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EXPERT REPORT - STRUCTURAL ENGINEERING

Site	17 Eildon Road, St Kilda
Brief	Inspect & Report re: Structural Issues
Our Reference	2211 R1
Client Reference	City of Port Phillip Purchase Order PO20019824
Inspection Date	26 April 2022
Report Date	29 April 2022
Client	City of Port Phillip
Instructor	[redacted] Head of Real Estate Portfolio (Development & Transactions)
Author	Patrick Irwin, forensic structural engineer

Summary

Brick Ties

These are sound.

Crack Over South Stair

This is not structural and no remedial works are required for structural reasons.

Shade-sail Fixings

These are unsound but there is no significant risk of failure in service in the medium term.

All fixings should be replaced with an appropriately engineered system in the medium term.

Southern Wall Concrete Lintel (Upstairs office window head)

This is structurally sound having only suffered minor spalling of the outer lower edge. Cover to reinforcement may be compromised. Repair works are recommended but are not urgent.

Building Movement & Distress

There are extensive minor but no problematic building movement issues at present. No works are required imminently but extensive works will be required if the building is to be restored or improved and timber floors are so irregular that their replacement may fall into the category of repairs rather than restoration. Works to the timber floor will be extensive. Deterioration will continue at a slow pace otherwise.

See recommendations from page 19 for further detail

Contents

1. Introduction

1.1. This is an assessment of the structural condition of a building currently in use for child care.

1.2. We were asked to report upon the following issues:

1.2.1. The condition of the brickwork wall ties.

1.2.2. The long term movement and cracking in the ceiling above the southern stair.

1.2.3. The adequacy of the sunshade (shade-sail) fixings, with specific regard to wind load.

1.2.4. The southern wall concrete lintel.

1.2.5. To these items, at our suggestion was added a general building movement investigation informed by reviewing the geology, site features and measuring levels throughout to inform foundation and footing performance.

1.3. The above ground access and physical investigation works outlined above were resourced by the City of Port Phillip.

2. Description & Background Information

2.1. The Victorian geological survey map for the area (Melbourne region) records upper Ludlovian era Sandstone/siltstone foundation material. This material is typically moderately reactive. The reactivity means that shrinkage and swelling due to changes in foundation moisture content is common behaviour. The contemporary response to this is to control sources of excessive changes in foundation moisture content (trees, site drainage etc.), to design deep, strong & stiff footings, and to control joint buildings to take up minor articulation with minimal damage. Little of this was implemented at the time of construction of the building. The building is thus susceptible to movement and distress.

2.2. The building is a two storey double brick construction of California Bungalow style, approximately 100 years old. It appears to have been built as a house and converted for its current purpose[1].

2.3. An investigation was conducted and **report provided by Mark Hodkinson Pty Ltd, structural engineer** in late 2021. From this the above items 1.2.1 to 1.2.4 were distilled for this further investigation. Salient background and information from that report includes:

2.3.1. The building was altered and extended in the 1980s.

2.3.2. Water staining was identified at stumps and was attributed to rot of the stumps. In my experience this is also likely to indicate prior inundation of the subfloor. Occasional inundation would typically not cause lasting structural damage. Regular inundation may cause structural damage and is likely to have other unhealthy effects such as rot and mould.

[1] Source, instruction from City of Port Phillip

2.3.3. Mould on base masonry within the subfloor was suggested to have been an indication of poor subfloor ventilation. I agree with this and also note that it is a sign of abnormal damp.

2.3.4. Distress to first floor walls indicative of movement was identified.

2.3.5. Some indication of rising damp was identified.

2.3.6. Distress to the northern wall gable brickwork and eastern end of the southern wall was observed.

2.3.7. Concern was raised about the condition of the brick ties, given proximity to sea air. This is a reasonable concern. Early cavity and brick veneer outer skins were simply tied with bent fencing wire which can corrode without external visible signs

2.3.8. The conclusion that the building was in generally sound structural condition was made on the basis of observations but in the absence of any measured check of floor levels or wall profile. This means it is possible that the building is out of level or walls out of plumb such as to compromise the structural integrity. Such irregularity can be difficult to repair and can complicate renovation or improvement works. This is why we recommended a floor level check be added to the initially requested scope.

