RPA METRO NORTH

Scheme Traffic Management Plan Version 8

Appendix E - Part 1

March 2009

E Detailed Description of Main Works in Local Areas

E.1 Description of Main Works in Area MN101

Estuary, Seatown and Swords stops are located on the R132 south of the Estuary Roundabout, Seatown Roundabout and Malahide Roundabout respectively. Main works will involve Estuary Roundabout, Seatown Roundabout and Malahide Roundabout.

Both Estuary Roundabout and Seatown Roundabout will be reconfigured as signalised junctions as part of the main works. The alignment will be located along the median of the R132 from Estuary Roundabout to the Swords Stop

Main works will also be located around Malahide Roundabout. During these works, this junction will continue to operate as a roundabout. Much of the works will be located outside of existing traffic lanes, within the internal diameter of the roundabout, along the central median or off-road.

The main works phasing for R132 works are shown in Drawings 1023 – 1037 and Drawings 1045-1049 in this Appendix.

E.1.1 Depot

The depot is located adjacent to the Belinstown Stop. The depot comprises stabling for up to 104 x 45m long Light Metro Vehicles, together with:

- a vehicle maintenance shed;
- an inspection shed;
- train wash facilities;
- infrastructure maintenance building and sidings;
- a central control and management building; and
- Other ancillary buildings include a gatehouse, gas meter house and electricity substation.

The operational area of the depot will be surrounded by a palisade type security fence. The depot will be constructed on an earthworks platform using suitable excavated material from the other worksites along the route to a level of up to 3.5m above existing ground level. The track work will then be laid on this platform with the buildings then erected.

The major traffic management aspect of these works at this site will be the number of spoil trucks importing excavated material from other works areas along the alignment into the depot site.

E.1.2 Belinstown Stop

Belinstown Stop is located at the entrance to the depot along with the proposed multi story Park and Ride car park building. The two island platforms are situated between two multi-storey car park blocks which accommodate a total of 2,000 parking spaces. Two high level bridges will be provided over the platforms to connect the car park buildings.

E.1.3 Belinstown Stop to Lissenhall Bridges

From Belinstown, the alignment of Metro North traverses green field land at grade and track will be laid on a track bed formed by excavating the ground and replacing it with suitable compacted material. Any surplus excavated material generated will be used for earth works at the Depot. An access road will be constructed parallel to the track and will provide an access route for construction traffic entering and leaving the depot.

E.1.4 Lissenhall Bridge (Broad Meadow River)

The existing Lissenhall Bridge will be used to carry the alignment over the Broad Meadow River. It is a five span masonry arch bridge over Broad Meadow River and has a total span of 25m. This bridge is on the alignment of the old Dublin to Belfast Road (N1).

A 300mm thick reinforced concrete slab will then be constructed over the existing bridge to assist with strengthening.

As the bridge is located away from the main road alignment there will be no implications for traffic movement on the R132. Access will be provided via a small dead end disused spur off the R132.

E.1.5 Balheary Bridge and Ward River Bridge Section

The existing Balheary Bridge is located on the route of the old Dublin to Belfast Road (N1). The bridge is about 95m south of the Lisenhall Bridge and is a two span bridge over the Ward River with a total length of 8m.

The southbound track will be taken over the existing Balheary Bridge whilst the north bound track will run on a new bridge (Ward River Bridge) immediately to the west of the existing bridge.

Work on the existing bridge will be similar to the Lissenhall Bridge described earlier with a 300mm load transfer slab being cast for reinforcement following maintenance of the existing structure.

E.1.6 Ward River Bridge

This is a new single track bridge which will carry the Metro North alignment in a northbound direction over the Ward River. It consists of piled abutments supporting a deck of precast beams. It has a span of 14.3 metres and is 5.3 metres wide.

E.1.7 Lissenhall Bridges to Estuary Viaduct

This section of the works follows the alignment of the old Belfast Road (N1), to the west of the R132.

The at-grade section will be constructed of ballasted track, with excavated material being disposed of at the depot.

Situated in the west verge of the R132, impact on traffic from this work will be minimal.

E.1.8 Estuary Viaduct

The alignment crosses the Estuary roundabout of the R132 on a new viaduct. This is a 21m span viaduct commencing immediately north of the Estuary Roundabout and ending immediately north of the Seatown Stop. The viaduct will be constructed on piers in the central reservation of the existing road. The piers and foundations can be constructed by coning off one lane of the R132 in each direction for both piling plant and excavation plant to operate.

In order to accommodate the construction of the viaduct the existing roundabouts at these locations will be converted into signal controlled cross road junctions requiring a number of main works stages leading to traffic diversions linked to these stages.

The new viaduct will be constructed using standard civil engineering methods with particular attention to traffic management.

The main spans will be made up of precast segments, installed onto temporary false work until a complete span is erected, with the segments then stressed together. The erection of each span will require the closure of the two outside traffic lanes on the R132. For safety reasons it is likely that the precast segments will be erected at night to minimise the disruption to traffic.

The traffic management proposals are shown on the drawings presented in Drawings 1023-1029, This Appendix.

E.1.9 Estuary Roundabout & Seatown Roundabout Footbridges

The two existing footbridges located at Estuary and Seatown Roundabouts crossing over the R132 will have to be demolished to accommodate the construction of the Estuary Viaduct and the subsequent widening of the R132 in this location. The footbridges will be demolished down to the top of their foundations. Pedestrians will be accommodated via at temporary at grade signalised crossings located in the vicinity.

The outside lanes of the R132 in both directions will be closed while any work is being undertaken within the central reservation. Road traffic can be locally diverted onto the bus lanes for short stretches.

After the footbridges superstructures have been stripped of fittings, a night time/weekend road closure will be required to take down the spans using suitable cranes, and the removed spans will then be broken up and the waste material taken to tip.

E.1.10 Swords Road

Between the Seatown and Pinnock Hill Roundabouts, the southbound carriageway of the R132 will be moved between 3m and 8m to the east to accommodate the proposed Seatown and Swords Stops.

The initial phases of work will be to construct new sections of footpath and carriageway using standard road construction techniques to the east of the existing southbound carriageway. The inside lane of the southbound carriageway on the R132 will be closed during this work. One lane of traffic will then be switched to the new pavement, whilst the new west kerb to the southbound carriageway is installed. The existing road surface will be planned off and replaced. These operations will be planned to allow maintenance of two lanes of traffic throughout the period of the main works.

E.1.11 Seatown Stop

The Seatown Stop is located in the central median of the R132 and comprises two tracks with two side platforms. The alignment is at grade.

E.1.12 Seatown to Malahide Underpass

This short section of track located between Seatown Stop and the start of Malahide Underpass is at grade and is located in the central median of the R132. To allow the construction of the track the existing road will need to be re-aligned in the same manner described for Swords Road above.

E.1.13 Chapel Lane Footbridge

A footbridge, to the south of Seatown Stop, is to be removed to allow construction of Metro North and re-alignment of the R132. After demolition of the existing footbridge, a new longer footbridge will be built to accommodate the widened road in this area. Approach ramps to the bridge are on earth embankments. Temporary footpaths and road crossing points are required to facilitate pedestrian movements across the R132 during the replacement of the footbridge.

E.1.14 Malahide Underpass

Metro North passes under the Malahide Roundabout via an underpass.

