Christchurch City Council
BE 0574 EQ2 (excluding BU 0574-003)
Aorangi Elderly Persons Home
110 Aorangi Road

QUANTITATIVE REPORT
FINAL

- Rev C
- 30 April 2013

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QUANTITATIVE ASSESSMENT REPORT

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1. Executive Summary

1.1. Background

A quantitative assessment was carried out on the buildings in Aorangi Court at 110 Aorangi Road, Bryndwr. There are eight buildings on the site, two of which are two storeys high, with the remainder single storey. There are seven blocks of residential units and one storage shed. One of the single storey buildings is constructed from lightweight timber-framing, while the others are constructed from combined masonry and timber wall systems. All of the buildings have a timber-framed roof with all but Building B having heavy tile roofing. An aerial photograph illustrating Aorangi Courts is shown below in Figure 1. Detailed descriptions outlining the age and construction type of the buildings are given in Section 5 of this report and drawings from 1977 Appendix I. For the purposes of this report block numbering is used instead of asset numbering. The block numbering is as follows:

- BU 0574-001 EQ2 – Block A
- BU 0574-002 EQ2 – Block B & Residential Lounge
- BU 0574-004 EQ2 – Block C
- BU 0574-005 EQ2 – Block D
- BU 0574-006 EQ2 – Block E
- BU 0574-007 EQ2 – Block F
- BU 0574-008 EQ2 – Block G
- BU 0574-003 EQ2 – SHED (Excluded from Quantitative assessment)

Figure 1 Aerial Photograph of 110 Aorangi Road

This Quantitative report for the building structure is based on the Engineering Advisory Group's "Guidance on Detailed Engineering Evaluation of Earthquake Affected Non-residential Buildings" (draft) July 2011, visual inspections on 17 September 2012, Architectural and Structural drawings for building A and C to G dated 1977 and SKM calculations.

1.2. Key Damage Observed

1.2.1. Blocks A, C, D, E, F, G

Key damage observed includes:-

- Step cracking along mortar joints
- Tearing of internal wall and ceiling linings throughout the buildings

1.2.2. Block B & Residential Lounge

Key damage observed includes:-

- Cracking in concrete footing and external ground slab
- Tearing of internal wall and ceiling linings throughout the building

A more detailed account of the damage can be found in section 5.

1.3. Critical Structural Weaknesses

No potential critical structural weaknesses have been identified for these buildings.

1.4. Indicative Building Strength

As described in the Engineering Advisory Group's "Guidance on Detailed Engineering Evaluation of Earthquake Affected Non-residential Buildings" (draft) July 2011, we have assessed the capacity of the building as a percentage new building standard seismic resistance using the quantitative method. Our assessment included consideration of geotechnical conditions, existing earthquake damage to the building and structural engineering calculations to assess both strength and ductility/resilience.

The assessments were based on the following:

- On-site investigation to assess the extent of existing earthquake damage.
- Qualitative assessment of critical structural weaknesses (CSWs) based on review of available structural drawings and inspection where drawings were not available.
- Geotechnical Desk Study by SKM on 8 February 2013 (Appendix J). No detailed geotechnical investigation has been undertaken.
- Assessment of the strength of the existing structures taking account of the current condition.

Any building that is found to have a seismic capacity less than 34% of the new building standard (NBS) is required to be strengthened up to a capacity of at least 34%NBS in order to comply with Christchurch City Council (CCC) policy – Earthquake-prone dangerous & insanitary buildings policy 2010.

1.4.1. Blocks A

Based on the information available, and using the Quantitative assessment procedure, the building has a capacity in the order of **37% NBS**. The damage observed during the site investigation was not significant, therefore the post earthquake capacity will not change as a result of earthquake damage.

1.4.2. Block B & Residential Lounge

Based on the information available, and using the Quantitative assessment procedure, the buildings have a capacity in the order of **58% NBS.** The damage observed during the site investigation was not significant, therefore the post earthquake capacity will not change as a result of earthquake damage.

1.4.3. Block C

Based on the information available, and using the Quantitative assessment procedure, the building has a capacity in the order of **38%NBS**. The damage observed during the site investigation was not significant, therefore the post earthquake capacity will not change as a result of earthquake damage.

1.4.4. Block D

Based on the information available, and using the Quantitative assessment procedure, the building has a capacity in the order of **39%NBS**. The damage observed during the site investigation was not significant, therefore the post earthquake capacity will not change as a result of earthquake damage.

1.4.5. Block E

Based on the information available, and using the Quantitative assessment procedure, the buildings have a capacity in the order of **40%NBS**. The damage observed during the site investigation was not significant, therefore the post earthquake capacity will not change as a result of earthquake damage.

1.4.6. Block F

Based on the information available, and using the Quantitative assessment procedure, the building has a capacity in the order of **40%NBS**. The damage observed during the site investigation was not significant, therefore the post earthquake capacity will not change as a result of earthquake damage.

1.4.7. Block G

Based on the information available, and using the Quantitative assessment procedure, the building has a capacity in the order of **37% NBS.** The damage observed during the site investigation was not significant, therefore the post earthquake capacity will not change as a result of earthquake damage.

1.5. Recommendations

1.5.1. Blocks A, B, C, D, E, F & G

The quantitative assessments carried out on the Aorangi Court buildings indicate that buildings A through G have seismic capacities more than 33% of NBS and less than 67% of NBS. Such capacity would lead to the building being considered as in the category 'moderate risk buildings' which are acceptable legally, but recommended to be improved.

Our key findings and recommendations are:

a) There is no damage to the buildings that would cause them to be unsafe to occupy.
b) Barriers around the building are not necessary.
c) Options to bring buildings to a target of 67% are investigated.

While structural strengthening is not legally required the performance of blocks B, C, D, E and F could be improved by replacing the current heavy roofing with a lightweight alternative such as profiled metal cladding and/or relining internal timber stud walls with structural plywood lining.

Strengthening of Blocks A & G would be a question of further (and likely more intrusive) structural improvements than outlined above.

2. Introduction

Sinclair Knight Merz was engaged by Christchurch City Council to carry out a Quantitative Assessment of the seismic performance of Aorangi Elderly Persons Home located at 110 Aorangi Road. Building numbering is defined in Figure 1 Aerial Photograph of 110 Aorangi Road.

The scope of this quantitative analysis includes the following:

- Analysis of the seismic load carrying capacity of the building compared with current seismic loading requirements or New Buildings Standard (NBS). It should be noted that this analysis considers the building in its damaged state where appropriate.
- Identify any critical structural weaknesses which may exist in the building and include these in the assessed %NBS of the structure.
- Preparation of a summary report outlining the areas of concern in the building.

The recommendations from the Engineering Advisory Group[1] were followed to assess the likely performance of the structures in a seismic event relative to the new building standard (NBS). 100% NBS is equivalent to the strength of a building that fully complies with current codes. This includes a recent increase of the Christchurch seismic hazard factor from 0.22 to 0.3[2].

The previous qualitative assessment identified that the seismic capacity of the building was likely to be less than 33% of the new building standard (NBS). A quantitative assessment was recommended to confirm the initial assessment findings and to determine a more accurate seismic rating of the building.

At the time of this report, no intrusive site investigation had been carried out. Architectural and Structural drawings were made available, and these have been considered in our evaluation of the buildings. The building descriptions below are based on a review of the drawings and our visual inspections.

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[1] EAG 2011, *Guidance on Detailed Engineering Evaluation of Earthquake Affected Non-residential Buildings in Canterbury - Draft*, p 10

[2] http://www.dbh.govt.nz/seismicity-info

3. Compliance

This section contains a brief summary of the requirements of the various statutes and authorities that control activities in relation to buildings in Christchurch at present.

3.1. Canterbury Earthquake Recovery Authority (CERA)

CERA was established on 28 March 2011 to take control of the recovery of Christchurch using powers established by the Canterbury Earthquake Recovery Act enacted on 18 April 2011. This act gives the Chief Executive Officer of CERA wide powers in relation to building safety, demolition and repair. Two relevant sections are:

Section 38 – Works

This section outlines a process in which the chief executive can give notice that a building is to be demolished and if the owner does not carry out the demolition, the chief executive can commission the demolition and recover the costs from the owner or by placing a charge on the owners' land.

Section 51 – Requiring Structural Survey

This section enables the chief executive to require a building owner, insurer or mortgagee carry out a full structural survey before the building is re-occupied.

We understand that CERA will require a detailed engineering evaluation to be carried out for all buildings (other than those exempt from the Earthquake Prone Building definition in the Building Act). It is anticipated that CERA will adopt the Detailed Engineering Evaluation Procedure document (draft) issued by the Structural Advisory Group on 19 July 2011. This document sets out a methodology for both qualitative and quantitative assessments.

The qualitative assessment is a desk-top and site inspection assessment. It is based on a thorough visual inspection of the building coupled with a review of available documentation such as drawings and specifications. The quantitative assessment involves analytical calculation of the buildings strength and may require non-destructive or destructive material testing, geotechnical testing and intrusive investigation.

It is anticipated that factors determining the extent of evaluation and strengthening level required will include:

- The importance level and occupancy of the building
- The placard status and amount of damage
- The age and structural type of the building
- Consideration of any critical structural weaknesses

- The extent of any earthquake damage

3.2. Building Act

Several sections of the Building Act are relevant when considering structural requirements:

3.2.1. Section 112 – Alterations

This section requires that an existing building complies with the relevant sections of the Building Code to at least the extent that it did prior to any alteration. This effectively means that a building cannot be weakened as a result of an alteration (including partial demolition).

3.2.2. Section 115 – Change of Use

This section requires that the territorial authority (in this case Christchurch City Council (CCC)) be satisfied that the building with a new use complies with the relevant sections of the Building Code 'as near as is reasonably practicable'. Regarding seismic capacity 'as near as reasonably practicable' has previously been interpreted by CCC as achieving a minimum of 67%NBS however where practical achieving 100%NBS is desirable. The New Zealand Society for Earthquake Engineering (NZSEE) recommend a minimum of 67%NBS.

3.2.3. Section 121 – Dangerous Buildings

The definition of dangerous building in the Act was extended by the Canterbury Earthquake (Building Act) Order 2010, and it now defines a building as dangerous if:

- in the ordinary course of events (excluding the occurrence of an earthquake), the building is likely to cause injury or death or damage to other property; or
- in the event of fire, injury or death to any persons in the building or on other property is likely because of fire hazard or the occupancy of the building; or
- there is a risk that the building could collapse or otherwise cause injury or death as a result of earthquake shaking that is less than a 'moderate earthquake' (refer to Section 122 below); or
- there is a risk that that other property could collapse or otherwise cause injury or death; or
- a territorial authority has not been able to undertake an inspection to determine whether the building is dangerous.

3.2.4. Section 122 – Earthquake Prone Buildings

This section defines a building as earthquake prone if its ultimate capacity would be exceeded in a 'moderate earthquake' and it would be likely to collapse causing injury or death, or damage to other property. A moderate earthquake is defined by the building regulations as one that would generate ground shaking 33% of the shaking used to design an equivalent new building.

3.2.5. Section 124 – Powers of Territorial Authorities

This section gives the territorial authority the power to require strengthening work within specified timeframes or to close and prevent occupancy to any building defined as dangerous or earthquake prone.

3.2.6. Section 131 – Earthquake Prone Building Policy

This section requires the territorial authority to adopt a specific policy for earthquake prone, dangerous and insanitary buildings.

3.3. Christchurch City Council Policy

Christchurch City Council adopted their Earthquake Prone, Dangerous and Insanitary Building Policy in 2006. This policy was amended immediately following the Darfield Earthquake of the 4th September 2010.

The 2010 amendment includes the following:

- A process for identifying, categorising and prioritising Earthquake Prone Buildings, commencing on 1 July 2012;
- A strengthening target level of 67% of a new building for buildings that are Earthquake Prone. Council recognises that it may not be practicable for some repairs to meet that target. The council will work closely with building owners to achieve sensible, safe outcomes;
- A timeframe of 15-30 years for Earthquake Prone Buildings to be strengthened; and,
- Repair works for buildings damaged by earthquakes will be required to comply with the above.

The council has stated their willingness to consider retrofit proposals on a case by case basis, considering the economic impact of such a retrofit.

We anticipate that any building with a capacity of less than 33%NBS (including consideration of critical structural weaknesses) will need to be strengthened to a target of 67%NBS of new building standard as recommended by the Policy.

If strengthening works are undertaken, a building consent will be required. A requirement of the consent will require upgrade of the building to comply ‘as near as is reasonably practicable’ with:

- The accessibility requirements of the Building Code.
- The fire requirements of the Building Code. This is likely to require a fire report to be submitted with the building consent application.

3.4. Building Code

The building code outlines performance standards for buildings and the Building Act requires that all new buildings comply with this code. Compliance Documents published by The Department of Building and Housing can be used to demonstrate compliance with the Building Code.

After the February Earthquake, on 19 May 2011, Compliance Document B1: Structure was amended to include increased seismic design requirements for Canterbury as follows:

a) Hazard Factor increased from 0.22 to 0.3 (36% increase in the basic seismic design load)
b) Serviceability Return Period Factor increased from 0.25 to 0.33 (80% increase in the serviceability design loads when combined with the Hazard Factor increase)

The increase in the above factors has resulted in a reduction in the level of compliance of an existing building relative to a new building despite the capacity of the existing building not changing.

4. Earthquake Resistance Standards

For this assessment, the building's earthquake resistance is compared with the current New Zealand Building Code requirements for a new building constructed on the site. This is expressed as a percentage of new building standard (%NBS). The new building standard load requirements have been determined in accordance with the current earthquake loading standard (NZS 1170.5:2004 Structural design actions - Earthquake actions - New Zealand).

The likely capacity of this building has been derived in accordance with the New Zealand Society for Earthquake Engineering (NZSEE) guidelines 'Assessment and Improvement of the Structural Performance of Buildings in Earthquakes' (AISPBE), 2006. These guidelines provide an Initial Evaluation Procedure that assesses a buildings capacity based on a comparison of loading codes from when the building was designed and currently. It is a quick high-level procedure that can be used when undertaking a Qualitative analysis of a building. The guidelines also provide guidance on calculating a modified Ultimate Limit State capacity of the building which is much more accurate and can be used when undertaking a Quantitative analysis.

The New Zealand Society for Earthquake Engineering has proposed a way for classifying earthquake risk for existing buildings in terms of %NBS and this is shown in Figure 2 below.

Description	Grade	Risk	%NBS	Existing Building Structural Performance	Improvement of Structural Performance	
					Legal Requirement	NZSEE Recommendation
Low Risk Building	A or B	Low	Above 67	Acceptable (improvement may be desirable)	The Building Act sets no required level of structural improvement (unless change in use) This is for each TA to decide. Improvement is not limited to 34%NBS.	100%NBS desirable. Improvement should achieve at least 67%NBS
Moderate Risk Building	B or C	Moderate	34 to 66	Acceptable legally. Improvement recommended		Not recommended. Acceptable only in exceptional circumstances
High Risk Building	D or E	High	33 or lower	Unacceptable (Improvement	Unacceptable	Unacceptable

Figure 2: NZSEE Risk Classifications Extracted from table 2.2 of the NZSEE 2006 AISPBE Guidelines

Table 1 below compares the percentage NBS to the relative risk of the building failing in a seismic event with a 10% risk of exceedance in 50 years (i.e. 0.2% in the next year). It is noted that the current seismic risk in Christchurch results in a 6% risk of exceedance in the next year.

- **Table 1: %NBS compared to relative risk of failure**

Percentage of New Building Standard (%NBS)	Relative Risk (Approximate)
>100	<1 time
80-100	1-2 times
67-80	2-5 times
33-67	5-10 times
20-33	10-25 times
<20	>25 times

5. Building Details

5.1. Blocks A & G

5.1.1. Building Description

The buildings contain two storeys and are currently utilised as residential units, with each block containing two units upstairs and two downstairs.

The building is constructed of a combination of reinforced masonry and timber stud walls, supplemented by small cast in situ concrete frame providing longitudinal stability at ground floor level (refer to drawings in Appendix I or simplified wall layouts in Figure 3 & Figure 4 below).

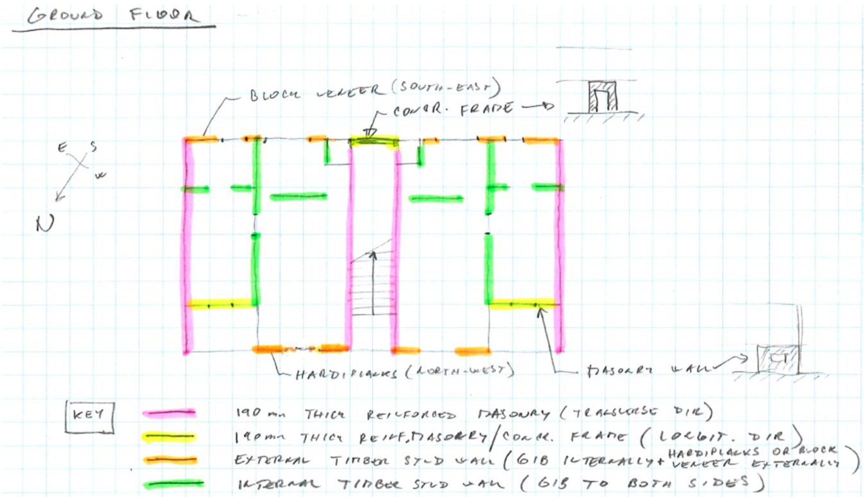


Figure 3: Block A & G - Ground Floor - Wall Layout

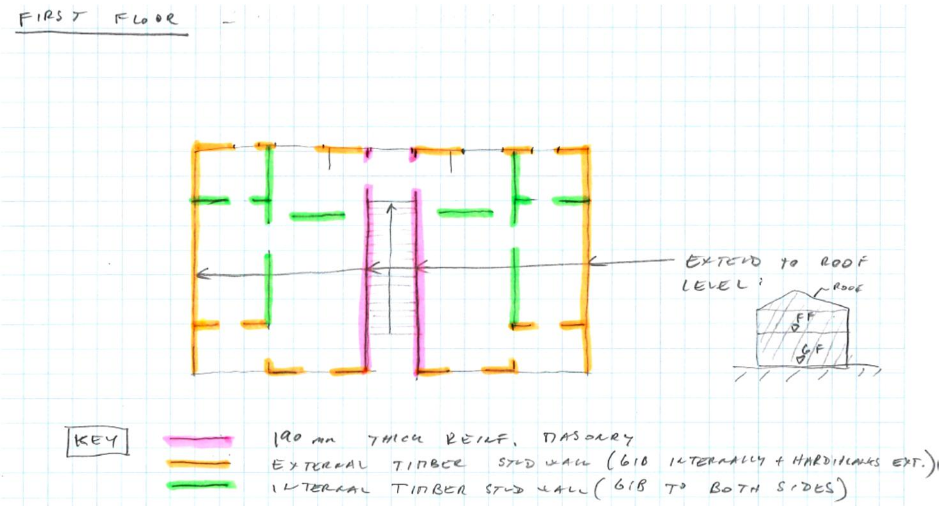


Figure 4: Block A & G - First Floor - Wall Layout

The upper storey floor is precast concrete slabs with a cast in-situ topping acting as a diaphragm, while the wall and ceiling linings on both levels is plasterboard. The roofs are constructed from timber gang nail trusses with concrete tile cladding (but no sarking). The ground floors are supported on a concrete slab foundation. The masonry walls and the small concrete frame are supported on reinforced concrete strip footings.

5.1.2. Gravity Load Resisting System

Gravity loads are taken by the timber gang nail trusses in the roof and transferred to the perimeter longitudinal walls. Loads at first floor are transferred to the ground floor masonry walls through the concrete floor spanning in longitudinal direction. These loads are transferred into bearing on the soil by reinforced concrete strip foundations.

5.1.3. Seismic Load Resisting System

At the roof level, the lateral loads in the transverse direction are transferred by the trusses into the ceiling fixed to the underside and redistributed into walls below running parallel to the trusses.

In longitudinal direction, since there is no roof sarking, the lateral loads are transferred by axial loading in roof tile battens into the two internal masonry walls running in the transverse direction, which transfer the load into the ceiling diaphragm. The forces are then redistributed through ceiling diaphragm into the walls running in longitudinal direction, although a certain portion of these forces are resisted by the out of plane flexure of the two internal masonry walls.

At the first floor level the lateral forces are redistributed into the supporting masonry walls and small concrete frame via the concrete floor slab which acts as a diaphragm.

Lateral loads at ground level have been omitted from consideration of seismic assessment. It is assumed that horizontal forces will be resisted by friction between ground bearing slab and ground below.

Horizontal forces at foundation level are resisted by friction and ground pressures between the surrounding soil and foundations.

5.2. Block B & Residential Lounge

5.2.1. Building Description

The building is a single storey building that is divided into a residential lounge and one residential unit. The building is constructed from timber framed walls and weatherboard cladding. Plasterboard lining is used on the walls and ceiling to create diaphragms. The roof is constructed from timber framing with metal corrugated roof sheeting. The ground floor is supported by a concrete perimeter strip footing and is assumed to be supported on timber piles. There is a 1.75m wide chimney on the south side of the building that is assumed to be constructed from concrete masonry in the absence of structural drawings.

5.2.2. Gravity Load Resisting System

Gravity loads are taken by the timber trusses in the roof and walls and are transferred into the ground through the timber framed walls and perimeter strip footings and internal piles.

5.2.3. Seismic Load Resisting System

Lateral loads acting across and along the building are resisted by the plasterboard bracing in the timber-framed walls and transferred into the timber floor diaphragm in the floor and into the timber piles and strip footings below.

Note that for this building the ‘across direction’ has been taken as north-south and the ‘along direction’ has been taken as east-west.

5.3. Blocks C, D, E & F

5.3.1. Building Description

The buildings are single storey structures and containing four or five self contained residential units separated by full height masonry walls. Plasterboard lining is used on the walls and ceilings. The roof is constructed from timber trusses with concrete tile roofing. The ground floor is a concrete slab on grade. The masonry walls are supported by concrete strip footings. Some of residential units are staggered in alignment across the building up to 3.2m. The distance of the offset and the number of units that are offset vary with each Block. See Figure 1 Aerial Photograph of 110 Aorangi Road.

5.3.2. Gravity Load Resisting System

Gravity loads are taken by the timber framing in the roof and transferred into the longitudinal light timber framed masonry clad walls and down into the concrete perimeter strip footings below. Concrete masonry walls between units are supported by concrete strip foundations.

5.3.3. Seismic Load Resisting System

Lateral loads acting across the building are transferred from the roof through the roof trusses into the timber framed walls which span between the transverse masonry walls which resist load through shear and transfer loads to the ground through concrete strip foundations. In the longitudinal direction roof loads are transferred to the longitudinal light timber framed walls through shear of the roof trusses and transferred to the concrete strip foundations through the plasterboard lining. In addition out of plane masonry wall loads are transferred to the light timber framed walls through the roof diaphragms. Masonry loads are transferred to the ground and roof diaphragm through vertical bending.

Note that for this building the 'across direction' has been taken as north-south and the 'along direction' has been taken as east-west.

5.4. Building Damage

SKM undertook an inspection on 17 September 2012. The following areas of damage were observed during the time of inspection:

General

1) No visual evidence of settlement was noted at this site and the neighbouring sites are classified as TC2 land[3]. Therefore a level survey is not necessary at this stage of assessment.

Block A Damage

1) Crack through masonry block (8mm wide) (refer to Photo 5 in Appendix 1).
2) Step cracking along masonry joints (up to 2mm wide) (refer to Photo 6 in Appendix 1).
3) Tearing of wall and ceiling lining/bracing along joints.
4) Cracking between masonry wall and aluminium window frame (refer to Photo 7 in Appendix 1).
5) Hairline crack in the concrete topping slab of the first floor (refer to Photo 9 in Appendix 1).
6) Indication of repaired earthquake damage. Stepped cracks looks to have been repaired and repainted with a different colour (refer to Photo 8 in Appendix 1).

Photos of the above damage can be found in Block A Photos.

Block B & Residential Lounge Damage

1) Cracking in concrete footing and external ground slab.
2) Cracking between timber cladding elements.
3) Tearing of wall and ceiling lining/bracing along joints.
4) Water damage was noted in the ceiling and along the south wall. Non earthquake related (refer to Photo 10 in Appendix 2).

Photos of the above damage can be found in Block B & Residential Lounge Photos.

[3] http://cera.govt.nz/maps/technical-categories

Block C Damage

1) Step cracking along masonry joints.
2) Tearing of wall and ceiling lining/bracing along joints.
3) Dislodged masonry block creating a gap between timber roof edge beam at the apex and the top of the masonry wall, apparently reducing the weather tightness of the building. It was noted that plywood sheeting had been placed in this area on the other end of the building (refer to Photo 5 in Appendix 3).
4) It was noted that square sections of the roof were covered with waterproof material and secured on all sides. This is unlikely to be earthquake damage (refer to Photo 11 in Appendix 3).

Photos of the above damage can be found in Block C Photos.

Block D Damage

1) Step cracking along masonry joints.
2) Tearing of wall and ceiling lining along joints.
3) It was noted that plywood sheeting had been placed in the area around the timber roof edge beam at the apex and the top of the masonry wall (refer to Photo 4 in Appendix 4).

Photos of the above damage can be found in Block D Photos.

Block E Damage

1) Step cracking along masonry joints.
2) Cracking in external concrete ground slab.
3) Tearing of wall and ceiling lining/bracing along joints.
4) Gap between timber roof edge beam at the apex and the top of the masonry wall. This is believed to be a construction issue instead of earthquake damage as the angle the block was cut at did not line up with the edge beam (refer to Photo 8 in Appendix 5).
5) On the other end of the building it was noted that there was a substantial gap horizontally between the edge beam and the masonry wall. This is believed to be a construction issue instead of earthquake damage as there appears to be no connection between these elements on other Blocks as well (refer to Photo 9 in Appendix 5).

Photos of the above damage can be found in Block E Photos.

Block F Damage

1) Step cracking along masonry joints.
2) Gaps opening up between external timber roof elements.
3) Cracking in external concrete ground slab.
4) Tearing of wall and ceiling lining/bracing along joints.
5) Dislodged masonry block creating a gap between timber roof edge beam at the apex and the top of the masonry wall. It was noted that plywood sheeting had been placed in this area on the other end of the building (refer to Photo 7 in Appendix 6).
6) It was noted that square sections of the roof were covered with waterproof material and secured on all sides. This is unlikely to be earthquake damage (refer to Photo 11 in Appendix 3).

Photos of the above damage can be found in Block F Photos.

Block G Damage

1) Step cracking along masonry joints.
2) Tearing of wall and ceiling lining along joints.
3) Cracking in external concrete ground slab.
4) Ceiling lining peeling off in a Unit on the top floor. This is not believed to be earthquake-related damage.

