Facilities - Engineering Reports
Proactive Release: 11 September 2019

30th August 2019

[redacted]

[redacted]

Dear [redacted]

Official Information Act (1982) Request

I write in response to your official Information Act request, originally requested on 8 April 2019. As part of your wider request for information for facilities remediation, you requested the following information:

Any Engineering Report from 1 July 2018 till 5 April 2019 that provides information around the NBS (new building standard) rating of

- Galbraith building
- Western campus
- Any other building where there currently is high or medium concerns re seismic issues (per categorisation in Dec 2017 Remediation Works document).

We have interpreted Engineering report to relate to independent expect worked commissioned by the DHB in the period, related to assessments by NBS

In our decision document on 8 May 2019 we noted that no further reports had been initiated on the Galbraith building, and withheld further information and related briefs on this process for other CM Health facilities because the information would be published soon, within two months of our decision.

On 28 June 2019 we wrote to advise you that we were awaiting receipt of the completed full suite of specialist assessments (DSA Reports) commissioned from Beca for the identified buildings, to enable full consideration of future options. We advised we were now expecting to publish the information by late August.

For context, the region under CMDHB's responsibility is classed as low seismic risk area, and hence the due date to identify potential earthquake-prone buildings is set to 1 July 2032 as per the Building (Earthquake-prone Buildings) Amendment Act 2016.

Counties Manukau Health has proactively started the exercise of identifying potential seismic prone buildings early this year with the help of third party consultant – Beca Limited (Beca).

With limited amount of funding available, a selection of 21 buildings which were constructed before 2000 were selected to undergo the Initial Seismic Assessment (ISA). *(Please refer to table 2 at end of letter for the summary result of the seismic assessments).*

A follow up survey of Detailed Seismic Assessment (DSA) has been carried out for any particular building that did not meet the minimum ISA level 34% NBS.

The three buildings that underwent DSA following unsatisfactory ISA results, and which we are now releasing as attached documents, are Franklin Memorial Hospital, Pukekohe Plant Room and Esme Green.

In response to your request for reports:

- **Galbraith Building:**

As already indicated CM Health has not received, nor required any further Engineering Report information on the Galbraith Building NBS. The building was deemed an Earthquake-prone building in 2018, and public notices have been placed to this effect. We provided this information to Radio NZ in June 2018.

- **Western Campus**

Building 38 is located on the Western campus of the Middlemore Hospital site.

An ISA by Beca initially indicated a score of 40% NBS (IL3) with a recommendation that intrusive investigation be undertaken to confirm the nature of the brick masonry walls. A subsequent DSA has recommended a further check of the adequacy of the spacing of cavity ties within the wall spans between the foundation and roof level supports. If the spacing is adequate, the score is likely to be >67% NBS (IL3). If not, the score is likely to be <34%NBS (IL3).

A final decision has yet to be made. *(Report attached)*

- **Any other building where there currently is high or medium concerns re seismic issues**

Esme Green
Beca has completed a Detailed Seismic Assessment (DSA) of the Esme Green Building (Middlemore Building 30). This building was built in 1947 and is not for clinical use.

The score of the building is 25%NBS (IL3) governed by the performance of several isolated shear walls which have a disproportionate impact on the seismic rating to the building due to their importance to maintain support to the floors and lateral stability of the building.

The DSA Report has provided two strengthening options for consideration: Strengthening to 35% NBS (recommended) and Strengthening to >67% NBS.

CM Health is currently investigating the high level strengthening scheme to bring the building's seismic rating to above 34% NBS (IL3). The strengthening targets the critical structural elements and features of the building that are currently less than 34%NBS (IL3) and involves strengthening an existing wall at the ground floor level of the South Wing and building an additional wall at the eastern elevation of the East Wing.

Design work to build the additional walls is currently underway. *(Report attached)*

Franklin Memorial Hospital
The Franklin Memorial Hospital, built in 1930, is located in Waiuku and currently provides care for up to 16 long term aged residents who require hospital level care. This was the oldest building assessed by Beca and received an earthquake prone score of 30%NBS (IL3).

Beca has provided three remediation recommendations ranging from Do Nothing to Full Strengthening Work.

Due to the importance of the earthquake rating for this building, and our commitment to safe working, the Board is considering all the possible options which include full strengthening, to disposing of the building and land and re-locating services.

The DHB has 35 years to make these decisions and implement. *(Report attached)*

Pukekohe Plant room
The Pukekohe Hospital Plant room is a small building which houses plant equipment critical for the function of the hospital; it is not occupied.

The plant room building was scored at 30% NBS (IL3) in an Initial Seismic Assessment by Beca. Because of the size and nature of the building, CM Health decided not to request a DSA Report, but instead requested a report on strengthening options which range from Do Minimum to Do Most.

No formal decision has yet been made *(Report attached)*

I trust this information satisfactorily answers your query. If you are not satisfied with this response you are entitled to seek a review of the response by the Ombudsman under section 28(3) of the Official Information Act.

Please note that this response or an edited version of this may be published on the Counties Manukau DHB website.

Yours sincerely,

Fepulea'i Margie Apa
Chief Executive

Table 2: Summary of seismic assessments carried out to date:

Building Name	IEP score
Botany Downs Primary Birthing Unit	>100%NBS (IL3)
Franklin Memorial Hospital	<34%NBS (IL3)
Middlemore Building 7 – Poutasi Link	60%NBS (IL3)
Middlemore Building 25	95%NBS (IL2)
Middlemore Building 26	95%NBS (IL2)
Middlemore Building 27	60%NBS (IL2)
Middlemore Building 30 – Esme Green	25%NBS (IL3)
Middlemore Building 31 – Colvin Building	60%NBS (IL3)
Middlemore Building 38 Western Campus	40%NBS (IL3)
Otara Hospital – Block A – Spinal Unit	55%NBS (IL3)
Otara Hospital – Block B – Spinal Unit	55%NBS (IL3)
Otara Hospital – Block C – Mental Health	60%NBS (IL3)
Otara Hospital – Block D – Gym	70%NBS (IL3)
Otara Hospital – Block E – Plant	55%NBS (IL3)
Otara Hospital – Block F – Classroom	80%NBS (IL3)
Otara Hospital – Block M – Motels	75%NBS (IL3)
Papakura Primary Birthing Unit – Wards	70%NBS (IL3)
Papakura Primary Birthing Unit	80%NBS (IL3)
Papakura Awhiniata Centre	>100%NBS (IL3)
Papakura Awhiniata Centre	>100%NBS (IL3)
Pukekohe Hospital – Maternity and Geriatric	60%NBS (IL3)
Pukekohe Hospital – Plantroom	30%NBS (IL3)

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Counties Manukau District Health Board
Private Bag 93323
Auckland 1640
New Zealand

10 May 2019

Attention: [redacted]

Dear [redacted]

Franklin Memorial Hospital - Intrusive Investigation Summary

Beca has been engaged to complete intrusive investigations at the Franklin Memorial Hospital site at Waiuku, Auckland. The investigation findings will inform the next steps of the seismic assessment and strengthening process. This letter summarises our findings and provides options and recommendations for Counties Manukau Health (CMH) to consider.

Background

Beca recently completed a number of Initial Seismic Assessments (ISAs) for a number of Counties Manukau Health facilities across the Auckland region.

The purpose of an ISA is to act as first step in the overall seismic assessment process. It is a coarse evaluation of a building, that can inform decision makers as to a priority list of buildings. If important decisions need to be made that rely on a buildings seismic status, generally an ISA is followed up with a Detailed Seismic Assessment (DSA).

The Franklin Memorial Hospital was the oldest building assessed and received an earthquake prone score, with 30%*NBS* (IL3). The extensive use of unreinforced masonry for load bearing walls and chimneys in the building severely influences the building score, due to their known poor earthquake behaviour. The Assessment Guidelines recommend structures with unreinforced masonry chimneys and load bearing walls be considered as earthquake prone until the stability of the walls and effectiveness of the restraint of the masonry can be confirmed. Because of this, we recommended intrusive investigations be undertaken to confirm details, followed by the development of structural remedial solution to address the potential critical structural weaknesses.

Intrusive Investigation Summary

Methodology

A Beca structural engineer undertook a site visit on 01 May 2019. During the development of the intrusive investigation scope of works it was identified that the ceiling space was unable to be accessed due to the presence of asbestos material. The inspection was therefore limited to areas available to be inspected from ground level.

A reinforcing scanner was used to detect brick veneer ties and determine their distribution to the walls. Access to the subfloor space was limited to that able to be observed through removed vent holes.

Observations

The observations are summarised as follows:

- Bricks – the bricks were measured as 210 mm long, 76 mm deep, and 100 mm wide. The bricks were noted as being 'hard' as they were unable to be scratched with a coin. The hardness of the brick, relative to the mortar is important as it can lead to a brittle failure mechanism.
- Mortar – the mortar joints were approximately 10 mm thick. The mortar did not scratch away easily when using a key, suggesting it is also 'hard'.

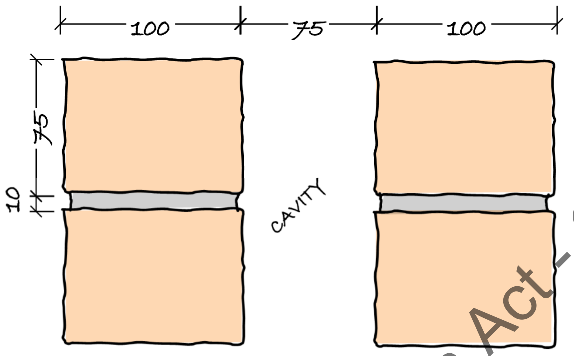


Figure 1: Typical brick dimensions and cavity layout

- Exterior Walls - the exterior walls are cavity brick construction. This consists of a single exterior veneer layer of bricks approx. 100 mm wide, a cavity 75 mm wide, then an internal brick layer. Beneath the floor level, the brick becomes solid to form a perimeter foundation wall. Cavity ties were observed to be at approximately 900 mm centres horizontally, and 1000 mm centres vertically. The ties appear as approximately an 8 gauge wire.

Figure 2: Evidence of cavity ties in external walls

- Interior Walls – the interior walls are generally single brick with plaster linings directly fixed to the brick surface. In the northern area of the building where renovation works have been undertaken, timber stud walls have been constructed adjacent to the brick partition walls, but are unlikely to have a physical connection between the studs and the brick.

  There is some evidence of internal double brick cavity walls. The construction of these, including cavity width is expected to be similar to the exterior walls.

  The connection to the top plate was unable to be observed.

