Countryside Traffic Measures Group: Demonstration schemes

Prepared for Charging and Local Transport Division, Department for Transport, Local Government and the Regions

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# CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Executive Summary</td>
<td>1</td>
</tr>
<tr>
<td>1 Introduction</td>
<td>3</td>
</tr>
<tr>
<td>2 Schemes</td>
<td>3</td>
</tr>
<tr>
<td>2.1 Norfolk coastal villages</td>
<td>3</td>
</tr>
<tr>
<td>2.2 Occold</td>
<td>4</td>
</tr>
<tr>
<td>2.3 Charlwood</td>
<td>4</td>
</tr>
<tr>
<td>2.4 Other schemes</td>
<td>5</td>
</tr>
<tr>
<td>2.4.1 Brockenhurst</td>
<td>5</td>
</tr>
<tr>
<td>2.4.2 Devon</td>
<td>6</td>
</tr>
<tr>
<td>2.4.3 Cumbria</td>
<td>6</td>
</tr>
<tr>
<td>3 Monitoring</td>
<td>6</td>
</tr>
<tr>
<td>3.1 Introduction</td>
<td>6</td>
</tr>
<tr>
<td>3.2 Traffic flow and speeds</td>
<td>7</td>
</tr>
<tr>
<td>3.3 Noise (Charlwood)</td>
<td>7</td>
</tr>
<tr>
<td>3.3.1 Vehicle noise</td>
<td>7</td>
</tr>
<tr>
<td>3.3.2 Noise from individual heavy vehicles</td>
<td>7</td>
</tr>
<tr>
<td>3.3.3 Traffic noise</td>
<td>7</td>
</tr>
<tr>
<td>3.3.4 Data collection</td>
<td>7</td>
</tr>
<tr>
<td>3.4 Air quality (Stiffkey and Charlwood)</td>
<td>8</td>
</tr>
<tr>
<td>3.4.1 Introduction</td>
<td>8</td>
</tr>
<tr>
<td>3.4.2 Site considerations</td>
<td>8</td>
</tr>
<tr>
<td>3.4.3 Measurement methods</td>
<td>8</td>
</tr>
<tr>
<td>3.4.4 Monitoring periods</td>
<td>8</td>
</tr>
<tr>
<td>3.5 Public opinion surveys</td>
<td>8</td>
</tr>
<tr>
<td>4 Results</td>
<td>9</td>
</tr>
<tr>
<td>4.1 Traffic flows</td>
<td>9</td>
</tr>
<tr>
<td>4.2 Vehicle speeds</td>
<td>9</td>
</tr>
<tr>
<td>4.2.1 Inbound speed reductions at the gateways</td>
<td>10</td>
</tr>
<tr>
<td>4.2.2 Changes within the villages</td>
<td>10</td>
</tr>
<tr>
<td>4.2.3 Outbound changes at the gateways</td>
<td>11</td>
</tr>
<tr>
<td>4.3 Noise measurements in Charlwood</td>
<td>11</td>
</tr>
<tr>
<td>4.3.1 Vehicle noise</td>
<td>11</td>
</tr>
<tr>
<td>4.3.2 Noise from individual heavy vehicles</td>
<td>12</td>
</tr>
<tr>
<td>4.3.3 Traffic noise alongside the rumble strips</td>
<td>13</td>
</tr>
<tr>
<td>4.4 Air quality</td>
<td>13</td>
</tr>
<tr>
<td>4.4.1 Stiffkey</td>
<td>13</td>
</tr>
<tr>
<td>4.4.2 Charlwood</td>
<td>13</td>
</tr>
<tr>
<td>Section</td>
<td>Page</td>
</tr>
<tr>
<td>--------------------------------------------------</td>
<td>------</td>
</tr>
<tr>
<td>4.5 Public opinion surveys</td>
<td>14</td>
</tr>
<tr>
<td>4.5.1 Stiffkey</td>
<td>14</td>
</tr>
<tr>
<td>4.5.2 Blakeney</td>
<td>14</td>
</tr>
<tr>
<td>4.5.3 Wiveton</td>
<td>14</td>
</tr>
<tr>
<td>4.5.4 Occold</td>
<td>16</td>
</tr>
<tr>
<td>4.5.5 Charlwood</td>
<td>16</td>
</tr>
<tr>
<td>4.6 Accidents</td>
<td>17</td>
</tr>
<tr>
<td>5 Summary</td>
<td>17</td>
</tr>
<tr>
<td>6 Discussion and conclusions</td>
<td>18</td>
</tr>
<tr>
<td>7 Acknowledgements</td>
<td>19</td>
</tr>
<tr>
<td>8 References</td>
<td>19</td>
</tr>
<tr>
<td>Appendix A: Measures and monitoring positions at Stiffkey, Norfolk</td>
<td>20</td>
</tr>
<tr>
<td>Appendix B: Measures and monitoring positions at Blakeney, Norfolk</td>
<td>22</td>
</tr>
<tr>
<td>Appendix C: Measures and monitoring positions at Wiveton, Norfolk</td>
<td>24</td>
</tr>
<tr>
<td>Appendix D: Measures and monitoring positions at Occold, Suffolk</td>
<td>26</td>
</tr>
<tr>
<td>Appendix E: Measures and monitoring positions at Charlwood, Surrey</td>
<td>28</td>
</tr>
<tr>
<td>Abstract</td>
<td>31</td>
</tr>
<tr>
<td>Related publications</td>
<td>31</td>
</tr>
</tbody>
</table>
Executive Summary

Introduction
The Countryside Traffic Measures Group (CTMG) was set up in 1997 by the Countryside Agency and the Department for Transport, Local Government and the Regions (DTLR) to support the planning and implementation by local authorities of innovative rural traffic management schemes. Under this initiative, local authorities were invited to propose schemes forming part of their traffic and transport strategies, which were designed to integrate sensitively into the local environment. The DTLR’s Charging and Local Transport Division commissioned TRL to monitor the effectiveness of a selection of schemes being progressed within the CTMG initiative. The chosen schemes were located in Norfolk (Stiffkey, Blakeney and Wiveton), Suffolk (Occold), Surrey (Charlwood), Hampshire, Devon and Cumbria, but for various reasons, those in Hampshire, Devon and Cumbria were not pursued.

The five schemes that were studied were all in villages and were aimed at reducing vehicle speeds. The scope of the monitoring depended on the scale of the scheme. Measurements of vehicle speed and traffic flow, along with public opinion surveys, were undertaken for all schemes. In addition, noise levels were monitored in Charlwood, and air quality in Stiffkey and Charlwood.

The schemes
The traffic calming schemes in Stiffkey, Blakeney and Wiveton, within the North Norfolk Coast Area of Outstanding Natural Beauty, included changes to signing, Outstanding Natural Beauty, included changes to signing, in order to maintain village character. Two-way traffic flows before scheme installation were about 3,500 vehicles per day in Blakeney, 2,500 in Stiffkey and under 1,500 in Wiveton, outside the summer season. Gateway features, comprising new signing and a patch of sandy coloured surfacing, were introduced in all three villages.

In Stiffkey, the speed limit on the A149 was 30 miles/h before scheme installation. Mean vehicle speeds were just above this at the gateways but much lower (about 22 miles/h) in the village centre, where they were constrained by the narrow carriageway and winding alignment, giving limited forward visibility. The main village centre measures were a 20 miles/h speed limit having sandy coloured surfacing with no road markings to impart a ‘country-lane’ feel, and a short stretch of overrunable footway (composed of grey imprinted surfacing).

In Blakeney, the A149 is relatively wide and much of the development is set back, imparting an open aspect. Mean speeds were between 30 and 35 miles/h before scheme installation, well below the 40 miles/h speed limit. This limit was lowered to 30 miles/h and a vehicle activated fibre optic speed limit reminder sign was installed 100m inside the western gateway.

The C599 in Wiveton has scattered frontage development but is narrow with a right-angled bend. Mean speeds before scheme installation were less than 34 miles/h. The national speed limit was retained, the main changes being to signing and the replacement of bend chevrons by reflector posts.

Occold had relatively low traffic flows (two-way flow under 1200 vehicles per day) and mean vehicle speeds (within the 30 miles/h speed limit) were below 25 miles/h before scheme installation. There is little footway provision. The scheme was specifically targeted at improving safety outside the school, which is situated at a Y-junction between two roads. A 20 miles/h zone was introduced, the ‘gateways’ to which have one-way working kerbed build outs with patches of light coloured surfacing and white edge markings. A further kerbed build-out and simulated narrowings (patches of light coloured surfacing and white edge markings) were installed at intervals through the zone. The Y-junction was re-aligned to a T-junction, using light coloured surfacing to give horizontal deflection.

In Charlwood, the two-way traffic flow was approximately 6000 vehicles per day and one of the aims was to reduce through traffic. Mean speeds at the gateways monitored were about 35 miles/h, whilst those in the centre of the village were between 28 and 32 miles/h (30 miles/h speed limit). The gateways comprised imitation gates, 30 miles/h signing and carriageway roundels. Rumble strips or a simulated narrowing (fencing and hatched edge markings) were installed at and/or just inside the gateways. In the village centre, the main features were continuous grey imprinted surfacing with footway widening / carriageway narrowing, and an informal pedestrian crossing (cream coloured imprinted surfacing). Later additional measures included patches of grey imprinted surfacing to highlight two hitherto untreated junctions on the main road through the village, and two further informal pedestrian crossings.

Results
- There appeared to be little change in levels of traffic flow (or in the proportion of heavy vehicles) in most of the schemes, although there was a slight reduction in Charlwood.
- Reductions in mean vehicle speed were relatively modest, up to about 6 miles/h. This is consistent with the fact that Before mean speeds were all below 40 miles/h.
- At the gateways in Stiffkey and the eastern ends of Wiveton and Blakeney, changes in mean inbound speeds were all less than 2 miles/h. By contrast, the reduction at the western end of Blakeney, with the vehicle activated fibre optic 30 miles/h reminder sign, was almost 5 miles/h.
- In the centre of Stiffkey, on the continuous sandy coloured surfacing with no road markings the mean speed from west to east was hardly changed, whereas that in the opposite direction was reduced by almost 3 miles/h. It remained just above the 20 miles/h speed limit outside the summer season. There was little effect on mean speeds in the centres of either Blakeney or Wiveton.
In Occold, there was a reduction in mean speed of 5-6 miles/h at the kerbed build outs with one-way working at the entries to the 20 miles/h zone. Most of this reduction was sustained in the village centre, but mean speeds remained slightly above the 20 miles/h limit.

In Charlwood, there were reductions in mean speed of about 5 miles/h at the gateways and on the continuous grey imprinted surfacing, but mean speeds elsewhere in the village centre were little changed in the first After survey. Following the implementation of two patches of imprinted surfacing, mean speeds at these sites showed a reduction of 3 to 5 miles/h compared to the Before situation and were below the 30 miles/h limit.

The public opinion surveys showed that there were mixed views over the effectiveness of the schemes. The vehicle activated fibre optic sign had the most approval. The 20 miles/h speed limits were also popular, but there was general agreement that speeds had not been reduced enough. The continuous grey imprinted surfacing in Charlwood was considered to improve safety, but was thought to be noisy. The footway widening / carriageway narrowing on the same stretch of road was thought to improve safety for pedestrians, but not for cyclists.

The level of satisfaction with the appearance of the schemes was fairly high, particularly the changes to signing in Norfolk. The sandy coloured surfacing in Stiffkey also met with approval, but the patches of light coloured surfacing in Occold were disliked. A few respondents considered the imitation gates and rumble strips in Charlwood to be out of keeping with a rural village.

Air quality measurements (Charlwood and Stiffkey), both before and after scheme installation, were well below the current Air Quality Standards.

Noise measurements (Charlwood) showed a change in character on the imprinted surfacing. Increased noise at the rumble strips was broadly offset by the accompanying reduction in speed.

The After periods were too short to assess the effect of the schemes on safety.

Discussion and conclusions
The main objective of the CTMG initiative was to demonstrate schemes that would achieve their traffic management objectives while integrating sensitively into the rural environment. This is an important objective, given the rapidly increasing traffic levels on rural roads and consequent intrusion into local communities. The scope of the CTMG initiative was, however, restricted, since the schemes that were fully monitored were relatively similar.

