TRANSPORT RESEARCH LABORATORY

Traffic calming - Public attitude studies: a literature review

Prepared for Driver Information and Traffic Management Division, Department of the Environment, Transport and the Regions

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Executive Summary

Traffic calming using road humps has been successful in reducing the speeds of vehicles in residential roads and has resulted in a reduction in the number of injury accidents. Some local highway authorities have a backlog of schemes involving traffic calming which have been requested by residents, indicating that traffic calming is still popular.

Schemes exist where traffic calming measures have been installed and have subsequently been altered or removed due to adverse public comments. To minimise the likelihood of this occurring it is important to understand public reactions to schemes. Accordingly, the Department of the Environment, Transport and the Region's (DETR) Driver Information and Traffic Management Division commissioned TRL to undertake a comprehensive review of public attitude surveys to traffic calming schemes.

Forty UK and five non-UK surveys have been reviewed; most were published since 1990. The report assesses the attitudes of respondents to traffic calming schemes in general and then examines the acceptability of different measures eg road humps, speed cushions, horizontal deflections, road closures and mini-roundabouts. The effectiveness of the various measures in terms of reducing vehicle speeds, traffic flows and injury accidents is compared with the perceived effectiveness, based on respondents' attitudes. A limited amount of comparative data was available concerning noise, vibration and pollution.

Most of the schemes considered were on roads with 20 or 30 mph speed limits. The survey sample size in most studies was 50 - 500 respondents, with a maximum of 1000. The length and number of questions used in the questionnaires varied considerably, as did the type of survey and types of respondent. Most surveys were carried out between 3 months and 2 years after scheme installation.

The overall percentage of respondents who approved of the schemes, across all the reviewed studies, was 65%. This varied according to the types of measures in the schemes: it was 72% for schemes including road humps; 53% for schemes including speed cushions; 59% (but particularly variable) for schemes including horizontal deflections.

Surveys which provided direct information on the relative popularity of different measures indicated that round-top road humps were the most popular measure, followed by flat-top road humps, speed cushions, chicanes and mini-roundabouts in descending order.

The cost of the schemes varied greatly but this did not seem to influence respondents' views on whether the locality had improved as a result of a scheme. This result suggests that schemes with high implementation costs per metre may not be justified unless general environmental improvements are required as part of the scheme objectives.

Comparisons between objective measures of the effectiveness of schemes (where they were made) and public reactions to those schemes indicated that:

i Vehicle mean speeds were reduced by an average of 8.5 mph, but the average proportion of respondents who thought speeds had been reduced was only 65%.

ii Speed reductions of more than 10 mph were, *in all cases*, perceived as a reduction by over half of the respondents questioned.

iii Traffic flow levels were reduced by an average of 23%, but the average proportion of respondents who thought flows had been reduced was only 33%.

iv Personal injury accident frequencies were reduced by an average of 63%, but the average proportion of respondents who thought that safety had improved was only 53%.

v There was no linear relationship between changes in mean speeds, traffic flows or accidents and the percentage of people who thought these things had improved.

vi For the few schemes where changes in noise, vibration or pollution levels were monitored, improvements were generally reported. Respondents' views, however, did not generally reflect this.

The usefulness of the results of a questionnaire is determined by the questionnaire design (including the number and type of questions). As each scheme is different, a standard questionnaire is not considered appropriate, but examples of questionnaires considered to be good starting points have been included.

It is important that a questionnaire includes a balance between types of questions, includes the opportunity for comment, and avoids jargon. The wording and order of questions is important, as is the use of prompts.

The main conclusions can be summarised as follows:

- Public attitude surveys to traffic calming schemes are useful in establishing overall approval levels and in identifying the relative popularity of individual measures and any problems associated with them.
- Public attitude surveys cannot be a substitute for objective measures of the effectiveness of a scheme. Perceptions of changes in speeds, flow and safety, which might appear on the face of it to be easy to judge, are relatively poor.
- Changes in the environmental measures ground vibration, noise and air pollution are even more difficult to assess subjectively.
- These differences between objective and subjective assessments suggest that the methods of objective measurement should perhaps be reviewed to determine measures that more accurately reflect peoples' concerns. For example, if measured noise levels have been reduced but people think they have increased, it may be because the noise *characteristics* have changed.
- Careful survey and questionnaire design are vital in eliciting the information required from respondents. A checklist of issues to consider in questionnaire compilation is given in Appendix C.

1 Introduction

TRL is undertaking research for the Department of the Environment, Transport and the Region's (DETR) Driver Information and Traffic Management Division on the effectiveness of innovative traffic calming measures. The aims are:

- to investigate and evaluate new traffic calming measures for their effectiveness in controlling traffic speeds and enhancing the local environment
- to develop advice on their design, performance and application.

Traffic calming is an important tool for Highway Authorities because it is well established that it can be used to reduce speeds and consequently accidents (see, for example, Webster, 1993; Webster & Mackie, 1996). However, it is increasingly clear that the success of such schemes is not determined only by *objective* measures of their effect (on speed, flows and accidents) but that *subjective* assessment is also important. If measures are introduced which the local public do not like then they soon become discredited (IHT, 1990). Indeed, some examples of situations exist where pressure from local communities (resulting, for example, from noise being generated by vehicles crossing measures) has led to the removal of measures (Webster and Layfield, 1993). Clearly this is not a cost-effective way to proceed; it is far better to be able to estimate the likely public reaction to the scheme before it is installed. Design advice can then be provided so that schemes have a better chance of acceptance and situations likely to prove unpopular can be avoided. Pharoah and Russell (1989) have also commented that attitude studies can be important at some schemes because 'the few who oppose it (traffic calming) make a lot of noise and some press media create the impression that this minority is the majority' whereas an attitude study reflects a more balanced view of the popularity of the scheme.

It is important that local authorities consult the emergency services and bus operators (Department of Transport, 1994 and 1996a) over new traffic calming schemes, but this is outside the scope of the present review.

This report reviews the published literature describing 45 studies (40 UK, 5 Non-UK) of public attitudes to traffic calming schemes. These represent all of the relevant UK studies identified through a search of the TRL Library's International Road Research Documentation (IRRD) data-base, a selection of the English-literature non-UK studies and Local Authority information obtained by the Author.

Section 2 outlines the studies covered, together with the survey techniques and the types of questions used in them. Section 3 presents the results reported and Section 4 compares the measured (objective) effectiveness of the calming schemes with the public (subjective) assessments, to determine to what extent there is agreement between them. In Section 5, issues concerning questionnaire design are discussed. The report is concerned specifically with surveys that took place *after* scheme implementation and not with the consultation process which occurs before scheme implementation. However, Section 5 also includes some discussion of that process. Overall conclusions are presented in Section 6. It has been assumed throughout that the views of respondents were not unduly influenced by any press coverage of the success or failure of the scheme reviewed.

2 The studies covered

The number of traffic calming schemes installed in the UK has increased since the introduction of the 1990 Highways (Road Humps) Regulations (DOT, 1990) which allowed greater flexibility in the siting and shape of road humps. The vast majority of the studies considered in the present review were published in the early 1990's. Only five UK references were found to public attitude surveys at traffic calming schemes before 1990. The earliest publication dated back to 1975.

2.1 Traffic calming measures used

Most of the public attitude surveys were concerned with traffic calming schemes in villages or on urban roads within 20 or 30 mph speed limits. A few schemes were on rural roads including trunk roads with higher speed limits of 40 or 60 mph.

A variety of measures were used in the traffic calming schemes including: round-top and flat-top road humps (Figure 1), speed cushions (Figure 2), gateways, chicanes and narrowings (Figure 3), rumble devices, islands, thermoplastic humps ('thumps') and mini-roundabouts. Road humps were by far the most common measure employed, featuring in 30 of the studies.

2.2 Survey techniques

The length of time between the installation of the schemes and the attitude surveys varied greatly; most of the surveys were carried out between 3 months and 2 years after the traffic calming schemes were installed.

The number of respondents in the surveys was typically between 50 and 500. Some surveys had larger samples (in one case, 1000) but this was usually because they consisted of a combination of a number of surveys at different schemes. The lower limit of 50 is similar to that used by Grigg (1981) when assessing the use of rating scale results. The target groups of interviewees varied between the surveys and included residents, local people, visitors, drivers and drivers of heavy goods vehicles (HGVs).

The types of survey used in the 40 UK studies were as follows:

- 14 personal interview
- 16 postal (self-completion) questionnaire
- 4 mixture of personal interview/postal questionnaire
- 6 consisted of feedback from residents to local authorities where no specific questions were asked.

Non-english speaking residents (Walker et al, 1989) were catered for in areas where this was likely to be a problem.

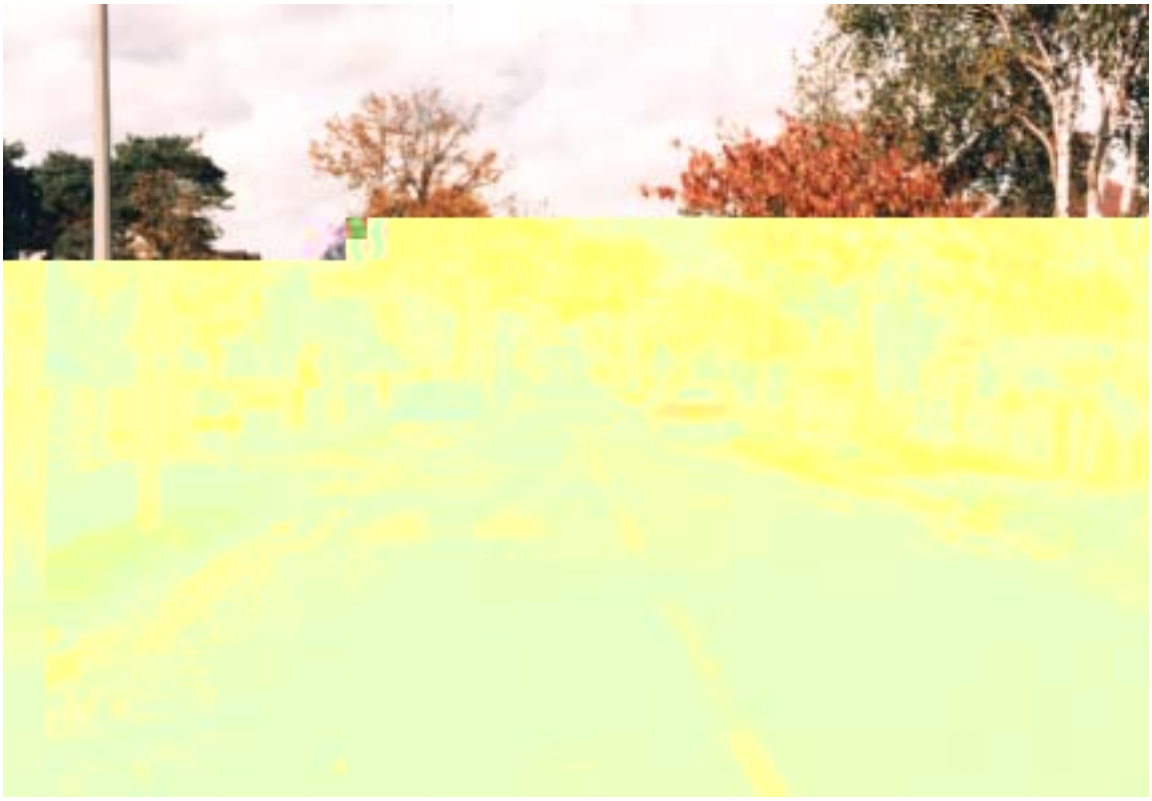

Figure 1a Example of round-top humps, Worcester Park (Survey 6d)

Figure 1b Example of a flat-top hump, Worcester Park (Survey 6d)

Figure 2a Example of speed cushions, York (Survey 27)

Figure 2b Example of speed cushions, York (Survey 27)

Figure 3a Example of a gateway, West Haddon (Survey 28)

Figure 3b Example of a chicane and a narrowing, Watford (Survey 29)

2.3 The questionnaires

The length and number of questions used in the questionnaires varied considerably from 20 questions (with subsidiaries) to just 3 questions (with Yes/No/Don't know format). The techniques used in the questionnaires also varied: for example, in some surveys prompts were used; some contained 'open' questions and some 'closed' questions; some contained 'multiple choice questions' and some contained combinations of these types of questions.

In the vast majority of cases, the scope of the questions covered the key issues of traffic speeds and safety. Some included questions on environmental factors and some on traffic flows along the traffic calmed roads.

In many of the surveys, scheme-specific questions were a feature. For example, for a scheme in the New Forest there were questions relating to animals; other schemes had specific questions relating to parking, to pedestrians, to bus passenger comfort, to agricultural vehicles, etc.

In some surveys of schemes incorporating different types of measure, questions were designed so that the relative effectiveness of the measures was assessed.

3 Opinion survey results

Details of the results obtained in each survey reviewed are given in Appendix A (UK studies) and Appendix B (non-UK studies), along with descriptions of the schemes and the surveys carried out. The information is summarised in Table 1.

Some of the attitude surveys reviewed were concerned with individual schemes while others covered a variety of schemes. Generally, the percentage approvals given in Table 1 relate to the *combined* effect of the traffic calming measures within a scheme or schemes.

3.1 The overall level of approval

Most of the surveys indicated that the majority of the respondents approved of the traffic calming schemes. Overall, the average percentage of respondents expressing approval across all of the UK surveys was 65 per cent; this varied from 18 per cent for a one-way chicane scheme in Leatherhead (Survey 21d) to 93 per cent for a residential scheme in Stockport (Survey 20a).

Sections 3.2 to 3.6 concentrate on the UK results relating to schemes with different types of measures: humps; cushions; gateways/chicanes/narrowings; road closures; mini-roundabouts. The relevant results are summarised in tables where appropriate; schemes involving a variety of measures feature in more than one of these tables.

3.2 Attitudes towards schemes with round-top and flat-top humps

As already indicated, humps were the most common traffic calming measure with 30 out of the 45 surveys relating to schemes which contained some humps, either round-top or flat-top, or both.

Table 2 summarises the results from surveys which contained appreciable numbers of road humps. The average percentage of respondents expressing approval for the hump schemes was 72 per cent; this varied from 47 per cent to 93 per cent.

There was little difference between public perception of schemes in 20 mph zones and those in 30 mph zones as they had 71 and 72 per cent of respondents approving respectively.

There was an indication that round-top humps may be slightly more popular than flat-top humps. In those schemes where only round-top or only flat-top humps were used, the average percentage of respondents approving was 78 per cent for schemes with round-top humps compared to 64 per cent for those with flat-top humps.

The percentage of respondents expressing approval can depend on whether the respondents themselves benefit from the traffic calming measures. Data from two UK surveys assessing a variety of hump schemes (Surveys 3 and 4) indicated that, on average, non-resident drivers were likely to be slightly less in favour of keeping the humps (66%) than residents (78%).

In Survey 41a (Australia), 75 per cent of residents living on the roads with the humps approved of the scheme but 80 per cent of residents living in the surrounding streets were opposed to the scheme. In Survey 41c, tight road layout configurations and flat-top humps were used and the level of acceptance of the scheme by residents was 89%. This could have been influenced by the fact that heavy vehicles were eliminated from the road. In Survey 41d, road humps which were spaced at 200 metres were removed because residents were unhappy that drivers chose to use severe acceleration and braking, indicating a lack of acceptance by drivers.

The five 75 mm high round-top humps considered in Survey 19y (Egerton Road) were subsequently removed at the request of the residents, who were unduly concerned by noise from HGVs crossing the humps as early as 5 am. The effect of noise generated by humps has been investigated by Abbott et al, (1995).

3.3 Attitudes towards schemes including speed cushions

Six surveys assessed traffic calming schemes that used speed cushions (Surveys 13, 17, 24, 27, 30 and 37). Survey 30 (Craven Arms) was of a trunk road traffic calming scheme through a village using narrow (1500 mm wide) cushions as one of the measures.

The percentage of respondents expressing overall approval for the schemes is 53% as given in Table 3. The degree of approval varied from 31 per cent in Survey 30 (a trunk road scheme at Craven Arms) to 80 per cent in Survey 13 (Greenwich). The average value for respondents expressing approval of schemes including cushions (53 per cent) was less than the average value for hump schemes (72 per cent). This difference may be because speed cushions are regarded as less effective at reducing speeds than road humps.

