

N28 / Rochestown Road / Mount Oval / Woodbrook Junction

Project note:	Douglas Traffic Study
Technical note:	N28 / Rochestown Road / Mount Oval / Woodbrook Junction

Version	Date	By	Reviewed by	Authorised (TN only)	Notes
1.0	07/02/2011	DB	KB	KB	ISSUED TO CLIENT
2.0	21/06/2011	CF	DB	KB	UPDATED WITH PM PEAK ASSESSMENT

WSP was requested by Cork County Council to carry out a morning and evening peak hour assessment of the N28 / Rochestown Road / Mount Oval / Woodbrook junction. In particular, the assessment focuses on the extent of morning peak hour congestion and queuing on the Rochestown Road and the development of recommended options for improving traffic capacity. This assessment is based on traffic count and queue length data collated in December 2010, on-site observations and measurement of existing capacity from analysis of video camera surveys.

The two junctions are located to the east and west of the intersection of the Rochestown Road and the N28 national secondary road and comprise the following layouts:

- A 6 arm roundabout to the east with approaches from the N28 southbound off-slip, the Rochestown Road, Mount Oval and Woodbrook residential areas and private accesses. This junction is known locally as St. Patrick's roundabout
- A 3 arm priority junction with a left slip from Rochestown Road to the northbound N28 on-slip

The layout of the two junctions is shown in Figure 1.



Figure 1: Existing Layout of the junctions at the Rochestown Road and N28

EXISTING SCENARIO

AM PEAK PERIOD

In the morning peak period, significant queuing has been observed on the Rochestown Road (east) arm to the St. Patrick's roundabout. Queue length surveys undertaken in January 2011 showed a max queue length on the Rochestown Road of approximately 780m back from the roundabout. It has been observed anecdotally by the public, based on comments submitted to Cork County Council, as extending beyond 1km in length on occasions.

There are no significant delays or queuing recorded on all other arms of the two junctions. On occasions, queuing of right turning traffic to the N28 northbound on-slip extends back under the bridge but not into St. Patrick's roundabout.

The traffic queues on the Rochestown Road from St. Patrick's roundabout regularly extend back past the junction with Clarke's Hill which is located approximately 175m east of the roundabout. Vehicles turning left from Clarke's Hill on to the Rochestown Road proceeding to Douglas and the N28 are facilitated by the courtesy of drivers on Rochestown Road. The number of vehicles turning from Clarke's Hill is much less than the demand on the Rochestown Road.

However the operation of the junction during morning peak hour congestion effectively results in equal priority given to Clarke's Hill traffic as Rochestown Road traffic, i.e. for one vehicle proceeding on Rochestown Road, one vehicle turns left from Clarke's Hill. This results in frustration for drivers on the Rochestown Road, from Passage West, as it adds to the significant delay on the approach to St. Patrick's roundabout.

PM PEAK PERIOD

During the evening peak period a build-up of queuing was recorded on both lanes of the N28 southbound off-slip with maximum queues of 24 vehicles recorded on the kerbside lane. There is a stacking capacity for approximately 35 vehicles per lane from the yield line of the roundabout to the start of the nosing at the diverge from the N28. Therefore there was no impact on the N28 mainline traffic. This queuing dissipated shortly after and no significant queues were present at the end of the peak period.

Traffic bound for Passage West on the Rochestown Road exit was observed to be queue back beyond the roundabout and on occasions under the N28 over-bridge contributing to the queuing on the N28 southbound off-slip. It has been observed anecdotally that the formation of queues extending back through this exit lane may be caused by right turners at the Clarke's Hill junction blocking the straight ahead traffic as they wait for an acceptable gap in westbound traffic on the Rochestown Road.

Queues recorded on the Rochestown Road east approach arm fluctuated between 2 to 20 vehicles with these queues dissipating quickly. On occasions, queuing of right turning traffic to the N28 northbound on-slip extends back under the bridge but not into St. Patrick's roundabout.