The main conclusions were:

- The success, in general, of the schemes in meeting CTMG objectives was mixed, in that most of the measures were not visually intrusive and were considered to enhance the appearance of the village, but only a few were effective in reducing vehicle speeds.

- The size of the speed reduction depended on the speed limit before and after scheme implementation, the Before speeds and the measures themselves. None of the measures incorporated reduced mean speeds below the 20 or 30 miles/h speed limits.

- Measures need to be continuous or repeated throughout the length of the village in order to maintain speed reductions. Repeated measures should be located at, or close to, particularly hazardous points, for example where people are most likely to cross the road or at junctions.

- More extensive physical measures might have been introduced, the opportunity being taken to develop variants of existing (urban) measures for use in rural situations. Mini-roundabouts, for example, were not included in any of the schemes, despite the fact that they are relatively cheap and do not need to be visually obtrusive.

- Footway widening can contribute to perceived safety for pedestrians. The use of an overrunable footway seems an excellent idea on quiet roads that are too narrow to accommodate a pavement for pedestrians.

- The trade-off between the effectiveness of a scheme in reducing speeds and increasing safety and visual intrusiveness needs to be explored more fully – for example, by greater use of appropriate colour and more experimentation with different sizes / types of sign.
1 Introduction

In recent years, local authorities have been able to install a wider range of speed reducing measures on main roads as a result of changes to legislation, together with special authorisation procedures. This has led to the implementation of a variety of village traffic calming schemes, many of which have been studied by TRL for the Department for Transport, Local Government and the Regions (DTLR) (Wheeler and Taylor, 1995, 1999, 2000; Wheeler et al., 1993, 1994, 1996, 1997, 1998; Taylor and Wheeler, 2000). A number of schemes, however, have been criticised for their appearance being out of keeping with the rural environment.

The Government announced in 1997 that Countryside and Rural issues would feature directly in its proposed transport review and White Paper. The Countryside Agency linked with DTLR to set up the Countryside Traffic Measures Group (CTMG), to support the planning and implementation by Local Authorities of innovative traffic schemes. The target of this forum was to get strategic schemes implemented sensitively in the local environment, strengthening good practice in design and local participation.

The CTMG, comprising members from the Agency and DTLR, and invited members from the County Councils of Norfolk, Suffolk, Cumbria, Devon, Kent, Derbyshire, Surrey, Hampshire and of the Peak District National Park, launched the initiative in July 1997. Members were requested to nominate possible pilot demonstration schemes for formal monitoring. These schemes would be likely to:

- deal with traffic flows and road networks directly to improve local environmental and road-space management; and/or
- deal with travel behaviour and local modal transfer.

Sustainability would be the keynote of scheme preparation and implementation. Schemes would fall in open countryside, villages/urban fringe, or designated areas. Importantly, they should form part of the authorities’ Transport Policies and Programmes (TPP) bids or have alternative funding.

Scheme selection was handled jointly by the Agency and DTLR, the main criteria being value for money and potential contribution to the development of best practice. A group of schemes which together would address a range of issues and introduce a range of innovative approaches across different authorities was sought.

From the 11 schemes proposed and presented to the Agency and DTLR, 6 were initially selected for monitoring. The DTLR’s Charging and Local Transport Division commissioned TRL to monitor the effectiveness of the selected schemes, which were located in Devon, Hampshire, Cumbria, Suffolk, Norfolk and Surrey.

In the event, only the schemes in Norfolk (Stiffkey, Blakeney and Wiveton), Suffolk (Occold) and Surrey (Charlwood) were fully monitored. Before monitoring was undertaken at Brockenhurst in the New Forest (Hampshire) and in Cumbria near Lake Windermere. The Brockenhurst scheme was abandoned due to local opposition. That in Cumbria was partially implemented after much delay and uncertainty, in Summer 2000; by this time the project was drawing to a close, two full years having elapsed since the Before survey, and therefore no After monitoring was undertaken. Monitoring of the Devon scheme by the County Council was already well-advanced, with further monitoring by TRL considered to be of limited value.

Section 2 describes all of the schemes initially selected. The remainder of this report summarises the monitoring undertaken for the schemes in Norfolk, Suffolk and Surrey. Full details are given in Wheeler et al. (2001a and b).

2 Schemes

2.1 Norfolk coastal villages

Traffic calming schemes were introduced in three Norfolk villages, at Blakeney and Stiffkey on the A149 and at Wiveton on the C599 (just off the A149), in May 1999 as part of Norfolk County Council’s North Norfolk Coast Transport Strategy. This includes the implementation of village traffic calming measures along the A149, which is a principal (non-primary) road, within the North Norfolk Coast Area of Outstanding Natural Beauty. The villages on the A149 suffer high tourist traffic pressure in summer. The schemes aim to enable lower speed limits to be used through sympathetically designed measures, together with a reduction in the numbers of traffic signs, in order to maintain village character.

Outside the summer season, traffic flows in all three villages are relatively low (mean two-way flows of about 3,500 vehicles per day in Blakeney, 2,500 in Stiffkey and under 1,500 in Wiveton).

In the centre of Stiffkey, many of the buildings abut the carriageway edge. This, in combination with the narrow carriageway (less than 5m in places) and winding alignment gives the road a constricted feel with limited forward visibility, thus constraining speeds. This effect is reinforced in summer by traffic congestion and by the numbers of pedestrians. The measures were intended to impart a ‘country-lane’ feel and a 20 miles/h speed limit was also imposed on this stretch of road.

By contrast, on the A149 in Blakeney, much of the development is set back, imparting an open aspect and encouraging higher speeds. The speed limit was reduced from 40 to 30 miles/h throughout the village (allowing a 20 miles/h limit on the narrow roads leading to the sea front, which was not monitored). The vehicle activated fibre optic sign 100m inside the western gateway is intended to remind drivers of the 30 miles/h speed limit. It is set to trigger at 35 miles/h.

The scheme in Wiveton was concentrated on the C599. This road has scattered frontage development but is narrow with a right-angled bend, constraining speeds. The national speed limit was retained.
The main elements of the Norfolk schemes (Table 1) are:

- **Changes to signing:**
  - rationalisation of signs;
  - new village name plates (Blakeney, Wiveton);
  - artistically designed village sign (Stiffkey);
  - speed limit signs mounted on wooden posts (Stiffkey, Blakeney);
  - finger post signs (Stiffkey, Wiveton);
  - replacement of bend chevrons by wooden reflector posts (Wiveton).

- **Gateway treatment:**
  - patch of sandy coloured surfacing;
  - reduction in previous speed limit from 40 to 30 miles/h (Blakeney);
  - vehicle activated fibre optic 30 miles/h reminder sign 100m inside gateway (Blakeney).

- **Village centre measures (Stiffkey):**
  - 20 miles/h speed limit;
  - sandy coloured surfacing with no road markings;
  - overrunable footway (grey imprinted surfacing) outside village shop.

- **Other minor measures:**
  - median strip (imprinted surfacing) on bend (Blakeney).

Scheme layouts and photographs of the main features are shown in Appendices A, B and C for Stiffkey, Blakeney and Wiveton respectively.

### 2.2 Occold

Occold lies about 4km south-east of Eye, just off the B1077 Ipswich-Debenham-Eye road. The village has relatively low traffic flows (two-way flow of 600-1000 vehicles per day), but little footway provision; the scheme was intended to improve school safety. It comprises a 20 miles/h zone within the village without the road humps or chicanes normally associated with urban schemes of this type. The village primary school is situated at a Y-junction between the two main roads.

The Occold scheme was implemented in August 1999. The main elements, shown in Table 1, are:

- ‘Gateway’ treatment at entry to 20 miles/h zone:
  - one-way working kerbed build outs;
  - patches of light coloured surfacing;
  - white edge markings;
  - new signs;
  - reduction in previous speed limit from 30 to 20 miles/h.

- **Village centre measures:**
  - 20 miles/h speed limit;
  - simulated narrowings;
    - white of light coloured surfacing;
    - white edge markings;
  - single kerbed build out;
  - white edge markings on the approach to the school;
  - re-alignment of the Y-junction to a T-junction (light coloured surfacing).

Light coloured surfacing was used to re-align the Y-junction outside the school to a T-junction and to impart horizontal deflection to traffic.

The scheme layout and photographs of the main features are shown in Appendix D.

### 2.3 Charlwood

A traffic calming scheme was implemented in November 1999 at the village of Charlwood (Surrey), which lies just to the north west of London Gatwick Airport. The scheme forms part of Surrey County Council’s Strategic Traffic Area Reduction (STAR) initiative, under which a pilot project, known as the Dorking Rural Box (within which lies Charlwood), had been proposed by the County Council as a demonstration project for the CTMG initiative.

The Dorking Rural Box, later extended into West Sussex, covers an area bounded by the A24, A25, A217 and A264. It suffers from both London commuter traffic and traffic to and from Gatwick Airport. The proposal was to reduce through traffic, encouraging it to use the peripheral main roads, thereby improving conditions for non-motorised road users such as walkers, cyclists and horse riders. This would be achieved by introducing an area-wide speed limit of 40 miles/h with perimeter gateways and traffic calming measures in the villages, which would have 30 miles/h limits on the approaches and 20 miles/h limits in the centre. Following the introduction of the area-wide speed limit, Charlwood was the first village to be traffic-calmed.

The measures initially proposed in Charlwood were 30 miles/h approaches and a 20 miles/h speed limit with speed tables and carriageway narrowing through the village centre. Following objections from residents, a decision was taken to omit the speed tables and use granite setts through the village centre. In the event, grey imprinted surfacing with a stone sett pattern was substituted for the granite setts, since the installation period needed is much shorter. The proposed 20 miles/h speed limit was not implemented, although the existing 30 miles/h limit was extended.

Shortage of funding led to completion of the scheme being postponed and as it was uncertain whether this would be within the time scale of the CTMG project, monitoring of the reduced scheme went ahead.

The main features of the scheme are shown in Table 1. Those implemented in November 1999 are as follows:

- **30 miles/h speed limit extension on 2 main approaches.**
- **Gateway treatment on five main approaches:**
  - imitation gates;
  - rumble strips at and/or just inside gateway on two approaches;
  - simulated narrowing (fencing and hatched edge-marking) just inside gateway on one approach.
Village centre measures:

- continuous grey imprinted surfacing:
  - footway widening;
  - carriageway narrowing;
  - informal pedestrian crossing (cream coloured surfacing).
- change in priority at T-junction;
- simulated narrowing using fencing to give channelling effect (two approaches);
- carriageway narrowing (two approaches).

Other minor measures:

- 30 miles/h carriageway roundels;
- new kerbing.

Additional measures to complete the scheme were implemented in November 2000, the main elements being patches of imprinted surfacing to highlight two hitherto untreated junctions on the main road through the village, and two additional informal pedestrian crossings. Limited additional monitoring took place after the scheme was completed.

The scheme layout and photographs of the main features are shown in Appendix E.

### 2.4 Other schemes

#### 2.4.1 Brockenhurst

The New Forest scheme, in Brockenhurst, was designed by Hampshire County Council and comprised the re-direction of through traffic away from the village centre using existing routes, followed by environmental enhancement within the village. This involved: narrowing and resurfacing the former main route through the village to single track, imparting a ‘country lane’ feel; traffic calming in the main shopping street; improvements to public transport facilities at the railway station. It was intended to increase safety for cyclists and pedestrians. The scheme met with opposition (a) from residents who were against the narrowing proposals and feared traffic would continue to use local roads to avoid the increasing traffic congestion at the station level crossing, and (b) from the business community concerned about loss of trade in the village centre. Monitoring by TRL of conditions before implementation of the New Forest scheme had already been completed when the scheme was dropped.
2.4.2 Devon
Prior to CTMG involvement, monitoring of the Dartmoor 40 miles/h zone had been carried out by Devon County Council. The speed limit was signed by the use of carriageway roundels, rather than upright repeaters. Signing the speed limit in an environmentally sensitive area such as Dartmoor had become an issue and was therefore subject to review. A proposal was put forward by Devon County Council to CTMG that TRL/DTLR monitor the effect of roundel removal from a number of narrow roads where the viability of roundels had been questioned by the public. However, monitoring by the County Council was already well-advanced and it was difficult to reach speeds anywhere near the 40 miles/h speed limit on these roads. Thus further monitoring by TRL was considered to be of little value.

