

METROLINK

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A7.4

**Charlemont Shafts
Options Report**

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Appendix A. Full Environmental MCA

Executive Summary

Transport Infrastructure Ireland (TII) held a non-statutory Public Consultation on the MetroLink Preferred Route in April 2019, during which the plan to terminate the MetroLink project services at Charlemont Station was presented to the general public and other stakeholders. This decision resulted in the requirement for a turnback facility south of the proposed station so that trains can reverse direction for the return journey.

At the time of the public consultation MetroLink had not been progressed to preliminary design stage and therefore design information on turnback arrangement had not been developed. It must also be borne in mind that while this options assessment takes into account the GDA 20016-2035 Transport Strategy and the proposed extension of Metro to the south along the Luas Green line it also provides options for alternative southern extension routes for Metrolink to be considered.

Jacobs/Idom has considered several options for the turnback at this location, largely based on where the necessary Intervention Shaft is located, safety/evacuation criteria and how the Tunnel Boring Machine (TBM) is to be dealt with once it has completed the tunnelling work. A total of eleven options (including two sub-options) were identified under four groupings as shown:

- A.** TBM buried at Turnback End and an Intervention Shaft constructed
- B.** TBM buried South of Turnback (or at Turnback end) and a Parallel Gallery constructed back to Charlemont Station
- C.** TBM buried south of Turnback and an Intervention Shaft constructed
- D.** TBM extracted at Station Box with Mined Cavern for the Turnback and Parallel Gallery

The options have been assessed in accordance with the Common Appraisal Framework (CAF) for Transport Projects and Programmes (updated October 2020) published by the Department of Transport. The options are described and assessed through a 4-stage assessment methodology including multi-criteria analysis (MCA).

The Stage 3 short-listing of options takes account of two high level Criteria - Project Objectives and Economy. Those options that did not satisfy these criteria were removed before the detailed assessments are undertaken in Stage 4, following which a preferred option was recommended (Option 7(b)). In line with the above, any option that prejudiced the direction of the future extension of the Metro System southwards was removed allowing future alignments to extend the tunnel southwards in any SE/S/ or SW directions.

The option that is recommended to be progressed through Preliminary Design is Option 7(b), where the Tunnel Boring Machine (TBM) is buried underground at the end of a 302m long turnback tunnel extending south of Charlemont Station. This option has a shorter turnback tunnel than the original Option 7(a) proposal, which extended the TBM bored tunnel a further 400m approximately to a point under the Luas Green Line.

For the safety and evacuation of maintenance staff a parallel gallery will be mined between the end of the turnback tunnel on its east side and Charlemont Station, where access to the surface will be available for staff using the station emergency stairs, while any smoke is vented via a station ventilation shaft. For the recommended Option 7(b), the TBM will be directed sufficiently far off any feasible tunnel extension alignment towards the south and, at its termination point, it will be buried behind a wall and grouted into the competent rock formation.

1. INTRODUCTION

1.1 MetroLink Route and the South Turnback

MetroLink southbound services terminate underground at Charlemont Station. A tunnel will be required beyond Charlemont Station of sufficient diameter and length to form a turnback facility to enable trains from the northern terminus at Estuary Station to reverse direction for the return journey. The end of the turnback tunnel will be in the vicinity of the existing Ranelagh Luas Green Line stop as shown in Figure 1-1.



Figure 1-1 MetroLink Alignment with Turnback at Charlemont

While the map shows a possible route south of Charlemont, it is not the only option. This will depend on the decision on whether MetroLink will be extended and, if it is to be extended, which direction it will take. Therefore, it must be borne in mind that while this options assessment takes into account the

GDA 2016-2035 Transport Strategy and the proposed extension of Metro to the south along the Luas Green line it also provides options for alternative southern extension routes for Metrolink to be considered.

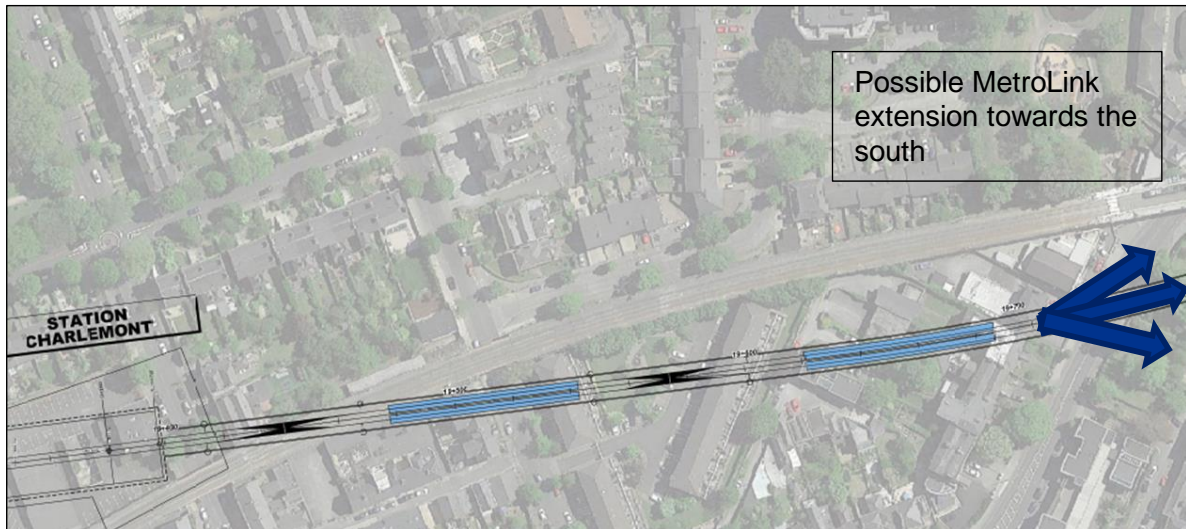


Figure 1-2 Turnback Tunnel south of Charlemont Station

The turnback tunnel will be placed on an alignment so that any future extension of MetroLink to the south is not made impossible. While a future connection might be made to the Luas Green Line, other alignment options need to be considered. It is possible that at some future time the MetroLink system will be extended to the south and, as indicated in Figure 1-2 the extended route could be directed to the west or to the east or it could continue south to connect to the Luas Green Line as is proposed in the GDA 2016-2035 Strategy. Some of the options presented in this report were developed on this latter assumption.

1.2 Scope of Option Selection

The scope of this turnback option selection takes into account the GDA 2016-2035 Strategy for the southern extension of the Metrolink and also provides for alternative southern extension routes to be considered. It would be preferable to have a definite decision on the route of the southern extension but in its absence the focus is on identifying the most efficient option for a turnback facility at Charlemont Station from an economic, engineering, environment, future integration, and safety perspective. The turnback facility incorporates two sets of crossovers so that trains operating at 90 second frequency can change running lines to reverse direction towards the north. The turnback tunnel section needs to be of sufficient length to provide stabling capacity for up to four trains on two tracks so that an efficient start of operations each morning can be made. This arrangement is also shown in Figure 1-2.

The Tunnel Boring Machine (TBM) may be required to continue south in any direction beyond Charlemont Station for an extension on an alignment to be decided. Therefore, the options identified in this report where the TBM is buried under the Luas Green Line are also considered relevant for any future extension of MetroLink. Construction methodologies are described in sufficient detail to differentiate between the various options considered.

2. Methodology for the determination of the Preferred Turnback Options for Charlemont

A four-stage options assessment was undertaken to identify the preferred turnback options. The analysis was undertaken in line with the Project Appraisal Guidelines (TII 2016) and The Common Appraisal Framework (DTTS 2016) to provide a robust framework for comparing options. The assessment stages are outlined in Figure 2-1 below:

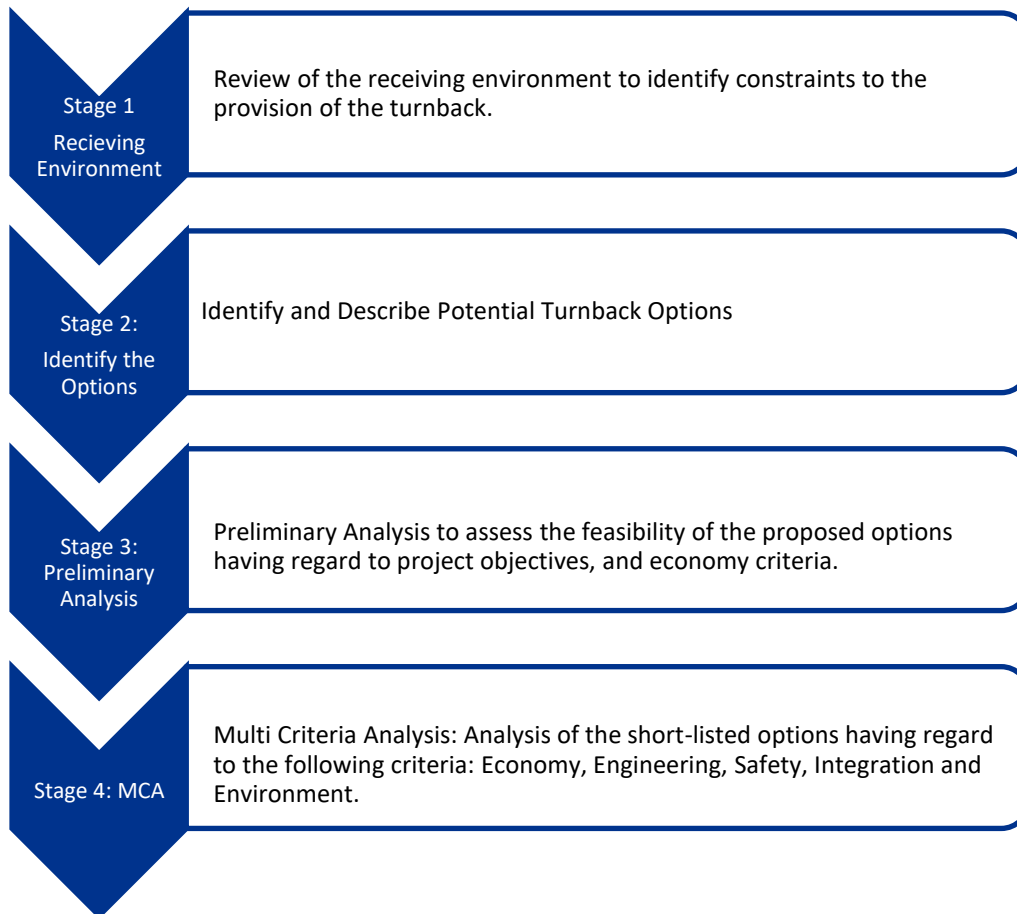


Figure 2-1 Outline Assessment Methodology

2.1 Stage 1: Review of the Receiving Environment

The New Metro North - Alignment Options Report (TII 2018) identified an Emerging Preferred Route (EPR) alignment terminating at Sandyford in the south. However, the negative impact on Luas Green Line services led to the plan to terminate the MetroLink project at Charlemont. Transport Infrastructure Ireland (TII) held a non-statutory Public Consultation on the MetroLink Preferred Route in April 2019, and the reduced MetroLink project was presented to the general public and other stakeholders.

The termination of services at the proposed Charlemont Station will require a turnback facility formed by a tunnel extension of sufficient diameter and length to enable trains from the northern terminus at Estuary Station to reverse direction for the return journey as well as enable 4 trains to stable overnight

for the start of early morning services. The turnback tunnel needs to be on an alignment so that any future extension of MetroLink to the south is not made impossible.

2.2 Stage 2: Identification and Description of Potential Turnback Options.

The above decision resulted in the development of 11 Options including 2 sub options for the turnback facility. These options were placed into 4 groups of options as follows:

- A. TBM buried at Turnback End and an Intervention Shaft constructed
- B. TBM buried South of Turnback (or at Turnback End) and a Parallel Gallery constructed back to Charlemont Station
- C. TBM buried South of Turnback and an Intervention Shaft constructed
- D. TBM extracted at Station Box with Mined Cavern for the Turnback and Parallel Gallery

2.3 Stage 3: Preliminary Analysis

The preliminary analysis undertaken consisted of a qualitative assessment of the potential 11 turnback options based on the criteria identified in Table 2-1 below. A pre-assessment sifting exercise was undertaken of all the options through a workshop with Jacobs/IDOM representatives for the key engineering disciplines of geotechnical, mining, construction, costing, as well as planning and environment.

The Stage 3 short-listing of options only takes account of two high level Criteria, Project Objectives, and Economy. Those options that don't satisfy these criteria are removed before the detailed assessments undertaken in Stage 4

Table 2-1 Criteria used for Stage 3 Assessment

Criteria	Sub-Criteria	Criteria Description	Note
Project Objectives	N/A	Does the Option satisfy the stated project objectives set out below	Should the option not satisfy the objects it fails and is removed from further assessment
Economy	Cost	This criterion considers the broad capital and operation costs of each of the proposed turnback options.	This criterion was assessed given the capital and operational cost implications of differing turnback options

The **Project Objectives** assessed were to ensure the turnback options developed were consistent with relevant project objectives as follows:

- to provide an underground facility to enable MetroLink trains operating at 90 seconds headway to safely reverse direction and to provide stabling capacity for up to four trains during non-operational periods.
- to provide a “turnback” that does not materially affect the direction of the southwards extension of the Metro System in the future simultaneously allowing but not favouring an extension to the existing LUAS Green Line or any alternative southwards alignment

- To ensure the safe operation of the turnback facility for all users

All options identified in Stage 3 were assessed against the relevant criteria identified in Table 2-1 with the intention to identify the options that are feasible to be taken further to the Stage 4 MCA analysis.

The criteria are scored against each other based on the colour scoring shown in Table 2-2 below.

Table 2-2 Stage 3 Scoring table

Options Assessment	Significance
	Feasible with least impacts/lowest risks
	Feasible with moderate impacts/moderate risks
	Feasible with negative impacts/high risks
	Not Feasible/Fail

2.4 Stage 4: Multi Criteria Analysis of Options

The MCA methodology has been developed in accordance with the Common Appraisal Framework (CAF) for Transport Projects and Programmes, (updated October 2020) published by the Department of Transport. Stage 4 involved taking the options which remained following the Stage 3 preliminary analysis and subjecting them to a more detailed MCA analysis to decide on the preferred turnback option.

The MCA also seeks to:

- demonstrate whether a proposal is socially, environmentally and economically deliverable and is technically and financially feasible;
- reveals the extent to which a proposal fulfils the planning objectives set; and
- demonstrates the full set of likely impacts of the proposal against the CAF's five objectives of environment, safety, economy, integration, and accessibility.

The CAF sets out a list of appraisal criteria used in the MCA for the turnback at Charlemont, it does not need to apply all of the listed criteria to make an option selection. The most appropriate characteristics and potential impacts of each option have been assessed against the following criteria in Table 2-3 below.

Table 2-3 Option Appraisal Criteria

Criteria	Description
Economy	The impacts of a transport investment on economic growth and competitiveness are assessed under the economic impact and economic efficiency criteria. In this case the comparative capital and operational costs/benefits of the option under consideration
Safety	Safety is concerned with the impact of the investment on the number of transport related accidents and in this case the emergency access/exit requirements, and safety of train

	operations including turnback frequency and headway management.
Integration	Integration considers the extent to which the project being evaluated promotes integration of transport networks and is compatible with Government policies, including national spatial and planning policy. In this case the requirement that the option can integrate with any future extensions of the ML system.
Environment	Environment embraces a range of impacts, such as emissions to air, noise, and ecological and architectural impacts
Engineering	Engineering identifies the degree of complexity and buildability of each option

Economy

It is accepted that the MetroLink project has a robust business case which depends on trains operating at high frequency, which means that all turnback options must provide for the required rate and reliability of turnback operations. Therefore, this criterion is concerned with the comparative capital cost of the options rather than overall economic benefits of the entire scheme.

For this assessment, it is assumed that the operating and maintenance cost of each turnback option is equal. However, the construction costs may vary depending on the option having regard to the following:

- Indicative construction costs based on length of tunnel
- Reinstatement costs;
- Major utility diversion costs;
- The requirement for an intervention shaft

Estimates of these comparative costs for each option are used to differentiate between options.

Safety

This criteria applies to the safe operation of the system for turnback and headways down to 90 seconds, as well as for fire access/evacuation routes. The turnback tunnel section needs to be of sufficient length to provide stabling capacity for up to four trains, typically on two tracks but for one option on four tracks. The option assessment therefore considers design features such as intervention, ventilation, and escape

Integration

A fundamental requirement of the selected option is that the option can integrate with any future extensions of the Metrolink system as well as satisfy local integration requirements of current planned operations. At the time of writing, the southerly extension has not been planned therefore the preferred turnback tunnel option will be that which best satisfies the criteria and objectives identified in the Stage 3 and 4 assessment.

Engineering

Given the complexity of the Engineering criteria a separate MCA covering the Engineering sub criteria was undertaken to populate the Stage 4 MCA table. Disposal of the TBM, ground conditions, mining verses tunnel for the escape route and tunnel extension, escape shaft at the tunnel end, construction safety and other sub criteria. The assessment rational are set out in Table 2-4 below.

Table 2-4 Engineering MCA Criteria

Engineering Factor	Rationale	Assessment
Alignment and structures	Does the alignment of the turnback option allow for extensions to the south and what structures are required for ventilation and access/exit	Assess and compare the turnback alignment, ventilation and escape structures required for each option
Demolition or buildings/structures impacted	Does the option require demolition of any structures and does it potentially impact any buildings or structures	Assess if any building is affected by surface or underground works including settlement potential for each option
Ventilation	The turnback facility and any escape shafts or adit will require ventilation some options require a greater or lesser degree of ventilation	Assess the ventilation space requirements and power requirements for same
Urban Integration	How well does the option integrate with the surrounding urban environment	Assess the effect of the option on the local urban environment and how it integrates with surrounding infrastructure
Utilities	Does the option require re-location of utilities and the relative cost of same	The impact of the option on the type and scale of the utility re location is assessed
Constructability/Safety	Some options are technically easier to construct than and may be relatively safer to construct	The relative ease of construction of the options are assessed as well as the relative safety of its construction
Construction Costs	Some options are more costly to construct than others. Costs are assessed in a relative context and based on unit measurement comparison rather than specific quantities	The relative budget cost of each options is assessed
Property Impact	Some options have no impact on property whilst others require property for the construction and installation of ventilation/escape shafts	Assess which options require public or private property for both construction and permanently as well as the scale and extent of the property required
Geology	Construction in rock, glacial or borderline material has different cost and safety profiles	Assess the impact of different option construction in the different underlying formation material

Environment

Similarly, for Environment a separate MCA to populate Stage 4 was undertaken having regard to all the environmental sub-criteria identified in Table 2-5 below. As some criteria were not considered to differentiate between options their environmental impacts were deemed similar.

Table 2-5 Environmental MCA Criteria

Environmental Factor	Included as a sub-criterion	Rationale	Assessment
Human Health	Yes	Human Health impacts may arise from a combination of effects on air quality, noise, dust, and access to opportunities for physical activity.	The assessment brought together the findings of the air quality and noise assessments, together with a review of mapping showing sporting facilities that may be affected. A qualitative assessment was then made.
Socioeconomics	Yes	Socio-economic effects may arise from works that would require the closure or restricted access to business premises or to facilities used by community groups.	The assessment involved a qualitative classification of negative impacts, largely during the construction phase. An assessment of the operational benefits was also undertaken.
Electromagnetic Interference / Compatibility	Yes	Where alignments differ, sensitive receptors may be closer to or further from electrical equipment that may affect them.	Reference was made to questionnaire responses which self-identified sensitive receptors.
Noise	Yes	It is not considered that the project will have a significant impact in terms of noise during the operational phase of the project due to modal shift from private vehicles to the MetroLink and the resultant reduction in noise. However, there is potential for impacts on sensitive receptors during the construction phase.	Sensitive receptors within 100m of each station box location were identified and assessed to identify potential impacts.
Vibration	Yes	It is not considered that the project will have a significant impact in terms of vibration during the operational phase of the project due to modal shift from private vehicles to the MetroLink and the resultant reduction in noise. However, there is potential for impacts on sensitive receptors during the construction phase.	Sensitive receptors within 40m of each option were identified and assessed to identify potential impacts.
Biodiversity	Yes	Construction has the potential for temporary and permanent effects on biodiversity, through vegetation clearance, which may reduce available habitat, or through noise, air quality, contaminated run-off, lighting, and disturbance, which may affect protected species.	Records of sensitive habitats and species in the study area were checked, including records from surveys carried out for the project. A qualitative assessment was then made of the potential for the options to affect biodiversity, as a result of construction and operation.
Air Quality	Yes	It is considered that the project will have a largely positive impact on air during the operational phase of the project due to modal shift from private vehicles to the MetroLink and the resultant reduction in emissions. However, there is potential for impacts on sensitive receptors during the construction phase due to emissions. Emissions of relevance during this phase	Sensitive receptors within 50m of each station box location were identified and considered and assessed to identify potential impacts.

Environmental Factor	Included as a sub-criterion	Rationale	Assessment
		include NOx and Particulate Matter (PM10).	
Climate	Yes	It is considered that the project will have a largely positive impact on climate during the operational phase of the project due to modal shift from private vehicles to the MetroLink and the resultant reduction in emissions. However, there is potential for impacts on sensitive receptors during the construction phase due to emissions from plant and from embedded carbon in construction materials.	Options were considered in terms of their size (as an indicator of the comparative amount of materials needed, and hence of embedded carbon) and, where possible, the duration of construction (as an indicator of the comparative use of plant and machinery)/
Flooding	Yes	Construction within a flood plain could increase the risk of flooding on neighbouring land or could put the development itself at risk of flooding.	Flood maps were checked and interpreted in order to understand the potential for the options to affect flood risk or to be affected by the risk of flooding.
Hydrology	Yes	Surface water flows and quality could be affected either by construction works in a channel, causing an obstruction or change in channel morphology, or by accidental spillages which could lead to water pollution.	Connectivity between the options and nearby watercourses was identified with reference to appropriate mapping.
Hydrogeology	Yes	Inner protection areas extend up to 300m from groundwater abstraction points, with outer protection zones extending to 1km. Works within those areas could have adverse effects on the quality of abstracted water. Excavations and underground construction can affect groundwater flows in underground aquifers.	Relevant mapping was checked for the presence of aquifers and wells or springs. A qualitative assessment was made of the risks associated with the options.
Land use, Soils and Geology	Yes	Options in close proximity to each other are likely to encounter the same ground conditions, although localised areas of contaminated land (e.g. former landfill sites) may mean that the risks of mobilising contaminants differ between options.	Reference was made to geological mapping and to earlier reports for the project, which had identified sources of contaminated land.
Properties	Yes	Potential for direct impacts on a number of land holdings and properties.	Properties likely to be affected directly, by land-take, or indirectly, by disruption to access, were identified with reference to mapping.
Agronomy	Yes	MetroLink is proposed to pass through agricultural areas to the north of Dublin. Options in those agricultural areas may have different potential effects on agriculture, depending upon their exact location.	Reference was made to the agricultural impact assessment to understand the nature of the agricultural land use in the relevant areas. A qualitative assessment was then made of the potential for the options to have adverse effects on agriculture in those areas.

Environmental Factor	Included as a sub-criterion	Rationale	Assessment
Resource Use and Waste Management	Yes	In most cases (e.g. for station box options), the resources required, and the waste generated would be the same for each option. However, for some of the assessments, including for the M50 crossing and for the shafts at Charlemont, the differences between options are more significant, and it is possible to make comparisons between the options in terms of the materials and waste involved.	The design footprints were used as an indicator of the relative sizes of the different options, and therefore of the associated variation in materials and waste volumes.
Archaeological Heritage	Yes	Potential for direct impacts on known and unknown archaeological remains during the construction of the options.	National and local archaeological records were accessed online to identify known archaeological remains in the study area. A qualitative assessment was then made of the potential for remains to be affected by each option.
Architectural Heritage	Yes	Buildings and structures of archaeological merit exist in close proximity to the Metrolink route. There is the potential for both direct, physical effects during construction, and for indirect effects on setting through both construction and operation.	A qualitative assessment of potential direct impacts from on elements of architectural heritage from each option and associated construction works.
Landscape and Visual	Yes	Potential for significant impacts on landscape/townscape and visual amenity, particularly during construction.	Assessment involved the qualitative assessment of visual impacts on nearby receptors and changes to the local landscape character.
Accidents and Disasters	No	It is assumed that safety measures will all achieve the same standard, regardless of the option, so this is not a differentiator.	Not applicable.

