Inclusive design at bus stops with cycle tracks

MARCH 2024

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By ‘walking’, we include ’wheeling’.

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This report is the work of Living Streets and the findings it describes are not necessarily endorsed by those listed above, nor any organisations they represent.

Disclaimer

Our remit was to answer the broad question: do bus stop bypasses and continuous footways lead to people being excluded from use of the streets (and bus services), and what would make them more inclusive? We have responded to the challenge by seeking to clearly describe the infrastructure (its key characteristics), desired outcomes, and the user experience for people who walk, wheel, cycle or drive. From the beginning, our underlying assumption has been that if infrastructure excludes people or exposes them to increased road danger then it is not performing well.

This infrastructure is being introduced partly in response to national policy objectives to increase levels of cycling, walking and wheeling. While clearly the product of a policy environment, the observations, conclusions and recommendations in this report are not a definitive statement of Living Streets' position on bus stop bypasses or continuous footways. In submitting the findings to a wider audience, we hope that this is the beginning of a much bigger conversation about what changes are needed to make streets inclusive.

Contents

Executive Summary

This work is an in-depth investigation relating to infrastructure designs where a cycle track continues past a bus stop. It was prompted by questions around whether these are necessary and effective, and/or whether they make streets less inclusive.

To answer these questions, we used a multi-threaded approach over a project spanning two years. This brought together hard data, softer evidence of real-life behaviours, and learning from literature, consultation, focus groups, and interviews. Initial findings were refined through consultation with people with a range of differing views. The result is a set of conclusions which describe a complex and nuanced situation, a proposal for a minimum design quality, and the recommendation that a small number of design enhancements are tested to work out whether they solve specific problems.

The initial report sections and accompanying appendices present the separate elements of evidence and threads of work that support our findings. The “Discussion of core findings” section of the report brings these together, covering the following issues in depth:

EVIDENCE OF EXCLUSION/DISADVANTAGE

There is inconsistency in current design approaches, and in terminology about designs that continue a cycle track past a bus stop. Existing British bus stop bypasses do not reliably allow a blind or partially sighted pedestrian to stop cyclists so they can cross the cycle track to or from the bus stop. The level of cycling, along with the complexity of the environment, dictate the overall level of impact.

Badly laid out bus stop bypasses multiply the issues faced by blind and partially sighted people. Insufficiently wide pavements or islands create overcrowding or real difficulties manoeuvring with mobility aids like wheelchairs or mobility scooters. Overly constrained designs can decrease the flexibility of bus drivers to deploy ramps. A lack of clarity about the presence of cycle tracks can result in people walking or queuing on them.

However, whilst there is some concern about bus stop bypasses, our observational data suggested the level of discomfort or difficulty most people experience in using these bus stops, **when well designed**, is very low. Where a cycle track is extremely busy – a much wider group of pedestrians can be disadvantaged, unless reliable support is provided to allow easier crossing. There are also examples of poor design.

CURRENT ATTEMPTS TO MITIGATE ISSUES

At many sites two approaches have been used to try to ensure the cycle track is easy to cross. The first is the provision of a zebra crossing. The second is a layout or arrangement that aims to produce slow cycling speeds. Our observations confirm neither of these approaches work reliably but point to the reasons for this failure being complex and multi-faceted. Indeed, we suggest some design features may be having effects that are the opposite of those desired.

AVOIDING THE USE OF BUS STOP BYPASSES

If levels of cycling are to be significantly increased, and this is to become an ordinary, inclusive means of transport, then entirely ruling out the use of bus stop bypasses is not a viable option. This would mean significant gaps in cycle tracks with cyclists returned to the carriageway, which is already understood to create risk or fear for cyclists.

However, it is preferable to avoid the need for bus stop bypasses in as many locations as is practical. Other approaches include the use of alternative (direct and attractive) routes for either the bus route or cycle track. We found that it is sometimes argued that where full separation isn't possible there could be a case for mixing cycling with very slow-speed bus traffic – excluding other vehicles. This might be another option employed in limited places, such as within a city centre. We did not attempt to look for evidence around whether this option could produce safe and attractive conditions, but behaviours at some of our study sites were consistent with this being a possibility worth further research (See Section 8.1).

MINIMUM DESIGN QUALITY

Any design enhancements will only be effective if the basic design follows some key principles, which we outline. These discuss simplifying the environment for all users, including blind and partially sighted pedestrians, and other disabled people. We also propose new ideas about the appropriate design of features to discourage higher speeds on cycle tracks.

In absolutely all cases there must be sufficient space for accessible design, including sufficient footway width (absolute minimum 2m) and a bus stop island/platform which can be easily negotiated using a wheelchair or other mobility aid.

We could see that many existing bus stop bypass designs do not meet the standard and principles we outline, and these should be reviewed, improved or alternative bus or cycle routes explored. In the longer term there is a need to predict changes in usage of cycle tracks, ensuring that at individual sites any enhancements to support safe crossings are modified if conditions require.

THREE CHARACTERS OF SITE / POSSIBLE DESIGN ENHANCEMENTS

The problems that bus stop bypasses create, and the enhancements needed, vary according to the environment. We identified three broad site characters - very quiet-simple, moderately busy-complex, and very busy-complex. We provide guidance on design enhancements that should be tested for their effectiveness in supporting people to cross the cycle track in these different situations.

Some sites are likely to provide quiet-simple environments, even in the long term. Conditions at these sites result in pedestrians being unlikely to meet a cyclist.

For busy-complex sites traffic-signals are needed to create safe crossing opportunities putting these sites on par with similarly busy junctions or carriageways where assistance is provided to pedestrians.

For moderately-busy moderately-complex sites we propose the testing of three new approaches to provide pedestrians who need it with extra support to cross. These need to be designed in the expectation that most pedestrians will not need or want to use them, and this creates some design challenges. Aims should include maintaining or building on existing levels of cooperation and accommodation between crossing pedestrians and people cycling on the track.

COLLABORATIVE WORK

It was clear that processes to create inclusive designs haven't worked well to date, and this needs to change. We found little evidence that concerns centred on blind and partially sighted pedestrians' experiences had had much effect on influencing design choices. The onus is on designers to address this lack of confidence around participation, consultation and to achieve a genuine shift to co-production.

More work is needed to bring disabled people and designers together in a constructive and respectful manner, identifying the reasonable adjustments that need to be made on equalities grounds. This should recognise the inherent challenge that adapting streets whilst meeting the needs of all users poses.

Further work is needed to ensure all those concerned are involved in evaluating whether our conclusions are correct, and in testing and/or refining the proposed design enhancements. A starting point is a series of pilots both involving new sites at the design stage and retrofitting existing sites. Disabled people should be at the heart of this work.

1 Introduction

This report sets out the results of research carried by Living Streets into situations where a cycle track continues past a bus stop. We concentrate on "bus stop bypasses" (sometimes known as "floating bus stops"), but also consider other arrangements. These include continued kerbside track arrangements, shared platform boarder arrangements, and hybrids of these three key options (see Figure 6 on page 22 and the associated discussion).

The work was funded by the Scottish Road Research Board, Transport Scotland and the Department for Transport, starting in 2019 and concluding in May 2023.

This document describes: our approach to the research; what we observed from each separate thread of enquiry; and our overall conclusions and recommendations.

Because of the depth of this research, and its multi-threaded nature, important details on observations and recommendations can be found throughout the report sections. However, Section 8 discusses the core findings, and many of the main conclusions and recommendations are briefly summarised in Section 9. More detailed information is presented in the Appendices for audiences that require it.

In parallel with this research, we also studied related (and some unrelated) questions about "continuous footway" designs. The latter is covered in a separate report[1].

RESEARCH PURPOSE

Bus stop bypass arrangements, and other means of continuing a cycle track at a bus stop, are a relatively new feature of British streets. This research was prompted by controversy around a number of issues, focusing on questions about whether this infrastructure makes streets more or less inclusive.

The purpose of this work was to investigate this situation thoroughly, looking to understand:

- What effect designers were aiming for in continuing a cycle track past a bus stop,
- What designs currently exist on the streets,
- Whether these arrangements achieve the desired effects,
- What concerns were held by those worried about inclusion,

[1] "Inclusive design at continuous footways"

- What evidence we could find to validate specific concerns, or that provided reassurance around them,
- What additional advantages or disadvantages we could see arising from the use of this infrastructure,
- The current role of written materials in supporting or hindering good design or inclusive practice.

Our role also extended to proposing a way forward, taking the above into consideration.

SUMMARY OF RESEARCH PROCESS

At the beginning of this research, we recorded that we were making a number of assumptions. These are outlined in Section 2, along with notes about the language used, and some helpful definitions.

In undertaking the study, we used what we have called **a "multi-threaded" approach**. The reasons for this include that:

- Most of the questions we were asking are complex and multi-faceted.
- Crucial factors around inclusion and exclusion, like how fearful people are, or how they might behave if less fearful, cannot easily be quantified.
- It was important to try to understand whether different designs, that do not currently exist, might work in future – without being able to test them.
- We could not observe the experiences of people who have already been excluded.
- We needed to understand how infrastructure might exclude people, but it would have been unethical to ask people who felt they were unsafe using infrastructure to do so in order that we could test how much this put them at risk.
- Changes to streets, and particularly those intended to reduce traffic or encourage cycling, create controversy and even fear. Discussions about their impact on inclusion are part of a much wider discourse around change. There are dangers that the views of disabled people can be appropriated or misrepresented by those with polarised interests.

To ensure the integrity of our work, and to support our access to a wide range of knowledge and expertise:

- We regularly consulted a "Reference Group" (membership listed inside the front cover) in which we brought together experts in design, disability, inclusion, and research.

- We worked with the disabled person's organisation "Transport for All" (which was also part of the Reference Group). Transport for All led our engagement and site-visit work with disabled people, and took part in key informant interviews, helping us to analyse these.
- We took emerging findings back to people who had been engaged in the research and consulted on these more widely. This allowed us to check these findings, our reasoning, our understanding, and the way in which we were explaining ourselves.

The advantage of the multi-threaded approach was that it brought together learning from across a wide range of sources and approaches. However, it should be emphasised that this makes reporting back on the fieldwork, analysis, conclusions and recommendations inherently complex. By way of example there was overlap between participants in the project who had design knowledge, those with a focus on inclusion, and those with lived experience of disability. For clarity we report as if we were learning from three separate groups in three distinct phases of project activity. Details can be found in subsequent sections but in summary **the main threads** comprised:

- A literature review (Section 3)
- Mapping and recording existing relevant bus stop and cycle track arrangements using a GIS system (Section 4)
- Structured interviews and further work with professional informants (encompassing both the design perspective and organisations representing disabled pedestrians) (Section 5)
- Work with disabled people as individual members of the public using focus groups and site visits (Section 6)
- An in-person study of a wide variety of relevant bus stops
- Detailed-study site work (see Section 7) at 10 locations where relatively good[2] designs existed, comprising:
  - (i) In-person study using both structured techniques and less formal approaches and,
  - (ii) analysis of behaviours at these sites using fixed-cameras (alongside shorter segments of video footage taken by researchers), supported by the use of artificial intelligence processing.

[2] Section 7.1 explains how sites were chosen.

Figure 1 on page 9 provides a simplified schematic showing the threads, and key elements of the work within each thread.

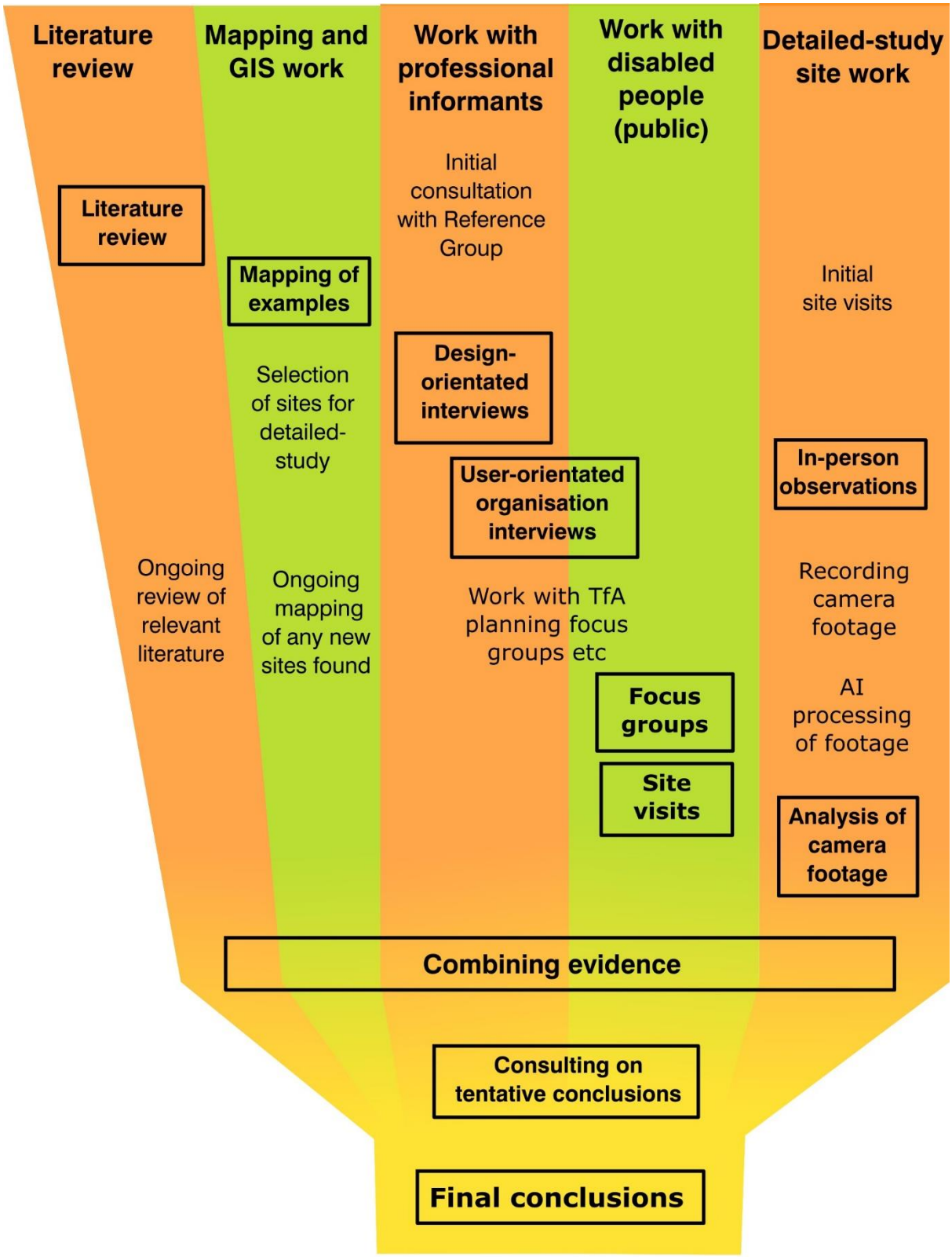
Overall, this multi-threaded approach meant that we were able to bring together hard data, softer evidence of real-life behaviours, and learning from literature, consultation, and interviews. To reach final conclusions, evidence from the separate threads of the research was combined. The result is a set of wide-ranging conclusions and recommendations presented in a narrative form.

ACCOMPANYING DOCUMENTATION

Accompanying this report, as separate documents, are:

- Appendix 1 (detailed-study site details)
- Appendix 2-6 (design classification details, suggested design principles/minimum quality, and images from cycling in a track with gaps at bus stops)
- A literature review (also summarised in Section 3 of this report).

Figure 1: Diagram illustrating threads in the multi-threaded approach



2 Definitions, language, and assumptions

USEFUL TERMS AND DEFINITIONS

We have aimed this document both at those with knowledge of street design and infrastructure, and at a much wider range of interested parties. A small number of technical terms – and some convenient phrases – are used throughout the text, as outlined below.

Because footways beside a carriageway are commonly called "**the pavement**" by members of the public we use this term. A **carriageway** is the area of a road or street intended for motor vehicle movement.

The term "**cycle track**" refers to situations where an area is provided for cycling that is physically separate from *both* the carriageway *and* the pavement, whereas a "**cycle lane"** is marked on the carriageway. A cycle track follows the course of a carriageway, close beside it. For the purposes of this work an area marked for cycling with paint or coloured surfaces, on what would otherwise appear to be an area of ordinary pavement, is not considered a cycle track.

We use the words "**inclusion**" and "**exclusion**" as shorthand to refer to the way in which design (and wider factors) can make the use of streets easier, more difficult, or impossible for disabled people.

There are comprehensive explanations of how we use the terms "**bus stop bypass**", "**bus stop boarder**", "**shared platform boarder**" and "**continued kerbside track arrangement**" in Section 4.2 of the report.

For simplicity we have had to use terms like pedestrian, cyclist and driver. We hope that it is clear that we understand that these are not separate groups of people, and that this is just a description of how people are travelling. We use the word "**pedestrian"** to refer both to people walking and those using wheeled mobility aids such as a wheelchair or mobility scooter. The phrase "**walking and wheeling**" describes how pedestrians get around, encompassing the need to ensure that pedestrian environments must be accessible to those using wheelchairs and other wheeled mobility aids, not just those on foot. We use the word **"cyclist"** to mean anybody using what are a very wide range of bicycles, tricycles, and other wheeled human-powered devices. We occasionally use the word "**bicycle**" to cover these devices. We did so because this is a familiar term in a report which is discussing complex ideas – when a more accurate title would be "cycle".

We write about work with **"disabled people".** By this we mean anyone who faces access barriers due to an impairment, including people who don't use the word "disabled" to describe themselves. This explicitly includes those who are deaf/Deaf, neurodivergent, chronically ill, have a mental health condition, have age-related impairments, and people with both visible and non-visible impairments.

We heard from disabled people who themselves preferred that we wrote about "disabled people" or "blind and partially sighted people" in line with the social model of disability. However, some participants preferred terms like "people who are blind or partially sighted". This is a sensitive issue, so we hope that readers will accept that we have chosen one option rather than the other in good faith, and in seeking consistency, whilst acknowledging the diversity of views on this topic.

BACKGROUND AND ASSUMPTIONS

At the beginning of this project we recorded a list of the assumptions we were making in approaching the work.

General background assumptions, which we expected to stand throughout the project, were as follows:

- There are big problems in relation to the accessibility of current streets. Some people are largely excluded from using them, or have only very limited or tenuous access. For these people the stress and difficulty involved in making everyday journeys can be overwhelming. Any conclusions about changes to accessibility must recognise this context.
- While this work will consider the perspectives of groups like pedestrians, cyclists, drivers and disabled people it is important we remember that these are not separate groups of people. During this work one factor to take account of is the existence of negative stereotypes and perceptions about some of the groups of people involved.
- We will need to remember that some people have already been excluded from the environments we are investigating. We won't be able to observe the experiences these people would have in these places.
- An *increase* in the accessibility of our streets is necessary. This will involve big changes.
- It is government policy (UK and devolved) to create a big increase in the level of cycling for everyday journeys. It is assumed that this requires a substantial increase in the general safety of cycling on direct, convenient, attractive routes. These must remain welcoming at night. This means that where routes are alongside faster or heavier traffic they must be protected from it.

- In considering issues of inclusion the project must focus not only on any problems for disabled pedestrians, but also on those experienced by a wider group. This includes those who walk more slowly (for example, because of age) or who are likely to be less able to judge vehicle movement (for example children). Infrastructure that meets the needs of all of these groups is likely to be of a good standard for everybody else.

Based on these initial assumptions, and on the basis of some initial investigations of conditions at bus stops, we made two further assumptions. These assumptions, and our reasons for making them, were explained to participants in the project.

They were that:

- Some British bus stop bypasses can be seen to provide conditions that aren't navigable by blind and partially sighted pedestrians.
- If cycling levels are to increase significantly then it will be necessary to have some situations where a cycle track continues past a bus stop.

3 Literature review summary

Early on in this research we conducted a literature review and a full report of this is provided separately. Key points are summarised below, but **readers wanting a referenced account of these details should refer to the separate document**.

We studied formal infrastructure guidance on bus stop bypasses, informal literature, research, and policy documents. We sought relevant written guidance or position statements from organisations focused on disabled people and/or inclusion.

The principal focus was on UK literature. However, because some informants and sources referred to infrastructure in Denmark, we also looked at some key Danish documents. While the focus was on bus stop bypass designs, we also looked for literature on alternative arrangements involving a cycle track at a bus stop.

PURPOSE

Design guidance (and similar documents) focus on the idea that bus stop bypasses are provided to increase the safety of cyclists in regard to interaction with buses. One key document suggests that "cyclists … need a means of passing stationary buses and trams without having to come into conflict with faster vehicles on the carriageway" [1]. Another identifies the purpose as providing both "safety" and "comfort" for cyclists passing stationary buses [2].

This contrasted with suggestions in some of the written positions of a number of the key organisations representing blind and partially sighted pedestrians. While some of these focused on the same issues, we found that as much emphasis was placed on the idea that these arrangements are provided mainly to improve the *convenience* of cycling [3]. We noted that some older design guidance also took this approach, for example focusing on how these arrangements enable people cycling to "maintain momentum and minimise delay" [4].

Safety and convenience are related, but this key difference in reasoning seemed worth noting.

TERMINOLOGY FOR DIFFERENT DESIGN ARRANGEMENTS

We confirmed that in the literature there are typically three arrangements described that involve a cycle track at a bus stop. These three arrangements are illustrated in a number of different configurations in Figure 2, Figure 3 and Figure 5.

Each of the images in these figures provides a simple plan view of a section of street. In these a stopped bus is shown in dark blue, moving cars are also shown in

dark blue, and parked cars are shown in pale blue. The cycle track is shown in red, and the pavement in the lightest grey colour. The darkest grey area is a building.

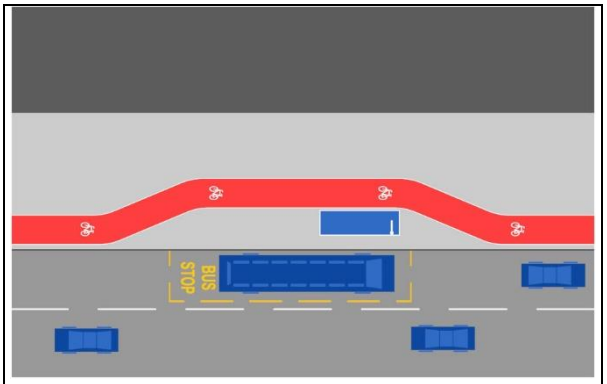
The first arrangement, where a cycle track runs behind the bus stop, is consistently named as either a "**bus stop bypass"** or a **"floating bus stop".** In this report we use the former term, although there might be reasons to argue that "bypass bus stop" (rather than "bus stop bypass") would be a more helpful formulation of that title. Three different design configurations achieving this effect are shown in Figure 2.

The second arrangement, where a cycle track ceases, and people are expected to cycle on an area that is effectively pavement (Figure 3, page 15), is not always named. In recent Scottish guidance this is referred to as a **"bus stop boarder"** (but see below).

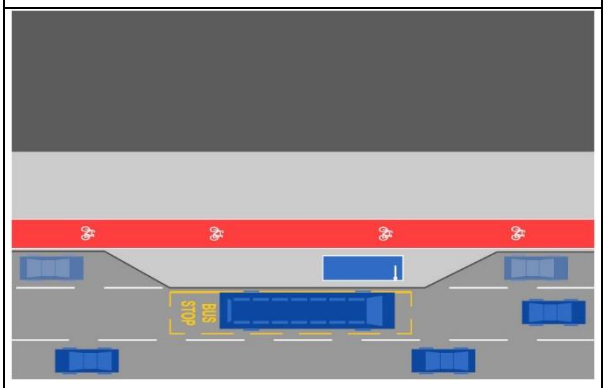
A third possibility involves providing a space for people to cycle between the bus stop and the carriageway, so that pedestrians cross this when getting on and off a bus. Arrangements that achieve this are usually also called a **"bus stop boarder"** (as above). Figure 5 on page 15 shows two different design configurations achieving this effect.

(In Section 4 we describe how the differences between the two arrangements shown in Figure 5 became apparent in later work. There we introduce the use of the names "continued kerbside track arrangement" and "shared platform boarder" to distinguish these.)

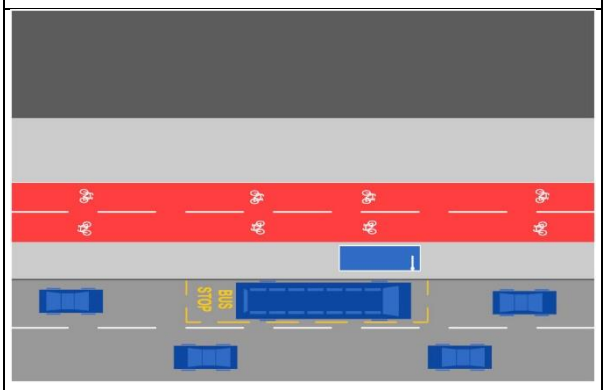
Figure 2: Bus stop bypasses



Design 1) A bus stop bypass where the cycle track curves around behind the bus stop



Design 2) A bus stop bypass with a straight track and an island that projects into the carriageway)

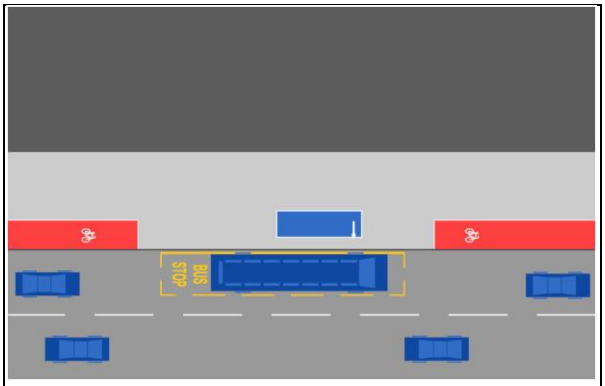


Design 3) A bus stop bypass with a two-way track and a bus stop on a multi-use strip not an island

Adding further confusion, we determined that the phrase "**bus stop boarder**" or "bus boarder" is also used for an arrangement, independent of any cycle track, where a section of pavement is extended outward into the carriageway and/or raised. This makes access to a bus easier for passengers, and/or means that a bus can stop without leaving the main traffic lane. This arrangement is shown in Figure 4.

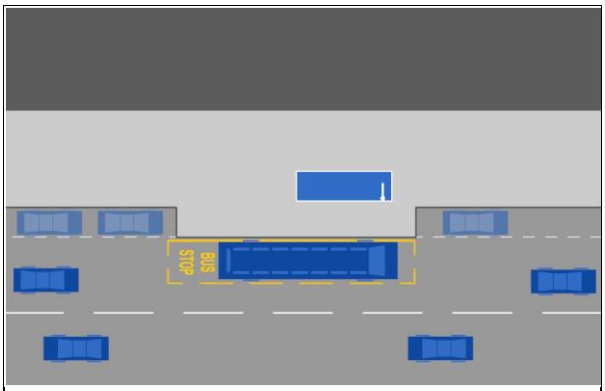
There are alternative images showing some of these design options, and discussion on naming (and of the confusion described above), in Section 4.2, Section 8.1 and Appendix 2.

Figure 3: Arrangement where track ceases



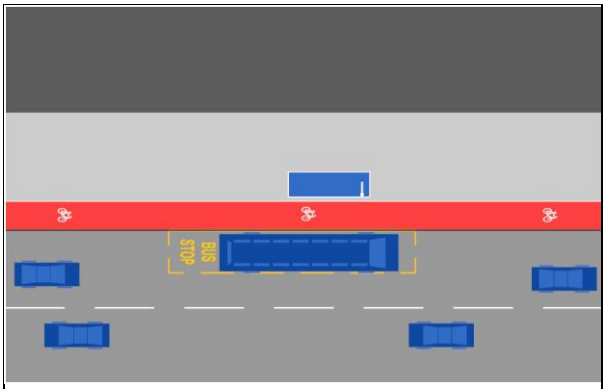
Design 4) An arrangement where the cycle track ceases and cycling is allowed on the pavement at the stop, called a "bus stop boarder" in Cycling By Design

Figure 4: Bus stop boarder with no cycle track at all

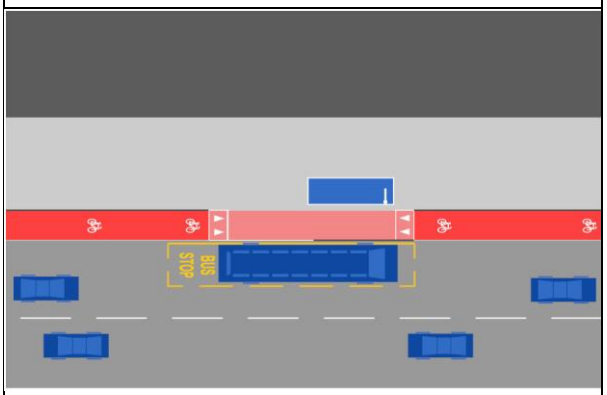


The phrase "bus stop boarder" is also used for an arrangement unconnected with cycle tracks

Figure 5: Further arrangements typically named "bus stop boarder"



Design 5) The cycle track continues beside the carriageway past the bus stop



Design 6) The cycle track raised onto an obvious platform beside the carriageway that looks neither like part of the cycle track nor like part of the pavement

ISSUES WITH DESIGNS AND INCLUSION

The review found that bus stop bypass arrangements are generally preferred, by government bodies, over arrangements with the cycle track sitting between the bus stop and the carriageway. Some other documents suggested that one or other arrangement would be safer, but we found no strong evidence in the literature to back this up.

We reviewed several published studies into bypasses and published position statements from stakeholder groups representing disabled people. This suggested that there is uncertainty from both people walking/wheeling and cycling over how to use the facilities, though there appears to be a general sense that both groups act differently at defined crossing points to how they act in the rest of the bus stop area. There was a lack of published research into shared platform boarders and continued kerbside track arrangements[3].

In the literature review we found formal position statements from RNIB and Guide Dogs, and we directly received a written statement from National Federation of the Blind for the UK (NFBUK). These, along with less formal material (for example via social media), made it clear that some organisations representing disabled people have significant concerns around inclusion and accessibility. These related to all designs including a cycle track, but objections to arrangements where the cycle track sits between the bus stop and the carriageway were stronger.

The clearest and most consistent concerns were in regard to accessibility for blind and partially sighted people. For example, there was a clear statement in an RNIB 2021 position statement [3] that "*there must be no further construction of bus stop bypasses / floating bus stops or bus stop boarders until a comprehensive investigation has been conducted into accessibility and safety issues, and new planning and construction guidance*".

Separately to this review of more formal literature we found plentiful evidence of objections to the use of these arrangements in social media, suggesting disadvantages for pedestrians and particularly for disabled people. Due to pressures of time, and the inherent challenges that relate to the way that social media works, we did not attempt to catalogue such evidence nor to analyse it in more depth.

In contrast, the inclusive cycling charity Wheels for Wellbeing has been openly supportive of the creation of well-designed bus stop bypasses. They appear clear about the role they play in protecting and encouraging disabled people who use a cycle as a mobility aid [5].

[3] Defined in Section 4.2

We found that there was a need for both guidance and legislation to be more specific and consistent in addressing concerns around accessibility.