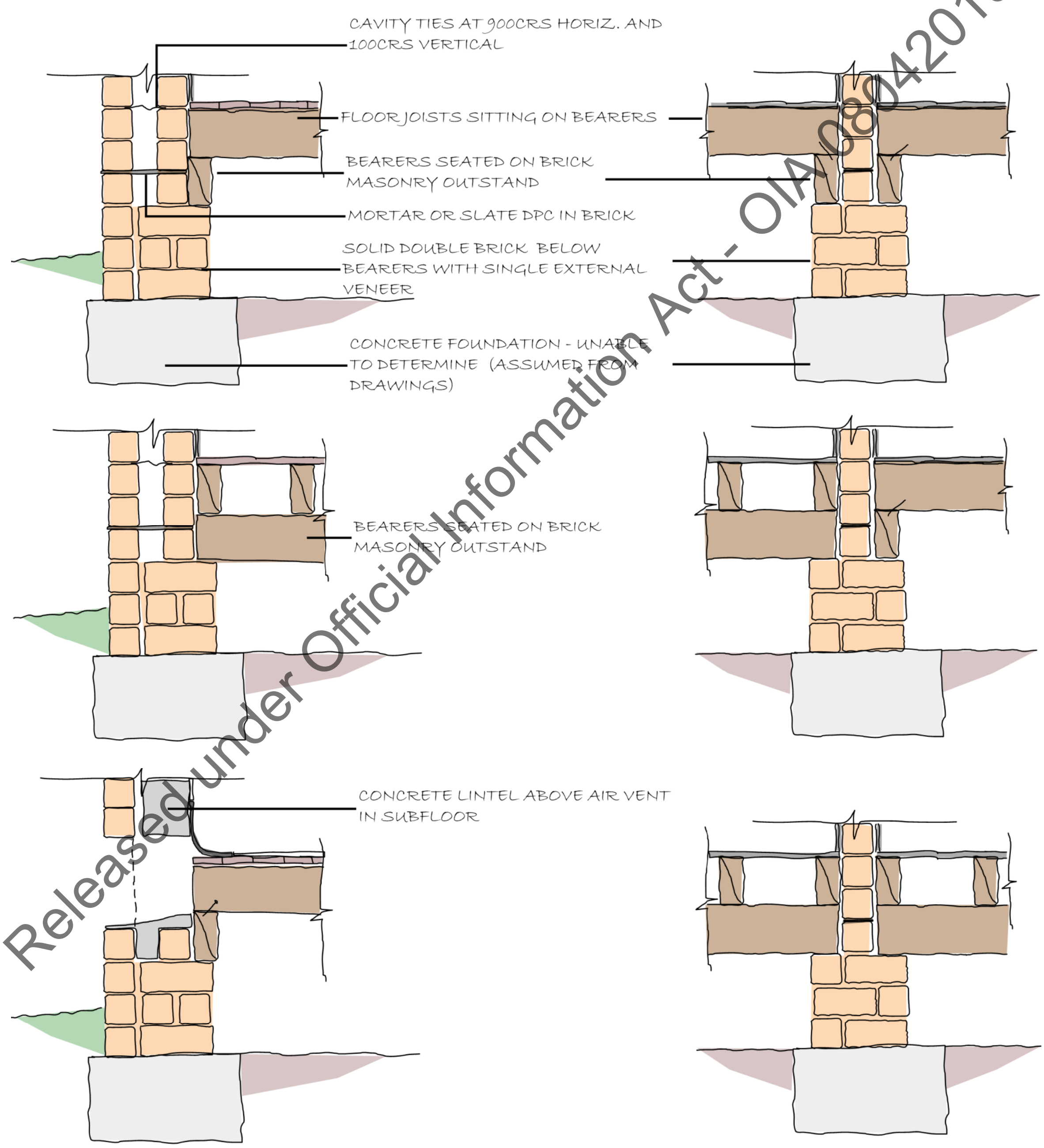


Figure 3: Typical construction details observed (top) typical cross section with joists transverse to exterior walls, (middle) joists parallel to walls (bottom) section through ventilation grate

- Subfloor framing – the subfloor structure generally consists of 140 x 45 timber floor joists at 400 centres supporting 25 thick timber tongue-in-groove flooring. The joists are supported by bearers which span between small brick columns or between the brick foundation walls that continue through from above. There does not appear to be any direct connection (other than gravity support) between the floor and the brick walls, with the walls passing through the floor. No blocking between the timber joists was observed.

Figure 4: Subfloor framing showing timber floor joists connected to timber bearers

- Foundations – the timber bearers sit on brick jack piles. The connection of these was not evident beyond simple bearing on the top surface of the column.
- Lintels – the lintels above windows and doorways are concrete. It is unknown if these are reinforced.

Figure 5: (left) Timber bearer sitting on solid brick column (right) concrete lintel above doorway

A plan mark-up of the various wall types and details are appended to the back of this letter.

Conclusions

The building has extensive use of unreinforced masonry (URM) load bearing internal single skin partitions and external cavity walls. Cavity ties were observed in the cavity walls, however the spacing and condition of these is inadequate to provide robust composite action between the two brick whythes. This suggests the external walls will act primarily as single skin walls. Single skin walls are particularly vulnerable to seismic shaking.

The walls are either cantilever or span vertically between the ceiling and the foundation, likely the former. This means the single layers of brick are particularly vulnerable to local failure, falling from height to form a potential life safety risk. The fact the walls are load bearing means there is a risk of local or global collapse of the roof structure due to failure of the walls, leading to a potential life safety risk for occupants.

The floor structure is discontinuous through the internal walls, and the floor joists are not blocked at their ends. The lack of a connection to the floor means the walls are required to span down to the foundation level. This also means there is little likelihood of a distribution diaphragm to create a load path to stiffer foundation elements.

Two brick chimneys are present in the building. Chimneys are particularly vulnerable to seismic shaking due to their slender nature, and pose a particular risk due to their height above the structure.

The asbestos ceiling material limits the options available for strengthening works without significant disruption.

Note the area shown in yellow below is the original structure that has a number of potential critical structural weaknesses. The areas in blue and green are of modern construction (1980s) and are expected to perform adequately in an earthquake. Strengthening works are thus concentrated to the original area of the building.

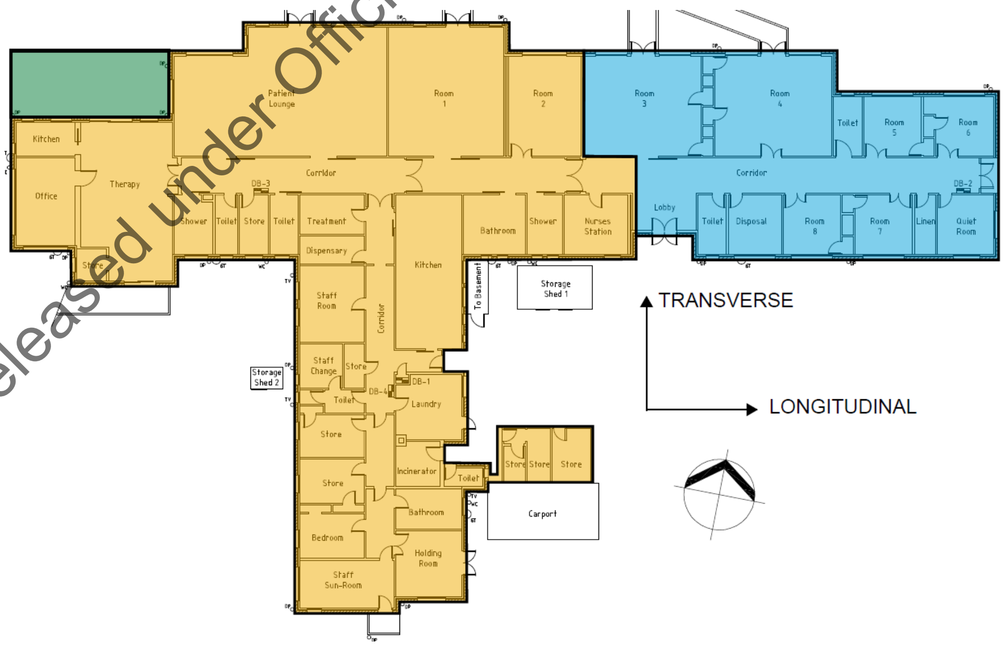


Figure 6: Plan of Franklin Memorial Hospital showing the various construction ages. The yellow section is the original building footprint

Recommendations

The building has a number of critical deficiencies, noted in the ISA and confirmed in the intrusive investigations. Based on the ISA results, the building is currently 'Earthquake Prone' (as it is less than 34%NBS (IL3)). The Auckland City Council Earthquake Prone Policy requires that for earthquake prone buildings:

- Are issued an Earthquake Prone Building (EPB) notice which must be displayed in a prominent location in the building. This notice informs the public and residents that the building is of a high risk.
- The building details are added to the national register of earthquake prone buildings
- Strengthening must occur within 35 years from the date of the EPB notice, such that the building is no longer earthquake-prone. If substantial alterations or change of use occurs within the 35 years, then the building must be strengthened at the same time

Full strengthening works to the building would be intrusive and relatively expensive. The presence of asbestos would make this additionally disruptive. By the EPB legislation, full strengthening would be required by 2054. In the interim, there are a number of short term options which CMH could consider depending on their strategic plan for the building and campus.

Short Term Option 1 – Do Nothing

Works are deferred to a later date.

Short Term Option 2 – Targeted Restraining Works

This option would prioritise the most high-risk aspects of the building to reduce the risk to occupants until the building is decommissioned or further strengthening works are required to be undertaken by Auckland City Councils Earthquake Prone Building policy. Works would be limited to those that have less disruption on residents.

The targeted works would likely involve:

- The removal the brick chimneys,
- Installation of fixing anchors (Python or Helifix fixings) between the cavity brick walls to improve their seismic performance.
- Strapping of timber restraints to the tops of the walls. These will fix through to the brick and span between adjacent walls. This will change the behaviour of the walls from cantilevers to vertical spanning walls, improving their seismic performance.

Disturbance to the occupants would be limited by keeping the works external to the building, or at high level in the rooms. The works will aim to avoid the asbestos materials in the ceiling, allowing operational continuity.

This option provides an improved level of robustness, lowering the key structural risks to occupants, however there will still be a significant cost associated with the works.

Short Term Option 3 – Full Strengthening Works

This option would involve full strengthening of the structure to >34%*NBS* (IL3) or greater. It will effectively create a new internal lining to all the rooms, acting as a new lateral load path.

The strengthening works would likely involve:

- The removal of the brick chimneys
- New structural timber stud walls and lining to all external and internal URM wall. The studs will be fixed through to the brick walls to improve their seismic performance. The new timber studs will also have a top plate securing the top of the brick walls. This top plate will sit under the asbestos material, to avoid disturbing it, and span between adjacent perpendicular walls. Alternatively the internal single skin walls would be removed completed and replaced with timber framing.
- New plywood or GIB ceiling diaphragm between the new wall top plates. The construction of this would be such that it fixes directly to asbestos material, avoiding complete removal of the ceiling structure.
- New connection of the base of the walls to the floor structure through timber blocking bolted through brick.
- New blocking between floor joists and connection of the bearers to the brick substructure

This will require extensive work to most of the building, displacing staff and residents. The costs associated for this option will also be significant.

The works could require the removal of asbestos in the building, although design would aim to avoid this.

Long Term – Full Strengthening Works

The building will require strengthening to the 'Option 3' level.

Summary and Our Recommendations

We propose discussing the options with CMH. We consider Option 3 is the appropriate response in the long term, but alternate options may be necessary in the short term.

Table 1: Summary of Short Term Options for Strengthening Franklin Memorial Hospital

Option No.	Description	Immediate Costs	Seismic Performance	Disruption
1	Short Term – Do Nothing	-	👎	👍
2	Short Term – Targeted Restraining Works	$$$	👍👍	👎👎👎
3	Short Term – Full Strengthening to >34%*NBS* (IL3)	$$$$	👍👍👍	👎👎👎👎

Next Steps

We recommend from here:

- CMH consider the above, and we discuss directly and in more detail each of these options.
- If either Option 2 or 3 are chosen, we will develop a concept design for the works which will inform some initial pricing.