Prior to construction of the underpass it will be necessary to demolish the footbridge located south of the Malahide Roundabout in a similar way to those at Estuary and Seatown Roundabouts described above.

A new longer footbridge will be constructed on completion of the Metro North main works to accommodate the road widening in the area. Signalised at-grade pedestrian crossing points on the R132 will be provided until the new foot bridge is opened.

The underpass consists of approach ramps in retained cut in the median of the R132, with a box underpass of the roundabout.

This central box section will be constructed in three phases to accommodate traffic management.

Phase 1. Divert circulatory traffic onto a temporary surface within the southern part of the central island and excavate, cast and backfill the ramp and underpass sections to the south thereby completing the Metro tunnel and ramp to the south. The approach ramps will be constructed as open cut, with the stiff Glacial Till supported by shotcrete and soil nailing as required. This will necessitate closure of the outer (fast) lanes and the bus lanes on the R132 during construction.

Circulatory traffic can then be returned to the south of the roundabout using the present alignment of the lanes. The southern ramp will allow access to the centre of the roundabout without disrupting traffic flow on the circulatory carriageway.

Phase 2. Similarly, divert traffic onto a temporary surface within the northern part of the central island and excavate, cast and backfill the ramp and underpass sections to the north, thereby completing the Metro tunnel and ramps to the north. The approach ramps will be constructed as open cut, with the stiff Glacial Till supported by shotcrete and soil nailing as required. This will necessitate closure of the outer (fast) lanes of the R132 during construction.

Circulatory traffic can then be returned to the north of the roundabout using the present alignment of the lanes. Construction of the ramps will allow access to the centre of the roundabout without disrupting traffic flow on the circulatory carriageway.

Phase 3. Construct the central section of the underpass (about 50m) while leaving the roundabout in operation as at present.

Phases 1 and 2 of this process may be undertaken concurrently.

E.1.15 Malahide Underpass to Pinnock Hill Viaduct

This section track is located in the central median of the R132. Works to re-align the R132 in this area have been described above (see 'Swords Road').

E.1.16 Swords Stop

The Swords Stop is located in the median of the R132, south of the Malahide Roundabout.

The stop comprises two tracks with a central island platform. The alignment is at grade. There will be minimal impact on traffic circulation.

E.2 Description of Main Works Area MN102

Main works will be located along the median of the R132, north of and including Pinnock Hill Roundabout. Between Pinnock Hill Roundabout and Nevinstown Road Junction, the main works are mostly located on the eastern side of the R132. Some works will also be located at the Fosterstown Junction, where the alignment crosses the R132 to run on the western side of this road towards Dublin Airport.

The main works are shown in Drawings 1040 –1044 and Drawings 2020 – 2025 in this Appendix.

E.2.1 Pinnock Hill Viaduct

Metro North crosses the Pinnock Hill roundabout on a new viaduct. The form of construction of this eight span viaduct and its abutments, piers and foundations is similar to that of the Estuary Viaduct, described in Chapter 9, requiring similar road restrictions and closures.

The spans over the roundabout circulatory carriageway will be constructed in a similar way to that described for the Estuary viaduct above. However, at Pinnock Hill the space available for traffic diversions is limited, and it is proposed to erect the spans crossing the roundabout circulatory carriageway by temporary road closures over two short (two day) periods. Traffic will be unable to make some right turns during these closures, but alternative routes are available, and advance signing should provide adequate warning to motorists.

A proposed sequence of traffic diversions enabling construction of the viaduct across the roundabout is shown on Drawings 1040-1044, This Appendix

E.2.2 Fosterstown Stop

The Fosterstown Stop is located to the east of the R132 Swords Road and to the north of Nevinstown Road Junction.

The Stop comprises two tracks with a 6m wide central island platform. The alignment is at grade, although the ground falls away steeply at the northwest corner of the stop.

Stairs and a lift provide access to the platform at the northern end where there is a 4m level difference between the adjacent Swords Road and the stop. At the southern end, the road rises up and a ramped pathway makes up the difference in level to the platform. This Stop provides for bus interchange and bus lay-bys have been provided.

A 300 car park space Park and Ride facility will be provided to the east of this stop.

Although this stop is at-grade, it will be more difficult to construct than the other at-grade stops due to the steeply sloping bank at its northern end. Furthermore a telecommunications tower needs to be moved before construction can commence.

The stop requires construction of a retaining wall that incorporates planters adjacent to the road and a lift/stairs core at its northwest end. A park and ride facility will be constructed to the east of the Stop. This will be entirely at grade so a paved area is required with the appropriate drainage, white lines, directions, lighting and landscaping, all of which can be built by conventional means.

E.2.3 Fosterstown Stop to Fosterstown Underpass

This is a short section of track from the Fosterstown Stop to the underpass ramps adjacent to Airside Retail Park. Over this section the alignment starts to descend through retained cut.

The retained cut will be dug using excavators with support in the form of in-situ reinforced concrete retaining walls.

E.2.4 Fosterstown Underpass

This underpass is required to take the running lines beneath the Airside Retail park access road and the R132. The ramps to the Fosterstown Underpass start just south of Fosterstown Stop and pass close to the Airside Retail Park. A 7.5m wide Fire Emergency Lane is to be retained around the retail units at all times. A single lane of the R132 will be occupied to give construction space to build a retaining wall parallel to the road. Pedestrians can be re-directed via the retail car parks during this work.

The underpass itself commences just north of the Airside Retail Park access road, and angles beneath the R132 to emerge in the Green Belt area, just south of the Texaco petrol station.

This underpass has been designed with a secant pile wall to retain the ground and a cast insitu concrete structure forming the tunnel.

A proposed sequence of traffic diversions enabling construction of the underpass in sections is shown on Drawings 2020-2025, This Appendix.

Construction beneath the Airside Retail Park access road will be in two phases. Initially, there will be a temporary occupation of the southbound filter lane into the Airside Access Road.

The second phase will involve reinstating the filter lane, and providing a slip road onto the R132 southbound in the garden of the adjoining bungalow, south east of the junction. Alternatively, if acceptable to the Roads Authority, a short closure of this access road may be allowed, with traffic diverted via the rear access to Airside Retail Park off Pinnock Hill Roundabout.

Construction across the R132 will proceed in three phases, with construction in the eastern side, centre and western side of the road. Four lanes of traffic (two in each direction) can be maintained around these working areas, though work in the centre of the road will necessitate two lanes of traffic on each side of the site.

Construction of the entire underpass can be completed during the phases described above.

The north and south approach ramps can be constructed in the same way as the Malahide Underpass ramps, so that they are available for removal of spoil from the tunnel between the secant piles.

E.2.5 Fostertown Underpass to Dublin Airport North Portal

Once through the Fosterstown Underpass the route traverses a section of primarily green field land in an open cut, passing under the Fosterstown Accommodation Bridge (part of works). The open cut section will be in ballasted track, constructed using conventional techniques. As the route progresses south, it rises and passes over two small streams where structures will be constructed to carry the alignment. The northern structure will also make provision for agricultural vehicles to pass underneath the Metro. The southern structure is a minor culvert type structure.

Bulk earthworks in this area will be undertaken by conventional means and the construction of track will be on ballasted track.

E.2.6 Fosterstown Accommodation Bridge (Quarry Access)

The Accommodation Bridge carries the Quarry Access Road over the Metro alignment.