There were no significant delays or queuing recorded on all other arms of the two junctions.

BASE YEAR AM & PM PEAK ASSESSMENT

In order to assess the capacity of the existing St. Patrick's junction, an Arcady analysis was undertaken using traffic count data, queue length surveys, saturation flow measurements and junction geometry.

As the Rochestown Road (east) approach to the roundabout is currently operating at capacity with significant queuing during the morning peak period, the traffic counts were increased so that the modelled queues in Arcady matched the observed queuing which has been observed by various

parties to prevail every weekday at the junction. This provided a full demand flow for this arm which has been used for all assessments.

The results of the base year AM peak Arcady assessment are shown in Table 1.

Table 1: 2010 AM Peak Arcady Assessment of St. Patrick's roundabout

Approach	AM		
	Max. RFC	Max. Queue (veh)	Av. Delay (s)
N28 Southbound off ramp	0.335	0.5	2.6
Woodbrook	0.005	0.0	3.9
Rochestown Road East	1.241	134.4	270.3
Mount Oval	0.324	0.5	22.2
Access Road	0.005	0.0	16.5
Rochestown Road West	0.192	0.2	3.0

Based on site observations and the Arcady assessment of St. Patrick's roundabout, it is clear that additional capacity is required on the Rochestown Road (east) approach. At present the average capacity of this approach over the peak hour is approximately 17 vehicles per minute. This results in significant queuing on the Rochestown Road (east) approach as observed and output by the base year model.

During the PM peak period, St Patrick's roundabout is operating within capacity with some queuing on the N28 Southbound off-slip and the Rochestown Road eastern arm approach. The results of the base year PM peak Arcady assessment are shown in Table 2.

Table 2: 2010 PM Peak Arcady Assessment of St. Patrick's roundabout

Approach	PM		
	Max. RFC	Max. Queue (veh)	Av. Delay (s)
N28 Southbound off ramp	0.783	3.5	6.4
Woodbrook	0.021	0.0	8.1
Rochestown Road East	0.756	3.0	11.5
Mount Oval	0.044	0.0	11.6
Access Road	0.008	0.0	11.2
Rochestown Road West	0.363	0.6	3.6

A review of the results in Table 2 shows that the maximum RFCs are on the N28 off-slip and the Rochestown Road East arms. The results of the Arcady assessment indicate that no significant queues are experienced during the PM peak period. This is in contrast to the recorded queues from the queue surveys as described above. However, given that the queue length surveys were only undertaken on one day, these should be treated with caution.

During peak periods, when RFC values are greater than 0.7, there can be a large daily variation in queue lengths. This is so even if the average flow for each time segment does not vary daily. In addition, the queues forming back from the Rochestown east exit arm due to right turners at Clarkes Hill are also contributing to the N28 off slip queues. This will further impact on the queues on the

N28 off-slip as recorded during the queue length surveys. However this cannot be modelled in the Arcady assessment of St. Patrick's roundabout as a stand-alone junction.

POTENTIAL IMPROVEMENTS TO ST. PATRICK'S ROUNDABOUT

In order to improve the capacity of the roundabout in the morning peak period, the impact of an additional approach lane from the Rochestown Road (east) arm of the roundabout with two through lanes on the circulatory carriageway in the westbound direction towards Douglas was assessed.

A capacity assessment was undertaken in Arcady to determine the impact of this proposal on the operation of St. Patrick's roundabout. The results of this assessment are shown in Table 3 and Table 4.

Table 3: 2010 AM Peak Arcady Assessment of improved St. Patrick's roundabout

Approach	AM		
	Max. RFC	Max. Queue (veh)	Av. Delay (s/veh)
N28 Southbound off ramp	0.335	0.5	2.7
Woodbrook	0.005	0.0	3.9
Rochestown Road East	0.879	6.7	14.0
Mount Oval	0.619	1.4	46.7
Access Road	0.009	0.0	23.3
Rochestown Road West	0.193	0.2	3.0

The results of the Arcady assessment indicate that the provision of an additional approach lane of approximately 50m in length on the Rochestown Road (east) approach to the junction will increase the capacity to approximately 24 vehicles per minute on this approach and give a ratio of flow to capacity (RFC) of 0.879. The analysis also indicates that there will be a significant reduction in queues.