All Stage 4 assessment criteria are scored against each other based on the performance outlined in Table 2-6 below

Table 2-6 Stage 4 Scoring table

Assessment Score for Individual Assessment Criteria	Significance Advantages/Disadvantages
High	Significant advantages over other options
Medium-High	Some advantages over other options
Medium-Low	Comparable to other options
Low	Some disadvantages over other options
Very Low	Significant disadvantages over other options

2.5 Stage 4 Summary MCA Table

Following the outcome of the Engineering and Environment sub MCA (respectively Table 2-4 and Table 2-5) the Summary table (table 2-6 above) is populated with the scores to identify the preferred Option. See Section 6 of this report for results of the assessment.

3. TURNBACK DESIGN

The decision to terminate MetroLink services at Charlemont Station requires a turnback facility at or near this location to the south essential. A key part of the required design is how and where the TBM should be disposed of once tunnelling is complete and this will have an influence on how the turnback is designed and constructed. TBM disposal is discussed in the following sections along with a description of the ventilation/evacuation shaft needed for smoke exhaust and escape purposes.

3.1 Disposal or Recovery of TBM

Once the TBM has completed the necessary tunnelling works south of Charlemont Station for the turnback facility, the TBM will need to be either recovered or buried safely underground at a location that does not restrict future tunnel extensions southwards. Recovery options would comprise extraction of the TBM via the Charlemont Station box; extraction via a purpose-built shaft at the end of the tunnel; or creating a cut and cover/retained cut ramp to ground level to facilitate removal.

From inspection of the residential area between Charlemont and Beechwood it is clear that the construction of a cut and cover ramp to the surface would be disruptive to the local community. It would require a significant extension southward of construction works with inevitable local impacts.

Alternatively, an intervention shaft could be constructed in the order of 15m diameter to safely remove the 9.5m diameter TBM or parts thereof. A large crane, in the order of 1000 tonnes capacity, would be required to lift out the major components as they are disassembled. A considerable construction footprint would be required to construct the shaft initially and to accommodate the crane, the shaft itself and the off-loading area. This would be similar to the construction site area proposed for the Albert College Park Shaft which has an approximate footprint of 6,500m². Depending on the access arrangements, time available and shape of site this area could be reduced but would still require a significant space within this congested urban area. with indicative requirements shown in Figure 4-4. Even if a suitably large open space was created within the required location, the environmental impact would be considerable. The other option for extraction of the TBM is to raise it, or parts of it, at the Charlemont Station box. The cutter head could be buried with other parts broken up and hauled back to the station box for extraction. Under this option, a smaller ventilation/evacuation shaft could be provided at the end of the tunnel with a smaller construction site requirement (approx. 4,500m²).

Information on the TBM dismantling procedures and the parts that might be recovered, and how the TBM shield is to be buried is presented in ML1-JAI-CGN-SC16_XX-RP-Z-00001, section 3.3.2 "solutions for terminating the tunnel".

Some of the options as shown in Figure 3-1 include disposal of the TBM underground just beyond the turnback tunnel. The TBM must be driven sufficiently far off any future extended alignment so that the tunnel is not restricted in its construction. The graphic shows the particular future situation where MetroLink might connect with the Luas Green Line, however, a deviation to the west or east is also feasible with only a limited impact on the previously built tunnel. A separate study on any future tunnel extension to the south will be necessary before this matter can be concluded.

For the cases shown in the figure it is clear by inspection that Option 2 (yellow) is closer to the existing Luas Green Line bridge and its foundations. Consequently, a greater stabilization of the buried TBM shield cutting face would be required for Option 2 (yellow) compared with Option 1 (blue), and for this reason Option 1 (blue) is the preferred location to bury the TBM.



Figure 3-1 Options for TBM Disposal

Regarding available geotechnical information, it can be observed in Figure 3-2 that there are existing boreholes close to termination of the tunnel and geotechnical information has been obtained from these boreholes.

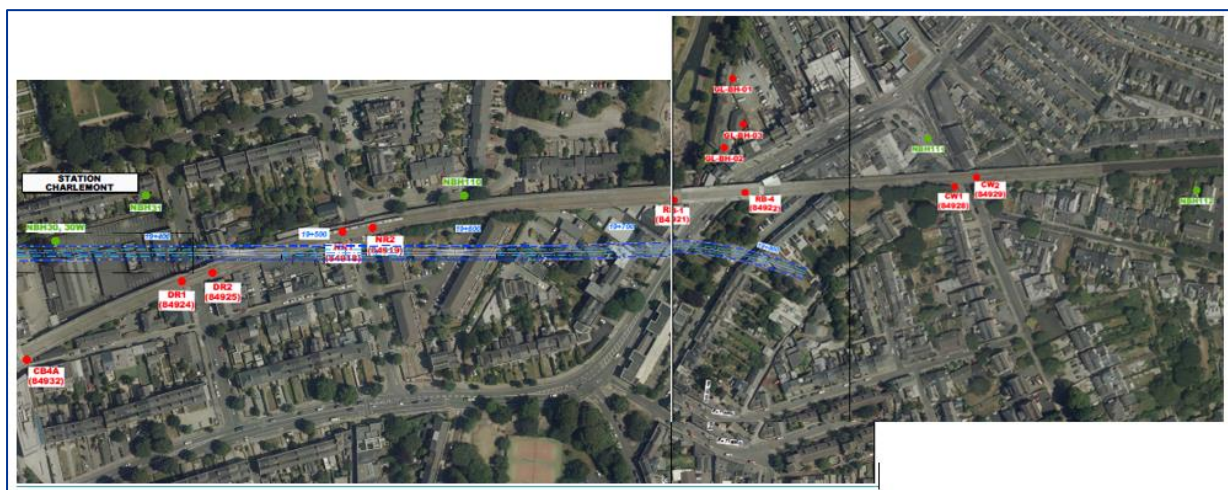


Figure 3-2 Existing boreholes close to TBM Disposal

Uniaxial Strength (UCS) of the CLU micritic limestone is approximately 60 MPa and the basic Rock Mass Ratio measured in NBH110 and NBH 111 is typically between 41 and 60 (fair rock mass conditions). One dilatometer test was carried out in each of the boreholes and the initial deformation modulus obtained were between 2 and 5 GPa and between 14 and 16 GPa for the unload-reload cycle. The RMR at location test was in the range of 54-57. Although the available information indicates that the TBM would be buried in a location of fair rock quality it is advisable that at the appropriate time in the project development a borehole is sunk at the tunnel end location to confirm the geotechnical model at the exact location where TBM will be buried.

Some of the other identified options (Options 6, 7(a) and 9) assume that the TBM continues its drive south by several hundred metres, before stopping and being buried underground. Depending on the chosen route, the bored tunnel drive would require additional monitoring and precautions to mitigate ground movement effects. An intervention shaft at the dead end of the tunnel would be required in each case for safety and ventilation purposes.

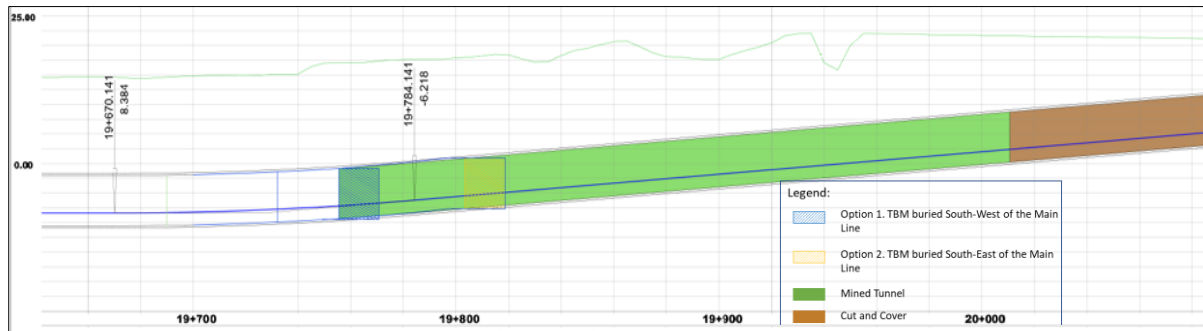


Figure 3-3 Longitudinal Section for Extended Tunnel Options.

The longitudinal section for the situation where a Green Line connection is formed is shown in Figure 3-3, which uses the same colour coding as the plan layout in Figure 3-1, that is, the mined tunnel connection is shown in green and a possible cut and cover portal section is shown in brown.

The TBM burial location shown in blue will be under an open space and this will reduce the risk of settlement affecting residential properties or the Luas Green Line structures. Indicative settlement calculations for the nearby buildings above the tunnel axis (property reference B-217 at chainage 19+660) and where the tunnel is also in rock, indicates only slight building damage potential.

However, settlements are related to long term behaviour of the tunnel and in this case can be mitigated by the efficacy of the backfilling operations used to bury the TBM. Any location proposed for underground TBM disposal needs to take account of the ground conditions and it is preferable that the TBM is left in sound rock that will not be subject to future ground movement, rather than at an interface between rock and overlying deposits that might require pre-treatment of the ground.

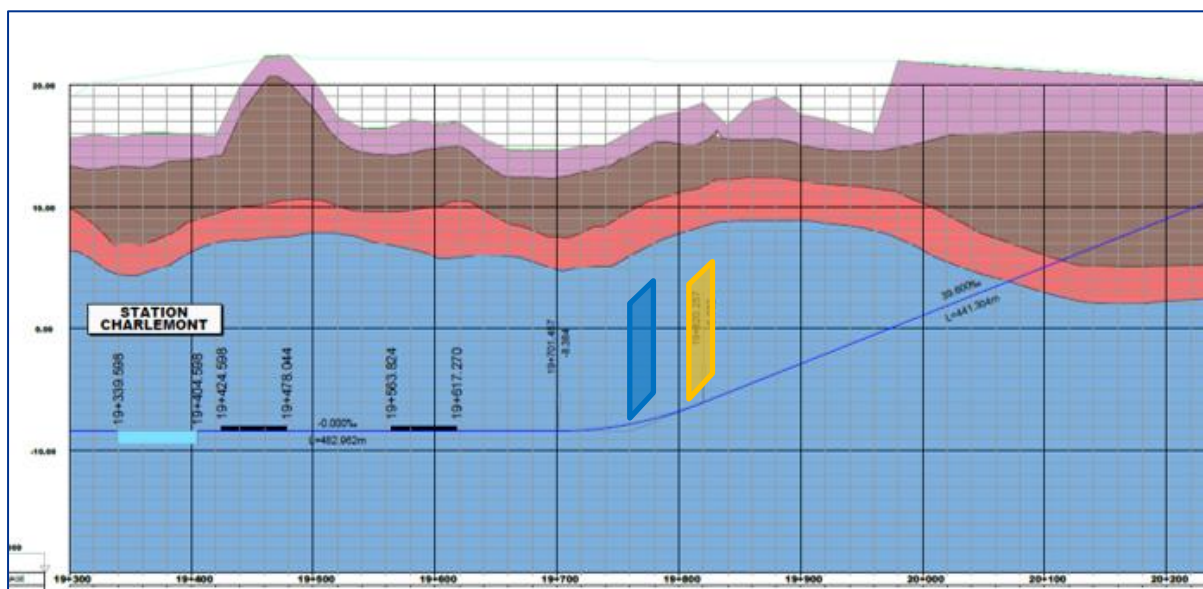


Figure 3-4 Ground Conditions at Turnback Tunnel with TBM burial for Option 1 (blue) and Option 2 (yellow).

It can also be seen that a TBM burial point just south of the turnback tunnel section and before any change in slope would be in solid rock so there would be a minimal risk of ground movement at the surface.

3.2 Ventilation/Evacuation Shaft

A ventilation/evacuation shaft is required at Charlemont for all turnback options for the following reasons:

- Ventilation and smoke exhaust of the dead-end turnback tunnel section, and
- emergency exit for maintenance staff in the event of a fire in the dead-end turnback tunnel.

No passengers are expected to be in the turnback tunnel section because they should have alighted previously at Charlemont Station. The MetroLink staff who might be working in the turnback section will be safety trained and so will be well aware of escape routes.

As well as a solution with a ventilation/evacuation shaft connected to the end of the tunnel by an adit, another solution is available where a mined gallery is constructed parallel to the main tunnel from the dead-end of the tunnel back to an intervention shaft in Charlemont Station. An adit is defined as a short connection at near right angles from the main running tunnel to connect to a vertical shaft. A gallery is defined as a longer access tunnel connecting the main tunnel with an evacuation/ventilation point (shaft or station box). The parallel gallery option connecting to the station would avoid surface impacts from the construction of a shaft in this residential area and would instead concentrate the works at the station construction site.

The shaft and adit design will allow for the separation of evacuation and ventilation routes, as shown in Figure 3-5.

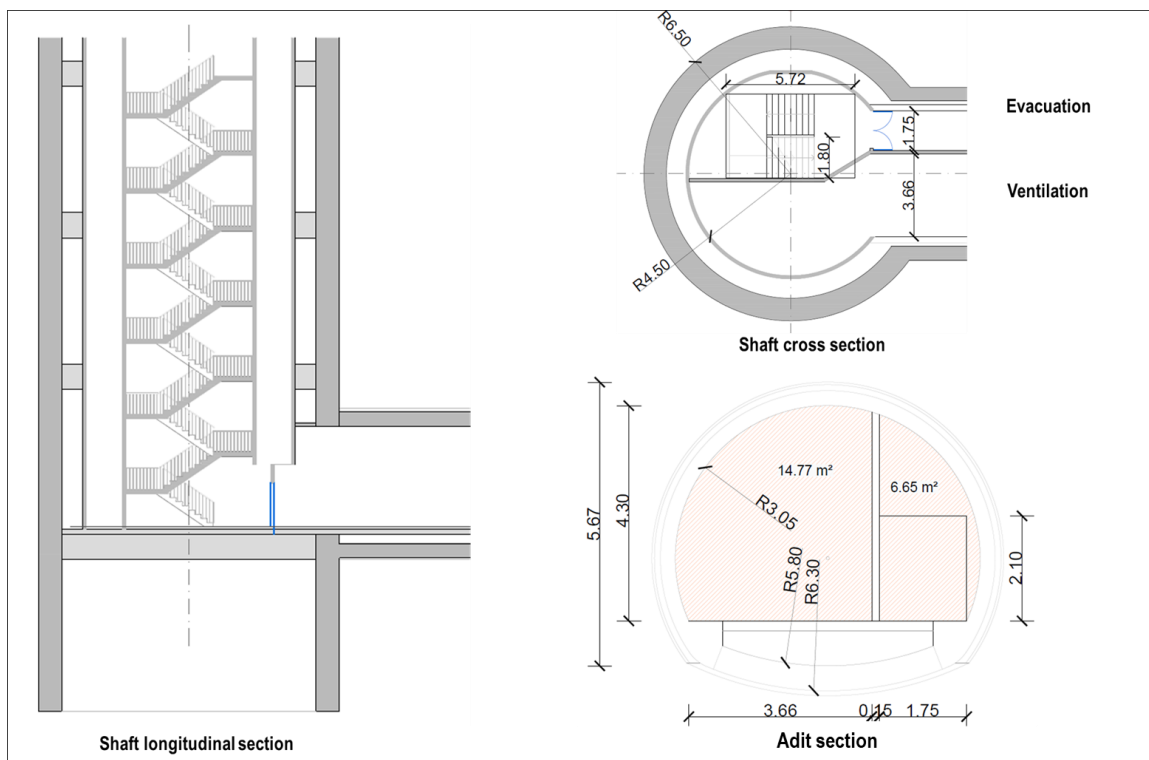


Figure 3-5 Shaft to Main Tunnel Gallery or Adit

The gallery option will not have a separating wall because compared to an adit its larger cross-sectional area means that the air velocity created by the emergency ventilation fans will be less and it

will function in the same way as the main line tunnel. Jet fans will be installed in the gallery and for the longer remote shaft options.

The visible pop-ups from the shaft at the surface, such as the ventilation grill and the emergency escape hatch, can be designed to be unobtrusive and close to ground level, without the need for a headhouse. For example, they could be as shown in the images Figure 3-6. A secure fence is advisable around the shaft air grille to limit unapproved access.



Figure 3-6 Typical Pop-ups for Shafts

The diagrams in Figure 3-7 and Figure 3-8 show how the ventilation/evacuation shaft is intended to operate in the event of a fire incident occurring in the turnback tunnel while maintenance staff are working. This model is applicable for a shaft either at the dead end or at the station. For the latter case, the smoke from an incident in the turnback tunnel will be exhausted to atmosphere via the mined gallery and the ventilation shaft located at the station.

No fans would be installed in the evacuation/ventilation shaft at the end of the turnback tunnel, or at the station if a parallel gallery is provided.

The bi-directional fans provided in the separate ventilation shaft in Charlemont Station would work together with the jet fans in the tunnel (and in the gallery if provided) to drive smoke in one of two ways, depending on the direction of evacuation. The preferred direction of evacuation from the turnback section will be towards the station. Smoke will be exhausted in the opposing direction towards a shaft via an adit or gallery. This direction will be established by the Operator according to the information obtained from the CCTV system and from direct communications with metro staff located in the turnback section. A decision on this is made on the basis that people escaping should always escape upwind.

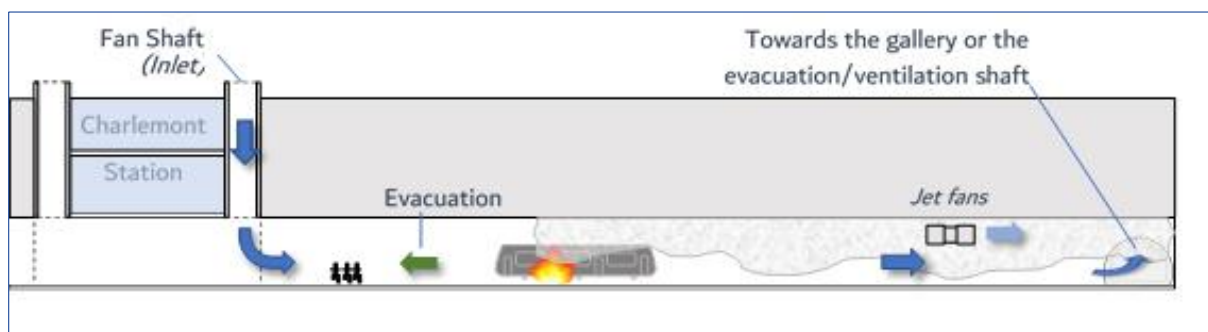


Figure 3-7 Escape of Maintenance Staff via Station Shaft with Airflow towards South

In the case shown in Figure 3-7 people will evacuate towards the station and the air flow and smoke will be towards the dead-end intervention shaft or, for some options, the parallel gallery and its connection to the intervention shaft in the station. This will result in a smoke-free path from the station for emergency services dealing with the incident. However, if the fire severity or location does not allow the people to head directly towards the station shaft using the turnback tunnel then the fans will

be reversed in direction and the people evacuating will be directed to either the dead-end intervention shaft, or the parallel gallery and station intervention shaft.



Figure 3-8 Escape of Maintenance Staff via Shaft/Gallery with Airflow towards North

4. OPTION ASSESSMENT

4.1 Identified Groups and Options

The options that were identified for the Turnback and its associated safety provisions fall into four groups:

- A.** TBM buried at Turnback End and an Intervention Shaft constructed
- B.** TBM buried South of Turnback (or at Turnback End) and a Parallel Gallery constructed back to Charlemont Station
- C.** TBM buried South of Turnback under Luas Green Line, and an Intervention Shaft constructed
- D.** TBM extracted at Station Box with Mined Cavern for the Turnback and Parallel Gallery

A total of eleven options, including sub-options, were identified for consideration and these are shown below in Table 4-1, colour coded into Groups A to D.

Table 4-1 – Options for Consideration

Option	1	2	3	4	5	6	7		8	9	
Sub Option	-	-	-	-	-	-	(a)	(b)	-	(a)	(b)
Group Type	A	A	A	A	A	C	B	B	D	C	C
TBM Disposal	TBM buried just beyond turnback	TBM buried just beyond turnback	TBM buried just beyond turnback	TBM buried just beyond turnback	TBM buried just beyond turnback	TBM buried under Luas Green Line	TBM buried under Luas Green Line	TBM buried just beyond turnback	TBM extracted at Charlemont Station	TBM buried under Luas Green Line	TBM buried under Luas Green Line
Intervention Method	Shaft in Ranelagh Park play area	Shaft in garden between Ranelagh Road and Selskar Terrace	Shaft in garden between Ranelagh Road and Manders Terrace	Shaft in a car park next to the Ranelagh Gardens Park	Shaft in a garden adjacent to a sports complex	Shaft at end of the tunnel	Mined Gallery parallel to turnback tunnel	Mined Gallery parallel to turnback tunnel	Walled section of turnback in Mined Cavern	Shaft (1) at end of Tunnel	Shaft (2) at end of Tunnel

These groupings depend mainly on whether the TBM is to be buried underground on completion of tunnelling or extracted to ground level for disposal or re-use and also whether or not there is a vertical shaft at some point along the length of the turnback tunnel section. If the TBM is to be buried then a decision is required on where the burying point is situated. This could be located at the turnback end,

and off the line of any future connection to the south, or the TBM could be driven further south to suit the alignment of a future tunnel connection yet to be decided.

For the purpose of this assessment it is assumed that the TBM will be buried underground for all options with the exception of Option 8 where the TBM is extracted at Charlemont Station. However, we do show how retrieval of the TBM via an Intervention Shaft is possible but disruptive due to the space requirements for the operation and the need to get a 1000Tonne crane into the site.

The five options listed as Group A, where the TBM is buried beyond the turnback and an Intervention Shaft constructed are shown in Figure 4 1. The circled number indicate the location of each shaft option and the connecting adit for each is: Option 1: 50 m; Option 2: 2-5 m; Option 3: 13 m; Option 4: 110 m; and Option 5: 170 m

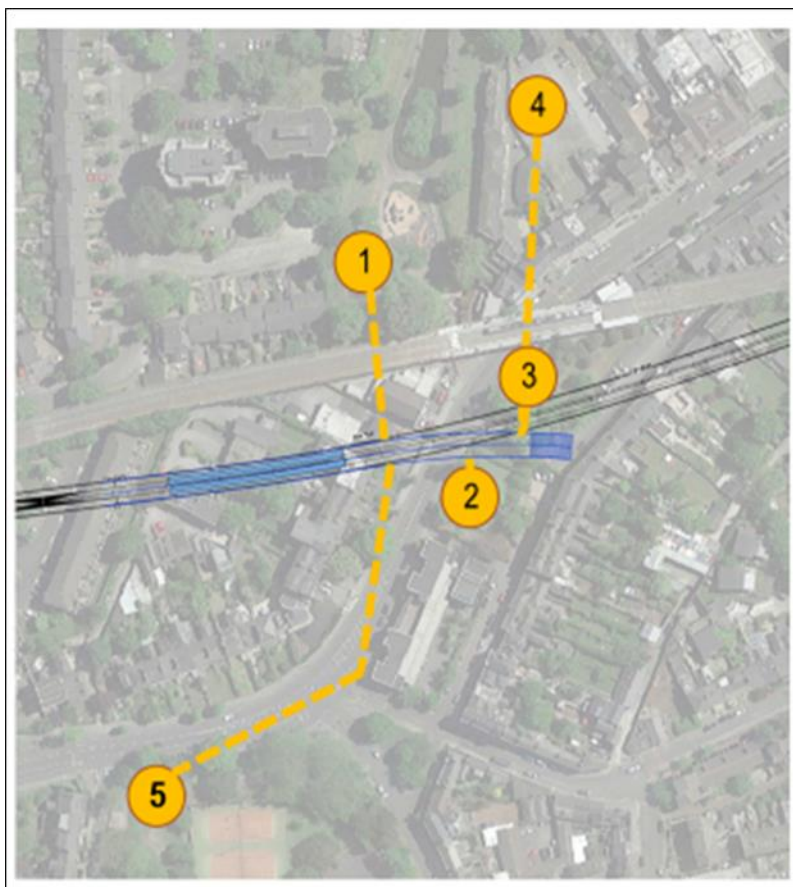


Figure 4-1 Initial Shaft Locations (Group A - Options 1 to 5)

The other Options 6, 7, 8 and 9 (with sub-options) are shown in Figure 4-2 and briefly described here:

- Option 6 is in Group C and it was from a proposal to form a connection to the Green Line and when this was requirement was revised the tunnel length was truncated. The TBM is buried at the end of the turnback and a shaft proposed on the west side of Ranelagh Road close to the end of the turnback.
- Option 7 and its sub options is in Group B and involves a mined gallery constructed parallel to the main tunnel on a rising gradient from the end of the turnback to the Mezzanine Level in the station, where access is available to the station escape route. The TBM is buried off-line at the end of the turnback.