2.4. A geotechnical investigation was conducted and reported by **Hardrock Geotechnical Pty Ltd, in May 2016**. One borehole was conducted which confirmed the expected geology (above). A footing exposure found the existing strip footing to be at a depth of 1100mm which is considerable and will be a reason for the building's comparatively good foundation performance. The report was carried out to inform the design and construction of potential works so did not make recommendations directly relevant to my investigation.

2.5. A wall verticality survey was conducted and drawn by **Reeds Consulting, in April 2022**. This took external wall profiles at 21 locations around the perimeter of the building. In round figures the results were:

2.5.1. Northmost boundary wall: 40 to 45mm outward rotation.

2.5.2. Eastern wall: No significant rotation.

2.5.3. Southern wall: Up to 25mm outward rotation approximately centrally.

2.5.4. Western side of building (including walls facing north); No significant rotation.

2.5.5. Northern wall: 25 to 45mm outward rotation.

2.5.6. Thus the significant rotation is mainly that of the north side. All figures are within reasonable expectations of a building of this age and type with so many trees close by but rotation are significant and would invite remedial works if the building was to be restored.

2.5.7. It is unfortunate that the opportunity of taking a perimeter level survey was not taken. This could have been readily achieved by using brick courses as a reference plane and would have provided a useful picture of foundation movement over the life of the building.

3. Terminology

The following terminology is used in this report:

3.1	*Footings*	The part of a building on contact with the ground.
3.2	*Foundation/s*	The ground upon which the building's footings are embedded.
3.3	*North, South etc*	The site is at close to 45° to cardinal axes but the building is orientated close to due north south. Thus, for reference purposes the building is considered to have cardinal elevations.

4. Inspection, Site & Surrounds

4.1. The site and immediate surrounds grade to the north east so there is probably adequate natural surface drainage.

4.2. The east end of the site contains a number of trees close to the building. Based on scale, type and size, these are likely foundation drying influences so may cause or exacerbate building movement.

4.3. 1 Inverleith Court contains one or more substantial evergreen trees immediately adjacent the boundary. Based on scale, type and size, these are unlikely foundation drying influences.

4.4. 15 Eildon Road contains a clump of substantial evergreen trees immediately adjacent the south east corner of the building. Based on scale, type and size, these are likely foundation drying influences so may cause or exacerbate building movement..

4.5. There are several small trees in the nature strip on both street elevations. Based on scale, type and size, these are unlikely foundation drying influences.

February 2022 Nearmap image showing trees described above.

4.6. We did not examine drainage or plumbing as it is outside our scope but is often important for foundation maintenance.