The results of the Arcady assessment indicates that the junction will still operate marginally over the theoretical operational RFC of 0.85. This means that variations in daily flow could result in significant queuing on this arm even with the additional approach. In general, queuing will develop at approaches with RFC values in excess of 0.85. This modelled queuing will grow exponentially for RFC values in excess of 1.00.

In addition the results of the AM assessment should be treated with caution as the Arcady model does not take into account downstream conditions at the priority junction of the Rochestown Road and the N28 northbound on-slip. The clearing of queues and the release of additional traffic through the roundabout will increase demand on the right turn to the N28 as approximately 70% of westbound traffic on the Rochestown Road turn right to the N28 northbound. This will result in blocking back through St. Patrick's roundabout and would also impact on queuing of vehicles on the N28 off-slip.

Table 4: 2010 PM Peak Arcady Assessment of improved St. Patrick's roundabout

Approach	PM		
	Max. RFC	Max. Queue (veh)	Av. Delay (s/veh)
N28 Southbound off ramp	0.783	3.5	6.4
Woodbrook	0.021	0.0	8.1
Rochestown Road East	0.517	2.1	5.0
Mount Oval	0.044	0.0	11.6
Access Road	0.008	0.0	11.2
Rochestown Road West	0.363	0.6	3.6

The PM assessment summarised in Table 4 also indicates that the provision of the additional approach lane on the Rochestown Road (east) approach will marginally improve the capacity of this arm. However this intervention would have negligible impact on the other approaches to the junction.

The provision of two approach lanes on the Rochestown Road (east) arm and two lanes on the circulatory carriageway would be constrained by the compact nature of the existing roundabout and the small exit radii combined with the location of the bridge parapet. The tight geometry involved will likely diminish the benefits of an additional through lane as the capacity will be reduced by the slow speeds necessary to negotiate the junction.

LINKED TRAFFIC SIGNAL CONTROL

In order to increase the capacity of the junction, particularly in the morning peak hour, an assessment of the signalling of both St Patrick's roundabout and the three arm priority junction with left slip to N28 northbound. The newly installed pedestrian crossing to the immediate east of the junction with Rochestown Rise was also incorporated into the analysis. This assessment was undertaken in order to provide additional capacity on the Rochestown Road (east) approach from Passage West and to:

- a) control queuing under the overbridge back from the right turn to the N28.
- b) provide unimpeded two lane traffic flow though from the Rochestown Road through the St. Patrick's junction.
- c) to provide satisfactory capacity on all arms.

The traffic signal staging was set up so that the traffic signals at the two junctions and pedestrian crossing are run with separate traffic signal controllers which are co-ordinated so that the queuing between all junctions can be managed.

As proposed in the roundabout upgrade option, it is necessary to provide an additional approach lane to the junction from the Rochestown Road (east) arm to accommodate morning peak hour traffic demand. The proposed layout of this junction is shown in Figure 2 overleaf.

The capacity of the linked traffic signals option has been assessed using the LinSig software for traffic signal design. As there are a number of minor arms on the St. Patrick's roundabout with a very low demand, these would be vehicle actuated, on-demand stages. Therefore they would only be called on a few occasions over the entire morning peak hour. For the purposes of a robust assessment, it was assumed that each minor road approach and pedestrian stage would be called

once every four cycles of 60 seconds. Therefore in the LinSig model, a cycle time of 240 seconds was used.

The results of the LinSig assessment are summarised in Table 5 and Table 6.

