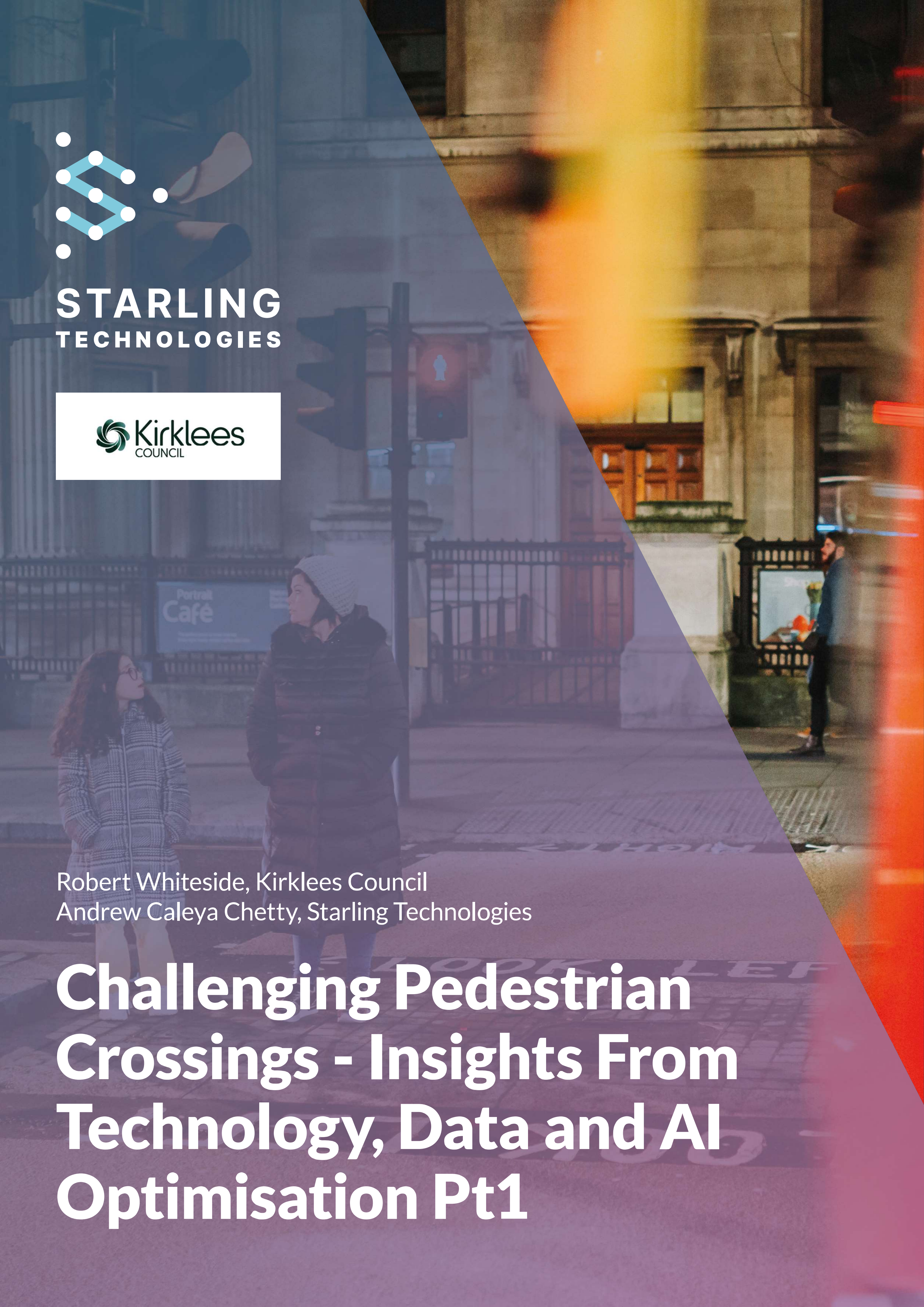

STARLING TECHNOLOGIES

Kirklees COUNCIL

Robert Whiteside, Kirklees Council
Andrew Caleya Chetty, Starling Technologies

Challenging Pedestrian Crossings - Insights From Technology, Data and AI Optimisation Pt1

STARLING TECHNOLOGIES

Kirklees COUNCIL

Sections

Abstract

The Trinity Street, Castlegate junction on the Huddersfield ring road is a key intersection for both vehicle and pedestrian traffic. Currently the timings and sequencing of pedestrian movements on a staggered crossing (four lanes + two lanes) on the southern arm of the ring road lead to reports of congestion of the refuge island and non-compliant pedestrian behaviour. Using Transforming Cities funding Kirklees are applying Starling Technologies equipment to firstly gather data, and quantify parameters for pedestrians to substantiate the reports, then, subject to the findings, apply Starling pedestrian driven optimisation. This paper presents preliminary findings from the data gathering phase. It shows strong tidal pedestrian movements, and looks at correlation of pedestrian to vehicle near misses with those tidal flows. It finds that the more time constrained two lane crossing has systemic pedestrian non-compliance.

Overview

The Starling trial was funded by CRSTS Funding as it was the proposed new junction which is to be funded by TCF. Kirklees are applying some of their Transforming Cities funding to address troublesome pedestrian crossings. This paper specifically looks at a staggered crossing over six lanes (four plus two) at the Castlegate, Trinity Rd junction and considers why there may be problems with the existing site. Pedestrian non-compliance has been reported from the site and consequently there may be a higher than acceptable level of risk to road-users. Funding is being applied to gather and assess statistically valid quantities of data and depending on the emergent issues, assessing options for mitigation.

The problem(s) for which remediation is sought

The starting point for defining the problems is detailed in the Statement of Works for the deployment of Starling equipment and services at this site which says:

“Kirklees wish to gather a wide range of data to facilitate their understanding as follows:

- Crowding and pedestrian density on the pedestrian island and pavements by time of day
- Other safety issues including near misses, vehicle failure to stop by time of day, and
- Other relevant data to support understanding of the site and pedestrian optimisation. Kirklees may also use that data to consider other potential changes or investment at the crossing but this is outside the scope of this project.”

The statement of works goes on to propose:

"Optimisation: implement optimisation using predictions to:

- Reduce the risks associated with crowding, particularly on the pedestrian island but also kerbside
- Deliver a 'flow' for pedestrians crossing from one side to the other
- Minimise the impact on traffic"

These objectives need little further explanation, but how they can be delivered is central to this paper.

However, to make the situation more accessible Figure 1 and Figure 2 typify why there is a concern.

Figure 1 High Levels of Pedestrian Demand.

Figure 2 Pedestrian Non-Compliance.

