

TECHNICAL NOTE 1

DATE:	10 September 2020	CONFIDENTIALITY:	Confidential
SUBJECT:	Old Maids Building – Summary of Initial Findings		
PROJECT:	70076238 - Royal Berkshire Hospital	AUTHOR:	Matthew West / Tim Wellington
CHECKED:	Brian Hillman	APPROVED:	Ben Moss

OLD MAIDS BUILDING – SUMMARY OF INITIAL FINDINGS

1. INTRODUCTION

The Old Maid's Wing of the Royal Berkshire Hospital is an extension to the main hospital that was constructed in 1865. The 3-storey grade 2* listed building is of traditional construction, comprising load-bearing masonry, suspended timber upper floors and a timber roof. The external elevations are clad with Bath Stone. The building is founded on shallow stepped brick strip footings. The building has been unoccupied since 2008.

The interior and exterior of the building are currently in poor condition. Much of the upper floors and roof is suffering from wet and dry rot. The main staircase between the ground and first floor has collapsed and areas of the upper floor have been reported as unsafe due to rot. An environmental investigation has highlighted the risk of toxic mould. Rainwater ingress has been halted due to the installation of a temporary roof and weather protection to the elevations. The northern end of the building has subsided, evidenced by significant cracking to the walls visible from inside and outside of the building.

This technical note focuses on the building subsidence and aims to provide a summary of all available information and make recommendations for remedial works.

Other aspects of building condition including; cracked lintels, roof integrity, wet/dry rot and environmental concerns are not covered in this document.

2. HISTORY OF EVENTS

The following summary has been compiled by WSP and is in approximate chronological order. Information has been taken from various sources and reports made available to WSP by the Hospital Trust. We are not aware of a history of subsidence prior to these events.

- Site investigations are reported to have taken place as early as 2006. WSP has not seen reports from these investigations.
- It is reported that a burst water main caused flooding in the vicinity of the north-eastern end of the building. This is referred to in various reports, however, the exact date of this event is uncertain due to conflicting dates of 2007 and 2008 being stated.
- A ground investigation was undertaken by Terramech Investigations Ltd in April 2007. These investigations included 3no boreholes together with soil testing. A factual report of these investigations is available
- In September 2007 expanding foam was injected under the building foundations by Uretek UK Ltd to stabilise some of the external walls. WSP have reviewed a key plan showing that the northern

TECHNICAL NOTE 1

DATE:	10 September 2020	CONFIDENTIALITY:	Confidential
SUBJECT:	Old Maids Building – Summary of Initial Findings		
PROJECT:	70076238 - Royal Berkshire Hospital	AUTHOR:	Matthew West / Tim Wellington
CHECKED:	Brian Hillman	APPROVED:	Ben Moss

elevation and part of the eastern elevation were treated. No details of the remedial works or the design/specification of the foam injection have been made available to WSP.

- During a drainage survey in November 2007 evidence was found of a possible leaking water supply pipe beneath the timber suspended floor of the building.
- The building was inspected by Scott Wilson in August 2008. WSP have not seen the report of this inspection, however a later report by URS Scott Wilson refers to findings of the 2008 investigation which were that the building showed signs of significant subsidence.
- It is reported that the building was vacated following settlement that occurred in 2008. The exact date that building was vacated is not known to WSP. The building has remained unoccupied to this date.
- It is reported that a drainage survey was carried out in 2012. WSP has not seen this report.

3. REVIEW OF PREVIOUS REPORTS

3.1. *URS Scott Wilson Assessment of Subsidence (2011)*

It is reported by URS Scott Wilson that during the period of 2008 to 2011 further settlement occurred, with photographs providing visual evidence of this. Crack patterns suggested that the building subsided in the same general locations as observed by Scott Wilson in August 2008. This suggested that either the original cause for subsidence still existed, causing gradual settlement over time, or that the original cause (or a very similar one) re-occurred once (or more) during the 3-year period.

