John Matheson & Associates Pty Ltd

27 Remembrance Drive, Tahmoor

Structural Inspection Report: R0194-Rev1

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27 July 2012

Xstrata Coal, Tahmoor Colliery
Remembrance Drive
Tahmoor NSW 2573

Attention: Ms Belinda Clayton

Re: 27 Remembrance Drive, Tahmoor

Dear Belinda,

Please find enclosed our investigation report on the captioned property subject to the mine subsidence impacts predicted by MSEC. The outcomes of the investigation are that recommendations have been made for monitoring of the property during the impact of longwall panels LW27, LW28 & LW29.

In summary, a review has been conducted of the main dwelling. The review was based on possible systematic mine-subsidence ground movements predicted by MSEC and if the ground movements occur as predicted, the above structures may sustain some impact in response.

It is possible that the main dwelling will develop some cracking, which is generally cosmetic and in the context of the Australian Standard AS2870: Residential slabs and footings, do not necessarily affect the serviceability of the structure and the damage is expected to be repairable. Recommendations have been made within this report intended to maintain the safety and serviceability of the main dwelling during the active subsidence period.

Yours faithfully
John Matheson & Associates Pty Ltd

John Matheson
Director

DOCUMENT HISTORY			
Revision	Date	Amendments	Author
Draft	23.07.2012	Draft, issued to MSEC	JM
Rev 1	27.07.2012	Issued to Tahmoor Colliery	JM

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1 INTRODUCTION

This report has been prepared by Mr John Matheson from this office at the request of Ms Belinda Clayton on behalf of Tahmoor Colliery and is based upon site inspections of the main dwelling conducted on 5 February 2009, 8 July 2010, 13 January 2011 and 10 May 2012 and information acquired from the Tahmoor House website. The site inspections were of a non-destructive nature and only the visible elements of masonry structure and the roof timber framing were inspected noting that it was not possible to gain access to the entire structure. All comments and advice contained within this report are qualified by this limitation. A detailed structural analysis or design check has not been carried out for this building and this report does not seek to confirm or imply compliance of the design of this building with the relevant Australian Standards. Some aspects of the construction have been inferred from the site observations with an underlying assumption that the building was constructed in accordance with practice that was considered normal at the time. Reference is made to literature dating back to 1898 for information concerning the construction of stone rubble foundation walls for guidance.

The external and internal building dimensions were recorded on site and by electronic distance measuring and the rooms and ground floor walls have been laid out in plan on a drawing in figure 2. The ceiling joists have been included in figure 2 and the termite affected ceiling joists and common/hip rafters have been identified by red and green dashed lines respectively.

The Tahmoor House website claims that the original dwelling was constructed in 1824 and it was extended in 1835. The original dwelling is nominated as a Part 1 heritage item (I232) on the Wollondilly LEP 2011, Schedule 5: Environmental Heritage. The owners provided a copy of some original drawings showing the ground floor wall layout with imperial dimensions. CAD drawings were prepared for the ground floor based upon the imperial dimensions and dimensions measured by tape. The lower ground floor wall dimensions and positions were measured in relation to the external building perimeter to tie the position of the lower ground floor walls in to the ground floor wall layout. Limited areas of the ground floor timber framing and lower ground floor sandstone rubble walls were visible through an access hatch that was constructed in one of the more recent lower ground floor brick walls; refer to figure 23 in Appendix A.

The property lies within a proclaimed Mine Subsidence District, which was proclaimed after the construction of the main dwelling on this property. The Subsidence Management Plan, known as Longwall 26, has been submitted to the Regulator and advertised in local newspapers. The Regulator requires Tahmoor Colliery to consult with landowners whose properties may be affected by the proposed mining and provide information regarding the structural systems supporting each building.

This site is known as CC92a using the MSEC numbering system and the structures located on this property that have been assessed are listed as follows:

i. CC92-a: Main dwelling

The subsidence, tilt and strain impacts are summarised in table 1.

2 HISTORICAL DATA AND CURRENT OBSERVATIONS

The original dwelling (refer to figure 1 in Appendix A) was constructed in the 1824 and was subsequently extended in 1835. The buildings was constructed as a single storey weatherboard clad timber frame with a pitched timber framed roof with timber battens and hardwood timber shingles and a suspended timber ground floor. The suspended ground floor was constructed above a lower ground floor cellar and was supported by sandstone rubble walls. Major restoration work was undertaken from 1972 onwards, which resulted in the sandstone rubble walls being concealed by a 110mm brick external wall (refer to figures 48 and 49 in Appendix D).

2.1 NORTHERN FOUNDATION WALL

The sandstone rubble foundation wall along the northern elevation of the dwelling (refer to figure 2 in Appendix A) appears to have been constructed as an infill between stack bonded sandstone block piers, refer to figures 3, 4 5 & 6 in Appendix A. Each stone comprising the stack-bonded piers appears to be bedded upon a cement mortar. The infill walls appear to have been constructed by setting the larger stones and then dry-fitting stone spalls more or less carefully into the interstices after which mortar was dashed into the remaining spaces in an attempt to work the mortar into the crevices. The walls appear to contain headers every metre or so along the wall that serve to bind the stones together and prevent the foundation wall from splitting under imposed vertical load.

The foundation wall to the kitchen chimney was constructed as a sandstone rubble wall where the external face of the walls was carried up with a good; refer to figures 6, 7 & 8 in Appendix A. There is some historical evidence inferring that the mortar used in the construction of much of the sandstone rubble walls was a cement stabilised clay mortar with the clay being locally sourced (no material testing was conducted). The mortar erosion evident figure 14 in Appendix A and figure 50 in Appendix D supports the argument that the mortar was most likely a cement stabilised clay mortar.

The mortar used in the external face of the kitchen chimney appears to contain a much higher percentage of cement, as the mortar appears to be harder and more durable than elsewhere. The may have been intended to reduce the transmission of moisture through the wall and it was normal to fill the space between the excavated external ground surface and the external face of the wall with gravel or sand to drain water away from the foundation wall. However, the photograph in figure 19 shows that moisture penetrated the chimney foundation wall and lateral damp caused the mortar in the internal brickwork to fret.

