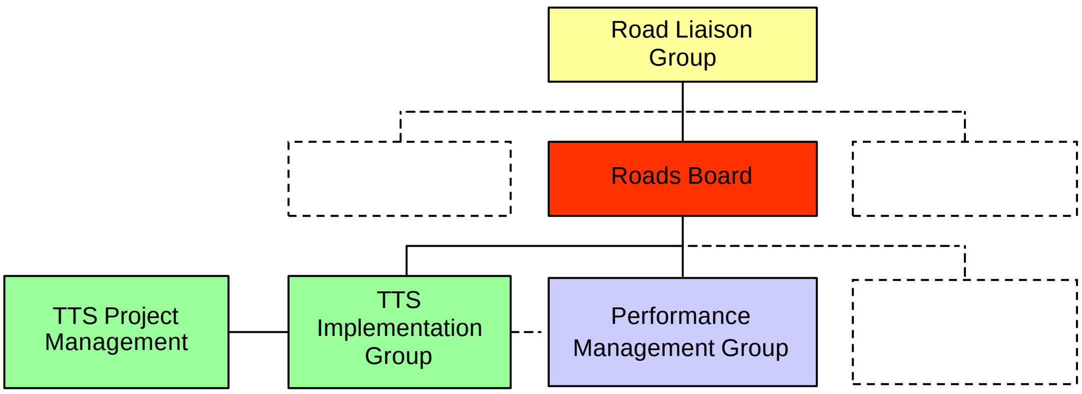

Figure 7.1 Project management structure for implementing TTS

The prime function of the project management team will be the implementation of TTS on non-principal roads. The TTS Implementation Group will provide feedback of the experience gained from implementation on principal roads. As part of the support to the Group, routine activities for the project management team will include:

- Contribution to the NRMCS Newsletter
- Design and maintenance of the TTS web-site
- Progress reports to the TTS Implementation Group and the Performance Management Group
- Maintenance of links between related TTS implementations (e.g. HA and SRMCS)
- Maintenance and management of the Risks and Issues Register
- Arrangement of regional workshops to explain the TTS implementation plan to local authorities

Options 2 and 3 include a significant research programme in 2004/05 and 2005/06. The project management team should be responsible for the management of those projects, forming a close link with the Performance Management Group, the TTS Implementation Group and the research contractors.

Options 1 and 2 assume significant work will be undertaken in 2003/04. It is, therefore, necessary to establish the project management team as soon as possible after the implementation option has been selected. Although shown as part of the implementation costs in the work programme for each implementation option, rather than wait for separate funding approval, it is assumed some of the RLG funding for 2003/04 can be used for the project management costs in that year. Longer term funding arrangements form part of the implementation plans.

8 Risks to Implementation

8.1 Management of Risk

The management of risk has a critical role to play in project delivery. Each option for delivering TTS on local roads entails varying levels of risk at different stages of implementation. This guidance is based on the route map for risk management contained in the Management of Risk: Practitioners Guide (Office of Government Commerce, 2002), and aims to set out the approach to successful management of risk during the project's planning and implementation. Effective management of risk should lead to increased certainty about the project, better service delivery and improved decision making. It will also give better value for money and ensure efficient use of resources. Key areas that need to be addressed in the approach to risk management are:

- The need for a risk 'owner' at a senior level (e.g. Chair of the Roads Board or the TTS Implementation Group)
- Due consideration of the organisational capacity of the Performance Management Group and the Roads Board to successfully achieve delivery of TTS
- The need for improved reporting and upward referral of risk
- The need for shared understanding of risk (and its management) by all involved in implementing TTS including a consistent approach to risk throughout
- Managing project risk in the wider context of the implementation of TTS on local roads

The successful management of risk will be strongly influenced by the context and environment in which it takes place. Clear communication to staff about the strategy adopted, and the benefits to them, and consistent application of risk management processes will also contribute to success. This can be achieved by establishing and adopting a framework for the management of risk that is transparent and repeatable. In collaborative working (as in the implementation of TTS) knowledge and understanding of partners risk management approaches will also be significant.

The framework in Figure 8.1 sets the context in which risks will be identified, analysed, controlled, monitored and reviewed and should be consistent with processes that are embedded in everyday management and operational practices. The minimum requirements for a risk management framework are:

- Existence of the organisations risk policy
- Clear identification of the main stakeholders
- Clarification of the main approaches to be used to identify, assess and report on risks as well as to look at actions to deal with risks
- Clear assignment of responsibilities for managing risk and reporting to senior management
- Clear audit trail of decisions to ensure that risk management reflects current good practice.

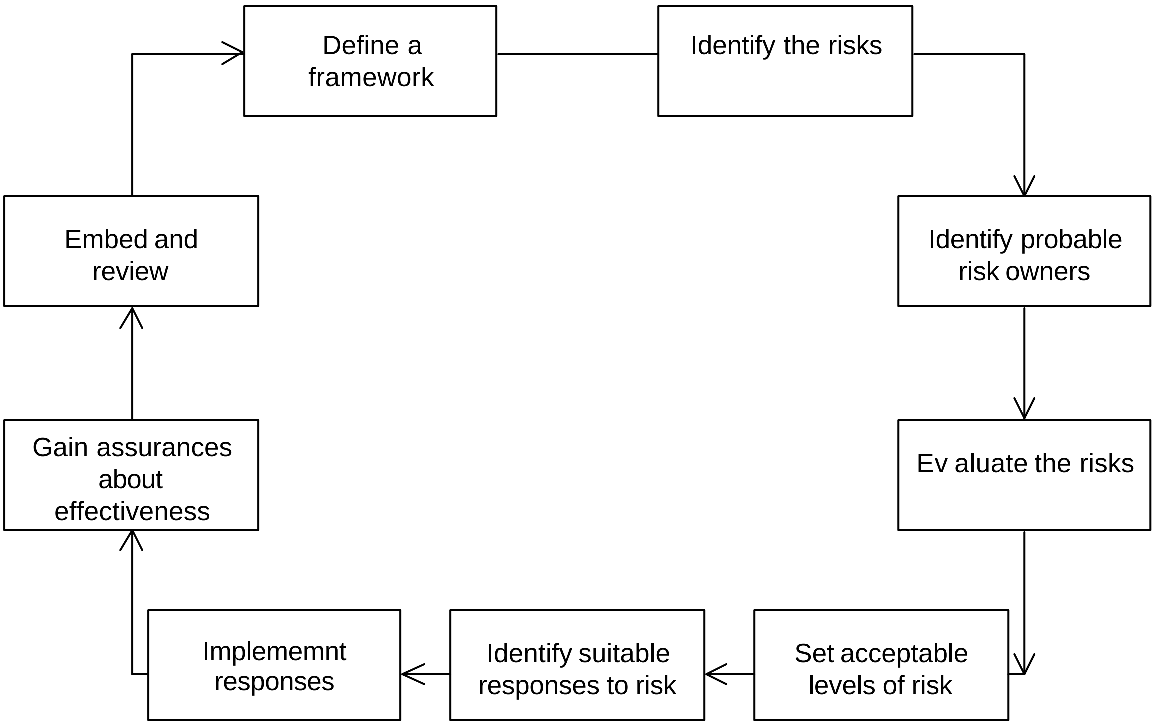

Figure 8.1 A strategic framework for the management of risk

When identifying the risks to project delivery, due consideration should also be given to the opportunities opened up by the activity – the management team should aim to identify 20% of risks that would have 80% of the potential impact. Section 8.2 gives a preliminary identification of the risks associated with the implementation of TTS – this list will inevitably change as the implementation option is agreed, more information becomes available and as the project progresses. As risk may result in both positive and negative outcomes, it must be set in the context of opportunity.

Following risk identification a useful tool for risk analysis is the Summary Risk Profile (or SRP) that allows a risk to be represented as the product of the probability of the risk occurring and the severity of its impact. An example of an SRP is shown in Figure 8.2. The position of the risk tolerance line depends on the organisation and the project. The Performance Management Group would consider all risks above the Tolerance Line

After a risk has been assessed, the next stage is to determine the response to the risk. There are four broad options – transfer, accept or tolerate, terminate or treat it so that it becomes acceptable. After completing this process much more will be known about each risk and the factors affecting it – the key to effective monitoring and management of these risks during the project lifecycle will be **ownership** of each risk. While the Performance Management Group or the Roads Board should own key risks, every risk should have an owner with authority to take on that responsibility. Once a risk has been identified, it must be managed continually until it is mitigated. Identification of the risk is not sufficient.

Finally, contingency plans should build appropriate risk allowance into the financial provision for the implementation, considering how the aims of the implementation of TTS can be met should the required outcome not be achieved, and, in the event of the risk not occurring, how unused funds can be re-deployed.

Probability

Very High					*
High	* *		*		
Medium	*		*Risk Tolerance Line*		
Low		* *	* *		
Very Low			*		
	Very Low	Low	Medium	High	Very High

Impact

* = Degree of risk (more *, higher risk)

Figure 8.2 Example of a summary risk profile

8.2 Risks to the Implementation of TTS

During the Scoping Study, some key risks to the implementation of TTS have been identified. No action has been taken to reduce or remove the risks at this stage, but, where possible, ways of mitigating the risks have been identified. Table 8.1 lists the risks identified and their effect on each of the implementation options. The impact and probabilities will be allocated when a clearer implementation path is available.

9 Costs

Wales currently takes part in the NRMCS and the National Assembly for Wales has confirmed that this is to continue and has also expressed an interest in principle to move to TTS. However, authorities in Wales are not constrained by the BVPI timetable that operates in England so the implementation times are not tied directly to those shown in Section 6.

Northern Ireland does not take part in the NRMCS but the Department for Regional Development (Northern Ireland) has also expressed an interest to introduce TTS. Again, Northern Ireland is not constrained by the BVPI timetable.

The costs are considered for each implementation option for England and separately for introducing TTS on the roads in Wales and Northern Ireland. The costs for TTS in Scotland are also summarised.

The components of costs considered to derive the total cost of each implementation option are:

- Project management
- Surveys and analysis
- Quality assurance
- Research

The costs for each quarter year for the 3 implementation options for England are shown in Figures 6.1, 6.2 and 6.3with the costs for the work needed to estimate the backlog shown in Figure 6.5. The total costs are broken down into the components for each year in Tables 9.1, 9.2 and 9.3. The survey costs are based on an average survey rate of 150km/day. The research costs include the initial research and the long-term research. All costs exclude VAT.

Table 8.1 Current risks to the TTS implementation

Description of Risk	Implementation Option		
	1	2	3
Project Management Team not established by September 2003 Actions for all options are required in 2003/04 to avoid delays to the future programme	✓	✓	✓
Funding for long-term research delayed The long-term research must commence in mid-2004 to give time to meet the full implementation timetable of 2007/08	x	✓	✓
Industry does not react quickly enough to build new equipment More survey machines than are currently available will be needed for Option 1 and the initial surveys for Option 2	✓	✓	x
TTS central funding for surveys not available Option 1 is based on a central contract	✓	x	x
Technology for measuring other defects not achieved Although estimates of time and cost for the research have been made based on experience gained on similar projects, the research may not be successful in the required timescale.	x	✓	✓
Lack of control of different measuring technology Increasing the amount of TTS will require more survey machines. Criteria must be developed to make sure all the machines give equivalent measures of condition	✓	✓	✓
Local authorities do not take up the TTS challenge Although TTS will form part of the BVPI requirement, for Options 2 and 3 will be managed locally and require local authorities to make the implementation arrangements	x	✓	✓
Cost of TTS is significantly higher than costs of CVI Estimates of the costs of TTS on non-principal roads have been made based on experience with similar surveys. If the costs turn out to be significantly higher, this will put pressure on the implementation.	x	✓	✓
Additional costs to local authorities from TTS Some authorities have questioned the extra cost of IT developments and recruitment that may be required for TTS	x	✓	✓
Network referencing for TTS The surveys will need a referenced network to enable measurements to be made and results stored. The Code of Practice for Maintenance Management (DETR, 2001) provides guidance on options for network referencing.	x	✓	✓
Local authorities left to organise surveys for their own area Small individual authorities may not be able to procure TTS effectively. Consortia need to be formed to gain efficiency in survey arrangements.	x	✓	✓

9.1 Project Management

The cost of a suitably qualified project manager is assumed to be £400 per day. At this rate, full-time employment of one person equates to approximately £25k per quarter.