(Throughout this paper the term pedestrians should be read as also including non-motorised users.)

The site and its context

The crossing is at intersection of Trinity St. and Castlegate. Castlegate forms part of the ring road for the centre of Huddersfield. Trinity St provides a main route to Huddersfield Royal Infirmary and beyond to J23 of the M62 for traffic to and from the west. This is not an isolated or simple site and interventions here could have wider-reaching effects on the rest of the network.

Figure 3 Wide Context View of the Site (indicated by the oval).

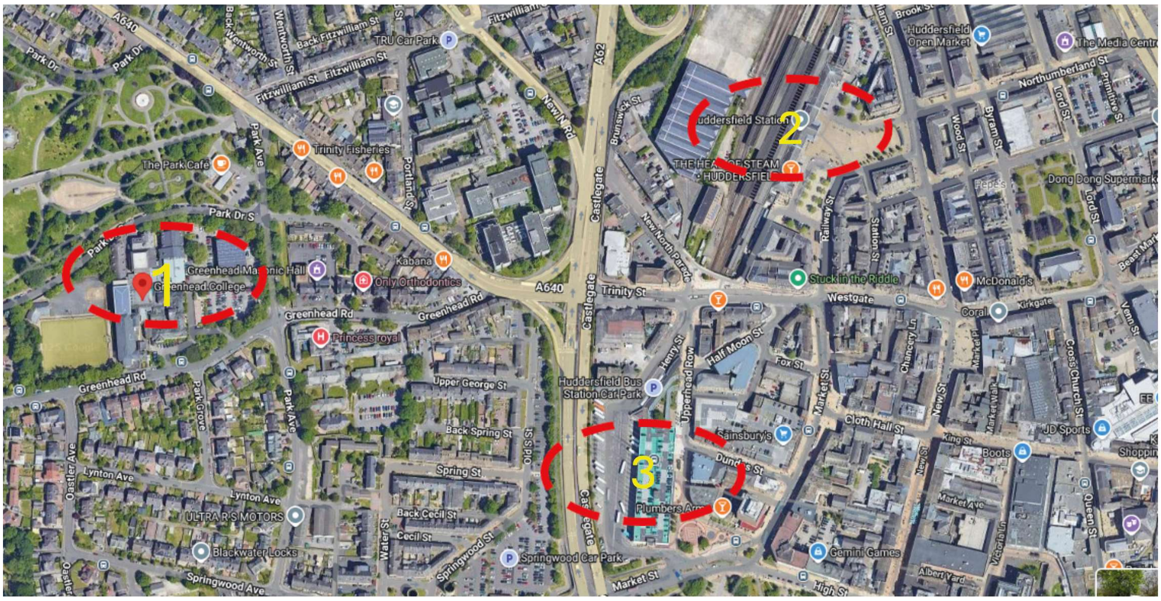

Figure 4 Local Context View of the Site (1 Greenhead Academy, 2 Train Station, 3 Bus Station).

The (Grade 1 listed) railway station is inside the inner ring road close to this intersection. The bus station is immediate to the southeast of this image with the entry off Trinity St and the exit at Market St which forms the next intersection south on Castlegate.

During peak times up to ten busses per hour cross Castlegate inbound. Busses also enter the Bus Station from the ring road. Due to the high levels of bus movements bus priority is not active at the site. It is a stated constraint by Kirklees that any interventions here must not adversely affect the movements of busses into the bus station.

An enforcement camera (shown by the yellow box in Figure 5) previously monitoring signal non-compliance for N bound traffic remains in place as a deterrent.

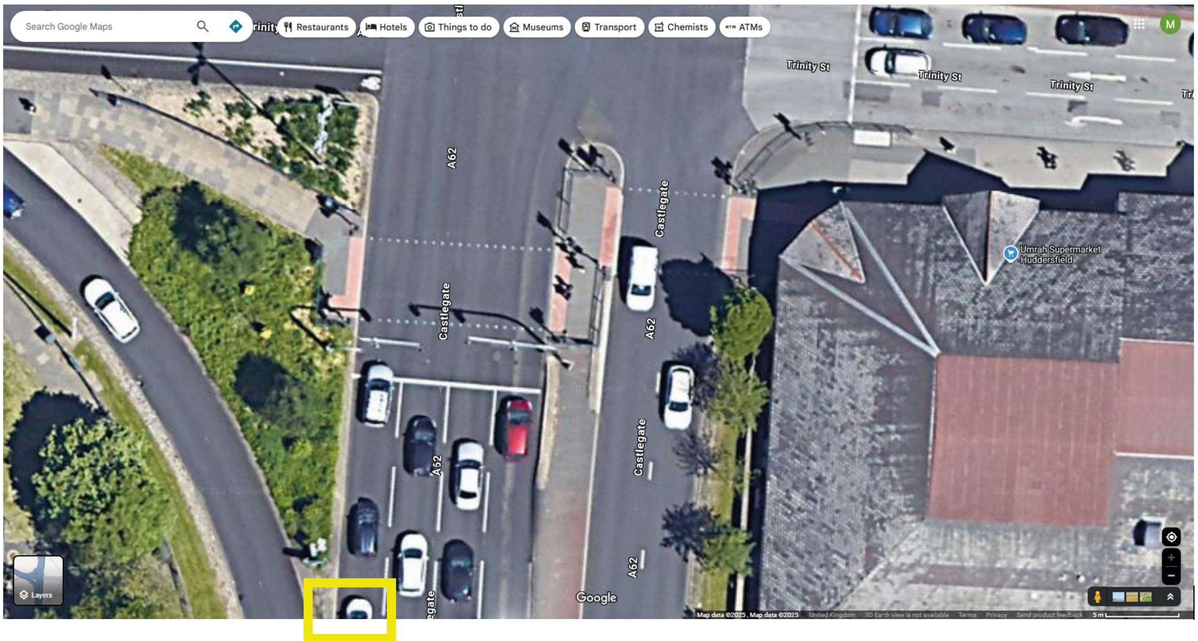

Figure 5 Google satellite view showing the enforcement camera location.

The only pedestrian crossing across the A62 at this intersection is to the south of the junction. On the north side of the intersection the at-grade lane separation of traffic turning movements off the south bound ring road would require pedestrians to traverse two islands, so there is no corresponding crossing on the north side. Kirklees do have a design to simplify the south-bound Castlegate and add pedestrian and cycle movements across this arm, and across Trinity Street and provide facilities for cyclists. The site plan and staging diagrams are included as appendix A.

Consequently all pedestrians have to use this one crossing to get across the ring road at this point.

