RPA
Railway Procurement Agency

METRO NORTH ORAL HEARING

PROOF OF EVIDENCE

SCHEME LAYOUT ALTERNATIVES

Richard J Spalding

Wednesday 1st April 2009

Metro North Oral Hearing
Proof of Evidence
Scheme Layout Alternatives
Richard J Spalding

1.0 INTRODUCTION

1.1 Personal Details

1.1.1 My name is Richard John Spalding. I hold an honours degree in Civil Engineering, and I am a Chartered Engineer and a Member of the Institution of Highways and Transportation.

1.1.2 I have been employed in the design and construction of major infrastructure projects in urban and rural areas for 40 years. I have recently managed the design of 4 major light railway systems (Metro North, Birmingham Metro Line 3, West London Tram, and Birmingham Skyrail) and have managed the design and implementation of railway systems throughout the UK and Europe for over 10 years. I have also had extensive experience of roads and drainage design and construction, and the design and construction of airports.

1.1.3 I have worked full time on Metro North since June 2006, as Design Manager for the Alignment, and for the section of Metro north of Albert College Park (excepting the Airport area). I was responsible for the design of Drainage, Earthworks, Roadworks, Bridges, Cut and Cover Tunnels and Underpasses, and the Stops at DCU and Ballymun.

1.2 Purpose of Evidence

1.2.1 My evidence explains the geometric constraints of Metro track design, and the various alternative layouts considered along the route leading to the scheme proposed in the Orders.

1.2.2 In general the layout seeks to:

- provide a safe tramway
- minimise travel time
- connect the key locations and stops
- minimise demolition of residential property
- minimise impacts on residences, businesses and occupiers
- minimise severance of property
- reduce impacts during construction
- allow for the simplification of construction methods
- minimise construction cost and environmental impacts.

and these factors have to be balanced against each other in determining the final design.

1.2.3 In this respect my evidence forms a link between the Strategic layout considerations described by Mr Rory O'Connor, and the detailed Stop layouts described in the Architectural evidence of Mr John Smith.

1.2.4 Formal appraisals were carried out where clear alternatives were apparent: these used the seven Metro objectives as evaluation criteria. These are:

- Compliance with transport and land use strategy
- Minimising environmental impact, congestion and pollution
- Generating social and economic benefits.

- Delivering good quality transport integration
- Optimising capital and operating costs
- Delivering a safe and operationally efficient system
- Efficiency and risk during construction

1.2.5 Each alternative was evaluated against these criteria, giving each criterion equal weighting.

1.2.6 I have begun my evidence by explaining the general requirements for track design, and I have then detailed the choices made in fixing the alignment in each of the seven areas of the scheme used throughout the Rail Order Application.

1.2.7 I have further sub-divided the evidence to deal with the design alternatives considered for the scheme, working from north to south.

1.2.8 The alternative layouts available to the scheme are largely determined by the system requirements, and the geometric constraints on track layout. The following are the more important criteria that have a bearing on the scheme layout.

2.0 GENERAL LAYOUT

2.1.1 The layout has been designed to maximize the extent of fully segregated and protected running and to avoid any situation where shared running with road vehicles would apply. It was possible to achieve this along the Metro North alignment by tunnelling through the heavily developed areas, by running over or under busy road junctions and by running at grade in the relatively undeveloped areas north of Swords, (which allows better integration of future overall development with Metro and other transport infrastructure).

2.1.2 The scheme has been designed in accordance with the Guidelines for the Design of Railway Infrastructure and Rolling Stock published by the Railway Safety Commission.

2.1.3 The scheme has been designed for 2.4 metre wide rail vehicles operating on a 1435 mm gauge track, which facilitates full interoperability with the existing and future Luas and Metro networks.

2.1.4 The scheme allows for a double track line along its entire length, as this is a requirement for efficient operations, where a frequent service is required.

2.1.5 The scheme has been designed to run underground in two separated tunnels to minimise the risk to passengers, staff and emergency services in the event of an emergency in the underground part of the scheme. Tunnels have been sized to accommodate the metro vehicles, an emergency escape walkway, a maintenance access way, and metro systems requirements including signalling and power supply equipment.

2.1.6 Other than at the Airport, stops are spaced at approximately 1 kilometre intervals along the route in order to encourage pedestrian access from the surrounding catchment, while maintaining fast and efficient journey times.

2.1.7 Stops are 94 metres long vehicles to accommodate the expected length of trams, and the predicted patronage. Underground Stop platforms are generally single island platforms, a minimum of 6 metres wide and are located between the northbound and southbound running lines to facilitate wayfinding and orientation for passengers.

2.1.8 SLIDE 1 TYPICAL CROSS SECTION

2.1.9 On above ground sections the absolute minimum width requirement on straight track using 2.4 metre wide vehicles is 6.1 metres. Additional provision has to be made for poles supporting the overhead supply system, emergency walkways, landscaping, signage, and lineside equipment. This results in a minimum overall landtake requirement of approximately 8 metres on straight sections of track. Additional widening is required on curves to allow for the drivers' sight lines and for the

overhang of trams on the inside and outside of bends. Further width is required for earthworks, structures and fencelines as appropriate.

3.0 GEOMETRIC CONSTRAINTS ON TRACK DESIGN

3.1 Railway alignments are designed to provide for the safe transit of the vehicles and a comfortable ride for passengers. The criteria used for Metro have been generally based on those used for Luas.

