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Derivation of the Single Bore Tunnel as the Proposed MetroLink Tunnel Option

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Derivation of the Single Bore Tunnel as the Proposed MetroLink Tunnel Option

In respect of a request to explain the basis of the proposed tunnel design, this note explains the derivation and justification for the proposed single bore tunnel.

EPR Tunnel considerations

The EPR tunnel proposals for MetroLink were presented in the 2018 EPR Public Consultation document – Alternative Tunnel Types. This noted that '*The Emerging Preferred Route has been developed on the basis of a twin tunnel arrangement*'; but continued '*An alternative arrangement is also under consideration, where both the northbound and southbound metros would run in a single, larger tunnel….This single tunnel option will be further assessed to establish its cost and construction advantages'*.

EPR Twin bore proposal

This comprised 6.7m outside diameter tunnels, 5.9m internal diameter, with cross-passages every 244m as per the requirements of the National Fire Protection Association (NFPA) 130 (2017 edition). Side walkways were included on both sides of the tunnel to facilitate side evacuation from the train. The design assumed manually driven trains.

EPR Single bore consideration

This comprised 10.3m outside diameter, 9.5m internal diameter tunnels. Intervention shafts assumed required at max 1000m to comply with The Technical Specifications for Interoperability on Safety in Railway Tunnels (TSI-SRT). As for the twin bore proposal, side walkways were included on both sides of the tunnel to facilitate side evacuation from the train. The design assumed manually driven trains.

Subsequent Preferred Route Tunnel Design Considerations

Further consideration of tunnel options was undertaken as part of the Preferred Route Design development from 2018 to 2019, with a proposal to adopt a single bore twin track tunnel for Metrolink. This was presented in the 2019 Preferred Route Design consultation with details provided in the Preferred Route Design Development Report (Appx A, Tunnel Configuration, Single Bore Tunnel).

This proposal was considered in combination with proposals for automated trains which enabled end evacuation from trains - assessment and modelling of train evacuation times indicated faster evacuation achieved from end evacuation compared to side evacuation. This removed the need for side walkways in tunnels and facilitated a reduction in tunnel outside diameter to 9.2m from the previous 10.3m assessment, with an 8.5m tunnel internal diameter considered appropriate.

The Updated NFPA 130 (2020) also offered additional standards justification for the design proposals adopted, in that extensions of the standard 762m maximum distance between exits in single bore tunnels could be adopted where supported by an engineering analysis addressing certain safety criteria.

Comparison of benefits and disbenefits: single bore twin track tunnel vs twin bore single track tunnel

The full comparison of the updated proposed single bore twin track tunnel vs twin bore single track tunnel is presented in the Preferred Route Design Development Report, Appendix A; and the EIAR Chapter 7 Section 7.7.2.

However, in summary, the benefits and disbenefits of the single bore tunnel against an alternative potential twin bore tunnel are summarised under the following categories:

Construction

- The single bore tunnel offers a faster construction option as it removes the need for multiple cross-over passages. Cross passage construction would follow completion of tunnel bores adding time and cost to the construction programme.
- The single bore tunnel removes the need for construction of large track crossover caverns along the tunnel route, which would be required under a twin bore option to support degraded operational running (the EPR assumed 2 required, one south of Griffith Park and one south of St Stephens Green).
- A twin bore tunnel would also require a very large and long turnback cavern south of Charlemont, to provide track crossovers compatible with those proposed in the single bore tunnel provision to support operational requirements. This would be likely to require a lowered track level and associated lowered station level at Charlemont to enable safe cavern construction.
- However, the single bore tunnel does require the introduction of an intervention shaft at Albert College Park and intervention tunnels between the Airport Station and the south portal of the Airport Tunnel, which would not be required if a twin bore tunnel were to be adopted.