Figure 6 Street View of the crossing looking east towards the town centre.

The pedestrian route crosses the ring road which at this point has four lanes N bound and two lanes south bound. There is a slight downhill gradient towards the town centre.

Figure 7 Street View of the refuge island at this crossing.

300m to the north of this intersection Fitzwilliam St is grade separated and provides a route to cross the ring road. 260m to the south the Market St intersection has grade separate pedestrian facilities. A further 160 m south at Outcote Bank there is another at-grade pedestrian crossing of Castlegate. These four crossings cover the whole west side of the ring road. Much of this road has barriers to prevent pedestrian access. The speed limit on this part of the ring road is 40mph and the site runs under SCOOT control at all times.

Looking at the traffic movements (Figure 8), pedestrian phase I crosses the four lane N bound A62 entry to the junction and occurs in 4 stages but the pedestrian phase J crossing the S bound exit understandable only occurs in one phase. In simple terms the opportunity to fill the refuge island is much greater than the opportunity to empty it.

For pedestrians leaving the town centre stage 2 runs and is followed immediately by four stages to clear the refuge, so they have a relatively continuous progression east to west across Castlegate. By contrast, pedestrians heading into the town centre cross the west side of Castlegate on phase I (in four stages) then there is an interval, during which stage 1 runs, with possibly the fastest moving traffic, before phase J runs. So east-bound pedestrians have a lot of opportunity to fill the refuge but then a delay before they can leave it. That is, this crossing is favourable to pedestrian heading away from the town centre but does not work so well for pedestrian heading into the town centre.

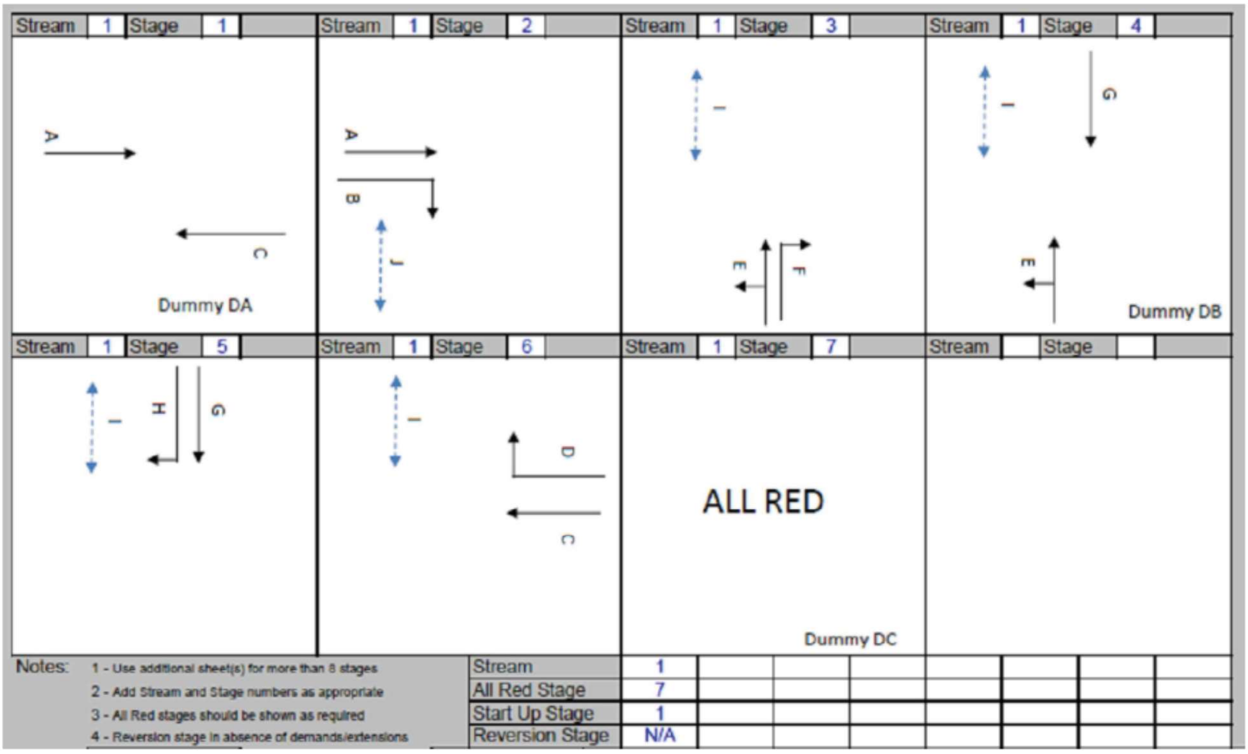

Figure 8 Site Stage Diagram.

A result of this sequencing is that, at the human level the perception of delay may be worse for pedestrians waiting on the island heading into town. Further their perception of the risk from exposure to traffic may be lower as the distance to the refuge island is shorter, so non-compliance would appear to offer less risk.

Figure 4 above shows the location of Greenhead College. A highly successful sixth-form college with ~2700 students on the roll attracting many students from outside of the town. Many of the students will walk to and from the bus and train stations. The college's working day runs from 08:45 to 15:55 and this appears to apply to most students, so may contribute to a 'peaky' pedestrian flow. Figure 1 and Figure 2 show instances of this student traffic. (College dates: Half Term 26th May – 30th May, Summer term final teaching day 4th July.)

Guard railing reduces the routes for pedestrians to by-pass the refuge, rightly channelling pedestrians to the crossing but intensifying the crowding effects that it causes, and to some extent may also increase the sense of crowding, which could provoke non-compliance.

This discussion has not considered the effects of counter-propagating pedestrian flows. Pedestrians leaving the town centre can reach the refuge and move to the opposite side in preparation to cross the N bound A62 only to be faced with a very large number of pedestrians using that crossing to head into town, so this crossing may be the scene of high levels of pedestrian friction.

