



Cambridge Guided Busway – Defects

Preliminary Advice on Quantum based on Capita Recommendations

1. Introduction

- 1.1 I am instructed by Bircham Dyson Bell LLP to provide an opinion on quantum arising out of the defects identified by the Capita report dated 11 September 2014 (“the Capita Report”) in respect of this matter, and in particular to advise on comparative costs potentially arising from adoption of one or other of the alternatives outlined.
- 1.2 This Advice Note is intended to provide some headline guidance on orders of magnitude, albeit on a provisional basis, based on present knowledge and forecasting provided by Capita. It is understood that this Advice will be considered for the purpose of informing strategic decisions by providing indicative costs, albeit provisional, of the various Options identified in the Capita Report. Preliminary conclusions are set out in the summary which appears at Section 5 below.

2. Overview of remedial schemes

- 2.1 The nature of the defects is set out in some detail in the Capita Report and is not repeated here. Various remedial options have been considered. These can be categorised first in terms of those which relate to the above-ground solutions, and then in terms of substructure solutions. There are three main options for each category; for convenience and shorthand Capita have labelled the above-ground solutions Options 1, 2 and 3, and the substructure solutions Options A, B and C. There are sub-options for Option 3 (3A and 3B) and for the three substructure solutions A, B and C (A1/A2, B1/B2 and C1/C2). Costing of possible remedial works has therefore been considered in terms of possible combinations of these options.
- 2.2 All the estimates include the cost of professional fees, but not building or planning fees or legal costs.

- 2.3 Inflation has been allowed at 3% per annum on professional fees and 4% on construction costs. A more detailed discussion of inflation allowances appears at Section 3.2 below in the context of Net Present Value (“NPV”) considerations.

3. The Superstructure Options

3.1 Option 1

- 3.1.1 This option is described at paragraph 111 of the Capita Report. This has been dubbed the “Grand Unifying Defect”, or “GUD”, because it addresses in one operation many of the defects identified in the Guideway. In summary, these are as follows:

- (a) 267: Guideway joints narrower than design.
- (b) 268: Gaps at Guideway fixed joints (addressed generally by Defect 294).
- (c) 279: Displaced beam at Chainage 2308 .
- (d) 282 & 283: Step detail between type 1 & 2 beams. This involves a degree of interpretation of the Ekspan quote that may require further analysis.
- (e) 284: Beams installed with consecutive free ends and without alternative longitudinal restraint (costing included in Defect 294).
- (f) 287A: Bearing displacements and consequential Guideway vertical displacement. This also involves a degree of interpretation of the Ekspan quote that may require further analysis.
- (g) 288: Beam joint relative horizontal displacement defects.
- (h) 289: Guideway beam/upstand cracking and Guideway durability. Traffic management for 12 days per phase is included.
- (i) 290: Horizontal load capacity of screwfast piles.
- (j) 293: Longitudinal restraint (costing included in Defect 294).

- (k) 294: Horizontal load of support bracket. Again, this involves a degree of interpretation of the Ekspan quote that may require further analysis.
- (l) 295: Non-functioning infiltration drains at Bridge Road Bridge (Chainage 17+530 to 17+710). There appears to be no firm corrective proposal in place at the time of preparing this Advice Note, and therefore the inclusion here is based on the provisional estimate of £300,000 given previously by Atkins.

3.1.2 Additionally, the costing for this option addresses Defect 294, involving overcoming of spalling until full correction is possible through carrying out the GUD works.

3.1.3 This option is of course the preventative, comprehensive, approach, but it requires closure of the Guideway in six sections, diverting bus traffic via public roads while work is carried out. It is estimated that closure of each section will be required for up to six months at a time while work is carried out, with an overall programme lasting four years, with work commencing in 2015 for three years after completion of necessary design and procurement activities. It will be a matter of judgement whether and to what extent this is more or less disruptive to the public as a whole than Options B or C.

3.1.4 Our costings include an allowance of 4% per annum construction inflation over the period from now to likely completion, and our estimate of the total cost of construction for this option, based on our discussions with Capita, is approximately £17,500,000.