The 2008 Scott Wilson report identified 18 locations where crack monitoring could be undertaken to record further movement. The 2011 report states that other than 5 days during August 2008, no monitoring data was available for the 3 years between 2008 and 2011. The 2011 report recommended that crack monitoring be re-instated at the locations previously identified, and that quarterly follow-up inspections of building should be undertaken to re-assess the structural integrity of the building and to re-assess building access restrictions.

3.2. *URS Quarterly Inspection Report (2012)*

This report found that only 2 weeks of crack monitoring at only 5 out of the 18 locations had been undertaken. These suggested that little or no movement occurred during this time period. It also reported that the crack monitoring devices were incorrectly installed across cracks. The report recommended a minimum period of 12 months of bi-weekly monitoring used correctly installed monitoring devices.

TECHNICAL NOTE 1

DATE:	10 September 2020	CONFIDENTIALITY:	Confidential
SUBJECT:	Old Maids Building – Summary of Initial Findings		
PROJECT:	70076238 - Royal Berkshire Hospital	AUTHOR:	Matthew West / Tim Wellington
CHECKED:	Brian Hillman	APPROVED:	Ben Moss

3.3. *Albury S.I. Ltd Ground Investigation (2012)*

The Albury S.I. Ltd ground investigation report dated 2012 reports that there are ‘weak spots’ in the near-surface soils overlying the chalk strata which would not be capable of accepting foundation loads in the order of those estimated to be present from the existing building. These ‘weak spots’ are interspersed with locations where testing has shown the ground to be medium-dense and capable of sustaining loads.

The report concludes that the cause of the structural distress may be due to the presence of solution features and the close proximity of the surface water soak-away chamber adjacent to the building. It suggests it may be sensible to undertake observations over a period of time (6 to 12 months) to monitor the building to establish if movement is still ongoing or has ceased. The report goes on to recommend that, to eliminate the risk of future settlement, the foundations be underpinned such that loads are taken down to the chalk strata. This would require a piled solution due to the depth of chalk being between 2.5 and 3.8m below ground level. The report contains information that will enable the design of piles.

3.4. *Parsons Brinckerhoff Inspection of Subsidence Damage Report (2013)*

This report summarised the extent and location of the damage due to subsidence. It also highlights evidence that the movement may have continued over a long period of time. It also reports that cracks up to 40mm were observed and that the level of damage is Category 5 to BRE Digest 251 – “Very Severe”.

The report concluded that:

- Significant foundation movement had occurred.
- The most likely cause of the subsidence damage appears to be water-related, but at this stage other causes cannot be ruled out.
- It is possible that repairing the water leak and taking the building out of service has arrested the foundation movement. However, it is also possible that, even if progressive movement had been arrested, that resuming the discharge of waste water from the building could lead to further movement unless the drains are repaired.
- Progressive movement could threaten the stability of parts of the building.

The report recommended that:

- The drains are repaired in accordance with a suitable drainage survey.
- Surface water drainage is diverted to new soakaways that are located further away from the building.
- Removal of the cause of subsidence is confirmed by a 12 month period of crack width monitoring after the drains have been repaired and the soakaways diverted.

TECHNICAL NOTE 1

DATE:	10 September 2020	CONFIDENTIALITY:	Confidential
SUBJECT:	Old Maids Building – Summary of Initial Findings		
PROJECT:	70076238 - Royal Berkshire Hospital	AUTHOR:	Matthew West / Tim Wellington
CHECKED:	Brian Hillman	APPROVED:	Ben Moss

- Any future repair schedule includes appropriate measures to restore structural continuity across significant cracks.

3.5. *Parsons Brinckerhoff Monitoring Report (2015)*

The Parsons Brinckerhoff monitoring report dated January 2015 reports on the monitoring of cracks between October 2013 and January 2015. The report concluded that crack width monitoring during this period has not indicated any significant progressive or seasonal movement. The crack monitoring results from this report are given in Appendix A.

It was suggested that the most likely cause of the subsidence was water-related foundation movement caused by the burst water main. This may have been exacerbated by the poor condition of underground drainage, as well as a soakaway positioned close to the north-east corner of the building. The report suggested that repairing the water mains leak and taking the building out of operation (and thus preventing the leaking of drains) has stopped the foundation movement.