DANISH ROAD USE RULES

We looked for details of Danish road-use rules. It had been suggested that these provided specific instructions about priority in situations where the cycle track sits between the bus stop and the carriageway. The review confirmed they specify clearly that where alighting pedestrians step directly onto a cycle track, cyclists must give way to these pedestrians. In contrast, if alighting passengers do not directly step onto the cycle track (but instead onto an area for boarding or alighting, as found at a bus stop bypass), and then separately prepare to cross the cycle track, then there is no such specific obligation on cyclists to give way.

CONFUSION OVER THE STATUS OF CYCLE TRACKS

We noted that in some literature there was an implication that cycle tracks must be either part of the pavement or part of the carriageway. This applied to a range of literature including some design guidance.

Such an idea contrasts with the definition used in this report, in which we specify that we use the term “cycle track” for structures which are clearly not part of the carriageway nor part of the pavement.

We anticipated that there might be wider confusion over this issue. Later work with organisations representing disabled people, and with members of the public (see Sections 5 and 6), confirmed many understood cycle tracks to be part of the pavement, and that the only alternative was for cycling to be accommodated on the carriageway.

4 Mapping and GIS work

We used a GIS (Geographic Information System) system to map the locations of over 600 bus stops in Britain at which some relevant arrangements had been made for cycling (GIS works with mapping and records data with a spatial/geographic dimension). In addition to the location, the project also recorded information about the characteristics of each site.

We also looked briefly for evidence of similar arrangements in some other countries. Examples were mapped in Dublin, Copenhagen, Frankfurt am Main, Lisbon, Victoria (Canada) and the Netherlands. These were located primarily on the basis of evidence we encountered by chance as the project progressed, or through the existing knowledge of our researchers.

We chose to do this exercise because it:

- Provided information about what designs have been used
- Gave us a more accurate idea of the number of sites in Britain at which an attempt has been made to continue a cycle track past a bus stop
- Supported our selection of sites for more detailed study
- Enabled us to give British sites a unique reference number for later reference in the study.

4.1 Process

To help us determine the locations of relevant British bus stops a range of techniques were used, as follows:

- We recorded locations we already knew about
- We searched social media channels (particularly Twitter) for the terms “bus stop bypass”, “floating bus stop” and “bus stop boarder”
- We followed up information from across the internet discussing the provision of new cycle tracks
- We used data from the OpenStreetMap project, searching for locations where cycle tracks and bus stops coincided
- Having found relevant bus stops, we then used the above approaches to seek further examples on any associated cycle routes or bus routes.

Each bus stop was given a unique reference number for future use.

Having found relevant examples we used Google Streetview images to support us to record data describing the design. This data included:

- A Google Streetview URL
- Whether the design provided a bus stop bypass, bus stop boarder (of either design), a situation where people cycle on what is effectively pavement space, or a hybrid of these arrangements
- Optionally, some flags recording the presence of a number of more important design features.

4.2 Learning

We recorded details of designs at 628 British locations, including a “type” (of design) at 571 of these. The others were either uncategorised (mostly for reasons of time) or they represented bus stops that were worth recording for other reasons.

We recorded:

- 348 of these as “bypass” designs
- 140 as “boarder” designs
- 42 as “hybrid” designs
- 41 as “shared” (i.e. where people are encouraged to cycle on a section of pavement).

While this was a comprehensive search for relevant bus stops, pressures of time meant it could not record every relevant bus stop in Britain. We also did not try to create a comprehensive record of the many poorer arrangements – where space for cycling is provided on the pavement, or with minimal separation from it (e.g. a painted line or change in surface colour), rather than on a separate cycle track. We recognised that there may be a large number of these poorer arrangements in existence but considered that the problems they can create are already well documented.

Relevant bus stops were recorded in some 40 to 50 towns and cities (an informal count that varies according to how “town” and “city” are defined).

Reasons for considering sites as less relevant, because of being broadly “poor” designs, are noted below. Less relevant sites also included situations where a cycle track continued past a bus stop but with the pavement next to the bus stop (the cycle track being crossed elsewhere), where it was debatable whether or not a space for cycling continued at all, or where cycling was accommodated on an access used by other vehicles.

THE EXISTENCE OF POOR DESIGNS

This work highlighted numerous examples of problematic designs which we felt would inevitably introduce problems in terms of inclusion, and most obviously problems (and fear) for blind and partially sighted pedestrians. Issues included:

- Areas for cycling in urban areas that were functionally part of the pavement rather than being separate cycle tracks (for example with areas for cycling and pedestrians being shared or distinguished only with a white line)
- Cycle tracks that stop at the bus stop, putting cyclists onto the ordinary pavement (illustrated in image 2 of Figure 6 below)
- Cycle tracks that become so insignificant at a bus stop that cyclists are, in effect, using the pavement
- Designs that introduce specific areas intended to be shared between cycling and pedestrians, but where these are so distant from obvious cycle tracks that pedestrians assume them to be sections of pavement
- Places where cycle tracks have been introduced in a way that has reduced the available pavement space to the extent that it becomes inadequate (often leaving motor-vehicle use prioritised).

Images showing a small selection of such designs can be found using the small selection of links to Google Streetview provided in Table 1 below:

Table 1: Selection of hyperlinks to Google Streetview images of "poor" designs, as above

Link to image: Space for cycling marked with painted lines only
Link to image: Space for cycling marked with painted lines only now worn away
Link to image: Cycle track ceases at bus stop, cycling is on a shared pavement
Link to image: Cycle track where pedestrians expect (consider) there to be pavement
Link to image: Uncertainty over what is track or pavement
Link to image: Unclear routes for pedestrians, lack of a clearly defined pavement
Link to image: Cycle track functionally part of the pavement, minimal separation
Link to image: Multiple colour changes, cycle track functionally part of the pavement

REDEFINING KEY DESIGN TYPES

In this mapping work, as noted above, we used a category we named "bus stop boarder" for any arrangements where the cycle track sits between a bus stop and the carriageway.

As this work progressed, it became clear that more than one distinct design existed for these situations.

For the purposes of this research we refer to the alternatives as “shared platform boarder”, and “continued kerbside track” designs. The distinguishing features are as follows:

- A **shared platform boarder** has a visibly distinct area, that is raised to create a distinct and obvious platform above the level of the cycle track or cycle lane. This area is marked in a way that implies it is not an ordinary section of cycle track, nor an ordinary section of pavement, for example using a surface more like the pavement than cycle track or with this being covered with a marked zebra crossing.
- A **continued kerbside track** arrangement simply requires that pedestrians cross the cycle track (between bus stop and carriageway), whether at a marked crossing point or without any crossing point being marked.

The overall result is that in the latter case the cycle track feels to continue uninterrupted, even if a crossing is marked. In the former case there is an area that more clearly has some special or different status.

Figure 6 (overleaf) shows simplified images of four key arrangements, including these two.

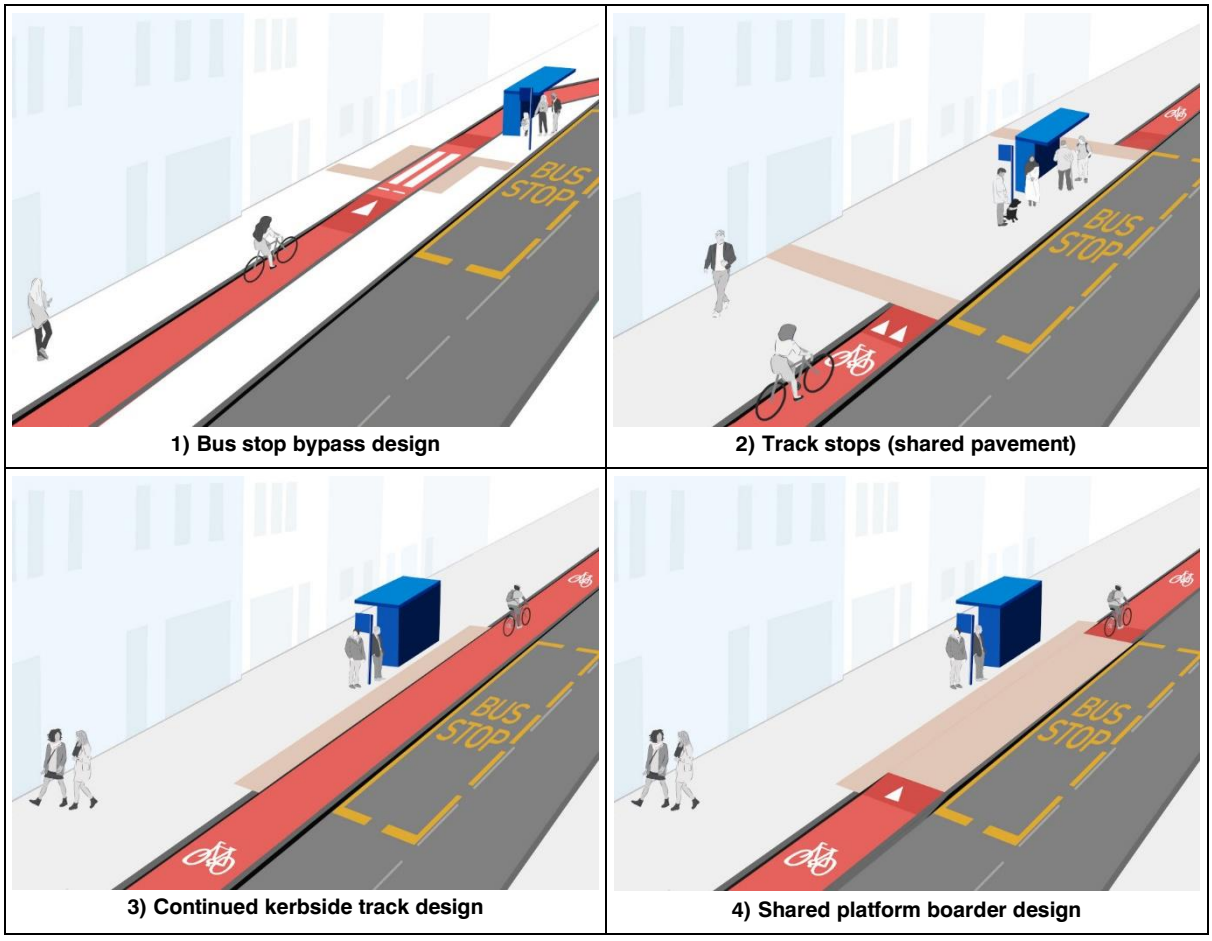
We used these definitions for the remainder of the work but due to pressures of time we did not attempt to re-classify bus stops mapped as “boarders” on the basis of these two new definitions.

Importantly, as work progressed it also became apparent that many real-world arrangements are difficult to classify, and that they did not fit clearly into any of these four categories. A “hybrid” category had to be introduced. Hybrid arrangements can be seen to sit mid-way between two or more of the categories shown in Figure 6.

For example, if elements of the bus stop – such as the shelter – are not on the island, and the island is present but only small, then it can be difficult to define whether the cycle track runs behind the bus stop, through it, or between the stop and the carriageway. The size of the island, the presence or absence of a shelter, and the shape of the cycle track might all influence an observer’s decision.

Similarly, hybrids exist between the designs shown in images 2, 3 and 4 in Figure 6. For example the ramp shown in image 4 might be very gentle, making the design more like that in image 3. Alternatively the area between the bus shelter and the carriageway in image 4 might appear much more like pavement than cycle track, making the design more like that in image 2.

Figure 6: Key design types and names



1) Bus stop bypass design

2) Track stops (shared pavement)

3) Continued kerbside track design

4) Shared platform boarder design

Overall, even in light of the above learning, it became apparent that it is difficult to classify bus stop designs according to such separate categories. While these ideas provided a useful initial framework for understanding a broad range of design options, they didn't adequately describe the variety of design encountered in the real world.

In Appendix 2 we try to detail a more helpful way to classify designs, and provide a table of factors to consider, looking beyond the categories above.

Summarising the details provided in that appendix, some of the main factors are whether:

- The cycle track passes in front of, behind, or between, elements of the bus stop area
- Passengers wait on an island or on an ordinary stretch of the pavement, *and* whether they alight onto the cycle track, near the cycle track, or onto an obvious island

- A bus stop island is part of something bigger (e.g. with multiple shelters, seats, trees, etc), smaller and well defined (e.g. dominated by a single bus shelter), or so small and/or insignificant that people wouldn't wait on it
- Cycle tracks are one-way or two-way (unidirectional / bi-directional)
- A bus stop island is separated from the rest of the pavement by a cycle track, by a road, or by some less conventional access arrangement (e.g. mostly used by cyclists, but open to some other vehicles)
- Pedestrians are crossing an area of cycle track, cyclists are crossing an area of pavement, or whether cyclists and pedestrians both cross something that feels to be neither quite part of the pavement nor of the cycle track.

FOREIGN EXAMPLES

While our search for foreign examples was brief, we found no evidence pointing to the use of any alternative arrangement that sits outside the design options discussed above. More comprehensive research might find one but it seems self-evident that there can only be limited design configurations that continue both the pavement and cycle track – unless designs in which cycling is accommodated in tunnels or on elevated platforms were to be considered realistic.

Foreign examples of bus stop bypasses that we did locate could be seen to vary considerably, and we did not find any evidence of a well-developed consistent set of standardised designs, other than in the Netherlands and in Copenhagen.

We did not study Dutch designs in detail, but they appear generally to involve the provision of an island of pavement that can be large or small. Crossing points with dropped kerbs are often marked with tactile paving, and some bus stops have guide-line tactile paving to support navigation (in a line designed to be followed). A line of black and white markings (or tiles) are typically used to mark where the bus stops, and this may help to highlight the presence of the bus stop even in the absence of a shelter. We did not find examples of continued kerbside track or shared platform boarder arrangements, although sometimes the island area provided was very small. We did not undertake a comprehensive or systematic search for Dutch continued kerbside track designs, but we conclude that if these arrangements exist, they are relatively rare.

Designs in Copenhagen vary considerably, but we observed a comparatively high proportion of continued kerbside track arrangements – in addition to many bus stop bypasses. Written material from one organisation objecting to the use of "bus stop boarder" designs suggested that building these in Denmark was now banned or

discouraged. We could find no evidence of this, and consultation with Danish engineers confirmed this was not the case.

The use of continued kerbside track arrangements in Copenhagen may arise because such a high proportion of their cycle tracks are of a “stepped” design. This means that the tracks are at a lower height than the pavement, and there is a further drop to carriageway level, without any raised feature dividing the cycle track from this. The cycle track in image 3 in Figure 6 on page 22 can be assumed to have such a design. We could see that sometimes their bus stops consist only of a sign on the main section of the pavement, and that the stepped cycle track continues unbroken through the area. Passengers wait on the pavement, crossing the track when joining a bus; and alight from the bus directly onto the track.

As noted in Section 3, there are some specific Danish road-use rules to cover this arrangement.

5 Work with professional informants

In this section we describe our approach to the work we carried out with professional informants – where we interviewed or worked with people because of their professional roles or because they represented a relevant organisation.

Rather than attempting to consult with a large number of organisations representing disabled people and other interest groups, we chose to work more intensively, and in-depth, with a smaller number of key organisations. We did so judging that:

- The extensive literature review meant the project had already established the views of many key informed/involved organisations
- It was more important to focus on organisations known to be well informed, to seek a deeper understanding of their knowledge and views
- While some of the professional informants were disabled people, the project would also work directly with individual disabled people who were members of the public – in order to understand the range of experiences that they encountered (see Section 6).

This part of the research took place mostly after completing the literature review and mapping/GIS work. It was ongoing throughout the remainder of the project.

5.1 Who we spoke to

This thread of work included activity with two different groups of professional informants. The title **"design-orientated informants"** was used for people who were involved either in designing or supporting the provision of arrangements involving a cycle track and a bus stop, or who had professional knowledge about them. Most of these people were also involved in work to introduce other changes to streets, not necessarily to support cycling. We spoke to these people primarily for their professional expertise. The title **"user-orientated organisational representatives"** was used for people with a relevant professional or voluntary role with an organisation. We spoke to them primarily because they could tell us about the views of their organisation.

For simplicity we describe this work as if those involved can be divided easily into these categories. Most design-orientated informants worked for organisations involved in the design or provision of infrastructure. Most organisational representatives worked for bodies organised to support or represent disabled people. However, there was some crossover. In reality these groups are

interconnected. For example, some user-orientated organisational representatives were also interviewed for their design-related expertise. Or they contributed wider personal knowledge. Some of this group also provided lived experience of disability, captured as evidence in Section 6 – alongside learning from members of the public.

It should be noted that the wider project also encompassed research on continuous footways. Most of our work with interviewees was simultaneously on both bus stops and continuous footways, but this report focuses purely on the former.

5.2 How we worked

The research work comprised both semi-structured key-informant interviews and more informal ongoing contact. The latter was an important element of our work and helped us to understand what we were learning, and to test out ideas and conclusions. Even where semi-structured interviews were used, these – by design – were followed up with informal and open discussion.

Throughout the research project we also had contact with a project "**Reference Group**" in which we brought together people with different aspects of professional knowledge and with a range of differing views. These people have expertise on design, engineering, inclusion, disability, academic research, the needs of pedestrians, and infrastructure to support cycling.

Reference Group members are listed inside the front cover of the report.

Work with **design-orientated informants** included semi-structured interviews with:

- Four local authority officers managing the installation of relevant new infrastructure in different cities
- An engineering consultant involved in supporting local authorities to install relevant new infrastructure.

We also had discussions with:

- A team in Manchester involved in researching the impact of relevant new infrastructure
- Consultants from five organisations with specialist knowledge about relevant new infrastructure
- A local authority team responsible for a specific project involving the installation of relevant infrastructure in Edinburgh (and for running research into its effects)
- Researchers and others looking at the effects of similar infrastructure in other countries

- Two local authority officers responsible for the installation of relevant new infrastructure in Leeds.

Work with **user-orientated organisational representatives** included semi-structured interviews with:

- Representatives of three national organisations campaigning for improved conditions for blind and partially sighted people
- A representative of a national organisation concerned with cycling for disabled people
- A senior representative of a national organisation campaigning for changes to infrastructure to support cycling
- A senior representative of a national organisation involved in promoting, designing, and funding changes in infrastructure to support cycling and walking/wheeling.

Staff from the organisation Transport for All attended the semi-structured interviews and some of the other discussions. They helped to analyse recordings for key points and themes, with a focus on understanding issues around accessibility.

Work not fitting the above categories included interviews with three staff employed to teach the use of long-canes or guide dogs (one themselves a long-cane user). Two of these habilitation/rehabilitation workers joined us on a site visit to bus stops at two of our detailed study sites in Glasgow. Together with them we also had conversations with the Rehabilitation Workers Professional Network, and lecturers involved in training workers who deliver orientation and mobility training.

The purposes of this included deepening our understanding of:

- how those who receive mobility training are taught to navigate different infrastructure, including when crossing a carriageway or cycle track
- what are understood to be standard techniques
- how technique and practice might vary between people in reality.

The first visited site (Garscube Road, Glasgow) was chosen because we considered it a quiet-simple environment (as discussed in Section 7.4) with a well-defined, detectable cycle track, which was clearly separate from the pavement, with low levels of use by pedestrians, and easily predicted pedestrian behaviours. The second (Sauchiehall Street, Glasgow) was chosen to contrast, because we considered the environment to be significantly busier and more complex.

SETTING UP INTERVIEWS/CONVERSATIONS

Contributors were assured that their input would be strictly confidential, they would not be named, we would be careful to ensure that any quotations provided in the report were anonymous, and that any recordings or transcripts would be deleted at the end of the project.

We did this because:

- It was vital for the project that contributors could be honest and open
- We wanted contributors to feel able to be clear about the limitations of their knowledge
- Where contributors were not involved officially as a representative of their employer, we wanted them to be able to speak freely about internal challenges within their organisation
- Where contributors were involved as representatives of their organisations, we wanted also to hear their personal views
- This was not an open consultation to establish what positions were held, but rather an exercise to deepen our understanding of views already established in the literature review work.

Before approaching the user-orientated organisations we had already used the literature review to establish a set of key concerns shared by many such organisations.

We reassured their representatives that we already understood:

- the importance of kerbs for blind and partially sighted people in defining the edges of a pavement
- the importance of tactile paving for marking kerb-free transitions between pavement and other areas
- problems with large areas of tactile paving
- the importance of consistency in the use of tactile paving
- the importance of access to buses, and the seriousness of problems arising from even small decreases in accessibility for people who are already on the edge of being excluded.

We also explained that we were making the two assumptions listed at the end of Section 2.

5.3 Learning from design-orientated interviews / discussions

This section (5.3) describes learning drawn mostly from interviews with **design-orientated informants**, whereas learning from work with user-orientated organisational representatives is covered separately below (Section 5.4).

These were individuals employed as designers, engineers, local authority officers, or in similar roles. Some of these informants were interviewed because of their involvement in specific schemes incorporating bus stop bypasses, but many were included because they were involved in changes to support pedestrians and/or cycling more broadly. For the sake of simplicity, we have included learning from interviews with representatives of organisations that support better cycling infrastructure in this section.

PURPOSE

Interviewees were asked about the purpose of bus stop bypasses and other arrangements continuing a cycle track at a bus stop. They suggested that these avoid the risk of conflict between people cycling and buses, or exist so that cyclists can easily overtake stopped buses. Typical phrases included “to not have to wait behind a bus”, “to remove the conflict with buses” and “to avoid needing to pull out around a bus”. Overall, it was evident that key concerns were about the safety of cycling more than its convenience.

Some interviewees indicated that the need for protected cycle tracks, and thus bus stop bypass (or equivalent) arrangements, are driven by bigger issues. One spoke about “the climate emergency” and “creating conditions which allow cycling by a wider group than just brave men”.

We were also told about situations where breaks in a protected cycle track would be more problematic. For example, it was said that there were particular challenges with breaking a two-way (bi-directional) cycle track. On these, some cyclists are travelling in the opposite direction to traffic in the closest carriageway lane. To return them to the carriageway at each bus stop would mean multiple crossings of the carriageway, or cycling against oncoming traffic[4].

RISKS ARE RECOGNISED

It is possible that the people we spoke to might not be representative, given the small sample and their prior interest in these issues. However, it was evident that there was a high level of awareness that bus stop bypasses (and similar

[4] We were surprised to find an example of this implemented near the junction of Great West Road and Windmill Road, Brentford (London). (Streetview image link / Openstreetmap map link).

arrangements) posed potential problems for pedestrians, and particularly for blind and partially sighted people. Based on this, we consider it to be likely this is quite widely understood, despite the limitations of our sample.

One designer spoke about being aware of growing opposition to bus stop bypasses and similar arrangements. They questioned whether this was because of an increased awareness of problems or – alternatively – an increase in specific local fears arising from national campaigning. Another suggested the fear of a collision is "quite high" for blind and partially sighted pedestrians, but that there is a lack of evidence of collisions actually occurring. They acknowledged that fear itself – and therefore active avoidance of certain areas by blind and partially sighted pedestrians – is a problem leading to exclusion, and suggested their role was to reduce both actual and perceived risks to the minimum. This was reinforced by one of the rehabilitation/habilitation workers, who commented that they would not teach a blind person to cross any cycle track – hence heightening the exclusion risk. Other designers spoke about the balance of risks, suggesting the difficulty of weighing up the risk that a cyclist is killed against the risks of some pedestrians being excluded.

Some spoke about problems arising from the culture of those who cycle in the UK, suggesting this is driven by ideas around sport and fitness rather than everyday transport. Their view was that their work was to make cycling more attractive for the latter purpose.

POSSIBLE IMPROVEMENTS FOR PEDESTRIANS

Several people spoke about how bus stop bypass arrangements could be used to increase the available space for pedestrians on the pavement. They described situations in which the construction of an additional bus stop island created a completely new area of pedestrian space – with this and the new cycle track taking space away from the carriageway.

They noted that this allowed for related infrastructure, such as the bus shelter, to be moved off the existing pavement space.

As noted in Section 5.4 (below), this contrasted with the concerns expressed by the representatives of organisations focused on the inclusion of disabled people. They typically described fears that cycle tracks were being built on areas that were formerly pavement.

However, none of the contributors referenced that changes at bus stops were seen to be an integral part of any wider national or local effort to improve conditions for pedestrians, or to increase the accessibility of streets. In our parallel report "Inclusive design at continuous footways", which is a product of the second theme

of our overall project, we write more about the need for this more profound level of change.

USE OF TRAFFIC LIGHTS

We discussed the option of providing a crossing of the cycle track with traffic lights (a “signalised crossing”). Costs were flagged as one barrier. We were also told this was not accounted for as an option in existing design guidance.

Two less obvious problems were raised. The first is the potential for traffic lights to distract drivers on the carriageway. The second was the inappropriate size of ordinary traffic lights in the more constrained environment beside a narrow cycle track (when compared to a normal carriageway). One person suggested “if you introduced that on a cycle track it would look absolutely monstrous”. Issues with the clutter introduced by poles and cabinets were also touched on.

OPENNESS TO DESIGN ADVICE

We noted that participants generally seemed open to receiving advice about how to design better bus stop bypasses or similar arrangements. When we made suggestions, based on observations arising from our work, these were generally received with interest.

Some spoke about how designers have to “feel their way” when introducing relatively unusual infrastructure. They noted that design guidance documents tend to lack detail, and that some experimentation is involved.

Typically, they sought to understand what we were learning about a number of specific issues, which included:

- The value of adding a coloured surface to the cycle track, and whether the value was short or long-term
- Problems of obscured visibility caused by bus shelters or advertising panels
- Whether raising the track to pavement level improved pedestrian priority
- Limitations around the use of tactile paving, given the difficulties and discomfort it can cause some disabled people
- How to slow down faster cyclists and what to do to ensure they stop at marked zebra crossings
- How to create consistency in design, given there is no clear guidance on critical elements
- What alternative solutions exist.

We concluded that there is probably an openness to receiving better and more detailed design advice amongst others employed in similar roles.

ADVANTAGES OF "FORGIVING" KERBS

We discussed the use of kerbs to segregate cycle tracks from the pavement, and from any bus stop island.

One key informant wondered about whether flush surfaces at the bus stop would emphasise pedestrian priority. Others were clear that kerbs were useful to highlight the presence of the track.

We discussed the use of **"forgiving" kerbs**. We found this term used informally to refer to kerbs with an angled face (i.e. not vertical) and a relatively low height compared to more standard carriageway-edge kerbs (e.g. around 60mm rather than around 110mm). Figure 7 shows an example of a kerb that that might be considered "forgiving" in this sense (this example is between the cycle track and pavement on Garscube Road in Glasgow).

Figure 7: Example of a "forgiving" kerb

It appears quite well understood/agreed that in case of collision the front wheel of a bicycle is more likely to ride up over such a kerb, rather than to be deflected by it. It is also understood that the reduced height avoids the risk of a "pedal strike" (see also Figure 24, page 104). Together these factors are seen to reduce the risk of a crash, given cyclists are often in a constrained space close to the cycle track edge. This also makes more of the cycle track width usable for cycling.

Several of those we spoke to flagged that there are additional advantages to the use of such kerbs. They suggested that they allow more pedestrians to cross than if a full-height kerb is used, and that some wheelchair users can cross them. Meanwhile, those using adapted cycles (sometimes used as a mobility aid) are not trapped in the cycle track.

5.4 Learning from user-orientated interviews / discussions

Below we report observations drawn from interviews with representatives of **user-orientated organisations**. Mostly we asked representatives for the views held by their organisations, but some conversations and interviews also drew on their personal expertise, or covered design details.

Our literature review had found detailed written positions only from organisations representing the interests of blind and partially sighted people, so we focused on work with several of these organisations. Our wider work with individual disabled people, organised with Transport for All, focused on the experiences of a more diverse range of participants taking a pan-impairment approach (see section 6).

PURPOSE

Our literature review revealed a distinction between how design guidance described the purpose of a bus stop bypass, compared to how this is described by organisations representing disabled people. There was a good deal of crossover in the literature, however whilst design guidance firmly emphasised *safety*, these organisations tended to highlight increased *convenience* for cyclists.

When asked in interviews about the justification for the use of bus stop bypasses (and similar arrangements) replies from organisational representatives were broadly in line with the literature review. They spoke both about preventing collisions between cyclists and buses and about preventing cyclists having to wait behind buses. It was evident they believed that the infrastructure was provided as much to increase the convenience of cycling as to increase overall safety.

SCEPTICISM AND DOUBTS OVER VALUE

Several of those we interviewed expressed real doubts over the value of bus stop bypasses (and other similar arrangements). For example, it was suggested that a large proportion of cyclists:

- Do not use cycle tracks at bus stop bypasses, remaining on the carriageway instead
- Do not use cycle tracks more widely.

One interviewee reported that “the whole aim of these bypasses is … that you’re trying to make these cyclists safe … but… if it’s going to cause a bit of delay, even if it’s for a minute, you will see that they will not use those cycle tracks, which will just have inconvenienced everybody for no reason.”

When asked about whether the value of cycle tracks was to encourage people who do not currently cycle to do so, one interviewee commented that both experienced and inexperienced cyclists should cycle on cycle tracks and not on the carriageway.

In contrast, one contributor expressed frustration that cyclists in Manchester were not using the bus stop bypasses on Oxford Road in the way that had been intended by designers. They explained they had been told that only inexperienced cyclists would be using the cycle track here, with experienced cyclists remaining on the carriageway. They said that in reality, experienced cyclists were also using the cycle tracks (and we confirmed this in our observations).

There was a sense from some interviewees that the impatience of cyclists was a key problem. Enforcement was a concern for others: "you can't take a picture of them and fine them, there's no enforcement".

CYCLE TRACKS AS SEPARATE FROM BOTH PAVEMENT AND CARRIAGEWAY

As described in Section 5.3 (above), we noted the sense that these interviewed disability/inclusion focused organisations generally considered cycle tracks to be part of the pavement, as opposed to something separate from both pavement and carriageway. Typically, their understanding was that space was being taken away from pedestrians, and/or the pavement was being divided into narrower sections sandwiching a cycle track. This corresponded to views expressed in some of our conversations with individual disabled people later in the project.

For example, one organisation spoke about their frustrations that guidance was ignored when it emphasised the need to "exhaust all avenues to put cyclists on the carriageway before putting them on the pavement". They suggested that "putting cyclists on the pavement" was an attempt to make cyclists safer, at the expense of the safety of blind and partially sighted people.

A REQUEST FOR RESEARCH

Representatives of one organisation expressed frustrations that mitigation options were ruled out without them being researched.

For example, they agreed that there might be problems with the provision of a signalised crossing (using traffic lights) across a cycle track at a bus stop. However, they were frustrated that this option had not been tested to check whether those problems really did arise.

We took this to indicate that they felt their concerns were not being taken seriously, and that more innovative solutions were not being seriously sought.

KERBS AND COLOUR

There was general agreement, among all organisations, that kerbs provide a clear and easily understood separation of cycle tracks from pavement areas.

It seemed understood that there might be a need for kerb-free crossings of the cycle track, but that these should be only as wide as required for those who really need

them. This would include adequate provision for wheelchair users, people with impairments to their walking or balance, and those using an array of mobility aids or small-wheeled devices (e.g. a walking frame, child's buggy, suitcase, or sack truck).

We discussed whether longer kerb-free sections of cycle track would create better conditions for pedestrians, as some design-oriented participants had raised this as a possibility. There was little support for this view.

