The Management of Traffic During the Dublin Port Tunnel Construction

by John W. Flanagan

Figure 1. The 'Cut & Cover' Tunnel Excavation.

The Dublin Port Tunnel is one of the largest Civil Engineering projects to be undertaken in Ireland. On its completion benefits will accrue to the commercial, residential and leisure life of Dublin City. However, before construction work could begin a traffic management plan had to be developed to facilitate the construction of the tunnel and to minimise the disruption to people travelling along its route.

1. BACKGROUND

The Dublin Port Tunnel with a total budget of €715million is one of Ireland's largest road engineering projects and is ranked amongst the largest urban road tunnel construction projects currently being implemented within Europe. The design and construction work on the project is being carried out by a consortium of Japanese, British and Irish construction companies, namely NMI (Nishimatsu, Mowlem, Irishenco) Consortium. The implementation of the overall project is being managed by Dublin City Council, and Kellogg Brown & Root Ltd. were commissioned as the project's Construction Supervisors. The National Roads Authority is the funding agency for the Project.

Construction work started on-site in June 2001 and work is currently progressing towards a completion date of December 2005, which will be followed by a three-month period of integrated testing of the tunnel's mechanical and electrical systems. The Dublin Port Tunnel will provide a motorway standard link of 5.6 km in length, of which 4.5 km is underground, running from the M1-Motorway at Coolock Lane Interchange in the North to Dublin Port in the South. The tunnel passes through Dublin boulder clays in the shallower 'lead-in' sections of the tunnel in the North and South and through hard limestone rock in the central sections of the scheme. The central and deeper sections of the scheme, under residential areas, were constructed using Tunnel Boring Machines and the shallower sections at each end were constructed using the 'cut and cover' tunnelling technique. The 'cut and cover' tunnelling technique consists of the excavation of a large trench, the construction of the tunnel within the trench, followed by backfilling of the trench to cover the tunnel.

The Northern Section of the tunnel alignment runs along the centre of the M1-Motorway and N1-Swords Road (M1 & N1) for a distance of 970m, where the tunnel was required to be constructed using the 'cut and cover' tunnelling technique. The construction of a large trench up to 34 m wide and 12 m deep along the centre of the M1-Motorway & N1-Swords Road reservation, one of Ireland's busiest roads and strategically of a very high importance to Dublin City, posed the first difficult task in the overall construction of the project. The M1 & N1 consisted of a two-lane dual carriageway facilitating 32,000 vehicles per day, including bus traffic of up to one bus per minute during peak periods. The 'cut and cover' tunnelling technique required the excavation of most of the road's reservation, leaving room for one traffic lane in each direction, to be accommodated at the top of the 12 m deep cutting, which has reinforced side slopes, as illustrated in Figure 1.

2. THE REQUIREMENTS OF A TRAFFIC MANAGEMENT PLAN

In order to construct the 'cut and cover' tunnel section over a distance of 970m along the M1 & N1 and to minimise as much as possible the disruption to traffic flows on this important route, it was necessary to develop an extensive and detailed traffic management plan. The objectives of this plan were set as follows:

- The detailed plan was required to facilitate the phased construction of the twin tube tunnel under the M1 & N1 road reservation over a distance of 970m, using the 'cut and cover' tunnelling technique.
- The plan was required to cater for all modes of traffic along the route, including public transport flows and pedestrian and cyclist movements. The public transport usage included the

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important Swords-Airport Quality Bus Corridor (QBC), which runs along the Shantalla Road (a route running parallel to the M1 - Motorway) and on to the N1 - Swords Road at Shantalla Bridge.