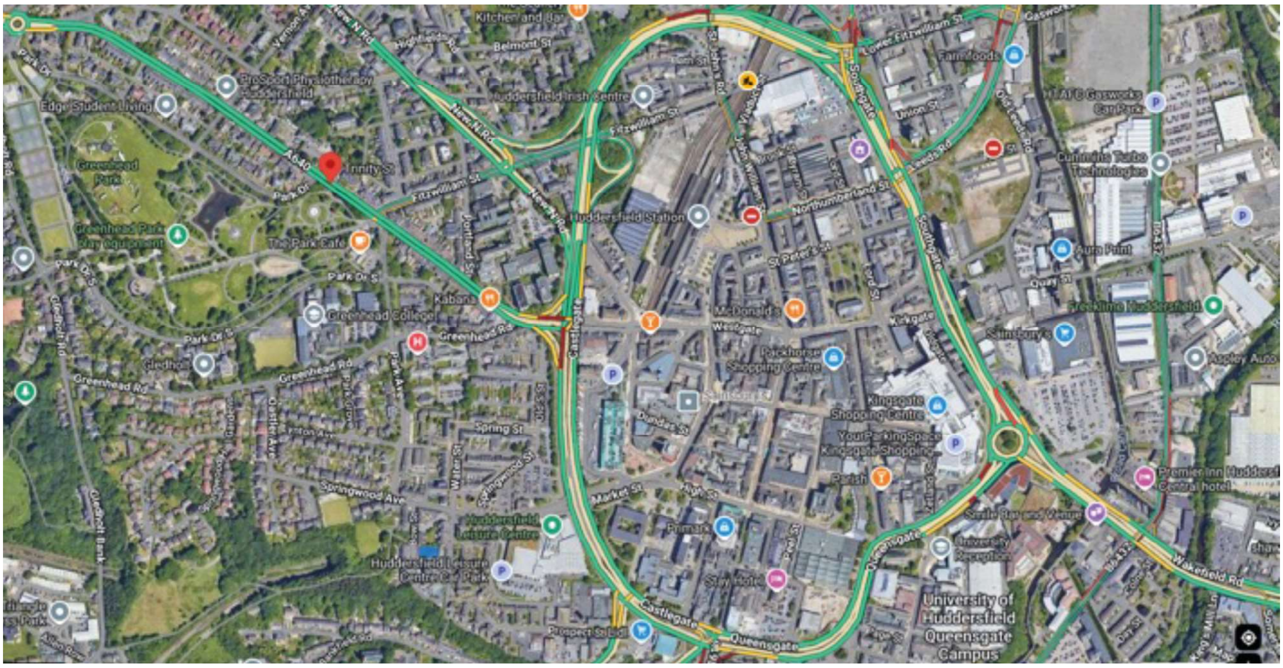

Figure 9 Snapshot of ring road traffic 09:45, Friday 18th July.

Figure 9 shows typical traffic flows on the right road late in the a.m. peak.

The methodology

The approach taken at this site follows the established practice of defining the nature of the problem and its symptoms, then setting out equipment that can provide data to measure the symptoms and related data and either substantiate or disprove the original hypothesis. Once there is clarity about the problem and its cause(s) then appropriate interventions may be applied and further data gathered to assess their impact.

As has been reported previously[1] [2]the Starling detection equipment can be used as part of such a deployment, initially providing data via a dedicated dashboard to assess many characteristics of vehicle and pedestrian movements, including but not limited to directional flows, counts, densities, Fruin numbers, average and variation in speeds, and interactions of pedestrian and vehicles and more. and subject to findings from this data then apply algorithmic processes to adjust the signal timings to respond to high levels of demand.

Specifically, based on the conversations with Kirklees about the pedestrian activity at this site Starling detection has been installed and connected over mobile data to the Starling Intelligence data processing service. Since mid-May data has been recorded and processed.

[1] https://jctsymposium.co.uk/taking-a-second-look-getting-a-bit-more-from-your-current-crossing-assets-andrew-caleya-chetty-starling-technologies

[2] https://jctsymposium.co.uk/developments-in-pedestrian-metrics-and-their-use-in-the-optimisation-of-signalised-crossings-andrew-caleya-chetty-starling-technologies-ltd

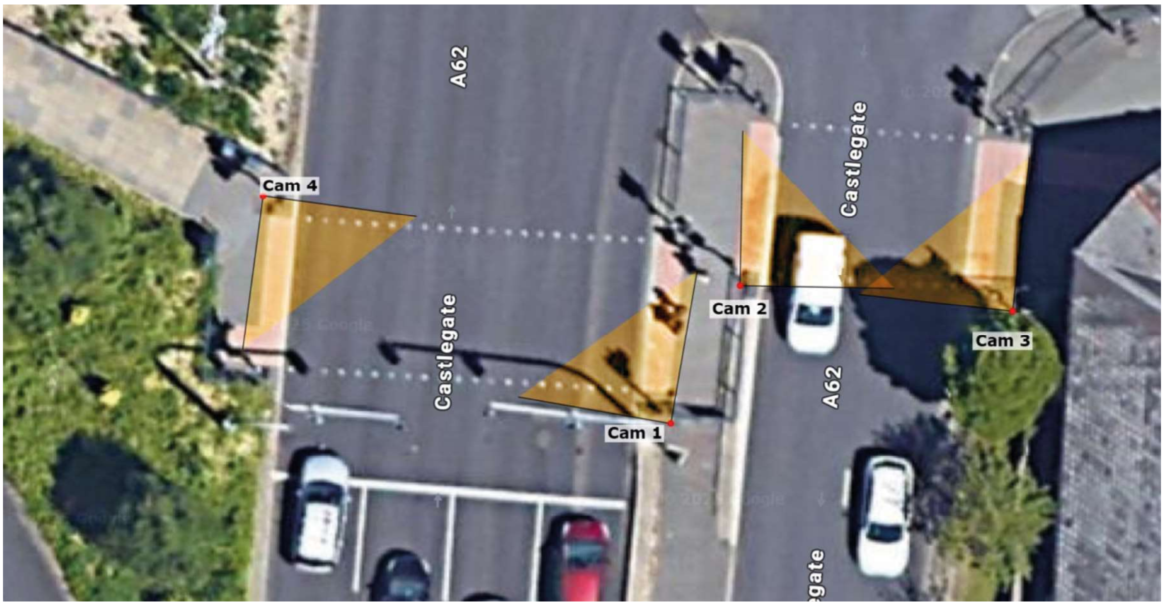

Figure 10 An indicative view of the Starling Detector coverage of the four deployed devices.

Figure 10 shows the location and direction of coverage of the four Starling units that were set out on May 2025. Figure 11 to Figure 13 on the following pages show the installed detectors and the views that they provide of the crossing and refuge island.

In Figure 13, the black boxes indicate zones of interest for the different scene parameters. Object and trajectory information are included in the images along with date and time stamps.