During construction of the bridge a temporary traffic diversion across the earthworks will be required to maintain access to the Quarry pre-cast works.

The excavated material in this area is expected to be of good quality, and can be re-used to form the approach embankments to the tunnel portal and tramway embankments further south in the Green Belt area thus minimising spoil that has to be transported to the depot.

E.2.7 Accommodation Underpass and South Culvert

The Accommodation Underpass is to be built in a field so no traffic diversions will be required. This underpass is required to allow agricultural vehicles to pass under the alignment. A turn back is provided for Metro North above this bridge. A temporary diversion

of the small stream will be required around the construction site and similar work will be required at the culvert further south. Access to these structures will be via the Metro North alignment from the Quarry Access Road.

E.3 Description of Main Works Area MN103

The works in this area consist of twin tunnels running beneath the airport connecting the surface line at Fosterstown to the north to Dardistown to the south. The Airport Tunnel ventilation systems will be provided at the North and South Portals as well as at a deep level Stop which will be constructed within the Airport.

The main tunnelling worksite will be located at Dardistown on the south side of the Airport. Here cutting will be excavated and the Tunnel Boring Machine (TBM) erected within this. The tunnel will then be driven and lined using pre-cast concrete segments in a northerly direction beneath the airport to the northern portal. The TBM will then be dismantled and transported back to the southern portal, where it can be re-assembled and the second tunnel bore constructed.

Once both tunnels have been bored and the machine withdrawn, the ventilation plant buildings can be constructed, using in-situ reinforced concrete walls.

The proposed Airport Stop structure is situated under the existing car parking areas at Dublin Airport.

The stop structure is generally on a north south alignment, parallel and to the west of a new road planned at the airport. This road will be completed when the Airport Stop is being built and construction traffic will be conditioned to use this road. Adjacent to the road there is a proposed footway.

A major constraint on the position of the box is an adjacent water reservoir. This is to be relocated ahead of the Airport box construction, but the empty reservoir will be left in place.

The stop box structure is about 144m long and its width will be approximately 33m widened to 36m at the ends. The depth of excavation for the Airport Stop will be approximately 27.5m.

Initially the site will be levelled to form a working platform. The temporary piled retaining wall will be constructed first followed by a capping beam ahead of excavation. Adjacent to the proposed road along the east side of the box, the piled retaining wall will be constructed in stages to maintain pedestrian and cycle movements adjacent to the construction site. Suitable temporary and permanent hoarding lines have been indicated on the work site drawings.

Grouting and ground treatment will then be carried out as required. An initial bulk excavation will take place followed by installation of struts and wailings at each designed excavation level.

Following completion of the excavation and propping of the retaining wall, the excavation will proceed in rock in 4.0m deep stages down to final formation level. The rock slopes will be stabilised using a combination of rock dowels and reinforced sprayed concrete. On completion of all excavation to final formation level, construction of the base slab will take place. Permanent ground anchors will be installed below the formation to provide resistance to uplift of the Stop structure.

A smoothing concrete layer will be cast up against the sprayed concrete slope to act as a back shutter and to provide a smooth surface for the waterproofing layer to be fixed.

The permanent stop structure can be constructed up to and including the concourse slab.

The remaining walls and the roof slab will then be constructed and the excavation backfilled to roof level where upon the area will be handed back to the Airport Authority to construct their surface facilities.

E.4 Description of Main Works in Area MN104

On exiting the Airport tunnel the route rises to grade through a cutting across green field land. The Dardistown Stop is at grade. South of Dardistown Stop the route is in a cutting to facilitate overbridges for Metro West and access roads, and then rises onto a low embankment to the M50 Bridge. The track will be constructed using conventional ballasted track methods.

There is to be a Park and Ride facility constructed to the north of Dardistown Stop which will serve as a construction worksite for the surrounding works. There will be minimal impact on traffic as excavated material and supply vehicles will access / egress the worksite onto the R108 Naul road which leads directly to the M50.

South of the M50 Bridge, the route continues over a small structure (Northwood Overbridge) to Northwood Stop (described below) as ballasted trackform on an earthworks embankment.

E.4.1 Dardistown Stop

The Dardistown Stop is located south of Dublin Airport on a green field site to the north of the M50.

The stop comprises a central island platform, with an additional side platform to the north. The central island allows for the future installation of Metro West tracks in the centre of the platform, leaving two island platforms. The alignment is at grade.

Adjacent to the Stop is a 300 space surface paved car park.

E.4.2 M50 Bridge

This is a 4 span integral bridge 80m long over the M50 motorway. Piers for the new bridge within the new central reservation are part of motorway upgrade works which widen the M50 to three lanes in each direction.

The proposal is to utilise precast elements wherever possible, so the piers and deck beam elements would be precast, with a cast in situ concrete deck. All of the precast elements could be constructed off site with minimum disruption to the operation of M50.

For erection of precast piers, two lanes on one side of the motorway would need to be blocked off (for crane operation) and one lane on the other side of the motorway for access and safety. Alternatively, traffic could be diverted via the slip roads and the Ballymun Interchange. This diversion route could also be used during placement of the main bridge deck beams, as the lanes under the span being erected would need to be closed. This work would normally be done at night. The slip road spans would be erected during a night time closure of the relevant slip road.

E.4.3 Northwood Overbridge

This is new small bridge in an area of little traffic.

Large lorries access the nearby Tesco Warehouse but they do not pass under this bridge. Access to four adjacent houses can be maintained by a temporary diversion around the works during construction.

Before construction of this bridge can start, the driveway to a St Anne's House to the east will have to be realigned to allow the owner access to his property. Bridge piles can then be installed from ground level, and then extended to the correct height and the capping beam cast. The precast deck units can then be placed and the concrete deck poured. When the deck has been poured the backfill and reinforced earth wing walls can be installed.

E.4.4 Northwood Stop

The Northwood Stop is located south of the M50 and to the east of the R108 dual carriageway road. The stop comprises two tracks with a central 8m wide island platform. The alignment is at grade.

E.5 Description of Main Works Area MN105

E.5.1 Ballymun Road

From Northwood Stop the tracks descend into a retained open cut and then into cut and cover tunnel which runs down the Ballymun Road. The cut and cover tunnel from Santry Portal to Ballymun Stop is nearly 1.0km long with a further 1.0km from Ballymun Stop to DCU Stop. Ballymun Road is generally 25.3m wide and gently falls about 11m from Santry down to DCU.

Busy junctions at Santry Retail Park, Santry Avenue, Shangan Road and Collins Avenue must be kept operational at all times. The traffic diversion phasing drawings in This Appendix describe how this can be achieved.

The cut and cover construction in this area will be achieved using diaphragm wall techniques. After placing the walls, the initial excavation would be to the underside of the tunnel roof. Then, using the excavated surface as formwork for the roof, the roof can be poured.

When the roof has been cast, the soil beneath can be excavated and removed by conveyor belt from below down to about 300mm above the base level. Internal struts would then be installed before excavating for the base slab, which would be cast in panels between struts.

Once the base slab has been installed and design strength reached, the temporary struts can be removed and the central dividing wall cast and grouted up to the roof slab. Back fill can then take place and traffic can then be diverted over the area.

In confined areas, to suit the traffic management, the cut and cover tunnels will need to be constructed in two halves with the central wall being constructed from the surface as a piled wall, minimising the area of carriageway occupied at any one time, but increasing the duration of construction. Constructing in two halves would also allow the road to be re-instated over the tunnels as soon as the roof slab had cured, minimising the period of surface disruption.