Photos of the above damage can be found in Block G Photos.

6. Available Information and Assumptions

6.1. Available Information

Following our inspections on the 17th September 2012, SKM carried out a seismic review on the structures. This review was undertaken using the available information which was as follows:

- Architectural (Ian Krause Associates) and Structural (A.E Tyndall) drawings of Buildings A, C, D, E, F, G dated 1977.
- Architectural plans for the renovation of Building B 1977 (Ian Krause Associates).

6.2. Survey

A Level survey was not deemed necessary for blocks B, C, D, E, F and G.

Partial verticality survey of the ground floor wall to the north-west corner of the block A was carried out on 15 April 2013 (Appendix K). This survey indicated that the out of verticality slightly exceeded construction tolerance, but was of insignificant structural importance.

6.3. Assumptions

The assumptions made in undertaking the assessment include:

- The building was built according to the drawings and according to good practice at the time. We have reviewed the building and from our visual inspection the structure appears to be built in accordance with the drawings.
- The soil on site is class D as described in AS/NZS1170.5:2004, Clause 3.1.3, Soft Soil. This is a conservative assumption based on our experience of soils around Christchurch. The ultimate bearing capacity on site is 300kPa, we believe that this assumption is reasonable. Liquefaction does not need to be accounted for in the foundation design. The latter two assumptions assume that the ground conditions classify as “good ground” as defined in NZS3604:2011.
- Standard design assumptions for typical office and factory buildings as described in AS/NZS1170.0:2002:
  - 50 year design life, which is the default NZ Building Code design life.
  - Structure importance level 2. This level of importance is described as ‘normal’ with medium or considerable consequence for loss of human life, or considerable economic, social or environmental consequence of failure.
- The building has a short period less than 0.4 seconds.
- Site hazard factor, Z = 0.3, NZBC, Clause B1 Structure, Amendment 11 effective from 1 August 2011

- The following ductility criteria used in the building:

Table 2: Assumed Building Ductility

Material	Ductility of Building in Current State	Ductility of Building in Strengthened State
Timber	2.0	2.0
Masonry	1.25	1.25

Nominal ductility has been assumed for masonry as it could not be shown that all elements within the load paths have been detailed to reach higher ductility. Where timber framing and plasterboard linings are the primary load path a ductility of 2.0 has been used.

For the overall building stability assessment, ductility of 1.25 throughout has been assumed.

- The following material properties were used in the analyses:

Table 3: Material Properties

Material	Nominal Strength	Structural Performance
Masonry (reinforced)	f_m = 12MPa	S_p = as per NZS 1170.5, Cl.4.4
Concrete	f_c’ = 25MPa	S_p = as per NZS 1170.5, Cl.4.4
Reinforcement	fy = 250MPa	S_p = as per NZS 1170.5, Cl.4.4
Timber - No 1 Fr.	f_b = 10MPa & f_c = 15MPa	S_p = as per NZS 1170.5, Cl.4.4

The detailed engineering analysis is a post construction evaluation. Since we did not design or monitor the construction of the building it has the following limitations:

- It is not likely to pick up on any concealed construction errors (if they exist)
- Other possible issues that could affect the performance of the building such as corrosion and modifications to the structure will not be identified unless they are visible and have been specifically mentioned in this report.
- The detailed engineering evaluation deals only with the structural aspects of the structure. Other aspects such as building services are not covered.

6.4. The Detailed Engineering Evaluation (DEE) process

The DEE is a procedure written by the Department of Building and Housing’s Engineering Advisory Group and grades buildings according to their likely performance in a seismic event. The procedure is not yet recognised by the NZ Building Code but is widely used and recognised by the

Christchurch City Council as the preferred method for preliminary seismic investigations of buildings[4].

The procedure of the DEE is as follows:

1) Qualitative assessment procedure
    a. Determine the building's status following any rapid assessment that have been done
    b. Review any existing documentation that is available. This will give the engineer an understanding of how the building is expected to behave. If no documentation is available, site measurements may be required
    c. Review the foundations and any geotechnical information available. This will include determining the zoning of the land and the likely soil behaviour, a site investigation may be required
    d. Investigate possible Critical Structural Weaknesses (CSW) or collapse hazards
    e. Assess the original and post earthquake strength of the building (this assessment is subsequently superseded by the quantitative assessment)
2) Quantitative procedure
    a. Carry out a geotechnical investigation if required by the qualitative assessment
    b. Analyse the building according to current building codes and standards. Analysis accounts for damage to the building.

The DEE assessment ranks buildings according to how well they are likely to perform relative to a new building designed to current earthquake standards, as shown in Table 4. The building rank is indicated by the percent of the required new building standard (%NBS) strength that the building is considered to have. Earthquake prone buildings are defined as having less than 33 %NBS strength which correlates to an increased risk of approximately 20 times that of 100% NBS[5]. Buildings that are identified to be earthquake prone are required by law to be strengthened within 30 years of the owner being notified that the building is potentially earthquake prone[6].

[5] NZSEE 2006, *Assessment and Improvement of the Structural Performance of Buildings in Earthquakes*, p 2-2
[6] http://resources.ccc.govt.nz/files/EarthquakeProneDangerousAndInsanitaryBuildingsPolicy2010.pdf

Table 4: DEE Risk classifications, below contains the likely new recommendations.

- **Table 4: DEE Risk classifications**

Description	Grade	Risk	%NBS	Structural performance
Low risk building	A+	Low	> 100	Acceptable. Improvement may be desirable.
	A		100 to 80	
	B		80 to 67	
Moderate risk building	C	Moderate	67 to 33	Acceptable legally. Improvement recommended.
High risk building	D	High	33 to 20	Unacceptable. Improvement required.
	E		< 20	

The DEE method rates buildings based on the plans (if available) and other information known about the building and some more subjective parameters associated with how the building is detailed and so it is possible that %NBS derived from different engineers may differ.

This assessment describes only the likely seismic Ultimate Limit State (ULS) performance of the building. The ULS is the level of earthquake that can be resisted by the building without catastrophic failure. The DEE does also consider Serviceability Limit State (SLS) performance of the building and or the level of earthquake that would start to cause damage to the building but this result is secondary to the ULS performance.

The NZ Building Code describes that the relevant codes for NBS are primarily:

- AS/NZS 1170 parts 0, 1 and 5 Structural Design Actions
- NZS 3101:2006 Concrete Structures Standard
- NZS 3404:1997 Steel Structures Standard
- NZS 2606:1993 Timber Structures Standard
- NZS 4230:1990 Design of Reinforced Concrete Masonry Structures

7. Results and Discussions

7.1. Critical Structural Weaknesses

No potential critical structural weaknesses have been identified for these buildings.

7.2. Analysis Results

The equivalent static force method was used to analyse the seismic capacity of buildings A, C-G and NZS 3604:2011 Bracing units have been used for building B. The results of the analysis are reported in the following table as %NBS. The results below are calculated for the building in its damaged state. The building results have been broken down into their seismic resisting elements by building.

(%NBS = the reliable strength / new building standards)

- **Table 5: DEE Results**

Seismic Resisting Element	Action	Seismic Rating %NBS
Blocks A and G		
Masonry Walls – Ground Floor	In plane response - bending	37%
	In plane response - shear	73%
	Out of plane response – bending	> 100%
Masonry Walls – First Floor	In plane response - shear	100%
	Out of plane response - bending	81%
Concrete Frame - Ground Floor	In plane response	120%
Shear Connection – First Floor	Shear between concrete floor slab and masonry walls/concrete frame	68%
Shear Connection – Ground Floor	Shear between masonry walls and foundations	90%

Seismic Resisting Element	Action	Seismic Rating %NBS
Foundations	Bearing pressure below masonry walls (longitudinal direction)	40%
	Bearing pressure below concrete frame (longitudinal direction)	57%
Block B		
Plasterboard bracing walls	Shear - In plane (T)	58%
Plasterboard bracing walls	Shear - In plane (L)	78%
Subfloor - Piles and strip footings	Shear (L)	>100%
Subfloor - Piles and strip footings	Shear (T)	>100%
Block C		
Plasterboard bracing walls	Shear - In plane (L)	38%
Masonry Wall	Out of plane flexural capacity (L)	>100%
Masonry Walls and End Wall GIB	Shear - In plane (T)	>100%
Roof to Masonry Wall Connection	Shear - In plane (T)	>100%
Block D		
Plasterboard bracing walls	Shear - In plane (L)	39%
Masonry Wall	Out of plane flexural capacity (L)	>100%
Masonry Walls and End Wall GIB	Shear - In plane (T)	>100%
Roof to Masonry Wall Connection	Shear - In plane (T)	>100%

Seismic Resisting Element	Action	Seismic Rating %NBS
Blocks E and F		
Plasterboard bracing walls	Shear - In plane (L)	40%
Masonry Wall	Out of plane flexural capacity (L)	>100%
Masonry Walls and End Wall GIB	Shear - In plane (T)	>100%
Roof to Masonry Wall Connection	Shear - In plane (T)	>100%

7.3. Recommendations

The quantitative assessments carried out on the Aorangi Court buildings indicate that buildings A through G have seismic capacities more than 33% of NBS and less than 67% of NBS. Such capacity would lead to the building being considered as in the category ‘moderate risk buildings’ which are acceptable legally, but recommended to be improved.

If it is determined that the building should be repaired or strengthened there are number of issues which will need to be investigated and associated documents prepared in order to submit a building consent application. These issues will need to be considered during the initial phase of repair/strengthening works. Listed below are the likely items the council may require to be explored:

- A geotechnical investigation may be required and associated factual and interpretive geotechnical reports prepared – the geotechnical reports will be required to enable completion of the strengthening design.
- A fire report will be required and all necessary upgrades to egress routes, emergency lighting and specified systems will need to be undertaken.
- An emergency lighting design will be required to meet the provisions noted in the fire report.
- A disabled access summary will be required including provision for disabled facilities.
- The site amenities (toilets and the like) will need to be reviewed to ensure that there are sufficient facilities for the expected number of people on site.
- Landscaping will need to be considered although we do not anticipate that any modifications will be required since you will not be adjusting the footprint area of buildings on site and will likely only be required for the new build option.

Our key findings and recommendations are:

a) There is no damage to the building that would cause it to be unsafe to occupy.

b) Barriers around the building are not necessary.

c) Options to bring buildings to a target of 67% are investigated.

While structural strengthening is not legally required the performance of the blocks B, C, D, E and F could be improved by replacing the current heavy roofing with a lightweight alternative such as profiled metal cladding and/or relining internal timber stud walls with structural plywood lining.

Strengthening of Blocks A & G would be a question of further (and likely more intrusive) structural improvements than outlined above.

8. Conclusion

SKM carried out a quantitative assessment of BE 0574 EQ2 located at 110 Aorangi Road with the following outcome:

- **Table 6: Quantitative assessment summary**

Description	Grade	Risk	%NBS	Structural performance
Building A	C	Moderate	37%	Acceptable legally. Improvement recommended.
Building B	C	Moderate	58%	Acceptable legally. Improvement recommended.
Building C	C	Moderate	38%	Acceptable legally. Improvement recommended.
Building D	C	Moderate	39%	Acceptable legally. Improvement recommended.
Building E	C	Moderate	40%	Acceptable legally. Improvement recommended.
Building F	C	Moderate	40%	Acceptable legally. Improvement recommended.
Building G	C	Moderate	37%	Acceptable legally. Improvement recommended.

The quantitative assessments carried out on the Aorangi Court buildings indicate that buildings A through G have seismic capacities more than 33% of NBS and less than 67% of NBS. Such capacity would lead to the building being considered as in the category ‘moderate risk buildings’ which are acceptable legally, but recommended to be improved.

9. Limitation Statement

This report has been prepared on behalf of, and for the exclusive use of, SKM's client, and is subject to, and issued in accordance with, the provisions of the contract between SKM and the Client. It is not possible to make a proper assessment of this report without a clear understanding of the terms of engagement under which it has been prepared, including the scope of the instructions and directions given to, and the assumptions made by, SKM. The report may not address issues which would need to be considered for another party if that party's particular circumstances, requirements and experience were known and, further, may make assumptions about matters of which a third party is not aware. No responsibility or liability to any third party is accepted for any loss or damage whatsoever arising out of the use of or reliance on this report by any third party.

Without limiting any of the above, in the event of any liability, SKM's liability, whether under the law of contract, tort, statute, equity or otherwise, is limited in as set out in the terms of the engagement with the Client.

It is not within SKM's scope or responsibility to identify the presence of asbestos, nor the responsibility of SKM to identify possible sources of asbestos. Therefore for any property pre-dating 1989, the presence of asbestos materials should be considered when costing remedial measures or possible demolition.

Should there be any further significant earthquake event, of a magnitude 5 or greater, it will be necessary to conduct a follow-up investigation, as the observations, conclusions and recommendations of this report may no longer apply Earthquake of a lower magnitude may also cause damage, and SKM should be advised immediately if further damage is visible or suspected.

Appendix A Block A Photos

	
Photo 1: North elevation	Photo 2: East elevation
	
Photo 3: South elevation	Photo 4: West elevation

	
Photo 5: 8mm wide crack through masonry block. Visible from the exterior. (refer to Photo 7 for external view).	Photo 6: Up to 2mm wide step cracking along masonry joints
	
Photo 7: Crack formed between masonry wall and aluminium window frame	Photo 8: Re-pointed masonry joint

	
Photo 9: Hairline crack in concrete deck slab	Photo 10: Gap opening up between ceiling cladding panels
	
Photo 11: Tearing of wall lining at joints	Photo 12: Tearing of wall lining at joints

Appendix B Block B & Residential Lounge Photos

	
Photo 1: East elevation of Residential Lounge	Photo 2: East elevation of Block B
	
Photo 3: North elevation	Photo 4: West elevation

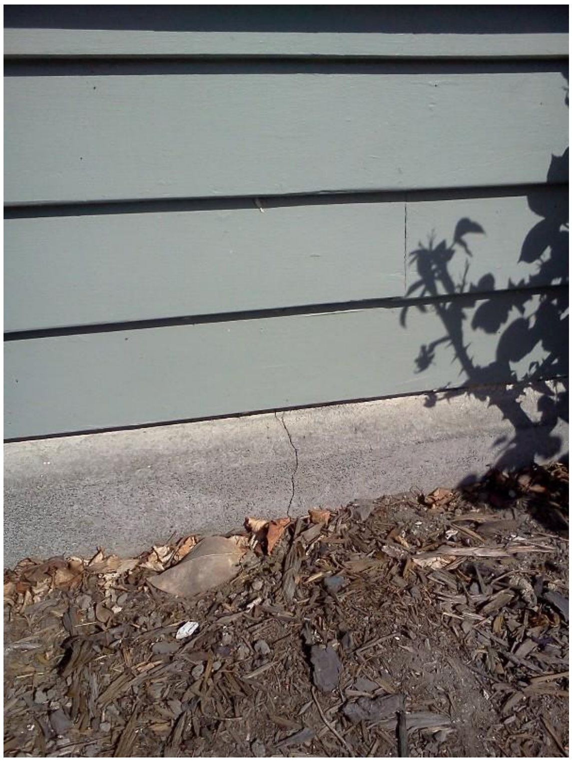
	
Photo 5: South elevation	Photo 6: Crack in concrete footing
	
Photo 7: Cracking in external concrete ground slab	Photo 8: Gap opening up between timber roof cladding elements

	
Photo 9: Suspected opening between cladding elements on the west side of the chimney on the south side of the building that is causing water damage inside	Photo 10: Suspected water damage
	
Photo 11: Tearing of ceiling lining at joints	Photo 12: Tearing of wall lining at joints

Appendix C Block C Photos

	
Photo 1: North elevation	Photo 2: East elevation
	
Photo 3: South elevation	Photo 4: West elevation

	
Photo 5: Dislodged or missing block near the apex.	Photo 6: Plywood sheeting near apex appears to be a temporary weather tightness repair.
	
Photo 7: Step cracking along masonry joints	Photo 8: Gap opening up between ceiling cladding panels

	
Photo 9: Gap opening up between wall lining, masonry wall and ceiling cladding	Photo 10: Steel flashing present between offset units
	
Photo 11: Suspected roof damage related to waterproofing	Photo 12: Damaged connection between masonry wall and downpipe. Not structural damage.

Appendix D Block D Photos

	
Photo 1: North elevation	Photo 2: East elevation
	
Photo 3: South elevation	Photo 4: West elevation

	
Photo 5: Step cracking along masonry joints	Photo 6: Gap opening up between masonry wall and ceiling cladding
	
Photo 7: Gap opening up between masonry wall and ceiling cladding	Photo 8: Tearing of wall lining at joints

Appendix E Block E Photos

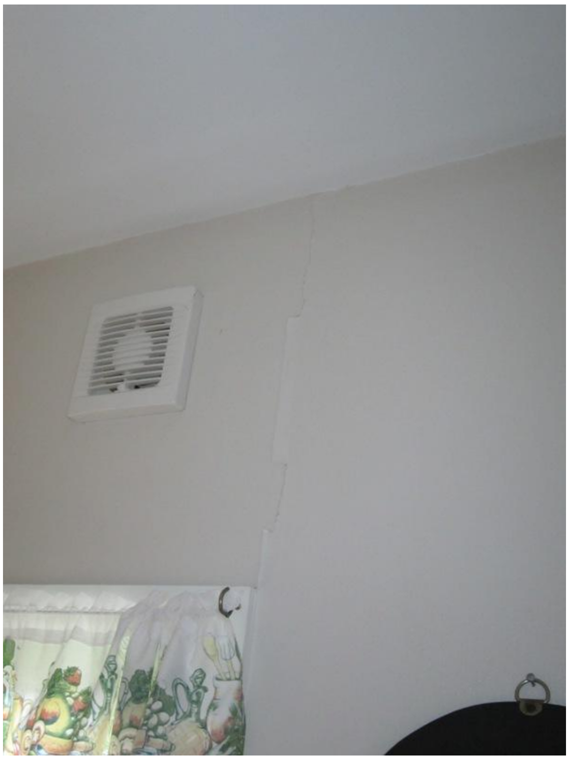
Photo 1: North elevation

Photo 2: East elevation

Photo 3: South elevation

Photo 4: West elevation

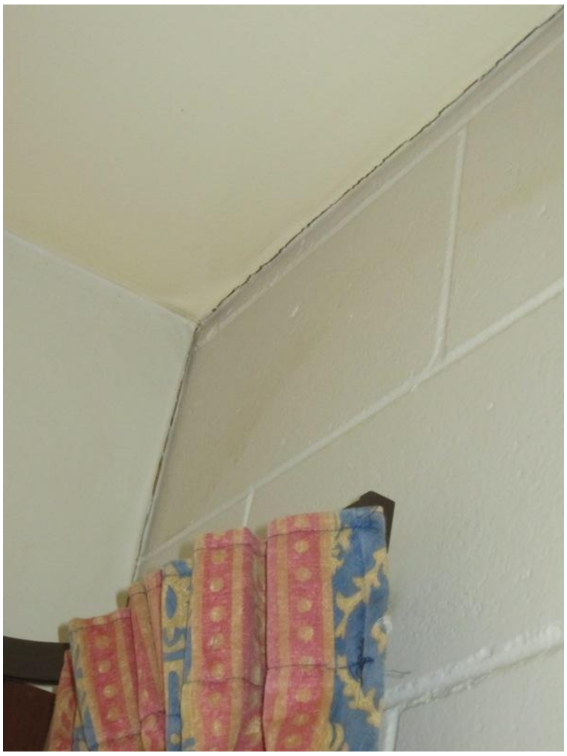
	
Photo 5: Step cracking along masonry joints.	Photo 6: 5mm horizontal gap opening up along masonry joint on 800mm long wall
	
Photo 7: Crack in external concrete ground slab	Photo 8: Masonry block at apex cut at a different angle to the timber roof edge beam, reducing weather tightness.

	
Photo 9: Gap between masonry wall and timber roof edge beam.	Photo 10: Tearing of wall lining at joints
	
Photo 11: Gap opening up between wall lining and ceiling cladding	Photo 12: Gap opening up between masonry wall and ceiling cladding

Appendix F Block F Photos

	
Photo 1: North elevation	Photo 2: East elevation
	
Photo 3: South elevation	Photo 4: West elevation

	
Photo 5: Step cracking along masonry joints	Photo 6: Gap between masonry wall and timber roof edge beam.
	
Photo 7: Dislodged or missing block near the apex.	Photo 8: Gap opening up between timber roof cladding elements

	
Photo 9: Gap opening up between masonry wall and ceiling cladding	Photo 10: Gap opening up between masonry wall and ceiling cladding
	
Photo 11: Hairline cracking in external concrete ground slab	Photo 12: Suspected roof damage related to waterproofing

Appendix G Block G Photos

	
Photo 1: North elevation	Photo 2: East elevation
	
Photo 3: South elevation	Photo 4: West elevation

	
Photo 5: Tearing of wall lining along joints	Photo 6: Gap opening up between wall cladding elements
	
Photo 7: Tearing of wall lining along joints	Photo 8: Gap opening up between wall and ceiling cladding

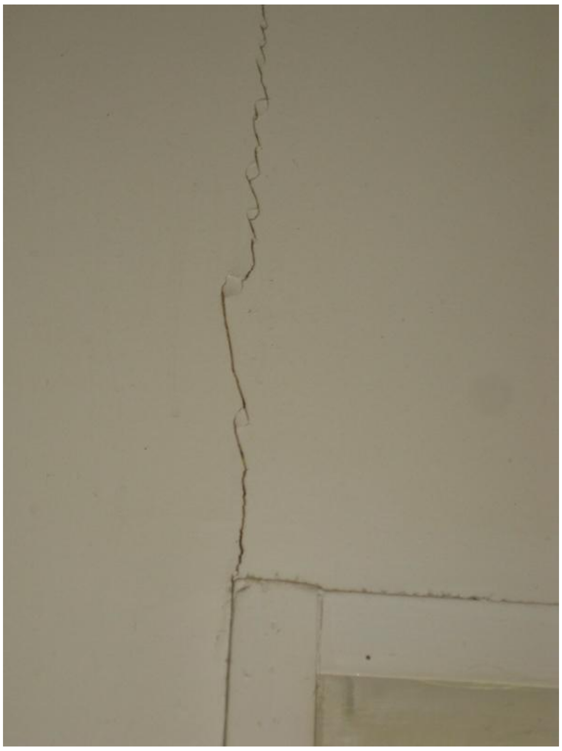


Photo 9: Tearing of wall lining at corner of opening	Photo 10: Gap opening up between masonry wall and wall cladding
	
Photo 11: Cracking between timber doorstep and external masonry wall cladding	Photo 12: Damaged connection between masonry wall and downpipe. Not structural damage.

Appendix H CERA Standardised Report Forms

Location

Building Name:	Aorangi Court - Blocks A	Reviewer:	N Calvert
	Unit / No: / Street	CPEng No:	242062
Building Address:	110 Aorangi Road, Bryndwr	Company:	SKM
Legal Description:		Company project number:	ZB01276.198
		Company phone number:	03 940 4923
	Degrees / Min / Sec		
GPS south:		Date of submission:	30/04/2013
GPS east:		Inspection Date:	17/09/2012
		Revision:	C
Building Unique Identifier (CCC):	PRO 0574-001	Is there a full report with this summary?	yes

Site

Site slope:	flat	Max retaining height (m):	
Soil type:		Soil Profile (if available):	
Site Class (to NZS1170.5):	D		
Proximity to waterway (m, if <100m):		If Ground improvement on site, describe:	
Proximity to clifftop (m, if < 100m):			
Proximity to cliff base (m,if <100m):		Approx site elevation (m):	

Building

No. of storeys above ground:	2	single storey = 1	Ground floor elevation (Absolute) (m):	
Ground floor split?	no		Ground floor elevation above ground (m):	
Storeys below ground	0			
Foundation type:	strip footings		if Foundation type is other, describe:	
Building height (m):	6.70		height from ground to level of uppermost seismic mass (for IEP only) (m):	6.7
Floor footprint area (approx):	105			
Age of Building (years):	40		Date of design:	1965-1976
Strengthening present?	no		If so, when (year)?	
			And what load level (%g)?	
Use (ground floor):	multi-unit residential		Brief strengthening description:	
Use (upper floors):				
Use notes (if required):				
Importance level (to NZS1170.5):	IL2			

Gravity Structure

Gravity System:	load bearing walls		
Roof:	timber framed	rafter type, purlin type and cladding	Unknown
Floors:	concrete flat slab	slab thickness (mm)	Unknown, & timber diaphragm for top level
Beams:	none	overall depth x width (mm x mm)	None
Columns:	none	typical dimensions (mm x mm)	None
Walls:	partially reinforced concrete masonry	thickness (mm)	200

Lateral load resisting structure

Lateral system along:	lightweight timber framed walls	**Note: Define along and across in detailed report!**	note typical wall length (m)	14.6
Ductility assumed, μ:	1.25			
Period along:	0.40	0.00	estimate or calculation?	estimated
Total deflection (ULS) (mm):	10		estimate or calculation?	estimated
maximum interstorey deflection (ULS) (mm):			estimate or calculation?	estimated
Lateral system across:	partially filled CMU		note total length of wall at ground (m):	7.2
Ductility assumed, μ:	1.25		wall thickness (m):	0.2
Period across:	0.40	0.40 from parameters in sheet	estimate or calculation?	estimated
Total deflection (ULS) (mm):	10		estimate or calculation?	estimated
maximum interstorey deflection (ULS) (mm):			estimate or calculation?	estimated

Separations:

north (mm):		leave blank if not relevant
east (mm):		
south (mm):		
west (mm):		

Non-structural elements

Stairs:	timber	describe supports	Unknown
Wall cladding:	plaster system	describe	Plasterboard
Roof Cladding:	Metal	describe	Corrugated sheeting
Glazing:	aluminium frames		
Ceilings:	plaster, fixed		Plasterboard
Services(list):	Water, sewerage		

Available documentation

Architectural	none	original designer name/date	
Structural	none	original designer name/date	
Mechanical	none	original designer name/date	
Electrical	none	original designer name/date	
Geotech report	none	original designer name/date	

Damage

Site: (refer DEE Table 4-2)

Site performance:		Describe damage:	Cracked masonry block, step cracking along masonry joints, tearing of plasterboard linings in the walls and ceilings, hairline crack in concrete deck
Settlement:	none observed	notes (if applicable):	
Differential settlement:	none observed	notes (if applicable):	
Liquefaction:	none apparent	notes (if applicable):	
Lateral Spread:	none apparent	notes (if applicable):	
Differential lateral spread:	none apparent	notes (if applicable):	
Ground cracks:	none apparent	notes (if applicable):	
Damage to area:	none apparent	notes (if applicable):	

Building:

	Current Placard Status:	green		
Along	Damage ratio:	0%	Describe how damage ratio arrived at:	Current damage noted will not diminish the capacity of the building.
	Describe (summary):	Cracked masonry block, cracking along mortar joints		
Across	Damage ratio:	0%		
	Describe (summary):	Cracked masonry block, cracking along mortar joints		
Diaphragms	Damage?:	no	Describe:	
CSWs:	Damage?:	no	Describe:	
Pounding:	Damage?:	no	Describe:	
Non-structural:	Damage?:	yes	Describe:	Cracked masonry block, step cracking along masonry joints, tearing of plasterboard linings in the walls and ceilings, hairline crack in concrete deck

$$Damage\_Ratio = \frac{(\%NBS\,(before) - \%NBS\,(after))}{\%NBS\,(before)}$$

Recommendations

	Level of repair/strengthening required:	minor non-structural	Describe:	
	Building Consent required:	no	Describe:	
	Interim occupancy recommendations:	full occupancy	Describe:	Not an immediate collapse hazard.
Along	Assessed %NBS before:	37%	If IEP not used, please detail assessment methodology:	Quantitative assessment
	Assessed %NBS after:	37%		
Across	Assessed %NBS before:	100%		
	Assessed %NBS after:	100%		

Location

Building Name: Aorangi Court - Blocks B & Residential Lounge
Building Address: Unit | No: 110 | Street: Aorangi Road, Bryndwr
Legal Description:
GPS south: Degrees | Min | Sec
GPS east:
Building Unique Identifier (CCC): PRO 0574-002

Reviewer: N Calvert
CPEng No: 242062
Company: SKM
Company project number: ZB01276.198
Company phone number: 03 940 4923
Date of submission: 30-Apr
Inspection Date: 17/09/2012
Revision: C
Is there a full report with this summary? yes

Site

Site slope: flat
Soil type:
Site Class (to NZS1170.5): D
Proximity to waterway (m, if <100m):
Proximity to clifftop (m, if < 100m):
Proximity to cliff base (m,if <100m):

Max retaining height (m):
Soil Profile (if available):
If Ground improvement on site, describe:
Approx site elevation (m): 14.00

Building

No. of storeys above ground: 1 — single storey = 1
Ground floor split? no
Storeys below ground: 0
Foundation type: timber piles
Building height (m): 3.30
Floor footprint area (approx): 113
Age of Building (years): 35

Ground floor elevation (Absolute) (m): 14.00
Ground floor elevation above ground (m): 0.20
if Foundation type is other, describe:
height from ground to level of uppermost seismic mass (for IEP only) (m): 3.3
Date of design: 1976-1992

Strengthening present? no
If so, when (year)?
And what load level (%g)?
Brief strengthening description:

Use (ground floor): multi-unit residential
Use (upper floors):
Use notes (if required):
Importance level (to NZS1170.5): IL2

Gravity Structure

Gravity System: frame system
Roof: timber framed — rafter type, purlin type and cladding: Unknown
Floors: timber — joist depth and spacing (mm): Unknown
Beams: timber — type: Unknown
Columns: timber — typical dimensions (mm x mm): Unknown
Walls: non-load bearing — 0

Lateral load resisting structure

Note: Define along and across in detailed report!