Table 9.1 Summary of the estimated cost of Option 1

Year	Estimated Costs (£k)						
	Project Management	Surveys and Analysis	Quality Assurance	Research	Defects Index	Backlog	Total
2003/04	30			95			125
2004/05	60		10		25		95
2005/06	85	660	100				845
2006/07	85	660	100				845
2007/08	85	660	100				845
2008/09	25						25
2009/10							0
2010/11							0
2011/12							0
Total	370	1980	310	95	25	0	2780

Table 9.2 Summary of the estimated cost of Option 2

Year	Estimated Costs (£k)						
	Project Management	**Surveys and Analysis**	**Quality Assurance**	Research	Defects Index	Backlog	Total
2003/04	50			145		30	225
2004/05	95		50	444	25	15	629
2005/06	95	990	150	266	10	40	1551
2006/07	95	990	150		10	55	1300
2007/08	95	990	150		10	60	1305
2008/09	95	990	150		15	50	1300
2009/10	95	990	150			20	1255
2010/11	95	990	150			20	1255
2011/12	25					5	30
Total	740	5940	950	855	70	295	8850

Table 9.3 Summary of the estimated cost of Option 3

Year	Estimated Costs (£k)						
	Project Management	Surveys and Analysis	Quality Assurance	Research	Defects Index	Backlog	Total
2003/04	40			70		30	140
2004/05	80			419		15	514
2005/06	80			266		30	376
2006/07	90		50			35	175
2007/08	95	990	150		10	60	1305
2008/09	95	990	150		15	60	1310
2009/10	95	990	150			30	1265
2010/11	95	990	150			20	1255
2011/12	25					5	30
Total	695	3960	650	755	25	285	6370

9.2 Surveys and Analysis for England

9.2.1 Option 1

To achieve the same coverage as achieved with the current NRMCS is estimated to require the survey vehicle to 'drive' over 25% of the road network.

Length of classified roads	85,000 km
Length of unclassified roads	180,000 km
Proportion of network covered per year	25%
Length of network covered per year	66,250 km
Length covered per day	150 km
Number of days surveying	440
Cost for survey and analysis (per day)	£1500
Total survey cost per year	£660,000

9.2.2 Options 2 and 3

The estimated costs are based on surveying the lengths currently required for BVPIs in England.

Length of classified roads	85,000 km
Proportion of network surveyed per year	50%
Length of classified roads surveyed per year	42,500 km
Length of unclassified roads	180,000 km
Proportion of network surveyed per year	25%
Length of unclassified roads surveyed per year	45,000 km
Total length surveyed per year	87,500 km
Length surveyed per day	150 km
Number of days surveying	583 (say 600)
Cost for survey and analysis (per day)	£1,650
Total survey cost per year	£990,000

9.2.3 Survey rates

The estimates for the costs of the surveys in each of the options are based on an average survey rate of 150km/day. The rates that will be achieved, in practice, will vary (e.g. with network size and mix of road types). To assess the effect on the total survey cost of achieving lower average rates, the costs of the surveys in options 2 and 3 have been recalculated with alternative survey rates of 125km/day and 100km/day. No effects on the other cost components caused by the lower survey rates have been considered as the effects are expected to be small. No effects have been estimated for Option 1. The effects on the survey costs for Options 2 and 3 are shown in Tables 9.4 and 9.5.

Table 9.4 Effects on the survey costs for Option 2 from alternative survey rates

Year	Estimated Survey Costs (£k)		
	Survey Rate 150km/day Survey Cost £1650/day	Survey Rate 125km/day Survey Cost £1800/day	Survey Rate 1050km/day Survey Cost £2000/day
2003/04			
2004/05			
2005/06	990	1260	1750
2006/07	990	1260	1750
2007/08	990	1260	1750
2008/09	990	1260	1750
2009/10	990	1260	1750
2010/11	990	1260	1750
2011/12	990	1260	1750
Total	5940	7560	10500

Table 9.5 Effects on the survey costs for Option 3 from alternative survey rates

Year	Estimated Survey Costs (£k)		
	Survey Rate 150km/day Survey Cost £1650/day	Survey Rate 125km/day Survey Cost £1800/day	Survey Rate 1050km/day Survey Cost £2000/day
2003/04			
2004/05			
2005/06			
2006/07			
2007/08	990	1260	1750
2008/09	990	1260	1750
2009/10	990	1260	1750
2010/11	990	1260	1750
2011/12	990	1260	1750
Total	4950	6300	8750

9.3 Quality Assurance

Experience has shown that the costs of providing the acceptance tests and audit function for TRACS and TTS is approximately £50,000 per vehicle per year. With the introduction of TTS, there is likely to be more vehicles and some savings will be possible from combining tests. On this assumption, the cost for providing the quality assurance role for 4 TTS vehicles has been estimated to be £150,000.

9.4 Savings for local authorities in England

Implementation of TTS on the local road network will replace the current CVI on the carriageways and the cost of the CVI will therefore be saved. However, on many of the roads, the footway associated with the carriageway will still be inspected using CVI or DVI. Where a DVI on the footway replaces a CVI for the carriageway and footway, the cost may actually increase, but where the CVI on the carriageway and footway changes to CVI on only the footways, then there will be a reduction in cost.

Length of classified roads	85,000 km
Proportion of network surveyed per year	50%
Length of unclassified roads	180,000 km
Proportion of network surveyed per year	25%
Length of network surveyed per year	87,500 km
Proportion without footways	25%
Length where TTS replaces CVI	21,875 km
Cost for CVI (per km)	£20
Total saving per year	£437,500

Some authorities carry out routine structural surveys (e.g. Deflectograph) on a proportion of their local roads. It is expected the number of surveys will be reduced when TTS are introduced as these will provide a filter for the need for the structural surveys. The current occurrence of the structural surveys is very variable between authorities so no general savings have been considered in this study. Authorities should, however, take these costs into account when considering the effects of introducing TTS in their authority.

9.5 TTS in Wales and Northern Ireland

The National Assembly for Wales and the Department for Regional Development (Northern Ireland) have expressed interest in adopting TTS but no year for the start of the surveys has been set. The costs of introducing the surveys have therefore been considered in terms of the annual survey cost, the start-up costs prior to the start of the surveys and the costs of project management and quality assurance. It has been assumed the results of the research already identified for England would also be applicable to the surveys in Wales and Northern Ireland. The costs are estimated for implementation option 1 for Wales and for implementation options 2 and 3 for Wales and Northern Ireland, based on the road lengths in Table 3.1.

9.5.1 TTS in Wales

Project Management
The same rate given in Section 9.1 has been assumed for the management of the implementation of surveys in Wales. It is expected that the project manager will be required for an average of one day per week to manage the implementation. The estimated cost of this involvement is £20k per year.

The 22 highway authorities in Wales already operate with 8 lead authorities. It has been assumed this arrangement will be adopted for the introduction of TTS.

*Surveys and Analysis - **Option 1***
To achieve the same coverage as achieved with the current NRMCS is estimated to require the survey vehicle to ‘drive’ over 25% of the road network.

Length of classified roads	12,804 km
Length of unclassified roads	15,924 km
Proportion of network covered per year	25%
Length of network covered per year	7,182 km
Length covered per day	150 km

Number of days surveying	48
Cost for survey and analysis (per day)	£1500
Total survey cost per year	£72,000

*Surveys and Analysis - **Options 2 and 3***
The estimated costs are based on surveying the lengths currently required in England.

Motorways (survey lanes 1 and 2)	100% of the network	6,724 km
Principal roads (survey in each direction)	100% of the network	1,592km
Classified roads (survey in one direction)	50% of the network	6,402km
Unclassified roads (survey in one direction)	25% of the network	3,981km
Total length surveyed per year		18,699km
Length surveyed per day		150 km
Number of days surveying		125
Cost for survey and analysis (per day)		£1,650
Total survey cost per year		£206,250

With the alternative survey rates considered for England, the survey and analysis costs are £270k (for an average survey rate of 125km/day) and £380k (for an average survey rate of 100km/day).

Quality Assurance
For Option 1, it is assumed no extra vehicles will be needed so the quality assurance costs are covered by the costs given for England.

For Options 2 and 3, it is unlikely that the extra surveys could be carried out by the number of vehicles estimated for the surveys in England, but the survey length is not enough to occupy an extra vehicle. Assuming the surplus capacity could be used elsewhere (e.g. Northern Ireland) the costs of quality assurance are estimated to be for 0.5 vehicles, £25,000 per year.

Start-up Costs
In advance of the surveys, the cost of the management activities associated with introducing the surveys (e.g. procurement) are estimated to be £85,000 over the preceding 30 months before the surveys start.

Summary
The costs for introducing TTS into Wales are summarised in Table 9.6.

9.5.2 TTS in Northern Ireland

Project Management
The same rate given in Section 9.1 has been assumed for the management of the implementation of surveys in Northern Ireland. The Department for Regional Development in Northern Ireland is responsible for all road hierarchies. This is expected to make the implementation of TTS, across the whole network, easier. It is expected that the project manager will be required for an average of one day per week to manage the implementation. The estimated cost of this involvement is £20k per year.

Table 9.6 Costs of introducing TTS in Wales

Start-up costs (over 30 months)	£85,000
Option 1 - Annual Costs Project Management Quality Assurance Surveys and Analysis Total	 £20,000 £0 £206,000 £72,000
Options 2 and 3 Project Management Quality Assurance Surveys and Analysis Total	 £20,000 £25,000 £206,000 £251,000

*Surveys and Analysis - **Options 2 and 3***
The estimated costs are based on surveying the lengths currently required in England.

Motorways (survey lanes 1 and 2)	100% of the network	440 km
Principal roads (survey in each direction)	100% of the network	4,540km
Classified roads (survey in one direction)	50% of the network	3,785km
Unclassified roads (survey in one direction)	25% of the network	3,708km
Total length surveyed per year		12,743km
Length surveyed per day		150 km
Number of days surveying		85
Cost for survey and analysis (per day)		£1,650
Total survey cost per year		£140,250

With the alternative survey rates considered for England, the survey and analysis costs are £189k (for an average survey rate of 125km/day) and £260k (for an average survey rate of 100km/day).

Quality Assurance
For Options 2 and 3, it is unlikely that the extra surveys could be carried out by the number of vehicles estimated for the surveys in England, but the survey length is not enough to occupy an extra vehicle. Assuming the surplus capacity could be used elsewhere (e.g. Wales) the costs of quality assurance are estimated to be for 0.5 vehicles, £25,000 per year.

Start-up Costs
In advance of the surveys, the cost of the management activities associated with introducing the surveys (e.g. procurement) are estimated to be £85,000 over the preceding 30 months before the surveys start.

Summary
The costs for introducing TTS into Northern Ireland are summarised in Table 9.7.

9.6 TTS in Scotland

In the autumn of 2002, following competitive tender, a new 4 year contract was awarded to WDM for the survey of the Scottish road network. The contract requires the collection of Ordnance Survey grid reference co-ordinates, longitudinal profile, rutting, texture depth, cracking and forward facing digital video, each year on all principal roads, 50% of the “B” and “C” routes and 25% of the unclassified network.