- It was required to facilitate the construction works involved in all of the tunnel's ancillary temporary and permanent works in the area, e.g. works associated with the Shantalla Road Bridge, the Northern Tunnel Operations Building, the diversion of utilities, the accommodation of a 25 m deep reception-pit for the soft ground Tunnel Boring Machine etc..
- The plan was required to cater for all of the various events of construction, including events such as the assembly and disassembly of temporary bridges, which crossed the tunnel excavation, the demolition of the existing Shantalla Road Bridge, the routine maintenance and cleaning of the traffic carriageway and other specialist outside events such as the Special Olympics, major football matches etc..
- The plan was required at all times to include for safety measures to provide for safe traffic flows for all, including pedestrians and cyclists, and to include for the protection of the tunnel's workforce.
- It was required to take into consideration all of the requirements of other authorities with responsibilities for roads and traffic in the area, the requirements of local residents and commercial groups in the area and other stakeholders requiring to use the route.
- The plan was required to include for emergencies such as breakdowns and accidents on the traffic carriageway.
- It was required to provide for a public information campaign and the distribution of information to all those affected.
- The plan had to include for 24 hours per day, 7 days per week traffic management during its operation, including monitoring of the plan's effectiveness, and the necessary responses and alterations when required.

3. THE DETAILED DEVELOPMENT OF THE TRAFFIC MANAGEMENT PLAN

The strategic Dublin Transportation Office (DTO) Saturn traffic prediction model for the City of Dublin was used by the DTO to assess the overall impact of the construction works plan on the City's road and public transport network. The DTO Saturn model is a strategic transportation model of Dublin City's transport network and is used to assess the impact of changes to the transportation network, including private vehicle and public transport networks. In addition, the Paramics micro-simulation traffic model (as illustrated in Figure 2) was developed by SiAS Transport Planners, who were commissioned by the Contractor, NMI Consortium, to assess the optimum measures that could be incorporated within the overall plan in order to minimise traffic delays. The Paramics micro-simulation model analyses in fine detail the movements of individual vehicles on the road network, providing a detailed picture of traffic flow information taking into consideration various suggested traffic management changes within the specific area being analysed.

These traffic management assessment tools were used first of all to assess a 'do-nothing' scenario, i.e., to carry out the construction works and narrowing the carriageway to one traffic lane in each direction, without the application of any mitigating measures. With this scenario, the Paramics micro-simulation model indicated that traffic queues during peak periods would 'build-back' over 3 km to the North and Southwards along Swords

Description of Journey Time Route	**Before Construction Works**[1] **(Rounded to nearest minute)**	**Model Prediction of 'Do-Nothing' Scenario (Rounded to nearest minute)**
From the M50 - M1 Interchange South to Collins Avenue - Swords Road Junction, through the work site area.	12 minutes	Greater than 20 minutes
Along Shantalla Road from the over-bridge at the M50 to Shantalla Road Bridge.	13 minutes (13 minutes for bus)	Greater than 24 minutes (Greater than 24 minutes for bus)

[1] Surveyed October 2001

Table 1. Comparison of Vehicle Journey Times.

Road towards the City centre area. In addition, the model showed a build-up of traffic Northwards along Shantalla Road. A comparison of actual journey times for before the commencement of construction works and model predictions of journey times with a 'do-nothing' scenario are shown in Table 1. It can be seen that the journey times for both private and public transport vehicles increase by approximately between 66% and 85%. With this scenario, it was considered that the increased vehicle queue lengths, particularly 'building-back' to over 3 km Northwards, with associated increased journey times for private and public transport vehicles would be unacceptable.

Various traffic management arrangements were tested using the Paramics traffic model and it was concluded that the combination of a number of traffic management measures (as illustrated in Figure 3) would reduce the impact of the construction works on traffic flows, queue lengths and journey times as follows:

A. As the Collins Avenue - Swords Road signalised junction is effectively controlling the volumes of traffic passing through the works area, it was recognised that if the configuration of this junction, including its link with the City's computer traffic control system (SCATS) could be maintained, together with its lane layout for a distance approaching and departing the junction, then the traffic volumes before construction works commenced could be maintained. Therefore, the traffic management detailed design efforts were concentrated to incorporate the existing junction configuration, particularly the Northbound traffic lanes, allowing these lanes to merge to form the one lane through the works area at a suitable distance North of the junction. It was recognised that the North bound traffic flows, queue lengths and journey times were sensitive to this particular traffic merge location and layout.