3.2 Thus the tightest curve allowable is dictated by the required speed of the Light Metro Vehicle (or LMV), to avoid derailment or excessive sideways force on passengers. On Metro North, the normal top speed of the LMV was determined to be 70kph, which is typical of LMV's , and results in acceptable journey times from Dublin to the Airport and to Swords.

3.3 A top speed of 70kph, and a maximum cant or tilt on the LMV of 120mm (a generally accepted value), requires a tightest full speed radius of 240m, if passengers are not to experience discomfort. Tighter radii can be used, but only in conjunction with speed restrictions on the LMV. The absolute minimum radius an LMV can negotiate is 25m, at a crawling speed.

3.4 For similar reasons, the vertical radius of the track at crests or in sags is limited to 1000m and 700m respectively.

3.5 A maximum track gradient of 6% has been used for Metro, because LMV's can slip, at steeper gradients, causing damage to the track.

3.6 Crossovers have been incorporated into the design to allow LMV's to cross from the northbound to the southbound track and vice versa. This provides operational flexibility during maintenance or security incidents. Crossovers incorporate turnouts (or points), and these components must be located on a straight section of track to avoid excessive wear and maintenance.

3.7 Finally, all platforms on Metro have been designed to lie on a straight section of track, to avoid large gaps between the LMV and the platform edge, which can be dangerous for passengers.

3.8 There are a number of other restrictions on geometry relating to smooth transitions between straights and curves, and the co-ordination of the horizontal and vertical curvature, but these are not generally critical.

3.9 Based upon the above constraints, alternative layouts of Metro were considered section by section, and the final layout was determined as described below.

4.0 AREA 101, BELINSTOWN TO SWORDS STOP

4.1 Belinstown Depot area

4.1.1 SLIDE 2 DEPOT AREA

4.1.2 The overall size of the depot is dictated by the number of LMV's it must accommodate, and the proposed layout just fits between Batter Lane in the west, and the M1 motorway in the east, making due allowance for proposed slip roads onto the motorway from the south. These slip roads would connect to the proposed Swords Western By-pass, and a corridor has been allowed for this road along the south side of the depot. The road would be partly built on the landscape mound south of the depot, allowing it to pass over Metro just south of Belinstown Stop.

4.1.3 Other locations for the depot have been considered at Sillogue, Dardistown and at Fosterstown, and these have been discussed in the evidence given by Rory O'Connor on alternative routes. The Depot was to be located at Belinstown to the north of the proposed Lissenhall Development area, proposed by Fingal County

Council. Three possible alternative locations for the depot were considered at Belinstown:

4.1.4 SLIDE 3 THREE DEPOT LOCATIONS

- a) an east west layout north of the Lissenhall development area and east of Batter Lane (as shown on the Railway Orders)
- b) an east west layout within the Lissenhall development area and east of Batter Lane
- c) a north south layout north of the Belinstown Stop and west of Batter Lane

4.1.5 The alternatives are shown on drawing B/MN/0000/DA/001/B01.

4.1.6 Location b) within the Lissenhall development area would occupy expensive potential development land and reduce Section 49 contributions from developers. It would be opposed by Fingal County Council.

4.1.7 Location c) west of Batter Lane would make future connections of Metro to the coastal communities more intrusive, and less efficient, and would result in an additional crossing of Batter Lane, thereby creating more intrusion to local properties.

4.1.8 With regard to environmental impacts, alternatives a) and b) were both considered to have potential impacts on archaeology, as the actual area of interest could well extend beyond that indicated on Department of Environment, Heritage and Local Government maps. The western option c) would also encroach into a new landscape area (the Turvey valley), not currently affected by development.

4.1.9 It was concluded that the alternative a) shown on the Order plans provided the most economic and efficient location, whilst reducing environmental impacts.

4.1.10 SLIDE 4 NOT USED

4.1.11 The level of the depot was set to be generally above existing ground level, to avoid excavating in the area of archaeological interest. This also allowed adequate cover to the culvert needed for stream diversions, and prevented views along the whole depot area from Batter Lane.

4.1.12 The depot would need to be some 700 metres in length as shown on the Railway Order Plans to provide adequate stabling areas for track, and circulatory requirements. The eastern boundary cannot be closer to the M1 than shown if adequate space is to be left for a slip road connection of the possible future Swords Western Ring Road to the M1. Furthermore, Metro must pass through the centre of the proposed Lissenhall Development Area in order to provide an accessible alternative sustainable transport corridor, and the track must connect to one end of the depot to allow efficient circulation. The Belinstown Stop is also located north of the proposed line of the Swords Western Ring Road, so as to minimise costs by bridging over the tracks, and not the Platforms as well. Thus the exact location of the Depot and Stop were fixed by strategic considerations.

4.1.13 Studies showed that a multi-storey car park was to be preferred to an at-grade park on grounds of both efficiency and economy. The location of the Park and Ride multi storey car park was therefore developed to provide a convenient link for passengers by minimising the transfer time from cars to metro, and to provide shelter from the weather. This suggested a car park built in two blocks directly over the Belinstown Stop. However, the layout of the car park was subsequently adjusted to reduce the impact on properties at Batter Lane by reducing the size of the block west of the Belinstown Stop, and enlarging that to the east, whilst retaining accessibility to

drivers. The lower storey of the car-park was also sunk below ground level to reduce the overall height of the building.

4.2 Broad Meadow River Valley (chainage 2000 to 2300)

4.2.1 The Metro North route crosses the Broad Meadow and the Ward rivers just to the west of the R132, using the line of the old Belfast Road.