They also confirmed their wish that cycle tracks should be of a consistent colour and tone, contrasting with the pavement, throughout their length and not only at bus stops.

PROBLEMS WITH LACK OF CHOICE

Some design-oriented informants had questioned why problems at bus stop bypasses were drawing particular attention. We heard suggestions that many other features of British streets could be at least as problematic, in terms of how they lead to the exclusion of disabled people. We understood there was a feeling that changes to support cycling caused particular controversy.

We explored this question with user-oriented organisational representatives. As part of the discussion we questioned whether their organisations were more worried about people crossing a cycle track than they were a carriageway on which people cycle.

A key point raised in response was about a lack of choice when needing to access a bus stop. Issues elsewhere might be worked around with a change of route. But only one or two bus stops would usually be available for a journey. We were also told of people using buses to accomplish very short journeys to bypass less accessible areas, or to cross a difficult road. Thus, problems at just one bus stop could exclude people from using the bus route, or from bypassing local accessibility problems. Such a change could lead to their complete exclusion from everyday journeys.

CONCERN OVER FUTURE INCREASES IN CYCLING

In these conversations interviewees often expressed a belief that the objective was that all cycle tracks would eventually be busy with cyclists. They were worried that the conditions currently seen at the busiest British cycle tracks would be reproduced on most cycle tracks in future.

FEAR

Interviewees reported how changes to infrastructure can cause particular fear to disabled people where they are already struggling to use streets to the point of being excluded entirely. We discussed how the introduction of a cycle track in a place people need to cross it can be alarming.

We heard that the fear created for many blind and partially sighted people can present a significant barrier. This can lead to them avoiding certain locations and trips, with this preventing important everyday journeys. Such fears had a corrosive effect on confidence and feelings of safety on pavements more widely, and could take people past a tipping point where they were excluded more completely.

USE OF TRAFFIC LIGHTS

Some interviewees suggested the reason that designers avoid the use of full signalised crossings (i.e. crossings with traffic lights) at cycle tracks is their cost – particularly in terms of maintenance.

The convenience of cycling was mentioned by others. Some understood that the way in which traffic signals would hinder the progress of cyclists was a central issue. One said “cyclists don’t want to keep stopping and starting, the whole idea of cycling is to be able to get through”. It was suggested that councils would be reluctant to provide such signals because cyclists would return to the carriageway if a red light was shown. They felt this would undermine the value of a having a separate cycle track in the first place, with money having been wasted providing it – noting that their view was that bus stop bypasses were provided to allow the overtaking of buses, and that it was a struggle to persuade cyclists to use them.

OPENNESS

Longer-term conversations with disabled people, and with organisations representing them, will be complex, and will be informed by past negative outcomes. It may take time to develop trust and capacity. However, as with conversations with design-oriented informants, we found that these informants were generally willing to engage in trying to find solutions that enable both the support of cycling and the inclusion of disabled people. Equally, most were interested to explore what we had observed at the sites we were studying.

6 Work with disabled individuals

This section reports on our work with disabled people, who were involved as individual members of the public rather than because of any professional role. This contrasts with the previous section (Section 5) which describes our work with "design-orientated informants", organisations representing disabled people, and those paid in supporting disabled people.

Most of this work was organised with the support of the organisation Transport for All. Our objective was to ensure we had understood the variety of experiences that different disabled people face.

It should be noted that the broader project also researched continuous footways. Much of the activity we describe below was designed to capture learning simultaneously about both types of infrastructure.

6.1 Process

Transport for All organised and ran four online focus groups and four site visits (each examining both bus stop bypasses and continuous footways). Researchers from Living Streets were closely involved in all activity throughout the process.

The partnership with Transport for All enabled:

- The focus groups and site visits to be arranged by a user-led organisation with expertise in ensuring an inclusive "pan-impairment" approach
- Focus groups to be facilitated by a disabled facilitator, appointed by Transport for All
- The concerns of the disabled people participating to be properly heard, and for them to have confidence that they were being treated equitably.

ORGANISATION AND PARTICIPATION

Transport for All sought contact with people who might be interested in being involved in this work and selected only some of those replying – seeking to ensure that participants had a range of impairments, ages, and other demographic characteristics.

25 participants were involved in total in this way, although not all took part in both focus groups and site visits.[5] Seven participants reported having a visual impairment, five hearing loss, and 14 a mobility impairment. Four reported using a walking frame or stick, 11 a wheelchair, and four a long-cane or guide dog.

Appendix 5 provides a table presenting these and other details.

Two Transport for All staff attended the London site visits, and one Transport for All employee attended the Glasgow site visits. Each of these was themselves a disabled person, one using a wheelchair on the visits.

Transport for All worked with us to assess the risks involved in organising site visits. A number of our study sites did not provide the conditions they felt necessary to ensure participants were comfortable and felt safe. Transport for All also had concerns about managing risks to participants, and about making them comfortable, on busy streets more generally. The sites we did visit with disabled people were not problem-free in this regard. Even here we judged that it would have been irresponsible to suggest to blind or partially sighted participants that they cross some of the spaces on the streets without support.

Sites were chosen (i) to provide a good understanding of what might be more effective designs, and what might be less-effective, and (ii) to be close to available accessible meeting space, enabling more focused conversation as part of the event.

LIST OF EVENTS

The events were as follows:

- Online focus group, London-based participants (continuous footways)
- Online focus group, London-based participants (bus stops)
- Online focus group, Glasgow-based participants (continuous footways)
- Online focus group, Glasgow-based participants (bus stops)
- Site visit, London, bus stops and continuous footways
- Site visit, London, continuous footways and bus stops
- Site visit, Glasgow, bus stops
- Site visit, Glasgow, continuous footways.

FOLLOW UP SOLUTIONS WORKSHOP

Following on from the work with disabled members of the public, Transport for All then organised a “solutions workshop”. This was attended by the key Living Streets

[5] The disabled people involved in the focus groups and the site visits were paid £50 each for attending each event.

researchers, four Transport for All staff (two being access consultants) and a representative of the Mobility and Access Committee for Scotland (MACS). It was facilitated by a Transport for All staff member who had not previously been involved in the project.

During the workshop those improvements to bus stops that had been suggested by members of the public (in the previous work) were analysed for their advantages, disadvantages, practicality, and value.

ADDITIONAL ACTIVITY

Outside of the structured work organised in partnership with Transport for All, the project's contact with disabled people also included:

- Discussions with a group of disabled people working on the accessibility of public transport
- Some of the work on mobility training discussed in Section 5
- Detailed discussions about the personal experiences of a (further) guide dog user, and about the specific techniques that person uses when navigating British streets.

6.2 Suggested solutions

Participants were given the opportunity to suggest solutions, that might make arrangements involving a bus stop and a cycle track more inclusive. The ideas they suggested included:

- Clear separation of the cycle track and pavement with kerbs, a change in level, and a change in surface colour and tone
- Removing kerbs in order to make it easier to cross the cycle track at the bus stop
- The use of sufficient (more than had been observed) tactile paving at any places where there were no kerbs delineating the edge of the cycle track
- Leaving tactile-free routes for wheelchair users and others who find walking or wheeling on tactile paving painful or difficult
- Providing enough space on the bus stop island, or around bus shelters and other street furniture, so that wheelchair users or those using guide dogs or a long cane are not blocked from getting on or off a bus by crowds or queues (we would note guidance suggesting at least 2 metres within the Department for Transport's Inclusive Mobility Guidance 2022)
- Ensuring islands are large enough for those using larger mobility aids
- Avoiding slopes (crossfall) on a bus stop island (see Figure 8 on page 46)

- Ensuring high quality surfaces around the bus stops to decrease problems caused by lack of maintenance
- Training or informing bus drivers about how best to position their bus for the convenience of users
- Various configurations of flashing or indicator lights to advise either cyclists or pedestrians
- Adding painted arrows or “look left” (or right) markings to indicate the direction cyclists are travelling to pedestrians
- Signs, markings, or other devices to warn cyclists to take care, pay attention, or to slow down
- Signs, markings, or other devices to warn pedestrians to look out for cyclists
- Physical features, such as speed bumps or rumble strips, to limit cycling speeds or to warn cyclists to pay attention
- The use of mirrors to increase visibility where this is blocked.
- Lighting that responds to particular situations, such as an approaching bicycle
- Ensuring street lighting is of good quality around bus stops in order to emphasise colour and tone contrasts between surfaces at night (particularly for partially sighted pedestrians)

6.3 Learning

This sub-section reports on key learning from the work with disabled members of the public.

UNDERLYING IDEAS AROUND DISABILITY

Some of what was learned from this work was unsurprising – corresponding with previous studies, or what we would expect from any conversation with members of the public. We have called these “underlying ideas” as they are fairly well established, not because they are unimportant. They are listed because – although widely recognised by disabled people – many participants had no confidence that designers understood or put these principles into practice.

These underlying ideas included:

- The degree to which poor design of streets already excludes people, and the great importance of improving them
- The importance of kerb-free routes for people using wheelchairs and other mobility aids, and the problematic low quality of some dropped kerb arrangements, particularly where slopes are greater, where slopes are not in the direction of travel, and where an upstand (step) remains present at the dropped kerb

- The way that poor surface quality makes some journeys impossible or extremely difficult for many wheelchair users, and for anyone with impairments affecting balance or walking
- The difficulties, risks, discomforts or pain caused to some people when they have to cross areas of tactile paving
- The importance of the presence of consistent, distinct surfaces, marked in particular by colour and surface material differences, for helping a wide range of people understand what areas are intended as pavement, carriageway, or cycle tracks
- The way that many people, including those using wheelchairs and some other mobility aids, can be hidden behind small vehicles or street furniture, and their visibility of oncoming threats blocked
- The importance of signalised crossings (using traffic lights) of carriageways for those who need more time to cross, and for those less able to predict more complex movements of vehicles (and suitable timing of these)
- That those driving or cycling do not necessarily behave as they are meant to – so therefore rules alone cannot be relied upon for pedestrian safety.

UNDERLYING IDEAS AROUND VISUAL IMPAIRMENT

The following underlying ideas were discussed in connection with the use of streets specifically by blind and partially sighted people. As above, these were not surprising to our researchers, corresponding to what had emerged from previous studies (as discussed in our literature review). However, participants did not feel that those responsible for changes to streets understood these principles.

- The degree to which poor design of current streets leads to the exclusion of people, and the importance of improving them
- The degree to which fear can limit or dominate the journeys of some people, when streets are not designed with their needs in mind
- The importance of consistency in providing predictability
- The additional difficulties arising in dealing with quiet vehicles or people using devices that are harder to hear (such as electric vehicles, e-scooters, and cycles)
- The role of traffic noise in hiding quieter sounds or in masking the specific sounds that someone is listening for
- The (positive) role of traffic noise in helping with broader navigation and orientation

- The importance of signalised crossings (using traffic lights) of carriageways
- The importance of tactile paving, installed consistently and correctly, advising of the presence of "controlled" crossing points and warning of locations where there is a kerb-free edge of a pavement
- The importance of visual contrast (in both colour and tone) making the difference between areas of pavement and other areas clear
- That visual contrast (as in the above point) needs to be present not only in dry weather and daylight, but also when surfaces are wet or after dark.

VISUAL IMPAIRMENT, CLARITY AND KERBS

Blind and partially sighted participants spoke about problems arising from situations where cycle tracks are not distinguished from the pavement by the use of kerbs. For example, one stated that: "The paving is completely flat. The pavement is flat, the cycleway is flat, the bus stop is flat and the street is flat. From the perspective of someone who is completely blind, it's really, really unnerving. I have no idea whether I'm in a safe place or not, and I've no idea if I'm in the correct place to get on a bus."

Another stated: "The key thing that really makes it feel unsafe is when they [cycle tracks at bus stops] have no kerbs. It is really difficult to determine whether you're on the bus bypass [cycle track] or not."

Partially sighted participants emphasised the importance of colour and tone contrast (e.g. "light reflectance value"), and how this becomes even more important with wet surfaces or after dark. On site visits (with these participants, and separately) we confirmed that at many locations there are numerous changes to the colour, tone and material of the carriageway, cycle track and pavement. This meant there were few consistent signs indicating areas of safety and areas likely to be used for cycling (or driving).

Several participants spoke about the value of lighting after dark. We discussed how this can help to ensure that material, colour and tone contrasts remain visible, or can lead to these becoming less easy to see. It was highlighted that brighter lighting, placed at a low-level, can dazzle some people.

Blind and partially sighted participants described to us that fears about clarity at *specific* locations create fears about the wider environment, and we noted that this problem hadn't been captured well in the literature we reviewed. For example, once a blind or partially sighted pedestrian finds that a specific pedestrian space has become confusing, so they cannot easily tell whether they are on the pavement, they may lose their overall confidence – fearing this issue might recur elsewhere.

VISUAL IMPAIRMENT AND BROAD NAVIGATION ISSUES

Related to points about clarity and fear, several blind and partially sighted participants discussed the overall level of difficulty involved in navigating current streets. Environments can become extremely complex when experienced primarily by touch, or with limited sight.

Importantly, on several occasions participants spoke about catching a bus to travel a very short distance, enabling them to bypass local obstacles.

We took this as an indication of the lengths that many disabled people need to go to in order to deal with current street conditions. This can be seen as an example of people needing to adapt their behaviour because streets aren't adapted to include them.

On a more specific point about navigation, one participant noted the difficulties in finding a bus stop once it is on an island, explaining: "Knowing where to walk across to where the bus stop [is] would be another barrier. The only indication of where you're meant to access the bus stop from the pavement is a piece of tactile paving. However, it is identical to tactile paving for normal controlled crossings…so are these tactiles for me to walk across to find a bus stop, cross a side road, or to cross all the way across the main road?"

We discussed this problem with other participants in the study, and with mobility trainers. They confirmed the importance of the presence of a bus shelter as the most obvious and easily identified feature confirming a bus stop location. We make recommendations related to this point in Section 8.2.

BROAD FRUSTRATIONS WITH CHANGES TO STREETS

Many participants expressed broad frustration that changes to streets were introducing difficulties that could have been avoided. Some implied (or stated) that those responsible were incompetent, or that they were zealously promoting cycling above all other considerations.

For example, one comment was "There is meant to be a hierarchy of transport use with pedestrians at the top… But it feels like pedestrians being at the top is not actually the case, that cyclists are being prioritised."

Another participant said "Waltham Forest was chosen to have the 'mini-Holland' so basically [to] create a 'cycle-only borough' I'd call it… we've got lots of these floating bus stops all over the place."

One participant expressed incredulity that the incompetence of designers had led to narrowing a carriageway to such a degree that buses had to wait to pass each other. They suggested that changes had to be made after installation to fix this design problem (see Section 8.4 for the local authority view of this issue).

Some participants expressed their overall sense that they did not understand why particular arrangements had been made, or why particular features were present in a location.

In some cases, once the reasoning for design features had been explained, participants noted that they felt less concerned or frustrated.

There were also suggestions from some participants that cycle tracks are not effective or that cyclists do not like using them. This added to the sense that changes to streets are hard to understand or were being made incompetently.

Some participants expressed particular doubts about cycle tracks at bus stops. One suggested that "from a cyclist's point of view, they're just not safe. You know, you're approaching it, you see someone standing there and you think 'are they going to cross, are they not going to cross', so I think there's problems." However separately this participant explained that he had previously cycled, but that he avoided using roads.

BROAD FEARS AND FRUSTRATIONS ABOUT INTERACTING WITH CYCLISTS

A wide range of participants saw interactions with cyclists as a threat.

One participant, who described her ability to walk and balance as impaired, commented that "they're sometimes cycling so fast that you're really hesitant to cross over [a cycle track]. And then these e-scooters now have come into the picture as well, which makes it even doubly frightening when they whizz past because some of them are illegal".

Another participant who described her ability to walk as impaired, spoke of fears about bus stop bypasses in London. She said: "I know Whitechapel and I know the cycle lane… and it's a hazard, and I find it a problem. It worries me sometimes being able to get out of the way quick enough. If a cyclist suddenly appears out of nowhere, as far as I'm concerned I have to make a quick exit to get out of their way."

She added comments about wider problems with cycling: "Even on pavements with cyclists suddenly coming round corners, and they're not taking much notice of where they're going. Being able to jump out of the way is a problem…. I think [bus stop bypasses] are very dangerous to people".

Some participants spoke about a wish for people to have to sit a test, be licenced, or to have training before being allowed to cycle. For example, one comment was that “they should have to have highway code knowledge… to educate the cyclists as well, because earlier in the year they changed the highway code for drivers to be more aware of cyclists and pedestrians, and anyone who is more vulnerable as well…but I’m not sure if that message is sent across to the cyclists”.

LIMITATIONS OF ZEBRA CROSSINGS

With participants we discussed the functioning of zebra crossings at cycle tracks, and a number of problems were raised or became apparent.

Some issues could be seen to arise because such zebra crossings can be much less obvious to the user in this environment than when a zebra crossing exists across a wide carriageway. The comments of one participant – who had expressed strong fears about crossing cycle tracks at bus stops – highlighted this. She said: “It sounds really silly, if I’m crossing the road I will look for a traffic light crossing, or zebra crossing, and I’ve seen the white lines on a cycle lane, but I’ve never thought of crossing there”. When asked why that might be, she explained: “Although I can see the white stripes it doesn’t feel like a zebra crossing, and I will just look up and down and cross when, you know, when it’s safe to cross on the cycle lane. But I would go out of my way to find a zebra crossing or a light controlled crossing if I was crossing the road. Maybe I don’t perceive the danger as much?”

Another participant, standing with us at a bus stop, said: “I wasn't really sure who has the right of way, like if cyclists will stop …? Or if I have to wait for them to ask? I don't really know initially what would these two lines mean, aside from this is your designated path.” When asked to elaborate on her comment about the “white lines” this participant said: “It's like this is the official pathway for someone to go from this to that.” Once it had been explained that this was a zebra crossing, a second participant added: “I almost think because it’s only two lines, it doesn't register immediately as like that's a zebra crossing, because when you think of a zebra crossing, you're used to seeing several lines. So when … you're not really thinking too hard about it, you're not thinking that’s a zebra crossing, you're just kind of like...okay some lines.”

Later in the research, in footage recorded on fixed cameras, we saw matching indications that many pedestrians didn’t behave in a way that would be consistent with the official status of a zebra crossing. For example, in one instance we saw two men step back from a zebra crossing to allow a cyclist (they had just noticed) to pass, clearly waving an apology for having been in the way.

PROBLEMS AROUND GENERAL BUS STOP ACCESSIBILITY

On site visits, and in focus groups, we discussed whether there were wider accessibility problems, unrelated to the crossing of the cycle track, that were created by bus stop bypass arrangements.

One participant (who was a wheelchair user) described situations in which bus drivers have stopped a bus without properly lining up to the kerb. He explained that the driver then needed to move further forward, having noticed that he would need to use the bus access ramp. It was suggested to us that a small bus stop island creates more challenges for drivers in ensuring ramps can be deployed.

Participants highlighted the physical problems negotiating a crowd in a restricted space (see Figure 8, image 1). We heard this was an issue for many different disabled people, including those using a wheelchair, long-cane or guide dog. They also described the social pressures – such as embarrassment or a fear of irritating others – involved in this.

Figure 8: Other accessibility issues

1) Crowded stop blocking accessibility

2) Excessive crossfall on island (exaggerated)

A second key problem raised was the difficulty caused by sloping surfaces. The way in which an individual bus stop island sloped toward the cycle track was highlighted. Participants who use a wheelchair spoke about how this slope made it difficult to travel *along* the bus stop island (with the slope taking them sideways). They also said this slope added a challenge to boarding a bus using the bus ramp. They could no longer "get a run up" toward the steeper bus ramp. There were also issues controlling their chair when alighting down the ramp. (Such a slope toward the edge or middle of a carriageway is generally known as crossfall – see Figure 8, image 2.)

At the stop in question the steeper crossfall was a result of the provision of a higher kerb beside the carriageway, raising the level of the pavement. The use of such kerbs is intended to make access to the bus easier, reducing the height difference between bus floor and pavement height.

Many participants implied that problems like these were arising because of the presence of the cycle track, or because the bus stop was on an island. Although we concur that these were real problems, we conclude that the problematic design details were not an inevitable result of the presence of the cycle track or the island. They arose as a feature of the space provided for the bus stop and because of the specific designs used.

It was evident that the introduction of a new bus stop arrangement might improve or worsen such problems, depending on design choices and constraints. There are obvious ways in which the locating of a bus stop on an island of pavement could lead to limitations on the space available, but we also heard from designers about how individual bus stop bypasses reclaimed carriageway space – thus *increasing* the overall pedestrian space available at a bus stop.

With regard to crossfall, an important concern is that a bus stop island might require a significant change in level, which could be difficult for people to navigate. However, at the same time good design might actually alleviate problems found elsewhere. Design challenges arise from the use of raised/high kerbs beside the carriageway, to provide easy access to the bus, with the use of lowered kerbs beside the cycle track (which we recommend in in Section 8.2).

OTHER COMMENTS AND IDEAS

One participant, who was using an electric wheelchair on our site visit, spoke about his frustrations when people did not stay in the spaces assigned for them. He noted that while he was using the cycle track in his electric wheelchair pedestrians had stepped in front of him without warning, becoming upset that he'd run into them.

Several participants spoke about locations in London where announcements on the bus reminded pedestrians that they would be crossing a cycle track after leaving the bus. They expressed the view that this was helpful.

Several participants, when asked if they ever cycled, responded that they had at some point in the past. None of the participants continued to cycle. Several indicated they would no longer consider it an option because of risks from traffic.

Commenting on the focus of the research, one participant noted that they had fallen naturally into discussion of problems with specific types of infrastructure. They were concerned this could be misleading as in reality problems were widespread. They noted that it was important to also discuss more positive aspects of design.

One participant, in Glasgow, spoke about the positive effects for wheelchair users of arrangements that remove kerbs. Speaking about changes to Sauchiehall Street, that others had criticised, she talked about how the design had created kerb-free routes for her. She said “I use a wheelchair full time. … I’ve never seen [a bus stop bypass] before and when I was crossing to get to the restaurant that I was getting to I thought ‘wow, this is great’ because I felt so safe.”

7 Detailed-study site work

Ten junctions were chosen for much more detailed study, referred to as “detailed-study sites”.

At these locations we measured dimensions, took standard sets of photographs, recorded behaviours on video, and took structured observations of behaviour. This was followed up by analysis of footage from fixed-cameras, mounted at height on masts, recorded over several days.

Eight of these sites had bus stop bypasses. Two (in Cardiff) had designs where the cycle track sits between the bus stop and the carriageway.

Full details about each detailed-study site can be found in Appendix 1. This section summarises our approach and what was learned.

7.1 Our approach

SITE CHOICE

The detailed-study sites were chosen from those mapped earlier in the research (see Section 4).

Each site was chosen because it represented a relatively good design, in as much as:

- There was a reasonably clear separation between pavement and cycle track (although we intentionally included designs lacking kerbs on the cycle track edges)
- The cycle track unambiguously continued through the bus stop area (so we excluded designs in which pedestrians shared pavement space with people cycling, or where the track effectively ceased or became physically insignificant).

It is important to note that this means the detailed-study sites were not representative. Our mapping exercise identified numerous examples of arrangements that did not fit these criteria (see Section 4), and which we felt would inevitably create some problems in terms of inclusion. However, the purpose of this research was not to study whether poor designs created problems for pedestrians, but whether good designs would also inevitably do so.

We also chose sites so that we had examples:

- with one-way and two-way cycle tracks ("uni-directional"/"bi-directional")
- with simple and complex environments
- with large and small numbers of pedestrians
- with large and small numbers of cyclists
- with cycle tracks that are straight and with bends
- with and without humps/ramps in the track
- with full, low and absent kerbs,
- in Scotland, England and Wales

By "complex environment" or "simple environment" we are referring to the level of pedestrian use, but also how pedestrians behave and the effects of the infrastructure. Complex environments include those where people are in groups, walking/wheeling in and out of shops, or in many different directions. Simple environments include those where pedestrians tend to be alone, and walking or wheeling along a predictable set of routes. Section 7.4 includes additional details.

Our chosen detailed-study sites were as shown in Table 2:

Table 2: Detailed-study site list

Ref	City	Short name	Google Streetview / Openstreetmap.org	Type
BS-38	Cardiff	Kingsway	https://goo.gl/maps/cK2raytmGnaMGtEEA Openstreetmap.org map link	other
BS-622	Cardiff	Newport Road	https://goo.gl/maps/HdrqGy5g44hbPQPk9 Openstreetmap.org map link	other
BS-631	Glasgow	Garscube Road	https://goo.gl/maps/txKZ6B6sGDEByn4n8 Openstreetmap.org map link	bypass
BS-133	Glasgow	Victoria Road	https://goo.gl/maps/ociGdUQME3ouKhgc6 Openstreetmap.org map link	bypass
BS-139	Glasgow	Sauchiehall Street	https://goo.gl/maps/25DCBRXDiBbAn4m2A Openstreetmap.org map link	bypass
BS-77	London	Whitechapel Road	https://goo.gl/maps/aNbLMAYQQkwMUgUc7 Openstreetmap.org map link	bypass
BS-67	London	Mile End Road	https://goo.gl/maps/aRpoRzgPg5fND7Cn9 Openstreetmap.org map link	bypass
BS-86	London	New Bridge Street at Blackfriars	https://goo.gl/maps/4pm2jgwcW58XB6i97 Openstreetmap.org map link	bypass
BS-184	Manchester	Oxford Road	https://goo.gl/maps/P4P2T8xVuSRQKgyEA Openstreetmap.org map link	bypass
BS-190	Manchester	Wilmslow Road	https://goo.gl/maps/VXtM3skioEmLzgwp7 Openstreetmap.org map link	bypass

Table 3 provides additional details indicating why each site was chosen for study:

Table 3: Details of detailed-study site designs

City	Short name	Why chosen / points of interest[6]
Cardiff	Kingsway	Shared platform boarder design that tends toward a continued kerbside track design.
Cardiff	Newport Road	Archetypal shared platform boarder design.
Glasgow	Garscube Road	Quiet-simple environment with plenty of pavement and track space for usage level, and a well-defined (kerbed) cycle track – two-way cycling. Well-defined zebra crossing of track.
Glasgow	Victoria Road	Quiet-simple environment, with a well-defined (kerbed) cycle track – one-way cycling
Glasgow	Sauchiehall Street	Moderately busy cycle track, very complex environment, less well-defined cycle track (lacking kerbed edges)
London	Whitechapel Road	Unusually busy cycle track, complex environment, plenty of pavement space for level of use, inadequate cycle track width for level of cycling, well-defined cycle track.
London	Mile End Road	Unusually busy cycle track, simpler environment than at Whitechapel, comparison with Whitechapel (on same route), plenty of pavement space for level of use, inadequate cycle track width for level of cycling.
London	New Bridge Street at Blackfriars	Extremely busy cycle track (high usage in both directions). Extremely busy pedestrian environment.
Manchester	Oxford Road	Moderate levels of cycling, moderately limited pavement space for level of use, moderate level of complexity in pedestrian behaviour, well-defined cycle track, use of Belisha beacons on zebra crossing of track.
Manchester	Wilmslow Road	Comparison to Oxford Road (on same route), but high level of complexity of environment and inadequate pavement space for level of use.

It can be seen that this selection of sites meant we had:

- Two sites in London where we already knew there were unusually high levels of cycling (BS-77, Whitechapel Road and BS-67, Mile End Road)
- Examples in Glasgow and Manchester where there were complex environments with shops and large numbers of pedestrians (BS-139, Sauchiehall Street and BS-190, Wilmslow Road)

[6] These points are only provided as an informal simplified summary, indicating what we thought might be true before studying these locations in more detail. These are not conclusions arising from the study of each site.

- An example in Glasgow with low levels of cycling and very simple pedestrian movement (BS-631, Garscube Road)
- Two sites in Cardiff with non-bypass designs (BS-38, Kingsway and BS-622, Newport Road).
- A range of sites with more moderate levels of cycling, and more ordinary mixed environments (including both quieter and busier examples)
- An example of a site with both extreme levels of cycling and more extreme pedestrian numbers (BS-86, New Bridge Street at Blackfriars).

IN-PERSON STUDY

A number of repeat visits were made to these sites, enabling us to see them at different times of day and at different times of year.

Our in-person study (i.e. as distinct from the fixed camera analysis) of these sites included:

- Careful evaluation of the context of each location
- Recording the dimensions and features at each site, and producing simplified site plans
- Taking a structured set of photographs for reference
- Recording longer videos (up to around an hour in total) using hand-held cameras and temporarily-fixed wide-angle cameras
- Recording our experiences walking and cycling through these sites
- Taking structured and semi-structured observations and counts of vehicles and behaviour.

We carried out a count of different road users with the aim of providing a general guide as to the level of use we were seeing (i.e. rather than a detailed analysis).

Our approach was standardised, recording counts for ten minutes at a time. It was judged that these counts gave a guide as to the level of use, and that this period was a practical one for in-person observation. At busier sites it was not possible for one researcher to record all traffic movement simultaneously; instead they recorded different aspects of use over two sequential ten-minute periods. We judged that these short sequential periods could adequately capture these different aspects without the bigger changes in usage levels that might occur over a longer period. At the busiest sites multiple observers were used to make this practical.

Where we saw more unusual behaviours (i.e. a behaviour that we only saw at specific sites, not more generally), a record was taken of how significant these were.

This in-person study also meant we were able to predict roughly what behaviours we might see on the fixed-camera footage, and to pay attention to the best locations for these cameras.

In addition, a more "auto-ethnographic" approach was taken, with the researchers walking and cycling through the sites and recording their own experiences. This element of the work was illuminating. However, the researchers involved do not have lived-experience of disability, so these auto-ethnographic observations were not used to try to predict specific experiences of disabled pedestrians or cyclists.

FIXED CAMERA SITING AND QUALITY

We used fixed cameras to provide footage of behaviours over a much longer period, using the services of the company "Streets Systems". The cameras were attached to a light telescopic mast. This was held upright by attaching it to appropriate existing signposts or lamp posts (i.e. lighting columns).

For most sites the cameras used provided four views, making it possible to cover multiple angles. Only one mast was used at most sites.

Footage was recorded over at least two days, and often three days – other than at two of the London sites where we recorded for shorter periods. The image quality can be described as high definition and the footage allowed us (usually) to observe details such as:

- Whether pedestrians turned their heads in looking to cross cycle tracks or carriageways
- Whether pedestrians changed their walking or wheeling speed or rhythm
- The routes pedestrians took through the site.

The limitations of the footage included the fact that we could not judge facial expressions or other similar fine details, but many such limitations also exist while observing behaviours in person. An advantage in the use of fixed cameras, in comparison to in-person observation, is that there is no observer present. We judge that the presence of an observer could be especially significant (in altering behaviours) at quieter sites and at quieter times.

ANALYSIS OF CAMERA FOOTAGE

Our analysis of fixed-camera footage sought both quantitative and qualitative evidence, using both a more formal structured analysis and a broader less structured observation of conditions and behaviours. Both elements were important.

Supporting both elements, Streets Systems were able to use artificial intelligence to extract video clips showing situations where pedestrians and cyclists came close

together. For all but the busiest sites this made it more efficient to analyse such interactions, meaning we did not need to watch the full length of the video footage.