The report goes on to recommend that consideration be given to underpinning the building to reduce the risk of future subsidence, without which the risk of progressive settlement will remain high due to the ground conditions reported by Albury S.I. Ltd in 2012. It also recommends:

- A comprehensive CCTV survey and integrity test is carried out on all stormwater and foul drains and all defects identified are repaired.
- Surface water drainage is diverted to new soakaways that are located further away from the building.
- Remedial works are undertaken to restore the structural integrity of the building and prevent the ingress of water through cracks in the walls.

3.6. *Clancy Drainage Review (2020)*

A review of the below ground drainage surrounding the Old Maids Wing was carried out by Clancy in February 2020. Clancy produced a marked-up drawing identifying various defects and suggested repairs/alterations including relocating the surface water soakaway further from the northeast corner of the building. The mark-up contains information and photos from a CCTV drainage survey. This drainage survey has not been made available to WSP. Damage to drainage runs at multiple locations along the northern and western faces of the Old Maids building exist and dependant on the degree of damage, it was recommended that the pipe at each damaged location be relined or re-laid.

TECHNICAL NOTE 1

DATE:	10 September 2020	CONFIDENTIALITY:	Confidential
SUBJECT:	Old Maids Building – Summary of Initial Findings		
PROJECT:	70076238 - Royal Berkshire Hospital	AUTHOR:	Matthew West / Tim Wellington
CHECKED:	Brian Hillman	APPROVED:	Ben Moss

3.7. Clancy Ground Investigation (2020)

The Clancy geotechnical site investigation report dated 2020 reiterates the options available to stabilise the foundations through either traditional or piled underpinning. Based on the site investigation data, the report states that the chalk strata are likely to provide a suitable bearing for foundations at a depth of approximately 2m BGL, providing the bearing layer is firm. An allowable bearing pressure of 100kN/m² is said to be likely achievable. If soft deposits were present, foundations would require being taken deeper into more competent material.

Anticipated pile capacities are also provided in the report, with values ranging from 50kN for 8m long 150mm dia, to 345kN for 16m long 250mm dia.

The report highlights the susceptibility of the chalk to dissolution features as it is of relatively shallow depth. Furthermore, potential evidence of historical collapsed dissolution features was identified during intrusive works, presenting as significant variation in the depth to surface of chalk.

The intrusive tests undertaken around the perimeter of the building did not identify any voids. It is not possible to carry out these tests over the area of the building, and therefore the presence / absence of voids under the building cannot be confirmed with certainty.

4. UPDATE ON CRACK MEASUREMENTS

Further to the Parsons Brinkerhoff monitoring report, an additional set of crack measurements were taken by WSP on 06 August 2020. These additional measurements have been added to the original crack monitoring results and are given in Appendix A.

The measurements were taken at four of six of the original monitoring locations set up by Parsons Brinkerhoff in 2013. The measurements do not suggest that there has been further significant progressive settlement since the original monitoring period ended in 2015. This may provide further support to the suggestions made in the 2015 Parsons Brinkerhoff report that the most likely cause of the subsidence damage is water-related foundation movement and that repairing the water leak and preventing the leaking of drains by taking the building out of service has stopped any further significant foundation movement.

It is important to note that these measurements were taken by a different individual using a different measuring tool to the original monitoring period. The length of time between the end of the original monitoring period and these new measurements is significant. No firm conclusions may be drawn from these measurements and the data should not be interpolated or extrapolated. The outside temperature was approximately 30°C when the measurements were taken.

