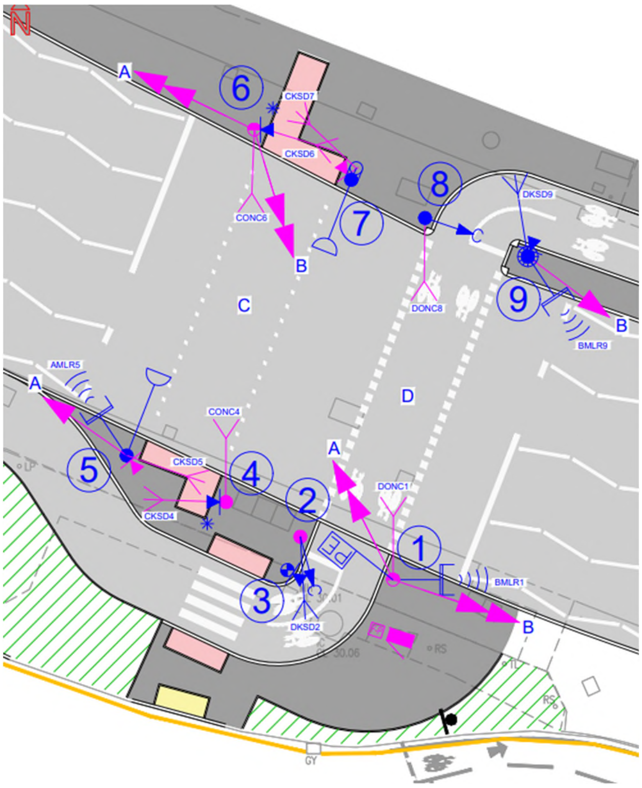
Get on your bike! Interpreting and evolving signal design guidance and practice for cycles

During the last year, the signals team at 4way Consulting have been involved in numerous signal design projects which have incorporated segregated, signalised cycle facilities. Those projects have ranged from fairly simple crossings, to multiple, very large 'Cyclops' style junctions, as part of significant cycle infrastructure projects, and are generally outside of London. However, almost all of the projects have had one thing in common – Whilst being designed to accommodate many cycles, initially at least, cycle flows are likely to be light, with likely less than one cycle per minute expected, often significantly less. Hopefully, the enhanced infrastructure will encourage modal shift and increase cycle numbers, but there have been many challenges in the design, to create solutions that works for both very light and sporadic cycle volumes, as well as an increased volume in the future.



When designing those sites, the team at 4way have had to understand the detail of the Traffic Signs Manual Chapter 6 and LTN 1/20 Cycle Infrastructure Design, and in doing so have found that these documents don't always fully document all elements of a 'normal' design. In addition, the 4way team have had very differing levels of experience of cycles and as cyclists, and ensuring that our designers understand the needs of cyclists has not always been straight forward.

This paper, and the accompanying presentation, looks to discuss how 4way are interpreting the national design guidance and evolving that into our own design policies, and sharing that with the wider industry. It should be noted that this paper concentrates on designs with low cycle volumes but significant cycle infrastructure, and our thinking as of summer 2024. We welcome discussion and opinions from the wider signals industry about the best way forward, how design practice can evolve further and potentially how national guidance may be later updated. Specific points for discussion are noted throughout this paper.

Who is a cyclist? And what is a cycle?

Whilst LTN 1/20 encourages scheme designers to be cyclists (LTN 1/20 1.6.1, item 20), it's perhaps unrealistic to imagine that every signal designer on a scheme will be a regular cyclist, or intimately familiar with the local environment of a design scheme. So as has been the case within 4way, it's worth a brief refresh of who a cyclist may be, and what they could be riding.