Lateral system along: lightweight timber framed walls — note typical wall length (m): 16
Ductility assumed, μ: 1.25
Period along: 0.10 — 0.00 — estimate or calculation? estimated
Total deflection (ULS) (mm): 10 — estimate or calculation? estimated
maximum interstorey deflection (ULS) (mm): — estimate or calculation? estimated

Lateral system across: lightweight timber framed walls — note typical wall length (m): 11
Ductility assumed, μ: 1.25
Period across: 0.10 — 0.00 — estimate or calculation? calculated
Total deflection (ULS) (mm): 10 — estimate or calculation? estimated
maximum interstorey deflection (ULS) (mm): — estimate or calculation? estimated

Separations:

north (mm): — leave blank if not relevant
east (mm):
south (mm):
west (mm):

Non-structural elements

Stairs:
Wall cladding: plaster system — describe: Plasterboard
Roof Cladding: Metal — describe: Corrugated sheeting
Glazing: timber frames
Ceilings: plaster, fixed — Plasterboard
Services(list): Water, sewerage

Available documentation

Architectural: partial — original designer name/date: Ian Krause Associates 1977 renovation
Structural: none — original designer name/date:
Mechanical: none — original designer name/date:
Electrical: none — original designer name/date:
Geotech report: none — original designer name/date:

Damage

Site: (refer DEE Table 4-2)
Site performance:
Describe damage: Tearing of plasterboard linings in the walls and ceilings, cracking in concrete ground slab

Settlement: none observed — notes (if applicable):
Differential settlement: none observed — notes (if applicable):
Liquefaction: none apparent — notes (if applicable):
Lateral Spread: none apparent — notes (if applicable):
Differential lateral spread: none apparent — notes (if applicable):
Ground cracks: none apparent — notes (if applicable):
Damage to area: none apparent — notes (if applicable):

Building:

Current Placard Status: green

Along — Damage ratio: 0%
Describe (summary): No structural damage
Describe how damage ratio arrived at: Current damage noted will not diminish the capacity of the building.

Across — Damage ratio: 0%
Describe (summary): No structural damage

$$Damage\_Ratio = \frac{(\%NBS(before) - \%NBS(after))}{\%NBS(before)}$$

Diaphragms — Damage?: no — Describe:
CSWs: — Damage?: no — Describe:
Pounding: — Damage?: no — Describe:
Non-structural: — Damage?: yes — Describe: Tearing of plasterboard linings in the walls and ceilings, cracking in concrete ground slab

Recommendations

Level of repair/strengthening required: minor non-structural — Describe:
Building Consent required: no — Describe:
Interim occupancy recommendations: full occupancy — Describe: Not an immediate collapse hazard.

Along — Assessed %NBS before: 78% — %NBS from IEP below
Assessed %NBS after: 78%
If IEP not used, please detail assessment methodology: Quantitative Assessment

Across — Assessed %NBS before: 58% — %NBS from IEP below
Assessed %NBS after: 58%

Detailed Engineering Evaluation Summary Data V1.11

Location

Building Name:	Aorangi Court - Blocks C	Reviewer:	N Calvert
	Unit No: Street	CPEng No:	242062
Building Address:	110 Aorangi Road, Bryndwr	Company:	SKM
Legal Description:		Company project number:	ZB01276.198
		Company phone number:	03 940 4923
	Degrees Min Sec		
GPS south:		Date of submission:	30-Apr
GPS east:		Inspection Date:	17/09/2012
		Revision:	C
Building Unique Identifier (CCC):	PRO 0574-004	Is there a full report with this summary?	yes

Site

Site slope:	flat	Max retaining height (m):	
Soil type:		Soil Profile (if available):	
Site Class (to NZS1170.5):	D		
Proximity to waterway (m, if <100m):		If Ground improvement on site, describe:	
Proximity to clifftop (m, if < 100m):			
Proximity to cliff base (m,if <100m):		Approx site elevation (m):	14.00

Building

No. of storeys above ground:	1	single storey = 1	Ground floor elevation (Absolute) (m):	14.00
Ground floor split?	no		Ground floor elevation above ground (m):	0.20
Storeys below ground	0			
Foundation type:	strip footings		if Foundation type is other, describe:	
Building height (m):	3.90		height from ground to level of uppermost seismic mass (for IEP only) (m):	3.9
Floor footprint area (approx):	236			
Age of Building (years):	35		Date of design:	1976-1992
Strengthening present?	no		If so, when (year)?	
			And what load level (%g)?	
Use (ground floor):	multi-unit residential		Brief strengthening description:	
Use (upper floors):				
Use notes (if required):				
Importance level (to NZS1170.5):	IL2			

Gravity Structure

Gravity System:	load bearing walls		
Roof:	timber framed	rafter type, purlin type and cladding	150x50mm, 50x50mm, Concrete Tile
Floors:	concrete flat slab	slab thickness (mm)	100
Beams:	none	overall depth x width (mm x mm)	None
Columns:	none	typical dimensions (mm x mm)	None
Walls:	partially reinforced concrete masonry	thickness (mm)	190

Lateral load resisting structure

Lateral system along:	lightweight timber framed walls	**Note: Define along and across in detailed report!**	note typical wall length (m)	32.8
Ductility assumed, μ:	1.25			
Period along:	0.40	0.00	estimate or calculation?	estimated
Total deflection (ULS) (mm):	10		estimate or calculation?	estimated
maximum interstorey deflection (ULS) (mm):			estimate or calculation?	estimated
Lateral system across:	partially filled CMU		note total length of wall at ground (m):	7.2
Ductility assumed, μ:	1.25		wall thickness (m):	200
Period across:	0.40	0.40 from parameters in sheet	estimate or calculation?	calculated
Total deflection (ULS) (mm):	10		estimate or calculation?	estimated
maximum interstorey deflection (ULS) (mm):			estimate or calculation?	estimated

Separations:

north (mm):		leave blank if not relevant
east (mm):		
south (mm):		
west (mm):		

Non-structural elements

Stairs:			
Wall cladding:	brick or tile	describe (note cavity if exists)	100 series concrete block 40mm to timber framing
Roof Cladding:	Heavy tiles	describe	Concrete Tiles
Glazing:	aluminium frames		
Ceilings:	plaster, fixed		Plasterboard
Services(list):	Water, sewerage		

Available documentation

Architectural	full	original designer name/date	Ian Krause Associates
Structural	full	original designer name/date	A.E. Tyndal
Mechanical	none	original designer name/date	
Electrical	none	original designer name/date	
Geotech report	none	original designer name/date	

Damage

Site:
(refer DEE Table 4-2)

Site performance:		Describe damage:	Step cracking along masonry joints, tearing of plasterboard linings in the walls and ceilings, cracks in concrete ground slab
Settlement:	none observed	notes (if applicable):	
Differential settlement:	none observed	notes (if applicable):	
Liquefaction:	none apparent	notes (if applicable):	
Lateral Spread:	none apparent	notes (if applicable):	
Differential lateral spread:	none apparent	notes (if applicable):	
Ground cracks:	none apparent	notes (if applicable):	
Damage to area:	none apparent	notes (if applicable):	

Building:

	Current Placard Status:	green		
Along	Damage ratio:	0%	Describe how damage ratio arrived at:	Current damage noted will not diminish the capacity of the building.
	Describe (summary):	Step cracking along mortar joints		
Across	Damage ratio:	0%		
	Describe (summary):	Step cracking along mortar joints		
Diaphragms	Damage?:	no	Describe:	
CSWs:	Damage?:	no	Describe:	
Pounding:	Damage?:	no	Describe:	
Non-structural:	Damage?:	yes	Describe:	Step cracking along masonry joints, tearing of plasterboard linings in the walls and ceilings, cracks in concrete ground slab

$$Damage\_Ratio = \frac{(\%NBS\,(before) - \%NBS\,(after))}{\%NBS\,(before)}$$

Recommendations

	Level of repair/strengthening required:	minor structural	Describe:	Replacement of heavyweight roof with alt light cladding and or strengthening of masonry walls
	Building Consent required:	yes	Describe:	
	Interim occupancy recommendations:	full occupancy	Describe:	
Along	Assessed %NBS before:	38%	%NBS from IEP below	If IEP not used, please detail assessment methodology: Quantitative Assessment
	Assessed %NBS after:	38%		
Across	Assessed %NBS before:	100%	%NBS from IEP below	
	Assessed %NBS after:	100%		

Detailed Engineering Evaluation Summary Data V1.11

Location

Building Name:	Aorangi Court - Blocks D	Reviewer:	N Calvert
Unit / No: / Street		CPEng No:	242062
Building Address:	110 Aorangi Road, Bryndwr	Company:	SKM
Legal Description:		Company project number:	ZB01276.198
		Company phone number:	03 940 4923
Degrees / Min / Sec			
GPS south:		Date of submission:	30-Apr
GPS east:		Inspection Date:	17/09/2012
		Revision:	C
Building Unique Identifier (CCC):	PRO 0574-005	Is there a full report with this summary?	yes

Site

Site slope:	flat	Max retaining height (m):	
Soil type:		Soil Profile (if available):	
Site Class (to NZS1170.5):	D		
Proximity to waterway (m, if <100m):		If Ground improvement on site, describe:	
Proximity to clifftop (m, if < 100m):			
Proximity to cliff base (m,if <100m):		Approx site elevation (m):	14.00

Building

No. of storeys above ground:	1	single storey = 1	Ground floor elevation (Absolute) (m):	14.00
Ground floor split?	no		Ground floor elevation above ground (m):	0.20
Storeys below ground	0			
Foundation type:	strip footings		if Foundation type is other, describe:	
Building height (m):	3.90		height from ground to level of uppermost seismic mass (for IEP only) (m):	3.9
Floor footprint area (approx):	236			
Age of Building (years):	35		Date of design:	1976-1992
Strengthening present?	no		If so, when (year)?	
			And what load level (%g)?	
Use (ground floor):	multi-unit residential		Brief strengthening description:	
Use (upper floors):				
Use notes (if required):				
Importance level (to NZS1170.5):	IL2			

Gravity Structure

Gravity System:	load bearing walls		
Roof:	timber framed	rafter type, purlin type and cladding	150x50mm, 50x50mm, Concrete Tile
Floors:	concrete flat slab	slab thickness (mm)	100
Beams:	none	overall depth x width (mm x mm)	None
Columns:	none	typical dimensions (mm x mm)	None
Walls:	partially reinforced concrete masonry	thickness (mm)	190

Lateral load resisting structure

Lateral system along:	lightweight timber framed walls	**Note: Define along and across in detailed report!**	note typical wall length (m)	32.8
Ductility assumed, μ:	1.25			
Period along:	0.40	0.00	estimate or calculation?	estimated
Total deflection (ULS) (mm):	10		estimate or calculation?	estimated
maximum interstorey deflection (ULS) (mm):			estimate or calculation?	estimated
Lateral system across:	partially filled CMU		note total length of wall at ground (m):	7.2
Ductility assumed, μ:	1.25		wall thickness (m):	200
Period across:	0.40	0.40 from parameters in sheet	estimate or calculation?	calculated
Total deflection (ULS) (mm):	10		estimate or calculation?	estimated
maximum interstorey deflection (ULS) (mm):			estimate or calculation?	estimated

Separations:

north (mm):		leave blank if not relevant
east (mm):		
south (mm):		
west (mm):		

Non-structural elements

Stairs:			
Wall cladding:	brick or tile	describe (note cavity if exists)	100 series concrete block 40mm to timber framing
Roof Cladding:	Heavy tiles	describe	Concrete Tiles
Glazing:	aluminium frames		
Ceilings:	plaster, fixed		Plasterboard
Services(list):	Water, sewerage		

Available documentation

Architectural	full	original designer name/date	Ian Krause Associates
Structural	full	original designer name/date	A.E. Tyndal
Mechanical	none	original designer name/date	
Electrical	none	original designer name/date	
Geotech report	none	original designer name/date	

Damage

Site: (refer DEE Table 4-2)	Site performance:		Describe damage:	Step cracking along masonry joints, tearing of plasterboard linings in the walls and ceilings, cracks in concrete ground slab
	Settlement:	none observed	notes (if applicable):	
	Differential settlement:	none observed	notes (if applicable):	
	Liquefaction:	none apparent	notes (if applicable):	
	Lateral Spread:	none apparent	notes (if applicable):	
	Differential lateral spread:	none apparent	notes (if applicable):	
	Ground cracks:	none apparent	notes (if applicable):	
	Damage to area:	none apparent	notes (if applicable):	

Building:

	Current Placard Status:	green		
Along	Damage ratio:	0%	Describe how damage ratio arrived at:	Current damage noted will not diminish the capacity of the building.
	Describe (summary):	Step cracking along mortar joints		
Across	Damage ratio:	0%		
	Describe (summary):	Step cracking along mortar joints		
Diaphragms	Damage?:	no	Describe:	
CSWs:	Damage?:	no	Describe:	
Pounding:	Damage?:	no	Describe:	
Non-structural:	Damage?:	yes	Describe:	Step cracking along masonry joints, tearing of plasterboard linings in the walls and ceilings, cracks in concrete ground slab

$$Damage\_Ratio = \frac{(\% NBS\ (before) - \% NBS\ (after))}{\% NBS\ (before)}$$

Recommendations

	Level of repair/strengthening required:	minor structural	Describe:	Replacement of heavyweight roof with alt light cladding and or strengthening of masonry walls
	Building Consent required:	yes	Describe:	
	Interim occupancy recommendations:	full occupancy	Describe:	
Along	Assessed %NBS before:	39%	%NBS from IEP below	If IEP not used, please detail assessment methodology: Quantitative Assessment
	Assessed %NBS after:	39%		
Across	Assessed %NBS before:	100%	%NBS from IEP below	
	Assessed %NBS after:	100%		

Detailed Engineering Evaluation Summary Data V1.11

Location

Building Name:	Aorangi Court - Blocks E	Reviewer:	N Calvert
	Unit / No: / Street	CPEng No:	242062
Building Address:	110 Aorangi Road, Bryndwr	Company:	SKM
Legal Description:		Company project number:	ZB01276.198
		Company phone number:	03 940 4923
	Degrees / Min / Sec		
GPS south:		Date of submission:	30-Apr
GPS east:		Inspection Date:	17/09/2012
		Revision:	C
Building Unique Identifier (CCC):	PRO 0574-006	Is there a full report with this summary?	yes

Site

Site slope:	flat	Max retaining height (m):	
Soil type:		Soil Profile (if available):	
Site Class (to NZS1170.5):	D		
Proximity to waterway (m, if <100m):		If Ground improvement on site, describe:	
Proximity to clifftop (m, if < 100m):			
Proximity to cliff base (m,if <100m):		Approx site elevation (m):	14.00

Building

No. of storeys above ground:	1 (single storey = 1)	Ground floor elevation (Absolute) (m):	14.00
Ground floor split?	no	Ground floor elevation above ground (m):	0.20
Storeys below ground	0		
Foundation type:	strip footings	if Foundation type is other, describe:	
Building height (m):	3.90	height from ground to level of uppermost seismic mass (for IEP only) (m):	3.9
Floor footprint area (approx):	236		
Age of Building (years):	35	Date of design:	1976-1992
Strengthening present?	no	If so, when (year)?	
		And what load level (%g)?	
Use (ground floor):	multi-unit residential	Brief strengthening description:	
Use (upper floors):			
Use notes (if required):			
Importance level (to NZS1170.5):	IL2		

Gravity Structure

Gravity System:	load bearing walls		
Roof:	timber framed	rafter type, purlin type and cladding	150x50mm, 50x50mm, Concrete Tile
Floors:	concrete flat slab	slab thickness (mm)	100
Beams:	none	overall depth x width (mm x mm)	None
Columns:	none	typical dimensions (mm x mm)	None
Walls:	partially reinforced concrete masonry	thickness (mm)	190

Lateral load resisting structure

Note: Define along and across in detailed report!

Lateral system along:	lightweight timber framed walls	note typical wall length (m)	32.8
Ductility assumed, μ:	1.25		
Period along:	0.40 (0.00)	estimate or calculation?	estimated
Total deflection (ULS) (mm):	10	estimate or calculation?	estimated
maximum interstorey deflection (ULS) (mm):		estimate or calculation?	estimated
Lateral system across:	partially filled CMU	note total length of wall at ground (m):	7.2
Ductility assumed, μ:	1.25	wall thickness (m):	200
Period across:	0.40 (0.40 from parameters in sheet)	estimate or calculation?	calculated
Total deflection (ULS) (mm):	10	estimate or calculation?	estimated
maximum interstorey deflection (ULS) (mm):		estimate or calculation?	estimated

Separations:

north (mm):		leave blank if not relevant
east (mm):		
south (mm):		
west (mm):		

Non-structural elements

Stairs:			
Wall cladding:	brick or tile	describe (note cavity if exists)	100 series concrete block 40mm to timber framing
Roof Cladding:	Heavy tiles	describe	Concrete Tiles
Glazing:	aluminium frames		
Ceilings:	plaster, fixed		Plasterboard
Services(list):	Water, sewerage		

Available documentation

Architectural	full	original designer name/date	Ian Krause Associates
Structural	full	original designer name/date	A.E. Tyndal
Mechanical	none	original designer name/date	
Electrical	none	original designer name/date	
Geotech report	none	original designer name/date	

Damage

Site:
(refer DEE Table 4-2)

Site performance:		Describe damage:	Step cracking along masonry joints, tearing of plasterboard linings in the walls and ceilings, cracks in concrete ground slab
Settlement:	none observed	notes (if applicable):	
Differential settlement:	none observed	notes (if applicable):	
Liquefaction:	none apparent	notes (if applicable):	
Lateral Spread:	none apparent	notes (if applicable):	
Differential lateral spread:	none apparent	notes (if applicable):	
Ground cracks:	none apparent	notes (if applicable):	
Damage to area:	none apparent	notes (if applicable):	

Building:

	Current Placard Status:	green		
Along	Damage ratio:	0%	Describe how damage ratio arrived at:	Current damage noted will not diminish the capacity of the building.
	Describe (summary):	Step cracking along mortar joints		
Across	Damage ratio:	0%		
	Describe (summary):	Step cracking along mortar joints		
Diaphragms	Damage?:	no	Describe:	
CSWs:	Damage?:	no	Describe:	
Pounding:	Damage?:	no	Describe:	
Non-structural:	Damage?:	yes	Describe:	Step cracking along masonry joints, tearing of plasterboard linings in the walls and ceilings, cracks in concrete ground slab

$$Damage\_Ratio = \frac{(\%NBS\,(before) - \%NBS\,(after))}{\%NBS\,(before)}$$

Recommendations

	Level of repair/strengthening required:	minor structural	Describe:	Replacement of heavyweight roof with alt light cladding and or strengthening of masonry walls
	Building Consent required:	yes	Describe:	
	Interim occupancy recommendations:	full occupancy	Describe:	
Along	Assessed %NBS before:	40%	%NBS from IEP below	If IEP not used, please detail assessment methodology: Quantitative Assessment
	Assessed %NBS after:	40%		
Across	Assessed %NBS before:	100%	%NBS from IEP below	
	Assessed %NBS after:	100%		

Detailed Engineering Evaluation Summary Data V1.11

Location

Building Name:	Aorangi Court - Block F	Reviewer:	N Calvert
Building Address:	Unit: No: 110 Street: Aorangi Road, Bryndwr	CPEng No:	242062
Legal Description:		Company:	SKM
		Company project number:	ZB01276.198
		Company phone number:	03 940 4923
GPS south: (Degrees / Min / Sec)		Date of submission:	30-Apr
GPS east:		Inspection Date:	17/09/2012
		Revision:	C
Building Unique Identifier (CCC):	PRO 0574-007	Is there a full report with this summary?	yes

Site

Site slope:	flat	Max retaining height (m):	
Soil type:		Soil Profile (if available):	
Site Class (to NZS1170.5):	D		
Proximity to waterway (m, if <100m):		If Ground improvement on site, describe:	
Proximity to clifftop (m, if < 100m):			
Proximity to cliff base (m,if <100m):		Approx site elevation (m):	14.00

Building

No. of storeys above ground:	1 (single storey = 1)	Ground floor elevation (Absolute) (m):	14.00
Ground floor split?	no	Ground floor elevation above ground (m):	0.20
Storeys below ground	0		
Foundation type:	strip footings	if Foundation type is other, describe:	
Building height (m):	3.90	height from ground to level of uppermost seismic mass (for IEP only) (m):	3.9
Floor footprint area (approx):	236		
Age of Building (years):	35	Date of design:	1976-1992
Strengthening present?	no	If so, when (year)?	
		And what load level (%g)?	
Use (ground floor):	multi-unit residential	Brief strengthening description:	
Use (upper floors):			
Use notes (if required):			
Importance level (to NZS1170.5):	IL2		

Gravity Structure

Gravity System:	load bearing walls		
Roof:	timber framed	rafter type, purlin type and cladding	150x50mm, 50x50mm, Concrete Tile
Floors:	concrete flat slab	slab thickness (mm)	100
Beams:	none	overall depth x width (mm x mm)	None
Columns:	none	typical dimensions (mm x mm)	None
Walls:	partially reinforced concrete masonry	thickness (mm)	190

Lateral load resisting structure

Note: Define along and across in detailed report!