TECHNICAL NOTE 1

DATE:	10 September 2020	CONFIDENTIALITY:	Confidential
SUBJECT:	Old Maids Building – Summary of Initial Findings		
PROJECT:	70076238 - Royal Berkshire Hospital	AUTHOR:	Matthew West / Tim Wellington
CHECKED:	Brian Hillman	APPROVED:	Ben Moss

5. CONCLUSIONS

- The building is founded on very shallow stepped brick footings bearing on the granular Taplow Gravel member.
- The building foundations were seemingly satisfactory for some 150 years when some other cause is deduced to have intervened at the Northern end of this wing.
- Significant foundation movement has occurred at its Northern end, which now appears to have stabilised.
- The cause of the movement is likely to be water related; the removal of fines from the gravels and/or dissolution of the chalk beneath.
- Damage to the building due to the subsidence movement has been evaluated as Category 5 to BRE Digest 251 – “Very Severe”.
- Intrusive ground investigations have found a combination of weak spots and competent strata at shallow depths. Where ‘firm’ the chalk underlying the granular material is likely to provide a suitable bearing stratum for foundations with an allowance ground bearing pressure of 100kPa at 2m bgl.
- Preliminary pile capacities of up to 345kN are anticipated in the chalk.

6. RECOMMENDATIONS

It is recommended that in the short-term the following actions are taken to minimise the risk of any further introduction of water into the ground in the proximity of the building. ie to remove the deduced cause of the movement:

- Repair the roof so that no further rainwater enters the building via this path. The temporary roof should remain in place until these works are complete.
- Ensure that the rainwater from the temporary roof is drained well away from the building foundations.
- Repair all defects to the existing below ground drainage where in the vicinity of the building.
- Relocate the surface water soakaway near to the north-west corner of the building so that it is at least 5m away from the foundations.
- Obtain confirmation from the Water Board that the leaking water main has been fixed.
- If possible, test all incoming water supply pipes for leaks between the mains and the building water meter.

TECHNICAL NOTE 1

DATE:	10 September 2020	CONFIDENTIALITY:	Confidential
SUBJECT:	Old Maids Building – Summary of Initial Findings		
PROJECT:	70076238 - Royal Berkshire Hospital	AUTHOR:	Matthew West / Tim Wellington
CHECKED:	Brian Hillman	APPROVED:	Ben Moss

The foundation movement currently appears to have stabilised and is likely to remain stable and thus satisfactory whilst the building remains vacant. This approach carries a small risk that should a significant water related event occur, further progressive settlement may recommence. Completing the above short-term recommended actions will mitigate this risk.

If it is the intention of the Hospital trust to bring the building back into operation and refurbish the building so it can be re-occupied, we recommend that foundation underpinning is carried out as part of the refurbishment project. Underpinning will provide the appropriate protection to the significant investment that the refurbishment project will represent.

We recommend that the underpinning works consist of a piled solution. Traditional methods of underpinning carry risks and limitations due to the ground conditions on site.

Piled underpinning is considered the most appropriate solution for the following reasons:

- Compared to traditional underpinning, a piled solution significantly reduces the risk of further subsidence caused by dissolution of the chalk or collapse of existing cavities by taking the foundations loads to a far greater depth in the chalk.
- The requirement of temporary support of excavations in the granular material during traditional underpinning is likely to be highly onerous.
- Piling removes the H&S risks associated with operatives entering excavations +2m deep to carry out labour intense and time-consuming activities.
- There are practical limits to the depths to which traditional underpinning can be taken. There is a risk that at a depth of 2m the chalk is either not encountered, or is not firm enough, requiring the excavation to be taken deeper further increasing the temporary works requirement and H&S risks.
- The Clancy Ground Investigation report dated 2020 estimates allowable bearing pressures of up to 100kPa could be achieved at 2m depth in firm chalk. The Albury SI ground investigation report dated 2012 stated that applied pressures are in the region of 180kPa under external walls at the current foundation widths. Subject to detailed design calculations a traditional underpinning scheme may simply not have enough load bearing capacity.

We consider that carrying out underpinning would be most appropriate during the refurbishment of the building for the following reasons:

- Features of the refurbishment scheme may influence the extent/requirements of the underpinning design. Carrying out the underpinning design in the absence of the refurbishment design (including

TECHNICAL NOTE 1

DATE:	10 September 2020	CONFIDENTIALITY:	Confidential
SUBJECT:	Old Maids Building – Summary of Initial Findings		
PROJECT:	70076238 - Royal Berkshire Hospital	AUTHOR:	Matthew West / Tim Wellington
CHECKED:	Brian Hillman	APPROVED:	Ben Moss

any alterations to the building internal layout that may be included) would potentially result in redesign or constraints being imposed on the refurbishment scheme.

