



Capital Delivery - Scotland's Railway

Barhead to Larkfield to East Kilbride Enhancement



PROJECT EARTHWORKS PHILOSOPHY

August 2021

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1 INTRODUCTION

The purpose of this paper is to set out the proposed earthworks philosophy for the double tracked section of the BLEKE project. The proposed double track section starts at Busby Station and extends East Kilbride station.

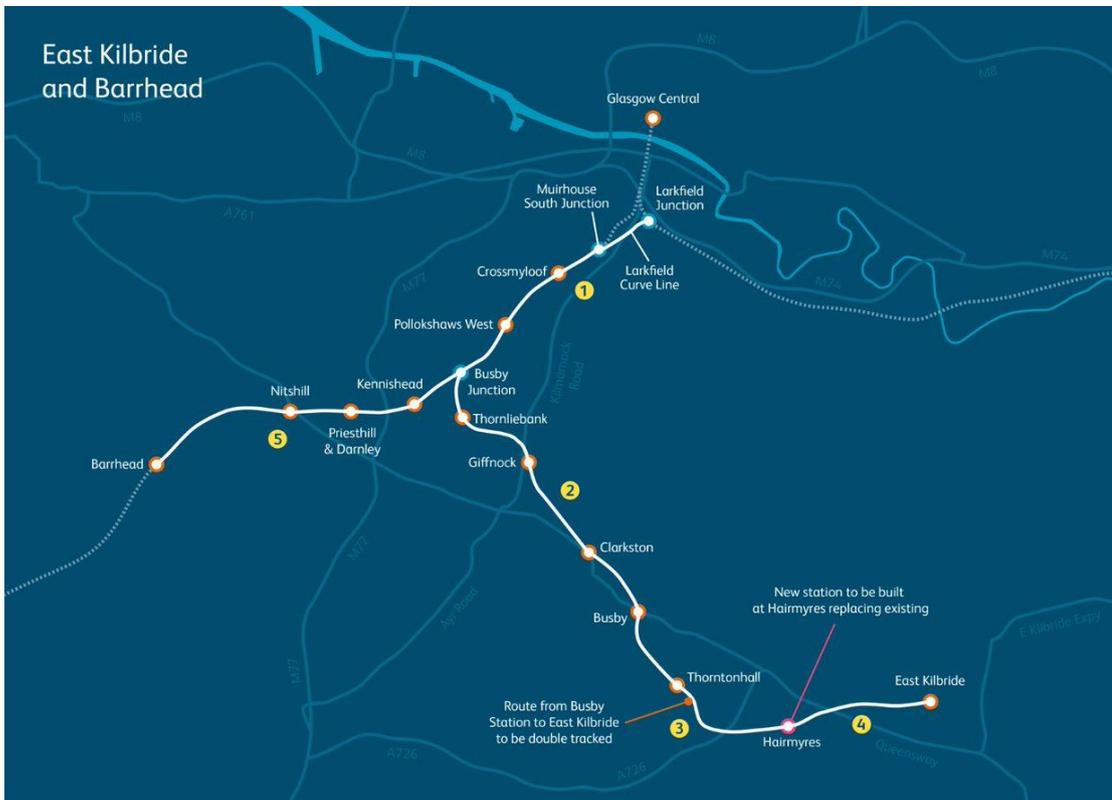


Figure 1: Extent of BLEKE Project

There are earthworks interventions over most the proposed section which is to be doubled tracked but to help emphasise the earthworks philosophy and highlight some of the key challenges involved in double tracking this section of the route this paper will focus on the three largest earthworks interventions which are being proposed which are follows:

- Cutting at OB 32 which is located south end of Busby station
- Cutting south of Thorntonhall Station
- Embankment west of OB 15A

2 HISTORY OF THE ROUTE EARTHWORKS

When considering earthworks strategy for the route it is important to understand the routes original layout as constructed in the 19th Century. The line from Busby station to East Kilbride was constructed as a single track rail line and this is reflected in the rail corridor width and thus the earthworks, however, it would seem that the structures on the route were constructed to accommodate a future double track. It is not clear whether this was passive provision for a future double track railway or whether the Victorians were simply employing a standard bridge solution for a railway which would generally be double tracked. The line was also constructed with sidings located at specific locations. These were located at Thorntonhall station and East Kilbride station and were probably there to provide a turnback facility or in the case of East Kilbride to provide access into the engine sheds provided at this location.

