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Sockburn Squash Centre
BU 1564-003 EQ2

Detailed Engineering Evaluation
Quantitative Report

Version FINAL-11/4/13

2-10 Takaro Avenue, Sockburn

INFRASTRUCTURE | MINING & INDUSTRY | DEFENCE | PROPERTY & BUILDINGS | ENVIRONMENT

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Quantitative Report
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2-10 Takaro Avenue, Sockburn

Christchurch City Council

Prepared By
Dioselo Cagandahan

Reviewed By
Stephen Lee

Date
11/4/2013

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Sockburn Squash Centre

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Detailed Engineering Evaluation

Quantitative Report - SUMMARY

Version FINAL-11/4/13

2-10 Takaro Avenue, Sockburn

Background

This is a summary of the Quantitative report for the building structure, and is based in general on the Detailed Engineering Evaluation Procedure document (draft) issued by the Structural Advisory Group on 19 July 2011, visual inspections on 18th January 2012 and available drawings itemised in 5.3.

Key Damage Observed

Key damage observed includes:-

- Minor cracks in the concrete masonry walls below columns on the front face of the building.
- Minor cracks in the connections between the original building and the addition.
- Minor cracks in the south-west concrete masonry wall of the two storey section of the building.
- Opening up works carried out on the 5th March 2012 revealed an absence of horizontal reinforcement around the cracks in reinforced concrete masonry column and wall on the left of the front face of the building (See Photograph 29).
- Opening up works were also performed at the location of the cracking around the beam linking the original structure and the subsequent addition (See Photograph 31).

Building Capacity Assessment

Based on the site inspection, opening up works, available drawings and the results of quantitative assessment, the building section capacities are as follows; Changing Shed 21% NBS, Squash Courts 35% NBS and Administration Building >100% NBS. The Changing Shed performs poorly due to lack of adequate timber wall bracing to transfer the roof lateral load into the reinforced concrete masonry walls in both longitudinal and transverse direction. The Changing Shed is therefore classified as 'Earthquake Prone'.

Squash Courts scored more than 34%NBS while the Administration Building achieved greater than 100%NBS. Considering the size and location of Changing Shed and Deck, GHD would not anticipate that the Squash Courts or the Administration Building will be significantly affected in the event of damage or potential collapse of the Changing Shed and Deck. Therefore the Squash Courts and

Administration Building may be considered separately as an Earthquake Risk structure. The Squash Courts and Administration Building may not be further considered as separate structures given the combined access to the two sections, common elements such as concrete masonry walls which support structural elements in both sections and the corresponding interaction of building sections in the event of seismic damage or potential collapse.

The slope at the rear of the property has appeared to have slumped and as a result, the concrete pads supporting the timber Deck posts have settled (see Photographs 14 and 17). It is not clear whether the settlement is due to long term movement of the slope or the recent seismic activity. However, if the movement will continue, there is a possibility that the Changing Shed foundation will settle unevenly and could result to cracking of the reinforced concrete masonry walls or potential structural failure.

Details of %NBS for each building is itemized below:

Squash Courts

Steel Columns

- Seven (7) steel columns are found to be less than 67%NBS. Least value is 35%NBS

Steel Beams/Rafters

- Two (2) steel rafters scores below 67%NBS. Scores are 55 and 65%NBS.

Timber Rafters

- All timber rafters scores 42%NBS which is less than 67%NBS.

Horizontal and Vertical Bracings

- All horizontal and vertical bracings scores 100%NBS.

Reinforced Concrete Masonry Walls

- Ten (10) reinforced concrete masonry wall panels are found to be less than 67%NBS with a least value of 51%NBS.

Reinforced Concrete Masonry Block Bond Beam (Out of Plane bending on walls)

- Critical bond beams are found to be less than 67%. Least value is 38%.

Administration Building

- All reinforced concrete masonry walls scores above 100%NBS

Changing Shed

- The front reinforced concrete masonry walls are found to be less than 34%NBS. With least score of 21%NBS.

Pounding Effect

The computed drift of the Squash Courts is 13.0mm and 2.0mm in the longitudinal and transverse direction respectively. These values are within the Code requirements.

There is no visible seismic gap provided between the Squash Courts and Administration building in the longitudinal direction. Similarly there is no seismic gap for Squash Courts and Changing Shed in the transverse direction. In the event of an earthquake, each building will produce a different period and there is a risk that they could pound upon each other. The pounding is likely to cause cracking, possible localised member and connection failure at the point or area of impact. It is also possible that some cracks mentioned in the investigation and opening up works may be attributed to some minor pounding.

Recommendation

GHD recommend that further work is undertaken in order to develop the scope of the strengthening and repair options. Developing a strengthening works scheme to increase the seismic capacity of the Squash Courts and Changing Shed to as near as practicable to 100%NBS, and at least 67%NBS. This will need to consider compliance with accessibility and fire requirements.

1. Background

GHD has been engaged by Christchurch City Council (CCC) to undertake a detailed engineering evaluation of Sockburn Squash Centre.

This report is a Quantitative Assessment of the building structure, and is based in general on the Detailed Engineering Evaluation Procedure document (draft) issued by the Structural Advisory Group on 19 July 2011.

2. 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.

2.1 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

2.2 Building Act

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

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).

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.

2.2.1 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 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.

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.

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.

Section 131 – Earthquake Prone Building Policy

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

2.3 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;
- 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.

2.4 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:

- Hazard Factor increased from 0.22 to 0.3 (36% increase in the basic seismic design load)
- 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.

3. 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 1 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 1 NZSEE Risk Classifications Extracted from table 2.2 of the NZSEE 2006 AISPBE

Table 1 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.

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

Table 1 %NBS compared to relative risk of failure

4. Building Description

4.1 General

Sockburn Squash Centre is located at 2-10 Takaro Avenue, Sockburn, Christchurch. The building provides gym, squash courts, shower and dressing room facilities, and office space.

The original building which houses squash courts and changing facilities was constructed in 1974. In 1985, additional floor area was added that houses the changing shed facilities and an administration building.

The structure of the original building comprises reinforced block masonry walls for the Squash Court enclosures. Steel portal frames sit on these walls and provide framing for the upper portion of the walls and support the mono-pitched roof. Adjacent to the Squash Courts is a two storey construction comprising reinforced block masonry walls generally to below first floor level. On the walls sit lean-to steel framing supporting the first floor and at higher level the mono-pitched roof. The lean-to framing is attached to the main portal frames over the Squash Courts. The building foundations consist of spread footings tied together with ground beams.

The additional Administration building to the east consists of reinforced concrete masonry walls supporting the steel framed roof structure. The foundation consists of ground beams and pad footings.

The Changing Shed and Deck to the south of the Squash Courts consists of timber wall framing and reinforced concrete masonry walls supporting a timber framed roof. The timber framed deck outside the Changing Shed is supported by isolated concrete pads founded on sloping ground. The timber deck is supported by timber joists on timber columns and is currently barricaded off as it appears to have settled during the recent earthquakes.

Figure 2 below shows the Floor Plan layout.

Key structural details of the buildings are shown in Figures 3, 4, 5 and 6 below.

Complete information mentioned above is shown in Appendix C.