3.2 Option 2

3.2.1 This Option is described at paragraphs 142 to 144 of the Capita Report. It involves, in essence, carrying out certain GUD works described above on a weekend working only basis. Option 2 envisages, substantially, eventual total replacement of the entire Guideway, as for Option 1, but on a reactive basis.

3.2.2 At the outset, Defects 289 and 295 (described above) would be addressed on a stand-alone basis. The main Defects 287A, 288 and 294 would then be undertaken with attention paid to early correction of the spalling element of Defect 294 until full correction is possible through carrying out the GUD works. For Defect 289, a

programme period of 1 year lead-in plus 3 years construction starting in early 2015 is envisaged.

- 3.2.3 It is estimated that this Option will take in the region of 30 years to complete, commencing in 2015. It will be appreciated that any estimate of costs involved is sensitive (and vulnerable) not only to the estimate of likely incidence of future failure, but also to construction inflation. If inflation is ignored, the “raw” construction costs, including traffic management, are estimated at around £75,200,000. The increase over Option 1 costs is due to the piecemeal nature of the works involved, and the assumed need for any such works to be executed – so far as possible – over weekends.
- 3.2.4 Inflation at 4% per annum, compounded to the mid-point of a 30-year replacement cycle, would take costs to around £158,500,000. How this is treated in terms of net present value (“NPV”) or cost, allowing for off-setting of interest gained on any sum putatively received now by way of settlement from BAM to finance future remedial works, is a matter that introduces further financial appraisal sensitivities involving estimates of credit interest compared with estimates of construction inflation. Any such estimates projected over 30 years involve a good deal of speculation, although a look back over the last few decades may assist.
- 3.2.5 The principles governing any putative NPV calculation can be summed up as follows:
- (a) Future inflation costs (“X”) need to be compared with the return to be expected on the best alternative use of money (“Y”) in the meantime that will eventually be spent on remedial works, or the cost of finance saved by the Claimant (here, the Council) generally on other projects (whichever is appropriate).
 - (b) Whilst many NPV estimates ignore inflation, estimates of either of these factors for the kind of time scale involved are often entirely speculative. More is said about uncertainty below.
 - (c) If X is greater than Y, then the result of any NPV calculation will be higher than a present-day estimate, but to the extent that there is a positive difference, there will be a discount on the total sum including inflation otherwise

estimated. If Y is greater than X, then there will be a discount on the net sum excluding inflation.

- (d) The closer that (X) and (Y) are, then the closer the net rate of discount (or augmentation) will be to zero.

3.2.6 The uncertain nature of any estimates of future interest rates and future construction cost inflation mean that it is possible for inflation to exceed interest gains, and for the converse to hold true, at any of the points in the project estimate. There will undoubtedly be peaks and troughs in both interest rates and inflation at different times. In the late 1960s and throughout the 1970s interest rates were generally lower than inflation. That is again the case. The Council might at some stage gain from a reversal of the present trend such as occurred in the 1980s where the converse was true for a period. Precisely where such peaks and troughs of comparative advantage will occur is a matter for speculation rather than estimation.

3.2.7 As envisaged by (d), it may turn out to be the case, of course, that inflation and interest will cancel each other out; there have been times in the past when this was possible for a few years at a time, but the general picture, taking a longer view and considering spreads and net gains expected by financial institutions, must be that inflation will outstrip credit interest.

3.2.8 Further research on this is perhaps beyond the scope of a preliminary Advice Note. Furthermore, as I have proposed in a published article on this point,¹ these are uncertainties that are, ultimately, induced by the breaches complained of and it is suggested a strong argument may be made that any settlement reached should not involve financial risk for the Council to suffer and provide against. These may be valid arguments for adding to inflation estimates or reducing estimated investment yields otherwise expected or derived from central government advice such as the Green Book to provide a margin for contingency and risk. As noted above, however, the closer the two rates become to each other and the closer the discount rate approaches zero, the more the net enhancement/discount otherwise indicated will equate to zero.

¹ "Credit for 'Betterment' in Quantum Arguments", (2000) 16 Const. L.J. 31.

3.2.9 My present advice would be to treat the estimate of construction inflation applied to the principal or capital sum arrived at as a net rate; this is because interest rates are presently and have been for some time at very low levels, and they are probably unlikely to rise sharply in the near future. Furthermore, NPV calculations are particularly sensitive to early years percentage adjustments and are less so in future years when the remaining capital sum is lower (because much of it will by then have been expended), and this would be an argument for extrapolating the present trend.