- The cost of the underpinning would be relatively small portion of the overall investment.
- Other structural works may be undertaken at this time and it would make practical and economic sense to do this simultaneously.

Prior to commencing the detailed design of a piled underpinning scheme, we recommend that a visual inspection of the damage to the internal and external walls at ground floor is undertaken, as we note this was omitted in the 2013 Parsons Brinkerhoff report due to access limitations. This will also be required to verify the extent of the buildings walls that should be underpinned by piling. Once underpinning has been completed, repairs to cracked walls should be undertaken to reinstate the structural continuity across the cracks.

TECHNICAL NOTE 1

DATE:	10 September 2020	CONFIDENTIALITY:	Confidential
SUBJECT:	Old Maids Building – Summary of Initial Findings		
PROJECT:	70076238 - Royal Berkshire Hospital	AUTHOR:	Matthew West / Tim Wellington
CHECKED:	Brian Hillman	APPROVED:	Ben Moss

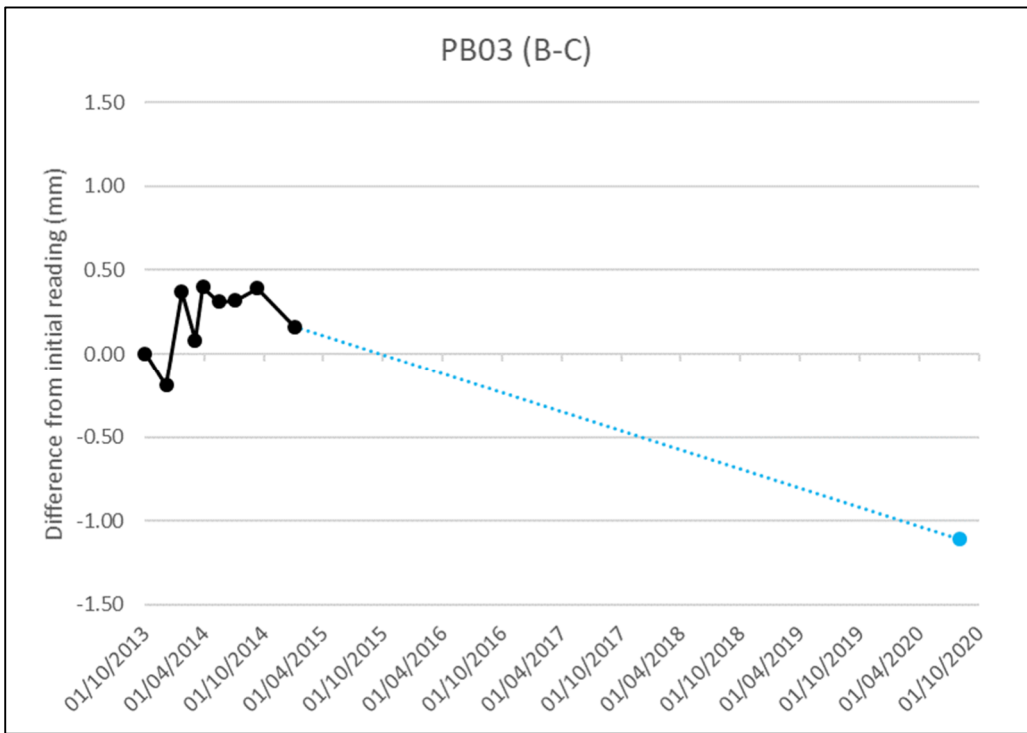
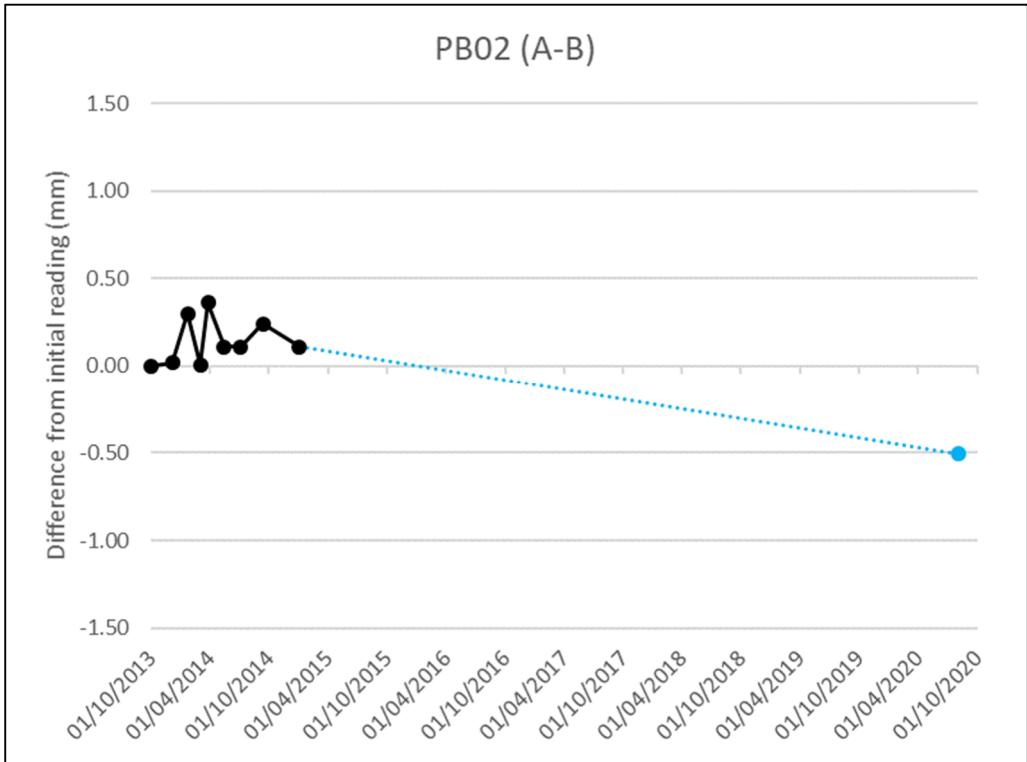
APPENDIX A. CRACK MEASUREMENTS