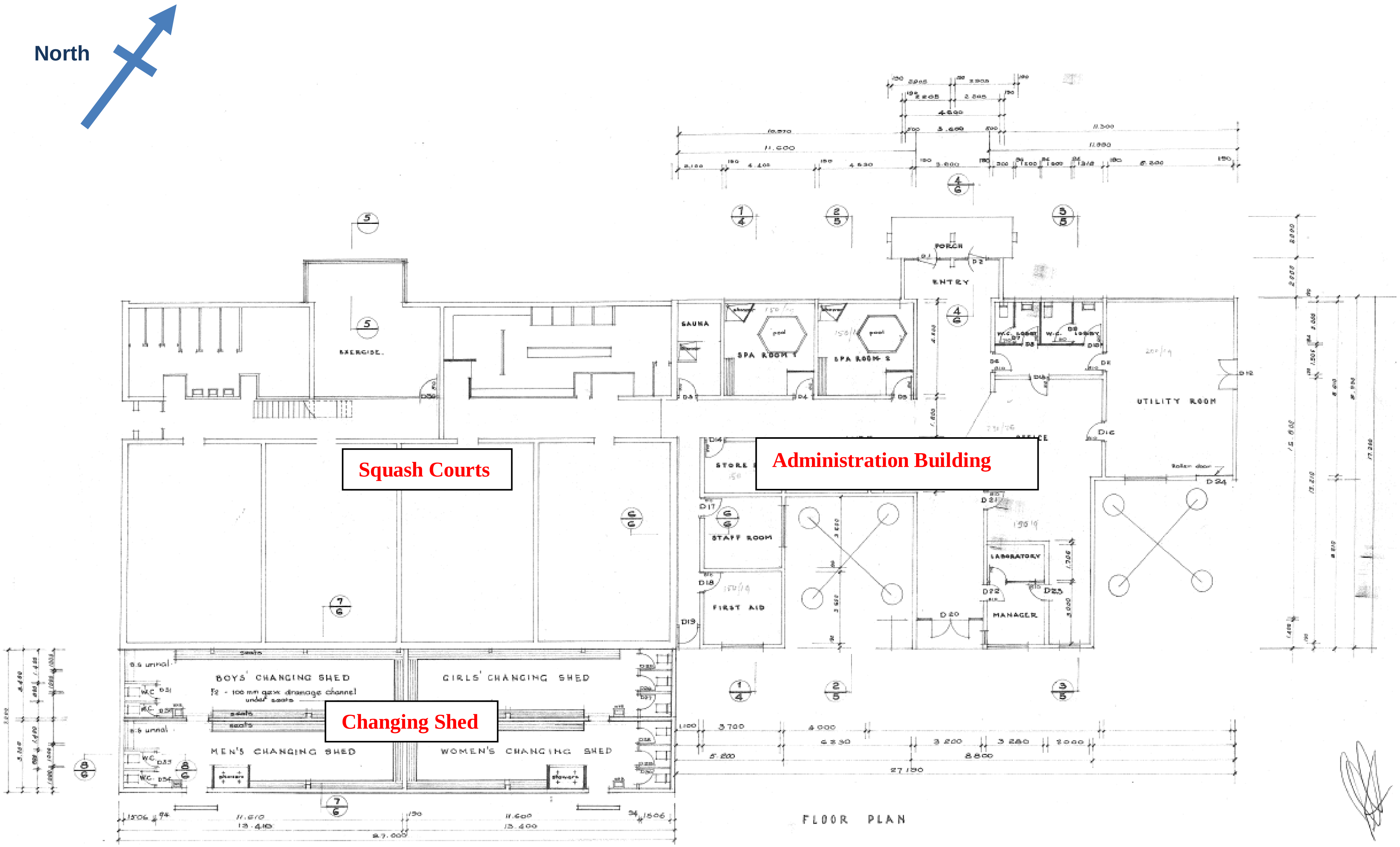


Figure 2 Plan Layout

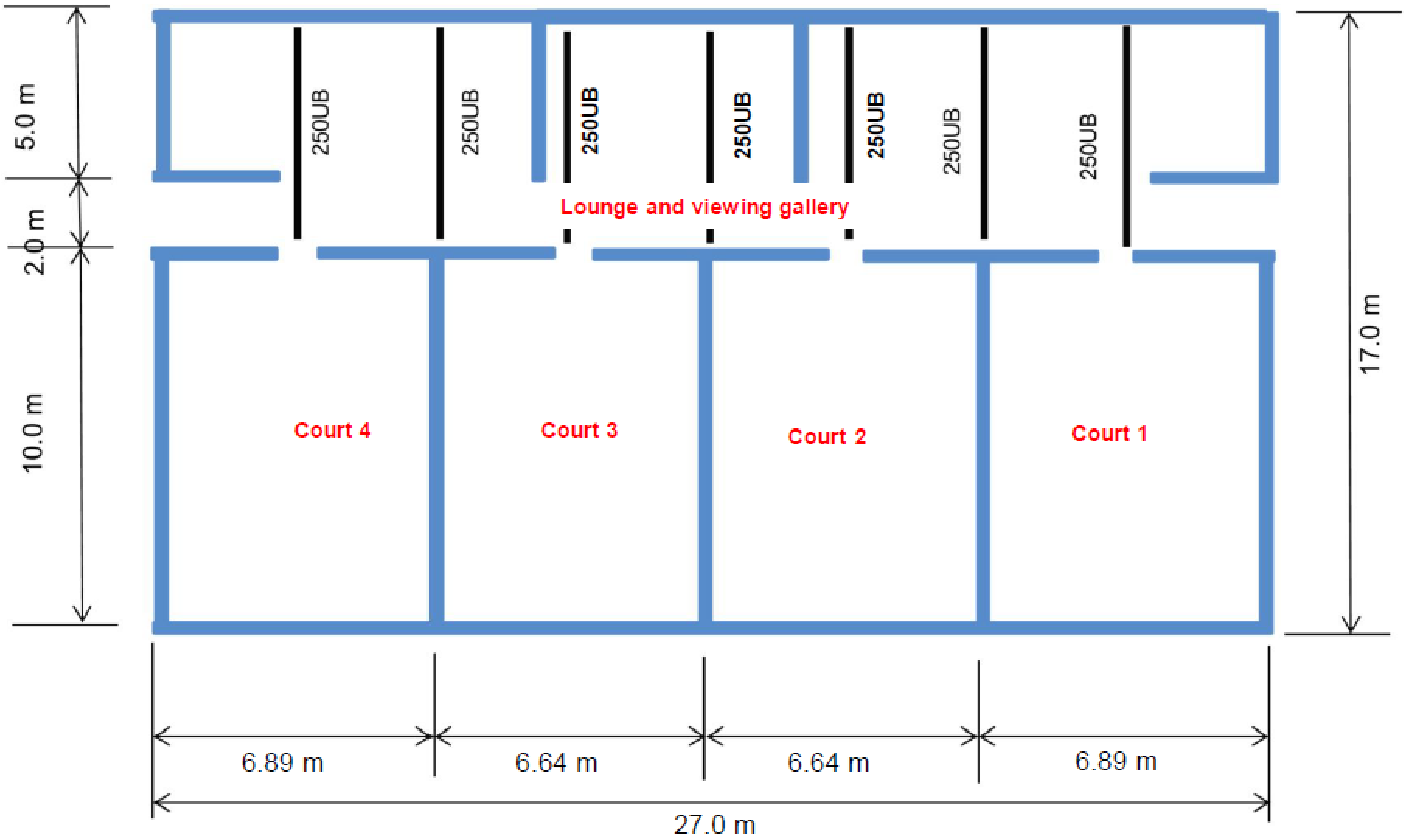


Figure 3 Squash Courts – Reinforced Concrete Masonry Layout and 1st Floor Framing Plan