Streets Systems also used artificial intelligence to provide:

- Images onto which the paths of street users are traced, according to whether they belonged to certain categories (e.g., pedestrian, cyclist, car, van), combined into hourly and multi-day images
- Heatmaps (bright colours showing areas of high usage on those images)
- Counts of street users passing specific points (strictly speaking these were lines, not points), allocated to the above categories, and presented as graphs showing usage hour by hour.

Much of this chapter describes the structured analysis process in which we sought to quantify pedestrian experiences. However, in less structured analysis, in person, on hand-held footage, and on recordings from fixed cameras, we looked for a range of evidence such as:

- Numbers of people, and changes in this over time.
- Signs of tension or irritation between people, pedestrian fear, concern, discomfort or caution
- Collisions, near-collisions, or last-minute actions to avoid collisions
- The behaviours of those who could be seen to be using mobility aids such as a mobility scooter, wheelchair, or walking frame, or who could be seen to walk much more slowly than was typical.
- Signs of pedestrians checking for oncoming cyclists (or failing to do so)
- General cyclist speed and obvious changes in cycling speed, and whether they looked relaxed or more focused on making progress
- The characteristics of cyclist flows (whether people were cycling alone, in groups, or part of a steady or intermittent flows)
- Behaviours when a closer interaction arose between people cycling and pedestrians
- Routes used by pedestrians, including whether they chose to cross the cycle track at marked crossing points
- The responses of those cycling to situations (where they occurred) where pedestrians were more obviously planning to cross a track

7.2 Structured analysis of footage

We devised a structured process to analyse the experiences of pedestrians at the detailed-study sites, as captured on the video footage.

SUMMARY OF STRUCTURED ANALYSIS PROCESS

This analysis focused on recording details about the experience of each separate pedestrian as they crossed the cycle track.

Our objective was to quantify the degree of inconvenience, difficulty or concern caused to pedestrians by the presence of the cycle track. In order to do this, we concentrated on the following key indicators of pedestrian experience:

- Whether they were delayed crossing the cycle track, and by how long
- Whether they looked for oncoming bicycles, and how much they did so
- Whether they chose the shortest crossing route (at or near 90 degrees to the track) or crossed diagonally, making the assumption that people cautious about crossing would tend to do so by the shortest possible route
- Whether they crossed at any marked zebra crossing, and whether they diverted to use such a crossing, making the assumption that people cautious about crossing would go out of their way to use the zebra crossing
- Whether they were crossing the track to reach or leave the bus stop, or for another reason.

Some journeys would mean a pedestrian would use a zebra crossing on the cycle track simply because it was on their desired route line. Some would lead to people naturally crossing a track at 90 degrees. We therefore recorded pedestrian behaviour with reference to the line of their ongoing journey.

At almost all sites marked crossings also provided a kerb-free route. We recorded any obvious indication that a pedestrian's use of a zebra crossing might have related to a wish to avoid kerbs. For example, it was clear that those using a mobility scooter, wheelchair, child's buggy or shopping trolley might be using the crossing for this reason, rather than because the crossing was marked.

We recorded whether those crossing a track were doing so to reach or leave the bus stop. We observed that at some sites there were many pedestrians using the bus stop island to cross the carriageway, rather than because of bus use. We took such behaviour to indicate that these pedestrians felt no significant discomfort in crossing the track, or that crossing the carriageway via the bus stop island provided some advantage.

More details of the parameters recorded for each pedestrian experience are shown in Table 4:

Table 4: Parameters recorded for each pedestrian experience

Parameter	Details
What the pedestrian or group of pedestrians was doing.	Options included accessing or leaving the island as a bus passenger, crossing the carriageway via the island, crossing the track on less obvious paths, encroaching on the track or walking/wheeling along it.
Group makeup	Recorded whether a pedestrian was alone or not, group numbers, approximate ages (adult, teenager, child), and whether there were adults or children in the control of someone else (e.g. an adult pushed in a wheelchair or a child holding hands with an adult).
Delay	Options included whether pedestrians were delayed at all in crossing the track, whether they broke stride, waited for less than a second, diverted their path or slowed to avoid waiting, or waited for a longer period (estimated in seconds).
Crossing place	Recording whether pedestrians crossed at a marked crossing, mostly touching or mostly not touching the crossing, not at the crossing, or effectively along rather than across the track.
Diversion degree	Recording whether pedestrians appeared to cross the track on a direct route to where they were going, with a small diversion, or with a more obvious diversion (for example turning to cross a track at right angles, or going in one direction to a crossing point to then turn back on themselves).
Looking/checking behaviours	Recording any signs that a pedestrian looked for oncoming bicycles, how much they did this, and situations where they did not need to do so because they were walking/wheeling towards (any) likely oncoming bicycles.
Other signs of caution or comfort	Options included recording that adults took or failed to take the hands of supervised children (and similar occurrences between adults), or that smartphone use, conversations, or telephone use were interrupted or uninterrupted.
Possible reasons for crossing use	Recording any obvious sign that use of a crossing point might be because it provided kerb-free access (e.g. use of wheelchair, mobility scooter, wheeled suitcase, etc).

Where a party to an interaction more obviously gave way, or showed signs of tension or irritation, we recorded additional parameters, as shown in Table 5:

Table 5: Additional optional parameters recorded

Parameter	Details
Pedestrian behaviour	Options included recording that a pedestrian intentionally or accidentally blocked a cyclist's progress, gave way, walked faster, or retreated.
Cyclist behaviour	Options included recording that a cyclist acted to avoid a collision, gave-way in an unanticipated manner, or did so in a more planned way.
Presence of tension	Recording any indicators of tension or irritation (recording details as required).

Pressures of time meant that it was only possible to analyse portions of the video footage in this more detailed and time-consuming manner. For most sites we focused on periods when the cycle track and pavement were busier, in order to ensure we had studied times when any problems might be most acute. At some sites it was necessary to analyse a much longer period to see a sufficient number of pedestrians crossing the track. Table 6 below provides details:

Table 6: Details of periods fully analysed (every crossing analysed) from video

Site	Crossing events analysed	People involved	Analysis periods	Notes
Garscube Road	98	118	08:00-19:00	
Victoria Road	50	50	08:00-09:00	
Sauchiehall Street	70	77	09:00-11:00	
Whitechapel Road	88	96	08:00-08:50 08:25-09:00 09:20-09:35	
Mile End Road	158	173	07:55-09:05 08:10-08:25 11:55-12:05	During the short period analysed around noon none of 15 people observed waited
New Bridge Street at Blackfriars	204	214	07:50-08:50 16:25-16:35 17:25-17:35 17:45-17:50	
Oxford Road	68	77	08:30-08:55 12:30-12:45	Plus 2 additional observations of people using mobility aids (neither waiting)

Wilmslow Road	98	117	17:00-18:00	Plus 5 additional observations of people using mobility aids (none waited)

Our researchers also flagged video recordings of more interesting interactions to make it possible to refer back to these.

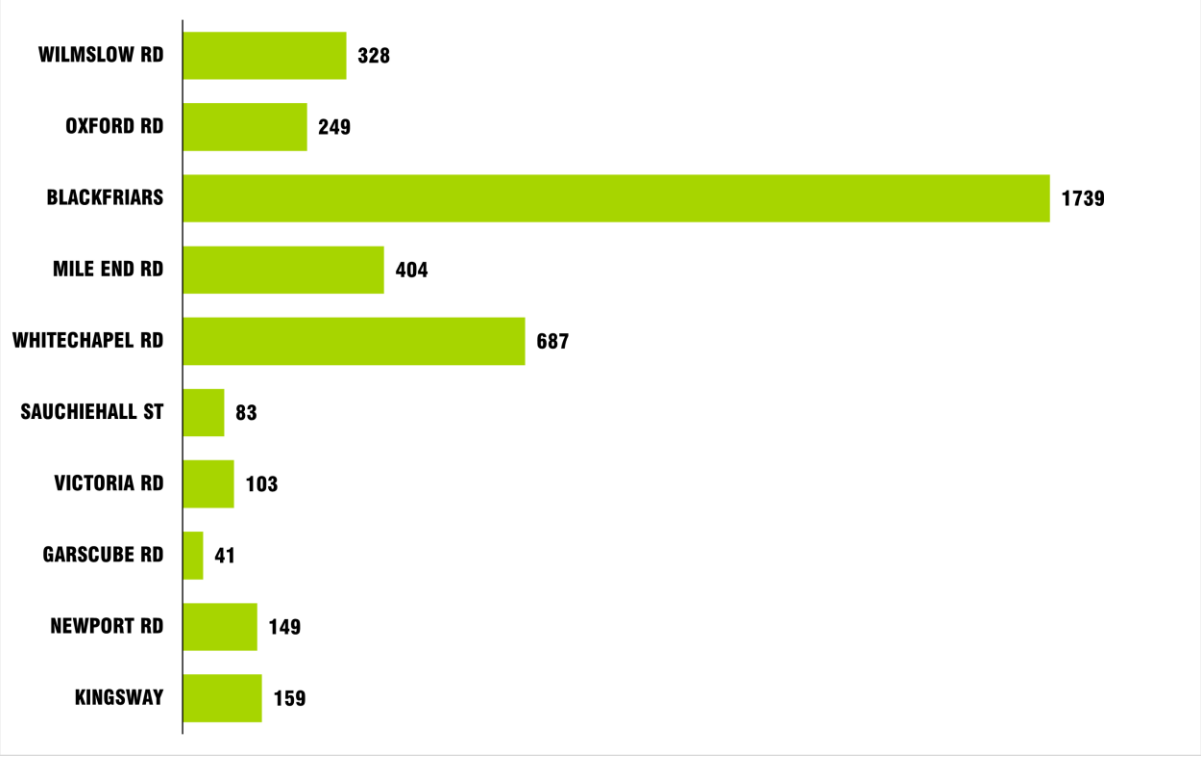
7.3 Analysis results summary

Additional details are available in Appendix 1, but this section provides several graphs summarising key results from our structured analysis process.

LEVEL OF USAGE

Figure 9 and Figure 10 show cycling and pedestrian levels at the different detailed-study sites. Full details describing these charts are provided in Appendix 1, however it is clear without further explanation that the sites varied greatly in character.

Figure 9: Number of cyclists (total in peak observation hour)



Peak cycling levels on the cycle track at Blackfriars were many times those at most other sites. Peak levels at Whitechapel Road in London were also very high, being around twice those at the busiest site we studied outside London (Wilmslow Road in Manchester).

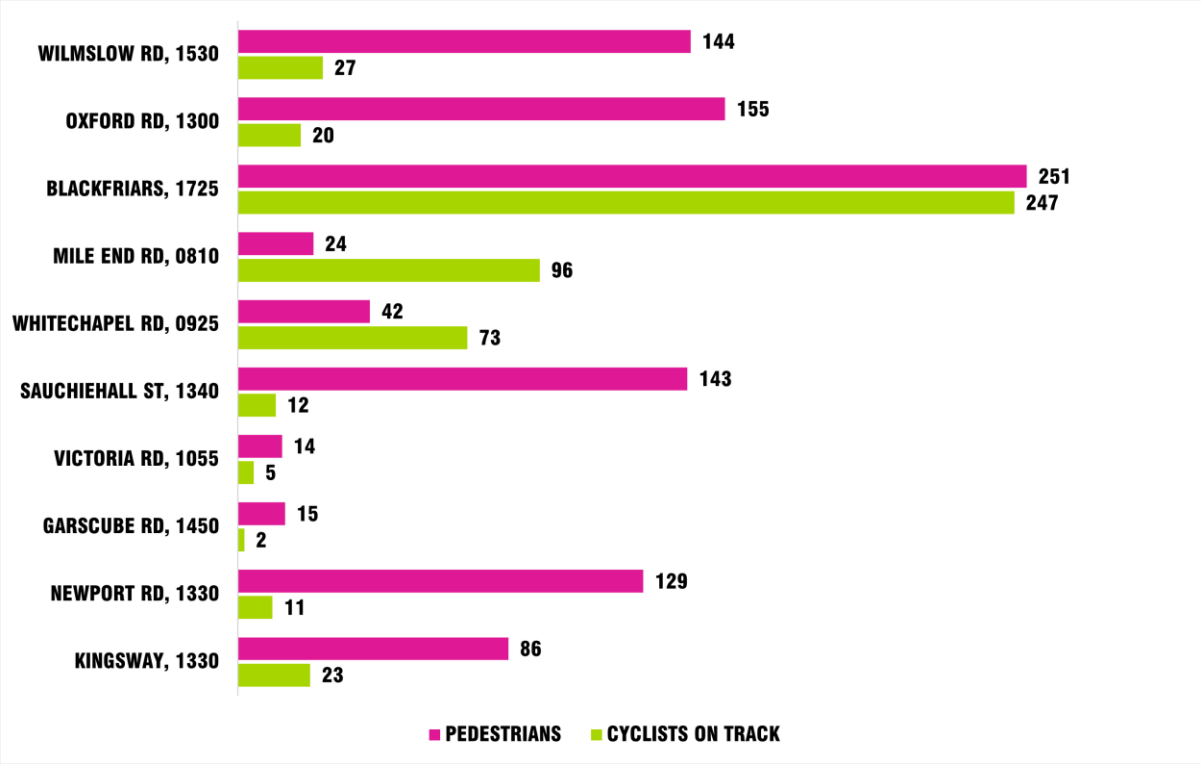
As noted above, we chose to study some of these sites specifically because of the unusually high or extreme levels of cycling, not because they are representative of cycle tracks and bus stops elsewhere.

The differences in the balance between pedestrian and cycling levels, shown in Figure 10 also seemed important in determining the character of each site. This records passing cyclists and passing pedestrians, in specific ten minute periods (the time is indicated).

Once again the site at Blackfriars in London stands out as providing conditions unlike those elsewhere. Pedestrian numbers were extremely high. The other London locations were not particularly unusual in this regard.

However, the other London bus stops (Whitechapel Road and Mile End Road) do stand out as unusual because levels of cycling here were, at these times, much higher than levels of pedestrian use. We chose to study these bus stops because they were on what seemed to be an important route for cycling into and out from central London. This created particular conditions, different from those seen elsewhere.

Figure 10: Cyclist and pedestrian numbers (specific 10-minute periods, times noted)



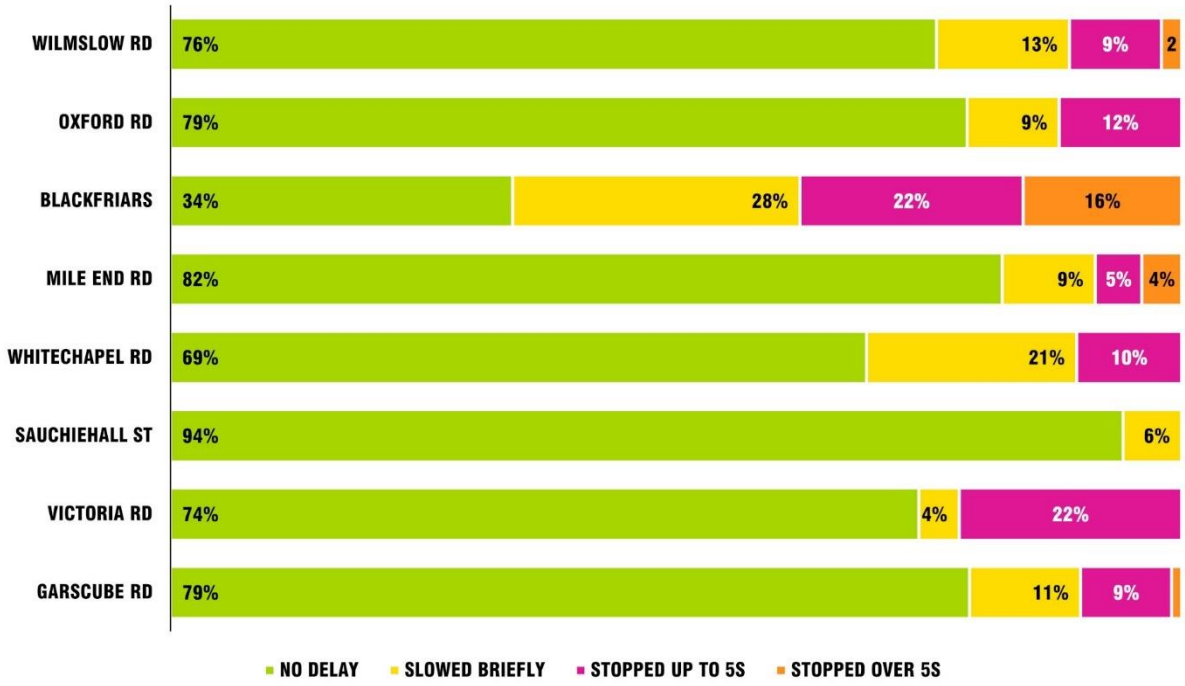
PEDESTRIAN DELAYS AND WAITING BEHAVIOUR

Figure 11 charts the delays caused to pedestrians crossing the cycle track. The "slowed briefly" category indicates pedestrians who could be seen to change their walking/wheeling speed slightly, but not to stop to wait to cross the cycle track.

While the graph does not break down the "stopped up to five seconds" category, most waits were much shorter than five seconds.

This figure should be read with reference to the data in Table 6 (page 57), which provides details of the number of crossings analysed for each site, and the times of day the analysis covered.

Figure 11: Delays to pedestrians by site



Generally, all the sites offered minimal delay to most pedestrians, the extremely busy Blackfriars site being the exception. Such delays need to be seen in context and to be compared to the delays common elsewhere. Our observations suggest that most bus stop bypasses are not a significant additional barrier to movement for most pedestrians.

CHECKING BEHAVIOURS

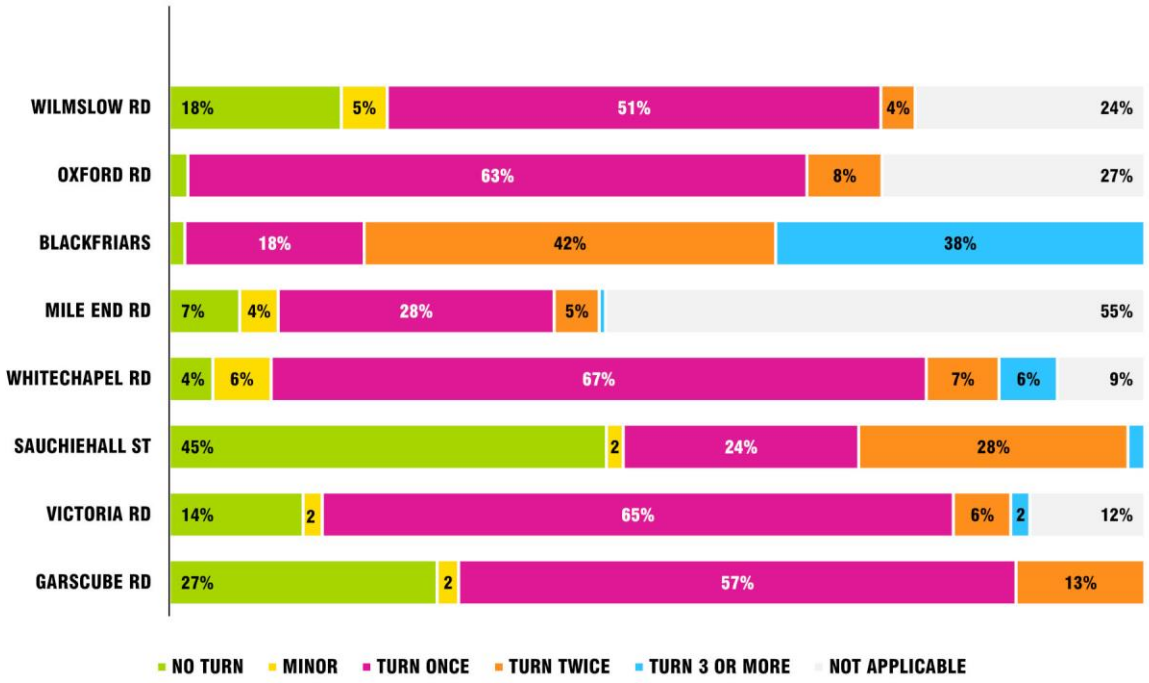
Figure 12 charts observations recording whether pedestrians appeared to check for oncoming bicycles when crossing the cycle track.

We considered that checking behaviours would indicate the ease with which pedestrians crossed the track, and their comfort in doing so. It should also indicate the complexity involved in interpreting the movement of people cycling. If

pedestrians don't check before crossing this suggests a simple situation, which they can navigate without difficulty or concern. Where pedestrians look back and forth before crossing it suggests a complex environment, requiring more judgement and care.

In the chart, the "turn once" category records a detectable turn of the head in one direction and the "minor" category something suggesting a possible check, but that fell short of an obvious look. The "turn twice" category indicates that a pedestrian could be observed to look both ways, or to pause and to look a second time in the same direction. The "not applicable" category was recorded for situations where a pedestrian crossed a one-way track diagonally, while walking/wheeling toward any oncoming cycles. In these cases there was no sign that pedestrians were checking for oncoming bicycles, but we wouldn't have expected to see any such signs.

Figure 12: Pedestrian checking behaviours



It can be seen that, with the exception of the sites at Blackfriars and Sauchiehall Street, the "turn once" category represents most checking behaviours where these occurred. With the exception of the site at Blackfriars, the percentage of pedestrians recorded in the "turn three or more" category was very low or negligible. The only other site where any significant number of people were seen to do this was at Whitechapel Road – another site with high cycling numbers.

It may be helpful, when consulting this graph, to recall that the only detailed-study sites with two-way cycle tracks were at Blackfriars, Sauchiehall Street, and Garscube Road. In this respect, that around 6% "turn three or more" behaviour was observed at Whitechapel Road, a one-way track which is very busy, is significant. Similarly, the

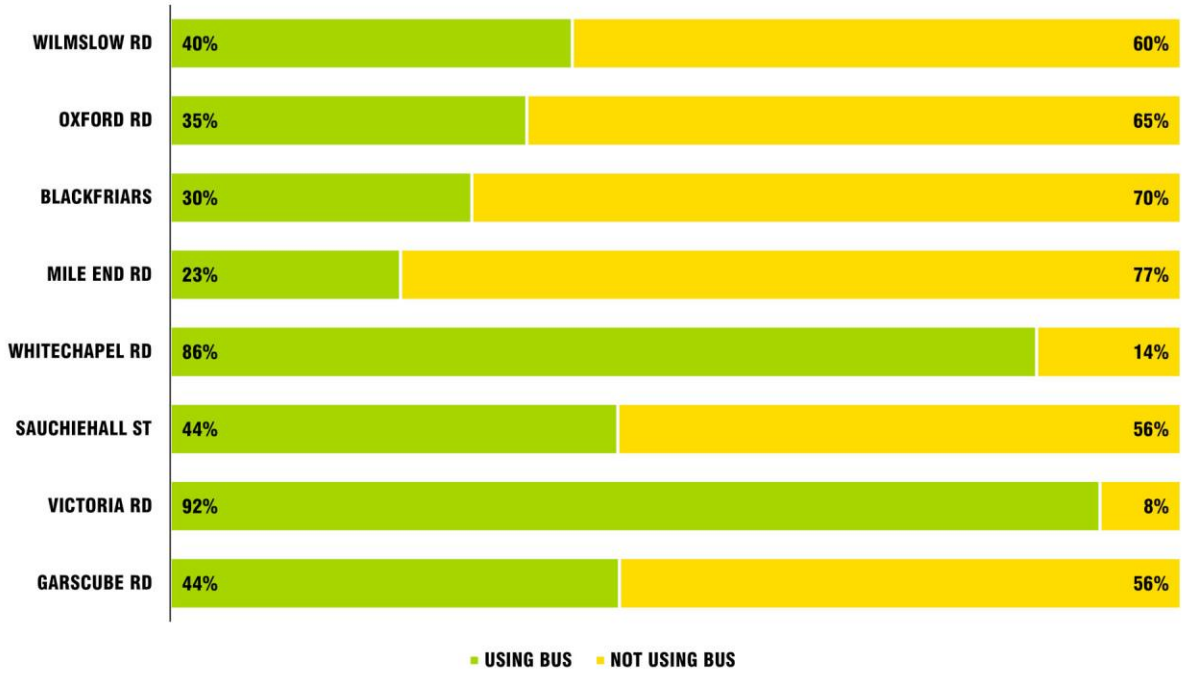
lack of checking behaviour at Garscube Road, a two-way track which is much quieter, is significant.

PURPOSE FOR CROSSING

Figure 13 records the proportion of pedestrians who were observed to be crossing the cycle track in order to board a bus, or in alighting from a bus. It compares this to the proportion of those crossing the cycle track at the bus stop for other reasons (including as part of a journey along the pavement, or in crossing the whole road).

We introduced this measure only after our on-site observations had highlighted how few of those crossing the cycle tracks were doing so because of bus use. It seemed likely that pedestrians were using the bus stop island as a means to narrow the width of carriageway they needed to cross. It also seemed possible that by doing so they gained a better view of the carriageway. This carriageway-crossing behaviour did not appear to arise from use of the opposite bus stop.

Figure 13: Was use of bus stop island associated with bus use?



Our observations showed that at most sites more than half of the pedestrians crossing the cycle track were not using a bus. Surprisingly, this was the case even where conditions on the carriageway were more challenging, such as at Blackfriars.

It may be that the differences between different sites mostly result from how many people wanted to cross the carriageway in each location, rather than because of conditions being more or less suitable for crossing.

Note that the unusually low number of pedestrians recorded as crossing the carriageway at Victoria Road may be misleading, as our camera view omitted the southern end of the bus stop island. Here, a signalised crossing was provided, the carriageway was narrowed further, and pedestrians could be seen to utilise a path cutting to the west. The analysis recorded above did not include what appeared to be much higher carriageway-crossing behaviour at this location.

The situation at Mile End Road is described in more detail below (in Section 7.4).

7.4 High-level learning

CONDITIONS VARIED ACCORDING TO BUSYNESS AND COMPLEXITY

Conditions for both pedestrians and cyclists could be seen to vary greatly, according to how busy and complex, or how quiet and simple, cycle tracks and their environments are.

The simplest effects were easily predicted, in that busier cycle tracks were less easy to cross. However, we observed more complex effects. Importantly, changes in conditions for pedestrians could also be seen to have a consequential effect on conditions for those cycling, and vice versa.

Table 7 lists a range of factors we conclude are relevant in determining the character of the environment.

Table 7: Distinguishing environment characteristics

Quiet-simple	Busy-complex
Occasional isolated individual cyclists	Flows of cyclists (i.e. a moving line)
One-way (uni-directional) cycle track	Two way (bi-directional cycle track)
Occasional isolated individual pedestrians	Crowds or flows of pedestrians including groups of pedestrians
Pedestrians well clear of the cycle track, not immediately beside it	Pedestrians walking/wheeling/standing on the cycle track or immediately beside it
Occasional buses stopping rarely	Steady flow of buses, stopping regularly
Single buses stopping briefly	Buses at stop for prolonged periods, bus stop rarely without a stopped bus, multiple buses stopped
Individual passengers alighting or boarding	Multiple passengers and groups of people both alighting and boarding
Individual pedestrians mostly walking/wheeling along the pavement, rarely crossing the carriageway, rarely joining or leaving the pavement	Pedestrians queuing, crossing the carriageway in numerous places, entering and exiting shops, walking/wheeling in groups, standing chatting to friends

No building frontages, or large faceless units with few entrances/exits	Crowded shopping street or similar, with numerous entrances to shops
Plenty of unobstructed space on pavement and cycle track (bearing in mind the level of use) allowing flexibility in movement	Pavement or cycle track space constrained or obstructed (bearing in mind level of use) so that pedestrians or people cycling are often brought closely together or/and are forced into more complex navigation
Cycle track free of breaks, free of risks from encroachment by vehicles	Cycle tracks with breaks where cyclists encounter risks from vehicles
High surface quality cycle track, with low forgiving kerbs and gentle ramps	Obstructions and imperfections in surface, drain covers, slippery metal gratings, kerbs at pedal height with vertical upstand, steep ramps
Wide straight cycle tracks	Cycle tracks with sharp bends (particularly if narrow and combined with high kerbs)
Clear space at the edges of cycle tracks, lack of bollards or similar obstructions on the track	Handlebar level (or higher) obstructions close beside the cycle track, bollards in the cycle track

It can be seen that levels of pedestrian use, and levels of cycling, are both accounted for in this table.

Informally, levels of pedestrian use (i.e. walking/wheeling along the pavement) might be categorised as in Table 8.

Table 8: Level of pedestrian use of pavement (informal scale)

Level of use	Characteristics
Quieter  Busier	Pedestrians usually alone (sometimes absent for long periods), distant from one another, pairs rare, groups rarer or absent, negotiations to pass others rare and trivial. Full width of pavement rarely or never required.
	Many alone. Pairs or small groups of friends more common, but these clearly separate from one another. Negotiations to pass others more involved (e.g. groups change shape). Full width of pavement occasionally used.
	Groups common, groups sometimes difficult to tell apart, negotiations to pass others common and constant. Full width of pavement often in use.
	A flow of pedestrians with no gaps or only occasional gaps, crowd behaviours begin to form (e.g. walking/wheeling to the left). Pedestrians forced to sometimes step off the pavement.

It could be seen that the space provided for pedestrians made a big difference in determining busyness. Thus "busyness" results not only from absolute pedestrian numbers, but also how constrained the available space was.

At some sites we observed conditions with very busy pavements, when there were larger groups of pedestrians, a flow of pedestrians, or when more pedestrians were standing or sitting. We concluded the behaviour of individual pedestrians changed in these circumstances. They seemed to become much less inclined to look individually for hazards (like a cycle track or oncoming cyclist). It could be seen (and we personally observed when walking) that in crowds the view of an individual pedestrian was sometimes limited by the presence of others. The human environment was also more complex, with some people negotiating passage with each other, and others standing talking, sitting, or looking at phones.

In a similar way, the level of busyness of a cycle track might be categorised *informally* as outlined in Table 9.

At most of the detailed-study sites, conditions were as in the quietest two categories for all or most of the time. The busier levels were only seen for short periods at a few sites – which we had chosen to study because we knew them to be unusually busy.

Table 9: Level of cycling on tracks (informal scale)

Level of use	Characteristics
Quieter  Busier	Cyclists usually passing rarely (may be absent for long periods), alone, distant from one another, pairs very rare, groups rarer or absent
	Cyclists passing more often, strangers occasionally stopped together at junctions or signals but tending to keep social distance from one another once moving, avoiding cycling together
	Many cyclists alone, but formation of occasional small groups of strangers cycling together (e.g. 3 or 4 people per group)
	Larger groups of strangers (e.g. 5 or more) are common, but there are clear gaps between these
	Large groups are merged together to create flows of cyclists

As part of the study, we ourselves cycled at the sites with the more extreme levels of cycling, at their busiest times. We concluded that conditions for cycling in such circumstances were quite unlike those found on more ordinary tracks, or at quieter times. There were several dimensions to this difference, as follows:

- We were much less able to act alone. Much as if driving on a major road in flowing traffic this meant behaving in a way which was predictable to those behind us, without sudden changes to speed or direction. However, less like

when driving, and more like the behaviour of pedestrians in a busy environment, cyclists came together into a closer group.

