Appendix C

Hannah · Reed

The Old Rectory TPO
Little Gransden

Report by Structural Engineer

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1 Brief (Dated 8 August 2012)

The following brief was provided by David Bevan, Conservation and Design Manager of South Cambridgeshire District Council, who required structural engineering advice in connection with a Tree Preservation Order (TPO).

The purpose of the structural engineer's report is to help inform the Council's decision on whether a Tree Preservation Order (TPO) should be confirmed for trees at the Old Rectory, a grade II listed building.

The report will advise on:

- The level of seriousness and future implications, including remedial work required, of movement and cracking at The Old Rectory involving the foundations, walls and any other elements.
- The cause or causes of the movement including but not limited to trees and modern changes and other works to the house.
- The solutions or solution to deal with the movement, the risks with their implementation and their nature and estimated costs. The costs should include and remediation works but not filling of cracks or redecoration which would be required whether or not the solutions would be implemented.

The report will also comment on the issues raised in Giles Biddle's report about the robustness of the methodology and data in original reports and any implications of this for the conclusions drawn.

The work will require the structural engineer to:

- Review existing reports and correspondence
- Review the planning history and building control history (if agreed by Mrs Seabright).
- Visit the property and carry out a visual inspection of the structures involved and their surroundings.
- Prepare a report on his findings.

The existing report and correspondence to be reviewed have been sent separately by Roz Richardson.

The planning history is attached with this brief. Planning applications can be searched on our website at http://plan.scambs.gov.uk/swiftlg/apas/run/wchvarylogin.display. More recent ones will include plans and documents. Plans and documents for earlier applications may be on microfiche at our office. Contact us if you have problems getting the information you need.

The building control history is not publicly available apart from start and finish dates which we can provide. We have contacted the owner to ask if she is willing for you to see this information.

2 Documents Reviewed

Gawn Associates report dated 18 December 2009, for owner

Mat Lab Ltd report dated 23 March 2010, for insurers

Crawford addendum report dated 4 May 2010, for insurers

OCA arboricultural report dated 28 May 2010 (by Margaret MacQueen), for insurers

Crawford letter dated 2 January 2012 with monitoring data

Writtle Park Ltd arboricultural report dated 10 October 2011, for owner

Note from Dr Charles Turner dated 5 March 2012 (independent)

P G Biddle report dated 15 March 2012, for Parish Council

Richard Jackson structural report dated April 2012, for Parish Council

John Cromar arboricultural report dated 15 May 2012, for SCDC

AFP structural report dated 29 June 2012, for SCDC

AFP email correspondence dated 5-9 July 2012, with SCDC

John Cromar email correspondence dated 5-9 July 2012 with SCDC

List of planning and listed building consents for The Old Rectory.

3 Methodology

3.1 I have reviewed the existing reports and correspondence made available to me and I visited the property on 18 August 2012 in order to make an inspection. I was met there by Mrs Seabright, who explained the building work that had been carried out in 2010 and pointed out the locations of the cracks and survey points as shown in the various reports.

3.2 Rather than reiterate the results of the site investigation, level monitoring and various specialist investigations already carried out, I have answered the brief directly, drawing the various threads of information together and referring to elements of specialist reports that have been prepared. In doing this, I discuss both supporting and dissenting views and draw my own conclusions to inform the Council.

4 Level of Seriousness

4.1 The damage to the fabric of the building is not structurally serious. The cracks observed are reported as being fine or hairline in width and there is no risk that the problems encountered will result in an unsafe structure.

4.2 The benchmark that is normally used for assessment of damage is BRE Digest 251, (ref 1). Specifically, in accordance with Table 1 of that document, which categorises

damage by crack width, the damage here is category 2 in a range spanning from 0 to 5. Category 0 is the least serious (for which no action is required) while category 5 is the most serious (which requires major repair involving partial or complete rebuilding).