2.4.3 Cumbria
The Lake District scheme as conceived was aimed to help cyclists using a seasonally busy (over 15,000 vehicles per day in August), narrow and tortuous stretch of the A591 Primary Route through the National Park. Designed by Cumbria County Council, the scheme proposed is for part of the Windermere-Ambleside section (i.e. between the National Park Visitor Centre at Brockhole, and Waterhead). It also forms part of the local and national cycle route networks and is an element of the Lake District Transport Strategy, an important aim of which is to reduce car usage.

In the absence of practical alternative roads to this section of the A591, the main aim of this scheme was to improve cyclists’ safety by reducing conflict between cycles and motor vehicles. Neither continuous cycle lanes nor sharing the footway that runs along one side of the road were options because of the narrowness of both road and footway.

The scheme aimed to provide safer and more comfortable cycling conditions by giving more precedence to cyclists, and to engender a mutual respect and understanding between cyclists and motorists. Termed a ‘bike ahead’ zone, the scheme’s main elements were:
- Signing asking motorists not to overtake cyclists when there is insufficient clearance (either because of oncoming traffic or the presence of double white lines);
- Signing asking cyclists to use provided passing places to allow drivers to overtake;
- Where carriageway width permits, lengths of cycle lane to help cyclists enter and leave the passing places and an additional cycle lane elsewhere;
- 30 miles/h speed limit;
- Advanced stop lines for cyclists at traffic signals at the Ambleside end of the scheme.

Before monitoring was completed by TRL and the County Council in August 1998, but implementation of the scheme, due to take place by March 1999, suffered a number of delays. The main problem was that this section of the A591 was found to have a below-standard skidding resistance that would cause excess differential between the existing surface and the surface of the cycle lanes. Scheme installation could not proceed until this problem was rectified. As a result, the scheme was excluded as a demonstration project. The scheme was partially implemented in Summer 2000.

3 Monitoring

3.1 Introduction
Monitoring of the schemes was undertaken to establish their effectiveness in meeting the objective of reducing speed by environmentally sensitive measures. The scope of the monitoring depended on the scale of the scheme and is summarised in Table 2. Traffic flow and speeds were measured at all sites, before and after scheme installation, at the same time of year (or the nearest equivalent time where this was not possible because of delays in scheme installation). The After measurements were undertaken at least three weeks after scheme installation.

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<th>Occold</th>
<th>Charlwood</th>
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Traffic calming measures have been found to affect both vehicle and traffic noise (Abbott et al., 1997). It is well established that the level of noise from roads is directly proportional to the volume and speed of the traffic and the proportion of heavy vehicles (Department of Transport and Welsh Office, 1988). It was anticipated that there would be a reduction in mean vehicle speeds resulting from the traffic calming surface treatments which would normally be expected to cause decreases in overall traffic noise levels. However, studies have shown that the presence of some designs of traffic calming surface treatments can cause slight increases in the level of noise or changes to the character of the noise (Sumner and Shippey, 1977; Webster and Layfield, 1993).

Monitoring of vehicle and traffic noise levels was undertaken at Charlwood, alongside the rumble strips and the new road surfacing in the centre of the village (initially intended to be granite setts, but eventually imprinted surfacing.) The results had to be corrected for the influence of aircraft noise, because of the proximity of Gatwick Airport.

Monitoring of air quality was undertaken at Stiffkey and Charlwood to ensure that it was not adversely affected by the schemes, for example by changes in driving behaviour. These two villages had the most measures and were therefore considered most likely to show an effect.

Opinion surveys were undertaken in all the villages, about 3 to 6 months after scheme implementation.
3.2 Traffic flow and speeds

Measurements of traffic flow and speeds were made in each direction using automatic traffic classifier (ATC) equipment connected to tube detectors; the measurements were carried out continuously for a period of 7 days at each scheme, Before and After scheme installation. Data were collected at a number of sites, depending on the schemes, usually just inside the gateways and at other traffic calming features. Monitoring positions are shown in the scheme diagrams in the Appendices.

In Stiffkey, the After measurements were taken at a slightly different time of year and showed a different level of traffic flow from the Before survey. Measurements on the sandy coloured surfacing with no road markings were therefore repeated at the same time of year as the Before survey. Owing to an equipment error, which led to a loss of data, a third survey was undertaken at this site.

At some schemes, the traffic flows were classified by vehicle type.

3.3 Noise (Charlwood)

Vehicle and traffic noise was monitored at Charlwood before and after scheme installation.

3.3.1 Vehicle noise

The Statistical Pass-By method (Franklin et al., 1979) was used to measure maximum vehicle noise levels, for light and heavy vehicles separately, at two locations, alongside the rumble strips (site N1) and imprinted surfacing (site N2) in Charlwood (see scheme diagram, Appendix E). The method involves determining the relationship between noise level and speed using observations for individual vehicles. This allows any change in noise level resulting from the introduction of traffic calming measures to be separated into that resulting from any change in vehicle speed and that resulting from the measure itself. A full description of the methodology is given in Wheeler et al. (2001b).

A microphone was placed 1.2m above the road surface and 5m from the centre of the nearside lane of the carriageway, connected to a noise analyser configured to record the maximum A-weighted sound level (L_{Amax}) during individual vehicle pass-bys. Vehicles chosen for measurement were judged to be sufficiently separated in the traffic stream so that their noise characteristics were not influenced by other vehicles. Speeds were measured concurrently using a radar gun.

3.3.2 Noise from individual heavy vehicles

During the After survey, tape recordings of noise from selected heavy vehicles were made directly alongside the rumble strips in Charlwood at site N1, and alongside a level section of road a short distance before the feature, using high quality digital audio tape (DAT) recorders. As with the Statistical Pass-By method, the microphones were positioned 5m from the centre of the nearside lane. It was intended that the analysis would show any change in the level or character of the noise from individual heavy vehicles as they passed over the features, compared to that alongside the level surface. It was not possible to carry out these comparative measurements alongside the imprinted surfacing at site N2b because the nearest section of level road was in an unsuitable position.

3.3.3 Traffic noise

Overall traffic noise levels in Charlwood were monitored immediately outside a residential property close to the rumble strips over a 48-hour period before and after scheme installation (site N1). Measurements of traffic noise exposure were also taken at a position chosen when plans to lay imprinted surfacing over the full length of The Street were still current (site N2a, shown in the scheme diagram in Appendix E). Because the scheme plans were changed following the Before survey, resulting in the surfacing not being laid in this position, it was necessary to select a different measurement position with equivalent site conditions. The position chosen was to the west of the village centre (site N2b). Ideally a site closer to site N2a would have been chosen, but no other suitable location could be found that was relatively free of reflecting (façade) surfaces close to either side of the road.

The assessment of traffic noise was complicated by the noise from aircraft movements at Gatwick airport, its runway being approximately 1.5km south-east of Charlwood. A methodology was developed as part of the study to identify and remove aircraft noise events from the noise record, as described in Wheeler et al. (2001b).

The L_{A10,18h} index, derived from the noise level exceeded for 10% of the time in each hour from 0600 to 2400 is normally used as the main measure of daytime traffic noise in the UK. However, because of the need to remove aircraft noise, it was considered that the A-weighted equivalent continuous noise index L_{Aeq} was the most appropriate measure for this particular survey. This scale is used in all other EU countries for this purpose. It is also widely used in the UK to measure many other sources of noise such as aircraft, railway and industrial noise. Various studies have shown that both L_{A10} and L_{Aeq} correlate well with traffic noise (Langdon, 1976; Watts, 1984).

3.3.4 Data collection

Table 3 summarises the types of measurements carried out at the various sites before and after scheme installation. The Before and After surveys were conducted during November 1998 and November 1999 respectively, prior to the installation of the additional measures in November 2000.

Table 3 Noise data collected before and after scheme installation

<table>
<thead>
<tr>
<th>Site N1 (rumble strips)</th>
<th>Site N2a (imprinted surfacing)</th>
<th>Remote site</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vehicle noise</td>
<td>B &amp; A</td>
<td>A</td>
</tr>
<tr>
<td>’DAT’ recordings¹</td>
<td>A</td>
<td>–</td>
</tr>
<tr>
<td>Traffic noise</td>
<td>A</td>
<td>–</td>
</tr>
</tbody>
</table>

¹ Digital audio tape recordings of individual heavy vehicles
3.4 Air quality (Stiffkey and Charlwood)

Air quality monitoring was undertaken at Stiffkey and Charlwood before and after scheme installation.

3.4.1 Introduction

For the UK as a whole, road traffic makes a large contribution to air pollution. This is illustrated in Table 4 (taken from the National Atmospheric Emissions Inventory Report – AEA, 1997). This shows the percentage contribution from road traffic, along with commercial sources and domestic heating to the emissions of five of the pollutants of concern in the Air Quality Strategy for England, Scotland, Wales and Northern Ireland during 1998 (DTLR, 2000).

Table 4 Percentage emissions of pollutants by end user

<table>
<thead>
<tr>
<th>End user</th>
<th>$NO_x^1$</th>
<th>$CO^2$</th>
<th>$SO_2^3$</th>
<th>$PM_{10}^4$</th>
<th>Benzene$^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Industry</td>
<td>21</td>
<td>17</td>
<td>34</td>
<td>19</td>
<td>16</td>
</tr>
<tr>
<td>Road transport</td>
<td>47</td>
<td>73</td>
<td>6</td>
<td>26</td>
<td>66</td>
</tr>
<tr>
<td>Other transport</td>
<td>6</td>
<td>&lt;1</td>
<td>5</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>Domestic</td>
<td>13</td>
<td>7</td>
<td>28</td>
<td>23</td>
<td>9</td>
</tr>
<tr>
<td>Other</td>
<td>13</td>
<td>3</td>
<td>27</td>
<td>30</td>
<td>4</td>
</tr>
</tbody>
</table>

1 $NO_x$ nitrogen oxides; $CO$ carbon monoxide; $SO_2$ sulphur dioxide; $PM_{10}$ particulate matter ($\leq 10\mu m$)
2 End user categories defined differently in raw data

At Stiffkey and Charlwood, which are in rural areas where there are no significant industrial sources, local traffic is likely to be the largest contributor to emissions. In addition, it is likely that the traffic emissions will show seasonal effects. For example, Charlwood is close to Gatwick Airport and Gatwick Zoo; the proximity of the airport to Charlwood leads to the possibility that aircraft emissions also affect local air quality.

The exhaust emissions from a stream of traffic are dependent principally on the volume of traffic, the types of vehicle present and their individual emission rates. Following scheme installation, any changes in driving pattern may result in a change in exhaust emission rates and this will in turn impact on the air quality of the local area.

3.4.2 Site considerations

To assess the impact of the schemes in Stiffkey and Charlwood on local air quality, the monitoring sites were located along the main street at the kerbside close to the emissions source. This enabled any changes in air quality resulting specifically from changes in emissions from traffic to be detected. Four sites were chosen in both villages, two on each side of the road.

A control site located away from the main road was also required to enable a distinction to be made between changes in air quality due to the scheme (i.e. driver behaviour) and changes due to other effects, such as a greater proportion of cleaner vehicles in the fleet and meteorological conditions (and at Charlwood, effects from Gatwick Airport).

3.4.3 Measurement methods

The choice of sampling apparatus and pollutants to be measured was based on the contribution that traffic makes to emissions and also the availability of a relatively cheap but effective method. Of most interest in terms of the Air Quality Strategy (DTLR, 2000) is the pollutant nitrogen dioxide ($NO_2$). There is evidence in some areas that $NO_2$ concentrations regularly exceed the health related air quality standards adopted in the Air Quality (England) Regulations 2000, and may continue to do so in the future. $NO_2$ is formed both in the exhaust and from chemical reactions of nitric oxide, which is also produced by vehicles. Benzene was also included in the surveys as vehicle exhausts are one of the main sources and it is an important pollutant in terms of local air quality.