To better emphasise the point noted above about the line being constructed as a single track railway figures 2 and 3 highlight the start of the single track section of line at Busby Station dating all the way back to 1892 and as will be highlighted later on in this report in section 4 that original layout is still the same today.



Figure 2: OB32 at Busby Station (1892-1914)

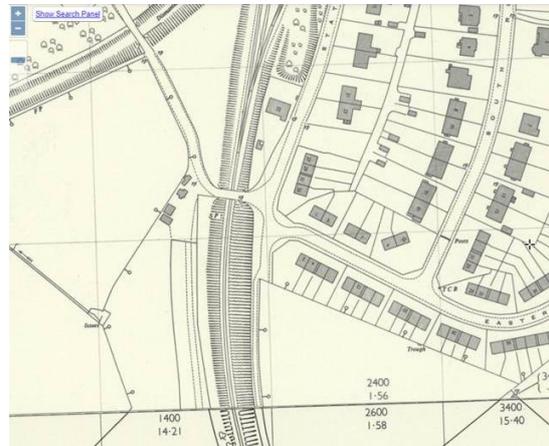


Figure 3: OB32 at Busby Station (1944-1972)

As noted earlier sidings were constructed as part of the line in the area of Thorntonhall station. This is highlighted in figure 4 below. At some point between 1914 and 1944 these sidings were removed as can be seen in figure 5. It is also worth noting that the siding south of OB 27 stops prior to the large cutting south of the station which is important when considering the earthworks strategy for this large cutting which will be discussed in section 5 of this paper. Figures 6 and 7 show the wide cess opposite the station following the removal of the sidings. It is also evident from figure 6 the point noted previously about the bridges being built to accommodate a future double track railway. This aids the project as it avoids the need for substantial earthworks in this area and provides room for the installation of the proposed second platform at the station.

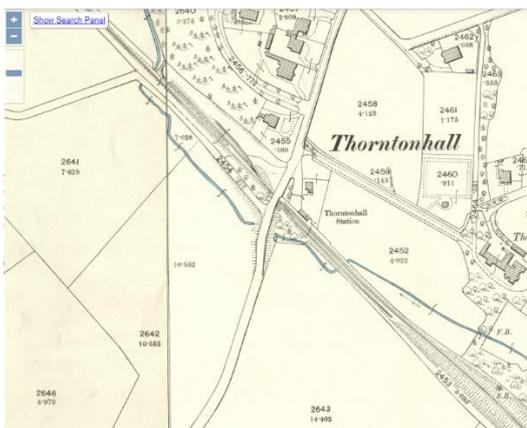


Figure 4: Thorntonhall Station (1892-1914)

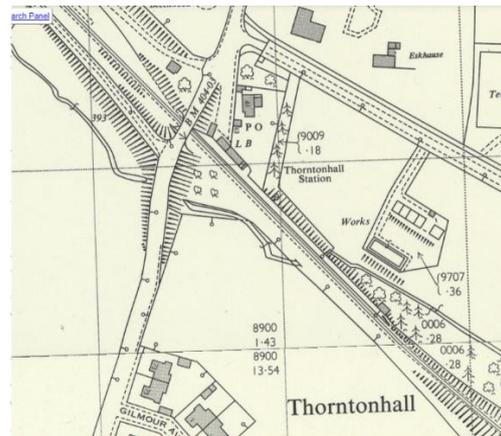


Figure 5: Thorntonhall Station (1944-1972)

The other area of the line where sidings were provided was in the area of East Kilbride station. On the approach to East Kilbride station the railway is on an embankment and then moves into a cutting as you travel below OB 15A before it breaks out into the various sidings etc..Figure 8 shows the historical layout from 1944-1972 for the area around OB 15A. This area will be discussed in section 6 of this report. Figure 9 shows the track layout at East Kilbride station looking towards Hairmyres. The mainline is on the left and the siding/ headshunt is the track on the right. The buffer to clearly visible in the distance. The building on the right hand side is believed to be an engine shed hence the additional sidings leading

into this area. The area where the siding and engine shed were located are the proposed location for the new platform at East Kilbride station.



