

THE IMPACT OF ON AND OFF-CARRIAGEWAY CYCLING INFRASTRUCTURE ON THE SAFETY AND AMENITY OF CYCLISTS AND PEDESTRIANS: A LONDON EXAMPLE

1. BACKGROUND TO THE STUDY AND CYCLING IN LONDON

Levels of cycling in London have grown considerably in recent years. There has been a 72% increase in cycle journeys since 2000 and, in the summer months, this increase rises to 100% (TfL 2006). Investment in cycling has also risen during the past five years from £5.5m in 2000 to £20m in 2005/06. In 2006/07, Transport for London (TfL) is investing £24m in cycling infrastructure, training, promotion and education. TfL is keen to monitor the impact of the new infrastructure to check that the money is being spent effectively. The London Cycling Action Plan (TfL 2004) sets out key objectives to deliver improvements in all aspects of the cycling environment, including research into new cycling measures.

TfL has established the following key indicators to determine the success of a cycling scheme:

- Cycle (and pedestrian) flows
- Casualty reduction
- User attitudes:- satisfaction (comfort, safety), modal shift
- Journey time

The specific scheme which TfL commissioned Atkins to monitor was a cycle track and cycle lane along West Hill on the A3 in Wandsworth (south west London). The scheme was implemented in 2004 and was initiated partly in response to the death of a cyclist. The scheme extends from the A205 South Circular Road in Wandsworth to the Tibbet's Corner underpass; a length of about 1.2km. It was completed in mid 2004 and comprised the following measures:

- An east-bound (downhill) cycle lane on the north side of the carriageway and advanced stop lines (ASLs) at a signal-controlled junction. The cycle lane width varies but is generally between 1.3m and 1.4m.
- A two-way cycle track on the south (uphill) side footway, including side-road and entrance cross-overs. The cycle track also varies in width but is generally between 1.2m and 1.4m.

2. METHODOLOGY

The following techniques were used to assess the impact of the scheme.

Analysis of accident data for cyclists

An analysis of accident data was carried out to enable comparisons to be made between the three year period preceding the implementation of the scheme and the period after (initially seven months).

Cycle and pedestrian traffic counts

Cycle and pedestrian traffic counts were carried out for a 12 hour period. Although there was no 'before' data with which to make comparisons, these counts revealed how many cyclists were choosing to use the dedicated cycle facilities, how many were using an on-carriageway alternative, and how many were cycling on the footway. They also revealed the total amount of cycle traffic using the facility and the degree to which it was peaked throughout the day.

Conflict study at side-road crossings

Video footage was taken at three of the junctions where the cycle track crossed a side road. One day's worth of footage was taken at each junction and this was assessed to determine the frequency and severity of any conflict between cyclists and other road users at the crossings. An analysis of pedestrian conflict was also carried out.

Questionnaire survey

A questionnaire survey was used to gather subjective feedback from cyclists and pedestrians on the impact of the scheme. The questionnaire included questions on the following: origin and destination; journey length, frequency and purpose; the impact of the new scheme on travel patterns; the impact of the scheme on safety, speed and comfort; any collisions respondents had been involved in; general comments on the scheme; and age and gender.

3. RESULTS

Analysis of accident data for cyclists

The initial 'after period' for the accident analysis was 7 months compared with 36 months of 'before' data.

There were five accidents involving cyclists in the 'before' period. One of these was the fatality (a collision with a goods vehicle) which partly prompted the scheme; the other four resulted in slight injuries (two were struck by oncoming cars turning right across their path, one by a moped who disobeyed the signals, and one where the cyclist rode off the footway and hit an undertaking goods vehicle).

During the 'before' period, 9% of all accidents had involved cyclists; during the initial after period none of the accidents had involved cyclists.

Cycle and pedestrian traffic counts

Cycle and pedestrian counts were carried out on one day from 7am to 7pm. In the morning peak (between 7am and 10am), a total of 111 cyclists and 600 pedestrians were counted travelling up or down West Hill (average hourly flow of 37 cyclists). In the inter-peak (10am-4pm), there were 59 cyclists and 629 pedestrians (average hourly flow of 10 cyclists). In the evening peak (4pm- 7pm), there were 117 cyclists and 397 pedestrians (average hourly flow of 39 cyclists).