In Survey 17 (Leicester), about half the respondents thought the speed cushions worked less well than the road humps, while a third thought they worked equally well. In Survey 27 (York), respondents thought that speed cushions were less effective than road humps (see section 3.7). Respondents in Survey 37 (Wrexham) were generally

Table 1 Summary of opinion survey results

Survey No.	*Location*	*Limit (mph)*	*Type of traffic[1] calming measures*	*Ref year*	*Survey[2] carried out after (months)*	*Survey[3] type & people surveyed*	*Number of people surveyed*	*Respondents[4] approving of scheme*
UK Surveys								
1	New Forest	40	Gateway,rumble,roundels	1993	27	I DN	422	89%
2	Tavistock	40	Village gateway,islands	1993	12	I RADN	100	50%
3a-e	national	30	Round-top humps	1979	3	I RDN	989	71%
4a-c	national	30	Round-top humps	1981	3+	I RDN	624	73%
5	national	30	Humps	1990	-	P RADN	753	50%
6a-d	various	30	Humps,chicanes,narrowings	1992	12-24	I RA	652	76%
7	Gateshead	30	Thermoplastic humps	1994	15	P R	8	88%
8	Ashridge Park	30	Round-top humps	1975	24	I N	84	73%
9	Milton Keynes	30	Flat-top humps	1993	12	I AN	612	47%
10	Windsor	30	Round-top humps	1996	39	P RA	150	50%
11	Gamlingay	30	Humps,chicanes,narrowings	1991	3	P RA	100	87%
12a	Southend	30	Flat-top humps	1992	6	I RA	748	approve
12b	Hadleigh	30	Round-top humps	1991	11	I RADN	726	74%
13	Greenwich	30	Cushions,raised junction	1995	6	P RA	256	61%
14	Borehamwood	30	Long flat-top humps	1990	8	I A	-	approve
15	Newport(IoW)	30	Flat-top humps/narrow	1994	6	P R	-	approve
16	Sittingbourne	30	Flat-top humps/narrow	1992	18	P R	223	68%
17	Leicester	30	Speed cushions	1994	6	P R	-	49%
18a-c	Oxfordshire	30	Round/flat-top humps	1991	12	P RA	1041	59%
19a-l	Richmond	30	Round-top humps	1990	4-15	P R	-	91%
19m-y	Richmond	30	Round-top humps	1994	15-43	P R	-	75%
20a	Stockport	30	Round-top humps	1995	17	P R	61	93%
20b	Stockport	30	Flat-top humps	1995	2	P R	65	66%
20c	Stockport	30	Humps,pinches,priority	1995	34	P R	104	56%
20d	Stockport	30	Humps,chicanes,rumbles	1995	8	P R	94	33%
21a	Guildford	30	Round-top humps	1995	23	P RA	-	83%[5]
21b	Ashford	30	Flat-top humps	1995	16	P RA	-	69%[5]
21c	Woking	30	Chicanes/2-way	1995	16	P RA	-	39%[5]
21d	Leatherhead	30	Chicanes/1-way	1995	22	P RA	220	18%[5]
22a-d	Bypassed towns	20	Flat-top humps, environ.	1995	3	IP RADN	39-360	65%
22e-f	Bypassed towns	30	Flat-top humps, environ.	1995	3	IP RADN	42-370	66%
23a,c	Brighton,Sheffield	20	Round/flat-top humps,gates	1995	4	IP R	437	86%
23b,d	Leicester,York	30	Humps, chicanes, cushions	1995	4	IP R	592	79%
24a,b	Sheffield,York	30	Cushions,flat/round humps	1995	4	P R	72, 360	variable
25a-d	various 20mph zones	20	Round/flat-top humps	1995	3-12	IP R	50-759	70%
26a-e	various villages	30	Gateways,islands,rumbles	1994	1-6	I RA	72-100	50%
26f	Tunstall	60	Gateways,rumble bars	1994	12	P RA	25	50%
27	York	20/30	Humps,cushions,chicanes	1994	3+	I RA	750	52%
28	national	30-60	Rumble strips	1993	-	LA -	-	variable
29a-d	distributor roads	30	Flat-top humps, chicanes	1995	-	LA -	-	approve
30	Craven Arms	30 (T)[6]	Gateways, red surface	1996	3	I RA	200	approve
30	Craven Arms	30 (T)[6]	Mini-roundabouts	1996	3	I RA	200	dislike
30	Craven Arms	30 (T)[6]	Narrow cushions	1996	3	I RA	200	approve
31	Thorney	20/30 (T)[6]	Gateway,chicane,mini-rbt	1995	6	I RA	199	26%
32a	Oxford	30	Narrowing/bypass	1996	90	I C	61	57%
32b	Wandsworth	30	Chicane,bypass	1996	20	I C	41	85%
32c	Oxford	20	Narrowing	1996	19	I C	54	51%
33b,d	Plymouth,Sheerwater	30	Chicanes/2-way	1994	-	LA -	-	acceptable
33a,c	Gosport,Leatherhead	30	Chicanes/1-way	1994	-	LA -	-	dislike
34	national	30	Chicanes	1996	-	LA -	-	variable
35	national	20/30	Various including humps	1992	-	LA R	-	80%
35	national	20/30	Various including humps	1992	-	LA DN	-	66%
35	national	20/30	Various including humps	1992	-	LA B	-	68%
36	Nelson	30	Area wide,safety project	1989	1	I R	160	65%
36	Nelson	30	Area wide,safety project	1989	15	I R	189	74%
37	Wrexham	20	Humps,narrowings,mini-rbt	1996	-	LA -	-	approve
37	Wrexham	20	Cushions	1996	-	LA -	-	dislike[7]
38	Camden	20	Humps,road closures	1996	6	P RA	58	variable
39	Huyton	20	Humps,road closures	1994	-	P R	-	64%
40	various estates	30	Narrow,rumble,pinches	1983	12+	P R	601	63%
Overall surveys (data available for 45 surveys or sub-surveys)								65%

Table 1 (Continued)

Survey No.	Location	Limit (mph)	Type of traffic[1] calming measures	Ref year	Survey[2] carried out after (months)	Survey[3] type & people surveyed	Number of people surveyed	Respondents[4] approving of scheme
Non UK Surveys								
41a	Australia	37	Round-top humps	1993	-	- R	-	75%
41a	Australia	37	Round-top humps	1993	-	- AD	-	20%
41b	Australia	25	Offset carriageway + parking	1993	24	P R	-	17%
41c	Australia	-	Chicanes and flat-top humps	1993	-	- R	-	89%
41d	Australia	-	Road humps at 200 m spacing	1993	-	- R	-	removed
41e	Australia	-	Road closures	1993	-	- R	-	oppose
41f	Australia	-	Angled slow points	1993	-	- R	-	approve
41f	Australia	-	Angled slow points	1993	-	- N	-	object strongly
41g	Australia	-	Roundabouts	1993	-	- R	-	variable
42	Denmark	25	Gateways,chicanes,rumbles	1992	-	I N	-	52%
42	Denmark	25	Gateways,chicanes,rumbles	1992	-	P R	-	approve
43	Israel	30	Humps,urban area	1992	-	- R	-	variable[8]
44	USA	25	Humps,urban area	1989	-	P R	147	82%
45	Austria	19/31	Gateway, 30 kph on road	1995	1,6,18	T R	-	77%

[1] *Major measures are included, see Appendix A for more details*
[2] *Time interval between installation of scheme and opinion survey if specified*
[3] *I = Interview, P = Postal, IP = Interview + postal, T = Telephone, LA = Local Authority, (-) = Type of survey or people surveyed not specified R = Resident on road, A = Resident on adjacent road, D = Driver (resident of road), N = Driver (non resident of road), C = Cyclist, B = Business*
[4] *Overall value of all respondents for all road users considered*
[5] *Per cent of residents who thought measures were 'beneficial'*
[6] *Trunk road schemes*
[7] *Cushions were subsequently replaced with humps*
[8] *Attitudes can vary with time*

Table 2 Hump schemes opinion survey results

			Approve	
Survey No.	Limit (mph)	Type of measures	Residents (%)	Non resident drivers (%)
3a-e	30	Round-top humps	83	58
4a-c	30	Round-top humps	73	73
5	30	Humps	50	-
6a-d	30	Humps,chicanes,narrowings	76	-
7	30	Thermoplastic humps	88	-
8	30	Round-top humps	-	73
9	30	Flat-top humps	47[1]	-
10	30	Round-top humps	50[2]	-
11	30	Humps,chicanes,narrowings	87	-
16	30	Flat-top humps/narrow	70	-
18a-c	30	Round/flat top humps	59	-
19a-l	30	Round-top humps	91	-
19m-y	30	Round-top humps	75[3]	-
20a	30	Round-top humps	93	-
20b	30	Flat-top humps	66	-
21	30	Round-top humps	83	-
21	30	Flat-top humps	69	-
22a-d	20	Flat-top humps, environ.	65	-
22e-f	30	Flat-top humps, environ.	66	-
23a,c	20	Round/flat-top humps,gates	86	-
23b,d	30	Humps, chicanes	79	-
25a-d	20	Round/flat-top humps	70	-
39	20	Humps,road closures	64	-
Average	20	4 surveys	71	-
Average	30	18 surveys or sub-surveys	72 3 surveys	68
Overall		22 surveys or sub-surveys	72	-

[1] *The ramp gradients which were originally (1:6) were made shallower after the survey had been carried out*
[2] *42% of residents wanted the humps removed and 7% wanted other measures to be investigated*
[3] *Included result for Survey 19y where only 11% of residents approved due to noise problems*

Table 3 Speed cushion schemes opinion survey results

Survey No.	Limit (mph)	Type of measures	Approval in survey
13	30	Cushions,raised junction	80%[1]
13	30	Cushions,raised junction	51%[2]
17	30	Cushions	49%
24a,b	30	Cushions, flat/round humps	Variable
27	20/30	Humps, cushions, chicanes	52%
30	30	Narrow cushions	31%
37	20	Cushions	No[3]
Overall	5 surveys or sub-surveys		53%

[1] *Residents of road with cushions*
[2] *Residents of surrounding roads without cushions*
[3] *Cushions replaced with flat-top humps*

supportive of the scheme but opposed (reasons not given) to the use of speed cushions, which were subsequently replaced with flat-top humps. It has been reported Webster (1994) that cushions were preferred by the bus company in Bradford but the residents preferred thermoplastic humps because they perceived cushions to be less effective at moderating bus speeds.

The dimensions of cushions on several roads in York were modified following off-road 'public acceptability' trials by York City Council (Layfield and Parry, 1998) to determine suitable cushion dimensions that would reduce discomfort for passengers in minibuses, ambulances and small cars and also eliminate any grounding problems. Opinion surveys carried out in the areas affected found that about 60% of respondents thought that the modified cushions were acceptable. The off-road trials also indicated that, over the range of cushion dimensions tested, cushion width had a much stronger influence on public acceptability than cushion spacing.

3.4 Attitudes towards schemes including horizontal deflections

There were 17 surveys which included gateways, chicanes, narrowings and other horizontal deflections. An advantage of horizontal deflections, compared with road humps, is that they can be used on roads which have speed limits above 30 mph.

The results are given in Table 4, which shows overall approval rates varying from 18% to 89% of respondents. Attitudes towards chicanes in particular were very variable (see Surveys 33 and 34). The one-way priority chicanes in Survey 25f (Nuneaton) were subsequently removed because of complaints about congestion which at peak times caused queues of approximately 25 cars at the chicanes (County Surveyor's Society, 1994).

A disadvantage of chicanes in residential areas can be the loss of parking spaces as noted in Survey 33b.

A review of traffic calming in Northamptonshire reported by Kendrick (1995) showed that the acceptability results were very variable but generally favourable for urban schemes, which included chicanes and one-way throttles. However, horizontal measures on main roads (A and B class) through villages were considered to be less successful on average.

In Australia (Survey 41b) a scheme which consisted of an offset carriageway and recessed parking had an approval rate of only 17%. This may have been partly due to the speeds being reduced by 14 mph but no reduction in traffic flow. Residents approved of angled slow points (Survey 41f) but non-resident drivers, not surprisingly, objected strongly to them.

3.5 Attitudes towards schemes containing road closures

Four of the surveys (Nos. 36, 38, 39 and 41) included road closures but generally these were not assessed separately. In Survey 36, Mackie et al (1990) and Walker et al (1989) found that total road closures caused most public opposition. In Survey 41e (Australia) it was noted that road closures should not be scattered 'randomly' around an area unless they are overwhelmingly supported. Residents are not able to understand random closures and they can split a community. A road closure in a 20 mph zone outside the local school in Valpy Avenue, Norwich was popular with 70% of residents (Norwich City Council, 1996) who wanted the closure to be retained. However, road closures may be less popular with residents on adjacent roads which through traffic may divert to. Clearly the popularity of road closures is very dependent on the area and the degree of access required.

Table 4 Gateways, chicanes, narrowings opinion survey results

Survey No.	*Limit (mph)*	*Type of devices*	*Approval in survey*
1	40	Gateway,rumble,roundels	89%
2	40	Village gateway,islands	50%
6a-d	30	Humps,chicanes,narrowings	76%
11	30	Humps,chicanes,narrowings	87%
20c	30	Humps,pinches,priority	56%
20d	30	Humps,chicanes,rumbles	33%
21	30	2-way chicane	39%
21	30	1-way chicane	18%
23b,d	30	Humps, chicanes	70%
26a-e	30	Gateways,islands,rumbles	50%
26f	60	Gateways,rumble bars	50%
27	20/30	Humps,cushions,chicanes	52%
30	30	Gateways, red surface	66%
31	20/30	Gateway,chicane,mini-rbt speed camera,part time 20	26%
32a	30	Narrowing/bypass	57%
32b	30	Chicane,bypass	85%
32c	20	Narrowing	51%
33b,d	30	Chicanes/2-way	acceptable
33a,c	30	Chicanes/1-way	dislike
34	30	Chicanes	variable
36	30	Area wide,safety project	65%
36	30	Area wide,safety project	74%
40	30	Narrow,rumble,pinches	63%
41c	-	Chicanes and flat-top humps	89%
Overall		21 surveys or sub-surveys	59%

3.6 Attitudes towards schemes including mini-roundabouts

Mini-roundabouts were used at a number of sites but specific opinions of the mini-roundabouts were only available for Surveys 30, 31, 37 and 41g. The mini-roundabout at Wrexham (Survey 37) was described as unpopular. In Surveys 30 and 31 a rating system was used and mini-roundabouts received a very low rating.

At sites in Australia (Survey 41g), high acceptance was reported for roundabouts generally but it was less so in smaller rural townships. There was sometimes confusion at mini-roundabouts by elderly drivers and also by drivers who drove in the wrong direction or over the roundabout.

3.7 Ranking of the effectiveness of measures

The surveys which provide information on particular measures indicate that there are some of these measures which are perceived as less effective than others. For example, in Survey 27 (York) respondents were asked to rate the various measures in terms of how effective they

considered them to be in reducing traffic speed and improving road safety. The most effective measures were perceived to be round-top road humps (75% effective), which although criticised on a number of issues, were felt to be more acceptable than other forms of traffic calming. Speed cushions and flat-top road humps were felt to be next best (50%) in terms of effectiveness, followed by chicanes (45%) and mini-roundabouts (41%) in descending order.

Table 5 shows the comparative rating of different measures in Surveys 30 (Craven Arms) and 31 (Thorney). Of all the features in these trunk road schemes (including others not shown here in the Table), the mini-roundabouts had the lowest rating - that is, they were the least popular.

Table 5 Comparative rating of mini-roundabouts in Surveys 30 and 31

Survey No	*Relative rating[1] of feature under consideration*				
	Gateway	Islands	Hatching	Speed cushion	Mini-rbt
30	2.94	2.74	2.60	2.28	1.47
	Gateway	Narrowing	Chicanes		Mini-rbt
31	2.61	2.31	2.06		1.58
Overall	2.78	-	-	-	1.53

[1] 1 = Causes concern, 2 = of little use, 3 = fairly useful, 4 = very useful

Boyd and Noon (1997) described a survey in Edinburgh which showed that round-top road humps and flat-top road humps were regarded as acceptable by 51% and 47% of respondents respectively, but that chicanes were the least popular measure with 74% of residents living close to one being dissatisfied with them. Chicanes were disliked because they were said 'to make driving conditions difficult and to encourage bad driving'.

3.8 Scheme costs and attitudes to aesthetic impact

The cost of schemes varies greatly, depending on the number and type of measures installed and whether additional lighting is installed as part of the scheme. The costs of a sub-set of schemes are given in Table 6 alongside the percentages of respondents who perceived the quality/appearance of the area to have improved.

The results demonstrate the wide range of scheme costs, even when considering costs per metre. For example, even the similar schemes, 6a,b,d, vary from £13 to £366 per metre. Despite the high cost of scheme 6a, only 37% of respondents thought the area was better and 50% thought it was the same. It is interesting to note that 56% of respondents thought the area was the same at scheme 6d. Overall, the percentage of respondents thinking the area had improved ranged from 9% to 90%, with an average of 48%, or just under a half. Mackie, (1989) reported that "a more integrated approach combining safety, environmental and land use planning objectives could gain better public support and provide more financial justification for schemes which may not be viable in either safety or environmental objectives separately".