Table 9.7 Costs of introducing TTS in Northern Ireland

Start-up costs (over 30 months)	£85,000
Options 2 and 3	
Project Management	£20,000
Quality Assurance	£25,000
Surveys and Analysis	£140,000
Total	£185,000

The survey of the Scottish non-principal roads is equivalent to Options 2 and 3 for England; i.e. surveyed in one direction only. The survey of principal roads is also in one direction (one lane) only in contrast to the proposals for England. The work in Scotland will involve the development of TTS techniques and procedures but no research costs are shown here for that work.

Project Management

The rate given in Section 9.1 is generally in line with the cost in Scotland. The overall project management costs for the SRMCS is £78,000 per year.

Surveys and Analysis

Based on the current contract, the costs include:

- cracking measurement
- edge condition rating
- data fitting
- road condition index analysis
- PI calculation for Scotland and also individual Councils
- Delivery of data to Councils
- Delivery of mapping to Councils

The total annual costs are:

Principal roads (survey 1 lane in one direction, dual carriageways count as 2 roads)	100% of the network	7,408km
Classified roads (survey 1 lane in one direction)	50% of the network	
B Class		3,704km
C Class		5,163km
Unclassified roads (survey in one direction)	25% of the network	6,390km
Total lane length surveyed per year		22,664km
Cost for survey and analysis (per km)		£26.50
Total survey & analysis cost per year		£602,849

Quality Assurance

Two vehicles are in use for the survey. It is likely that some of the costs for these are included in the estimates for England, Wales and Northern Ireland. Assume that the costs of quality assurance are for 1 vehicle, £50,000 per year.

Start-up Costs

The start-up costs have already been met.

Summary

The costs for TTS in Scotland are summarised in Table 9.8.

Table 9.8 Costs of TTS in Scotland

Start-up costs (over 48 months)	£35,000
Annual Costs	
Project Management	£78,000
Quality Assurance	£50,000
Surveys and Analysis	£602,849
Total	£765,849

10 Communications

10.1 Effective Communication

Effective communication will be an integral and necessary part of the implementation of TTS on non-principal roads. A comprehensive communications strategy will ensure expectations of the various stakeholders are managed appropriately and will enable the key elements of successful communication to be met. These include:

- Raising awareness
- Maintaining interest
- Gaining commitment
- Prompting action
- Providing clarity
- Receiving feedback
- Managing stakeholder expectations
- Reporting on issues and risks

Ineffective communications adversely impact the ability to realise the benefits from a project. It is therefore essential that best use is made of communications to generate support and buy-in to the project, and, subsequently, to retain confidence in the project by the stakeholders. Ineffective management of stakeholders' expectations is a primary cause of failure in projects.

10.2 Communication Activities

The following formal communications have already occurred during the Scoping Study:

- Inception meeting involving the Project Team, representatives from the Roads Board, SRMCS, Chris Britton Consultancy and TRL.
- Review meetings (3) between the Project Team and the Chair of the Roads Board
- Review meetings (3) between the Project Director and Department for Transport representatives
- Progress meetings between the Project Director and the Project Manager at approximately 2 week intervals
- Presentation on interim findings from the Study to the Roads Board (April 2003)
- UKPMS TTS Seminar – technical presentations and workshops
- Presentation on the Scoping Study to the UKPMS Owners Forum

- Article for NRMCS Newsletter No. 2
- Discussions with survey contractors, research contractors and specialist consultants.
- Other ad hoc meetings

10.3 Other Communication Activities

It is essential that there is visible on-going commitment to TTS communications from the Roads Board and NRMCS TSG. It is not uncommon for communication activities to rank low amongst project priorities and to become abandoned over time but it is essential this is not allowed to happen during the implementation of TTS. The following activities are planned after completion of the Scoping Study:

- Contribution to NRMCS Newsletter No. 3
- Presentation at the Surveyor Conference (July 2003)
- Presentation to "New Developments in Pavement Assessment" Conference (July 2003)
- Journal article describing the Scoping Study

Following agreement on the way forward for the implementation of TTS, there should be a series of regional workshops to explain the way forward to local authority representatives and seek feedback on issues to consider during the implementation phase. These workshops should be organised as part of the TTS project management activities to help raise the profile of the TTS implementation.

In addition, as implementation progresses, there will be a need for a TTS User Group that can address issues arising from surveys on principal and non-principal roads. The TTS Sub-Group to the NRMCS TSG should act in the role of the User Group. The structure of the TTS Sub-Group is considered as part of the project management activities.

Reasons often quoted for the poor performance of user groups are:

- Insufficient representation from direct users in the user groups
- Feeling that conclusions to questions raised are predetermined by the project team
- Lack of consistency in attendance

Each of these potential problems must be addressed at the start of the implementation. Many of those who attend user groups are not typical users but "enthusiasts" and it is particularly important to manage the expectations of these people. This can be best achieved by a close working relationship between the user representatives and the project management team (e.g. allow discussion of user concerns, provide user input to meeting agenda, empowering users to act as user champions and providing a feedback process). Receiving and acting on feedback is a prime requirement for a successful user group. Feedback can come from training sessions, user meetings or ad hoc comments or queries to the project manager. All of these routes must be easily available to the users.

Training sessions provide an opportunity to communicate about the project. The training provision should include an overview of the process of data collection, analysis and interpretation rather than concentrate on points of detail that prevent the appreciation of the overall process.

Face to face communications are often more effective than indirect approaches. During the implementation of TTS, opportunities should be taken for regional meetings to describe the current position. For example, the launch of new versions of the TTS specification should be undertaken at public events (seminars) where the types of changes being introduced and the effect on current processes can be fully explained to users. These activities will help to retain the high profile required for the successful implementation of TTS.

The NRMCS Newsletter, issued every 3 months during the implementation of TTS, will continue to be a main vehicle for informing local authorities of progress with the introduction of TTS. It is essential a balance is sought between an overview of the overall development and more technical information for those requiring detailed project information. It is likely that the Newsletters, produced by the project management team, should contain articles with different levels of detail.

Currently the distribution list for the NRMCS Newsletter is compiled from a variety of sources. It is necessary to create appropriate circulation lists for TTS information and keep these lists up to date. Most importantly there is a need for commitment to produce and distribute the Newsletters according to a timetable communicated to the readers. Sufficient numbers of Newsletters should be sent to each authority so that the copies do not remain with senior management in the authority.

An easy to access service for up to date information on progress with the implementation of TTS should be made available on a web site for the work. This could be contained within an existing site (e.g. DfT) or a site established specifically for TTS information.

11 Conclusion and Recommendations

The Scoping Study has looked at the issues associated with implementing TTS on non-principal roads and has reached the following conclusions.

1. The implementations of TRACS on the trunk road network and TTS on principal roads in London, roads in Scotland and roads in other English local authorities have provided valuable experience in the use of this type of survey on the local road network.

2. TTS should be implemented on non-principal roads as soon as practicable. Of the options considered, Option 2 is the recommended way forward. This option builds on the lessons learned from earlier TTS on local roads. It involves the implementation of TTS, for a sub-set of the aspects of condition currently considered by CVI, until further measurement techniques have been developed sufficiently to provide TTS as a full replacement for CVI.

3. Scotland has already introduced TTS on local roads. The National Assembly for Wales and the Department for Regional Development (Northern Ireland) have expressed an interest in adopting TTS. A formal commitment should be sought from both of these Administrations as part of the selection of the implementation option for England. This will enable any particular aspects of the road networks in all parts of the UK to be considered in the initial research activities and procurement of the surveys. The adoption of Scotland and Northern Ireland will enable the NRMCS to represent all of the UK.

The following recommendations are made to support these conclusions.

1. A project manager should be appointed to manage the implementation process by the end of September 2003.

2. The implementation process should include a series of regional workshops to explain the way forward adopted for TTS on non-principal roads and obtain feedback from prospective local authority users.

3. A new management structure for the implementation of TTS on all local roads should be established as soon as possible.

4. The research funding approved by the Roads Liaison Group for 2003/04 be made available for the initial research activities identified by the Scoping Study.

5. The Roads Board should approach the Road Liaison Group to secure funding for the long-term research to develop the full capabilities of TTS to provide a full replacement for CVI on local roads.

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WDM Ltd

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14 Annex 1. Glossary

BVPI	Best Value Performance Indicator (See Annex 3)
CHART	Computerised Highway Assessment and of Ratings and Treatments
COST	Co-operation in the field of Scientific and Technical research
CSS	Formerly the County Surveyors' Society
Deflectograph	A lorry-based machine that measures the deflection of the pavement as it passes over it.
DfT	Department for Transport
FEHRL	Forum of European Highways Research Laboratories
FWD	Falling Weight Deflectometer
HA	Highways Agency
HARRIS	Highways Agency Road Research Information System
HMDIF	Highway Maintenance Data Interchange Format
Local road network	Road network managed by local authorities (i.e. excludes trunk roads)
Long-life pavement	A pavement whose structural component does not deteriorate under the effect of applied traffic loading, but which does deteriorate under the combined effects of time and of 'wear and tear' of the surface. (Applies to Flexible Pavements only).
NRMCS	National Road Maintenance Condition Survey
NRMCS TSG	National Road Maintenance Condition Survey Technical Sub-Group
National road network	Another name for trunk roads
Non-principal road	The local road network that excludes principal roads
OSGR	Ordnance Survey Grid Reference
PIARC	Permanent International Association of Road Congresses (now known as the World Road Association)
Principal road	Top hierarchy of the local road network
RLG	Road Liaison Group
SCRIM	Sideway-force Coefficient Routine Investigation Machine
SRMCS	Scottish Road Maintenance Condition Survey (See Annex 5)
TRACS	TRAffic speed Condition Surveys
Trunk road	A Road (either a Motorway or an All Purpose Trunk Road) maintained and operated by or on behalf of the Highways Agency.

TTS	TRACS Type Surveys
UKPMS	United Kingdom Pavement Management System

15 ANNEX 2. Work specifications for the Scoping Study

15.1 Project Director

Main duties and responsibilities:

(i) The Project Director will direct the work of the Project Manager.

(ii) The Project Director will have personal responsibility for devising and implementing a programme of engagement and communication to allow authorities' views to be fully reflected in the delivery plan and to keep them informed of latest progress. This should mean that:

- the delivery plan's recommendations meet the requirements of local authorities, BVPI and NRMCS;
- the delivery plan will be accepted and implemented by all local authorities;
- the local authorities will have ownership of the project.

15.2 Project Manager

Main duties and responsibilities:

(i) Produce a comprehensive delivery plan within three months. This should identify options and make recommendations for the work needed, how it would be done, estimated costs and other resources. The principal activities to be included are:

- Advise on the feasibility of introducing TTS to the planned timetable.
- Examine the research needed to ensure TTS provides robust information on defects relevant to each road class and delivers outputs suitable for local monitoring purposes, BVPI, NRMCS, calculation of backlog and allocating maintenance funds. This will include consideration of completed research, the research proposals agreed by the Roads Board and links to UKPMS
- Within existing formal arrangements, review the membership and structure of sub-group(s) with responsibility for the measurement of local road conditions and identify options and make recommendations with a view to ensuring efficient and effective steering and management arrangements.
- Identify and develop options for managing the move to TTS on local roads, including contractual arrangements, survey commissioning and project management. Make recommendations based on the strengths and weaknesses of the options.
- Produce a detailed and achievable work programme which identifies resources needed and key milestones.
- Prepare a communication strategy to ensure successful delivery by obtaining the support and co-operation of all stakeholders, particularly the local highway authorities.
- Produce a risk register that can be maintained during the development of TTS for local roads
- Prepare a report, with recommendations on the move to TTS and the incorporation of the survey results in NRMCS. This should include a specification for a Project Manager to be responsible for delivering the extension of TTS across the local road network.