4.3 The movement of the foundations recorded along the east wall (nearest the cedar tree) reached a maximum of 12mm in 2010-11. In purely structural terms, this is not serious, but is enough to give rise to damage. The amplitude of seasonal movement, up and down, is not likely to increase significantly from that experienced in 2010-11, although it is possible that there will be a gradual ratcheting down of the affected parts of the building over several years if the problem is not dealt with. This will result in overall settlement locally becoming greater than at present, though not dangerously so, and there will be a permanent distortion of the superstructure.

4.4 The BRE categorisation of damage is often used, and has been referred to in both the OCA report and the Richard Jackson report. It does not give a complete picture, however. Although the damage is not structurally serious, if it is allowed to continue, the wall and ceiling cracking will be a nuisance to the owners as it is recurrent and seasonally cyclic in nature; it is probably, to some degree, progressive. Either the cracking would have to be endured, or continual repairs and re-decoration would be needed. As suggested by AFP, if the problem is not dealt with, it could render the property difficult to insure and sell. These points are considered further in section 7.

5 The Causes of the Movement and Damage

5.1 There is widespread agreement amongst the various reports that the cause of the damage is settlement arising from seasonal cyclical shrinkage and swelling of the narrow band of clay beneath the foundations of the east elevation; the seasonal movement having been brought about by tree root action of the cedar tree referred to as T1.

5.2 The above reflects the summary view of Leslie Gawn, for the owner; Crawford and OCA, for the insurer; Writtle Park, for the owner; John Cromar and AFP, for SCDC.

5.3 Dr P G Biddle, for the Parish Council, gives qualified acceptance of the above in para 29 of his report, while Richard Jackson, for the Parish Council, dissent based on their desktop study of the documents.

5.4 The clay described in Mat Lab's site investigation report appears to be the feather edge of a superficial deposit referred to as Till on the Geological Survey map, an extract of which is shown below, in figure 1. This is as described in the letter dated 5 March 2012, from Dr Charles Turner and is referred to by Dr Biddle (para 12). Till was called Boulder Clay on earlier versions of the geological map. It is essentially a variable, sandy or silty clay deposit and laboratory tests carried out by Mat Lab have shown it to have intermediate shrinkage potential.

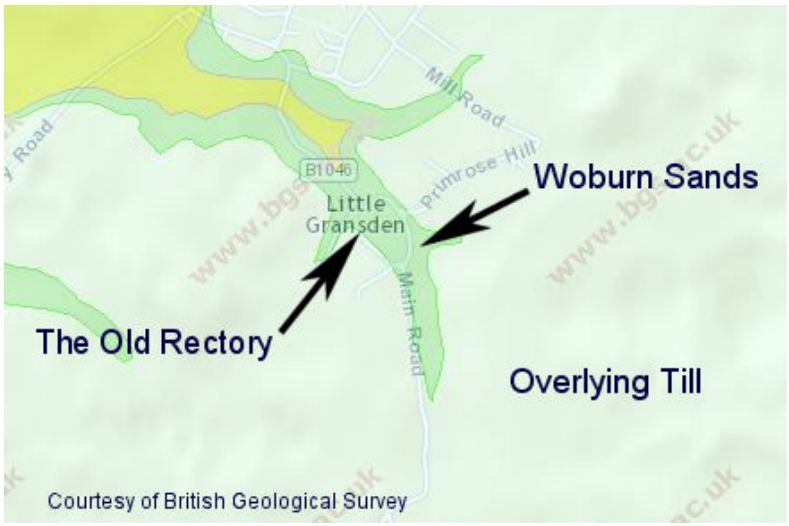

Figure 1. Extract from Geological Map

5.5 Dr Biddle suggested that the damage might have been caused by shrubs (para 27) although he had not been able to visit the site to check this. The walls in the vicinity of survey points 6, 7 and 8 are surrounded by hard paving and the nearest vegetation is the group of yew trees referred to as G1 in the Writtle Park report. These yews are 6m tall, occupy an area where the ground level is lower, and are 10m from the bay window area of the house (about 20m north of survey point 8). No shrubs or other vegetation were recorded in the vicinity in any of the reports and I saw none during my visit. It therefore seems to me that this possibility can be ruled out for the area of movement and damage in the vicinity of survey points 6-8.