4.2.2 SLIDE 5 THREE BRIDGES

4.2.3 In order to minimise impacts in this area Metro crosses the Broad Meadow River on the old Lissenhall road bridge, which is a Protected Structure. The chosen route will minimise disturbance to habitats along the riverbank and avoid constructing another river crossing. The parapets of the bridge are of massive rough hewn masonry, and these will need to be retained, with new copings provided to the south to match the existing. Structural work on the bridge is minimised to limit impacts on the structure, and consists of a new slab laid over the existing bridge deck.

4.2.4 Alternative alignments were considered, involving new bridges either east or west of the Lissenhall Bridge. However, any new crossing would require major construction works, which may disturb wildlife, and affect the visual setting of the old bridges. Furthermore, a new route to the east would result in an alignment close to the residential property at the end of Ennis Lane, or even require its demolition. A new route to the west would impact the field to the north of the Broad Meadow River, which is noted to be of archaeological interest, and would be close to the major 18 inch diameter water main that supplies rural areas to the north of Swords.

4.2.5 At the Ward River crossing, the Balheary Bridge is also a Protected Structure. It was not found possible to fit both Metro tracks over the existing Balheary bridge, and the northbound track has therefore been located over a new bridge (called the Ward River Bridge) just upstream of the Balheary Bridge.

4.2.6 At the Balheary Bridge consideration was given to widening the existing structure to accommodate both Metro tracks, but advice from the Fingal County Council Conservation Officer, and the Department of the Environment suggested that an altered bridge would not retain the value of the existing structure. Under the scheme, travellers on the new bridge will benefit from views of this protected structure.

4.2.7 The river crossing is only 100 metres south of the Ennis Lane, and it is not possible to devise a vertical alignment for this road to pass either over or under Metro North on its existing route. In any case, such a profile would be intrusive for the adjacent residential property. As an alternative, Ennis Lane will be diverted over an at-grade crossing of Metro further to the north, to form a new junction with the Depot Access Road. A signal controlled junction will be provided at this junction, giving priority to LMV's. Pedestrian access along Ennis Lane will be maintained by means of an at-grade pedestrian crossing of Metro.

4.3 Estuary Roundabout to Seatown Roundabout (chainage 2800 to 3600)

4.3.1 Metro is on a viaduct through this area to avoid causing additional road traffic congestion at the busy Estuary and Seatown roundabouts, and consequent delays to LMV's. However, pedestrian overbridges are currently provided at the Estuary and Seatown roundabouts, and the elevated structure carrying Metro will clash with these bridges, so they will have to be removed.

4.3.2 In order to provide alternative facilities for pedestrians the existing roundabouts will be re-modelled as signal controlled junctions incorporating full pedestrian and cycle facilities. Such at-grade crossings will be more convenient to pedestrians than traversing the existing footbridges and ramps, which are sub-standard in width and

ramp gradient. The provision of at grade crossings caters safely for all users, and minimises the risks to those pedestrians who currently choose not to use the footbridges.

4.3.3 An elevated route is chosen across these roundabouts, as underpasses would be well below flood levels in the nearby rivers, and would be susceptible to inundation. A Metro level above the existing footbridges would require much longer ramps, prejudicing the optimum location of the Estuary and Seatown Stops, and creating much more visual intrusion. Similarly, raising the pedestrian bridges to pass over the Metro viaduct would result in significant visual intrusion, with very long ramps, and be inconvenient in use. The alternative of pedestrian subways was also considered, but these are unattractive to vulnerable pedestrians. The proposed layout of Metro and the road junctions is supported by Fingal County Council.

4.4 Malahide Roundabout to Pinnock Hill Roundabout.

4.4.1 The Swords Stop is located to facilitate use of the Pavilions Shopping Centre, and associated development, which include plans to create a retail park to the east of the R132, connected to the Pavilions site by a plaza above the road and Stop, and an underpass beneath. The Swords Stop is therefore designed with an island platform 8 metres wide, to facilitate future connection (by lifts and escalators) to the planned shopping and plaza developments at its northern end.

4.4.2 SLIDE 6 SWORDS STOP OPTION

4.4.3 An alternative location (Option 2) was considered for this Stop to the west of R132 in the existing car park of the Pavilions shopping centre. The alternative Stop would be an open cut Stop, with underpasses and ramps for Metro connecting the track to the central reserve of R132 north and south of the Malahide roundabout.

4.4.4 Option 2 was found to be less favourable than the proposed option, because it would result in significant additional cost and disruption during construction, and would be less accessible to the planned retail developments on each side of the R132. It would also preclude the development of an underpass to link the proposed developments.

4.4.5 The Route passes beneath the Malahide roundabout in an underpass. An underpass at this location avoids clashes with the proposed Plaza deck over the R132, and minimises visual intrusion.

4.4.6 South of the Swords Stop the route rises on a ramp in the central reserve of R132, and crosses the Pinnock Hill roundabout on a viaduct. The form of the proposed viaduct is as shown on the drawing, together with an artists impression.

4.4.7 SLIDE 7 VIADUCT SECTION

4.4.8 SLIDE 8 VIADUCT 3D

4.4.9 Following representations from residents of Carlton Court, which lies to the west of the R132, a route was considered that carried Metro beneath Pinnock Hill Roundabout in an underpass. This would require a lowering of the Fosterstown Stop to the south to reduce the gradient from the Stop to the roundabout.