Yours sincerely

[redacted]

[redacted]
Technical Director - Structural Engineering

on behalf of
Beca Limited
[redacted]

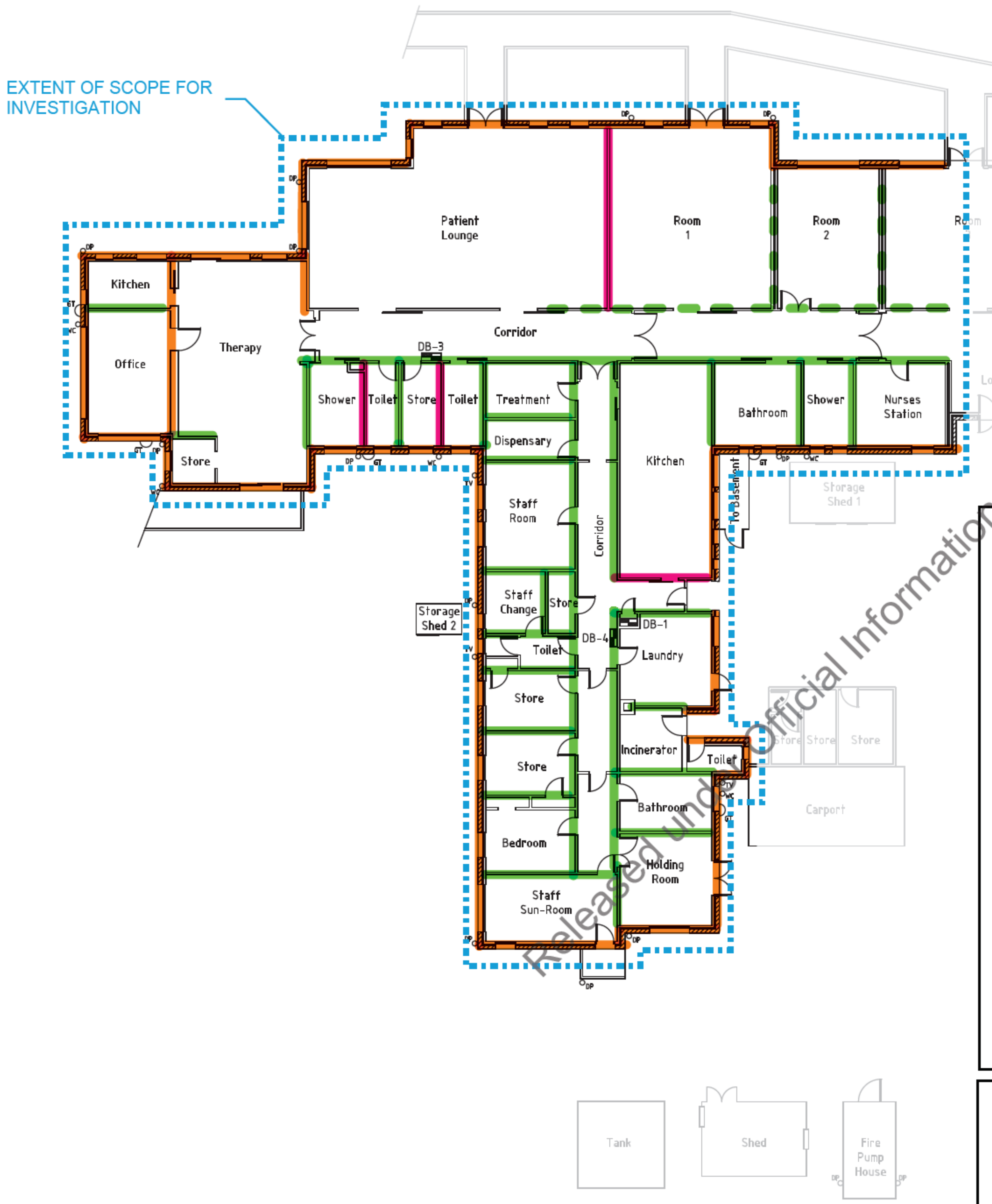
[redacted]

[redacted]
Structural Engineer

on behalf of
Beca Limited
[redacted]

Copy

[redacted]



OBJECTIVES OF INVESTIGATIONS:

To determine whether the brick masonry walls observed in the Franklin Memorial Hospital Building are:

a.) Load-bearing or veneer / partition walls
b.) Cavity, single leaf, or solid brick construction (may vary up height of building)
c.) Have ties in the cavity, or veneers are tied back, and the condition of these ties
d.) Have suitable connection details to restraints at ceiling/roof, ground floor, and foundation locations

The information gathered will feed into the strengthening and restraining works for the building.

NOTE THAT ASBESTOS IS PRESENT IN CEILING MATERIAL, AND CEILING SPACE. DAMAGE TO THE CEILING MATERIAL AND ACCESS TO THE CEILING SPACE IS PROHIBITED.

INSTRUCTIONS FOR INTRUSIVE INVESTIGATIONS:

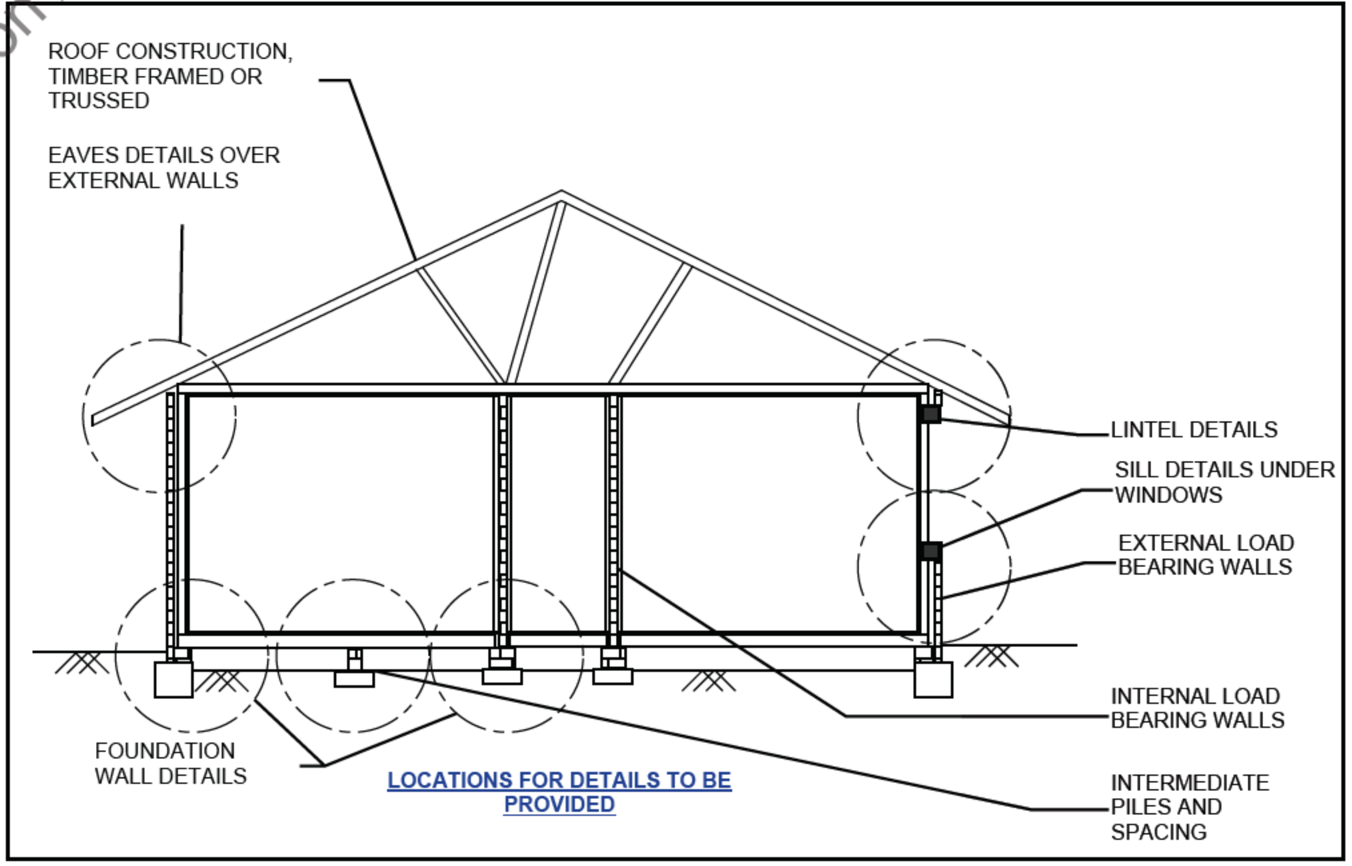
In first instance, information shall be gathered by visual inspection. Where required, intrusive investigations may be undertaken.
For walls shown,

1.) Drill brick and use key hole camera to view and inspect the details of the wall. Alternatively a brick may be removed. Take measurements of details including:
   a.) Cavity width
   b.) Brick dimensions incl. mortar thickness
   c.) Use a stud finder to work out spacing of studs to timber framed walls. Check presence of dwangs to timber stud walls
2.) Take photographs of connections and within cavity for evidence of ties or restraint.
3.) Sketch elevation of wall communicating construction observed
4.) Scratch brick and mortar to confirm condition and hardness and record. Observe general condition of the wall with focus on horizontal cracking in bed joints, vertical cracking in header joints, and diagonal cracking near openings.

Also general investigations required:
1. Confirm if ceiling is lathe and plaster
2. Confirm presence of roof tile ties to the tile battens

OUTPUT REQUIRED:

1. This drawing (19-01-Grnd-A.01) to be marked up with the wall type based on the legend below. A blank copy has been included.
2. Summary sheet for each wall / section requested filled out. An example is included with this documentation.
3. Photographs of the intrusive / opening up findings



LEGEND:

Double cavity wall (orange highlighter)	solid orange line
Double cavity wall with timber framed lining	dashed orange line
Single skin wall (green highlighter)	solid green line
Single skin wall with timber framed lining	dashed green line
Timber framed walls	solid pink line

PLEASE PRINT IN COLOUR

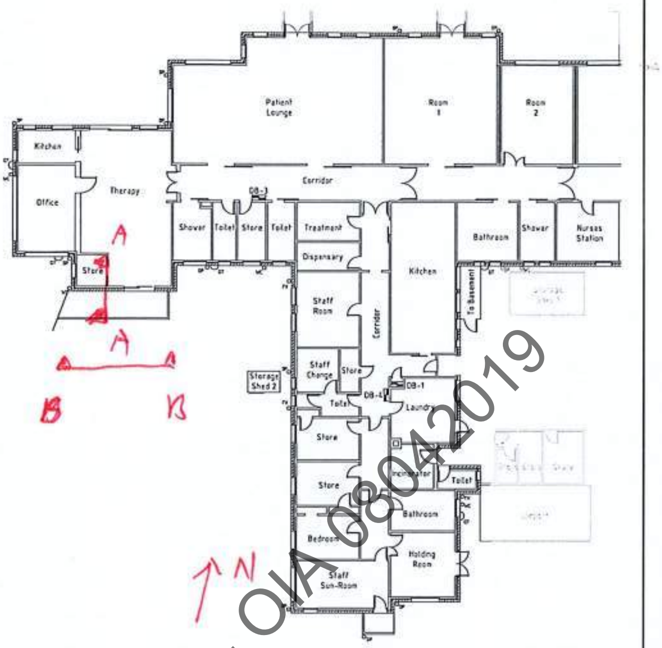
JOB TITLE:	COUNTIES MANUKAU HEALTH SEISMIC ASSESSMENTS		
SKETCH TITLE:	INTRUSIVE INVESTIGATION - FRANKLIN MEMORIAL HOSPITAL		
DATE:	05/04/2019	JOB No.:	5321175
SCALE:	NTS	SKETCH No.:	5321175-E03-SK01
DRAWN:	HM	REV:	1
VERIFIED:	JH	APPROVED:	JK
REASON FOR ISSUE:	FOR INFORMATION		
SOURCE OF BACKGROUND:	CMH DRAWING - 19-01-Grnd-A.01		

INTRUSIVE INVESTIGATION - BRICK MASONRY INSPECTION

Section No.: Exterior Wall 1

Description/ Comments: Exterior wall on southern side of building. Removed the ventilation net to observe cavity construction. Bricks with minor cracks