5.6 I am less certain about the smaller-scale movements at survey points 9 and 10, the bay window area, which could possibly be related to tree root action from the nearby yew trees. The yews are much smaller, lower in the ground and less vigorous than the cedar and the movements recorded at points 9 and 10 do not appear to have caused any nuisance to the owner.

5.7 Dr Biddle makes the valid point that the cedar (T1) will have been having a similar influence on the building for many decades and it might be expected that damage would have developed long ago. I accept this point and it is discussed below.

5.8 According to the geological map, the cedar tree sits in Woburn Sands, which are fine, free draining sands. During my visit, I estimated the ground level at the cedar tree to be approximately 1m lower than the ground floor of the house (which is approximately 51m AOD). Further east behind the tree, the ground level drops away, leading to the lower garden near Gransden Brook. Here, I estimated the ground level to be approx. 44m AOD, ie 6m lower than at the tree and 60m away. At the time of my visit, Gransden Brook was largely dry. Given these relative levels, it seems reasonable to me that the tree roots might extend beneath the house as the water table in the Woburn Sand is likely to be at roughly 44m AOD, ie 6m below the tree.

5.9 As part of my investigations, I visited the offices of South Cambridgeshire District Council to inspect the planning applications referred to in the list of documents, together with any building regulations submissions.

5.10 I inspected two planning applications that are relevant to this investigation: the 2009 application for the extension and renewal of the cellar area at the southern end of the building; and a 1999 listed building application (ref S/0216/99/LB) that related to

various alterations including underpinning the single storey area at the northeast corner.

5.11 The 2009 planning application, and related building regulations submission, showed rebuilding of the store and utility area at the southern end of the building, including deepening the cellar and associated underpinning of the adjacent wall of the main building, so that the deepened cellar did not undermine it.

5.12 The 1999 application was lodged by David Pitts (architect) and refers to *"serious settlement along the north side of the building to the single storey element which will require underpinning."* The drawing attached to the application indicates underpinning of indeterminate extent in that area, to engineer's details. The architect's drawing showed the underpinning, schematically, as extending under most of the single storey area and the northeast side of the cellar. Unfortunately, no engineer's details were included. The owner's recollection at the time of my visit was that only a small area of underpinning was undertaken locally to the northeast corner.

5.13 The 1999 listed building application does therefore indicate that problems with settlement have been present in the south eastern corner of the building for at least 13 years.

5.14 A related question has been posed which is relevant here: could the cedar roots found in the trial pit have come from the second cedar tree, further to the north of T1? In response, I refer to Writtle Park's report, which states in para 4.3:

"There are no other trees in the area of a size, stature or proximity to the area where the roots were retrieved that this root may be associated with other than T1 Cedar."

5.15 Dr Biddle has acknowledged that the crack monitoring shows a pattern consistent with the influence of vegetation (para 11) but has suggested that the damage may have been exacerbated by the differences in foundation depth (para 29). As an engineer, I agree this is possible and the matter is discussed below.

5.16 I agree with Dr Biddle (para 30) that there is no evidence to suggest the involvement of the wellingtonia tree. However, the only trial pit excavated was adjacent to survey point 8, which is 27m from the wellingtonia. That tree lies approximately 23m from point 6 and could be contributing to the foundation movements there. It is not known what roots might exist in the soil beneath point 6 although there is seasonal movement there and the cedar (T1) is the closest tree, at approximately 19m.

5.17 Richard Jackson make the following points to justify their view, which I deal with below in some detail, using the paragraph numbers in their report:

5.18 Para 2.7 Richard Jackson suggest that the differential foundation movement and consequential damage can result from foundations at different depths, such as between the recently deepened basement area, which is located at the southeast corner, and the adjacent shallow footings. They note that this is where the cracking has been reported.