4.4.10 SLIDE 9 PINNOCK HILL PROFILES

4.4.11 Even if the Fosterstown Stop were redesigned as an open cut Stop 10m deep, a gradient of over 6% would be required to pass from that Stop to an underpass of Pinnock Hill Roundabout. This would be unacceptable, as it would exceed the maximum permitted gradient. In any case, lowering the Fosterstown Stop would not in fact be possible because the additional stairs or escalators required for access

would be difficult to accommodate, whilst still allowing a passenger bridge over the R132, and allowing Metro south of the Stop to pass between Reid's store and the R132. Making the Stop more than 10m deep would require special additional fire precautions (such as forced emergency ventilation of the Stop and Tunnels), which would be inordinately expensive. In any case, an underpass of Pinnock Hill Roundabout would result in substantial additional costs. This option was therefore rejected.

4.4.12 The residents have also proposed that Metro pass across Pinnock Hill Roundabout at grade. An at grade crossing of the Roundabout would result in unacceptable delays to trams and road traffic, especially when the frequency of the Metro is increased to 2 minute headways. This option was therefore rejected.

4.4.13 SLIDE 10 EAST ROUTE AT PINNIOCK HIILL

4.4.14 Finally, the residents have suggested that the link road east from the Pinnock Hill Roundabout be closed off and Metro be run at grade along the east side of R132, and past the east side Pinnock Hill Roundabout. However, as described above, Metro is committed to providing a Swords Stop in the central reserve of the R132 opposite the Pavillions shopping centre. Crossing the southbound carriageway of R132 to its eastern verge would require a long skewed underpass, or major delays to road traffic if a skewed at-grade crossing were used. This alternative would require additional land-take from property on the east of the road, and closure of the link road east of Pinnock Hill would be very detrimental to businesses along its length. This option was therefore rejected on the grounds of unacceptable impacts on Economy, and lack of Transport Integration.

4.4.15 SLIDE 11 VIEW FROM CARLTON COURT

4.4.16 The proposed alignment will result in some visual intrusion to properties in Carlton Court to the west of R132, but Metro is 35 metres away from the house facades, and screened by a row of trees and a wall. Views to and from Metro could be further screened by planting additional evergreen trees among the existing boundary.

4.4.17 Residents have proposed a screen wall, but this would cause additional intrusion.

4.4.18 SLIDE 12 WALL AT CARLTON COURT

5.0 AREA 102, SWORDS STOP TO DUBLIN AIRPORT NORTH PORTAL

5.1 Pinnock Hill Roundabout to Fosterstown (chainage 4650 to 5900)

5.1.1 Horizontal Alignment

5.1.1.1 Metro North passes over the Pinnock Hill roundabout to the Fosterstown Stop on the east side of the R132, just north of the Airside Shopping Centre.

5.1.1.2 SLIDE 13 FOSTERSTOWN STOP ALTERNATIVES

5.1.1.3 Alternative routes west of the R132 in this area were considered but discarded because they detracted from the area of land available for development to the west of R132, and required significant additional structural and utilities works to pass between the Boroimhe residential area and the R132. A route in the centre of the R132 was also discarded because of the significant additional highways and earthworks that would be required to create a central reserve for Metro to follow. It was also found that the proposed route to the east of the R132 minimised the

overall width of road traffic lanes, footways and tramway in the bottleneck formed between the Boroimhe housing and the Airside Retail Park Buildings.

5.1.1.4 An alternative route passing to the east of the Airside Retail Park was considered at feasibility study stage, before publication of the Emerging Preferred Route. This alternative was discarded because it was more expensive than the current proposal, would cause more visual intrusion, and was longer.

5.1.1.5 An alternative Fosterstown Stop location partly in the Airside Shopping Centre Car Park and partly in the east verge of the R132 was also assessed. This alternative was discarded because it inhibited links to other transport systems (especially busses), would significantly reduce parking availability at Airside, and would require complex and disruptive construction works.

6.0 AREA 104, DUBLIN AIRPORT SOUTH PORTAL TO SANTRY AVENUE

6.1 Metropark (chainage 9000 to 10400)

6.1.1 Horizontal Alignment

6.1.1.1 SLIDE 14 OVERALL METROPARK

6.1.1.2 The alignment through Metropark comprises a large radius reverse curve, designed to link the line of the route through Ballymun with the line through the Airport buildings. The curves used will allow 65kph running (with maximum cant). An alternative route passing east of the Irish Food Processors Plant and the Commercial Vehicle testing centre was considered, but would not facilitate a future connection to Metro West, without taking an excessive amount of valuable development land for Metro.

6.1.1.3 It is possible that Metro West will connect to Metro North in the Metropark area, and various alternative layouts of Metro North track were considered so as not to prejudice the viability of this junction, or the integration of future metro services. In particular, any future Metro West services should be able to run through to the Airport so that passengers would not have to change to Metro North. Allowance was also made for the continuation of metro services eastwards towards the coastal main line railway.

6.1.1.4 SLIDE 15 DARDISTOWN LAYOUTS

6.1.1.5 Four possible alternative Dardistown Stop layouts were evaluated in this regard, namely:

- Option 1: a two level stop, with a cross platform interchange between Metro West and Metro North.
- Option 2: a stop with three platform faces, one reserved for Metro West services only.
- Option 3: a single island platform shared with Metro West
- Option 4: a stop with four platform faces, as proposed in the Orders. This Stop would be built as a single island platform under Metro North, and the Metro West lines would be installed into the middle of the island if Metro West was implemented.