B. The banning of right-turning traffic movements from Swords Road to Collins Avenue during the evening peak periods, preventing the 'blocking-back' of right-turning vehicles, would result in less restrictions to City bound traffic and allow an increase in time to traffic exiting the City.

C. In order to maintain traffic volumes through the Collins Avenue-Swords Road junction and to incorporate the tunnel construction works, adjustments to the position of the adjacent pedestrian lights and its linkage with the main junction had to be facilitated.

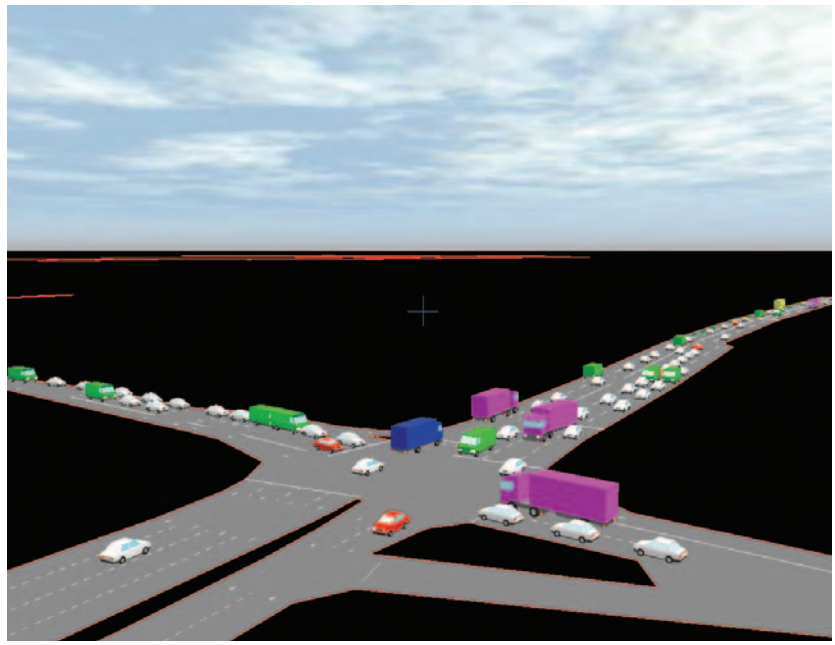

Figure 2. An Example of the SiAS Paramics Micro-Simulation Traffic Model.

D. It was evident from the traffic modelling work carried out that in order to minimise the traffic impact of the construction works, it would be necessary to encourage a travel mode shift from private vehicle usage to that of public transport. Figure 3 illustrates the combination of proposals, which were specifically targeted to facilitate additional public transport usage. They included:

- The extension of the Finglas and Malahide QBCs Northwards towards the M50 and N32.
- The construction of a new QBC on the N32.
- The enhancement of the Swords-Airport QBC through Santry Village and the restriction of the Shantalla Bridge City bound ramp to public transport only during the morning peak period.
- The restriction of the Shantalla Bridge ramp to public transport only was supported by the extension of the bus lane from the ramp Southwards to the junction with Collins Avenue.

The extension of the Finglas and Malahide QBCs together with the construction of the N32 QBC provided alternative direct public transport links between the City centre and the Airport.

The restriction of the Shantalla Bridge ramp provided a dedicated public transport link from the Airport to the City Centre. The effect of restricting the Shantalla Bridge City bound ramp to public transport only during morning peak periods maintained public transport journey times along the Swords-Airport QBC in the City bound direction. In addition, it reduced traffic flows entering on to the N1, thereby decreasing traffic disruption on the N1 approaching the Collins Avenue junction.