- Option 8 is in Group D and consists of a shorter mined cavern containing 4 parallel turnback tracks and a walled off escape route back to the station. The TBM is extracted at the station box.
- Option 9 and its sub options (A and B) is in Group C where the tunnel is extended south of the turnback section and an intervention shaft provided at its termination. The TBM is buried at the end of the turnback.



Figure 4-2 Options 6, 7, 8 and 9

The following sections discuss the key design features of each option under the five headings of:

- Alignment of connecting shaft adit or gallery;
- Impacts on surroundings;
- Urban Integration;
- Construction; and
- Environment.

4.2 Option 1 – TBM buried beyond Turnback End with a Shaft in Ranelagh Park Playground

As shown in Figure 4-3 the shaft is located on the east side of the main tunnel and the **alignment** of the 50m long adit connection between the shaft and the main tunnel passes under the Luas Green Line. The adit commences at the point in the main tunnel where the TBM will be closed off and sealed. The sealing wall will be as close as possible to the connection between the gallery and the tunnel to avoid an unventilated zone.

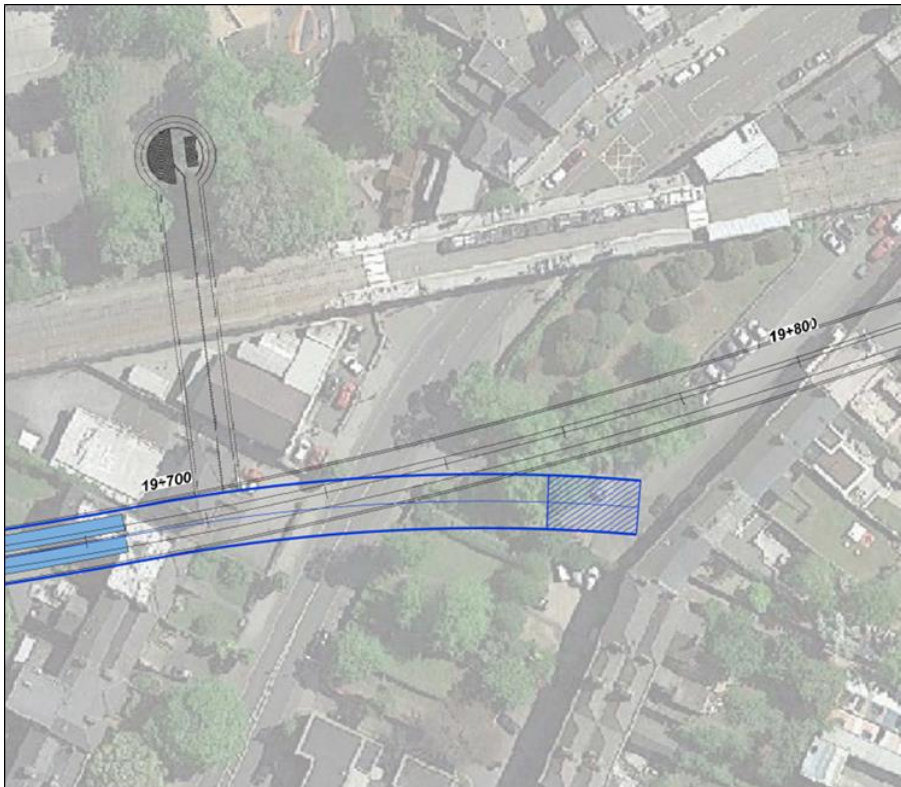


Figure 4-3 Option 1 - Shaft in Ranelagh Park Playground, close to Ranelagh station.

The shaft has been located in a park next to Ranelagh Luas Green Line station and access to the shaft during construction and during operations will be via Northbrook Avenue, a residential area. This option for a shaft might have an impact on utilities as listed and this will need careful consideration:

- 225mm combined sewer,
- 150mm water main,
- MV ESB cables,
- 125mm MP and 250mm LP gas mains

The remote location of the shaft from Charlemont Station and its incident support facilities would also separate emergency services personnel who would need to attend both the shaft and the Charlemont Station in an incident. This is less desirable than maintaining a single location for incident control as it adds additional coordination issues.

Urban Integration for the shaft including the access point, emergency exit and ventilation should be relatively simple to achieve. Pop-ups from the shaft are at ground level and will be restricted in area as shown as the black shading with the shaft outline.

The construction of a 50m length of mined tunnel to reach the shaft location from the main tunnel is significant because it passes under the Luas Green Line viaduct and other residential properties located above the tunnel. Ground improvement works to limit surface settlements is a likely requirement and this would probably be undertaken by boring machinery placed on the Ranelagh Road. Inevitably, this would involve some traffic disruption. Construction access to the shaft site in the park area would be through a residential cul-de-sac road.

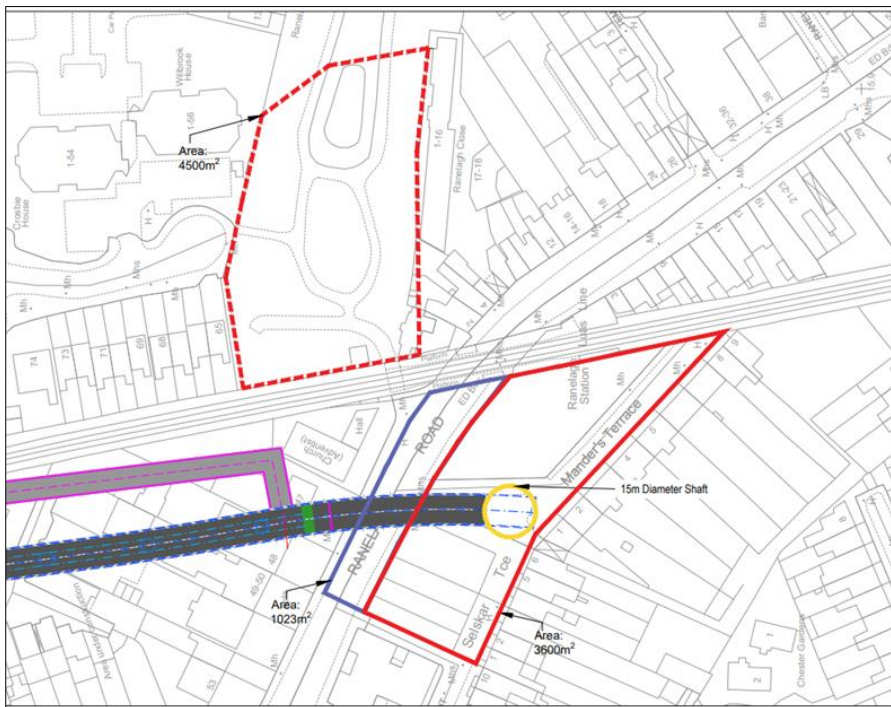


Figure 4-4 Shaft Construction Compounds for Options 1, 2 & 3

The dashed red lines in Figure 4-4 indicate a reasonable construction compound perimeter for the intervention shaft depicted under Option 1.

On the same figure the non-dashed red lines indicate a typical construction compound for intervention shafts required for Options 2 and 3, which would use the same compound. This demonstrates that the available site area is restricted and the fact that Manders Terrace would have to be closed for access.

For Option 1 the connecting adit between the tunnel and shaft would be constructed through rock and the requirement for blasting would need to be considered having regard to potential noise and vibration impacts during the construction phase. The shaft is located in a designated Dublin City Council Quiet Area and is in close proximity to noise sensitive receptors including park users. Due to the proximity to residential sensitive receptors to the shaft location potential for air quality impacts during the construction phase on sensitive receptors would need to be considered. Furthermore, the potential for impacts on the amenity value of the park and the playground during the construction phase is a further constraint that requires consideration.

To retrieve the TBM from a shaft, the shaft must be located at the end of the TBM drive. This may be coincident with the permanent alignment or offset from it. However, it is difficult to imagine how the requirements for locating an intervention shaft and a TBM retrieval shaft can be met at the same location and therefore none of the adit/shaft options (1-5) consider removal of the TBM via the shaft.

Figure 4.4 illustrates the working space restrictions that would be imposed for construction of shafts for Options 1, 2 and 3 and illustrates the difficulty in avoiding considerable construction disturbance for construction of shafts in this area.

For **Environment** there is an underground river that crosses under Ranelagh Park as well as an ornamental pond in the park. However, in terms of biodiversity, there are no protected European or National sites in the vicinity and no identified protected species present. It is likely that trees will need to be felled during construction of this option. In terms of resource and waste considerations, the

longer tunnel for this option would generate high volumes of spoil compared to other options and will also need more construction material.

A dwelling site listed on the RMP (DU018-057), is located less than 100m from the construction site. A railway bridge was built c.1854 to carry the Dublin and Wicklow Railway over Ranelagh Road is considered an important industrial heritage feature of Dublin and is located approximately 60m from the construction site. There are properties designated on the Dublin City Council RPS, located at Ranelagh Road, which may be impacted by ground borne noise and vibration. The setting of Ranelagh Gardens Park, a historic garden, would be directly impacted during construction of the site. The shaft access point would be a permanent feature in this park.

4.3 Option 2 - TBM buried beyond Turnback End with a Shaft between Ranelagh Road and Selskar Terrace

As shown in Figure 4-5 the shaft is located close to and west of the main tunnel **alignment**, with only a short connection adit required of approximately 2m in length.

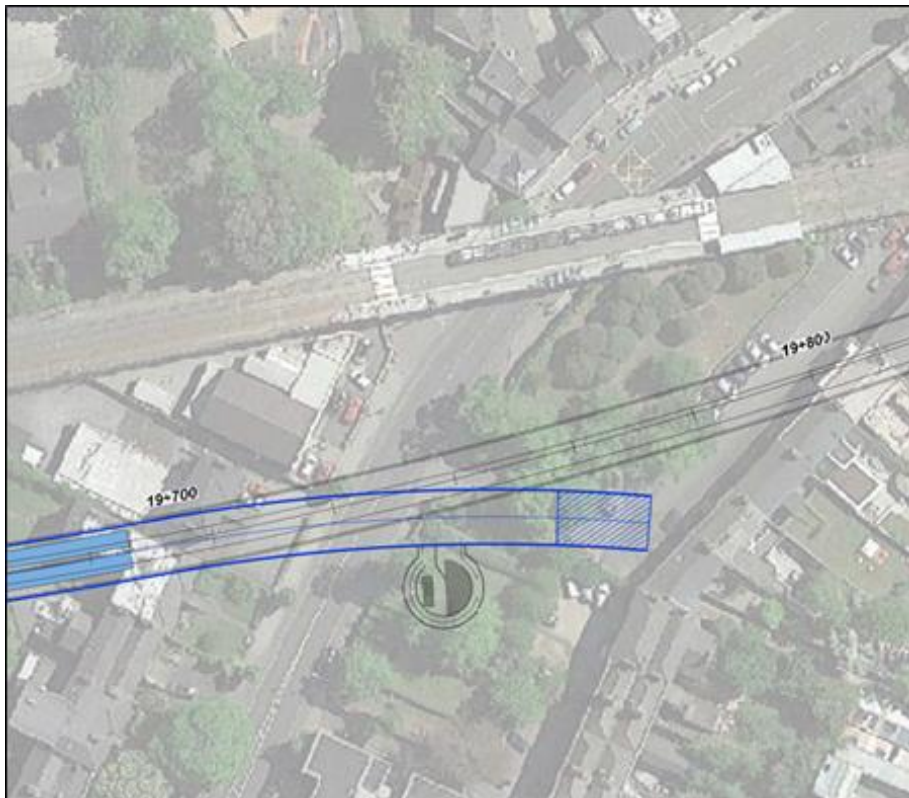


Figure 4-5 Option 2 - Shaft in garden between Ranelagh Road and Selskar Terrace

The associated construction working area is indicated on Figure 4.4.

The remote location of the shaft from Charlemont Station and its incident support facilities would also separate emergency services personnel who would need to attend both the shaft and the Charlemont Station in an incident. This is less desirable than maintaining a single location for incident control as it adds additional coordination issues.

The **Impact** on the surrounding area is limited and no property demolition is likely because the shaft is positioned in an existing green / garden area, made up of several private land parcels. The footway

along the south side of the Ranelagh Road is likely to be affected during construction of the shaft as well as the following utilities running along the southern edge of the road:

- 1220mm combined sewer,
- Eir telecommunication ducts,
- MV ESB cables,

Urban integration of the intervention shaft and its access points and pop-ups should be relatively simple to integrate into the environment. The pop-ups are at ground level as indicated by the shaded areas in Figure 4-5.

The shaft lies close to the bored tunnel alignment and this limits the **construction** of the SCL mined length to approximately 18m. Working space similar to that shown in Figure 4-4 will require all of the current garden area and footway restrictions on the southern footpath of Ranelagh Road, as well as traffic management to facilitate site access. The site area is more constrained than Option 1 and 3, and large diameter sewers along Ranelagh Road might require settlement protection.

An **Environmental** assessment confirms that this option for the shaft is in close proximity to a number of residential sensitive receptors and their garden areas. Ranelagh Seventh Day Adventist Church is located near the site on the opposite side of the Ranelagh Road. There are no known water courses in close proximity and groundwater vulnerability in the area is classified as “moderate”. There are no protected European or National sites and no identified protected species are present. However, it is likely that trees will need to be felled during construction with a direct impact on private gardens. The shorter adit tunnel for this option will generate lower volumes of spoil compared to other options and will also need less construction material. There are no National Monuments within 100m of the site, the nearest being 225m away. Due to the distance and the intervening built environment as well as the significantly reduced construction work for this option, it is unlikely that there would be any impact on this asset. A number of properties on Selskar Terrace are designated on the Dublin City Council RPS for their architectural heritage. The construction works and permanent structures could affect the setting of this RPS.

4.4 Option 3 - TBM buried beyond Turnback End with a Shaft between Ranelagh Road and Manders Terrace

The shaft for this option is located close to the **alignment** on its east side as shown in Figure 4-6 below. A short connection gallery of approximately 13m is required between the shaft and the main tunnel.

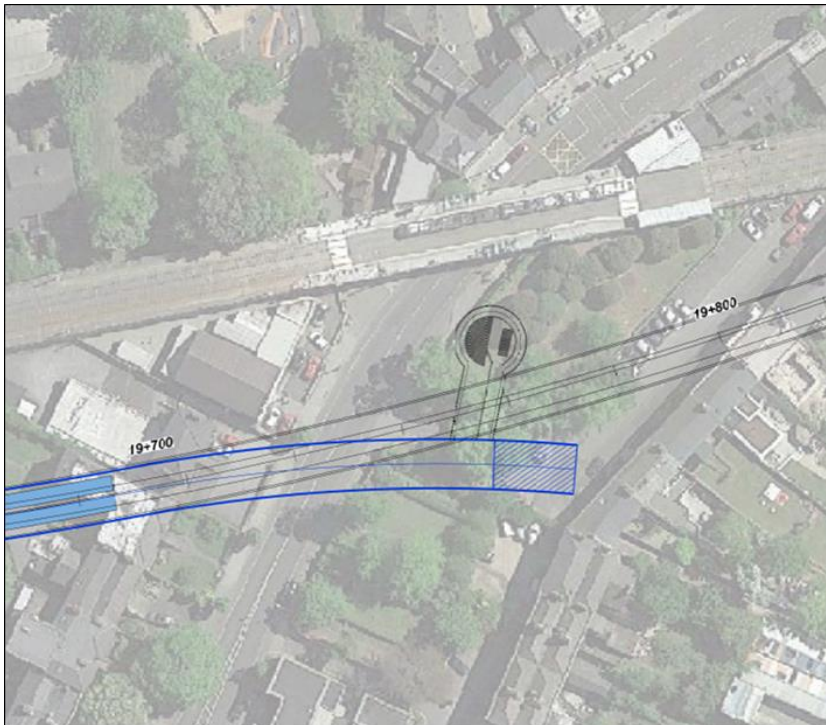


Figure 4-6 Option 3 - Shaft in garden between the Ranelagh Road and Manders Terrace

The associated construction working area is indicated on Figure 4.4.

The remote location of the shaft from Charlemont Station and its incident support facilities would also separate emergency services personnel who would need to attend both the shaft and the Charlemont Station in an incident. This is less desirable than maintaining a single location for incident control as it adds additional coordination issues.

The **Impact** on the surrounding area is limited and no property demolition is needed because the shaft is located in a garden near to the Ranelagh Luas Green Line stop. The south footway and part of the Ranelagh Road carriageway are likely to be affected during construction of the shaft. The following utilities running along the southern edge of Ranelagh Road could be impacted:

- 1300 x 930mm combined sewer
- Eir telecommunication ducts,
- MV ESB cables,

Urban integration of the intervention shaft and its access points and pop-ups should be relatively easy to integrate into the environment. Pop-ups of the shaft are at ground level as indicated by the shaded areas in the figure.

Construction requirements are similar to Option 2 although the mined connecting tunnel is slightly longer and the proposed shaft, although still located in a green area, would lie closer to the Luas Green Line Ranelagh Road bridge. Ground strengthening works would potentially be required during shaft construction to minimise settlement impacts on the Luas Green Line. Working space would be required along most of the current 'green' area, and footway restrictions on the south footpath of Ranelagh Road with associated traffic management would be necessary. The large diameter sewers along Ranelagh Road may require settlement protection.

Having regard to **Environmental** constraints this option for the shaft is in close proximity to a number of residential sensitive receptors. There is a church located near the site on the opposite side of the Ranelagh Road. There are no known water courses in close proximity and groundwater vulnerability is classified as “moderate. There are no protected European or National sites and no identified protected species present. The location of a shaft on Manders terrace would require the felling of trees. The shorter tunnel for this option would generate lower volumes of spoil compared to other options and will also need less construction material. There are no protected structures within 100m of the site, the nearest one (a 18th/19th century dwelling site) being 175m away. A number of properties on Manders Terrace are designated on the Dublin City Council RPS for their architectural heritage. The construction works and permanent structures could affect the setting of this RPS.

4.5 Option 4 - TBM buried beyond Turnback End with a Shaft next to Ranelagh Gardens Park

The shaft for this option is located more remote from the **alignment** on its east side as shown in Figure 4-6 below. A longer adit/connection gallery of approximately 110m is required between the shaft and the main tunnel.

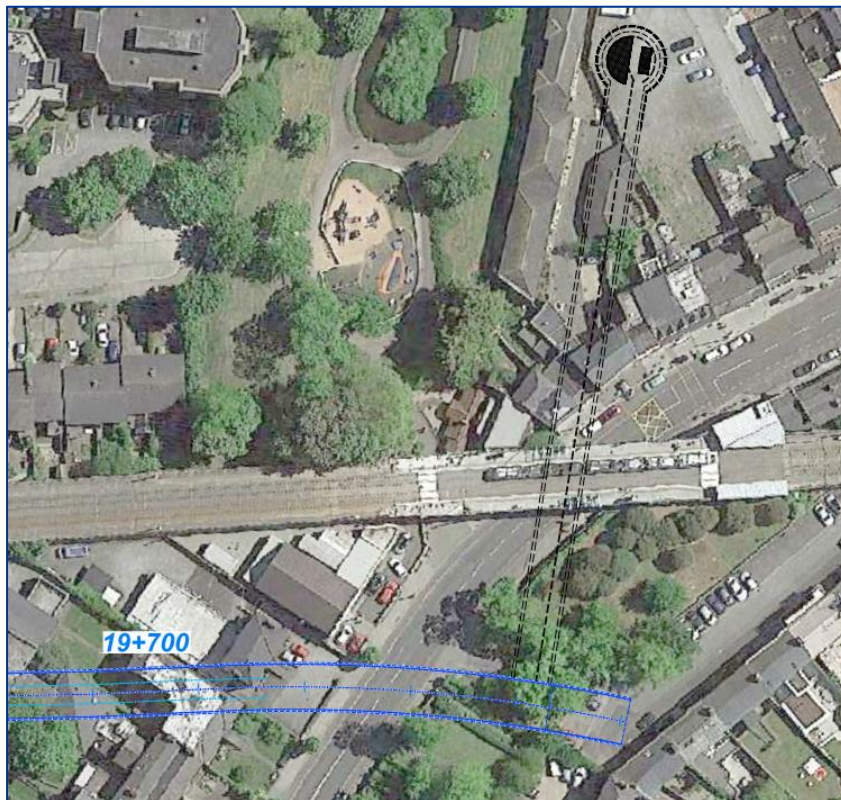


Figure 4-7 Option 4 Shaft in car park next to Ranelagh Gardens Park

This option locates the shaft in the car park behind properties on the Ranelagh Road and next to the Ranelagh Gardens Park, which is designated as a Quiet Area by Dublin City Council. This location is a relatively long distance from the tunnel compared to the other options. For this reason, a connecting gallery to the shaft with a greater cross-sectional area and no central wall instead of an adit is proposed. This implies a greater cost and a longer construction period. It also requires increased power for the ventilation equipment, which will be provided by the jet fans installed in the gallery.

The remote location of the shaft from Charlemont Station and its incident support facilities would also separate emergency services personnel who would need to attend both the shaft and the Charlemont Station in an incident. This is less desirable than maintaining a single location for incident control as it adds additional coordination issues.

The **Impact** on the surrounding area would be significant during construction. Access to the shaft site is not possible without the demolition of residential and commercial properties on the Ranelagh Road to create necessary construction access to the shaft site as the existing access is constrained by existing buildings (including a height restriction). Operational access to the site for maintenance etc would require retention of appropriate access restricting rebuilding on the road frontage. The site is overlooked by several residential and commercial buildings which would be impacted by construction activities.

Urban integration of the intervention shaft and its access points and pop-ups should be relatively easy to integrate into the immediate environment, which is currently a carpark. Pop-ups of the shaft are at ground level as indicated by the shaded areas in the figure.

Construction requirements are similar to other shaft locations and the compound area would need to extend from the car park into the Ranelagh Park area as shown in Figure 4-8.

