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Memo

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Date:	05 January 2009 (a)	Direct tel no:	01452 583490

A4173/A46 PITCHCOMBE JUNCTION
Installation of Traffic Signals – Initial Comments

Glenn,

I have spent some time modelling this junction in LINSIG2 models and looking at various possible layouts should the traffic signal option be pursued. The following are my initial observations and comments.

Accidents
It is assumed that the reason for proposing traffic signals at this junction is due to the accident record at the site. The following table is a summary of the number of accidents and severity at this junction in the last 5years. It should be noted that the A46 was closed throughout 2007 and that not all 'damage only' accidents are reported (However, I have included those available as they give an indication of the type of problems encountered at the junction).

YEAR	SEVERITY				TOTAL
	Damage	Slight	Serious	Fatal	
2003		1			**1**
2004		4			**4**
2005	1	3	1		**5**
2006		1			**1**
2007	**Road closed**				
2008	1	2			**3**
TOTAL	**2**	**11**	**1**	**0**	**14**

Of the 14no accidents recorded:
2no (14%) were due to loss of control
2no (14%) were caused by vehicles 'U' turning
4no (29%) were shunts
6no (43%) were due to vehicles pulling out into the path of oncoming traffic

Only one of the accidents occurred during peak traffic periods (08:27 on 17 Sept 2004) and was the result of the driver's foot slipping on the brake, causing the vehicle to move into the path of an on-coming vehicle.

The accident pattern seen could indicate that people take more care during busy periods as they expect any turning movements to be opposed, or perhaps due to the increased volume, traffic speeds are slower and so drivers have more time to react.

Traffic Flows
All right turn movements must be catered for even though very few vehicles turn right from Cheltenham to Pitchcombe or from Cheltenham to Gloucester during the peak periods. The private residences in the junction may have to 'U' turn, depending on their destination. The left turn from Gloucester to Cheltenham is very tight and records show that medium goods vehicles occasionally make this manoeuvre (see attached sketch showing flows).

Pedestrian Flows
No detailed pedestrian crossing information has been gathered. However, only limited pedestrian activity has been observed during numerous site observations. Although there are bus stops in close proximity to the junction on all arms, it is understood that the layby on the Gloucester arm is no longer used. There is a post box in the service road on the Stroud arm of the junction. It is highly probable that any controlled pedestrian facilities installed here will rarely, if ever, be used, with pedestrians preferring to use the traffic islands during intergreens, as this is likely to be quicker than waiting for a green man signal. It is recommended that pedestrian facilities are not included, unless a need is positively identified.

Cycle Facilities
The existing carriageway is not wide enough to allow cycle lanes to be installed. As this is a high speed road, the cycle lanes should be at least 1.5m wide. Advance cycle stoplines should only be installed if adequate lead in lanes can be provided. This will require carriageway widening which will be costly as it will require relocation of street lighting columns and possible diversion of statutory undertakers apparatus. Very short, 'stub' lead in lanes could be provided as a compromise, but these tend to have limited benefit as cyclists are unable to safely pass queued vehicles until they are close to the traffic lights without danger of hitting wing mirrors etc. The Stakeholder manager in conjunction with local councillors should make a decision as to whether the limited facilities that are feasible would be of enough benefit to be worth including in the design.

Traffic Signal Layout
The safest method of control is to allow each arm of the junction to receive green time in turn, so that all turning movements can be carried out without conflict. However, as there are few turning movements at the junction, it is highly likely that this strategy will not be popular with the public, and the junction will be criticised as inefficient. There is a danger of driver frustration and anti-social driving behaviour, such as red light running, tail-gating etc and although the junction will reduce the number of right turning accidents, there is a possibility that the number of shunts will increase.

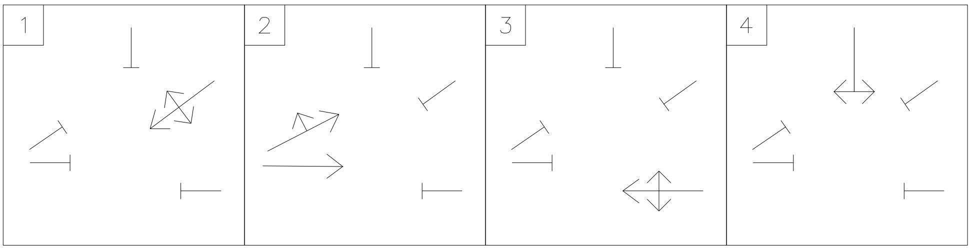
The current speed limit on all arms of this junction is 50mph. TAL2/03 recommends that vehicles should not be allowed to gap accept across traffic where the 85%ile speeds are 45mph or more. It is also not good practise to allow vehicles to gap accept where there are multiple lanes to be crossed. These recommendations should be followed due to the existing number of right turn accidents at the site. Therefore, either the 85%ile speed must be reduced to allow gap accepting right turns or it must be possible to separately signal right turn movements if ahead movements from separate arms are to move at the same time. The Stroud arm is already a two lane approach, but Gloucester arm and Cheltenham arm are both single lane. Existing verge and footway would need to become carriageway to allow additional lanes to be installed on both of these arms, even if the bus bay were incorporated on the Gloucester arm. This would be costly due to road lighting and possible statutory undertakers equipment diversions, and first indications are that this would not give a good alignment through the junction for the ahead movements from the Cheltenham arm and Stroud arm. Traffic calming would be needed together with a speed limit reduction if the 85%ile speeds are to be lowered for gap acceptance to be feasible. The measures would need to be agreed and proven satisfactory prior to the junction signalisation works.