Alternatively, it would be possible to construct the tunnels entirely from the surface. This approach would require longer periods of road diversion, but may well shorten the overall construction periods assumed herein.

It is envisaged that construction will proceed from the Santry and DCU ends of the tunnel, with excavated material extracted to compounds at these points.

A proposed sequence of traffic diversions enabling construction of the tunnel in sections is shown on the drawings in This Appendix.

E.5.2 North of Santry Cross

In this area the tunnels can be constructed by diverting four lanes of Ballymun Road to the west of the tunnel works. This will require the use of a strip of land 8m wide to the west of the existing highway boundary. Temporary diversions of the access road to the Santry Business Park will be required to maintain this important access.

E.5.3 Santry Cross

The northern half of the tunnels across this junction can be constructed by diverting crossing traffic to the south of the works, and the southern half of the tunnels by diverting crossing traffic to the north. Side road traffic will be restricted to one lane in each direction during the work.

E.5.4 South of Santry Cross

As the tunnels are widened in this area for jet fans, it will be necessary to construct each half of the tunnel separately. The southbound tunnel can be built with two lanes of traffic on each side, and the northbound tunnel with four lanes to the east.

E.5.5 Santry to Ballymun Stop

In this area the tunnels are located towards the east side of Ballymun Road, so that traffic diversions will provide 4 lanes to the west of the works, encroaching onto the existing open space outside the Ballymun Flats.

E.5.6 South of Ballymun Stop

The tunnels are centrally located in the road, and traffic will be diverted onto two lanes each side of the tunnels.

E.5.7 Collins Avenue Cross roads

The northern half of the tunnels across this junction can be constructed by diverting crossing traffic to the south of the works, and the southern half of the tunnels by diverting crossing traffic to the north.

E.5.8 Ballymun Stop

This is a 10m deep cut and cover stop, with side platforms located beneath the Ballymun Road. The main stop entrance is at the north east of the stop at mezzanine level with access directly to a proposed public Plaza area.

A proposed sequence of traffic diversions enabling construction of the Stop in sections is shown on the drawings in This Appendix.

The first stage of construction of the Stop will be to divert four lanes of road traffic (two northbound, two southbound) to the west of the main box footprint, necessitating the

occupation of an 8m strip of land to the west of Ballymun Road currently proposed for development of a Treasury Holdings Shopping Centre. During this stage it will be necessary to close Shangan Road, and to divert local traffic along Coultry Road, to a new temporary signal controlled junction with Ballymun Road some 150m to the north. This will allow the construction of the main box including walls, excavation, base slab insitu concrete works and roof slab.

On completion of the roof slab, Ballymun Road can be reinstated, and traffic diverted over the main box, to allow the western Stop access corridors to be constructed.

As a final stage, northbound and southbound road traffic will need to be diverted each side of the south western plant room areas opposite Silogue Crescent. This will necessitate reducing the footway width outside the flats opposite the Civic centre to 2m.

E.5.9 Dublin City University (DCU) Stop

DCU Stop is to be built on the strip of land between Ballymun Road and the houses to the east of Dublin City University which is presently a public lawn with trees. The Stop box is some 212m long, 17.7m wide and 9.8m deep. To facilitate the Stop No.1 Albert College Lawn will be demolished as well as Westfield House, which lies within a walled garden. The eastern wall to the garden will be retained.

The station box comprises two distinct types of construction. The first is the station itself where there is a clear height from the platform up to the curved arch shaped roof with its light well, and the second is the plant rooms at the north and south of the platforms where there is an intermediate floor between the top of the tunnels and the ground level. Between the platforms and plant rooms at both the north and south of the platforms there are the lifts and stairs to the surface.

The proposed method of construction is to use 1000mm diaphragm walls in the platform and lifts/stairs sections, and 800mm thick diaphragm walls in the plant room sections. The box can be excavated either by top down or bottom up construction.

To install the diaphragm wall it will be necessary to take the bus lane along Ballymun Road and these lanes will be needed until the ground level slab has been cast and the road reinstated.

E.6 Detailed Description of Main Works in Area MN106

From Hampstead Park to St. Stephens Green, Metro North's alignment is located within a bored tunnel. The site at Hampstead Park will facilitate spoil removal from the Tunnel Boring Machines (TBMs). There is a stop located north of Griffith Avenue, between The Rise and Walnut Rise.

St. Patrick's Ventilation Shaft will be located within an existing sports field off Millbourne Avenue, beside St. Patricks College. Excavation of this shaft will mostly occur from within the tunnel, thus reducing the required activity above ground and minimising the effect on the locality.

The next stop, Drumcondra, is located just north of Drumcondra station (DART). The final stop in this area is located within the Mater Hospital, Phibsborough.

On leaving the Dublin City University Stop the route remains in a cut and cover section along the east margin of the R108 adjacent to Albert College Park Road and then turns to the south east through Albert College Park. The tunnel portal will be constructed in the park from where the route will enter a twin bore tunnel for the remaining distance to St. Stephen's Green.

Albert College Park is currently a large open space containing sports pitches and other leisure amenities. For the duration of the main works this area will be used as the main tunnelling worksite with the permanent works cut and cover tunnels being constructed concurrently with bored tunnelling activities.

Both the temporary uses of the park as a work site and the permanent works are described below.

E.6.1 Cut and Cover through Albert College Park (including TBM portal)

The proposed cut and cover tunnel runs from the south end of DCU Stop to the TBM launch portal. The length of the works is approximately 530m.

Thus the depth of excavation (formation level) for the cut and cover varies from approximately 10.95m below ground level at the shallowest portion to 21.8m at the deepest portion.

Horizontally, the tracks run in separate cut and cover cells from the south of DCU Stop for approximately 60m where they merge into a twin cell box for a further 145m. As the tracks diverge to achieve the required separation at the tunnel portal, they are once again situated within separate cells.

A dedicated site access will be provided into Albert College Park from Ballymun Road. There are a large number of small trees along the Ballymun Road side of the park, and the exact access and egress points to the site are located to minimise the number of trees to be removed.

Worksite drawings and traffic management proposals are indicated on the drawings in Appendix C.

Before the installation of temporary retaining structures can commence, the site will be levelled to form working platforms at the various construction areas.

The cut and cover works has been divided into 3 different forms of construction as detailed below. These have been adopted as they best suit the surface constraints and excavation depths required.

- Diaphragm walls - Tunnel portal;
- Contiguous Bored pile retaining walls; and
- Soil nailed and sprayed concrete slopes.

The tunnel portal area will be constructed first to give the earliest possible date for commencement of the bored tunnel works.

The contiguous piles and soil nailed slopes will follow afterwards to meet the overall project programme.

TBM Portal (diaphragm wall)

The temporary retaining wall (diaphragm wall) will be constructed first followed by a capping beam ahead of excavation. If required, shear pins will be installed through the base of the piles to provide extra toe stability.

An initial bulk excavation will take place followed by installation of struts and walings at each excavation level. The final formation level will be 100mm below the underside of the cut and cover structural base slab to allow for a blinding layer.

During excavation temporary sump pumps will be installed at each level to dewater groundwater inside the walls. On completion of all excavation to final formation level the temporary sump pumps will be left in place to keep the area dry during construction of the permanent structure.