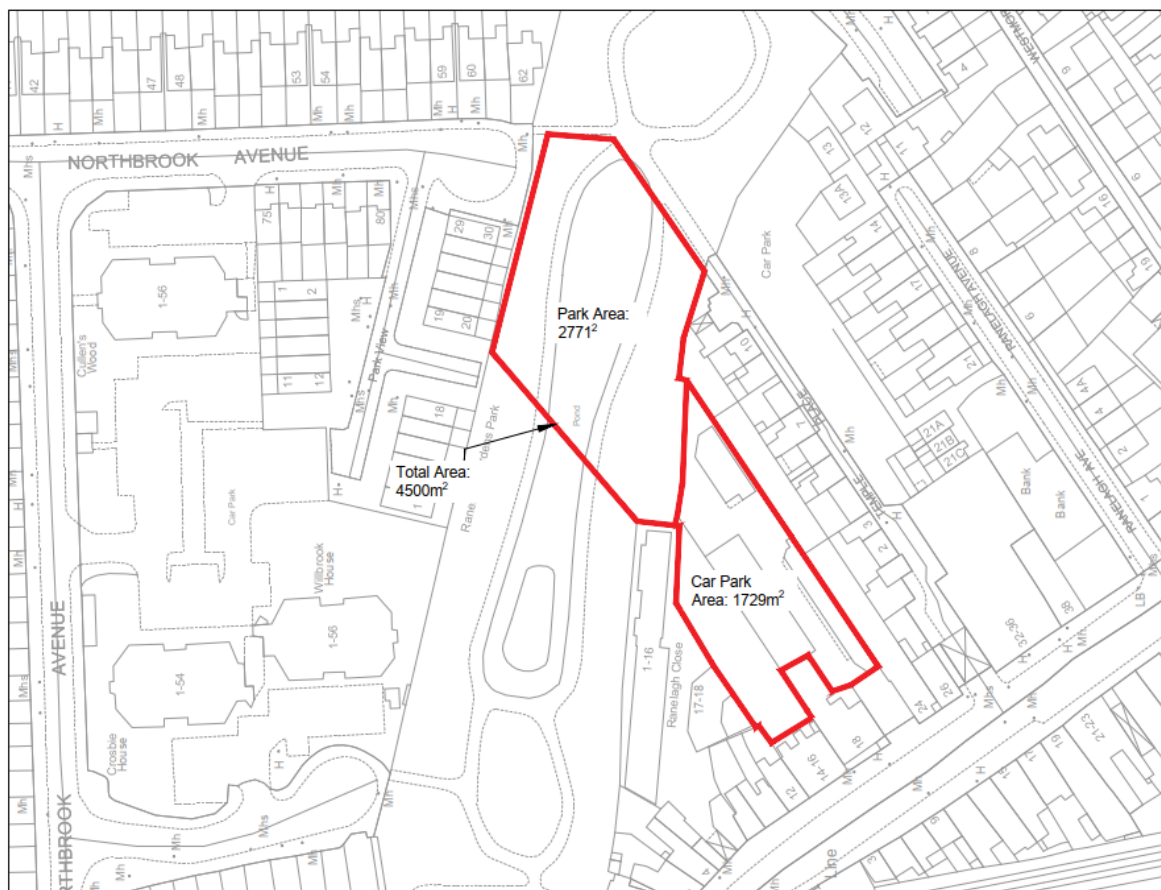


Figure 4-8 Construction Compound for Option 4

The **Environmental** impact of the shaft in this location will be substantial during construction, given the access requirements off the Ranelagh Road, the loss of the green space in the park, the requirement for the demolition of property, the residential nature of the area and the architectural heritage value of the area having specific regard to the Temple Place ACA.

4.6 Option 5 - TBM buried beyond Turnback End with a Shaft in Mount Pleasant Square Park

The shaft for this option is located remote from the **alignment** on its west side as shown in Figure 4-6 below. A long connection gallery of approximately 170m is required between the shaft and the main tunnel.

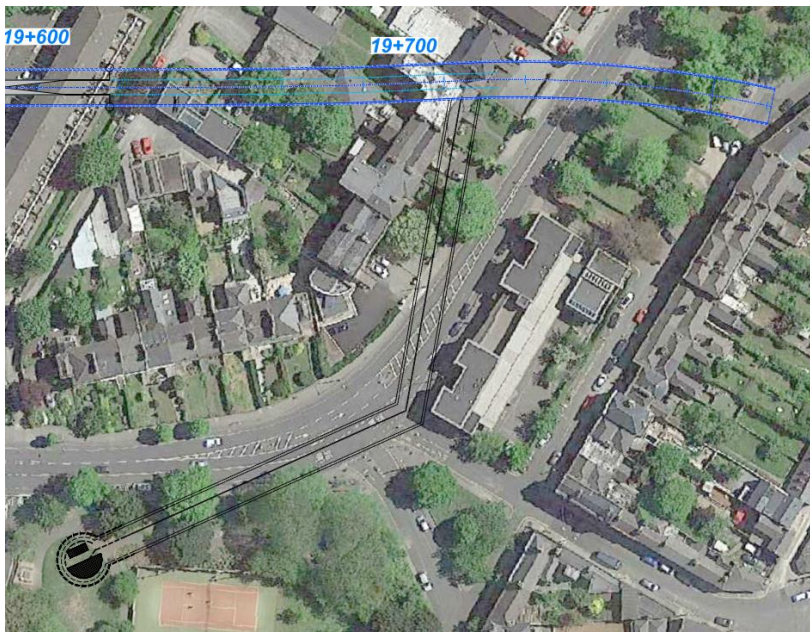


Figure 4-9 Option 5 west of the alignment towards Mount Pleasant Square sports complex

This Option sought to identify a shaft location which did not directly impact residential buildings in this built-up part of Dublin. The nearest identified location is within the Mount Pleasant Square adjacent to the sports complex. This would require an approximately 170m long gallery between the tunnel and the access shaft, generally following the Ranelagh Road alignment. The shaft itself would be located in the north-east corner of the park to avoid existing mature vegetation and tennis courts.

The remote location of the shaft from Charlemont Station and its incident support facilities would also separate emergency services personnel who would need to attend both the shaft and the Charlemont Station in an incident. This is less desirable than maintaining a single location for incident control as it adds additional coordination issues.

The **Impact** on the surrounding area during operation would be restricted to a small area of the park, though vehicular access would be required for maintenance and emergency situations. During construction more of the park area would be required to provide the necessary working space with potential impacts on some facilities to keep all construction working areas off the road. The site is overlooked by residential properties which would be impacted during construction.

Urban integration of the intervention shaft and its access points and pop-ups should be relatively easy to integrate into the environment. Pop-ups of the shaft are at ground level as indicated by the shaded areas in the figure.

Construction requirements are more onerous than Options 1 to 4 due to the longer length of the access tunnel required, to a gallery design of increased cross-sectional area and with jet fans. Leading to increased cost and programme duration. Ventilation power requirements would be higher

due to the longer length of tunnel. The available space for construction of the shaft at this location is limited as shown in Figure 4-10



Figure 4-10 Construction Compound for Option 5

Whilst the permanent surface area required for shaft access would be limited and contained within the existing grassed area the construction space required would either require loss of the existing adjacent mature trees and/or partial tree loss and temporary use of the three tennis courts area for the construction compound with reinstatement required afterwards.

On **Environment** there are no protected European or National sites and no identified protected species present. The Swan river is known to pass under this location with potential impacts during the construction phase. Mount Pleasant Square is surrounded by a number of buildings on the Dublin City Council RPS. The potential loss of open and recreational facilities is a significant constraint.

4.7 Option 6 - TBM buried under Luas Green Line and a Shaft west of Ranelagh Road

This option assumes that the main tunnel is extended further south in anticipation of an extension to MetroLink. In this case a connection to the Luas Green Line is assumed although other route options to the west or east are feasible. In any situation for the extended tunnel an intervention shaft would be required and for this Option 6 the proposed shaft is located at the end of the turnback tunnel section shown in Figure 4-11. The 360m length of unused tunnel has maintenance and ventilation requirements and these will be considered if this option is selected as preferred.

The shaft is located in a garden on the west side of Ranelagh Road and close to the main route alignment on its west side. A connecting adit of approximately 30m is required between the shaft and the main tunnel.

The remote location of the shaft from Charlemont Station and its incident support facilities would also separate emergency services personnel who would need to attend both the shaft and the Charlemont

Station in an incident. This is less desirable than maintaining a single location for incident control and adds additional coordination issues.

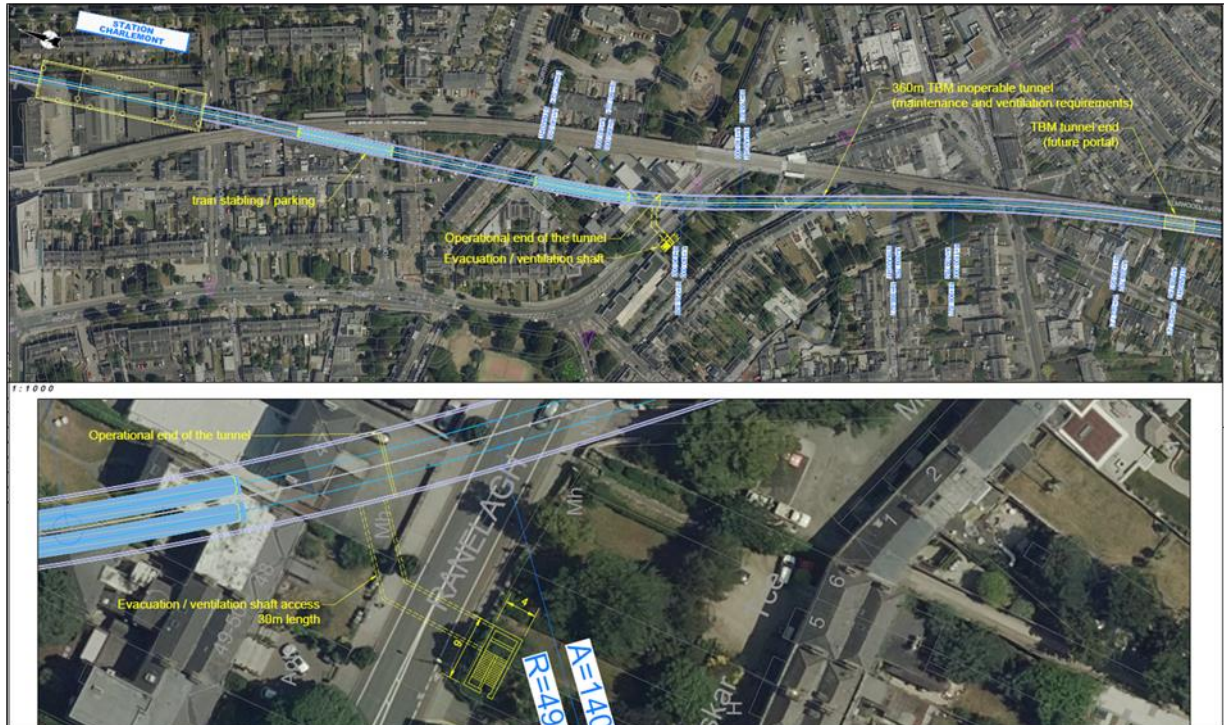


Figure 4-11 Option 6 - Shaft to west of Ranelagh Road and TBM stopped under Luas Green Line (Future Portal)

Impacts would be substantial in the future because construction of the portal as the tunnel rises from below ground means cutting the Luas Green Line and stopping services at a suitable station stop to the south. The geotechnical information available shows that the TBM would be in an area of poor soil liable to surface settlement unless it is left in the rock formation around 100m north from the position shown. The shaft may have an adverse impact on the following utilities along the southern edge of Ranelagh Road:

- 1220mm combined sewer,
- Eir telecommunication ducts,
- MV ESB cables.

Urban integration intervention shaft and its access points and pop-ups should be relatively easy to integrate into the environment. Pop-ups of the shaft are at ground level as indicated by the shaded areas in the figure.

Construction methods will be similar to the previous Options with the shaft near Ranelagh Luas Green Line station, other than abandonment of the TBM under the Luas Green Line. The vertical alignment profile for this Option 6 and the following Options 7, 8, and 9 will be almost identical and this is shown in Figure 4-12 below.

On **Environment** there are a number of residential properties, a creche and a school in close proximity to this shaft option. There are no protected structures within 100m of the site, the nearest being 250m away. A number of properties on Selskar Terrace are designated on the Dublin City Council RPS for their architectural heritage. Temple Place ACA is located 200m east of the

construction site. No significant impact is anticipated on this asset due to the intervening built environment between them.

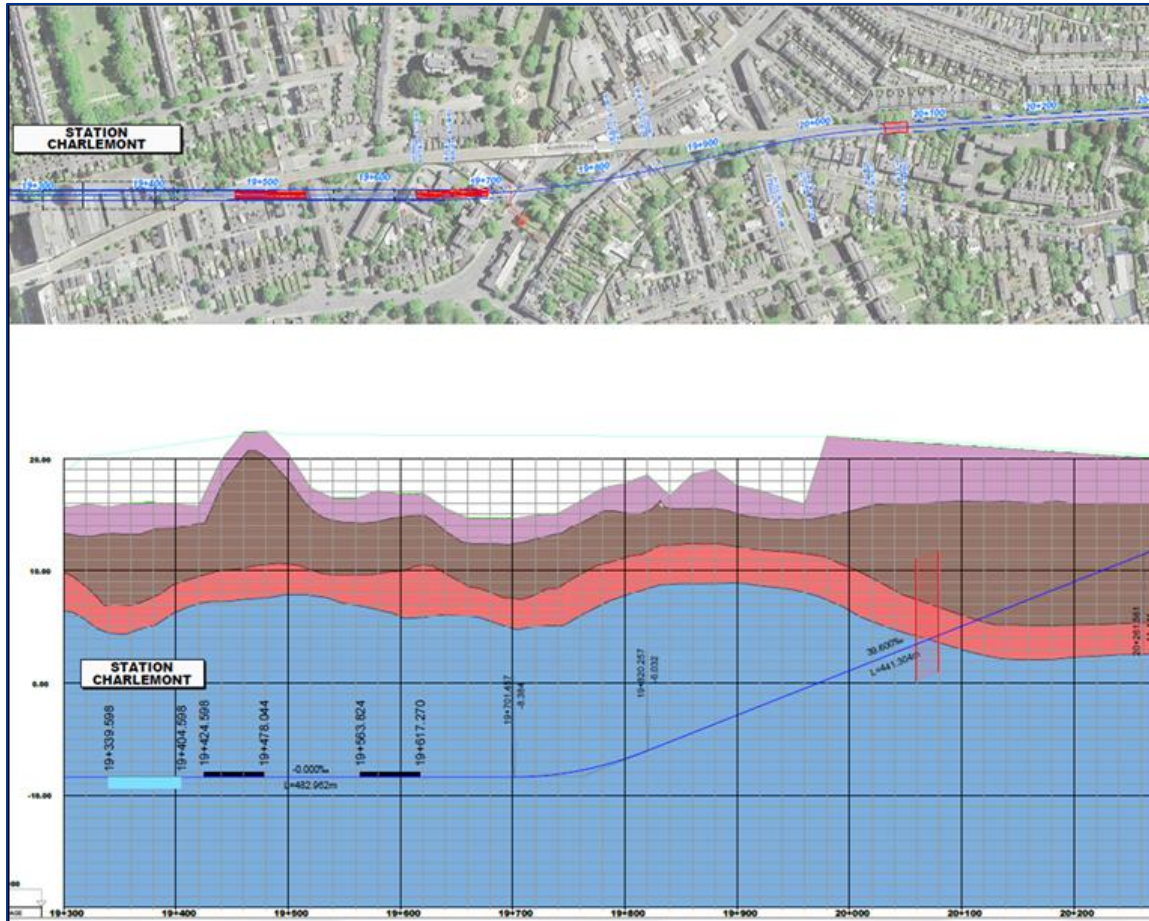


Figure 4-12 Geological Profile for Options 6, 7 and 9 [Colour Coding: blue-Rock; pink-Transition; brown-Boulder Clay]

4.8 Option 7 - TBM buried [under Green Line Option 7(a)] or at end of Turnback [Option 7(b)] and including a parallel Mined Gallery

Option 7 was developed in two stages. Option 7(a) was on the assumption that a connection to the Luas Green Line would be formed in the future, while Option 7(b) accepted that a decision on whether MetroLink would be extended to the south had not yet been made and the TBM should be stopped and buried just after the turnback tunnel section. Option 7(b) would be designed so that any decision on an extended route alignment could be achieved.

For an extended tunnel with a dead end, an intervention shaft would normally be required. However, this option differs from the others because instead of a separate shaft there is a 302m long mined gallery parallel to the main tunnel bore **alignment**. As shown in Figure 4-13, the gallery is to the east of the turnback tunnel and it runs back to the station from the end of the turnback tunnel.

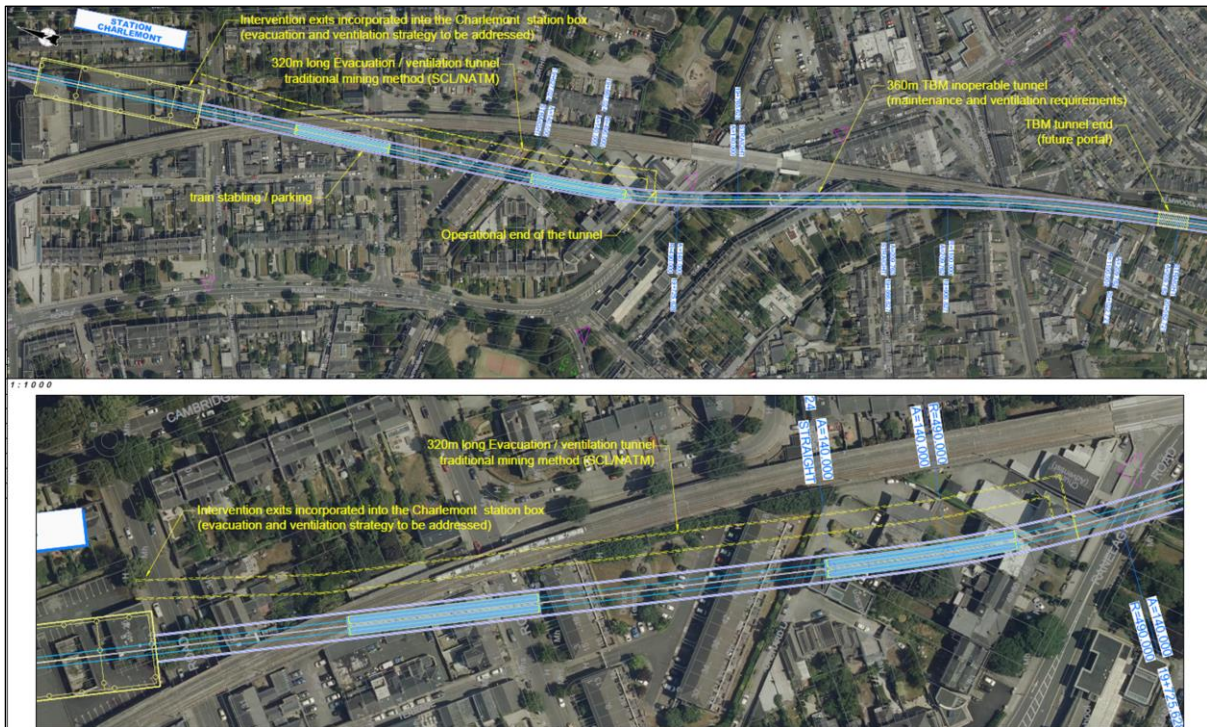
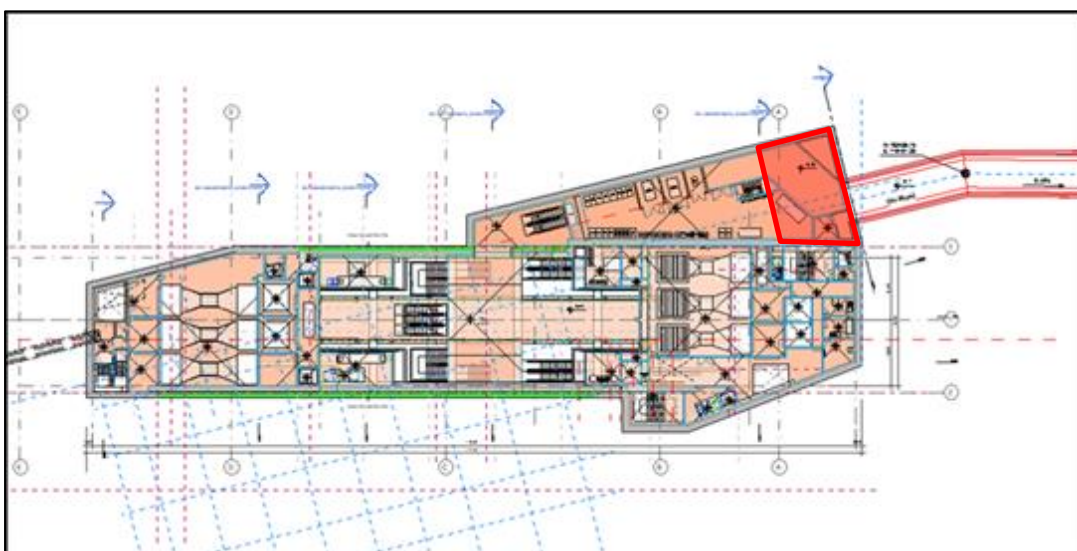


Figure 4-13 Option 7 - Mined Gallery to Station parallel to Turnback Tunnel

The gallery gives access to the emergency escape route in Charlemont Station as shown in Figure 4-12 and avoids the surface impacts in the residential area south of Charlemont Station as introduced by the previous options. Unlike the other options, this Option has the significant benefit of enabling emergency services personnel to manage incidents directly from the Charlemont Station, as there is no separate remote shaft to attend and intervention and evacuation is managed from within the station. The orange shaded area in Figure 4-14 indicates the area dedicated to the shaft for the gallery.




 Increased station footprint for Gallery Shaft

Figure 4-14 Charlemont Station Mezzanine Level showing Gallery Connection

A 3D model image of the gallery as it enters the Charlemont Station box at Mezzanine Level is shown in Figure 4-15.

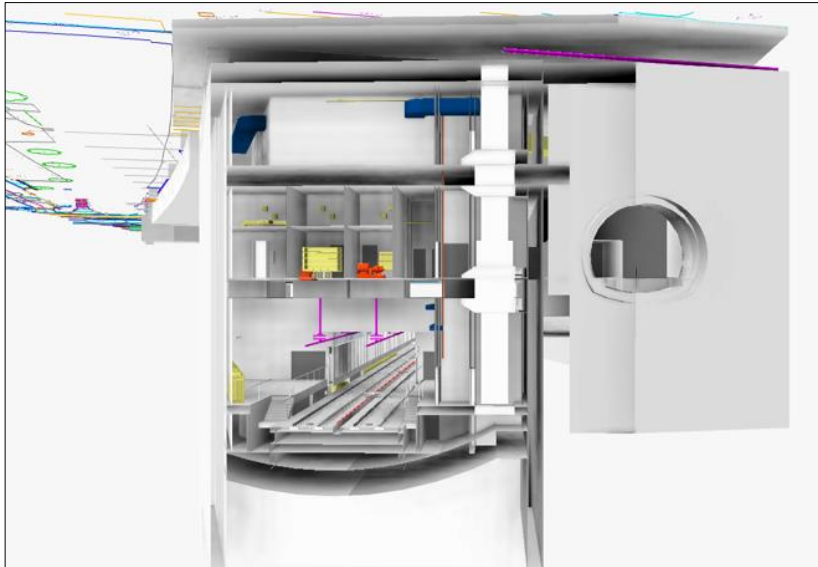
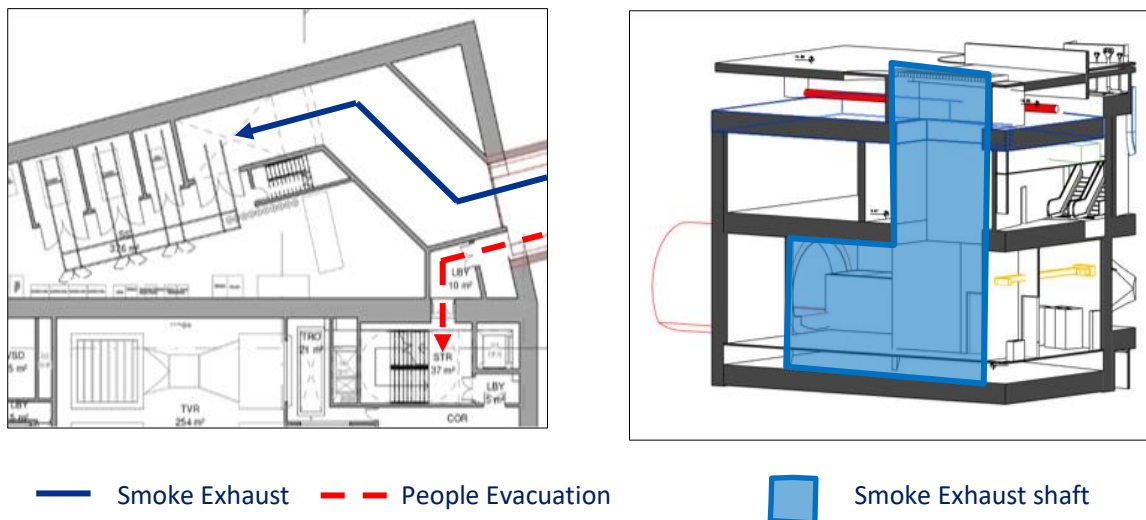


Figure 4-15 Charlemont 3D model to show Intersection of the Gallery with the Station Mezzanine.