The total daily flow uphill was 777 pedestrians and 136 cyclists. The total daily flow downhill was 849 pedestrians and 151 cyclists. The overall daily flow (in both directions) was 1626 pedestrians and 287 cyclists (average hourly flow of 24 cyclists per hour).

The daily cycle flows are shown below. The graph shows that the large majority of downhill cyclists used the cycle lane rather than the cycle track or the footway.

Figure 3.1 – Downhill cycle traffic on West Hill

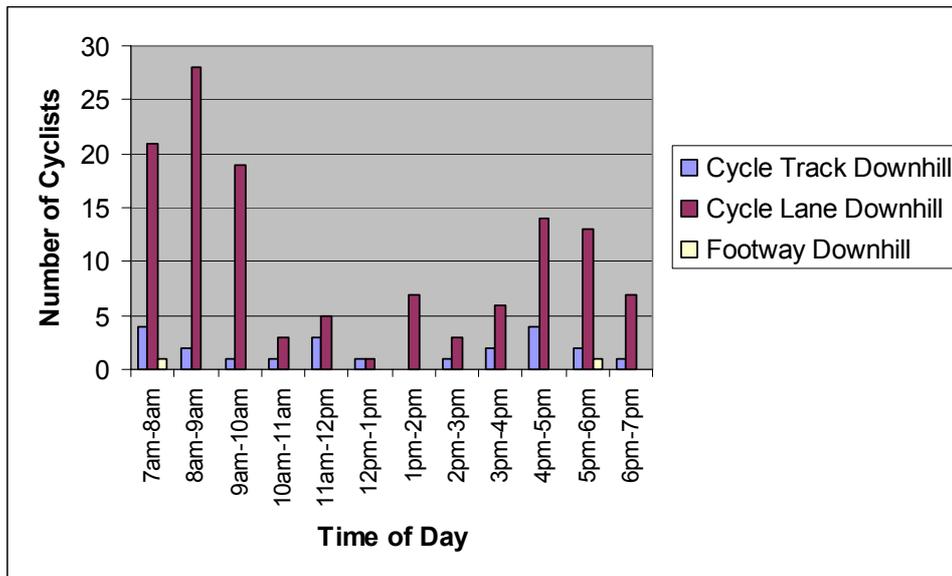
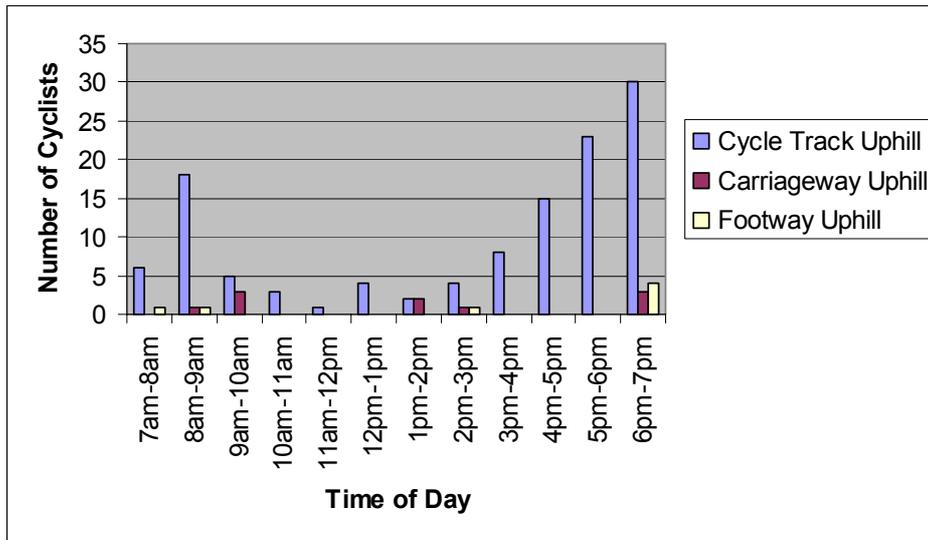


Figure 3.2 – Uphill cycle traffic on West Hill



The graph above shows that most of the cyclists travelling in the uphill direction used the cycle track. However, a small number either used the carriageway or the footway on the opposite side of the road (not a cycle track).

The counts revealed that cycle traffic was heavily peaked on West Hill and that most cyclists were using the cycle lane in the downhill direction and the cycle track in the uphill direction. The cycle track was a two-way facility and could have been used in the downhill direction but most cyclists were opting to stay on-carriageway.