The base slab will be cast, following which the first TBM will be launched. The second TBM will be launched approximately 2 months after the first. Once the TBM operations have been completed, the remaining portion of the cut and cover structure will be cast and waterproofed.

Backfilling operations will continue up to original ground surface, where the capping beams will be broken out to 2m below ground level and the original landscaping to the area will be re-instated.

Contiguous Bored piles

The construction of this section will follow a similar sequence to that outlined above for the tunnel portal area. There will be a requirement to phase the works around the entrance to DCU and the overall depth of the works will be significantly less than the portal area. Traffic management layouts are presented in Appendix C.

E.6.2 Soil Nailed slopes

It is likely that this section of the work will commence after the tunnel portal area has been completed. As no retaining walls are required to be installed, this operation will commence with mass earth moving to reduce the ground levels. As the excavation proceeds, soil nails will be installed to strengthen the ground and if necessary, sprayed concrete will be applied to protect the face of the excavation against the weather.

Once formation has been reached, a similar method of construction to that outlined below for the tunnel portal area will be adopted. Following backfill, the park will be re-instated to its original condition.

E.6.3 Albert College Park Worksite

The main tunnelling worksite will be set up in Albert College Park. In summary the park is bordered to the west by the Ballymun Road, to the south and north by residential housing, and to the east by Dublin City University (DCU).

Approximately 7,000m^2 of site area will be required to carry out the tunnelling works, with road access limited to Ballymun Road.

This site has been selected for the construction of the majority of the bored tunnel works because of its proximity to good traffic routes directly out of the city centre and the available space for a major tunnelling worksite.

E.6.4 Tunnel Works Overview

To construct the running tunnels between the Albert College Park portal and St. Stephens Green two mixed mode Tunnel Boring Machines (TBM's) which will be specifically designed to meet the local ground conditions and environmental constraints will be used. Each machine will drive independently in a southerly direction. The tunnels will pass through a variety of hard rocks, clays, sands and water bearing gravels, and the working modes of the TBM's will need to be changed to suit each ground condition as it is encountered. The tunnels will be constructed using industry standard methods for segmental lined tunnels incorporating best practice to minimise face loss.

Cross-passages

Cross-passages will be constructed at approximately 250m intervals along the bored drives in order to interconnect the running tunnels in the case of emergency evacuation and rescue.

These cross-passages will need to be excavated in a variety of ground conditions. The design for each cross-passage will therefore need to be adapted to suit the conditions at each location.

E.6.5 Griffith Avenue Stop

The proposed Stop at Griffith Avenue will be in a cut and cover box located just north of Griffith Avenue, the main entrance to the box being adjacent to the road.

The proposed Griffith Avenue Stop structure is situated beneath open grass land on the north side of Griffith Avenue and to the west of Walnut Rise. The stop location is constrained by the trees running along Griffith Avenue at the south end of the stop and by private land to the north end of the stop.

The final formation for the stop structure will be at a depth of excavation of approximately 25.2m.

A dedicated site access will be provided from Griffith Avenue. There are a large number of mature trees along Griffith Avenue and the exact access and egress points to the site have been located to avoid the removal of trees. Traffic management proposals are indicated on the drawings in Appendix C.

The proximity of Griffith Avenue and houses on the opposite side of Griffith Avenue precludes the adoption of an open cut method of excavation and the construction of a braced wall system will be necessary.

The depth of excavation for the Griffith Avenue Stop will be 25m. The length of the excavation will be 146m and its width will be 25m widened to 29m at the ends.

The preferred method of ground support is either by interlocking secant piles or by contiguous piles bored into bedrock with multi-level struts and wailings.

The sequence of excavation will be similar to that at the Airport Stop (see Chapter 11).

Once the excavation is completed the permanent structure can be constructed to roof level. Backfilling operations will continue up to original ground surface where the final landscaping proposals will be constructed.

E.6.6 Intervention Shaft

A shaft to facilitate ventilation and emergency evacuation to the tunnels is required between Grifffith Avenuue Stop and Drumcondra Stop.

A 14m diameter shaft is located in the South West Corner of St Patricks College. Tehre will be an entrance to the site from Millbourne Avenue established. The site will include:

Shaft

- Install secant piles or other temporary support to upper soft ground strata. Install guide beam to enable installation of the secant piles. Construct piles.
- Construct capping beam and commence shaft excavation in suitable rounds according to ground conditions and the ground water presence.

- Specific attention will be paid to groundwater control as dewatering of the ground may generate consolidation settlements that could affect adjacent structures.
- Install temporary ring beams as excavation progresses. The excavation sequence is repeated until engineering rock head is reached.
- As the rock mass is found it is likely that mechanical methods and limited blasting will be required to excavate the shaft and tunnels. Vibration predictions are required and monitoring to validate the predictions. Noise and vibration limits are included in the Environmental Impact Statement.
- Excavation of the shaft in the rock carried out using a Sequential Excavation Method, (SEM). Primary support consisting of sprayed concrete, lattice girders and rock bolts.
- Ground water inflow to be controlled. If water inflow has potential to drawdown water in upper levels and create consolidation settlement then either a re-injection system or permeation grouting should be considered.

Ventilation Tunnel and Cross Passage

- Construct temporary shaft base at ventilation level. Form opening, excavate and support ventilation tunnel using SEM.
- Excavate to base of shaft and construct base slab. Provision for the sump shall be made. Install any permanent anchors required for floatation control.
- Form openings in vent tunnel and excavate cross passage up to running tunnel position.

Connections to running tunnels

- Final sequence depends on whether shaft and connections are constructed before or after the running tunnel TBM's have passed the shaft location. Assume most likely scenario that running tunnels are constructed before connection is made. Install propping to running tunnel segments.
- Break out from running tunnel and excavate junction. Install primary lining support and form junctions with ventilation tunnels and cross passage connections to main shaft.

Sump and Lift-pit Construction

- Excavate area for sump and lift pit in base of shaft. Construct drainage openings in running tunnels. Bore drainage pipe from running tunnel to sump. Install any permanent anchors required for floatation control.

Permanent Lining

- Install geotextile fleece and waterproofing. Fix reinforcement, install shutters and cast secondary lining. Process covers running tunnel junctions, ventilation tunnels, cross passages, sump structures and main shaft. In upper levels of shaft structure any temporary ring beams are removed.

Shaft Internal Structures

- Construct internal ventilation dividing walls, staircase and lift well.
- Install internal structures including stairs.

Head House Construction

- Removal of made ground and excavate to base slab level.
- Construct foundations for structure.
- Construct structure.

M&E/Systems installation

- Install shaft and tunnel services, ventilation systems, communication systems, signalling equipment.
- Install permanent water supply, power supply, and drainage water connection to existing sewer system
- Undertake testing and commissioning.

Urban Context – Site Layout

- Complete surface works including permanent roads, fencing, gates, landscaping and reinstatement of areas used as part of the temporary work site.

Emergency Cross-over

Work on the crossover will begin when the first TBM reaches its park up position at St Stephens Green. Additional ground reinforcement measures throughout this area of cavern will be installed before the dismantling of segmental tunnel lining and start of excavation works. These include items such as fibre reinforced bolts, spiling and fissure grouting as required according to detailed structural study.

The segments will then be propped and broken out at the location of bifurcation/step plate chamber and the rock removed to the finished profile utilising sprayed concrete and rock bolts for support.