(ii) Use the experience and knowledge of the Project Director to build links with highway authorities of different types (e.g. Counties, Unitary Authorities) in England and Wales and take appropriate action to ensure they are fully engaged in the planning process.

(iii) Produce a newsletter to be issued as an NRMCS Newsletter on completion of the three month period.

(iv) Work closely with the project manager of the Scottish Road Maintenance Condition Survey (SRMCS) to ensure the experience from using TTS on all road classes in Scotland is considered for the England and Wales survey and recommend a strategy to build consistency into UK measures of road condition.

(v) Recommend effective channels of communication that will be needed during the introduction of TTS, between highway authorities, DfT, Highways Agency, the road maintenance industry and other key stakeholders to share knowledge, pool resources, minimise risk and understand the available skills, needs and interests. In particular form close links with the:

- Roads 2000 project which is introducing TTS on principal roads in London;
- TTS Working Group which has responsibility for introducing TTS on principal roads in 2003.

(vi) Undertake any other duties which may be reasonably considered to be part of the project as they arise during the period of the contract.

16 ANNEX 3. Best Value Performance Indicators 2003/04

16.1 BV 96 - Condition of Principal Roads

Percentage of the network with negative residual life, derived from Deflectograph surveys, Coarse Visual Inspections (CVI) or TRACS Type Surveys (TTS).

Authorities **must** select one of the options listed below (1-3), but **may** choose to carry out more than one type of survey this year (2003/04). This is to help establish a benchmark during the handover to TTS, option (1), which will become the only permitted survey method for BV 96 from 2004/05.

Authorities are therefore encouraged to choose option (1), either on its own or in addition to option (2) or (3), where they are able to do so.

1) The preferred option would be to derive BV 96 from TRACS type surveys based on the measurements of rut depth, longitudinal profile, texture depth, and intensity of both wheel track cracking and overall lane cracking. Guidance on the detailed specification for procuring these surveys will be available separately. Details of the standards for processing each aspect of condition will be defined in a later guidance note.

Processing of the outputs from the TTS will be undertaken in accordance with a UKPMS accredited pavement management system using the prevailing standard rules and parameters which are currently being updated to include TTS data.

TTS apply to all road surface types (i.e., asphalt and concrete) and will represent the condition of 100% of the Principal Road network each year. Deemed coverage will not be permitted for TRACS type surveys.

2) Alternatively or additionally, a visual survey of all principal road length in the year using UKPMS CVI or DVI, carried out in accordance with the UKPMS Visual Survey Manual, Version 1.0, with optional use of rutbar (Appendix 11). Local authorities will be requested to indicate percentage of network with a UKPMS condition index score in excess of a figure to be defined in further guidance.
Detailed Visual Inspection (DVI) surveys may be used for BV 96, if carried out in accordance with version RP3.02 of the UKPMS Rules and Parameters.

If DVI surveys are used, they should be converted to a 'CVI-equivalent' survey, using Version 2.00 or later of the UKPMS HMDIF Conversion Software, and processed as a CVI survey.

3) Alternatively or additionally, the percentage of the network with negative residual life, derived from Deflectograph surveys of nominally 100% of the network (concrete pavements are the only exception).

When reporting on BV 96, authorities must clearly identify the survey method each set of results is based on (i.e., (1), (2) or (3)). No mixture of survey methods is permitted within each set of results.
Further detailed guidance on BV 96 for 2003/04 will be published in due course that will include:

- TTS data specification (for contract procurement).
- Suitable accreditation procedures for TTS equipment.
- Detailed advice to authorities that is likely to include technical guidance, advice on procurement of TTS and guidance on the calculation of the BVPI.

16.2 BV 97 - Condition of Non-Principal Roads

Coarse Visual Inspection (CVI) survey of the non-principal road network, to be carried out under UKPMS Rules and Parameters and in accordance with the UKPMS Visual Survey Manual, Version 1.0.

Detailed Visual Inspection (DVI) surveys may also be used, if carried out in accordance with version RP3.02 of the UKPMS Rules and Parameters.

If DVI surveys are used, they should be converted to a 'CVI-equivalent' survey, using Version 2.00 or later of the UKPMS HMDIF Conversion software, and processed as a CVI survey.

As with the 2002/03 indicator, the 2003/04 indicator will be divided into BV 97 (a) for non-principal classified roads and BV 97 (b), which will be based on a proportion of the unclassified road network. The measurement of rut depths automatically using a 'rut bar' will remain optional for the 2003/04 indicator, although DfT strongly recommends its use where authorities are carrying out CVI surveys for 97 (a).

16.3 BV 187 (Amended) - Condition of Footways

The indicator will be based on the collection and analysis of Detailed Visual Inspection (DVI) measurements, using the national Rules and Parameters for UKPMS, to provide the percentage length of the footway network with a Footway Condition Index greater than a defined threshold value for deficiency. These rules cover different footway types and the defects associated with the type of footway (e.g., bituminous, flags) on different footway categories (hierarchies).

Authorities should measure the percentage length of the footway Category 1, 1a and 2 network with a Footway Condition Index greater than a threshold value of 20.0, calculated using the Variable Length Merge method set out within UKPMS through the approved set of Rules and Parameters. It will be based on a 50 per cent survey of Category 1, 1a and 2 footways each year, so that the complete Category 1, 1a and 2 network will be covered every two years. Footway categories are defined in the Code of Practice for Maintenance Management (The Institution of Highways and Transportation, 2001).

For 2003/04, this indicator will cover only the Category 1, 1a and 2 footway network.

17 ANNEX 4. TRACS-Type Surveys for Principal Roads - Advice Note

Contents

1 Aim of this Advice Note

The aim of this document is to provide Local Authorities with everything they need to make informed decisions about the procurement of TRACS-Type Surveys (TTS) for their Principal Road networks and to make best use of the resulting TTS data.

The document aims to promote good practice in the procurement, operation and application of TTS and draws on the experience of Authorities that have implemented TRACS and TTS on their own networks as well as other practitioners and technical experts.

The authors recognise that this Advice Note is aimed at a wide audience, many of whom will be unfamiliar with the collection and use of TTS data. Advice and support is therefore available through the UKPMS Owners Forum, email support@ukpms.com.

2 Introduction

For the Financial Year 2003/04, the Department for Transport (DfT) has included TRACS-Type Surveys (TTS) as the recommended survey that Local Authorities are permitted to use for the calculation of BV96, the Best Value Performance Indicator for the condition of Principal Roads. DfT has also indicated that, from 2004/05, TTS Surveys will become the only permitted survey option for the calculation of BV96 on Principal Roads and options are being investigated to introduce TTS Surveys on Local Authorities' sub-Principal networks.

The TTS Sub-Group of the NRMCS Technical Group, which reports to the Roads Board, commissioned the production of four key deliverables to support Local Authorities wishing to undertake TTS Surveys of their Principal Roads during Financial Year 2003/04. These comprised:

- Specification for TTS Surveys of Principal Roads
- Accreditation Mechanism for TTS Survey Equipment
- Any necessary changes to UKPMS Rules and Parameters to enable processing of TTS data
- Advice for Local Authorities on the procurement of TTS Survey services and use of the data

As well as providing advice on the procurement of TTS Survey Services and in the use of TTS data, this Advice Note includes the TTS Specification as a stand-alone Appendix and provides details of the Accreditation Mechanism for TTS Survey Equipment.

It is anticipated that modified UKPMS Rules and Parameters will be published in mid 2003 to enable Local Authorities to use the TTS data in their UKPMS systems for operational purposes as well as for the calculation of BV96. Advice on the use of TTS data, including their use in UKPMS is also given in this Advice Note.

Although the initial driver for undertaking TTS Surveys is likely to be the requirements of BV96, it is important to recognise that there are potentially significant benefits to be gained by Local Authorities from the implementation of TTS Surveys on their Principal Road networks. This Advice Note explains how these benefits can be realised by the adoption of good practice in the procurement and use of TTS data.

Although much of the advice given in this Advice Note is applicable to all Local Authorities, because of the differing circumstances of individual Authorities, some of the advice is presented as a series of options; individual Local Authorities should identify how they wish to make use of the TTS data before selecting the options that they feel apply to them.

3 Background to TRACS-Type Surveys

3.1 TRACS Surveys

In 1999, the Highways Agency introduced routine Traffic-speed Condition Surveys (TRACS) on the Motorway and Trunk Road Network in England. The key concept of TRACS was to implement automatic, traffic-speed, detection of surface cracking within a routine network survey. The specification for TRACS was the result of an extensive research programme undertaken by TRL into the identification and measurement of road surface cracking from images collected at traffic-speed that culminated in the development of the proof-of-concept HARRIS (Highways Agency Road Research Investigation System). TRACS replaced the existing High-speed Road Monitor (HRM) surveys and included the collection and processing of road surface cracking data in addition to GPS location referencing and a more detailed measurement of transverse profile as well as the more traditional measurements of longitudinal profile, surface texture and road geometry.

The principle behind the implementation of TRACS was to minimise disruption to road users and reduce operating costs by increasing the range of road condition data collected by machine that had previously been collected by manual inspections. At about the same time, the HA identified that strong, well-constructed pavements, which comprise a large proportion of its network, do not deteriorate structurally provided that they are well maintained. This finding allows maintenance to be directed by surface condition; either identifying a requirement for preventative maintenance, such as sealing or resurfacing to prevent water ingress through surface cracking, or the need to rectify deterioration in serviceability, such as poor texture. Therefore, following the introduction of TRACS, the HA was able to implement a new survey strategy based on the use of TRACS and SCRIM data, collected on a routine basis at traffic speed, as the initial measure of road condition. Lengths of road identified as possible candidates for maintenance from TRACS and SCRIM surveys were further investigated using slower, more expensive Deflectograph and visual surveys. Thus, the HA's road maintenance programme became driven by the data collected by TRACS.

3.2 Best Value Performance Indicators

In the meantime, the DETR (and subsequently DTLR and now DfT) chose to make use of established survey techniques as the basis for the introduction of a Best Value Performance Indicator (BVPI) for road condition to enable central government to compare Local Authorities' local road conditions and to determine funding needs for each Authority. In the first year of implementation (1999–2000), the application of a BVPI was restricted to the Local Authority Principal Road network and could be determined from Deflectograph data or from UKPMS visual inspection data. Subsequently, BVPIs based solely on UKPMS visual inspections were developed for the sub-Principal network.

However, following initial implementation of road condition BVPIs, the DfT now has concerns that the subjective nature of visual surveys means that they are not sufficiently robust or consistent for the purposes of monitoring national road condition. Therefore, DfT is proposing that machine surveys be used for the collection of pavement condition data to support the production of BV96 on the Principal network from 2003-04, with possible subsequent application to the sub-Principal network.

These machine surveys will have similar specification to that developed for the HA network and, hence, are termed TRACS-type surveys (TTS). As described above, the use of TTS for BVPI determination for the Principal network will be mandatory in 2004–05 and is strongly recommended for 2003–04 to ease the transition to this form of survey and increase familiarity with the data before its prescribed application.

3.3 National Road Maintenance Condition Survey

The National Road Maintenance Condition Survey (NRMCS) was introduced in 1977 to provide information on trends in the condition of roads in England and Wales. It includes CHART visual survey of randomly selected 100m lengths of road. Results are published annually in a DfT statistical bulletin.

A review of NRMCS undertaken in 2000, concluded that there should be no data collection specifically for NRMCS and that the report should make use of survey data authorities collect for producing BVPIs and for their own operational use. As soon as the TTS-based BVPI's are implemented on Principal Roads NRMCS will be seeking to report upon TTS surveys.