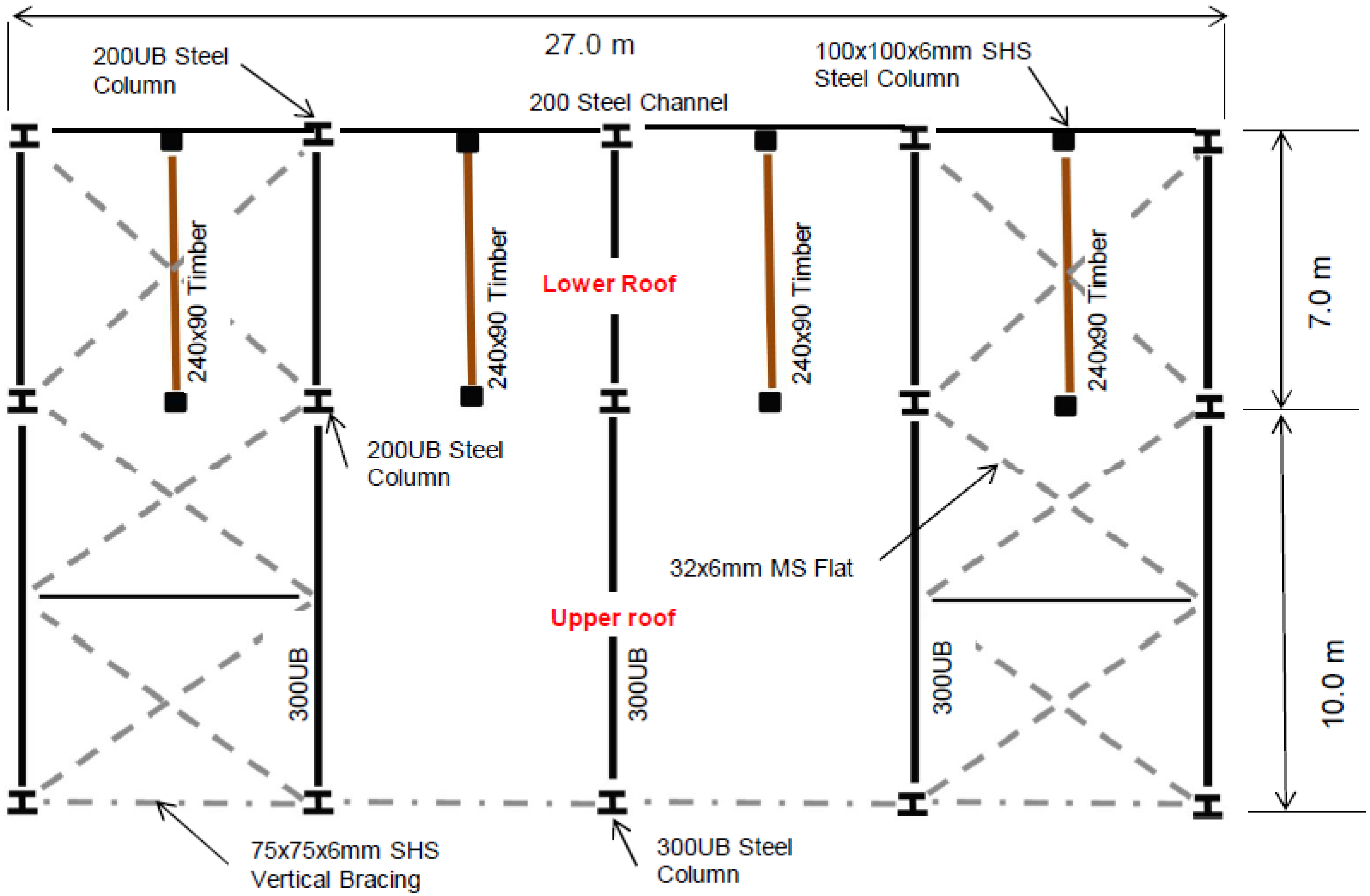


Figure 4 Squash Courts – Roof Framing Plan

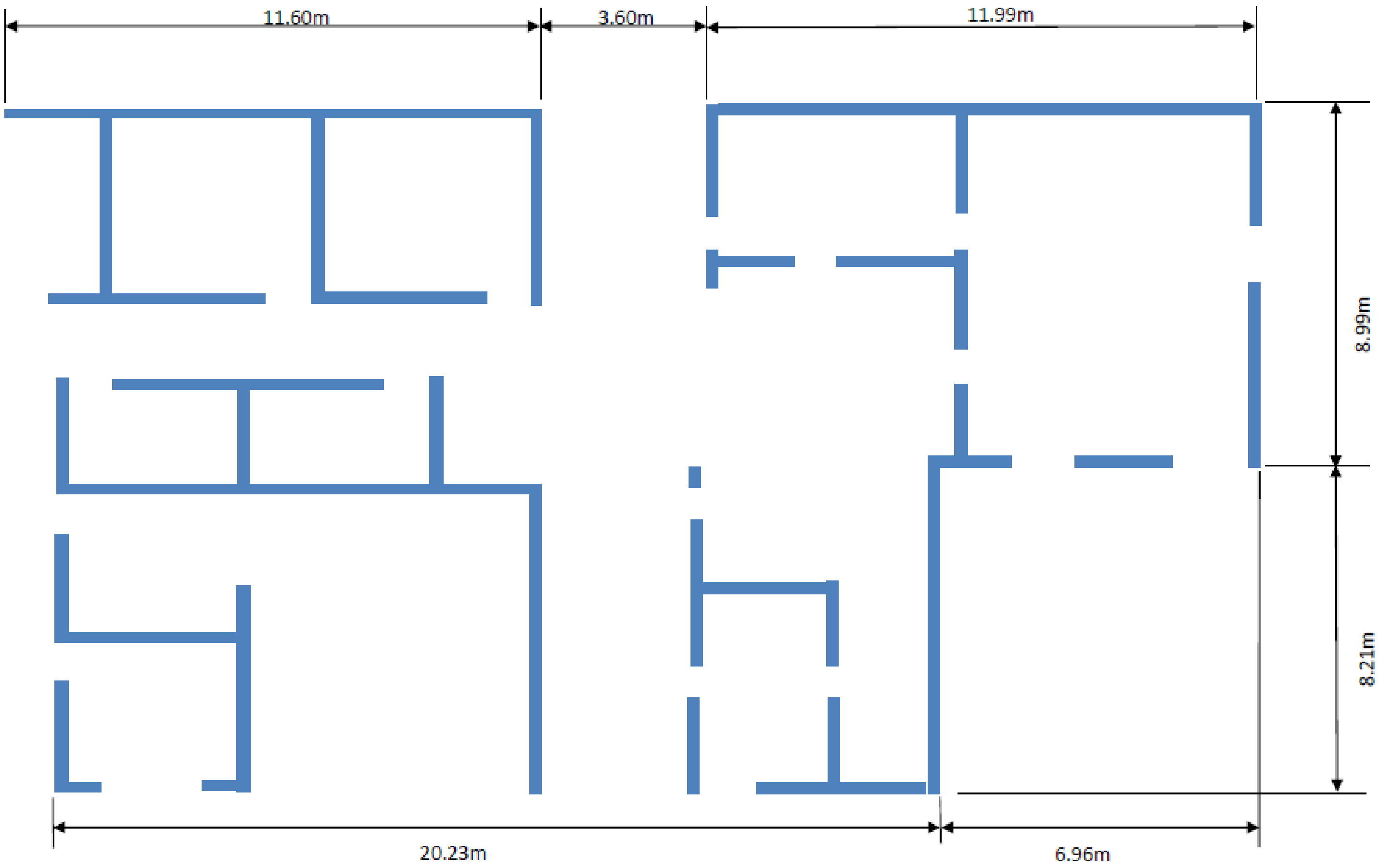


Figure 5 Administration Building – Reinforced Concrete Masonry Wall Layout Plan

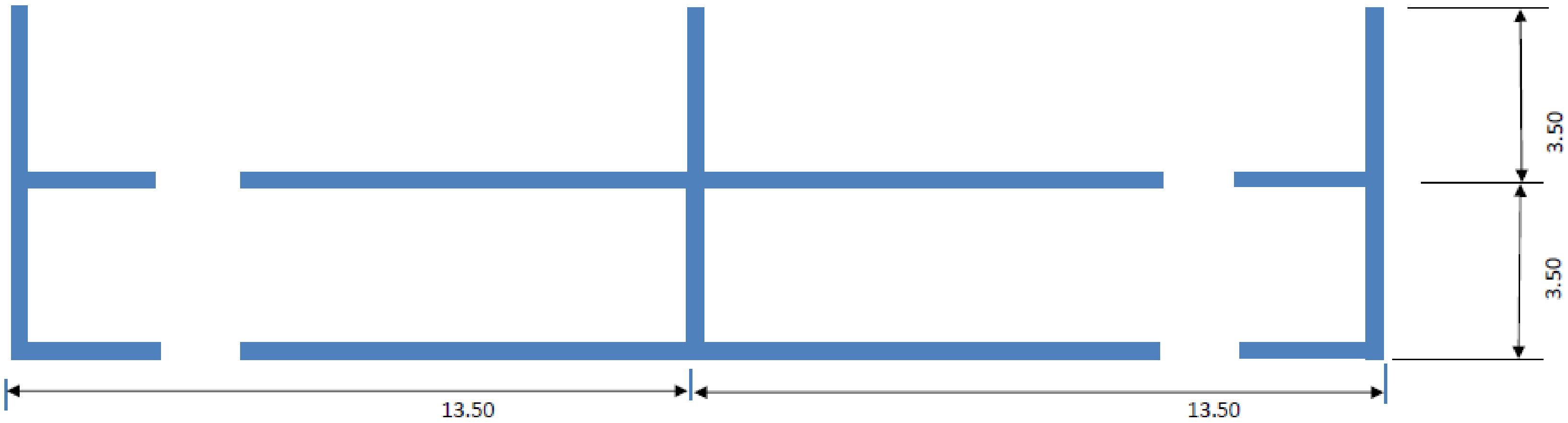


Figure 6 Changing Shed – Reinforced Concrete Masonry Wall Layout Plan

4.2 Gravity Load Resisting System

The gravity loads in the structure are resisted by a steel portal frame system and reinforced concrete masonry walls which form the squash courts section of the building and reinforced concrete masonry walls in the changing room and administration areas.

The roof structure of the Squash Courts area consists of a light steel roof cladding supported by steel purlins on the steel portal frames. A similar roof construction is supported by steel purlins on steel beams over the two storey section. The SHS/RHS posts and steel UB columns sit on top of reinforced concrete masonry walls. The two storey flooring system consists of 250x50 timber joists spanning between steel beams.

The gravity loads in the changing shed are resisted by the reinforced concrete masonry walls on the south side and steel frames constructed against the masonry structure along the north side. There is an internal half-height concrete masonry wall with timber framing sitting on top of the masonry wall that supports the rafters at mid-span. The roof structure for the changing room areas consists of timber framing supporting a light steel roof cladding.

The gravity loads in the single storey administration building are resisted by reinforced concrete masonry walls and lightweight galvanized corrugated steel roofing supported by steel purlins.

The foundations for the building based on the available drawings consist of reinforced concrete footing beams and pads.

4.3 Lateral Load Resisting System

Lateral loads acting on the building are resisted by steel roof portal frames and reinforced concrete masonry walls in both the longitudinal and transverse directions of the building.

The steel portal frames that span over the Squash Courts area are braced in the longitudinal direction by SHS members and in the short direction by steel angles as can be seen in Photographs 21, 22, 23 and 25 (See Appendix B). The steel portal frames then transfer the upper lateral load to the reinforced concrete masonry walls which resist the overall lateral load on the structure.

In the Changing Shed and the single storey Administration Building, lateral loads are distributed to the reinforced concrete masonry walls of the building through diaphragm action of the timber framings and steel purlins respectively. The lateral loads are then resisted by the reinforced concrete masonry walls in both the longitudinal and transverse directions of the building.

5. Assessment

5.1 Site Inspection

An inspection of the building was undertaken on the 18^{th} of January 2012. Both the interior and exterior of the building were inspected. The building was observed to have a green placard in place. A large portion of the main structural components of the building were able to be viewed due to the exposed nature of the structure. The reinforced concrete masonry walls are unlined and the steel and timber framing is generally exposed. No inspection of the foundations of the structure was carried out.

The inspection consisted of observing the building to determine the structural systems and likely behaviour of the building during an earthquake. The site was assessed for damage, including damage in areas where it would be expected for the structure type observed and noting general damage observed throughout the building in both structural and non-structural elements. Site assessment also included the ground condition observation.

5.2 Investigation & Opening Up Work

Further inspections were carried out on the 5^{th} of March 2012 to further assess the extent of damage to several areas of the building. Two sections of the reinforced concrete masonry wall to the left of the entrance at the front of the building were opened up to determine the extent of cracking and whether reinforcement was present (See Photographs 28, 29 and 30). Opening up work was also undertaken in the internal corridor at a reinforced concrete masonry beam to wall connection linking the original structure and the extension. Again the purpose of the opening up work was to determine the extent of cracking between beams and walls (See Photographs 32 and 31).

On 25 May 2012, some further investigation was carried out using a Hilti PS200 Ferroscan. A portion of squash courts reinforced concrete masonry wall was scanned and it was detected that only vertical bars are present (i.e. there were no horizontal bars) (See Photograph 33 for location of scan). This confirms the details shown in the available drawings provided in the Quantitative Detailed Engineering Evaluation Stage.

5.3 Available Drawings

There are available existing drawings provided to GHD and are itemised below:

Item #	Title	Sheet No.	Date
1	Squash Courts for Paparua Council	1	24 Oct 1974
2	Squash Courts for Paparua Council	2	24 Oct 1974
3	Squash Courts for Paparua Council	3	21 Oct 1974
4	Squash Courts for Paparua Council	4	25 Oct 1974
5	Squash Courts for Paparua Council	5	24 Oct 1974
6	Squash Courts for Paparua Council	6	24 Oct 1974

7	Squash Courts for Paparua Council	7	24 Oct 1974
8	Squash Courts for Paparua Council	8	25 Oct 1974
9	Squash Courts for Paparua Council	9	21 Oct 1974
10	Site Plan – Youth Centre - Sockburn	8	-
11	Proposed Additions and Alterations Squash Court Building – Sockburn Park for Paparua County Council	A1	18 April 1985
12	Proposed Additions and Alterations Squash Court Building – Sockburn Park for Paparua County Council	A2	18 April 1985
13	Proposed Additions and Alterations Squash Court Building – Sockburn Park for Paparua County Council	A3	18 April 1985
14	Proposed Additions and Alterations Squash Court Building – Sockburn Park for Paparua County Council	A4	18 April 1985
15	Proposed Additions and Alterations Squash Court Building – Sockburn Park for Paparua County Council	A5	18 April 1985
16	Proposed Additions and Alterations Squash Court Building – Sockburn Park for Paparua County Council	A6	18 April 1985
17	Proposed Additions and Alterations Squash Court Building – Sockburn Park for Paparua County Council	A7	18 April 1985
18	Proposed Additions and Alterations Squash Court Building – Sockburn Park for Paparua County Council	A8	18 April 1985
14	Proposed Additions and Alterations Squash Court Building – Sockburn Park for Paparua County Council	A9	18 April 1985
15	Proposed Additions and Alterations Squash Court Building – Sockburn Park for Paparua County Council	A10	18 April 1985
16	Proposed Additions and Alterations Squash Court Building – Sockburn Park for Paparua County Council	A11	18 April 1985
17	Proposed Additions and Alterations Squash Court Building – Sockburn Park for Paparua County Council	A12	18 April 1985

5.4 Analysis and Modelling Methodology

Mathematical Modelling

The three-dimensional frame modelling of the Sockburn Squash Courts structure was performed to realistically simulate the effects of the applied loads on the structure under different conditions such as normal operation, earthquake and combinations thereof.

This modelling approach determines the adequacy of members or sections for the structure under various loading conditions.

Each section, member and node of the model was defined using the physical dimensions, material properties and connection details from the available drawings described in Section 5.3. Using the Etabs Version 9.7.2 structural analysis software, a computer model that incorporates all the properties of the steel portal frame and reinforced masonry structure was prepared.

The Administration Building and Changing Shed were analysed separately using manual calculations and spread sheets.

Loading Conditions

The Basis of Design shows the loading conditions and load combinations used in the analysis of the structure. Such loading conditions take into account relevant New Zealand Building Code requirements that include required factors of safety.

Critical load combinations – those that impose the greatest stress on the structure – are selected for analysis. Please note, however that it is not always the biggest load combination that produces the most critical load condition.

The Basis of Design is shown in Appendix D.

Determination of %NBS

Upon determination of the critical loading conditions, each of the members that make up the Sockburn Squash Centre was checked to determine %NBS of the members indicated in the available drawings. Member demand and capacity ratio was computed and %NBS was calculated accordingly.

Seismic Design

The Sockburn Squash Centre structure was checked to the seismic design standards in accordance with the AS/NZ 1170.5, NZBC Clause B1 Structure and New Zealand Society of Earthquake Engineering Guidelines for Assessment and Improvement of the Structural Performance of Buildings in Earthquakes.

6. Damage Assessment

6.1 Surrounding Buildings

No damage to surrounding buildings was observed during site inspection.

6.2 Residual Displacements and General Observations

No residual displacements of the structure were noticed during site inspection of the building.

Minor cracks were observed in the reinforced concrete masonry walls in several areas of the building. There are also minor cracks below the windows in the reinforced concrete masonry walls (on the front face of the building). It is expected that these cracks are due to localised stresses around the bottom of the short columns between the windows during earthquake shaking. These cracks can be seen in Photographs 4, 5 and 21 in Appendix B. Cracking was also observed near the top of the south-west reinforced concrete masonry wall in the two-storey section of the building as shown in Photograph 27.

Minor cracks were observed at the connection between the original building and the extension indicating that the two structures systems moved relative to one another during earthquake shaking. The risk of pounding (one part of the building impacting on another during an earthquake) was considered insignificant as both parts of the structure are low-rise and have similar stiffness. The beam above a doorway between the two structures has cracking around the connection to the reinforced concrete masonry wall as can be seen in Photograph 20. The minor cracking was also observed in the same location on the opposite side of the corridor and in other location along the same line.

Opening up works were undertaken to determine the extent of the damage observed on the exterior of the reinforced concrete masonry walls and around the reinforced concrete masonry beam in the corridor. The observations from the opening up works indicate an absence of reinforcements in these areas. Cracking in the reinforced concrete masonry wall would have occurred in these areas due to tension forces being carried by the concrete rather than steel in these areas. The cracking around the reinforced concrete masonry beam to wall connection in the corridor is likely due to relative movement between the two elements during earthquake shaking as there is little or no positive connection between the two elements.

6.3 Ground Damage

Minor ground damage was observed during our site inspection. The slope at the rear of the property has appeared to have slumped and as a result, the concrete pads supporting the timber deck posts have settled (see Photographs 14 and 17). It is not clear whether the settlement is due to long term movement of the slope or the recent seismic activity. Some cracks of concrete cover at the entrance to the changing room area were noted. However, this appears to be non-structural and attributable to the movement of the deck. Access to the timber deck is currently restricted.

7. Structural Analysis

7.1 Seismic Parameters

Earthquake loads shall be calculated using New Zealand Code.