The issues could be overcome by banning the right turns and U turns. However, a suitable alternative route would need to be identified and signed that would be capable of allowing all types of vehicle access without causing an excessive diversion for drivers, and in particular, local people. 'Wragg Castle Lane' joins A38 Cheltenham to A4173 Gloucester routes and would allow access to Pitchcombe via a turning from A4173 before the junction. However, as a 'lane' it is unlikely that the route will be suitable for some vehicles. Wragg Castle Lane is located approx 1000m east of the junction on the A38 Cheltenham arm.

LINSIG Models

The junction was modelled using the worst case scenario in all instances; that is, demands for all approaches including the lightly trafficked Pitchcombe arm each cycle. However, to allow a comparison, the results have also been shown for the scenario when Pitchcombe approach does not run in any cycle and all arms have their own stage (see 1 below) A pedestrian stage has not been modelled as it is considered that, should a controlled facility be installed, any pedestrian demand would be rare. Where possible, the cycle times have been adjusted to show 10% practical reserve capacity on day of opening as this will ensure that the junction will be able to cope with some future growth in traffic volumes.

1. **All arms run independently of one another in their own stage:**



Summary of Linsig results if Pitchcombe appears each cycle and there are no pedestrians.

APPROACH NAME	AM PEAK			PM PEAK		
	Green time (sec)	Degree Sat (%)	Mean max queue (PCU)	Green time (sec)	Degree Sat (%)	Mean max queue (PCU)
From Gloucester	23	87.9%	12.8	22	81.3%	10.4
From Cheltenham	31	87.1%	15.6	34	80.9%	14.4
From Stroud (ahead, left)	31	69.6%	11.1	29	64.7%	9.6
From Stroud (right)	31	85.2%	15.5	29	81.1%	13.4
From Pitchcombe	7	9.2%	0.4	7	6.7%	0.3
	Cycle time (sec)		120s	Cycle time (sec)		120s
	Practical Reserve Capacity		2.3%	Practical Reserve Capacity		10.7%

In reality, the Pitchcombe arm is unlikely to be regularly called as the traffic flow is so light. The following is a summary of the Linsig results when there is no demand for Pitchcombe, or for pedestrians. I have only shown AM peak results as Linsig shows this as the period with most delays to traffic:

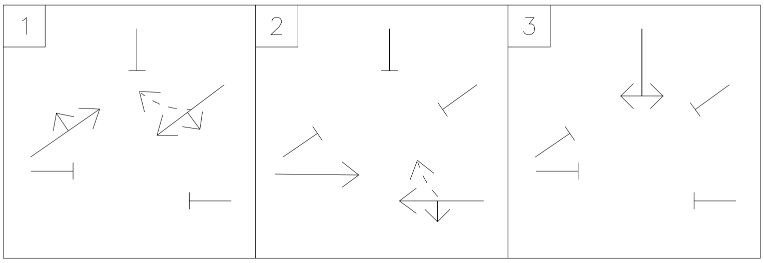
Summary of Linsig results if Pitchcombe does not appear.

APPROACH NAME	AM PEAK			PM PEAK		
	Green time (sec)	Degree Sat (%)	Mean max queue (PCU)	Green time (sec)	Degree Sat (%)	Mean max queue (PCU)
From Gloucester	17	81.8%	8.7	Not modelled		
From Cheltenham	23	81.1%	10.6			
From Stroud (ahead, left)	23	64.6%	7.6			
From Stroud (right)	23	79.5%	10.6			
From Pitchcombe	0	0	0			
	Cycle time (sec)		84s	Cycle time (sec)		

	Practical Reserve Capacity	10.0%	Practical Reserve Capacity	

Predictably, the junction performs much better when the Pitchcombe arm does not appear in the cycle. In actuality, the junction will perform somewhere between both sets of results, allowing for the random appearance of vehicles at Pitchcombe. However, should Pitchcombe have demands on consecutive cycles, the waiting time for other traffic becomes greatly increased as more green time is needed on all approaches to clear the longer queues developing as well as allowing for the Pitchcombe stage to appear in the sequence. Although some practical reserve capacity is achieveable which will allow for some growth in traffic volumes, long cycle times of 120s will occur when there are demands on all approaches and drivers could become frustrated at the seemingly cumbersome way that the junction operates.