Monitoring location	Between studs	Average reading (mm)									
		01/10/13	06/12/13	21/01/14	03/03/14	27/03/14	15/05/14	04/07/14	11/09/14	02/01/15	06/08/20
PB01	A-B	49.93	50.02	50.05	50.15	50.15	50.29	50.27	50.22	50.09	
PB02	A-B	32.98	33.00	33.28	32.99	33.34	33.09	33.09	33.22	33.09	32.47
PB03	A-B	32.38	32.56	32.88	32.63	32.99	32.75	32.74			
PB03	B-C	58.86	58.67	59.23	58.94	59.26	59.17	59.18	59.25	59.02	57.75
PB04	A-B	39.80	39.91	39.95	39.86	40.03	39.83	39.83	39.81	40.07	39.35
PB04	A-C	38.61	38.60	38.77	38.24	38.37	38.14	38.16	38.23	38.25	38.89

Monitoring location	Between studs	Difference from initial reading (mm)									
		01/10/13	06/12/13	21/01/14	03/03/14	27/03/14	15/05/14	04/07/14	11/09/14	02/01/15	06/08/20
PB01	A-B	0.00	0.09	0.12	0.22	0.22	0.36	0.34	0.29	0.16	
PB02	A-B	0.00	0.02	0.30	0.01	0.36	0.11	0.11	0.24	0.11	-0.51
PB03	A-B	0.00	0.18	0.50	0.25	0.61	0.37	0.36			
PB03	B-C	0.00	-0.19	0.37	0.08	0.40	0.31	0.32	0.39	0.16	-1.11
PB04	A-B	0.00	0.11	0.15	0.06	0.23	0.03	0.03	0.01	0.27	-0.45
PB04	A-C	0.00	-0.01	0.16	-0.37	-0.24	-0.47	-0.45	-0.38	-0.36	0.28