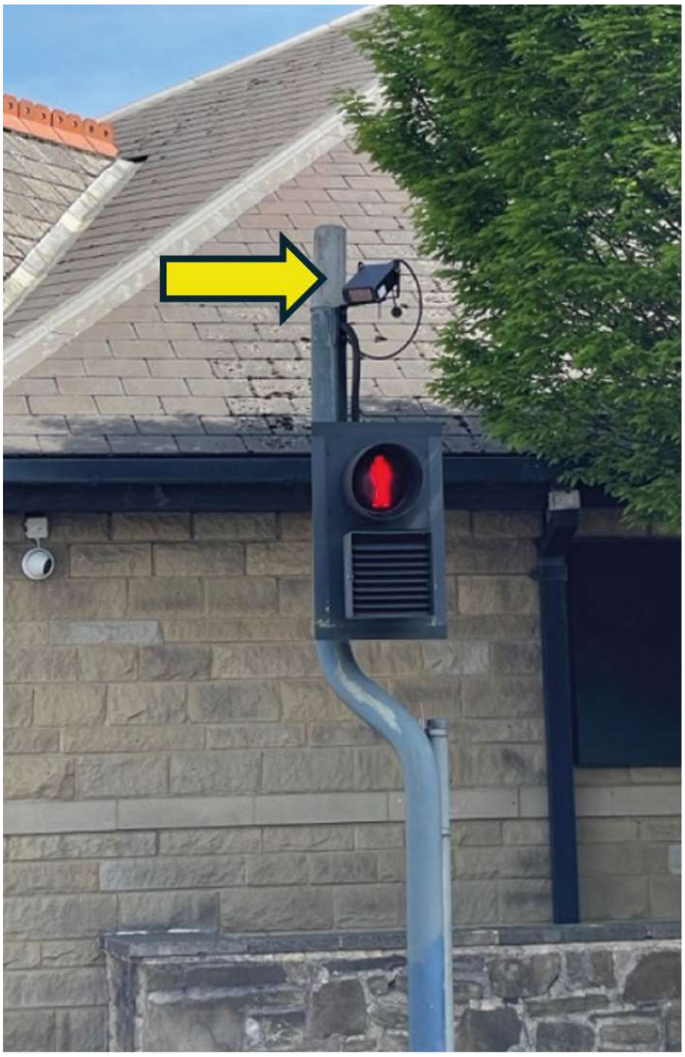

Figure 11 Starling Detector (Cam1) on the East Side of Phase J across the S Bound Ring Road.

Figure 12 Starling Detector (Cam 4) on the West Side of Phase I across the N Bound Ring Road.

Figure 13 Starling Detector Views – Phase I Cam 1 top left, Cam 4 top right and Phase J Cam 2 bottom left Cam 3 bottom right. (Recoloured for easier interpretation).

Data gathering and processing

The gathered data has to be representative of times of day, of traffic load, of weather, and of many other factors, so the monitoring has to cover a reasonable period of time to maximise the chance of the data being truly a fair representation of site conditions.

As the information accumulates Kirklees can make an informed assessments of the magnitude of pedestrian and vehicle non-compliance, of crowding, of pedestrian delay from which they can assess the associated risk and correlate it with other information relating to the site to get substantiated insights.

These form the basis for determining appropriate interventions, whether a review of

- the phasing and stage sequencing,
- the timings,
- the marking, lining and signing,
- the lighting or
- the control strategies,
- the site layout (see appendix A) or of course any combination of these.

Each of these interventions carries with it some level of cost and disruption so a benefit cost analysis is then brought to bear.

Informing the Options: Initial Findings and Possible Interventions

Perhaps pre-emptively it has already been noted that the stage sequence makes the experience of pedestrians heading towards the town centre less favourable than those heading away from it.

While the stage order could be altered to move west bound pedestrians across the west side of the crossing then immediately service the movement across the east side, there is a problem of terminating and re-starting either A or C. Shortening stage 1 or assimilating fully into stages 2 and 6, which would both need to be extended to maintain the cycle time and could help alleviate this problem. This could lead to a stage sequence 6, 3, 4, 5, 2, (1), however re-ordering the staging on neighbouring SCOOT-controlled junctions to align with this could lead to wider costs. Less disruptive interventions would either pass pedestrian density information back to SCOOT to alter splits to give ped bearing stages more time, or drop the site off SCOOT into a local mode of control with timings driven by pedestrian optimisation during periods of high demand.

Examining a small sample of pedestrian flow data captured by Camera 4 (on the west side of the crossing) suggests that there are both east- and west- bound flow issues.

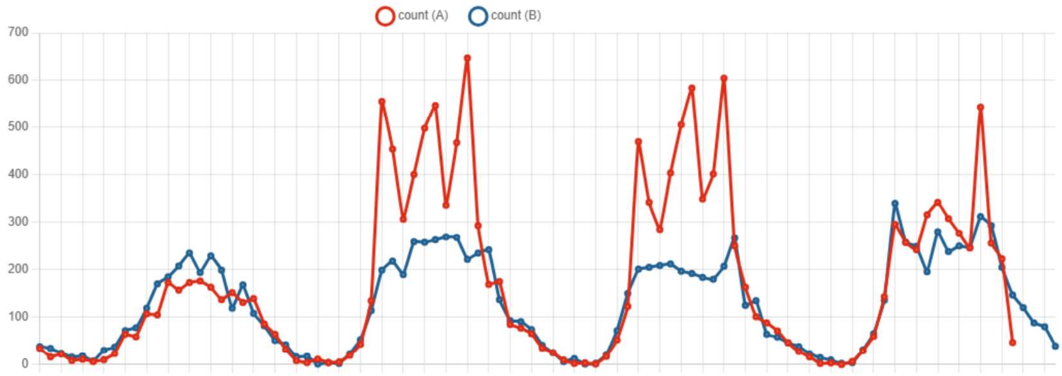

Figure 14 Bidirectional Pedestrian Flows (per hour) for Sun 1/6/25 – Wed 4/6/25 (red) and Sun 13/7/25 – Wed 16/7/25 (blue).

Figure 14 compares the start of a term-time week, to a corresponding period only 6 weeks later. Sundays are included to compare non-school day flows.

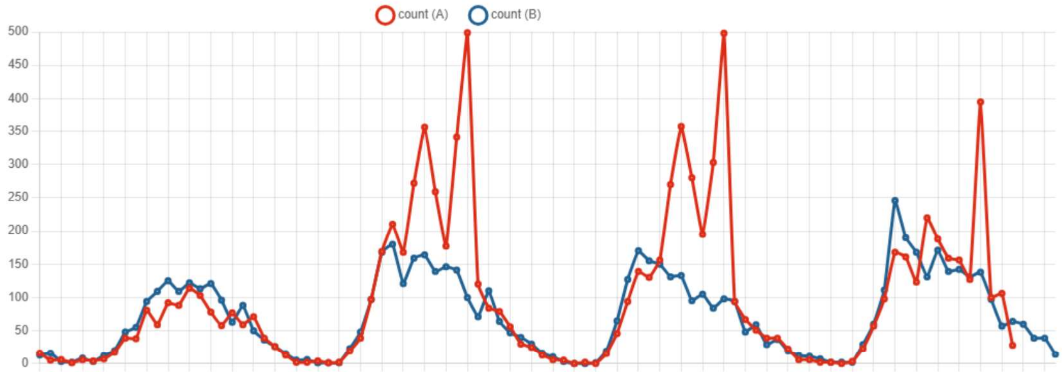

Figure 15 East bound (town-wards) Pedestrian Flows (per hour) for Sun 1/6/25 – Wed 4/6/25 (red) and Sun 13/7/25 – Wed 16/7/25 (blue).