E. It was recognised that other adjoining radial routes were running at capacity and it would be difficult for traffic to divert and obtain an advantage in journey time. However, as part of the traffic management plan it was proposed to provide signage for alternative routes, i.e., via the Ballymun Road and M50 and via Finglas Road and M50 for Northbound and Airport bound traffic, and via the N32 and Malahide Road for City bound traffic, also shown in Figure 3.

These alternative routes also facilitated the traffic plan during special events such as the M1 & N1 road closures required for the demolition of the Shantalla Road Bridge, the cleaning and maintenance of the carriageway carried out during night-time hours, the Special Olympics etc..

In addition to the alternative route static signs, variable message signs were at times used at strategic locations to advise

Figure 3. The Combination of Traffic Management Measures Across the Northern Area of Dublin City.

motorists of up-to-date information on alternative routes, expected delay times etc..

In addition to the above traffic management measures, it was proposed that CCTV cameras at the junction with Collins Avenue, Coolock Lane Interchange and the M1 / M50 Motorway Interchange, linked using fibre optics to the Office of the Director of Traffic's Control Centre, would facilitate the operation of the plan.

The Contractor, NMI Consortium, were required in accordance with the Construction Contract to appoint a specialist sub-contractor and a Traffic Safety Officer to develop the detail of the traffic management plan through the construction site area and to also manage the operation of the plan 24 hours a day, 7 days a week. As part of the management of the traffic plan, a heavy and light recovery vehicles together with a traffic management crew were located on-site at all times to respond to any incident that could occur.

The detailed development of the traffic management plan required the close liaison of the tunnel construction and traffic management teams. The detailed traffic management plan had to allow the weaving of the traffic lanes through the construction works area in order to accommodate all of the various phases in the construction of the tunnel. Fifteen principal phases of the traffic management plan were developed to accommodate the works, each phase having a different layout. The switching from one traffic phase to the next was carried out over night, presenting the driver with a different route and views of the tunnel construction works than that of the previous day. The switching of traffic phases required the detailed planning and design of temporary carriageways and bridges and all of the traffic plan's associated traffic barriers, cones, signs, road markings, traffic signals etc..

In order to take account of the requirements of other authorities responsible for road and traffic matters in the area, a Traffic Forum for the project was formed. The Traffic Forum consisting of representatives from An Garda Síochána, The Office of the Director of Traffic, Dublin Bus, Fingal County Council, NMI Consortium (the Contractor), Dublin City Council's Dublin Port Tunnel Project team and the Construction Supervisors (Kellogg Brown & Root Ltd.). The Traffic Forum met for a period of three months once per week prior to work commencing on-site, to discuss and guide the development of the traffic management plan. The Traffic Forum also took special meetings to take representations from other interested groups such as local resident associations and commercial groups. Following the final development of the plan, it was presented to the relevant Council Committees of Dublin City Council and their approval to proceed was obtained.

4. THE PLAN'S PUBLIC INFORMATION CAMPAIGN

It was recognised that it was an essential part of the traffic management plan to publicise and inform the public of the plan. Prior to the implementation of the traffic plan on the 5th November 2001 one month of a planned information campaign took place consisting of consultation / information meetings with various interested groups, national and local radio advertisements, newspaper advertisements, distribution of information using leaflets, provision of information using variable message signs located along the M1 & N1 route and a press conference immediately prior to the plan's implementation. The message of the campaign was for motorists to allow extra time for their journey during peak hours, where possible to use the alternative signed routes and if possible to use public transport.

5. THE OPERATION OF THE TRAFFIC MANAGEMENT PLAN

The plan's operation is managed by the Traffic Safety Officer and his traffic management crew. The plan is monitored by the Construction Supervisors (Kellogg Brown & Root Ltd.) and Dublin City Council's Project team, the Office of the Director of Traffic, An

Garda Síochána and Dublin Bus. If adjustments to the detail of the traffic management plan at any time on-site are required, they are carried out immediately by the Traffic Safety Officer and his team. The Traffic Forum continues to meet on a monthly basis to monitor and advise on the continued operation of the plan.