Figure 6: Thorntonhall Station looking toward Busby (1960)



Figure 7: Thorntonhall Station looking towards East Kilbride

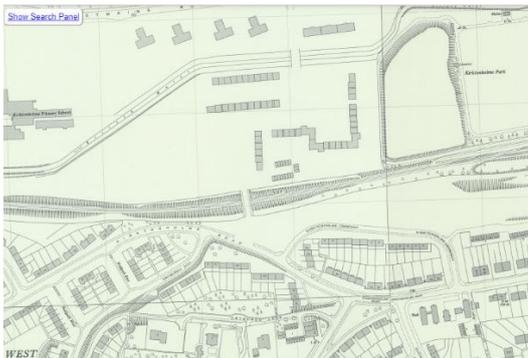


Figure 8: OB 15A West of East Kilbride Station (1944-1972)



Figure 9: East Kilbride Station view looking towards Hairmyres

It is also worth noting that OB 15A was redecked in 1956 and based on the historical redeck plan shown in Figure 10 you can clearly see the passive provision for a second track, however, the earthworks on the approaches were adjusted to suit the new structures and were not radically altered to accommodate a future double track railway. Figure 11 shows OB 15A today from a track level looking towards East Kilbride station.

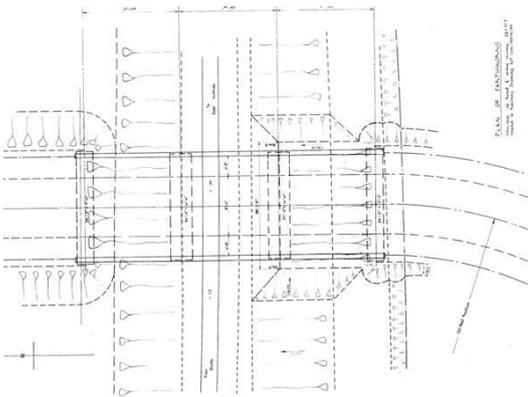


Figure 10: OB 15A Reconstruction Plan (1956)



Figure 11: OB 15A today (looking towards East Kilbride)

3 EARTHWORKS PHILOSOPHY

Lessons learned from previous projects such as Airdrie to Bathgate, Borders and Aberdeen to Inverness have highlighted that it should not be automatically assumed land is not available for acquisition. The assumption that all earthworks have to be contained within the existing rail boundary has resulted in large lengths of retaining structures that were

subsequently discovered could have been avoided as the land could have been purchased. Generally, a 1:2 slope profile provides the quickest, most cost effective and best whole life cost solution over any form of earthworks solution.

At the inception of the project an 'idealised' cross section including full safe cess walkway, troughing, drainage, and a large safety margin for maintenance, with 1:2 slopes was adopted to determine where earthworks would go outwith the NR land boundary. This generated an indicative schedule of land acquisition requirements.

In conjunction with the NR Property team, the landowners of each of these parcels of land were identified. Where it was judged there would be issues with the landowners, the design was modified to retain the earthworks within the NR boundary. Where it was assessed that it was possible to purchase the land for a reasonable cost or where the land was owned by the Local Council, the design was progressed based on indicative 1:2 slopes.

As Grip 3 and subsequently Grip 4 progressed through design development a series of workshops were held to evaluate cess width requirements in different scenario and fundamentally consider lineside safety of the workforce for ongoing maintenance of the line following completion. Additionally, it was decided to move all proposed new lineside infrastructure to the upside cess side of the line reducing the need for dedicated walkways on the downside cess where possible. All of this resulted in a reduction of the cess widths from the initial 3.76m which were adopted at the Grip 2 stage of the project to the following values as detailed in Table 1 below.