Conflict study

A conflict study was carried out at three side-road junctions in the study area. There was a total of five side-road junctions within the study area. One was ruled out because it was very close to the eastern end of West Hill with traffic frequently queuing past the junction. Another side road was discounted due to the lack of a suitable vantage point for a camera.

Video footage from each of the three sites in the study was used to identify cyclist conflicts. The following four conflict assessment categories (adapted from a previous TfL research project into ASLs) were used:

- (1) Cyclist discomfort (where the cyclist did not brake or change direction but was likely to have felt discomfort perhaps due to the close proximity of another vehicle);
- (2) minor conflict (cyclist or motorist has to brake or change direction but the movement is calm and controlled);
- (3) major conflict (cyclist or motorist has to take emergency action in what is considered to be a near miss); and
- (4) collision.

Table 3.1 - Summary of conflict involving cycle traffic

Site	Discomfort	Minor	Major	Collision	Total Conflict	Cycle Flows	Conflict per Cyclist
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Haldon Road	1	1	0	0	2	132	1.5%
Sutherland Grove	3	4	0	0	7	116	6.0%
Beaumont Road	1	1	0	0	2	115	1.8%
Average	1.7	2	0	0	3.7	121	3.1%

In each of the 11 cases, contributory factors included cyclists' behaviour or failure to give way. From the video footage, it was not possible to determine whether this was due to cyclists assuming that they had priority at these points, or simply not realising that cars were approaching.

Questionnaire survey

Atkins staff distributed questionnaires on four occasions in November and December, 2005 (during the peak and the inter-peak periods). 78 questionnaires were handed out to cyclists of which 41 were returned (giving a response rate of 53%). 185 pedestrians were handed a questionnaire and 50 were completed (response rate; 27%).

Responses were received for a total of 52 cyclists (41 who were cycling on the survey day and an extra 10 who were but had recent experience of cycling along West Hill).

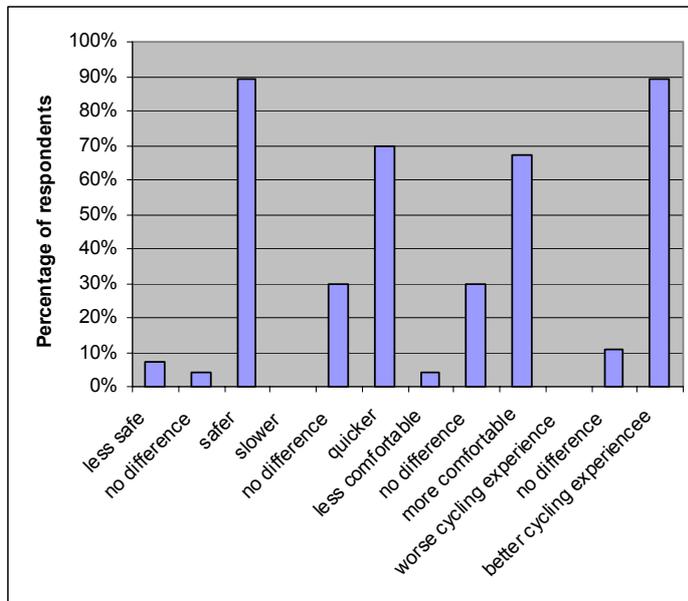
The mean distance for cycle trips was 7.9 miles and the mean journey time was 38 minutes (mean speed 12.5 mph). Over 70% of respondents cycled on West Hill at least three times a week.

Most respondents (86%) were commuting. 5% were on business travel and the remaining respondents were going shopping, to education destinations or visiting friends and relatives.

A small majority (58%) of respondents were able to give 'before and after' comparisons of the scheme having been cycling on West Hill before the new scheme was implemented (just over 18 months beforehand). These respondents were asked to comment on the impact of the scheme on their safety, speed, comfort and 'overall cycling experience'. Safety, speed and comfort are TfL's three key design criteria for cycling schemes as stated in the London Cycling Design Standards (TfL 2005). The following definition of comfort was provided for respondents: 'Comfort means having a good surface to cycle on, no unpredictable interruptions from other vehicle users or pedestrians, clear visibility, and it is pleasant to use and easy to follow'.

The results of the impact of the scheme on cyclists are summarised in the following two graphs. The results of the downhill and uphill directions are similar; nearly 90% of all respondents felt that the scheme had resulted in a better cycling experience. No respondents felt that the scheme had resulted in a worse cycling experience.