A subsequent, ongoing, investigation into the prospects for using machine surveys on all classes of road for BVPIs and NRMCS has yet to report, but in the meantime it has been agreed that random CHART surveys should continue, at least until 2004, to provide statistical continuity.

3.4 TRACS-Type Surveys

3.4.1 TTS Surveys

TRACS-Type Surveys (TTS) are high-speed surface condition surveys, based on the Highways Agency TRACS Contract and adapted to be suitable for the Principal Road Network. TTS will collect the following data:

- 3-Dimensional Spatial Co-ordinates
- Road Geometry
- Survey Speed
- Longitudinal Profile
- Wheelpath Rutting
- Texture Profile
- Cracking
- On the following principal roads:
- Both directions of Single Carriageways
- Lane one in each direction on Dual Carriageways
- All Slip Roads

The data will be delivered as a HMDIF file, called a TTS BCD file in the specification, that can be loaded into Local Authorities' UKPMS-accredited systems either for the calculation of BV96 or to assist in the development of highway maintenance programmes. The requirements for each of these data items, including accuracy and coverage requirements, as well as methods for their acceptance, are given in the TTS Specification (Appendix A of this Advice Note). Further information about longitudinal profile, rut depth, texture profile and cracking is given in Section 5.1 of this Advice Note.
The proposed data flow for TTS Survey Data is shown in Figure 1:

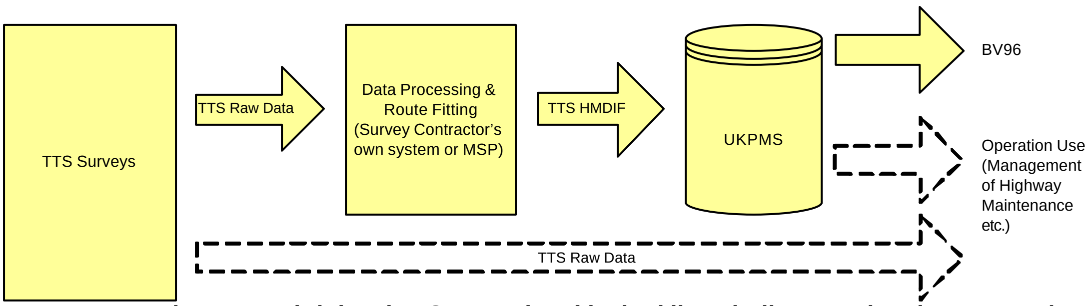

Figure 1 – High-level TTS Data Flow (dashed lines indicate optional processes)

3.4.2 Quality Assurance Procedures

One of the major differences between TRACS and TTS is the scale of network to be surveyed. It is likely that multiple Survey Contractors using a range of different Survey Equipment will be needed to survey all Principal Roads in England each year and this range will almost certainly increase if the decision is taken to implement TTS survey on sub-Principal Roads.

To provide Local Authorities, and DfT, with confidence that the TTS data being provided is consistent, and of high-quality, a detailed Quality Assurance procedure has been developed and fully incorporated into the TTS Specification. The TTS Quality Assurance Procedure will be operated by TRL independently of Local Authorities or Survey Contractors and, in 2003/04, will be fully funded by DfT. There are three aspects to the TTS Quality Assurance Procedure:

Initial Acceptance Tests
To provide Local Authorities with the confidence that Survey Equipment is able to undertake TTS surveys, a series of detailed Acceptance Tests have been designed to assess the initial performance of Survey Equipment against the requirements of the TTS Specification. TRL will oversee the Acceptance Tests and, upon successful completion, the Survey Equipment will be awarded with a TTS Acceptance Certificate that is valid for one year from the date of issue. Once the certificate has expired, the Survey Equipment is required to successfully complete an annual calibration check before the certificate is renewed. Local Authorities must insist that only Survey Equipment possessing a valid TTS Acceptance Certificate be used to undertake TTS Surveys, and should not use data provided by Survey Equipment that does not hold a valid certificate to calculate Best Value performance Indicators. Further details of the Acceptance Tests are included in the TTS Specification.

Ongoing Quality Assurance
To ensure that Survey Equipment continues to meet the requirements of the TTS Specification, a detailed Quality Assurance procedure has been developed and fully incorporated into the TTS Specification. This Quality Assurance procedure includes a number of regular checks that the Survey Contractor must undertake and an annual calibration check or Equipment Audit that must be passed in order to renew the TTS Acceptance Certificate. The operation of the Quality Assurance procedure, including the annual calibration checks will be the responsibility of TRL. Local Authorities are strongly advised to insist that Survey Contractors fully comply with the requirements of the TTS Quality Assurance procedure. Further details of the Quality Assurance procedures are given in the TTS Specification.

Independent Advice and Arbitration
The third aspect of the Quality Assurance procedure is the availability of independent, expert advice on the collection, quality, interpretation and application of TTS data provided by TRL and, in 2003/04, fully funded centrally by DfT. In addition to overseeing the Acceptance tests and operating the Quality Assurance procedures described above, this role – described as the Auditor in the TTS Specification – will be available to provide independent advice and support to both Local Authorities and Survey Contractors and to act as an arbiter in case of any disagreements or disputes. The role of the Auditor is explained in more detail in the TTS Specification. Local Authorities are advised to contact TRL when they are commissioning their TTS surveys, providing contact details and the details of the selected survey contractor, so that TRL will be able to provide this Auditing Service.

Data Processing and Route Fitting
The HA has developed a software application called the Machine Survey Pre-processor (MSP) for the pre-processing of TRACS, Deflectograph and SCRIM data before it is loaded into the HA's pavement management system (HAPMS). Given the similarities between TTS and TRACS, a new version of MSP will be produced to enable TTS data to be processed before loading it into Local Authorities' UKPMS-accredited pavement management systems.

MSP will be made available to Survey Contractors who wish to use it, instead of their own systems, to generate TTS HMDIF (TTS BCD) files. MSP will be used by the independent auditing body in the calibration and auditing of TTS Survey Equipment to check that they are producing the right outputs.
Whether using MSP or their own systems, Survey Contractors will need to be provided with a minimum amount of location referencing information to enable them to build survey routes and, post-survey, to fit the collected data to the Local Authority network. The location referencing information that the Local Authority must be able to provide to the Survey Contractor are given in the TTS Specification (see Appendix A) and includes:

- Road Number
- Section Label
- Label describing the Section Start Point
- Label describing the Section End Point
- Section Length
- Description of the Section and/or a map showing the location of the section
- Any other additional information to enable the Survey Contractor to prepare survey routes

Optionally, the Local Authority may also provide National Grid co-ordinates, obtained from GPS or other means, describing the locations of the Section Start and End Points, which may then be used by the Survey Contractor to locate the Section Start and End Points in the Survey Data. However, the Local Authority should be aware that if this option is taken, the locational accuracy of the survey data would be adversely affected if the accuracy of the National Grid co-ordinates provided by the Local Authority is poor.

Cross Section Position Referencing

Note that in order that lane-referenced TTS data, or indeed any machine survey data, can be used within UKPMS systems, it must be referenced to "Full" Cross-Section Positions. In order to allow this, the *On Carriageway XSP Referencing Method* must be set to "Full" for those sections that are to have TTS data loaded (i.e. Principal Road Sections). If survey data, except for CVI surveys[1], have already been loaded to the carriageways of those sections, they will no longer be valid for processing on those sections.

4 Procurement of TTS Services

During the Financial Year 2003/04, the implementation of TTS on the Principal Road Network is the recommended option for Best Value purposes. If Local Authorities wish to introduce TTS Surveys this year, it will be their responsibility to procure the surveys individually, it should be noted however that the situation for 2004/05 and subsequent years is being reviewed and may change. As with the procurement of any services, the form of contract between the Local Authority and the Survey Contractor is vital to the success of the project. This section provides advice on the procurement of TTS Surveys including suggestions for contractual arrangements to ensure that Local Authorities receive TTS data that meet their individual needs.

4.1 General Advice on Procurement

The first thing to consider is what use will be made of the TTS data. Although, as a minimum, the data will be able to be used for the calculation of Best Value Performance Indicators, as described elsewhere, there are considerable benefits to be gained from using the TTS data for operational purposes. The decision on what use will be made of the TTS data will strongly influence the form of contract that will be needed for the procurement of the TTS Survey services.

Although, as mentioned above, Local Authorities wishing to procure TTS Surveys, for whatever purpose, in 2003/04 will be required to do so on an individual basis, some Local Authorities may wish to group together in regional consortia. This would have a number of benefits:

- Economies of scale; individual Local Authorities are likely to have relatively small Principal Road Networks, and it is likely that, by grouping together in this way, savings may be achieved by reducing the contractors' mobilisation and administrative costs, although there may be limits to the economies achieved.
- Aggregation into larger networks could facilitate more efficient route planning and hence more efficient programming and data delivery.
- The number of individual contracts required to cover all individual Local Authorities would impose a considerable burden on the current limited number of survey contractors.

There are a number of issues that would need to be resolved if such a consortium approach is adopted:

- The total value of such a group contract may be such that more onerous procurement procedures, such as notification in the Official Journal of the European Community (OJEC), must be followed.

[1] *There is an exception within the UKPMS logic that allows minimal XSP CVI data to be processed on Full XSP sections, provided a Full XSP Inventory has been collected and loaded. All machine survey data loaded to UKPMS systems should use "Full" XSPs. It is likely, therefore, that this issue will only affect minimal XSP-referenced DVI surveys.*

– The individual Local Authorities would need to agree on what services were needed so that all their requirements could be covered by a single contract.
– The Individual Local Authorities may wish to select one Local Authority as a "Lead Authority" to act as the main contact point for the Survey Contractor, and who would also be considered as the "Employer" in terms of the TTS specification given in Appendix A.
– The agreement of contractual Terms and Conditions may require extensive discussion and approval at a senior level within Local Authorities, which may introduce delays.
– All Local Authorities within the consortium would have to be able to meet whatever contractual demands were placed on them – for example, each Local Authority would have to be able to provide similar network referencing information to the survey contractor.

It should be noted that 2003/04 is being seen as a transitional year, before the proposed mandatory implementation of TTS Surveys on the Principal Road Network for BVPI purposes in 2004/05 – and the possible extension to sub-Principal Roads in subsequent years, it is recommended that this need for flexibility should be reflected in the contractual arrangements. It may be that partnering and other similar arrangements may enable greater flexibility if future requirements may change.

4.2 Contractual Matters

This Advice Note includes a specification for TTS data that may be used for the procurement of TTS Survey Services. However, there are a number of other contractual matters that Authorities should consider in order to get the best from any procured TTS Survey Services.

The main consideration when drafting a contract for TTS Survey Services is to provide a robust mechanism to ensure that the required data coverage, data quality and delivery timescales are achieved. In general, this will be done through a carefully considered payment mechanism and by incentives and penalties that encourage quality, coverage and timeliness.

4.2.1 TTS Specification

Appendix A of this Advice Note is a specification for TTS Survey Services. This specification is based on a detailed review of the HA's TRACS Specification and also draws on the experiences of organisations who have previously commissioned TRACS and TTS surveys. The Specification includes the following components:

– Description of Services and Deliverables
– Data Requirements
– Data File Formats
– Survey Procedures
– Data Processing Algorithms
– Acceptance Testing
– Quality Assurance Procedures
– Contract Definitions

Of course, individual Local Authorities may adapt the Specification to meet their own needs but great care should be taken if this is done to ensure that the quality of the data, or the comparability of the data with that collected by other Local Authorities, is not adversely affected and remains "fit for purpose" for Best Value Performance Indicator purposes.