Situation	Width (mm from Rail Edge)	Notes
Cuttings & at Grade (Up cess – no drainage)	2720	
Cuttings & At Grade (Up cess – drainage)	3050	the combined walking route is to be locally diverted in front of the OLE masts to avoid clash
Cuttings & at Grade (Down Cess)	2400	
Existing track which are to be retained (minor tamp)	2700	works required to install combined walk/cable route into the existing cutting
Embankments (Up Cess)	3200	
Embankments (Down Cess)	2500	
Embankments (Down Cess – approach to EK station)	3200	

Table 1: Proposed Cess Widths

As the earthwork design progresses through the detailed design stage, further assessment and refinement of the above noted cess widths will be undertaken. Additionally, any areas where land acquisition proves to be difficult or where costs are deemed unacceptable to the project then a further reassessment of earthworks retention options will be considered.

4 EARTHWORKS INTERVENTION EXAMPLE 1: CUTTING AT OB 32

The cutting is located at the southern end of Busby station on either side of OB 32. This is where the track switches from double to single track. Figure 12 provides an aerial view of the bridge and cutting. It is worth noting the proximity of the surrounding private properties and the extent of their gardens in relation to the adjacent railway cutting. The indicative track formation is circa 4.13m as indicated within Figure 13. The required width from ballast shoulder to ballast shoulder for a double track railway is 6.8m and this dimension excludes

provision for drainage, troughing, walkways and continuous positions of safety which depending on the specific situation would need to be included in addition to the 6.8m dimension.



Figure 12: Aerial view of OB 32

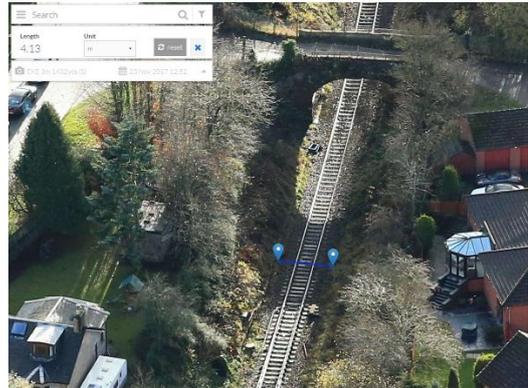


Figure 13: Indicative Cess to Cess width



Figure 14: Trackside view of OB 32 (looking towards EK)



Figure 15: Trackside view of OB 32 (looking towards Busby)

Figures 14 and 15 provide a trackside view of the earthworks and OB 32. It is worth noting the steep nature of the earthworks slope on the left hand side i.e. down cess in figure 15 and this is reflected in the proposed earthworks intervention shown in figure 16.

4.1 EARTHWORKS PHILOSOPHY AT CH 6400m

The current single track alignment starts here as it drops down from double track section at the up mileage end of Busby Station and passes below OB 32 into a narrow cutting. It will be necessary to widen this cutting to accommodate the proposed new double track alignment and associated cess width, noting also the presence of existing track cess drainage at this location which needs to be retained in the final solution.

Residential properties and gardens extend very close to the crest of the cutting and the proposed earthworks cut slope profile at 1:2 would encroach onto this private land on both sides, which is not considered feasible to purchase. Retaining structures are proposed here to accommodate the proposed cutting widening without encroaching into the private land. The preferred form of retaining wall construction is yet to be determined, but may comprise gabions, modular block walls or a king post wall. The proposed plan layout and cross section of the works are illustrated in figures 16 and 17.