Lateral system along:	lightweight timber framed walls		note typical wall length (m)	32.8
Ductility assumed, μ:	1.25			
Period along:	0.40	0.00	estimate or calculation?	estimated
Total deflection (ULS) (mm):	10		estimate or calculation?	estimated
maximum interstorey deflection (ULS) (mm):			estimate or calculation?	estimated
Lateral system across:	partially filled CMU		note total length of wall at ground (m):	7.2
Ductility assumed, μ:	1.25		wall thickness (m):	200
Period across:	0.40	0.40 from parameters in sheet	estimate or calculation?	calculated
Total deflection (ULS) (mm):	10		estimate or calculation?	estimated
maximum interstorey deflection (ULS) (mm):			estimate or calculation?	estimated

Separations:

north (mm):		leave blank if not relevant
east (mm):		
south (mm):		
west (mm):		

Non-structural elements

Stairs:			
Wall cladding:	brick or tile	describe (note cavity if exists)	100 series concrete block 40mm to timber framing
Roof Cladding:	Heavy tiles	describe	Concrete Tiles
Glazing:	aluminium frames		
Ceilings:	plaster, fixed		Plasterboard
Services(list):	Water, sewerage		

Available documentation

Architectural	full	original designer name/date	Ian Krause Associates
Structural	full	original designer name/date	A.E. Tyndal
Mechanical	none	original designer name/date	
Electrical	none	original designer name/date	
Geotech report	none	original designer name/date	

Damage

Site: (refer DEE Table 4-2)

Site performance:		Describe damage:	Step cracking along masonry joints, tearing of plasterboard linings in the walls and ceilings, cracks in concrete ground slab
Settlement:	none observed	notes (if applicable):	
Differential settlement:	none observed	notes (if applicable):	
Liquefaction:	none apparent	notes (if applicable):	
Lateral Spread:	none apparent	notes (if applicable):	
Differential lateral spread:	none apparent	notes (if applicable):	
Ground cracks:	none apparent	notes (if applicable):	
Damage to area:	none apparent	notes (if applicable):	

Building:

	Current Placard Status:	green		
Along	Damage ratio:	0%	Describe how damage ratio arrived at:	Current damage noted will not diminish the capacity of the building.
	Describe (summary):	Step cracking along mortar joints		
Across	Damage ratio:	0%		
	Describe (summary):	Step cracking along mortar joints		
Diaphragms	Damage?:	no	Describe:	
CSWs:	Damage?:	no	Describe:	
Pounding:	Damage?:	no	Describe:	
Non-structural:	Damage?:	yes	Describe:	Step cracking along masonry joints, tearing of plasterboard linings in the walls and ceilings, cracks in concrete ground slab

$$Damage\_Ratio = \frac{(\%NBS\,(before) - \%NBS\,(after))}{\%NBS\,(before)}$$

Recommendations

Level of repair/strengthening required:	minor structural	Describe:	Replacement of heavyweight roof with alt light cladding and or strengthening of masonry walls
Building Consent required:	yes	Describe:	
Interim occupancy recommendations:	full occupancy	Describe:	

Along	Assessed %NBS before:	40%	%NBS from IEP below	If IEP not used, please detail assessment methodology:	Quantitative Assessment
	Assessed %NBS after:	40%			
Across	Assessed %NBS before:	100%	%NBS from IEP below		
	Assessed %NBS after:	100%			

Detailed Engineering Evaluation Summary Data V1.11

Location

Building Name:	Aorangi Court - Block G
Building Address: (Unit / No: / Street)	110 Aorangi Road, Bryndwr
Legal Description:	
GPS south: (Degrees / Min / Sec)	
GPS east:	
Building Unique Identifier (CCC):	PRO 0574-0008
Reviewer:	N Calvert
CPEng No:	242062
Company:	SKM
Company project number:	ZB01276.198
Company phone number:	03 940 4923
Date of submission:	30-Apr-13
Inspection Date:	17/09/2012
Revision:	C
Is there a full report with this summary?	yes

Site

Site slope:	flat
Soil type:	
Site Class (to NZS1170.5):	D
Proximity to waterway (m, if <100m):	
Proximity to clifftop (m, if < 100m):	
Proximity to cliff base (m,if <100m):	
Max retaining height (m):	
Soil Profile (if available):	
If Ground improvement on site, describe:	
Approx site elevation (m):	14.00

Building

No. of storeys above ground:	2 (single storey = 1)
Ground floor split?	no
Storeys below ground	0
Foundation type:	strip footings
Building height (m):	7.00
Floor footprint area (approx):	105
Age of Building (years):	35
Ground floor elevation (Absolute) (m):	14.00
Ground floor elevation above ground (m):	0.20
if Foundation type is other, describe:	
height from ground to level of uppermost seismic mass (for IEP only) (m):	6.7
Date of design:	1976-1992
Strengthening present?	no
If so, when (year)?	
And what load level (%g)?	
Brief strengthening description:	
Use (ground floor):	multi-unit residential
Use (upper floors):	
Use notes (if required):	
Importance level (to NZS1170.5):	IL2

Gravity Structure

Gravity System:	load bearing walls		
Roof:	timber framed	rafter type, purlin type and cladding	200x50, 75x50, Concrete tile
Floors:	concrete flat slab	slab thickness (mm)	Ground floor 100mm cast in situ flat slab, Level 1 75mm thick Stresscrete panels with 95mm cast in situ topping slab
Beams:	cast-insitu concrete	overall depth x width (mm x mm)	Stair landing support 300x500mm
Columns:	cast-insitu concrete	typical dimensions (mm x mm)	Landing columns, 300x400mm
Walls:	partially reinforced concrete masonry	thickness (mm)	200

Lateral load resisting structure

Note: Define along and across in detailed report!

Lateral system along:	lightweight timber framed walls		note typical wall length (m)	14.6
Ductility assumed, μ:	1.25			
Period along:	0.40	0.00	estimate or calculation?	estimated
Total deflection (ULS) (mm):	10		estimate or calculation?	estimated
maximum interstorey deflection (ULS) (mm):			estimate or calculation?	estimated
Lateral system across:	partially filled CMU		note total length of wall at ground (m):	7.2
Ductility assumed, μ:	1.25		wall thickness (m):	0.19
Period across:	0.40	0.40 from parameters in sheet	estimate or calculation?	estimated
Total deflection (ULS) (mm):	10		estimate or calculation?	estimated
maximum interstorey deflection (ULS) (mm):			estimate or calculation?	estimated

Separations:

north (mm):	(leave blank if not relevant)
east (mm):	
south (mm):	
west (mm):	

Non-structural elements

Stairs:	timber	describe supports	Concrete landing supported by concrete columns
Wall cladding:	brick or tile	describe (note cavity if exists)	100 series concrete Masonry
Roof Cladding:	Heavy tiles	describe	Concrete tiles
Glazing:	aluminium frames		
Ceilings:	plaster, fixed		Plasterboard
Services(list):	Water, sewerage		

Available documentation

Architectural	full	original designer name/date	Ian Krauss Associates
Structural	full	original designer name/date	A.E. Tyndall
Mechanical	none	original designer name/date	
Electrical	none	original designer name/date	
Geotech report	none	original designer name/date	

Damage

Site:
(refer DEE Table 4-2)

Site performance:		Describe damage:	Cracked masonry block, step cracking along masonry joints, tearing of plasterboard linings in the walls and ceilings, hairline crack in concrete deck
Settlement:	none observed	notes (if applicable):	
Differential settlement:	none observed	notes (if applicable):	
Liquefaction:	none apparent	notes (if applicable):	
Lateral Spread:	none apparent	notes (if applicable):	
Differential lateral spread:	none apparent	notes (if applicable):	
Ground cracks:	none apparent	notes (if applicable):	
Damage to area:	none apparent	notes (if applicable):	

Building:

	Current Placard Status:	green		
Along	Damage ratio:	0%	Describe how damage ratio arrived at:	Current damage noted will not diminish the capacity of the building.
	Describe (summary):	Cracked masonry block, cracking along mortar joints		
Across	Damage ratio:	0%		
	Describe (summary):	Cracked masonry block, cracking along mortar joints		
Diaphragms	Damage?:	no	Describe:	
CSWs:	Damage?:	no	Describe:	
Pounding:	Damage?:	no	Describe:	
Non-structural:	Damage?:	yes	Describe:	Cracked masonry block, step cracking along masonry joints, tearing of plasterboard linings in the walls and ceilings, hairline crack in concrete deck

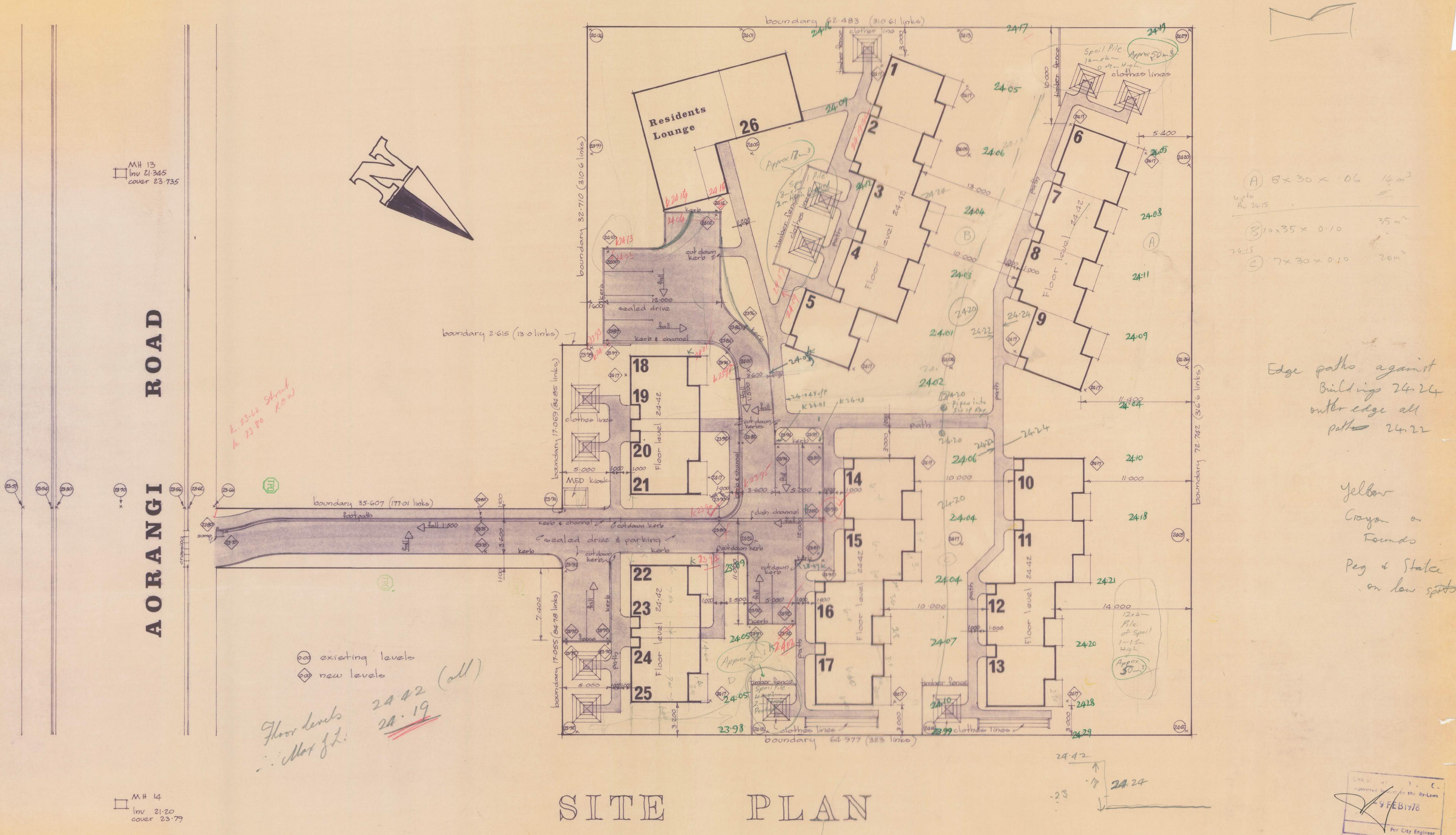
$$Damage\_Ratio = \frac{(\%NBS(before) - \%NBS(after))}{\%NBS(before)}$$

Recommendations

	Level of repair/strengthening required:	minor structural	Describe:	Reduce roof load by using alternative light cladding or strengthen masonry walls
	Building Consent required:	yes	Describe:	
	Interim occupancy recommendations:	full occupancy	Describe:	
Along	Assessed %NBS before:	37%	If IEP not used, please detail assessment methodology:	Quantitative assessment
	Assessed %NBS after:	37%		
Across	Assessed %NBS before:	100%		
	Assessed %NBS after:	100%		

Appendix I Architectural & Structural Drawings (1977)

ELDERLY PERSONS HOUSING



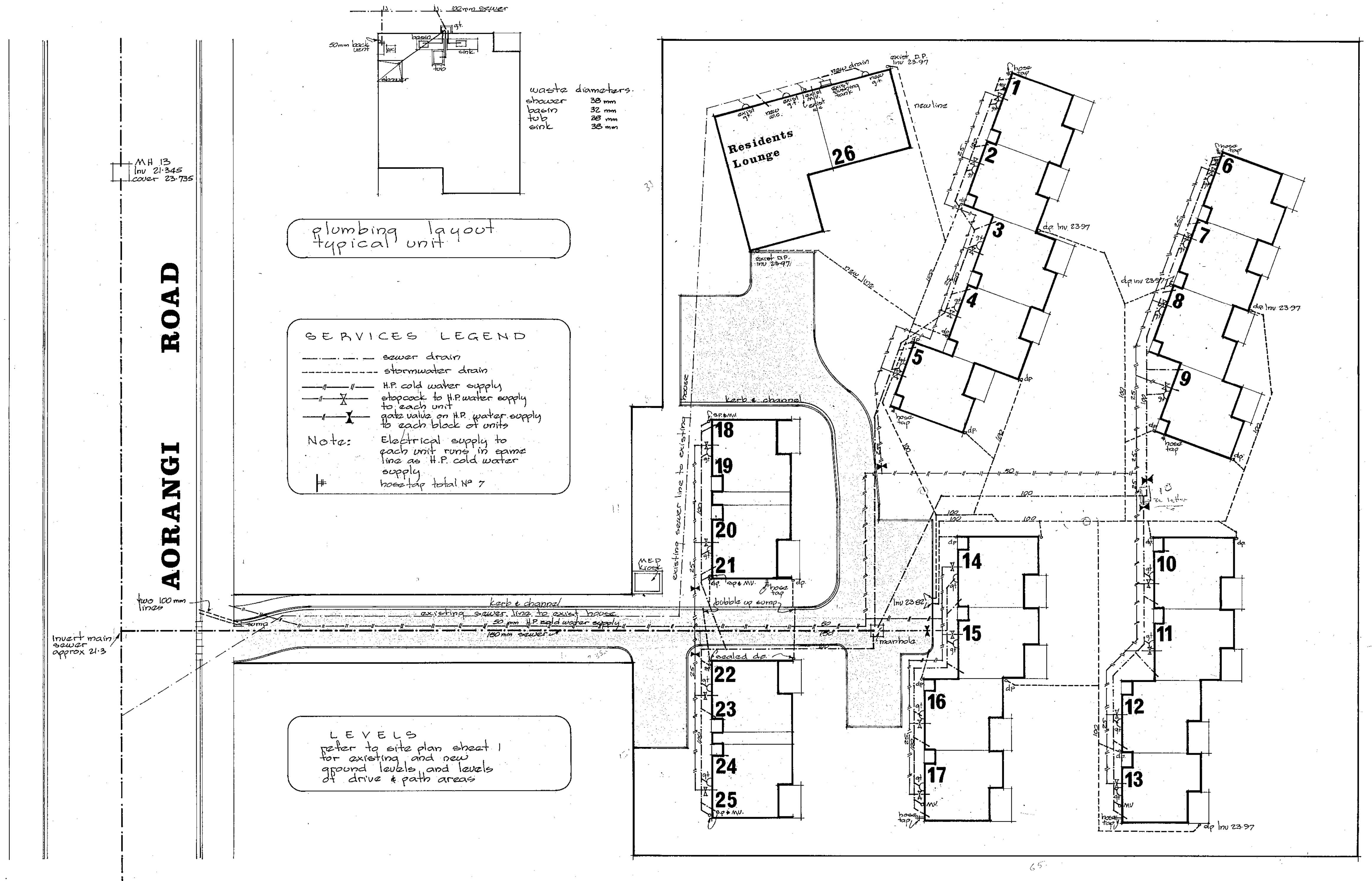
SITE PLAN

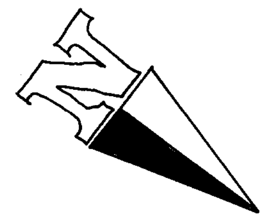
ELDERLY PERSONS HOUSING CHRISTCHURCH

FOR BRYNDWR BUILDERS LTD – CHRISTCHURCH

Date:	DEC 1977
Scale:	1:200
Job No:	535
	1A

IAN KRAUSE ASSOCIATES
REGISTERED ARCHITECTS Urban Design & Environment Consultants
P.O. Box 1786 Christchurch Phone 60323





IMPORTANT—Please read this information carefully. Non compliance could result in prosecution.

INSPECTION

24 hours' notice MUST be given to the Building Inspector prior to pouring any concrete or fixing any linings.

On the completion of ANY building 7 days' notice will be required so that a final inspection can be made.

DEVIATION FROM PERMIT

After a permit has been issued no departure shall be made from any of the particulars supplied upon any plan, drawing, specification or document deposited with the application upon which the permit was issued, unless amended particulars clearly describing the intended deviation are supplied to the Engineer at his office, and the Engineer shall have given his written approval of such deviation.

SITE LEVELS

In general, site levels at street boundaries and minimum section levels should be set at the existing level of the back of the footpath or the crown of the road, whichever is the higher.

All levels should be shown in terms of Christchurch Drainage Board's datum.

Designers and/or Builders should check the validity of proposed levels with the City Engineer's Design Office, particularly where compliance with the above requirements would cause concern.

STORMWATER DRAINAGE

Unless otherwise approved, pipe drains must be provided to convey all stormwater to the street channel system from all buildings, and only stormwater may be discharged into this system.

STAFF AMENITIES

Relating to Commercial and Industrial buildings only.

The Department of Labour administers legislation which prescribes the minimum scales of staff amenities including clothing accommodation, sanitary, washing, mealroom, restroom and other facilities. You are advised to contact the Department to ensure that any proposed staff amenities are adequate. Later provisions could be costly.

M.E.D. Domestic Water Heating Requirements:
Relating to dwelling units only.

(a) Minimum cylinder capacity 40 gallons.
(b) Hot water service pipes shall be lagged copper.

Christchurch Drainage Board Requirements:
Relating to all applications.

Your attention is drawn to any requirements which the Christchurch Drainage Board may have in relation to all applications.

These requirements will be attached to the approved plans.

P.W.A. Ltd. 22187

DRAINAGE & SERVICES PLAN

... COUNCIL ... By-Laws FEB 1978 ... City Engineer

ELDERLY PERSONS HOUSING CHRISTCHURCH

FOR BRYNDWR BUILDERS LTD — CHRISTCHURCH

9-1-78 Drainage to Residents Lounge and unit 26 added

Date: DEC 1977
Scale: 1:200
Job No: 535

2A

IAN KRAUSE ASSOCIATES
REGISTERED ARCHITECTS Urban Design & Environment Consultants
P.O.Box 1766 Christchurch Phone 50323

UNITS 10 – 13
14 – 17

Note
For details of plans see sheet

UNITS 1 – 5

9-1-78 Additional bracing shown
9-1-78 Bedroom windows increased in depth.

ELDERLY PERSONS HOUSING
CHRISTCHURCH

FOR BRYNDWR BUILDERS LTD - CHRISTCHURCH

IAN KRAUSE ASSOCIATES
REGISTERED ARCHITECTS Urban Design & Environment Consultants
P.O.Box 1756 Christchurch Phone 60323

Date: DEC 1977
Scale: 1:100
Job No: 535

3 A

UNITS 6 — 9

UNITS 18 — 21
22 — 25

9-1-78 Additional bracing showing
9-1-78 Bedroom windows increased in depth.

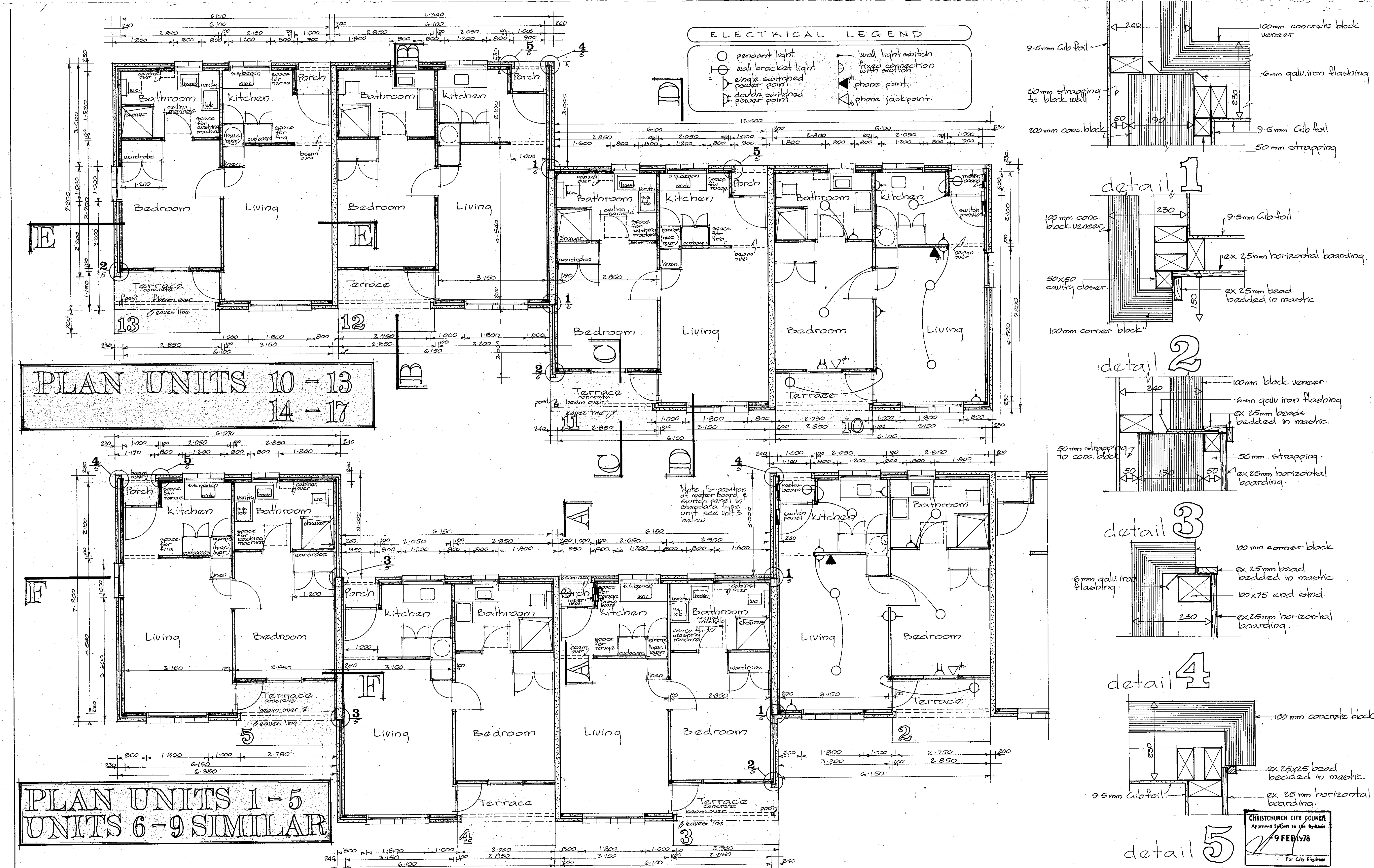
ELDERLY PERSONS HOUSING CHRISTCHURCH

FOR BRYNDWR BUILDERS LTD — CHRISTCHURCH

Date:	DEC 1977
Scale:	1 100
Job No:	535

4A

IAN KRAUSE ASSOCIATES
REGISTERED ARCHITECTS Urban Design & Environment Consultants
P.O.Box 1766 Christchurch Phone 60323



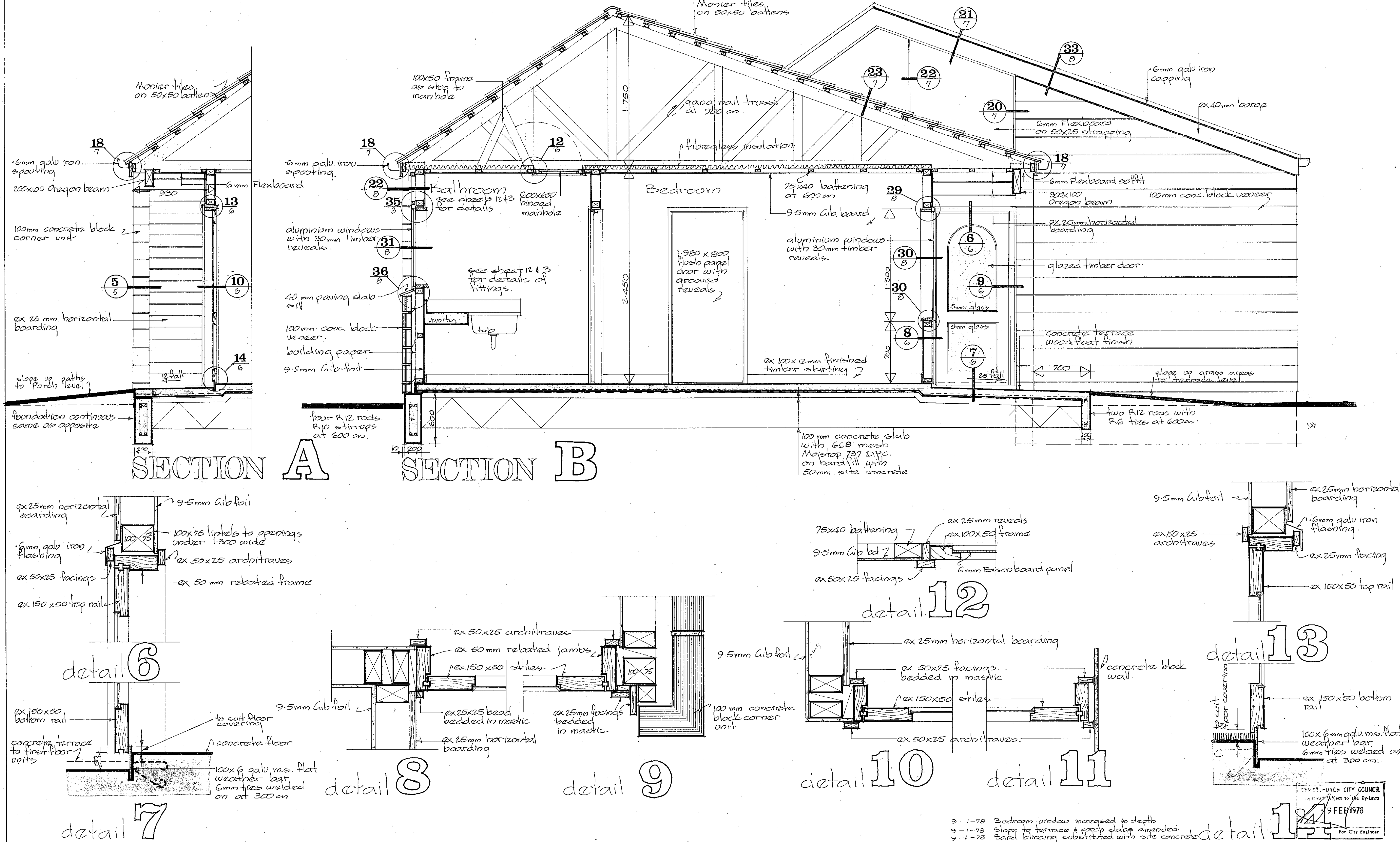
ELDERLY PERSONS HOUSING CHRISTCHURCH

FOR BRYNDWR BUILDERS LTD CHRISTCHURCH

Date:	DEC 1977
Scale:	1:50 1:5
Job No:	535

5

IAN KRAUSE ASSOCIATES
REGISTERED ARCHITECTS Urban Design & Environment Consultants
P.O.Box 1766 Christchurch Phone 60323