Sampling of $NO_2$ and benzene was carried out using diffusion tubes. The tubes were mounted on lamp posts approximately 2.5m above ground such that they were in the region where people are exposed to air pollution but were also relatively inconspicuous and less likely to be stolen. Positions where the samplers would be sheltered (e.g. by bushes or trees) were avoided.

The benzene diffusion tubes were analysed with a mass spectrometer using gas chromatography and the $NO_2$ diffusion tubes were analysed using a UV spectrophotometer. The analytical error on each procedure is ±5% and ±10% respectively.

Other pollutants associated with road traffic, such as $PM_{10}$ and $CO$, are also important in terms of local air quality but were not included in the surveys. This was due to the high cost of the instrumentation required to achieve adequate coverage of the area.

3.4.4 Monitoring periods

Diffusion tubes are usually deployed for between one and four weeks depending on the ambient concentrations found at a site. For the surveys in Stiffkey and Charlwood the tubes were exposed for consecutive periods of two weeks. This was to allow as much detail on temporal variation as possible without the risk of levels being undetectable. Each monitoring period was continued for at least three months in order to be confident that the data were representative. The monitoring periods are shown in Table 5.

Table 5 Air quality monitoring periods in Stiffkey and Charlwood

<table>
<thead>
<tr>
<th></th>
<th>Stiffkey</th>
<th>Charlwood</th>
</tr>
</thead>
</table>

The kerbside monitoring positions (AQ1 to AQ4) and the control sites are shown on the scheme diagrams in Appendices A (Stiffkey) and E (Charlwood). The survey in Charlwood took place prior to the installation of the additional measures in November 2000.

3.5 Public opinion surveys

Samples of between 50 and 150 people resident in all the villages were interviewed in their homes several months after scheme installation, to allow time to become
accustomed to the measures. The aim was to establish people’s perceptions of the measures, both in terms of their effectiveness in reducing speeds and their effect on the appearance of the village. Residents were only considered eligible for interview if they were living in the villages prior to scheme implementation. Visitors to the area were also interviewed in Stiffkey, Blakeney and Wiveton. The survey in Charlwood took place in May 2000, prior to the installation of the additional measures in November 2000.

The main issues covered were:

- Problems before the changes.
- Effectiveness of the scheme at reducing speed and improving safety.
- Effect of the scheme on the visual appearance of the village.
- Overall satisfaction with the scheme.

The full questionnaires are reproduced with results in Wheeler et al. (2001a and b).

4 Results

4.1 Traffic flows

Table 6 shows the flow levels recorded at a monitoring point in the centre of four of the schemes and at the western gateway in Wiveton. Flow levels before and after scheme installation were difficult to compare in the cases where it was not possible to measure them at the same time of year, particularly where (as in Stiffkey, Blakeney and Wiveton) there were seasonal variations. There was little change in the proportions of heavy goods vehicles (HGVs).

In Stiffkey, the flow in the first After survey, in October 1999, was 20% lower than in the Before survey, in June 1999. However in the second After survey, taken in the same month as the Before survey, in June 2000, the flow was 5% higher; a further survey in August 2000 gave a value that was 58% higher than in the Before survey. The After flows (September 1999) in Blakeney and Wiveton were 7% and 18% lower respectively than in the Before surveys (June 1998). All these changes appear to be seasonal rather than being due to the schemes, as there are no obvious alternative routes. There was little change in the percentage of HGVs following the introduction of the schemes, which remained between 3 and 6%.

In Occold, there was little change in overall traffic flow levels, or in the percentage of heavy vehicles (12 to 13%), as a result of the scheme.

In Charlwood, flow levels through the centre of the village were 7% lower in the first After survey, one year after scheme installation, but were unchanged on a possible diversion route. The reasons for this are uncertain; the area-wide 40 miles/h speed limit and perimeter gateways associated with the Dorking Rural Box may have influenced traffic flow through the village. At the junction where priority had changed, traffic on the former minor arm had increased by 7%, possibly because it had become easier to turn right from this arm. Following the implementation of the additional measures in November 2000, village centre traffic had increased slightly but was still 4% below the Before levels. The percentage of HGVs (between 6 and 7%) was similar before and after scheme installation.

4.2 Vehicle speeds

Changes in mean and 85th percentile vehicle speed measurements are shown in Tables 7a and 7b for Stiffkey, Blakeney, Wiveton and Occold and in Tables 8a and 8b for Charlwood. The main features are also indicated.

Before scheme installation, the gateways all had a 30 miles/h speed limit except in Wiveton, where the national speed limit applied, and in Blakeney, which had a 40 miles/h limit. Before speeds were all below 40 miles/h. After scheme installation, the speed limit at the gateways was reduced to 30 miles/h in Blakeney and to 20 miles/h in Occold, where the ‘gateway’ was the entry to the new 20 miles/h zone. The western gateway in Wiveton was not surveyed. A 20 miles/h speed limit was also introduced in the village centre in Stiffkey.

The largest speed reductions were at the vehicle activated fibre optic sign in Blakeney, at the kerbed build outs with one-way working in Occold, and at the rumble strips and on the imprinted surfacing in Charlwood. Mean speeds mostly remained slightly above the speed limit where this was 20 or 30 miles/h, however.

Reductions in 85th percentile speeds were generally slightly greater than the reductions in mean speeds.

The large volume of data collected means that all of the speed changes quoted were highly statistically significant.

Table 6 Mean flows at monitoring site in centre of village (western gateway at Wiveton) – two-way annual average daily totals

<table>
<thead>
<tr>
<th>Village (monitoring site)</th>
<th>Before Date</th>
<th>Flow</th>
<th>After 1 Date</th>
<th>Flow</th>
<th>Change1 (%)</th>
<th>After 2 Date</th>
<th>Flow</th>
<th>Change2 (%)</th>
<th>After 3 Date</th>
<th>Flow</th>
<th>Change3 (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blakeney (S1)</td>
<td>Jun 1998</td>
<td>3938</td>
<td>Sep 1999</td>
<td>3648</td>
<td>-7.4</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Wiveton (S1)</td>
<td>Jun 1998</td>
<td>1437</td>
<td>Sep 1999</td>
<td>1176</td>
<td>-18.2</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Occold (S1)</td>
<td>Mar 1999</td>
<td>1139</td>
<td>Sep 1999</td>
<td>1169</td>
<td>+2.6</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Charlwood (S4)</td>
<td>Dec 1998</td>
<td>6263</td>
<td>Dec 1999</td>
<td>5893</td>
<td>-5.9</td>
<td>Dec 2000</td>
<td>6007</td>
<td>-4.1</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

1 See scheme diagrams in Appendices
2 Compared to Before level
4.2.1 Inbound speed reductions at the gateways

At the gateways in Stiffkey and the eastern ends of Wiveton and Blakeney, the main features were new signs and patches of sandy coloured surfacing. Changes in mean and 85th percentile inbound speeds were all less than 2 miles/h (Tables 7a and 7b).

At the vehicle activated fibre optic 30 miles/h reminder sign at the western end of Blakeney, however, there was a reduction of about 5 miles/h in mean speed. There were similar reductions at the entries to the 20 miles/h zone in Occold, where there were kerbed build outs to narrow the carriageway (giving one-way working), and at the three gateways monitored in Charlwood (Table 8), which had imitation gates, 30 miles/h signing and carriageway roundels and rumble strips or a simulated narrowing at and/or just inside the gateway.

4.2.2 Changes within the villages

Speeds on the continuous sandy coloured surfacing with no road markings with a 20 miles/h speed limit in the centre of Stiffkey were already constrained by the narrow carriageway and (partial) absence of road markings. The measures had less effect on the mean speed of vehicles travelling from west to east than on those travelling in the opposite direction. The greatest reduction was recorded in August 2000 (in the 3rd After survey) when flows were much higher. Apart from this, mean speeds remained above the 20 miles/h limit.

In Blakeney, where the only change on the A149 (other than signing) was the median strip on the bend, there was little change in mean speed. Speeds in the centre of Wiveton, where the changes were to signing and the replacement of set of chevrons on a sharp bend with reflector posts, increased slightly.

In Occold, most of the reduction in mean speeds at the entry to the 20 miles/h zone was sustained in the centre of the village, where there were simulated narrowings and a further kerbed build out with patches of light coloured surfacing, but mean speeds remained slightly above the limit. Light coloured surfacing was also used to impart horizontal deflection at the junction outside the village school.

In Charlwood (Table 8), the first After survey showed a reduction in mean speed of 5 miles/h on the grey continuous imprinted surfacing (site S3), although this may have been affected by the change in priority at the junction. Mean speeds at two other survey points in the village centre (sites S4 and S5), away from the imprinted surfacing, were little changed. Following the implementation of two further patches of imprinted surfacing in November 2000, mean speeds at these two survey points showed a reduction of 3 to 5 miles/h compared to the Before situation and were below the 30 miles/h limit.

<table>
<thead>
<tr>
<th>Village</th>
<th>W/N gateway (inbound)</th>
<th>In village centre (both directions combined, except in Stiffkey)</th>
<th>E/S gateway (inbound)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stiffkey</td>
<td>30 miles/h B and A</td>
<td>30 miles/h B, 20 miles/h A</td>
<td>30 miles/h B and A</td>
</tr>
<tr>
<td></td>
<td>Sandy coloured surfacing</td>
<td>Sandy coloured surfacing</td>
<td>Sandy coloured surfacing</td>
</tr>
<tr>
<td></td>
<td>S2</td>
<td>S1 (W to E)</td>
<td>S1 (E to W)</td>
</tr>
<tr>
<td>B</td>
<td>33.2</td>
<td>21.9</td>
<td>23.2</td>
</tr>
<tr>
<td>A1</td>
<td>32.6 (-0.6)</td>
<td>21.2 (-0.5)</td>
<td>20.6 (-2.6)</td>
</tr>
<tr>
<td>A2</td>
<td>31.7 (-1.5)</td>
<td>21.2 (-0.7)</td>
<td>20.5 (-2.7)</td>
</tr>
<tr>
<td>A3</td>
<td>19.5 (-2.6)</td>
<td>18.8 (-4.4)</td>
<td></td>
</tr>
<tr>
<td>Blakeney</td>
<td>40 miles/h B, 30 miles/h A</td>
<td>40 miles/h B, 30 miles/h A</td>
<td>40 miles/h B, 30 miles/h A</td>
</tr>
<tr>
<td></td>
<td>Sandy coloured surfacing</td>
<td>Median strip</td>
<td>Sandy coloured surfacing</td>
</tr>
<tr>
<td></td>
<td>S2</td>
<td>S1</td>
<td>S3</td>
</tr>
<tr>
<td>B</td>
<td>32.0</td>
<td>33.9</td>
<td>31.3</td>
</tr>
<tr>
<td>A</td>
<td>27.3 (-4.7)</td>
<td>32.9 (-1.0)</td>
<td>30.7 (-0.6)</td>
</tr>
<tr>
<td>Wiveton</td>
<td>60 miles/h B and A</td>
<td>60 miles/h B and A</td>
<td>60 miles/h B and A</td>
</tr>
<tr>
<td></td>
<td>Sandy coloured surfacing</td>
<td>Sandy coloured surfacing</td>
<td>Sandy coloured surfacing</td>
</tr>
<tr>
<td></td>
<td>S1</td>
<td>S2</td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>32.0</td>
<td>35.5</td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>33.7 (+0.7)</td>
<td>35.3 (+0.2)</td>
<td></td>
</tr>
<tr>
<td>Occold</td>
<td>30 miles/h B, 20 miles/h A</td>
<td>Patches of light coloured surfacing</td>
<td>30 miles/h B, 20 miles/h A</td>
</tr>
<tr>
<td></td>
<td>Advance signing</td>
<td>Simulated narrowings</td>
<td>Advance signing</td>
</tr>
<tr>
<td></td>
<td>20 zone sign</td>
<td>Horizontal deflection at junction</td>
<td>20 zone sign</td>
</tr>
<tr>
<td></td>
<td>Light coloured surfacing</td>
<td>Single build out</td>
<td>Light coloured surfacing</td>
</tr>
<tr>
<td></td>
<td>Double build out</td>
<td></td>
<td>Single build out</td>
</tr>
<tr>
<td></td>
<td>Edge markings</td>
<td></td>
<td>Edge markings</td>
</tr>
<tr>
<td></td>
<td>S1</td>
<td>S2</td>
<td>S3</td>
</tr>
<tr>
<td>B</td>
<td>29.1</td>
<td>25.4</td>
<td>30.1</td>
</tr>
<tr>
<td>A</td>
<td>23.8 (-5.3)</td>
<td>21.4 (-4.0)</td>
<td>24.0 (-6.1)</td>
</tr>
</tbody>
</table>

1 In Occold, the ‘gateway’ is the entry to the 20 miles/h zone
B Before survey, A After survey, S1–S3 Speed monitoring positions
4.2.3 Outbound changes at the gateways

Outbound changes at the gateways (not shown in the tables) were generally similar to, or slightly lower than, the inbound changes. Even though only the back of the vehicle activated fibre optic 30 miles/h reminder sign in Blakeney was visible for outbound traffic, the reduction was only slightly lower than that observed for the inbound traffic.