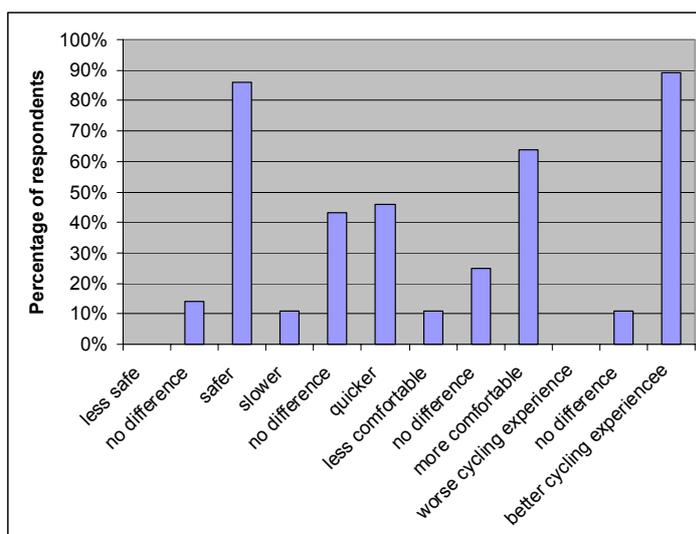
Figure 3.3 - Impact of scheme in the downhill direction



Of the three assessed categories (safety, speed and comfort), the scheme appears to have had the greatest positive impact on perceived safety with over 85% of respondents (in both uphill and downhill directions) considering that the scheme has brought an improvement. Not surprisingly, more respondents considered the downhill scheme to have improved speed (70%) than the uphill scheme (46%) (most downhill respondents used the cycle lane which, as an on-carriageway facility, means the cyclists keep priority at the junctions and can undertake slow-moving traffic). Improvements to comfort were similar in both directions (60-70%).

These results compare favourably with the Vauxhall Cross scheme (monitored by Atkins in 2005) where only 47% thought that safety had been improved, 33% said comfort was better and 26% noticed an improvement to speed.

Figure 3.4 – Impact of scheme in the uphill direction



Respondents were asked whether they had ever been involved in a collision when cycling or walking along West Hill. Seven people (13% of all respondents) said that they had. These collisions are listed in the following table.

Table 3.2 – Self-reported cyclist collisions

Date	Cycle Facility	Description	Category
April 2005	Downhill cycle lane at Texaco garage	Car travelling uphill turned across my lane into garage	Car travelling uphill turned across downhill cycle lane
No date provided	Downhill cycle lane	Not on the cycle path going away from London, but several times on cycle path on road coming into London.	No description
August 2005	Downhill cycle lane at junction with Portinscale Road	Heading downhill towards Wandsworth. Car did not indicate left turn as I was coming down cycle lane - got hit by car!	Car travelling downhill turned across (downhill) cycle lane
NDP	Downhill cycle lane	Vehicle pulling across cycle lane at speed forcing me into kerb - Happened a few times	Car travelling downhill turned across (downhill) cycle lane
November 2005	Downhill cycle lane	Yesterday! 8.11.05. My brakes failed and I bumped into another car turning across my path. Otherwise No.	Mechanical failure (bicycle)
NDP	Downhill cycle lane	Regularly 'caught' by cars using downhill cycle lane as extended carriageway and therefore clipping my wheel/handlebars	Clipped by passing cars
November 2005	Uphill cycle track at side road	I was cycling on the cycling route and a car came from the left to the main road without stopping - about 3 weeks ago	Cyclist on cycle track failed to give way at side road junction

Of the seven collisions described by the respondents, six took place in the cycle lane and one on the cycle track. Most of these collisions appear to have involved a motor vehicle turning across the cyclist's path unexpectedly. One collision took place on the cycle track and involved a car emerging from one of the side roads. This was one of the main conflict types observed in the video survey.

Respondent comments on the new facilities

The cycle lane and cycle track were generally very popular with the respondents. One of the main requests was that the facilities were extended over a wider geographical area.

Some respondents complained about encroachment onto the cycle lane and its use by motorcycle traffic. The number of collisions involving motorcycles was particularly high which suggests that there is a large volume of motorcycle traffic on West Hill.