Excavation will be carried out using either drill and blast methods or impact hammers for the rock breaking, with primary support in the form of shotcrete, bolts, mesh and fibres as required by the design.

On completion of the excavation, secondary lining works as detailed below will be carried out.

The second bifurcation/step plate chamber will be constructed from the second running tunnel using the same techniques as before again once the Tunnel Boring Machine has reached the park up position at St Stephen's Green.

E.6.7 Drumcondra Stop

The proposed Drumcondra Stop structure is situated in land to the west of Drumcondra Road and adjacent to St. Joseph's Avenue. The pedestrian entrance to the stop will be from the Drumcondra Road through a new development.

At the southern end of the Stop is the twin-track Maynooth Railway Line which runs on a retained embankment and on a small bridge over St Joseph's Avenue, while at the northern end of the stop there are houses on St. Alphonsus Road Lower.

Existing buildings and structures constrain the length of the proposed stop structure.

The depth of excavation for the Drumcondra Stop will be approximately 27m below the temporary site formation level. The length of the excavation will be approximately 103m and its width will generally be 20m.

Construction access to and from the stop will be provided from Drumcondra Road. There will be no access from St Joseph's Avenue. In order to gain access to the site, it will be necessary to demolish the Catholic School for the Deaf. Traffic management proposals are indicated on the drawings in Appendix C.

Before the installation of temporary retaining walls can commence, the site will be levelled to form a working platform.

The close proximity of St. Joseph's Avenue, St. Alphonsus Avenue, the Maynooth Railway and houses precludes the adoption of an open cut method of excavation and the construction of a braced excavation will be necessary.

The sequence of excavation will be similar to the Griffith Stop but with extensive grouting and ground conditioning required following pile installation to limit water inflow into the Stop during excavation.

E.6.8 Mater Stop

It has been assumed that the construction of the Mater Stop Box will be done as advance works. Its sequence of construction would be similar to the other cut and cover boxes.

E.7 Detailed Description of Main Works in Area MN107

E.7.1 Parnell Square

The Parnell Square stop structure is situated beneath Parnell Square East. On the east side of the proposed stop there is a row of four storey brick built period properties with basements that extend under the footway and possibly under the road. It is believed that these structures were built from a lower ground level and the existing road level was built up to its present level. On the west side of the stop there is a drop in level from Parnell Square East down to the Rotunda Hospital grounds. To the north of the stop is the Garden of Remembrance and Abbey Church and to the south of the stop there is the Gate Theatre. These constraints limit the size and construction options of the stop structure at this location. Construction of the stop is further constrained by the need to maintain access for buses and emergency vehicles along Parnell Square East through the construction period.

The stop box structure is approximately 128m long and 24m wide, with a 43m long central section widened to 38m. The construction of Parnell Square Stop will be carried out within a constrained site. Due to the restricted nature of this site, diaphragm wall cage fabrication will need to be carried out at a remote location and completed cages will need to be transported to site.

Before the installation of the walls for the stop box can begin, the site will need to be levelled to form a series of working platforms to suit the sloping topography. The working platforms will be topped by a designed piling mat.

A temporary construction deck spanning between the diaphragm walls will be required to provide access to the excavation area. This will be installed prior to commencement of excavation.

It is expected that extensive grouting of the overburden and the soil rock interface will be required to reduce ground water inflow into the excavation. This will be carried out ahead of excavation.

The depth of excavation needed and the requirement to limit ground and building movements at the Parnell Square stop will necessitate the use of rigid diaphragm wall construction for the excavation down to formation level. The diaphragm wall in combination with multi-level struts and wailings will act as the temporary retaining wall during excavation stage as well as the permanent wall for the stop box structure.

In order to limit ground movements associated with the excavation of the diaphragm wall the panel lengths have been limited to 3m in length. Walling may need to be undertaken during restricted working hours to accommodate the Rotunda Hospital HARI unit at the south west corner of the box, which is sensitive to vibration.

Following installation of the diaphragm wall panels, the shear pins/tension anchors will be installed through the base of the diaphragm wall prior to a capping beam being constructed ahead of excavation.

Excavation will be in stages, with the installation of temporary struts and wailings at each designed excavation level. In addition the permanent waling beams and props will be constructed as excavation progresses downwards (Top Down construction). The lowest level of temporary struts will be installed close to the formation level and will be removed after casting and curing of the concrete base slab. The temporary struts below Mezzanine floor level will need to be removed before arrival of the TBM's.

It will be necessary to lower the water table within the box ahead of excavation so that works are carried out in a reasonably dry environment. This may be achieved by temporary sump pumps installed at each level to de-water the ground inside the excavation or subject to design and detailed site investigation information it may be necessary to install deep wells from original ground level and commence dewatering at an earlier stage of the excavation. The dewatering method will be left in place to keep the excavation dry during construction of the base slab.

Firstly, this stop is formed by installing these diaphragm walls to form the walls of the box, installing a temporary working deck and then excavating the box down top formation. The internal structure of the stop will then be cast in concrete. The major civil engineering element of the work is expected to last 36 months.

In order to continue bus routes in this area, a traffic lane will be maintained along Parnell Square East at all times. To achieve this, the works will be carried out in phases as indicated in the phasing diagrams in this Appendix.

O'Connell Street

This is a complex stop with entrances located on either side of the River Liffey. On the south side of the river, the works are on Westmoreland Street between Fleet Street and the Quays, whilst to the north of the river the works are on O'Connell Street between Abbey Street and Eden Quay.

The work of constructing the stop on both sides of the river will be by installing secant piles to form the walls to the stop and then installing a temporary steel road deck to facilitate traffic movements, whist excavating the stop below.

During the course of the construction works it is required to maintain a number of traffic lanes on both O'Connell Street and Westmoreland Street. To facilitate this, the worksite is split into a number of differing areas as shown on the phasing drawings contained in this Appendix.

The main tunnels for the proposed O'Connell Bridge Stop will be located within the limestone strata beneath O'Connell Bridge over the River Liffey. North and south of these tunnels cut and cover boxes are to be provided to house the main station equipment rooms (including ventilation plant), lifts, escalators, emergency escape stairs and the Stop entrance ticket halls.

The cut-and-cover boxes are located to the north of the Liffey on O'Connell Street South between Abbey Street and Eden Quay, and the south box on Westmoreland Street between the Quays and Fleet Street. The boxes are linked by a central concourse tunnel of approximately 12m diameter.

The redevelopment of the Carlton Site on O'Connell Street and Arnotts off Henry Street/ Middle Abbey Street may run concurrently with some of the construction works of the O'Connell Street stop.

Method of Construction

North Stop Box

- **O'Connell's Statue** - It will be necessary to carry out significant piling and excavation activities in very close proximity to this structure and therefore the risk of either accidental damage or damage due to settlement effects, particularly from the construction of the concourse tunnel, will be significant. It is therefore recommended that this structure be temporarily relocated for the duration of the works.
- **O'Brien's Statue -** This structure will be directly affected by construction of the north stop box. Therefore, it will require removal from its current location in the O'Connell central median to a suitable temporary or permanent location in order for construction to take place.

- **Stop Boxes -** Construction of both North and South cut and cover boxes will require a rigid retaining wall system (secant piles) to allow excavation to rock head level. Below this level every hard pile will be drilled to depth or vertical anchors installed via reservation tubes in areas where a vertical rock cut slope is required.