2. Gap accepting right turns and U turns



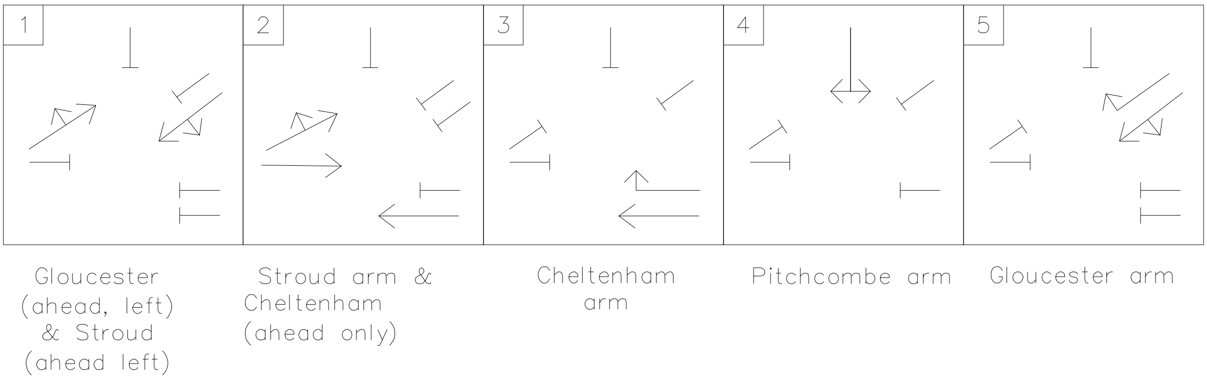
Gloucester arm & Stroud arm (ahead & left) | Cheltenham arm & Stroud arm(right) | Pitchcombe arm

Summary of Linsig results if Pitchcombe appears each cycle and there are no pedestrians.

APPROACH NAME	AM PEAK			PM PEAK		
	Green time (sec)	Degree Sat (%)	Mean max queue (PCU)	Green time (sec)	Degree Sat (%)	Mean max queue (PCU)
From Gloucester	22	63.0%	6.4	16	63.3%	5.0
From Cheltenham	27	60.8%	7.6	20	69.0%	7.3
From Stroud (ahead, left)	22	80.4%	8.6	16	79.5%	6.7
From Stroud (right)	27	81.0%	10.0	20	80.7%	8.0
From Pitchcombe	7	6.7%	0.2	7	4.1%	0.1
	Cycle time (sec)		78s	Cycle time (sec)		65s
	Practical Reserve Capacity		11.1%	Practical Reserve Capacity		11.5%

The junction works well with plenty of reserve capacity for future growth in traffic volumes on a relatively short cycle time in both peak periods. The mean/max queue for the right turn lane on the Stroud arm at 10pcu's in the AM peak and 8pcu's in the PM peak should not block ahead traffic as the existing lane can accommodate approx 15pcu's. Similarly, the Stroud ahead and left lane traffic queue at 8.6pcu's in the AM peak and 6.7pcu's in the PM peak would not prevent vehicles wishing to turn right from entering their lane. The actual numbers of right turners and U turners on the Cheltenham and Gloucester arms are so low that it is unlikely that more than one vehicle will be waiting to make these moves at any given time and initial sketching of possible junction layouts indicate that sufficient waiting areas can be provided in the junction design to allow other traffic to pass those waiting to complete their manoeuvres in gaps. However, it must be possible to reduce 85%ile speeds to less than 45mph for this option to be viable.

3. Fully signalised right turns and U turns



Summary of Linsig results if Pitchcombe appears each cycle and there are no pedestrians.