◗ Site Classification	D
◗ Seismic Zone factor (Z)	
(Table 3.3, NZS 1170.5:2004 and NZBC Clause B1 Structure)	0.30 (Christchurch)
◗ Annual Probability of Exceedance	
(Table 3.3, NZS 1170.0:2002)	1/500 (ULS) Importance Level 2
◗ Annual Probability of Exceedance	
(Table 3.3, NZS 1170.0:2002)	1/25 (SLS)
◗ Return Period Factor (Ru)	
(Table 3.5, NZS 1170.5:2004)	1.0 (ULS)
◗ Return Period Factor (Rs)	
(Table 3.5, NZS 1170.5:2004 and NZBC Clause B1 Structure)	0.33 (SLS)
◗ Ductility Factor (μ)	1.25
◗ Performance Factor (Sp)	0.925
◗ Gravitational Constant (g)	9.81 m/s^2

An increased Z factor of 0.3 for Christchurch has been used in line with recommendations from the Department of Building and Housing recommendations resulting in a reduced % NBS score.

7.2 Structural Ductility Factor

A structural ductility factor of 1.25 has been assumed in both the longitudinal and transverse directions of the building based on the reinforced concrete masonry wall system as indicated on the available drawings. The reinforced concrete masonry walls have been assessed as the limiting structural elements in terms of the ductility of the structure and the ability to dissipate energy during an earthquake. As a result, the structural ductility factor of 1.25 associated with the reinforced concrete masonry walls has been used for the purpose of this Detailed Engineering Evaluation Quantitative Assessment.

8. Geotechnical Consideration

8.1 Introduction to Geotechnical Consideration

Following the completion of a geotechnical desk study for the subject structure at the above address, a more detailed evaluation has been undertaken. As part of this evaluation, intrusive geotechnical testing was undertaken to provide a better understanding of the site's underlying ground conditions, particularly in relation to historic land use and how the ground conditions may have contributed to the observed structural damage. Quantifying the liquefaction potential of this site was not considered to be a significant driver to the investigation.

The desktop study highlighted the site was potentially located on the edge of a former quarry later used for waste disposal and that the building may straddle the change from natural ground to fill. The intrusive investigation was planned around the potential for buried waste and comprised test pit excavation.

8.2 Published Information on Ground Conditions

8.2.1 Published Geology

The geological map of the area[1] indicates that the site is underlain by Holocene alluvial soils of the Yaldhurst Member, sub-group of the Springston Formation, comprising dominantly alluvial sand and silt overbank deposits.

8.2.2 Environment Canterbury Logs

Information from Environment Canterbury (ECan) indicates that five boreholes are located within a 200m radius of the site. Of these boreholes, two were within 85m with lithographic logs that are summarised below. The site geology described in these logs shows the area is predominantly fill, gravel, sandy gravel, and clay with occasional timber.

Bore Name	Depth	Ground Conditions
M35/2272	0 to 5m	Rubbish dump fill
	5 to 7.3m	Gravel and sand
	7.3 to 8.8m	Grey/Yellow clay
	8.8 to 32.7m	Grey/Brown gravel & sand
	32.7 to 77m	Layers of clay, gravel and sand with timber
M35/2273	0 to 0.5m	Filling
	0.5 to 5m	Grey gravel & sand
	5 to 6.69m	Grey clay & timber
	6.69 to 12m	Grey sandy clay, timber & some gravel
	12 to 37.2m	Gravel & sand

[1] Brown, L. J. & Weeber, J.H. 1992: *Geology of the Christchurch Urban Area*. Institute of Geological and Nuclear Sciences 1:25,000 Geological Map 1. IGNS: Lower Hutt.

Bore Name	Depth	Ground Conditions
	37.2 to 68m	Layers of clay, gravel & sand with timber

Table 2 ECan Bore Log Summary Table

It should be noted that the boreholes, were sunk for groundwater extraction and not for geotechnical purposes, therefore, the amount of material recovered and available for interpretation and recording will have been variable at best and may not be representative. The logs have been written by the well driller and not a geotechnical professional or to a standard. In addition strength data is not recorded.

8.2.3 EQC Geotechnical Investigations

The Earthquake Commission has not undertaken geotechnical testing in the area of the site.

8.2.4 Land Zoning

Canterbury Earthquake Recovery Authority (CERA) has published areas showing the Green Zone Technical Category in relation to the risk of future liquefaction and how these areas are expected to perform in future earthquakes.

The site is classified as TC1 Grey. This indicates that future land-damage from liquefaction is considered unlikely.

8.2.5 Post February Aerial Photography

Aerial photography taken following the 22 February 2011 earthquake shows no signs of liquefaction outside the building footprint or adjacent to the site, as shown in the Figure 7.

Figure 7 Post February 2011 Earthquake Aerial Photography[2]

[2] Aerial Photography Supplied by Koordinates, from http://koordinates.com/layer/3185-christchurch-post-earthquake-aerial-photos-24-feb-2011/

8.2.6 Summary of Ground Conditions

From the ECan borehole information the ground conditions adjacent to the site comprise fill material underlain by layers of gravel, sand and clay with discrete pockets of timber. Fill material is also shown to be present. The nature of the fill material is unknown, i.e. its composition, likelihood of gas build up, compaction and hence how it may behave in a seismic event.

8.3 Seismicity

8.3.1 Nearby Faults

There are many faults in the Canterbury region, however only those considered most likely to have an adverse effect on the site are detailed below.

Known Active Fault	Distance from Site	Direction from Site	Max Likely Magnitude	Avg Recurrence Interval
Alpine Fault	128 km	NW	~8.3	~300 years
Greendale (2010) Fault	14 km	W	7.1	~15,000 years
Hope Fault	105 km	N	7.2~7.5	120~200 years
Kelly Fault	105 km	NW	7.2	150 years
Porters Pass Fault	58 km	NW	7.0	1100 years

Table 3 Summary of Known Active Faults[3,4]

Recent earthquakes since 4 September 2010 have identified the presence of a previously unmapped active fault system underneath the Canterbury Plains, including Christchurch City, and the Port Hills. Research and published information on this system is in development and not generally available. Average recurrence intervals are yet to be estimated.

8.3.2 Ground Shaking Hazard

This seismic activity has produced earthquakes of Magnitude-6.3 with peak ground accelerations (PGA) up to twice the acceleration due to gravity (2g) in some parts of the city. This has resulted in widespread liquefaction throughout Christchurch.

New Zealand Standard NZS 1170.5:2004 quantifies the Seismic Hazard factor for Christchurch as 0.30, being in a moderate to high earthquake zone. This value has been provisionally upgraded recently (from 0.22) to reflect the seismicity hazard observed in the earthquakes since 4 September 2010.

[3] Stirling, M.W, McVerry, G.H, & Berryman, K.R. (2002): "A New Seismic Hazard Model for New Zealand", *Bulletin of the Seismological Society of America*, Vol. 92 No. 5, pp 1878-1903, June 2002.

[4] GNS Active Faults Database, http://maps.gns.cri.nz/website/af/viewer

8.4 Slope Failure and/or Rockfall Potential

The site is located within Sockburn, a flat suburb in western Christchurch. Global slope instability risk is considered negligible. However, the south eastern side of the building is located on an embankment; the deck is founded into the sloping ground.

8.5 Liquefaction Potential

The risk of liquefaction at this site is considered to be low based on:

- No effects of liquefaction were reportedly observed at the ground surface in Sockburn;
- The anticipated presence of predominantly gravels, sandy gravels and clay beneath the site;
- No liquefaction was observed, during an inspection undertaken on 18 Jan 2012, by GHD personnel; and,
- The liquefaction potential of the fill material is unknown, but is considered unlikely.

8.6 Historic Land Use

8.6.1 Historic Aerials

Historic aerial photographs were obtained from the Christchurch City Council Archives. An aerial photograph form 1955 (Figure 8) indicates the building is now located on or nearby a quarry pit.

Figure 8 (a) Aerial Photograph Taken 12 May 1955, compared to (b) 2011 Earthquake Aerial Photograph

8.6.2 Environment Canterbury Contaminated land Request

The Listed Land Use Register held by ECan reports that the site has a history of gravel extraction and infilling with sawmill and demolition waste prior to 1955.

From the mid 1960's, the site was used for recreation and a swimming pool. The pool was closed in 2006 and underground diesel storage tanks were removed.

An extract from an Environmental Site Assessment report, dated 2007 indicates that soil contamination is present at levels that exceed guidelines for parklands use.

8.7 Field Investigations

The potential presence of shallow buried waste steered the method of investigation to that of test pit excavation in order to maximise the amount of ground exposed. A single test pit was excavated at the rear of the subject building in the base of the former quarry. A second pit was planned to trench from the higher ground (assumed to be the edge of the quarry) to the quarry base however this was not possible due to buried services.

The location of the single test location is show in Figure 9 and tabulated in Table 4.

Investigation	Depth (m bgl)	Easting (NZMG)	Northing (NZMG)
TP 1	3.4	2474045	5741130

Table 4 Coordinates of Investigation Locations

The test pit excavation was undertaken by City Care Limited on 31 May 2012, to a depth of 3.4m.

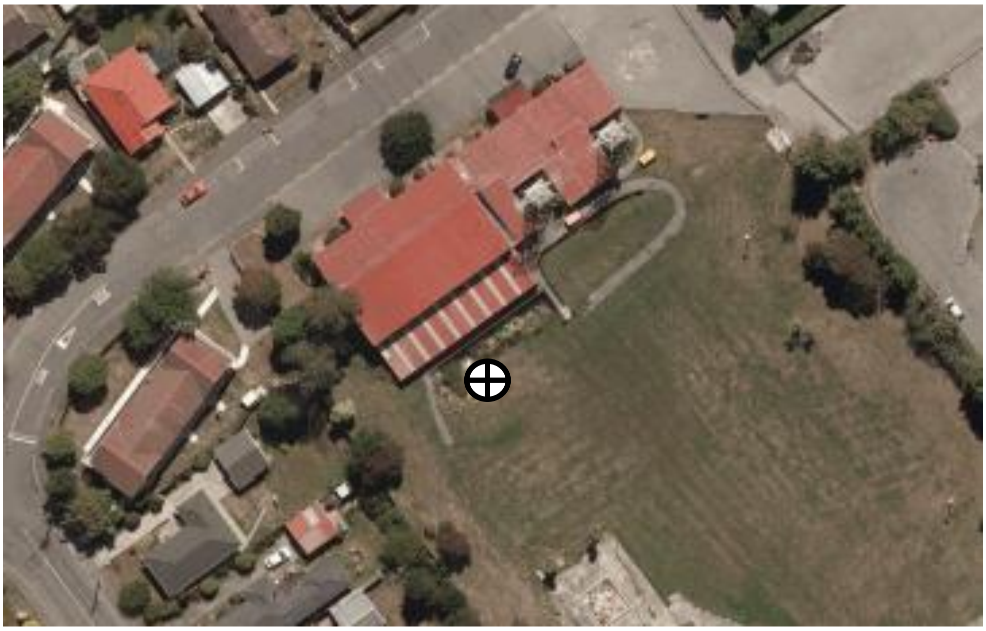


Figure 9 Test Pit Location Plan[5]

[5] Aerial Photography Supplied by Koordinates, from http://koordinates.com/layer/3185-christchurch-post-earthquake-aerial-photos-24-feb-2011/

8.8 Ground Conditions Encountered

The ground conditions encountered are summarised in Table 5.