4.3 Noise measurements in Charlwood

4.3.1 Vehicle noise

Table 9 shows the changes in the maximum level of vehicle noise measured at each of the monitoring locations in Charlwood, as described in Section 3.3, and the corresponding changes in the mean speed of vehicles measured at approximately the same time (using a radar gun).

The decreases in noise level were less than would have been estimated from the reductions in mean speed, especially alongside the imprinted surfacing (site N2b), based on the noise/speed relationships obtained for the Before survey. The reduction in power train noise (i.e. noise from the engine, engine ancillaries, transmission and exhaust) expected from a reduction in vehicle speed at site N2b was possibly offset by the increase in tyre/road noise generated by the imprinted pattern. The survey team noted that the noise from vehicles passing over the imprinted surfacing had a particular character generated by the interaction of the tyres and the imprint pattern.

4.3.2 Heavy vehicles

The mean heavy vehicle noise level following the installation of the rumble strips (site N1) was increased slightly by 0.3 dB(A) (Table 10). The reduction in mean (radar) speed, calculated from the (small) sample of vehicles selected for the noise survey was just 0.5 miles/h.

Alongside the imprinted surfacing (site N2b), mean heavy vehicle (radar) speeds during the After survey were reduced by 17 miles/h and the mean noise level was reduced by 2.8 dB(A). However, this speed reduction cannot be attributed entirely to the effect of the imprinted surfacing as the After survey had to take place at a slightly lower speed.
different location, which was close to a bend in the road.

For light vehicles, it was possible to correct for this by using the mean speed measured on a section of imprinted surfacing similar to the site layout in the Before survey and calculating a noise level for this mean speed from the regression statistics. For heavy vehicles, the speed data were not available and the relationships between noise level and heavy vehicle speed were not statistically significant, meaning it was not possible to estimate the noise level at other speeds.

### 4.3.2 Noise from individual heavy vehicles

Time histories of selected heavy vehicles passing over the rumble strips sometimes showed distinct, multiple noise peaks caused by body rattle noise. For some vehicles this caused substantial increases in the maximum pass-by noise level. In other cases the occurrence of commercial body noise did not affect the maximum noise level. However, the impulsive nature of the noise would be expected to make the pass-by noise more noticeable and therefore potentially disturbing to nearby residents. Simply measuring the maximum A-weighted noise level may not, therefore, fully reflect the degree of disturbance experienced by some residents in response to body noise caused by some heavy vehicles. This is likely to be dependent on the time of day, where the residents are and what they are doing, and the associated background noise levels.

### Table 8a Mean speeds (changes from Before speeds in brackets) with main features in Charlwood

<table>
<thead>
<tr>
<th>W/N gateways (inbound)</th>
<th>In village centre (both directions)</th>
<th>E/S gateway (inbound)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean speeds (miles/h)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>B Before survey, A After survey, S1–S3 Speed monitoring position</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Site Feature</th>
<th>Change in noise level (dB(A))</th>
<th>Change in mean speed (miles/h)</th>
</tr>
</thead>
<tbody>
<tr>
<td>N1 Rumble strips</td>
<td>-0.7 (-1.5)</td>
<td>0.3</td>
</tr>
<tr>
<td>N2a None</td>
<td>-</td>
<td>-3.1</td>
</tr>
<tr>
<td>N2b Imprinted surfacing</td>
<td>0.3 (-3.6)</td>
<td>-2.8</td>
</tr>
</tbody>
</table>

1 Negative numbers indicate a reduction in speed or noise level.
2 Measured using radar speed guns close to the time of the noise survey
3 Measured during the noise survey
4 The figure in brackets is the estimated reduction in noise level at the mean speed measured in the After survey, calculated from the relationship between speed and noise determined in the Before survey.

### Table 9 Vehicle noise

<table>
<thead>
<tr>
<th>Site Feature</th>
<th>Change in noise level (dB(A))</th>
<th>Change in mean speed (miles/h)</th>
</tr>
</thead>
<tbody>
<tr>
<td>N1 Rumble strips</td>
<td>-0.7 (-1.5)</td>
<td>0.3</td>
</tr>
<tr>
<td>N2a None</td>
<td>-</td>
<td>-3.1</td>
</tr>
<tr>
<td>N2b Imprinted surfacing</td>
<td>0.3 (-3.6)</td>
<td>-2.8</td>
</tr>
</tbody>
</table>

### Table 8b 85th percentile speeds (changes from Before speeds in brackets) with main features in Charlwood

<table>
<thead>
<tr>
<th>W/N gateways (inbound)</th>
<th>In village centre (both directions)</th>
<th>E/S gateway (inbound)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>85th percentile speeds (miles/h)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>B Before survey, A After survey, S1–S3 Speed monitoring positions</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Site Feature</th>
<th>Change in noise level (dB(A))</th>
<th>Change in mean speed (miles/h)</th>
</tr>
</thead>
<tbody>
<tr>
<td>N1 Rumble strips</td>
<td>-0.7 (-1.5)</td>
<td>0.3</td>
</tr>
<tr>
<td>N2a None</td>
<td>-</td>
<td>-3.1</td>
</tr>
<tr>
<td>N2b Imprinted surfacing</td>
<td>0.3 (-3.6)</td>
<td>-2.8</td>
</tr>
</tbody>
</table>

1 Negative numbers indicate a reduction in speed or noise level.
2 Measured using radar speed guns close to the time of the noise survey
3 Measured during the noise survey
4 The figure in brackets is the estimated reduction in noise level at the mean speed measured in the After survey, calculated from the relationship between speed and noise determined in the Before survey.

### Table 10 Before and After traffic noise levels alongside the rumble strips (site N1)

<table>
<thead>
<tr>
<th>Noise index</th>
<th>Before noise level (dB(A))</th>
<th>After noise level (dB(A))</th>
<th>Difference (After – Before) (dB(A))</th>
</tr>
</thead>
<tbody>
<tr>
<td>L_{Aeq,18h}</td>
<td>65.6</td>
<td>64.6</td>
<td>-1.0</td>
</tr>
<tr>
<td>L_{Aeq,6h}</td>
<td>54.6</td>
<td>52.2</td>
<td>-2.4</td>
</tr>
</tbody>
</table>
4.3.3 Traffic noise alongside the rumble strips

A procedure was developed to identify aircraft noise events, so that the measurements of traffic noise could be corrected for their influence, as described in Wheeler et al. (2001b). With this correction made, the daytime traffic noise exposure (L_{Aeq,18h}) was found to be reduced by just 1 dB(A) at site N1 following the installation of the rumble strips (Table 10). When the effects of changes in traffic flow and composition were taken into account, the estimated reduction in L_{Aeq,18h} was only 0.5 dB(A). Night-time noise levels were reduced by 2.4 dB(A) (L_{Aeq,6h}).

Overall, the reductions in traffic noise at this site were fairly small and demonstrate that traffic noise exposure did not increase as a result of the rumble strips.

4.4 Air quality

The measurement of air quality both before and after scheme installation (Tables 11 and 12) showed that concentrations of benzene and NO\textsubscript{2} were well below the Air Quality Standards of 5 ppb for benzene and 40 µg/m\textsuperscript{3} for NO\textsubscript{2}. Benzene concentrations were also within the provisional objective of 1 ppb for the year 2005.

Table 11 Mean benzene concentrations (ppb) in winter before and after scheme installation

<table>
<thead>
<tr>
<th>Site</th>
<th>Stiffkey Before</th>
<th>Stiffkey After</th>
<th>Change (%)</th>
<th>Charwood Before</th>
<th>Charwood After</th>
<th>Change (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control site</td>
<td>0.37</td>
<td>0.31</td>
<td>-17</td>
<td>0.54</td>
<td>0.50</td>
<td>-9</td>
</tr>
<tr>
<td>AQ1</td>
<td>0.38</td>
<td>0.44</td>
<td>+14</td>
<td>0.68</td>
<td>0.59</td>
<td>-14</td>
</tr>
<tr>
<td>AQ2</td>
<td>0.38</td>
<td>0.38</td>
<td>0</td>
<td>0.76</td>
<td>0.56</td>
<td>-26</td>
</tr>
<tr>
<td>AQ3</td>
<td>0.43</td>
<td>0.40</td>
<td>-9</td>
<td>0.72</td>
<td>0.47</td>
<td>-35\textsuperscript{1}</td>
</tr>
<tr>
<td>AQ4</td>
<td>0.48</td>
<td>0.39</td>
<td>-18</td>
<td>0.64</td>
<td>0.60</td>
<td>-7</td>
</tr>
<tr>
<td>Combined kerbside sites</td>
<td>0.42</td>
<td>0.40</td>
<td>-4</td>
<td>0.70</td>
<td>0.55</td>
<td>-20</td>
</tr>
</tbody>
</table>

\textsuperscript{1}Statistically significant at the 5% level

Table 12 Nitrogen dioxide concentrations (µg/m\textsuperscript{3}) in winter before and after scheme installation

<table>
<thead>
<tr>
<th>Site</th>
<th>Stiffkey Before</th>
<th>Stiffkey After</th>
<th>Change (%)</th>
<th>Charwood Before</th>
<th>Charwood After</th>
<th>Change (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control site</td>
<td>14.17</td>
<td>12.10</td>
<td>-15</td>
<td>16.17</td>
<td>11.70</td>
<td>-28\textsuperscript{1}</td>
</tr>
<tr>
<td>AQ1</td>
<td>16.40</td>
<td>12.31</td>
<td>-25\textsuperscript{3}</td>
<td>22.38</td>
<td>14.74</td>
<td>-34\textsuperscript{1}</td>
</tr>
<tr>
<td>AQ2</td>
<td>15.32</td>
<td>12.22</td>
<td>-20</td>
<td>19.04</td>
<td>13.78</td>
<td>-28</td>
</tr>
<tr>
<td>AQ3</td>
<td>16.86</td>
<td>12.87</td>
<td>-24</td>
<td>19.31</td>
<td>14.61</td>
<td>-24</td>
</tr>
<tr>
<td>AQ4</td>
<td>15.57</td>
<td>13.66</td>
<td>-12</td>
<td>23.51</td>
<td>16.51</td>
<td>-30</td>
</tr>
<tr>
<td>Combined kerbside sites</td>
<td>16.04</td>
<td>12.77</td>
<td>-20</td>
<td>21.06</td>
<td>14.91</td>
<td>-29\textsuperscript{1}</td>
</tr>
</tbody>
</table>

\textsuperscript{1}Statistically significant at the 5% level

In what follows, changes are stated to be statistically significant if they are significant at least at the 5% level.

4.4.1 Stiffkey

In Stiffkey, there was no significant difference between the kerbside sites and the control site in the two winter periods, but in the summer survey, concentrations at the kerbside sites were significantly higher, suggesting that the increase in traffic during the summer months was sufficient to affect the pollutant concentrations.

From Tables 11 and 12, measured concentrations at the control site decreased for both benzene and NO\textsubscript{2}, by 17% and 15% respectively, indicating a general reduction of both pollutants in the ambient air of the local area between the two winter surveys. Effects at the kerbside sites varied, with some sites showing increases and others decreases in mean benzene concentrations, with a mean decrease of 4%. Measured concentrations of NO\textsubscript{2} at the kerbside decreased by between 12% and 25%, with a mean decrease of 20%.