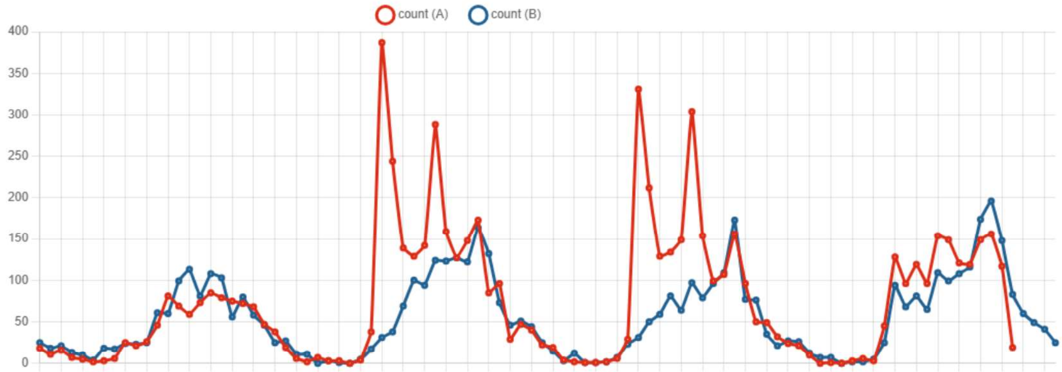

Figure 16 West bound (college-wards) Pedestrian Flows (per hour) for Sun 1/6/25 – Wed 4/6/25 (red) and Sun 13/7/25 – Wed 16/7/25 (blue).

Figure 15 aligns with the experience of Figure 1 and Figure 2 but examination of Figure 16 shows that there is also a very high flow west in the mornings. It is reassuring that the Sunday flows for the two periods are very similar suggesting that the student movements are at least a substantial part of the excess flows seen in June over the flows in July. Also, the underlying flows (the blue trend) slopes oppositely to the red flows, suggesting that there may be a level of counter-propagating pedestrian friction both a.m. and p.m.

There is an implicit assumption that crossers seen by Camera 4 will all end up on the opposite side of the A62, so comparative flow data is not presented for the other cameras, albeit that it would provide an internal accuracy cross check between the cameras. The flows shown don’t necessarily correlate to dangerous behaviour by road users. Assessing the pedestrian to vehicle near misses on the four-lane crossing and the two-lane crossing over the same period offers some insights into pedestrian risk-taking. The following data are from the July period when the college was closed, so can not be attributed to the students. (Other near-miss types have ben removed from the data for clarity.)

Figure 17 shows one bad situation occurring on the Wednesday morning with 38 near misses recorded on the four lane N bound part of the crossing.

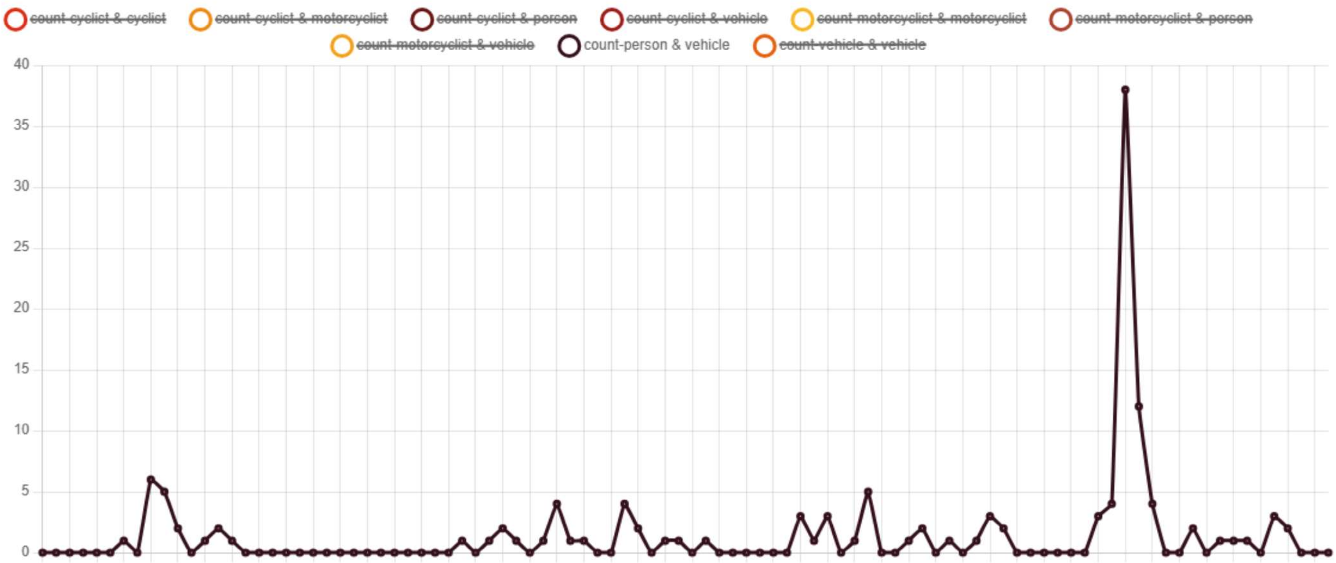

Figure 17 Pedestrian to Vehicle Near Misses Phase I (four lanes) Sun 13/7/25 – Wed 16/7/25.

By contrast, Figure 18 shows a steady pattern of near misses on the two-lane section of the crossing, with the Sunday having the highest single period report but the weekdays having higher daily near misses.