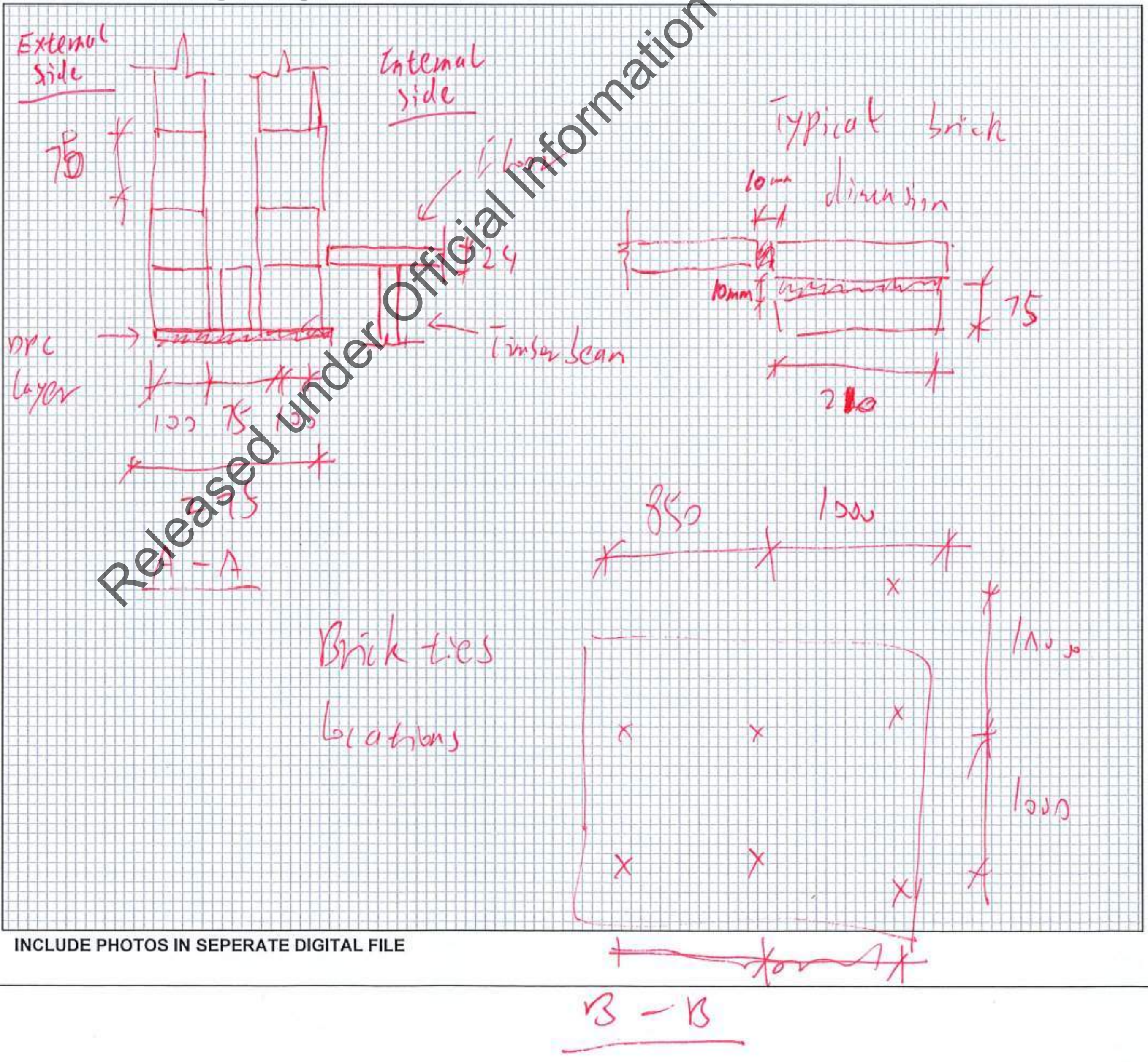
Location of detail / sketches:



Condition of mortar:		
	Very soft - raked out by finger pressure	☐
	Soft - scratches easily with fingernails	☐
	Medium - scratches with fingernails	☐
	Hard - Scratches with aluminium pick	☑
	Very Hard - Does not scratch with above tools	☐

Condition of brick:		
	Soft - Scratches with aluminum pick	☐
	Medium - Scratches with 10 cent copper coin	☐
	Hard - Does not scratch with above tools	☑

Sketches of section through building:



INCLUDE PHOTOS IN SEPERATE DIGITAL FILE

INTRUSIVE INVESTIGATION - BRICK MASONRY INSPECTION

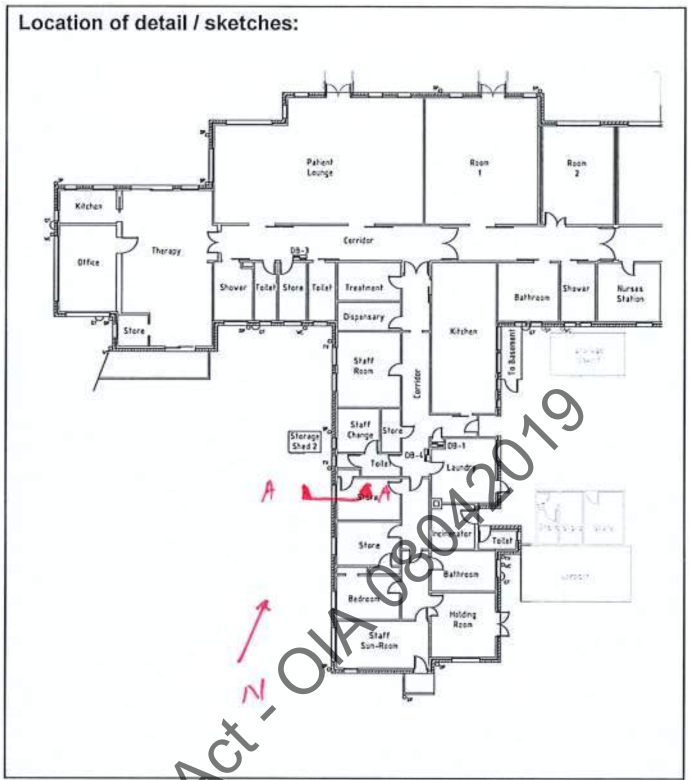
Section No.: Exterior wall 2

Description/ Comments: Exterior wall on western side of building.

Removed ventilation net to observe cavity construction.

Wall in good condition with minor cracks.
- Brick tie spacing similar to wall 1.

Location of detail / sketches:



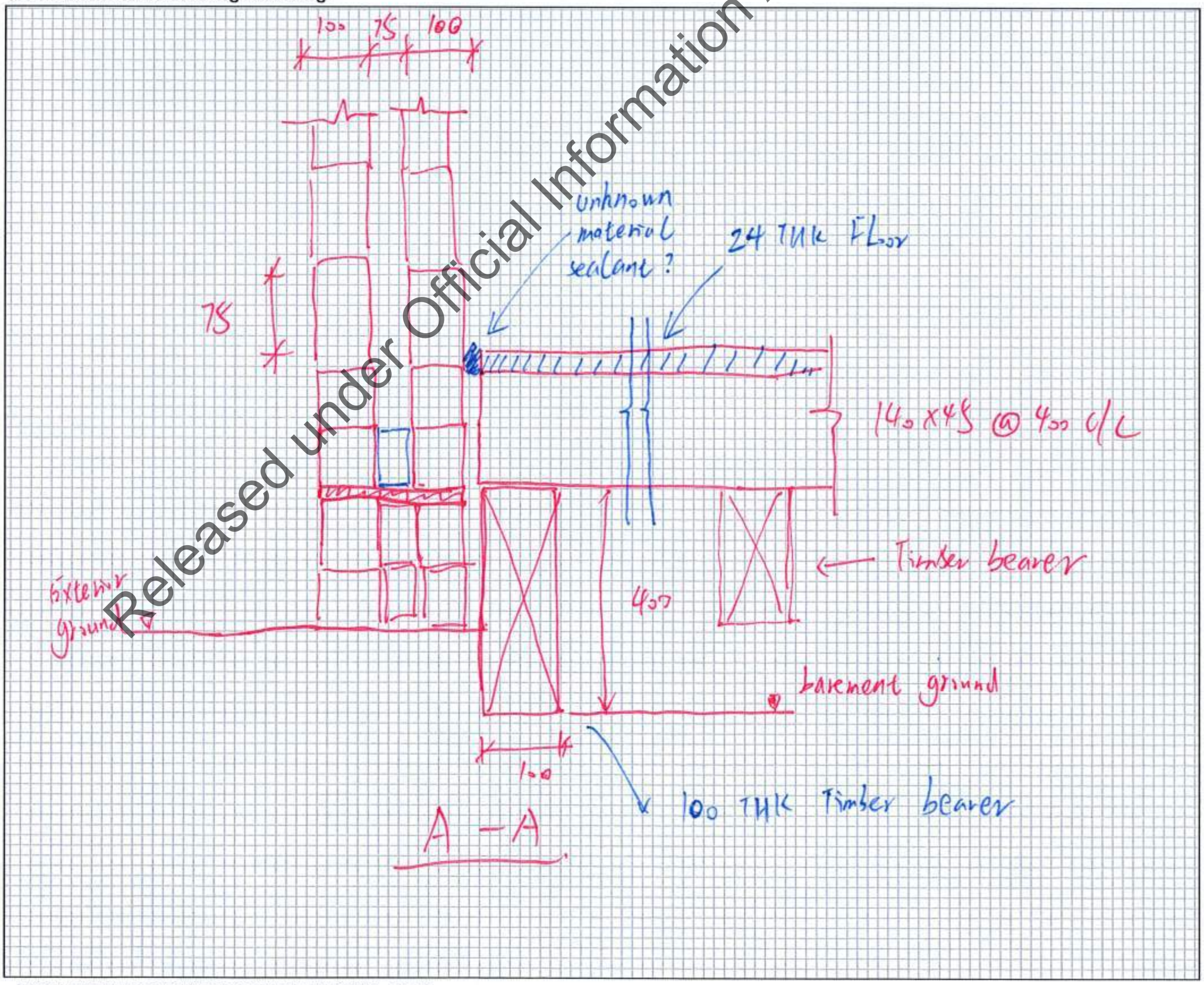
Condition of mortar:

- [ ] Very soft - raked out by finger pressure
- [ ] Soft - scratches easily with fingernails
- [ ] Medium - scratches with fingernails
- [x] Hard - Scratches with aluminium pick
- [ ] Very Hard - Does not scratch with above tools

Condition of brick:

- [ ] Soft - Scratches with aluminum pick
- [ ] Medium - Scratches with 10 cent copper coin
- [x] Hard - Does not scratch with above tools

Sketches of section through building:



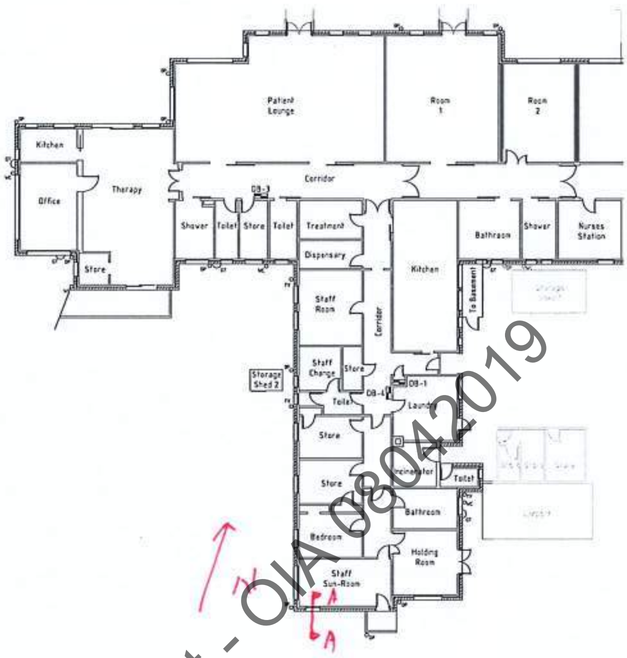
INCLUDE PHOTOS IN SEPERATE DIGITAL FILE

INTRUSIVE INVESTIGATION - BRICK MASONRY INSPECTION

Section No.: Exterior wall 3

Description/ Comments:
- New Mortar repair in late stage
- wall recess 75mm from exterior
- No brick tie found on this wall
- Minor cracks on bricks