6.1.1.6 Option 1, the two level stop, was found to require more land and to be more intrusive than other options, because it required approach embankments to the

upper level. The three platform face Option 2, and the shared island platform Option 3 resulted in restrictions in capacity and lacked operational flexibility, particularly if Metro West was added. Other assessment criteria were neutral with regard to these options, so that it was concluded that Option 4 should be promoted, as shown on the draft Rail Orders. This gave maximum capacity, especially for services running to the Airport, whilst allowing the option for Metro West to operate independently of Metro North, by terminating and reversing at Dardistown Stop.

6.1.1.7 Consideration was also given to possible future links between Metro West and the city centre. These would need to be accommodated without major disruption to Metro North services. A delta junction layout was devised to allow full interchange between Metro North and Metro West. It was found necessary to increase the separation of the Metro North tracks south of Dardistown Stop so that any future connection to Metro West could be built, whilst maintaining Metro North services. Retaining this flexibility also required that the northbound Metro North track be lowered to the south of Dardistown, to allow for future overbridges carrying Metro West.

6.1.1.8 The Dardistown Stop was initially located partly within the Outer Public Safety Zone (PSZ) of Dublin Airport. The Stop was subsequently moved some 20m southwards to avoid this zone, and reduce any risk to tram and airline passengers. The associated 300 space Park and Ride site will be located inside the PSZ, to the north of the Stop, but this is acceptable within current guidelines on PSZ's, and has been accepted by Dublin Airport Authority and the Irish Aviation Authority.

6.1.1.9 Finally, an additional side platform was added to the park and ride side of the Stop for the convenience of northbound Metro users.

6.2 M50 to Santry Cross (chainage 10550 to 11500)

6.2.1 Three alternative locations were considered for the location of the Northwood Stop:

6.2.2 SLIDE 16 NORTHWOOD OPTIONS

- Option 1: an at-grade stop east of R108 Ballymun Road (as shown on the Railway Order plans)
- Option 2: an elevated stop above the central reserve of R108 Ballymun Road
- Option 3: An open cut Stop west of R108 Ballymun Road and closer to the R108/ Santry Avenue junction.

6.2.3 Option 2 was an integral part of an elevated option through Ballymun, and was eliminated, along with that option, for reasons of visual intrusion and severance.

6.2.4 Option 3 west of Ballymun road was eliminated because its passenger catchment area overlapped that of the Ballymun Stop; because the stop would be less accessible as the platforms would be below ground level; and because it would cause greater disruption during construction as it would require two crossings of the R108 northbound carriageway; and finally because it was more expensive than the alternatives.

6.2.5 Option 1 was considered to best serve the existing high density residential areas to the south east, and to maximise patronage at minimum capital cost, with least disruption during construction. In future, a link road could be provided from the Stop to the development lands east of the R108 (the IKEA site). The Orders Plan location for Northwood Stop is supported by both Fingal County Council and Dublin City Council.

7.0 AREA 105 SANTRY AVENUE TO ALBERT COLLEGE PARK, AND AREA 106, ALBERT COLLEGE PARK TO MATER STOP

7.1 Ballymun and DCU (chainage 11500 to 13300) and DCU to Drumcondra Stop (chainage 13300 to 15850)

7.1.1 Alignment Options through Ballymun, and from DCU to Drumcondra, including the location of the Griffith Avenue Stop, are of a strategic nature, and have been reviewed by Mr O'Connor in earlier evidence.

7.2 Drumcondra Stop to Mater Stop (chainage 15850 to 16500)

7.2.1 SLIDE 17 DRUMCONDRA OPTIONS

7.2.2 As a part of the Emerging Preferred Route, the Stop at Drumcondra was proposed to be mined beneath the Irish Rail Maynooth Line and residential property to the south, with entrances on St Anne's Road North and Grattan Parade. In the detailed design however, this was considered to involve significant risk to the stability of the railway embankments, and intrusion to residential property.

7.2.3 Five alternatives were therefore considered for the location of the Stop at Drumcondra:

- Option 1: A mined stop beneath Drumcondra Road
- Option 2: A partly mined, partly cut and cover stop, in land to the east of St Joseph's Avenue
- Option 3: A cut and cover stop beneath Drumcondra Road
- Option 4: A mined stop under St Joseph's Avenue
- Option 5: A cut and cover stop in land to the east of St Joseph's Avenue.

7.2.4 Options 1, 2 and 4 required mining the Stop and its access shafts in Boulder Clay with water bearing sand and gravel lenses, and was considered too great a construction risk. Option 3 would cause significant disruption to residents, traffic, utilities and Croke Park crowds.

7.2.5 Option 5 was therefore chosen, and the Stop layout was reconfigured to obviate any demolition on St Alphonsus Road. This required a widening of the Stop box into the old playground of the Catholic Institute for the Deaf, and the accommodation of plant rooms above ground level to shorten its overall length.

7.2.6 Access to the Stop for construction and for passengers in this option was also problematic, since St. Joseph's and St Alphonsus' Avenues are quiet residential streets, and are not readily accessible from Drumcondra Road. Their use would cause particular accessibility and congestion problems for crowds using Croke Park. It was therefore decided to approach the Catholic Institute for the Deaf with a view to purchasing their property allowing direct access to Drumcondra Road, The Institute was found to be available for purchase by agreement.