ELDERLY PERSONS HOUSING CHRISTCHURCH

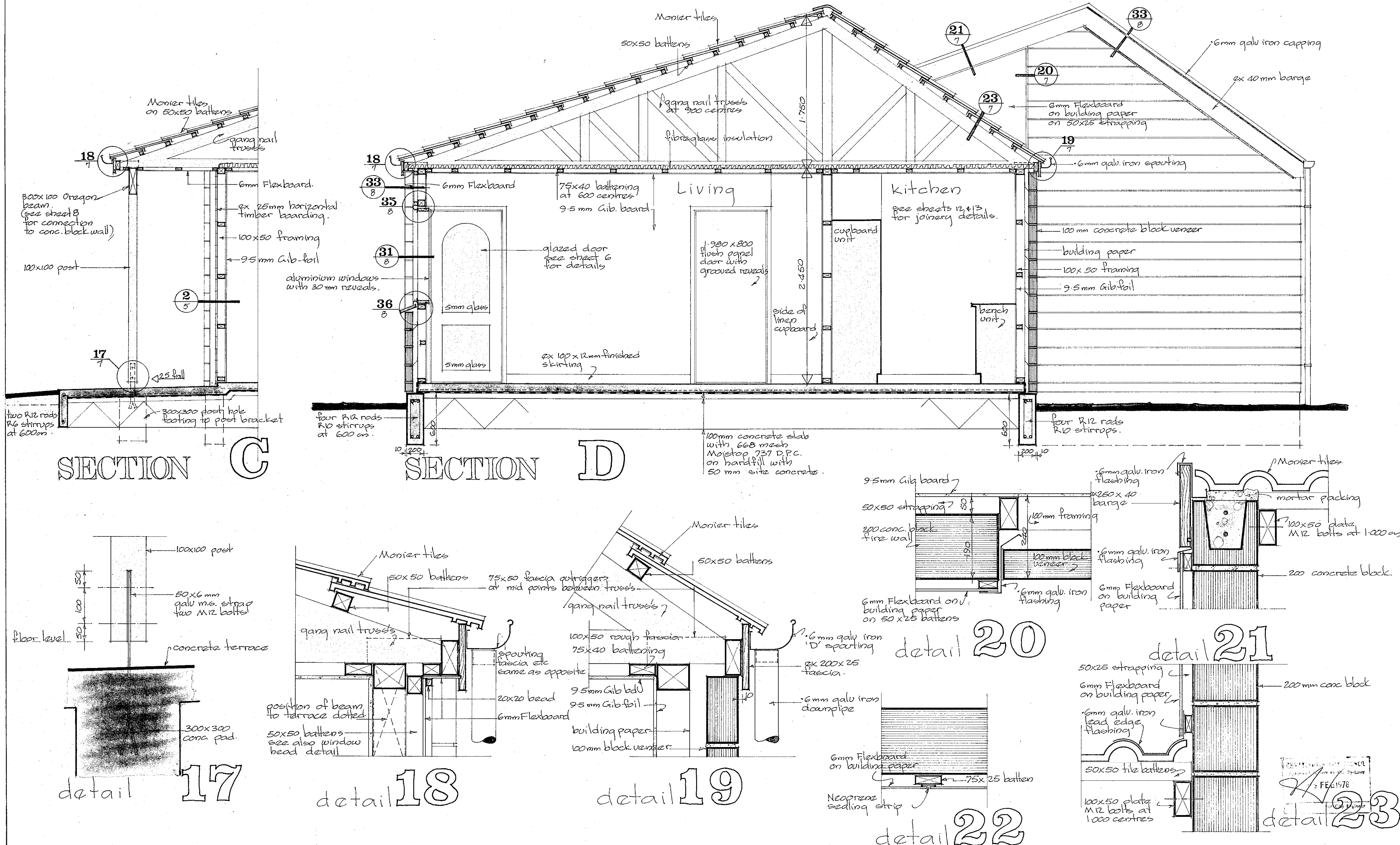
FOR BRYNDWR BUILDERS LTD – CHRISTCHURCH

Date:	DEC 1977
Scale:	1:20 1:5
Job No:	535

6A

IAN KRAUSE ASSOCIATES

REGISTERED ARCHITECTS Urban Design & Environment Consultants P.O.Box 1766 Christchurch Phone 60323



ELDERLY PERSONS HOUSING CHRISTCHURCH

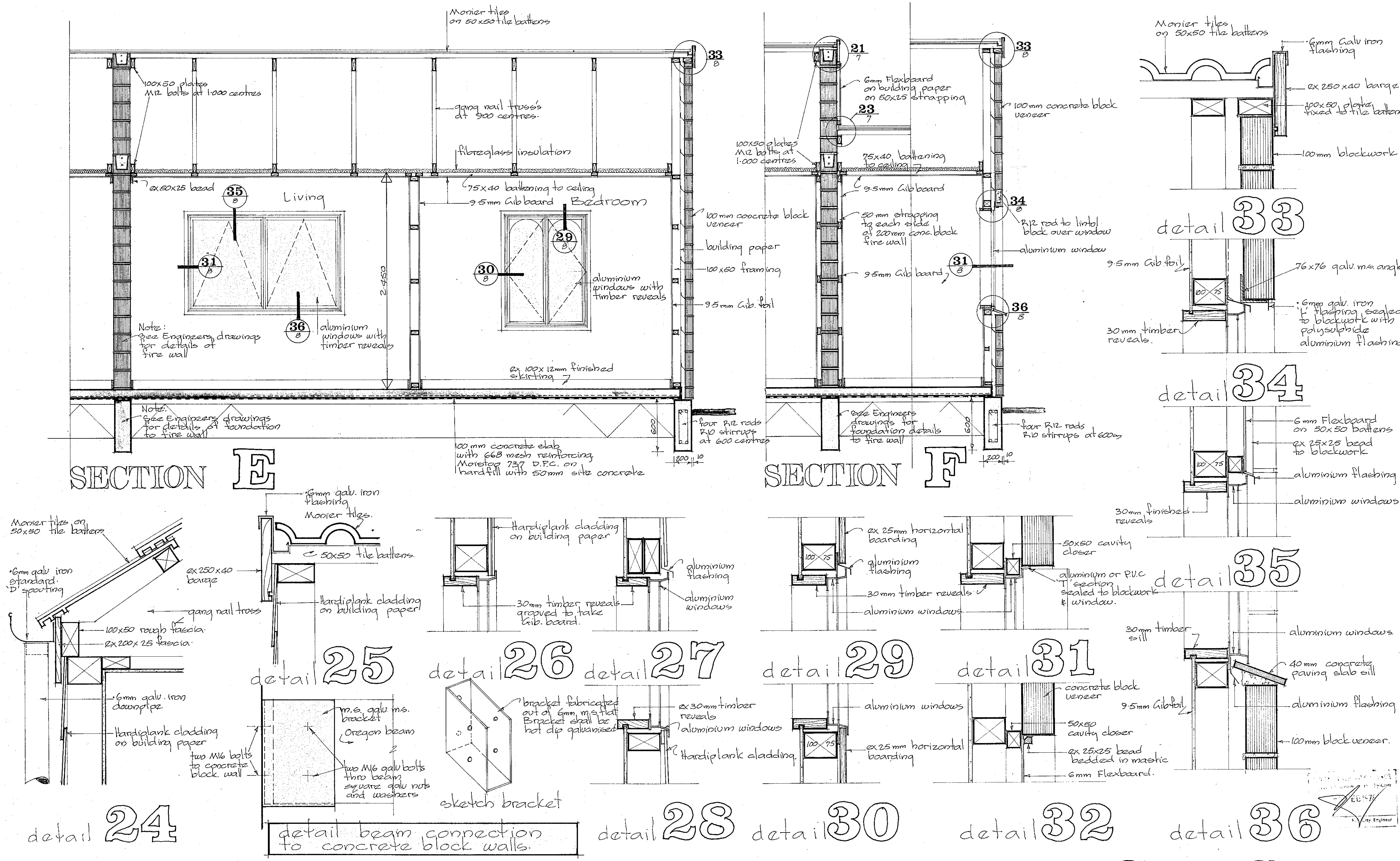
FOR BRYNDWR BUILDERS LTD – CHRISTCHURCH

9-1-78 sand blinding substituted with site concrete
9-1-78 fascia outriggers added to details 18 & 19.

Date: DEC 1977
Scale: 1:20 1:5
Job No: 535

7 A

IAN KRAUSE ASSOCIATES
REGISTERED ARCHITECTS Urban Design & Environment Consultants
P.O.Box 1766 Christchurch Phone 60323



ELDERLY PERSONS HOUSING CHRISTCHURCH

FOR BRYNDWR BUILDERS LTD - CHRISTCHURCH

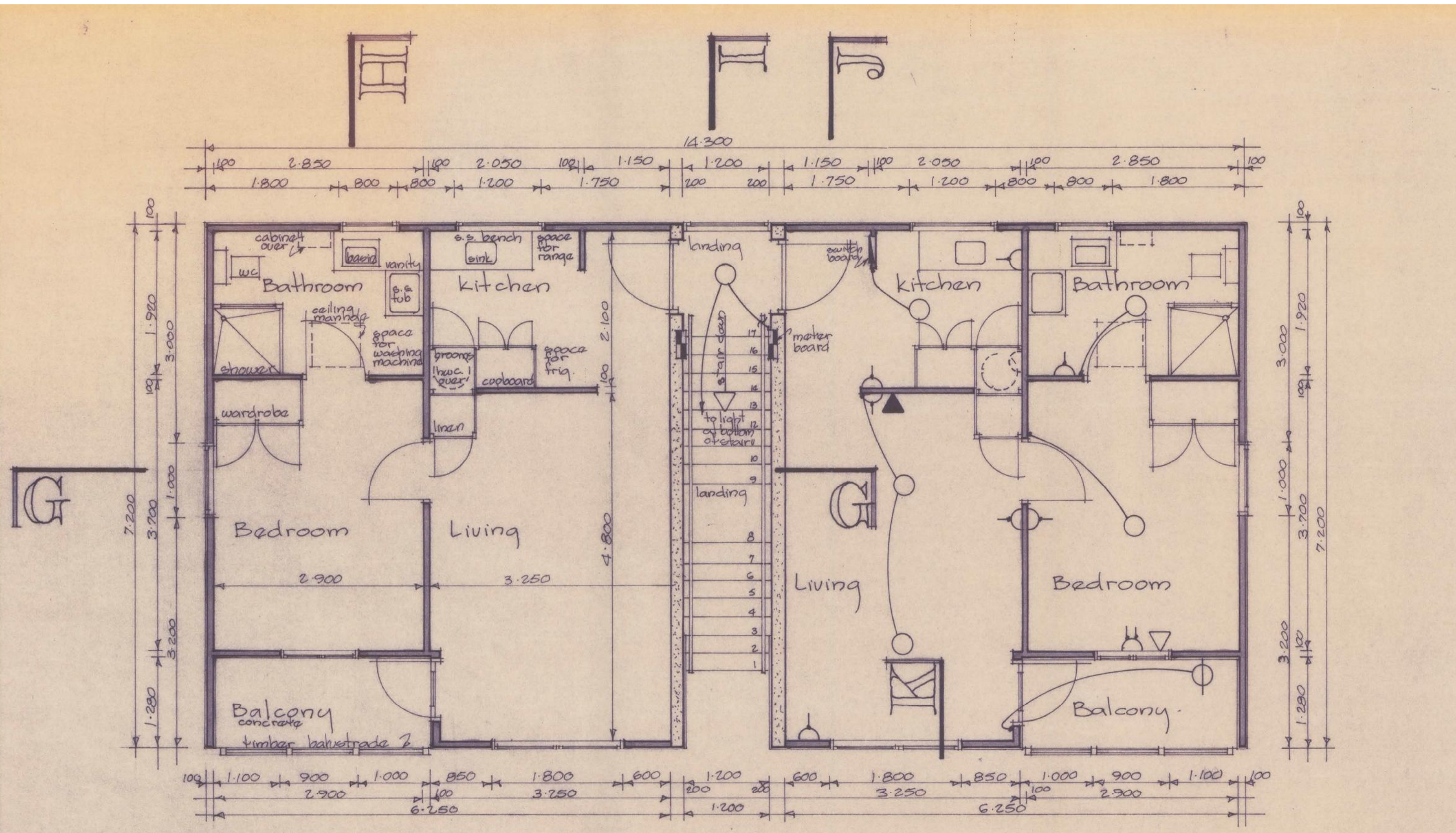
9-1-78 Detail 33 amended
9-1-78 Sand blinding substituted with site concrete
9-1-78 Bedroom window increased in depth.

Date:	DEC 1977
Scale:	1:20 1:5
Job No:	535

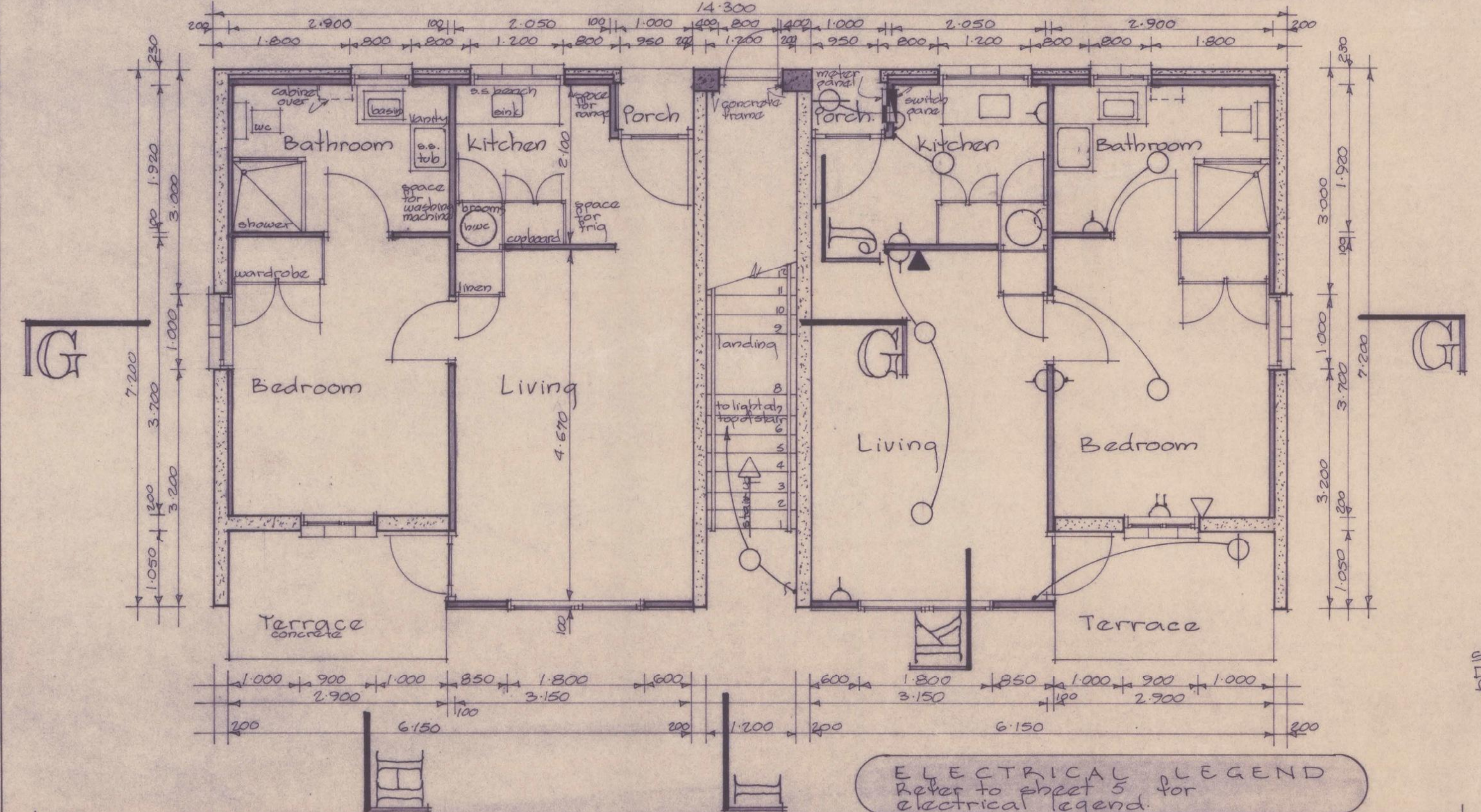
8

IAN KRAUSE ASSOCIATES

REGISTERED ARCHITECTS Urban Design & Environment Consultants
P.O.Box 1765 Christchurch Phone 60323

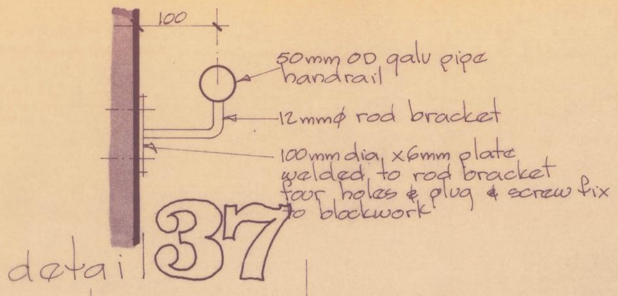


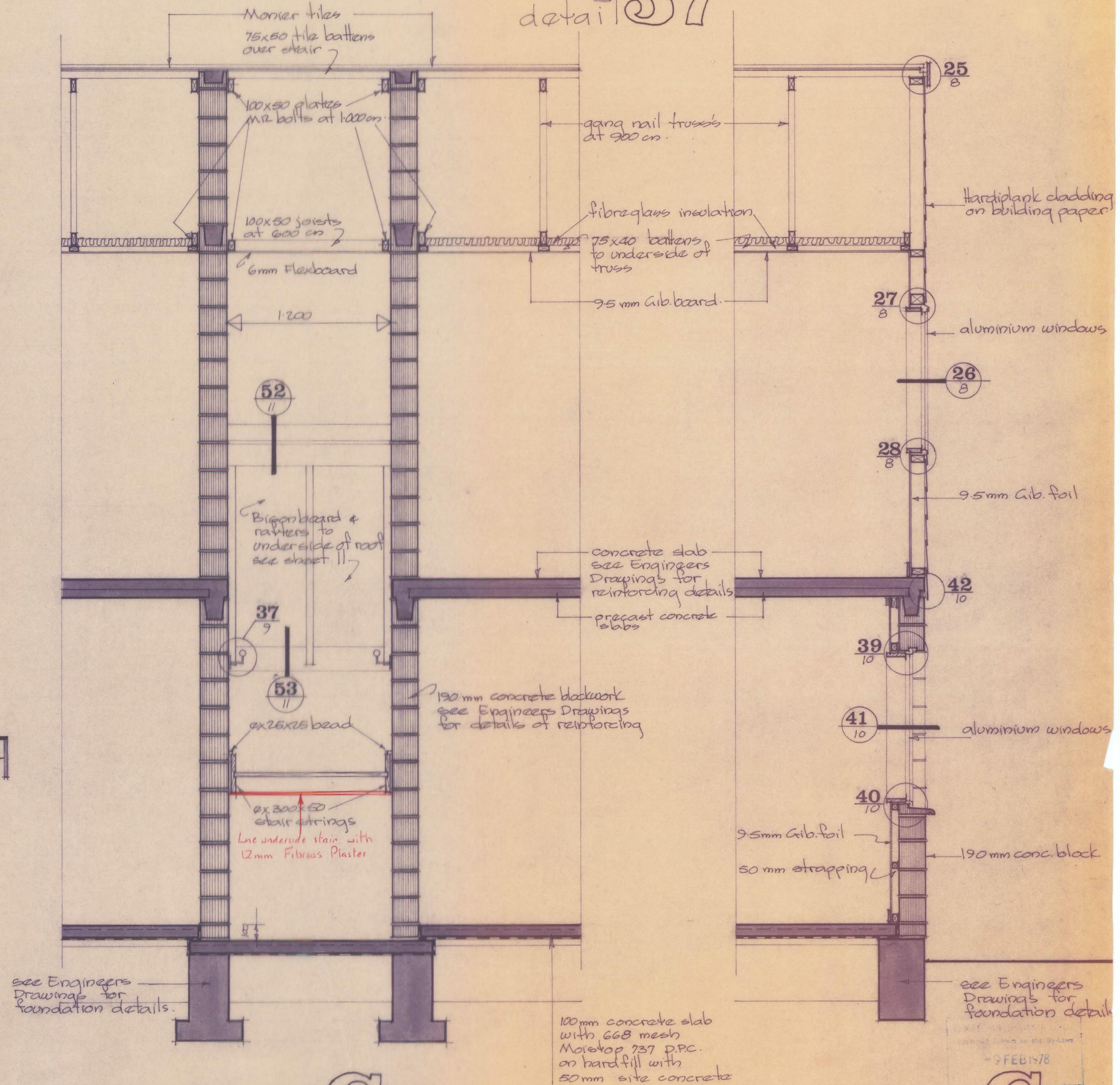
FIRST FLOOR UNITS 19 & 21 · 23 & 25



ELECTRICAL LEGEND
Refer to sheet 5 for electrical legend.

GROUND FLOOR UNITS 18 & 20 · 22 & 24





SECTION G

SECTION G

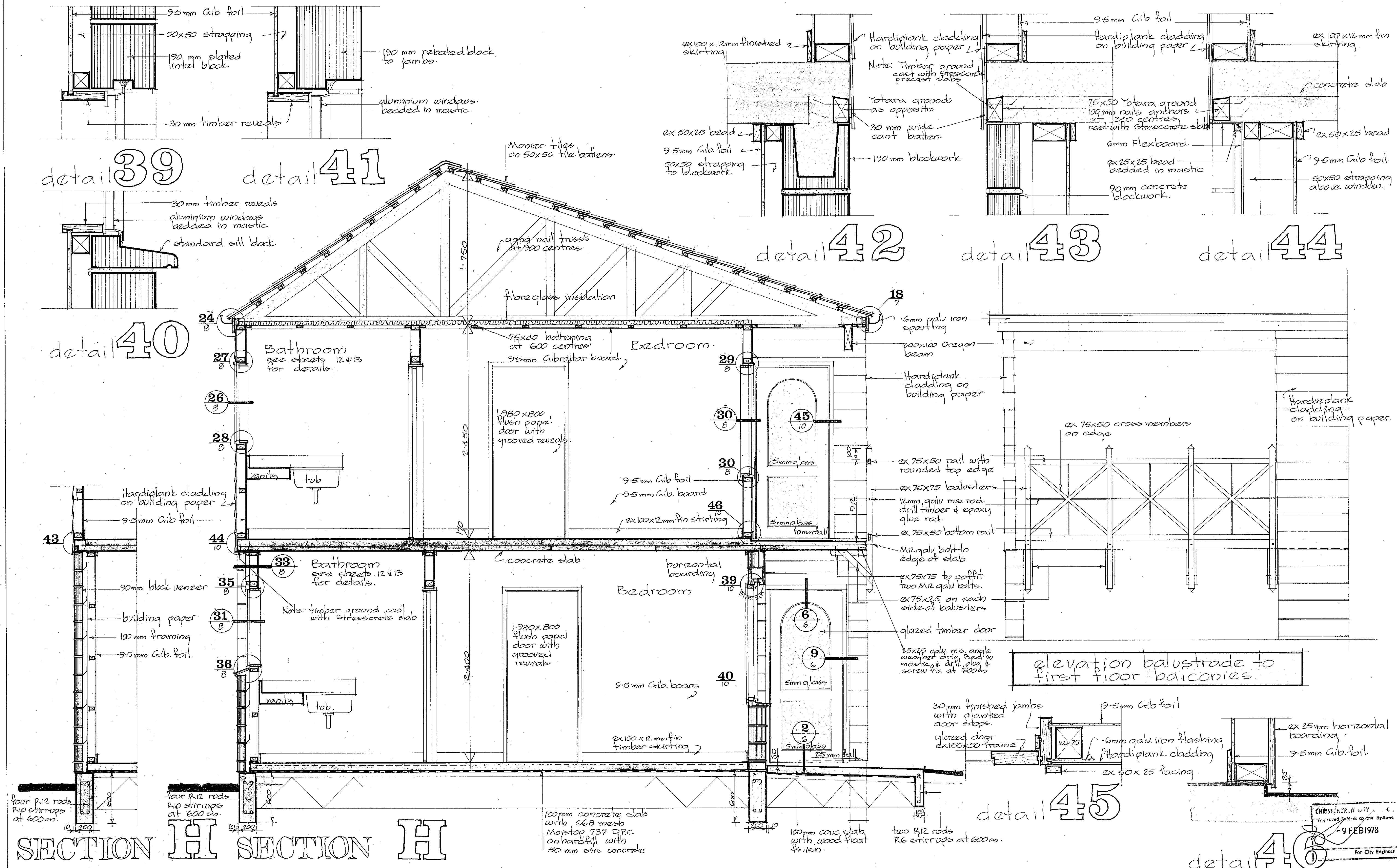
ELDERLY PERSONS HOUSING
CHRISTCHURCH

FOR BRYNDWR BUILDERS LTD — CHRISTCHURCH

Date: DEC 1977
Scale: 1:20 1:50
Job No: 535

9A

IAN KRAUSE ASSOCIATES
REGISTERED ARCHITECTS Urban Design & Environment Consultants
P.O. Box 1768 Christchurch Phone 60323



ELDERLY PERSONS HOUSING CHRISTCHURCH

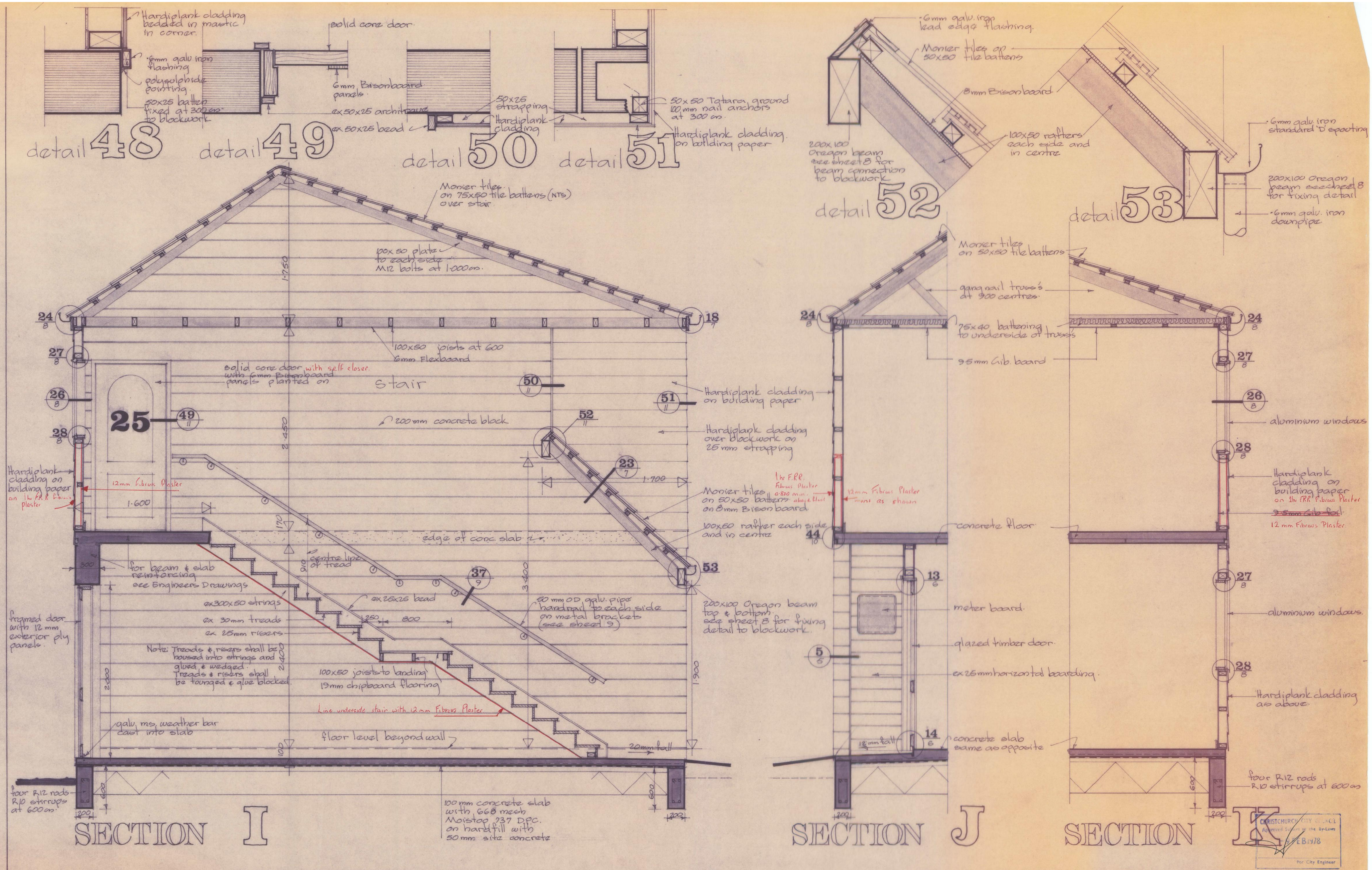
FOR BRYNDWR BUILDERS LTD - CHRISTCHURCH

9-1-78 slope to terrace amended
9-1-78 sand blinding substituted with site concrete
9-1-78 Bedroom window increased in depth.