Surveys 22a - 22f relate to the Bypass Demonstration Project sites, for which the environmental and traffic calming cost was approximately £10 million. This makes the unit cost very high indeed and unrepresentative because considerable environmental work was also included with the humps. These surveys have therefore been omitted from Table 6. Overall 65% of respondents thought that the Bypass Demonstration Project sites were an improvement.

The Leicester scheme (Survey 23b), which used high quality block paving, was regarded as aesthetically pleasing by 38% compared with only 10% at Brighton (Survey 23a). The latter consisted of asphalt round-top humps and gateways at the entrances to the scheme.

Table 6 Perceived effect on environment against cost of scheme

Scheme No	*Type of measures*	*Estimated cost for the complete scheme*		*Respondents who thought that the area was better*
		Total	*Per metre*	
2	Gateway,islands	£6500	£6.5	90% attractive
6a	Humps,chicanes	£220000	£366	37% (50% same)
6b	Humps,narrowings	£198000	£29	15% (61% same)
6d	Humps,narrowings	£168000	£13	9% (56% same)
13	Cushions,raised junction	£35500	£39	80% in favour
19a-l	Round-top humps	£94000	£13	91% in favour
20a	Round-top humps	£4800	£7	84% quality
20b	Flat-top humps	£9700	£9	55% quality
20c	Humps,pinches etc	£70000	£100	52% quality
20d	Humps,chicanes,rumbles	£50000	£56	33% quality
23a	Round-top humps, gates	£60000	£12	10% appearance
23b(Phase 1)[1]	Flat-top humps, gates	£165000	£49	38% appearance
23c(Phase 1)	Flat-top humps, gates	£245000	£47	30% appearance
26a-f	Gateways,islands,hatching	£104000	£15	50% favourable
	Average all schemes	£102000	£54	48%

[1] The Phase 1 area surrounded Worthington Street which is 167 metres long and cost £180,000 when it was built (£1078/metre) using the 'Woonerf' style of traffic calming. The influence of Worthington Street on attitudes to the Phase 1 area could not be separated.

3.9 Other considerations

The approval rate does not appear to be dependent on the timing of the survey in relation to installation of the measures.

In Survey 23, there was some evidence that calming was less popular with increasing length of residence. These 'long-term' residents wanted to have a greater say in designing the schemes.

Public opinions may alter with time (Zaidel et al, 1992) as countries install more traffic calming. This was shown to some extent at Richmond (Survey 19 in Table 1) where the earlier (19a-1) and later (19m-y) schemes had approval rates of 91% and 75% respectively. However, it should be noted that the later schemes contained a site (Survey 19y) which had to be removed because of complaints about noise. Modifications to schemes after installation can be carried out, if required, to improve the public acceptability (Taylor and Tight, 1996) and (Layfield and Parry, 1998).

In Graz, Survey 45, the approval rate varied from a low of 44% during the public discussion period to 77% 18 months after implementation. This long term improvement is similar to the Urban Safety Project (Mackie, 1989) where "the overall response to the schemes were mixed...and the general opinion of the Urban Safety schemes had improved over time".

4 Effectiveness of measures compared with public reactions to the measures

It has been suggested (Hawley et al, 1993) that 'where the speed and/or through traffic problem is perceived as critical, there is greater acceptance of speed humps'. Therefore, this section compares public reactions with objective measures of the effectiveness of schemes. The objective measures considered are the changes in speeds, traffic flows, and accidents and in the environmental factors noise, vibration and pollution.

4.1 Changes in vehicle speeds

Table 7 shows, for each survey, where actual speed changes were measured, the measured change, together with the percentage of respondents who thought that speeds had reduced. The changes in mean vehicle speeds for each site are based on approximately 200 radar measurements or at least 1,000 automatic measurements both before and after scheme installation. The speed reductions for the hump sites were averages of the 'between' hump and 'on' hump reductions; the gateway speed reductions relate to 'inbound' vehicles. The speed reductions at the schemes which contained a mixture of measures (Surveys 6, 11, 16, 26, 30 and 31) were overall average speed reductions for the whole scheme. In some surveys respondents were also asked whether speeds had been reduced enough and the percentages who thought that they had are also shown.

The results given in Table 7 show that mean vehicle speeds were reduced at all sites, by an average of 8.5 mph. However, on average, only 65% of people questioned thought that speeds had in fact been reduced. The value ranged from 18% at a 1-way chicane site (Survey 21d) to 90% at a site (Survey 20a) with humps. In Surveys 2, 26a-e, 30 and 31 respondents were asked whether speeds had been reduced enough. An average of 39% of the respondents thought that speeds had been reduced enough, the value ranging from 14% to 62%. It should be noted that the speed measurements are average reductions and may not necessarily have been measured at exactly the same position within the scheme as considered by the respondent. There are many factors which might influence respondents' views - for example, the time of day or time of year considered may be significant. A single speeding car may be remembered by one respondent but the same vehicle may not be remembered by, or be a problem to, another respondent.

Table 7 Comparison of measured mean speed changes and perceived effect

Survey No.	*Types of measures installed*	*Measured speed reduction (mph)*	*Respondents who thought that speed reduced*	
			Yes (%)	*Enough (%)*
1	Gateway and rumble area	2	69	-
1	Roundel,slogan	7	67	-
1	Undulations[1]	18[1]	68	-
2	Gateway,islands	4	50	14
3	Round-top humps	12	58	-
4	Round-top humps	5	46	-
6a	Humps,chicanes	10	62	-
6b	Humps,narrowings	9	52	-
6c	Humps	17	56	-
6d	Humps,narrowings	12	64	-
7	Thermoplastic humps	9	88	-
11	Humps,narrow,chicanes	6	87	-
16	Flat-top hump,narrow	5	70	-
17	Cushions	12	71	-
19n	Round-top humps	10	84	-
20a	Round-top humps	4[2]	90	-
20b	Flat-top humps	10[2]	80	-
20c	Humps,pinch,priority	16[2]	71	-
21a	Round-top humps	14	85	-
21b	Flat-top humps	15	64	-
21c	2-way chicane	7	27	-
21d	1-way chicane	4	18	-
24a	Cushions	5	29	-
24b	Cushions	11	73	-
25a	Humps	7	66	-
25b	Humps	9	56	-
25d	Humps	11	81	-
26a	Gateway,pinch	7	42	34
26b	Gateway,narrow	3	66	36
26c	Gateway,narrow	8	72	44
26d	Rumbles,30 mph on road	4	82	62
26e	Gateway,rumbles,roundels	3	64	52
26f	Gateways,rumbles	10[3]	48	-
30	Gateways,red,rbts,cushions	8	74	49
31	Gateway,chicane,mini-rbt	9	61	24
44	Humps	2	82	-
	Average all surveys	8.5	65	-
	Surveys with humps	10.1	71	-
	Surveys without humps	6.5	57	-
	Surveys 2 & 26a-26e,30 & 31	5.8	64	39

[1] Included in humps (removed after fatal accident)
[2] 85th percentile speeds
[3] 85th percentile speed in village

Considering schemes with and without humps shows that there was a higher average speed reduction at the hump schemes (10.1 mph) than the non-hump schemes (6.5 mph), but the percentages of respondents believing speeds had been reduced were similar, at 71% and 57% respectively.

Figure 4 shows the percentage of respondents who believed speeds had been reduced, plotted against the measured reduction in mean speed. No relationship is discernible. Indeed, a linear regression line fitted to the data was not statistically significant ($r = 0.13$, $n = 36$). This perhaps suggests that respondents are more strongly influenced by prejudice or by what they think is the 'right' answer to give, than reality. Figure 4 does show that speed reductions of over 10 mph appear to be consistently perceived by over half of the respondents questioned. It is likely that smaller changes in speed are quite difficult to identify reliably with the 'naked eye', particularly if lower gears and higher engine speeds are used, possibly 'masking' the actual speed reduction obtained.

4.2 Changes in traffic flows

Table 8 shows percentage changes in vehicle flow for surveys where this was measured. Alongside are the percentages of respondents who thought that flows had reduced or had stayed the same. Changes in vehicle flows are notoriously difficult to measure reliably due to the large day-to-day and seasonal variability. The results should therefore only be used as a guide. All of the flows were based on a minimum of a 12 hour count in both the 'before' and 'after' periods. Survey 25d relates to an area scheme and therefore the flow change was estimated for the whole area.

The results show that vehicle flows were reduced at all schemes in Table 8. The average reduction was 23%, ranging from 9% to 43%. On average, approximately 33% of the public thought that vehicle flows had been reduced, ranging from 12% to 86%. An average of 56% thought that they were unchanged at the 11 sites where this information was available. It should be noted that the flow measurements are average reductions over the whole area and therefore the best estimate which can be made. They are unlikely to relate directly to the position in the scheme considered by the respondent. Again there are many other issues that might influence respondents views.

Figure 5 shows the percentage of respondents who thought that the vehicle flows had been reduced after the traffic calming had been installed, plotted against the measured flow reductions. A linear regression analysis was carried out but the relationship was not statistically significant ($r = 0.21$, $n = 17$).

In Survey 13, Greenwich, the flows on the surrounding roads, which were not treated, increased by 35% and 69% of the residents of these roads thought that flows had increased.

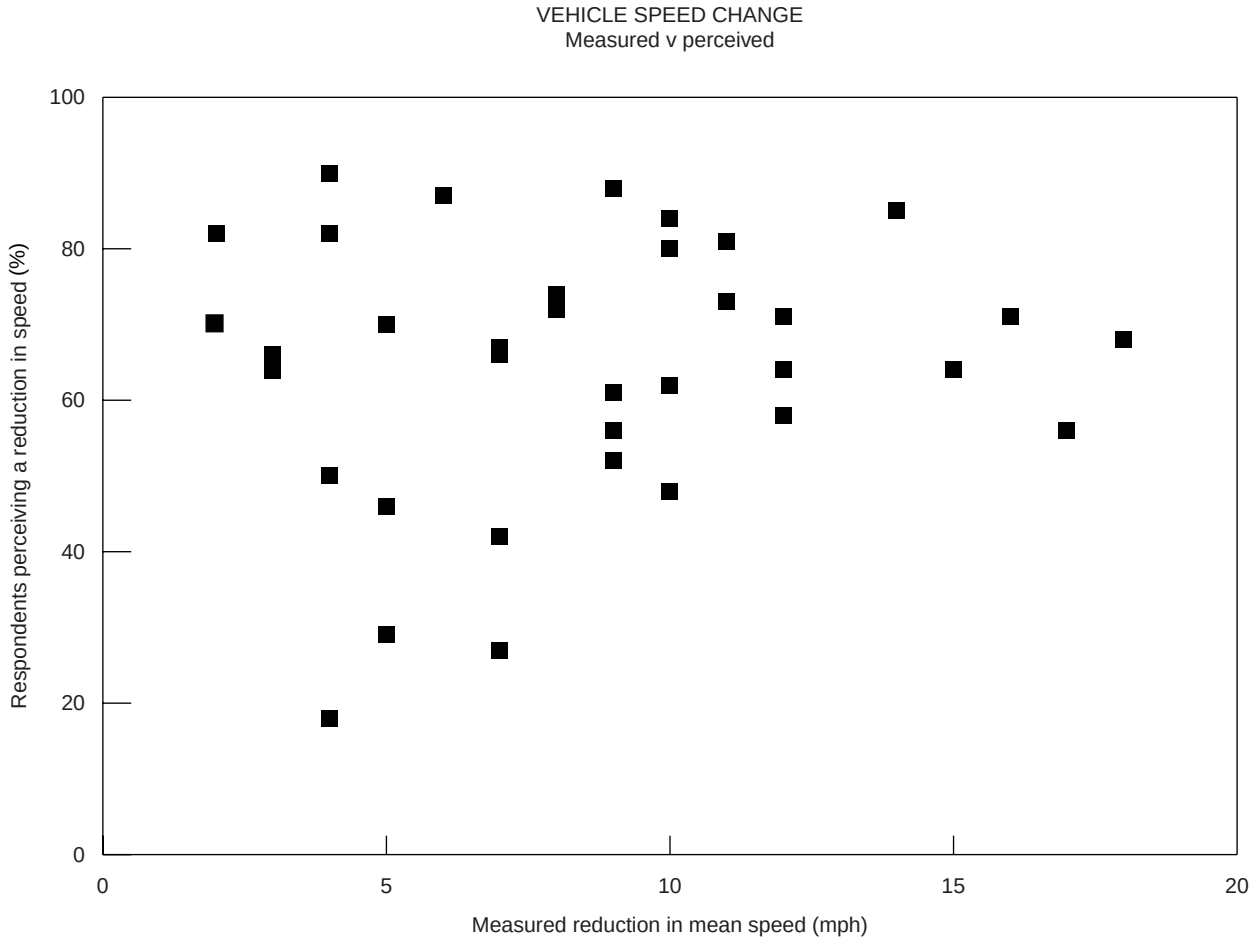

Figure 4 Relationship between measured and perceived speed reduction

Table 8 Comparison of observed changes in vehicle flows and perceived effect

Survey No	*Type of measures installed*	*Measured reduction in vehicle flow (%)*	*Respondents who thought that flows reduced*	
			Yes (%)	*Same (%)*
3	Humps	34	34[1]	-
4	Humps	25	20[1]	-
6a	Humps,chicanes	12	25	60
6b	Humps,narrowings	36	23	54
6c	Humps	11	18	60
6d	Humps,narrowings	12	27	46
11	Humps,narrow,chicanes	13	30[2]	-
13	Cushions,raised junction	22	86	-
16	Hump,narrow	27	16	58
17	Cushions	16	50	-
20c	Humps,pinch,priority	43	28	-
21a	Round-top humps	40	63	36
21b	Flat-top humps	37	44	40
21c	2-way chicane	9	12	75
24a	Cushions	13	13	78
24b	Cushions	21	20	70
25d	Humps	12	58	40
	Average all surveys	23	33	-
	Surveys 6,16,21,24 & 25	21	29	56

[1] *Based on difference between 'before' and 'after' attitude surveys of amount of traffic using the road*

[2] *Based on difference between 'before' and 'after' attitude surveys of general traffic conditions on the traffic calmed road*

4.3 Changes in accidents

Table 9 shows percentage changes observed in personal injury accident frequency for surveys where this was examined. Alongside are the percentages of respondents who thought that safety had improved or was unchanged. All of the schemes showed a reduction in accident frequency. The accident reduction range was 13 - 100% with an average of 63%. On average for these surveys, 53% of respondents believed that safety had improved. In some surveys, respondents were asked whether safety had improved, stayed the same or got worse. An average of 40% thought that it was improved and a further 40% thought that it was unchanged at the 5 sites where this information was available.

Figure 6 shows the percentage of respondents who thought that the safety of the traffic calmed road had been improved after the measures had been installed, plotted against the measured accident reduction. A linear regression analysis was carried out but the relationship was not statistically significant ($r = 0.21$, $n = 17$). In most cases the accident reduction will have been measured over a longer period than the interval between scheme installation and the opinion survey. However, the result emphasises the difficulty of subjective determination of safety.