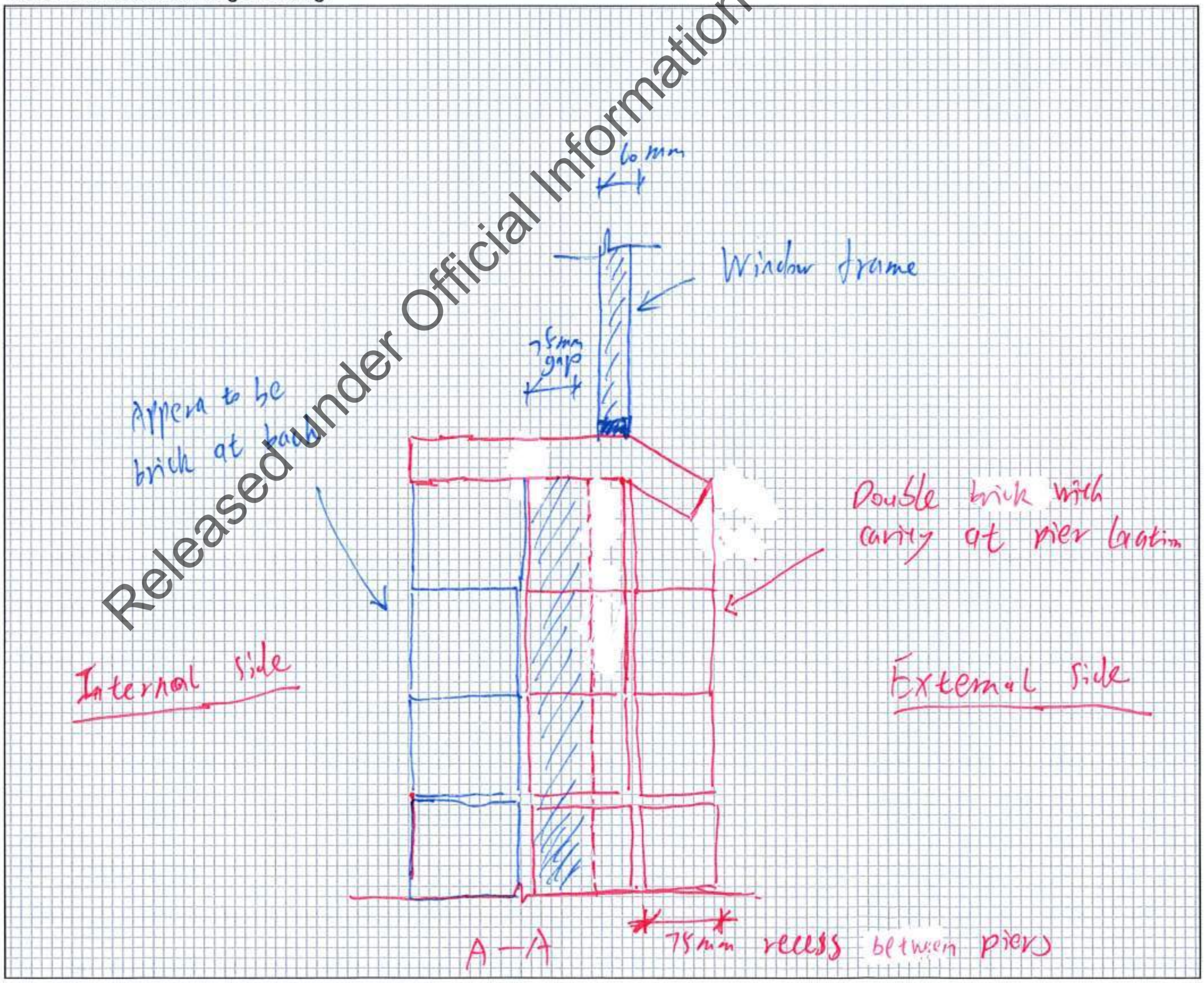
Location of detail / sketches:



Condition of mortar:		
	Very soft - raked out by finger pressure	☐
	Soft - scratches easily with fingernails	☐
	Medium - scratches with fingernails	☐
	Hard - Scratches with aluminium pick	☑
	Very Hard - Does not scratch with above tools	☐

Condition of brick:		
	Soft - Scratches with aluminum pick	☐
	Medium - Scratches with 10 cent copper coin	☐
	Hard - Does not scratch with above tools	☑

Sketches of section through building:



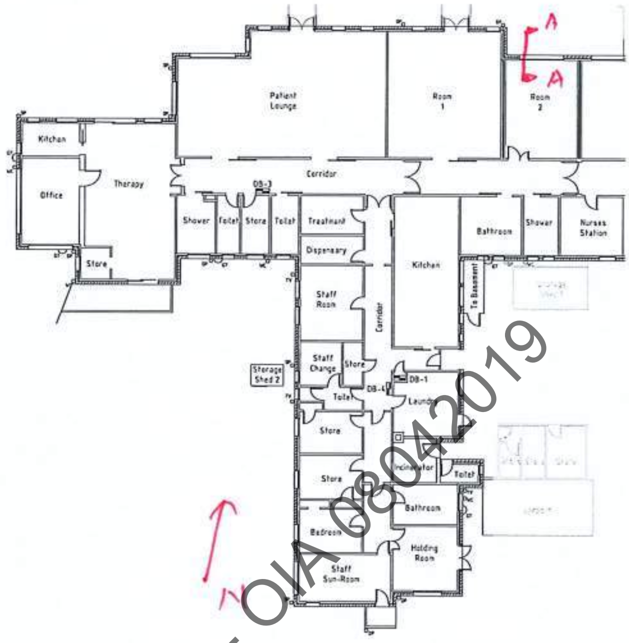
INCLUDE PHOTOS IN SEPERATE DIGITAL FILE

INTRUSIVE INVESTIGATION - BRICK MASONRY INSPECTION

Section No.: Interior Wall 1

Description/ Comments:
- No Jib wall inside
- Jeel like wall paper
+

Location of detail / sketches:



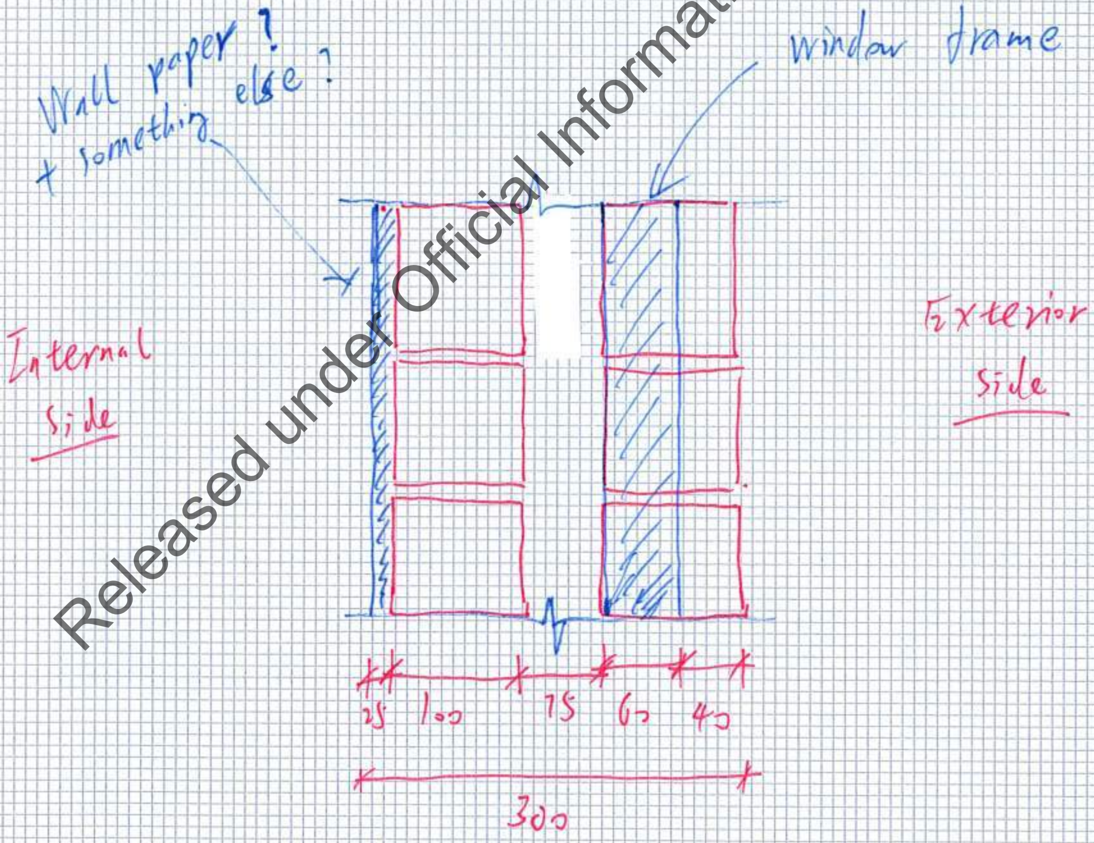
Condition of mortar:

- Very soft - raked out by finger pressure ☐
- Soft - scratches easily with fingernails ☐
- Medium - scratches with fingernails ☐
- Hard - Scratches with aluminium pick ☐
- Very Hard - Does not scratch with above tools ☐

Condition of brick:

- Soft - Scratches with aluminum pick ☐
- Medium - Scratches with 10 cent copper coin ☐
- Hard - Does not scratch with above tools ☐

Sketches of section through building:



A - A

- Section taken at window level

INCLUDE PHOTOS IN SEPERATE DIGITAL FILE

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E: info@beca.com // **www.beca.com**

Counties Manukau District Health Board
Private Bag 93323
Auckland 1640
New Zealand

14 June 2019

Attention: [redacted]

Dear [redacted]

Middlemore Building 38 - Intrusive Investigation Summary

Beca has been engaged to complete intrusive investigations at Building 38 located on the Middlemore Hospital campus, in Otahuhu, Auckland. The investigation findings will inform the next steps of the seismic assessment and strengthening process. This letter is a factual summary of our findings and provides options and recommendations for Counties Manukau Health (CMH) to consider.

1 Background

Beca recently completed a number of Initial Seismic Assessments (ISAs) for a number of Counties Manukau Health facilities across the Auckland region.

The purpose of an ISA is to act as first step in the overall seismic assessment process. It is a coarse evaluation of a building, that can inform decision makers as to a priority list of buildings. If important decisions need to be made that rely on a buildings seismic status, generally an ISA is followed up with a Detailed Seismic Assessment (DSA).

Building 38 was given a score of 40%*NBS* (IL3) in the ISA, with a recommendation that intrusive investigations were undertaken to confirm the nature of the brick masonry walls. The building is light-weight timber framed construction, with light-weight cladding to both the roof and upper walls. There are unreinforced masonry (URM) veneers arounds the perimeter of the building that extend up to window height, and full cavity walls in some areas. The end walls of the two-storey sections of the building have full height brick masonry, which drawings appear to label these walls as reinforced brick. The drawings are unclear and this is an uncommon construction form. URM walls are known to perform poorly during earthquake shaking, particularly when at upper levels where the shaking is intensified.

2 Intrusive Investigation Summary

2.1 Methodology

A Beca structural engineer undertook a site visit on 22 May 2019 to inspect a hole formed in the wall by a Counties Manukau Health contractor. The removal of the brick allowed a camera to be inserted into the wall to observe the construction of the cavity.

A visual inspection was also undertaken at ground floor level around the two-storey walls .