A 'cyclist' can be almost anyone, and LTN 1/20 encourages us to think this way. We could be talking about Tour de France athletes, children, regular commuters, those with disabilities, those riding a bike professionally and aiming to make their latest food delivery rapidly and more. And a 'cycle' comes in many shapes and sizes. Whilst most of us are likely familiar with an ordinary 'bike', our designs should also be taking account of 3 or 4 wheeled recumbent bikes, larger cargo bikes, tandems, bikes pulling trailers, children's bikes and more. LTN 1/20 figure

5.2 gives a range of cycle types and sizes. With the rise of E-scooters, those provided through formal hire scheme trials are typically allowed to use cycle routes and hence we should be allowing for them. And it would appear likely that privately owned E-scooters will become legal within the lifespan of infrastructure we design today, so should likely be considered too.

It's important to remember that the needs, abilities and confidence of the different riders all needs to be accommodated in our designs. And the differing sizes, manoeuvrability and rider positioning of cycles can make significant differences to how those cyclists navigate our signal designs.

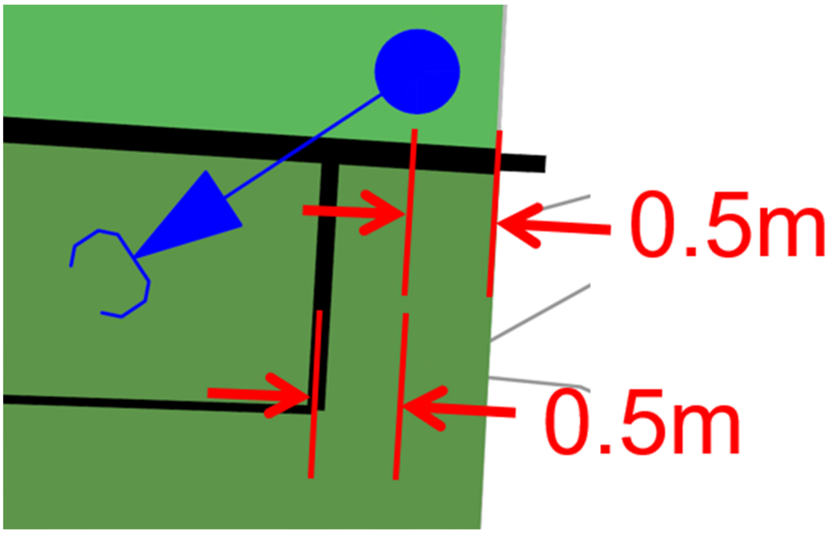
Segregated cycle facilities: Where to stop?

Design guidance is clear: where we separately signalise cycle movements, the signal head (or heads) must be used in conjunction with a stop line (TSM Chapter 6 12.7.2, TSRGD). It is not optional to use, or omit, a stop line. The stop line must be present. However, the exact positioning of that cycle stop line is not clearly given.

Logically, following normal motor vehicle design 'styles', the cycle stop line should be placed before the cycle primary signal head. It certainly shouldn't be after the primary signal head, as that could imply that a cyclist should pass a signal at red to reach the position identified for stopping at.

The 4way policies have established that positioning the cycle stop line approximately 0.5m before the primary cycle signal should allow clear visibility of the cycle signal heads and ensure the cyclist stops before the signal head. However, with signal poles typically set back 0.5m or more from the kerb edge, we start to hit problems with our own design policy: Space, and the lack of it. With a pole 0.5m from the kerb edge and the cycle stop line

0.5m before that, we now start to 'hold' cyclists 1m from the kerb edge, and with a cycle potentially being 2-3m (or even more) in length that's a fair amount of space required.



Points for discussion:

1. Where should the stop line be positioned? Could it be positioned in line with the primary cycle signal head? Could it even be placed after the primary cycle signal head, potentially at the kerb edge?

2. Do we need a stop line for segregated cycle signals? For years, cyclists have used Toucan crossings which do not incorporate cycle stop lines. Would it be obvious to a cyclist, and no less safe, to do away with the cycle stop line and assume a cyclist should stop at the primary signal head?