7.2.7 Development of a unified access from Drumcondra Road necessitated demolition of the main Institute building and the Chapel, which are of local architectural importance. However, it was concluded that the advantages of allowing space for a holding area for Croke Park Crowds, a direct visual connection to the Stop from Drumcondra Road, and an improved connection to the Irish Rail Maynooth Line outweighed the

value of the existing buildings. The forecourt area created also has potential for limited redevelopment to form a focal point for the local community.

7.2.8 The rational for the detailed layout of this Stop will be given by Mr John Smith in his Architectural evidence.

7.3 Mater Stop to Parnell Stop (chainage 16500 to 17200)

7.3.1 As a part of studies for the Emerging Preferred Route, various alternative locations were considered for the Mater Stop.

7.3.2 SLIDE 18 ALTERNATIVES AT MATER (Slide 19 not used)

7.3.3 These included locations

- 1 beneath the existing Mater Misericordia buildings
- in the existing car park between the Mater Misericordia and the Mater Private hospitals
- beneath residential property in Leo Street
- beneath Hardwicke Street and the St Georges church
- beneath the west side of Dorset Street Upper
- beneath the east side of Dorset Street Upper
- Beneath the public gardens on the corner of Berkeley Road and Eccles Street

7.3.4 Alternatives 3, 5 and 6 beneath Leo Street, and Dorset Street were rejected because they would require extensive demolition of residential property. Location 4 beneath Hardwicke Street was rejected for the same reason, and because the effects on St Georges Church were uncertain. Location 1 beneath the Mater Hospital buildings was considered to carry undue risks of impacts on the running of the hospital. Location 7 could not be connected satisfactorily to the route between Parnell Square and Drumcondra Stops.

7.3.5 As a result of this analysis, three alternative locations were considered in more detail:

- Option A: A cut and cover box under the Mater Hospital Car park
- Option B: A cut and cover Stop on the west side of Dorset Street
- Option C: A Mined Stop under Dorset Street.

7.3.6 As at Druncondra, Option C required mining the Stop and its access shafts in Boulder Clay containing water bearing sand and gravel lenses, and was considered too great a construction risk.

7.3.7 Option B would have required the demolition of 20 residential properties on Dorset Street, which was regarded as unacceptable, given that less intrusive alternatives existed.

7.3.8 Design of Option A was therefore progressed, taking account of the plans for development of the Mater Hospital. It was found that the Stop structural box could be integrated with the Mater proposals if the Stop was located in the north east corner of the Mater site. This avoided placing the Stop directly under the new hospital buildings which may have affected the running of the Hospital, and resulted in a loss of parking

spaces in the proposed Mater underground carparks. The Stop was therefore located beneath the hospital Ambulance Access and service road.

7.3.9 The accommodation of the Stop emergency escape and ventilation shafts was then an issue, as they could not be located in the emergency access road. The shafts would therefore have to be placed within the proposed hospital structure, or require demolition of three houses on Leo Street, and houses at 389 and 400 North Circular Road. Integration of the shafts into the hospital structure was unacceptable because in the event of an incident on Metro, evacuation would cause conflicts with the new Accident and Emergency building, so that the demolition of the houses was required. The visual impact of the vent and escape buildings can be mitigated by careful architectural design.

7.3.10 Detailed discussions with the hospital and other involved parties has resulted in the entrance and ventilation duct layout shown in the Order Plans, and these matters are discussed further in the Architectural evidence of Mr John Smith.

8.0 AREA 107, MATER STOP TO ST STEPHEN'S GREEN

8.1 Parnell Stop to O'Connell Bridge Stop (chainage 17200 to 18000)

8.1.1 Parnell Stop

8.1.1.1 Ground Investigation has determined that the ground in this area comprises saturated sands and gravels up to 20 metres below ground level. In consequence it will be necessary to construct this Stop using Cut and Cover techniques. Mining of the Stop would not be a practical option.

8.1.1.2 It was found that the area available beneath the carriageway of Parnell Square East alone could not accommodate the entire footprint of a cut and cover Stop structure. Consequently the alternatives of extending parts of the stop box beyond the carriageway of Parnell Square East into the adjacent properties was considered as follows:

8.1.1.3 SLIDE 20 PARNELL OPTIONS

- Option 1: to locate the stop entrances within the Ambassador building;
- Option 2: to locate the Stop partially in the grounds of the Rotunda Hospital and the Garden of Remembrance;
- Option 3: to locate the Stop partially beneath the carriageway of Parnell Square North, and the Garden of Remembrance;
- Option 4: to locate the Stop beneath the full extent of Parnell Square East for the full width of the road, with Stop entrances on Parnell Square North and Parnell Street;
- Option 5: to locate the Stop beneath the full extent of Parnell Square East for the full width of the road, with stop entrances located along the boundary with the Rotunda Hospital;

8.1.1.4 Option 6: To locate the Stop partially beneath the carriageway on Parnell Square East and partially within the grounds of the Rotunda Hospital.

8.1.1.5 Options 1, 2 & 3 were eliminated as the impact on the Ambassador, the Rotunda and the Garden of Remembrance would have been too great.

8.1.1.6 Option 4 & 5 were eliminated because of difficulties in traffic management during construction at the junction at the north east corner of the square, and the requirement to maintain a bus lane and emergency access along the Georgian terrace on Parnell Square East and to maintain an access to the rear of the Gate Theatre for the full duration of the works.