There is no separating wall in the gallery for smoke exhaust and for evacuation, the diameter is sufficient to work as a single section for both evacuation and ventilation as in the main tunnel. Once the gallery reaches the station, there is a lobby equipped with emergency doors that separate the evacuation route from the ventilation flow. The lobby connects to the emergency stairs at the station that also serve the platforms and tunnel sections. The ventilation flow is directed to the surface via an existing shaft at the station box used for the entrance and removal of back of house equipment. The emergency doors prevent entry of smoke to the station evacuation route as shown in Figure 4-16. To accommodate the gallery connection, the station box east area will be adapted and enlarged.



— Smoke Exhaust - - - People Evacuation Smoke Exhaust shaft

Figure 4-16 Escape route from Gallery to Charlemont Station – Maintenance Staff and Smoke Separation

Impacts. The ventilation/evacuation gallery is 302m long and this results in increased construction costs and a longer construction period compared to other options with an intervention shaft. This will have an effect on the power consumption for the fans at the Charlemont ventilation shaft, involving a power increase of 10-15% and increased noise from the fans as well as increased space requirements for silencers to mitigate this. The Charlemont Station box will need to be increased in size for the necessary gallery access and separate ventilation shaft.

Urban integration of the turnback tunnel is not relevant in this case because all works will be underground except for the changes needed to the ventilation shaft at Charlemont Station.

Construction of the mined gallery introduces additional underground work, but balanced by the removal of the vertical shaft and shorter adits at the end of the turnback tunnel. Depending on progress at Charlemont Station it is possible that the mined gallery could be completed prior to the arrival of the TBM so the connection to the main tunnel could be made on completion of the bored tunnel. The additional volume of excavated material for the gallery is not significant in relation to Charlemont station. However, the gallery will impact the station programme and the additional space for construction equipment in an already constrained site will be an important consideration. It is noted that the rock cover is minimal at the start of the mined tunnel close to Charlemont Station. Forward probing will need to be carried out to prove adequate rock cover and the first 50m of tunnel will require steel frames or lattice girders and a combination of rock bolting and forepoling to ensure the stability of the tunnel crown. Thereafter, the gallery should be in rock with very limited settlement expected (numerical analysis indicates theoretical settlements of the order of 0.05 mm).

Potential for groundborne noise and vibration impacts arising from the construction of a parallel gallery on residential sensitive receptors above this alignment would need to be considered as constraints to this option. However, the option removes impacts further south of Charlemont and keeps all surface construction interventions at the Charlemont Station works site and with no additional permanent surface interventions and their associated future maintenance and security issues.

Any **future extension** could be driven or mined from the south to minimise disruption to MetroLink Operations. Working outside of normal operational hours, the future project would gain access through Charlemont Station to enable the construction of a blockwork Isolation wall at the end of the turnback tunnel to isolate the future connection construction works from the operation of the existing MetroLink. The turnback tunnel would need to be sufficiently long to for the isolation wall to be constructed outside of the existing MetroLink operational area. This would create a dead space which is not desirable, although the wall could be partially erected thereby minimising the work which the future project would need to undertake. Upon final closure of the isolation wall, all construction activities for the line extension would be from the south and beyond the wall, thus avoiding affecting the operation of MetroLink. Following the structural completion of the connection, fit out of the tunnel and track installation would be completed outside of operational hours.

4.9 Option 8 - TBM Extracted in Charlemont Station Box with Turnback Tunnel formed in a Mined Cavern

This option differs from other options in that the TBM is extracted through the Charlemont Station box and the turnback section is formed in a cavern mined in rock using SCL techniques. The cavern is mined to form the turnback section on a suitably designed **alignment** that allows for any future extension. The length of the cavern is shorter than the other options at 240m but it is made sufficiently wide so that four trains can be stabled on a parallel arrangement as shown in Figure 4-17 below.

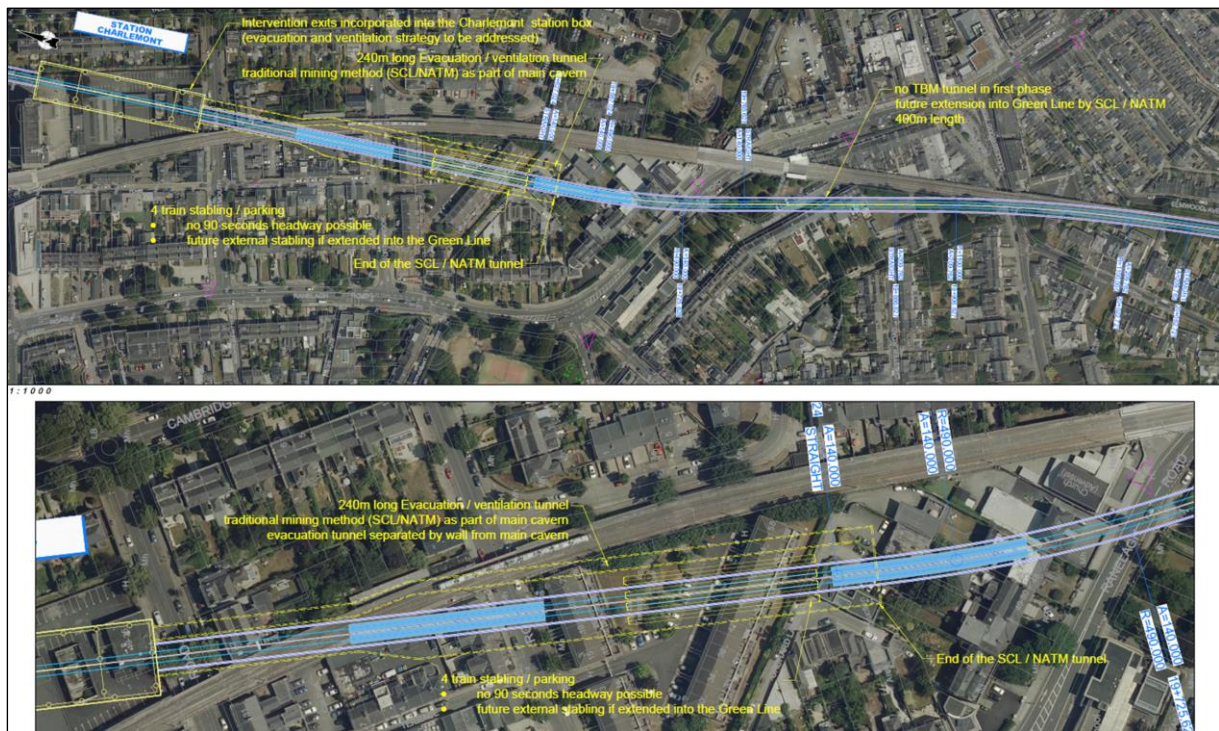


Figure 4-17 Option 8 - TBM recovered in Charlemont Box and Turnback formed in Mined Cavern

In figure above it can be seen that proposed cavern (with 4 lines and space for ventilation) is as wide as Charlemont Station box, it is to say around 25m width.

The shape of a similar cavern (case studied for option of mined tunnel in Tara Street station) is shown in Figure 4-18.

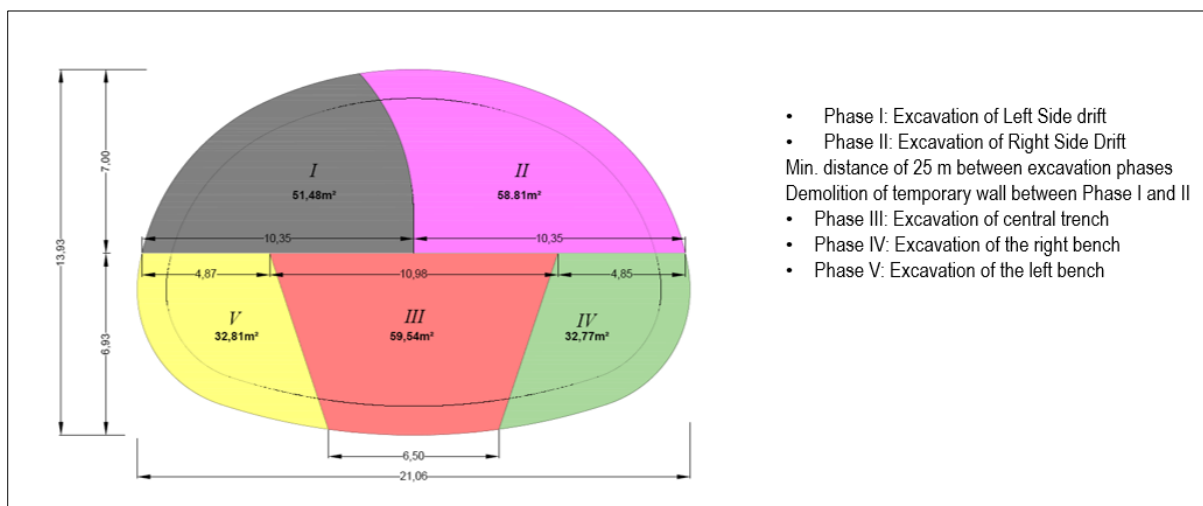


Figure 4-18 Option 8 – Example Shape of a Mined Cavern

In the case of the turnback at Charlemont, the horizontal dimension of the cavern would be about 25 m, to allocate the 4 parallel stabling tracks and the ventilation and evacuation gallery, which would be separated from the track area by means of a dividing wall (see figure “Option 8 – TBM recovered in Charlemont Box and Turnback formed in Mined Cavern”) . Given this width, the corresponding height

would be 16m to 17m. The excavated area would be in the order of 370m². The geotechnical profile shown in Figure 4-19 is overlaid with a red box that indicates the location and size of this cavern.

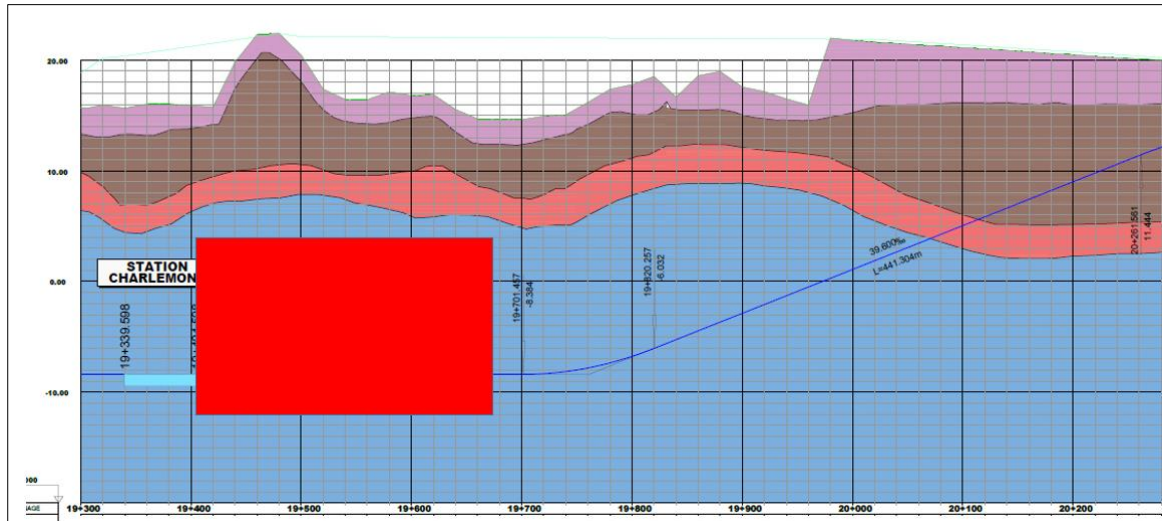


Figure 4-19 Option 8 – Geotechnical profile with Turnback Formed in Mined Cavern

The **impact** of the increase in cross-sectional area of the cavern leads to increased airflow demand. This implies bigger fans in the Charlemont Station ventilation shaft, larger areas for the air path in the station and its intervention shaft with larger areas for grilles at street level.

Urban integration of the turnback tunnel is not relevant in this case because all works will be underground except for the changes needed to the ventilation shaft at Charlemont Station

Construction of the mined cavern introduces substantial underground work, although this is balanced by the removal of the vertical shaft from the work scope. Depending on progress at Charlemont Station the mined cavern could be completed prior to the arrival of the TBM at Charlemont Station and the final connection made on completion of the bored tunnel. Whilst the TBM removal at Charlemont Station reduces the time waiting for the bored tunnel to reach the Luas Green Line the site is constrained, and it is likely that there is no overall programme advantage. The size of the main line cavern for the turnback would mean that its crown would be at or close to the weathered rock layer. As the caverns are proposed beneath residential buildings and under the Green Line embankment, it is likely that significant ground treatment and support will be required to limit ground movement and it is likely that these measures would be disruptive to the residents. These would also be significant mining works to create this large cavern directly under the LUAS embankment and there would be significant protection measures required to ensure maintenance of the line.

Potential for groundborne noise and vibration impacts arising from the construction of a cavern on residential sensitive receptors above this alignment would need to be considered as constraints to this option. However, the option removes impacts further south of Charlemont and keeps all surface construction interventions at the Charlemont Station works site and with no additional permanent surface interventions.

4.10 Option 9(a) & 9(b) - TBM buried under Green Line with a Shaft near end of Tunnel

This option has the TBM continuing its drive beyond Charlemont Station for a total distance of 680m to a point under the existing Luas Green Line where the TBM is buried until such time when the Luas Green Line connection might be made. While there are other options for the extended alignment,

diverging to the west or east compared to the Luas Green Line connection route, this option can be considered as typical for the purposes of this assessment.

A ventilation and evacuation shaft at the end of the TBM bored tunnel is indicated at one of two locations as shown in Figure 4-20 below. Option 9(a) has the shaft at Charleston Road, while for Option 9(b) the shaft is located at Elmwood Avenue Upper.

As for the other options, the remote location of the shaft from Charlemont Station and its incident support facilities would also separate emergency services personnel who would need to attend both the shaft and the Charlemont Station in an incident. This is less desirable than maintaining a single location for incident control as it adds additional coordination issues.

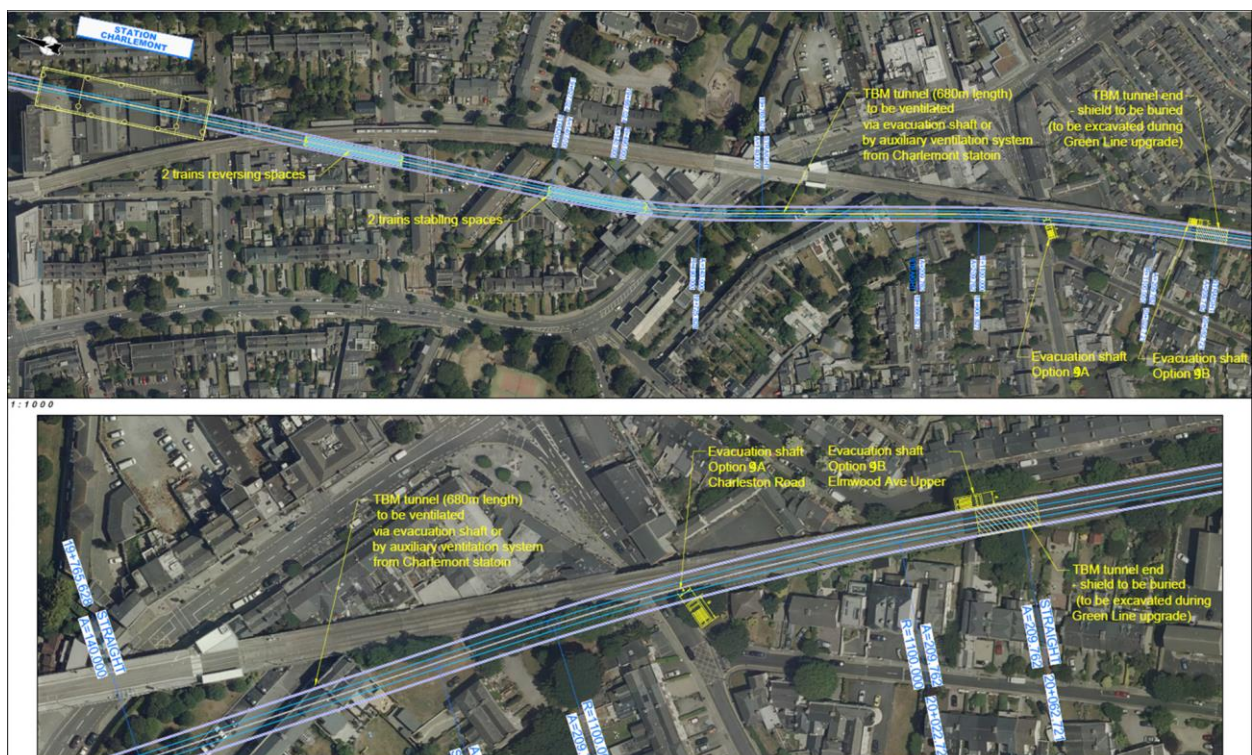


Figure 4-20 Option 9 - TBM stopped under the Luas Green Line with a single Shaft at end of Tunnel

Impacts are substantial because the dead-end tunnel is relatively long and the available geotechnical information shows that the abandoned TBM will be in an area of poor soil, which could result in surface settlements. The TBM should be directed off the main tunnel alignment, preferably into a solid rock formation.

The proposed shaft may have an adverse impact on the following utilities running along the southern edge of Charleston Road:

- Eir telecommunication ducts
- MV ESB cables
- 9in Water Main

- Low Pressure Gas Main
- 450mm foul sewer.

Urban integration for both shaft locations is affected by the constrained site locations, particularly at Elmwood Ave. There could be large impacts from ground stabilisation works and traffic restrictions. Pop-ups of the shaft are at ground level.

Construction of a shaft located at either Charleston Road or Elmwood Avenue Upper will have similar issues to the other shaft options. The utilities will need to be diverted from the road and due to the working area required for the shaft construction, the road would need to be closed for a prolonged period. It would be less disruptive to utilities and traffic if the shaft was located within the property boundary at the junction of Charleston Rd and Oakley Road.

For a shaft located at Elmwood Avenue Upper the size of the construction area required means that the road would need to be closed to traffic and the site boundary would be immediately adjacent to the kerb line outside the properties. For both shaft location options, ground improvement work may be needed to limit ground movement near to the adjacent properties. If this is required, it would be disruptive to residents.

On **Environment** the location of sensitive residential units at Oakley Avenue in close proximity to the intervention shaft location for option 9-4A and residential properties on Elmwood Avenue Upper in close proximity to the shaft location for option 9-4B would be considered as constraints to these proposed options. A number of properties on Charleston Road and Oakley Road are designated as RPS for architectural heritage, and there would be an impact on the setting of these as a result of construction of option 9-4a. In option 9-4b, the shaft would be constructed within the Elmpark Avenue and Elmwood Avenue Architectural Conservation Area. There is potential for impact on the culverted river under Charleston Road for option 9-4A, as well as felling of trees and impact on a number of RPS's in vicinity. Trees will also have to be felled for option 9-4B.

5. STAGE 3 PRELIMINARY ANALYSIS

5.1 Assessment Criteria

The assessment criteria with sub-criteria for the Stage 3 Preliminary Analysis are set out in Table 5-1 below.

Table 5-1 Assessment Criteria for Environment, Engineering, and Economy

<u>Criteria</u>	<u>Sub-Criteria</u>	<u>Criteria Description</u>	<u>Note</u>
Project Objectives		Does the Option satisfy the stated project objectives set out below	Should the option not satisfy the objects it fails and is removed from further assessment
Economy	Cost	This criterion considers the broad capital and operation costs of each of the proposed turnback options.	This criterion was assessed given the capital and operational cost implications of differing turnback options

An MCA appraisal table has been prepared using a Scoring System as shown in Table 5-2. The results of the MCA analysis shown in

Table 5-2 Scoring Table

Options Assessment	Significance
	Feasible with least impacts lowest risks
	Feasible with moderate impacts/moderate risks
	Feasible with negative impacts / high risks
	Not Feasible/Fail

Assessment results given in Table 5-3 collates and summarises the appraisal of each potential option under the Stage 3 assessment criteria.

Table 5-3 Summary of Results of Stage 3 Analysis

Option	1	2	3	4	5	6	7		8	9	
Sub option							a	b		a	b
Project Objectives	Pass	Pass	Pass	Pass	Pass	Fail	Fail	Pass	Pass	Fail	Fail
Economy	Pass	Pass	Pass	Warn	Warn	Fail	Fail	Warn	Warn	Fail	Fail
Overall	pass	pass	pass	pass	pass	fail	fail	pass	pass	fail	fail

Option 9 is shown to fail on two criteria:

1. it does not meet the project objectives as it materially affects the direction of the southwards extension of the Metro System in the future and the 400m long dead-end tunnel extension is a safety hazard.
2. it is economically significantly more expensive to construct a 400m tunnel extension up under the Green Line and maintain this as opposed to a tunnel extending only to the end of the turnback facility.

Options 6 and Option 7(a) also fail on two criteria:

1. they both prejudice the future extension of the Metro System and therefore don't meet the project objectives.
2. they both have the negative safety impacts of a long dead-end tunnel and need a shaft and construction compound in a residential area with attendant environmental concerns.

For these reasons Options 1, 2, 3, 4, 5, 7(b), and 8 are taken forward to Stage 4 MCA.

6. STAGE 4 MCA OF REMAINING OPTIONS

6.1 Option Groups

The remaining options for assessment through the Stage 4 MCA are listed below in Table 6-1.

Table 6-1 Remaining Options and Groupings

Option	1	2	3	4	5	7 (b)	8
Group Type	A	A	A	A	A	B	D
TBM Disposal	TBM buried just beyond turnback	TBM buried just beyond turnback	TBM buried just beyond turnback	TBM buried just beyond turnback	TBM buried just beyond turnback	TBM buried just beyond turnback	TBM extracted Charlemont Station
Intervention	Shaft in Ranelagh Park Playground	Shaft in garden between Ranelagh Road and Selskar Terrace	Shaft in garden between Ranelagh Road and Manders Terrace	This option locates the shaft in the car park next to the Ranelagh Gardens Park	Shaft near sports complex in vacant space	Mined gallery parallel to turnback	Turnback in mined cavern

All 7 remaining options were assessed through a Stage 4 Multi-Criteria Analysis (MCA). This is described in the previous Section 2 of the report. Engineering impacts/design and Environmental impacts were addressed at the same time in a sub assessment shown separately in the sections below.

Following the outcome of the Engineering and Environment sub MCA (see criteria in section 2 of the report tables 2-5/6). The overall Stage 4 summary table (Section 2 table 2-3) is populated with the scores to identify the preferred Option.

Engineering Impacts

Using the Assessment Scoring shown in Table 6-2 below, the Sub-MCA for Engineering is presented in Table 6-3.