Depth (m bgl)	Ground Conditions Encountered	Inferred Formation
0.0 – 0.1	TOPSOIL; dark brown. Moist.	
0.1 – 2.0	MADE GROUND: Dark brownish grey silt, with construction debris (including timber posts, concrete blocks up to 2m, reinforcing steel, bricks, drainage pipes).	FILL
2.0 – 2.4	MADE GROUND: Dark brown black organic decomposed waste, possible degraded sawdust. Slightly odourous.	FILL
2.4 – 2.9	Gravelly, fine to medium SAND, with some silt; bluish grey. Moist. Gravel, fine to coarse, subrounded greywacke.	Springston (spy)
2.9 – 3.4	SILT; bluish grey. Firm to stiff; wet, low plasticity.	Springston (spy)
3.4	End of Borehole	

Table 5 Summary of Ground Investigation Results

Groundwater was not encountered during the investigation.

The ground conditions confirm the site is underlain by at least 2m of uncontrolled fill. The fill type suggests there have been at least two periods of filling. The layer extending to 2.0 m bgl is modern fill (construction debris) which overlies an older well decomposed historic waste to 2.4m.

8.9 Ground Performance

The footprint of the subject building straddles the edge of the quarry with the two storey squash courts founded on in-situ ground and the changing rooms and deck potentially founded on made ground. Observed differential settlement between the original main structure and the newer changing rooms could be attributed to settlement of the made ground depending on the foundation system.

If the changing rooms are founded on the made ground, the settlement has probably been on-going due to gradual decomposition of the older organic fill. It is unlikely that recent ground shaking associated with the seismic activity since Sept 2010 has contributed much to the settlement, however the more modern fill which comprises large blocks of concrete with potential voids could have shifted.

8.10 Ground Contamination

There is significant potential for this site to be underlain by contaminated material.

8.11 Geotechnical Recommendations

Based on the information presented above, we recommend the following for the subject site:

- Determine the actual foundation system used for the changing rooms

Investigation may be required to determine the target depth for end bearing piles.

Before any work in the former quarry is undertaken, a risk assessment should be undertaken for exposure to both ground contamination and hazardous waste associated with construction demolition debris (in particular buried asbestos).

8.12 Summary

The ground conditions underlying the site are understood to be recent fill, comprising construction debris of variable density, overlying decomposed older fill, over stratified Holocene alluvial deposits comprising sandy gravels and silt typical of the Yaldhusrt Member of the Springston Formation.

The site is considered to have a relatively low liquefaction susceptibility.

For the main part of the structure a soil class of **D** (in accordance with NZS 1170.5:2004) as recommended in Section 8 of the DEE/IEP is still believed to be appropriate. However, the presence of made ground beneath the changing rooms precludes the adoption of a soil class.

The potential for differential settlement between the in-situ and the made ground requires consideration in any foundation solution.

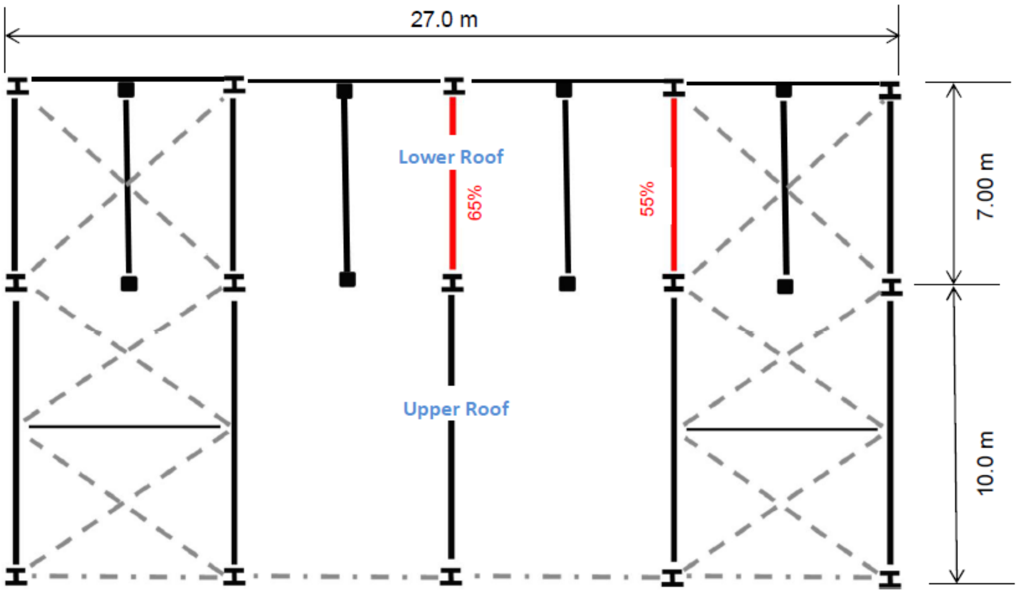
9. Results of Analysis

The following are the results of structural analysis to Sockburn Squash Centre structure.

9.1 Squash Courts Building

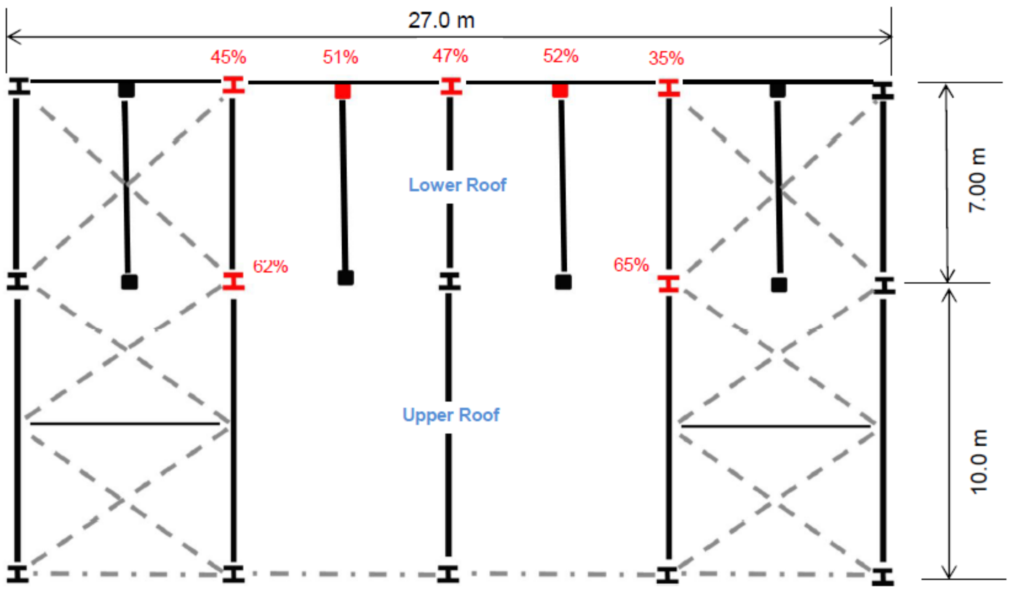
Steel Beams/Rafters

Two (2) steel rafters scored below 67%NBS and are highlighted in red below.



Steel Columns

Two (2) SHS and Five (5) UB steel columns scored below 67%NBS are highlighted in red below.

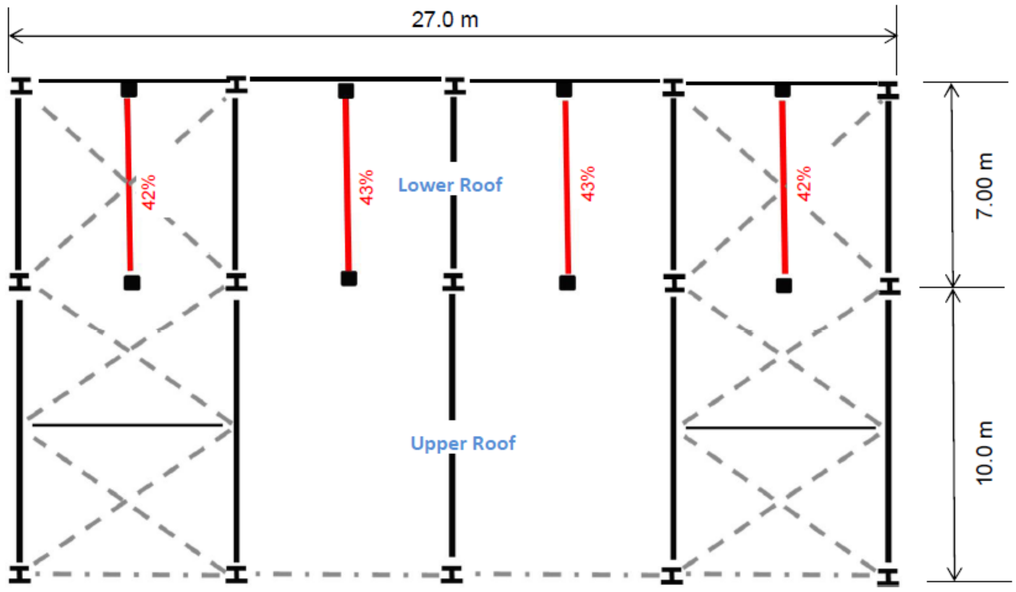


Horizontal and Vertical Bracings

All horizontal and vertical bracing are found to be more than 67%NBS in the analysis.

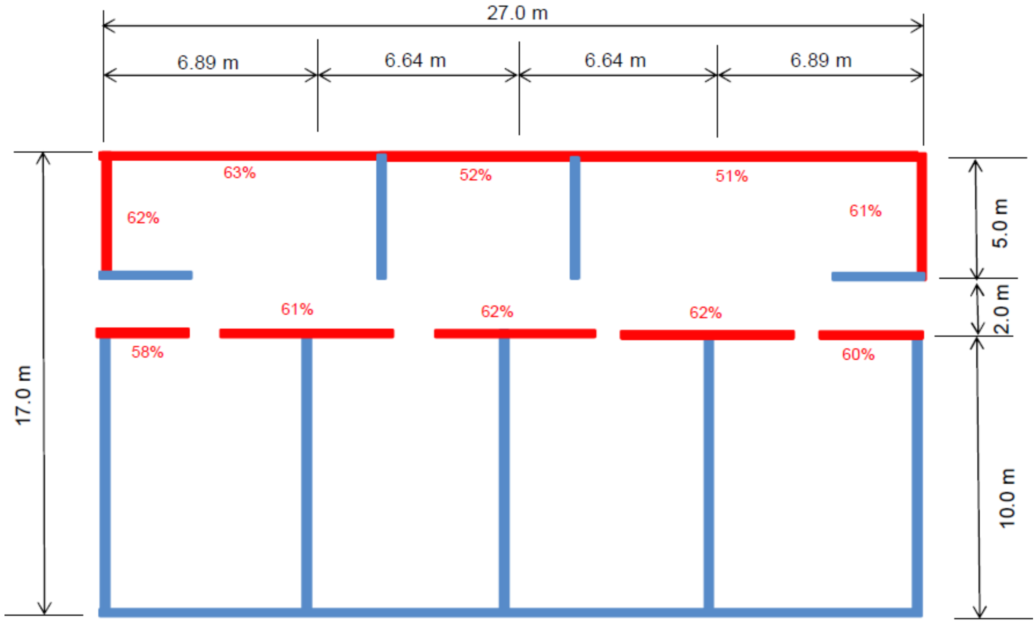
Timber Rafters

All timber rafters are found to be less than 67% NBS and highlighted in red below.