Table 5: 2010 AM Peak Assessment of linked traffic signals

Phase	Link	AM		
		D.O.S (%)	MMQ (PCU)	Delay (s/PCU)
A	Rochestown Road (east) Left Ahead	56.8	7.4	17.1
A	Rochestown Road (east) Ahead Right	69.8	10.8	19.7
B	Mount Oval	63.5	5.0	158.7
C	Private Access	3.0	0.1	171.7
D	Rochestown Road (eastbound under bridge)	28.7	5.5	19.3
E	N28 southbound off-slip	69.2	10.6	28.8
F	Woodbrook	8.3	0.3	155.4
G	Rochestown Road (westbound under bridge) Ahead	42.5	3.6	2.6
H	Rochestown Road (westbound under bridge) Right	56.5	3.1	4.4
I	Rochestown Road (west) Ahead	70.5	6.4	38.6
J	Rochestown Road (west) Left	28.5	0.9	1.8
P	Rochestown Road (west) westbound	45.8	1.7	2.4
Q	Rochestown Road (west) eastbound	45.6	7.0	3.2
Practical Reserve Capacity		27.6%		

The results of the LinSig assessment during the AM peak period indicate that there will be a significant improvement in queuing and delay on the Rochestown Road (east) arm of the junction. This option provides for a capacity of approximately 30 vehicles per minute on the Rochestown Road (east) approach in the morning peak hour. Therefore the queuing and delay is significantly reduced as capacity exceeds demand.

The proposed staging of the traffic signals has been designed to minimise the blocking back of right turning vehicles from the Rochestown Road to the N28 northbound. The model results show a mean maximum queue of 3.1 vehicles in the AM peak which demonstrates that there will not be a problem with blocking back of traffic queues.

Overall, the model results show that the two junctions have a practical reserve capacity of 27.6% in the AM peak.

Table 6: 2010 PM Peak Assessment of linked traffic signals

Phase	Link	PM		
		D.O.S (%)	MMQ (PCU)	Delay (s/PCU)
A	Rochestown Road (east) Left Ahead	63.3	7.4	24.6
A	Rochestown Road (east) Ahead Right	25.3	2.6	18.2
B	Mount Oval	19.9	0.8	159.0
C	Private Access	3.0	0.1	171.7
D	Rochestown Road (eastbound under bridge)	73.4	9.0	16.8
E	N28 southbound off-slip	89.1	26.8	31.4
F	Woodbrook	8.3	0.3	155.4
G	Rochestown Road (westbound under bridge) Ahead	55.7	2.8	2.6
H	Rochestown Road (westbound under bridge) Right	24.1	3.3	16.3
I	Rochestown Road (west) Ahead	53.6	9.4	16.1
J	Rochestown Road (west) Left	21.4	1.1	1.9
P	Rochestown Road (west) westbound	60.0	1.4	2.8
Q	Rochestown Road (west) eastbound	52.6	9.1	3.6
	Practical Reserve Capacity	1.1%		

During the PM base scenario, the N28 off slip experienced the highest RFC. All arms continue to operate within capacity with the highest queuing occurring on the N28 off slip. However this queuing of 26.8 pcus is over two lanes and is well below the stacking capacity of 35 pcus per lane on this approach.

The queuing of eastbound vehicles on the Rochestown Road between the junctions (i.e. under the bridge) reaches 9.0 pcus which can be accommodated within the stacking space between the junctions. This queuing should be monitored closely in the evening peak following an upgrade to the junction with a view to maximising the capacity of the N28 off-slip.

Overall, the model results show that the two junctions have a practical reserve capacity of 1.1% in the PM peak.

ROCHESTOWN ROAD / CLARKE’S HILL

With the proposed introduction of traffic signals and the provision of additional capacity on the Rochestown Road, the results of the assessment indicate that queue lengths on Rochestown Road will reduce significantly. The modelled queue lengths are in the region of 75m and therefore the queue will not extend back to the Clarke’s Hill junction.

This will remove the existing morning peak congested conditions at this junction and the priority will appropriately switch to the mainline traffic on the Rochestown Road. Therefore, no interventions are required at the Clarke’s Hill junction as the improvements at St. Patrick’s roundabout will mitigate the existing traffic problems here.