The accident figures given in the surveys all relate to the part of the road network on which the traffic calming scheme actually lies. If, as a result of a scheme, traffic

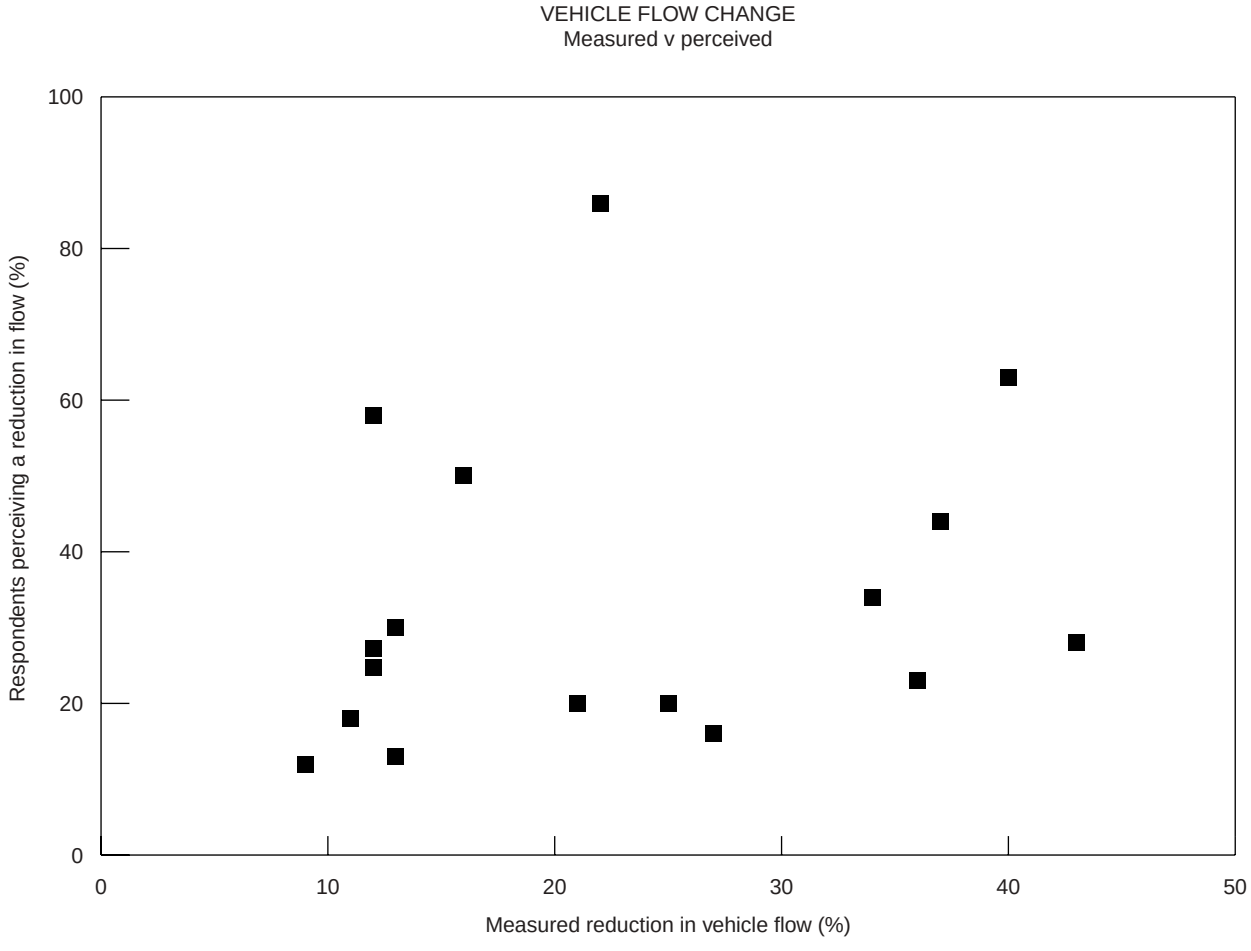

Figure 5 Relationship between measured and perceived flow change

Table 9 Comparison of changes in accident frequency at schemes and perceived effect

Survey No.	Type of measures installed	Reduction in accident frequency (%)	Respondents who thought that safety	
			Improved (%)	Same (%)
3	Humps	61	43[1]	-
4	Humps	100	22[1]	-
6a	Humps,chicanes	53	47	39
6b	Humps,narrowings	61	37	39
6c	Humps	50	48	31
6d	Humps,narrowings	47	50	34
11	Humps,narrow,chicanes	100	82[2]	-
13	Cushions,raised junction	100	74	-
18a	Humps	56	67	-
18b	Humps	56	52	-
18c	Humps	70	62[3]	-
21a	Round-top humps	73	85	-
21b	Flat-top humps	84	69	-
21c	2-way chicane	74	46	-
21d	1-way chicane	54	17	55
31	Gateway,chicane,mini-rbt speed camera,part-time 20	20	40[4]	-
45	Gateways, 30 kph on road	13	68	-
	Average all surveys	63	53	-
	Surveys 6 & 21d	53	40	40

[1] *Based on difference between 'before' and 'after' attitude surveys*
[2] *Based on pedestrian attitude surveys*
[3] *The respondents rate of 62% is an average of 55%, 43%, 50%, 42%, 84%, 84% and 78% who thought car users, bus users, cyclists, motorcyclists, school children, elderly residents and other road users would be safer respectively.*
[4] *The respondents rate of 40% is an average of: 60% who thought that it was safer to cross the road, 30% who thought it was safer on the footway, 33% who thought it was safer for motorists and 37% who thought it was safer for cyclists.*

diverts onto adjacent roads, then accidents may decrease at the scheme but increase elsewhere. Since traffic levels have tended to decrease at the sites in the reported surveys (section 4.2) this may be a real problem.

Public opinions on whether accidents had transferred to adjacent areas were investigated for Surveys 6a, 6c and 6d. The changes measured and perceived in the adjacent areas Windle and Mackie (1992), Webster (1993) are shown in Table 10. In Survey 6d the belief that accidents had shifted to other areas was highest and this coincided with an observed increase in accidents in other areas.

Table 10 Comparison of change in accident frequency in other areas and perceived effect

Survey No	Type of measures	Measured change in accident frequency in other areas (%)	Respondents who thought accident problems shifted (%)
6a	Humps,chicanes	-29 (decrease)	27
6c	Humps	-26 (decrease)	20
6d	Humps,narrowings	14 (increase)	40
	Average all surveys	-14 (decrease)	29

4.4 Changes in noise, vibration and pollution

Taylor and Tight (1996) showed that perceived changes in noise and pollution vary greatly between traffic calming schemes, with perceived increases at some schemes and decreases at others.

Traffic noise (DOT, 1996b) and vibration were explicitly measured at several sites and the results are given in Tables 11 (noise) and 12 (vibration). Table 11 indicates a measured reduction in noise at all sites. At 4 sites the percentage of respondents who were bothered by noise decreased but at 3 sites quite large percentages of respondents thought that noise had increased. Noise is complex to assess because nighttime noise can be more annoying than daytime noise, particularly loud noises. The degree of perceived noise in houses may vary between summer and winter, due to windows being open more in the summer. Double-glazing can reduce noise appreciably in houses in winter when windows are closed for longer periods so individuals' perception of noise levels can depend on the characteristics of their home.

In Survey 21, Cumberland Avenue, 63% of residents thought that noise had been reduced after the humps were installed. This response is consistent with the vehicle flows and speeds being reduced along the road and the fact that there were very few HGV movements.

In Survey 16 in Kent, 82% of the residents living directly beside a hump thought that the noise had increased compared to 33% of residents who did not have a hump directly outside their house. It is interesting to note that 42% of residents who did not have a hump directly outside their house thought that there had been no change in the noise after installation of the humps along their road.

Ground vibration is often a function of the soil type and local conditions (Baguley, 1981). The results given in Table 12 are limited but they suggest that residents can be concerned about vibration even when the measured values are very low. In Survey 30, the 'before' and 'after' measured values were similar, as were the respondents' 'before' and 'after' views.

In Survey 45 (Graz), the measured exhaust emissions were a 24% reduction in NOx, a 0.5% increase in HC and a 3.8% increase in CO. Several attitude surveys were carried out after scheme installation and the percentage of respondents who thought emissions had increased reduced from 52% to 24% between the first and last of these surveys.

Pollution can be very difficult for residents to assess because background pollution can influence their views (DOT, 1996c). Abbott et al (1995) reported that there was 'no clear evidence that the amount of annoyance or concern is directly related to the measured amount of pollution' and 'the public tend to be much more concerned about smoke/fumes/odour when they are outdoors'. In recent years catalytic converters have reduced some emissions but they can produce some very pungent smells while warming up. Diesel-engined vehicles are now much cleaner than they used to be. Overall, the usefulness of pollution questions appears to be limited.

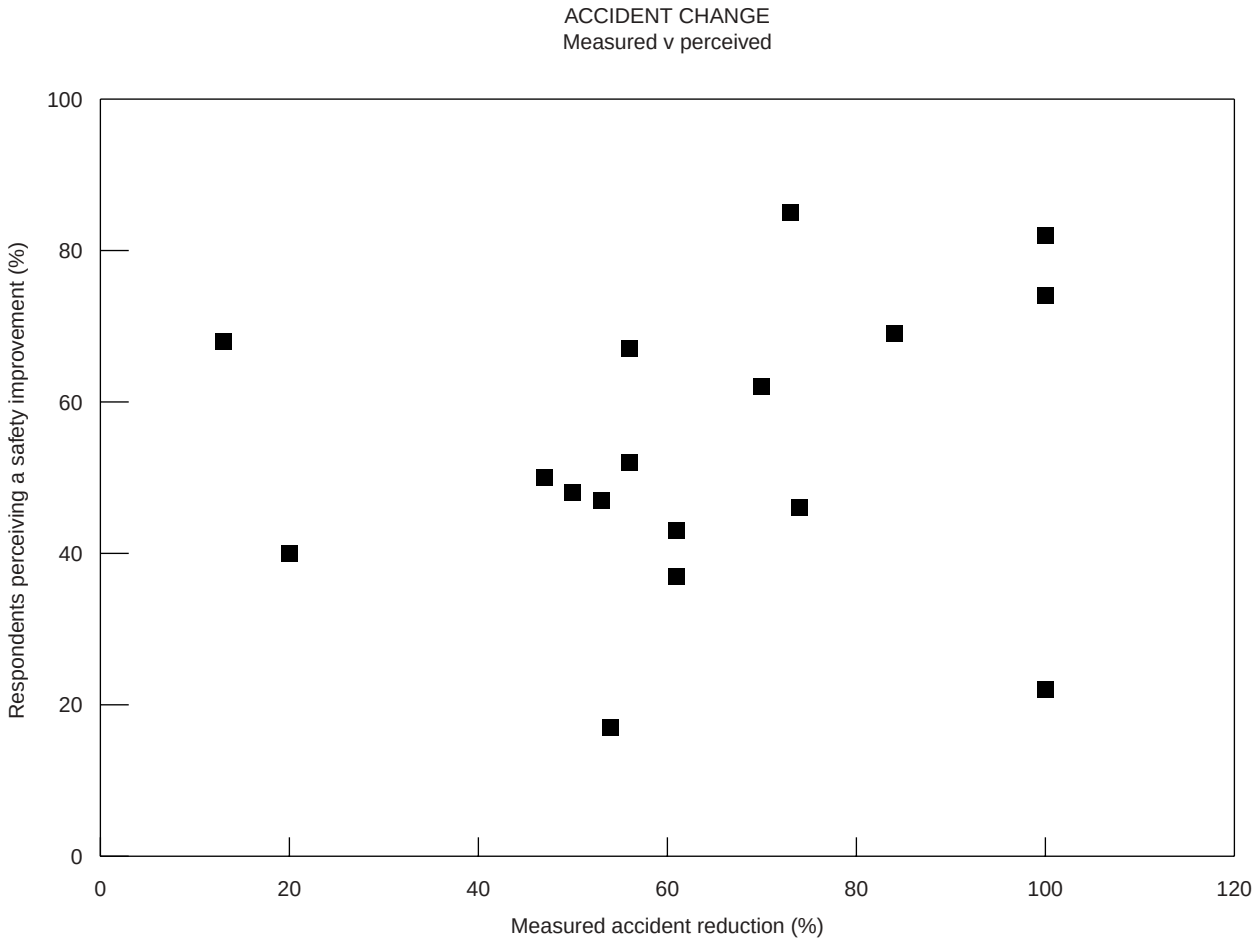

Figure 6 Relationship between accident reduction and perceived safety improvement

Table 11 Comparison of change in noise levels and perceived effect

Survey No.	*Type of measures installed*	*Measured reduction dB(A) $L_{A10,18h}$*	*Respondents attitude to noise after measures installed (before)*	
3a	Humps	4	(25%)	6% still bothered
3b	Humps	2	(31%)	27% still bothered
3d	Humps	6	(42%)	17% still bothered
4a	Humps	14	(33%)	20% still bothered
30	At cushions (Daytime)[1]	4	-	57% Increased
31	In village (Daytime)[1]	4	-	82% Increased
45	Gateway, 30 kph on road	1	-	34% Increased
	Average all surveys	5	-	35% concerned

[1] *On a trunk road carrying a high traffic flow*

Table 12 Comparison of change in vibration levels and perceived effect

Survey No	*Types of measures installed*	*Measured vibration*	*Respondents attitude to vibration after measures installed (%)*
4a	Humps	Low	13% still concerned
30	Cushions[1]	Very low	68% House shakes as HGVs pass
30	Cushions[2]	Very low	68% House shakes as HGVs pass
31	Gateway[3]	Quite high	82% House shakes as HGVs pass
Average all surveys		Variable	58% adverse comment

[1] *Measurements for heavy vehicles 'clipping' the cushion (ie at least one tyre touches the cushion when the vehicle passes over the cushion)*
[2] *Measurements for heavy vehicles 'not clipping' the cushion (ie no tyres touch the cushion when the vehicle passes over the cushion)*
[3] *'Imprint' surfacing used at the gateways*

5 Issues concerning questionnaire design and initial consultation

5.1 Questionnaire design

5.1.1 Structure

The aim of a traffic calming attitude survey is to establish whether the objectives of the scheme are perceived to have been achieved and whether there are any concerns with the traffic calming measures that have been used. The usefulness of the results of a questionnaire is determined by the questionnaire design (including the number and type of questions). The depth to which a questionnaire should go will be influenced by whether the calming features are new or novel. Novel features can have problems associated with them because they are untried, so it is important that public reaction is sought after a few months when residents have had experience of them (Walker *et al*, 1989).

The main purposes of questionnaires, carried out after the scheme has been installed, vary depending on the type and location of the scheme but this review shows that the following objectives should be considered when appropriate:

a Are the residents, public, emergency services and bus operators satisfied with the measures which have been installed?

b Have the measures assisted all road user groups?

c Which measures are popular and effective?

d Which measures are unpopular but effective?

e Are the measures considered environmentally friendly? Noise? Pollution? Vibration?

f Could the measures be improved?

g Do the measures give value for money in terms of accident reductions and/or environmental improvements?

h Are the materials used complimentary with the surroundings?

As each scheme is different a 'standard' questionnaire would not appear to be appropriate but it is suggested by the author that Davies and Ryley (1996), May and Hopkinson (1992), Windle and Mackie (1992), Windle and Hodge (1993) and Wheeler et al (1993, 1994 & 1996) include questionnaires which provide good starting points. These questionnaires can then be customised to give a questionnaire which covers all of the road users and residents affected by the scheme. The type of survey will therefore be determined more by local considerations such as, the number of people affected, who the scheme is designed to benefit most and the cost of the surveys to be carried out.

Appendix C provides a useful checklist for issues to consider when compiling questionnaires for assessing reactions to traffic calming schemes, based on information from this review.

5.1.2 Types of questions

The type and phrasing of a question asked may affect the response which is given (Taylor and Tight, 1996) because the respondent may assume that a particular answer is expected. Jargon such as 'speed cushions' and 'pinch points' should be avoided unless a photograph of the measure is supplied, otherwise respondents may misunderstand the question and give an unintended answer. It is therefore important that the questionnaire has a balance between:

1 Open questions

2 Yes/No questions

3 Multiple choice questions

4 Opportunity for general comments.

Open questions

An open question allows the respondent to give their view or may also be used to see if they understand or know a particular fact. Examples of questions from this review are:

Can you describe what was done to slow traffic?

What do you think of the speeds of vehicles along this road?

Why do you think the humps were installed?

However, the answers can be varied and lengthy and are therefore costly to code up and analyse. Such questions are often used in pilot surveys to establish a set of responses for closed questions.

Closed questions

The following are examples of questions from Stockport, Survey 20.

Do you feel the scheme has reduced

a) vehicle speeds? Y/N

b) numbers of vehicles? Y/N

Do you feel the scheme is successful? Y/N

These questions are easy to understand and answer but they do not allow the respondent to say that speeds or vehicle numbers have not been altered, or to indicate the degree of change. In this case, it was possible for respondents to add brief comments at the end of the questionnaire.

Multiple choice questions

A seven box system was used in a questionnaire in Camden, Survey 38 which had 'positive' or 'good' values on the right (eg safe, clean) and 'negative' or 'bad' values on the left (eg unsafe, filthy) as follows:

What do you feel about Air Quality in your Neighbourhood?

Filthy □ □ □ □ □ □ Clean

The following is an example of a question from Craven Arms, Survey 30.

Can you tell me, for the following groups of people whether the changes have been a good thing, bad thing or have had no effect?

	Very good	Quite good	No effect	Quite bad	Very bad	Don't know
Pedestrians	1	2	3	4	5	6
Drivers	1	2	3	4	5	6
Children	1	2	3	4	5	6
Cyclists	1	2	3	4	5	6
Old people	1	2	3	4	5	6
Residents on main road	1	2	3	4	5	6
Shopkeepers	1	2	3	4	5	6

This type of question contains a number of useful points such as the 'no effect' box and the 'don't know' box. The words used are easy to understand to assist the respondent.

The following is an example of a question from the New Forest, Survey 1.

Please look at the following 7 photographs and give each a score between one and ten for how effective you think it would be at slowing vehicles down.

	Score
A. Gate	__
B. Rumble strip	__
C. Mini-gate	__
D. Sign with slogan	__
E. 40 mph marking on road	__
F. Pinch point	__
G. Undulations	__

This question type allows respondents to rate the effect, which can be an advantage if the effects due to alterations have been quite small.