2.2 Observations

The observations are summarised as follows:

- **Bricks** – the bricks were measured as 210 mm long, 65 mm deep, and 100 mm wide. The bricks were identified as 'hard' being unable to be scratched with a coin. The hardness of the brick, relative to the mortar is important as it can lead to a brittle failure mechanism. The bricks have numerous holes through them to allow grout to flow through and provide a better bond, however is unlikely to improve out-of-plane performance of the block walls.

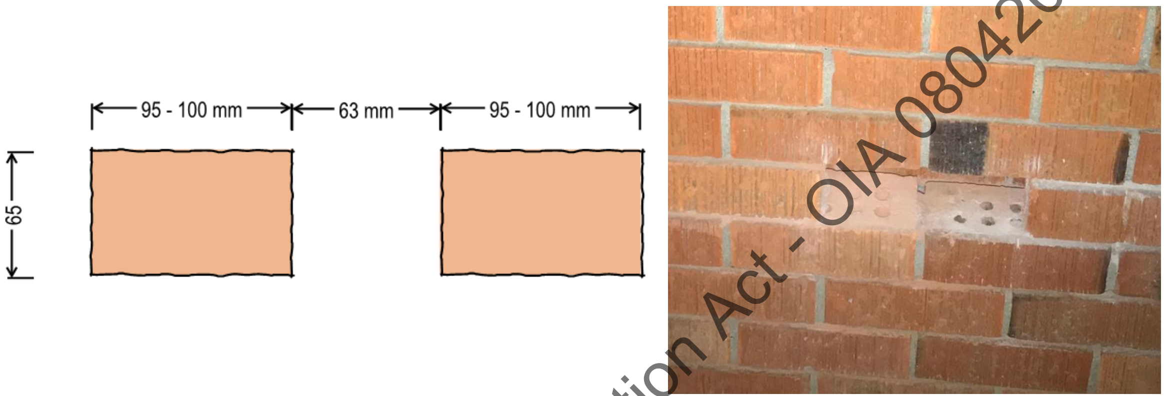


Figure 2.1: Typical brick dimensions (left) and type with numerous penetrations through the brick

- **Mortar** – the mortar joints were approximately 10 mm thick. The mortar did not scratch away easily when using a key, suggesting it is also 'hard'. It was observed to be recessed approximately 10 mm from the external edge of the brick.

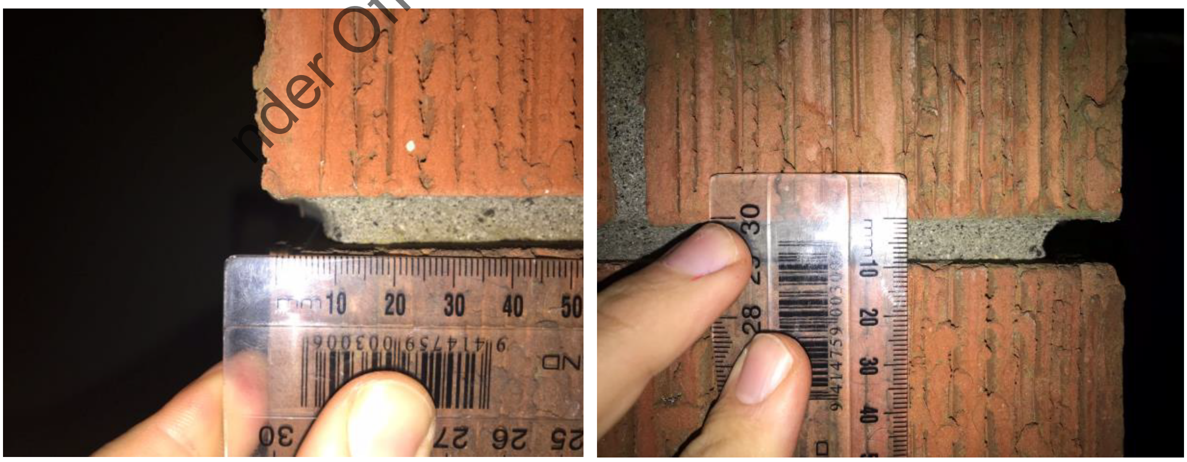


Figure 2.2: Typical brick dimensions and cavity layout

- **Exterior Walls** - the exterior walls are cavity brick construction. This consists of a single exterior veneer layer of bricks approx. 100 mm wide, a cavity 60-75 mm wide, then an internal 100 mm wide brick layer. The drawings note that the walls have three reinforced concrete columns present within the cavity space, with horizontal concrete beams at Level 1 and roof level. Formwork for constructing these columns was observed. The end column formwork did not appear to have a reinforced concrete column behind it, indicating the original contractor may not have constructed it per the drawings. An error like this from a contractor is uncommon but not unheard of. It does not affect the structural system for static vertical loads, however will have an affect on the lateral capacity.

  Cavity ties were observed at 4-brick spacing vertically (approx. 300 mm centre) and 2 ½ bricks horizontally (approx. 500 mm centres).

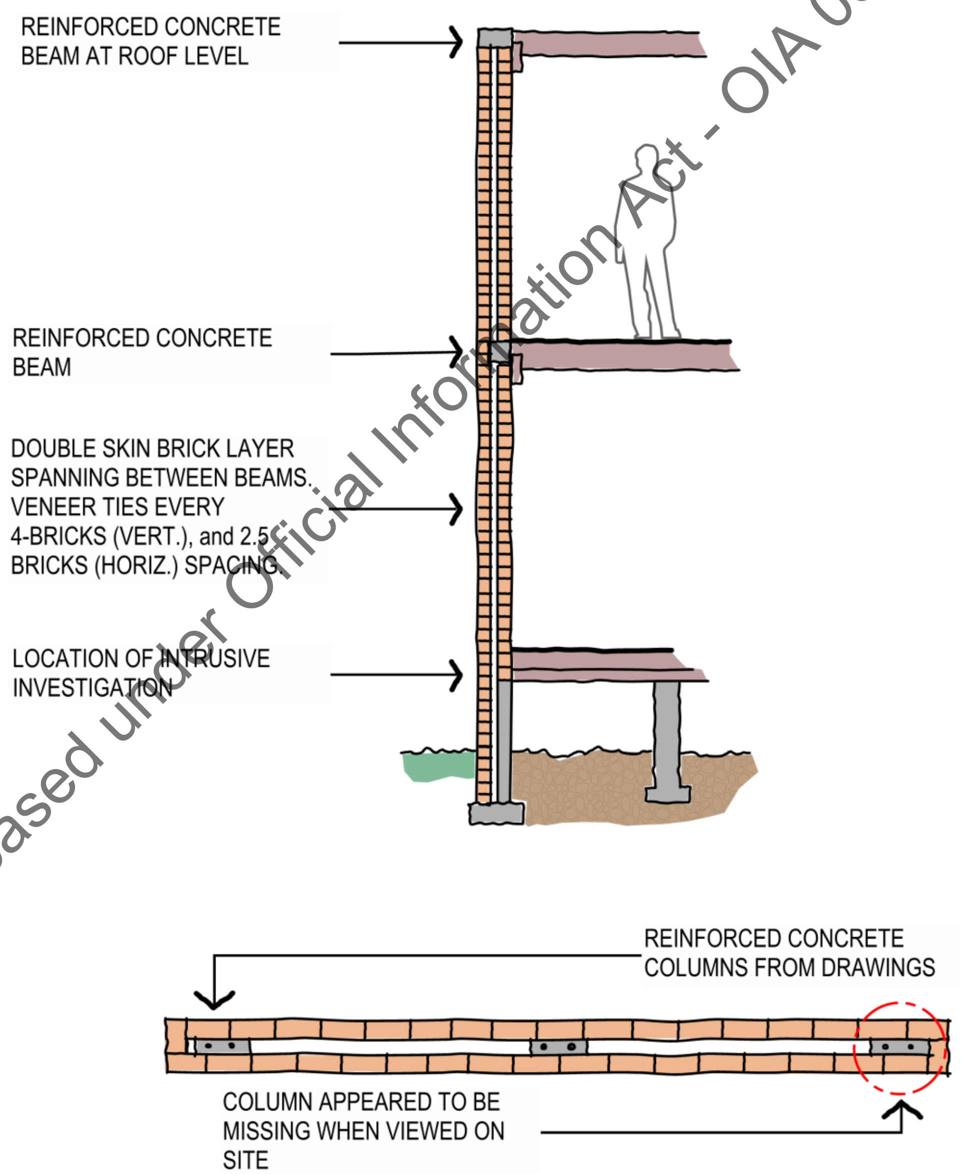
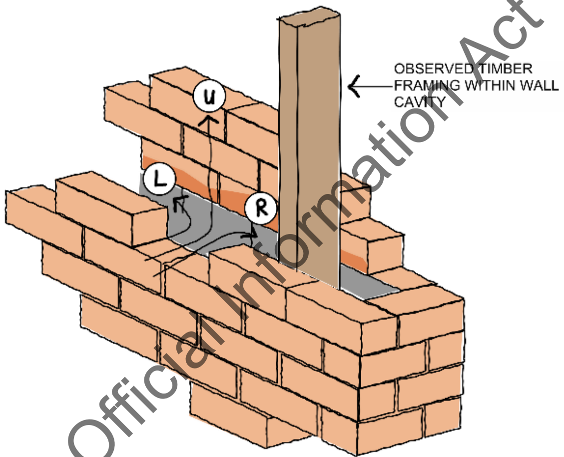


Figure 2.3: Sketch of structural system as detailed on drawings and partially viewed during investigation. Section through (above) and plan view (below)

Evidence of packing formwork in distance

Packing in the distance used as form for internal column



Timber form, however column not apparent behind

Note the concrete foundation wall on right side of photo

Concrete can be seen spilling out side of timber form

Figure 2.4: Photos within cavity wall rotating 360 degrees as shown in central image

3 Conclusions

Beca has undertaken an intrusive investigation of the unreinforced masonry (URM) walls around Building 38 at Middlemore Hospital. The locations of these walls are shown in the figure below.

Figure 3.1: Extent of unreinforced masonry cavity walls in Building 38

The intrusive investigation has found that there is an internal concrete frame to the two-storey cavity brick walls. The frame consists of three columns, with horizontal bond beams at first floor and roof level. This means the walls are required to span vertically between the horizontal concrete beams, and these which in-turn span between the concrete columns.

The single-storey sections of the walls are cavity construction and do not have the vertical concrete columns but do have a continuous reinforced concrete bond-beam at the top of the wall which is connected to the roof sarking. This means the wall spans between the foundation and roof level supports. It is assumed that the cavity ties are at a similar spacing to that observed in the two-storey walls.

Cavity ties were observed, and appeared to be in relatively good condition. Detailed calculations will be required to check the adequacy of the spacing. If the spacing is adequate and the cavity wall behaves as a single element, the score is likely to be >67%*NBS* (IL3). If not, then the score is likely to be <34%*NBS* (IL3).

Further calculations and investigations will also be required to check the consequences of the missing internal concrete column. The locations of the URM walls are shown in the figure below.

4 Recommendations

We recommend that Beca undertakes the detailed calculations for the cavity ties between the walls. The checks will be a detailed seismic assessment of the walls. The results of these checks will either facilitate an update to the original ISA report, noting the improved performance; or will require the development of some strengthening solutions (like those for Pukekohe Hospital Plant room and Franklin Memorial Hospital).

5 Next Steps

We recommend from here:

- Beca proceed with the additional detailed calculations.
- Beca provide the follow deliverable (dependent on the findings of the additional calculations):
  - If >34%*NBS* (IL3) the ISA report is updated
  - If <34%*NBS* (IL3) we develop concept strengthening solutions

We expect the steps above to will require minimal effort to complete.