The ground near the northwestern corner of the dwelling appears to be damp (see above) and there is an external sump and garden tap located around 1.5metres to the south. The foundation soil moisture appears to be elevated and foundation settlement has occurred beneath the kitchen chimney, which is evident from the foundation wall crack recorded on 8 July 2010 in figures 8 & 9 in Appendix A. Repairs were carried out to repair the crack. However, the underlying cause of the original settlement remains a potential cause of future settlement and cracking of the foundation wall in this location.

2.2 1824 WESTERN FOUNDATION WALL

The western foundation wall and the walls supporting the external stair have been substantially repaired since the veneer brick wall was demolished during 2009. The owner advised that the repairs were carried out using a cement stabilised clay mortar “consistent with the mortar used elsewhere in the original building”. There was significant mortar damage at a number of locations with the most severe damage shown in figure 50 in Appendix D resulting from rainfall erosion. Rising damp softened the mortar above ground level in the sidewalls to the external stair; refer to figure 14 in Appendix A.

2.3 1835 WESTERN FOUNDATION WALL

The foundation walls constructed during the 1835 extension using a harder and more durable lime-cement mortar. The exposed masonry is of much fairer face than the original walls, refer to figures 17 and 18 in Appendix A and contrast with figures 9 through 16 in Appendix A. The mortar was largely uncracked with minimal deterioration and the masonry was in serviceable condition.

2.4 1824 Internal Foundation Walls

The condition and construction of the internal foundation walls varied somewhat depending upon what materials that was available at the time of construction. The lower levels of the internal wall beneath the kitchen chimney was constructed as brick masonry but transitioned to sandstone rubble masonry between lower ground and ground floor level, refer to figure 19 in Appendix A.

Elsewhere within the lower ground floor area, long stones were laid alternately at external wall corner junctions intended to not only tie the masonry and distribute concentrated loads applied at the wall corners but also to keep the walls true and plumb, refer to figures 20 & 21 in Appendix A and figure 46 in Appendix D. The mortar appeared to be similar throughout the lower ground floor area.

The original suspended timber framed ground floor consisted of hardwood timber joists at 450mm centres supported by roughhewn hardwood bearers, that appeared to be oversized for the spans and applied loads. The bearers were originally supported upon the sandstone rubble walls and are now supported by the more recent internal brick partition walls that conceal the original sandstone rubble masonry, refer to figures 22, 23 & 24.

2.5 Post-1972 Internal Brick Partition Walls

The lower ground space was partitioned using 110mm load bearing brickwork walls during the restoration carried out during the 1970's. The brickwork is load bearing and provides support to the original roughhewn hardwood timber bearers (refer to figures 22, 23 & 24 in Appendix A). The brickwork was in serviceable condition at the time of the inspections.

2.6 Ground Floor Timber-Framed Structure

The ground floor wall layout is shown in figure 25 of Appendix B and some internal photographs of the kitchen chimney that is shown in figure 26 and the lounge room chimney and plasterboard walls are shown in figures 27 & 28 of Appendix B.

The original hardwood timber framework was concealed by external weatherboard and internal plaster/weatherboard linings and could not be inspected. It was noted from the Tahmoor House website that the ceiling and wall linings had been removed during the restoration work that was commenced in 1972 in response to visible termite damage to the weatherboard cladding, timber stud wall frames and ceiling joists, refer to figures 47 & 51 in Appendix D. Other sections of timber wall framing may have been repaired throughout the dwelling during this period but it has not been reported.

The clad ground floor and timber-framed walls appeared to be serviceable at the times of the inspections. There was no detectable bounce in the suspended ground floor that would be symptomatic of undersized timber floor joists and bearers or loss of support due to wall or pier settlement. The ground floor walls appeared to be robust with a few hairline cracks visible in the internal plaster wall linings.

It was noted that the current internal partition wall layout differs from the original wall layout drawing, which may be attributed to walls either not having been constructed in the first instance or the more likely event that they had been removed during later renovations.

2.7 Roof Structure

The roof was constructed as a collar tied and pitched timber framed roof with internal under purlins and roof struts carrying roof load down to internal timber framed walls and chimney structures, refer to figures 29, 30, 31, 35, 38, 39, 40, 41, 43 & 45. The ceiling joists were generally concealed by a T&G timber floor that provided access throughout the roof space that appears to be used for storage. Some supplementary repair work was carried out at a time unknown to the original under purlins and timber struts, refer to figures 30, 31, 35, 36, 43 & 45 in Appendix C, which is presumed to be a response to structural damage caused by termite activity.

The original roof was clad with hardwood timber shingles supported by 25x100 hardwood timber battens spanning between the hardwood timber rafters. The original timber shingles were subsequently clad using galvanised corrugated steel roof sheeting that was fastened down to the roof along the sheet junctions, which did not necessarily coincide with the common rafters. The new roof battens at the southern end of the roof were aligned with a specific row of the original roof battens (see figures 30, 32 & 44) and it is therefore concluded that the corrugated cladding was intentionally fixed through the original hardwood shingles and into the original battens. However, it is not known whether the original battens were tied down to the original rafters as is now the standard requirement.

Termite damage was evident at a number of locations within the roof structure. The timber rafter shown in figure 33 and the nearby roof batten shown in figure 34 in Appendix C were severely damaged by termites. The damage appeared to be localised and more widespread termite damage was not apparent in the adjoining members. The rafter shown in figure 36 has lost support near the external support wall where the rafter has displaced downwards. The aforementioned rafters should be replaced by the owner to maintain structure serviceability.

The original roof battens and shingles appeared to have been removed at the southern end of the dwelling, refer to figures 30 and 44 that show 50x75 timber battens packed out from the common rafters and the exposed underside of the corrugated steel roof sheeting. Other localised areas of shingles and battens were removed as shown in figures 33, 37, 41 & 42.