At Huyton, Survey 39, respondents were asked to grade their answer by marking on a horizontal line from zero to 100, where the zero value was 'the bad' value (eg increased vehicle speeds, decreased pedestrian safety, objectionable road network) and 100 was 'the good' value (eg decreased vehicle speeds, increased pedestrian safety, improved road network). The 50 value was the no change or tolerable state, as given in the following example:

MARK ON THE LINE YOUR OPINION

Question 1. VEHICLE SPEEDS

0----------50----------100
Increased No change Decreased

After an opinion survey has been carried out it may be apparent that some answers are not as expected. This could be due to respondents misunderstanding the question or assuming that an answer was required for every question. The following example is from Surrey, Survey 21:

Do you think the road humps have affected road safety in your road?

	Safer	Less safe	No change	Not applicable
As a pedestrian	( )	( )	( )	( )
As a pedal-cyclist	( )	( )	( )	( )
As a motor-cyclist	( )	( )	( )	( )
As a driver	( )	( )	( )	( )

This question would appear to be straightforward but the responses showed that some people who were not motor-cyclists had filled in the answer whereas others had used the 'not applicable' box. This shows that the 'not applicable' box would have been better placed as the first box rather than the last box. It is important that the respondents have clear questions and that they do not have to assume anything.

General comments

Many questionnaires invited general comments at the end. These comments may not be directly relevant; however, they could give additional information which was not considered to be important when the questionnaire was prepared but has subsequently become an important issue. It also allows respondents generally to 'air their views' and to suggest ways of improving the scheme.

5.1.3 Other issues

Order of questions

Quimby and Glendinning (1990) report that the order of the questions could be more important as the number increases because the respondents may become disinterested with too many questions, especially if the questions appear quite similar.

Prompts

Prompts are an important part of a questionnaire because they allow respondents to choose suitable answers, but it can also be useful to have some questions which are not prompted. These unprompted questions can then be followed up by a supplementary question after explaining certain aspects of the scheme. This type of approach is appropriate if the scheme is novel or likely not to be fully understood by respondents (Wheeler et al, 1994). Photographs of features (used for example in Surveys 30 and 31) can be a useful aid in face-to-face interview surveys.

Wording

Mackie (1989) reported that it may be advisable not to describe a new scheme as 'experimental' or as a 'trial' because communities may not like being guinea pigs for a scheme which is 'novel' or 'innovative' and is therefore not tried and tested.

Some questions, which appear to be similar, can often result in different responses. An example of two questions from York, Survey 27 is:

Do you find that your vehicle has suffered more than acceptable wear and tear due to traffic calming measures?

Result - Yes 53%.

Has your vehicle had to have any repairs as a result of traffic calming measures?

Result - Yes 28%.

It is probable that the 'wear and tear' items are suspension/ dampers and tyre side walls whereas repairs are confined to exhausts striking the hump or cracked alloy wheels caused by excessive speed over the humps.

5.2 Initial consultation

So far, any consultation process with the public which occurred *prior* to the implementation of a scheme has not been considered. This sub-section presents findings concerning initial consultations reported in the reviewed literature.

The consultation process may have 'political' considerations which are specific to the scheme but these

are not dealt with here. In a review of public attitudes and consultation in traffic calming schemes, Taylor and Tight (1996) noted that the type and format of the public consultation can vary considerably and that the overall acceptability of a scheme 'does not appear to be straightforward with the least successful consultation resulting in the highest satisfaction rating'. They also noted that the ability to adjust designs was very important if problems were encountered.

Kendrick (1995) reported that it is important that all sections of the local community are consulted, especially any minority groups which may be particularly affected by the measures proposed. The particular client population - pedestrians, children, non-car users - should be identified and their views sought by sample interviews both before and after introducing schemes. It is often possible to accommodate minor alterations without adversely affecting the effectiveness of the scheme.

Initial consultations with the police, emergency services and bus operators are generally constructive but the general public are sometimes very unresponsive to public meetings before the schemes are built. However, they can become very vociferous after the scheme has been built if the measures are regarded as too severe (Goddard, 1996). This sort of problem appears to vary across the country and therefore Local Authorities need to refine their own consultation procedures for the particular area under consideration.

It should be noted that very detailed drawings can be misunderstood by the general public who may assume that the details of the scheme have already been decided (Taylor and Tight, 1996). It is useful if the public are aware of schemes already installed in their local area so that they can make a considered response, especially if a postal consultation is used (York City, 1994).

6 Summary and conclusions

A total of 40 UK and 5 non-UK surveys of public attitudes to traffic calming schemes have been reviewed. Road humps have been installed in increasing numbers since the 1990 Highways (Road Humps) Regulations were introduced in the UK and all but five of the UK references date from 1990 onwards.

Most of the schemes considered were on roads with 20 or 30 mph speed limits. A variety of measures was used, humps being by far the most common, featuring in 30 of the studies.

The survey sample size in most studies was 50 - 500 respondents, with a maximum of 1000. The length and number of questions used in the questionnaires varied considerably, as did the type of survey and types of respondent. Most surveys were carried out within between 3 months and 2 years of scheme installation.

The results can be summarised as follows:

1 The overall percentage of respondents who approved of the schemes, across all the reviewed studies, was 65%. This varied according to the types of measures in the schemes: it was 72% for schemes including road humps; 53% for schemes including speed cushions; 59% (but particularly variable) for schemes including horizontal deflections. The timing of the survey in relation to installation of the measures appeared to have little, if any, effect on approval levels.

2 Surveys which provided direct information on the relative popularity of different measures indicated that round-top road humps were the most popular measure, followed by flat-top road humps, speed cushions, chicanes and mini-roundabouts in descending order.

3 The cost of the schemes varied greatly but this did not seem to influence respondents' views on whether the locality had improved as a result of a scheme. Schemes with high implementation costs per metre may not be justified unless general environmental improvements are required as part of the works.

4 Comparisons between objective measures of the effectiveness of schemes (where they were made) and public reactions to those schemes indicated that:

   i Vehicle speeds were reduced by an average of 8.5 mph, but the average proportion of respondents who thought speeds had been reduced was only 65%.

   ii Speed reductions of more than 10 mph were, *in all cases*, perceived as a reduction by over half of the respondents questioned.

   iii Traffic flow levels were reduced by an average of 23%, but the average proportion of respondents who thought flows had been reduced was only 33%.

   iv Personal injury accident frequencies were reduced by an average of 63%, but the average proportion of respondents who thought that safety had improved was only 53%.

   v There was no linear relationship between changes in mean speeds, traffic flows or accidents and the percentage of people who thought these things had improved.

   vi For the few schemes where changes in noise, vibration or pollution levels were monitored, improvements were generally reported. Respondents' views, however, did not generally reflect this.

5 The usefulness of the results of a questionnaire is determined by the questionnaire design (including the number and type of questions). As each scheme is different a standard questionnaire is not considered appropriate, but examples of questionnaires considered to be good starting points have been indicated.

6 It is important that a questionnaire includes a balance between types of questions, includes the opportunity for comment, and avoids jargon. The wording and order of questions is important, as is the use of prompts.

It should be noted that, for the purposes of the present report, all the surveys have been considered equally robust and the results given equal weighting in terms of scale and robustness.

The main conclusions can be summarised as follows:

- Public attitude surveys to traffic calming schemes are useful in establishing overall approval levels and in identifying the relative popularity of individual measures and any problems associated with them.
- Public attitude surveys cannot be a substitute for objective measures of the effectiveness of a scheme. Perceptions of changes in speeds, flow and safety, which might appear on the face of it to be easy to judge, are relatively poor. This is likely to be largely due to the difficulty in matching judgements to observations in terms of time and location, plus an inherent difficulty in judging vehicle speeds and flows.
- Changes in the environmental measures ground vibration, noise and air pollution are even more difficult to assess subjectively because they are influenced by a greater number of external factors.
- These differences between objective and subjective assessments suggest that the methods of objective measurement should perhaps be reviewed to determine measures that more accurately reflect peoples' concerns. For example, if measured noise levels have been reduced but people think they have increased, it may be because the noise *characteristics* have changed.
- Careful survey and questionnaire design are vital in eliciting the information required from respondents. A checklist is given in Appendix C.

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8 References

Abbott P G, Hartley S, Hickman A J, Layfield R E, McCrae I S, Nelson P M, Phillips S M and Wilson J L (1995). *The environmental assessment of traffic management schemes: A literature review*. TRL Report 174. Transport Research Laboratory, Crowthorne.

Abbott P G, Phillips S M and Layfield R E (1995). *Vehicle and traffic noise surveys alongside speed control cushions in York*. TRL Report PR103. Transport Research Laboratory, Crowthorne. (Survey No. 24)

Abbott P G, Tyler J and Layfield R E (1995). *Traffic calming: Vehicle noise emissions alongside speed control cushions and road humps*. TRL Report 180. Transport Research Laboratory, Crowthorne.

Baguley C J (1981). *Speed control humps - Further public road trials*. Department of Transport, TRRL Laboratory Report LR1017, Transport and Road Research Laboratory, Crowthorne. (Survey No. 4)

Berkshire County Council (1996). *Hatch Lane, Windsor - Review of road humps*. Area Highways Section (Windsor & Maidenhead, 1/10/96. Berkshire County Council, Reading. (Survey No. 10)

Boyd G and Noon A (1997). *Beneath the calm exterior*. Surveyor 23/1/97.

Brennan D T (1994). *The evaluation of residential traffic calming: a new multi-criteria approach*. Traffic Engineering + Control, January 1994, Vol 35, No.1, pp19-24. (Survey No. 39)

Cambridgeshire County Council (1991). *Report on a scheme of traffic calming measures on the B1040 through Gamlingay*. Transportation Dept, Cambridge. (Survey No. 11)

County Surveyor's Society (1994). *Traffic Calming in practice.* County Surveyor's Society, Landor Publishing Ltd. London

Davies D G, Ryley T J, Taylor S B and Halliday M E (1997). *Cyclists at road narrowings*. TRL Report 241. Transport Research Laboratory, Crowthorne. (Survey No. 32)

Department of Environment, Department of Transport (1977). *Residential roads and footpaths*. Design Bulletin 32. HMSO, London. 1st edition. Note 2nd edition issued in 1992.

Department of Transport (1990). *Speed control humps.* Traffic Advisory Leaflet 2/90. Traffic Advisory Unit, London.

Department of Transport (1994). *Fire and ambulance services traffic calming: A code of practice*. Traffic Advisory Leaflet 3/94. Traffic Advisory Unit, London.

Department of Transport (1996a). *Highways (Road humps) Regulations 1996*. Traffic Advisory Leaflet 7/96. Traffic Advisory Unit, London.

Department of Transport (1996b). *Traffic calming:traffic and vehicle noise*. Traffic Advisory Leaflet 6/96. Traffic Advisory Unit, London.

Department of Transport (1996c). *Traffic management and emissions*. Traffic Advisory Leaflet 4/96. Traffic Advisory Unit, London.

Department of Transport (1995). *Better Places through bypasses*. Report of the Bypass Demonstration Project. HMSO, London. (Survey No. 22)

Duffell J R and Hopper R (1975). *'Sleeping policemen' - their effectiveness in regulating vehicle speeds - a study at Ashridge Park, Hertfordshire*. Journal Instn. Municipal Engineers, August 1975. (Survey No. 8)

Essex County Council (1992). *Southend, Marine Parade.* Results of a questionnaire. Essex County Council, Chelmsford. (Survey No. 12)

Esteves R (1996). *The impact of traffic calming on residents perception of the safety, noise and air quality*. Bartlett School, University College London. (Survey No. 38)

Goddard R (1996). *A residential 20 mph Zone - the Wrexham experience*. Aston University conference on 15th May 1996. (Survey No. 37)

Gorman M, Moussavi M and McCoy P (1989). *Evaluation of speed hump program in the City of Omaha*. ITE Journal, June 1989, USA. (Survey No. 44)

Greenwich, London Borough (1994). *Riefield Road - Review of traffic calming scheme*. London Borough of Greenwich. (Survey No. 13)

Grigg A O (1981). *Rating scales - measures of central tendency and sample sizes*. Department of Transport, TRRL Supplementary Report SR647, Transport and Road Research Laboratory, Crowthorne.

Hass-Klau C, Nold I, Bocker G and Crampton G (1992). *Civilised streets. A guide to Traffic Calming*. Environmental and Transport Planning, 10 Clermont Terrace, Brighton. (Survey No. 35)

Hawley L, Henson C, Hulse A and Brindle R (1993). *Towards traffic calming. A practitioners manual of implemented local area traffic management and black spot devices*. Report No. CR 126. Western Sydney Regional Organisation of Councils Ltd. Australia. (Survey No. 41)

Herrstedt L (1992). *Traffic calming design - A speed management method. Danish experiences on environmentally adapted through roads*. Accid.Anal.& Prev. Vol 24 No.1 pp 3-16. (Survey No. 42)

Hodge A R (1992). *The effectiveness of speed reducing measures in the New Forest.* Unpublished Working Paper WP/TS/83. Transport Research Laboratory, Crowthorne. (*Unpublished report available on direct personal application only*). (Survey No. 1)

Hopper K and Cannon R (1994). *Traffic calming. Hertfordshire's town centres*. Highways & Transportation, October 1994. (Survey No. 14)

Institution of Highways and Transportation (1990). *Urban Safety Management Guidelines.* IHT, 3 Lygon Place, London.

Isle of Wight County Council (1994). *Newport (Isle of Wight), Pan Estate traffic calming scheme*. Isle of Wight County Council. (Survey No. 15)

Jenks M (1983). *Residential roads researched*. Architects Journal Special Report, 29th June 1983. Architects Journal. (Survey No. 40)

Jones S M and Farmer S A (1993). *Pedestrian ramps in Central Milton Keynes: a case-study*. TEC article, March 1993. (Survey No. 9)

Kendrick M J (1995). *Review of Traffic Calming 1995*. Northamptonshire County Council, Planning and Transportation.

Kent County Council (1992). *Traffic Calming A code of practice & Review of Traffic Calming Schemes in Kent, January 1992*. Kent County Council, Maidstone. (Survey No. 16)

Layfield R E, Hodge A R and Parry D I (1994). *On-road trials of speed cushions in Sheffield and York.* Project Report PR/TT/030/94, Transport Research Laboratory, Crowthorne. (*Unpublished report available on direct personal application only*) (Survey No. 24)

Layfield R E and Parry D I (1998). *Traffic calming - Speed cushion schemes*. TRL Report 312, Transport Research Laboratory, Crowthorne. (*In preparation*)

Leicester City Council (1995). *Speed cushions: Leicester City*. Eyres Monsell/Glen Parva traffic calming schemes. Leicester City Council. (Survey No. 17)

Mackie A M (1989). *Public participation in urban safety schemes*. Proc of seminar, Recent developments and research in road safety. University of Salford, September 1989.

Mackie A M and Griffin L J (1977). *Before and after study of the environmental effects of Tring by-pass*. Department of Transport, TRRL Laboratory Report LR746, Transport and Road Research Laboratory, Crowthorne.

Mackie A M, Ward H A and Walker R T (1990). *Urban Safety Project 3. Overall evaluation of area wide schemes*. Department of Transport, TRRL Research Report RR263, Transport and Road Research Laboratory, Crowthorne.

May A D and Hopkinson P G (1992). *Perceptions of the pedestrian environment*. Department of Transport, TRRL Contractor Report CR148, Transport and Road Research Laboratory, Crowthorne.

Norwich City Council (1996). *Opinion survey of the road closure outside the local school in Valpy Avenue, Norwich*. Norwich City Council, Norwich.

Oxford County Council (1991a, 1991b & 1992). *Results of questionnaires from traffic calming schemes: Northcourt Road, Abingdon (1991a), The Moors, Kidlington 1991b, and Kennington Road, Kennington, (1992)*. Oxford County Council, Oxford. (Survey No. 18)

Pharoah T and Russell J (1989). *Traffic calming: Policy and evaluations in 3 European countries*. Southbank Polytechnic. Occasional Paper 2/89.

Quimby A and Glendenning R (1990). *Perceived effectiveness and favourability towards some road accident countermeasures: A national survey*. Department of Transport, TRRL Contractor Report CR234, Transport and Road Research Laboratory, Crowthorne. (Survey No. 5)

Richmond, London Borough (1990 & 1994). *Installation programme and review of traffic calming schemes in London Borough of Richmond Upon Thames*. (Survey No. 19)

Sayer I A and Parry D I (1994). *Speed control using chicanes - A trial at TRL*. TRL Project Report PR102. Transport Research Laboratory, Crowthorne. (Survey No. 33)

Sayer I A, Parry D I and Barker J K (1998). *Traffic calming - An assessment of selected on-road chicane schemes*. TRL Report 313. Transport Research Laboratory, Crowthorne. (*In preparation*) (Survey No. 34)

Stockport M B C (1995). *Traffic Calming in Stockpor*t. Stockport MBC, Technical Services Division, Traffic Management Section. (Survey No. 20)

Sumner R and Baguley C (1979). *Speed control humps on residential roads*. Department of Transport, TRRL Laboratory Report LR878, Transport and Road Research Laboratory, Crowthorne. (Survey No. 3)

Surrey County Council (1995). *Summary of results for traffic calming schemes in Cumberland Avenue, Guildford; Feltham Hill Road, Ashford; Albert Drive, Woking and Cleeve Road, Leatherhead*. Surrey CC, Highways and Transportation Department. (Survey No. 21)

Taylor D and Tight M (1996). *Feet First:public attitudes and consultation in traffic calming schemes*. Transport 2000 Trust, London. (Survey No. 23)

Walker R T, Gardner G and McFetridge M (1989). *Urban Safety Project: The Nelson scheme*. Contractor Report CR191. Transport and Road Research Laboratory, Crowthorne. (Survey No. 36)

Webster D C (1993). *Road humps for controlling vehicle speeds*. TRL Project Report PR18. Transport Research Laboratory, Crowthorne.