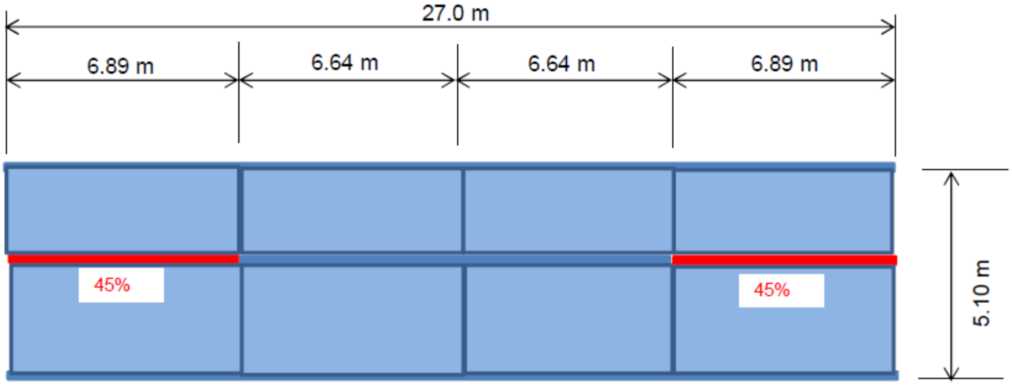
Reinforced Concrete Masonry Walls

Ten reinforced concrete masonry wall panels are found to be less than 67% NBS are highlighted in red below.

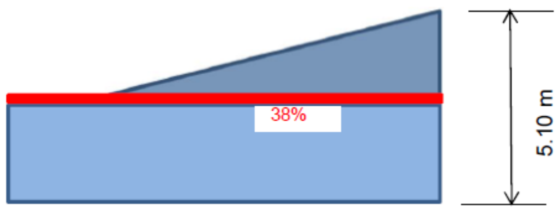


Reinforced Concrete Masonry Bond Beam (Out of Plane Bending)

The critical reinforced concrete masonry bond beams are found to be less than 67%NBS and are highlighted in red.



South Side



East and West Side

Lateral Seismic Drift

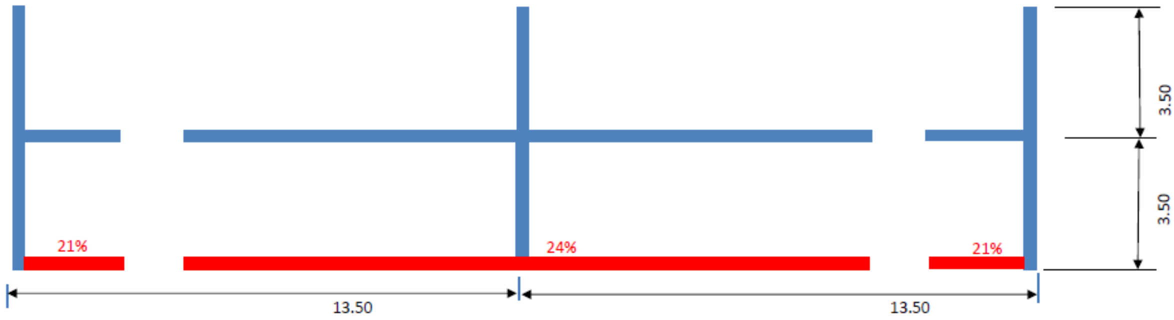
The computed drift of the Squash Courts is 13.0 mm in the longitudinal direction and 2.0 mm in the transverse direction. These values are within the Code requirements.

9.2 Administration Building

All reinforced concrete masonry wall panels are found to be over 100% NBS.

9.3 Changing Shed Building

The lateral resisting reinforced concrete masonry walls shown on the next page and highlighted in red are found to be less than 34% NBS.



9.4 Discussion of Results

The results obtained from the analysis are consistent with those expected for a building of this age and construction type founded on Class D soils.

The squash courts were constructed in 1974 and were likely to be designed to the loading standard current at the time, NZS 1900:1965. The design loads used in this code are likely to have been less than those required by the current loading standard. In addition, the detailing requirements for ductile seismic behaviour that are present in the current codes are unlikely to have been considered in the design of this building. As a result, it would be expected that the building would not achieve 100% NBS. The increase in the hazard factor for Christchurch to 0.3 further reduces the %NBS score and as a result, it is reasonable to expect the building to be classified as ‘Moderate Risk’.

The two (2) additions, Administration Building and Changing Shed were constructed in 1985 and would be expected to score higher than the Squash Courts. However for the Changing Shed scores less due to lack of adequate timber wall bracing to transfer the roof lateral forces into the reinforced concrete masonry walls.

There is no visible seismic gap provided between the Squash Courts and Administration Building in the longitudinal direction. Similarly there is no seismic for Squash Courts and Changing Shed in the transverse direction. In the event of an earthquake, each building will produce a different period and there is a risk that they could pound upon each other. The pounding is likely to cause cracking, possible localised member and connection failure at the point or area of impact. It is also possible that some cracks mentioned in the investigation and opening up works may be attributed to some minor pounding.

10. Conclusions

10.1 Building Capacity Assessment

The Changing Shed has been assessed as having a seismic capacity of 21% NBS and is therefore classified as 'Earthquake Prone'. The discreet and isolated location of the Changing Shed, with independent access and minimal influence on the remaining structure's performance, has allowed the Squash Courts and Administration Building to be assessed separately as Earthquake Risk given the seismic capacity of 35% NBS.

Squash Courts

The critical structural weakness for this building are the steel columns in the lounge area (See Figure 3) which supports the steel roof system and transfer the roof lateral load into the reinforced masonry walls. The structural steel components scored 35% NBS.

The timber rafters were found to be less than 42%NBS but since it is only critical under gravity loading, the inadequacy is considered to be localised. Generally, the building would still be standing in the event of a localised timber rafter failure or collapse.

Administration Building

The building scored greater than 100%NBS.

Changing Shed

The front reinforced concrete masonry walls are considered as the critical structural weakness and scored only 21%NBS. This is due to lack of adequate timber wall bracing to transfer the roof lateral forces into the reinforced concrete masonry walls. The front walls which have a height that extends from ground to timber roof framing are only considered as the lateral load resisting system.

The slope at the rear of the property has appeared to have slumped and as a result, the concrete pads supporting the timber deck posts have settled (see Photographs 14 and 17). It is not clear whether the settlement is due to long term movement of the slope or the recent seismic activity. However, if the movement will continue, there is a possibility that the Changing Shed foundation will settle unevenly and could result to cracking of the reinforced concrete masonry walls or potential structural failure.

Pounding Effect

The computed drift of the Squash Court is 13.0mm and 2.0mm in the longitudinal and transverse direction respectively.

There is no visible seismic gap provided between the Squash Courts and Administration Building in the longitudinal direction. Similarly there is no seismic gap for Squash Courts and Changing Shed in the transverse direction. In the event of an earthquake, each building will produce a different period and there is a risk that they could pound upon each other. The pounding is likely to cause cracking, possible member and connection failure at the point or area of impact. It is also possible that some cracks mentioned in the investigation and opening up works may be attributed to the pounding effect

11. Recommendations

GHD recommend that further work is undertaken in order to develop the scope of the strengthening and repair options. Developing a strengthening works scheme to increase the seismic capacity of the Squash Courts and Changing Shed to as near as practicable to 100%NBS, and at least 67%NBS. This will need to consider compliance with accessibility and fire requirements.

12. Limitations

12.1 General

This report has been prepared subject to the following limitations:

- Available drawings itemised in 5.3 was used in the assessment.
- The roof structure and foundations of the building were unable to be inspected.
- Foundations were not checked.
- No level or verticality surveys have been undertaken.
- No material testing has been undertaken.

It is noted that this report has been prepared at the request of Christchurch City Council and is intended to be used for their purposes only. GHD accepts no responsibility for any other party or person who relies on the information contained in this report.

12.2 Geotechnical Limitations

The data and advice provided herein relate only to the project and structures described herein and must be reviewed by a competent geotechnical professional before being used for any other purpose. GHD Limited (GHD) accepts no responsibility for other use of the data by third parties.

Where drill hole or test pit logs, cone tests, laboratory tests, geophysical tests and similar work have been performed and recorded by others under a separate commission, the data is included and used in the form provided by others. The responsibility for the accuracy of such data remains with the issuing authority, not with GHD.

The advice tendered in this report is based on information obtained from the desk study investigation location test points and sample points. It is not warranted in respect to the conditions that may be encountered across the site other than at these locations. It is emphasised that the actual characteristics of the subsurface materials may vary significantly between adjacent test points, sample intervals and at locations other than where observations, explorations and investigations have been made. Subsurface conditions, including groundwater levels and contaminant concentrations can change in a limited time. This should be borne in mind when assessing the data.

It should be noted that because of the inherent uncertainties in subsurface evaluations, changed or unanticipated subsurface conditions may occur that could affect total project cost and/or execution. GHD does not accept responsibility for the consequences of significant variances in the conditions and the requirements for execution of the work.

The subsurface and surface earthworks, excavations and foundations should be examined by a suitably qualified and experienced Engineer who shall judge whether the revealed conditions accord with both the assumptions in this report and/or the design of the works. If they do not accord, the Engineer shall modify advice in this report and/or design of the works to accord with the circumstances that are revealed.

An understanding of the geotechnical site conditions depends on the integration of many pieces of information, some regional, some site specific, some structure specific and some experienced based. Hence this report should not be altered, amended or abbreviated, issued in part and issued incomplete in any way without prior checking and approval by GHD. GHD accepts no responsibility for any circumstances which arise from the issue of the report which have been modified in any way as outlined above.

Appendix A

Geotechnical Investigation Reports and Analysis

TEST EXCAVATION LOG

GHD Limited
PO Box 13468
Christchurch 8141

Site Identification: **TP1**

Sheet 1 of

Project: 15 - Sockburn Recreation Centre
Client: Christchurch City Council
Site: Sockburn Park
Job No.: 5130596/15

Coordinates: **E** 2474 045, **N** 5741 130
Surface RL (m):
Datum: NZMG
Total Depth: 3.4m
Commenced: 31-May-12
Completed: 31-May-12
Contractor: City Care
Operator: Jamie

Equipment: 14t Excavator
Bucket Size (m): 0.8
Shear Vane:
Bucket Type: Toothed
Excavation Width (m): 1.5
Excavation Length (m): 3.8
Orientation/ Bearing: East West

Logged:	DW/HN
Processed:	DW
Checked:	SW

Depth Scale (m)	Water	Depth (m)	Geological Unit	Graphic Log	Classification	SOIL DESCRIPTION: (Soil Code), Soil Name [minor MAJOR], colour, structure [zoning, defects, cementing], plasticity or grain size, secondary components, structure. (Geological Formation) / ROCK DESCRIPTION: Weathering, colour, fabric, ROCK NAME (Formation Name)	Moisture Condition	Consistency/ Relative Density	Sample Depth	Sample Type	Sample/Test Number / Records & Comments	Depth Scale (m)
						Top Soil; dark brown. Moist.	M					
						FILL. Dark brown grey SILT, with construction debris (timber, large concrete blocks, bricks, drainage pipes).	M					
1												1
2		2.0				FILL. Dark brownish black organic decomposed waste, possible degraded sawdust. Slightly odourous.	M					2
		2.4			SP	Gravelly fine to medium SAND, with some silt; bluish grey. Moist. Gravel fine to coarse, subrounded, grewacke.	M					
		2.9			ML	SILT; blueish grey. Firm to stiff, low plasticity.	W	S			Groundwater not encountered.	
3												3
		3.4				Termination Depth = 3.4m (Target Depth)						
4												4
5												5