3.2.10 It is therefore recommended that the Council treats the costs arising under Option 2 as not subject to any substantial discount for NPV, and allows for the full £160,000,000.

3.3 Option 3

3.3.1 This Option is described at paragraphs 152(v) and (vi) of the Capita Report. It involves first of all the same preliminary works considered as necessary for Option 2 described above, viz., rectification of Defects 289 and 295, and the element of Defect 294 dealing with spalling. For Defect 289, a programme period of 1-year lead-in plus 3 years construction starting in early 2015 is envisaged. Thereafter it involves the following remedial works, carried out on an “if and when required” basis, i.e., as and when defects manifest themselves:

- (a) Correction of displaced bearings.
- (b) Lateral displacement: see paragraph 157 of the Capita Report, based on 4,400 instances (derived from the estimate for Defect 288).
- (c) Overcoming spalling as per paragraph 158 of the Capita Report.

3.3.2 Once again there is considerable scope for uncertainty in predicting likely incidence of bearing failure. There is also the possibility (and indeed probability) that the same bearings or groups of bearings may need to be replaced more than once. There are therefore sub-variants of this Option, described as Options 3A and 3B. Option 3A envisages replacement of 50% of bearings throughout the Guideway, and Option 3B 65%. Both variants are discussed here.

- 3.3.3 The provisional estimate for Option 3A is £32,200,000 without any inflation allowances at all. It is thus not comparable for that reason alone with the estimate for Option 1 because Option 1 includes for inflation during the programme period assumed to start in 2015. If inflation at 4% is assumed for Option 3A, covering replacement over the planned 40 year life of the Guideway, commencing in 2015 the total cost would in fact be around £61,500,000.
- 3.3.4 The estimated cost for Option 3B is £41,500,000 excluding any allowance for inflation; allowing inflation on the same basis as for Option 3A, total estimated costs are £80,000,000.
- 3.3.5 For the reasons discussed in Section 3.2 above in connection with Option 2 it is recommended that these estimated costs should not, for present purposes, be discounted by way of NPV calculations.

4. The substructure options

4.1 Option A

- 4.1.1 This may be regarded, as for Option 1 of the above-ground solutions, as the comprehensive but most immediately disruptive solution. The scope and full description of what is involved appears at paragraphs 184 and 186 of the Capita Report. In outline it involves monitoring foundations (as described in Defect 016) up to 2015 and then carrying out the full remedial works prescribed for Defect 016A in respect of either 904 (Option A1) or 679 (Option A2) foundation structures considered to be at high risk, including 36 locations South of Histon where Capita considers that foundations are already proven to have failed.²
- 4.1.2 A notional allowance of £350,000 has been made for removal of new trees and replacement with suitable varieties plus continuing arboriculture. This applies to all the substructure Options; it is based upon an earlier estimate provided by Atkins acknowledging that no firm corrective proposals are in place. The cost of arboricultural works to existing trees is excluded for all Options because there is presently no detail of what is required to enable any reliable estimate to be made. It is possible that some

² We are aware that Atkins may be considering a different number of locations where these works are necessary.

of this may be considered routine maintenance that would have been needed anyway, to be funded from elsewhere in Council budgets.

4.1.3 A four-year design, procurement and construction period starting in early 2015 is envisaged; there may be some mis-match with Option 1, but the principle is the same, involving closure of the Guideway in sections over three years.

4.1.4 Our provisional estimates are £12,100,000 for Option A1 and £9,200,000 for Option A2, including inflation, for the design, procurement and construction period.

4.1.5 When comparing these Options with Options B and C, it should be noted that there is no allowance here for lifting Guideway tracks specifically for works to foundations, because it is assumed that Options A1 and A2 would only be considered viable in conjunction with Superstructure Options 1 or 2, which already include for lifting tracks.

4.2 Option B

4.2.1 The scope and full description of what is involved appears at paragraphs 188 and 191 of the Capita Report. Again, it involves monitoring foundations, but for the full 40 year design life of the Guideway, together with carrying out the full remedial works prescribed for Defect 016A in respect of 141 foundation structures considered to be at high risk, including the 36 locations South of Histon where Capita considers foundations already to have failed, together with the same arboricultural works allowed for Option A, plus provision of root barriers and additional drainage. The same programme period is assumed.