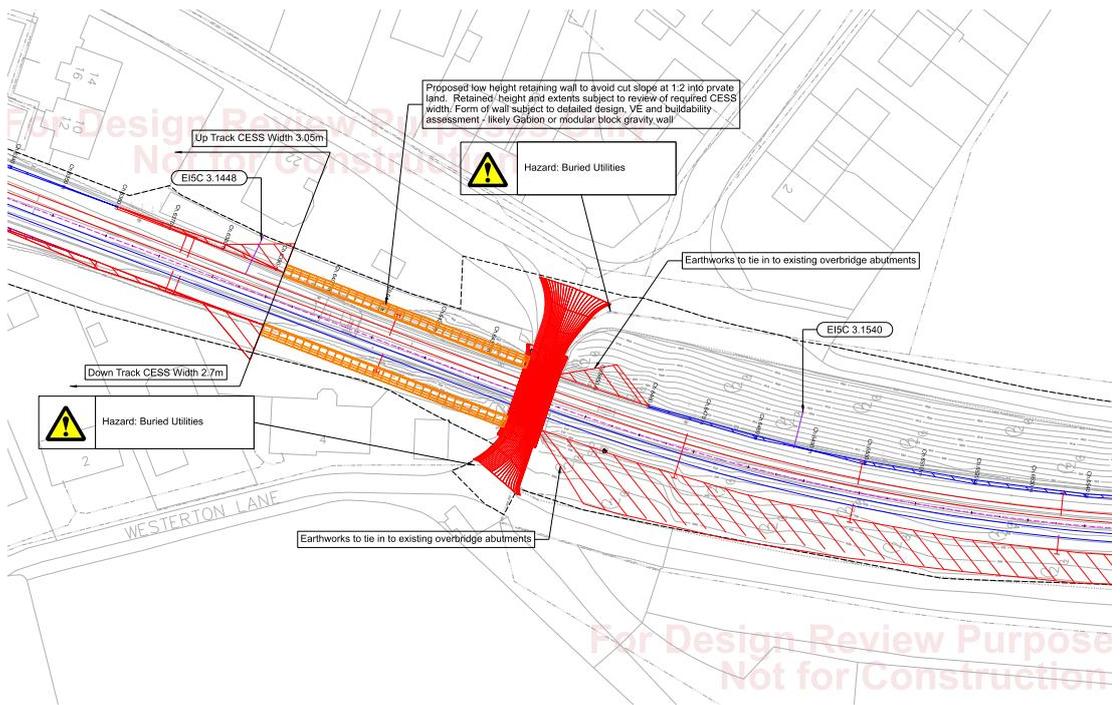


Figure 16: Proposed Earthworks Plan at OB 32

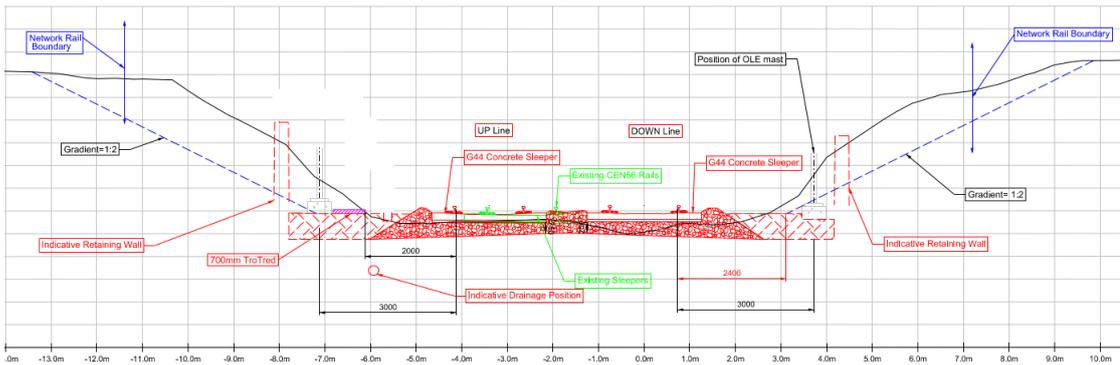


Figure 17: Proposed Earthworks Cross Section at chainage 6400m

5 INTERVENTION EXAMPLE 2: CUTTING SOUTH OF THORNTONHALL STATION

The cutting is located just beyond the southern end of Thorntonhall Station. This is beyond the area where the historical siding existed as noted in section 2 above. Figure 18 indicates an indicative rail corridor width from toe to toe of circa 4.13m. The narrowness of the rail corridor through this cutting is further emphasised in figure 19 which is a trackside view within the cutting looking towards Hairmyres. The existing 4.13m wide rail corridor provides insufficient width for the desired double track rail corridor as described in section 4 above.