Webster D C (1994). *Speeds at 'thumps' and low height road humps*. TRL Project Report PR101. Transport Research Laboratory, Crowthorne. (Survey No. 7)

Webster D C and Layfield R E (1993). *An assessment of rumble strips and rumble areas*. TRL Project Report PR33. Transport Research Laboratory, Crowthorne. (Survey No. 28)

Webster D C (1995). *Traffic calming - four schemes on distributor roads*. TRL Report 182. Transport Research Laboratory, Crowthorne. (Survey No. 29)

Webster D C and Layfield R E (1996). *Traffic calming. Road hump schemes using 75 mm high humps.* TRL Report 186. Transport Research Laboratory, Crowthorne.

Webster D C and Mackie A M (1996). *Review of traffic calming schemes in 20 mph zones.* TRL Report 215. Transport Research Laboratory, Crowthorne. (Survey No. 25)

Wernsperger F and Sammer G (1995). *Results of the scientific investigation accompanying the pilot trial of 30 kph limit in side streets and 50 kph limit in priority streets*. Paper presented to the PTRC Annual meeting, September 1995. (Survey No. 45)

Wheeler A, Taylor M and Payne A (1993). *The effectiveness of village 'gateways' in Devon and Gloucestershire.* TRL Project Report PR35. Transport Research Laboratory, Crowthorne. (Survey No. 2)

Wheeler A, Taylor M and Barker J (1994). *Speed reductions in 24 villages: Details from the VISP study*. TRL Project Report PR85. Transport Research Laboratory, Crowthorne. (Survey No. 26)

Wheeler A H, Abbott P G, Godfrey N S, Lawrence D J and Phillips S M (1996). *Traffic calming on major roads: the A49 trunk road at Craven Arms, Shropshire*. TRL Report 212. Transport Research Laboratory, Crowthorne. (Survey No. 30)

Wheeler A H, Abbott P G, Godfrey N S, Phillips S M and Stait R (1996). *Traffic calming on major roads: the A47 trunk road at Thorney, Cambridgeshire.* TRL Report 238. Transport Research Laboratory, Crowthorne. (Survey No. 31)

Windle R and Hodge A R (1993). *Public attitude survey - The New Forest traffic calming programme*. TRL Project Report PR14. Transport Research Laboratory, Crowthorne. (Survey No. 1)

Windle R and Mackie A M (1992). *Survey on public acceptability of traffic calming schemes*. Department of Transport, TRRL Contractor Report CR298. Transport and Road Research Laboratory, Crowthorne. (Survey No. 6)

York City Council (1994). *Traffic calming.* Market research June/July 1994. Customer and Marketing services, York. (Survey No. 27)

Zaidel D, Hakkert A S and Pistiner A H (1992). *The use of road humps for moderating speeds on urban roads*. Acc. Anal & Prev. Vol. 24, No.1, pp 45 - 56. (Survey No. 43)

Appendix A: Public attitude literature reviewed UK

1. Refs. Windle and Hodge (1993) & Hodge (1992).

Location	New Forest, Hampshire (B3078, B3079, B3080 and C31)
Sample	121 residents, 150 local and 151 visitors interviewed
Measures	Gateways, 40 mph roundels, rumble strips/cattle grids
Installed	Spring 1990
Survey	Summer 1992
Questions	20 questions to residents living in Forest, 18 questions to residents outside Forest & 11 questions to visitors.
Reaction	Overall very favourable. Residents are most enthusiastic (95% approve). Visitors think that it is a good idea (90% approve) but some residents outside the forest are less enthusiastic (84% approve).
Results	Effect on measured speed v perceived effectiveness: Gateway. -2 mph v 6.90 (out of 10) Roundel, sign & slogan. -12 mph (peak) -2 mph (off peak) v 6.71 overall Undulations. -21 mph (peak) -16 mph (off peak) v 6.85 Pinch point. + 1 mph (off peak) v 7.71
Cost	£300,000

2. Ref. Wheeler, Taylor and Payne (1993).

Location	Tavistock village, Devon
Sample	100 residents interviewed
Measures	Gateways, central islands, centre hatching, extra lighting
Installed	March 1992
Survey	Feb/March 1993
Questions	A total of 15 to ascertain: If the changes to the road were noticed Problems before calming Improvements noted Effect on road users Overall effects of measures Consultation procedure
Reactions	Overall: Nearly half looked on measures favourably.
Results	Mean speeds reduced by 4 mph to 39 mph. Half thought speeds were reduced, half thought not reduced. 86% thought not reduced enough. No before survey. 90% thought measures attractive.
Cost	£6500 = £6.5/metre

3. Ref. Sumner and Baguley (1979).

Location	5 sites: 3a) Oxford, 3b) Norwich, 3c) Haringey, 3d) Kensington & 3e) Glasgow
Sample	417 residents at sites 3a - 3e, 572 drivers at sites 3a, 3c & 3d interviewed
Measures	Round-top humps, 102 mm high
Installed	1975 - 1977
Survey	3 months after installation
Questions	Residents (5 sites, 14 questions on speed, safety, measures, traffic). Drivers (3 sites, 9 questions on measures, safety, whether resident or not).
Reaction	Residents, 83% thought the humps served a useful purpose and wanted to keep them. Of 551 non-resident drivers, 71% thought the humps were a good idea but only 58% were in favour of keeping the humps
Results	Measured effect v perceived effectiveness (before to after): Speeds. Reduced 27 to 15 mph v 88% to 30% (thought speeds too fast) Flow. 3866 to 2541 (-34%) v 69% to 35% Noise. 64 dB(A) to 60 dB(A) v 32% to 17% Accidents. 27.9 to 11/yr (-61%) v 67% to 24% (All residents)
Cost	£271 - £718 per hump.

4. Ref. Baguley (1981).

Location	4a) Lytham, 4b) Ventnor, 4c) Rotherhithe & 4d) Winchester
Sample	107 residents (sites 4a - 4c), 473 car + light van drivers (sites 4c & 4d) & 44 HGV drivers (site 4c) interviewed
Measures	Round-top humps (76 mm high at site 4a & 102 mm at sites 4b - 4d)
Installed	1977 - 1979
Survey	At least 3 months after installation
Questions	Residents (3 sites, Questions as Survey 3). Non- resident drivers (2 sites, Questions as Survey 3 but additional question on whether driver still uses road after humps).
Reaction	Residents 73% thought the humps served a useful purpose and wanted to keep them. Non-resident drivers, 73% were in favour of keeping the humps.
Results	Measured effect v perceived effectiveness (before to after): Speeds. 19 to 14 mph v 77% to 31% (too fast) Flow. 2412 to 1809 (-25%) v 59% to 39% Noise. 60 dB(A) to 46 dB(A) v 33% to 20% (Only at 1 site) Accidents. 5.0/yr to zero (-100%) v 44% to 22% (All residents)
Cost	Not stated

5. Ref. Quimby and Glendenning (1990).

Location	National
Sample	753 residents postal questionnaires returned (63% of total sent out)
Measures	Humps
Installed	Not applicable
Survey	1989 approx
Questions	National survey. One relevant question. “Should have more humps in built-up areas to discourage speeding”.
Reaction	In favour 50%. Effective 38%
Results/Cost	Not stated

6. Ref. Windle and Mackie (1992).

Location	6a) Exeter, 6b) Maidstone, 6c) Bridgwater and 6d) Worcester Park
Sample	652 residents interviewed
Measures	Round-top, flat-top humps, chicanes and narrowings
Installed	1989 - 1990
Survey	January/February 1991
Questions	Comprehensive questionnaire with 18 questions, on speed, safety, noise, pollution, traffic, benefits, measures.
Reaction	Respondents 59% thought traffic was slower, 76% thought they were a good idea near schools and 55% thought they reduce accidents.
Results	Effectiveness v perceived: Speeds 28 to 16 mph v 58% (Lower) Flow. 5122 to 4200 (-18%) v 23% (lower) 55% (no change) Accidents. -38% v 45% (improved) 36% (not changed) Accident migration. ‘Only shift problem somewhere else’ Actual difference surrounding area a)-5/yr, c)-5/yr and d)+10/yr v residents perception (problem shifted) a)27%, c)20% and d)40%
Cost	6a) £220,000 = £366/metre 6b) £198,000 = £29/metre 6c) N/A 6d) £168,000 = £13/metre which includes 47 humps + 8 throttles

7. Ref. Webster (1994).

Location	Bowes Incline, Gateshead
Sample	8 residents along road. Postal questionnaire
Measures	21 thermoplastic humps, 57 mm high and 940 mm long
Installed	February 1992
Survey	May 1993
Questions	Short questionnaire. Questions on speed, success of scheme, number of humps and proposed alterations.
Reaction	Residents concerned about the close spacing (30 - 40 metres) of humps.
Results	Measured effect v perceived effectiveness: Speeds 29 mph to 20 mph, 88% residents agreed they were successful
Cost	£4630 = £5.6/metre

8. Ref. Duffell and Hopper (1975).

Location	Ashridge Park, Hertfordshire
Sample	84 non-resident drivers interviewed
Measures	Round-top humps, 100 mm high at 350 metre average spacing
Installed	1972
Survey	1974
Questions	Acceptability of the humps
Reaction	In favour 73%, not in favour 17%
Results	Low ground clearance sports car (e.g Jaguar) drivers thought that humps were too high. Hump crossing speed of 4.3 mph compared with 9.0 mph for other cars. No accidents 'after' to deer or vehicles including damage only accidents.
Cost	Not stated

9. Ref. Jones and Farmer (1993).

Location	Milton Keynes
Sample	612 interviews including 575 residents and 37 non-residents
Measures	Six flat-top humps 100 mm high (with ramp gradients of 1:6) including pedestrian crossing points
Installed	Summer 1988, modified in 1990 by making gradients shallower at 1:12
Survey	July 1989
Questions	(1) All respondents; attitude to humps, priority at humps. (2) Drivers/riders; damage to car, awareness of drivers to pedestrians (3) Bus passengers; any problems and if so what? (4) Hump crossers and non-hump crossers
Reaction	In favour of humps 47%, wanted changes 33%, wanted humps removed 20%. 60% of bus passengers had problems mainly with the bumpy ride. Found to be more acceptable to people who did not use regularly. Results were divided into age bands of 0-4, 5-12, 13-16, 17-20, 21-59 & 60+ which gave some age related effects regarding pedestrian crossing behaviour.
Results	None applicable
Cost	£30,000

10. Ref. Berkshire County Council (1996).

Location	Hatch Lane, Windsor.
Sample	150 residents returned postal questionnaire (38% of total sent out)
Measures	Round-top humps.
Installed	March 1993
Survey	July 1996
Questions	Please tick the box you prefer: Road humps to be retained □ Road humps to be removed □ Investigate the introduction of alternative traffic calming measures □ Additional comments
Reactions	Retain humps 41%, retain humps & investigate other measures 9%, remove humps 19%, remove and investigate other measures 23%, investigate other measures 7%. Of the 42% who wanted the humps removed, 84% were side road residents.
Results	None applicable
Cost	Not stated

11. Ref. Cambridgeshire County Council (1991).

Location	B1040 through Gamlingay.
Sample	Before and after survey of returned questionnaires from 100 residents on the road and local residents affected by the road.
Measures	Round and flat-top humps (50 to 100 mm high), narrowings & chicanes.
Installed	November 1990
Survey	February 1991
Questions	(Q1) How do you consider vehicle speeds? (Q2) How difficult is it to cross the road? (Q3) How safe do you feel when using the footways? (Q4) How do you regard traffic noise and pollution? (Q5) How do you regard general traffic conditions? (Q6) How difficult is it to find a parking space? (Q7) How safe are conditions for cyclists?
Reaction	(A1) Acceptable 87% (A2) Not difficult/easy 84% (A3) Safe/very safe 82% (A4) Acceptable/not concerned 72%. (A5) Congested/occasionally congested 51% (81% before) (A6) Difficult/very difficult 46%. (63%before) (A7) Acceptable/safe 68%.
Results	Speeds reduced (average of 4 sites) from 34.6 to 29.0 mph v Speeds were acceptable to residents 9% to 87%. Flow reduced from 3235 to 2806 (13% reduction) v Traffic conditions 81% thought congested before compared to 51% thought congested after.
Cost	Not stated

12. Ref. Essex County Council (1992).

Location	12a) Southend, Marine Parade.
Sample	748 residents interviewed
Measures	Flat-top humps, pelicans and road width reduced from dual to single lanes.
Installed	March 1992
Survey	September 1992
Questions	(Q1) What form of transport do you use on Marine Parade? (Q2) At what time of the day do you use this road? (Q3) Did you use this road before the road improvements were made? (Q4) Why do you think these tables have been put in this road? (Q5) What changes have you noticed in activity since the speed tables were introduced? (Q6) Have the speed tables made you change your route? (Q7) Do you consider this to be a significant inconvenience? (Q8) Interviewer to note the subjects Age group, sex and whether trader, resident or visitor
Reaction	(A4) To reduce speed 84%, pedestrian safety 23%, road safety 14%, restrict traffic flow 3%, improve area 2%, Don’t know 2%
Results	Speeds reduced from 28 to 26 mph
Cost	£181,000

Location	12b) Hadleigh, Scrub Lane.
Sample	726 residents interviewed
Measures	Round-top humps (4 x 50 mm & 13 x 100 mm high)
Installed	September 1991
Survey	October 1992
Questions	(Q1) Before road humps were introduced in this area, did you think that it was necessary to reduce the speed of vehicles in Scrub Lane? (Q2) Did you think that it was necessary to reduce the amount of traffic using Scrub Lane? (Q3) Have you ever been over the humps in Scrub Lane? (Q4) Have the road humps made you slow down? (Q5) Would you be happy to travel over road humps if you knew they reduced accidents? (Q6) Do you think it acceptable to reduce vehicle speeds to improve the environment solely for residents by reducing vehicle speeds? (Q7) What do you most like about the road humps? (Q8) What do you dislike most about the road humps?