It is noted that the absence of evident termite damage is not evidence that the timber structure has not been damaged in some way that was not manifestly apparent during the inspections. There was a significant amount of cob webbing up in the roof space and there appeared to be sawdust collected in the cob webbing, which is presumed to have been blown around the roof space since the roof was permeable to the wind and not completely sealed. This could be the result of wind borne dispersion within the roof of detritus left over from the removal of the termite affected timber battens and shingles at the southern end of the dwelling. It does not necessarily imply that termites are active in the roof structure.

3 IMPACT ASSESSMENTS

The impact assessments have been conducted based upon the systematic mine subsidence predictions carried out by MSEC.

Table 1 Predicted maximum systematic mine subsidence movements and impact on the main dwelling

Description	Value/Category
Predicted Subsidence	870mm after LW30
Predicted Tilt	3.0mm/m
Predicted Strain	+1.2mm/m to -0.45mm/m
Tilt Impact Assessment	A[1]
Tensile Strain Impact Assessment for walls	If the predicted tensile strain occurs, 2.0mm cracking, 2.0mm in aggregate, could occur in the sandstone rubble walls, which is classified as Category 2[2] damage. Some hairline cracking is possible internally in the plaster lined timber framed walls.
Compressive Strain Impact Assessment for walls	Category 2[2] damage is possible at the base of sandstone rubble and brick walls due to diagonal distortion of the footings (1.0mm<crack width<5mm). Category 1 damage is possible elsewhere above footing level (0.1mm<crack width<1mm) if compressive strain occurs

Notes: 1 refer to table 2 in Appendix E for the classification of tilt impact
2 refer to table 3 in Appendix E for the classification of damage to walls

The ground movements predicted by MSEC are summarized in Table 1 in this section of the report. A strain and tilt impact assessment on the structure has been based on the full transmission (unreduced) of the predicted ground strain and curvature since it is unlikely that sandstone rubble walls will either arch (to reduce curvature) or be sufficiently integrated to limit the effects of the transmission of ground strain into the masonry. Variation and anomalies in ground strain could develop where near-surface geological features underlie or are located near the original dwelling on the subject site that could lead to increased ground displacements. In the unlikely event that ground displacements exceed the systematic predictions, increased structure impacts could result.

3.1 TILT

When tilt is imposed upon a structure, additional horizontal forces are imposed at the eave level as the structure responds to the imposed load eccentricity to maintain equilibrium. The additional horizontal forces are deemed to act in conjunction with other loads generally and with wind load in particular. In order to maintain structural stability in accordance with Australian Standards, the calculated sum of the horizontal in-plane wall segment bracing capacity (with capacity reduction factors applied) must exceed the calculated wind load corresponding to the ARI 500-year wind speed (implied load factor 1.5) in addition to the factored tilt load (load factor 1.5). This is applied about both principal axes of the structure.

The effect of the additional tilt induced load on the timber-framed structure above ground floor level has the effect of increasing the horizontal wind load calculated at the eave level by 4%, which is within the normal acceptance interval for calculated loads. The tilt-induced loads are therefore unlikely to affect the serviceability of the timber-framed structure above ground floor level adversely.

The chimney structures are in the order of 7metres tall and a tilt of 3mm/m finds the centre of mass still within the middle third of the base of the structure. The masonry forming the chimney structure therefore remains in compression subject and the predicted tilt is unlikely to cause instability of the chimney structures. The situation is similar situation for the sandstone rubble walls where the centre of mass remains within the middle third of the base of the wall for the predicted tilt and therefore the entire wall cross section remains in compression.

3.2 Ground Strain and Curvature

When a brick masonry structure is affected by tensile ground strain and convex (hogging) curvature caused by mine subsidence, cracking is most likely to develop around door and window openings, which serve as a stress concentration within the body of a long section of wall in response to the ground strain and curvature. Where openings are not present in longer sections of brickwork, cracking may initiate where the combined effects of curvature and tensile ground strain exceed the tensile strength of the wall and this is more likely to occur toward the middle of the panel where structure tensile strain is usually at a maximum.

The sandstone rubble walls have been constructed with a random distribution of sandstone blocks and the mortar is of varying thickness, widely varying material properties and low tensile strength. Under these circumstances, tensile ground strain and convex curvature might initiate tension cracking earlier than would be the case for brick masonry, which has greater tensile strength and therefore later onset of tension cracking. If the predicted +1.2mm/m tensile ground strain is fully transmitted into the sandstone rubble walls, cracking in the order of 2mm wide may develop based on the analysis of brickwork. However, rather than developing one larger crack, the sandstone rubble is more likely to develop a number of smaller cracks through the random and deeply raked mortar joints. Under these circumstances, the tension cracking may not be so apparent. The predicted tensile ground strain and convex (hogging) curvature may cause some fine cracking to develop within wall plaster linings and existing gaps between the timber linings may increase slightly, which may not be noticeable.

The subsidence modelling conducted by MSEC indicates compressive ground strain may also develop. If the predicted -0.45mm/m compressive ground strain develops and is fully transmitted up into the sandstone rubble walls, compressive stresses may exceed the compressive strength of the cement stabilised clay mortar and some mortar crushing in “perpend” joints between sandstone blocks or shearing of mortar along a bed joint could occur. Some horizontal cracking could develop near the top and bottom of wall openings where brickwork is continuous above and below the openings if the tensile stresses exceed the masonry tensile strength, e.g. in the brickwork surrounding the door opening to the bathroom on the lower ground floor. If compressive ground strain is orientated at 45º to the direction of the sandstone rubble walls, some wall distortion in wall alignment and tilt is possible. However, given that, the predicted compressive ground strain is only slightly greater than survey tolerance, these impacts are expected to be slight. The impact of mine subsidence is generally slow to develop and the effects of the predicted compressive ground strain are unlikely to significantly reduce the stability of the sandstone rubble and brick walls without structure impacts being detected, during the active subsidence period.