- We found that narrower or more constrained cycle tracks brought cyclists much closer together than was comfortable, with the result being that we had to pay considerable attention to our own safety.
- These very busy conditions also meant we could sometimes not see far ahead.

There was interplay between the levels of busyness of the pavement space, and the level of use of the cycle track.

The level of cycling on a cycle track appeared to be an important factor in whether pedestrians noticed its presence, and whether they reacted to this. Pedestrians seemed more likely to walk or stand on a track where cycling was rarer, even if this seemed to be physically obvious (see the discussion of encroachment in Section 7.5). They seemed to stay off busier tracks.

When cycling past busier pavements, or in conditions where pedestrians were brought closer to the cycle track, we found that it became progressively more challenging to try to predict the behaviours of every pedestrian. It became important to pay attention to pedestrians who were closest, ignoring those further ahead.

Where there were many pedestrians actually on the track, we tried to cycle as we could see many others did. This meant trying to continue cycling where this was safe, but at a very slow speed. It became important to pay attention to safely negotiating the immediate interactions, with the result that we could pay much less attention to pedestrians further ahead.

Table 7 also indicates that the complexity of the physical environment is an important distinguishing factor. On better designed stretches of cycle track the experience of cycling could be a simple one. In other cases, tracks had been built so that we had to pay attention to numerous risks, with these coming one after the other even when travelling at only a moderate speed.

Risks arose from rough surfaces, drain covers, kerbs high enough for a “pedal strike”, sharp corners, posts in the track, and objects at handlebar height close to the track. At bus stops, ramps and corners often added to the complexity. Bus shelters and posts were sometimes close enough that we were worried our handlebars might strike them. Shelters and advertising panels blocked views. Many cycle tracks also had gaps in the protection they offered at side road or other

entrances, and we found we needed to pay considerable attention here, looking ahead to predict risks from vehicles at these locations.

In stark contrast, the environment at quiet-simple sites provided both pedestrians and cyclists with conditions which were much easier to negotiate. Here, we could see that those involved could:

- see each other easily (unless visually impaired)
- easily predict when they might need to account for the behaviour of someone whose desired path conflicted with their own
- act individually
- use the greater space available to them, making it trivial for all involved to avoid a closer interaction

OBSERVED PEDESTRIAN BEHAVIOUR

From Figure 11 (page 60) it can be seen that at most of the detailed-study sites only a minority of pedestrians were delayed at all, despite our analysis focusing on times when cycle tracks were busiest, with most not even slowing their walk to cross the track. 74%-94% of pedestrians proceeded without significant delay if data from the unusually busy London sites is excluded. Most pedestrians didn't need to stop to wait to cross the cycle track, even at the busiest site in the study at its busiest times. At all sites, of those who actually paused to cross the track, this was usually for less than five seconds (and usually for much less than this). While any wait may be frustrating, and does represent some level of inconvenience, much longer delays are typical for pedestrians elsewhere.

We included the site at Blackfriars in the study to ensure we had an example where there were extremely high levels of cycling. We judged that these levels are representative of only a tiny number of cycle tracks in Britain, and that they are higher than on most cycle tracks in countries/cities where cycling levels are generally high. We included sites at Whitechapel Road and Mile End Road as examples of tracks with very high levels of cycling – perhaps more typical of very busy tracks more widely.

Only at the Blackfriars and Mile End Road sites was any notable percentage of pedestrians waiting to cross the cycle track for more than five seconds. At Whitechapel Road the percentage of pedestrians waiting for more than five seconds was insignificant.

Only at Blackfriars were any pedestrians observed waiting to cross the cycle track for more than ten seconds. The longest delay at this site, for one individual

pedestrian, was for 48 seconds (4% were 20 seconds or more, and about 1.5% 30 seconds or more). These *are* undesirably long delays, and it seems likely that pedestrians here would have felt some frustration. However, these are shorter than typical delays at many signalised pedestrian crossings (i.e. crossings with traffic lights).

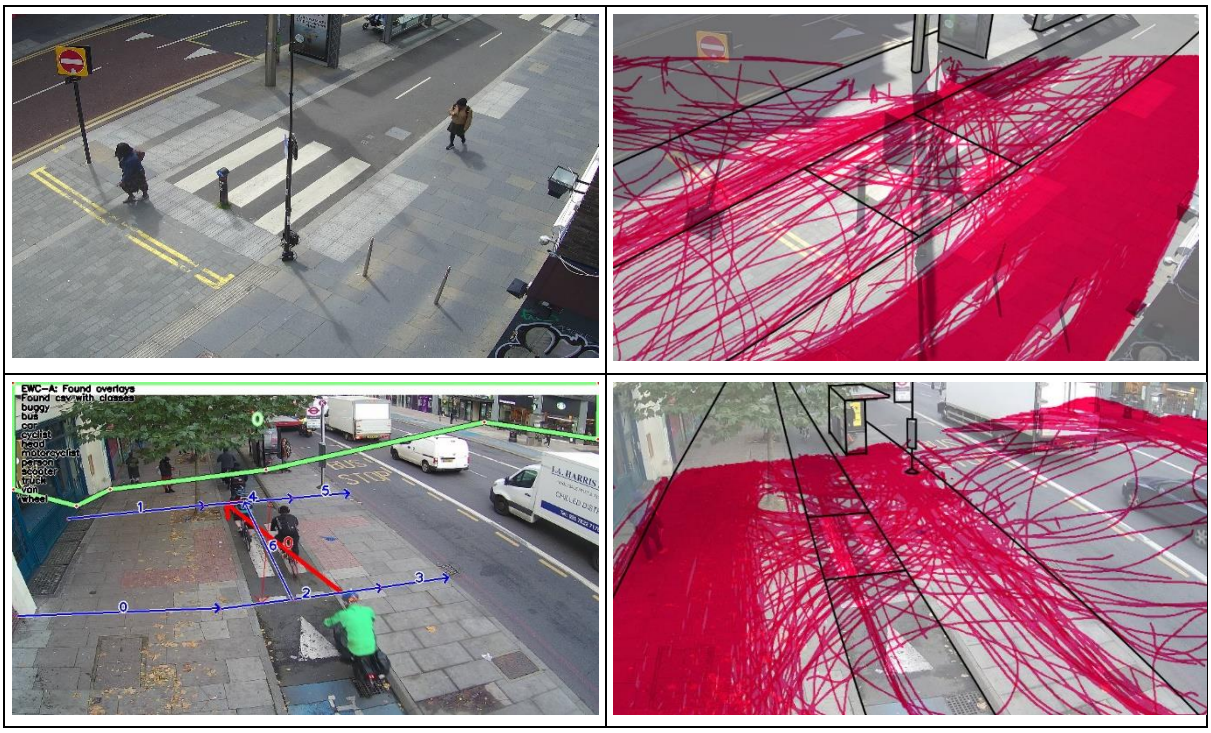
At other sites the longest waits, for one individual pedestrian, were of ten seconds (Wilmslow Road) and nine seconds (Mile End Road). Our study had determined that the Wilmslow Road cycle track had the next highest peak levels of cycling after those at Mile End Road (see Figure 9, page 58).

It appeared extremely rare that a pedestrian went significantly out of their way to use a marked zebra crossing or any other marked crossing point. It was also rare to see any pedestrian using a zebra crossing in the manner that would be seen at a carriageway crossing - walking or wheeling to one side of a zebra crossing, turning to cross directly, then turning again to continue in a desired direction. Almost all pedestrians stepping on a zebra crossing did so on an obviously diagonal path, and many of these were only on the marked area for part of their crossing.

In many cases marked zebra crossings were at places that also provided a kerb-free crossing, we presumed this making crossing here somewhat more convenient for most pedestrians. In many cases, where a pedestrian could be seen to use a marked crossing in a more obvious manner, they also had a visibly obvious reason for seeking such a kerb-free route – for example because they were pulling a suitcase, pushing a child, or using a wheelchair.

Figure 14 shows two typical images on which the paths taken by pedestrians (recorded by the fixed-cameras) have been drawn. These show the Sauchiehall Street and Whitechapel sites, with a background image for each alongside one on which pedestrian paths are recorded. These images clearly illustrate that there is little focus of pedestrian routes on the zebra crossings. It can be seen that those who do cross at these points tend to do so on a diagonal path across the track, often only encountering a section of the crossing.

Figure 14: Pedestrian tracks

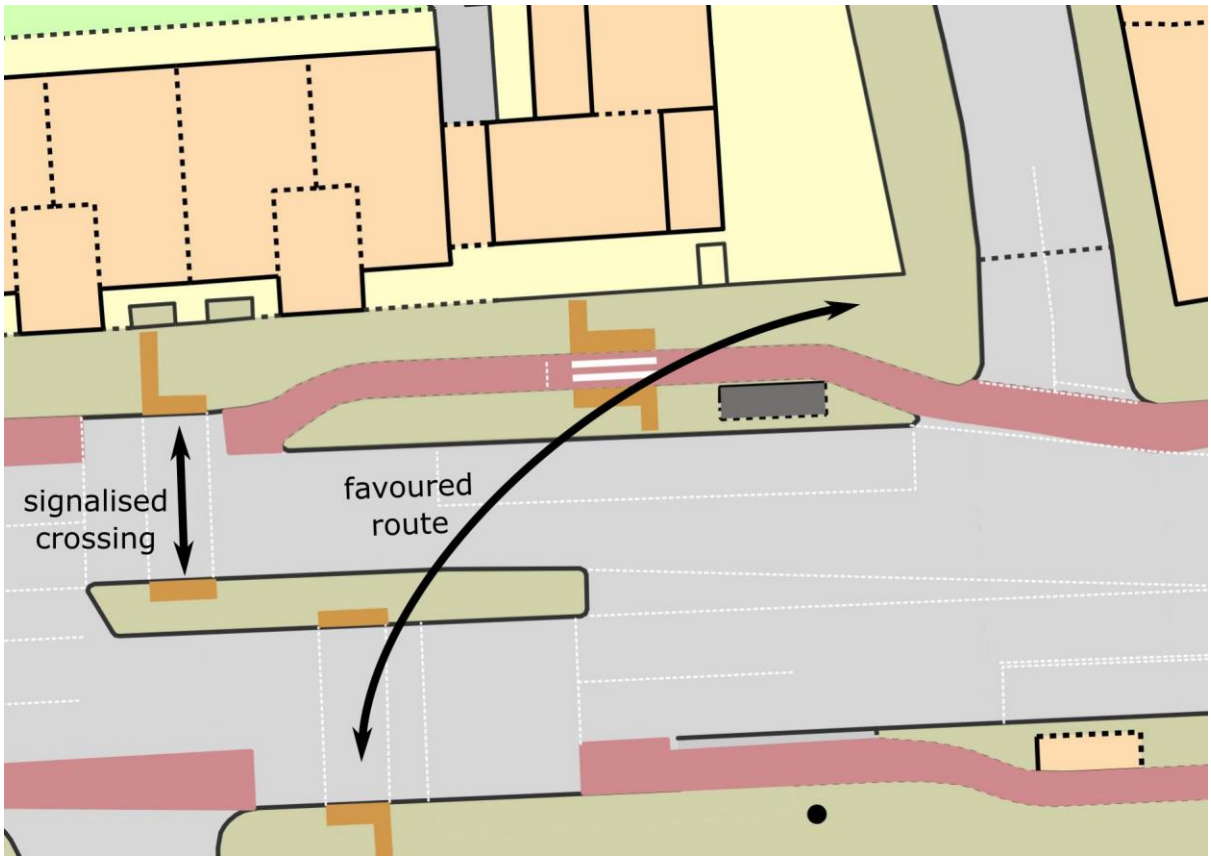


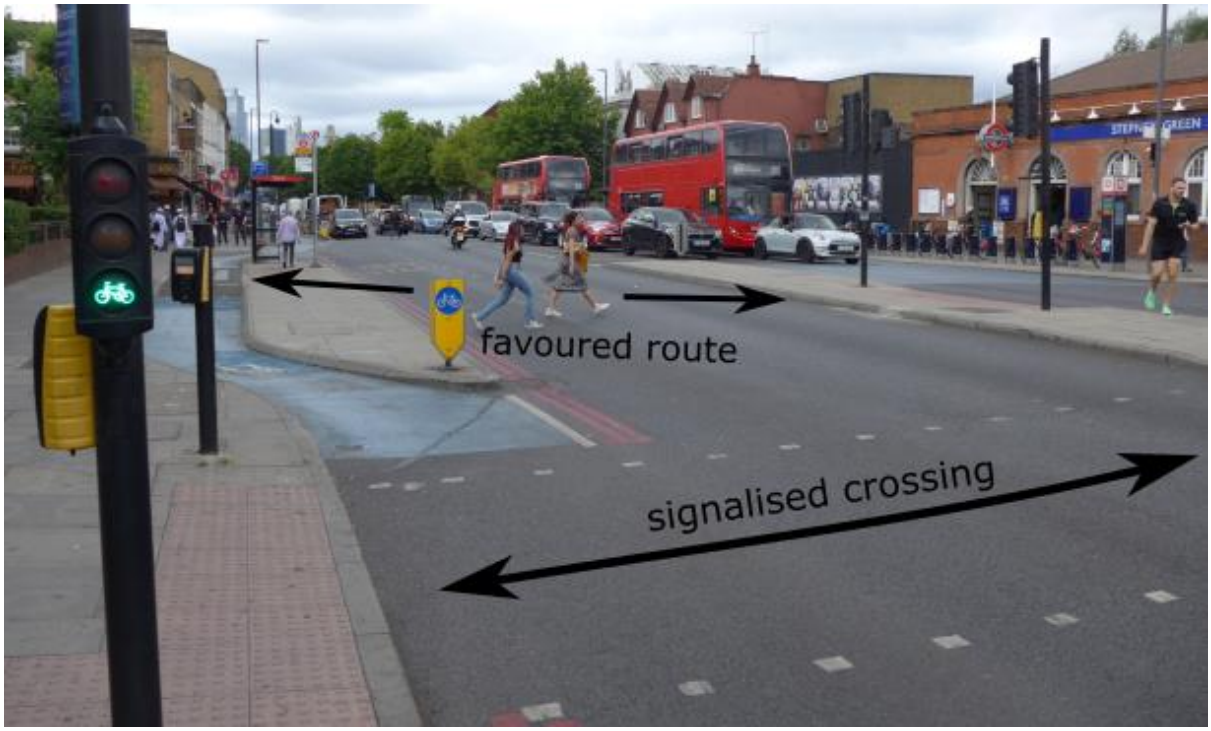
We also saw pedestrians, even in locations where there were high levels of cycling, using the bus stop island to support a route across the wider carriageway. At one of the busiest sites (BS-67, Mile End Road) there is an adjacent signalised crossing (using traffic lights) that stops both cyclists and vehicles, as shown in Figure 15 (below). This provides access to a pedestrian refuge island in the middle of Mile End Road (and a second crossing of the other half of the carriageway).

Whereas on the other side of the carriageway almost all pedestrians could be seen to be crossing at the signalised crossing point, at the bus stop a very high proportion could be seen to instead use the bus stop island on route to the central refuge. This is also reflected in Figure 13, which shows that at the Mile End bus stop only around 23% of the people crossing the cycle track here were doing so because of bus use.

For 15 minutes we recorded the behaviour of pedestrians who were travelling past the bus stop, to and from the west, on the south side of Mile End Road. In this time 45 crossed Mile End Road using the bus stop island. Only four did so by using the signalised crossing. Of those four, two had reasons to use this because it offered a kerb-free route (one pushing a child's buggy, one with a rolling case) and the other two were a couple accompanying two small children (not counted separately in this case).

Figure 15: Mile End Road, route ignoring signalised crossing





EXCLUSION OF CERTAIN GROUPS

In our initial assumptions we recognised that observations at the detailed-study sites would not show the experiences of people who had already been excluded from their use. Our observations below should be understood within this context.

We looked for evidence that some people were struggling with conditions at the bus stops. It seemed likely that if significant numbers found conditions challenging then we would observe a spectrum of experiences. We had considered it possible that we would see many people negotiating the cycle tracks with ease, some showing concern, and a small number struggling more. In reality, we saw little evidence of any pedestrians facing significant issues.

However, we remain in no doubt that some pedestrians would find crossing some of the cycle tracks we observed uncomfortable, frightening, difficult or impossible.

We could see that zebra crossings did not operate as might be expected, and that they did not offer a reliable way to stop cyclists. Figure 12 (page 61) shows that many pedestrians carried out checks for oncoming cyclists, even if these were cursory. The level of use of some cycle tracks, at some times (as shown in Figure 9, page 58 and Figure 10, page 59), meant cyclists passing every few seconds. At the site at Blackfriars (BS-86, central London), which we studied to help us understand more extreme conditions, our analysis shows around 30 cyclists passing per minute at peak times.

This left us in no doubt that some bus stop bypass arrangements excluded blind and partially sighted people (from using the bus stops / unless they recruited assistance).

It also seems self-evident that at the Blackfriars site a wider group of pedestrians would struggle to cross the cycle track when at its busiest. In particular, this applies to anyone who would have been less able to judge when it was safe to cross, and less able to cross quickly. This could apply to people with a less significant visual impairment, those who struggle to predict more complex vehicle movements, and people with some physical impairments. Younger children and some older people would also be included.

MOST CYCLISTS USE WELL DESIGNED TRACKS

The path trace images provided in Appendix 1 show that what we observed did not support some of the statements made to us during other parts of the research. Various contributors had suggested that many or most cyclists ignored cycle tracks, used tracks in a way that was not intended, or continued to use the carriageway.

At our detailed-study sites it could be seen that most cyclists used the cycle tracks. In some locations use of the carriageway was rare or absent altogether.

One exception was at Mile End Road in London (BS-67). We could see here that cyclists regularly approached at speed, in relatively large groups (loose groups of up to around 15 were occasionally seen) travelling in a bus lane and cycle lane rather than on a cycle track. Here a relatively high proportion of cyclists could be seen to skip the section of track at the bus stop, instead joining the track after passing this.

There was a lower, but still comparatively high level of use of the carriageway further along the same route at Whitechapel Road (BS-77).

In our on-site investigations and from our own experience of cycling through these locations it was clear that a number of factors contributed to the use of the carriageway. For example:

- This is a major route towards central London leading to very high levels of cycling
- This route may attract a high percentage of cyclists who are focused on covering much longer distances, with high fitness levels and a focus on high speeds and short journey times
- Cyclists on Mile End Road/Whitechapel Road are not on protected cycle tracks throughout its length, but often also had to share space on the carriageway with vehicles, excluding those cyclists not sufficiently comfortable in coping with such conditions
- The comparatively narrow cycle track (of varying width) with high kerbs and sharp corners in the track, and very high levels of cycling, created challenging conditions that required a high level of concentration to stay safe if using the track
- The cycle track at Mile End Road began just before the bus stop, being only wide enough for single cyclists, terminating immediately after the bus stop to allow vehicles to exit from a side road
- Cyclists avoiding the Mile End Road bus stop bypass gained additional clearance from the front of any vehicles exiting the side road sited immediately after this bus stop, which sometimes blocked the track
- Cyclists avoiding the Mile End Road track at the bus stop could join the track after passing this side road.

FAILURE OF ZEBRA CROSSINGS

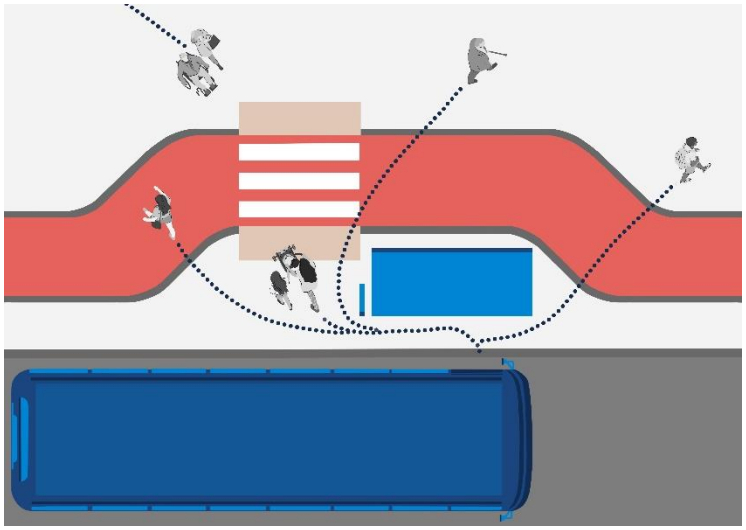
We saw little evidence that zebra crossings of cycle tracks are performing a useful role at bus stop bypasses, in the way that might be expected given their legal status. That said, zebra crossings may be useful for other reasons which are described in Section 8.2.

We rarely saw pedestrians using a zebra crossing of a cycle track, at a bus stop bypass, in the manner that would be seen at crossings on an ordinary carriageway.

Figure 16 provides an illustration of behaviours more typically seen. In this image we include people who are choosing to use the zebra crossing because it offers a kerb-free route – one using a wheelchair, and the other a child's buggy.

Note that this diagram provides a greatly simplified image which is not to scale. Path traces, as in Figure 14 (page 69) and Appendix 1, provide a more useful illustration of what this behaviour looks like in reality. These path traces show little focus of crossing activity on the zebra crossings. There were only rare occasions on which any pedestrians crossed straight across the track at these crossings.

Figure 16: Typical behaviours, ignoring crossing (NB: simplified diagram, not to scale)



In analysis of over 500 people crossing cycle tracks that had zebra crossings nearby, we saw around 2% appear to stop at the zebra markings and wait for cyclists to give way. Around half of these had a cyclist stop for them, with the rest crossing in the next available gap. The longest we observed a pedestrian standing waiting at a zebra crossing for was seven seconds.

However, it was challenging to perform this analysis. The way pedestrians approached zebra crossings did not fit into neat categories which could be easily

analysed. Most people crossed without meeting anyone cycling and so had no need to wait. They were also not deviating from their route, so appeared to be only at the zebra markings incidentally. We saw very few people appearing to stand at the edge of the zebra crossing in the way typically seen for a zebra crossing on a carriageway. Often people approaching would slow or pause a little way back from the cycle track, as if indicating that they were not expecting (or wishing) for cyclists to stop, but instead that they were waiting a second or two for a gap in which to cross. This matched the way we saw people cross at places where there was no zebra crossing, and suggests that the presence of the zebra crossing was not significantly shaping how most people went about crossing.

This was true even at extremely busy sites – although at the Blackfriars bus stop no zebra crossing was provided. We suspect that had one been provided it would have functioned badly due to the extremely high levels of cycling and the volume complexity of pedestrian movement.

Details describing the zebra crossing markings at the eight detailed-study sites that had a bus stop bypass design are in Table 10.

Table 10: Crossing details by site

Unique ref	Short name	Zebra crossing provided?	Stripes	Notes
BS-631	Garscube Road	Yes	3	
BS-133	Victoria Road	Yes	2	Image 1 in Figure 17
BS-139	Sauchiehall Street	Yes	3	Two crossings. Image 4 in Figure 17
BS-77	Whitechapel Road	Yes	2	Image 2 in Figure 17
BS-67	Mile End Road	Yes	2	Image 3 in Figure 17
BS-86	New Bridge Street at Blackfriars	No	-	
BS-184	Oxford Road	Yes	3	Full “Belisha” beacons (also two points without zebra)
BS-190	Wilmslow Road	No	-	Two crossing points without zebra markings

These designs (some of which are shown in Figure 17) are similar to those we saw in other locations, and elsewhere we saw examples with just one white stripe. It seems unlikely that zebra crossings with two or three white stripes are seen as formal zebra crossing markings when in many other places in Britain – such as car parks – such markings are used for a variety of less formal purposes.

Figure 17: Images of zebra crossing markings

1) Most zebra crossings of tracks have few stripes

2) Crossing markings lost in a sea of other markings and colour changes

3) Crossing markings lost in a sea of other markings and colour changes

4) Zebra crossings (two close ahead) lost in a complex environment (including a side road crossing)

Section 8.1 includes a discussion of the reasons zebra crossings may not be performing as might be expected.

The subsection below, on the functioning of the shared platform boarder designs in Cardiff, is also relevant to this discussion. Here the zebra crossings performed differently.

DIFFERENCES IN CARDIFF (DESIGNS OTHER THAN BUS STOP BYPASSES)

The two Cardiff bus stop sites we studied were not bus stop bypasses, but rather designs where the cycle track sits between the bus stop and the carriageway.

Figure 18 shows a photograph and 3D diagram of each site. Further images and details about the designs are provided in Appendix 1.

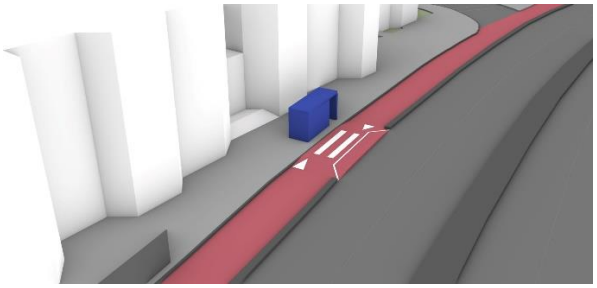
One of these sites (BS-622, Newport Road) had a shared platform boarder design (see Figure 6, page 22 for definitions). This had a very short obvious platform not much longer than the zebra crossing stripes marked on it.

At the other site (BS-38, Kingsway) the cycle track is raised for a much longer length, with zebra crossing markings in three locations matching the locations of three related bus stops – the southern two close together. This might be described as a hybrid between a shared platform boarder and a continued kerbside track. While the cycle track was brought onto a ramped platform (as with a shared platform boarder) most of the bus stop area is a considerable distance from the first ramp.

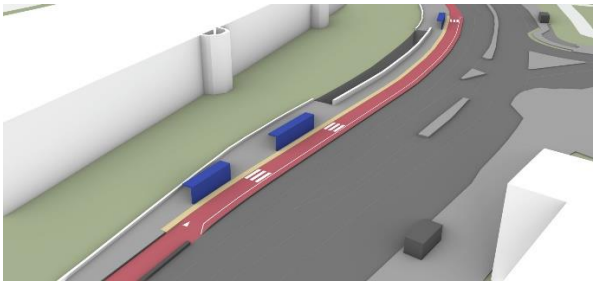
Figure 18: Photographs/images of Cardiff sites

Newport Road (photograph)

Kingsway (photograph)



Newport Road (3D diagram)



Kingsway (3D diagram)

At the Kingsway site buses often stopped for prolonged periods of many minutes, usually (but not always) with their entrance doors matching the position of the zebra crossing. Pedestrians typically queued across the crossing, with almost all boarding rather than alighting.

Here we observed a range of complex behaviours. This regularly included:

- Queuing pedestrians stepping back to provide a space through which a cyclist could pass
- Cyclists negotiating their way through the queue by approaching slowly and adapting behaviours according to how pedestrians responded ahead of them.

Occasionally we saw:

- Cyclists dismounting to walk around the queue
- People cycling around the queue using the pavement behind the bus shelters.

The photographs in Figure 19 illustrate some of these behaviours.

Figure 19: Behaviours at Kingsway site

1) Queuing across zebra crossing

2) Delivery cyclist bypassing long queue using pavement

3) Cyclist approaching (image 4 follows)

4) Cyclist (as image 3) walking around queue

It was difficult to assess what appeared to be low levels of tension (or its absence), at the distance of our observations. Notably we did not observe sudden, chaotic or more obviously risky interactions. However, based on our consultations with disabled people it seems likely that some pedestrians would be alarmed by the close nature of some of these interactions, despite cyclists proceeding with care and at low speed. This may particularly be the case for people who fear falling over or who are blind or partially sighted or who are concerned for the welfare of a guide dog.

At Newport Road 90% of pedestrians were alighting rather than boarding. As can be seen in Figure 18 (left image) there was an area about 1m wide at the edge of the short platform (beside the carriageway) separated by a painted line, meaning that pedestrians were not stepping directly onto the cycle track. The width of this area was such that pedestrians alighting from a bus had only two or three steps before stepping onto the cycle track. However, we concluded that this provided a helpful and significant separation of alighting passengers and oncoming cyclists. We could

see this allowed some pedestrians to respond to oncoming cyclists, and people cycling avoided riding in this buffer area, especially when a bus was stopped.

We noted that at these Cardiff sites most (but not all) cyclists gave way at the zebra crossing markings when pedestrians were on them, or were alighting beside them. We conclude that the zebra crossing markings in these locations provided a clearer message about the expectation to give way to these pedestrians, and that unlike at the bus stop boarders the behaviour of pedestrians was more consistent with them expecting this behaviour.

We analysed around 500 passengers getting on or off buses at this Newport Road stop. 17% of these passengers were present at the crossing area when a person cycling was either passing or was giving way.

Looking only at these situations, 40% of pedestrians had a cyclist stop to wait at the crossing and another 59% had a cyclist give way without stopping, by either slowing noticeably or allowing obvious consideration when passing. 5% of people had someone continue cycling past on the cycle track without such action. This included two instances of a pedestrian seeing a cyclist approaching – delaying stepping off the bus while they cycled past; a pedestrian who was waiting on the middle of the zebra markings for over a minute despite three people cycling past them (in both directions); and a cyclist slowing to give way to some alighting pedestrians, and then continuing after these had crossed, but while further pedestrians alighted.

We assessed in each of these occasions whether the pedestrian appeared to need to respond to the approach of someone cycling. In 79% of encounters no reaction was needed – people cycling had usually stopped or slowed without the pedestrian having noticed them. In around 10% of cases pedestrians had given way to people cycling, and the remaining 11% of cases included pedestrians stepping out of the path of a cycle, or visibly checking for approaching cycles before proceeding.

We could see that sometimes someone cycling stopped quite quickly (within half a bus length) when a pedestrian stepped into the cycle track ahead of them with the pedestrian not obviously aware of their presence.

However, at these sites we also saw a much higher level of close interaction between passengers and cyclists. There were minor indications that tensions were higher than at other bus stop bypass sites. For example, one interaction was recorded after which a pedestrian could be seen holding her hands/arms as if in complaint about a cyclist who had not stopped to give way to her and a second pedestrian (at Newport Road). This was the only time we observed such a visible expression of frustration on the camera footage from any site.

Our observations suggested additional challenges for a blind or partially sighted pedestrian alighting from a bus at sites with designs of this nature. Problems include:

- Alighting passengers are inherently more hidden until actually stepping from the bus and therefore cyclists cannot anticipate an interaction with a long cane or guide dog user
- A passenger's long cane or guide dog may be on the cycle track before they themselves are completely off the bus
- Alighting passengers need to deal with several challenges at once, which include stepping safely from the bus, orientating themselves, and accounting for risks from cyclists.

7.5 Learning on design points

The following provides details about some more specific learning, which arises from the detailed-study site work.

PEDESTRIAN ENCROACHMENT

In both our analysis of video, and during site visits, we often observed pedestrians walking/wheeling along or standing on cycle tracks. At some sites it was normal to find that the cycle track was obstructed, at least to some degree, for much of the time.

For example, at Sauchiehall Street in Glasgow close to the detailed-study site (BS-139) a 100m stretch of track was obstructed for around 40% of a ten-minute sample observation period, mid-afternoon on a weekday. Obstructions included pedestrians walking along the edge of the track for a short time, those walking/wheeling along it for a substantial period, and people standing on the track while chatting or while collecting themselves having alighted from the bus. We conclude that almost all cyclists using the track on Sauchiehall Street at that time would have encountered at least one pedestrian walking, wheeling or standing on the track (or occasionally an obstructing vehicle at a side road crossing point) at some point on its full length.