Table 6-2 Stage 4 MCA Scoring Table for Engineering Criteria

Table 6-3 Assessment Scoring Assessment Score for Individual Assessment Criteria	Significance Advantages/Disadvantages
	Significant advantages over other options
	Some advantages over other options
	Comparable to other options
	Some disadvantages over other options
	Significant disadvantages over other options

Table 6-3 Sub MCA for Engineering with no Tunnel Extension beyond the turnback to the South

Option	1	2	3	4	5	7(b)	8
Alignment and structures	Shaft is far from Tunnel Alignment	Shaft is near to tunnel alignment	Shaft is near to tunnel alignment. Adit to be removed in future	Shaft is further away from Tunnel Alignment	Shaft is further away from Tunnel Alignment	Gallery is parallel to TBM bored tunnel and no shaft required	Large diameter cavern in proximity to tunnel alignment,
Demolition / Settlement or buildings impacted	No buildings affected	No buildings affected	No buildings affected	No buildings affected	No buildings affected	No buildings affected	Limited or no settlement
Ventilation	The increase in the length of the adit implies increased ventilation area needs	No ventilation issues	No ventilation issues	The increase in the length of the adit implies increased ventilation area needs	The increase in the length of the adit implies increased ventilation area needs	More fan power required for gallery and bigger silencers	More fan power required and bigger silencers

Option	1	2	3	4	5	7(b)	8
Urban Integration	Access through residential area	Within residential gardens	Within private park	In a car park	In a park with sports facilities	Shaft integrated at the station area	No separate shaft required
Utilities	Minor impact	Potential impact to large diameter sewers	Potential impact to large diameter sewer	Minor impact	Minor impact	Unaffected	Unaffected
Constructability /Construction Safety	50m mined adit plus shaft	Short adit plus shaft	Short adit plus shaft	110m mined adit plus shaft	170m mined adit plus shaft	Mining of 300m parallel escape gallery	Prepare Charlemont site for future mining works. impact in a large surface (due to cavern dimensions) for ground stabilisation
Construction Costs	Shaft and 50m adit	Shaft and short adit	Shaft and short adit	Shaft and 110m long adit	Shaft and 170m long adit	Long mined gallery to connect to the station	Large Cavern
Property Impact	Land for Shaft and construction compound	Land for Shaft and construction compound	Land for Shaft and construction compound	Land for Shaft and construction compound	Land for Shaft and construction compound	Shaft integrated in the station	Shaft integrated in the station
Roads/Access/ Car park/ Impacts	Ranelagh Road and Manders Terrace	Ranelagh Road	Ranelagh Road	Car Park	Vehicle access	No impact	No impact

Option	1	2	3	4	5	7(b)	8
Geology	Underground works in Rock	Underground works in Rock	Underground works in Rock	Underground works in Rock	Underground works in Rock	All underground works in Rock	All underground works in Rock but near the soil layer due to the large dimension of the cavern
Recommendation						recommended	

The summary scoring for Engineering Criteria show Option 7(b) as offering more advantages when compared to all other options. Scores are closer between Options 1, 2, 3 and 7(b). Options 4 and 5 score less than 1, 2, and 3 as they require additional length of connection adit between the shaft and the turnback tunnel, increasing construction cost, safety and programme, as well as potentially requiring more fan power for ventilation, without any significant benefit compared to options 1, 2, 3. The main differentiators between Options 2/3 and 7(b) are in the areas of Urban Integration where Option 7(b) has no impact on gardens or parks as it doesn't have a separate intervention shaft in gardens or in a park. Option 1 has slightly less impact on utilities and urban integration than 2 or 3 but has a longer adit. Option 7(b) has no impact on utilities compared with Options 1-5. Options 1-5 also have additional property costs/residual impacts and land required for a construction compounds.

Whilst Option 7(b) will be somewhat more expensive to construct than Options 2 and 3 (in the context of the project as a whole the difference is minor) and will require slightly greater fan power requirements it is considered that Option 7(b) offers greater advantages over all the other options assessed.

6.2 Environmental Assessment

The MCA for the Environmental Assessment was carried out for all feasible options using the criteria listed in Table 2-5.

The summary MCA for Environment assessment is shown in Table 6-4. The full text of the Environmental MCA is included in Appendix A. It should be noted that the full environmental MCA used a more detailed, seven-point scale of impacts, which has been transposed into the Stage 4 five-point comparative scale for this report.

Options 7b and 8 have lower impacts under certain disciplines as they do not require an intervention shaft to progress to the surface (outside of the station box), but that is to be balanced against the need for excavated galleries to connect them, and the associated impacts relating to embedded carbon, materials use and waste generation.

Table 6-4 MCA for Environmental Assessment

Options	1	2	3	4	5	7(b)	8
Noise and Vibration	<p>Construction of this adit and shaft would generate ground borne noise which may impact the number of residential receptors along Northbrook Avenue, Ranelagh Close and Orchard Lane, all of which are located in close proximity , the nearest being at 25m. Ranelagh Seventh Day Adventist Church and Kids Inc, a creche and Montessori school are located approximately 60 - 70m to the west of the construction site. The shaft is located in a DCC designated Quiet Zone and is in close proximity to noise-sensitive receptors in terms of park users.</p> <p>Impacts from noise would be temporary.</p>	<p>This location is within 50m of residential sensitive receptors at Selskar Terrace and Manders Terrace. In addition, a church, Ranelagh School, and a nursery are located within 50m of the site on Ranelagh Road. Other residential properties are also located on Ranelagh Road within 50-100m. Construction noise impacts would affect these properties. Such impacts would be temporary. Construction of the shaft would generate significant amount of noise. The short adit length would limit noise associated with excavation and removal of material.</p>	<p>This location is within 50m of the residential sensitive receptors of Manders Terrace and their gardens. There is a nursery located within 50m of the site on Ranelagh Road. Other residential properties are also located on Ranelagh Road and within 50-100m from the site. Noise generated by the works could impact the sensitive receptors. Such impacts would be temporary in nature and may be reduced by adopting suitable measures.</p>	<p>Construction would generate ground borne noise which may impact the number of residential receptors at, Ranelagh Close and Temple Place, all of which are located in close proximity , Ranelagh Seventh Day Adventist Church and Kids Inc, a creche and Montessori school are located approximately 100m to the north of the construction site. The shaft is located in a DCC designated Quiet Zone and is in close proximity to noise-sensitive receptors in terms of park users.</p> <p>Impacts from noise would be temporary during the construction period only.</p>	<p>This location is within 50m of residential sensitive receptors on Mount Pleasant Square. Noise and Vibration impacts would also affect the park and tennis court users in the area during construction.</p>	<p>Excavation of the intervention shaft would be in the immediate vicinity of the Charlemont Station site. This is in close proximity to properties in Dartmouth Square West and Dartmouth Road. One vibration- and noise-sensitive building (Viktor Frankl Institute) is located 40m from the construction works. Construction of the 302m tunnel would create Groundborne noise & vibration and might impact occupants of a number of properties along the tunnel alignment during the construction phase. These would be along Dartmouth Road, Northbrook Road, Orchard Lane, and Ranelagh Road. The Luas Green Line would also be sensitive to vibration</p>	<p>Shafts would be within the station box, hence there is a potential for cumulative noise impact the same set of receptors as identified for Charlemont station. The excavation of the 240m long tunnel would impact the receptors lying between station box and Orchard Lane. The Luas Green Line would also be sensitive to vibration effects.</p>

Options	1	2	3	4	5	7(b)	8
						effects.	
Air and Climate	Dust impacts at local properties and in Ranelagh Park. 50m adit construction would involve more GHG emissions and embedded carbon than would shorter adit options.	Dust impacts at local properties, a church, a school, and a nursery. Only 2m long adit, so limited GHG emissions and embedded carbon	Dust impacts at residential properties and a nursery. Relatively short 13m long adit, with associated levels of GHG emissions and embedded carbon.	Dust impacts at local properties and in Ranelagh Park. And construction would involve more GHG emissions and embedded carbon than would shorter adit options.	Dust impacts at properties on Mount Pleasant Square. Furthermore, potential for dust impacts on the park users and tennis club. Long gallery at 170m, hence more significant GHG emissions and embedded carbon.	Dust impacts at receptors in proximity to Charlemont Station. Very long evacuation gallery at 302m, hence more significant GHG emissions and embedded carbon.	Dust impacts at receptors in proximity to Charlemont Station. Long gallery at 240m, hence more significant GHG emissions and embedded carbon.
Water	Potential impacts during construction on quality of an underground river that crosses under Ranelagh Park and on the ornamental pond in the park. Construction works	Impacts limited by short length of gallery construction. Construction works could affect groundwater flows and/or quality.	Impacts limited by short length of gallery construction. Construction works could affect groundwater flows and/or quality.	Potential impacts during construction on quality of an underground river that crosses under Ranelagh Park and on the ornamental pond in the park. Construction	Potential impacts during construction on quality of an underground river that	Potential for construction works to affect a culverted historic watercourse and water quality in the Grand Canal. Construction works could affect groundwater	Potential for construction works to affect a culverted historic watercourse and water quality in the Grand Canal. Construction works

Options	1	2	3	4	5	7(b)	8
	could affect groundwater flows and/or quality	Underground river is approximately 80m from the works and may be affected indirectly.	Underground river is approximately 90m from the works and may be affected indirectly.	works could affect groundwater flows and/or quality	crosses through the area.	flows and/or quality	could affect groundwater flows and/or quality
Biodiversity	No protected European or National sites. No identified protected species present. However, it is likely that trees will need to be felled during construction.	No protected European or National sites. No identified protected species present. However, it is likely that trees will need to be felled during construction.	No protected European or National sites. No identified protected species present. However, it is likely that trees will need to be felled during construction.	No protected European or National sites. No identified protected species present. However, it is likely that trees will need to be felled during construction.	No protected European or National sites. No identified protected species present. However, it is likely that trees will need to be felled during construction.	No protected European or National sites. No identified protected species present. Potential to disturb breeding birds in the Dartmouth Square area.	No protected European or National sites. No identified protected species present. Potential to disturb breeding birds in the Dartmouth Square area.
Landscape and Visual	Construction activities would impact views from residential receptors on Park View, Northbrook Avenue and Temple Place. Additionally, users of the park would also experience visual impact during construction phase.	Construction activities would impact views from residential receptors Manders Terrace and Selskar Terrace. Vegetation removal, including of mature trees, would impact on the local	Construction activities would impact views from residential receptors Manders Terrace. Access point, emergency exit and ventilation shaft would be permanent features above ground within	Construction activities would impact views from residential receptors on Park View, Northbrook Avenue, Ranelagh Close and Temple Place. Additionally, users of the park would also experience visual	Construction activities would impact views from residential receptors on Mount Pleasant Square.	It is anticipated that the shafts would be excavated at the same time as the Charlemont Station box and would impact the same set of receptors so a cumulative landscape and visual impact would be experienced by these	Since construction of the shafts would be at the same time as the station box, they would have a cumulative landscape and visual impacts on same receptors as the

Options	1	2	3	4	5	7(b)	8
	The access point, emergency exit and ventilation shaft would be a permanent feature on the parkscape, however they would be close to ground level and integrated into the surrounding environment.	townscape. The access point, emergency exit and ventilation shaft would be permanent features above ground, however, they would have a minimal permanent impact on the townscape.	the garden, however with careful integration, they would have a minimal permanent impact on the landscape.	impact during construction phase. The access point, emergency exit and ventilation shaft would be a permanent feature on the parkscape, however they would be close to ground level and integrated into the surrounding environment	Vegetation removal, including of mature trees, would impact on the local townscape.	receptors. The ventilation hatch would be a permanent feature on the ground however it can be integrated with careful landscaping.	Station options. The tunnel would be excavated underground hence no landscape and visual impact. The ventilation pop-ups would be a permanent feature on the ground however it can be integrated with careful landscaping.
Resources and Waste	The 50m adit for this option will generate high volumes of spoil compared to the other options and will also need more construction material	The shorter tunnel for this option will generate lower volumes of spoil compared to other options and will also need less construction material	The shorter tunnel for this option will generate lower volumes of spoil compared to other options and will also need less construction material	This option will generate high volumes of spoil compared to the other options and will also need more construction material	Significant excavation of soil material to create 170m tunnel	Significant excavation to create 302m tunnel.	Significant excavation to create 240m tunnel with larger cross section than option 7.
Properties	This option would directly impact the usage of Ranelagh Park. Access to properties along Northbrook Avenue would also be restricted during the construction of this	No property demolition for this option. However, the shaft would be located within private gardens, which would be permanently lost or	No property demolition for this option as the shaft has been located in an existing green / garden area within Manders Terrace. There may also be	Significant property demolition and this option would directly impact the usage of Ranelagh Park.	No property demolition. Impact on Mount Pleasant Park	Construction may cause access impedence to properties on Dartmouth Road. However, this would be cumulative in nature if	The shafts are expected to be constructed along with the station box, hence impacts on properties within vicinity would be

Options	1	2	3	4	5	7(b)	8
	option. Additionally, the duration of works is anticipated to be longer due to the comparatively longer gallery length. Permanent land take from Ranelagh Park may be necessary for construction of access point, emergency exit and ventilation shaft.	reduced in size. There may also be access impedance to properties on Manders Terrace and Selskar Terrace while construction work is carried out. Additionally, properties in the immediate vicinity of the site, for example the church, school and nursery may also face reduced access during construction.	access impedance to properties on Manders Terrace and Selskar Terrace while construction work is carried out. Additionally, properties in the immediate vicinity of the site, for example the nursery may also face reduced access. However, these would be temporary.			constructed alongside the Charlemont station box.	cumulative in nature. The evacuation tunnel would have no access impacts on properties or require any demolition.
Cultural Heritage	Temple place is an Area of Architectural Conservation (ACA). Although not afforded statutory protection Ranelagh park is, using professional judgement, assessed as being of cultural heritage significance and would be directly and negatively impacted by the construction of the shaft. The shaft access point would be a permanent	Numbers 1-6 Selskar Terrace are designated as RPS for their architectural heritage. The construction works and permanent structures could affect the setting of these RPS.	Numbers 1-9 Manders Terrace are considered as RPS for their architectural heritage. The construction works and permanent structures could affect the setting of these RPS.	There is an area defined as a Zone of Archaeological Potential centring on Park View. Temple Place is an Area of Architectural Conservation (ACA). Although not afforded statutory protection Ranelagh park is, using professional judgement, is assessed as being of cultural heritage significance and would	Mount Pleasant Park is surrounded by properties designated on the Dublin City Council RPS. The properties would not be directly impacted but the park setting would be impacted	RMP DU018-057--- an 18th century dwelling site is located around 150m from the tunnel alignment. Ground borne noise and vibration during tunnel excavation potentially may impact this structure. Carroll's Building, a designated RPS on Grand Parade (RPS Ref. 3280) is located within 100m of the shaft site at the northern end of the tunnel.	RMP DU018-057--- an 18th century dwelling site is located around 150m from the tunnel alignment. Ground borne noise and vibration during tunnel excavation potentially may impact this structure. Carroll's Building, a designated RPS on Grand Parade (RPS

Options	1	2	3	4	5	7(b)	8
	feature in this park.			be directly and negatively impacted by the construction of the shaft. The shaft access point would be a permanent feature in this park.	during the construction and operational phase.	Dartmouth Square is part of Dartmouth Square Architectural Conservation Area, located immediate east of the site. Properties within this ACA are designated as RPS. Construction of the tunnel may potentially cause vibration impacts along Dartmouth Terrace, Dartmouth Square and Northbrook Road. There are also a number of buildings along Dartmouth Road which have been designated as RPS.	Ref. 3280) is located within 100m of the shaft site at the northern end of the tunnel. Dartmouth Square is part of Dartmouth Square Architectural Conservation Area, located immediate east of the site. Properties within this ACA are designated as RPS. Construction of the tunnel may potentially cause vibration impacts along Dartmouth Terrace, Dartmouth Square and Northbrook Road. There are also a number of buildings along Dartmouth Road which have been designated as RPS.

6.3 Result of Stage 4 Assessment - Preferred Option

The Stage 4 MCA summary is shown in Table 6-5.

Table 6-5 Stage 4 MCA Summary

Option	1	2	3	4	5	7(b)	8
Economy	Shaft and 50m mined adit Land for shaft	Shaft and short adit Land for shaft	Shaft and short adit Land for shaft	Shaft and 110m mined adit	Shaft and 170m mined adit	Parallel mined gallery to connect to the station	Large Diameter Cavern No Property for Shaft but increased station area
Safety – Operational and Evacuation	Medium length adit, implies more distance to be covered than 2 / 3 before the exit. Longer distances of ventilation. Emergency Services coordination concerns due to remote shaft location.	Exit close to the main tunnel. Quick evacuation and easy smoke exhaust. Emergency Services coordination concerns due to remote shaft location.	Exit close to the main tunnel. Quick evacuation and easy smoke exhaust Emergency Services coordination concerns due to remote shaft location.	Longer adit, implies more distance to be covered before the exit. Longer distances of ventilation Emergency Services coordination concerns due to remote shaft location.	Longer adit, implies more distance to be covered before the exit. Longer distances of ventilation may require more fans. Emergency Services coordination concerns due to remote shaft location.	Longer adit, implies more distance to be covered before the exit. Longer distances of ventilation require more jet fans and power supply to exhaust smoke. Incidents fully controlled from station.	Great surface and volume of the cavern requires a larger flow rate from Charlemont ventilation shaft. It may require a larger section for the return of the ventilation to the station outlet
Integration	Access through residential area	Within residential gardens	Within private park	Requires property demolition to access car park site	Access via recreation/sport park	Shaft integrated at the station area	No separate shaft

Option	1	2	3	4	5	7(b)	8
Environment	Impacts on park users, local community, local biodiversity, landscape, and heritage. Whilst not the shortest gallery, impacts on private properties are avoided.	Impacts on local community, private property, local biodiversity, landscape, and heritage. Short gallery limits materials, waste, and climate impacts	Impacts on local community, private property, local biodiversity, landscape, and heritage. Short gallery limits materials, waste, and climate impacts.	Impacts on park users, local community and properties, local biodiversity, landscape, and heritage.	Impacts on park users, local community, local biodiversity, landscape, and heritage.	Disadvantage in terms of materials, waste, and climate, but some advantages for the local environment as impacts are concentrated at the station location.	Disadvantage in terms of materials, waste, and climate, but some advantages for the local environment, as impacts are concentrated at the station location.
Engineering	Disadvantage with medium length Adit construction and land for construction compound, Ranelagh and Mandars roads affected by site compound requirements during construction Minor impact on utilities.	Disadvantage with Impact on utilities (sewer lines) and land for shaft / construction compound in private gardens Ditto Ranelagh Rd affected Short Adit construction	Disadvantage with Impact on utilities (sewer lines) and land for shaft/ construction compound in park. Ditto Ranelagh Rd affected Short Adit construction	Disadvantage with 110m long Adit construction and land for construction compound, Minor impact on utilities Car Park to be closed during construction	Disadvantage with 170m long Adit construction. Land for construction compound impacts sports facilities Minor impact on utilities	Advantage of no Intervention shaft or property for same, no impact on utilities but requires parallel u/g escape gallery and larger fans for ventilation	Disadvantage with construction/ventilation of a large diameter underground cavern at relatively higher costs to the other options.
Overall MCA Outcome						Preferred Option	

The summary Stage 4 MCA under the five criteria Economy, Safety, Integration, Environment and Engineering identifies the option offering relatively greater advantages over all other options as **Option 7(b)** (the turnback facility in a TBM single bore tunnel with a parallel evacuation and ventilation gallery connecting the end of the turnback with the intervention shaft in Charlemont Station).

A costing analysis for all the tabulated options shows only a relatively limited variation in direct construction cost in the order of €10m. Considering the overall scale of the project this is not considered crucial in option selection.

Whilst the scoring is close between Options 1,2,3 and 7(b) the main differentiators are Integration where Option 7(b) has no impact on gardens or parks (as it doesn't have a separate intervention shaft in gardens or in a park); also under Engineering where Option 7(b) has no impact on utilities compared with Options 2 and 3. Option 7(b) has no additional property costs, compared with options 1,2,3 where land is required for a compound to construct the shaft of area 4500m² approx. Option 7(b) also has no impact during construction on Ranelagh Road, Manders Terrace, car parks and sports grounds as do Options 1 to 5. Finally, under Environment, Option 7(b) offers greater advantages over the other options due to impacts being concentrated at the one station location

Whilst Option 7(b) will be slightly more expensive to construct and maintain than Options 2 and 3, in the context of the project as a whole the relative economic impact is minor. However, it is scored lower on economy than Options 2 and 3.

Option 7(b) does have a lower safety score given the need for larger fans and a longer escape adit relative to Options 2 and 3 and is scored yellow (2 points lower than options 2 and 3).

From an incident management perspective at the station or in the turnback tunnel, the emergency services would manage the situation from the Charlemont Station Incident room. Having direct ability to access the turnback tunnel or the maintenance evacuation tunnel from the station under Option 7(b) retains local coordination and is a significant advantage over a remote shaft provided under other options which would segregate emergency service personnel and add to coordination issues. In addition, whilst urban safety and terrorist risk is not within the assessment criteria, it is clear that Option 7(b) also offers greater advantages than the options with a shaft and open grating in an unmanned remote location from the station.

Summarising all the Criteria without weightings and relative to all the other Options assessed, Option 7(b) emerges as the preferred Option offering overall greater advantages for the Charlemont turnback facility over Options 1, 2, 3 and 8.

6.4 Features of the Preferred Option 7b

The preferred option 7(b) for the turnback with the parallel gallery is shown Figure 6-1 and its key features are listed below.

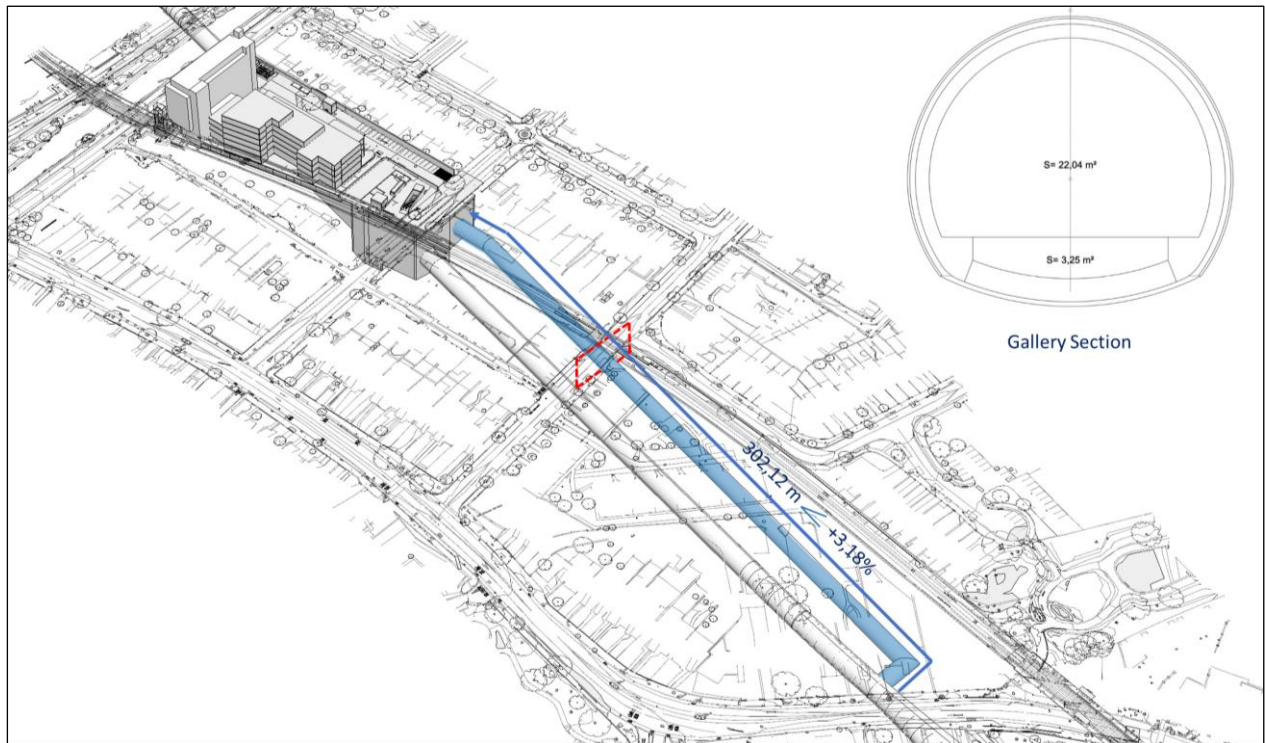


Figure 6-1 Charlemont Turnback with parallel Gallery and TBM buried at End

- It has the TBM buried off the line of any future MetroLink extension and this situation needs a separate study to confirm option suitability in detail.
- It allows connection, evacuation, and ventilation through the station box
- It avoids the construction of an intervention shaft at the end of the turnback tunnel and its associated impact on private properties
- The evacuation/ventilation gallery connects the end of the tunnel with the station box at the mezzanine level to give access to the evacuation stairs and the station ventilation shaft for any smoke.
- The gallery is considered as an extension of the tunnel and the strategy for evacuation and ventilation follows the same philosophy as for the main tunnel, which means that the gallery will not require a separation wall between ventilation and evacuation zones.
- The direct connection of the evacuation tunnel with the station provides a good arrangement for emergency services coordination in the event of an incident with resources retained at one location
- The TBM is buried at the end of the turnback in rock formation with no surface impacts and more options for future connections
- This Option satisfies the 3 Project Objectives:
 - to provide an underground facility to enable MetroLink trains operating at 90 seconds headway to safely reverse direction and to provide stabling capacity for up to four trains during non-operational periods.