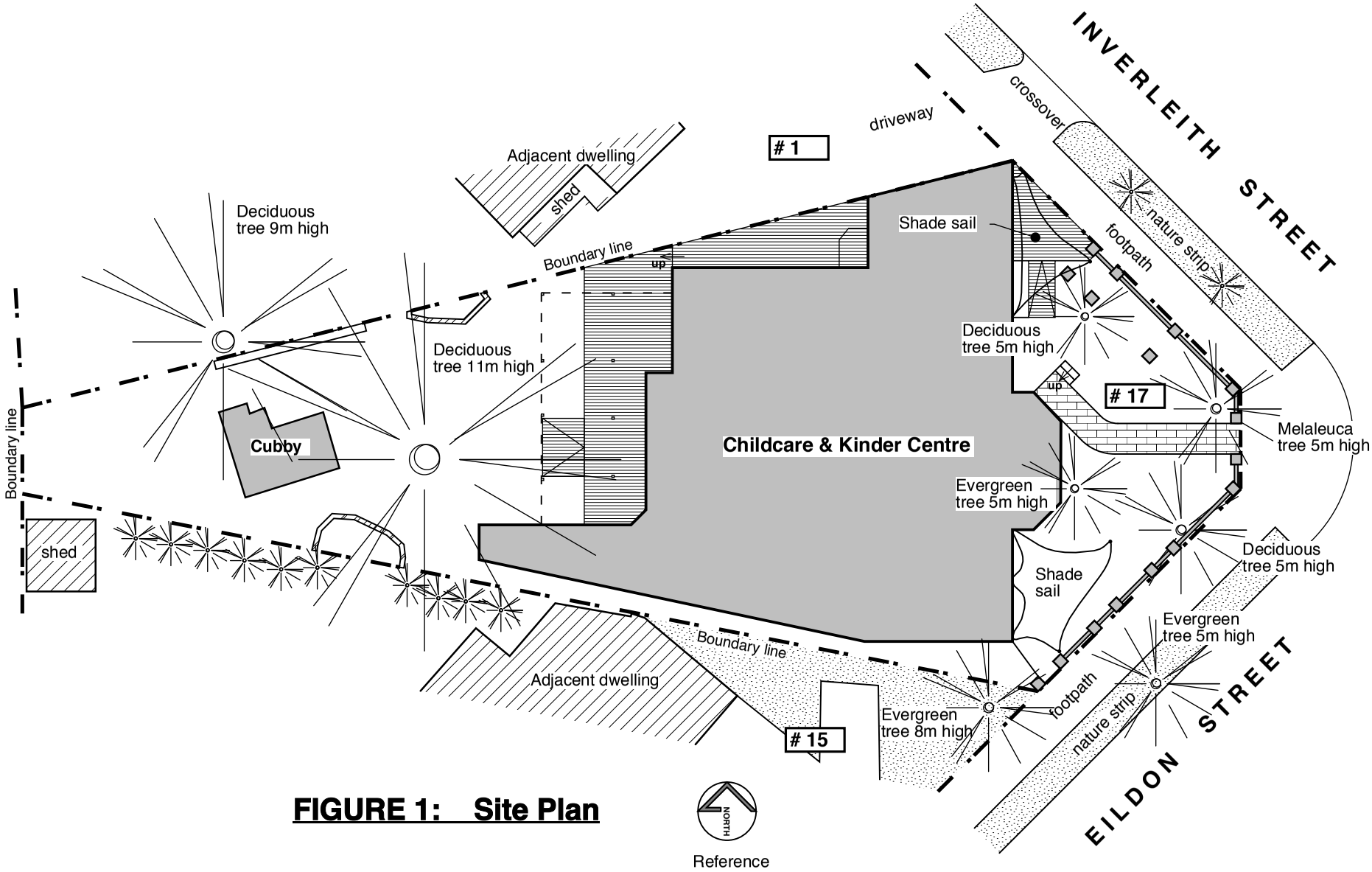


FIGURE 1: Site Plan

5. Inspection, Brick Ties

5.1. Brick ties were viewed in several locations in both north and south gables from within the roof space where cavities were accessible. No destructive investigation was required.

5.2. The view at right looks south to the south gable wall within the root space.

5.3. This view of a pre-existing penetration clearly shows a brick tie on the mortar bed under the electrical cable.

5.4. These detail views within the cavity show un-corroded galvanised wire brick ties. Image quality was compromised by lighting and the constraints of photographing within the cavity but the findings are clear.

5.5. The view immediately below looks north west towards the north gable from within the roof space. The view at left far below shows an un-corroded wire tie exposed with the pre-existing penetration and the view at right far below looks down the cavity showing an un-corroded tie (ringed).

5.6. Both gable cavities are open at the top within the roof space. This give them ventilation and will have assisted the provision of an un-corrosive environment.

5.7. Since the gable walls are much the most sensitive to the need for brick ties we did not investigate further.

6. Inspection, Crack Over South Stair

6.1. The concern is that this crack to the bulkhead plasterwork over the rear (south west) stair. The view at left below faces south and that right below faces east. The area of concern is ringed.

6.2. There is no reason to suppose this is a structural mechanism. The bulkhead will be framed off a rafter which only spans the width of the stairwell so is very lightly stressed.

6.3. Close examination shows a high level of irregularity in the plasterwork, which has a stucco surface profile, and previous repair works. It looks likely that there has been a leak here at some stage and repairs have not soundly re-established the edge joint.