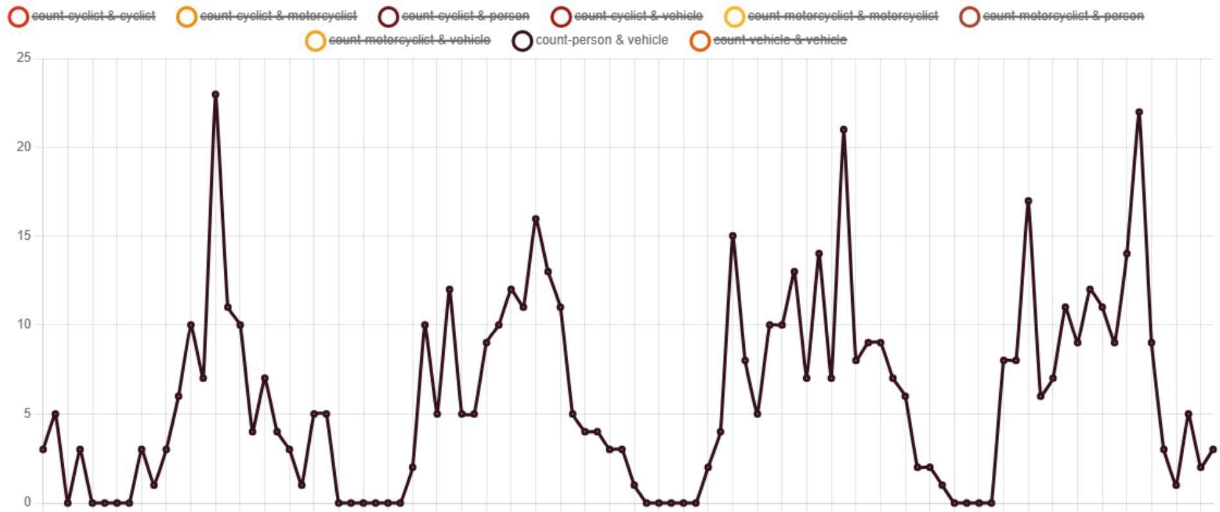

Figure 18 Pedestrian to Vehicle Near Misses Phase J (two lanes) Sun 13/7/25 – Wed 16/7/25.

This would seem to substantiate the idea that pedestrians are more willing to risk non-compliance with signals on shorter crossings.

There is a lot more work to do here to identify the overall level of risk within the stage sequence and within the time of day, but given the bi-directional high flows during term time that are not present during holiday periods re-ordering the stage sequence is unlikely to address all the issues. Which does suggest that another level of intervention may be needed. This aligns with the second group of Kirklees objectives, that a pedestrian driving optimisation may be needed. In a manner similar to alternating between SCOOT and MOVA for different times of day, there may be a case for dropping off SCOOT to better service particularly high levels of pedestrian demand.

Figure 19 suggests that the ring road vehicle flows are relatively stable between term times and college holidays, so dropping off SCOOT may also bring problems, however it would be wrong to infer this only from data from this site.

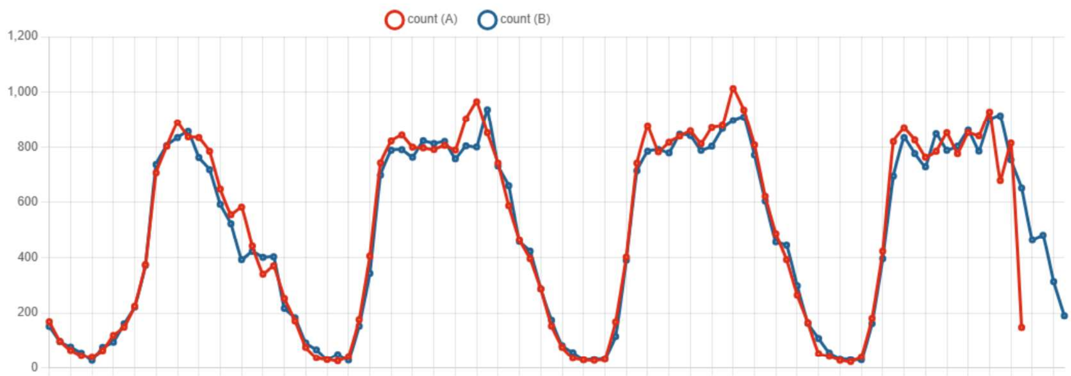

Figure 19 A62 Castlegate N bound flows Sun 1/6/25 – Wed 4/6/25 (Red) and Sun 13/7/25 – Wed 16/7/25 (blue).

At the time of writing a full analysis of the data is yet to be undertaken and the observations made above suggest looking into this data and other sources in more detail, not only to understand the problems better but to better appreciate how interventions might affect the whole site, and the neighbouring sites.

The Starling dashboard has facilities to provide substantially more analysis of the pedestrians but also of the vehicles at the site, however for the purposes of this paper the specific ideas of tidal pedestrian flows and non-compliance have been explored. Pedestrian density in the wait areas could be extracted to further assess the differences between the wait zone densities on the east and west side of Castlegate as compared to the refuge island density, but these data are likely only to further substantiate the emergent conclusions about pedestrian behaviour, and the reasons for it.

Conclusions

The preliminary data presented above exposes some insights into the behaviours of pedestrians on this staggered crossing.

- The pedestrian behaviour is strongly tidal
- The asymmetry of the timings leads to particularly high levels of refuge island congestion during the p.m. pedestrian flows, which are strongly correlated to the local college, being higher during term times
- Pedestrian non-compliance is higher during p.m. flows
- Pedestrian non-compliance is higher on the shorter duration phase of the staggered crossing which is also the two lane section
- There may be a lower perception of risk on this shorter crossing

These insights warrant further assessment over longer periods to understand, for example, the effects of weather. Specifically; pedestrian non-compliance may be worse in wet weather, which may also have lower ambient light and longer stopping distances, so have a higher level of associated risk.

There is also a case for taking a wider look at the network around Huddersfield. Currently there is no comparative data for neighbouring sites, which might help baseline typical pedestrian flows. Extending this idea further knowing the extent to which a crossing departs from typical behaviour may provide a metric for business cases for intervention.

Looking at pragmatic interventions, any intervention that does not entail civil engineering works warrants assessment. The second phase of the Kirklees study, which would involve dropping the site off SCOOT and using demand dependant local Starling optimisation of the pedestrian crossings could significantly alleviate the problems reported here.

Appendix

Appendix B – proposed revised site layout with enhanced pedestrian and cycle facilities

Figure 20 shows a proposal for changes to the site. The inclusion of a pedestrian and cycle crossing on the northern arm of the site could significantly balance the pedestrian flows and of course increase the total crossing capacity on Castlegate.