Many comments were made in relation to the cycle track. Some respondents noted that pedestrians appeared to be unaware that it was a cycle facility. Several comments were made relating to the condition of the cycle track e.g. the quality of the surface (smoother on carriageway or the pedestrians part of the footway), and the presence of leaves making it slippery. Although complaints were made by cyclists about the bumpiness of the track; it is likely that this would have kept cyclist speeds down a little (i.e. acting as a form of cycle traffic-calming). It is hard to establish the impact of this on pedestrians. It could be interpreted as a beneficial side-effect for pedestrians who complained about the speed of the cyclists. However, it may also be the reason why some cyclists chose to cycle on the pedestrian part of the footway.

Several respondents commented on problems with crossings of minor roads (and driveways) which included that they made cycle journeys slower, less safe and more confusing. Two respondents mentioned problems with bus stops e.g. the risk of cyclists and pedestrians colliding due to the close proximity of the cycle track to the bus stop.

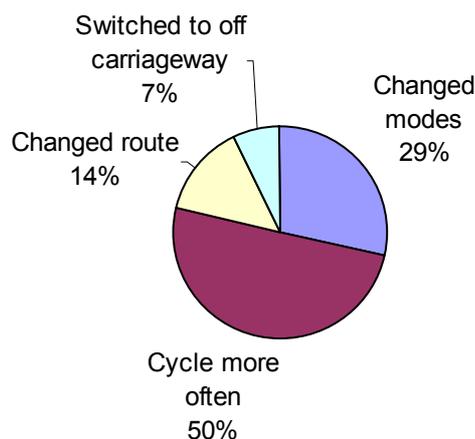


Figure 3.5 - Impact of new facilities on cyclists' travel behaviour

Over a quarter of the respondents claimed that the new facility had caused them to change their travel pattern in some way. The chart above shows how travel patterns were affected. The main impact of the scheme was that cyclists had switched modes

or were cycling more often. The remainder had changed routes to use the new facility (previously taking a less direct route) or had simply started cycling off-carriageway.

Impact on pedestrians

Like the cyclists, pedestrians who used West Hill before the new scheme was implemented were also asked to evaluate the impact of the scheme (on their walking environment). Although 23% said that the scheme had improved conditions, over a third claimed that it had made them worse.

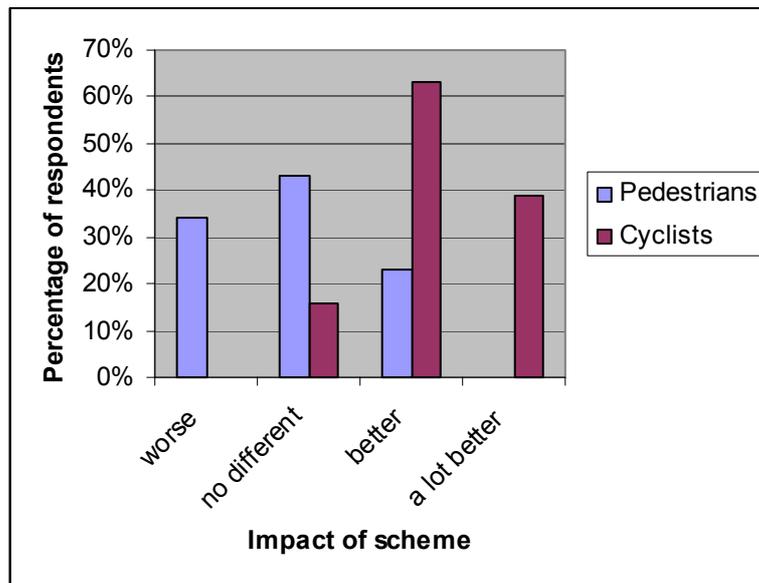


Figure 3.6 - Impact of scheme on pedestrians and cyclists

The graph above compares the impact of the scheme on pedestrians with the impact on cyclists (NB the figures for cyclists are an average of the uphill and downhill scores). The graph shows that, whereas the impact on cyclists has been positive, most pedestrians felt that it had made no difference to them or it had made conditions worse.

Over thirty 'negative' comments were made by the pedestrians about the scheme. Approximately half of these comments related to the cyclists themselves; the pedestrians thought they were cycling too quickly, that they were oblivious to pedestrian traffic, or that they used the wrong part of the footway (i.e. the pedestrian section). Some pedestrians mentioned the side-road crossings and claimed to have seen many near misses.