4.2.2 The difference in cost between this and Option A is driven by the decrease in the number of foundations to be attended to, the works in connection with root barriers and the increased monitoring and rectification period involved, leading to the need for major inflation allowances.

4.2.3 We have allowed for the probability that up to a third of the root barrier work will need to take place in steep embankments, that half of them will require adaptation of drainage, and that all will require lifting of the Guideway tracks with associated traffic management.

- 4.2.4 The difference between Options B1 and B2 is the manner of treatment of the foundations deemed in need of root barrier work – Option B1 assumes application of the full NHBC standards,³ and Option B2 allows for 25mm of differential settlement, thus reducing the number of foundations deemed to be affected.
- 4.2.5 Our provisional estimate for Option B1 is £85,000,000 including allowance for inflation over the entire period. For Option B2 the figure is £61,500,000. These estimates are based on the same assumptions as those set out in paragraph 4.1.3 above, allowing for pre-emptive works being carried out over a 20-year period⁴ and remedial works over the remaining design life of the Guideway.
- 4.2.6 The major increase over Options A1 and A2 is due to the need to price separately here for lifting Guideway tracks since it is assumed that these Options would only be viable for superstructure Options 2 and 3, which do not include these costs.

4.3 Option C

- 4.3.1 These Options, described at paragraphs 198 and 201 of the Capita Report, involve early work to the 36 foundation bases considered already to have failed, together with the monitoring and arboricultural works described for Option B, once again assuming the same programme periods. The difference between Options C1 and C2 is the same as for B1 and B2, *viz.*, whether full NHBC standards are applied or whether 25mm differential movement is allowed for.
- 4.3.2 The estimated cost for Option C1 is £92,400,000 including inflation, and for Option C2 £69,000,000.
- 4.3.3 Again, the major increase over Options A1 and A2 is due to the need to price separately here for lifting Guideway tracks since it is assumed that these Options would only be viable for superstructure Options 2 and 3, which do not include these costs.
- 4.3.4 The reason for the increase over Options B1 and B2 is the need for provision of more extensive root barrier works to more foundations in the future, and the addition of

³ See paragraph 190 of the Capita Report.

⁴ See paragraph 189 of the Capita Report: 15 years plus 4 years plus 1 year lead-in.

associated inflation allowances: Option B provides for addressing 105 foundation locations in the shorter term and under Option C these would be addressed later.

5. **Summary**

- 5.1 The comparative combined cost of alternative approaches is set out in the table below. In discussions with Capita, it has emerged that it would probably be impractical and uneconomic to combine the comprehensive above-ground Options 1 or 2 with the more reactive substructure solutions B and C, but clearly this question would be more correctly addressed by engineering expertise rather than from the point of view of quantum. These permutations are therefore omitted from the range of estimated costs set out here, which also avoids potential duplication of costs for lifting Guideway sections that would otherwise arise.

		Superstructure Options			
Substructure Options:		1	2	3A	3B
	Option sub-totals:	£17,500,000	£158,500,000	£61,500,000	£80,000,000
A1	£12,100,000	£29,600,000	£170,600,000	£73,600,000	£92,100,000
A2	£9,200,000	£26,700,000	£167,700,000	£70,700,000	£89,200,000
B1	£85,000,000	-	-	£146,500,000	£165,000,000
B2	£61,500,000	-	-	£123,000,000	£141,500,000
C1	£92,400,000	-	-	£153,900,000	£172,400,000
C2	£69,000,000	-	-	£130,500,000	£149,000,000

- 5.2 I would emphasise once again the preliminary nature of this advice and the many variables involved. Whilst there is a degree of contingency and allowance for risk included in the estimates, there can be no warranty or reliance attached to these figures, particularly for those involving the longer-term “if and when” solutions. As technical proposals are developed further it is recommended that these estimates should be reviewed. However, it is hoped that the wide gap between costs for some of the various permutations will assist in allowing any decision that needs to be made with political and operational considerations to the fore to be informed by these indications of likely cost differential.