- to provide a “turnback” that does not materially affect the direction of the southwards extension of the Metro System in the future
- to ensure the safe operation of the turnback facility for all users

The Preliminary Design for the recommended Option 7(b) has been prepared as presented in document number [ML1-JAI-CGN-SC16_XX-RP-Z-00001](#)

7. CONCLUSION AND RECOMMENDATIONS

The decision to terminate MetroLink services at Charlemont Station until such time as a decision is made to extend MetroLink to the south means that a facility to turn trains back northward to Estuary Station is necessary. The turnback facility must be able to manage a train frequency of up to 90 seconds and studies have shown that four trains should be stabled at Charlemont to enable an efficient morning re-start of services. This means that for most options two sets of crossovers are required along with two standing sections on each line for reversing trains use as well as those trains stabling overnight. The alternative is a cavern mined wide enough to have parallel stabling for four trains with a suitable width for staff evacuation back to the station.

The turnback tunnel will have a dead end at least temporarily (until Metrolink is extended southwards) and this needs safety consideration in terms of evacuation, ventilation, and intervention. This would apply only to the safety of MetroLink staff because all passengers should have alighted from the train in Charlemont Station. A further consideration is how the TBM is to be dealt with once it has completed tunnel boring work.

Through the design and consultation process several options were identified. These were assessed through a Multi-Criteria Analysis methodology using engineering and environmental criteria and a Preferred Option was selected.

This selected Preferred Option is Option 7(b) where the main line single bore TBM tunnel is to be extended approximately 360m south of the Charlemont Station box. A 302m long evacuation gallery will be formed by mining techniques parallel to and east of the main tunnel and this will give access from the dead-end tunnel to the escape and ventilation routes in Charlemont Station. The TBM shield will diverge from any feasible MetroLink extension route alignment and will be permanently buried underground in a rock formation.

The recommendation is that the preferred option is further developed through the Preliminary Design stage.

Appendix A. Full Environmental MCA Tables

ACTIVITY NAME	Human Health	Population	EMI/EMC	Noise	Vibration
Option 1: Ranelagh Park Playground	Construction Impacts: Dust, noise and visual impacts are anticipated to impact the number of residential receptors located within close proximity of the construction site. Furthermore, usage of Ranelagh Park as a children's playground would be severely impacted during the construction phase.	Construction Impacts: Construction of the shaft at this location is not anticipated to impact on employment or facilities, however the amenity area (i.e. playground) would be affected and would be acquired during construction. Further, the adjacent Multi-Denominational School may also experience some construction dust, noise and vibration as a result of construction at this location .	Construction Impacts: N/A	Construction Impacts: All options would require excavation for a shaft from the surface of the ground to the gallery. The magnitude of noise generated is anticipated to be significant and will be largely similar for all the options, however the impacts will vary depending upon the distance of sensitive receptors from the construction site. This option would have a gallery tunnel length of 50m. Construction of this gallery and the shaft would generate groundborne noise which may potentially impact the number of residential receptors along Northbrook Avenue, Ranelagh Close and Orchard Lane, all of which are located in close proximity , the nearest being at 25m. Ranelagh Seventh Day Adventist Church and Kids Inc, a creche and Montessori school are located approximately 60 - 70m to the west of the construction site. The shaft is located in a Dublin County Council designated Quiet Zone and is in close proximity to noise-sensitive receptors in terms of park users. Impacts from noise would be temporary.	Construction Impacts: There are no specifically vibration-sensitive receptors within 50m of the construction site. However, construction of the shaft would generate significant amount of vibration. Furthermore construction of the 50m connecting tunnel would generate additional groundbourne vibration. Due to the proximity of a number of residential properties in the vicinity, there is the potential for local residents to be affected by vibration. Vibration may potentially impact the number of residential receptors along Northbrook Avenue, Ranelagh Close and Orchard Lane, all of which are located in close proximity to the construction site, the nearest being at 25m.
	Operation Impacts: No health impact on nearby residential receptors due to the operation of the shaft at this location. Children's park would be reinstated and hence there would not be any loss of facility.	Operation Impacts: Operation of the shaft at this location is not anticipated to impact any businesses, facilities including this playground and/or local population.	Operation Impacts: Not relevant to a ventilation/access shaft	Operation Impacts: Operation of this option is not anticipated to generate any noise and hence there would be no noise impacts.	Operation Impacts: Operation of this option is not anticipated to generate any vibration and hence there would be no vibration impacts.
	Construction Score: 2 Operation Score: 4	Construction Score: 3 Operation Score: 4	Construction Score: 4 Operation Score: 4	Construction Score: 1 Operation Score: 4	Construction Score: 3 Operation Score: 4
Option 2: Selskar Terrace	Construction Impacts: Dust, noise and visual impacts are anticipated to impact the number of residential receptors located within close proximity of the construction site. However there would not be any impact on sports facilities or playground during the construction of this option.	Construction Impacts: Southern footway along Ranelagh Road is likely to be affected during construction of the shaft. This may potentially have a minor impact on a nursery opposite the construction site. There are some other businesses on the eastern side of the Green Line however those are not anticipated to be impacted. No other businesses are likely to be impacted during construction. Ranelagh School is located approximately 40m west of the works, but no land would be taken from the school and there would be no direct effects.	Construction Impacts: N/A	Construction Impacts: This location is within 50m of a number of residential sensitive receptors of Selskar Terrace and Mander's Terrace and within the garden areas associated with those properties. In addition, a church, Ranelagh School and a nursery are located within 50m of the site on Ranelagh road. Additionally, a number of other residential properties are also located on Ranelagh Road and within 50-100m from the construction site. Noise may be generated from the construction works at this location and impact these sensitive receptors. Such impacts would be temporary and may be reduced by adopting suitable measures. Construction of the shaft would generate significant amount of noise. As the gallery length is only 2m, it would require significantly reduced construction work and thereby overall reduced impacts from noise in comparison to the other options.	Construction Impacts: There are no identified vibration-sensitive receptors within 50m of the construction site. However, residential properties on Selskar Terrace and Mander's Terrace may experience significant vibration due to excavation and construction of the shaft. As the gallery length is 2m (the least amongst all the three options), a significantly reduced construction work would be needed for this element, thereby generating reduced overall impacts from groundbourne vibration.

ACTIVITY NAME	Biodiversity	Air Quality	Climate	Flooding	Hydrology
Option 1: Ranelagh Park Playground	<p>Construction Impacts: The construction site is not near to any protected sites. No protected species or breeding birds identified in the immediate vicinity, although Mistle Thrush, Robins and Swifts have been noted within Dartmouth Square Green space, approximately 300m to the north. However Ranelagh park is considered as a flagship for Biodiversity by Dublin City Council, and provides habitat for pollinator friendly plants as well as numerous birds. Common bat species also recorded at Ranelagh Park (common pipistrelle, soprano pipistrelle and Leisler's bat). Potential impacts on bats may occur. It is likely that trees would be felled during construction. Noise, vibration, lighting, dust etc would adversely impact the biodiversity. Additionally the pond within Ranelagh Park may have biodiversity value, which may be impacted by any polluted run-off from the construction site. These impacts would be temporary in nature and can be mitigated through best practice measures. Trees removed could be replaced through planting of new trees at the end of construction.</p>	<p>Construction Impacts: Construction works for this option would be within close proximity to a number of residential receptors along Northbrook Avenue, Ranelagh Close and Orchard Lane, the nearest being at 25m. Additionally, ecological receptors within Ranelagh Park would also be impacted from dust. Close proximity to residential receptors of the shaft location could result in dust impacts during the construction phase. These impacts would be temporary in nature and can be mitigated through best practice measures.</p>	<p>Construction Impacts: Higher GHG emission anticipated during construction due to longer length of the gallery, involving the use of plant and machinery over a longer time frame, and increased use of materials. The other elements of this option, for example the shaft would also involve a significant amount of embedded carbon, however this would be largely same between the various options.</p>	<p>Construction Impacts: Location not within any flood zone, hence no impact on flood risk.</p>	<p>Construction Impacts: Potential for an impact on the water quality of an underground historic river that crosses underneath Ranelagh Park. Construction of the shaft element may create pollution pathways to the historic river. Potential for contamination of the pond feature within the park. In the absence of appropriate mitigation, contaminated run-off from the construction site may reduce the quality of the water of this pond.</p>
	<p>Operation Impacts: Operation of this option is not anticipated to impact biodiversity.</p>	<p>Operation Impacts: Operation of this option is not anticipated to impact air-quality.</p>	<p>Operation Impacts: It is assumed that the operation of a shaft in any location would have similar operational emissions.</p>	<p>Operation Impacts: Location not within any flood zone, hence no impact.</p>	<p>Operation Impacts: Permanent drainage arrangements would not be expected to have any effect on hydrology, following appropriate design.</p>
	<p>Construction Score: 3</p>	<p>Construction Score: 3</p>	<p>Construction Score: 3</p>	<p>Construction Score: 4</p>	<p>Construction Score: 2</p>
	<p>Operation Score: 4</p>	<p>Operation Score: 4</p>	<p>Operation Score: 4</p>	<p>Operation Score: 4</p>	<p>Operation Score: 4</p>
Option 2: Selskar Terrace	<p>Construction Impacts: The construction site is not near to any protected sites. No protected species or breeding birds identified in the immediate vicinity, although Mistle Thrush, Robins and Swifts have been noted within Dartmouth Square Green space, approximately 450m to the north east. There are a number of trees within the construction site and it is likely that some of them would be felled. The trees may provide links to important ecological habitats in the surrounding area. Noise, dust and lighting during construction may disturb birds or other species using this site as their habitat. However due to reduced construction work, the impact would also be reduced when compared to other options.</p>	<p>Construction Impacts: This location is within 50m of a number of residential receptors, which may be affected by construction dust. These properties are on Selskar Terrace and Mander's Terrace, with works taking place within the garden areas associated with those properties. In addition, a church, Ranelagh School and a nursery are located within 50m of the site on Ranelagh road. Additionally, a number of other residential properties are also located on Ranelagh Road and within 50-100m from the construction site. Due to being located within an existing garden site, dust may also impact the surrounding biodiversity. The greatest potential for dust generation comes from the shaft excavation. However, the movement of material from the gallery may also generate dust. Since the gallery length is only 2m for this option (and least amongst all options), the potential magnitude is lower for this option. Dust impacts would be temporary in nature and may be reduced by adopting suitable measures. Dust impacts would be temporary in nature and mitigated by adopting suitable measures.</p>	<p>Construction Impacts: Lower GHG emission anticipated during construction due to shorter length of the gallery. This is due to shorter usage of construction plants and reduced volume of construction materials, resulting in overall lower amount of embedded carbon. The other elements of this option, for example the shaft would also result in significant amount of embedded carbon, however this would be largely same between the various options.</p>	<p>Construction Impacts: Location not within any flood zone, hence no impact on flood risk.</p>	<p>Construction Impacts: Potential for an impact on the water quality of an underground historic river that crosses at 80m of the construction site. There are no surface waterbodies within 100m of the site. Construction of the shaft element may create pollution pathways to the historic river. However the length of the gallery is least in this option and hence requires the least amount of construction work for this element. This would reduce the overall impacts on hydrology when compared with the other two options.</p>

ACTIVITY NAME	Hydrogeology	Land Soil Geology	Properties	Agronomy	Resource & Waste Mgmt.
Option 1: Ranelagh Park Playground	<p>Construction Impacts: The site is located on a Locally Important Aquifer - Bedrock which is Moderately Productive only in Local Zones and has a Moderate vulnerability for groundwater contamination. There is a well located at 550m north (No. 8 Harcourt Terrace) and a historical pump approximately 650m to the north of the construction site of the shaft location. Construction works could affect groundwater flows and/or quality, and dewatering may lower the water table.</p>	<p>Construction Impacts: The construction works would be undertaken within a built urban environment and the soil has been classified as urban. There are no active landfill sites or quarries in the vicinity of the site.</p>	<p>Construction Impacts: This option would directly impact the usage of Ranelagh Park. Access to properties along Northbrook Avenue would also be restricted during the construction of this option. Additionally the duration of works is anticipated to be longer due to the comparatively longer gallery length. Permanent land take from Ranelagh Park may be necessary for construction of access point, emergency exit and ventilation shaft.</p>	<p>Construction Impacts: No impact on agricultural land during construction.</p>	<p>Construction Impacts: It is assumed that shaft depth would be similar for all the options hence waste generated from construction of this element is not a differentiator for the three options. However, overall greater volume of waste is expected to be generated during construction of this option, due to its longer gallery length.</p>
	<p>Operation Impacts: The shaft and gallery would be sealed and there should be no further impact on hydrogeology.</p>	<p>Operation Impacts: No new impacts associated with operation of this option</p>	<p>Operation Impacts: No new impacts associated with the operation of this shaft location.</p>	<p>Operation Impacts: No impact on agricultural land during operation.</p>	<p>Operation Impacts: Materials and waste during operation limited to routine maintenance.</p>
	<p>Construction Score: 2 Operation Score: 4</p>	<p>Construction Score: 4 Operation Score: 4</p>	<p>Construction Score: 2 Operation Score: 4</p>	<p>Construction Score: 4 Operation Score: 4</p>	<p>Construction Score: 2 Operation Score: 4</p>
Option 2: Selskar Terrace	<p>Construction Impacts: The site is located on a Locally Important Aquifer - Bedrock which is Moderately Productive only in Local Zones and has a Moderate vulnerability for groundwater contamination. There is a well located at 550m north (No. 8 Harcourt Terrace) and a historical pump approximately 650m to the north of the construction site of the shaft location. Construction works could affect groundwater flows and/or quality, and dewatering may lower the water table.</p>	<p>Construction Impacts: The construction works would be undertaken within a built urban environment and the soil has been classified as urban. There are no active landfill sites or quarries in the vicinity of the site.</p>	<p>Construction Impacts: No property demolition foreseen for this option. However, the shaft would be located within private gardens, which would be permanently lost or reduced in size. There may also be access impedence to properties on Mander's Terrace and Selskar Terrace while construction work is carried out. Additionally, properties in the immediate vicinity of the site, for example the church, school and nursery may also face reduced access during construction.</p>	<p>Construction Impacts: No impact on agricultural land during construction.</p>	<p>Construction Impacts: Lower volume of waste in comparison to option 1 is expected to be generated during construction of this option, due to considerably shorter gallery length of 2m.</p>

ACTIVITY NAME	Archaeology and Cultural	Architectural Heritage	Landscape & Visual	Accident Disaster
Option 1: Ranelagh Park Playground	<p>Construction Impacts: RMP DU018-057---, a dwelling site, is located less than 100m from the construction site. Groundbourne noise and vibration during excavation of the shaft potentially may impact this structure. The setting of this asset may not be impacted due to the intervening built environment between itself and the construction site.</p>	<p>Construction Impacts: A railway bridge built c.1854 to carry Dublin and Wicklow Railway over Ranelagh Road and considered an important industrial heritage feature of Dublin, is located approximately 60m from the construction site. Groundborne noise and vibration as well as views from the structure may impact its setting. There are a few properties designated as RPS, located at Ranelagh Road, which may be impacted by groundborne noise and vibration. The setting of Ranelagh Gardens Park, a historic garden, would be directly impacted during construction of the site. The shaft access point would be a permanent feature in this park.</p>	<p>Construction Impacts: Construction activities would impact views from residential receptors on Park View, Northbrook Avenue and Temple Place. Additionally, users of the park would also experience visual impact during construction phase. The access point, emergency exit and ventilation shaft would be a permanent feature on the parkscape, however they would be close to ground level and integrated into the surrounding environment. The removal of trees for construction would lead to an ongoing landscape impact beyond the end of the construction period.</p>	<p>Construction Impacts: It is assumed that construction risks would be appropriately managed and this is not a differentiator.</p>
	<p>Operation Impacts: Operation of the shaft at this location is not anticipated to impact the setting of any archaeological asset.</p>	<p>Operation Impacts: Operation of the shaft at this location is not anticipated to impact the setting of any architectural assets.</p>	<p>Operation Impacts: No additional impact on landscape and visual aspects from the operation of the shaft.</p>	<p>Operation Impacts: It is assumed that safe evacuation procedures would be implemented. The gallery and shaft together would be used as an evacuation route in the event of a fire inside the Metrolink Tunnel. However this is true for all the options and hence is not a differentiator.</p>
	<p>Construction Score: 3 Operation Score: 4</p>	<p>Construction Score: 2 Operation Score: 4</p>	<p>Construction Score: 3 Operation Score: 4</p>	<p>Construction Score: 4 Operation Score: 4</p>
Option 2: Selskar Terrace	<p>Construction Impacts: There are no RMP assets within 100m of the site, the nearest being 225m away. Due to the distance and the intervening built environment as well as the significantly reduced construction work for this option, it is unlikely that there would be any impact on this asset.</p>	<p>Construction Impacts: A number of properties on Selskar Terrace are designated as RPS for their architectural heritage. The construction works and permanent structures could affect the setting of this RPS.</p>	<p>Construction Impacts: Construction activities would impact views from residential receptors Mander's Terrace and Selskar Terrace. Vegetation removal, including of mature trees, would impact on the local townscape, which would continue beyond the end of construction. The access point, emergency exit and ventilation shaft would be permanent features above ground, however they would have a minimal permanent impact on the townscape.</p>	<p>Construction Impacts: It is assumed that construction risks would be appropriately managed and this is not a differentiator.</p>

ACTIVITY NAME	Human Health	Population	EMI/EMC	Noise	Vibration
	Operation Impacts: No health impact on nearby residential receptors due to the operation of the shaft at this location.	Operation Impacts: Operation of the shafts/tunnel is not anticipated to impact on the population, local businesses, facilities and/or amenities.	Operation Impacts: Not relevant to a ventilation/access shaft	Operation Impacts: Operation of this option is not anticipated to generate any noise and hence there would be no noise impacts.	Operation Impacts: Operation of this option is not anticipated to generate any vibration and hence there would be no vibration impacts.
	Construction Score: 3	Construction Score: 4	Construction Score: 4	Construction Score: 1	Construction Score: 3
	Operation Score: 4	Operation Score: 4	Operation Score: 4	Operation Score: 4	Operation Score: 4
Option 3: Manders Terrace	Construction Impacts: Dust, noise and visual impacts are anticipated to impact the number of residential receptors located within close proximity of the construction site. However there would not be any impact on sports facilities or playgrounds during the construction of this option.	Construction Impacts: Southern footway and part of Ranelagh Road carriageway are likely to be affected during construction of the shaft. There are a number of businesses, on the eastern side of the Green Line, which may face reduced patronage due to access problem through Ranelagh Road. These impacts are anticipated to be temporary.	Construction Impacts: N/A	Construction Impacts: This location is within 50m of a number of residential sensitive receptors of Mander's Terrace, and within the garden areas associated with those properties. In addition, there is a nursery located within 50m of the site on Ranelagh road. Also, a number of other residential properties are also located on Ranelagh Road and within 50-100m from the construction site. Noise may be generated from the construction works at this location and impact these sensitive receptors. Such impacts would be temporary in nature and may be reduced by adopting suitable measures. Construction of the shaft would generate significant amount of noise. As the gallery length is 13m, it would require slightly more construction work than option 2 and thereby have the potential for more noise generation during construction.	Construction Impacts: There are no specifically vibration-sensitive receptors within 50m of the construction site. Residential properties on Mander's Terrace may experience vibration. As the gallery length is 13m, it would require slightly more construction work than option 2 and thereby generate slightly increased impacts from vibration.
	Operation Impacts: No health impact on nearby residential receptors due to the operation of the shaft at this location.	Operation Impacts: Operation of the shafts/tunnel is not anticipated to impact on the population, local businesses, facilities and/or journey amenity.	Operation Impacts: Not relevant to a ventilation/access shaft	Operation Impacts: Operation of this option is not anticipated to generate any noise and hence there would be no noise impacts.	Operation Impacts: Operation of this option is not anticipated to generate any vibration and hence there would be no vibration impacts.
	Construction Score: 3	Construction Score: 3	Construction Score: 4	Construction Score: 1	Construction Score: 3
	Operation Score: 4	Operation Score: 4	Operation Score: 4	Operation Score: 4	Operation Score: 4

ACTIVITY NAME	Biodiversity	Air Quality	Climate	Flooding	Hydrology
	Operation Impacts: Operation of this option is not anticipated to generate any new impact to biodiversity.	Operation Impacts: Operation of this option is not anticipated to impact air-quality.	Operation Impacts: It is assumed that the operation of a shaft in any location would have similar operational emissions.	Operation Impacts: Location not within any flood zone, hence no impact.	Operation Impacts: Permanent drainage arrangements would not be expected to have any effect on hydrology, following appropriate design.
	Construction Score: 3	Construction Score: 3	Construction Score: 3	Construction Score: 4	Construction Score: 3
	Operation Score: 4	Operation Score: 4	Operation Score: 4	Operation Score: 4	Operation Score: 4
Option 3: Manders Terrace	Construction Impacts: The construction site is not near to any protected sites. No protected species or breeding birds identified in the immediate vicinity, although Mistle Thrush, Robins and Swifts have been noted within Dartmouth Square Green space, approximately 425m to the north east. There are a number of trees within the construction site and it is likely that some of them would be felled. The trees may provide links to important ecological habitats in the surrounding area. Noise, dust and lighting during construction may disturb birds or other species using this site as their habitat. However this option would require 13m of shaft length, hence more work than option 2, thereby slightly increased impact on biodiversity.	Construction Impacts: This location is within 50m from a number of residential receptors of Manders Terrace. In addition, there is a nursery located within 50m of the site on Ranelagh road. Also, a number of other residential properties are also located on Ranelagh Road and within 50-100m from the construction site. Dust may be generated from the construction works at this location and impact these sensitive receptors. Such impacts would be temporary and may be reduced by adopting suitable measures. Furthermore as the gallery length is 13m, it would require slightly more excavation than option 2 and potentially generate slightly increased impacts from dust. Dust impacts would be temporary in nature and mitigated by adopting suitable measures.	Construction Impacts: As the gallery length is 13m, it would require slightly more construction work than option 2 and thereby generate slightly more GHG emissions during construction.	Construction Impacts: Location not within any flood zone, hence no impact on flood risk.	Construction Impacts: Construction of the shaft alongwith 13m of the gallery tunnel has the potential for an impact on the water quality of an underground historic river that crosses at 90m of the construction site. No other surface waterbody within 100m of the site. Length of the gallery tunnel is considerably lower than option 1 and hence reduced total overall impacts anticipated, assuming that shaft depths are similar across the options.
	Operation Impacts: Operation of this option is not anticipated to generate any new impact to biodiversity.	Operation Impacts: Operation of this option is not anticipated to impact air-quality.	Operation Impacts: It is assumed that the operation of a shaft in any location would have similar operational emissions.	Operation Impacts: Location not within any flood zone, hence no impact.	Operation Impacts: Permanent drainage arrangements would not be expected to have any effect on hydrology, following appropriate design.
	Construction Score: 3	Construction Score: 3	Construction Score: 3	Construction Score: 4	Construction Score: 3
	Operation Score: 4	Operation Score: 4	Operation Score: 4	Operation Score: 4	Operation Score: 4