8.1.1.7 Option 6 was selected as it takes due cognisance of stakeholders' requirements, and heritage constraints and Masterplans in the area. Furthermore, while Option 6 encroaches into the hospital grounds this is unavoidable if a bus/emergency access lane is to be maintained along the east side of the stop and if the impacts on the Garden of Remembrance and Parnell Square North are to be avoided. The Stop platform has been reduced to a practical minimum of 9 metres wide to minimise these impacts.

8.1.1.8 The minimum width of Stop at this location will allow the retention of the basement coal cellars appertaining to the Victorian Terrace fronting Parnell Square East. The space above the basements is required for the diversion of the existing utilities on Parnell Square East. After construction the footpath above these utility diversions will be reinstated and widened to minimise effects on the setting of the terrace.

8.1.1.9 Detailed discussions with stakeholders in this area have proceeded to mitigate the impacts of the Stop, and will be described further by Mr John Smith in his architectural evidence.

8.1.2 <u>O'Connell Bridge Stop</u>

8.1.2.1 A large number of alternative locations for a Stop in this vicinity were considered at feasibility study stage, and have been described in the evidence of Mr Rory O'Connor.

8.1.2.2 The selected location beneath the River Liffey dictates that the Stop platforms must be mined in rock, and this in turn dictates the depth of the Stop, which at 27 metres is the deepest on the scheme.

8.1.2.3 The Stop requires large structures connecting to ground level on each side of the river to accommodate passenger circulation and stop operational equipment.

8.1.2.4 SLIDE 21 O'CONNELL BRIDGE ORIGINAL

8.1.2.5 Two main alternatives for the layout of this stop were considered, relating to the configuration of the below ground structures south of the river:

- Option 1: with shorter structures below both D'Olier Street and Westmorland Street
- Option 2: with a single longer structure below Westmorland Street

8.1.2.6 Both options also require structures beneath O'Connell Street, on the north bank of the Liffey.

8.1.2.7 Option 1 was eliminated because it required very complex traffic management arrangements to construct, resulting in a longer period of disruption, and more disruption to the City centre than Option 2.

8.1.2.8 The Option 2 layout was further optimised to reduce the width of the boxes in both O'Connell Street Lower, and in Westmorland Street, and to integrate consideration of methods of construction with the pedestrian and traffic management plans. The

Stop access boxes north and south of the River Liffey will therefore be generally constructed in two halves (one to the east and one to the west) and the roof slabs will be cast at an early stage to allow the maximum number of traffic lanes to be maintained.

8.1.2.9 Further details of the layout of the O'Connell Bridge Stop will be given by Mr John Smith in his Architectural evidence.

8.2 O'Connell Bridge Stop to St Stephen's Green Stop (chainage 18000 to 19050)

8.2.1 St Stephen's Green Stop

8.2.1.1 SLIDE 22 INITIAL 3 OPTIONS IN SSG

8.2.1.2 Initial feasibility studies considered alternative locations for this Stop:

- A in St Stephen's Green West
- B in the centre of the Green, and
- C in St Stephen's Green East.

8.2.1.3 It was concluded that only the West alternative gave good transport connections to the Luas Green Line, whilst a Stop in the centre of the Green would have unacceptable heritage impacts.

8.2.1.4 Subsequently, three alternatives for the construction of a Stop in St Stephen's Green West were considered, together with possible construction techniques to minimise impacts on adjacent businesses, the Luas Stop, and the Green itself. Furthermore, integration with the proposed Irish Rail Interconnector was assessed. It was concluded that a Stop could be built at St. Stephen's Green West without unacceptable impacts.

8.2.1.5 The choice of the precise location and orientation of the stop at St Stephen's Green is complicated by the limited availability of space, the multiple uses of the area, and the importance of the Green as a National Heritage site.

8.2.1.6 The initial location proposed was for a Stop beneath St Stephen's Green West, but the disruption to the Luas system, the potential effect on nearby buildings, and nuisance to the working and visitor population of the area were substantial. A second option, partly in the street, and partly within the western boundary of St. Stephen's Green was therefore investigated. However this option caused disruption of the Green and its heritage features, whilst still having significant impacts on users of Luas and of St Stephen's Green West.

8.2.1.7 Discussions with the owners of the Green (the OPW) developed a detailed constraints map of the trees and features of the park.

8.2.1.8 SLIDE 23 CONSTRAINTS IN THE GREEN

8.2.1.9 This indicated that work largely inside the park could be allowed, provided the most sensitive vegetation and features were avoided or protected. In particular construction in the area of the north west or Upper Pond was identified as having least potential impact on the Green, and an area of ancient woodland west of the pond was identified as of great ecological importance, so that it could not be disturbed. It was also concluded that important features, such as the Pullham Rock features, statues, railings and the Fusiliers Arch could be protected, or removed, stored, and replaced at the conclusion of construction. Vegetation could be renewed

after construction. OPW therefore agreed that a limited area of the Green could be made available for construction, centred on the Upper Pond. This area was therefore delineated and Options within the Green were considered, because they reduced impacts on businesses, pedestrians and other users of the surrounding roads, without having permanent impacts in the Green.

8.2.1.10 Seven feasible design alternatives within the Green were developed and considered in conjunction with the Irish Rail Interconnector design team, in order to minimise the combined impacts of both schemes.

8.2.1.11 All options included a combined ticket hall under the junction of Grafton Street, King Street South and St Stephen's Green North and West. This allows the Stop and Interconnector entrances to be close to the busiest public area, provides sufficient space for a combined Interconnector and Metro ticket hall, and, because the ticket hall is of shallow 'top-down' construction, allows the early return of the area to public use. It is also possible to maintain adequate access for pedestrians and service vehicles around the works during construction of the ticket hall. All options also allowed for interchange with the Interconnector platforms via escalators and lifts from the Stop concourse level. A further option of not connecting the Interconnector and Metro schemes was rejected because of lack of transport integration.