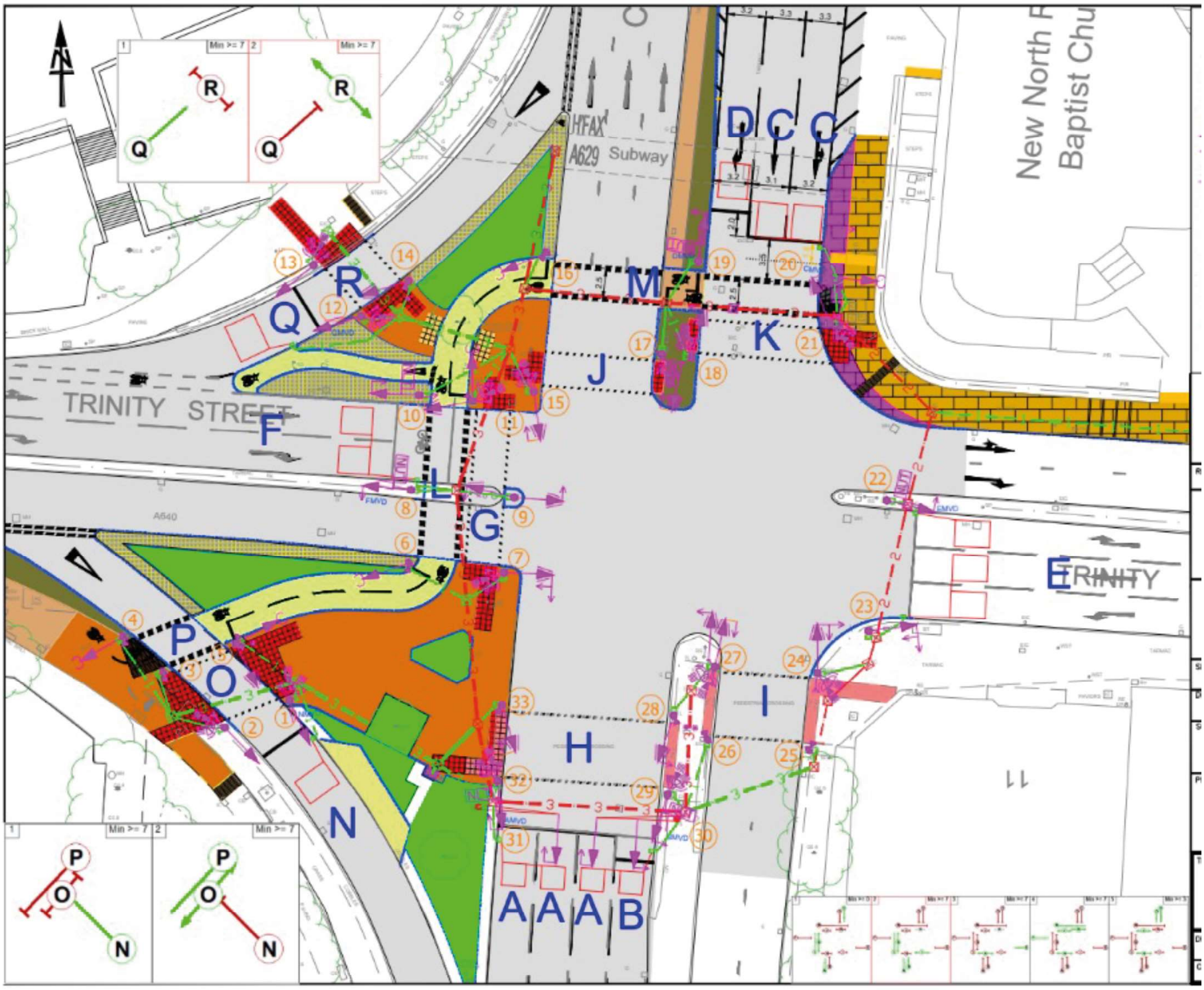

Figure 20 Proposed Site Redesign.

The larger storage capacity for pedestrian on the islands to the west of Castlegate might also alleviate perceptions of crowding and enhance compliance.

Appendix B - a short history of the site

The evolution of the site supports the context section in the body of the paper and may be of interest. It is offered below.

Chronology

- 1973 Huddersfield Inner Ring Road Western section opened.
- 1993 Ferranti Mk 2 controller installed, formal pedestrian facilities added.
- 2005 Castlegate clockwise altered to 4 lanes in place of 3+1 with splitter island for the right turn. Mast arms introduced to make signals on four lanes more conspicuous.

Formal pedestrian provision until 1993 did not exist. A minor concession in the 1980's was the cutting of small apertures in the traffic signal hoods so intending pedestrians could see when the signals controlling the traffic were red or green, allowing a decision to cross or wait.

As the change in focus of travel has been redefined, pedestrians now occupy the top spot.

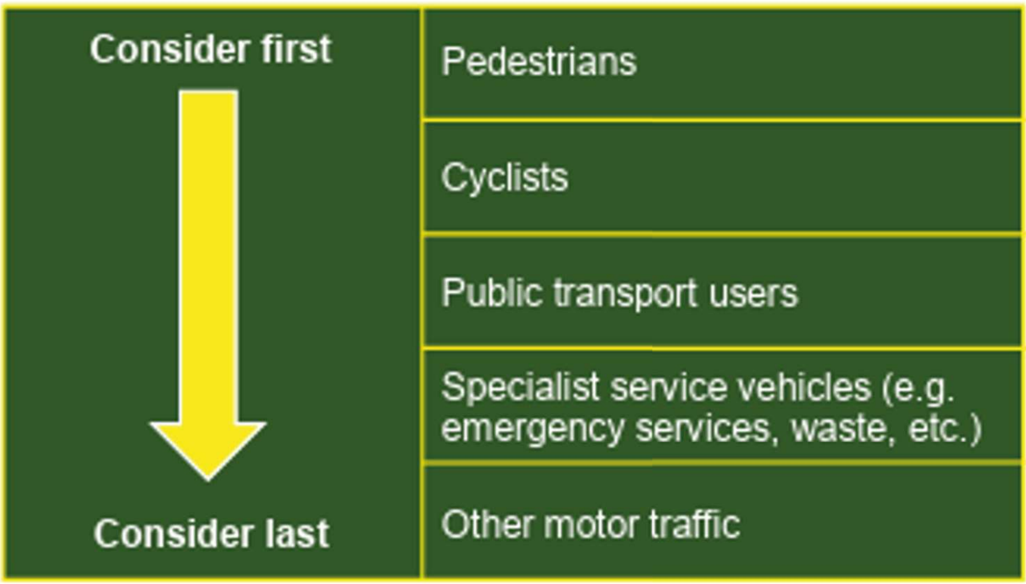

Figure 1-1 Hierarchy of Provision.

STARLING
TECHNOLOGIES

Email: support@starlingtech.co.uk
Telephone: +44 20 3286 6403