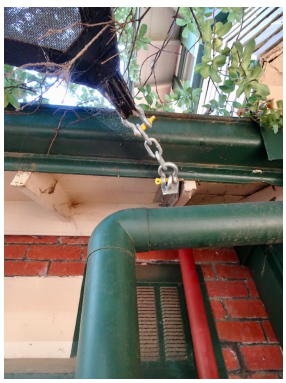
6.4. As we were satisfied that this is not a structural issue on the above basis, we choose not to request destructive investigation. Another factor in this decision is that this would have disturbed flashings and delicate old concrete roof tiles risking other damage.

7. Inspection, Shade-sail Fixings

7.1. There are two shade-sails [Figure 1], a southern and a northern:

7.2. **The southern sail is shown below.**

7.3. It is fixed to rafter ends with bolted brackets at three points. These are shown from south to north (left to right) below. In each case the direction of load is not parallel to the rafter so a lateral load is being imparted to the raft tip. In the northern case (rhs below), the bracket can be seen bending away from the rafter.



7.4. The fixings will not fail but they are poorly configured and do not present as having been engineered. Damage to rafters and further deformation of fixings may occur.

7.5. The other issue with this is that there is very little opportunity for fixings to yield and absorb wind loads. Longer fixings of flexible lines are more appropriate for this reason.

7.6. **The northern sail is shown below.**

7.7. The southern fixing is shown below left and similar comments to above apply regarding integrity of fixing.

7.8. The northern fixing is shown below right. It is fixed through what appears to be a facia board and, without destructive investigation, we cannot be sure that it is fixed soundly to rafters. Note also, immediately below the eaves soffit what appears to be a previous fixing. This is fixed to the outer skin of the brickwork which will not have been adequate.

7.9. The fixings may not fail but they are poorly arranged and do not present as having been engineered. Damage to rafters and further deformation of fixings may occur.

7.10. As for the southern case, the other issue with this is that there is very little opportunity for fixings to yield and absorb wind loads. Longer fixings of flexible lines are more appropriate for this reason.

8. Inspection, South Wall Concrete Lintel

8.1. The concern is the structural condition of this first floor south elevation reinforced concrete window head lintel. It has the unusual characteristic of being cranked horizontally and is seen from outside and from within below.

8.2. We first investigated whether the lintel was effectively supported mid span, at its most eccentric position. The surrounding window frames and linings are timber. There is just room for a very small section steel column between the window frames. We drilled a small investigation hole through from with the window frame and did not strike steel. Timber is never used to support reinforced concrete in such cases and would be ineffective due to shrinkage. Thus we are satisfied that the lintel is both spanning and resisting the eccentric loads from the brickwork. This means it is acting in torsion. The torsional moment is very low but is likely to be well beyond the capacity of the brickwork to arch. Many such conventional small brickwork openings can persist with deficient lintels due to brickwork arching. This is not such a case.

8.3. We viewed the lintel externally off a ladder and obtained the views below. Minor spalling has occurred at the lower outside edge which appears to have been scabbled. There is no sign of reinforcement and no sign of corrosion of reinforcement, usually evidenced by iron oxide stains.

8.4. The loss of a small amount of concrete below the reinforcement in this manner will not effect the structural capacity of the lintel measurable. It will compromise cover and thus corrosion protection of the reinforcement but, if this has occurred, it has not caused a significant issue yet as evidenced by the lack of corrosion product.

8.5. The issue requires attention to better protect the lintel but it is not structurally compromised in its current condition.

9. Inspection, Building Movement

9.1. Figures 2 and 3 show the level profile of the ground and first floors. These are floor levels, not the levels of the walls. At ground floor level the building has a combination of timber floors and infill slabs. In either case these are independent of the external walls but the timber floor levels immediately adjacent the walls will be indicative of the wall levels in most cases as the floor is carried on the base brickwork.

9.2. On the ground floor the pattern is dominated by two locally low areas, in the toddler room and around the main stairwell and stores. These will be due to stump settlement.

9.3. There is also a general trend of the central areas being low. This is usual for timber floored houses on reactive sites as the foundation dries out more beneath the building than around the perimeter.

9.4. The high region at the south side of the toilet may be a deliberate grade to drain. Ignoring this, the difference from highest to lowest levels around the perimeter is about 45mm which is not severe.

9.5. The first floor levels do not tell us much about perimeter levels and were recorded mainly to check for first floor frame settlement as the performance of long span timbers in buildings of this age and type is commonly an issue. The low region about the stair is reflected from downstairs. Otherwise there are other internal low points that one would expect from a timber frame of this age and type. For example, centres of the office and the larger store room being low.