At other locations similar situations occurred.

Initially, at some sites, we speculated that this resulted from the high level of pedestrian use of insufficient pavement space – however on visiting these sites at quieter times we continued to observe the problem.

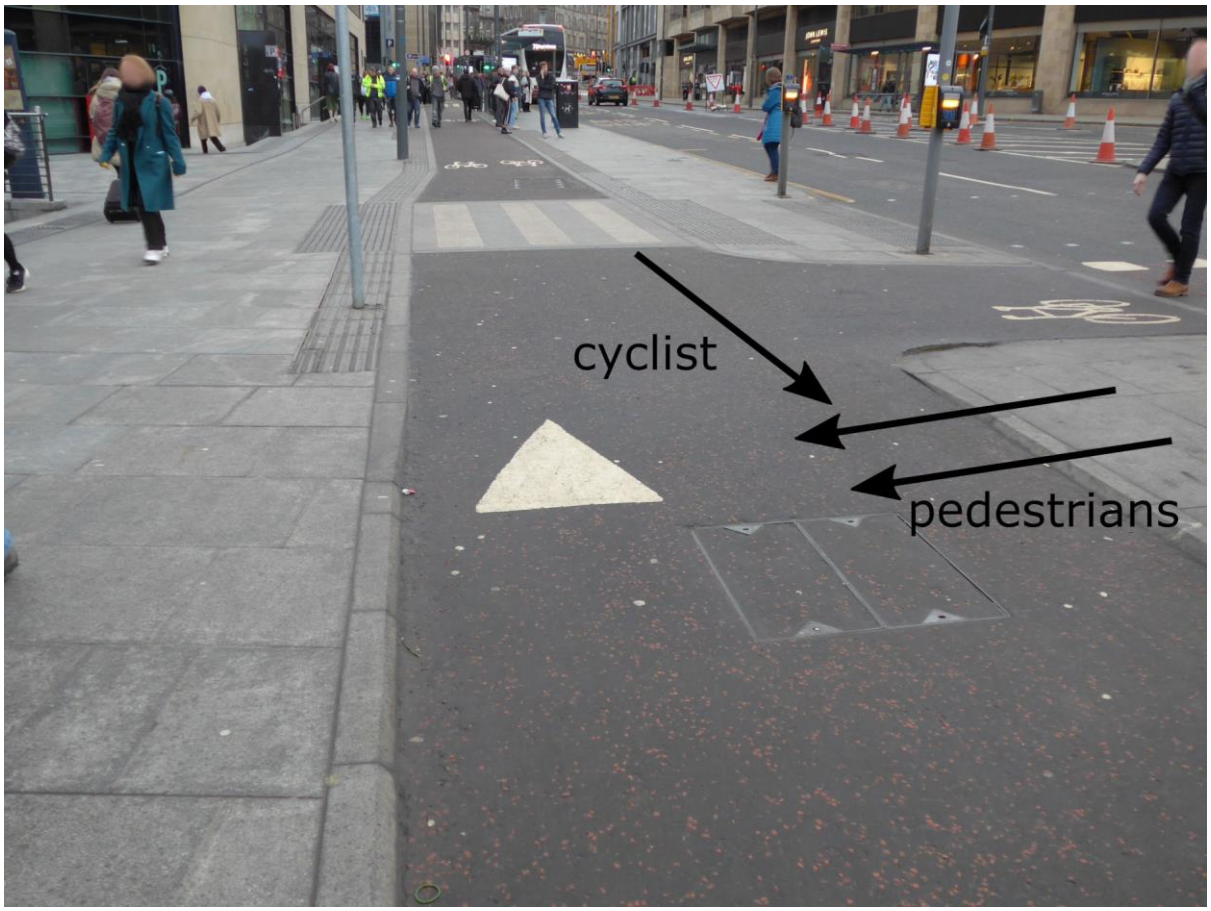
In one notable incident, observed at a bus stop on Leith Street in Edinburgh, a couple walked directly into the path of an obvious oncoming cyclist. The cyclist was an older woman, not travelling at speed. Although our researcher had anticipated

the possibility of this interaction and was watching carefully, she showed no sign of anticipating it. Once the pedestrians reached the track (walking straight onto it) she stopped abruptly, avoiding a collision.

The cycle track here appeared to be obvious, with its edges marked by kerbs and a consistent obvious colour that is different to the pavement – as can be seen in Figure 20.

When questioned, the couple expressed anger at the cyclist's behaviour. They explained that they had not noticed the presence of the track at all.

Figure 20: site of described incident



Sometimes pedestrians walked or stood on a cycle track until they noticed they were obstructing a cyclist, whereupon they moved from it.

At quiet-simple sites this was much less of a problem. In these locations pedestrians also walked on the track, or stood on it, sometimes for long periods. But this caused fewer issues, with active cooperation around space and no signs of tension at all.

For example, at Victoria Road (BS-133) a man waited for a bus for at least seventeen and a half minutes (our recording begins after he arrives and ends before he

leaves). During that time he spent seven separate prolonged periods standing in a relaxed manner on the cycle track or walking in various directions on it (for periods of 44, 51, 44 seconds, 1 min 40 sec, 11 seconds, 47 seconds, 1 min 54s, during which time 14 people cycled past on the track). We had no sense that this man was confused about the status of the cycle track, and he tended to move to the pavement to allow cyclists to pass.

We looked for indicators of tension between pedestrians and people cycling at all the detailed-study sites, but particularly where encroachment was an issue. Such indicators might have included:

- Arguments or signs of an irritated exchange of words
- Social signals of irritation or outrage, such as waved hands or a head shake
- Repeated ringing of a bicycle bell.

These indicators were surprisingly rare, even at sites where cyclists were significantly obstructed, and after accounting for some irritation not being manifested or detectable. We spent several hours making informal observations at one such site in Edinburgh. Here levels of obstruction often reached the point that cyclists could not pass pedestrians walking on the track. In general, we saw little detectable tension here. We noted that on many occasions cyclists showed they were adept at avoiding or adapting to the presence of pedestrians on a track, usually without the pedestrians noticing that this had happened.

This point should, however, be qualified. Although rare, there were occasions on which an individual cyclist could be seen to behave in a risk-taking manner – cycling close past people obstructing the track. Whether this action was driven by frustration at being obstructed, inattention, or simply a higher tolerance of risk was not apparent. However this risk taking behaviour, of a few individual cyclists, could be seen to put pedestrians at increased risk and discomfort. It seems likely that pedestrians will find these closer interactions easier to recollect than the more common situations where interactions are avoided or were unremarkable.

Elsewhere we made informal observations of behaviours on a busy path in Edinburgh (unconnected with any bus stops – see Figure 21) where there was only a worn painted line dividing space intended for cycling from space intended for pedestrians. Here cycling is common, although levels are not particularly high, and there is often crowding of the pedestrian space (the latter is the case in the images). In contrast to the above observations, despite the crowded nature of the pedestrian space and the relatively unobvious status of the cycling space, almost all pedestrians stayed clear of the cycling space. The layout here is a very simple one in comparison to the situation seen at many bus stop bypasses, and this has been in place for decades.

Figure 21: Edinburgh path, separation with painted line

Separately, it could be seen that on much busier cycle tracks – for example at the London detailed-study sites – there was much less encroachment of pedestrians onto the tracks.

Considering multiple observations of pedestrian behaviour we concluded that:

- Pedestrians, if viewed as a single group, take little notice of cycle tracks (or any other space marked for cycling), even if the tracks are obvious, until there are cyclists regularly using them
- Pedestrians, noting that they are obstructing cyclists, often move off the cycle track, meaning that the clarity of purpose of the track matters in reducing tensions
- Pedestrian (and cyclist) behaviour is not just a result of immediate circumstances, but also familiarity with infrastructure and local circumstances established over time.

Overall, we concluded from these observations that cycle tracks must be built to be as obvious as possible to pedestrians. This means the use of a single, distinct colour for tracks across a whole town or city, and the presence of suitable height kerbs and a drop in level from pavement height. It will be more difficult to regularise behaviours if a variety of layouts and materials are used – especially within one locality.

DISTRACTIONS ARISING FROM PHYSICAL DESIGN

In line with comments in the earlier sub-section on environment complexity (part of Section 7.4), we conclude that specific design features can greatly increase the level of attention that cyclists need to give to their own safety – thus distracting them, and limiting their ability to consider the needs of pedestrians.

We explored these factors in more depth with repeated trips through the different sites by bicycle, and found that the distractions included:

- Cycle tracks that in most places were wide enough for two to easily cycle abreast, but which narrowed a little at bus stops
- Kerbs that were high enough to catch a pedal, particularly when combined with narrowed sections or corners in the cycle track
- Obstacles at handlebar height that are close enough to the cycle track to *feel* like a potential threat (even if theoretically not a threat)
- Poor areas of surface or potholes, drainage covers, or slippery metal access covers
- Bollards in the cycle track
- Nearby gaps in the cycle track that allow incursion by vehicles
- Unprotected side road entrances (or similar) where cyclists were needing to anticipate possible risks from crossing vehicles
- Crowded pedestrian environments immediately adjacent to the cycle track, meaning there is a risk that any one pedestrian (of the many present) might suddenly step onto the cycle track.

In other threads of project work we had noted there were suggestions that physical features should be used to slow cyclists down at the bus stop. There were conversations about cyclist speed in our focus groups and site visits with disabled people (see Section 6.3), and suggestions for measures to achieve this (Section 6.2). Features discussed, here and elsewhere, include narrowing of the cycle track, corners, and ramps. Whilst cyclist speed is an issue, our observations strongly question whether these features significantly slow cyclists down. Indeed, we conclude that they can act as a distraction for cyclists from the observation of people crossing ahead.

From our own experience of cycling through the detailed-study sites (using an autoethnographic research approach), we concluded that where these features are sufficiently severe to have any effect, this effect is mainly to focus the attention of cyclists on negotiating them safely.

Speed calming features on a carriageway generally slow drivers because they are afraid of damage to their vehicle – and accelerating involves only a light press on the accelerator. We intentionally observed our own reactions in encountering some of these features while cycling through the detailed study sites, and through others encountered as part of the study. We noted (in contrast) that we were not concerned about damage to a bicycle, but our own physical comfort and safety. At the same time, we noted that we wanted to avoid the physical effort that would be involved in slowing and accelerating more significantly and found, by concentrating or

changing body position, that these features could almost always be negotiated without doing so.

Where such features are severe enough to affect speed there is a risk that these will cause problems for less confident cyclists, those who are caused pain by rougher surfaces, those using adapted cycles, or people using other wheeled mobility aids on the cycle track.

In places in London we felt that it was obvious that the width of cycle tracks was insufficient for the volume of people cycling. Cycling here we had to have a significant degree of our attention focused on our own safety. For comparison, our researchers noted they had cycled in the centre of Amsterdam, Utrecht, and Copenhagen, at rush hour, and found the situation in these places in London more stressful.

INEFFECTIVE OR CONFUSING PAINT MARKINGS

At the detailed-study sites, and much more widely, we noted that cycle tracks could be decorated with a high number of paint markings (in addition to any zebra crossing), typically indicating:

- The presence of ramps (with triangles)
- Direction of travel (with arrows)
- That this was a cycle track (with bicycle symbols)
- That cyclists should slow down (with a “SLOW” marking).

We consider that there may be a number of problems with the provision of such markings, which include:

- The addition of complexity
- Confusion (most obviously because ramp markings look much like direction arrows).
- Generic use irrespective of the specific site conditions
- Their ineffectiveness in communicating meaning or changing behaviours
- Overuse, which reduces impact where they might be useful
- Inconsistency with the use of such markings on carriageways.

Our evidence demonstrated that members of the public were confused about the status of zebra crossing markings on cycle tracks (see Figure 17 on page 75 for relevant photographs and the associated discussion). Arguably these are the most familiar of the markings typically used, and we surmise that less familiar markings will be even less well understood.

Generally, we saw that in simpler environments cyclists were more free to pay attention to the wider environment, and thus more able to predict pedestrian behaviours. While it may be difficult to prove the specific role of paint markings in increasing complexity the addition of more markings seems likely to be an indication of a suboptimal design. It also seems safe to assume this added complexity will mean markings distracting from one another.

The use of the word SLOW to describe desired behaviour at an upcoming zebra crossing, which we observed in some locations, is inconsistent with designs used to communicate the same point to cyclists and drivers on a carriageway. Here, if required, there is typically a warning sign, highlighting the presence of a crossing. On the carriageway SLOW is typically used instead to highlight situations of risk to the driver, like an unusually tight corner or hidden junction. Its official meaning, as indicated in legislation on signage and road markings (Traffic Signs Regulations and General Directions), is “Vehicular traffic should proceed with caution because of potential danger ahead”.

At multiple sites triangular ramp markings had been used to highlight the presence of ramps. However these ramps were often of such insignificance that cyclists were unlikely to notice them, even if travelling at speed. This seemed to us to indicate confused thinking by designers, or by those who modified designs, particularly as these triangular markings can be mistaken for direction arrows.

Based on our site observations we conclude – tentatively – that such markings are at best ineffective and at worst may do more harm than good.

RESPONSES TO TRAFFIC SIGNALS

Alongside our detailed observations of people crossing cycle tracks at bus stops, we undertook some brief observation of how people use pedestrian crossings with traffic lights when these exist across cycle tracks.

Dedicated signalised crossings (i.e., with traffic lights) of cycle tracks are very unusual. However examples exist at several points along Embankment in London. Here the cycle track is crossed separately to the main carriageway, with a wide multi-use area between the two. We observed two different examples of these crossings for a total of 26 minutes. Although during the middle of the day this still allowed us enough time to observe 112 people crossing, 152 passing cycles and 349 motor vehicles. During this time the separate crossing signals for the main carriageway were activated 13 times, and the signals for crossing the cycle track were not activated at all.

Figure 22: Crossings on Embankment

In this small snapshot we could see that most people (90%) were making some use of the crossing signals for the main carriageway, while nobody was seen using the signalised crossing of the cycle track. When crossing the main carriageway some people waited for the green signal, while in some cases people started waiting and then found a gap before the signals changed. In contrast, as in our detailed studies elsewhere, almost no one had to stop to wait to cross the cycle track.

We carried out a short study of behaviours at the traffic signals immediately to the south of the detailed-study site at Blackfriars. The main role of these is to provide a pedestrian crossing (but a small side road exits here too). There were fluid and dynamic behaviours from both people walking and cycling. Around a third of pedestrians were giving way to, or otherwise accommodating people cycling, while two-thirds of pedestrians could cross without any negotiating or interruption to give way to people cycling. These proportions were almost identical whether the cycle track had a green or red signal. Pedestrians were equally likely to cross without interacting with people cycling when people cycling had a green light as when they were shown red.

People cycling would often respond to the red light as if it were a give-way instruction (rather than a requirement to stop) slowing/stopping for people crossing. Some then continued through the red signal after people had crossed rather than waiting for a green light. We saw two-thirds of people cycling who arrived at a red light either stop or slow to give way to pedestrians. Of the remaining third of cyclists, around half were riding through when no pedestrians were at the crossing, and half (about 15% of total) were riding through while pedestrians waited and gave way to them.

Notably, when one or two cyclists had stopped – whether pedestrians were present or absent – others arriving behind them were likely to stop and form a group who would wait until shown a green light before restarting.

We did not see any cyclists slowing or stopping to give way while the cycle track had a green light.

At a cycle track in Edinburgh, where a signalised crossing is provided across both a carriageway and an adjacent bi-directional (two way) cycle track, a short informal survey showed that it was usual for cyclists to stop at a red signal to allow waiting pedestrians to cross the cycle track, only for them to proceed through the red light once the pedestrians were on the carriageway/pavement and clear of the track (see Figure 23).

Figure 23: Sequential images of typical behaviour at Edinburgh crossing

Cyclist stopped for waiting pedestrian, pedestrian now clearing cycle track and entering carriageway

Faced with an obviously empty cycle track the cyclist re-starts cycling (the pedestrian can be seen to have reached the far side of the carriageway)

Together these observations suggest that while showing a red light to people cycling results in most (though not all) riders giving way to people crossing, in comparison cyclists are unlikely to give way when they have a green light.

Such small surveys only provide indicative evidence, do not capture many elements of behaviour at these crossings, and cannot expect to identify experiences that happen less often. What they did appear to show was that there is a profound difference in the experience people have of crossing motor traffic compared to crossing dedicated cycle tracks – and that the factors affecting how cyclists respond to red traffic signals arise from a range of complex factors, some of which are social. It also suggests, as discussed in Section 9.3, that on tracks where they are not usually needed there may be more disadvantages than advantages arising from the presence of traffic signals.

Further research is required to determine the degree to which traffic signals might be useful at the busiest cycle tracks. It should investigate how cyclists typically change their behaviour in situations where it is clear that pedestrians need them to stop. It should look for evidence as to whether signals are used or ignored by pedestrians, and of cyclists behaving less cooperatively in situations where a green light is displayed to them.

These observations inform the discussion in Section 8.3 around the option of adding signal-controlled crossings of cycle tracks at bus stops.

8 Discussion of core findings

This project investigated whether bus stop bypasses – and other arrangements where a cycle track continues past a bus stop – create problems for pedestrians, and whether they lead to the exclusion of disabled people. It evaluated the extent of problems and explored possible solutions.

Our literature review confirmed that some people believe bus stop bypasses cause significant problems to a considerable proportion of pedestrians, no matter how they are designed. Others insist that bus stop bypasses are needed if Britain is to encourage more cycling and more diverse groups of people to cycle. They believe the wider benefits of doing so are already proven.

It is government policy (UK and devolved) to create significant increases in the number of people cycling, as part of wider health, social, economic and environmental strategies. It is assumed that this requires significant increases in the safety and comfort of the conditions experienced, and that routes need to be direct and welcoming, even after dark [1] [2] [6] [7] [8] [9].

At the same time, some express frustration that cycling is not currently inclusive and believe safety and comfort are key in changing that [5] [10]. One contributor to this project used the phrase “brave men” to title the group most likely to cycle in current conditions. It is clear that in countries and cities where conditions are more comfortable, cycling is open to much wider groups of people. For example, female cyclists outnumber male cyclists on Dutch streets and cycling levels decline only at a much later age [11] [12].

This background set a challenging context for the study. There was agreement that bus stop bypasses (and other ways that a cycle track might continue past a bus stop) were intended to support cycling. However, there was debate about many other ideas, such as whether these changes:

- Actually support cycling, or fail to do so
- Make cycling more inclusive, or only benefit those cycling as a lifestyle choice
- Disadvantage a large proportion of pedestrians, or are part of a suite of more profound changes to support pedestrians by challenging the dominance of motor vehicles.

With a view to drawing together the many threads of a complex project, this section is framed as a discussion, organised in themes that include both conclusions and recommendations.

It is important to note that earlier sections of the report and the appendices contain significant additional details about this complex subject. However, because we expect many readers to read this section before others, we have also chosen to repeat some points made in the wider text.

Many of the main conclusions and recommendations are also listed/summarised separately in Section 9, “Summary of main conclusions and recommendations”.

8.1 Key findings

UNCERTAINTY OVER PURPOSE AND VALUE

Early conclusions of this work included that:

- there is a level of confusion over the purpose of bus stop bypasses (and other arrangements continuing a cycle track past a bus stop)
- some people question the value of the infrastructure in terms of whether it actually is encouraging cycling.

In Section 3 we report on how guidance describes the purpose of this infrastructure. In Sections 5.4 we report on relevant learning from conversations with organisations representing disabled people. In Section 7.3 we report on similar conversations with individual disabled people.

The reasons given for the provision of this infrastructure fell broadly into two categories. In the first were ideas about cyclist safety. Literature and contributors discussed the risks involved in interactions between cyclists and buses, or in cyclists passing a bus waiting at a stop. In the second category were ideas about the convenience of cyclists. Cyclists were said not to like losing momentum, and to find waiting behind a stopped bus inconvenient.

We noted some difference in emphasis in the way that design-orientated informants discussed cyclist convenience and safety compared to user-orientated organisational representatives focused on disability and inclusion. The same difference was apparent in the literature – with designers and design guidance focusing more on safety, while organisations that were worried about inclusion focused more on the idea this infrastructure is provided for the convenience of cyclists.

We concluded that this creates an unhelpful division, and this difference in thinking is representative of more widely conflicting ideas. On the one hand, it was apparent that some see this infrastructure to be essential for the support of cycling, and that it is being provided as part of making much more profound changes to how streets work. They feel such changes may improve inclusion. Such changes are seen to

have wide benefits. On the other hand, some see these changes as being focused on the convenience of a small group who have made a lifestyle choice. There is an assumption that, in comparison to many disabled people, this group tends to enjoy some level of privilege. They believe that the convenience of this small group of people is being prioritised over much more profound problems – problems that lead to people being excluded from ordinary use of the streets. They see this exclusion as life-defining.

Associated with this confusion about purpose, questions were also raised over whether bus stop bypasses (and equivalent arrangements) had any value at all.

Some contributors suggested to us that we would see that many or most cyclists do not use cycle tracks. Some suggested that it was a challenge to persuade cyclists to do so. Some told us that cyclists particularly disliked bus stop bypasses, or found them dangerous or confusing, and that we would see them avoiding these.

CONCLUSIONS AROUND PURPOSE AND VALUE

The detailed-study site work (described in Section 8) provided convincing evidence that most cyclists, at all of our detailed-study sites, used the cycle tracks at these bus stops. At most sites very few remained on the carriageway, and where a slightly higher proportion did so there were obvious reasons for this. More details on this evidence are provided in Section 8.4, and the path trace images provided in Appendix 1 also make this use of cycle tracks clear.

It seemed safe to assume that this use of the cycle tracks was due to it feeling much safer to cycle here than on the carriageway. No other advantage was apparent. We saw nothing to suggest that tracks at bus stop bypasses were being used primarily to overtake stopped buses. Use of the tracks continued when buses were absent, which was for most of the time.

Bringing these ideas together, we conclude that the purpose of bus stop bypasses (and other equivalent arrangements) is not primarily about safety from buses, nor the convenience of cycling. Instead, the main reason for continuing a cycle track at a bus stop is because of the overall protection from traffic that this affords. The alternative is to leave gaps in the cycle track returning cyclists to the ordinary carriageway at these points.

We conclude that cycle tracks which have such gaps are unlikely to be seen by most people as providing conditions safe and inviting enough for cycling. Should it become standard practice to provide cycle tracks like this then many potential cyclists (which includes disabled people) would be excluded from their use. Only those already prepared to accept more dangerous or frightening conditions are likely to use cycle tracks that contain such gaps.

It might be assumed that the necessary gaps in the cycle track could be short. However, we established that these gaps need to be of several times the length of a bus. This length is needed in order to allow a bus to pull into the gap, and to continue forward until the vehicle is lined up with the kerb. Space is also needed to enable the bus to pull out of the gap. If provision is required for more than one bus to stop at a time then the necessary gap is significantly longer, as it must be for a wider track. On routes with many bus stops, such gaps become even more significant. They can also combine with gaps left for other reasons.

Importantly, these gaps create a problem irrespective of the presence of a bus, with cyclists vulnerable to injury by ordinary traffic, or simply intimidated by its proximity. Risks arise not only from the ordinary flow of traffic but also because the gaps are attractive as a place to stop or park, or as additional carriageway width when there is congestion.

In Appendix 4 we show a sequence of images from such a cycle track. It can be seen that the cyclist who recorded the images encounters extended gaps in the track, one of which has a parked car in it (which blocks easy return to the track), and that they also experience several interactions with buses.

Interactions with buses can be frightening, and potentially dangerous, so removing these from a cyclist's experience is helpful. But except on very busy bus routes, such interactions can be quite rare. We conclude this effect is of less importance than the general protection provided by the cycle track from other traffic.

In theory the convenience of cycling might be increased by making it easy for cyclists to overtake stopped buses, however we found no evidence that it is a common behaviour for cyclists to wait behind buses, nor that this feels to be a safe place for cyclists to sit stationary. We conclude that improvements in convenience are of a secondary benefit.

We recommend that these issues are discussed in more depth in design guidance. It should be emphasised that the primary aim of these arrangements is the provision of a safe, coherent cycle track which provides consistent protection from general motor vehicle traffic.

DESIGN NAMES ARE INCONSISTENT

In writing about this infrastructure, a complication is that there is inconsistency about what to call the different designs that have been used to continue cycle tracks past a bus stop.

We could see that this inconsistency has confused discussion over options and issues.

We recommend that design options are more accurately described in future, and that confusion over the term “bus stop boarder” is tackled.

Figure 6 on page 22 provides illustrations of what we conclude are key design types.

The idea of a bus stop bypass is well established, although we found that there can be big differences between a situation where a bus stop is on a small island – dedicated to this purpose – and one in which it is sited on a long multi-use strip between a cycle track and the carriageway (see Figure 2 on page 14).

In this research we have referred to “continued kerbside track” and “shared platform boarder” arrangements to distinguish what we see as two different designs currently both being called a “bus stop boarder”. The use of these terms also avoids confusion with a third arrangement, also typically called a “bus boarder”, where there is no cycle track at all.

To this purpose we use the title “shared platform boarder” to describe an arrangement in which a platform is provided, raised from cycle track level and clearly not part of the ordinary track, alongside which buses stop. In contrast we use the title “continued kerbside track” to describe an arrangement where pedestrians cross something which is more obviously a continuation of the cycle track, as they access or depart a bus (See Figure 6, page 22 and associated discussion).

This research also concludes that hybrid designs are common, although rarely mentioned in discussions about this infrastructure. These can combine features from two or more of the key design types, and we conclude that it can help to describe them by reference to these key types.

We conclude that design guidance should, in future, more accurately describe this range of options, even if some are recommended against. The difference between shared platform boarder and continued kerbside track arrangements should be made clear, whether or not so named. The idea that hybrids can exist should be included.

We could find no easy collective term to refer to bus stop bypasses, shared platform boarders, and continued kerbside track arrangements and so in this report we need to refer to designs “continuing a cycle track past a bus stop”.

Section 4.2 and Appendix 2 provide some additional information on these points.

PAST POOR PRACTICE SETS A CONTEXT

We mapped over 600 British sites where there was some sense that protected provision for cycling continued past a bus stop. Many of these arrangements appeared suboptimal for both pedestrians and cyclists. Indeed, only a small proportion of these arrangements would satisfy the key principles and minimum design quality we propose in Section 8.2.

We could see that one of the most common problems is that an area intended for cycling has been provided at the same level as the pavement, with few features making its edge detectable by a blind or partially sighted pedestrian.

In Sections 3 and 5.4 we note that there is confusion about whether cycle tracks are part of the pavement or not. This confusion seems unsurprising given that we saw many situations in which the provision for cycling was not a separate cycle track, and *was* effectively just an area marked on part of the pavement. In other cases insufficient pavement space was provided, meaning pedestrians often used the area intended for cycling.

We also heard a key problem was that arrangements could be confusing, with it being difficult for pedestrians to remember to look out for cyclists. Yet we found numerous designs in which cycle tracks stop and start, with cyclists expected to share sections of pavement, or with tracks changing colour or surface material multiple times.

Our experience was that many design-orientated informants understood that bus stop bypasses might cause problems for blind and partially sighted people, but it is clear there have been no major trials of ideas to solve these problems. One contributing organisation gave a specific example: They agreed it was possible that crossings of cycle tracks using traffic lights might not work well. However they pointed out that their use had simply been ruled out without this being tested.

Given this context it seems reasonable to agree with those groups, that in the past their concerns about bus stop bypasses have not been taken seriously enough. Given the number of examples of historic poor and inconsistent practice we conclude that the degree of opposition we found to future bypasses is understandable. However, such historic failures do not provide evidence that all bus stop bypasses *inevitably* cause problems to all pedestrians or lead to exclusion in all circumstances.

The purpose of this research was to more clearly evaluate the problems that exist, to look for what features make a difference, and to consider whether better and enhanced designs might offer some solutions.

ENVIRONMENT CHARACTER MATTERS

A key conclusion of the research is that conditions at a bus stop vary greatly as the level of cycling, level of pedestrian use, and complexity of the environment change.

It is relatively obvious that differences in the level of cycling would make a difference to the environment pedestrians experience. However we observed also that differing levels of pedestrian use make for very different conditions for cycling. Even less obviously, these factors interact. Overall conditions for both groups result from the level of use by both groups. Section 7.4 provides more detail.

The research highlights that such effects are not typically discussed. We recommend that in future this dimension is explored in much more depth in design guidance. To be well informed, any discussion about inclusion at bus stop bypasses must take account of these factors.

Some contributors suggested that those supportive of increases in cycling were aiming for all cycle tracks to become as busy as the busiest sites we saw. However a wide range of conditions exist in countries where cycling levels are high. Conditions seen at the busiest British sites can be found only rarely, even in such countries.

To support our observations and conclusions we draw a distinction between quiet-simple environments, moderately-busy-complex, and busy-complex environments. This distinction proved helpful both when evaluating problems, and when considering how these might be solved. Table 7 in Section 7.4 provides more details about the features that distinguish these.

Of course, conditions at individual sites are likely to change if cycling levels rise significantly, and this potential for change must be taken into account.

WHO IS, AND IS NOT, DISADVANTAGED

Most literature, and most contributors, pointed to blind and partially sighted people being disadvantaged or excluded from access to a bus stop at which there is a cycle track. We discuss these issues in a separate section, below. However, some literature and some contributors suggested that those with other impairments, a much wider range of pedestrians, or all pedestrians, were inconvenienced or disadvantaged. It was also suggested that a wide range of pedestrians found cycle tracks to be intimidating or frightening spaces.

It was part of our brief to seek evidence that would confirm or reject each of these suggestions, and to use this to define the extent of any problems.

As described in Sections 7.3 and 7.4 the detectable inconvenience to most pedestrians at most of the detailed-study sites was very low, and signs of discomfort or difficulty were rare or absent.

It is important to take account of the fact that we made no attempt to choose detailed-study sites to be representative of typical British designs. Rather, we focused on sites where the presence of a dedicated cycle track was clear, and we omitted any sites where the distinction between cycle track and pavement was unclear.

It would have been misleading to use a study of people currently using bus stops as simple evidence that people are not excluded, because excluded people would be missing from our observations. Three days of daylight footage of ten bus stops was very valuable in assessing general conditions, but we knew these observations would provide very little direct evidence of how people with specific impairments negotiated the infrastructure, or whether they were present or absent.

With this in mind we looked carefully in these observations for pedestrians being disadvantaged, but not being disadvantaged to such an extent that they were excluded. We reasoned that study of the difficulties such pedestrians encountered would help to show issues that could have excluded people entirely.

In our observations at most sites, it was very rare to see any signs of any concern at all from pedestrians, and checks for oncoming cyclists were typically quick and simple (and at some sites often absent). We saw almost no use of formalised crossing points, other than by those who needed kerb-free routes. Others appeared to use these only as convenient locations to cross because they were on the path they happened to be taking.