ACTIVITY NAME	Hydrogeology	Land Soil Geology	Properties	Agronomy	Resource & Waste Mgmt.
	Operation Impacts: The shaft and gallery would be sealed and there should be no further impact on hydrogeology.	Operation Impacts: No new impacts associated with operation of this option	Operation Impacts: No new impacts associated with the operation of this shaft location.	Operation Impacts: No impact on agricultural land during operation.	Operation Impacts: Materials and waste during operation limited to routine maintenance.
	Construction Score: 2	Construction Score: 4	Construction Score: 1	Construction Score: 4	Construction Score: 4
	Operation Score: 4	Operation Score: 4	Operation Score: 4	Operation Score: 4	Operation Score: 4
Option 3: Manders Terrace	Construction Impacts: The site is located on a Locally Important Aquifer - Bedrock which is Moderately Productive only in Local Zones and has a Moderate vulnerability for groundwater contamination. There is a well located at 550m north (No. 8 Harcourt Terrace) and a historical pump approximately 650m to the north of the construction site of the shaft location. Construction works could affect groundwater flows and/or quality, and dewatering may lower the water table.	Construction Impacts: The construction works would be undertaken within a built urban environment and the soil has been classified as urban. There are no active landfill sites or quarries in the vicinity of the site.	Construction Impacts: No property demolition foreseen for this option as the shaft has been located in an existing green / garden area within Mander's Terrace. There may also be access impedence to properties on Mander's Terrace and Selskar Terrace while construction work is carried out. Additionally, properties in the immediate vicinity of the site, for example the nursery may also face reduced access. However these would be temporary.	Construction Impacts: No impact on agricultural land during construction.	Construction Impacts: Amount of waste generated would be lower than option 1 as gallery length is shorter and hence smaller construction works.
	Operation Impacts: The shaft and gallery would be sealed and there should be no further impact on hydrogeology.	Operation Impacts: No new impacts associated with operation of this option	Operation Impacts: No new impacts associated with the operation of this shaft location.	Operation Impacts: No impact on agricultural land during operation.	Operation Impacts: Materials and waste during operation limited to routine maintenance.
	Construction Score: 2	Construction Score: 4	Construction Score: 1	Construction Score: 4	Construction Score: 3
	Operation Score: 4	Operation Score: 4	Operation Score: 4	Operation Score: 4	Operation Score: 4

ACTIVITY NAME	Archaeology and Cultural	Architectural Heritage	Landscape & Visual	Accident Disaster
	<p>Operation Impacts: Operation of the shaft at this location is not anticipated to impact the setting of any archaeological asset.</p>	<p>Operation Impacts: Operation of the shaft at this location is not anticipated to impact the setting of any architectural assets.</p>	<p>Operation Impacts: No additional impact on landscape and visual aspects from the operation of the shaft.</p>	<p>Operation Impacts: It is assumed that safe evacuation procedures would be implemented. This is not a differentiator.</p>
	Construction Score: 4	Construction Score: 2	Construction Score: 2	Construction Score: 4
	Operation Score: 4	Operation Score: 4	Operation Score: 4	Operation Score: 4
Option 3: Manders Terrace	<p>Construction Impacts: There are no RMP assets within 100m of the site, the nearest one (a 18th/19th century dwelling site) being 175m away. Due to the distance and the intervening built environment as well as reduced construction work for this option, it is unlikely that there would be any impact on this asset.</p>	<p>Construction Impacts: A number of properties on Mander's Terrace are designated as RPS for their architectural heritage. The construction works and permanent structures could affect the setting of this RPS.</p>	<p>Construction Impacts: Construction activities would impact views from residential receptors Mander's Terrace. Access point, emergency exit and ventilation shaft would be permanent features above ground within the garden, however with careful integration with surrounding, they would have a minimal permanent impact on the landscape.</p>	<p>Construction Impacts: It is assumed that construction risks would be appropriately managed and this is not a differentiator.</p>
	Operation Impacts: Operation of the shaft at this location is not anticipated to impact the setting of any archaeological asset.	Operation Impacts: Operation of the shaft at this location is not anticipated to impact the setting of any architectural assets.	Operation Impacts: No additional impact on landscape and visual aspects from the operation of the shaft.	Operation Impacts: It is assumed that safe evacuation procedures would be implemented. This is not a differentiator. The gallery and shaft together would be used as an evacuation route in the event of a fire inside the Metrolink Tunnel. However this is true for all the options and hence not a differentiator.
	Construction Score: 4	Construction Score: 2	Construction Score: 2	Construction Score: 4
	Operation Score: 4	Operation Score: 4	Operation Score: 4	Operation Score: 4

ACTIVITY NAME	Human Health	Population	EMI/EMC	Noise	Vibration
Option 6: Ranelagh Rd	Construction Impacts: Dust, noise and visual impacts are anticipated to impact a number of sensitive human receptors located within close proximity of the construction site. However there would not be any impact on sports facilities or playground during the construction of this option.	Construction Impacts: Construction of the shaft at this location is not anticipated to cause any loss of jobs or facilities, however the amenity area (i.e. playground) would be acquired during construction. Further, the adjacent Multi-Demonominational School may also experience some construction dust, noise and vibration as a result of construction at this location.	Construction Impacts: N/A	Construction Impacts: This location is within 50m of a number of residential sensitive receptors of Selskar Terrace and Mander's Terrace and within garden areas associated with those properties. In addition, there is a church, a school and a nursery located within 50m of the site on Ranelagh road. Additionally, a number of other residential properties are also located on Ranelagh Road and within 50-100m from the construction site. Noise may be generated from the construction works at this location and impact these sensitive receptors. Such impacts would be temporary in duration and may be reduced by adopting suitable measures. Construction of the shaft would generate significant amount of noise, although it would be largely similar in magnitude for each of the options. However due to a large number of sensitive receptors within 50m of the work-area, the impact is anticipated to be high. On the otherhand, the gallery tunnel length is 30m and would require slightly reduced construction work in compared to that in Option 1.	Construction Impacts: There are no specifically vibration-sensitive receptors within 50m of the construction site. However there are other sensitive receptors within 50m of the construction site. Residential properties on Selskar Terrace and Mander's Terrace may experience vibration during construction, especially during mining of the shaft element. This, together with the 30m gallery tunnel, also has the potential to generate groundbourne vibration which may impact users of Kids Inc Nursery, Ranelagh Church and Ranelagh School. Impacts from these effects may be temporary or permanent depending upon the receptor, although the magnitude of the impact may be mitigated through appropriate measures.
	Operation Impacts: No health impact on nearby residential receptors due to the operation of the shaft at this location.	Operation Impacts: Operation of the shaft at this location is not anticipated to impact any businesses or facilities including this playground and the adjoining school.	Operation Impacts: Not relevant to a ventilation/access shaft	Operation Impacts: Operation of this option is not anticipated to generate any noise and hence there would be no noise impacts.	Operation Impacts: Operation of this option is not anticipated to generate any vibration and hence there would be no vibration impacts.
	Construction Score: 3	Construction Score: 3	Construction Score: 4	Construction Score: 1	Construction Score: 3
	Operation Score: 4	Operation Score: 4	Operation Score: 4	Operation Score: 4	Operation Score: 4

ACTIVITY NAME	Biodiversity	Air Quality	Climate	Flooding	Hydrology
Option 6: Ranelagh Rd	Construction Impacts: Similar to effects from option 2.	Construction Impacts: Similar receptors as in Option 2. Dust would primarily be generated from the surface activities for mining the shaft at a depth which would be similar across all the options. However due to the proximity of a number of sensitive receptors within 50m of the site, the impacts from dust may be higher for this option. Construction of the sub-surface gallery tunnel may also generate dust during transportation. However with a 30m tunnel length, the impact would be more than option 2 and slightly less than option 1. Dust impacts would be temporary in nature and mitigated by adopting suitable measures.	Construction Impacts: Higher GHG emission anticipated during construction due to longer length of the gallery. This is due to longer usage of construction plants and increased volume of construction materials, resulting in higher amount of embedded carbon. The other elements of this option, for example the shaft would also result in significant amount of embedded carbon, however this would be largely same between the various options.	Construction Impacts: Location not within any flood zone, hence no impact on flood risk.	Construction Impacts: Potential for an impact on the water quality of an underground historic river that crosses at 80m of the construction site. No other surface waterbody within 100m of the site. With the significant volume of surface excavation required for mining the shaft, there may be a potential for contaminated surface water run-off in the local drainage network.
	Operation Impacts: Operation of this option is not anticipated to generate any new impact to biodiversity.	Operation Impacts: Operation of this option is not anticipated to impact air-quality.	Operation Impacts: It is assumed that the operation of a shaft in any location would have similar operational emissions.	Operation Impacts: Location not within any flood zone, hence no impact.	Operation Impacts: Permanent drainage arrangements would not be expected to have any effect on hydrology, following appropriate design.
	Construction Score: 3	Construction Score: 3	Construction Score: 3	Construction Score: 4	Construction Score: 3
	Operation Score: 4	Operation Score: 4	Operation Score: 4	Operation Score: 4	Operation Score: 4

ACTIVITY NAME	Hydrogeology	Land Soil Geology	Properties	Agronomy	Resource & Waste Mgmt.
Option 6: Ranelagh Rd	<p>Construction Impacts: The site is located on a Locally Important Aquifer - Bedrock which is Moderately Productive only in Local Zones and has a Moderate vulnerability for groundwater contamination. There is a well located at 550m north (No. 8 Harcourt Terrace) and a historical pump approximately 650m to the north of the construction site of the shaft location. Construction works could affect groundwater flows and/or quality, and dewatering may lower the water table.</p>	<p>Construction Impacts: The construction works would be undertaken within a built urban environment and the soil has been classified as urban. As per available information, there are no active quarries, waste facilities or historic landfill sites within the vicinity of the construction site. Thus potential for cross contamination of excavated soil is minimal in presence of appropriate mitigation measure.</p>	<p>Construction Impacts: No property demolition foreseen. However, the shaft would be built in private gardens, which would be permanently lost or reduced in size. There may also be access impedence to properties on Mander's Terrace and Selskar Terrace while construction work is carried out. Additionally, properties in the immediate vicinity of the site, for example the church, school and nursery may also face reduced access. However these would be temporary.</p>	<p>Construction Impacts: No impact on agricultural land during construction.</p>	<p>Construction Impacts: Assuming that the shaft depth is similar across all the options, amount of waste generated would be lower than option 1 as the gallery tunnel is shorter and hence less amount of excavated material.</p>
	<p>Operation Impacts: The shaft and gallery would be sealed and there should be no further impact on hydrogeology.</p>	<p>Operation Impacts: No new impacts associated with operation of this option</p>	<p>Operation Impacts: No new impacts associated with the operation of this shaft location.</p>	<p>Operation Impacts: No impact on agricultural land during operation.</p>	<p>Operation Impacts: Materials and waste during operation limited to routine maintenance.</p>
	<p>Construction Score: 2 Operation Score: 4</p>	<p>Construction Score: 4 Operation Score: 4</p>	<p>Construction Score: 1 Operation Score: 4</p>	<p>Construction Score: 4 Operation Score: 4</p>	<p>Construction Score: 3 Operation Score: 4</p>

ACTIVITY NAME	Archaeology and Cultural	Architectural Heritage	Landscape & Visual	Accident Disaster
Option 6: Ranelagh Rd	Construction Impacts: There are no RMP assets within 100m of the site, the nearest being 250m away. Due to the distance and the intervening built environment, it is unlikely that there would be any impact on this asset.	Construction Impacts: A number of properties on Selskar Terrace are designated as RPS for their architectural heritage. The construction works and permanent structures could affect the setting of this RPS. Temple Place ACA is located 200m east of the construction site. No significant impact is anticipated on this asset due to the intervening built environment between them.	Construction Impacts: Construction activities would impact views from residential receptors at Mander's Terrace, Ranelagh Road and Selskar Terrace. Access point, emergency exit and ventilation shaft would be permanent features above ground, however they would have a minimal permanent impact on the townscape.	Construction Impacts: It is assumed that construction risks would be appropriately managed and this is not a differentiator.
	Operation Impacts: Operation of the shaft at this location is not anticipated to impact the setting of any archaeological asset.	Operation Impacts: Operation of the shaft at this location is not anticipated to impact the setting of any architectural assets	Operation Impacts: No additional impact on landscape and visual aspects from the operation of the shaft.	Operation Impacts: The gallery and shaft together would be used as an evacuation route in the event of a fire inside the Metrolink Tunnel. There might be visual and noise impact on the nearby external receptors whilst evacuation process would be undertaken. However this is true for all the options and hence is not a differentiator.
	Construction Score: 4 Operation Score: 4	Construction Score: 3 Operation Score: 4	Construction Score: 2 Operation Score: 4	Construction Score: 4 Operation Score: 4

ACTIVITY NAME	Human Health	Population	EMI/EMC	Noise	Vibration
Option 7: Shaft in station A (320m tunnel) Assumptions: Intervention shaft would be within station box. The ventilation shaft is considered to be separate from the intervention shaft, though exact location not clear. Not known at this stage if any properties would be demolished or trees felled exclusively for this option.	Construction Impacts: Dust noise and visual impacts to residential and other sensitive receptors in the vicinity of the shaft construction sites. Noise impact may affect occupants of properties along the 320m tunnel alignment.	Construction Impacts: Construction of the shafts at both end of tunnel might cause access problems within the vicinity and thus impact on local amenity and functionality of adjoining businesses and facilities. However the duration of this impact would be temporary and the vent/shaft would be incorporated into the construction of the Charlemont station box.	Construction Impacts: N/A	Construction Impacts: Excavation of the ventilation shaft would be undertaken in the immediate vicinity of some of the properties of Dartmouth Square West and Dartmouth Road. There is one vibration- and noise-sensitive building (Viktor Frankl Institute) located approximately 40m from the construction works. Some properties on Dartmouth Place may also be impacted as they are within 50m of the construction site. It is anticipated that the mining of the Intervention shaft would be taken up at the same time as construction of Charlemont Station, thus noise impacts from this element would act cumulatively with the station box construction and impact similar receptors. Construction of the 320m tunnel would create significant noise. Groundborne noise might impact occupants of a number of properties along the alignment of the tunnel. These would be along Dartmouth Road, Northbrook Road, Orchard Lane and Ranelagh Road. However noise impacts would be temporary and might be reduced by adopting appropriate mitigation measures.	Construction Impacts: The 320m long evacuation tunnel would be mined through SCL/NATM methods and would pass under residential, commercial and educational properties. The LUAS Green Line would also be sensitive to vibration. Additionally, mining of the shafts would also generate groundbourne vibration. These can potentially cause significant impacts at properties on Dartmouth Square West, Dartmouth Road, Cambridge Terrace, Northbrook Road, Orchard Lane and Ranelagh Road resulting from vibration due to blasting and structure-borne noise from SCL construction due to percussive breaking out of concrete. Construction of the intervention shaft within the station box would also generate groundbourne vibration and impact similar receptors to those impacted during construction of the station box.
	Operation Impacts: No health impact on nearby residential receptors due to the operation of the shafts/tunnel for this option.	Operation Impacts: Operation of the shafts/tunnel is not anticipated to impact on the population, local businesses, facilities and/or journey amenity.	Operation Impacts: Not relevant to a ventilation/access shaft.	Operation Impacts: Operation of this option is not anticipated to generate any noise and hence there would be no noise impacts.	Operation Impacts: Operation of this option is not anticipated to generate any vibration and hence there would be no vibration impacts.
	Construction Score: 3	Construction Score: 2	Construction Score: 4	Construction Score: 2	Construction Score: 1
	Operation Score: 4	Operation Score: 4	Operation Score: 4	Operation Score: 4	Operation Score: 4

ACTIVITY NAME	Biodiversity	Air Quality	Climate	Flooding	Hydrology
<p>Option 7: Shaft in station A (320m tunnel) Assumptions: Intervention shaft would be within station box. The ventilation shaft is considered to be separate from the intervention shaft, though exact location not clear. Not known at this stage if any properties would be demolished or trees felled exclusively for this option.</p>	<p>Construction Impacts: Construction of shafts at the Charlemont Station area has the potential to impact the same set of biodiversity receptors as for Charlemont Station. The breeding bird survey identified various species using Dartmouth Square, and noise during construction may disturb breeding birds. The Grand Canal is located within 150m to the north of the construction area, and any sediment-laden or contaminated run-off from surface excavation for the shafts could potentially impact the aquatic biodiversity. On its own the potential for this to happen is low but might act cumulatively if constructed at the same time as the station box. Grand Canal is a proposed Natural Heritage Area which means that it could be important for the habitats or could contain species of plants and animals whose habitat needs protection.</p>	<p>Construction Impacts: There is a potential for impact on air quality via emission of dust during surface excavation work for the shafts. There is potential for localised dust impacts on the residential receptors identified in the noise column as well as ecological receptors mentioned in the Biodiversity column. Additional impact on these receptors if the spoil from tunnel excavation is exported from the shaft excavation sites. If the intervention shaft is mined at the same time as the station box then dust impacts would act cumulatively with station box construction, thereby impacting same receptors as identified for Charlemont station options. Dust impacts would be temporary in nature and mitigated by adopting suitable measures.</p>	<p>Construction Impacts: Significant amount of embedded carbon, due to the 320m long tunnel using SCL.</p>	<p>Construction Impacts: Location not within any flood zone, hence no impact on flood risk.</p>	<p>Construction Impacts: Potential to impact historic waterbody. Surface excavation of the shafts may cause potential run-off to Grand Canal. Additionally, run-off from excavation sites might enter the local drainage network. Impacts from such effects can be reduced by adopting suitable mitigation measures.</p>
	<p>Operation Impacts: Operation of this option is unlikely to cause any significant impact on biodiversity.</p>	<p>Operation Impacts: Operation of this option is not anticipated to impact air-quality.</p>	<p>Operation Impacts: It is assumed that the operation of a shaft in any location would have similar operational emissions.</p>	<p>Operation Impacts: Location not within any flood zone, hence no impact.</p>	<p>Operation Impacts: Permanent drainage arrangements would not be expected to have any effect on hydrology, following appropriate design.</p>
	<p>Construction Score: 3 Operation Score: 4</p>	<p>Construction Score: 3 Operation Score: 4</p>	<p>Construction Score: 2 Operation Score: 4</p>	<p>Construction Score: 4 Operation Score: 4</p>	<p>Construction Score: 3 Operation Score: 4</p>

ACTIVITY NAME	Hydrogeology	Land Soil Geology	Properties	Agronomy	Resource & Waste Mgmt.
<p>Option 7: Shaft in station A (320m tunnel) Assumptions: Intervention shaft would be within station box. The ventilation shaft is considered to be separate from the intervention shaft, though exact location not clear. Not known at this stage if any properties would be demolished or trees felled exclusively for this option.</p>	<p>Construction Impacts: The site is located on a Locally Important Aquifer - Bedrock which is Moderately Productive only in Local Zones and has a Moderate vulnerability for groundwater contamination. There is a well located at 230m north (No. 8 Harcourt Terrace) and a historical pump approximately 330m to the north of the construction site of the shaft/tunnel location at the station box. Additionally there are three boreholes located within Charlemont Station works boundary. Construction works could affect groundwater flows and/or quality, and dewatering may lower the water table. There are no wells recorded near the southern extent of the tunnel.</p>	<p>Construction Impacts: The construction works would be undertaken within a built urban environment and the soil has been classified as urban. As per available information, there are no active quarries, waste facilities or historic landfill sites within the vicinity of the construction site. Thus potential for cross contamination of excavated soil is minimal in presence of appropriate mitigation measure.</p>	<p>Construction Impacts: It is not anticipated that there would be any requirement to demolish properties exclusively for any of the elements of this option. Construction may cause access impedence to properties on Dartmouth Road. However this would be cumulative in nature if constructed alongside the Charlemont station box.</p>	<p>Construction Impacts: No impact on agricultural land during construction.</p>	<p>Construction Impacts: Significant volume of waste would be generated as a 320m long evacuation and ventilation tunnel is required to be excavated in addition to the shafts.</p>
	<p>Operation Impacts: The shaft and gallery would be sealed and there should be no further impact on hydrogeology.</p>	<p>Operation Impacts: No new impacts associated with operation of this option</p>	<p>Operation Impacts: No new impacts associated with the operation of this option.</p>	<p>Operation Impacts: No impact on agricultural land during operation.</p>	<p>Operation Impacts: Materials and waste during operation limited to routine maintenance.</p>
	<p>Construction Score: 2 Operation Score: 4</p>	<p>Construction Score: 4 Operation Score: 4</p>	<p>Construction Score: 3 Operation Score: 4</p>	<p>Construction Score: Operation Score:</p>	<p>Construction Score: 2 Operation Score: 4</p>

ACTIVITY NAME	Archaeology and Cultural	Architectural Heritage	Landscape & Visual	Accident Disaster
<p>Option 7: Shaft in station A (320m tunnel) Assumptions: Intervention shaft would be within station box. The ventilation shaft is considered to be separate from the intervention shaft, though exact location not clear. Not known at this stage if any properties would be demolished or trees felled exclusively for this option.</p>	<p>Construction Impacts: RMP DU018-057--- an 18th century dwelling site is located around 150m from the tunnel alignment. Groundborne noise and vibration during tunnel excavation potentially may impact this structure. There are no other archaeological monuments within the vicinity of the excavation sites.</p>	<p>Construction Impacts: Carroll's Building, a designated RPS on Grand Parade (a protected structure RPS Ref. 3280) is located within 100m of the shaft site at the northern end of the tunnel. Dartmouth Square is a Victorian square and part of Dartmouth Square Architectural Conservation Area, located in the immediate east of the construction site. A number of properties within this ACA are designated as RPS. The ventilation shaft might be a permanent feature on the settings of these assets, however it can be mitigated through careful landscaping. Construction of the tunnel may potentially cause vibration impacts on a number of architectural assets along its alignment along Dartmouth Terrace, Dartmouth Square and Northbrook Road. There are also a number of buildings within Dartmouth Road which have been designated as RPS.</p>	<p>Construction Impacts: It is anticipated that the shafts would be excavated at the same time as the Charlemont Station box and would impact the same set of receptors. Hence it is concluded that a cumulative landscape and visual impact would be experienced by these receptors. The ventilation hatch would be a permanent feature on the ground however it can be integrated with careful landscaping.</p>	<p>Construction Impacts: A mined tunnel typically carries higher construction safety risks than other construction methods. However it is expected that these risks would be managed appropriately.</p>
	<p>Operation Impacts: Operation of the shaft at this location is not anticipated to impact the setting of any archaeological asset.</p>	<p>Operation Impacts: No new impacts on the architectural assets.</p>	<p>Operation Impacts: No additional impact on landscape and visual aspects from the operation of the shafts.</p>	<p>Operation Impacts: The tunnel and shaft together would be used as an evacuation route in the event of a fire inside the Metrolink Tunnel. However this is true for all the options and hence is not a differentiator.</p>
	<p>Construction Score: 3 Operation Score: 4</p>	<p>Construction Score: 2 Operation Score: 4</p>	<p>Construction Score: 4 Operation Score: 4</p>	<p>Construction Score: 4 Operation Score: 4</p>