The termite affected rafters and roof battens that were identified during the site inspections could possibly be affected by mine subsidence if tensile or compressive ground strains are transmitted up through the lower ground floor sandstone rubble walls and brickwork (masonry) into the timber framed ground floor and walls roof framing and upwards into the roof framing. However, significant structural displacement or failure of the termite-affected members is more likely to result from environmental factors such as strong winds than strains attributable to mine subsidence.

4 PUBLIC RISK

The subsidence impacts predicted by MSEC have been considered for the original dwelling identified in this report. Whilst a formal risk assessment has not been conducted, it is likely that the public risk is low for this structure given that:

i. The analysis of the original dwelling for wind and tilt loads indicates that the predicted tilt occurs, additional tilt-induced loads might increase in calculated wind loads at eave level by 4%, which is within the normal tolerance interval for design. Tilt induced loads are therefore unlikely to affect the serviceability of the timber- framed structure. The termite-affected rafters identified during the inspections could present a pre-existing hazard to the occupants as the structural capacity of these members has already been reduced. On a qualitative level, the tongue and groove flooring up in the roof space (assuming that it is fully reinstalled to cover the ceiling) may provide a degree of fall protection to the occupants below for falling debris such as termite affected timber battens and possibly a single rafter section. However, termite-affected timber members should be replaced by the owner to maintain the serviceability of the roof structure for maintenance access loads and wind load, irrespective of possible effects due to mine subsidence.

ii. The centre of mass of the chimney structures will remain within the middle third of the base/foundation. The chimney sections will therefore remain in compression for the predicted tilt.

iii. The centre of mass of the sandstone rubble walls will remain within the middle third of the base of the walls. The sandstone rubble walls will therefore remain in compression for the predicted tilt. The restorations carried out during the 1970's saw the construction of a number of internal load-bearing brick walls in the lower ground area that support the suspended timber ground floor structure. These additional brick walls have significantly improved the lateral bracing of the dwelling between ground and lower ground floor level.

iv. If the predicted tensile ground strain occurs, up to 2.0mm (or 2.0mm in aggregate) may develop in the sandstone rubble or brick lower ground floor walls. It is noted that the predicted subsidence impacts will be slow to develop. If cracking is identified, it can be monitored and action taken if required.

v. If the predicted compressive ground strain occurs, some distortion of the sandstone rubble and brick walls is possible but unlikely given the magnitude of the predicted compressive strain is slightly above survey tolerance. If cracking or distortion is identified, it can be monitored and action taken if required.

5 RECOMMENDATIONS

In summary, the following recommendations are made:

i. The main dwelling is predicted to develop Category 2 cracking in response to tensile ground strain and Category 1 cracking in response to compressive ground strain above the foundation level of the sandstone block wall. Compressive ground strains may cause distortion of the sandstone rubble walls if ground compression causes the foundation to these walls to deform in shape from a rectangle to a parallelogram. It is recommended that baseline tilt measurements be taken of each chimney and panel of sandstone rubble wall with subsequent weekly tilt measurements taken during the active subsidence period to compare structure tilt with predicted ground tilt. These measurements could be taken by a qualified building inspector.

ii. The interface between the sandstone rubble and brick walls and the timber framed ground floor structure should be monitored weekly.

iii. Internal baseline distance measurements should made across the diagonals of the roof building and at three positions across the roof before active subsidence ground movements due to Longwall panel LW27 occur at this property. These measurements should be repeated weekly during the active subsidence period after ground movements are detected around the perimeter of the building. This is required to detect for any significant change in the roof structure during the active subsidence period.

Considering the heritage significance of Tahmoor House, the main dwelling should be generally monitored by a qualified building inspector during the active subsidence period in addition to the specific recommendations made above. Where damage is observed, the damage should be recorded by the inspector noting the date of the occurrence and any change over time and notification of such occurrence should be given to both Tahmoor Colliery and the Mine Subsidence Board. Where damage exceeds or looks likely to exceed the predictions, this should serve as a trigger point for the structural engineer to be notified, with any recorded data being provided to the engineer for further consideration and if warranted a structural inspection should be carried out within 48hours, where practicable.

If the effects of mine subsidence induced ground strain and curvature cause more severe impacts on the sandstone rubble walls than has been predicted, temporary strengthening including confining the rubble wall in the sections most affected could be carried out to improve wall behaviour. The confinement could be achieved by installing sheets of Tensar Geogrid reinforcement and 100x50 F7 vertical timber soldiers at regular spacing along both faces of the affected sections of rubble wall and bolting through the timber soldiers and rubble wall to connect the opposing soldiers. Access into the underfloor area is possible if required to carry out confinement activities to the rubble walls or to install packing between bearers and piers or provide other temporary support should it be required during the active subsidence period.