The changes in the concentration of benzene and NO\textsubscript{2} at the kerbside sites compared to the changes at the control sites were calculated. These relative changes were between -1% and +31% for benzene and between -10% and +3% for NO\textsubscript{2}. None of these differences were statistically significant.

Overall, the scheme did not have a significant effect on air quality. The additional traffic in the summer months probably led to the increase in measured concentrations of benzene and NO\textsubscript{2} at the kerbside sites relative to the control site, but concentrations remained well below the current Air Quality Standards.

4.4.2 Charlwood

At Charlwood, After (summer) concentrations of NO\textsubscript{2} were greater than during the winter Before and After sampling periods, whereas those of benzene were lower. Measured concentrations of benzene at the control site decreased by 9% between the winter Before and After surveys, whereas at the kerbside sites they decreased by between 7% and 35%, with a mean decrease of 20%. Only at one site was the change statistically significant. There was no statistically significant difference between the effect at the control site and the effect at the kerbside sites.

Measured concentrations of NO\textsubscript{2} showed a statistically significant 28% decrease at the control site between the Before and After (winter) surveys and a similar change in kerbside concentrations (decrease by between 24% and 34%, with a mean decrease of 29%). There was again no statistically significant difference between the reduction in concentration at the control site and those at the kerbside sites.

There is no evidence to suggest that the changes in concentrations of benzene and NO\textsubscript{2} were due to scheme installation. The fact that the two pollutants did not follow the same winter/summer variation suggests that the excess NO\textsubscript{2} may not be attributed to the local traffic, but may have been transported from outside the survey area.

Aircraft emissions from Gatwick Airport may be one of many sources of NO\textsubscript{2} in the local area. Also summer conditions such as bright sunlight and higher temperatures allow for greater conversion of NO\textsubscript{2} to NO\textsubscript{2}, leading to higher summer concentrations.
4.5 Public opinion surveys

Numbers of male and female respondents were approximately equal in all surveys. The age distributions broadly reflected that of the local populations. Between 80 and 90% of respondents drove a car. The findings of the surveys are summarised in Table 13.

Respondents were asked to assess a variety of issues, by saying to what extent they agreed or disagreed with a set of statements. The results were analysed to give ‘mean’ responses by allocating a score of 1 to 5 to each individual response, where 5 indicated strong satisfaction or agreement and 1 the opposite. For some questions, scores were from 1 to 3, as indicated in Table 13. In what follows, where opinions are described as being ‘divided’, it indicates that the mean score was between 2.5 and 3.5 out of 5 (or 1.7 to 2.3 out of 3).

Opinions about the effectiveness of the schemes were on a scale of 1 to 3, where 3 indicated ‘very useful’ and 1 indicated ‘of little use’. A score of less than 1.7 was taken in what follows to indicate that the feature was ‘of little use’, and a score of greater than 2.3 to indicate that it was ‘very useful’.

4.5.1 Stiffkey

Residents

Nearly 60% of respondents lived on the main road.

Around half of the respondents thought that the main problems in the village before the changes were speeding traffic and danger to pedestrians, especially when walking along the road (seen as a particular problem for the elderly and those with children). The latter was almost certainly related to the narrow width of the carriageway and the lack of a footway through much of the village. One third mentioned the volume of traffic (e.g. in the summer).

The overall level of satisfaction with the scheme was mixed (mean score of 3.3 out of 5). There was general agreement that the changes were necessary (mean score 4.1) and that the appearance of the village had been improved (mean score 3.8), with signing now less visually intrusive (mean score 3.9). In spite of the introduction of a 20 miles/h speed limit, measured reductions in vehicle speed were modest and respondents did not consider that speeds had been reduced enough (mean score 2.2).

Opinions were divided as to whether the scheme had improved safety for pedestrians, cyclists and motorists, and over the effect on the environment.

The most effective feature of the scheme was considered to be the 20 miles/h speed limit (mean score 2.3 out of 3). The new overrunable footway outside the shop was well received (mean score 2.7), despite a tendency for vehicles to park on it. Respondents also liked the sandy coloured surfacing with no road markings (mean score 2.4), although there were some concerns over colour and durability. Suggestions for enhancing the scheme included more speed-reducing measures, such as signs with flashing lights, rumble strips, road humps, speed cameras or traffic signals on the approaches, more enforcement and an extension to the 20 miles/h limit. One in six respondents wanted more footway installed.

Visitors

Seven out of ten of the visitors interviewed were on holiday. Nearly all had driven through the village; over half had walked and over one third had cycled through it at some time.

Generally visitors were more positive about the effectiveness of the measures than the residents, particularly the 20 miles/h speed limit and the new footway. They also thought that the scheme improved the appearance of the village (mean scores at least 2.7 out of 3 for all features).

4.5.2 Blakeney

A roadside survey of pedestrians was carried out on the A149 in Blakeney. Two-thirds of those interviewed lived within five miles of the village.

Residents considered that the main problems before the changes were the speed and volume of traffic, danger to pedestrians from traffic and the lack of a pedestrian crossing. They were generally satisfied with the changes (mean score 3.9 out of 5), but over three-quarters of them perceived no difference in crossing the A149 as a pedestrian and half perceived no change in speeds. The most effective measure was considered to be the vehicle activated fibre optic 30 miles/h reminder sign on the western approach to the village (mean score 2.5 out of 3), whilst the least effective was the imprinted median strip on the bend (mean score 1.5). Opinions were divided over the effectiveness of the gateways. Nearly 90% of the residents were satisfied with the appearance of the village since the changes.

Visitor reactions were somewhat more favourable towards the measures. Nearly all said that the vehicle activated fibre optic 30 miles/h reminder sign was useful (mean score 2.8 out of 3). Almost 80% and more than 60% said the same about the gateways and the median strip respectively. Less than half of the visitors had problems crossing the A149.

Suggestions for improvements related to signing, road layout or the speed limit; in the latter case, higher visual impact signing and more enforcement were proposed.

4.5.3 Wiveton

Three-quarters of respondents were residents. The main problems in the village before scheme installation were considered to be speeding traffic (mentioned by nearly 60% of respondents) and danger to pedestrians, particularly children.
### Table 13 Key results from the public opinion surveys (see text for explanation)

<table>
<thead>
<tr>
<th>Measures</th>
<th>Stiffkey Residents</th>
<th>Blakeney Residents</th>
<th>Wiveton Visitors</th>
<th>Occold Visitors</th>
<th>Charlwood Visitors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measures</td>
<td>(77)</td>
<td>(69)</td>
<td>(29)</td>
<td>(84)</td>
<td>(150)</td>
</tr>
<tr>
<td>Problems before the changes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Percentage of respondents thinking there was a problem</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Speeding traffic</td>
<td>51%</td>
<td>–</td>
<td>58%</td>
<td>58%</td>
<td>56%</td>
</tr>
<tr>
<td>Danger to pedestrians</td>
<td>47%</td>
<td>–</td>
<td>33%</td>
<td>20%</td>
<td>7%</td>
</tr>
<tr>
<td>Volume of traffic / congestion</td>
<td>33%</td>
<td>–</td>
<td>33%</td>
<td>12%</td>
<td>4%</td>
</tr>
<tr>
<td>Heavy vehicles</td>
<td>17%</td>
<td>–</td>
<td>1%</td>
<td>4%</td>
<td>9%</td>
</tr>
<tr>
<td>Narrowness of carriageway</td>
<td>12%</td>
<td>–</td>
<td>–</td>
<td>8%</td>
<td>–</td>
</tr>
<tr>
<td>Mean scores (based on: Very satisfied = 5)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Level of satisfaction with changes</td>
<td>3.3</td>
<td>–</td>
<td>3.9</td>
<td>3.6</td>
<td>2.8</td>
</tr>
<tr>
<td>Statements</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The changes were necessary</td>
<td>Agree a lot=5</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Village appearance improved</td>
<td>3.8</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Signing is less visually intrusive</td>
<td>3.9</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Safer/easier to cross the road now</td>
<td>2.7</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Safer to walk along the road now</td>
<td>2.7</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Safer for motorists now</td>
<td>3.1</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Safer for cyclists now</td>
<td>2.6</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Safer for children now</td>
<td>3.0</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Speeds have been reduced</td>
<td>3.3</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Noise has increased</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Traffic fumes have increased</td>
<td>2.2</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>The environment has been improved</td>
<td>3.3</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Mean scores (based on: Very useful = 3)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Effect of change on safety</td>
<td>Gateway features</td>
<td>1.9</td>
<td>1.8</td>
<td>1.8</td>
<td>2.0</td>
</tr>
<tr>
<td>Different surfacing in village centre</td>
<td>1.9</td>
<td>2.6</td>
<td>–</td>
<td>–</td>
<td>1.9</td>
</tr>
<tr>
<td>20 miles/h limit in village centre</td>
<td>2.3</td>
<td>2.7</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Overrunable footway</td>
<td>2.1</td>
<td>2.8</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Vehicle activated fibre optic reminder sign</td>
<td>–</td>
<td>–</td>
<td>2.5</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Median strip</td>
<td>–</td>
<td>–</td>
<td>1.5</td>
<td>1.8</td>
<td>–</td>
</tr>
<tr>
<td>Features to make carriageway appear narrower</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Rumble strips</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Informal pedestrian crossing</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>1.8</td>
</tr>
<tr>
<td>Footway widening / carriageway narrowing</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>2.0</td>
</tr>
<tr>
<td>Horizontal deflection at junction</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>1.6</td>
</tr>
<tr>
<td>Change in priority at junction</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Reflectors posts replacing chevrons</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Mean scores (based on: Satisfied = 3)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Level of satisfaction with appearance</td>
<td>2.7</td>
<td>–</td>
<td>2.8</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Effect on appearance</td>
<td>Gateway features</td>
<td>2.4</td>
<td>2.8</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Different surfacing in village centre</td>
<td>2.4</td>
<td>2.8</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Overrunable footway</td>
<td>2.7</td>
<td>2.9</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Vehicle activated fibre optic reminder sign</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Signing on wooden posts</td>
<td>2.7</td>
<td>2.7</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Fewer signs</td>
<td>2.7</td>
<td>–</td>
<td>–</td>
<td>2.6</td>
<td>–</td>
</tr>
<tr>
<td>Smaller signs</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>2.6</td>
<td>–</td>
</tr>
<tr>
<td>New signs</td>
<td>2.8</td>
<td>2.9</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Finger post signs</td>
<td>2.8</td>
<td>2.9</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Features to make carriageway appear narrower</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Carriageway narrowing</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>1.7</td>
</tr>
<tr>
<td>Rumble strips</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>2.1</td>
</tr>
<tr>
<td>Horizontal deflection at the junction</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>1.8</td>
</tr>
<tr>
<td>Marker posts replacing chevrons on bend</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>2.5</td>
<td>–</td>
</tr>
</tbody>
</table>

1 Adjusted from a scale 3=satisfied, 2=no opinion, 1=dissatisfied
2 20 miles/h gateway in Occold
3 Patches of light coloured surfacing with white edge markings in Occold; fencing (with/without hatched edge markings) in Charlwood
4 No footway in Occold; footway widening in Charlwood
Respondents were generally satisfied with the scheme (mean score 3.6 out of 5) but eighty per cent did not perceive any change in vehicle speeds, which is in line with the direct measurements. Opinions were divided about the usefulness of the various individual features, for example the gateways and the replacement of chevron signing on a bend by timber marker posts.

Three-quarters of the respondents were satisfied with the appearance of the village since the changes. The signing alterations were particularly popular.

When asked about improvements to the scheme, more than half of respondents made suggestions relating to the need for a lower speed limit (20 or 30 miles/h). Others suggested enhanced signing and better pedestrian provision.

4.5.4 Occold

Nearly 60% of respondents lived on the main road.

The main problem before scheme installation was seen as speeding traffic. Only a few respondents mentioned other problems, such as the number of HGVs (although vehicles over 7.5 tonnes were already banned), the absence of footways, and danger to children from traffic.