Appendix B

Photographs

Photograph 1 View from the north-east of the administration area

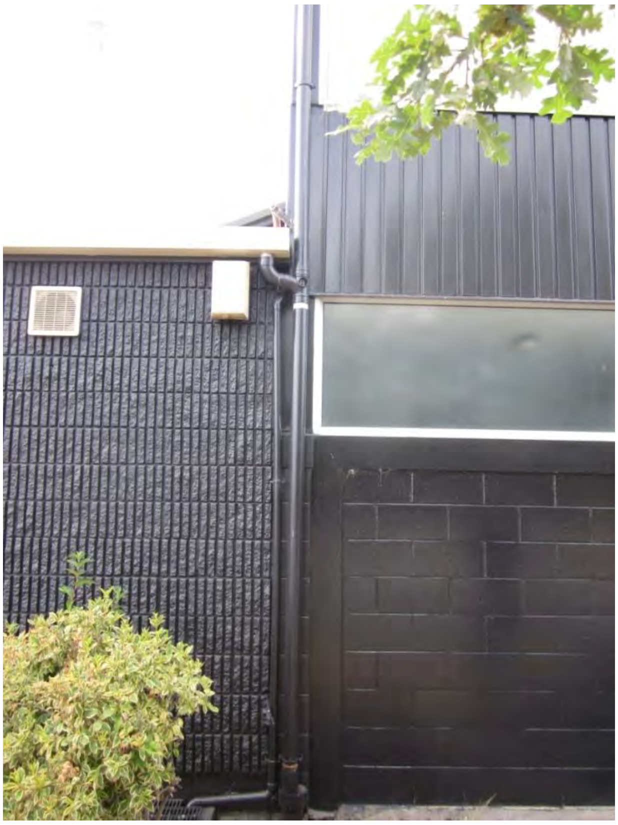
Photograph 2 View from the north of the administration area

Photograph 3 View of building from Takaro Avenue

Photograph 4 **Cracking in the reinforced concrete masonry wall beneath the columns on the front face of the building**

Photograph 5 **Cracking at the edge of the window between the column and concrete masonry wall on the front face of the building**

Photograph 6 **View from Takaro Avenue**



Photograph 7 **Connection between original structure and subsequent addition**

Photograph 8 **Timber framed canopy**

Photograph 9 **External view of concrete masonry infill panels between steel portal frames**

Photograph 10 **View from the west**

Photograph 11 **Timber deck and changing rooms at rear of building**

Photograph 12 **Cracking of asphalt footpath where ground appears to have slumped**

Photograph 13 **View from the south**

Photograph 14 **Timber deck at rear of building**

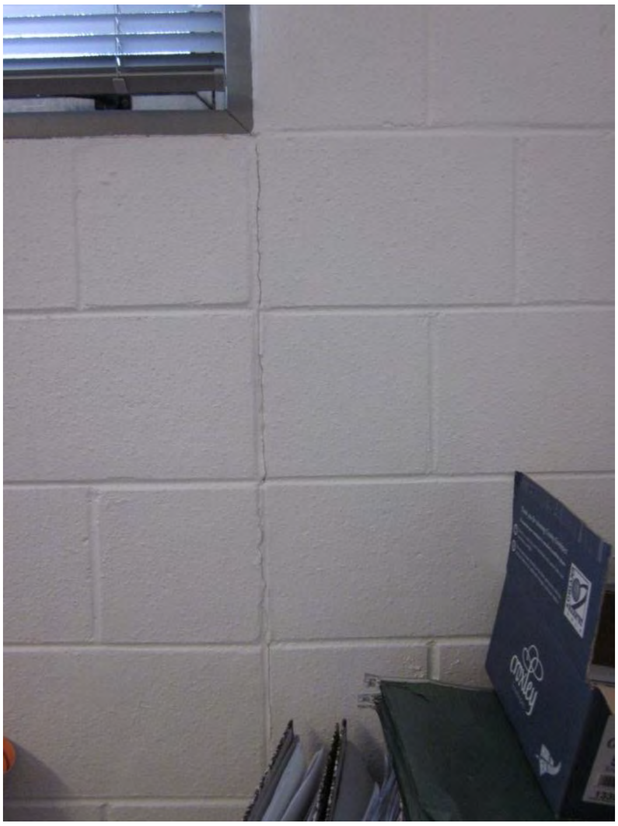
Photograph 15 **View from the south-east**

Photograph 16 **Isolated concrete pads supporting the timber deck**

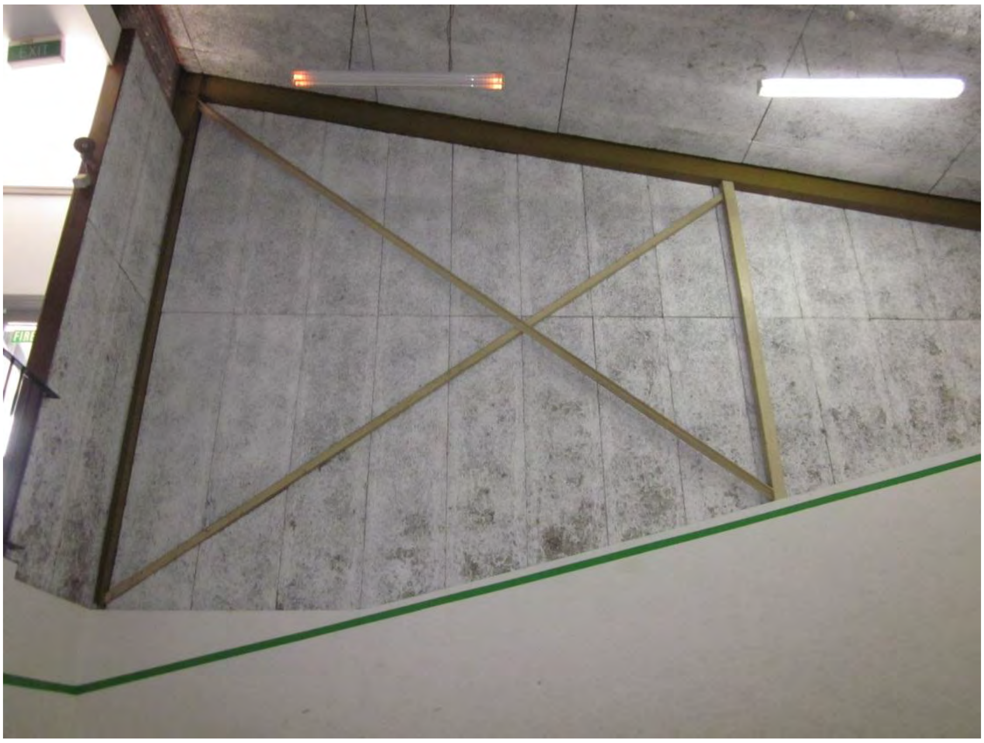
Photograph 17 **Timber deck sub-structure**

Photograph 18 Timber framing supporting rafters at midspan in changing room

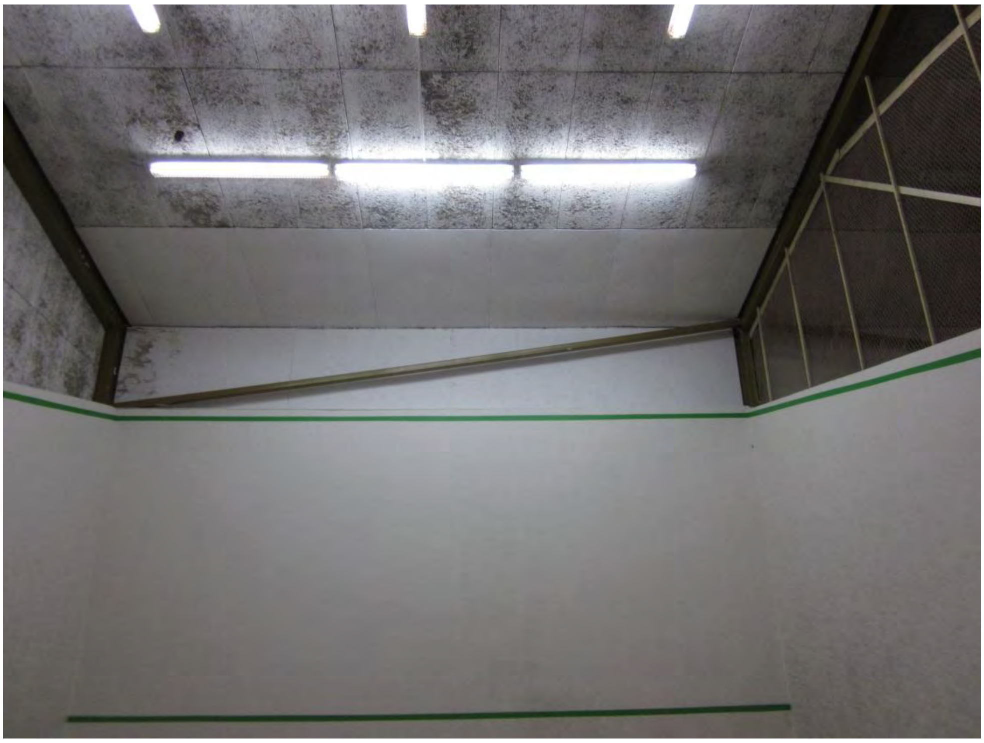
Photograph 19 Cracking around doorway in internal corridor



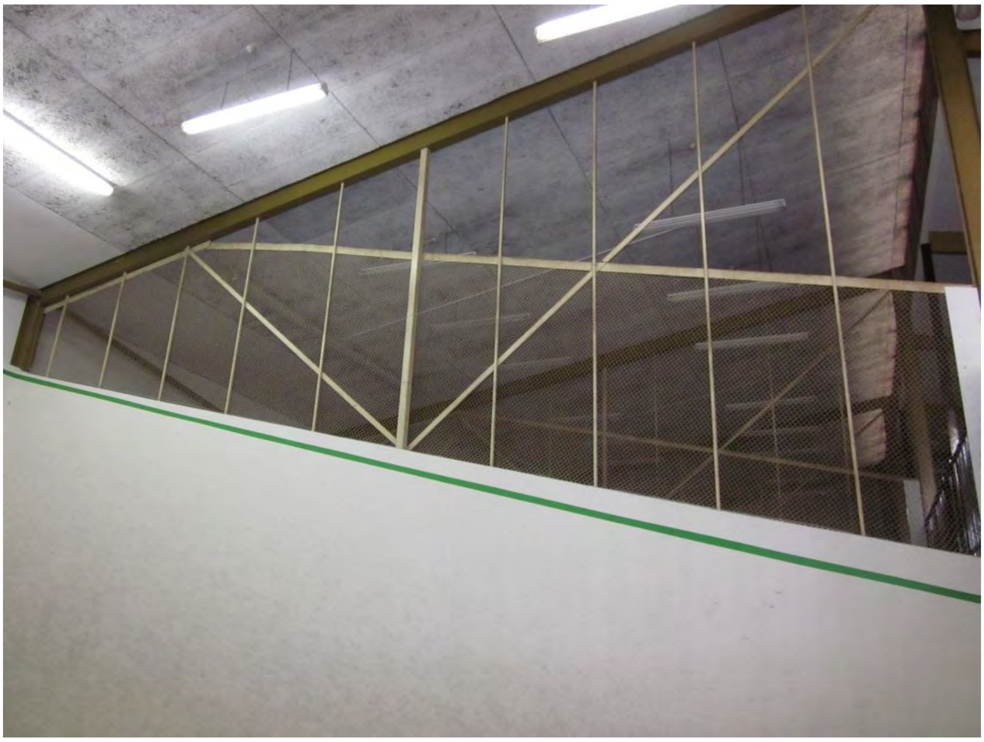
Photograph 20 Internal cracking beneath window on front face of building