6 APPENDIX A

Figure 1 Site layout with north directly up the page

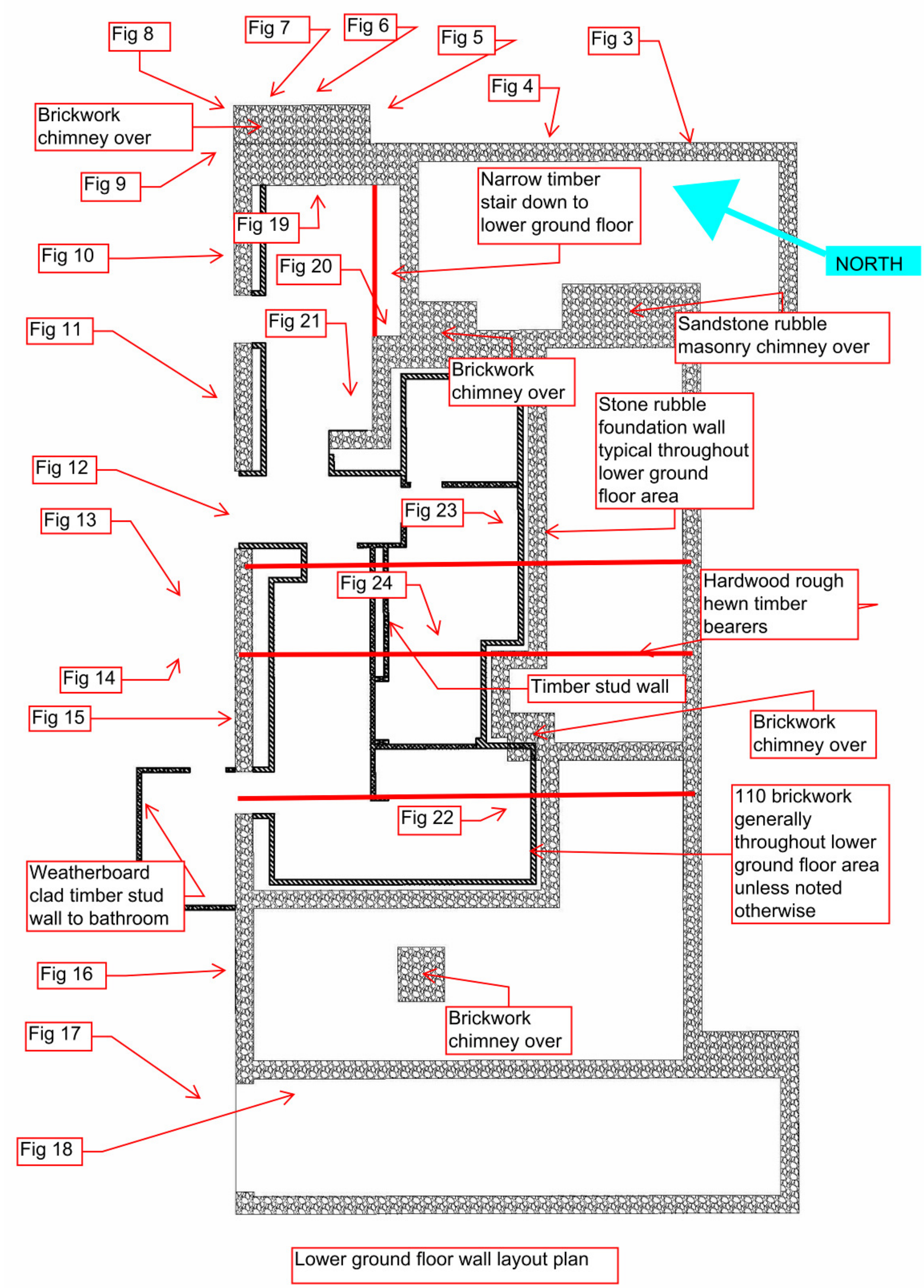
Fig 8
Fig 7
Fig 6
Fig 5
Fig 3
Fig 4
Brickwork chimney over
Fig 9
Narrow timber stair down to lower ground floor
NORTH
Fig 19
Fig 10
Fig 20
Fig 21
Sandstone rubble masonry chimney over
Fig 11
Brickwork chimney over
Stone rubble foundation wall typical throughout lower ground floor area
Fig 12
Fig 23
Fig 13
Fig 24
Hardwood rough hewn timber bearers
Timber stud wall
Fig 14
Fig 15
Brickwork chimney over
110 brickwork generally throughout lower ground floor area unless noted otherwise
Fig 22
Weatherboard clad timber stud wall to bathroom
Fig 16
Brickwork chimney over
Fig 17
Fig 18
Lower ground floor wall layout plan

Figure 2

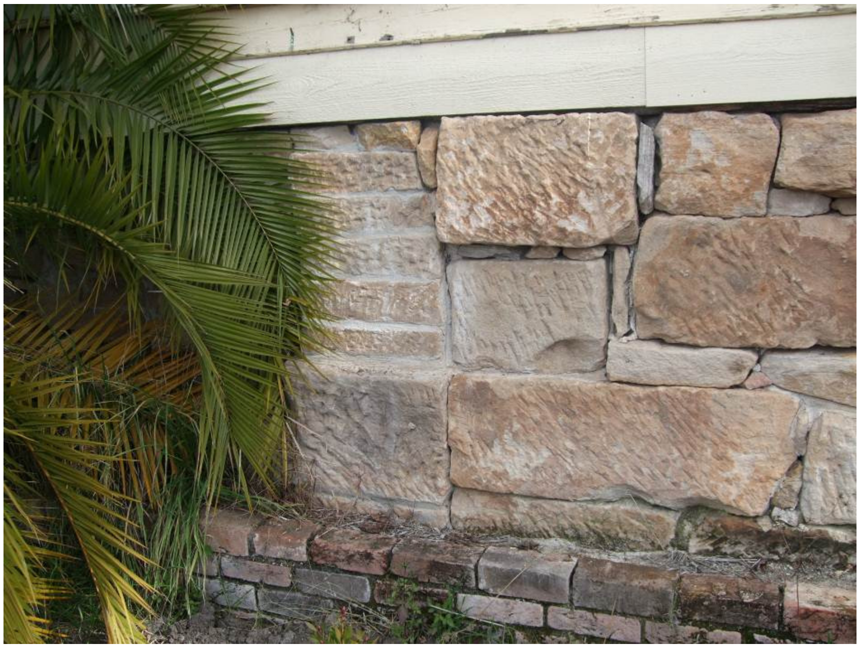

Figure 3

Figure 4

Figure 5

Figure 6

Figure 7

Figure 8

Figure 9 the northwestern corner of the foundation wall outside the laundry prior to repair

Figure 10

Figure 11 Repaired foundation wall outside laundry at the northwestern corner of the dwelling contrast with the damage evident in figure 50 in Appendix D after the brick veneer wall was demolished