Opinions were divided about the overall success of the scheme (mean score 2.8 out of 5), with less than 40% of respondents satisfied with it, although there was general agreement that the changes were necessary (mean score 3.6). Opinions were also divided as to whether vehicle speeds had been reduced, but only one-third thought they had been reduced enough (mean score 2.6), despite the fairly encouraging speed reductions achieved.

The gateway features, which included kerb bed outs with one-way working and new signs both at and in advance of the 20 miles/h zone, were considered effective, as was the 20 miles/h zone itself (mean scores 2.0 out of 3). The light coloured surfacing intended to impart horizontal deflection at the junction was not considered effective (mean score 1.6); the same was true for the patches of light coloured surfacing and associated edge markings to simulate carriageway narrowing (mean score 1.3).

Respondents were not fully satisfied with the appearance of the village since the changes (mean score 2.2 out of 5). There were mixed reactions to the effect of individual measures. The patches of light coloured surfacing and associated white edge markings, intended to make the carriageway appear narrower, came in for the most criticism (mean score 1.7 out of 3), as looking messy or untidy.

The most popular suggestions for improvements to the changes were for further speed-reducing measures, namely the installation of road humps (30%) or speed cameras, and better enforcement (18%), followed by a call for footways, kerbs or bollards to replace the edge lines.

As a principal aim of the scheme was to improve safety for schoolchildren, respondents were asked specifically about the scheme’s effect on school journeys. One fifth of the respondents had children (aged 5-11) attending the village school, and all respondents lived within 10 minutes walk of the school. The children of all but two of the respondents walked to school, the children of only one respondent switching mode following scheme implementation.

Five teachers at the school were also questioned about the scheme. Their views were broadly in line with those of residents, although a higher proportion (4 out of 5) was satisfied with the measures. Suggestions for improvement included footways, road humps (particularly outside the school) and a ban on HGVs through the village (though vehicles over 7.5 tonnes were already banned).

4.5.5 Charlwood

The survey in Charlwood took place prior to the installation of the additional measures in November 2000. About half of the respondents mentioned excessive speed and heavy traffic (some thought to be rat-running or associated with Gatwick airport) as the main problems before scheme installation. Other problems mentioned were HGVs and difficulties in crossing the road (particularly for children), parking and using driveways.

Just over half of the respondents were satisfied with the scheme overall (mean score 3.1 out of 5). It was generally agreed that the changes were necessary (mean score of 3.9) and that they made it safer to walk along the footways (mean score 3.8). However speeds were not thought to have reduced enough (1.9) and safety for cyclists was not considered to have improved (2.3). The measures were considered to have increased noise (3.5) but traffic fumes were not thought to have been affected (2.4).

There was general agreement that the imprinted surfacing in conjunction with footway widening / carriageway narrowing in the village centre made the village safer (mean score 2.0 out of 3). The simulated narrowing using fencing was not considered effective (mean score 1.2). Opinions were divided about the other measures.

Two-thirds of respondents were satisfied with the effect of the scheme on the appearance of the village (mean score 2.5 out of 3). More than 60% thought that the imprinted surfacing improved the appearance of the village, but opinions were divided on the other features. Criticism of measures, particularly the gateway signing, with imitation gates, carriageway roundels and rumble strips, was usually based on the feeling that they looked urban or modern and thus out of keeping with the village/rural environment. Other concerns not related to the appearance included the rumble strips being uncomfortable to drive over and damaging to cars, the imprinted surfacing being noisy and unsafe to walk on, and the fencing making it difficult to maintain hedges and obstructing verges.

There were many suggestions for improving the scheme, about half related to vehicle speed (e.g. speed cameras, humps, chicanes and lower speed limits). There were also calls for an extension to the imprinted surfacing and better pedestrian crossing facilities (both partly addressed by the additions to the scheme in late 2000). More pedestrian crossing facilities, a mini-roundabout at the junction where priority had changed, and measures to discourage through traffic were also suggested.

The Charlwood survey also included questions on consultation. Nearly all had heard about the scheme prior to installation, through leaflets, an exhibition/public meeting, from friends or relatives or by mailshot. Most
thought that people had been given enough opportunity to air their views on the proposals and were satisfied with the information given about these. Those who were dissatisfied cited insufficient detail and consultation, unclear plans and a lack of options.

4.6 Accidents

Table 14 shows for each scheme the numbers of reported injury accidents within the speed limit before and after scheme implementation, together with the number of years during which they occurred and the resulting accident frequency. There was rather too short an After period for valid conclusions to be drawn about the effectiveness of the schemes in reducing accidents. There were very few accidents except in Charlwood.

<table>
<thead>
<tr>
<th>Scheme</th>
<th>Before (fatal, serious)</th>
<th>Year</th>
<th>Accidents per year</th>
<th>After (fatal, serious)</th>
<th>Year</th>
<th>Accidents per year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stiffkey</td>
<td>3 (0,0)</td>
<td>7.3</td>
<td>0.4</td>
<td>2 (0,0)</td>
<td>1.2</td>
<td>1.6</td>
</tr>
<tr>
<td>Blakeney</td>
<td>8 (1.4)</td>
<td>7.3</td>
<td>1.1</td>
<td>1 (0.0)</td>
<td>1.2</td>
<td>0.8</td>
</tr>
<tr>
<td>Wiveton</td>
<td>2 (0.0)</td>
<td>7.3</td>
<td>0.3</td>
<td>0 (0.0)</td>
<td>1.2</td>
<td>0.0</td>
</tr>
<tr>
<td>Occold</td>
<td>0 (0.0)</td>
<td>5.0</td>
<td>0.0</td>
<td>0 (0.0)</td>
<td>0.3</td>
<td>0.0</td>
</tr>
<tr>
<td>Charlwood</td>
<td>37 (1.6)</td>
<td>4.8</td>
<td>7.7</td>
<td>7 (1.0)</td>
<td>1.7</td>
<td>4.2</td>
</tr>
</tbody>
</table>

In Charlwood, the majority of the accidents before scheme implementation occurred on bends (on Horley Road) at the eastern end of the village away from the village centre, either as head-on collisions or single vehicle accidents.

5 Summary

Traffic flows

There appeared to be little change in the levels of traffic flow in the Norfolk villages (other than seasonal variations) or in Occold. In the Charlwood scheme, which was the only one intended to reduce through traffic; there was a 7% reduction in traffic flow levels initially, but only a 4% reduction after 2 years. There was no change on a possible diversion route.

There was little change in the percentage of heavy goods vehicles following scheme installation in any of the villages.

Vehicle speeds

Reductions in mean vehicle speed were relatively modest, up to about 6 miles/h. This is consistent with the fact that before speeds were all below 40 miles/h even in Wiveton where the national speed limit applies.

At the gateways in Stiffkey, and the eastern ends of Wiveton and Blakeney, where the main features were new signing and patches of sandy coloured surfacing, changes in mean inbound speeds were all less than 2 miles/h. At the vehicle activated fibre optic 30 miles/h reminder sign 100m inside the western gateway in Blakeney, however, there was a reduction of almost 5 miles/h in mean speed.

Speeds on the continuous sandy coloured surfacing with no road markings with a 20 miles/h speed limit in the centre of Stiffkey were already constrained. The mean speed of vehicles travelling from west to east was hardly changed, whereas that for vehicles travelling in the opposite direction was reduced by 3 miles/h. There was little effect on mean speed in the centres of either Blakeney or Wiveton, where most of the changes were to signing.

There was a reduction of 5-6 miles/h at the entries to the 20 miles/h zone in Occold, where there were kerbed build outs to narrow the carriageway (giving one-way working). Most of this reduction was sustained in the village centre, where there were simulated narrowings at intervals and a further kerbed build out with patches of light coloured surfacing, but mean speeds remained slightly above the speed limit.

In Charlwood, there was a reduction of about 5 miles/h at the three gateways monitored. These had imitation gates, 30 miles/h signs and carriageway roundels, with either rumble strips or a simulated narrowing at and/or just inside the gateway. The first After survey showed a reduction in mean speed of 5 miles/h on the grey continuous imprinted surfacing, whilst mean speeds elsewhere in the village centre were little changed. Following the implementation of patches of imprinted surfacing at two hitherto untreated junctions, mean speeds at these sites showed a reduction of 3 to 5 miles/h compared to the Before situation and were below the 30 miles/h limit.

Vehicle noise (Charlwood)

Before and After measurements of vehicle noise were made alongside the imprinted surfacing and a set of rumble strips. Despite a reduction in mean speed, the changes in noise level from light vehicles measured at these sites would be imperceptible to residents. The reduction in power train noise (from the engine, engine ancillaries, transmission and exhaust) was possibly offset by the increase in tyre/road noise caused by the imprint pattern. The noise from vehicles passing over the imprinted surfacing had a particular character.

Alongside the rumble strips, neither the noise from heavy vehicles nor their speeds changed to any degree. The degree of disturbance experienced by residents in response to body rattle noise when heavy vehicles pass over the rumble strips is likely to be dependent on the time of day, where the residents are and what they are doing, and the associated background noise levels.

Alongside the imprinted surfacing, heavy vehicle noise was reduced by 2.8 dB(A), coinciding with a large reduction in mean speed. However, this speed reduction must be partly attributed to a change in monitoring position for the After survey, resulting from the reduction in the length of surface treatment originally proposed.

Traffic noise (Charlwood)

Before and After measurements of traffic noise were made in Charlwood alongside a set of rumble strips. The influence of aircraft was removed from the noise record in order to estimate the changes in traffic noise. When the
effects of changes in traffic flow and composition were also taken into account, the estimated reduction in $L_{A_{eq,18h}}$ noise exposure was only 0.5 dB(A). Night-time traffic noise (also corrected to remove the influence of aircraft noise) was reduced by 2.4 dB(A) ($L_{A_{eq,18h}}$).

Therefore the total noise exposure levels were shown not to have increased as a result of the rumble strips.

Air quality (Stiffkey and Charlwood)
From the air quality measurements, there was no evidence to suggest that the schemes in Charlwood or Stiffkey had affected local air quality with regard to benzene and nitrogen dioxide concentrations, which were well below current Air Quality Standards.

Opinion surveys
The public opinion surveys showed that residents had mixed views as to whether the schemes were effective. The vehicle activated fibre optic 30 miles/h reminder sign in Blakeney had the most approval. The 20 miles/h speed limits were also popular, but there was general agreement that speeds had not been reduced enough. The continuous grey imprinted surfacing in Charlwood was considered to improve safety, but was thought to be noisy. The footway widening / carriageway narrowing on the same stretch of road was thought effective in improving safety for those on foot, but not for cyclists. The rumble strips in Charlwood were not thought to be very effective.

The level of satisfaction with the appearance of the villages following scheme implementation was fairly high, except in Occold, where the patches of light coloured surfacing were seen as untidy. Respondents in the Norfolk coastal villages particularly liked the changes to signing. The sandy coloured surfacing with no road markings in Stiffkey also met with approval. A few respondents considered some features in Charlwood, for example the rumble strips, imitation gates and carriageway roundels, to be out of keeping with a rural village. Measures to simulate narrowing (white edge lines and fencing) were generally disliked. There was some concern over the colour and durability of the contrasting surfacing.

Many of those interviewed suggested there should be further speed-reducing measures (speed cameras, humps or chicanes and rumble strips), more enforcement of speed limits, fibre optic reminder signs, more pedestrian crossing facilities and mini-roundabouts.

Accidents
The After periods were too short to assess the effect of the schemes on safety. Accident numbers were very low, except in Charlwood, where there were 7.7 reported injury accidents per year (over 4.8 years) before scheme installation, and 4.2 per year after (over 1.7 years).

6 Discussion and conclusions
The main objective of the CTMG initiative was to demonstrate schemes that would achieve their traffic management objectives while integrating sensitively into the rural environment. This is an important objective, given the rapidly increasing traffic levels on rural roads and consequent intrusion into local communities, which is well-supported.

The selection of a range of appropriate schemes was critical in fully achieving the objective. Early on in the process, it became clear that funding for some of the selected schemes was not guaranteed. A particular issue was that some TPP package bids had not been met, the settlement emphasis being heavily towards urban schemes. Thus, from the start, there was slippage in scheme implementation and the subsequent monitoring, and ultimately, several of the selected schemes had to be excluded. It is recommended in any future exercises of this kind, where schemes are to be selected for demonstration/monitoring to a prescribed timescale, that greater emphasis be placed on the selection process. Submissions need to be sufficiently detailed to ensure that authorities have progressed their ideas far enough to be able to demonstrate both local support and a reliable source of funding.