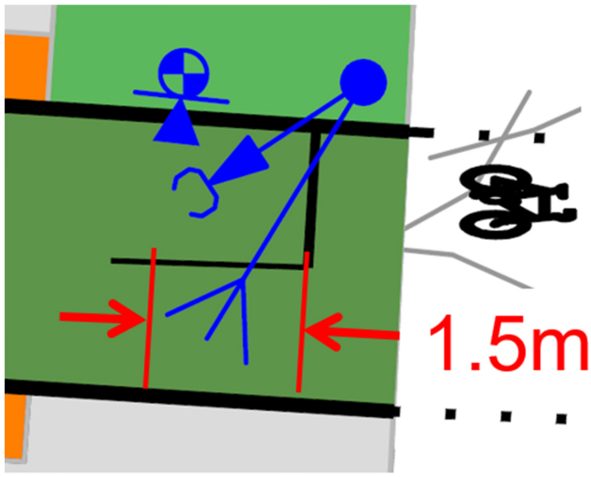
3. Is it realistic to use a stop line to 'control' cyclist movements? Do cyclists actually recognise the need to stop at the stop line when a red signal is shown, or is solely the red signal used as the indication to stop?

Segregated cycle facilities: How to detect?

LTN 1/20 and TSM Chapter 6 are sparse when it comes to suggested details of how cyclists should be detected. LTN 1/20 1.6.1 item 2, states that cycles 'must be treated as vehicles', which could be interpreted as requiring an automatic detection system, but also is written in the context of segregation of cycles and pedestrians.

On many sites 4way have worked on, it is very typical for the direction of intended travel for a cycle to not be discernible until the cycle is at, or very close to, the stop line. As such, 'advance' detection is not typically useful, as it can lead to many false demands. The need for detection at, or close to the stop line is typical.

Automatic detection can be used at the stop line, but at the time of writing, the 4way team has yet to use a system which presents as a cost effective solution, that reliably detects legitimate users of a cycle facility only, without also detecting pedestrians or missing some cycles at least on occasion. Typically, the 4way team are specifying a push button, reinforced with an above ground detector, typically a standard pedestrian kerb side detector or 'AI assisted' stop line detector. This allows demands to be lodged by either the above ground detector itself (acting as a call/cancel detector), and/or through the use of the push button, combined with the kerbside detector, as per normal pedestrian or Toucan behaviour. This allows the automatic triggering of cycle demand normally, but at areas which may see multiple false demands from pedestrians crossing the cycle route, a fall back to push button operation is possible.



Where a push button is used, space for the ideal push button location can be difficult to find. The push button needs to be positioned before the stop line, so a cyclist does not have to cross a stop line at red to reach it. But not all cycles position the rider's hands close to the front of the bike, especially recumbent and some cargo bike styles. Where possible, 4way have settled on positioning the push button approximately 1.5m from before the stop line, but space does not always permit this.

On certain schemes, where siting the push button becomes very difficult, the 4way designs rely solely on above ground detection. But this does omit what is thought to be a very useful feature - the wait lamp. Cyclists have long been used to Toucan crossings, where a wait lamp is used to communicate that a demand has been lodged. Where cycle demand is infrequent, it is thought that the wait lamp is a very useful way of communicating that demand is lodged, and hopefully helps the cyclist wait for their green signal. It is thought that at sites with high cycle flows, the wait lamp could become less useful, as regular users could quickly become used to operation, and non-regular users may well 'follow the crowd' of cyclists around them. Whether this is truly the case is not clear.

Points for discussion:

1. Have any authorities had success in omitting the push button and wait lamp at low cycle flow sites? Did this lead to good understanding and compliance by cyclists?

2. Could a cycle signal head be developed and prescribed that incorporates a small 'wait lamp' either above the red aspect or below the green aspect?

3. Have authorities settled on a detector type that is cost effective, reliable in operation and reliable in detecting legitimate cycle facility users with limited/no false detects?