Figure 12

Figure 13

Figure 14

Figure 15

Figure 16

Figure 17

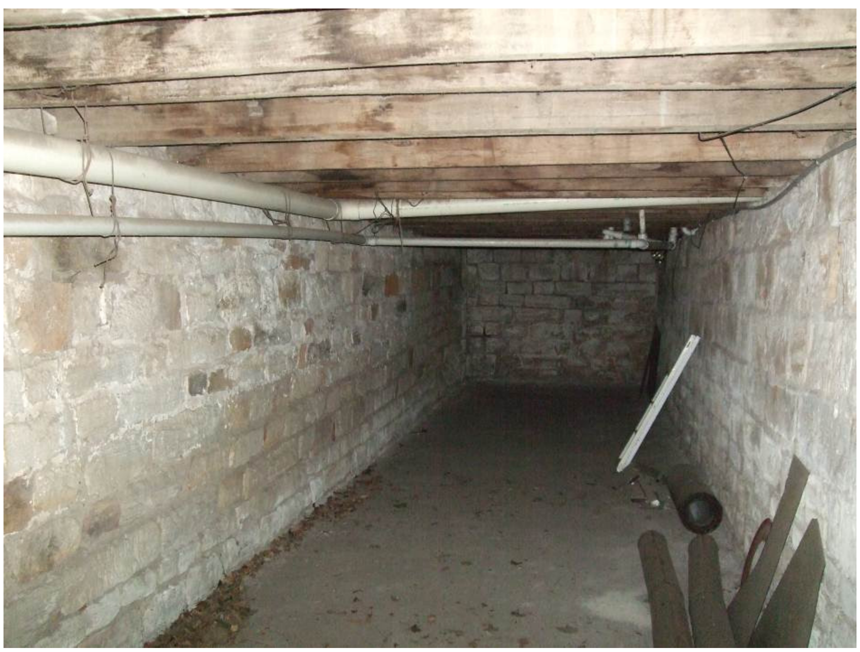

Figure 18

Figure 19

Figure 20

Figure 21

Figure 22 Underside of roughhewn hardwood beam, which is supported by the new brickwork

Figure 23 Underside of roughhewn hardwood beam, which is supported by the new brickwork

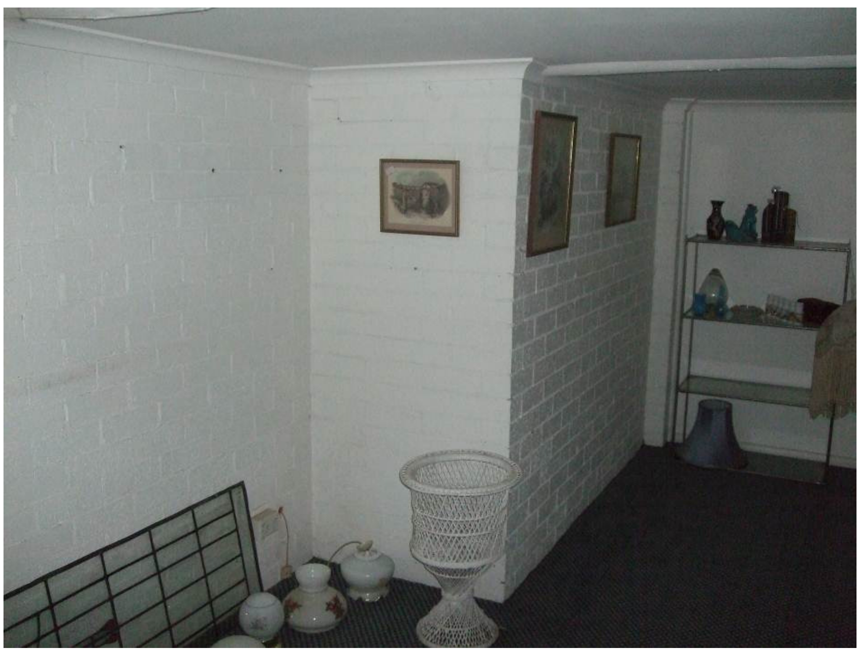

Figure 24 Underside of roughhewn hardwood beam, which is supported by the new brickwork