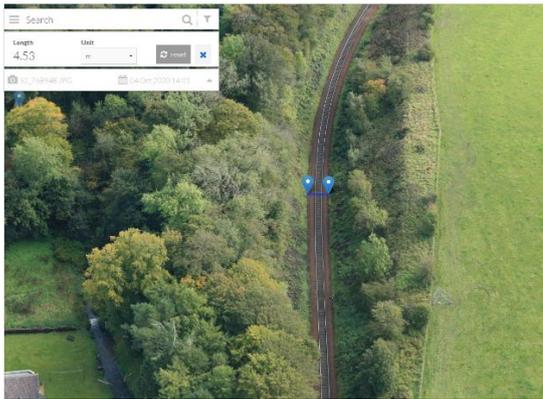


Figure 18: Trackside view of OB 32 (looking towards EK)



Figure 19: Trackside view of OB 32 (looking towards Busby)

5.1 EARTHWORKS PHILOSOPHY at CH 8050m

The single-track railway passes through a deep and narrow soil cutting on the Up mileage side of Thorntonhall station. To accommodate new double track, a new Down line is proposed on the inside of the curve, with the existing up line remaining at or close to current alignment. The new track alignment has been kept as far as practical away from the wooded cut slope on the Up line side but is constrained by the new platform extensions at Thorntonhall station on the Down mileage end and the culvert to the Thorntonhall Burn on the Up mileage end. The required alignment of the new Down line and the increased cess width on the Up line requires the cutting to be widened. The extent of the proposed earthworks and the constraints of the Thorntonhall Station platforms and existing culvert are highlight in Figure 20.

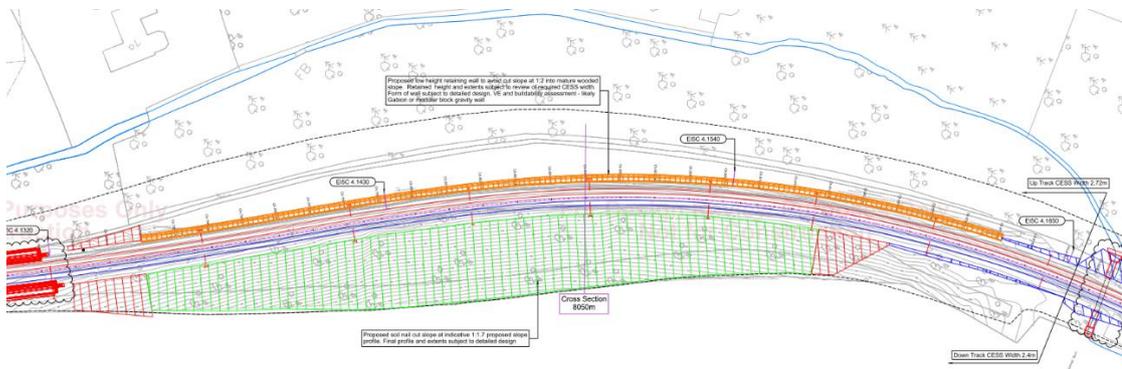


Figure 20: Proposed Earthworks Plan at Chainage 8050m

On the Up line side, to avoid large scale earthworks affecting the mature forested cutting slope, a low height retaining wall is proposed. On the Down line significant widening of the cut slope is required. This slope is up to 14m in height and is currently at a gradient of between 1:1.5 and 1:2. This slope has some evidence of past instability and is currently being considered for remedial works as part of the route work bank. Analysis indicates a slope of 1:2 would not provide long term stability in the prevailing soil and groundwater conditions. A new widened cut slope profile of 1:2.5 would be required which would result in significant land take and generate large volumes of cut soil arisings. To reduce cut volumes and land take requirements at the crest, a steeper soil nailed reinforced slope at a profile of 1:1.7 is proposed and this could be potentially steeper up to 1:1 subject to detailed analysis at Grip 5. The proposed works are shown in the cross section in figure 21.