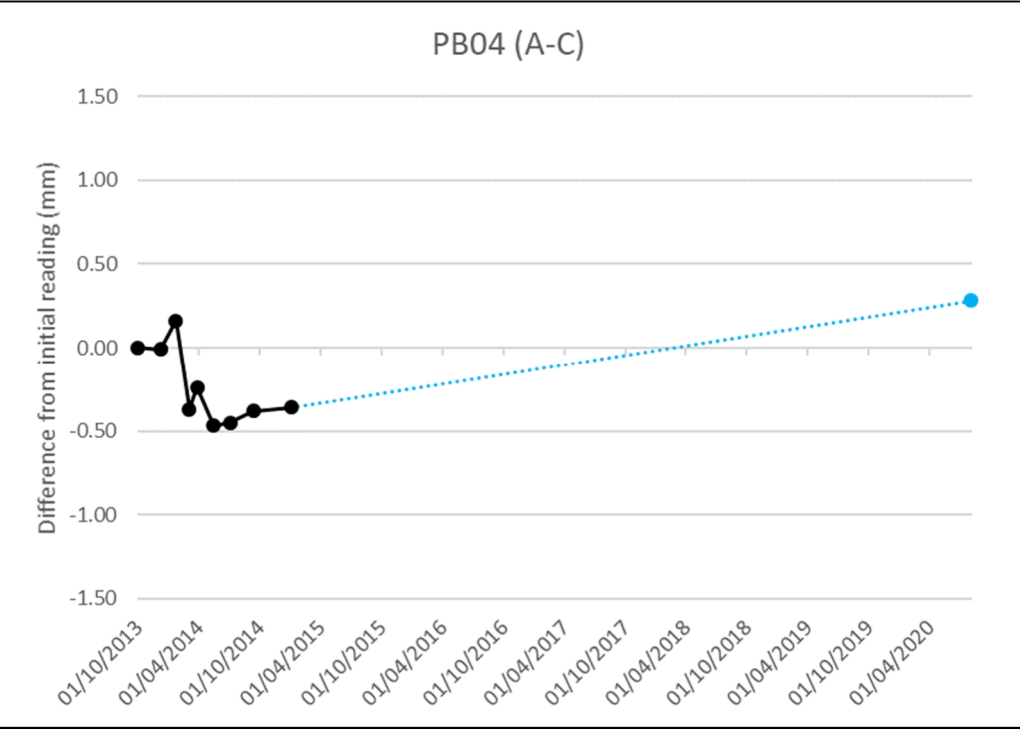
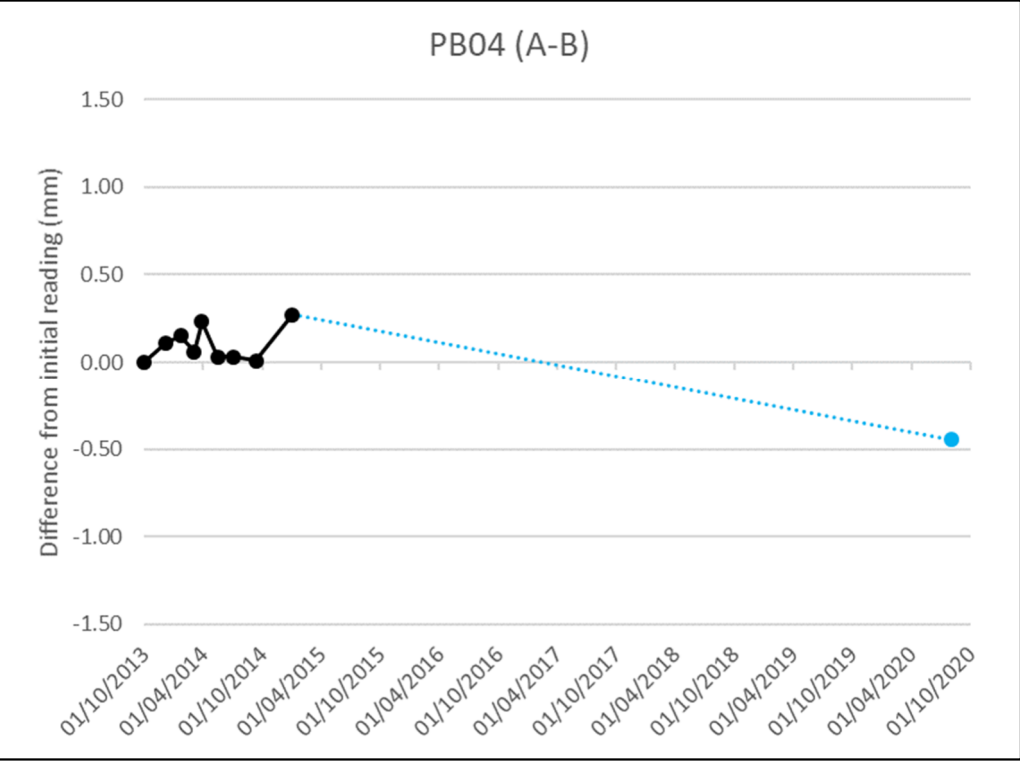
TECHNICAL NOTE 1