APPROACH NAME	AM PEAK			PM PEAK		
	Green time (sec)	Degree Sat (%)	Mean max queue (PCU)	Green time (sec)	Degree Sat (%)	Mean max queue (PCU)
From Glos (ahead, left)	22	81.5%	9.4	17	81.2%	7.7
From Glos (right)	7	0.8%	0.0	7	0.7%	0.0
From Chelt (ahead)	45	57.5%	7.9	38	59.1%	7.2
From Chelt (right)	7	2.5%	0.1	7	8.9%	0.3
From Stroud (ahead, left)	46	44.7%	6.0	34	46.0%	5.2
From Stroud (right)	31	80.6%	11.7	24	80.8%	9.7
From Pitchcombe	7	8.7%	0.3	7	5.5%	0.2
	Cycle time (sec)		95s	Cycle time (sec)		83s
	Practical Reserve Capacity		10.4%	Practical Reserve Capacity		10.9%

The junction performs well, even when each right turn stage and the Pitchcombe arm is called each cycle, which is unlikely to happen in actuality. Should the right turn stages not be called, the junction will operate with similar results to those shown with gap acceptance (see 2). The average cycle times are relatively low and there is spare capacity to cope with future growth in traffic volumes. However, to achieve the right turn lanes, there will need to be considerable carriageway widening, diversion of statutory undertakers apparatus and street lighting. The initial findings also show that the alignment for drivers through the junction may not be very good and improvement may be difficult due to the topography of the area.

Conclusion

It should be noted that the installation of traffic signals are unlikely to reduce the number of shunt type accidents at a junction as there is always the possibility of the vehicle in front stopping unexpectedly. In fact, the introduction of traffic signals can increase the number of this type of incident occurring as drivers anticipate others moving or not at start and end of green time. At this particular junction, the forward visibility on all approaches is not good due to the horizontal and vertical alignment and unless awareness of the new signals can be raised, shunt type accidents and (possibly) loss of control incidents may increase if traffic signals are installed. Driver frustration at delays can also be a contributory factor to this type of accident. In the last 5 years, 29% of accidents were shunt types and 14% were due to loss of control.

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To minimise the number of collisions at this junction, it must be possible for any turning vehicles to be able to complete their manoeuvre without conflict. This can only be achieved if each approach has its own discrete stage in the junction (Linsig model 1) or if fully signalised right turn phases are included in the

design (Linsig model 3). Each of these options has advantages and disadvantages. There is a financial advantage if each approach runs in its own stage as the traffic signals can be installed without any additional lanes. Therefore, carriageway widening, stats diversions and road lighting alterations may not be required. However, as turning movements are few, it is likely that this method of control will be criticised by the public, who may feel that they are subjected to unnecessary delays and increased journey times.
The provision of fully signalised right turn lanes has the advantage of allowing various approaches to run safely at the same time as one another, so delays are minimised and the public are likely to more readily accept the change as the junction will be seen as efficient. However, the cost of carriageway widening, stat diversions and alterations to road lighting will be costly, and the possible sub standard alignment through the junction may result in criticism or, worse, accidents, albeit of a different nature to those seen at the moment.

A compromise would be to allow right turners to gap accept (Linsig model 2), although it must be acknowledged that there is still a danger of right turn collisions if drivers misjudge opposing traffic speeds. It would appear that this method of control could be achieved within the existing carriageway boundary. The disadvantages are that this option does not fully resolve the right turn collision issues and the 85%ile speeds must be reduced to below 45mph for this option to be considered acceptable. The option will rely heavily on roadmarkings to allow vehicles to position themselves in such a way that other traffic can pass those waiting to turn right, as islands will not be possible at the right turn bay locations because they will obstruct other traffic movements. Roadmarkings are useful only if they are easily understood by drivers and if they are maintained and not allowed to become worn out. Maintenance of any roadmarkings will be difficult here, due to the complex arrangement of the junction, and the roadmarkings are likely to become worn quite quickly as opposing traffic will need to traverse the right turn bays.

From the data given on the police reports, all of the 43% of collision accidents occurring at this junction in the last 5years involved vehicles turning out of the Gloucester arm of this junction. The installation of traffic signals will help to reduce this statistic, although care must be taken that the existing accident pattern is not simply changed for another i.e. more shunts, and all right turn movements can be safely carried out, especially as forward visibility is not very good here.

Recommendations
The Gloucester arm of the junction should also be realigned to allow large vehicles to view on coming traffic without having to position themselves any differently from other road users, as this can otherwise cause confusion with car drivers expecting HGV’s to be turning left rather than right. Once these measures have been implemented, traffic speeds and accidents should be monitored. If speeds can be reduced but the accident situation persists, it is then recommended that traffic signals be installed with gap accepting right turns as outlined in Linsig model 2. If speeds remain high and the accident situation unresolved, traffic signals with separately signalled right turns should be considered. This option will be costly as carriageway widening will be required, but it is felt that this option is preferable to that where each arm runs in its own discrete stage as driver frustration could result in as many accidents but of a differing nature to those currently seen i.e. shunts.

Although traffic volumes are much lower during the off peak periods, it is not recommended that any traffic signals installed be part time as most accidents currently occur during this time.

With regards