Reaction	Residents like the scheme
Results	Average speed decreased by 9 mph
	Flow down from 8700 to 3580 (-59%)
	Accidents reduced from 3 in 11 months before to 0 in 11 months after.
Cost	£23,000

13. Ref. Greenwich London Borough (1994).

Location	Riefield Road.
Sample	256 residents. Postal questionnaire
Measures	Speed cushions (80 mm high) and raised junction (75 mm high & 1:15 ramps)
Installed	September 1994
Survey	March 1995
Questions	(Q1) Did you support original request for speed cushions in Riefield Road?
	(Q2) Do you support the scheme now or would you like to see it removed?
	(Q3) By how much do you feel this scheme has improved safety in your road?
	(Q4) Do you consider the heights of the speed cushions to be excessive?
	(Q5) Do you consider that traffic noise has increased due to this scheme?
	(Q6) Do you think traffic volumes have increased in your road because of the scheme?
	(Q7) Comments
Reactions	Support (before and after calming).
	Riefield Road, Before 80% After 80%
	Non-treated Roads, Before 31% After 51% After (all roads) 61%
Results	Flows.
	Riefield Road, Measured -22%. Residents 14% thought increased.
	Non-treated Roads, Measured 35%. Residents 69% thought increased.
	31% thought that noise had increased. No accidents after installation.
Cost	£35,500 = £39/metre

14. Ref. Hopper & Cannon (1994). (Hertfordshire County Council).

Location	Borehamwood, Shenley Road.
Sample	Shoppers
Measures	Flat-top humps, narrowing of road and horizontal deflection.
Installed	February 1990
Survey	October 1990
Questions	Various questions concerning safety and acceptability of scheme.
Reactions	Overall shoppers approved of the scheme.
Results/Cost	Not stated

15. Ref. Isle of Wight County Council (1994).

Location	Newport (I of W), Pan Estate.
Sample	Residents, postal questionnaire
Measures	Two-way block paved 75 mm high ramped (1:10 gradient) narrows
Installed	June 1993
Survey	December 1993
Questions	(Q1) Vehicle speeds have been reduced by 18 mph, do you agree Yes/No?
	(Q2) Vehicle flows have been reduced by 30%, do you agree Yes/No?
Reactions	Overall a successful scheme.
Results	Speeds reduced from 35 mph to 17 mph, accidents reduced 50%.
Cost	£40,000

16. Ref. Kent County Council (1992).

Location	Sittingbourne, Stanhope Avenue.
Sample	223 residents returned postal questionnaire (58% of total sent out)
Measures	Two-way block paved, 100 mm high, ramped narrows
Installed	August 1989
Survey	February 1991
Questions	(1) Speeds/flows/noise (2) Do you drive? More or less than once a week? (3) Effects of scheme on traffic for pedestrians,parents,cyclists,drivers (4) Is there a hump DIRECTLY outside your house? Access to property
Reactions	Most in favour of the scheme, 68% felt less concern or no difference.
Results	Speeds. Actual 28 to 23 mph, 70% thought reduced. Noise results variable. Flows. Actual -27%, 16% thought decrease, 58% thought no change. Pollution. 11% thought it was worse
Cost	£43,000

17. Ref. Leicester City Council (1994).

Location	Leicester, Eyres Monsell.
Sample	139 residents returned postal questionnaire (41% of total sent out)
Measures	Sets of 2 or 3 cushions, 75 mm high, 1600 mm wide & 1:8 ramps
Installed	May 1994
Survey	November 1994
Questions	(Q1) Do you think that the traffic calming has slowed the speed of most cars? (Q2) Do you find it easier to cross the roads that have been traffic calmed? (Q3) Do you think that less cars use the roads that have been traffic calmed? (Q4) Has there been an increase in joy riders using these roads since the traffic calming was installed? (Q5) Do you think the traffic calming looks reasonably attractive in the street scene (once repairs have been carried out)? (Q6) Is the traffic calming what you were expecting? If not why? (Q7) Do you think the traffic calming has been successful? If not why? (Q8) Do you think the small cushions work as well as the humps which go straight across the road? (Q9) Would you recommend traffic calming to other people as a way of solving problems of speed, accidents and rat running?
Reactions	Residents answers to questions, percentage who agreed: (A1) Speeds reduced, 71% (A2) Crossing road easier, 71% (A3) Flow reduced, 50% (A4) Joy riding increased, 17% (A5) Street attractive, 43% (A6) Expected humps, 6% (A7) Scheme successful, 46%; Unsuccessful,43% (A8) Humps work better than cushions, 56%; cushions work as well as humps, 35%.
Results	Measured results Speeds. Mean speeds reduced from 38 mph to 26 mph. Flows. Overall mean flows of two roads reduced by 16%.
Cost	Not stated

18. Ref. Oxfordshire County Council (1991a, 1991b & 1992).

Location	18a) Northcourt Road, Abingdon, 18b) The Moors, Kidlington, 18c) Kennington Road, Kennington
Sample	Postal questionnaire (18a) Residents, (18b) 220 residents, (18c) 821 residents; Sample was (18a) 70%, (18b) 55%, (18c) 59% of total sent out respectively
Measures	Round-top and flat-top humps/zebra crossings (75 - 100 mm high)
Installed	1991
Survey	1992 (1 year after installation)
Questions	(Q1) Have speeds, decreased, not changed or increased (Scheme a, b, c) (Q2) Is road safer, no change or less safe (Scheme a, b, c) (Q3) Traffic volume (Q4) Traffic noise (Increase, decrease, no change) (Q5) Safety of different road users (Car, bus, cycle, m/c, child, elderly) (Q6) Frequency/mode of passing hump (Car, bus, cycle, walk, m/c, goods) (Q7) Details of respondent (pupil, parent with children, retired, other)
Reactions	Speeds (18a) N/A (18b) 32 to 27 mph (18c) 31 to 22 mph Flows (18a) N/A (18b) -30%, -50% W/end (18c) -25% Safety (18a) 67% think road is safer (18b) 52% think road is safer (18c) 59% Satisfied with scheme. Perceived safety improved, elderly 73%, school children 68%.
Results	Actual accident reductions 18a) 56%, 18b) 56% and 18c) 70%

	At site 18c, 17% thought noise had increased.
Cost	18a & 18b not given. (18c) £65,000 (Mini-rbts, 13 round-top humps, 3 humped zebra crossings and additional humps on adjoining roads. (1.5 km = £43/metre)

19. Ref. Richmond London Borough (1990 & 1994).

Location	12 schemes (19a - 19l), 13 schemes (19m - 19y)
Sample	All residents
Measures	Round-top humps 19a - 19l (94 x 100 mm, 12 x 75 mm & 9 x 50 mm high) 19m - 19y (17 x 100 mm, 117 x 75 mm & 2 x 50 mm high)
Installed	May 1989 - Aug 1990 & Nov 1990 - Dec 94
Survey	Sept/Dec 1990 (19a - 19l) & July 1994/June 1995 (19m - 19y)
Questions	14 Questions including:- Are you in favour of retaining scheme.
Reactions	Residents were 83% to 97% (average of 91%) in favour 1990. Residents were 11% to 97% (average of 75%) in favour 1994/95. 84% of residents at site 19n thought speeds were reduced.
Results	Average mean speeds reduced from 30 to 20 mph at site 19n.
Cost	Total £94,000 for 115 humps (7115 metres) £13/metre 1990 schemes.
Note	Egerton Road, 19y, 5 humps were removed due to residents (89% were against retaining humps) concern of noise from Heavy Goods Vehicles.

20. Ref. Stockport Metropolitan Borough Council (1995).

Location	20a) Swann Lane, Cheadle, 20b) Cross Lane, Marple, 20c) Woodsmoor Lane, Woodsmoor, 20d) Regent Road, Heaviley.
Sample	20a) 61, 20b) 65, 20c) 104, 20d) 94 residents returned postal questionnaire which represented 20a) 68%, 20b) 54%, 20c) 47% & 20d) 52% of total sent out
Measures	20a) Round-top road humps (90 mm high) 20b) Flat-top road humps (80 mm high) 20c) Speed tables, flat-top humps, pinch points and priority changes 20d) Humps (90 mm high), chicanes and rumble devices
Installed	20a) October 1993, 20b) April 1995, 20c) June 1992, 20d) September 1994
Survey	April - June 1995
Questions	(Q1) Do you feel that there was a need for traffic calming on your street? (Q2) Do you feel that the scheme has reduced a) Vehicle speeds? b) number of vehicles? (Q3) Do you feel that the scheme has improved the quality of your environment? (Q4) Do you feel the scheme is successful?
Reactions	(A4) Overall scheme success 20a) 93%, 20b) 66%, 20c) 56%, 20d) 33%

Results	Site	Speed mph	Residents	Environ	Scheme success:
	20a	29 to 25	90% lower	84% better	93%
	20b	38 to 28	80% lower	55% better	66%
	20c	38 to 22	71% lower	52% better	56%
	20d	N/A	49% lower	33% better	33%

	Flows. Survey (20c) decreased 2875 to 1650 vehicles/day but only 28% of residents thought the traffic volume had reduced.
Cost	20a) £4,800 = £7/metre 20b) £9,700 = £9/metre 20c) £70,000 = £100/metre 20d) £50,000 = £56/metre

21. Ref. Surrey County Council (1995).

Locations	21a) Cumberland Avenue, Guildford; 21b) Feltham Hill Road, Ashford;	
	21c) Albert Drive, Woking; 21d) Cleeve Road, Leatherhead	
Sample	21a) Residents, 21b) Residents, 21c) Residents, 21d) 220 Residents; Returned postal questionnaires 21d) represented 49% of total sent out	
Measures	21a) 75 mm round-top humps, 21b) 100 mm flat-top humps & 1:15 ramps	
	21c) Two-way chicanes 21d) One-way chicanes	
Installed	January - August 1991	
Survey	December 1992	
Questions	(Q1) Do you live in Cumberland Avenue? Yes/No	
(Typical)	(Q2) Do you think the road humps are beneficial? Yes/No/Unsure	
	(Q3) Do you think that vehicle speeds **IN THAT PART OF ALBERT DRIVE** have Increased/Decreased/ not changed/unsure?	
	(Q4) Since the road tables were introduced do you think that the amount of traffic in **YOUR** road has Increased/Decreased/not changed/unsure?	
	(Q5) Do you think that the chicanes have affected road safety **IN THAT PART OF ALBERT DRIVE** as a pedestrian,parent,pedal-cyclist,motor-cyclist,driver? Safer, less safe, no change, not applicable?	
	(Q6) Further questions on Effect on car journeys, Effect on bus journeys, Access, parking and noise near tables and whether cyclists use the cycle track (always/sometimes/most times/never).	
	A short Questionnaire was sent to each business on Albert Drive.	
Reactions	Approval (beneficial) 21a) 83%, 21b 69%, 21c) 39%, 21d) 18%	
Results	Speeds	
	21a) 14.3 mph, reduction	85% thought speeds reduced
	21b) 15 mph reduction,	64% thought reduced
	21c) 7 mph reduction,	27% thought reduced (60% same)
	21d) 3.7 mph reduction,	18% reduced (40% same)
	Flows	
	21a) 40% lower	63% thought lower 36% same
	21b) 37% lower	44% thought lower 40% same
	21c) 9% lower	12% thought lower 75% same
	Accidents	
	21a) 73% lower	85% thought lower
	21b) 84% lower	69% thought lower
	21c) 74% lower	46% thought lower
	21d) 54% lower	17% thought lower 55% same
Cost	21a) £35,500 = £50/metre	21b) £80,000 = £61/metre
	21c) £84,000 = £35/metre	21d) £6,000 = £40/metre

22. Ref. Department of Transport (1995). Bypass demonstration project.

Location	6 bypass demonstration sites (a) Berkhamstead, (b) Dalton, (c) Market Harborough, (d) Whitchurch, (e) Petersfield, (f) Wadebridge
Sample	39 to 360 (22a - 22d) & 42 - 370 (22e -22f). Surveys of residents, businesses, pedestrians and cyclists. 90% of interviews successful but postal questionnaires represented 28% of those sent out.
Measures	22a) 20 mph zone, gateways, humps, chicanes
	22b) 20 mph zone, humps
	22c) 20 mph zone, humps, chicanes, cushions
	22d) 20 mph zone, gateways, humps
	22e) Narrowing, very shallow ramps
	22f) Humps, segregated facilities
Installed	1993/1994
Survey	1994/1995
Questions	Parking, noise, fumes, vibration, crossing, traffic speeds, pavement widths and conditions. Measures considered separately.
Reactions	Overall: Changes were better than before, 22a) 53%, 22b) 63%, 22c) 67%, 22d) 78%, 22e) 67% & 22f) 64%
Results	See full report for more details
Cost	£1.2 - £2 million for complete schemes

23. Ref. Taylor and Tight (1996).

Location	23a) Brighton, 23b) Leicester, 23c) Sheffield and 23d) York
Sample	23a) 244, 23b) 244, 23c) 193, 23d) 348. A total of 1029. Returned postal questionnaires represented 41% of total sent out
Measures	23a) Brighton, 20 mph zone, round and flat-top humps, chicanes and narrowings 23b) Leicester, flat-top humps 23c) Sheffield, Nether Edge & Sharrow 20 mph zone, flat-top humps 23d) York, humps, chicanes, cushions
Installed	1992 - 1994
Survey	1993 - 1994
Questions	Comprehensive questionnaire. Below is a sample of the Questions. (Q1) Do the streets have a better appearance? (Q2) More people walking in the street? (Q3) Stronger community feeling? (Q4) Main purpose of your street? (Q5) Have environmental problems got better? (Q6) Feel safer crossing your street? (Q7) Drivers changing route? (Q8) Drivers more likely to let pedestrians cross? (Q9) Do humps damage your car? Some questions were split into age groups
Reaction	Residents supported the principle of calming. 23a) 90%, 23b) 73%, 23c) 82%, 23d) 85%.
Results	Only reactions stated
Cost	23a) £60,000 = £12/metre, 23b) Worthington Street £180,000 = £1078/metre, 23b) Phase 1, £165,000 = £49/metre, 23c) £245,000 = £47/metre

24. Refs. Layfield, Hodge and Parry (1994) & Abbott, Phillips and Layfield (1995).

Location	24a) Sheffield and 24b) York: Foxwood Lane, Tang Hall, Muncaster.
Sample	Residents, 72 in Sheffield, 360 in York
Measures	Cushions, chicanes, narrowings and humps
Installed	24a) April 1993, 24b) April 1993
Survey	24a) July 1993, 24b) July 1993
Questions	Short postal survey, traffic speeds/volumes, safety, noise etc
Reactions	(24a) Half thought no change in speeds or safety. (24b) Most thought speeds were reduced, some concern for cyclists
Results	Speeds were reduced by 5 mph in Survey 24a and 11 mph in Survey (24b) on average.
Cost	£320 - £3400 per pair of cushions

25. Ref. Webster and Mackie (1996).

Location	25a) Barnsley, 25b) Richmond, 25c) Sheffield, 25d) Solihull, 25e) York, 25f) Nuneaton
Sample	25a) 759, 25b) 50, 25c) N/A, 25d) N/A, 25e) 262, 25f) Residents
Measures	Round and flat-top humps, chicanes and narrowings
Installed	25a) February 1994, 25b) January 1990, 25c) April 1993, 25d) May 1994, 25e) April 1991, 25f) April 1994
Survey	25a) September 1994, 25b) April 1992, 25c) 1991, 25d) 1992, 25e) 1991, 25f) 1995
Questions	25a) Town centre survey carried out by Transport Executive for Barnsley MBC covering mode of travel, effect of measures, safety, effect on bus passengers, alternative measures 18 questions in total. 25b) Richmond. Acceptability, safety. 25c) Sheffield, Tinsley. Acceptability, safety to road users. 25d) Solihull. Acceptability, safety. 25e) York, The Groves. Before and after (1991) survey. Traffic speeds/flows, effectiveness of measures. 25f) Nuneaton, Camp Hill. Residents unhappy with chicanes.
Reaction	Acceptability 25a) 58%, 25b) 96% & 25d) 57% (average 70%).
Results	Overall 25a) Speeds reduced 21 to 14 mph, 66% said they were effective. 25b) Speeds reduced from 25 to 16 mph, 56% thought reduced and 42% same. 85% thought the 20 mph zone should be permanent. 25c) Majority views were favourable with pedestrians and children as main beneficiaries. 25d) Speeds reduced 27 to 16 mph, 81% thought reduced, volumes reduced by average of 12%, 58% thought reduced and 40% same. 25e) Speeds reduced 23 to 12 mph. Residents thought 60% (before) and 27% (after) that speeds were major problem. Flows reduced by 42% overall. Flows thought to be a major problem 72% (before) 37% (after). 76% of residents wanted a 20 mph speed limit. (f) Chicanes removed due to chicanes causing congestion.
Cost	Not stated

26. Ref. Wheeler, Taylor and Barker (1994).

Location	26a) Crondall, 26b) Gisburn, 26c) Jersey Marine, 26d) Ludford, 26e) Sanquhar, 26f) Tunstall.
Sample	26a - 26c) 100, 26d) 72, 26e) 100 residents interviews, 26f) 25 residents postal questionnaire
Measures	Gateways, central islands, centre hatching, rumbles, extra lighting Average length of scheme 1182 metres.
Installed	Various
Survey	Various
Questions	A total of 15 as Tavistock (Survey No. 2). Tunstall postal.
Reaction	Overall: Nearly half looked on measures favourably.
Results	Speeds reduced for 26a-f by 7, 3, 8, 4, 3, 10 mph respectively corresponding to respondents who thought speeds had reduced 42, 66, 72, 82, 64, 48% and for 26a-e who thought speeds had reduced enough 34, 36, 44, 62, 52%
Cost	26a) £8500 = £16/metre, 26b) £50800 = £40/metre, 26c) £17600 = £16/metre, 26d) £4300 = £2/metre, 26e) £17100 = £13/metre, 26f) £5700 = £8/metre Total cost all sites = £104000 = £15/metre

27. Ref. York City (1994).

Location	York (Various locations)
Sample	750 face to face interviews with York residents
Measures	Humps, cushions, speed tables, 20 mph zones, chicanes, mini-rbts
Installed	All York schemes installed before 1994
Survey	June/July 1994
Questions	How often do you travel by car, m/c, bus, taxi, cycle (Choice of 7 answers)
(Abbreviated)	Effect of road safety for pedestrians, cyclists, bus users, car users Types of various measures used in York Effectiveness of measures used Locations/heights etc. of measures Period during installation of measures Satisfaction with schemes Future schemes Any damage to vehicle Route changing
Reactions	52% satisfied with traffic calming in York 69% think traffic calming improves road safety

	71% think it is now safer for pedestrians				
	Also see Surveys 23 & 24.				
Results	Percentage believing measures to be effective				
	Round-top humps	Cushions	Flat-top humps	Chicanes	Mini-rbts
	75%	50%	50%	45%	41%
Cost	Not stated				

28. Ref. Webster and Layfield (1993).

Location	35 sites in UK, mainly approaching 30 mph areas
Sample	Residents reactions given to Local Authority
Measures	Rumble strips and rumble areas
Installed	1987 - 1992
Survey	No specific surveys carried out
Questions	None asked
Reactions	Devices were modified or removed at 11 out of 35 sites due to objections. See also Bexley Site (Ref.Traffic Calming in practice, County Surveyor's Society, 1994).
Results	Noise was dominant at many sites (see reactions)
Cost	£500 - £1500 for thermoplastic strip sites and £2500 - £10000 for coarse aggregate sites.