4.2.2 Payment Mechanisms

It is recommended that a rate per kilometre is requested for each activity undertaken by the Survey Contractor. It is also recommended that the majority of payment is only made upon successful delivery of fitted, validated data and any other associated information that is requested (for example, maps of routes surveyed etc.). This approach will encourage the delivery of data that is of the required quality in a timely way.

Thought should also be given to how survey coverage should be reflected in the payment mechanism. It should be recognised that, due to physical restrictions, Survey Contractors are unlikely to be able to provide valid data from 100 per cent of the network[2] but the payment mechanism should encourage them to endeavour to provide as much valid data as possible. There are two important distinctions that should be noted here; **survey coverage** is the proportion of the network surveyed by the TTS Survey Equipment and **valid data coverage** is the proportion of the network from which valid data is provided.

It is recommended that Survey Contractors should be encouraged to achieve survey coverage of as near to 100 per cent of the network as possible and that all collected data should be provided. Any invalid data should be clearly identified and valid data should be provided according to the proportions[3] defined in the TTS Specification. This requires Authorities to know the actual length of the network to be surveyed otherwise discrepancies may arise between the length of the Network that can actually be surveyed and the length which was expected to be surveyed as a result of errors in the estimated network length. It should also be noted that different valid data coverage requirements are given for individual data items. This is to reflect the fact that some TTS data items are adversely affected by certain network conditions (for example, the accuracy of longitudinal profile measurements can be adversely affected by vehicle speeds and accelerations).

The payment mechanisms could also be structured to reflect the different application of the TTS data. For example, for the production of Best Value Performance Indicators, Local Authorities are likely to require that all data items that are to be used in the calculation of the BVPI are collected from a consistent proportion of the network[4] and this could be strongly incentivised in the payment mechanisms (see below). On the other hand, for operational purposes, a range of levels of coverage may be acceptable for particular data items and a different payment mechanism could be used.

These differences must be carefully considered when drafting the payment mechanism for TTS Survey services.

As described above, incentives and disincentives can be introduced to encourage contractors to maximise the amount of valid data that they provide. It is suggested that this type of approach is likely to provide the best quality data to the Authority. For example, a simple payment mechanism, including incentives and penalties, might be:

Rate	£X per km for valid data, successfully fitted to the network
Incentives	£X per km for valid data of up to 80% of the whole network
	£(X + Y) per km for valid data coverage of 81 – 100% of the whole network
Disincentives	£0.5X per km for valid data coverage of less than 50% of the whole network

A payment mechanism where the majority of the payment is tied to data collection, rather than the provision of valid, fitted data, is not recommended as this is unlikely to encourage Contractors to deliver quality data on time.

4.3 Tender Evaluation

4.3.1 Quality Evaluation

It is understood that individual Local Authorities will have their own procedures for the procurement of services within the Best Value framework. The following guidelines aim to offer general advice on the procurement of TTS Surveys that are applicable to all Local Authorities, whatever their size or particular procurement procedures.

[2] *Estimates for TTS in Scotland suggest that approximately 6% of their local road network could not be surveyed due to physical restrictions although, in practice, this figure may be lower when new, more streamlined, survey equipment comes onto the market*

[3] *Local Authorities may wish to vary these proportions to accommodate networks with, for example, high levels of traffic calming but it is recommended that this is only done in extreme circumstances*

[4] *The current definition of BV96 requires 100% coverage each year which, in practice, is generally taken to mean that at least 95% coverage is achieved*

Although the overall *cost* of the TTS Survey services is extremely important in selecting the successful survey contractor (see below), emphasis must also be placed on the evaluation of the *quality* of the proposed survey procedures.

Although the specification for the TTS data requirements is very prescriptive, the Acceptance and Quality Assurance procedures (see Section 0) should give Local Authorities confidence that the Survey Equipment is "fit for purpose". Details of Survey Contractors with accredited TTS Survey Equipment will be available from the UKPMS website (www.ukpms.com). Experience has shown that it is equally important to ensure that suitable operational procedures are followed; therefore, it is recommended that, as far as possible, greater emphasis is placed on quality than cost. In particular, the following quality aspects should be considered:

System Accreditation	Does the tenderer demonstrate that their survey equipment has been formally accredited (i.e. does the Survey Equipment hold a valid TTS Acceptance Certificate)? Have any provisions been placed on the Certificate (e.g. Partial acceptance), and will these affect the suitability of the Equipment? Details of the approved Accreditation and Calibration Mechanisms are given in the TTS Specification.
Data Quality	Does the tenderer demonstrate an understanding of the various data items required to be collected under the contract? Does the tenderer demonstrate an understanding of the issues relating to the quality of the data items? This should include general data quality issues as well as issues relating to the quality of individual data items. Descriptions of the various data items to be collected, including any data quality issues, are described in detail in the TTS Specification in Appendix A.
Network Referencing	Has the tenderer demonstrated an understanding of the issues relating to network referencing? Does their proposal adequately explain how the collected data will be referenced to the network?
On-site survey procedures	Does the tenderer provide a detailed explanation of the survey procedures to be followed on site? This may include: – Night-time surveys due to high-levels of traffic – Identification of invalid data (e.g. an indication that the survey data is collected outside the survey lane due to parked cars, etc.) – Identification of any physical limitations (e.g. width restrictions, one-way streets) and how they will be handled
Post-survey Processing	Who will carry out post-survey processing? It is often recommended that the staff who collected the data should be the ones who process it as they will be aware of unusual circumstances that occurred on site. Has the tenderer explained how the route fitting will be carried out? How will any differences between measured and planned survey routes be resolved?
Authority Obligations	Does the tender place any obligations on the Authority? This is most likely to relate to the provision of network referencing data. There will be a minimum level of referencing data that the Contractor will need to carry out the surveys (see Section 0).

Added Value Options	Tenderers may offer additional 'added value' services or data items. These may be of benefit to the Authority but it should be noted that the core data items (i.e. those required in the TTS Specification) must still be provided, and that any additional data items or services will not necessarily be covered by the formal Accreditation Procedures. For 'added value' services the Local Authority should consider whether the options will provide a real benefit to the assessment of their network, and should ask for evidence that the additional measurements will be provided to an acceptable level of accuracy. If in doubt it is recommended that the Authority consult the Auditor (TRL).

4.3.2 Cost Evaluation

In terms of evaluating costs, tenders should be evaluated on the basis of the proposed payment mechanism discussed in Section 0. It is important to be clear about what this rate covers and the following points should be considered:

What is included in the Rate?	What does the rate cover? Does the rate include processing and delivery of data as well as data collection? Are there any additional costs?
Data coverage	Is the quoted rate for distance surveyed or for valid data provided? Of course, in practice, these may not be the same.
Added Value Options	If any 'added value' options are provided, what are the incremental costs of taking them up?

5 Using TTS Data

Whilst the primary function of TTS Surveys is the provision of data for BV96, the use of TTS data for other operational purposes is to be encouraged. This Section provides advice to Local Authorities on the interpretation and use of TTS data for operational purposes as well as in the calculation of Best Value Performance Indicators.

5.1 Operational Use of Data

Analysis of TTS data through an accredited UKPMS system configured with appropriate processing rules and parameters, or through other suitable data management utilities, may be used to identify lengths of road in need of further investigation or for prioritization for treatment. In this way, TTS data may conveniently be analysed in combination with other road condition data to achieve a more complete and robust assessment. A paved surface inventory would be of great value for this form of application to ensure appropriate handling of data from, for example, block paved construction where interpretation of the data may otherwise be misleading.

However, the data parameters collected by TTS are of intrinsic engineering value and can provide useful information to contribute to scheme level investigation for treatment determination. A brief description of TTS data parameters and guidance on their interpretation is given below. More detailed information is presented in Sections 9, 10 and 11 of the TTS Specification in Appendix A.

5.1.1 Texture Depth

The surface texture depth measured by the TTS Survey Equipment is the coarser element of macro-texture and the finer element of mega-texture of the pavement surface. This range of 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. Texture depth, as measured by TTS and when compared with SCRIM results, may therefore be considered primarily as a parameter for assessment of the safety serviceability of the pavement surface.

5.1.2 Rut Depth

Rut depth as determined from TTS surveys corresponds to a measurement made with a 2m straight edge and wedge.

5.1.3 Longitudinal Profile

Profile variance, the measure of longitudinal profile obtained from TTS, is principally of value for assessing ride quality, but may also be used to derive information on pavement distress. The short, medium and long wavelength features found to have the most effect on vehicle ride are represented by variance of profile from 3m, 10m and 30m moving averages respectively.

High levels of 3m variance typically arise from short wavelength features such as faulting, potholes and poor reinstatements. Extremely high levels of 3m variance may be linked with the presence of severe wheelpath cracking.

10m variance is influenced by short undulations, possibly arising from localised subsidence of reinstatements and subsurface utilities, and bay irregularities on concrete roads.

30m variance covers such a length of the pavement that it can be influenced by the road geometry and so caution is required in its interpretation as an indicator of pavement distress. Its application for this purpose is, therefore, typically restricted to reasonably straight sections of pavement, often on higher speed roads, where high levels of 30m variance will have more influence on the user's perception of ride quality. On such roads high levels of 30m variance may be due to long undulations in the pavement resulting from the presence of subsidence.
The validity of longitudinal profile data will be compromised by traffic calming measures such as speed humps, cushions and gateway treatments.

5.1.4 Cracking

The resolution of crack detection systems employed on current TTS Survey Equipment will, typically, limit the minimum crack width detectable by such systems to around 2mm. The identification of cracking relies on interpretation of the recorded image by the particular TTS system's crack identification software, and experience to date indicates that this may produce a different interpretation than an inspector carrying out a visual inspection of the same pavement. In consequence, TTS cracking data does not replicate visual survey cracking data, but will generally report a lower intensity of cracking than would be observed visually. Also, TTS may misrepresent fretting on a heavily chipped surface as cracking. However, good correspondence has been obtained between the two methods in identifying sections where deterioration is present.

Guidance, in terms of threshold values, for interpretation of these parameters is reproduced below from:

- Advice issued by the Highways Agency (HA Interim Advice Note 42/02) based on the development and use of TRACS on trunk roads and motorways
- The Scottish Road Maintenance Condition Survey (SRMCS) project, where interpretation of TTS data was related to Local Authority network conditions

It should be recognised that routine use of TTS surveys is in its early stages and is subject to continuing research and development. The advice on interpretation may, therefore, change in the future and should be considered to be for general guidance only.

5.1.5 Highways Agency Interim Advice Note 42/02

Four Condition Categories are defined by threshold values[5] applicable to each parameter measured by the TRACS survey vehicle.

[5] *It should be noted that all the above threshold values are based on characteristic values associated with 100m lengths and are not relevant to road geometry or geographical position.*

Condition Categories

Category	**Definition**
1	Sound – no visible deterioration
2	Some deterioration – lower level of concern. The deterioration is not serious and no action is needed unless extending over long lengths or several parameters are at high levels at isolated positions
3	Moderate deterioration – warning level of concern. The deterioration is becoming serious and needs to be investigated. Priorities depend on the extent and values of parameters
4	Severe deterioration – intervention level of concern. Immediate action required. This condition should not occur very frequently on the motorway and trunk road network as earlier maintenance should have prevented this state from being reached

Longitudinal Profile

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

Rut Depth

Category	**1 Threshold Value 2**	**Threshold Value 3**	**Threshold Value 4**
Maximum Rut (mm)	6	11	20

Texture Depth

Category	Threshold Value 1	Threshold Value 2	Threshold Value 3	4
Texture depth (mm)				
Anti-skid surfacing (HFS)	0.6	N/A	N/A	
Concrete surface	0.6	0.3	N/A	
Other surfaces (eg Thin Surfacing, Hot Rolled Asphalt, Surface Dressing, Porous Asphalt, Unknown).	1.1	0.6	N/A	

Cracking

Category	Threshold Value 1	Threshold Value 2	Threshold Value 3	4
Whole Carriageway Cracking (%)				
Bituminous Surface	0.15	0.5	2.0	
Concrete Surface[6]	N/A	N/A	N/A	

Scottish Road Maintenance Condition Survey

Parameter	Amber Threshold	Red Threshold	Applicable road classes
Rut depth	11mm	20mm	All
3m Variance	$4mm^2$	$10mm^2$	A, B
	$7mm^2$	$17mm^2$	C, urban unclassified
	$15mm^2$	$25mm^2$	C, rural unclassified
Texture depth	0.6mm	0.3mm	All

Key

Amber Threshold: Road condition indicates that further investigation is needed to establish if treatment is required

Red Threshold: Road has deteriorated to the point at which repairs to prolong future life should be considered

5.2 Best Value Performance Indicator – BV96

The DfT intends to introduce a new TTS-based BV96 ("Condition of Principal Roads") from 2003/04, for reporting in 2004. In 2003/4 TTS are the recommended option for reporting on the Condition of Principal Roads, the other options being UKPMS Visual Surveys; from 2004/5, TTS surveys are likely to be the only permitted survey method for BV96.