There is the option to introduce traffic signals at the junction if vehicles on Clarke's Hill have difficulty finding acceptable gaps to join the Rochestown Road in the improved scenario. This will also overcome existing safety issues at the junction, namely the restricted sight visibility from Clarke's Hill.

In the evening peak there is anecdotal evidence that right turning traffic from the Rochestown Road (eastbound) to Clarke's Hill is blocking through traffic and impacting on the operation of the St. Patrick's roundabout. It is recommended that the situation at this junction be assessed in further detail to provide a clear understanding of the issues in the morning and evening peak.

IMPACT ON THE N28 NATIONAL ROAD

From the junction turning counts undertaken in the morning peak hour, 774 no. vehicles turned right from the Rochestown Road to the N28 northbound slip lane. This flow is restrained somewhat due to the existing capacity issues on the Rochestown Road approach to the St. Patrick's roundabout.

The build-up of queues on the Rochestown Road approach to the St. Patrick's roundabout occurs between 07:30 and 09:00 in the morning. Therefore a portion of the peak hour flow at present comprises vehicles that joined the queue before the peak hour period but were delayed on the approach to the junction.

With the proposed increase in capacity provided by the signals, all traffic arriving at the junction, before the morning peak period commences, will clear through the junction without any residual queuing carrying over into the peak hour. The existing queues on the Rochestown Road will not develop as the capacity provided by the signals is well above the demand in the hour before the peak hour and the peak hour itself.

Given the proposed increase in capacity at the St. Patrick's junction and the associated reduction in queues and delay, it is reasonable to assume that a portion of drivers on this route in the morning peak period will alter their time of departure. For example, someone who leaves for work at 07:45 at present may leave it until 08:05 to make the trip based on the reduction in delay at the junction.

If the two hour period between 07:00 and 09:00 is examined, a total of 1925 vehicles travel through the junction. This is a finite demand flow as all of these vehicles get through the junction in the two hour period with no residual queuing.

For the purposes of providing a conservative estimate of the impact on the N28 National Road in the peak hour, the additional traffic joining the N28 northbound flow in the peak hour is estimated as follows:

- It is assumed that, due to of the improvements in capacity, a change in time of departures occurs where 1925 vehicles now travel through the junction in 1.5 hours as opposed to 2 hours.
- This translates into an equivalent hourly flow of 1283 vehicles (~ 21 veh/min).
- The average split of westbound traffic from the Rochestown Road through the roundabout at the N28 on slip junction is 75% north to the N28 and 25% west towards Douglas Village.
- Therefore 962 vehicles would turn right to the N28 northbound slip road.
- This represents an increase of 188 vehicles (from the existing 774 vehicles) joining the N28 northbound flow in the peak hour period.
- For a cycle time of 60 seconds this equates to an average of approximately 3 vehicles per cycle of the traffic signals.

Therefore, based on the above robust assessment, the proposed junction improvements would not have any significant impact on the N28 mainline northbound flow.



N28 / Rochestown Road / Mount Oval / Woodbrook Junction

In the evening peak, the maximum queues modelled on the N28 off slip are in the region of 22 pcus across the two lanes. The stacking capacity of this arm from the yield line back to the end of the nosing at the diverge is 35 vehicles per lane. Therefore the queuing back from the signals will not impact on the N28 mainline southbound flow.

CONCLUSION & RECOMMENDATION

In order to improve the existing congestion at the N28 / Rochestown Road junctions, it is recommended that linked traffic signals be introduced at the two junctions. This will provide significant additional capacity for westbound vehicles on the Rochestown Road travelling to Douglas and the N28 in the morning peak. The proposed junction improvements will also accommodate evening peak traffic movements with no significant queuing or delay.

The next steps in the design process will be to develop the linked traffic signals junction improvement to preliminary design layouts and undertake a preliminary cost estimate.

WSP 14/04/2010