8.2.1.12 SLIDES 24 TO 30 SSG OPTIONS

8.2.1.13 The seven options considered were:

- Option 1: Entrances to the Stop located on Grafton Street, on St. Stephen's Green North and on St. Stephen's Green West with two escalators per entrance. The entrances are located close to the surrounding buildings, to allow full vehicular access around the Green to continue after construction. Option 1 has an island platform and a side platform to allow it to operate as a terminus stop.

- Option 2: Entrance to the Stop via a bank of three heavy duty London Underground Specification escalators at the Grafton Street junction. The stop box is moved south by 6 metres relative to the Option 1 to allow the escalators to be located as far as possible from the adjacent buildings. Option 2 has the same arrangement underground as Option 1. Moving the Stop south allows the southern escape stair to emerge on the southern bank of the pond which could then be reinstated in its existing form.

- Option 3: Entrances located similarly to option 1. The Stop has a simple island platform arrangement, with a loop of track in tunnel south of the Stop for turning back of LMV's. This layout reduces the overall size of the cut and cover box in the Green.

- Option 4: Entrance to the Stop via a bank of three escalators at the top of Grafton Street, with staggered single escalators on St Stephen's Green North and West. The Stop has an island platform and a side platform as per option 1. This layout was discarded during the discussions, as it required the Interconnector Stop to be located directly beneath the Metro Stop, which was not feasible for construction programme reasons.

- Option 5: As Option 1, but the entrance to the Interconnector Station is via a bank of three escalators beneath St Stephen's Green North. The Stop box is moved south by 6 metres relative to Option 1. It has an island platform and a side platform as per option 1.

- Option 6: Entrance to the stop is via 2 banks of two escalators in St Stephen's Green West. In this option the entrances emerge on the footpath inside the Green in the demise of the OPW. This option has an island platform and a side platform as per option 1.

- Option 7. This option is the similar to option 6, but the interconnector running tunnels are moved south, further from the buildings on St. Stephen's Green North. Entrance to the stop is via 3 banks of three escalators: one at the top of Grafton St, and one each at St Stephen's Green North and St Stephen's Green West. In this option the north and west entrances emerge on the footpaths alongside the Green in the demise of the OPW. This option has an island platform and a side platform as per option 1.

8.2.1.14 The options were evaluated by means of a weighted multi-criteria analysis. This analysis identified the key issues to be resolved in the design, and assigned a weighting to each. Each option was then rated for compliance with each criteria, and an overall score calculated as the weighting multiplied by the rating. Options 2 and 7 scored best, followed by option 3. However option 7 required the provision of entrances alongside the boundary railings of St Stephen's Green North and St Stephen's Green West, which was later found to be unacceptable to OPW, so that this option was not progressed. Option 3 (with a loop for LMV turnback) was noted to reduce impacts on the Green.

8.2.1.15 The preferred option was therefore a combination of Option 2, keeping the stop as far away from buildings as possible within the land available in the Green, and option 3, with a loop for LMV turn back, and a single island platform. The loop configuration was found to be more efficient for the operation of services, and to have less direct impact on the Green, because it removed the need for a side platform thereby reducing the width of the box. A single island platform also allowed direct access from the ticket hall to the Interconnector, which is preferable for wayfinding purposes.

8.2.1.16 Finally, a further analysis was undertaken of the layout of entrances to the Stop. As a result, it was decided to replace the escalators at the end of Grafton Street with sets of three escalators in both St. Stephen's Green North and St. Stephen's Green West.

8.2.1.17 SLIDE 31 FINAL ENTRANCES SSG

8.2.1.18 This was preferred by Dublin City Council: it allowed better access for service vehicles at the end of Grafton Street, and more open views to and from the Green.

8.2.1.19 Discussions have continued on the location of these escalator banks to try to address comments received on publication of the Orders. The proposed final location will be explained in the evidence of Mr John Smith relating to the Architectural design of Stops.

8.2.1.20 At street level, pedestrian modelling and service vehicle monitoring has shown that the current solution of larger entrances on St Stephen's Green North and West will allow adequate capacity to be maintained around the Stop accesses.

8.2.1.21 The design of the stop and loop arrangement at St Stephen's Green does not preclude the future extension of the scheme to the south as envisaged in Transport 21.

8.2.1.22 Consideration was given to incorporating operational crossovers just north of the St Stephen's Green platforms, to facilitate the return of trams to the north, instead of a loop. However, this arrangement required three platform faces at St Stephen's Green Stop to maintain high frequency services, and large caverns beneath

important buildings on Grafton Street. The option of providing operational crossovers south of the stop box was also considered, but after computer analysis was rejected, as it would not allow the required two minute turn round of LMV's.

8.2.1.23 A loop arrangement was therefore provided south of the platforms,

8.2.1.24 SLIDE 32 LOOP

8.2.1.25 which allows turn round of LMV's at the required frequency, and also provides some storage of vehicles for timetable balancing. The loop is accommodated within the extent of the Green, which minimises potential impacts on adjacent buildings.

9.0 CONCLUSION

9.1 I consider that the important practicable alternatives for the layout of Metro North have been examined, and that the proposed Orders represent the optimal balance between the practical, financial and environmental impacts of construction and operation.

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