5.2.1 BV96 TTS Survey Requirements

For 2003/2003 the following provisions apply for the programming and reporting of TTS surveys:

- 100% of the network will be reported each year (1 lane in each direction).
- Survey data may be up to one year old (i.e. data collected in 2002/03 may count towards the 2003/04 BV96 result)
- TTS apply to all road surface types, including concrete.
- "Deemed coverage"[7] will not be permitted.

6 *The current TRACS survey vehicle has not been approved for surveys of cracking on concrete surfaces on the Trunk Road Network.*

7 *"Deemed Coverage" is the rule, used in previous years, that allows authorities to nominate lengths of known good condition for inclusion in the calculation of the indicator, without having to provide survey data for those lengths.*

- In 2003/04 no mixture of survey methods is permitted within each set of results, so that if an authority opts to use TTS for it's BV96 it must not also use data from UKPMS Visual Surveys or Deflectograph

5.2.2 Calculation of the Indicator

Although the survey provisions for the TTS-based BV96 have already been defined, the detail of the indicator has, at the time of drafting, not yet been determined. The detailed rules for calculating and reporting the indicator will be made available to UKPMS Developers and Users through the UKPMS Web site (www.ukpms.com) as a UKPMS Technical Note.

A number of aspects of the indicator have already been signalled by the DfT:

- Processing of the outputs from the TTS will be undertaken in accordance with a UKPMS-accredited pavement management system
- Processing will use the latest available default UKPMS Rules and Parameters (currently version RP3.0.2) which are being updated to include TTS data

A number of options are being considered and tested for the calculation and reporting of TTS data to produce the new BV96:

1. A UKPMS condition-index based equivalent to the current CVI/DVI-based BV96 – which reports on the percentage of network with Structural Condition Index greater than or equal to a threshold 70
2. An indicator based upon that used for the Scottish Road Maintenance Condition Survey (SRMCS), reporting the percentage of the network where "treatment should be considered", based 10m length where any or all of the following defects exceed a threshold:
    - 3m Longitudinal profile
    - Rutting
    - Texture Depth
    - Cracking (in future years)
3. A similar indicator based on lengths exceeding the thresholds in HA Interim Advice Note 42/02
4. Reporting directly on levels of defectiveness (e.g. mean cracking intensity on the network)
5. To liase with the Highways Agency with a view to defining a joint indicator suitable for use on both the Principal and Trunk and Motorway Networks

Note that irrespective of which indicator is adopted for reporting BV96, the national indicator, there is scope for more than one indicator to be provided within UKPMS for use in local reporting and benchmarking and for use in the NRMCS.

Note also that there is unlikely to be any continuity between the new TTS-based BV96 and the Visual Survey and Deflectograph based indicators (which, in any case do not cross-correlate).

18 ANNEX 5. Machine Based Condition Surveys In Scotland

Prepared by: Alistair Gow, Project Manager, SRMCS

The Scottish Road Maintenance Condition Survey was implemented during 2002/03 on the basis of an initial contract with WDM, undertaken as an extension of an existing contract with the Scottish Executive to survey the trunk road network in Scotland. In many respects this was viewed as a proving ground to establish the applicability of the technology to local roads.

The survey utilised a Multifunction Road Monitor (MRM) to undertake a survey of the principal road network across all 32 Scottish Authorities, including the islands, and consequently involved surveying roads of radically different types from urban dual carriageways to single track roads in the most remote corners of the Highlands. Further, as a prelude to the second stage of the project which will involve the survey of all roads in Scotland on a cyclical basis, more extensive surveys were undertaken within 5 authorities. This involved surveying 50% of the “B” class roads in all 5 authorities, 50% of the “C” class roads in 3 authorities and 25% of the unclassified routes in 2 Councils. Despite encountering the wettest weather in Scotland in many years there were no insurmountable problems and the fears expressed regarding potential difficulties in urban areas and on narrow rural roads proved unfounded.

In the autumn of 2002, following competitive tender, a new 4 year contract was awarded to WDM for the survey of the Scottish road network. The contract requires the collection of Ordnance Survey grid reference co-ordinates, longitudinal profile, rutting, texture depth, cracking and forward facing digital video, each year on all principal roads, 50% of the “B” and “C” routes and 25% of the unclassified network. The new contract has therefore built on the experience of the first years survey and it is the intention to work in partnership with WDM to develop a methodology to incorporate the recording of edge deterioration as an integral part of the survey.

While the introduction of a new statutory performance indicator was undoubtedly a key determinant in all 32 Authorities joining together to participate in the contract, it was not the only factor. In common with Authorities throughout the United Kingdom, Councils in Scotland have been arguing the case for increased maintenance expenditure to halt the decline in the condition of the road network and have achieved some moderate success in this regard. However, in discussion with Scottish Transport Ministers, it became evident that their ability to compete for funds with other Government priorities was severely restricted by the lack of objective factual data to support the case being made. The repeatability of machine based surveys and the consistency in output across administrative boundaries was therefore viewed as offering major advantages in this regard. Although it is recognised that there are currently limitations to the extent that machine-based surveys can be substituted for other techniques, it is felt that these will reduce as the technology improves and the ability to interpret the data develops.

The Scottish Key Performance Indicator (KPI) is based on the proportion of the network which exceeds threshold levels for longitudinal profile (roughness), surface texture (macro texture depth) and wheel track rutting. Two threshold levels have been defined and roads are classified as:

- Green - below the lower threshold level, roads are considered to be in an acceptable condition
- Amber - falling between the two thresholds, roads are considered to require further investigation to establish what treatment may be required and when
- Red - above the higher threshold level, roads are considered to have deteriorated to a point at which repairs to prolong future life should be considered.

Each Authority is provided with the Performance Indicator value for its network, the processed results in HMDIF format which can be imported into their pavement management system software and further analysed, and as a map overlay, either in hard copy or electronic format. Authorities, therefore, have the ability to utilise the output to highlight critical sections within their network and with further investigation, utilise this information to develop their detailed maintenance programmes.

Initialisation testing on the MRM4 survey vehicle is currently being undertaken at TRL and commencement of this years survey will commence as soon as this is completed.

19 ANNEX 6. Pavement Condition Assessment Regimes[8]

Developments in Pavement Condition Assessment

In specifying a condition assessment regime, and in making a case for instituting a particular survey or assessment, it is important to note that data are not usually collected only to support a single information need. Opportunities should be taken to gain maximum value from the data by utilising it in a number of ways.

Condition assessment can support, but need not be limited to, the following activities:

a. At the scheme or project level:

– To support decisions on what, where and how to treat.
– To develop detailed scheme designs, and options for scheme designs.
– To provide an audit on the decisions taken by maintenance engineers in the choice, timing and priority of treatments.
– To target more detailed assessments.
– To determine whether treatments and reinstatements have been carried out to an appropriate standard.
– To identify locations where functional or safety–related pavement characteristics do not meet a defined local or national standard (such as skid resistance, ride quality).

b. At the authority highway network level:

– To pursue Best Value by aiming to optimise spend of limited resources.
– To determine an appropriate level of budget for maintenance within an authority.
– To determine physical characteristics of road pavements.
– To develop and monitor local performance indicators.
– To support the production of long–term programmes of work.
– To enable sub–authority benchmarking (e.g., between agents or areas).

c. Regionally, Nationally and Internationally:

– To assist production of national BVPIs.
– To support international benchmarking.
– To support inter–authority comparison.
– To support highway condition and maintenance–related research and development.
– To determine relative levels of funding at a regional or national level.
– To monitor condition of the national road network.
– To assess maintenance need at the national level
– To assess functional performance of the national road network.

The first step in determining the surveys and associated data requirements is to review the information needs for each part of the network, in particular to determine how they vary by feature (carriageway, footway and cycleway etc.) by environment and by road class, or by levels within the hierarchy.

In practice, however, a number of additional considerations come into play when determining the regime:

– Availability of funding for assessment purposes.
– Physical constraints. (For example, the geometry on parts of the road network, particularly the unclassified network may make the use of certain machine surveys impractical).

[8] Extract from the Code of Practice for Maintenance Management (DETR, 2001)

- Pavement construction. (For example, Deflectograph surveys are of very limited value on rigid construction pavements).
- Availability of resources and machinery, at the appropriate time to undertake surveys and to process data.

The timing of surveys and techniques may be constrained by weather and seasonal factors. SCRIM surveys are generally intended to be carried out between mid–April and mid–September, and a lower rate of productivity and progress should be assumed when planning visual surveys for the winter months.

When the information needs have been established for each part of the network under consideration, and constraints on the application of surveys identified, then the required assessment regime can be defined.

Minimum Survey Regime

It is suggested that the starting point should be the "minimum" regime that will allow to support requirements for Best Value Performance Indicators and to provide for participation in the National Road Maintenance Condition Survey (NRMCS). Table A5.1 shows a possible minimum survey regime that meets these requirements. Note the following:

- Inventory data is not required
- Full cross–section position recording is only used where machine surveys such as rut surveys and TRACS type surveys (TTS), using a survey machine similar to that used on the Highways Agency contract, to record rut, transverse and longitudinal profile, texture and cracking are proposed
- DVI surveys are proposed for the off–carriageway features

Enhanced Survey Regime

Authorities may establish data requirements, over and above this minimum regime to support their own maintenance and management of the local road network. At this stage the focus is on network level functionality consistent with the application of UKPMS, where the purpose of condition assessment is primarily for the determination of budgetary need and for the first–cut determination of treatment proposals, for more detailed consideration by maintenance engineers.

Table A5.2 illustrates this enhanced regime. Note the following:

- Inventory data is collected to provide more accurate calculation of areas, rating of defects and derivation of cost estimates.
- More detailed, DVI surveys may be chosen to provide additional information on the local road network. In the case of principal road carriageways, this is in addition to the TTS survey.
- 1/3 of the principal road network is subject to SCRIM surveys.
- TTS surveys are optionally extended to the classified road network.