Date: DEC 1977
Scale: 1:20 1:5
Job No: 535

10A

IAN KRAUSE ASSOCIATES
REGISTERED ARCHITECTS Urban Design & Environment Consultants
P.O.Box 1766 Christchurch Phone 60323



ELDERLY PERSONS HOUSING CHRISTCHURCH

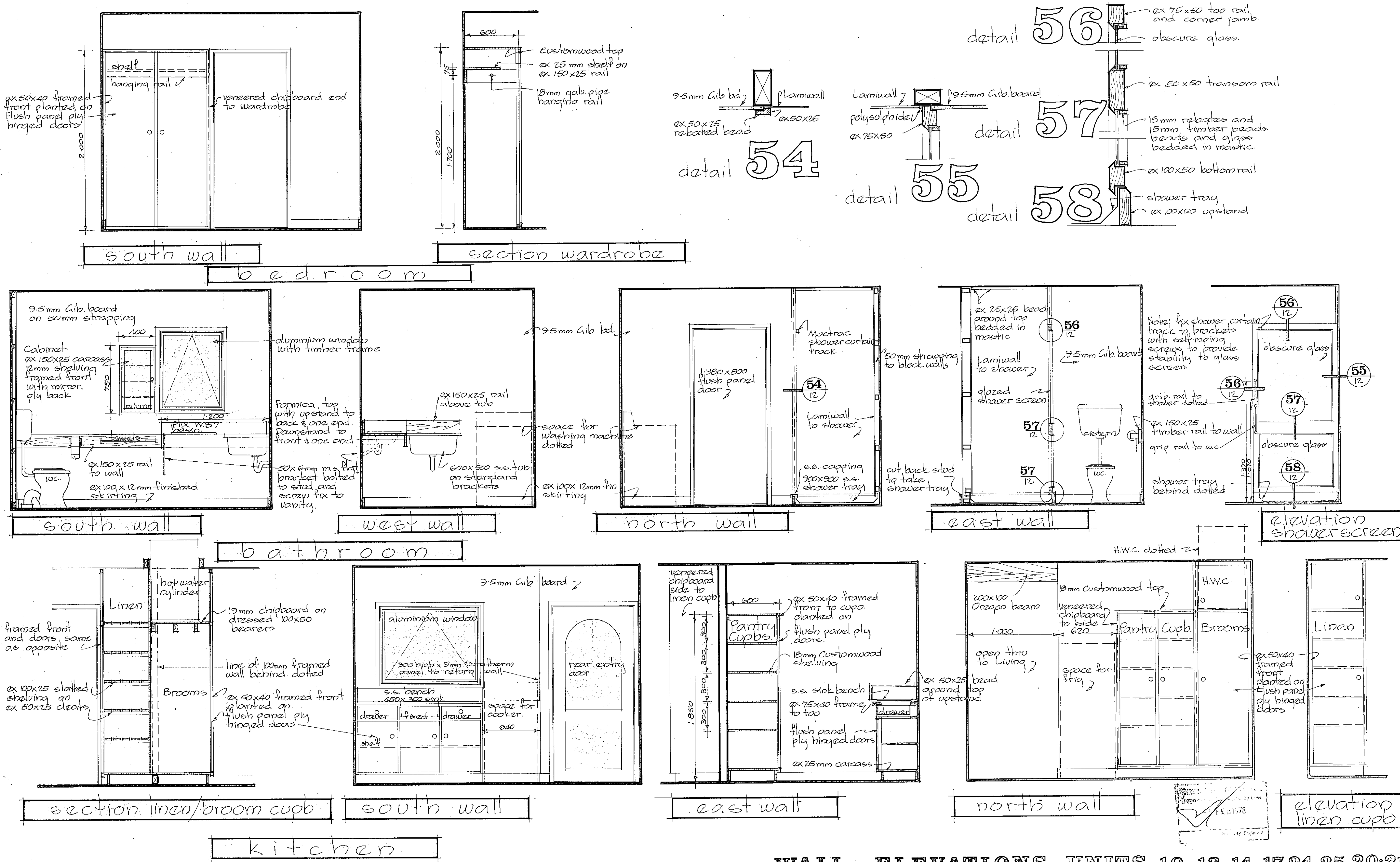
FOR BRYNDWR BUILDERS LTD - CHRISTCHURCH

9-1-78 sand blinding substituted with site concrete
9-1-78 Note added on stair construction

Date: DEC 1977
Scale: 1:20 1:5
Job No: 535

11A

IAN KRAUSE ASSOCIATES
REGISTERED ARCHITECTS Urban Design & Environment Consultants
P.O. Box 1755 Christchurch Phone 60323



WALL ELEVATIONS UNITS 10-13,14-17,24,25,20;21

ELDERLY PERSONS HOUSING CHRISTCHURCH

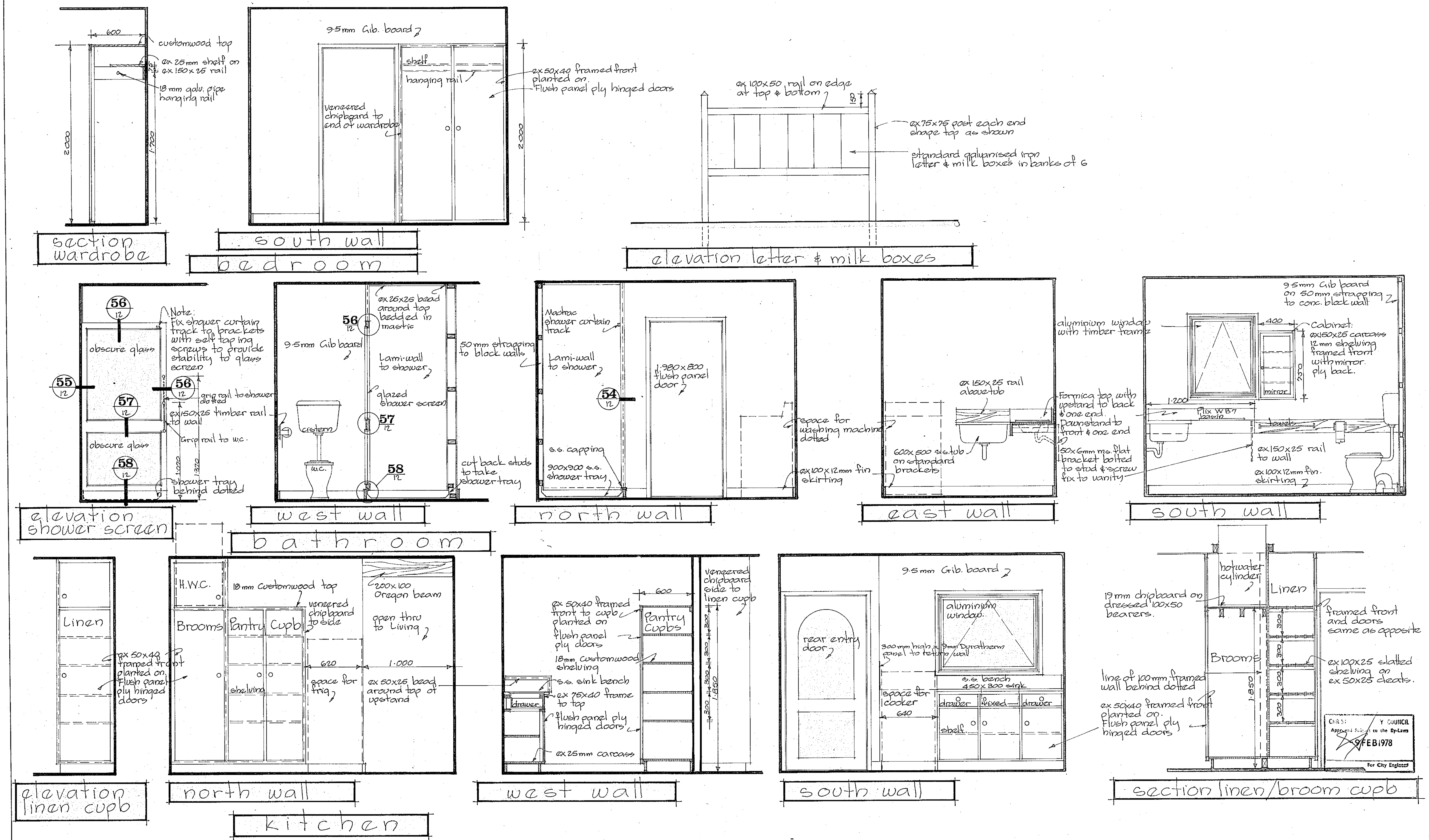
FOR BRYNDWR BUILDERS LTD - CHRISTCHURCH

9-1-78 Grip rails to bathroom added.
9-1-78 Duratherm panels added to wall at side of range

Date: DEC 1977
Scale: 1:20 1:5
Job No: 535

12 A

IAN KRAUSE ASSOCIATES
REGISTERED ARCHITECTS Urban Design & Environment Consultants
P.O.Box 1766 Christchurch Phone 60323



WALL ELEVATIONS UNITS 1-5, 6-9, 18, 19, 22, 23.

ELDERLY PERSONS HOUSING CHRISTCHURCH

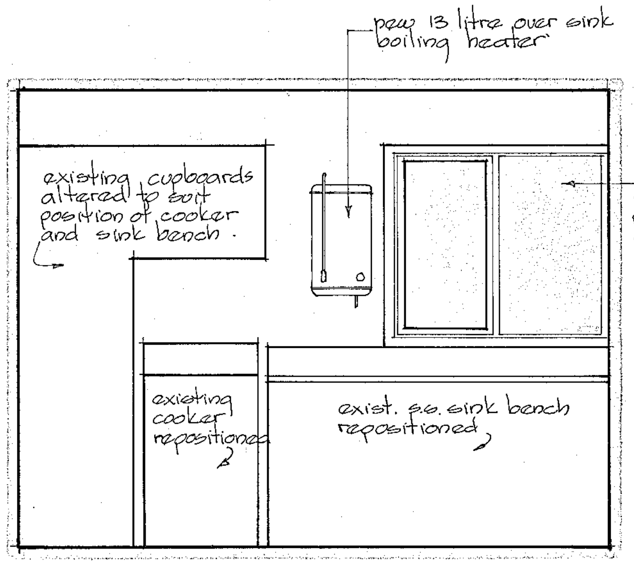
FOR BRYNDWR BUILDERS LTD – CHRISTCHURCH

9-1-78 Grip rails added to bathroom
9-1-78 Duratherm panels added to wall at side of range.

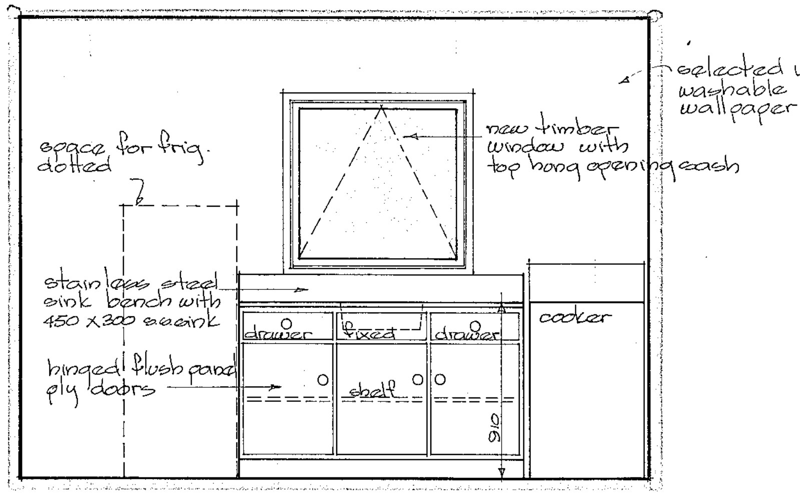
Date: DEC 1977
Scale: 1:20
Job No: 535

13

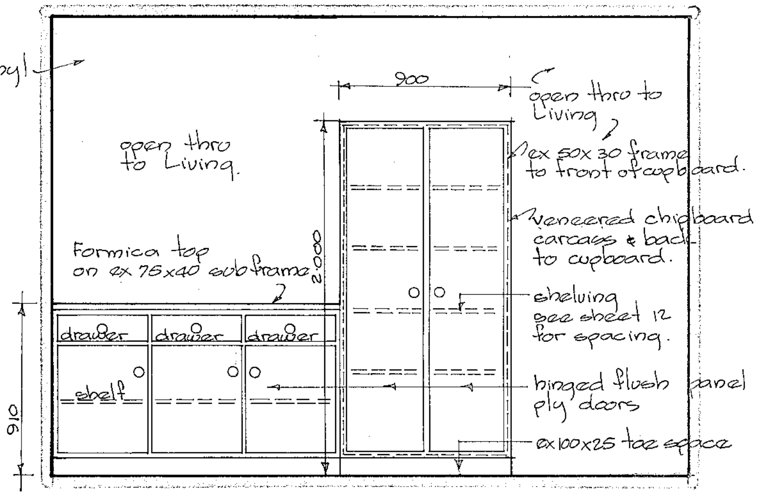
IAN KRAUSE ASSOCIATES
REGISTERED ARCHITECTS Urban Design & Environment Consultants
P.O. Box 1766 Christchurch Phone 60323



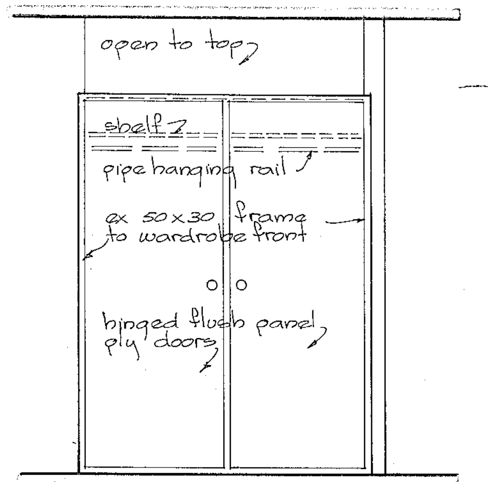
elevation sink bench kitchen residents lounge



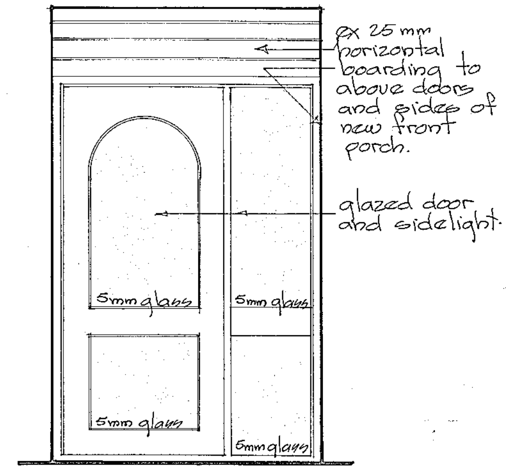
elevation sink bench kitchen unit 26



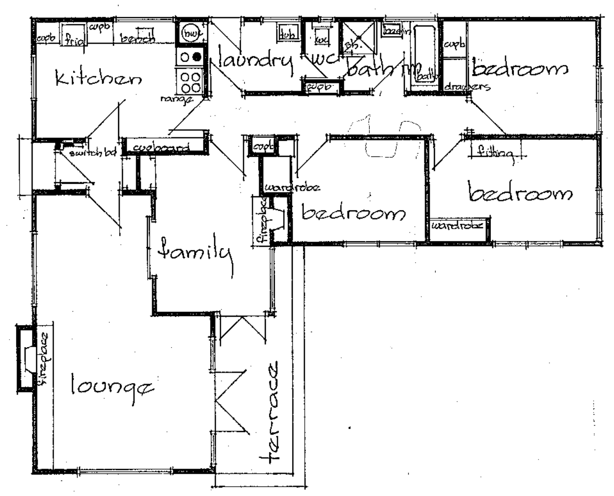
elevation servery & cupboard kitchen unit 26



elevation wardrobe to bedroom



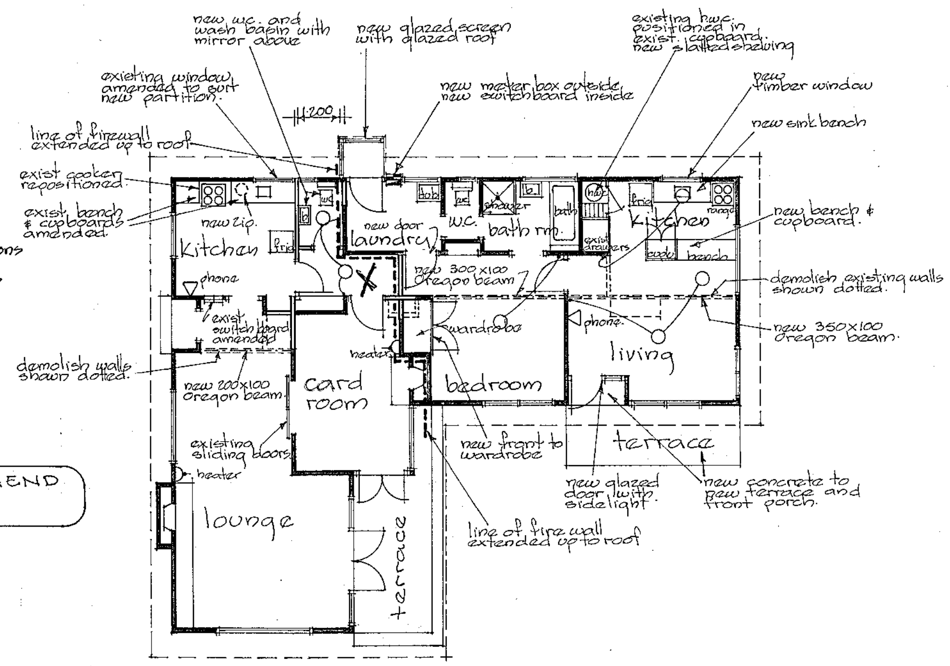
exterior elevation new front door unit 26.



EXISTING HOUSE PLAN

existing partitions
new partitions

ELECTRICAL LEGEND
refer to sheet 5 for electrical legend.



NEW FLOOR PLAN

CHRISTCHURCH CITY COUNCIL Approved Subject to the By-Laws 9 FEB 1978 For City Engineer

RESIDENTS LOUNGE & UNIT 26

ELDERLY PERSONS HOUSING CHRISTCHURCH

FOR BRYNDWR BUILDERS LTD — CHRISTCHURCH

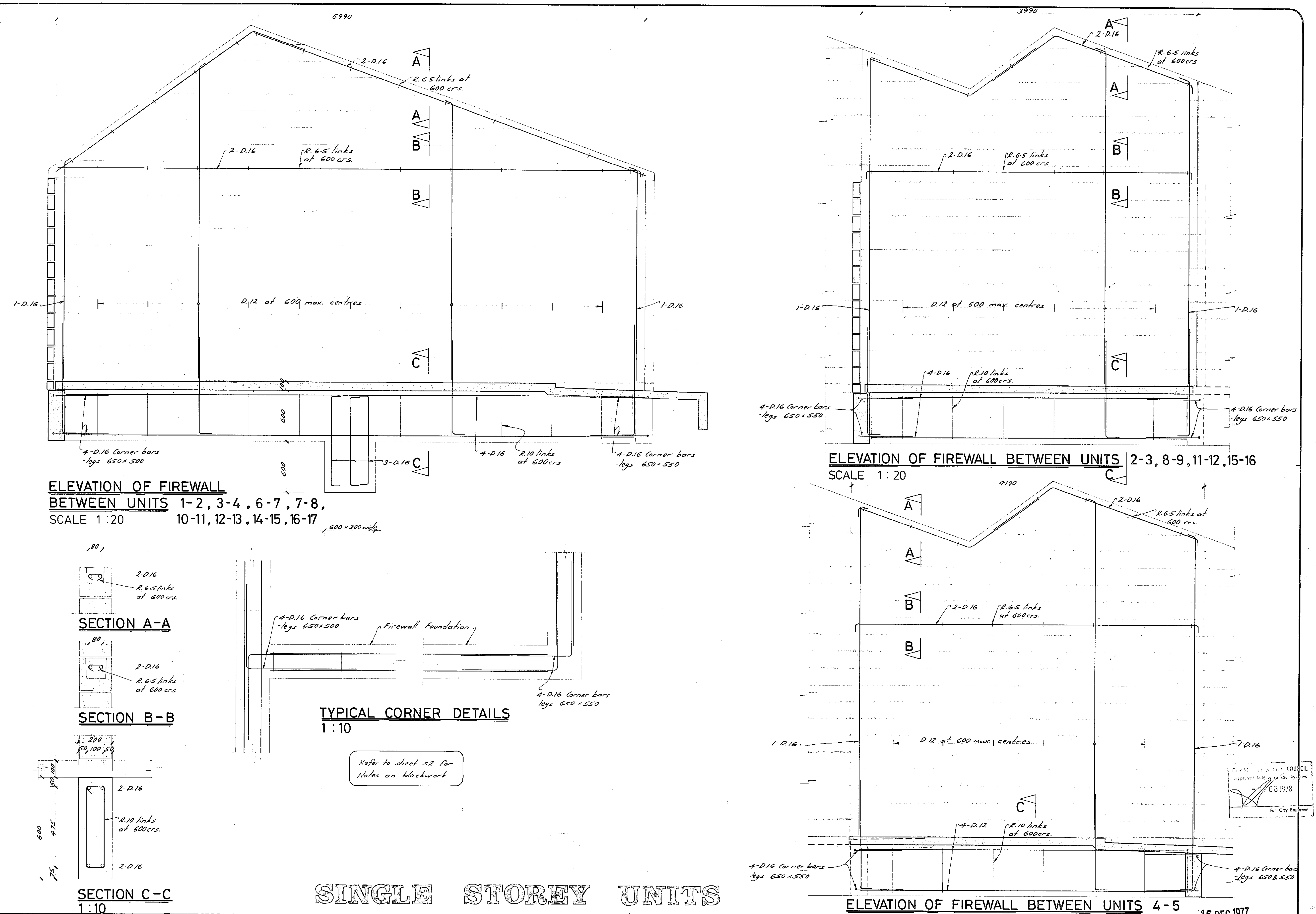
9-1-78 Door added between laundry & bedroom

Date:	DEC 1977
Scale:	1:100 1:20
Job No:	535

14

IAN KRAUSE ASS

REGISTERED ARCH



16 DEC 1977

ELDERLY PERSONS HOUSING —— CHRISTCHURCH
—— FOR BRYNDWR BUILDERS LTD. ——

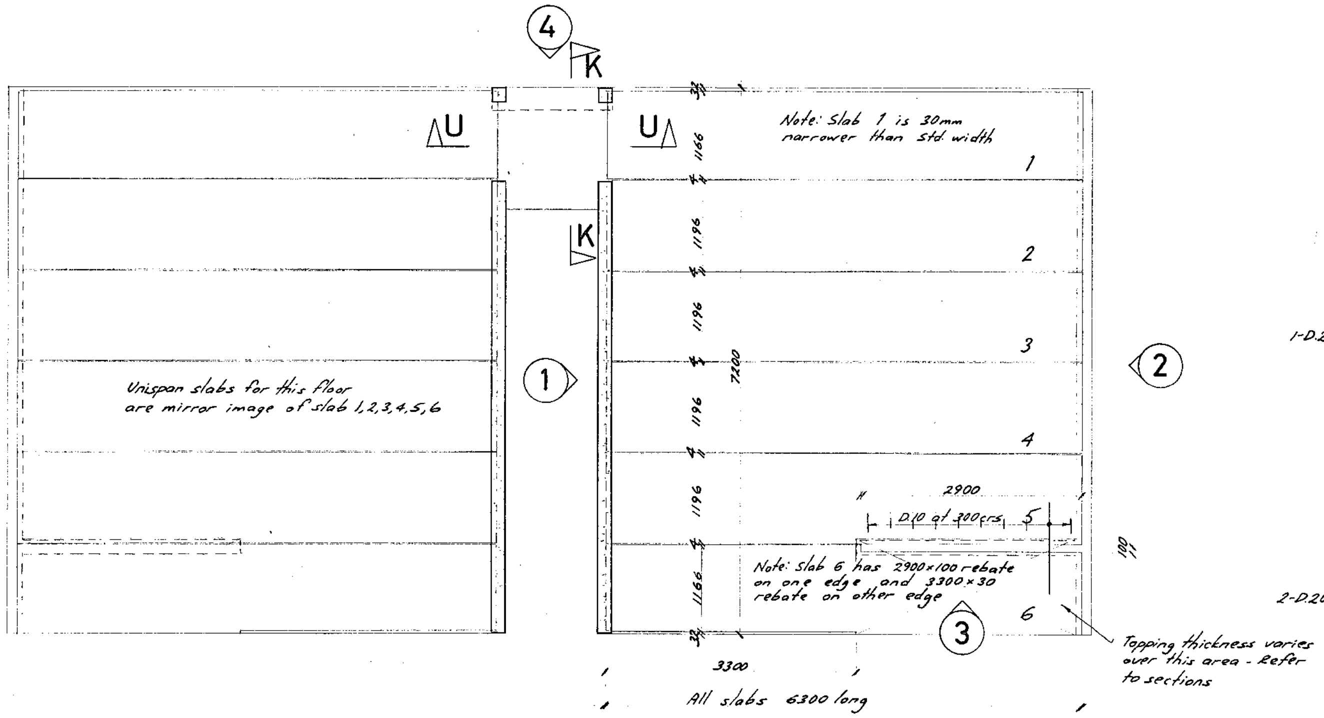
IAN KRAUSE ASSOCIATES
REGISTERED ARCHITECTS
137 VICTORIA STREET P.O. BOX 1766
CHRISTCHURCH PHONE 60 323