There are obvious limits to what can be assessed from camera footage, and we anticipated observing only statistically insignificant numbers of pedestrians who would be identifiable as having specific impairments. Therefore we did not attempt to use this footage to assess how people with specific impairments negotiated bus stops (instead relying on other study threads to understand issues). However, in the footage we did note a small number of pedestrians with visible mobility impairments behaving much as other pedestrians.

Adding evidence, our observations suggested that a majority of pedestrians were very comfortable negotiating cycle tracks in many locations. For example, in some places it was common to see pedestrians walking/wheeling along the cycle track. Elsewhere, in quieter locations, they could be seen standing for lengthy periods on a cycle track. Some were seen stepping out of the way of oncoming cyclists, only to return to standing on the track afterwards.

We initially speculated that we might be seeing behaviours caused by crowded pavements or that had arisen because people had not noticed the cycle track. However, we confirmed that these behaviours occurred even when there was adequate space, when conditions were quieter. In some cases we observed pedestrians step off a cycle track to allow a cyclist to pass, returning to it afterwards. In many the response to oncoming or passing cyclists, for example in leaving the track, was very obviously unhurried and relaxed. It seemed clear that these were indications that these pedestrians did not consider these specific cycle tracks to be places where they would be subject to any significant risk.

Overall, we conclude that while some people may be disadvantaged (see below) most *better-designed* bus stop bypasses currently in use, at which there are normal levels of cycling, do not significantly inconvenience most pedestrians.

This leaves questions about unusually busy-complex sites. Our detailed-study sites included:

- Some of the busiest cycle tracks in Britain
- Locations with unusually high levels of pedestrian use
- Complex and constrained environments.

At the detailed-study site at Blackfriars, which we chose to study because there were extreme levels of cycling and walking, the longest delay to any pedestrian crossing the cycle track was of 48 seconds. Elsewhere the longest delays we recorded were of 10 seconds (Wilmslow Road) and 9 seconds (Mile End Road). These delays may have been irritating but they are very limited in comparison to typical wait times experienced by pedestrians elsewhere, and at these sites it was clear there were other features, unconnected to the cycle track or bus stop, that caused the same or much greater levels of inconvenience to most pedestrians.

However, in line with the discussion above, we consider that the difficulties experienced by a larger number of pedestrians in crossing the cycle track at Blackfriars provides evidence that a wider group might have been excluded from accessing the bus stop here, and that this would also happen in other equivalently busy-complex environments at bus stop bypasses. This may mean real problems for a range of people, including those who walk more slowly or with difficulty, people at more risk of injury from falling than would be typical, and people who find it more difficult to anticipate movement in more complex environments (who might have learning disabilities, mental health problems, dementia or who might be neurodivergent).

THE FUNCTIONING OF ZEBRA CROSSINGS

Until now the key solution for providing additional support to pedestrians, to cross a cycle track, has been through the provision of a zebra crossing.

In the detailed-study site work we could see that zebra crossings do not perform as might be expected based on their legal status (Section 7.4). Consequently, they do not provide a reliable tool to help a pedestrian who feels they need support to cross the cycle track.

Based on observations, our researchers tried to understand what factors create this situation.

We found it helpful to consider what other rules in the Highway Code fail to create the behaviour they mandate, and why this might be. For example, it has long been the case that the Code has specified that drivers should "*give way to pedestrians crossing the road into which you are turning*" (Rule 108, 1978). Current rules say *"…give way to pedestrians crossing or waiting to cross a road into which or from which you are turning. If they have started to cross, they have priority, so give way*" (Rule 170. 2022). It is self-evident that British drivers do not habitually follow this rule. The lack of priority for pedestrians at side roads creates real problems, but it is generally understood that driver behaviours arise from a complex mix of practical, design and cultural factors.

Our researchers looked for such factors. Some may relate to the interpretation of the markings:

- Zebra crossings on cycle tracks are small and are visually insignificant when compared to zebra crossings marked across carriageways (see Figure 17, page 75).
- Zebra crossing markings on cycle tracks do not appear to be understood to be ordinary zebra crossings by many members of the public (see Section 6.3).
- Zebra crossings on carriageways are normally provided only where it is clear to the public that they are needed, influencing any interpretation of the markings and of what behaviours are desirable. Few pedestrians appeared to need these at most of the cycle tracks studied (see Section 7.3).

Some factors may relate to how little a pedestrian who needs the crossing can stand out. From our own experience cycling through the detailed study sites, we concluded:

- Bus stops are typically very complex cluttered environments, with anyone at a crossing standing close to shelters, signs, bins, and moving or stationary

buses. This contrasts with the situation at well-designed zebra crossings of a carriageway, where waiting pedestrians are made obvious.

- People standing at a zebra crossing of a cycle track are often right beside people standing waiting for buses. This contrasts with pedestrians standing expectantly at a zebra crossing of a carriageway.
- In more busy and complex environments, pedestrians are typically crossing back and forth across cycle tracks in multiple locations, with others walking or wheeling along the track. This contrasts with typical zebra crossings on a carriageway, which are usually provided where crossing is difficult.

Other factors might arise from the expectations of pedestrians and cyclists, and the behaviours that arise as a result. For example:

- Pedestrians could often be seen to hold back from crossings, as if to allow a cyclist to progress. We almost never saw pedestrians waiting expectantly, as if asking a cyclist to stop.
- Pedestrians could often be seen to judge a crossing movement as part of an ongoing journey, only crossing at the zebra crossing if it was on their way, and if there was a suitable gap in the cycle traffic.
- Cyclists at some tracks had only recently left environments where they were sharing space (legally) with pedestrians.

In cycling through the detailed-study sites we also observed that:

- In places, even at gentle speeds, many of these tracks provided much more complex environments than those experienced while driving on typical British roads. This tended to arise where space for the track was insufficient – with better-designed tracks creating significantly more relaxed environments.
- In places, at some sites, threats to our safety were common. In cycling here, our focus was on these issues. Problems included sharp corners, kerbs intermittently at pedal height, slippery surfaces, holes in the surface, and unsigned sudden narrowing of a busy track. In some cases, risks were much higher, introducing what felt to be a genuine risk of serious injury or worse. For example, we experienced that large gaps at side roads (sometimes neighbouring a bus stop) introduced risks from fast moving or large vehicles.
- Where cycling levels were very high we were in a group or flow of others, so we were followed by strangers cycling close behind us. There was no way to signal an intention to slow or stop (see the suggestion on new signals for this purpose in Section 8.3).

The literature review, and our work with organisations representing disabled people, raised wider issues about zebra crossings. It is clear that even where these function as is expected, when used across a carriageway, they are not seen to be particularly useful to blind and partially sighted people.

EFFECTS ON BLIND AND PARTIALLY SIGHTED PEOPLE

Our work backs up the idea that busier cycle tracks can be difficult or impossible for blind or partially sighted pedestrians to cross, at least as these are currently designed in Britain.

As the complexity and busyness of the environment increase, these problems grow. For the reasons given in the previous sub-section, the inclusion of zebra crossings makes little difference.

We heard evidence that the effect of problems at a bus stop can be particularly profound:

- There is often little flexibility available in terms of a pedestrian's bus stop use (whereas an issue on a particular carriageway might be worked around by using a different route).
- Buses are sometimes used for very short journeys, to bypass infrastructure that is currently too difficult to negotiate walking or wheeling.
- For those on the brink of being excluded by issues elsewhere, even a small increase in the difficulty experienced accessing a bus can be life-defining.

AVOIDING THE USE OF BUS STOP BYPASSES

We considered options for avoiding the need to continue a cycle track past a bus stop. It is clear that in some places there are options that mean cycle tracks and bus stops can be kept separate.

Where there is a denser road network this can be achieved, for example, by separating key cycle tracks and key bus routes. Both can still be direct, attractive and convenient routes. This is clearly a key way to minimise conflict and promote the safety, comfort and convenience of all users (with the possible exception of those cycling to a bus stop). Designers should start from this point in terms of network planning.

However even where there are dense networks of streets, with multiple options for direct and attractive routes, it may be that there are popular bus routes on all of these. It should be remembered that attractive routes for cycling after dark are likely to be on popular streets, which is where bus routes are typically found.

Significant diversions for cycling, from main routes to back streets, are likely to be suboptimal, given the aim of increasing cycling levels. Even if such streets exist then

space on them may be limited, junction designs may introduce risk or make cycling a slow and inconvenient option, and conditions may be unwelcoming after dark.

It may be that the best option involves continuing cycle tracks past bus stops more widely, but with alternative arrangements made at very specific locations. This might be the case where an individual bus stop is unusually busy, or where one section of street is particularly narrow. More minor one-off diversions of a cycle track, on an otherwise direct route, might be more acceptable. Similarly, a good solution might sometimes involve moving a bus stop a short distance along a route to a location where the available space is greater.

We found that it is sometimes argued that where full separation isn't possible there could be a case for mixing cycling with very slow-speed bus traffic – excluding other vehicles. This might be another option employed in limited places, such as within a city centre.

Although most cyclists used the track, it seems relevant that evidence from the detailed-study site at Oxford Road in Manchester showed a relatively high use of the carriageway in comparison to other sites. Here there is a daytime restriction on motor vehicle use of the carriageway, excepting "buses, taxis and permit holders". It could be seen that this produced much quieter conditions on the carriageway.

We did not attempt to look for other evidence around whether this option could produce safe and attractive conditions.

A WAY FORWARD

Some contributors to the project suggested that the use of bus stop bypasses (and equivalent arrangements) should cease entirely. We considered this option.

For the reasons given in Section 8.1 we conclude that doing this would mean provision for cycling, in some places, could never be to the standard that most people would consider acceptable (to use themselves). This study provided evidence that the continuation of cycle tracks at bus stops gave protection that people cycling found important, and that there were advantages to pedestrians from the presence of good quality cycle tracks in reducing cycling – and the use of other fast moving wheeled vehicles like e-scooters – on the pavement. Without this infrastructure, conditions that currently exclude many people from cycling would continue.

It is government policy that cycling levels should be increased. Consequently, in the remainder of this discussion and particularly Sections 8.2 and 8.3, we assume that such arrangements will still be used in future.

Importantly, we concluded that problems for blind and partially sighted pedestrians crossing a cycle track at a bus stop also apply when crossing cycle tracks elsewhere. Similarly, they exist not just at cycle tracks but when crossing any carriageway on which people are cycling (although poorly designed cycle tracks caused problems as noted in Sections 4.2, 6.3, 7.1, 7.5 & 8.2). It was also clear that equivalent problems apply in regard to the use of a wide range of other quiet, electrically driven devices and vehicles, whether used on carriageways or cycle tracks (or pavements).

However, we did hear evidence that conditions at bus stops caused particular concern because the accessibility of buses is profoundly important to some people. We were told that this was particularly true where buses were used to bypass streets or junctions which were difficult or impossible to use for other reasons. Of course cycle tracks can also become a focus of route choices for people cycling, especially where other streets are unwelcoming, increasing cycling levels in a specific location.

These observations raise much bigger questions about how streets will be organised once cycling levels are higher, and in a future where quiet devices are used. This suggests a need for a wider reform of our streets.

8.2 Key principles and minimum design quality

Enhancements for improving accessibility at some bus stop bypasses are discussed in Section 8.3. We conclude these are worth testing but consider that they will only be effective where the overall design of the bus stop is up to a sufficient quality, as discussed below.

Badly designed bus stop bypasses are likely to be problematic for some pedestrians, even if levels of cycling on the cycle track are quite low. Where existing bus stop bypasses are not to this minimum quality then they should be regarded as problematic and should be upgraded or replaced.

In this respect, good design should seek the following:

- The use of simple designs for pedestrians that are legible and intuitive in use
- Careful use of levels to segregate space, whilst maximising accessibility
- The use of other features that make a design simple and clear for blind and partially sighted pedestrians, and which clearly identify the bus stop location (see section below)
- The use of a design that creates a simple environment for cyclists, free of distracting obstacles or risks at and immediately around the bus stop
- The provision of good visibility between pedestrians and cyclists

- The highlighting, to cyclists, of the presence of the bus stop and any locations where pedestrians are likely to cross
- Good design for wider accessibility e.g. in terms of appropriate pavement and island widths, lack of clutter and pinch points, and limited crossfall

More details on these points are provided below.

SIMPLICITY AND CLARITY FOR PEDESTRIANS

In order for any combination of a cycle track and a bus stop to work for blind and partially sighted people the cycle track must be detectable – and the arrangement must be simple. It is likely that clarity and simplicity will be advantageous for a much wider group of pedestrians.

The need for clarity and simplicity probably preclude the use of designs that try to influence behaviour through uncertainty. Uncertainty entails creating some level of anxiety for one or more user group, and thus disadvantages people unfamiliar with new arrangements, already very worried about their safety, or with less ability to react quickly.

In particular, cycle tracks must be clearly distinct from the pavement. This requires a consistent use of kerbs, with a corresponding drop in surface level to the track, to distinguish one from the other. Only at limited points within the bus stop area should there be kerb-free access across the cycle track, and these points should be appropriately and correctly marked with (blister style) tactile paving.

We note that some literature, and some project participants, implied that cycle tracks were either part of the carriageway or part of the pavement. A key conclusion of the project is that confusion over this issue has been a barrier to discussions on inclusive design. Good design at a bus stop (and elsewhere) should produce a situation in which it is clear that the cycle track is not part of either the carriageway nor part of the pavement. We recommend that design guidance more broadly should be improved, making this much clearer.

A distinct, consistent difference in colour and tone between cycle track and pavement is important, as is consistency in the colour of the track – with the only exception being the possible provision of zebra crossing markings. We saw no evidence that changes in colour along a cycle track intended to signal changes in the status of the track to cyclists and to change their behaviour did so. On the other hand, it was clear that these easily create a confusing environment. This might be particularly problematic for partially sighted pedestrians looking for a clear visible indication of the presence of the track. Those with impairments that make added complexity a barrier will also be affected.

This clarity is also necessary to make the presence of the cycle track, and its purpose, as obvious as possible to pedestrians as a whole. Such clarity should help to reduce problems created by pedestrians walking or standing on the track.

GENERAL ACCESSIBILITY

The project looked for more general accessibility problems, beyond those related to the interaction of cyclists and pedestrians. As we outline in Section 6.3, most of the problems that were suggested to our researchers were a result of the space that had been made available, or specific design features, and were not due to the bus stop being on an island per se.

For good accessibility it is important that sufficient space is made available. Situations where cycle tracks are squeezed into an environment leaving insufficient space for the number of pedestrians using this, are not inclusive and must be avoided. Situations where the bus stop island is too small (in either length or width) should be avoided for similar reasons (see Section 6.3).

Where space is limited one less obvious issue can be of excessive "crossfall" (slope) on the bus stop island. This is described in Section 6.3 (also Figure 8, page 46). This seems more likely to become an issue where there are raised kerbs at the carriageway edge (to enable access to a bus), and lower "forgiving" kerbs at the cycle track. Crossfall on the island can be a particular problem for those using a ramp to access or leave a bus. Good designers may be able to locate raised crossing points of the cycle track near where bus ramps will be deployed – thus minimising or avoiding this issue.

A second specific issue relates to difficulties finding the bus stop, for blind and partially sighted pedestrians. This is discussed in a sub-section below "Highlighting the bus stop location".

While the inclusion of a bus shelter takes up space, it is important to note that we heard of their importance for inclusion. Shelters provide somewhere to sit and protection from the weather.

For good accessibility it is obvious that kerb-free crossing points of a cycle track should be provided, not least to accommodate disabled people using a wheelchair or other mobility aid.

We noted some debate about whether kerb-free crossing points should be provided by raising the cycle track level or by dropping the pavement (footway) level. In theory the slope at a dropped kerb is helpful as an orientation feature for blind and partially sighted pedestrians. However, we noted that where reduced height "forgiving" kerbs are provided alongside the cycle track (which we recommend) then this slope can be so insignificant as to be undetectable. Elsewhere, we

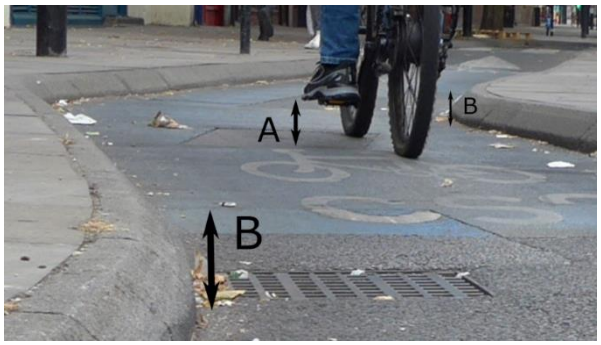
recommend against the use of steep ramps on the cycle track at a bus stop. Consequently, the difference between these two arrangements – raising the cycle track, or lowering the kerbs – can be minimal in practice.

SIMPLICITY AND SAFETY FOR CYCLING

A key conclusion – arising from the evidence discussed in Sections 7.4 and 7.5 – is that in order to ensure the most favourable conditions for pedestrians, it is necessary to keep the environment for cyclists as simple as possible. Distracting features, such as sharp corners or sharp ramps in the cycle track, kerbs that are at pedal height (risking a "pedal strike" – see also section 5.3 on "forgiving kerbs"), or posts close to the track (particularly above handlebar height), must be avoided.

Figure 24 illustrates issues with kerb height and the need for cyclists to assess whether objects and posts at handlebar height may be too close to the cycle track. Hitting either a kerb with a pedal or an object with the handlebar will likely result in a crash. In the right image the cycle track has narrowed gradually, and without warning, from a previous section where it was possible to cycle side by side. There is now insufficient clearance from the second cyclist, bearing in mind the need to account for an uncertain distance from high kerbs. The bin and shelter may be sufficiently far from the track, but assessing the gap provides a distraction.

Figure 24: Distractions



A = pedal height from ground
B = kerb height, particularly at corners

C = clearance of handlebars from bin
D = clearance of handlebars from cyclist/handlebars
E (in distance) = clearance of handlebars from shelter

A situation like this is quite different from that typically set up for vehicle drivers approaching a controlled (zebra / signalised) crossing of the carriageway. In the latter situation risks to the driver themselves are usually minimal, and any pedestrians wishing to cross are very obvious. The effects of ramps (and other features creating "vertical deflection"), and chicanes in a cycle track, are also entirely different to the effects that such features would have on a vehicle and its driver.

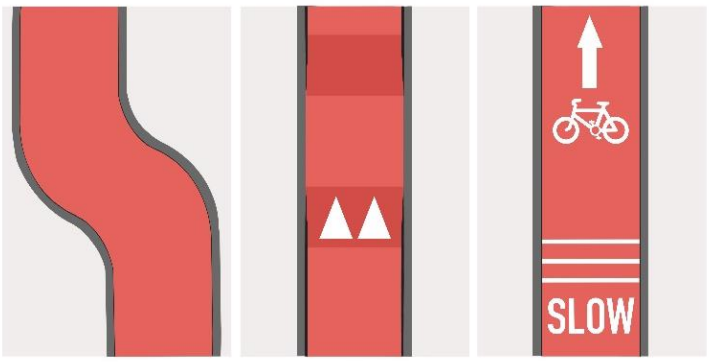
Such features may slow cyclists, provided they are severe enough, but we conclude that any advantage gained from this is lost because of the distraction caused by negotiating them. Making the features more severe also tends to exclude wider use of the cycle track, not least by those using wheeled mobility aids.

Issues with these features become particularly prominent where cyclists find themselves together in groups with strangers. This introduces additional distractions and problems of forward visibility, which increase radically with larger group sizes or (when groups merge) full flows of cyclists. Cycle tracks that are too narrow for such groups also heighten the risk that cyclists collide, with a resulting need for them to concentrate on avoiding this.

In addition, where people cycling need to look out for their own safety because of risks to their life, like vehicles turning across their path into a side road, they are very much less likely to consider the needs of pedestrians.

Avoiding unnecessary paint markings on a cycle track seems important, as these add complexity for all users. Triangular ramp markings in particular (see Figure 25, and also Figure 17 on page 75) should be avoided, except to warn of *unusually* steep ramps. Typical ramps at cycle tracks should not require such a warning. Steeper ramps should generally be avoided as they may exclude those using adapted cycles, mobility scooters, or wheelchairs. SLOW markings (see Figure 25) probably achieve very little but add to the complexity of the environment. Direction arrows and ramp markings are easily confused, and on a cycle track can be as visually significant as any zebra crossing. If placed before a crossing point they perhaps provide a sense that they are an instruction to continue, or of the priority of cycling over pedestrians, undermining any message about giving way.

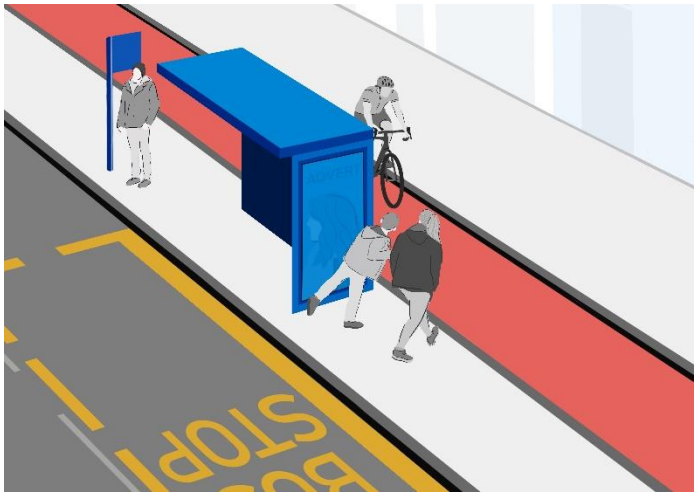
Figure 25: Distractions and unhelpful complexity



VISIBILITY

To ensure the most favourable conditions for pedestrians, it is important to ensure good visibility of them by cyclists, and vice versa. Advertising panels can be a particular problem in blocking visibility (see Figure 26). The effects of this were apparent, for example, at the Victoria Road detailed-study site (see Appendix 1).

Figure 26: Advertising panel blocking visibility



Tracks with plenty of width and a suitably wide pavement, mean that cyclists can keep some distance from pedestrians. Narrow tracks, or tracks too narrow for the volume of cycling, bring cyclists close to their edge. Similarly, pavements too narrow for the volume of pedestrians bring people close to the cycle track. This proximity raises the complexity of the environment for all involved, and it makes it less likely that individual pedestrians who are crossing, or intending to cross, stand out to a cyclist.

HIGHLIGHTING CROSSING LOCATIONS

In Sections 7.4 and 8.1 we highlight that zebra crossing markings do not, on their own, provide safe crossing points of busier cycle tracks for a pedestrian who needs a reliable way to stop cyclists so they can cross a track. More broadly, we explain they do not work as might be expected, and that in most cases neither pedestrians nor cyclists use them in the way that zebra crossings on carriageways are used.

However, we conclude that zebra crossing markings may be useful for other reasons, the most obvious being that they might:

- Draw the attention of a cyclist to the bus stop as a whole, making it relatively obvious that people may be more likely to cross the track in the general vicinity of the bus stop

- Mark specific places at the bus stop where people may be particularly likely to cross
- Draw the attention of cyclists to any places where it is less obvious that pedestrians may cross (although good design should try to avoid creating these)
- Draw the attention of pedestrians to a kerb-free crossing point.

In Section 6.3 we note pedestrian confusion over the meaning of the typical two or three white stripes making up zebra crossings of a cycle track. We also highlighted that examples with one stripe are sometimes seen. With this in mind, we conclude there may be value in a nationally coordinated test of non-standard white stripe widths (not officially allowed by the TSRGD legislation [13]). The objective should be to more closely replicate the visual effect of a zebra crossing of a carriageway – given that in such situations the marking is made up of numerous white stripes. It seems unlikely that such an arrangement would lead to a profound change in behaviours, but it might mean more people understanding that these markings indicate a crossing point.

A further reason to include a zebra crossing of the cycle track is provided in the sub-section below.

At some carriageway crossings there are built out sections of pavement. These can make the crossing more obvious, a waiting pedestrian more visible, and their intention to cross clearer. We did not see this at any crossing of any cycle track in Britain. Such an effect might be difficult to achieve on much narrower cycle tracks, but we recommend that it is considered an option where tracks are wider.

HIGHLIGHTING THE BUS STOP LOCATION

We identified that blind and partially sighted pedestrians are likely to find it more difficult to locate a bus stop which is on the far side of a cycle track.

At many ordinary bus stops the presence of a bus shelter provides an unmistakable indication of the location of the stop. Other features, such as a recognisable post with an information board may also help. However, where a bus stop (and specifically its shelter) is on an island, these features cannot be used to identify the location until after crossing the cycle track.

Tactile paving may indicate a crossing point of the cycle track. However, in more complex situations it can be difficult to interpret whether a particular section of tactile paving indicates a crossing point of the track, a point where people might cross the carriageway, or simply the presence of a dropped kerb which has been provided for

other reasons. This leaves open the possibility that a blind or partially sighted pedestrian, mistakenly believing they are facing a cycle track, initiates an unintended walk into the middle of a major carriageway.

This problem arises because (blister-style) tactile paving is not only used to identify places where people might choose to cross a carriageway, but also the absence of the step provided by a kerb at a range of other crossing points, whether these are suitable locations for a blind or partially sighted pedestrian to cross or otherwise.

The interpretation of tactile paving at a bus stop will be simpler where it is used to indicate the presence of a zebra or signalised crossing, provided it is in the standard layout. This standard layout distinguishes the tactile paving as marking this kind of crossing point.

This may be a further reason to provide zebra crossings of cycle tracks at bus stops.

There may be other solutions, from the use of a new tactile paving feature to the presence of recognisable posts, and a national approach should be explored. Designers should also understand that many blind and partially sighted pedestrians use recognisable known local features while navigating known routes.

More broadly, the inclusion of bus shelters, seating, and accessible sources of information, are all important for making bus services as inclusive as possible.

PREVENTING EXTREME SPEED

Comments about maintaining the simplicity of the environment for cycling should not be taken to imply a recommendation against any features to control speed. It may, in places, be desirable to use physical features to limit more *extreme* cycling speeds. Illegally modified e-bikes can be used to travel at speeds impossible on an ordinary bicycle, and electric motorbikes have become more common. Downhill cycle tracks can also lead to higher speeds. Importantly, measures to limit extreme speed might be designed in a way that does not complicate the environment at the bus stop itself.

Given our recommendation to provide a simple environment at bus stops, we conclude that any features to prevent extreme speeds should be encountered *well before* a cyclist needs to be looking ahead to consider the needs of pedestrians at the bus stop.

This research did not study techniques for such an approach, but we conclude that there are some important considerations.

An overall objective might be to encourage anyone travelling at much higher speeds to choose to use the carriageway. There may be a number of methods to do so. These could include relatively gentle bends in a track, or some appropriately designed speed-hump features (i.e. features creating horizontal or vertical deflection).

Features should not make it difficult or uncomfortable to use adapted cycles, nor for disabled cyclists on standard bicycles. They should not prevent users of mobility scooters, wheelchairs, or other wheeled mobility aids from using the cycle track.

It must be remembered that many of the techniques used to control vehicle speeds do not easily transfer. For example, it could be seen that cyclists negotiate chicane-like bends in a cycle track by following a careful line cutting close to kerb edges, not by following the actual line of the track. Similarly, ramps that would slow a vehicle can often be negotiated at speed on a bicycle – except by some disabled or elderly cyclists – by using knees and elbows as if shock-absorbers. In one notable video image from the study, a young cyclist in Cardiff, rather than being slowed by a ramp, used it to assist in performing a jump/wheelie.

Clearly such features should be used with caution, and only as a way of controlling extreme speeds. Speed calming focused on vehicle drivers rarely risks actual injury to a driver, but the features discussed here could introduce actual risk of injury to someone using an illegally fast bike. However, at the same time if illegal use of a track is anticipated, or high speeds on a hill are likely, then without these features the risk of injury to pedestrians might be judged to be unacceptably high – so that a formalised process of assessing and comparing risks should be followed.

Outside the bus stop area SLOW markings, or markings indicating a steeper ramp or other feature, may be appropriate to indicate the presence of features that cyclists will not want to take at speed. The markings would be as a means of warning about risks from the feature itself. Unlike some common current practice, this is a use consistent with signage on ordinary carriageways, where SLOW markings usually warn of a risk *to the driver* (such as at unexpectedly tight corners). On carriageways signage warning of the presence of a crossing, or of a need to look out for pedestrians, is with standard triangular signs (see Figure 27). Such signage may be useful on cycle tracks.

Figure 27: Relevant traffic signs and their meanings (© Images Crown copyright)

Meaning: "Pedestrians in road ahead"

Meaning: "Zebra crossing ahead"

8.3 Enhancements to existing practice

There is clearly a need to seek solutions to some of the problems outlined earlier in this discussion. In the course of this research, we found some options which, while currently unproven, are clearly worthy of further research.

It should be clear that the success of these enhancements will depend on their context, and in particular on the busyness or quietness, and the simplicity or complexity of the environment – as we outlined above. Research must be used to determine the limits of the effectiveness of each option. In this regard, the numerous factors involved will mean that simple counts of pedestrian and cyclist numbers will be insufficient.

The success of these enhancements will also depend on designs meeting the principles and minimum design quality detailed in Section 8.2.

Given the risks and sensitivity, these enhancements should be tested/piloted in a coordinated way, rather than in experiments by individual designers working separately. Appropriate guidance should be produced according to the results. Disabled people must be at the heart of this research, working as informed and trusted partners – taking note of the recommendations on building trust and knowledge in Section 8.4.

Possible enhancements are summarised in Table 11.

Table 11: Summary of enhancements by environment character

	Approach	Details
All environments (including quiet-simple)	Ensuring an environment which is simple to navigate, where desirable behaviours are as likely as possible	Designs according to the key principles and minimum design quality outlined in Section 8.2
Busy-complex environments	Instructing and informing cyclists	Use of signalised crossings
Moderately-busy-complex environments	Informing pedestrian – simple sound approach	Simple detector providing audible and tactile signal indicating an approaching bicycle
	Informing pedestrian – artificial intelligence approach	Camera detects presence of, movement of, or stopping of cyclists. Pedestrian informed audibly and with tactile signal
	Informing cyclists – button-operated light signals	Use of flashing light signals (or a close equivalent) to draw attention

We are recommending that different enhancements are tested for use in different environments. The sub-sections which follow explore these in more depth.

This means that when considering what designs are suitable for a site there will be a need to assess the character of the environment there.

For this study it was comparatively simple to organise the use of fixed cameras to survey conditions. There was a financial cost, but the modern equipment used did not require complex installation. Artificial intelligence was used for “path tracing” and for counting people and vehicles. Simpler processes can also be used. We judged that even an in-person count of users, taken over a ten minute period, was useful. This provided a rough guide as to the conditions at that moment in the day – and counts around rush hour gave some idea of maximum levels of use.

These methods could be used over time to gain an idea of how conditions are changing, prompting a more detailed review as particular thresholds are reached.

While cycling levels might change substantially with the installation of a cycle track, there is less likely to be a very big change in pedestrian numbers. Thus it may be useful to check whether existing pavement (footway) widths are sufficient for the levels of pedestrian use, before a new cycle track is built. As outlined elsewhere, this is important because pavement width is a key factor in shaping the conditions at a

bus stop. Sufficient pavement width seems a key requirement for the accessibility of the environment around a bus stop and should be a non-negotiable prerequisite.

This research has highlighted that the complexity of an environment does not arise simply from its level of use. Appendix 2 lists some other features which should be taken into account.