7 Appendix B

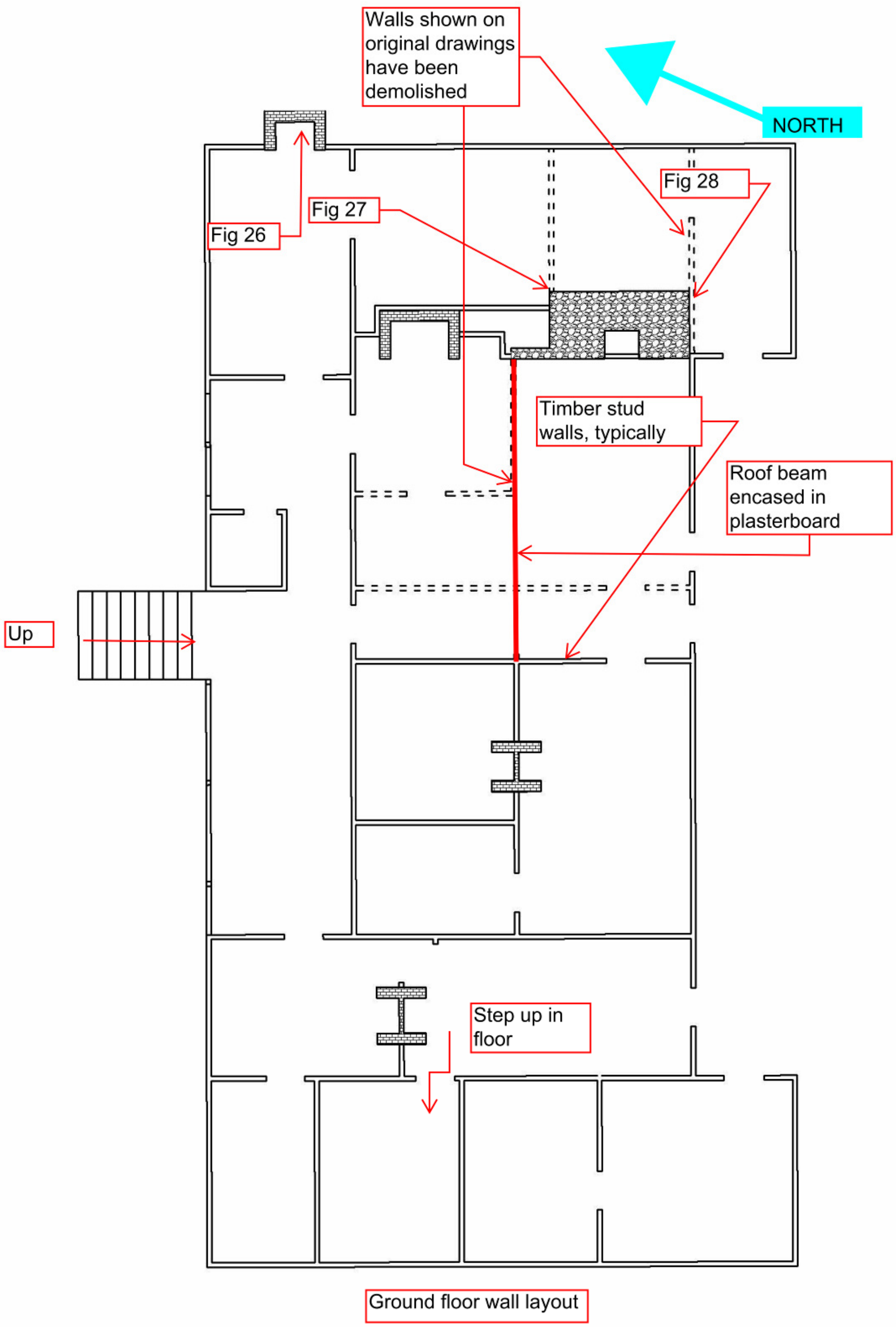

Figure 25 Ground floor wall layout

Figure 26

Figure 27

Figure 28

8 APPENDIX C

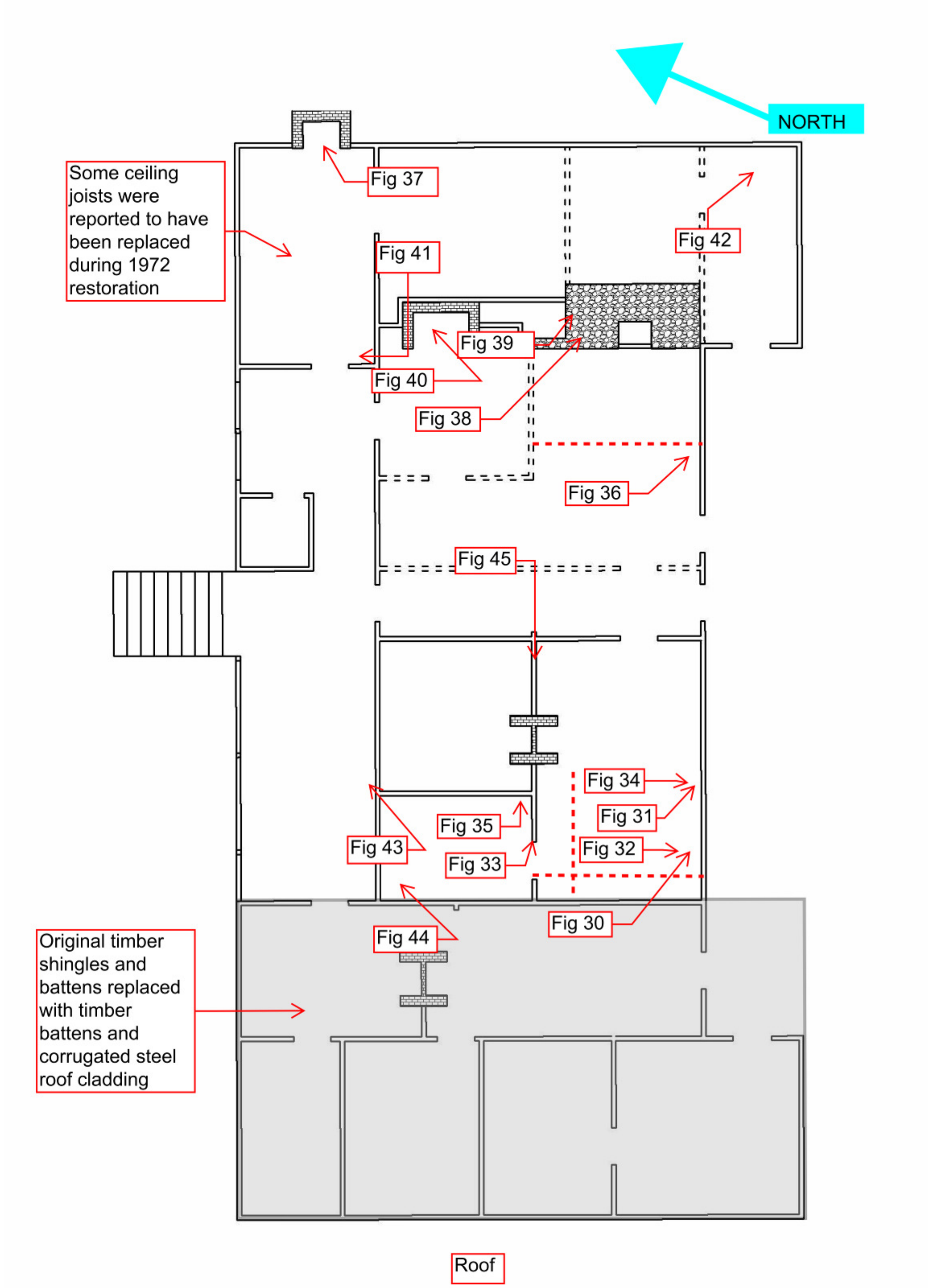

Figure 29

Figure 30

Figure 31

Figure 32

Figure 33

Figure 34

Figure 35

Figure 36

Figure 37

Figure 38

Figure 39

Figure 40

Figure 41

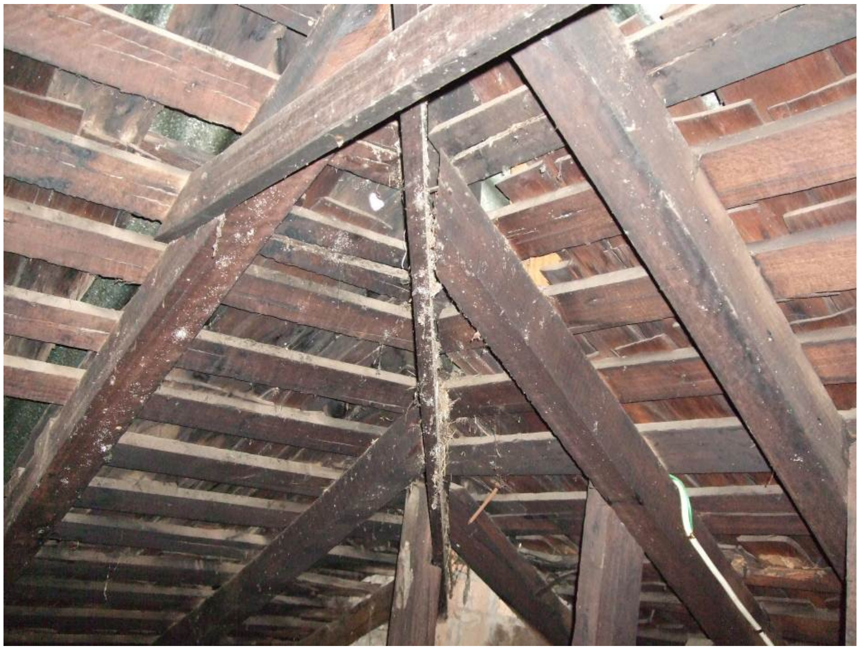

Figure 42

Figure 43

Figure 44

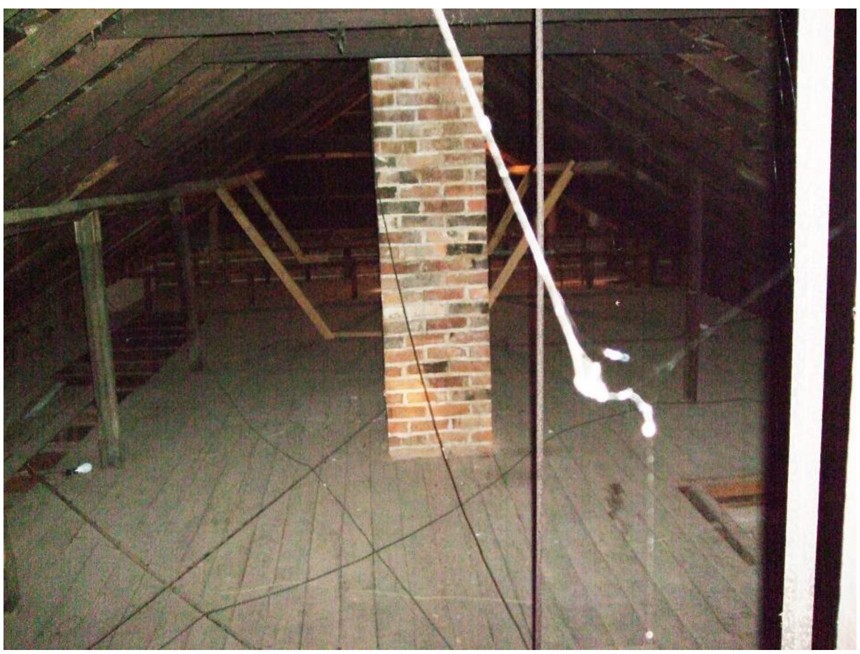

Figure 45

9 APPENDIX D

Figure 46 Northwestern corner of dwelling taken prior to 1972

Figure 47 Dilapidated structure adjacent to northwestern corner of the dwelling circa 1972

Figure 48 looking back towards northwestern corner of dwelling before recent renovations began

Figure 49 Photograph taken on 5 February 2009

Figure 50 Mortar erosion exposed when the external brickwork was removed near the northwest corner of the dwelling during recent renovation.

Figure 51 Exposed ceiling joists in kitchen located in the northwestern corner of the dwelling taken during the restoration than began in 1972.

10 APPENDIX E

Table 2 Classification of Tilt Impacts generally based on Digest 475: British Research Establishment and work conducted by MSEC

Description	Measured Building Tilt	Category
• Building tilt can be noticeable at this level of tilt but remedial work unlikely. Tilt induced load at eave level approximately 5% of 20-year ARI wind load.	5mm/m	A
• Adjustment to roof drainage and wet area floors might be required. Tilt induced load at eave level approximately 10% of 20-year ARI wind load.	5mm/m<Tilt<7mm/m	B