Yours sincerely

[redacted]

Technical Director - Structural Engineering

on behalf of

Beca Limited

[redacted]

[redacted]

Structural Engineer

on behalf of

Beca Limited

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Counties Manukau District Health Board
Private Bag 93323
Auckland 1640
New Zealand

9 May 2019

Attention: [redacted]

Dear [redacted]

Pukekohe Hospital Plantroom - Concept Strengthening

Beca has been engaged to complete strengthening works to the Pukekohe Hospital Plantroom at Pukekohe, Auckland. The purpose of this letter is to provide a summary of our work to date and direction for next steps going forward.

Background

Beca recently completed a number of Initial Seismic Assessments (ISAs) for Counties Manukau Health (CMH) facilities across the Auckland region.

The purpose of an ISA is to act as first step in the overall seismic assessment process. It is a coarse evaluation of a building, that can inform decision makers as to a priority list of buildings. If important decisions need to be made that rely on a buildings seismic status, generally an ISA is followed up with a Detailed Seismic Assessment (DSA).

The Pukekohe Hospital Plantroom Building was scored at 30%*NBS* (IL3) in the ISA. The structure has some particularly undesirable structural features including unreinforced masonry infill frames which have performed poorly in recent earthquakes. Due to its low occupancy and use only as a plant building housing the back-up generator and boilers for the main hospital unit, it has a low life-safety risk, however it's failure may have consequences on the operational continuity of the main hospital post-earthquake. We recommended a remedial solution was developed for this building to address the potential critical structural weaknesses.

The strengthening design process includes assessment of the existing structure directly and would thus avoid a double up of works.

Structural Description

The building is a single storey structure housing plant equipment critical for the function of the Pukekohe Hospital. The gravity and lateral load resisting system consists of reinforced concrete moment frames. The perimeter frames have URM infills to the frames and a single skin external veneer. There is no evidence of veneer ties but are likely to present (but ineffective). The transverse frames are occasionally infilled with a single layer of brick to form fire separations between different compartments of the building.

The roof is a doubly reinforced concrete slab which ties the frames together.

Summary of Concept Calculations

The critical structural weakness identified in the building is the unreinforced masonry (URM) walls failing out-of-plane. The key failure mechanisms evident in the structure are:

- Out-of-plane failure of the URM veneer 20%*NBS* (IL3)
- Shear failure of the concrete columns due to short-column effects 45%*NBS* (IL3)
- In-plane failure of the URM infill layer 50%*NBS* (IL3)
- Bare frame column flexural strength (URM removed) 80%*NBS* (IL3)

The exterior URM veneer is critical with a score of 20%*NBS* (IL3). There is no evidence of restraint to the top of these veneers, and the wall is thus required to cantilever from ground floor level.

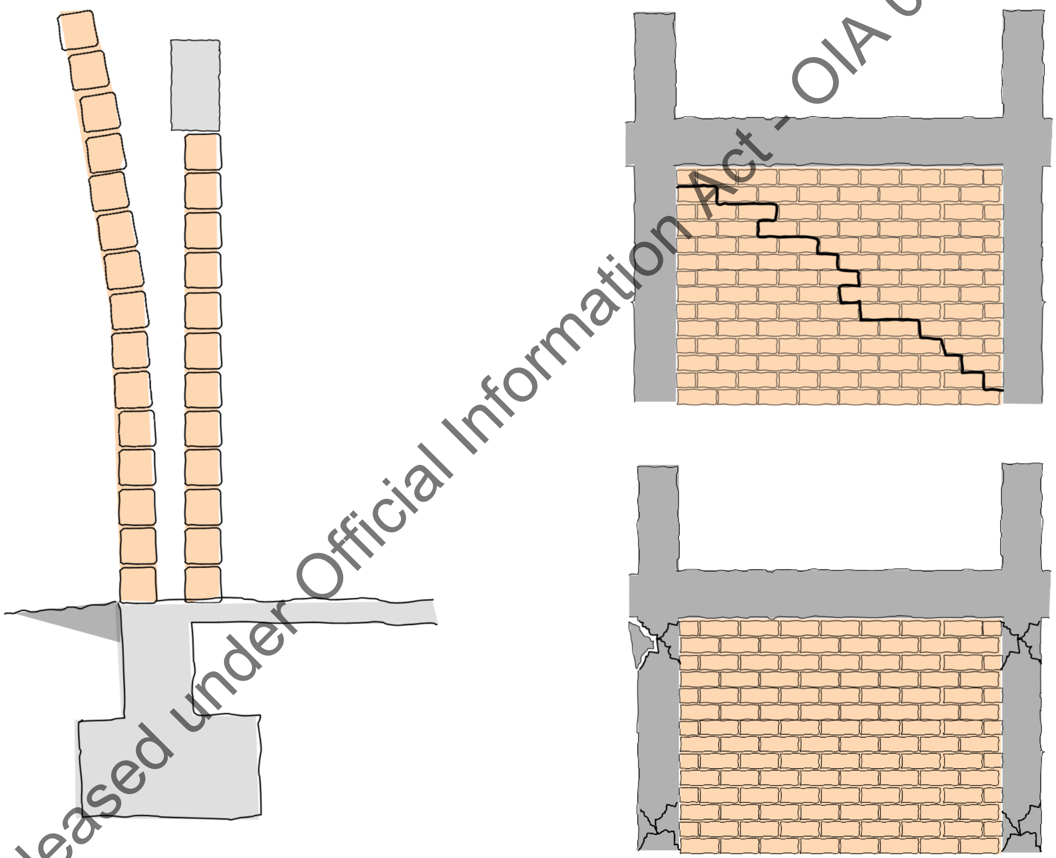


Figure 1: Clockwise - out-of-plane failure of the external veneer, direct tension failure of the URM infill, shear failure of the columns from short column effects

The column shear failure is caused by the development of compression struts in the brick infill. These struts are eccentric to the frame intersection points, forming large shear demands in the columns or beams. As the smaller infills fail progressively in compression, the load is distributed to the larger walls which fail the columns. The column failure in shear is non-ductile and deemed a loss of gravity support to the roof structure.

Our assessment of the existing structure methodology included checking the bare frame, in the scenario that the URM disconnected. Generally the bare frame scored well at 80 %*NBS* (IL3) governed by the flexural capacity of the base of the columns.

Strengthening Options

The building has a number of critical deficiencies, noted in the ISA and confirmed in the intrusive investigations. Based on the ISA results, the building is currently 'Earthquake Prone' (as it is less than 34%NBS (IL3)). The Auckland City Council Earthquake Prone Policy requires that for earthquake prone buildings:

- Are issued an Earthquake Prone Building (EPB) notice which must be displayed in a prominent location in the building. This notice informs the public and residents that the building is of a high risk.
- The building details are added to the national register of earthquake prone buildings
- Strengthening must occur within 35 years from the date of the EPB notice, such that the building is no longer earthquake-prone. If substantial alterations or change of use occurs within the 35 years, then the building must be strengthened at the same time

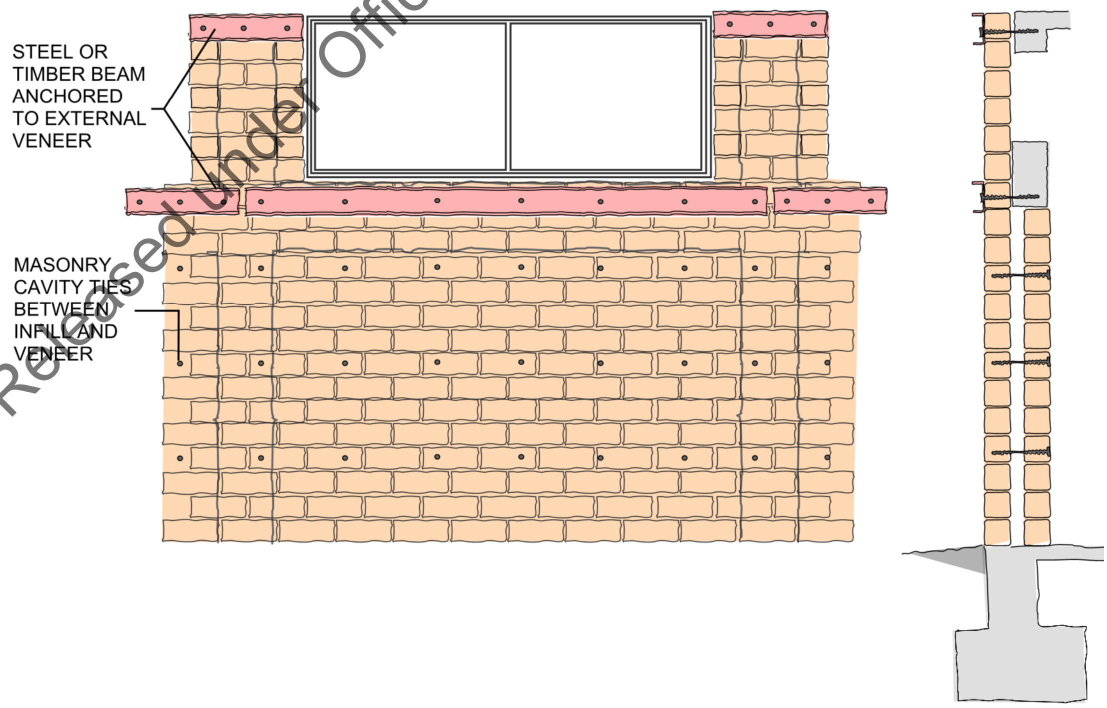
Because the building has limited occupancy, the life safety risk from its failure is relatively small, however the consequence on the operational continuity of the Pukekohe Hospital site is high.

We have developed three options at concept level for strengthening:

Option 1 – Do minimum - Strengthening to >34%NBS

This option would focus on strengthening the URM veneer and infills of the building through restraining the top of the veneer and tying the inner and outer layer of brick together.

The URM walls will have a timber or steel member connected at the top of the wall spanning horizontally between the concrete columns, or connected directly to the frame elements. This member provides restraint, improving the behaviour of the walls out-of-plane. An immediate improvement to approximately 45%*NBS* (IL3) would be expected from this.

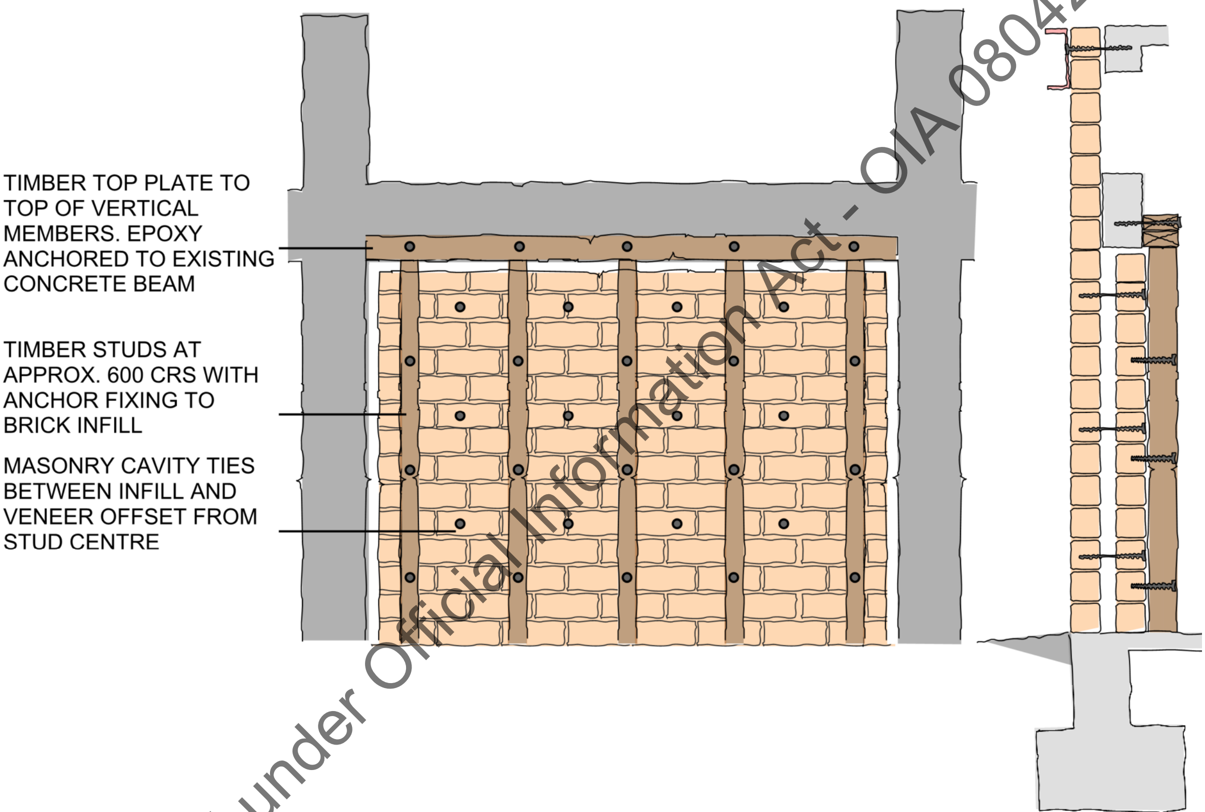


Option 2 – Do more - Strengthening to >67%NBS

This option focusses on strengthening the URM veneer and infills of the building in a more robust manner and reducing the shear demand of the concrete columns.