5.19 While I agree that the phenomenon described by Richard Jackson is a well-known source of structural problems, I do not consider that it is the cause of the cracking at this property. There are several reasons for this: firstly, from my own inspection, the cracking that was recorded by Gawn and has been monitored by Crawford is in a zone between four and ten metres away from the utility area with the deepened foundations; it is too far away. Secondly, the damage was recorded before the basement was deepened (although a half-cellar was already present at the same location); thirdly, it would not explain the cyclic movement, particularly at some distance from the basement. Fourthly, the report by AFP following their inspection,

records no significant cracking where the cellar meets the shallow foundation. My own inspection confirmed this.

5.20 Para 2.8.and 3.2 Richard Jackson state the clay stratum is thin and they would have expected the damage to occur many decades previously as the clay would have been fully desiccated as the trees approached their mature height. This is the same point made by Dr Biddle and is considered in my paragraphs 5.7 to 5.13, above.

5.21 Para 2.9. Richard Jackson use NHBC recommendations as to tree distances and foundation depths to suggest that the cedar is too far away for its roots to have an effect below 900mm, which they state is the normal depth of seasonal variation. 900mm is the minimum depth recommended by NHBC for foundations in such clay soils. I consider this argument irrelevant as it ignores both the actual depth of the foundations and the presence of cedar roots in the clay beneath them. I deal with the normal depth of seasonal variation below.

5.22 Para 2.10 and 3.3 Richard Jackson again cite the NHBC recommendations to suggest that the horse chestnut tree is the culprit. This may be indicated theoretically but ignores the fact that cedar roots were identified beneath the foundations and not those of the horse chestnut.

5.23 Para 3.4 - 3.6 Richard Jackson state the foundations of the main house are too shallow to resist the effects of seasonal variations… in the clay, and that any property founded in such a way can expect damage up to BRE Digest 251 level 2. Therefore, removal of the two trees is unlikely to stop foundation movement under the house. Again, I think a quasi-theoretical argument is used to arrive at an inappropriate conclusion. The inference from the argument is that the cedar roots discovered in the clay beneath the foundations did not have any noticeable effect: the movements would have taken place without them due to normal seasonal variations in the moisture content of the clay.

5.24 I agree that the house foundations are too shallow, based on modern practice in clay soils. Therefore, the foundations are more at risk from normal, seasonal moisture changes due to evaporation. However, I do not agree with the inference drawn by Richard Jackson. John Cromar considers this in his report at the paragraph entitled, 'Footings', and notes the presence of the patio, an impermeable cap, over the ground adjacent to the east wall. He suggests that this would have effectively retarded or prevented simple evaporation and concludes that tree root action is the cause of the shrinkage.

5.25 Dr Biddle also considers this point, in ref 2, p74.

> *"…evaporation from a bare soil surface, even under a prolonged drought, is unlikely to reduce the moisture content below a depth of 0.3m. It requires vegetation and a root system to extract moisture from any greater depth."*
>
> *"Any form of hard surface, such as tarmac or paving slabs, will reduce, or virtually eliminate, any evaporation and drying from the soil surface."*

I therefore do not accept Richard Jackson's conclusion (para 3.6) that removing the trees is unlikely to stop foundation movement under the house.

5.26 If I interpret their paragraph 3.8 correctly, Richard Jackson seem to be unconvinced that the movement shown by the level monitoring is seasonal cyclic; it may be 'truly' progressive, ie going inexorably in one direction. Looking at the graphs attached to Crawford's letter dated 23 January 2012, there is, in my view and that of Biddle and others, a distinct cyclic movement of points 6, 7 and 8. It is not simply progressive. Unfortunately, there does not seem to have been a set of readings taken in December 2010, which might have made things clearer. Also, I have just received

Crawford's results from March and August 2012 that show that almost complete recovery has taken place. There can be no doubt that the foundation movements are seasonally cyclic.

5.27 Given the above, I have no doubt that the foundation movements and consequent damage have been caused by tree root action, as set out above in paragraph 5.1.

6 Dr Biddle's Comments on Original Reports

6.1 Dr Biddle has raised concerns about the methodology and data in the original reports and each of these points is considered below with a view to the implications for the conclusions drawn.