29. Ref. Webster (1995).

Location	Distributor roads at 4 locations: 29a) Woking, 29b) Farnborough, 29c) Windsor & 29d) Watford.
Sample	Residents reactions given to Local Authority
Measures	Flat-top humps, chicanes, pedestrian refuges, hatching.
Installed	29a) May 1993, 29b) August 1992, 29c) September 1993, 29d) April 1994
Survey	29b) Short postal questionnaire to residents but few replies received by Local Authority
Questions	None asked
Reactions	These 4 schemes were generally well received with comments such as: Can the scheme be extended (residents), can we have humps like those in ....(non residents) Some of the public disliked the red colour of one set of humps used but the colour has toned down as it has weathered. Redistribution of traffic at one scheme was thought by the public to be problem but this could not be quantified. Noise and vibration was commented on but it was not found to be a problem at similar sites.
Results	None stated
Cost	29a) £40,000, 29b - 29d) Not given

30. Ref. Wheeler et al. (1996).

Location	A49 Craven Arms, Shropshire.
Sample	200 residents interviewed
Measures	Gateways, painted roundels, speed cushions, pedestrian refuges, patches of red surface.
Installed	May 1995
Survey	September 1995
Questions	Problems before installation Photographs of measures used to assist respondents Safety of road users, speeds, noise, vibration, fumes
Reactions	Mini-roundabouts disliked by 80% (Priority unclear, vehicle speeds). Gateway 2.94, Islands 2.74, Hatching 2.60, Speed cushion 2.28, Mini-roundabout 1.47 (out of 4)
Results	No accidents (5 months). Noise and vibration. Considerably worse for people near cushions but not borne out by measurements. Isolated noise at night could be reason for discrepancy. Speeds reduced by about 8 mph, respondents agreed that speeds were reduced (74)% and 49% thought they were reduced enough.
Cost	£80,000

31. Ref. Wheeler et al. (1996).

Location	A47 Thorney, Cambridgeshire.
Sample	199 residents interviewed
Measures	Gateway, chicane, mini-rbt, speed camera, part-time 20 mph sign.
Installed	May 1995
Survey	November 1995
Questions	Problems before installation Photographs of measures used to assist respondents Safety of road users, speeds, noise, vibration, fumes
Reactions	26% satisfied with scheme Gateway 2.61, Narrowing 2.31, Chicanes 2.06, Mini-rbt 1.58 (out of 4)
Results	Average speeds reduced by 9 mph. 61% thought reduced but 24% thought reduced enough. Noise reduced by 4 dB(A) in village (daytime), 82% thought there had been an increase. Vibration was ‘quite high’ and 82% said house shook when an HGV passed. Accidents reduced by 20% and 40% of respondents thought road safer.
Cost	£486,000

32. Ref. Davies and Ryley (1996).

Location	32a) Abingdon Road, Oxford; 32b) Burntwood Lane, L B of Wandsworth and 32c) Cricket Road, Oxford
Sample	32a) 61 cyclists, 32b) 41 cyclists and 32c) 54 cyclists
Measures	32a) A narrowing with bypass, 32b) Chicane with bypass, 32c) Narrowing
Installed	32a) April 1988, 32b) March 1994, 32c) April 1994
Survey	November 1994
Questions	Purpose and estimated distance of journey Likes/dislikes of section of road Behaviour of motor vehicles Safety/cyclist behaviour at narrowing Whether measures were an improvement
Reactions	Cycle lane was popular, 32a) 33%, 32b) 59% and 32c) N/A. Threat at narrowing was a concern 32a) 57%, 32b) 24% and 32c) 46%. Nearest vehicle in narrowing causes no problem, 32a) 72%, 32b) N/A and 32c) 75% . Road improved 32a) 57%, 32b) 85%, 32c) 51%
Results/Cost	Not stated

33. Ref. Sayer and Parry (1994).

Discussion at TRL chicanes seminar 16/3/94.

Surveys in which public opinion was mentioned were:

Location	33a) Braemer Road, Gosport; 33b) Budshead Road, Plymouth; 33c) Cleeve Road, Leatherhead; 33d) Albert Drive, Sheerwater.
Sample	Various
Measures	33a) Half carriageway buildouts, 33b) Two-way working, 33c) One-way working, 33d) Two-way working and raised roundabout.
Installed	1991 - 1993
Survey	Various
Questions	Various
Reactions	33a) The public wanted the buildouts replaced with road humps. 3b) Favourable reaction from residents. Speeds and accidents reduced. A disadvantage is the loss of parking. 33c) Local people (69%) think that the scheme is a waste of money and they prefer humps. Bus passengers (30%) thought journeys were less comfortable. (See Survey 21d for more detail) 33d) The scheme is perceived as a success. (See Survey 21c for more detail)
Results/Cost	Not stated

34. Ref. Sayer, Parry and Barker (1998).

Location	Local Authority schemes in UK.
Sample	Comments to Local Authorities
Measures	Chicanes and buildouts
Installed	Dates not given
Survey	None carried out
Questions	No specific questions
Reaction	Cars which hit buildouts/marker posts are a concern.
	Hazards during darkness and bad weather.
	Priority signing at chicanes.
	Visual intrusion and loss of parking spaces.
	Congestion and safety concerns.
	Most of the above could not be quantified.
Results	Not stated
Cost	Minimum of £400 and maximum of £8150 per chicane

35. Ref. Hass-Klau et al (1992).

Location	Various
Sample	Residents affected by traffic calming.
Measures	All traffic calming measures
Installed	Before 1992
Survey	Before 1992
Questions	General questions
Reactions	Residents were 80% in favour & 2% totally against traffic calming. Businesses, 68% in favour & 13% opposed.
	Car drivers 66% in favour & 11% against. Emergency services were divided.
Results	Not stated
Cost	Round-top humps, £500 - £1,000 each. Flat-top £4,000 - £12,000 each.

36. Ref. Walker, Gardner and McFetridge (1989).

Location	Nelson, Lancashire.
Sample	160 & 189 residents interviewed
Measures	Area wide scheme including pedestrian crossings, roundabouts, street closures and parking bays.
Installed	June 1985
Survey	July 1985 & November 1986
Questions	39 questions not given. Non-English residents had an interpreter present
Reactions	Approve of scheme; 65% in July 1985 & 74% in November 1986
	Roundabouts were very polarising with 12% & 33% being very unhappy in July 1985 & November 1986 but 13% and 33% being very happy.
Results	Accidents reduced by 15%.
Cost	£406,000

37. Ref. Goddard (1996).

Location	Wrexham, Queen's Park 20 mph Zone
Sample	Residents
Measures	Humps, cushions, narrowings and mini-roundabouts
Installed	April 1995
Survey	Public meeting after scheme implemented
Questions	None given
Reactions	Generally supportive but reaction against cushions on Queensway was very vociferous. Cushions replaced with flat-top humps. Mini-roundabout was unpopular. No adverse comments after modifications to scheme.
Results/Cost	Not stated/£200,000

38. Ref. Esteves (1996).

Location	Camden, Calthorpe Street area 20 mph Zone
Sample	Before 85 residents & after 58 residents.
Measures	Humps and road closures.
Installed	Early 1994
Survey	Before installation October 1993, after installation June 1994
Questions	A seven box system was used which had 'positive' or 'good' values on the right (eg safe, clean) and 'negative' or 'bad' values on the left (eg unsafe, filthy) as follows: What do you feel about Air Quality in your Neighbourhood? Filthy□ □ □ □ □ □ □ Clean
Reactions	Generally perception that safety improved but noise and pollution were worse. Seven box system used for questionnaire with 'positive' or 'good' value on the right. Noise, 12% thought it had increased. Based on changes of box 1-3 markings 'before' to 'after' Pollution, 2% thought it had increased.
Results/Cost	Not stated

39. Ref. Brennan (1994).

Location	Huyton, Hillside Estate
Sample	Residents
Measures	Speed humps/tables, 20 mph zone, road closures & realigned road
Installed	1993 approx
Survey	Not stated
Questions	Weighted system for traffic calming surveys. Asked to grade on line from zero to 100 with 50 as no change.
Reaction	64% of residents approved of the scheme.
Results/Cost	Not stated

40. Ref. Jenks (1983).

Location	13 estates in a Local Authority which was not specified
Sample	601 residents returned questionnaires in postal survey
Measures	Narrow carriageways, shared surfaces, pinch points, rumble strips as recommended by Design Bulletin 32. (DOE & DOT, 1977)
Installed	1970 - 1979
Survey	At least 12 months after installation
Question	Satisfaction of residents with estate appearance:- Very satisfied? Satisfied? Dissatisfied? Very dissatisfied? or Undecided?
Reaction	63% of residents satisfied with appearance of the estate.
Results/Cost	Not stated

Appendix B: Selected examples from outside UK

41. Australia (Hawley *et al*, 1993)
Various schemes are discussed in this Australian practitioners manual. The more important are summarised briefly below:

Location	41a) City of Stirling, Light Street, a residential street (C53)
Sample	Residents and motorists
Measures	Humps (100 mm high round-top)
Installed	c1981
Survey	After 3 months
Questions	Not given
Reactions	75% of residents found humps satisfactory and wanted them to be retained 80% of residents in surrounding streets were opposed to the humps and 20% of motorists thought that they should be retained.
Results	Mean speeds reduced from 38.2 mph to 17.2 mph (average of between and on measure. Humps removed and bus route reinstated.
Cost	Not stated

Location	41b) East Hornsby, Sydney (C10)
Sample	Residents
Measures	Offset carriageway and recessed parking
Installed	1986 -1987
Survey	May 1989
Questions	Has there been change in the amount of through traffic in your area since
(Total of 15)	the LATM scheme?

Example	Much less	Slightly less	No change	Slightly more	Much more
	☐	☐	☐	☐	☐

Reactions	17% overall approval
Results	No effect on traffic volume (0% change) 14.3 mph mean speed reduction
Cost	Not given

Location	41c) Philip Street (B256)
Sample	Residents
Measures	Tight configurations, flat-top humps
Installed	1991
Survey	Not given
Questions	Full evaluation, but not given in manual
Reactions	Residents acceptance of the scheme at 89%
Results	Heavy vehicles eliminated
Cost	$70,000 for measures, scheme total of $450,000

Location	41d) Gold Coast, Queensland (B49)
Sample	Residents
Measures	Round-top humps at a spacing of 200 metres
Installed	Not given
Survey	Not given
Questions	Not applicable
Reactions	The humps were removed at the request of local residents.
Results	Drivers chose to use severe acceleration and braking indicating a lack of acceptance by drivers.
Cost	Not given

Location	41e) Various (B25)
Sample	Residents
Measure	Road closures
Installed	Various
Survey	Various
Questions	Not applicable
Reaction	Can split a community unless they are overwhelmingly supported
Results	Should not be scattered ‘randomly’ around an area otherwise residents will not be able to understand the system and closures
Cost	Not given

Location	41f) Mosman, NSW (B62)
Sample	Residents
Measures	Angled slow points
Installed	Not given
Survey	Not given
Questions	Not given
Reaction	Approved of by residents but non-resident drivers objected strongly to the installation
Results/cost	Not given

Location	41g) Various (B12)
Sample	Residents
Measures	Roundabouts
Installed	Various
Survey	Various
Questions	Not given
Reaction	High acceptance was reported generally but it was less so in smaller rural townships. There was some confusion at mini-roundabouts sometimes by elderly drivers and also by drivers who abused the roundabout.
Results/cost	Not given

42. Denmark (L.Herrstedt, 1992)

Location	Vinderup, Skaerbaek, Ugerlose, environmentally adapted through roads.
Sample	Residents and motorists
Measures	Gateways, chicanes and rumble devices.
Installed	1984 - 1985
Survey	September 1985
Questions	Speed, measures and speed limits.
Reactions	Of car drivers (52%) approved of the schemes. Residents were generally all positive regarding the schemes
Results	Overall successful
Cost	£800,000

43. Israel (Zaidel et al, 1992)

Locations	Urban streets
Sample	Various
Measures	Traffic calming including humps
Questions	Various
Reactions	Can vary with time as countries install more traffic calming.
Result	Poses the question as to the degree and usefulness of public opinion surveys with regard to level of approval.

44. USA (Gorman et al, 1989)

Location	City of Omaha.
Sample	147 returned postcards
Measures	Road humps (100 mm high round-top)
Installed	1982 - 1986
Survey	1986 - 1987
Questions	Not given
Reactions	82% in favour of the humps and 18% were against. Survey showed that speed humps are very polarising.
Results	Speed reductions (85%) were quite small, up to 6 mph (average of 2.3 mph) and after speeds were in the range 31 to 37 mph (10 sites)
Cost	Not stated

45. Austria (Wernsperger and Sammer, 1995)

Location	Graz
Sample	Residents
Measures	30 kph in side streets and 50 kph in priority streets
Installed	Public discussion started in 1990, trial started at end of August 1992.
Survey	By telephone in 1985, 1989, August 1992, September 1992, March 1993 and June 1994.
Questions	Attitudes to the 30 kph limit
Reactions	Approval rates 56%, 64%, 44%, 60%, 72 and 77% respectively.
Results	Attitudes to accidents, noise, congestion and exhaust gases taken in June 1992, October 1992, March 1993 and June 1994. Accidents (fall) 62%, 54%, 68% and 71%, noise (increase), 31%, 20%, 19% and 34%, congestion (increase), 68%, 37%, 26% and 32%, exhaust gases (increase), 52%, 43%, 31% and 24%.
Cost	Not stated

Appendix C: Checklist of issues to consider in questionnaire[1] compilation

Issue	Comments		
Method of questioning			
	Interview	Advantage	Detailed questions can be asked
		Disadvantage:	Cost
	Postal	Advantage:	Cost may be less than for a face to face interview
		Disadvantage:	May be less representative due to low response rate
	Telephone	Advantage:	Immediate response
		Disadvantage:	No photographs can be shown (see below)
Road user group	If the scheme is aimed at assisting particular groups, are specific questions required for the group? a) Pedestrians; with mobility problems? children? all pedestrians? b) Cyclists? c) Residents? d) Emergency services? e) Bus operators/passengers? f) Motorists? g) All general public including non-local motorists?		
Photographs	Photographs of 'before' and 'after' installation are useful to ensure that respondents are considering the correct section of road. Very important for large schemes or if the environment was enhanced.		
Effectiveness	The perceived effectiveness will depend on the respondents' expectations. Before and after attitude surveys would therefore be useful but would double the cost of monitoring and would only be worthwhile for innovative schemes. Is the effectiveness the same for all types of vehicles? Prompts may be required if specific information relating to cars, buses, goods vehicles, bicycles and motorcycles is wanted.		
Safety	The safety of the scheme should be considered because it may be that pedestrians or cyclists felt very vulnerable before the scheme was implemented but it did not show up in the accident statistics. This could lead to the effect 'risk compensation' in which they may feel safer afterwards and take less care.		
Feedback	This can be considered to be the most important part of any survey because it allows the Local Authority to analyse comments from the respondents and then to: a) Consider if the comments are justified b) Adjust the scheme if required c) Review any adjustments made and add to local knowledge d) Share experiences with others in the same field.		

[1] *All methods of questioning can be susceptible to vociferous people who are against the scheme.*

Abstract

Traffic calming has proved to be an effective way of reducing vehicle speeds and accidents. The public generally approve of the concept of traffic calming and they often petition their local highway authority to have calming installed.

This report reviews the published literature describing 45 studies (40 UK, 5 Non-UK) of public attitudes to traffic calming schemes after installation. It gives details of the survey techniques and the types of questions used, together with the results obtained. It also compares the measured effectiveness of the calming schemes with the public assessments of changes in vehicle speeds, traffic flow, accidents, noise, vibration and pollution, to determine to what extent there is agreement between them.

Related publications

TRL312 *Traffic calming - speed cushion schemes* by R E Layfield and D I Parry (*In preparation*)

TRL313 *Traffic calming - an assessment of selected on-road chicane schemes* by I A Sayer, D I Parry and J K Barker. (*In preparation*)

TRL241 *Cyclists at road narrowings* by D G Davies, T J Ryley, S B Taylor and M E Halliday. 1997 (price code I, £32)

TRL238 *Traffic calming on major roads: the A47 trunk road at Thorney, Cambridgeshire* by A H Wheeler *et al*. 1997 (price code L, £40)

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