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Cycle signal operation: Stage sequence

At junctions, the use of long, straight-across cycle crossings, as is typical for a Cyclops style junction, typically brings an all-round cycle (and pedestrian) stage. Whilst generally a good way of handling the differing modes of transport and allowing safe movement of cycles, the introduction of an all-round pedestrian and cycle stage will typically reduce efficiency at a site, and also introduce long waiting times: If a large junction were running a two minute cycle time with a conventional all-round pedestrian and cycle stage, then an average waiting time for cyclists would be in the region of one minute, and actual waiting times varying between virtually nothing to two minutes. Along a route with multiple such junctions, it's not difficult to imagine that a free flow journey time for cyclists of, say, 10 minutes could be increased by 50%-100%. At such a point, would a cyclist feel like they are receiving a high level of service from such facilities, or just suffering delays?

To alleviate this, 4way have developed a technique that we hope will significantly reduce cyclist (and pedestrian) waiting times, without compromising capacity and delays for other users. The technique is particularly suitable for sites with low, variable or sporadic cycle flows, and sites under local control, such as MOVA or VA. It is likely to have only limited benefit for sites with high and consistent cycle (or pedestrian) flows, and currently integrating the technique with CLF or UTC/SCOOT control has proved challenging.

On the following page, such a junction layout is shown, along with its stage sequence. It should be noted that stages 3, 5 and 7 are identical to each other, being repeats of the all-round pedestrian and cycle stage.

The technique is:

- When a cyclist (or pedestrian) is detected, that demand is serviced in the next available pedestrian/cycle stage. So if a cyclist were detected whilst the controller were in stages 1 or 2, the demand would be serviced in stage 3. If the cyclist were detected in stage 6, the demand would be serviced in stage 7.
- If stage 3 were to be at green, stages 5 and 7 are 'locked out' in the current controller stage sequence, 'unlocking' only once the controller has returned to just prior to stage 3, or a reset timer is reached.
- Similarly, if stage 5 were at green, stages 7 and 3 are locked out. And if stage 7 were at green, stages 3 and 5 are locked out.
- In this manner, only one all-round pedestrian/cyclist stage can be at green in any complete controller stage sequence, which negates capacity implications of multiple such stage occurrences. But at the same time, the waiting time for the cyclist or pedestrian is significantly reduced.
- If cycle demand volumes were high at certain times of day, the technique is still useful, but at those busy times it's likely that the controller would 'settle' into a pattern of always running a certain all-round pedestrian/cyclist stage each stage sequence, and always omitting the others, effectively running likely a conventionally configured controller. However, if cycle demand volumes decreased in the off peak, the technique would then become much more useful.
- Whilst perfectly possible to run such a configured junction under CLF or UTC/SCOOT control, to minimise the impact on overall cycle time, it's likely that only one of the option all-round stages would be utilised each full stage sequence, negating benefits. But if CLF, UTC or SCOOT are only in place at certain times of day, some benefit could still be realised.