A.E.TYNDALL B.E., M.N.Z.I.E.
CONSULTING CIVIL AND STRUCTURAL ENGINEER
240 ARMAGH STREET P.O. BOX 13 117
CHRISTCHURCH PHONE 61 501

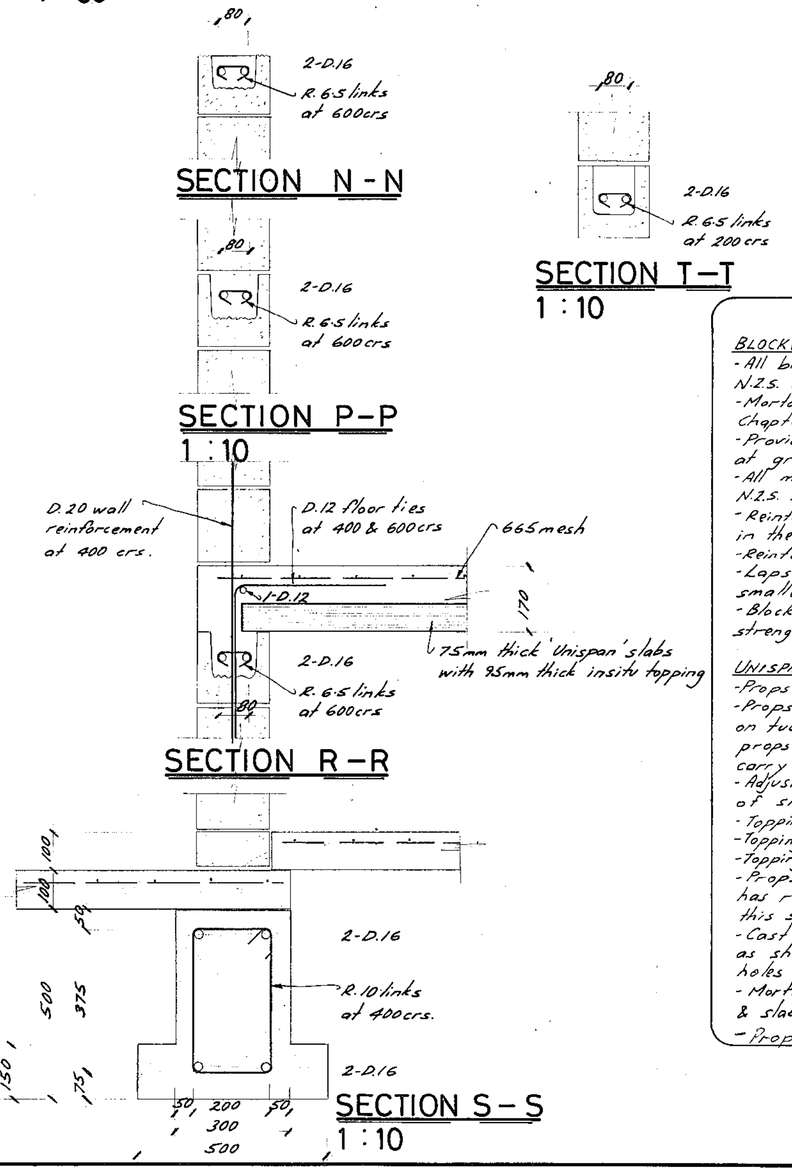
SCALES: 1 : 50
1 : 10
DATE: DEC 1977

VERIFY ALL DIMENSIONS BEFORE STARTING WORK
DRAWN: Grant Wilkinson

sheet no. S1
of 3 sheets
JOB No 1174



PLAN OF FLOOR SLAB
AT FIRST FLOOR LEVEL
1 : 50



SECTION N-N

SECTION P-P
1 : 10

SECTION R-R

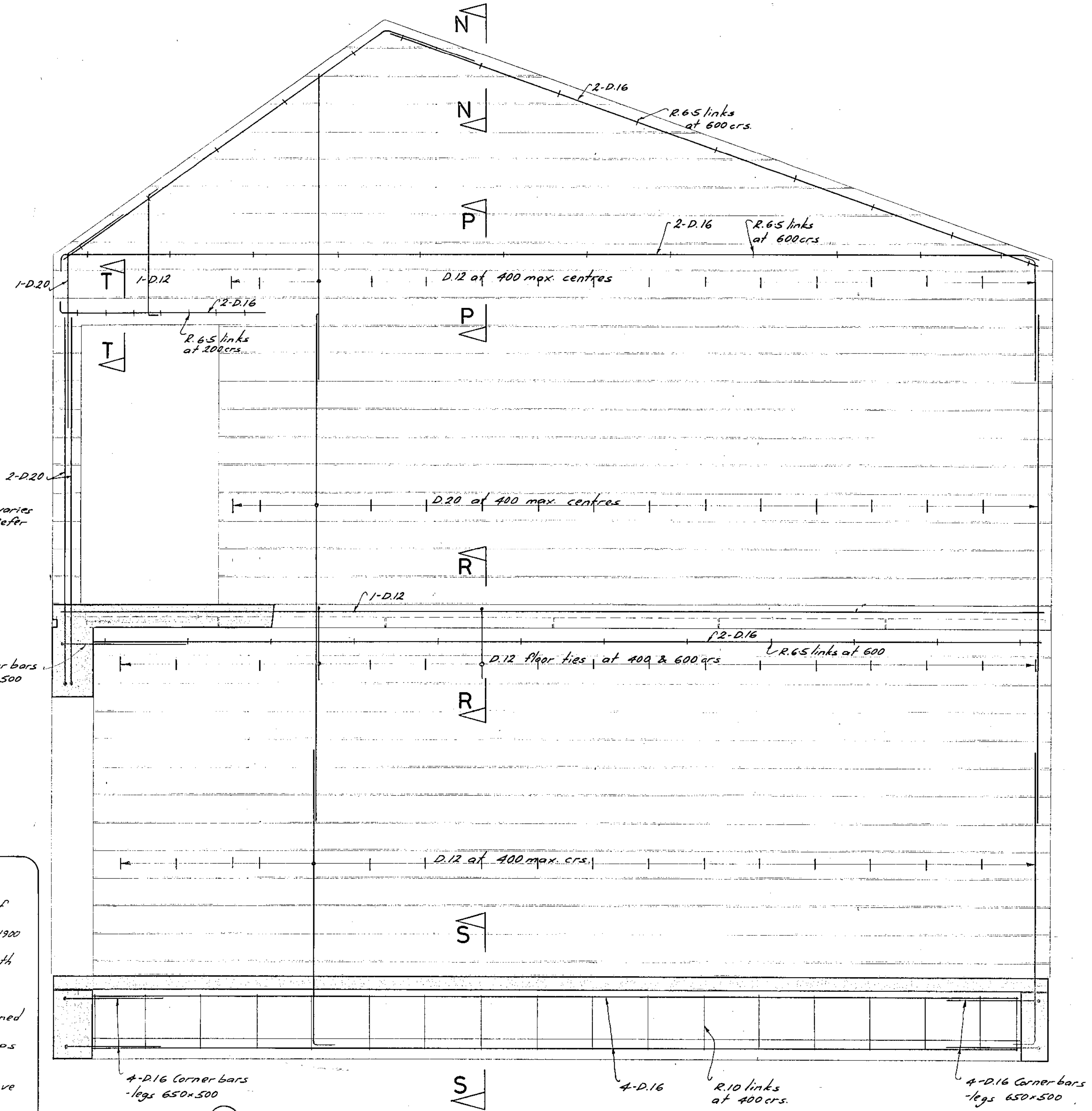
SECTION S-S
1 : 10

SECTION T-T
1 : 10

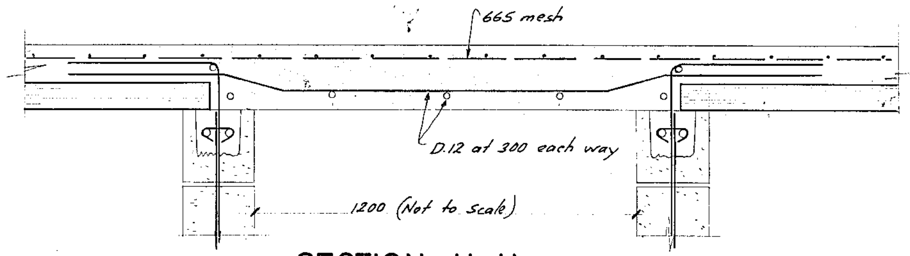
NOTES

BLOCKWORK
- All blockwork shall comply with the relevant clauses of N.Z.S. 1900, Chapter 9.2 - 1964
- Mortar shall be Mix No 1 (12.5MPa) as defined in N.Z.S.1900 Chapter 9.2
- Provide clean-out pockets to all reinforced cores, both at ground level and first floor level
- All main reinforcing shall be deformed steel to N.Z.S. 3402 P Grade 275
- Reinforcing shall be accurately positioned and maintained in the centre of the cavity unless detailed otherwise
- Reinforcing shall be tied to starter bars and at laps
- Laps shall be a minimum of 40 diameters of the smaller bar
- Block filling shall have a minimum 28 day compressive strength of 17.5 MPa.

UNISPAN SLABS
- Props must be erected before slabs are placed.
- Props shall consist of 100×75 timber plates on edge on tubular steel adjustable props at 1200crs. Steel props & sole plates shall be of such a size as to carry a minimum of 2.5 tonne each without settlement.
- Adjust propping to obtain 25mm camber at midspan of slabs and 10mm camber to edges of slab 1 & 6
- Topping concrete strength shall be 20MPa at 28 days
- Topping concrete is to follow same camber as Unispan slabs
- Topping concrete shall be water or membrane cured for 7 days
- Props may be removed once the topping strength has reached 14 MPa. Concrete suppliers can advise when this strength is available
- Cast out holes and slots, fix timber to edge of slabs as shown on the drawings and make provision for any holes that may be required for plumbing, wastes, etc.
- Mortar seating is to be a plastic sand/cement mortar & slabs are to be placed while mortar is still plastic
- Props shall be placed in 2 rows.



ELEVATION 1
1 : 10



SECTION U-U
N.T.S.

CHRISTCHURCH CITY COUNCIL
Approved Subject to the By-Laws
9 FEB 1978
For City Engineer

TWO STOREY UNITS

16 DEC 1977

ELDERLY PERSONS HOUSING —— CHRISTCHURCH
—— FOR BRYNDWR BUILDERS LTD ——

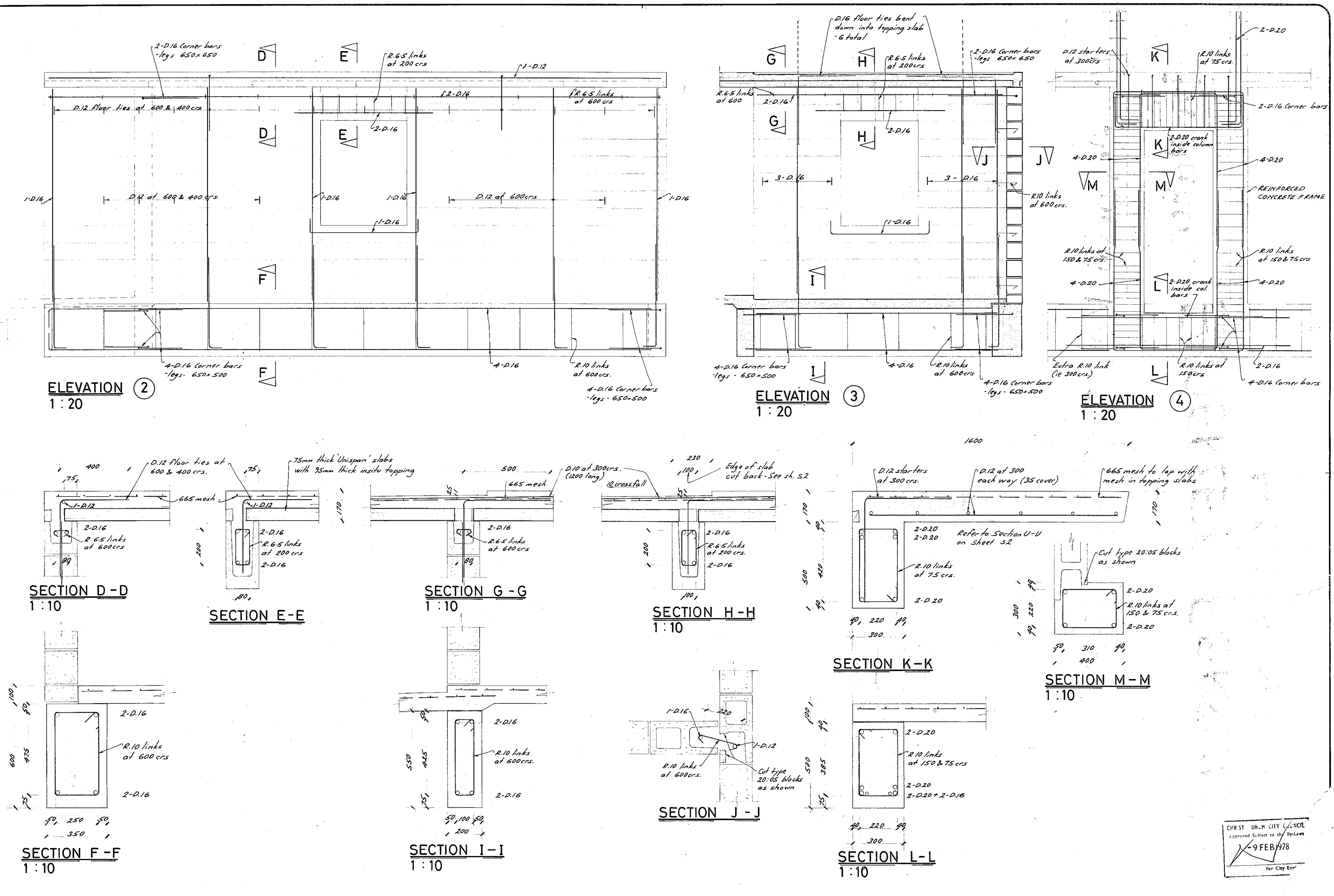
IAN KRAUSE ASSOCIATES
REGISTERED ARCHITECTS
137 VICTORIA STREET P.O. BOX 1766
CHRISTCHURCH PHONE 60 323

A.E. TYNDALL B.E., M.N.Z.I.E.
CONSULTING CIVIL AND STRUCTURAL ENGINEER
240 ARMAGH STREET P.O. BOX 13 117
CHRISTCHURCH PHONE 61 501

SCALES: 1 : 50
1 : 20 1 : 10
DATE: DEC 1977

VERIFY ALL DIMENSIONS BEFORE STARTING WORK
DRAWN: Grant Wilkinson

sheet no. S2
of 3 sheets
JOB No 1174



TWO STOREY UNITS

ELDERLY PERSONS HOUSING —— CHRISTCHURCH
—— FOR BRYNDWR BUILDERS LTD ——

IAN KRAUSE ASSOCIATES
REGISTERED ARCHITECTS
137 VICTORIA STREET PO BOX 1766
CHRISTCHURCH PHONE 60 323

A.E. TYNDALL B.E., M.N.Z.I.E.
CONSULTING CIVIL AND STRUCTURAL ENGINEER
240 ARMAGH STREET P.O. BOX 13 117
CHRISTCHURCH PHONE 61 501

SCALES: 1 : 20
1 : 10
DATE: DEC 1977

VERIFY ALL DIMENSIONS BEFORE STARTING WORK
DRAWN: Grant Wilkinson

sheet no
of 3 sh
JOB No

16 DEC 197

2710

H66

110 Aorangi Rd 77-2710

Fendalton

ELDERLEY PERSONS' HOUSING

25

7-2710

PLOTTED 17-2-78 KQ

Appendix J Geotechnical Desk Study (8 February 2013)

Sinclair Knight Merz
142 Sherborne Street
Saint Albans
PO Box 21011, Edgeware
Christchurch, New Zealand

Tel: +64 3 940 4900
Fax: +64 3 940 4901
Web: www.globalskm.com

Christchurch City Council - Structural Engineering Service

Geotechnical Desk Study

SKM project number	ZB01276
SKM project site number	198
Address	110 Aorangi Road
Report date	8 February 2013
Author	Durga Ragupathy
Reviewer	Leah Bateman
Approved for issue	No

1. Introduction

This report outlines the geotechnical information that Sinclair Knight Merz (SKM) has been able to source from our database and other sources in relation to the property listed above. We understand that this information will be used as part of an initial qualitative DEE, and will be supplemented by more detailed information and investigations to allow detailed scoping of the repair or rebuild of the building.

2. Scope

This geotechnical desk top study incorporates information sourced from:

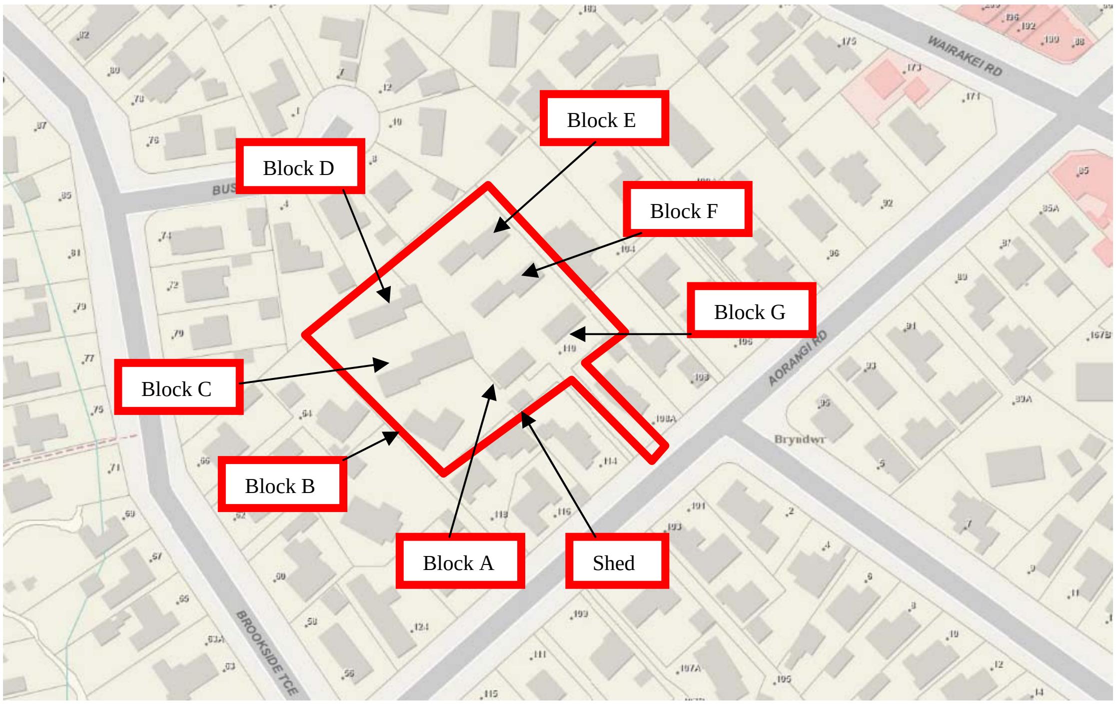
- Published geology
- Publically available borehole records
- Liquefaction records
- Aerial photography
- Christchurch City Council files
- A preliminary site walkover

3. Limitations

This report was prepared to address geotechnical issues relating to the specific site in accordance with the scope of works as defined in the contract between SKM and our Client. This report has been prepared on behalf of, and for the exclusive use of, our Client, and is subject to, and issued in accordance with, the provisions of the contract between SKM and our Client. The findings presented in this report should not be applied to another site or another development within the same site without consulting SKM.

The assessment undertaken by SKM was limited to a desktop review of the data described in this report. SKM has not undertaken any subsurface investigations, measurement or testing of materials from the site. In preparing this report, SKM has relied upon, and presumed accurate, any information (or confirmation of the absence thereof) provided by our Client, and from other sources as described in the report. Except as otherwise stated in this report, SKM has not attempted to verify the accuracy or completeness of any such information.

4. Site location



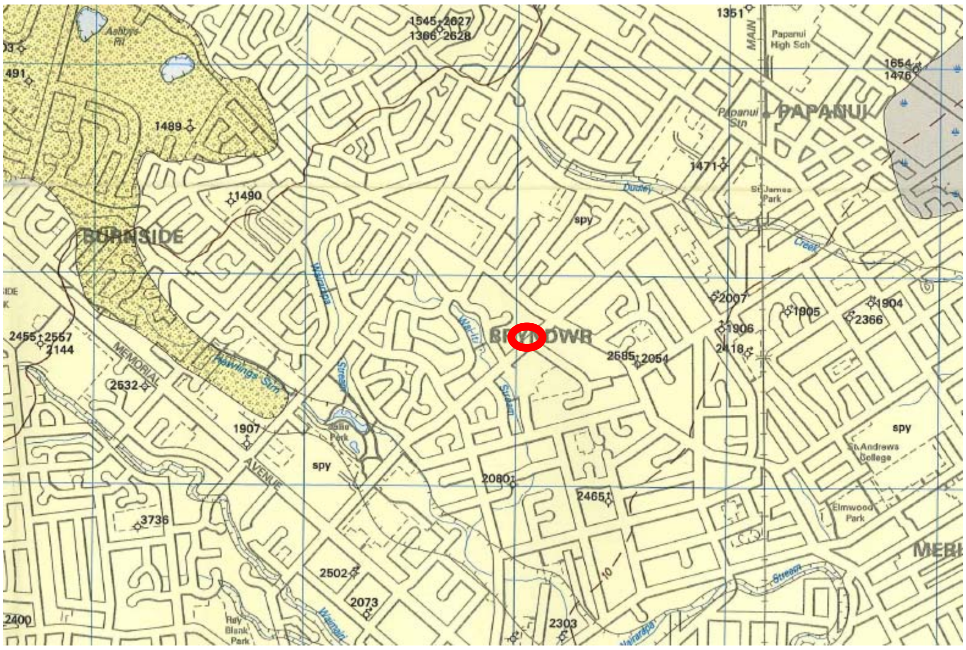
- **Figure 1 – Site location (courtesy of LINZ http://maps.cera.govt.nz/advanced-viewer) (site shown in red)**

These structures are located on 110 Aorangi Road at grid reference 1567011.984 E, 5183108.892 N (NZTM).

5. Review of available information

5.1 Geological maps

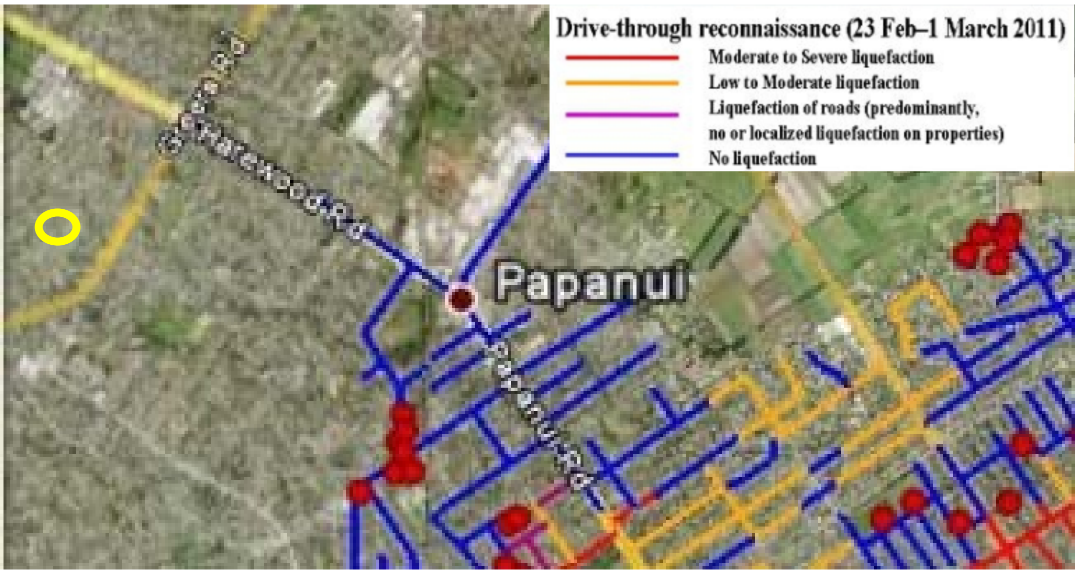
- **Figure 2 – Regional geological map (Forsyth et al, 2008). Site marked in red.**



- **Figure 3 – Local geological map (Brown et al, 1992). Site marked in red.**

The site is shown to be underlain by Holocene deposits comprising predominantly alluvial sand and silt overbank deposits of the Springston Formation.

5.2 Liquefaction map



- **Figure 4 – Liquefaction map (Cubrinovski & Taylor, 2011). Site marked in yellow.**

Following the 22 February 2011 event drive through reconnaissance was undertaken from 23 February until 1 March by M Cubrinovski and M Taylor of Canterbury University. The map does not extend to Bryndwr.

5.3 Aerial photography

- **Figure 5 – Aerial photography from 24 Feb 2011 (courtesy of LINZ http://maps.cera.govt.nz/advanced-viewer) (site shown in yellow)**

It should be noted there is evidence of water on the driveway of Aorangi Court shown in the aerial photo. It is unclear if this material is liquefaction ejecta or water from a burst pipe. This was present between blocks A and G. Minor liquefied ejecta can be seen on Colwyn Street as seen in Figure 5.

5.4 CERA classification

A review of the LINZ (**http://maps.cera.govt.nz/advanced-viewer**) website shows that the site is:

- Zone: Green
- DBH Technical Category: N/A (Urban Non-residential) – surrounding properties are classified as TC2.

5.5 Historical land use

Historic documents (e.g. Appendix A), show swamps and marshland were present at the site in 1856, with creeks and rivers noted to be located to the south west. . This suggests that soft river or swamp deposits could be present at the site. It should be noted however that the map is of low accuracy.