Differences between Plans

6.2 Dr Biddle states that interpretation of the available information is complicated by the major differences between the plans in the various documents. I agree that there are differences between the plans contained in the two Crawford documents, that in OCA's report and in Cromar's report. While they do make interpretation more difficult, I do not consider the differences to be major, nor do I consider they imperil the conclusions that have been drawn.

6.3 The original Crawford plan, and that used by OCA, appear to have been taken from the small scale block plan used in the planning applications, which is not accurate in every detail. The plan Crawford used in their level monitoring is more accurate in detail, but was drawn before the basement works were undertaken at the south end of the property: it shows the building as it had been before that work. Once the basement work was carried out, the shape of the building changed in that area and survey points 4 and 5 were lost. That plan is attached to Crawford's letter dated 23 January 2012 and I believe it to be accurate in other respects. I note that the level monitoring results include x and y coordinates of the various points, giving measured dimensions.

6.4 Dr Biddle makes the point that level monitoring invariably provides the most useful information on the cause of damage (para7). He does not raise this as a concern, but implies that it is a valuable and important part of the original methodology adopted. I fully agree.

Use of Different Datum

6.5 Dr Biddle has used survey point 3 as a datum point instead of that used by Crawford. Crawford adopted point 1 as the datum presumably because they considered that part of the building to be accessible and least likely to be affected. In comparison with that datum, their subsequent results show the level of point 3 steadily rising by slightly less than 2mm in the year to April 2011. This is unlikely to be a true movement, and Dr Biddle has recalibrated the levels with point 3 as the datum in order to remove the anomaly. That successfully deals with the problem and has the effect of depressing all other readings by a similar amount. It does not have a significant effect and does not alter the conclusions that have been drawn. Dr Biddle acknowledges this at para 8.

Information from Soil Investigations

6.6 Dr Biddle makes the point (para 15) that the oedometer strain value is not necessarily indicative of root-induced desiccation. He notes (para 16) that penetrometer values are not relevant for determination of desiccation in a soil of this type. Dr Biddle notes that the clay moisture contents were determined in March, at which time of year any seasonal drying by root activity is likely to have been corrected by seasonal rehydration. He concludes that the investigations are therefore of no value in determining whether root activity is involved.

6.7 I would not argue with Dr Biddle's statements concerning the oedometer strain, the relevance of the penetrometer readings or the value of the desiccation result. I do not accept that the investigations are of no value, however, as it provides information on the type of soil and its index properties, together with tests on five root samples (not one sample, as noted by Dr Biddle). I feel sure Dr Biddle would accept this. Again, in my view, Dr Biddle's criticisms concerning the results do not alter the conclusions that have been drawn, which are mainly reliant on the level monitoring and, to a lesser extent, on the crack width monitoring. I do not think there is any dispute about the shrinkage characteristics of the clay beneath the foundations.

7 Threat to Use and Safety

7.1 I have been asked to comment on whether the movement taking place represents any threat to the use and safety of the building, as opposed to minor cracking that requires filling and redecoration.

7.2 It is often found that level monitoring shows foundation movements of greater magnitude than are reflected in the crack damage above ground. This is due to a number of factors, including the geometry of the situation, the strength and elasticity of the structure and the ability of the structural materials to absorb and disperse strain movements in a ductile fashion. For example, it is well known that lime mortar is better able to absorb structural movement without cracking than is modern cement mortar.

7.3 In my opinion, the movement of the foundations, and consequent cracking, are not of sufficient magnitude or severity to imperil the safety of the building or its occupants; nor are they likely to become so in future.

7.4 The movements that have been measured have not threatened the use of the building. However, in my opinion, it is quite possible that the penetration of the roots beneath the house will become more widespread in future and will begin to affect walls and floors within the main body of the house. In my experience, once roots penetrate below foundations, they can extend a long way beneath the building in their search for moisture. During my visual inspection there were signs of slight movement some distance from the single storey garden room area which is the focus of this investigation.