Cyclist behaviour was the pedestrians' main concern. However, many comments were made about the design of the cycle facilities. The width of the footway (particularly at street furniture locations) and the accumulation of leaves were mentioned. One respondent mentioned that the footway has a smoother surface so

was often used by cyclists in preference to the cycle track, and the lack of clear markings was also highlighted. Two comments were made about the cycle lane. One was its negative impact on traffic congestion near Sutherland Grove (where a right-turn pocket was removed to provide room for the cycle lane) and the other was the difficulty that pedestrians have in seeing cyclists in the cycle lane (obscured by queuing motor vehicles) when they are walking across the road. This is an issue which applies to most cycle lanes but perhaps is a particular problem on long downhill sections where cycle traffic is likely to be relatively fast-moving. Changes were made to the location of the bus stop at the bottom of West Hill during the study so it was not possible to gain any reliable data on the interaction of cyclists and bus passengers (boarding or alighting).

Cycle track design

There appears to be a trade-off with the design of the cycle track in terms of maximising cyclist comfort and minimising conflict with pedestrians. Ideally, for cyclists, the cycle track would have a smooth surface and follow a straight alignment. However, this would encourage cyclists to travel faster and have a negative impact on pedestrian amenity and perceived safety. A cycle track with relatively sharp bends and a bumpy surface could act as a means of calming cycle traffic but care would need to be taken not to make the track unacceptably hazardous.

The cycle track and the cycle lane are both narrower than the minimum widths stated in the London Cycling Design Standards. The cycle track (which is two-way) is at least 10cms narrower than the absolute minimum width for a one-way track. However, the track seems to attract very little two-way traffic with most cyclists using the cycle lane when travelling downhill (there were no more than four cyclists per hour using the track in the downhill direction). This study has shown, therefore, that sub-standard width cycle facilities can still be of considerable use to cyclists, and lessons could be transferred to other cycling schemes where there is insufficient width to achieve recommended widths. Factors to bear in mind, however, are that cycle and pedestrian flows were both relatively low. Furthermore, the substandard width cycle lane had a coloured surfacing over its entire length which could help to improve motor vehicle compliance (the impact of coloured surfacing on motor vehicle compliance has not been well researched).

Accident data made available at the end of the study

During a project meeting after the submission of the draft report, TfL requested that Atkins looked in more detail at the apparently large increase in the accident rate which had taken place since the implementation of the scheme. This was based on 7 months of 'after' casualty data. However, once 15 months of 'after' data had become available, it was found that this large increase was a statistical blip. The additional data did, however, reveal that several collisions involving cyclists had taken place.

In the 'after' period, there were three cycle accidents (12% of all accidents) compared with five (9%) in the before period. This included one serious and two slight injury-accidents. Two slight-injury accidents occurred at the junction of West Hill and Lytton Grove, and each involved a right-turning car colliding with a north-eastbound cyclist in the cycle lane. The serious injury-accident involved a right-turning car colliding with a north-eastbound cyclist in the cycle lane at the junction with Sutherland Grove (very close to Lytton Grove). All three accidents involved north-eastbound cyclists in the cycle lane colliding with south-west bound cars turning right into a side road.

These relatively recent collisions appeared to confirm the finding from the questionnaire survey where most of the respondent collisions had taken place in the cycle lane. The layout of the Lytton Road junction, where two of the recent cycling collisions took place, is due to be altered imminently. This may address the cause of the problem.

4. SUMMARY

The West Hill cycle scheme appears to have improved conditions for cycling considerably. Respondents reported that speed, safety, comfort and 'overall cycling experience' had all improved. The largest improvement has been to perceived safety. One of the many positive comments included 'Overall the scheme is a great success. I am convinced lives will be saved'. Another respondent, stated: '(It is) so much safer as no longer sharing with lorries pounding up the hill'.

Despite the improvements that the cycle facilities have provided, there were many comments about problems that cyclists faced, particularly in relation to the cycle track (e.g. the width and surfacing), side-road crossings, and the unpredictable behaviour of some pedestrians.

Among the cyclists who responded to the questionnaire, the scheme has led to an increase in cycling, a switch from other modes (but not the car), and a change in routes.

There appears to be considerable ambiguity about priority on the cycle-track crossings of side roads. The layout of the crossings (where the colour and the surface of the cycle track is continued across the side roads) could suggest that the cycle track has priority although there are no signs or markings to that effect. It could be made clearer that cyclists do not have priority.