The retaining walls will be installed in phases to accommodate pedestrian and vehicle movements. Proposed sketches of these phases are included in This Appendix.

On completion of the piling works being carried out in phases, the ground will be excavated and a temporary road deck or working platform will be installed. This excavation will be sequenced in with archaeological excavations as detailed above.

Grouting of the soil rock interface will be required to reduce ground water inflow into the excavation. This will be carried out ahead of excavation.

Excavation will be carried out in stages from beneath temporary work platforms through access hatches. Support will be applied as required in the form of props, anchors, sprayed concrete.

On completion of excavation, blinding concrete water proofing will be installed and the base slab will be cast. The walls, slabs and roof structure will then be cast after waterproofing has been applied. Lining concrete will be cast in-situ for public areas with sprayed concrete as an option in non public areas.

Tunnelling Works

Excavation will take place using drill and blast methods or a combination of drill and blast and impact breaker mounted on tracked excavators in progressive enlargements within these chambers until the full diameter is reached. Ground treatment will be required ahead of the excavations to reduce inflows of water to an acceptable level. Support to the excavations will be by a combination of rock anchors and sprayed concrete applied sequentially in layers and reinforced with fibres or with lattice arch girders.

Following on as closely as possible from the excavation of the main tunnels the cross passages, equipment rooms and ventilation tunnels and connections will be excavated, using the same methods as described above. As for the main tunnels, ground treatment will be required ahead of the excavation to reduce inflows of water to acceptable levels. The openings between the central concourse and stop boxes will be excavated at the last stage as breaking through the stop box structure will only be possible after the boxes have been excavated and the main walls including supports to the openings constructed.

Following the installation of waterproof membrane lining of all the public area tunnels will be in in-situ concrete, with sprayed concrete linings being utilised in non public areas.

Sequence of Construction

North Stop Box

The general construction sequence will be as follows:

- Re-locate substations & statues;
- Carry out first phase of utility diversions;
- Divert traffic to west side of road;
- Set up worksite, construct secant pile walls west side of box and carry out ground treatment around toe of piles;
- Excavate to underside of temporary road deck (approx. 4m deep), installing temporary ground support as necessary. Suitable allowance to be made in excavation for archaeological investigations;
- Install temporary road deck;
- Divert traffic to the east side of the road and carry out the second stage of service diversions;
- Complete construction of the secant pile wall on the west side of the road and carry out ground treatment around toe of piles;
- Install suitable working platform, leaving suitable openings for excavation of box top down;
- Excavate to formation installing temporary support as required;
- Excavate to final depth (approx 32.6m deep), excavation in bed rock and blind base;
- Construct tension piles/anchors against flotation;
- Install formwork and reinforcement and cast base slab;
- Install waterproof membrane to walls and construct lining walls to box;
- Cast walls and floors removing temporary propping as required;
- Builders-work, M&E installations & Architectural finishes to box; and
- Divert traffic back onto the east side of O'Connell street south and remove the temporary road deck, reinstating the road and leaving it open to traffic.

South Stop box

- Carry out first phase of utility diversions;
- Divert all traffic to D'Olier Street and close Westmoreland Street;
- Set up worksite, construct walls in sequence;

- Excavate to underside of temporary road deck (approx. 4m deep), installing temporary ground support as necessary. Suitable allowance to be made in excavation for archaeological investigations;
- Install working platform;
- Excavate to formation installing temporary support as required;
- Excavate to final depth (approx 32.6m deep), excavation in bed rock and blind base;
- Construct tension piles/anchors against flotation;
- Install formwork and reinforcement and cast base slab;
- Install waterproof membrane to walls and construct lining walls to box;
- Cast walls and floors removing temporary propping as required; and
- Builders-work, M&E installations & Architectural finishes to box.

Tunnel Construction

- Divert services for temporary shafts and set up worksite;
- Construct temporary access shafts, including ground treatment;
- Excavate platform tunnels, maintaining approximately 30m minimum between working faces and carrying out ground treatment of rock as necessary;
- Excavate central concourse, working a minimum of 30m minimum behind the platform tunnel faces and carrying out ground treatment of rock as necessary;
- Working a minimum of 20m behind the concourse face commence excavation of the cross-passages and plant rooms and carrying out ground treatment as necessary;
- Cast invert concrete to platforms for passage of running tunnel TBM's;
- Install waterproof membrane and cast secondary lining to concourse and cross-passages;
- Construct suspended slab concourse;
- Following passage of running tunnel TBM's complete installation of waterproof membrane and complete secondary lining to Stop platform tunnels;
- Working from previously excavated Stop boxes excavate ventilation tunnels and connections, install waterproof membrane and cast secondary lining; and
- Builders-work, M&E installations & Architectural finishes to tunnels.

TBM Interface

To give the best overall programme for the construction of O'Connell Bridge Stop, the platform tunnels will need to be excavated and first stage invert concrete placed prior to the arrival of the running tunnel TBM's. This will allow the TBM's to be driven through the

O'Connell Bridge stop by building temporary segments in the invert of the tunnel behind the TBM and shoving off these to advance the machine.

Tunnelling from O'Connell Bridge Stop to St Stephens Green Stop

The tunnels will be driven from O'Connell Bridge to St Stephen's Green through the Limestone bed rock. This section of tunnel will be driven up grade passing under Westmoreland Street between the Bank of Ireland and Trinity College before heading along to the west of Grafton Street to St Stephens Green. An emergency crossover will be provided south of O'Connell Bridge Stop.

Method and Sequence of Construction

The anticipated geology through which the tunnels will be constructed is Limestone which should enable the TBM's to be operated in open modes.

On arriving at St Stephen's Green the cutting head and main body of the TBM's will be dismantled and removed via St Stephen's Green Stop box. Concurrent with this operation the back up sledges to the TBM's will be transported back through the tunnels for removal at the Albert College Park worksite.

Following on from the removal of the sledges, the temporary rails and conveyor belt will be removed and the invert to the running tunnels will be sequentially cleaned out working back towards Albert College Park. This will be followed by the placing of the first stage invert concrete in readiness for track laying and tunnel fit out.

Emergency Crossover

The crossover will be constructed from the running tunnels once the TBM's have been driven past. The Crossover tunnel will be suitably enlarged from both the north and southbound running tunnels in the same manner as the crossover north of the Drumcondra stop again using drill and blast techniques and excavated until the entire crossover has been built. Primary support will be with shotcrete, mesh and rock bolts.

St. Stephens Green

The construction of this underground stop will take approximately 5 years to complete.

The stop will be excavated within diaphragm walls to retain the upper part of the stop with rock bolting and sprayed concrete used as support as the excavation proceeds to depth. A combination of Top Down and Bottom Up techniques will be used in the construction of the station.

For a period of approximately 27 months parts of the roads on St Stephens Green North and West will be occupied by the construction work site. This will mean that the current through traffic from St Stephens Green North through to Glovers Alley will no longer be an available

route. After completion of these works, the road will remain permanently closed to through traffic as it will form part of the route for Luas Line BX. The phases of the main works are shown in drawings included in this Appendix.

The proposed St Stephen's Green Stop structure is situated predominantly beneath the north and west corners of St Stephens Green. The Ticket Hall area extends out into St. Stephens Green North and St. Stephens Green West with entrances provided from both of these areas. Emergency escape and vent structures are located within St. Stephens Green Park.

