Technical Note No. 5 – Geotechnical

Date:	18 May 2025	**Prepared by:**	CC
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Comment on Roseburn Cutting (Coltbridge Viaduct and Craigleith Drive)

The route comprises a cutting associated with a historic railway which opened in the 1860s. Based on selected cross sections provided for the section of route between Coltbridge Viaduct and Ravelston Dykes, the slopes are generally between 1(V):1.5(H) and 1(V):1.8(H) (*1) and comprise predominantly glacial deposits, till and locally sand and gravel (Ref. BGS maps and 2006 GI data). The till generally comprises firm to very stiff clay with varying proportions of sand and gravel within the clay matrix and/or as more distinct horizons. Where more granular horizons and strata overlie predominantly cohesive deposits, groundwater has been recorded as perched upon the upper surface of the clay. There are no records of bedrock being present within or at shallow depth below the cutting.

The slopes are too steep to be compliant with current design codes, for them to become code-compliant would likely involve significant engineering which may pose considerable challenges due to the constraints of 3rd party properties adjoining the corridor. Some suggestions as to the type of solutions which may be considered are provided in a later paragraph, however, there appears to be limited evidence of instability of the existing slopes (*2). 150+ years have elapsed since the cutting slopes were formed, so the changes in behaviour and properties of glacial till which occur over the years / decades after construction would be expected to have occurred by now and a state of equilibrium to have been reached.

From a purely geometrical point of view, the total width of the proposed single tram line and active travel corridor is similar to the base width of the existing cutting, so it is possible that only minor works would be required to accommodate the proposal and the existing slopes could generally be left undisturbed, provided it is accepted that the slopes are not code compliant. In this situation, a geotechnical inspection should be undertaken in the winter months to check for signs of instability, tension cracks etc. which may be obscured by vegetation during the growing season.

The slopes are heavily vegetated with mature trees, bushes and shrubs, the root systems of which are likely helping to reinforce the slopes. The image overleaf shows the types of vegetation present and gives an indication of the steepness of the slopes. If the vegetation was stripped, the exposure of the slope to direct rainfall and increased percolation into the soil may negatively impact the short term stability of the slope.

If the slopes are generally to be left undisturbed and the majority of the vegetation retained, it is recommended that surveys be undertaken to identify, assess and, if necessary, arrange for controlled removal of dead, diseased or dangerous trees to eliminate the risk of them falling onto the corridor, potentially causing injury, damage to infrastructure and disturbance to the slope by ripping up the roots. Furthermore, it would be helpful to identify the types of trees present and whether their root systems are deep or shallow, to assess how they are impacting on slope stability and whether they could pose an increased risk of falling during high winds due to lack of root support.

Additionally, current design standards should be consulted as to the required clearance zone of woody material above the corridor itself and potentially within an offset alongside. (Network Rail appear to remove woody material overhanging the rails or within a 3m wide corridor along the cess, to mitigate the risk of material falling onto the track.) If this type of restriction is applicable to tram lines, the geometry of the narrow corridor, steep slopes and tall trees may require the removal or trimming of a large number of trees.

It is noted that there is no allowance for drainage in the proposed cross section. Current design standards would need to be consulted to determine the drainage requirements and whether these would result in additional width being required at the toe of the cutting slopes. Excavation along the toe of existing slopes, whether to install drainage, services or remove and replace the made ground beneath the current cycle path, would need careful controls to avoid destabilising the existing slopes above. See also the text below regarding drainage and potential for residual contamination from the historic railway.

If non-code-compliant cutting slopes are not accepted, it is expected that significant engineering measures will be required to bring the slopes up to a compliant condition (*3). Strengthening the slopes to increase the margin of safety could involve soil nailing. It is good practice to ensure that soil nails do not extend beyond the site boundary and, given the geometry of the existing cutting, this is likely to prove challenging. Also, all vegetation would likely require to be removed from the section of slope to be nailed, and erosion protection installed on those slopes. Pre-seeded meshes / matting can be used to improve the rate of re-vegetation following installation; however, these can take some time to become established and can be sensitive to slope orientation / exposure to sunshine to help them to grow.

Alternatively, changes in the vertical alignment of the track could be considered to allow weight to be added to support the toe of the slopes and allow for slackening of the cutting slope gradients. This would be subject to headroom requirements at the bridges for trams themselves and OLE infrastructure clearances (if OLE is required). An assessment of bearing and stability of the underlying materials would also be required as increased loads would be applied. Other works at the toe of the existing slopes to increase the margin of safety may also be feasible, whether by installing anchored sheet pile walls or other retaining features. These may prove costly when applied along both sides of a significant length of track. Challenges with this type of solution may include boulders within the till obstructing installation of sheet piles, and additional intrusive works on the lower slopes interfering with trees / root systems such that they have to be removed in any case.

The corridor comprises a historic railway. Exploratory holes along the former track bed (now cycle path) record made ground comprising ash, clay, sand, gravel, cobbles and rubble. The 2006 Ground Investigation included contamination testing; these data should be reviewed by the Land Quality team to enable an assessment to be undertaken of the levels of contamination detected and the likely remediation and treatment of the material still present within the former track bed, implications in terms of whether drainage systems would require to be lined and the levels of treatment required for the run-off from the scheme (*4).

Footnotes

(*1) Locally as steep as 1(V):1.2(H) in the vicinity of the Holiday Inn footbridge to the north of this section.

(*2) Notwithstanding the apparent lack of evidence of slope movement, it would be prudent at the next stage of design development to undertake a full review of any remedial works that may have been undertaken on the cycleway.

(*3) Undisturbed samples of the till were taken during the 2006 GI to enable testing to derive slope stability parameters however it appears that the samples were ultimately unsuitable for advanced testing so the GI factual report includes primarily classification testing and CBR results. Back analysis is ongoing to derive indicative parameters, further work would be required to use empirical relations / literature sources to determine appropriate design parameters. Alternatively, more GI could be undertaken although it is noted that this may be challenging due to limited access to the crest of the existing cuttings, and there is no guarantee that the samples required would be suitable for testing.

(*4) No information was found in the 2008 files regarding the output of any such assessment at that time. It may be present in the files, but it is also likely that legislative requirements have changed in the intervening time and so a new assessment in line with current regulations would likely be most appropriate.

Additional Notes

Other sections of the route outside the Roseburn Cutting have not been considered at this time, other than the general archive trawl that turned up information which might benefit a wider review of ground conditions / previous work in the future.

A double track design between Ravelston Dykes and Craigleith has not been considered, other than to note that the cross section just south of the Holiday Inn footbridge already has slopes of 1(V) in 1.2(H). It will therefore be a struggle to fit a double track solution into this area, particularly in the vicinity of the bridges, without major interventions.

Additionally, an Esso filling station is present at the Queensferry Road. The location of the tank vents to the east side of the site would suggest that the tanks are similarly located. However, at the OBC stage, the precise location(s) of the underground tanks would need to be confirmed as they may interfere with the existing cutting slopes in this section, from the dual point of view of encountering long term leakage / contamination and the potential for loss of support causing movement of the tanks resulting in failure.