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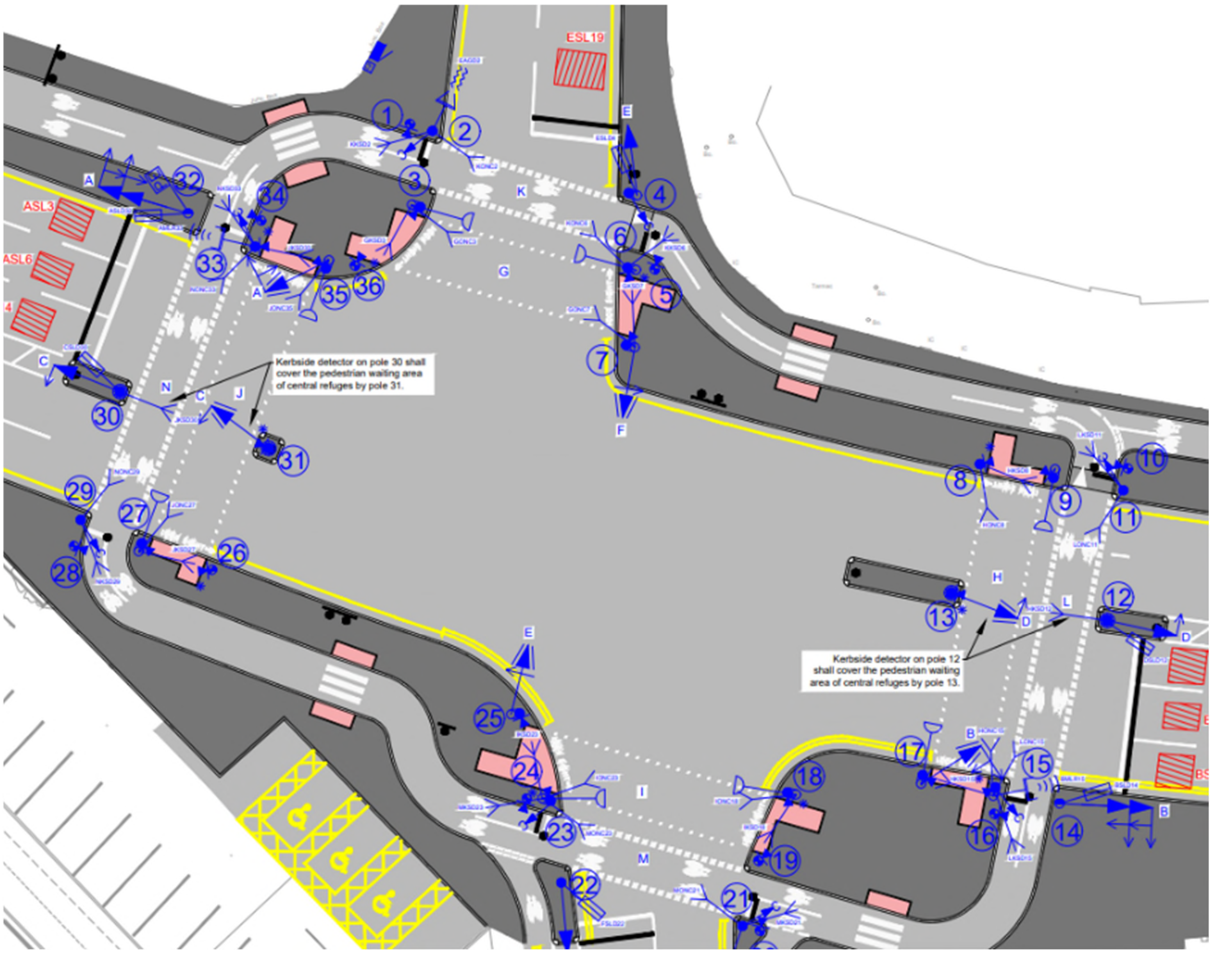