DATE:	10 September 2020	CONFIDENTIALITY:	Confidential
SUBJECT:	Old Maids Building – Summary of Initial Findings		
PROJECT:	70076238 - Royal Berkshire Hospital	AUTHOR:	Matthew West / Tim Wellington
CHECKED:	Brian Hillman	APPROVED:	Ben Moss



TECHNICAL NOTE 1

DATE:	10 September 2020	CONFIDENTIALITY:	Confidential
SUBJECT:	Old Maids Building – Summary of Initial Findings		
PROJECT:	70076238 - Royal Berkshire Hospital	AUTHOR:	Matthew West / Tim Wellington
CHECKED:	Brian Hillman	APPROVED:	Ben Moss



TECHNICAL NOTE 1

DATE:	10 September 2020	CONFIDENTIALITY:	Confidential
SUBJECT:	Old Maids Building – Summary of Initial Findings		
PROJECT:	70076238 - Royal Berkshire Hospital	AUTHOR:	Matthew West / Tim Wellington
CHECKED:	Brian Hillman	APPROVED:	Ben Moss

APPENDIX B. LOCATION PLAN



Figure 1 – Royal Berkshire Hospital Site Plan (Source: OpenStreetMap)

TECHNICAL NOTE 1

DATE:	10 September 2020	CONFIDENTIALITY:	Confidential
SUBJECT:	Old Maids Building – Summary of Initial Findings		
PROJECT:	70076238 - Royal Berkshire Hospital	AUTHOR:	Matthew West / Tim Wellington
CHECKED:	Brian Hillman	APPROVED:	Ben Moss

APPENDIX C. IMAGES



Figure 2 - Old Maids Building 3D Render (Source: Aworth Survey 2020)

TECHNICAL NOTE 1

DATE:	10 September 2020	CONFIDENTIALITY:	Confidential
SUBJECT:	Old Maids Building – Summary of Initial Findings		
PROJECT:	70076238 - Royal Berkshire Hospital	AUTHOR:	Matthew West / Tim Wellington
CHECKED:	Brian Hillman	APPROVED:	Ben Moss



Figure 3 - Old Maids Building Northern Face – Captured May 2019 (Source: Google Street View)

TECHNICAL NOTE 1

DATE:	10 September 2020	CONFIDENTIALITY:	Confidential
SUBJECT:	Old Maids Building – Summary of Initial Findings		
PROJECT:	70076238 - Royal Berkshire Hospital	AUTHOR:	Matthew West / Tim Wellington
CHECKED:	Brian Hillman	APPROVED:	Ben Moss



Figure 4 - Old Maids Building Western Face - Captured October 2018 (Source: Google Street View)