Costs

- Due to the optimised tunnel diameter, tunnel excavation volumes for the single bore tunnel are now less than the earlier EPR considerations, reducing spoil disposal costs. The twin bore option would generate similar disposal quantities to the adopted single bore.
- An overall construction cost and schedule saving is achieved with the single bore construction cf twin bore; the Preliminary Business Case (Section 7, Affordability Considerations) ref https://www.nationaltransport.ie/wp-content/uploads/2022/07/MetroLink-Preliminary-Business-Case-Updated.pdf indicates that a twin bore solution has been assessed at approximately €0.6 billion over the single bore tunnel solution.

Environmental

- The adopted single bore tunnel reduces spoil disposal and associated lorry movements with associated environmental benefits compared to the twin bore option.

Settlement issues

- A larger diameter single-bore tunnel has greater potential for ground settlement compared to smaller twin bore tunnels along and close to the centre-line of the tunnel. The twin bore tunnel has potentially less settlement above the tunnels themselves but the tunnel separation and resulting settlement bowl will extend settlement risks over a wider area potentially impacting additional properties.
- However, the settlement assessment to-date indicates that the proposed single bore tunnel will generally be expected to cause only negligible to slight damage.

Operations

- In degraded running in a single bore tunnel a limited train service would need to continue using one of the tracks in the tunnel, with segregation of workers from this live track and with restricted speed running.
- In a twin bore arrangement, degraded running provides opportunity to remove trains from one tunnel to facilitate safe access into this tunnel, while a restricted service operates in the other tunnel.
- The single bore tunnel offers easier opportunity and flexibility in providing cross-over locations within the tunnel, including the possibility of adding additional crossovers in the future if required for operational reasons.
- Crossovers for a twin bore tunnel arrangement require crossover cavern locations determined at fixed locations prior to construction.
- Way finding within the station can be considered easier with a twin bote tunnel and a central platform from which both north and southbound services can be accessed. However, the single bore proposal with side platforms will provide clarity of access with appropriate signage within the station.

Operational Safety

- Both twin bore and single bore tunnels provide equally safe conditions for train operations, passenger safety, and evacuation and emergency intervention during incidents. Both types of tunnels are used on existing and planned metros, with single bore twin track tunnels used on existing metros such as Barcelona Line 9, Sao Paulometro, Metro de Madrid, Metro Paris; and being adopted for some other current metros under development, eg Metro de Lima, Riyadh Metro.
- The proposed single bore tunnel will:
    - Support fast evacuation of passengers via front and rear exits off a train and into the tunnel to access emergency exits;
    - Provide increased space at high level for smoke stratification, helping to keep smoke higher in the tunnel for longer;
    - Provide increased space for emergency services access and working space adjacent to a train in the tunnel.
- Passenger egress in emergencies to an evacuation point can be safely accommodated by either tunnel option:
    - For the proposed single bore tunnel, the proposed ventilation strategy and tunnel size facilitates safe passage in clean air to an evacuation point at an adjacent station;
    - For a twin bore tunnel option, the egress from the train would be via side walkways to a cross-passage and access into the adjacent tunnel bore, considered the place of safety.
- Emergency services access to the incident:
    - In the single bore, this will be from a station to the incident train through clean air in the ventilated tunnel section;
    - In a twin bore arrangement, access would be via the second bore and through a cross-passage near to the incident train.

Summary

Based on the design development and comparative assessments, the single bore, twin track, tunnel design is considered preferable to the earlier EPR twin bore consideration and has been incorporated into the MetroLink design and RO submission.

All of the factors above were taken into consideration when considering the tunnel proposal to be adopted. Building on the EPR considerations, whilst there were certain advantages identified in the twin bore tunnel alternative, the design changes identified (automated trains, front and rear evacuation, consequential changes in tunnel design, updates in NFPA 130) informed the decision to progress with the single bore twin track tunnel.

Ultimately, the primary reasons for this change were construction programme and cost benefits, including the removal of the need to provide large crossover caverns, whilst retaining the operational requirements of the system, and in light of the fact that both tunnel options performed equally well from an operational safety perspective.