7.5 In my view, the movements and cracking do represent a significant nuisance to the owner in the following respects:

(i) worry arising from foundation instability;

(ii) continual need for repairs and redecoration to wall, ceiling and floor finishes;

(iii) doors and windows are likely to bind in future (see para 4.3, above);

(iv) possible difficulty insuring and/or selling the property, and;

(v) consequent diminution of value

7.6 In the context of points (i) and (ii), above, it has been suggested that periodic repairs and redecoration are to be expected in any house, particularly one as old as this. I accept this. From my inspection, it is clear that the owners have put a lot of effort into upgrading the house and they keep it in a good state of decoration. In my opinion, however, there is a distinction to be drawn between normal, superficial cracking arising from thermal and moisture effects in superstructure, which many people are content to live with, and movements arising from foundation instability, which most people in my experience find worrisome and intolerable.

8 Rates and Trends of Cracking and Movement

8.1 The quantitative information on these matters is given in the level and crack width monitoring results attached to Crawford's letter dated 23 January 2012.

8.2 The owner reported the damage in late 2009, giving rise to the initial report by Gawn Associates. Monitoring commenced in March 2010. During the first twelve months, the results of the monitoring show foundation movements of 5-6mm amplitude although, as noted in para 5.20, there was no reading in December 2010. During 2011, the amplitude of seasonal movement increased to 11.7mm (using point 1 as the datum).

8.3 Between late September 2010 and early October 2011, representing the same part of the annual cycle, the level of point 6 had dropped by 4.5mm (using point 1 as the datum). This appears to be partly due to the ratcheting down referred to in para 4.3, coupled with an increasing amplitude of fluctuation. It may, however, be the result of the recent changing pattern of rainfall in different seasons.

8.4 From an inspection of the graphs attached to Crawford's letter, the amplitude of the seasonal variation in levels at points 6-10 seems generally to have increased during 2011/12.

8.5 The crack width monitoring also shows a small but increasing amplitude of movement: that in the kitchen increasing from 1mm during 2010 to 2mm during 2011.

8.6 Whether the amplitude of the seasonal cyclic movements continues to increase is dependent on two things: the moisture demand of the tree and future rainfall characteristics. Since the cedar (T1) is fully mature, it seems unlikely that its moisture demand will increase. The second determinant is the weather and, in that regard, we have been warned by climatologists to expect more extremes in future, arising from climate change effects. For that reason, there is a risk that extended periods of very low rainfall will become more common and the cedar will continue and perhaps extend its attempts to draw moisture from the soil beneath the house.

9 The Solution

9.1 From an engineering perspective, I believe it is better to remove the cause of a problem rather than to deal with its effects. In this case, the cause has two facets, both of which have to be present if problems are to arise, as follows:

9.2 Firstly, the foundations are embedded in a soil (the clay) which is potentially unstable if subject to changes in moisture content; secondly, seasonal moisture changes in the clay are being caused by tree root action from the cedar, and possibly the wellingtonia, along the eastern side of the property.

9.3 The problem would be overcome if either of the above contributory causes were removed. In other words, the problem could be solved either by underpinning the foundations of the building, or by felling the offending tree(s).

9.4 Alternatives to both of those solutions have been considered in the various reports: installation of a root barrier instead of underpinning; and tree management instead of felling. However, both of the alternative suggestions have been considered to be problematic and less reliable in this particular situation. Although I have used root barriers successfully in the past, I consider that, in this situation, a root barrier would be impractical and ineffective in the medium to long term.

9.5 So, if the problem is to be solved, either the tree(s) have to be felled or the foundations underpinned. Both of these are considered below.

Tree Felling

9.6 Risks of felling the cedar T1. It has been established that there is no risk of long-term heave (ref Dr Biddle's report, para 31, for example). In order to minimise any problems with short-term foundation recovery, ideally, felling should take place at a time when the soil has naturally recovered its moisture content after desiccation in the summer and autumn growing season. If this is not possible, the tree can be felled at any time but repairs and redecoration should be delayed until soil moisture has recovered in the spring.