The public information campaign is continuing during the operation of the plan with information being conveyed via Dublin City Council's web site, advertising on the radio and the provision of a dedicated telephone, 'hot-line', to deal with the public's / motorist's inquiries.

Table 2 illustrates the changes in vehicle journey times and queue lengths before and after construction works commencing. Traffic volumes are generally maintained, however, queue lengths have increased by 0.3 km on the M1 & N1 due to less queueing space being available on the road, and vehicle journey times have increased on average by 3 minutes on the M1 & N1 route. Traffic queue lengths have increased on the secondary route, Shantalla Road, with vehicle journey times increasing on average by 4 minutes. Public transport journey times have been maintained and there is a reported increase of 32% in passenger numbers on the bus routes passing through the construction site area since the traffic plan was implemented. The exact numbers of people transferring from private vehicles to public transport as a result of the traffic plan are difficult to quantify. Pedestrian and cyclist movements have been catered for as before the works started.

Tunnel breakthrough.

6. SUMMARY

The construction of a 970m long section of the Dublin Port Tunnel project along the centre of the M1-Motorway and N1-Swords Road, a busy section of the national road network and strategically of high importance, was seen as the first difficult task to be overcome in the construction of the project.

The combination of ideas and advice from representatives of other roads and traffic authorities who formed a Traffic Forum for the project; the input of sophisticated traffic assessment models;

Description of Journey	**Before Construction Works[1]** (Rounded to nearest minute)	**Model Prediction of 'Do-Nothing' Scenario** (Rounded to nearest minute)	**Model Prediction with Traffic Plan in Place** (Rounded to nearest minute)	**Actual Journey Time During Construction[2]** (Rounded to nearest minute)
From the M50 - M1 Interchange South to Collins Avenue - Swords Road Junction, through the work site area.	12 minutes	Greater than 20 minutes	16 minutes	15 minutes
Along Shantalla Road from the over-bridge at the M50 to Shantalla Road Bridge.	13 minutes (13 minutes for bus)	Greater than 24 minutes (Greater than 24 minutes for bus)	19 minutes	17 minutes (13 minutes for bus)

Description of Queue	**Before Construction Works[1]**	**Model Prediction of 'Do-Nothing' Scenario**	**Model Prediction with Traffic Plan in Place**	**Actual Journey Time During Construction[2]**
Northwards from the Sword Road to Collins Avenue Junction along the N1 and M1	0.8 km	Greater than 3.0 km	1.2km	1.1km

[1] Surveyed October 2001 [2] Surveyed January 2005

Table 2. Changes in Vehicle Journey Times and Queue Lengths.

the detailing of the traffic management plan through the works area by a dedicated specialist Traffic Management Contractor together with an appointed Traffic Safety Officer; the development of the Quality Bus Corridor element of the plan by the Office of the Director of Traffic; a series of consultation meetings with stakeholders and a public information campaign; all resulted in an overall traffic management plan to facilitate the works. The Plan minimised as much as possible the journey time delays to motorists and public transport passengers and provided a safe traffic route for all, including pedestrians and cyclists. The traffic management plan during the operational stage was managed using the continued advice of the Traffic Forum; the 24 hours a day 7 days a week management by the Traffic Safety Officer and his team; and the continuous distribution of information to those affected by the plan.

For motorists traffic volumes were maintained on the M1-Motorway and N1-Swords Road with some 'acceptable' increase in traffic queue lengths and journey times. Public transport passenger routes and journey times were maintained with an increase in public transport passengers being reported.

To quote the Irish Independent of the19th August 2004 in an article relating to the Dublin Port Tunnel, titled 'Getting there': "... aspects of the project are well worth celebrating. One of them should be a challenge for other planners. In a break with precedent, the traffic disruption on the Belfast road has been far less than feared... It can be done."

7. ACKNOWLEDGEMENTS

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8. REFERENCES

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