Timber strong backs at approximately 600 mm centres will be strapped to the internal face of the URM walls with proprietary masonry anchors (Python or Helifix), in combination with new cavity ties between the veneer and infill layers.

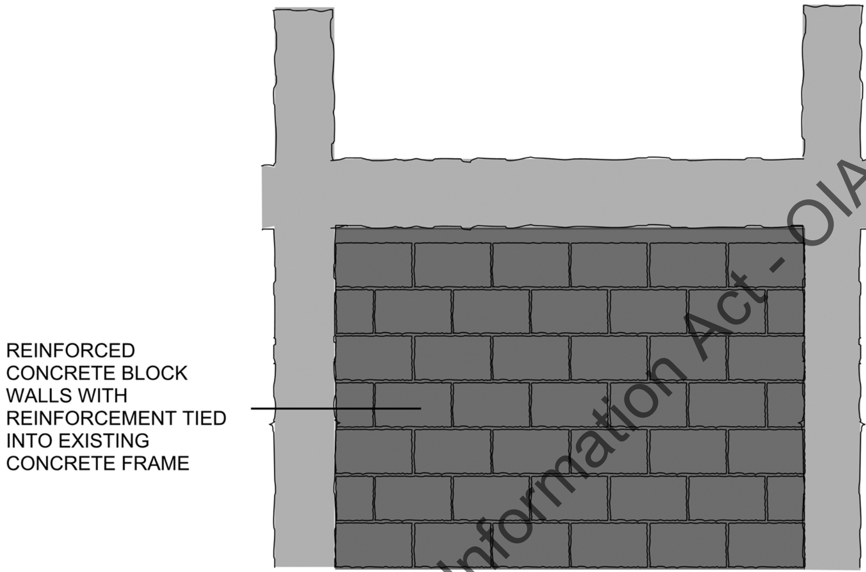
The brick infill layer will be disconnected from their surrounding concrete frames to prevent them 'locking up' under lateral loading. This will likely involve cutting a chase around the infill panel



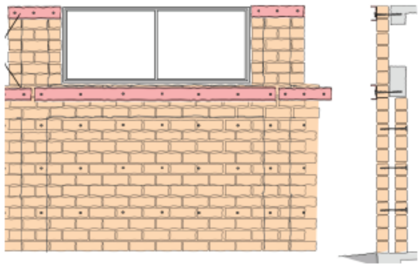
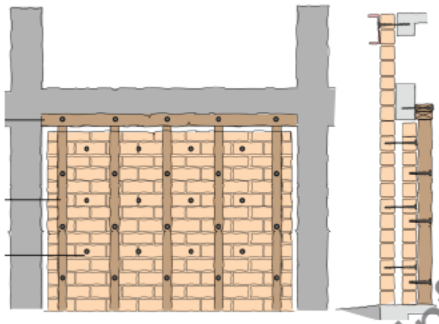
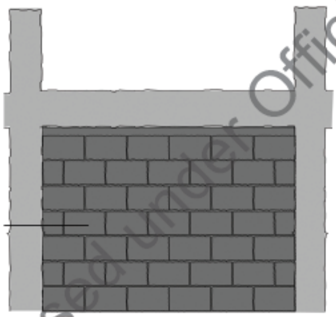
Option 3 – Do most - Strengthening to 100%NBS

This option will remove the URM walls completely, replacing them with a suitable fire-rated lining such as reinforced concrete block, or reinforced concrete shear walls. The replacement cladding / walls will act as the new lateral load resisting system, reducing the demand on the primary concrete frame.

This option will require the removal of the URM walls which will be very intrusive to the operations of the plant room building. Service ducts in the building may need to be re-routed or temporarily supported to allow removal of the brick walls.



The options can be summarised holistically in the table below:

Option No.		Likely Costs	Performance	Disruption
1		$$	👍	👎
2		$$	👍👍	👎
3		$$	👍👍👍	👎👎👎

Next Steps

Beca recommends that Option 2 is adopted as the best balance of improved seismic performance with minimised disruption.

Next steps from here are:

- CMH consider the above options, and confirm acceptance of our recommendation (proceeding with Option 2)
- We will then progress the detailed design and construction deliverable of the option chosen

Yours sincerely

[redacted]

[redacted]
Technical Director - Structural Engineering

on behalf of
Beca Limited

[redacted]

[redacted]

[redacted]
Structural Engineer

on behalf of
Beca Limited

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05 July 2019

Attention: [redacted] (Manager Capital Works)

Dear [redacted]

Strengthening Summary - Middlemore Building 30 - Esme Green

We have now completed our Detailed Seismic Assessment (DSA) of the Esme Green Building (Middlemore Building 30) at Middlemore Hospital, Auckland. The score of the building is 25%*NBS* (IL3) governed by the performance of several isolated shear wall elements. These shear wall elements have a disproportionate impact on the seismic rating to the building due to their importance to maintaining support to the floors and lateral stability of the building.

The purpose of this correspondence is to provide additional detail around strengthening options, including the implications of increasing the target strengthening level to sit above the potentially Earthquake Risk threshold of 67%*NBS*.

The graph below shows the relationship between the effort to strengthen (cost and intrusiveness on occupants) and the earthquake risk for the Esme Green building. It can be seen that the largest improvement in the earthquake risk is achieved by pushing the building from where it currently sits, to >34%*NBS*.

As the target level is increased, the strengthening costs and intrusiveness increase disproportionately for the Esme Green Building. This is due to the age and construction of the building. While there are few elements that are < 34%*NBS* , there are numerous members that sit in the Earthquake Risk range of 34 – 67%*NBS* and strengthening schemes would need to fundamentally change the structural system of the building.

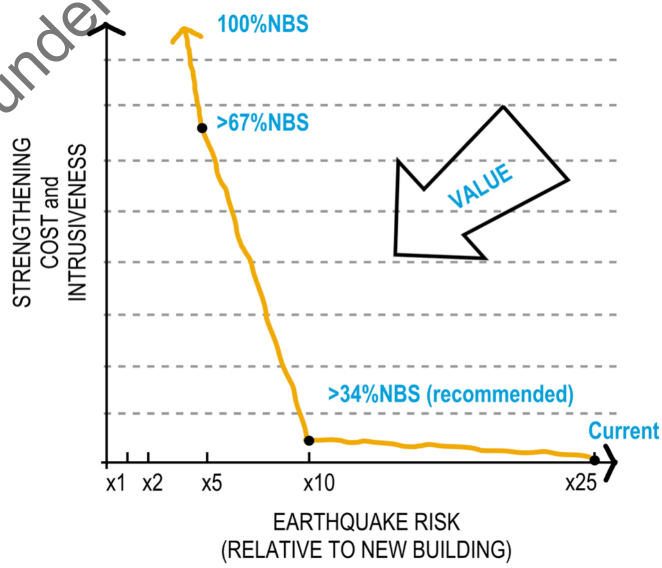

Figure 1: Graph of the relative earthquake risk and strengthening costs to improve

Strengthening to 35%*NBS* (Recommended)

The DSA report has provided high level concept strengthening schemes to bring the building's seismic rating to above 34%*NBS* (IL3). This strengthening targets the critical structural elements and features of the building that are currently less than 34%*NBS* (IL3). These elements are discrete and located in the South and East Wing buildings:

- South Wing
  - Strengthen existing wall - Wall at ground floor level on Gridline 9 (in main lobby of building near the lifts) – retrofit with thickening to the wall
- East Wing
  - Removal or fixing back of unreinforced masonry veneer above the egress paths to the building
  - New wall - Additional wall at eastern elevation of the building

The figure below highlights the extent of strengthening required to achieve 35%*NBS*. The North Wing and Linen Store building do not require any strengthening to meeting this strengthening target.

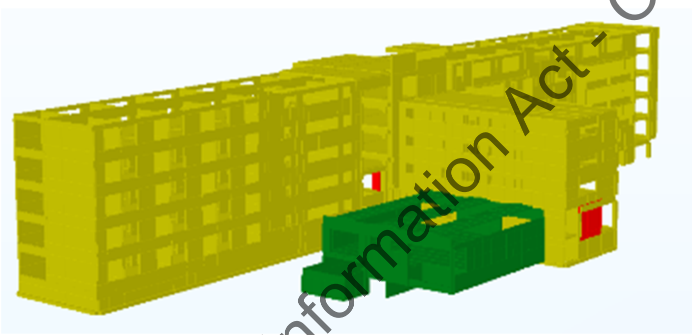

Figure 2: 3D view of the Esme Green structural model with the elements < 34%NBS shown in red

Strengthening to >67%*NBS*

The strengthening to achieve >67%*NBS* is much more extensive. Only the most critical walls, floor slabs and gravity frame elements (beams and columns) are reported in the DSA. Our analysis shows that there are numerous elements that would require strengthening. Localised strengthening to these elements would unlikely to be practical and more extensive fundamental revisions of the lateral load resisting systems would be required. This may include some or all of the following:

- New lateral load resisting system – the existing wall system makes the installation of retrofitted lateral load systems difficult. Steel bracing would unlikely be able to significantly improve the performance of the shear walls. New load paths would also need to be considered such as drag beams and concrete floor diaphragm strengthening. New multi-storey shear walls would likely be stiff enough, however would be difficult to construct.
- New energy dissipating devices – there are various mechanical devices designed to reduce the seismic demand on buildings by dissipating the energy imparted on the structure. Examples of these include friction sliders and viscous dampers.
- Seismic isolation – this would utilise the existing basement to provide an isolation plane. The seismic isolation would significantly reduce the seismic demands on the building, requiring limited work to the superstructure, however would involve extensive costs to implement.

While we do not have detailed costing for this scheme, we expect it to be orders of magnitude more than strengthening to 35%*NBS*.

Recommendations

We recommend that Option 1 (strengthening to 35*%NBS*) is pursued by Counties Manukau Health on the basis that it provides the best value and a 'sweet spot' between investment in strengthening and reduction in the seismic risk It is our understanding that the Esme Green building is not part of CMH's long-term plan for the site and hence any major investment in the building is non-preferred.

Please do not hesitate to contact us if you have any questions regarding the content of this letter.

[redacted]

[redacted]

Technical Director – Structural Engineering

on behalf of

Beca Limited

[redacted]

[redacted]

[redacted]

Structural Engineer

on behalf of

Beca Limited

[redacted]

Copy to: [redacted]