9.6. We have not attempted a distress investigation of the building but noticed a number of sites of signifiant external distress such as the north wests corner and north elevation. Most of this is the result of he building movement described above.

NOTES

1. #s are spot levels to arbitary datum and are generally taken as close to corners are practicable.

2. All measurement by Bosch GLL3-80, accuracy +/-0.3mm per metre. Manufacturer's specified generally +/- 1mm, slightly less in carpeted areas and over long distances.

3. All levels adjusted for floor coverings.

4. In addition to measurement error the original construction will have unknown local variations as it will not have been constructed to exact level. Thus levels should not be relied upon for local variations but viewed to discern overall trends.

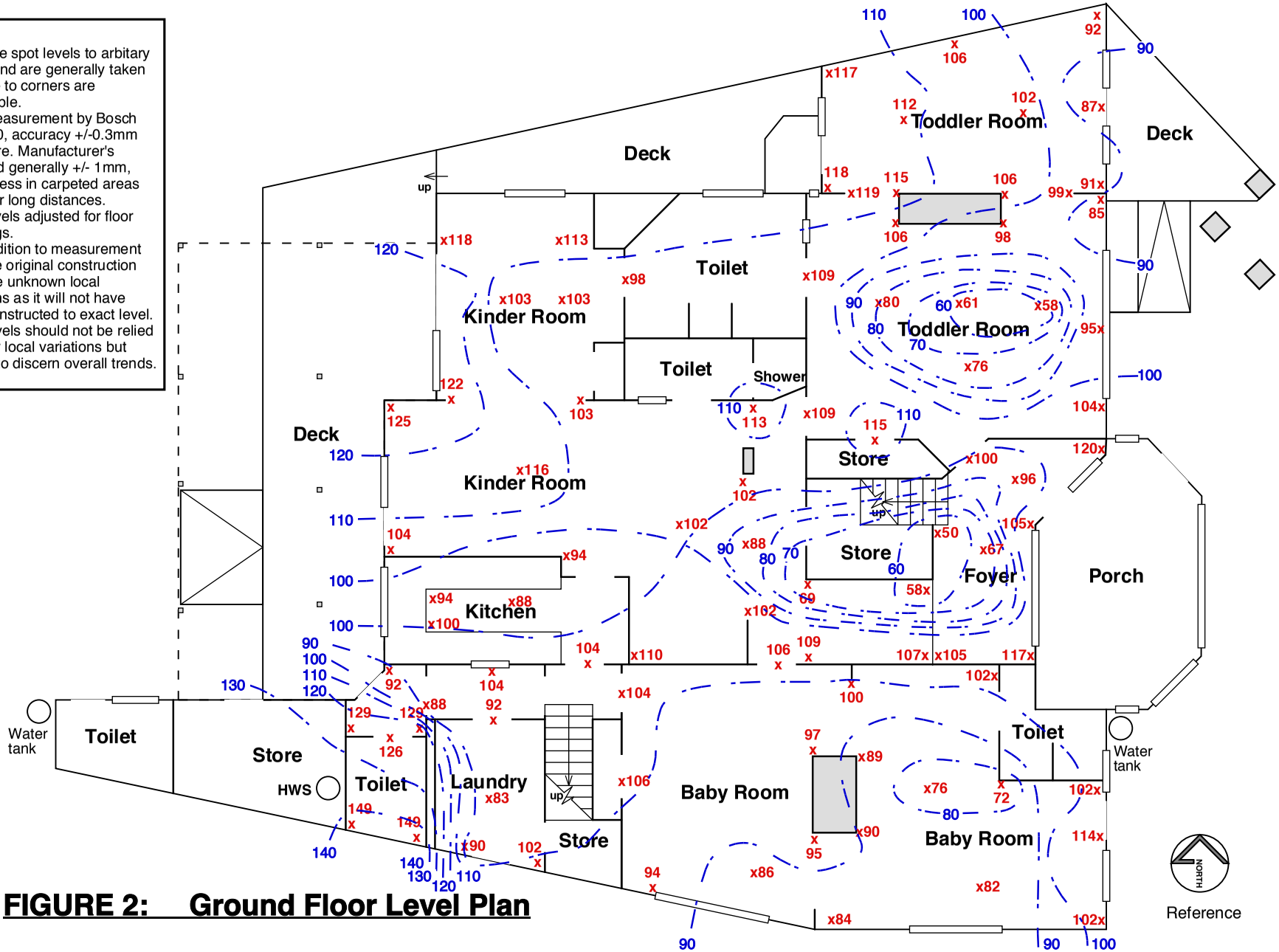


FIGURE 2: Ground Floor Level Plan

NOTES

1. #s are spot levels to arbitary datum and are generally taken as close to corners are practicable.

2. All measurement by Bosch GLL3-80, accuracy +/-0.3mm per metre. Manufacturer's specified generally +/- 1mm, slightly less in carpeted areas and over long distances.

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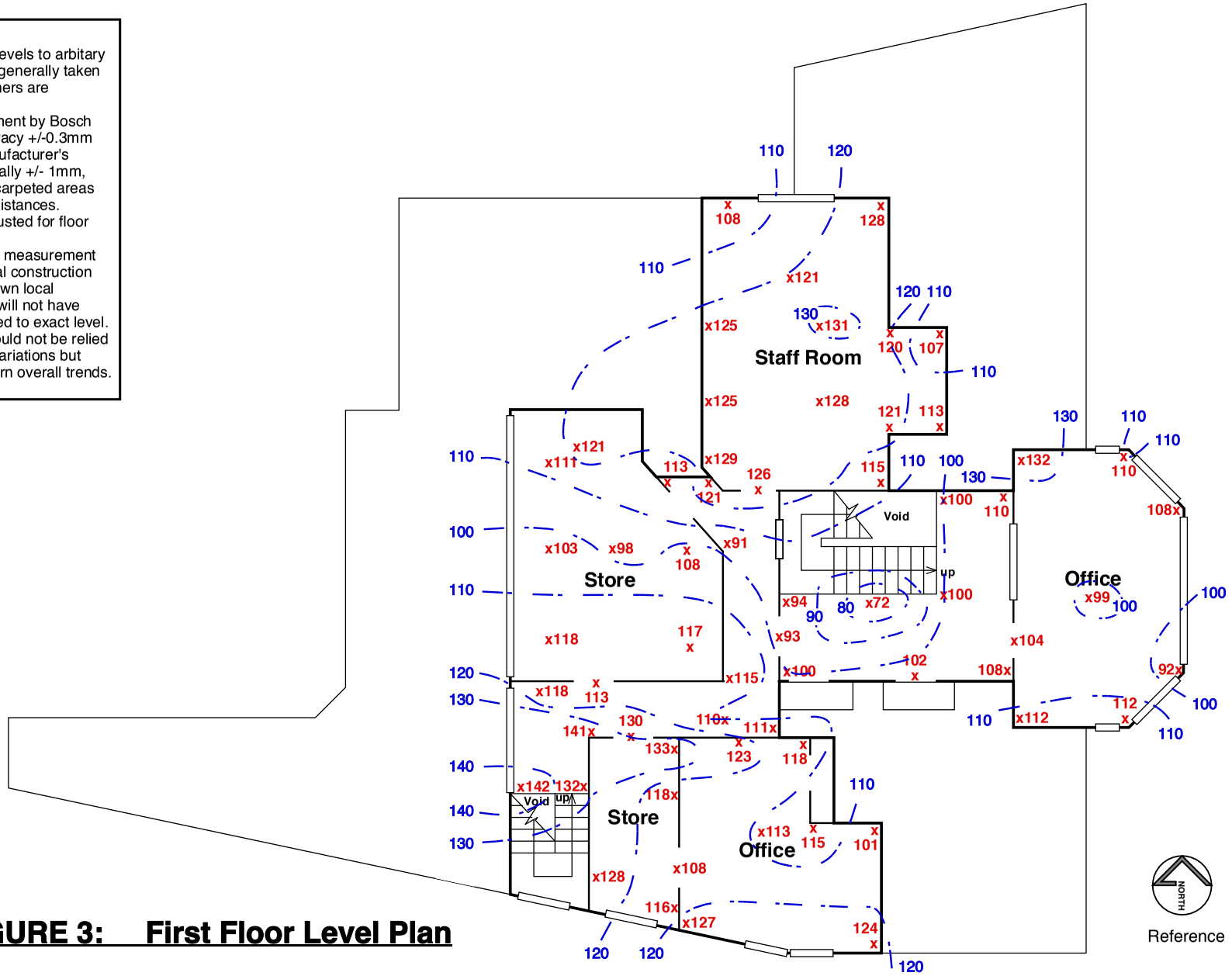