• Minor structural work may be required to rectify for tilt. Adjustments to roof drainage and wet area floors will probably be required and remedial work to surface water drainage and sewerage systems might be necessary. Tilt induced load at eave level approximately 15% of 20-year ARI wind load.	7mm/m<Tilt<10mm/m	C
• Considerable structural work may be required to rectify tilt. Jacking to level or rebuilding could be necessary in the worst cases. Remedial work to surface water drainage and sewerage systems might be necessary. Tilt beyond 20mm/m, structure distress may be apparent.	>10mm/m	D

Table 3 AS2870: Classification of Damage With Reference to Walls

Description of typical damage and required repair	Approximate crack width (w) limit (see note 1)	Damage Category
Hairline cracks	w<0.1mm	0
Fine cracks, which do not need repair	0.1mm<w<1mm	1
Cracking that is noticeable but easily filled. Doors and windows stick slightly	1mm<w<5mm	2
Cracking that can be repaired and possibly a small amount of wall may need to be replaced. Doors and windows stick. Service pipes can fracture. Weather tightness often impaired.	5mm<w<15mm (or a number of cracks 3mm or more in one group)	3
Extensive repair work involving the breaking-out and replacement of wall sections, especially over doors and windows. Window and doorframes distort. Walls lean or bulge noticeably, some loss of bearing in beams. Service pipes disrupted.	15mm<w<25mm but also depends on the number of cracks	4