This enhanced regime better supports the following activities at a local level:

- Consequences of historic funding and polices are monitored by tracking changes in network condition
- Treatment length costing and evaluation. Once treatments have been formulated, priorities are established on a condition (worst condition) or economic (best value) basis
- Maintenance policies aimed at reducing wet–skidding accidents

Network	Features	Surveys (% per year)									XSP Method		Use Inventory?
		CVI (Driven)	CVI (Walked)	Rutbar	TTS	SCRIM	DVI	Deflectograph	Ground Radar	FWD	CVI	Others	
Urban Principal	Carriageway	50			100	33	50				M	F	N
	Others	50	50				50				M	M	N
Rural Principal	Carriageway	50			100	33					M	F	N
	Others	50	50								M		N
Urban Classified	Carriageway	50					50				M	F	N
	Others	50	50				50				M	M	N
Rural Classified	Carriageway	50									M	F	N
	Others	50	50								M		N
Urban Unclassified	Carriageway	25									M	F	N
	Others	25	25								M		N
Rural Unclassified	Carriageway	25									M		N
	Others	25									M		N

Table A5.1 Minimum Survey Regime

Notes and Key

- Inventory will always be required on jointed concrete carriageways
- Other features comprise kerbs, footways and footpaths, cycleways and cycle paths and hard–paved verges.
- The tables assume the new NRMCS regime including SCRIM surveys to be carried out on a three–year cycle.
- CVI (walked) surveys may be carried out by cycling where appropriate.
- Further details of highway network categories are referred to in Section 8.8 of this Code.
- Summary of abbreviations. For full details refer to UKPMS *Visual Survey Manual.*
- XSP – cross section position: M – minimal, F – full.
- TRACS type (TTS) Surveys are to be introduced as a requirement for NRMCS from 2002–3. Other options are indicated for present use.
- Rutbar information shown as optional but recommended for principal and classified roads where TTS surveys are not used.

survey	uency (% of Network Per Year)
upplementary survey	
urvey	

Network	Features	Surveys (% per year)									XSP Method		
		CVI (Driven)	CVI (Walked)	Rutbar	TTS	SCRIM	DVI	Deflectograph	Ground Radar	FWD	CVI	Others	Use Inventory?
Urban Principal	Carriageway				100	33	50					F	Y
	Others						50					F	Y
Rural Principal	Carriageway	50			100	33	50					F	Y
	Others	50					50				M	M	Y
Urban Classified	Carriageway			50	50		50				M	F	Y
	Others						50				M	F	Y
Rural Classified	Carriageway	50		50	50						M	F	Y
	Others	50	50								M	F	Y
Urban Unclassified	Carriageway	25									M		Y
	Others	25	25								M		Y
Rural Unclassified	Carriageway	25									M		Y
	Others	25									M		Y

Table A5.2 Example Enhanced Survey Regime

Further Enhanced Survey Regime to Support Scheme–Level Operation

Table A5.3 illustrates a regime that has been further enhanced by the following:

- Locations where DVI surveys have not been routinely carried out are subject to scheme–specific DVI surveys.
- Ground radar and Deflectograph or FWD investigations are proposed in to support the design of individual treatments.

Note that Scheme level surveys only collect data required over and above the network–level data previously collected.

This regime is designed to support the detailed assessment of treatment options at a scheme level. Condition data are used to justify bids for funding for specific maintenance schemes, to allow future audit of treatment decisions, and to allow allocation of relative priorities to schemes on a condition or on an economic basis.

Network	Features	Surveys (% per year)									XSP Method		Use Inventory?
		CVI (Driven)	CVI (Walked)	Rutbar	TTS	SCRIM	DVI	Deflectograph	Ground Radar	FWD	CVI	Others	
Urban Principal	Carriageway				100	33	50					F	Y
	Others						50					F	Y
Rural Principal	Carriageway				100	33	50					F	Y
	Others	50					50				M	M	Y
Urban Classified	Carriageway			50	50		50				M	F	Y
	Others						50				M	F	Y
Rural Classified	Carriageway	50		50	50						M	F	Y
	Others	50	50								M	F	Y
Urban Unclassified	Carriageway	25									M		Y
	Others	25	25								M		Y
Rural Unclassified	Carriageway	25									M		Y
	Others	25									M		Y

Table A5.3 Example Enhanced Survey Regime

20 Annex 7. Survey and Analysis Research Activities

20.1 Edge deterioration

Currently research is ongoing into the feasibility of using specialised methods for deriving CHART-type edge deterioration from machine measurements. These techniques could be assessed and, if appropriate, developed into reliable and robust methods. However, a first step would be to ascertain from engineers, what are the most important elements of the CHART definition in case the priority elements are more easily measured. These solutions could become quick wins.

Identify long term needs	**3 months**	**£10k**
Develop long term solutions	**12 months**	**£60k**
Assess interim solutions	**3 months**	**£10k**
Develop long term implementation plan	**3 months**	**£10k**
Total (elapsed time)	18 months	£90k

20.2 Transverse profile

At present, TTS equipment measures the transverse profile using a number of discrete non-contact laser sensors mounted across the measuring vehicle. The TRACS contract and the TTS specification for principal roads requires that the measuring equipment needs at least 20 non-contact height sensors, equally spaced over a 3.2m width. This has been found adequate for the normal geometry of most of the trunk road network. However the dimensions of non-principal local authority roads are rather more varied. Using the information from Task 0, the optimum measuring configurations for such roads could be investigated.

The level of transverse unevenness, which can indicate inadequate surface material properties as well as a safety hazard, is currently summarised by measuring the gap beneath a 2m straight edge, the rut depth. This manual measurement can be simulated on a measured transverse profile if the profile is obtained with sufficient detail. However, there are some circumstances when it is difficult to devise an algorithm that can correctly estimate rut depth - for example, the presence of a kerb or steep verge can exaggerate the estimated depth considerably.

Characterising transverse profile by rut depth is only appropriate where clear canalisation of traffic occurs. On the narrower, generally unclassified rural lanes, or in urban areas with many parked vehicles, this means that although the transverse evenness is poor there are no clear ruts to measure and a summary indicator of transverse unevenness may be better derived by other means. A measure such as the variance about a filtered transverse profile, as used for the longitudinal profile may be more appropriate.

Investigation of these problems would involve the collection of survey data on a representative range of sites and examination of the transverse profiles and their interpretation, by conventional algorithms, for comparison of the results with the views of local engineers on the seriousness of the conditions. If necessary, the development of new algorithms or new measuring equipment for these situations may be needed.

Collect measured transverse profile samples	6 months	£20k
Assess current equipment and analyses	3 months	£20k
Assess interim solutions	3 months	£15k
Develop long term solutions	9 months	£50k
Develop final specification	3 months	£5k
Total (elapsed time)	**18 months**	**£110k**

20.3 Longitudinal evenness

The current TTS system measures longitudinal profile in the nearside wheel track of the survey vehicle. On the trunk road network this has been found to be a good representation of the evenness of the road as experienced by the user and a useful indication of deterioration which can be related to the structural performance of a pavement. On local roads this case has not been proven. For many local roads, parked vehicles make the consistent identification of the wheel track difficult to achieve. On trunk roads, in the vast majority of cases, the paved lanes correspond to the trafficked lanes but this is not necessarily the case with non-principal, or even principal, roads. Many of the local roads have been built up over many years and have non-standard widths with unclear trafficked paths. Haunching repairs are common, with different constructions across the width of a lane. In addition it has been found by research in other countries that the ride comfort experienced by users depends on not just the nearside wheel track profile but the profile of both wheel tracks as out-of-phase features can have a significant effect on the vehicle behaviour.

It is therefore necessary to investigate what profiles should be measured in these circumstances. This work would involve the collection of a substantial sample of 3D profiles of the non-principal local road network and corresponding views from the local engineers and users on the state of evenness of these roads. An analysis would then investigate the minimum profile requirement to correctly reflect the opinions of the engineers and propose a practical monitoring solution.

The current method of interpreting and summarising longitudinal evenness for trunk roads is in terms of variance about moving average lengths (3m, 10m and 30m). Although this is simple and quick to calculate it has been shown to respond to a wider range of wavelengths than is desirable. Large geometrical features in the road layout can influence the value of the longer wavelength variances. The significance of this has been shown to be fairly low on the predominantly “standard” geometry of the trunk road network, but assessments of local roads, in particular the B and unclassified roads, will frequently include extreme geometries. It may therefore be necessary to replace the present moving average filters with more sophisticated digital filters to identify appropriate thresholds for maintenance investigation and action. A significant sample of profiles from a range of local roads will be needed together with corresponding views on the quality of the road profile to support this research.

Collect measured 3-D profile samples	**6 months**	**£20k**
Assess current equipment and analyses	**3 months**	**£30k**
Assess interim solutions	**3 months**	**£20k**
Develop long term solutions	**9 months**	**£80k**
Develop final specification	**3 months**	**£5k**
Total (elapsed time)	18 months	£155k

20.4 Cracking

The present crack system used in the TRACS contract was evaluated on typical trunk road surfacings. Even in this limited range of type and quality of surfacings a range of performance was observed and for one surfacing type, (concrete surfacings) approval for use in the contract was not given. The range of road surfacings encountered on local roads is much wider and there is little experience of how the current crack detection systems will perform on these surfaces under a much wider range of operating conditions. For example at the lowest level of classification, there is much more likelihood of ‘contamination’ of the surface (e.g. with conventional contaminants such as mud or water and with visual ’contaminants’ such as patches, trenches or road furniture). This is likely to introduce significant errors into the results. How frequently this will occur is not yet known and will need to taken into consideration in the interpretation of the results and the setting of appropriate thresholds. For trunk roads the setting of the crack algorithms according to the type of the road surface is altered. This is more likely to be the case for local roads and a thorough preparatory check of the offered systems will be necessary before formal accreditation. Such work will involve not only collection of a range of samples of results but a number of manual surveys as references.

Collect measured crack detection samples	6 months	£20k
Assess current equipment and analyses	3 months	£25k
Assess interim solutions	3 months	£15k
Develop long term solutions	9 months	£40k
Implement and retest	3 months	£20k
Develop final specification	3 months	£5k
Total (elapsed time)	**18 months**	**£125k**

20.5 Other visual defects

A number of visual defects, other than cracking, are considered important in the evaluation of maintenance need by local highway engineers (e.g. fatting up, fretting, ravelling, crazing and potholes). Rather than measure these other defects directly, it is possible that the current TTS systems could provide information that could at least act as proxies for the presence of these defects. For example current research has suggested that on trunk roads, measures of texture can be used to predict the degree of fretting. An investigation into the significance of each of these additional defects needs to be carried out, followed by the development of techniques to quantify the degree of defectiveness for the parameters considered most important. Depending on the number of such parameters required this could involve more resources than given by the figures below.

Collect survey samples of selected defects	**6 months**	**£20k**
Assess current equipment and analyses	**3 months**	**£25k**
Investigate and develop monitoring solutions	**9 months**	**£40k**
Develop final specification	**3 months**	**£5k**
Total (elapsed time)	18 months	£90k

20.6 Skid resistance

The current policy for trunk roads is to place a strong emphasis on providing a safe road network that includes the routine network measurement of skid resistance using SCRIM. At present this does not extend to local roads and this measure is not included in any BVPI required by the DfT for local roads. A desk study should be carried out to ascertain whether this is a significant omission. If so, methods of measuring this economically should be explored, including whether a non-contact measure, such as texture depth, could be used as a proxy.

Measures of texture depth have been shown to relate to potential accident risk even in dry conditions at moderate speed. TTS vehicles currently use the texture profile measured along one narrow longitudinal line within the nearside wheel track to assess the state of the texture of the whole lane. On well-maintained trunk road surfaces this is a reasonable representation but on local roads there is much more variability in the pavement surface, particularly across a lane. On some roads, there is no clear trafficked lane to take as the most heavily trafficked part of the road. Therefore, there is clearly a need to explore what coverage is appropriate for the different classes of local roads. This would comprise:

Basic skid resistance measurement requirement.		
• Collection of skid resistance and texture data	2 months	£10k
• Analysis and recommendations	2 months	£15k
Adequacy of texture depth coverage		
• Collection of sample texture data	4 months	£10k
• Assess interim solutions	3 months	£20k
• Develop long term solutions	9 months	£50k
• Develop final specification	3 months	£10k
Total (elapsed time)	**18 months**	**£115k**