In most of the recorded cyclist conflict, cyclists appeared to assume priority. Conversely, there was relatively little conflict among pedestrians at side-road crossings possibly due to their slower speed, ability to stop very quickly (compared with cyclists), and it being more visually obvious that the footway does not continue across the side road.

Despite the problems with the cycle-track crossings, most of the collisions took place in the cycle lane. This could be partly due to the fact that the cycle lane was downhill and cyclists were therefore likely to be travelling a lot more quickly than on the cycle track (where most travelled uphill).

Many respondents used the cycle track in one direction and the cycle lane in the other. This suggests that the decision to cycle on or off-carriageway is not simply a question of cyclist confidence and ability as has often been thought in the past. The average distance that cyclists were travelling was 8 miles which is relatively long, even for London. This suggests that even long-distance utility cyclists are happy to use off-carriageway cycle facilities in some situations.

Among the pedestrians who responded to the questionnaire, the overall impact of the scheme appears to have been slightly negative. The problems which were listed related to the design of the scheme and to cyclist behaviour (excessive speed, failure to keep to the cycle track, and a general lack of consideration). The improvement for cycle traffic does appear to be much greater than the negative impact on pedestrians. However, there were over five times as many pedestrians using the scheme so the net benefit to local residents may be less clear.

No collisions involving cyclists had been reported to the police since the scheme was implemented (up to the initial cut-off point for which 7 months of collision data had been provided). However, several cyclist collisions were mentioned in the questionnaire but, judging from the descriptions, they did not involve injury and would therefore not normally be reported to the police. This highlights the amount of under-reporting of cycling collisions and the need to rely on alternative techniques (such as conflict studies and questionnaire surveys) to monitor the impact of schemes on cyclist safety.

There were complaints about the cyclists' speed from the pedestrians but also about the bumpiness of the cycle track from the cyclists. There is, therefore, a need to strike a balance between providing a comfortable cycle facility (to minimise discomfort) and encouraging cyclists to keep their speeds down (to minimise conflict with pedestrians).

Design and research recommendations

Neither of the cycling facilities covered in this study met the minimum required widths as stated in the London Cycling Design Standards (e.g. 1.5m for a cycle lane). Some organisations have called for even wider minimum widths (e.g. 2.0m) and argue that it is better to have nothing at all if such widths cannot be provided. However, it has been found that both facilities have increased the speed, comfort and perceived safety of cycle journeys. It is possible that the provision of coloured surfacing is a key element in the successful use of substandard width cycle lanes. It is recommended that TfL researches the impact of colour on cycle lanes to see whether coloured

surfacing should be used more widely, particularly where cycle lane widths of 1.5m cannot be achieved.

This study found that there was considerable ambiguity about priority at the cycle-track crossings of side roads. Consideration should be given to reducing this ambiguity through the design of the crossings with improved surfacing and, where necessary, additional signing.

The findings in this study highlighted the effectiveness of conflict studies in detecting potential safety problems where no collisions have been formally reported. It was recommended that conflict surveys should be carried out at other junction types (e.g. cycle-track crossings of minor roads where the cycle track has priority) so that conflict comparisons can be made between different junctions.

This study found that relatively long-distance, utility cyclists were happy to use the off-carriageway facilities. This finding should be used to inform TfL policy on appropriate design solutions for different road environments and journey types.

Additional summary and recommendations following analysis of more recent collision data

An additional eight months of collision data became available towards the end of the study. This increased the 'after' period to 15 months. This additional data confirmed the finding from the self-reported collisions that there were more problems where the cycle lane crossed junctions than on the cycle-track crossings. In the additional data, two collisions involving cyclists had taken place at the same location; Lytton Road. This junction had already been identified by TfL as one which required a re-design (due to congestion problems caused by the removal of a right-turning pocket) and construction had been scheduled for this year (2006).

It was recommended that TfL carry out studies of cycle lanes at side-road junctions to establish whether this is an area of above-average conflict, and to determine whether typical problems can be designed out.

5. REFERENCES

TfL (2004) *London Cycling Action Plan*
<http://www.tfl.gov.uk/cycles/downloads/reports/cycling-action-plan.pdf>

TfL (2005) *London Cycling Design Standards*
<http://www.tfl.gov.uk/cycles/company/standards.shtml>

TfL (2006) <http://www.tfl.gov.uk/tfl/press-centre/press-releases/press-releases-content.asp?prID=823>