FIGURE 3: First Floor Level Plan

10. Conclusions & Recommendations

10.1. Brick Ties

10.1.1. All ties observed are sound. There are no signs of corrosion or related deterioration and the general environment does not suggest this is likely in the upper parts of the walls. Lower parts were not examined but are much less critical. The surveyed profiles of the walls confirm some outward rotation but this is not sufficient to load brick ties.

10.1.2. Remedial works are not required.

10.2. Crack Over South Stair

This is not structural and no remedial works are required for structural reasons. Finishes may be repaired as and if required.

10.3. Shade-sail Fixings

10.3.1. The manner in which rafter ends are loaded is inappropriate and is leading to some deformation of fixings. The fixing at the extreme south east corner is into a timber that may not be sufficiently sound. Fixing types, being high stiffness metals, are not ideal.

10.3.2. There is no significant risk of failure in service in the medium term.

10.3.3. All fixings should be replaced with an appropriately engineered system in three to five years.

10.4. Southern Wall Concrete Lintel

10.5. This is structurally sound having only suffered minor spalling of the outer lower edge of the lintel. Cover to reinforcement may be compromised.

10.6. Remedial works are recommended in the medium term to maintain integrity and appearance. These should consist of breaking away all loose material and repairing with an appropriate cementitious repair mortar.

10.7. Building Movement & Distress

10.8. Internal floors have suffered significant movement and are noticeably irregular. Although stumps have not been examined there is evidence of a prior damp issue and, given the age of the building, stumps and/or soleplates will be deteriorated. In the medium term it should be assumed that the building requires re-stumping. This will likely require access through the floor and replacement of most flooring and some works to the frame so the scope will be significant. Considering the findings of Mark Hodkinson Pty Ltd [2.3], it is likely that the frame will require replacement.

10.9. The few infill slabs (mainly wet areas) are probably sound and can remain should their profile be acceptable.

10.10. External walls have suffered minor differential movement, mainly due to tree drying effects. They have also rotated outwards. Some distress to brickwork has resulted. There is also extensive mortar loss to brickwork which is not a subject of our investigation but relevant in our concluding that the walls remain structurally sound and serviceable but are in generally poor condition and required extensive minor repairs.

10.11. The reactive foundation has shrunk and expanded with changes in moisture content over some 100 years. As the footings are comparatively deep [2.4] there has not been a great deal of settlement and heave. However deep strip footings are very susceptible to rotation from differences in foundation moisture on each side. Most such variations occur on the outside as the area beneath such a building is typically stable. When the volumetric change tends to inwards rotation, the structure of the building resists this. When the volumetric change tends to outward rotation, there is little resistance. As the footing rotates within the soil gaps are filled by soil and the rotation does not fully recover. Thus a racketing mechanism develops. This is usual with older full masonry buildings on strip footings. The extent of the issue is not severe but it has created problems that may be difficult to repair.

10.12. The differential movement and footing rotation issues will gradually deteriorate if no action is taken.

10.13. The foundation is being influenced by drying from trees within and adjacent the site. If the building is to be preserved, improved or renovated this issue will ultimately require attention. Removal of some trees or isolation via root barriers are likely reqwuired.

10.14. If the building is to be conserved medium term, the stability of the brick walls should be reviewed in detail. A likely scope of remedial work would include the installation of steel ties to better restrain the walls to the first floor and roof frame or the provision of through tie rods.

10.15. Overall

Although we were not asked to make an overall assessment it is relevant to comment that the building is in serviceable but deteriorated condition and if it was to be renovated to continue its current use long term it would require a complete conservation assessment from which recommendations for extensive works are likely.

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