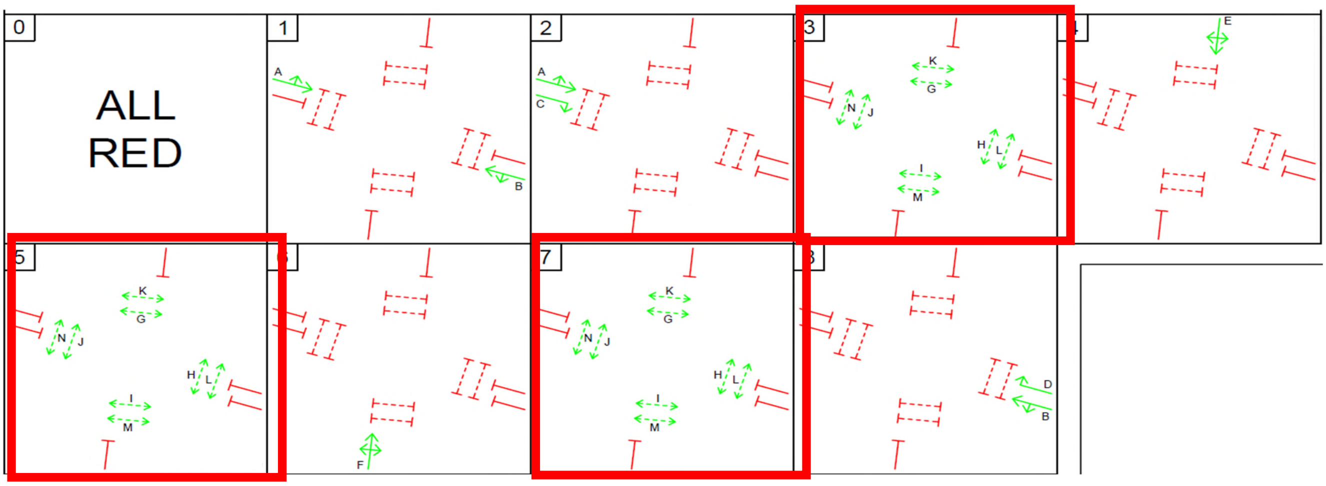

Points for discussion:

1. 4way have seen some evidence of cyclists, especially confident cyclists, disliking Cyclops style junctions due to the long waiting times. Have others seen such evidence, and have other techniques been developed to resolve this?

2. The technique would work equally effectively for sites with all-round pedestrian stages (e.g. at sites with no cycle facilities). Whilst this is a new staging strategy to the team at 4way, has this technique been used by others previously?

Cycle Signal Operation: Minimum green duration

For a conventional motor vehicle signalised phase, the conventional minimum green duration is 7s, but Chapter 6 point 6.11.3 also states 'At sites with very low flows, a minimum of 5s may be used with caution'.

For Toucan phases, the conventional minimum green duration could be 4s for nearsided facilities and 6s for farsided facilities.

A cyclist making use of the above facilities, could be faced with, and used to coming across minimum green durations of 4s, 5s, 6s, or 7s depending on which part of the highway they are using and the type of equipment in use.

Yet for dedicated cycle phases, Chapter 6, point 12.2.2 states 'Cycle phases at junctions should have a minimum green duration of 7s…'

To the 4way team, it's unclear why a single cyclist would need a longer minimum green on a dedicated cycle phase (which will often have a starting amber) than they would at a Toucan crossing, or could come across if cycling on the main carriageway where motor vehicles are also permitted.

Therefore, when conditions permit, 4way are also utilising a 5s minimum green duration for dedicated cycle phases.

Where cycle flows are heavy, or the movement is on a steep uphill, a 7s minimum green may well remain the most appropriate value, and techniques to further extend the cycle green duration used for very heavy movements.

In addition, where the primary cycle route crosses two or more arms of a junction, the 4way team are designing to ensure that timings are appropriate to allow the cyclist to clear the entire junction in one movement, rather than having to wait multiple times at the same junction. This could mean longer minimum green durations, or carefully controlling green extensions for the cycle phase.

Concluding thoughts

The knowledge, experience and guidance for the design of signalised cycle facilities is expanding and evolving all the time.

Applying that knowledge and guidance to existing sites with limited space can be challenging, and it is likely that further experience and evolution of the guidance can assist, especially if the need for, or locations for the cycle stop line can vary. The removal of push buttons and use of automatic detection could again reduce space requirements, but the wait lamp is thought useful and current automatic detection not yet reliable and cost effective enough to detect any type of cyclist.

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Adding high quality cycle facilities to sites where cycle volumes can reasonably be expected to be low, at least initially, can provide challenges in how to balance all user's needs, whilst still providing safe, effective and rapid cycle facilities. Techniques have been proposed to assist in this.

Overall, as signal designers, we are being asked to 'squeeze' ever more facilities into our designs, typically enhancing service levels to cyclists without detriment to others. Whilst formal design guidance assists with this, many techniques and aspects are continually evolving. It is hoped that by documenting here the approach that 4way Consulting has been taking, it will stimulate further discussion and sharing of knowledge and ideas, leading us all, as a signals industry to improve. We welcome any feedback from others in the industry.

tom.siddall@4wayconsulting.com