In the event, the 5 schemes that were fully monitored were all in a similar situation (villages) and all with a common aim (to reduce vehicle speeds). Thus the scope of the initiative was restricted. The success, in general, of these 5 schemes in meeting CTMG initiatives was mixed.

Most of the measures incorporated were considered by those interviewed to enhance the appearance of the villages, but only a few were considered by them to be effective. The size of the speed reduction depended on the speed limit before and after scheme implementation, the Before speed (less than 40 miles/h in all five villages) and the measures themselves. More extensive physical measures would be required to bring mean speeds below 20 or 30 miles/h speed limits.

Measures need to be continued or repeated throughout the length of the village in order to maintain speed reductions. They should be located at, or close to, particularly hazardous points, for example where people are most likely to cross the road or at junctions.

It is possible that more could have been done in terms of scheme design to meet the objective of reducing vehicle speeds. More physical measures might have been introduced, the opportunity being taken to develop variants of existing (urban) measures for use in rural situations. Mini-roundabouts, for example, were not included in any of the schemes, despite the fact that they are relatively cheap and do not need to be visually obtrusive. They could be used with either 20 or 30 miles/h speed limits.

Footway widening was generally seen as improving safety for pedestrians. Where used in conjunction with carriageway narrowing, however, it may be perceived as being less safe for cyclists. The use of an imprinted footway seems an excellent idea on quiet roads which are too narrow to accommodate a pavement for pedestrians.

There will generally be some trade-off between the effectiveness of a scheme in reducing speeds and increasing safety and visual intrusiveness. This is an issue that needs to be explored more fully – for example, by greater use of appropriate colour and more experimentation with different sizes / types of sign.
Acknowledgements

The work described in this report was carried out under a project placed by the Charging and Local Transport Division of DTLR. The authors are grateful to Eric Wyatt for his support and guidance throughout.

The authors would also like to acknowledge the extensive contributions from the following TRL staff:

Technical advice: Marie Taylor
Analysis of speed/flow data: David Nicholls
Noise measurements: Greg Harris and Richard Stait
Air quality measurements: Jane Cloke, Gareth Davies and Joanne Green
Public opinion surveys: Joan Franklin and interviewers

Thanks are also due to staff of the local authorities involved with the schemes and their consultants for the supply of speed/flow data (where applicable), accident data and background information.

References


Appendix A: Measures and monitoring positions at Stiffkey, Norfolk

- **30 miles/h gateway**
  - Contrasting surfacing
  - Internally illuminated speed limit signs and 'road narrows' signs replaced by reflective 30mph signs on wooden posts

- **Plastic marker posts replaced by wooden marker posts**

- **250yds' sub-plate added to 'pedestrian' sign**

- **Road narrows' signs removed**

- **New 'pedestrian' sign with '250yds' sub-plate**

- **Imprinted overrunnable pedestrian strip**

- **Conventional directional signs replaced by finger post arrangement**

- **Pedestrians' sign and internally illuminated 'give way' sign removed**

- **'Side road' sign removed**

- **'Road narrows' signs removed**

- **'Children' sign removed**

- **'Pedestrian' sign removed**

- **'Give way' sign removed**

- **Plastic marker posts replaced by wooden marker posts**

- **Centreline markings on bend only**

- **20 miles/h speed limit terminal signs (contrasting surfacing and no markings within this speed limit on A149)**

- **20 miles/h repeater sign**

- **Buildings**

- **20 miles/h gateway**
  - Contrasting surfacing

- **KEY**
  - Speed/flow monitoring position
  - Air quality monitoring position
  - 20 miles/h speed limit terminal signs (contrasting surfacing and no markings within this speed limit on A149)
  - 20 miles/h repeater sign
  - Buildings
Finger post arrangement replacing conventional direction signing.

West gateway.

Western end of 20 miles/h speed limit and associated contrasting surfacing.

Village sign erected just inside each gateway.

20 miles/h repeater on wooden post.

Finger post arrangement replacing conventional direction signing.

Imprinted overrunable footway past village shop within 20 miles/h speed limit.
Appendix B: Measures and monitoring positions at Blakeney, Norfolk

- **B1156 Langham Road**
- **Saxlingham Road**
- **Wiveton Road**

30/40 miles/h speed limit signs removed
Illumination removed from 'give way' sign
30 miles/h vehicle activated fibre-optic reminder sign

- A149 to Wells
- Hunstanton
- A149 to Sheringham
- Cromer

30 miles/h speed limit signing and village nameplate on wooden posts
Contrasting surfacing
(Speed limit previously 40 miles/h)

1200mm illuminated 'give way' sign replaced by 600mm reflective sign
'Saxlingham' direction sign replaced by street nameplate

30 miles/h gateway
Speed limit signing and village nameplate on wooden posts
Contrasting surfacing
(Speed limit previously 40 miles/h)

1200mm advance 'give way' sign replaced by 600mm sign

30 miles/h gateway
Speed limit signing on wooden posts
Contrasting surfacing
(Speed limit previously 40 miles/h)

- The Quay
- Westgate Street
- High Street
- Back Lane
- S2
- S1
- S3

**KEY**
- Speed/flow monitoring position
- Buildings
Left and far left: Overrunable median strip of imprinted material to constrain speeds, A149, running past junction with Saxlingham Road.

East gateway, A149, Before (left) and After (right).

1200mm advance ‘give away’ sign (left) replaced by 600mm sign on scheme installation, Saxlingham Road (distance plate also corrected).

Village nameplate, east gateway.

Fibre-optic 30 miles/h reminder sign (arrowed) just inside west gateway (A149), being triggered by blue car (looking towards village).

Left and far left: Overrunable median strip of imprinted material to constrain speeds, A149, running past junction with Saxlingham Road.
Appendix C: Measures and monitoring positions at Wiveton, Norfolk

- To Wiveton Downs Langham
- To Glandford Letheringsett, Holt
- To Cley-next-the-Sea
- To Sheringham Cromer
- To Salthouse Heath Holt
- To Blakeney and A149
- A149 to Blakeney Wells Hunstanton
- A149 to Sheringham Cromer

**KEY**
- Speed/flow monitoring position
- Buildings

- Gateway
  - Contrasting surfacing
  - Village nameplate on wooden post (No speed limit signing)

- ‘Bend’ sign removed
- Direction signs replaced by finger post arrangement
- 600mm chevron replaced by 400mm chevron
- Chevron replaced by wooden marker posts
- 1200mm ‘give way’ sign replaced by 600mm sign
- 200m approx.
South gateway, C599. Signing (left) replaced by village nameplate on wooden post arrowed in After picture. (Bend sign (left) was for 'chevroned' bend beyond bend shown.)

Appendix
Village green, looking north along C599 (bending left) towards The Street. Conventional direction signing replaced by finger post arrangement; one chevron reduced in size and the other replaced by wooden marker posts.

Left and far left: Village green, looking west from Cley Road towards C599 (ahead). Direction signing replaced by finger post arrangement and small 'give way' sign; wooden marker posts replacing chevron.
Appendix D: Measures and monitoring positions at Occold, Suffolk

- **20 miles/h zone entry**
- **Double build-out**
- **20 Zone signing**
- **Contrasting surface treatment**
- **Edge markings**

Contrasting surfacing laid to create horizontal deflection to The Street: Mill Road traffic (which has priority) and change geometry of junction from "Y" to "T".

- **100m approx.**

**KEY**
- **Speed/flow monitoring position**
- **Contrasting surfacing with edge markings**
- **Start of 30 miles/h speed limit (no gateway features)**
- **Buildings**

- **20 miles/h zone entry**
- **Single build-out**
- **Contrasting surfacing**
- **Edge markings**

‘Traffic calming ahead’ warning signing.

- **‘Traffic calming ahead’ warning signing**

B1077 to Eye

B1077 to Debenham

To Earl Soham

To Redlingfield

Redlingfield Road

To Redlingfield
20 miles/h zone entry, Mill Road.

Kerbed build-out and contrasting surfacing within village, Mill Road.

Horizontal deflection feature using contrasting surfacing at The Street/Mill Road junction, adjacent to the school (building, left) in the village centre.

Use of contrasting surfacing to alter geometry of the junction of The Street and Mill Road.

20 miles/h zone signing incorporating village name of design by local children (one of three designs).

Traffic calming ahead.
Appendix E: Measures and monitoring positions at Charlwood, Surrey

Chalmers Close
Priority changed from Wooden marker posts NW side Build out to increased deflection for left-turning traffic E side

The Street
Norwood Hill Road
Ifield Road
Rectory Lane
To Hookwood Horley & A21
To Leigh
To Rusper

Lowfield Heath Road
To Lowfield Heath Crawley

N
100m approx.

KEY
- Gateway feature (village nameplate on ‘gate style’ structure, 30 miles/h signing, 30 miles/h carriageway roundel)
- Fencing for channelling effect
- Rumble strip
- Edge marking
- Imprinted surfacing and footway widening
- Buff surfacing
- Changed priority
- Informal pedestrian crossing
- * Implemented November 2000
- Speed/flow monitoring position
- Noise monitoring position
- Air quality monitoring position
- Buildings

S1
S3
S6
S2
AQ2
AQ1
N2b (After)
N2a (Before)

Build-out + wooden posts
Build-out to increase deflection into junction and widen footway
Wooden posts at pedestrian access into recreation ground

N1
To Hookwood Horley & A217

30mph carriageway roundel

Control site
Widened footway & verge

Shops
Church
Recreation ground
Farm
Farm
Pub
Pub
Pub
Pub

30
(no gateway features)

100m approx.
Rumble strips and fencing, Norwood Hill Road (looking north).

Changed priority and imprinted surfacing at Rectory Lane / Norwood Hill Road / The Street junction (from Rectory Lane). Arrowed is the build-out to increase deflection for Norwood Hill Road – The Street traffic.

Imprinted surfacing, The Street, between Rectory Lane and Ifield Road (looking south-east).

Informal pedestrian crossing just west of Ifield Road junction, The Street (looking west).
Additional measures in Charlwood implemented November 2000

Surface treatment on Ifield Road at junction with Chalmers Close (on left), looking north. A stretch of imprinted surfacing was laid between here and The Street (see plan).

Top pair: After picture shows imprinted surfacing extended across junction of The Street with Ifield Road, with additional informal pedestrian crossing in foreground (looking west). Shops on the right. Crossing shown on previous page is just beyond the junction.

Middle pair: After picture shows imprinted surfacing at the junction of The Street and Chapel Road, with informal pedestrian crossing in foreground (looking east). Footway widening and new verge on left.

Bottom pair: After picture shows imprinted surfacing, looking east, at the junction of The Street / Horley Road and Lowfield Heath Road (on right). Widened footway and renewed kerbing on right.
Abstract

Various traffic calming schemes have recently been implemented under the Countryside Traffic Measures Group initiative, set up by the Countryside Agency and the Department for Transport, Local Government and the Regions. The initiative aimed to support the planning and implementation by local authorities of innovative rural traffic schemes designed to integrate sensitively into the local environment.

The schemes were in Norfolk (Blakeney, Stiffkey and Wiveton), Suffolk (Occold) and Surrey (Charlwood). Three other schemes in Cumbria, Devon and Brockenhurst in Hampshire were originally included in the initiative, but for various reasons, were not pursued.

The report describes the schemes and presents the results of monitoring undertaken to assess their effectiveness in terms of vehicle speeds and public opinions. Measurements were also undertaken of air quality at Stiffkey and Charlwood, and of noise at Charlwood.

Related publications

TRL452  Changes in accident frequency following the introduction of traffic calming in villages by A H Wheeler and M C Taylor. 2000 (price £25, code E)
TRL385  Traffic calming in villages on major roads: Final report by A H Wheeler and M C Taylor. 1999 (price £35, code H)
TRL364  A traffic calming scheme at Costessey, Norfolk by A H Wheeler, G Harris, L Chinn, M C Taylor and P Abbott. 1998 (price £35, code J)

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