5.6 Existing ground investigation data

- **Figure 6 – Local Boreholes and CPT from Project Orbit and SKM files (https://canterburyrecovery.projectorbit.com/) (courtesy of LINZ http://maps.cera.govt.nz/advanced-viewer)**

Where available logs from these investigation locations are attached to this report (Appendix B), and the results are summarised in Appendix C. Details of boreholes and cone penetration tests are summarised in Section 6.1.

5.7 Christchurch City Council property files

There are available council records for the Aorangi Court housing complex which include site layout plans, structural and architectural plans. The architectural plans indicate foundations are concrete slab on grade with a perimeter strip footing (200 mm wide by 600 mm deep) design to support masonry blocks.

5.8 Site walkover

A site walkover was conducted by a SKM engineer on 9 January 2013.

The structures are light timber frame with block veneer with masonry block end walls and separation walls. With the exception of block B which is clad with weatherboard.

No significant land evidence of land damage was noted during the site walkover, while it is expected that ejecta would have been removed the ground appeared to be level with no notable undulations. There were two areas of the asphalt in the driveway that had been cut and gravel exposed, the holes are in the same location as where evidence of liquefaction was noted on the aerial photos. It is likely the holes have been cut to repair damaged underground utilities.

The shed was noted to be out of level, it is possible there has been minor differential settlement of this structure.

- **Figure 8 - Overview of the block units on site, cut in asphalt to right of picture**

- **Figure 10 – Shed, middle of structure appeared to be sagging.**

6. Conclusions and recommendations

6.1 Site geology

The geotechnical information available is laterally variable. The three boreholes west of the site are all similar in soil geology. However the CPT and borehole east and south of the site respectively differ. Investigation locations are limited to 5.0 m depth. West of the site sand and gravel are expected to be present from 0.3m depth, whereas geology to the south and east shows upper layers to comprise sand. It should be noted that the geotechnical data is a minimum of 230 m from the site.

The ground water table is expected to be 1-2 m below ground level.

6.2 Seismic site subsoil class

The site has been assessed as NZS1170.5 Class D (deep or soft soil).

As described in NZS1170, the preferred site classification method is from site periods based on four times the shear wave travel time through material from the surface to the underlying rock. The next preferred methods are from borelogs including measurement of geotechnical properties or by evaluation of site periods from Nakamura ratios or from recorded earthquake motions. Lacking this information, classification may be based on boreholes with descriptors but no geotechnical measurements. The third preferred method is from surface geology and estimates of the depth to underlying rock.

In this case the third preferred method has been used to make the assessment due to the lack of geotechnical information available.

6.3 Building performance

The overall performance of the buildings suggests that the existing foundations are adequate for their current purpose.

The shed was observed to be sagging, this may be due to differential settlement or construction.

6.4 Ground performance and properties

Liquefaction risk appears to be low for this site, though localised liquefied material was observed in the aerial photographs taken after the 22 February earthquake.

As all available investigations are located at least 230m away from the site and due to some variations in the geology indicated by existing investigations, an estimation of the surface soil properties is not provided in this desk study. Additional investigations are required in order to assess the likely ground properties.

6.5 Further investigations

There is a lack of existing geotechnical information at this site. Therefore, if remedial works are required on the foundation or if structural strengthening changes the structure loading a geotechnical investigation may be required as part of the building consent. This would also be required to provide any material characteristic parameters or to quantify the liquefaction potential at the site.

Recommended additional investigations are:

- Two boreholes with sample recovery and insitu testing to Riccarton Gravel

- If soil profile comprises of sand mixtures additional investigation shall be two cone penetrometer tests carried out to refusal.
- However of shallow gravels are encountered then two additional boreholes with sample recovery and insitu testing will be required to confirm the geological profile across the site.

Department of Building and Housing guidelines suggest shallow investigations however it is considered shallow investigation techniques will not yield the information necessary.

Additional site investigation may be required for detailed design depending on the scope for the work to be carried out.

7. References

Brown LJ, Weeber JH, 1992. Geology of the Christchurch urban area. Scale 1:25,000. Institute of Geological & Nuclear Sciences geological map 1.

Cubrinovski & Taylor, 2011. Liquefaction map summarising preliminary assessment of liquefaction in urban areas following the 2010 Darfield Earthquake.

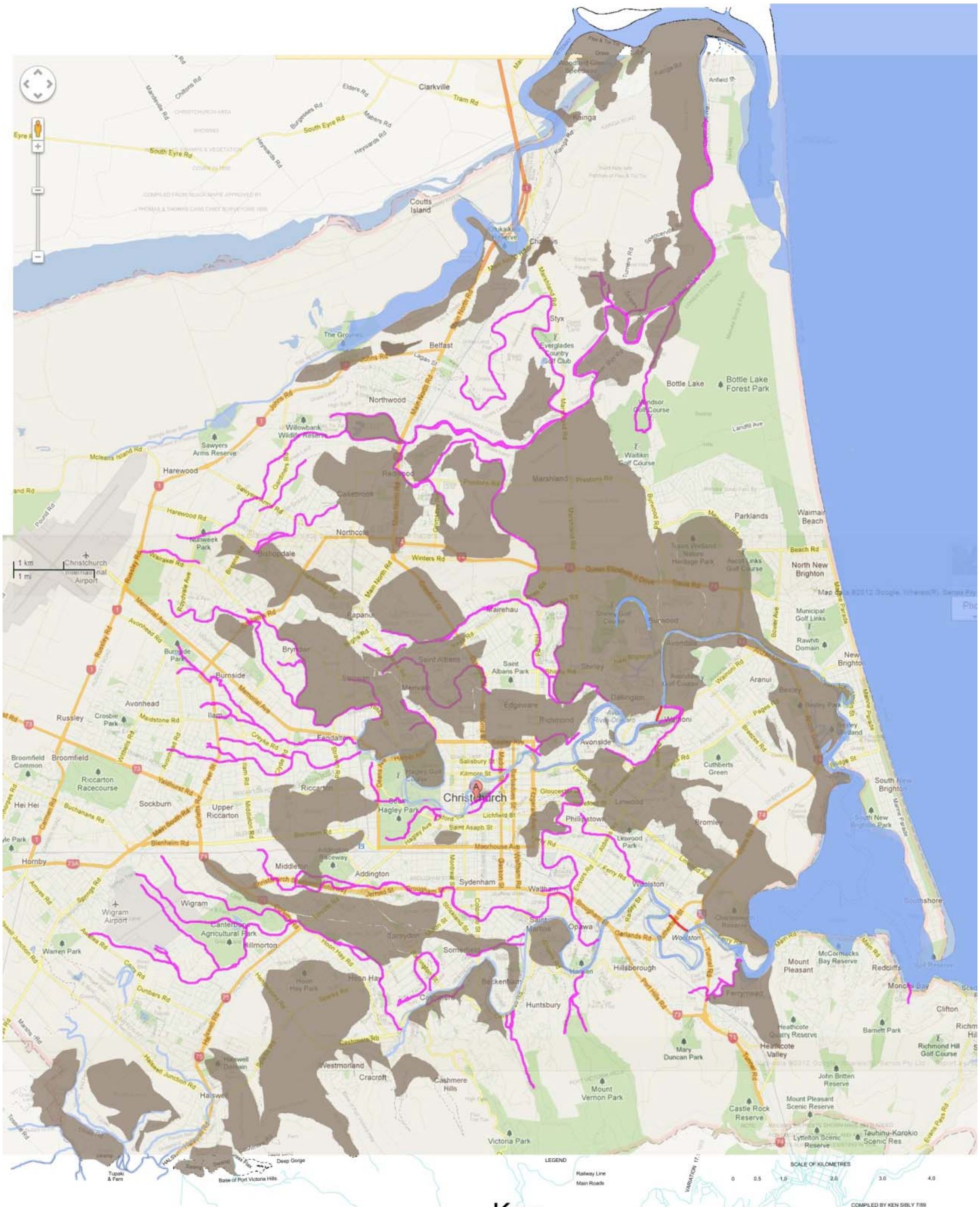
Forsyth PJ, Barrell DJA, Jongens R, 2008. Geology of the Christchurch area. Institute of Geological & Nuclear Sciences geological map 16.

Land Information New Zealand (LINZ) geospatial viewer (http://viewers.geospatial.govt.nz/)

EQC Project Orbit geotechnical viewer (https://canterburyrecovery.projectorbit.com/)

Land Information New Zealand (LINZ) geospatial viewer (http://maps.cera.govt.nz/advanced-viewer)

Appendix A – Christchurch 1856 land use



The swamps and previous creeks/rivers from 1856 have been overlayed onto a map of Christchurch in 2012

Key

- Previous creeks/rivers
- Existing creeks/rivers
- New creeks/rivers
- Swamp/Marshland

Appendix B – Existing ground investigation logs

Borelog for well M35/10896

Gridref: M35:7679-4469 Accuracy : 3 (1=high, 5=low)
Ground Level Altitude : 16 +MSD
Driller : Job Osborne (& Co/Ltd)
Drill Method : Not Recorded
Drill Depth : -5.18m Drill Date : 1/10/1951

Depth(m)	Full Drillers Description	Formation Code
-0.30m	Soil	sp
-2.13m	Blue sand and gravel	sp
-5.18m	Blue gravel	sp

Borelog for well M35/10895

Gridref: M35:7675-4466 Accuracy : 3 (1=high, 5=low)
Ground Level Altitude : 16 +MSD
Driller : Job Osborne (& Co/Ltd)
Drill Method : Not Recorded
Drill Depth : -5.18m Drill Date : 1/10/1951

Depth(m)	Full Drillers Description	Formation Code
-0.30m	Soil	sp
-5.18m	Blue gravel and sand	sp

Borelog for well M35/10894

Gridref: M35:7671-4465 Accuracy : 3 (1=high, 5=low)
Ground Level Altitude : 16 +MSD
Driller : Job Osborne (& Co/Ltd)
Drill Method : Not Recorded
Drill Depth : -5.18m Drill Date : 1/10/1951

Environment Canterbury Regional Council

Scale(m)	Water Level	Depth(m)	Full Drillers Description	Formation Code
		-0.30m	Soil	sp
		-1.52m	Yellow clay	sp
		-5.18m	Blue gravel and sand	sp

Scale: -0.2, -0.4, -0.6, -0.8, -1, -1.2, -1.4, -1.6, -1.8, -2, -2.2, -2.4, -2.6, -2.8, -3, -3.2, -3.4, -3.6, -3.8, -4, -4.2, -4.4, -4.6, -4.8, -5

Calibration Certificate

C10CFIIP.C10267 / 002

4-Jan-12

Geomil equipment

Cone number :	C10CFIIP.C10267	**Client :**	Perry Drilling LTD. 37 Glenlyon Avenue Greerton Tauranga New Zealand
Kind of cone :	Compression		

Calibration date : 4-Jan-12

Channel 1:		**Channel 2:**		**Channel 3:**		**Channel 4:**		**Channel 5:**	
Cone resistance		Local sleeve friction		Pore pressure		Inclination X		Inclination Y	
Load limit :	100 kN	**Load limit :**	22.5 kN	**Load limit :**	50 bar	**Angle limit :**	± 20 °	**Angle limit :**	± 20 °
Area :	10 cm²	**Area :**	150 cm²						
Zeroshift :	191 mV	**Zeroshift :**	207 mV	**Zeroshift :**	208 mV				
Load (kN)	**Output (mV)**	**Load (kN)**	**Output (mV)**	**Load (bar)**	**Output (mV)**	**Angle (°)**	**Output (mV)**	**Angle (°)**	**Output (mV)**
0	0	0.000	0	0	0	-20	2156	-20	2155
2	167	0.450	186	5	772	-15	2236	-15	2232
5	418	1.125	468	10	1546	-10	2324	-10	2315
10	836	2.250	952	15	2321	-5	2422	-5	2411
25	2091	5.625	2391	20	3096	0	2496	0	2498
50	4183	11.250	4789	25	3870	5	2588	5	2577
75	6252	16.875	7195	30	4642	10	2676	10	2666
100	8332	22.000	9398	35	5414	15	2762	15	2752
75	6250	22.500	9616	40	6185	20	2841	20	2842
50	4176	22.000	9408	45	6955				
25	2084	16.875	7221	50	7724				
10	831	11.250	4833						
5	415	5.625	2426						
2	167	2.250	979						
0	-1	1.125	496						
		0.450	209						
		0.000	-2						
100 kN equals 100 MPa		**22.5 kN equals 1.5 MPa**		**50 bar equals 5 MPa**					
Zeroshift error :	0.01 %	Zeroshift error :	0.02 %						
Max. linearity :	0.20 %	Max. linearity :	0.26 %						
Max. hysteresis :	0.08 %	Max. hysteresis :	0.46 %						

Calibration instrument(s) :	**Certificate number(s) :**	**Date :**
C2 E26990 + CW-921007.01 Mark III	3230930	11-Mar-08

Remarks :

Hereby we declare that the electrical cone with serial number C10CFIIP.C10267 has been calibrated and that the specifications are according to the prEN ISO 22476-1.11, Application Class 1 and NEN 5140, Class 1.

Date :	4-Jan-12	**Date :**	4-Jan-12
Approved by technician :	[signature]	**Approved by supervisor :**	[signature]
P. Treffers		**J.E. Jansen**	

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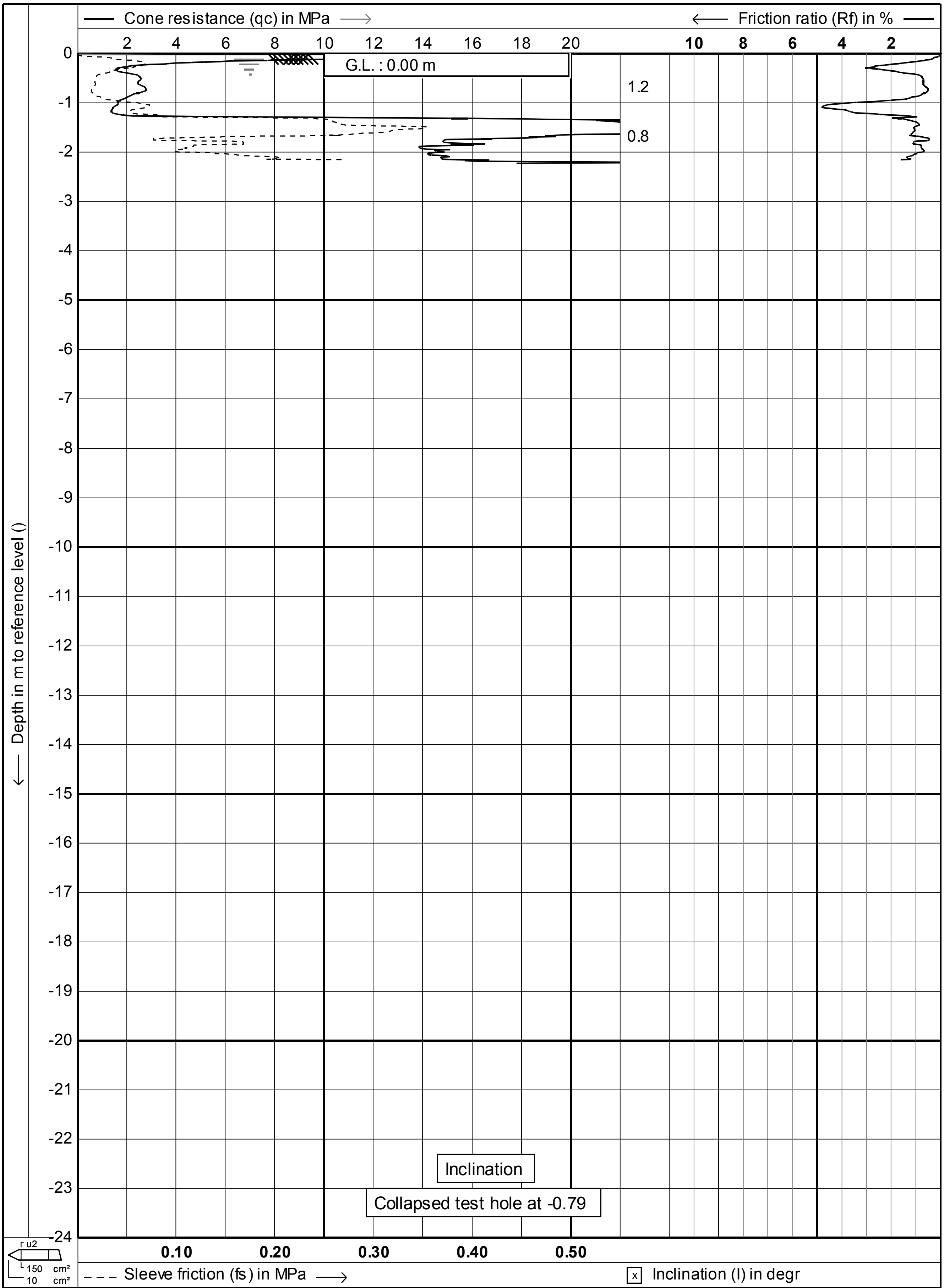
info@geomil.com - www.geomil.com



Test according A.S.T.M. Standard D 5778-07

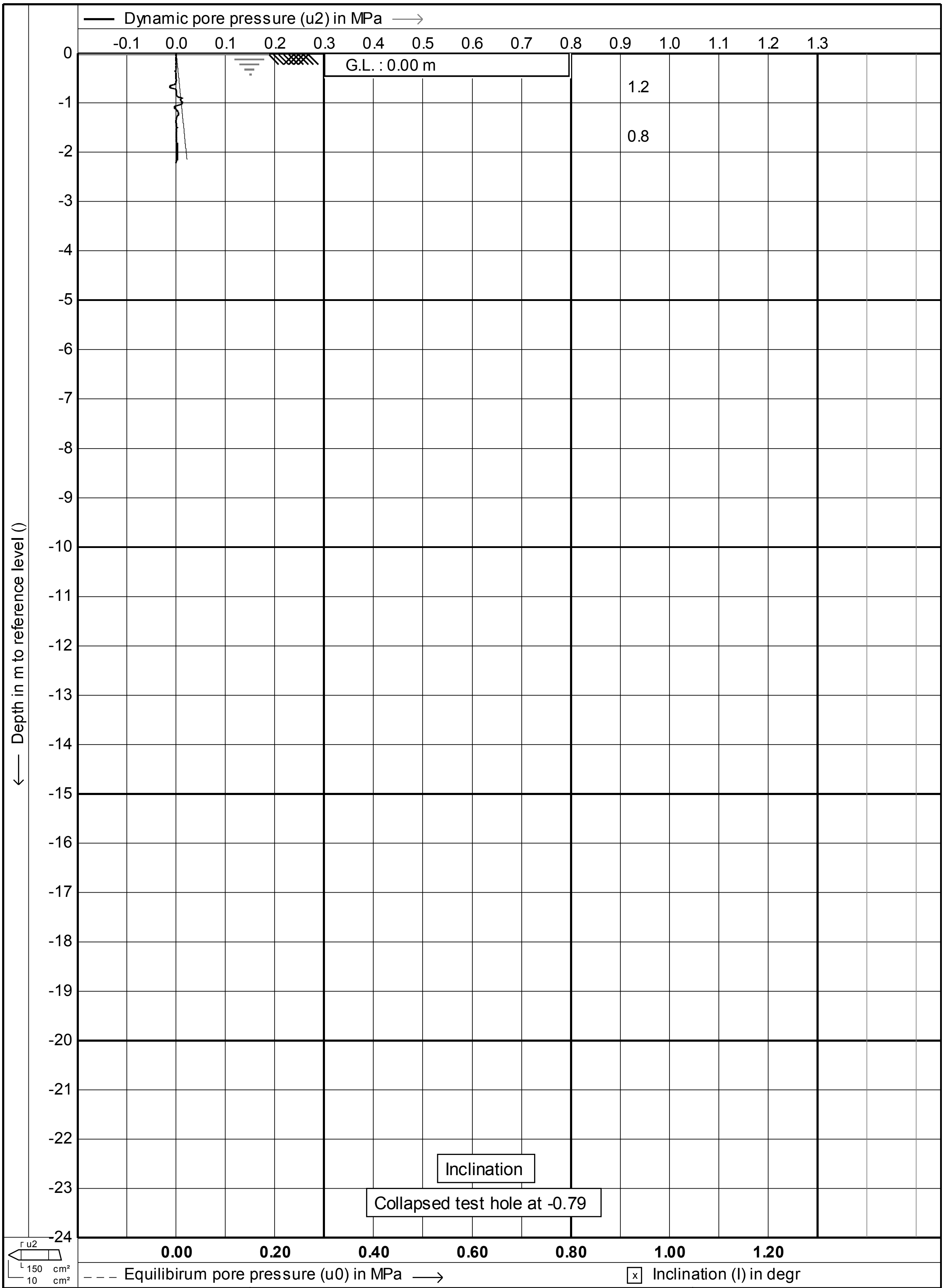
Project : **MAS - Site Investigation**

Location: **Phase 661**

Position: **1567225, 5183116**

Date	: **8-8-2012**
Cone no.	: **C10CFIIP.C10267**
Project no.	: **01BC2**
CPT no.	: **661 - 1** **1/14**

1.40



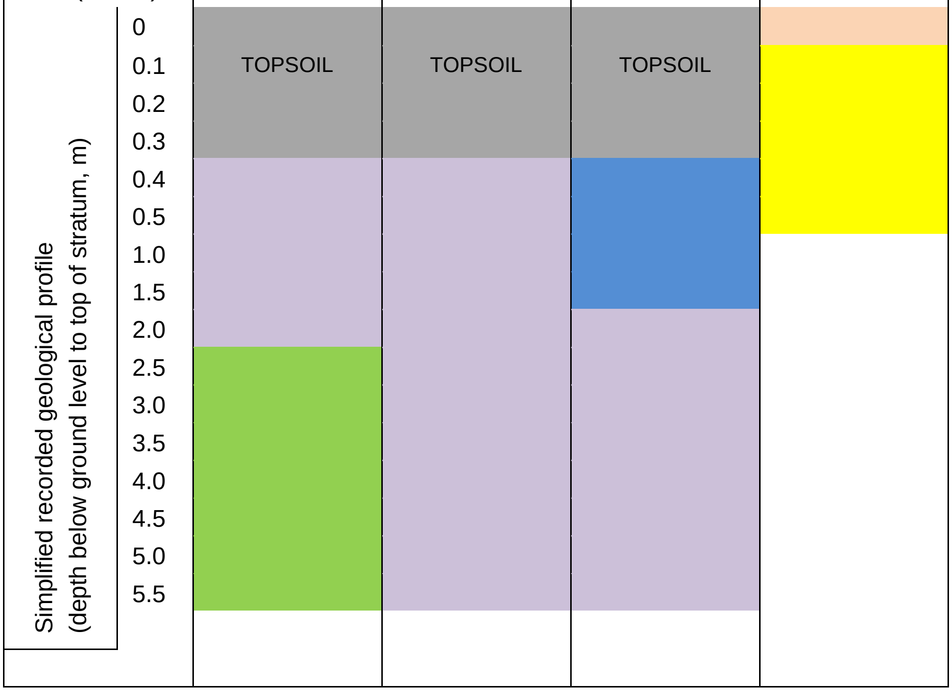
Test according A.S.T.M. Standard D 5778-07	Date	: **8-8-2012**
Project : **MAS - Site Investigation**	Cone no.	: **C10CFIIP.C10267**
Location: **Phase 661**	Project no.	: **01BC2**
Position: **1567225, 5183116**	CPT no.	: **661 - 1** **2/14**

1.40

Appendix C – Geotechnical Investigation Summary

- **Table 1 Summary of most relevant investigation data**

ID	1	2	3	4
Type *	BH	BH	BH	CPT
Ref	M35/10896	M35/10895	M35/10894	CPT_8826
Depth (m)	5.18	5.18	5.1.8	2.22
Distance from site (m)	230	280	318	225
Ground water level (mBGL)	1.37	1.22	1.83	N/A



*BH: Borehole, HA: Hand Auger, WW: Water Well, CPT: Cone Penetration Test

Sand to Gravel
Clay
Clayey silt to silt
Gravel
Sand
Silty sand to Sand
Gravelly sand to sand

VL = very loose, L = loose, MD = medium dense, D = dense, VD = very dense
VS = very soft, So = soft, F = firm, St = stiff, VS = very stiff, H = hard

Appendix K Partial verticality survey (Block A) (15 April 2013)

NOTES

1. Levels are in terms of an assumed datum. Datum point is corner of sump at edge of driveway.

2. All level measurements have been taken on the surface labelled.

3. Levels taken where accessible. Various furniture and fittings prevent survey in some locations.

4. The measurements were taken on 15 April 2013.

5. Equipment was an automatic level WILD NA2-193456 and Leica Total station TCRA 1205 R300 #1849534

KEY

half +15mm - deviation from bottom of wall to halfway up wall (away from building)

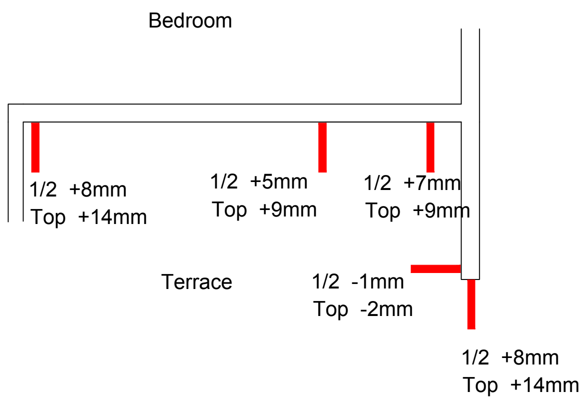
top +20mm - deviation from bottom of wall to top of wall (away from building)

half -15mm - deviation from bottom of wall to halfway up wall (into building)

top -20mm - deviation from bottom of wall to top of wall (into building)

X 50.231 - level and position of level

— - approximate position of verticality measurement



SCALEBAR (M)
0 0.5 1.0 2.5

REVISION DETAILS	NAME	DATE
1. FOR INFORMATION	CA	22/04/13

CLIENT: SKM

110 AORANGI RD

BLOCK A - UNIT 3 WALL VERTICALITY

CHRISTCHURCH CITY COUNCIL

WOODS
Engineers. Surveyors. Planners.

DESIGNED:
ISSUED FOR INFORMATION
CHECKED:
DRAWN: CA
APPROVED:
SURVEYED: NP/JCD
JOB NUMBER: 40184
SCALE: 1:50 @ A3
ISSUED: 22/04/13
DWG. NO. 40184-GE-001
REV. 1

L:\40184 - Aorangi Road, Burnside\Project Data\Acad Drawings\40184 ge 001.dwg