ENHANCEMENTS AT BUSY-COMPLEX BUS STOPS

"Busy-complex" environments are very unusual, and will probably remain very unusual, but these require particular attention. That is particularly the case because they are likely to be in key locations, which may be destinations for many bus passengers.

In our study, the site at Blackfriars (BS-86) is the obvious example of a location where conditions were quite different to those at the other bus stops we studied. This difference is made clear in the figures in Section 7.3.

We conclude that sites where conditions are comparable to those at the Blackfriars stop will probably benefit from the introduction of a signalised crossing (i.e. a crossing with traffic lights activated with a push-button).

Use of signalised crossings elsewhere may be counterproductive. Likely problems include:

- Cost and maintenance burden (for minimal or no use)
- Possible confusion for drivers on the carriageway
- Increased associated street clutter such as power cabinets
- Green lights encouraging cyclists not to give way
- The over provision of these undermining the sense of their importance where they are genuinely required.

Some of these disadvantages may also apply at very busy cycle tracks, but we conclude that the balance of advantage to disadvantage differs, on the basis of the points below.

During the study we made informal observations of cyclist behaviour at traffic lights. More details can be found in Section 7.5.

What emerged was some evidence that it is important to only use traffic signals on cycle tracks in locations where it is clear, to members of the public, that these are needed. In these situations, signals are seen to give a significantly increased priority to people crossing. However, we saw that showing people cycling a green signal means they are unlikely to give way to approaching or waiting pedestrians. This

contrasts with locations without signals, where some cyclists do give way or slow down to assist or accommodate pedestrians crossing the track.

It seems likely that installing signals can undermine the usual level of negotiated interaction between cyclists and pedestrians at quieter cycle tracks. This could mean that people wanting to cross will be expected to press a button and wait, when previously they would have felt confident to cross without delay.

It also seems likely that adding signals in places where they are rarely used by pedestrians could undermine how well they are noticed, and the way in which cyclists respond to them, at sites where they are really needed.

With these issues in mind, it may be that at some sites the best approach would involve only having traffic signals operational at times when they are needed. In this case it would be necessary to provide information to a blind or partially sighted pedestrian indicating that the signals were or were not operational.

In all cases it is important that signals change as soon as requested by a pedestrian, in order that cyclists are not presented with red lights that are no longer needed (the pedestrian having crossed). While it is important that those crossing more slowly feel confident to do so, it is also important that red signals do not remain after they are needed. Technology used in what are known as “Puffin” crossings applies here, but it may be challenging to make it sufficiently effective given the big differences between a crossing on a carriageway and one on a cycle track. Issues will include:

- The proximity of cyclists and pedestrians so detectors confuse cyclists with pedestrians
- The proximity of pedestrians who do not intend to cross
- Much shorter crossing times.

Other design problems include:

- The need for signals to stand out (we observed that small low-level signals at Sauchiehall Street in Glasgow were lost in the complex environment)
- The need for signals to be visible to cyclists stopped at them (an aspect that favours the inclusion of small, low-level signals)
- Sufficiently simplifying the environment so that cyclists can more easily pay attention to the signals
- Avoiding confusion for drivers on the carriageway.

A signalised crossing has been provided at a bus stop bypass in Wood Street in Cardiff. At the time of writing this has just been brought into operation. Further evidence should be collected here.

ENHANCEMENTS AT MODERATELY-BUSY-COMPLEX BUS STOPS

New solutions need to be tested for use in environments which are moderately-busy and moderately-complex. These may be useful not only at bus stops but in other locations that people need to cross a moderately-busy cycle track.

There are two key approaches to be tested, and three resulting options – that may all be useful. These might also be combined (see Table 12 below for an outline).

Table 12: Approaches/options to be tested at moderately-busy-complex sites

Overall approach	Options within approach
Inform pedestrians about cyclists	Notifications about oncoming cyclists provided using a simple detector that provides a simple sound and tactile signal
	Notifications about oncoming or stopping cyclists by using a camera and artificial intelligence to provide more detailed guidance (e.g. a voice reporting conditions)
Inform cyclists about pedestrians	Light signals that aim to draw attention to the crossing pedestrian.

The first overall approach focuses on informing blind and partially sighted pedestrians about the movement of cyclists.

Figure 11 (page 60) made clear how easily most pedestrians crossed most of the cycle tracks we studied. However, Figure 12 (page 61) makes clear that while checks for oncoming cyclists were usually brief, they were quite often made. A pedestrian who cannot (easily) see oncoming cyclists cannot make a similar check.

We consider that there are two main options to provide a pedestrian with information about oncoming cyclists.

In both cases it seems likely that the information should be presented audibly and from a tactile device that would be found on a post beside a crossing point – activated by pushing a button.

The first option (within this overall approach) involves the detection of an approaching cyclist and the corresponding creation of a simple sound. This might use relatively standard detection technology, and the sound produced (and corresponding tactile signal) should probably consist of little more than a beep or click – leaving the pedestrian to judge when it is safe to cross.

Factors to be considered in such a design include:

- the need for a notification/signal that the device is active (so that the absence of the beep or click can be trusted to be an indication that the track is clear)
- the detector-crossing distance (so that pedestrians can use the absence of sound/beeps/clicks as an indicator of a sufficient gap)
- whether the sound indicates cyclist speed (noting that a detector signalling a wheel passing over it will provide this naturally as the two wheels of a bicycle are detected)
- whether any more complex arrangement would be helpful or confusing (for example with separate sounds produced as a cyclist crossed a sequence of detectors, with these sounds getting louder as they cross closer detectors and quieter as they continue onwards)
- sound volume (so this can be heard above traffic)
- the distinction between the sounds of this system and those produced by standard crossings
- the use of a sound that has a character to make it as detectable as possible by those with (some) hearing loss.

It should be clear that such a solution will only be useful at bus stops where these sounds reassure a pedestrian of long periods where there are no oncoming cyclists. It will not be helpful in situations where it confirms that the track is too busy to cross.

The second option (within the approach of informing pedestrians about cyclists) involves the use of cameras, or an equivalent detector, and artificial intelligence. Such a system could be used to detect/describe the presence of oncoming cyclists, their absence, or that cyclists have stopped. It is likely that more information could be provided through an audible description than through simpler sounds. However, the needs of those with limited hearing should be considered, and the length of any spoken message must be tailored to how quickly a situation could change.

Some research in Manchester is exploring this approach.

We rejected a third/wider set of options that would require blind and partially sighted pedestrians to use a smartphone app. On principle it seemed important that any such app would be used only to provide additional helpful information, and that streets should not be designed based on an assumption that one group of pedestrians will have to use a smartphone for even basic access given issues around digital exclusion. We also heard that such apps may introduce unhelpful complexity to an already difficult situation.

The second overall approach would involve informing cyclists about the presence of pedestrians crossing.

An option to this effect is being used in Victoria in Canada. This involves push-button activated flashing lights, which are designed to draw the attention of people cycling to any crossing pedestrians who choose to activate them.

We could not visit these bus stops as part of the study, but from on-line video material noted that the lights used appear visually distinctive, flashing much more brightly and rapidly than might be expected to readers familiar with other flashing light systems (e.g. outside schools) used in the UK.

We judge that this option should be researched, based on the following reasoning:

- We identified that a key element in creating the behaviours we saw at bus stops is the complexity of the environment. One of the effects of this is that individual pedestrians do not stand out among the many crossing a track easily along its length, walking/wheeling close beside the track, or standing on or immediately beside the track.
- The unusual nature of these flashing lights, their distinctiveness, and the likelihood that they would be used only very rarely, would mean that when they were used they would naturally draw attention to individual pedestrians in this complex environment.
- As they would be used rarely, and as the lights would normally be off, they could be solar powered (as appears to be the case in Victoria). This is likely to make their installation and use much cheaper than if they required mains power, which must be connected underground.
- The purpose of the lights, in this configuration, would be to draw attention not to instruct behaviour, making them easier to introduce on UK streets.

In relation to the final point, it might also be argued that such lights could flash red after a short amber period – conveying an instruction to cyclists to stop. This or other similar arrangements (e.g. a static red light) could be tested – although to give the legal meaning to such signals would require changes to TSRGD legislation [13] (with consequent changes to the Highway Code). Some of the points made about the use of full traffic lights, in the sub-section on busy-complex stops above, are also relevant here. Additional design considerations include:

- The need for lights to show up in bright sunshine
- The potential for distraction of drivers, particularly if they appear very bright after dark
- The need for lights to be at a suitable level, so they are immediately within a cyclist's view

- The possibility that the lights will have more effect if they are unobvious until activated, but also that the opposite might be true (research is required)
- The need for the lights to be sufficiently high so they can be seen by cyclists further back in a group
- That the success of a system like this will depend on the environment faced by cyclists being sufficiently simple.

A (Canadian) tribunal took place regarding the bus stops in Victoria which now have a flashing light system installed, before this was the case [14].

In relation to use by blind people this tribunal found that "the complainant has established an adverse impact based on disability" on the basis of "fears of personal harm". It noted "it was incumbent on both the City and Transit [transport provider] to take reasonable steps to remove the barriers created for the blind by the new design." However, it rejected the complaint in relation to a bus stop where a flashing light option had already been installed. It rejected calls to remove the bus stop bypasses concluding that if added "the pedestrian activated audible flashing yellow [light] is a reasonable accommodation of the issue raised by this complaint at this point in time" and that the city had "established a 'bona fide reasonable justification'" for the continued use of these specific bus stops with the lights. However, it also concluded that "the use of the audible flashing light is not a full answer [and that this] does not mean the City should not implement technologies that would provide fully guaranteed protection for blind pedestrians if such solutions become available in the future".

Combining approaches and options

There are various potential combinations of these approaches and options (for example informing cyclists using flashing lights, and at the same time informing pedestrians using one of the two options described above). Some of these design enhancements might also be useful as part of the provision of full traffic signals at busy-complex locations. Such options should also be researched.

Although we have rejected options requiring pedestrians to carry a smartphone with a special app it is possible that apps could provide additional information.

Some contributors suggested the use of barriers as found at a level crossing, physically descending to close the cycle track. We rejected these options for cost and maintenance reasons. Equivalent arrangements to open and close streets to motor vehicles, such as descending bollards, are seen to fail regularly. Such an option was also rejected in the above-mentioned tribunal because it would "put the health of cyclists in jeopardy".

Some contributors also suggested the use of flashing lights as a standard feature, activated automatically when pedestrians were leaving a bus. We rejected this option. Regular use of the lights, as a broad indication that pedestrians might be crossing, would make them a familiar feature. The result would be that they would not be effective (in the manner described above) when individual pedestrians needed to use them to draw attention.

There may be an argument for exploring such an approach while pedestrians are boarding or leaving a bus at a shared platform boarder. The risk that this would make them familiar, reducing their effectiveness for the purpose we describe, should be understood.

8.4 Other conclusions and recommendations

This research led us to a wider set of conclusions and recommendations on points of detail. They are presented below in no particular order.

RAILINGS AND SHELTER DIRECTION

Questions were raised with us about whether a bus shelter should open towards the cycle track or towards the carriageway.

Our detailed-study sites included examples of both arrangements. We did not come to firm conclusions. We made the following observations around the advantages and disadvantages of these options as regards any interaction between cyclists and passengers. We note that there may be other unrelated advantages and disadvantages as regards accessibility that we did not explore.

It seemed that in some circumstances the bus shelter opening *towards the cycle track* could help to open up the sense of space, providing a less complex environment for cycling. For example, this seemed true at Garscube Road in Glasgow. Here there was excellent visibility between pedestrians, waiting passengers, and cyclists, and a sense that the track was clear of obstructions. This was a quiet bus stop, with plenty of space for the level of pedestrian and cyclist use.

However, at busier and more constrained sites opening the bus shelter toward the cycle track could lead to an increase in the complexity of the environment. This seemed true at Wilmslow Road in Manchester. Here larger groups of waiting passengers were immediately beside the cycle track, with nothing to separate them from it. Pedestrians were also often close beside the track on the pavement side of the track. The result was a very complex environment.

It could be seen that having a bus shelter *facing the carriageway* could sometimes help to keep waiting passengers away from the cycle track, simplifying the

environment for cycling. This was the case, for example, at Victoria Road in Glasgow. A disadvantage was that the shelter could feel to be very close to the track. This could obstruct visibility between cyclists and pedestrians. It could also add to the sense that the track was a physically constrained and complex environment, with a range of obstacles at handlebar height.

At some of the sites arranged like this pedestrians could be seen walking along the edge of the cycle track, behind the bus shelter. This added to the complexity of the environment for cycling. This happened very little where cycle tracks were much busier (for example at the London detailed-study sites). It was a bigger issue at Sauchiehall Street in Glasgow. This is a fairly wide track, which may have meant that pedestrians felt they weren't obstructing it. An additional factor here was that the shelter had an exit through the back panel.

At the Oxford Road site some short sections of railing had been used to add additional separation between waiting passengers and crossing pedestrians, as shown in Figure 28. From our own experiences cycling through this stop we felt that it was easier to know which pedestrians might cross the track. We felt the effect was less pronounced at the northern side of the northern of the two bus shelters, where one railing was much shorter (shown in the left image).

Figure 28: Railing use at Oxford Road

ISSUES WITH USER PERCEPTION

Some individual contributors had strong views about the incompetence or misplaced motivation of designers. To explore this issue we followed up some specific points made to us.

As noted in Section 6.3, one site visit participant had commented about some specific design mistakes. They said that a new design had led to a situation in which buses had not been able to pass one another, and that the design had to be modified after installation to fix the problem. They were clear that their point was

about the incompetence of the designers involved. A member of local authority staff confirmed that at this location there were occasions when buses needed to slow, but said that they could still pass. They suggested this provided useful speed calming. They emphasised that this was a particularly constrained space in a much longer route, and that a significant amount of design time had been spent considering different options here before the design was installed. Many options had been explored, including the purchase of land to widen the available space. They advised that the design was not actually modified after delivery. They suggested that what was seen by the participant as an oversight had actually been the result of conscious design choices and was the best response to local constraints.

In regard to some of the sites we visited with them, individual disabled people expressed their frustrations (and anger) that cycle tracks had been added in space that had previously been pavement. This mirrored concerns described by some of the organisational representatives we interviewed.

One participant described a particular bus stop as follows: “The pavement is [now] tiny, … I'm not the only one who's maybe stopped at the bus stop, … it’s right outside a large store, so many people use it, and my wheelchair taking up space of two people, you know, it's just really narrow. You know where the shelter is placed and the distance to get onto the bus, you’re only talking a couple of feet.” He added: “When they were resurfacing and creating a cycle path, the decision [was taken] to leave the bus shelter where it was practically originally… just, have a raised kerb, have a pavement, have a cycle path, have all of these things in a smaller space.”

Figure 29: Google Streetview images showing changes to a bus stop

2019 2022

Older Google Streetview images (as shown in Figure 29) show that the older situation had been problematic, with the bus shelter roof covering the whole pavement, and a significant degree of obstruction of the pavement with bins and other street furniture. In contrast, the new arrangement involved the removal of obstructions on the pavement, the addition of a cycle track on what had previously been carriageway, and a bus stop island that was of comparable width than the original pavement. However, we noted that the addition of an advertising panel on the bus shelter may have restricted movement (and visibility) at the stop itself.

These situations were representative of a wider disparity between how we were told streets had changed when compared to what changes had actually been made. In particular, the recollections people had about how a street had previously been designed could sometimes be seen to be inaccurate.

Similarly, there were sometimes big differences between what behaviours we were told we would observe, and what was actually the case. In Section 7.4 we discuss the way in which the level of use of cycle tracks was far higher than we were told we would see.

Clearly these observations are site-specific, and not necessarily representative of all sites. In addition, this does not indicate an absence of problems. Added complexity or lack of familiarity can exclude people, and such problems should not be ignored. However, those looking to learn about the effects of changes should remember that members of the public, who are genuinely disadvantaged by changes, may not be accurate in how they describe the conditions they face, or the causes of these.

We also speculate that members of the public may not see or complain about problems with existing infrastructure which they are accustomed to accepting, such as the narrowness of pavements. Changes to streets may lead them to reevaluate spaces more accurately. Judgements about loss of space or an increase in disadvantage may therefore be unreliable, while still pointing to real problems. This is perhaps to be expected given how human perception works, however there are consequences for anyone involved in trying to introduce new infrastructure.

Involving people more deeply in efforts to change streets, employing techniques such as street audits, might allow members of the public to more accurately gauge conditions before and after changes take place.

"I'M STOPPING" SIGNALS FOR CYCLING

Although not researched in this study, it is known that people cycling in Copenhagen regularly use a simple hand signal for indicating, to cyclists behind, that they are slowing or stopping. Our researchers have observed and used these hand signals there. In contrast, it is clear that the official signal for this in Britain is

rarely if ever used. Our video evidence also confirms this. It seems likely – although we did not seek evidence to confirm this – that few people cycling in Britain would recognise the official British signal.

It seems credible that the difference in the usage of these signals may arise from their practicality. The Danish example involves holding a flat hand above the shoulder (primarily moving the lower arm rather than the whole arm to achieve this). Either left or right hand can be used to achieve a similar effect.

The British Highway Code mandates that a cyclist holds their whole right arm out horizontally to their side, with the hand palm down, moving their entire arm upwards and downwards. Images of both signals are shown in Figure 30.

Figure 30: Cyclist hand/arm signals

Danish signal

British signal

It seems self-evident that the Danish signal (left image) is:

- Considerably faster and less awkward to use
- More clearly different from a “turning right” signal
- More naturally meaningful to indicate “stopping”
- Somewhat less destabilising
- Usable even if another cyclist is immediately to the user’s right (which we observed can be the case on some busier cycle tracks).

Earlier we discussed the experiences of our researchers, in finding they lacked any means to signal to cyclists behind that they wanted to slow or stop. We conclude that the Danish hand signal should be trialled in Britain.

The introduction of a formal hand signal, with adaptations to the Highway Code, may be a slow process – but it seems likely that the usefulness of the Danish signal

could be tested in a more informal manner. One option would be an informal introduction of this signal to cyclists on the busiest cycle tracks (in London), where the need for such a signal is pressing. It seems possible that use of this signal would simply catch on – being passed from cyclist to cyclist as its usefulness was established.

We recommend that organisations and groups with an interest in cycling discuss this possibility, and that Transport Scotland and Department for Transport consider how they could support such testing.

CHECKERED ALTERNATIVES TO ZEBRA MARKINGS

We noted the use, in Barcelona, of an alternative to a zebra crossing marking. Where a zebra marking might have been used on a cycle track, a checkered pattern was used instead. This was of interest because the form of the pattern remained clear when used on both wider and narrower cycle tracks. In comparison, standard (legal) width white zebra stripes do not work well on a narrow track, with there sometimes being space for only one stripe to be provided.

At this stage we are not recommending the testing of the use of such a marking because of the risk of adding to the inconsistent design of bus stops across the country. However, in future there may be value in the use of this marking. It seems unlikely that checker markings would become well understood in the short term, even if their use was formalised (e.g. in the TSRGD legislation and Highway Code). However, as noted elsewhere, it seems clear that the existing legal meaning of zebra markings on cycle tracks is not well understood. Consistent use of a checker marking, in places where a zebra marking might have been used (as described elsewhere), might lead to a broad understanding that it highlights situations where crossing pedestrians are to be expected.

RESEARCHING LEVELS OF BUSYNESS ABROAD

As noted in Section 5.4, many of the organisations most concerned over the introduction of bus stop bypasses (and other equivalent arrangements) were worried about how busy the cycle tracks would be. It was commonly said to us that the aim is for all cycle tracks to eventually have large numbers of cyclists on them.

Above, we have suggested that conditions can be seen to vary considerably in countries where cycling is popular. We have said that is self-evidently the case that many cycle tracks are quieter than the busiest examples studied here. However, we did not locate independent objective evidence to confirm this view.

It would be useful to research this issue more accurately, looking at what proportion of bus stops – in such countries – would fit the categories we suggest (i.e., quiet-

simple, busy-complex, etc). Such research should also investigate whether busy-complex environments are usually associated with town and city centre bus stops.

THE BENEFITS OF BI-DIRECTIONAL ARRANGEMENTS

Some of the findings of this project might lead to the conclusion that "bi-directional" (two-way) cycle tracks are problematic.

However, with this in mind, it is important to note that we heard evidence of some advantages to the use of bi-directional cycle tracks. In particular we were told of situations where the use of such a design had meant that it was possible to provide for two-way cycling on the opposite side of the road from a particularly busy bus stop. This meant that the need for a bus stop bypass had been avoided.

It was also argued that such arrangements can save a small amount of space, which might be helpful in particular locations.

CYCLE TRACKS REDUCE PROBLEMATIC USE OF PAVEMENTS

Some contributors emphasised the fear caused to them by people illegally cycling on the pavement. The risks to blind and partially sighted pedestrians were highlighted, but we were told of the effects of this by a much wider group of people.

We noted that cycling on the pavement was rare at the detailed-study sites, even where cycling levels were very high. Cyclists almost always used the cycle track. We also noted that a wide variety of other devices, such as e-scooters, were almost always used on the cycle track (although wider concerns should be noted with the speed and quietness of e-scooters – a subject not explored in detail in this report).

It might be argued that, in these locations, the addition of a good cycle track had led to safer conditions on the pavement. This might be seen as making streets more inclusive.

For completeness we note that some contributors argued that such issues were best addressed, instead, by prosecuting poor behaviour.

INDIVIDUAL BEHAVIOUR AS PROBLEMATIC

We saw, unsurprisingly, that some people cycled in a more problematic manner. The effects of this should not be underestimated.

At one Edinburgh site (Leith Street – not a detailed-study site) it was common for pedestrians to ignore the presence of the cycle track, blocking cyclists from easy progress. Most cyclists behaved carefully. We recorded that we were surprised there were so few signs of frustration or irritation between those involved. However, on one occasion we watched as a delivery cyclist overtook several groups who were spread across the track, with their backs to him. He used the power of his e-bike to

overcome the hill here, passing close and at speed. We speculated that this would be more memorable to the pedestrians than any of the less remarkable negotiations we had observed. We judged that in some circumstances, such as if a pedestrian had had limited mobility, such an interaction could easily have caused real alarm.

It was clear from our work with disabled people, as described in Section 6.3, that many had been alarmed by interactions with people cycling. We were also clear that for some pedestrians the fears they face in navigating streets have the potential to lead to exclusion.

We conclude that the effects of behaviours like this may be disproportionate, both in terms of actual effect, and because this behaviour is more memorable. It is clear that designers should understand the potential for such poor behaviour, and that this might be more significant – in terms of the overall experience of pedestrians, and the potential to disadvantage some – than the behaviour of the majority of those cycling.

EXCLUDING CONTEXT MATTERS

Much of the work of this project was on the basis that there are pedestrians on the edge of being excluded by current conditions. There are also potential pedestrians who are already excluded.

It was clear to the project that some of the problems caused by bus stop bypasses (and equivalent arrangements) are as serious as they are because of this context.

We conclude that one important way to decrease these effects is to increase the wider accessibility of streets. The idea of "net-benefit" for pedestrians may be useful. Measures to *significantly* improve conditions for pedestrians more widely should be seen as an important part of any scheme that includes the continuation of cycle tracks past bus stops.

Such improvements should not be limited to widening or maintaining a pavement. Taken as a whole, this is a big subject, beyond the scope of the current report, but the parallel report on continuous footways touches on the subject.

We reiterate the value of street audits and working with disabled people to improve the whole street environment.

BUILDING TRUST AND KNOWLEDGE

In Sections 5.4, 6.3 and 8.1 we report that we encountered confusion over why cycle tracks are continued past bus stops, and we report scepticism over the value of cycle tracks more widely. We also report differences between what we were told we would observe, and what was actually the case.

In some ways it could be seen that professional informants effectively sat in two separate camps. Those supportive of building cycle tracks and those concerned over their introduction generally shared a focus on improved conditions for pedestrians. However these camps seemed disconnected, with misunderstandings and a lack of trust arising, and a loss of learning on all sides.

Earlier, we comment on the need for clarity in guidance documents. We also conclude that those involved in promoting infrastructure to support cycling need urgently to find a way to bridge this gap. Organisations which are currently excluded from key conversations about improving streets, or from work to draw up design guidance, must be fully embedded in the processes involved. There is a need for this to be more than “consultation”. These organisations should be provided with the support they need to contribute to a wider vision for more profound change to streets. While we heard from designers who were well informed, we concluded that there is wider need for those providing new infrastructure to be open to learning from those worried about its provision.

In immediate terms, we recommend that those promoting or providing bus stop bypasses should more clearly acknowledge that continuing a cycle track at a bus stop is likely to introduce some disadvantage to blind and partially sighted pedestrians, even if well-designed, and even if the design enhancements described in this report are proven effective. The risks of disadvantage to a wider group of pedestrians and other disabled people should also be acknowledged for complex environments where cycle tracks are busy, if cycling speeds in the location are higher, and in any case where cycling levels are very high. Careful local design and consultation with users then becomes critical to minimise overall impacts.

In our parallel report “Inclusive design at continuous footways”, we highlight that changes intended to improve conditions for pedestrians are being badly compromised by a wish to maintain current traffic flow and speed. In this we recommend that realistic plans are made for more profound changes to streets. This requires a much stronger vision for implementing the sustainable transport hierarchy and traffic reduction.

In the absence of such plans it seems unsurprising if some conclude that a wish to support cycling is being put ahead of any desire to make streets inclusive. Although this work has highlighted situations where space has been taken away from motor vehicles, we also found many situations where space for cycling had been taken from that previously for pedestrians.

9 Summary of main conclusions and recommendations

Following on from the previous section's discussion on the complex themes and findings arising, **a selection of some of** the project's main conclusions and recommendations are summarised below.

9.1 Conclusions

1. The main reason for continuing a cycle track at a bus stop is because this provides protection from general traffic, avoiding significant gaps in this protection. It can help that interactions between buses and people cycling are avoided, but this is a secondary effect. Increases in the convenience of cycling should be regarded as a side-effect. Confusion over this point has been a barrier to discussions on inclusive design. (See Section 8.1)
2. Good quality cycle tracks are separate from both the carriageway and the pavement (footway). Some literature, including design guidance, implies that cycle tracks are inevitably either part of the carriageway or part of the pavement. Confusion over this creates a barrier to work on inclusive design. (See Sections 3 and 5.3)
3. Past poor design, and a failure to treat concerns seriously, sets a context for current fears about bus stop bypasses. There are key design principles and a minimum design quality, often ignored until now, which would make bus stop bypasses easier for many to negotiate, particularly blind and partially sighted pedestrians. (See Section 8.2)
4. Conditions at a bus stop vary greatly as the level of cycling, level of pedestrian use, and complexity of the environment change. It is helpful to consider that there are three types of environment – quiet-simple, moderately-busy-complex, and busy-complex. (See Section 8.1)
5. In certain circumstances cycling on a track can reach levels, particularly in complex environments, which make it difficult for a broad range of pedestrians to cross comfortably. For some, crossing safely and comfortably can become difficult or impossible. This is particularly true for those who walk more slowly, who have impairments to their balance, or who find it harder to judge cyclist speeds. (See Section 8.1)
6. The demonstrable inconvenience to most pedestrians at most of the detailed-study sites in this study was very low, and signs of discomfort or difficulty were rare or absent. (See Section 8.1)

7. This study provided evidence that where a good quality cycle track was provided beside a busy carriageway, cycling on either the pavement or carriageway was rare. People using a range of other wheeled devices (e.g. e-scooters) also used the cycle track instead of the pavement. It could be argued that this makes pavements more inclusive. (See Section 8.4)
8. Some accessibility problems arise where the space made available (for the bus stop, cycle track and pavement) is insufficient, rather than as an inevitable consequence of the use of a design continuing a cycle track past a bus stop. (See Section 8.2)
9. We identified two problems which might arise where a bus stop is on an island, which were not widely discussed, and which deserve attention. The first is that excessive crossfall (slope) might be created on the island. The second is that it becomes more difficult for a blind or partially sighted pedestrian to find the bus stop. (See Section 8.2)
10. Zebra crossings do not perform as might be expected based on their legal status. The reasons for this appear complex and multi-faceted, but the consequence is they are not currently providing a reliable tool to sufficiently help a pedestrian who feels they need support to cross the cycle track. (See Section 8.1)
11. For many disabled people bus travel is an essential tool to allow them to bypass otherwise inaccessible or challenging streets or junctions. Changes to the accessibility of bus stops may have heightened negative effects arising from this wider issue, and vice versa. (See Section 8.4)
12. Specific design features, like high kerbs, tight corners, ramps, handlebar-level obstacles, narrow tracks, and gaps in a cycle track's protection, can greatly increase the level of attention that cyclists need to give to their own safety. This can limit their ability to consider the needs of pedestrians. (See Section 8.2)
13. More work is needed to bring disabled people and designers together in a constructive and respectful manner, identifying the reasonable adjustments that need to be made on equalities grounds. This should recognise the inherent challenge that adapting streets whilst meeting the needs of all users poses.
14. There are design enhancements which should be tested, through a series of pilots, with the aim of making it easier or possible for blind and partially sighted pedestrians to cross cycle tracks, and to support all pedestrians at very busy cycle tracks. Disabled people should be at the heart of this work. (See Section 8.3)

9.2 Recommendations

1. Disabled people, and organisations led by and representing disabled people, should be provided with the necessary support to be fully embedded in the work recommended here. (See Section 8.4)
2. Design guidance should be revised to make it clearer that the reason for continuing a cycle track past a bus stop is primarily about the integrity of the track, and about avoiding the need for people to cycle on the carriageway. (See Section 8.1)
3. Design guidance, and other documentation, should make clear that well-designed cycle tracks are neither part of the carriageway, nor part of the pavement. (See Sections 3, 5.4, 8.2)
4. Those promoting or providing bus stop bypasses should more clearly acknowledge that continuing a cycle track at a bus stop is likely to introduce some disadvantage to blind and partially sighted pedestrians, even if well-designed, and even if the design enhancements described in this report are proven effective. (See Section 8.4)
5. The risks of disadvantage to a wider group of pedestrians and other disabled people should be acknowledged for complex environments where cycle tracks are busy, if cycling speeds in the location are higher, and in any case where cycling levels are very high.
6. Design guidance should explain more clearly that conditions for pedestrians at a bus stop bypass vary considerably according to the level of cycling, level of pedestrian use, and the complexity of the environment. (See Section 8.1)
7. Local authorities should work to understand which cycle tracks (at what locations) are likely to be providing quiet-simple, moderately-busy-complex, or busy-complex environments.
8. Design guidance should more accurately describe the range of options, including both “shared platform boarder” and “continued kerbside track” arrangements (whether or not so named), even if some are recommended against. The idea that hybrids can exist should be included. (See Section 8.1)
9. Design guidance should be updated to include the key principles and minimum design quality described in Section 8.2, along with options for avoiding the use of bus stop bypasses.
10. The enhancements suggested in Section 8.3 should be tested, and if it is found that they are effective, design guidance should be updated accordingly.

11. Use of the Danish “I’m stopping” hand signal (used by cyclists) should be explored. (See Section 8.4)

References

The accompanying literature review document lists all of the literature consulted. **The following are only those sources referenced in this "Main Report".**

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