9.7 Provided the cedar is felled competently, there should not be any residual risk, other than the possible future effect on the foundations of the wellingtonia (not established) or that tree's instability once it is no longer sheltered by the cedar. If both trees are felled, clearly, neither risk exists.

9.8 Felling the tree(s) would be quick and effective; I imagine it would be considerably less expensive than underpinning, though I have no knowledge of the likely cost.

Underpinning

9.9 Underpinning along the northeast facing external wall. As suggested by AFP, this is a practical option and would take the form of contiguous mass concrete sections cast below the existing foundations and taken down below the clay, to a depth of approximately 1.5m below ground level. It should extend along the entire side of the building except for the southern cellar and the south-facing end of the play room (I understand that was underpinned in or around 1999).

9.10 The proposed underpinning would amount to approximately 30m in length and would require the removal and reinstatement of the patio and stone paving; removal and reinstatement of the surface water gulleys and drains along that elevation, plus any other services that may exist there; plus temporary support to the columns adjacent to the entrance door that support the first floor overhead.

9.11 If designed and undertaken competently, this form of underpinning should not present any construction risks. Although it is time-consuming, messy and disruptive, it is much less disruptive than underpinning carried out within the building and should not require any reinstatement of interior floors or finishes.

9.12 In my opinion, the cost estimate provided by AFP is too low: Hannah-Reed's recent experience of similar external underpinning is that it costs approximately £1,000 per metre run, excluding design costs and VAT. That would imply a cost of approximately £40,000 incl VAT for the work described. I should stress that this is no more than a broad-brush estimate; more exact costs will clearly be subject to tendering contractors' views of the risks and work involved.

9.13 As far as the residual risks of this solution are concerned, I am less sanguine than AFP about the risk and likely impact of root penetration beneath the underpinning and into the body of the building. (Ref email correspondence dated 5-9 July 2012, between John Howlett, AFP, and David Bevan, SCDC).

9.14 Cedar roots were found in the trial pit for the full depth of the hole, ie down to 3.5m below ground. If we are proposing to underpin down to a depth of 1.5m, it seems clear to me that the roots will travel past the foundation into the building, seeking moisture. I would not characterise this as a very low risk but very likely. Neither do I think it possible to say that the impact is likely to be limited to minor cracks. If roots find a source of moisture beneath the building they will exploit it if they need to, with all the consequences discussed above. Whether the cedar will find it expedient to do this I cannot say, but I certainly consider it to be a risk.

Peter Woolley

10 References

1 BRE Digest 251, Assessment of Damage to Low-Rise Buildings with particular reference to progressive foundation movement. Revised 1995.

2 P G Biddle, Tree Root Damage to Buildings, Vol 1, Causes, Diagnosis and Remedy, 1998, Willowmead Publishing Limited.

11 Curriculum Vitae of Peter Woolley

Qualifications: BSc (Hons) CDipAF CEng MICE MIStructE

I graduated from The University of Southampton in 1973 with a BSc Honours Degree in Civil Engineering. I am a chartered civil and structural engineer, having been a corporate member of the Institution of Civil Engineers since 1979 and a corporate member of the Institution of Structural Engineers since 1982. The first four years of my career were spent with a major building contractor working on site in London followed by two years abroad with an internationally known firm of consulting engineers.

In 1979, I joined Hannah, Reed and Associates, a firm of consulting engineers in Cambridge. I became a partner of that firm in 1986; my role transferring to director in 1993 when the firm incorporated its business.

I am managing director of the company and, apart from my general management responsibilities, I have been principally responsible for the firm's work on a wide range of building and civil engineering projects. My work has encompassed reports and investigation of building failures, together with design and supervision of new buildings and refurbishment work to existing structures.

I have personally carried out numerous investigations of existing buildings suffering from settlement damage, often arising from tree root action, and have proposed remedial schemes. In the past twelve years or so I have provided expert witness reports in several legal disputes concerning subsidence, tree root damage, vibration damage, drainage and building construction.

I have worked alongside Dr Biddle on several of the disputes relating to tree root action.