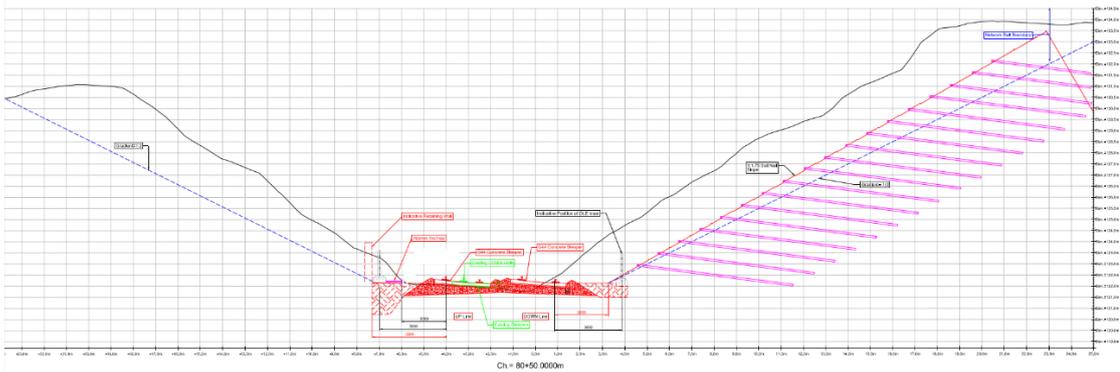


Figure 21: Proposed Earthworks Cross Section at chainage 8050m

There are possible opportunities for value engineering in this area. The land owner on the Down line side is not opposed to selling the project the strip of land to allow the desired soft slope solution and avoid the possible need for slope retention works. Further value engineering will be undertaken on the Up line side of the cutting to try and reduce the need for earthworks interventions but this will be dependent on the safety requirements associated with lineside access as the Up line cess is where the project intends to provide a safe cess walking route.

6 INTERVENTION EXAMPLE 3: EMBANKMENT APPROACHING OB 15A

The single track alignment at this location on the approach to OB 15A and subsequently East Kilbride Station is positioned on an embankment. As the line reaches OB 15A it then reverts to a cutting. As highlighted by figure 22 the shoulder to shoulder width of the railway corridor is 3.51m on the embankment. It is also worth noting that UB 15C which is shown in the trackside view in figure 23, just like OB 15A which is just further Up mileage from this point, has been built to accommodate a double track railway, however, the earthworks haven't. This is clear highlighted in the cross section in figure 25.

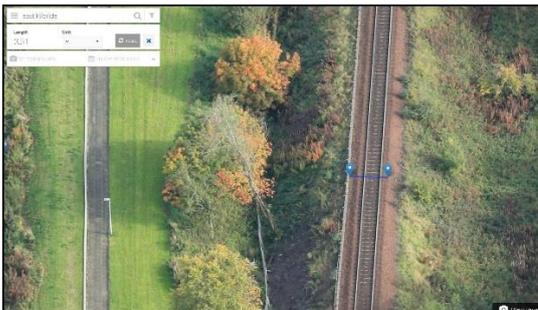


Figure 22: Aerial view on Embankment



Figure 23: Trackside view looking towards East Kilbride

6.1 EARTHWORKS PHILOSOPHY AT CH 12050m

The existing embankment on the approach to East Kilbride station was originally constructed to support a single track and is not sufficiently wide to support new double track width and associated cess requirements. The new Down line alignment and the required increased cess width to the existing Up line results in a need to widen this embankment on both sides. This will be achieved using imported granular fill placed at a gradient of 1v:2h, benched into the existing side slopes. This will require temporary access for the earthworks and permanent land take as the toe of the new widened embankment encroaches beyond the current NR boundary in several areas. Optimisation of cess widths on both the Up and Down side can be developed at GRIP 5 which may result in slight amendments to the required cess width, but that will not result in large scale alterations to

the overall requirement for embankment widening for this section. The proposed earthworks plan and cross section for this area are shown in figures 24 and 25.