This stop is to form an interchange with the proposed Iarnród Éireann Interconnector Station that is located to the east of the Metro stop and at a deeper level. It is proposed to have a combined ticket hall serving both stations.

On St Stephen's Green North and West there are a number of shopping centres, shop premises and hotels. Access to these premises and adequate footway provision will be maintained at all times during construction.

The south end of the structure is at approximate chainage 18860 and the north at 18706 giving a length of the stop structure of 154m. The width of the main box structure is 34m. The ticket hall area is irregular in shape but is generally 73m wide and 42m Long.

Ground level in the Park is at about 11mOD. The twin rail tracks through the stop are parallel, straight and level with rail levels at -10.280mOD. The Iarnród Éireann platform level is located beneath the Metro North platform level. The approximate Iarnród Éireann Rail level is -17.145mOD. The maximum depth of excavation for the St Stephens Green Stop will therefore be approximately 28m below existing ground level.

Archaeology

The main area of potential archaeology will be within the Park itself, and would consist of shallow fortifications associated with the 1916 Easter uprising.

Once the site has been given over to Metro North and initial hoarding works carried out, the Park area will be made available to the archaeological team for a suitable period to carry out their work.

Geology

The anticipated ground conditions consist of Made Ground between 1m and 3m thick, overlying Glacial Till to depths of between 4m and 8m below ground level. Glacial Sands and Gravels, which are likely to be water bearing and have a high relative permeability, generally underlie the Glacial Till, although are absent locally. The depth to bedrock is likely to be between 6m and 10m below ground level. Bedrock consists of the Lucan (Calp) Limestone Formation. 'Blowing' sandy gravel was recorded during the formation of an exploratory hole located close to St. Stephen's Green at depths of between 6m and 7m below ground level.

Reference should be made to the inferred geological sections and geotechnical reports contained in the Data Room for further details

Utility diversions

Before main construction activities can take place along St Stephen's Green North and West, it will be necessary to establish a Utility Corridor / Zone around the edge of the construction site. This utility corridor will be under the existing road and footway around the outside of the site. RPA are currently working to relocate all major utilities into this zone before commencement of diaphragm wall activities.

The utilities will experience movement during the construction activities and consideration should be given to placing them within a culvert or box structure so that adjustments can be made to the level of the utilities during the works.

Method and Sequence of Construction

Site Formation

Before the installation of the walls for the stop box can begin, the site will need to be levelled and working platforms constructed to suit the topography of the site. The working platforms will be topped by a designed piling mat or blanket, to enable the diaphragm wall plant to work in a safe manner. This mat will be drained by perimeter U-channels through primary treatment to catchpits and an outfall connection.

Temporary / Permanent Retaining Structures

- **Ticket Hall Area** - The depth of excavation required for the current box layout and the requirement to limit ground and building movements along St Stephen's Green North and West will necessitate the use of rigid diaphragm wall construction for the excavation down to formation level. The diaphragm walls in combination with multi-level struts and walings will act as the temporary retaining wall during excavation stage as well as the permanent wall for the stop box structure.
- **Main Box -** The proposed method of ground support for the main Stop box is diaphragm walling into bedrock with multi-level struts and wailings. Detailed design will determine toe stability requirements for the walls, and if found necessary increased toe stability may be provided by either deeper rock sockets or by shear pins installed through the bottom of the piles.

Ticket Hall Area

- RPA have expressed a desire for the area around St Stephens Green North and West and the south end of Grafton Street to be returned back to the public as soon as possible after the commencement of construction activities. It is also possible that the proposed Luas BX line construction will commence during the Metro North construction

period. In order to comply with this requirement of an early hand back of this area, it is proposed to construct the Ticket Hall portion of the stop box in a Top – Down manner;

- At the same time as the installation of the perimeter wall, a series of piles will be installed throughout the ticket hall area with Top – Down stanchions inserted to enable the support of the roof slab above. The Top – Down stanchions will be positioned so that they can be incorporated in to the permanent stop structure;
- Grouting of the soil rock interface may be required to reduce ground water inflow into the excavation. This will be carried out ahead of excavation;
- Excavation methods could include backhoe excavation through the soft ground with rock being removed by various methods including ripping, impact breakers, hydraulic breaking, chemical splitting, low VOD pyrotechnics and traditional drill and blast;
- Once the walls and stanchions are complete, the ticket hall area will be excavated to the underside of the roof slab and the roof slab cast across the area that is to be handed back early. Waterproofing and protection to the waterproofing will be laid and the area backfilled. Allowance will be made for the future Luas track works and the roads, drainage and footpaths will be reinstated. The Memorial Arch could be re-erected at this time; and
- Excavation and construction of the stop below the roof slab will then be carried out from the main box excavation within the park.

Main Box

- The sequence of excavation for the main box will be similar to that at the Griffith Avenue Stop;
- Excavation methods could include backhoe excavation through the soft ground with rock being removed by various methods including ripping, impact breakers, hydraulic breaking, chemical splitting, low VOD pyrotechnics and traditional drill and blast;
- During excavation and construction groundwater levels will be maintained in the surrounding area to minimise the impact of the works on surrounding vegetation and trees;
- The TBMs will arrive during the stop construction period, and will be broken up and their heads removed through the stop structure with the backup equipment withdrawn through the tunnels;
- Adequate space provision has been made in the stop design for the arrival and removal of the TBMs. A suitable vertical access shaft should be left through the structure to allow the removal operation to take place;
- Following completion of the main civil structures within the stop box, the Builders work, M&E fit out, Architectural fit out and testing and commissioning phases can take place; and

- Backfilling operations will continue up to original ground surface and the area will be handed back. The original appearance of the park will be re-created before handing back to the OPW / Parks Authority.

St Stephen's Green Loop

In parallel with the stop box excavation, the loop tunnel will be constructed from the south end of the stop.

The radius of the loop is approximately 60m and is designed so as to minimise the length of the loop whilst still maintaining a suitable speed to maintain the head way between exiting the south bound platform and entering the northbound platform.

Traditional drill and blast methods will be used to construct the loop tunnel (or if the rock is suitable then it could be driven by excavators equipped with impact hammers).

Due to the city centre location of the works, control of noise and vibration will be critical. Prior to starting work the contractor will have to determine and demonstrate that noise and vibration from his chosen method of work will comply with the allowable limits within the contract. To this end it is assumed that only short rounds will be drilled, limiting the amount of explosive per delay.

It is therefore assumed that the loop tunnels will be driven on two fronts, one clockwise and one anti clockwise, utilising the same equipment in both tunnels. There would be at least two blasts per day one from each heading.

The tunnels will be initially lined with sprayed concrete, mesh, fibre reinforcement, and rock bolts as appropriate, with waterproofing and a cast insitu lining placed following excavation.

Typical plant for the loop excavation will include a twin boom drill jumbo with basket, ANFO loaders, and 10 tonne scoop trams. Shotcrete plant, ventilation plant, cranage, and blast nets and doors will also be required.

Railway Procurement Agency
Ghníomaireacht um Fháil Iarnród
Parkgate Business Centre,
Parkgate Street, Dublin 8, Ireland
Phone +353 1 646 3400
Fax +353 1 646 3401
www.rpa.ie

Responsible for

LUAS METRO Integrated Ticketing System

With funding and support from

NDP