It is noted that whilst this is the most significant area of embankment widening required, similar situations occur on a smaller scale, often on only one side and at lower heights, for other sections of the route where embankment widening is required, and there are numerous other locations where this results in earthworks extending beyond the NR boundary.

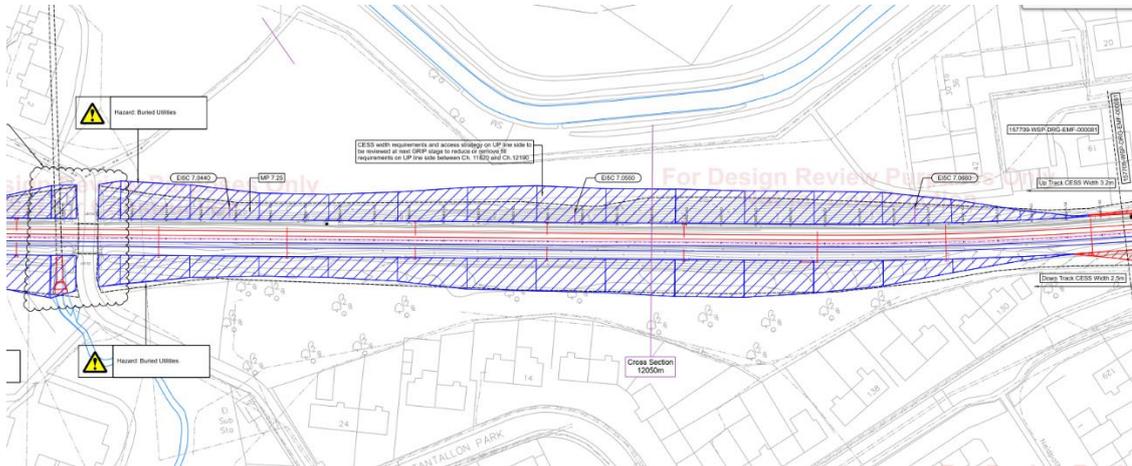


Figure 24: Proposed Earthworks Plan at chainage 12050m

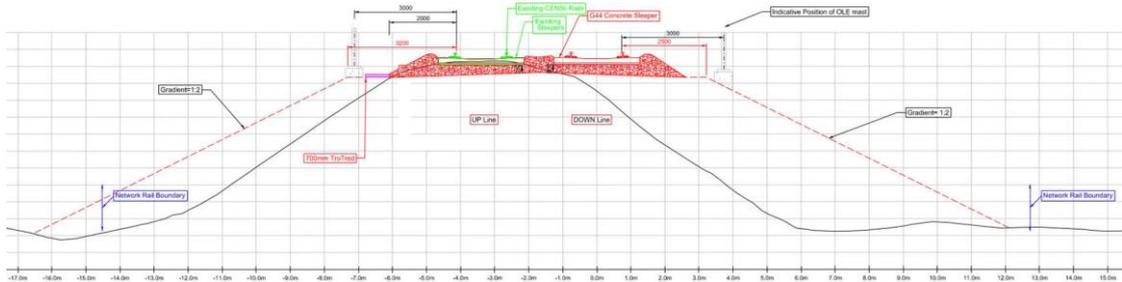


Figure 25: Proposed Earthworks Cross Section at chainage 12050m

7 SUMMARY

In summary it is very challenging and difficult to provide a double track railway between Busby Station and East Kilbride Station without some form of earthworks interventions. As design development continues through the detailed design phase further efficiencies will be sought regarding the earthworks to ensure that the project provides a cost effective and safe railway corridor.

Lastly it is worth noting that reduction or avoidance of earthworks interventions on the project is not simply related to cost efficiencies but also de-risks the programme as all of the proposed earthworks need to be undertaken within the 20 week blockade planned for construction of this section. Other elements of the works e.g. track, OLE etc. are dependent on the completion of these earthworks prior to commencement their installation. A high level aspiration for the earthworks on the project is to try and reduce any interventions to at least one side of the railway only thus allowing other elements of work to happen prior to the blockade in the side of the rail corridor where no earthworks intervention has taken place.