Photograph 21 Steel portal frame bracing in the short direction of the building



Photograph 22 **Bracing between steel portal frames**



Photograph 23 **Steel portal frame bracing**

Photograph 24 **Steel portal frame base connection**

Photograph 25 **Bracing in each portal frame bay with masonry infill**

Photograph 26 Cracking on the south-western wall of second story

Photograph 27 Rafter to portal frame connections

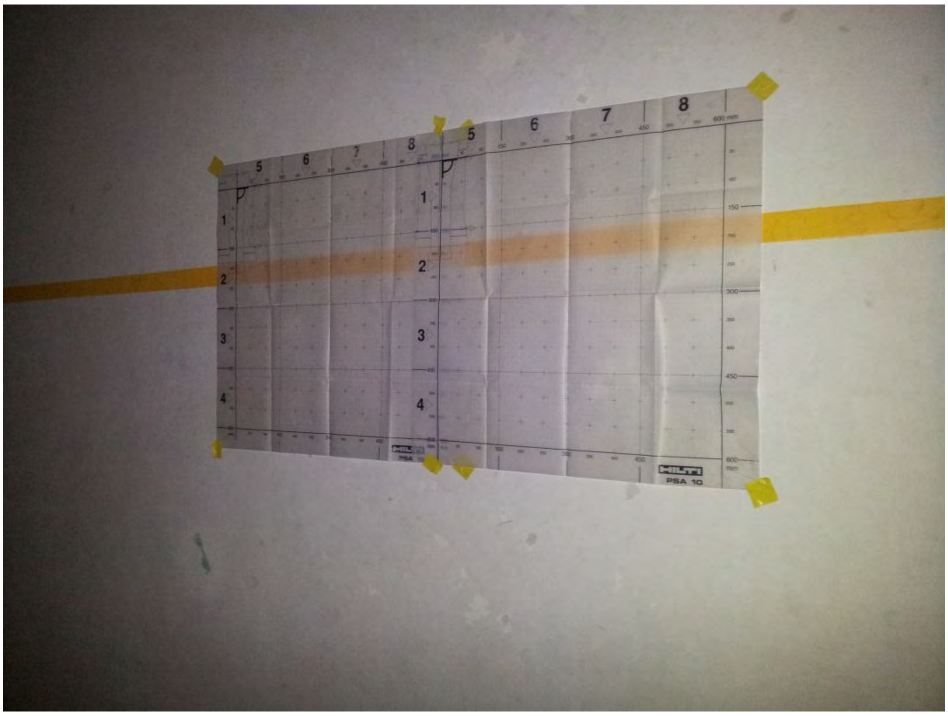
Photograph 28 Opening up works at crack location on left side of front face of the building. No reinforcement was observed.

Photograph 29 Opening up works at crack location below concrete masonry column. No reinforcement was observed.

Photograph 30 **View of external opening up works undertaken**

Photograph 31 **Opening up works undertaken at location of cracking around connection between original structure and addition. No reinforcement was observed.**

Photograph 32 **View of location of internal opening up works**

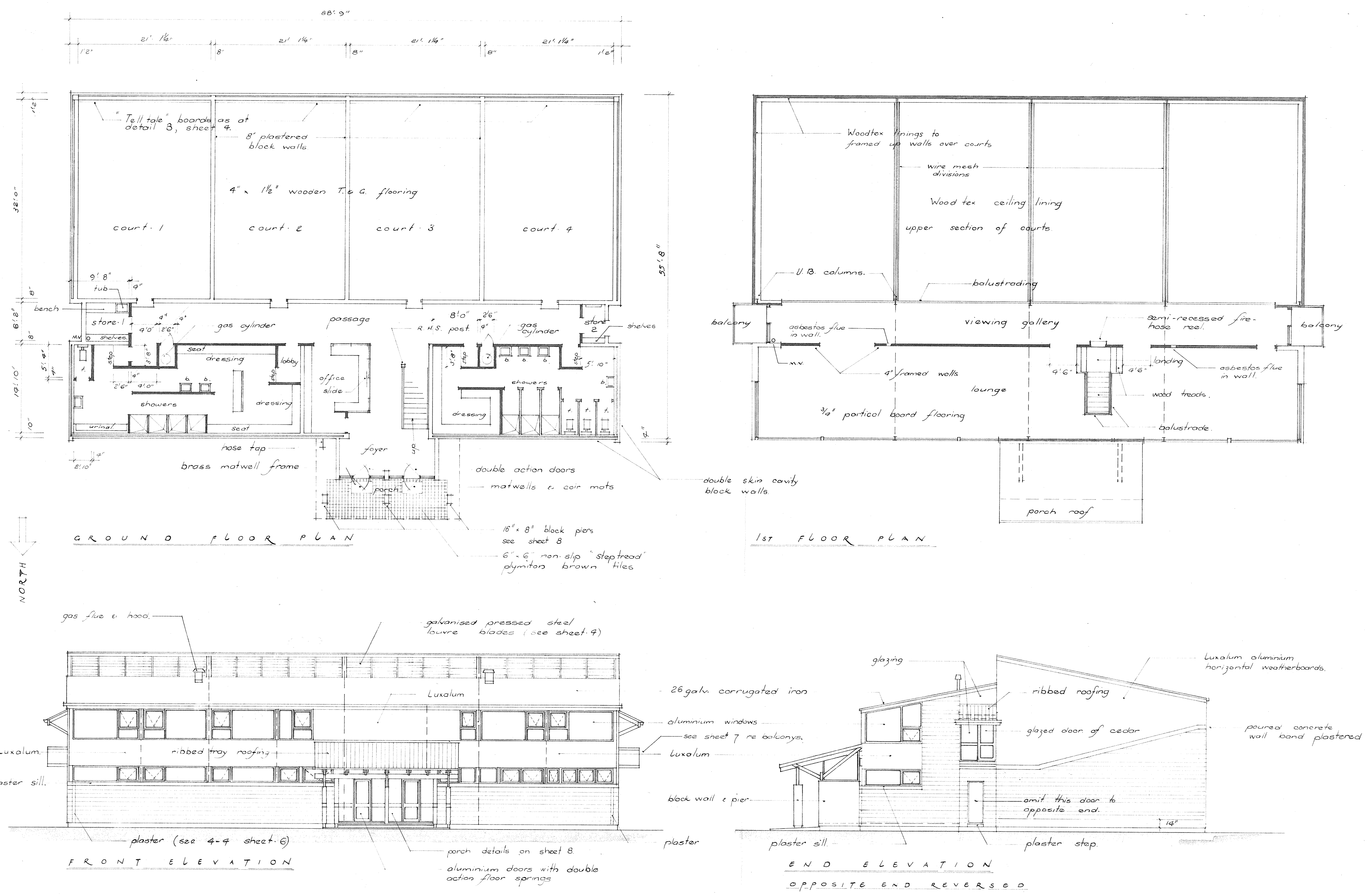


Photograph 33 **Hilti Ferroscan rebar scanning location at Court 2.**

Appendix C

Existing Drawings

Contractors are to verify all measurements on site and general site conditions



SQUASH COURTS FOR THE PAPARUA COUNTY COUNCIL

drawn by Lloyd Childs m.n.z.i.d. architectural draughtsman Christchurch

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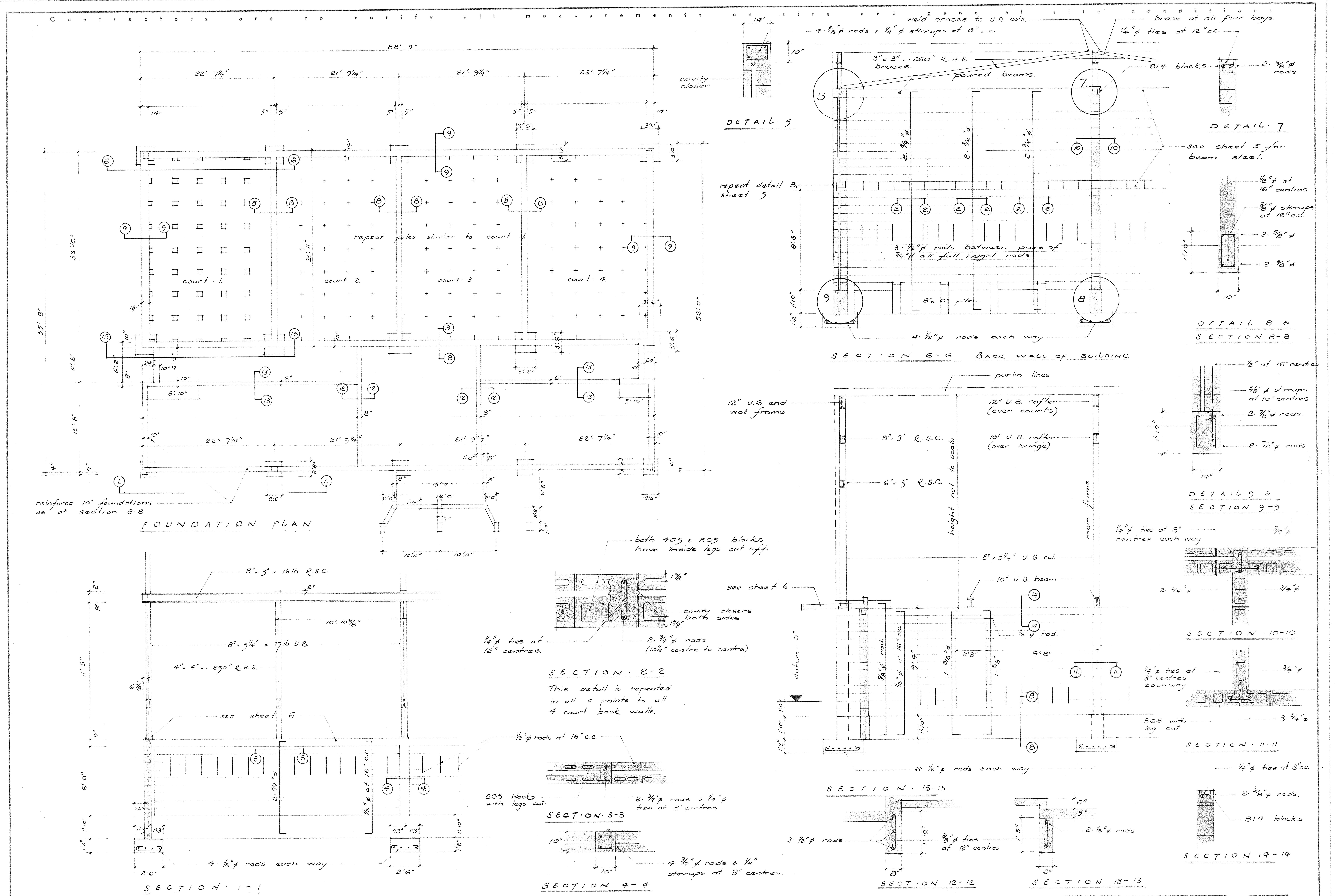
date	24 · 10 · 74
sheet	one of nine sheets

sheet 1. AMENDED



SQUASH COURTS FOR THE PAPARUA COUNTY COUNCIL

drawn by Lloyd Childs m.n.z.i.d. architectural draughtsman Christchurch

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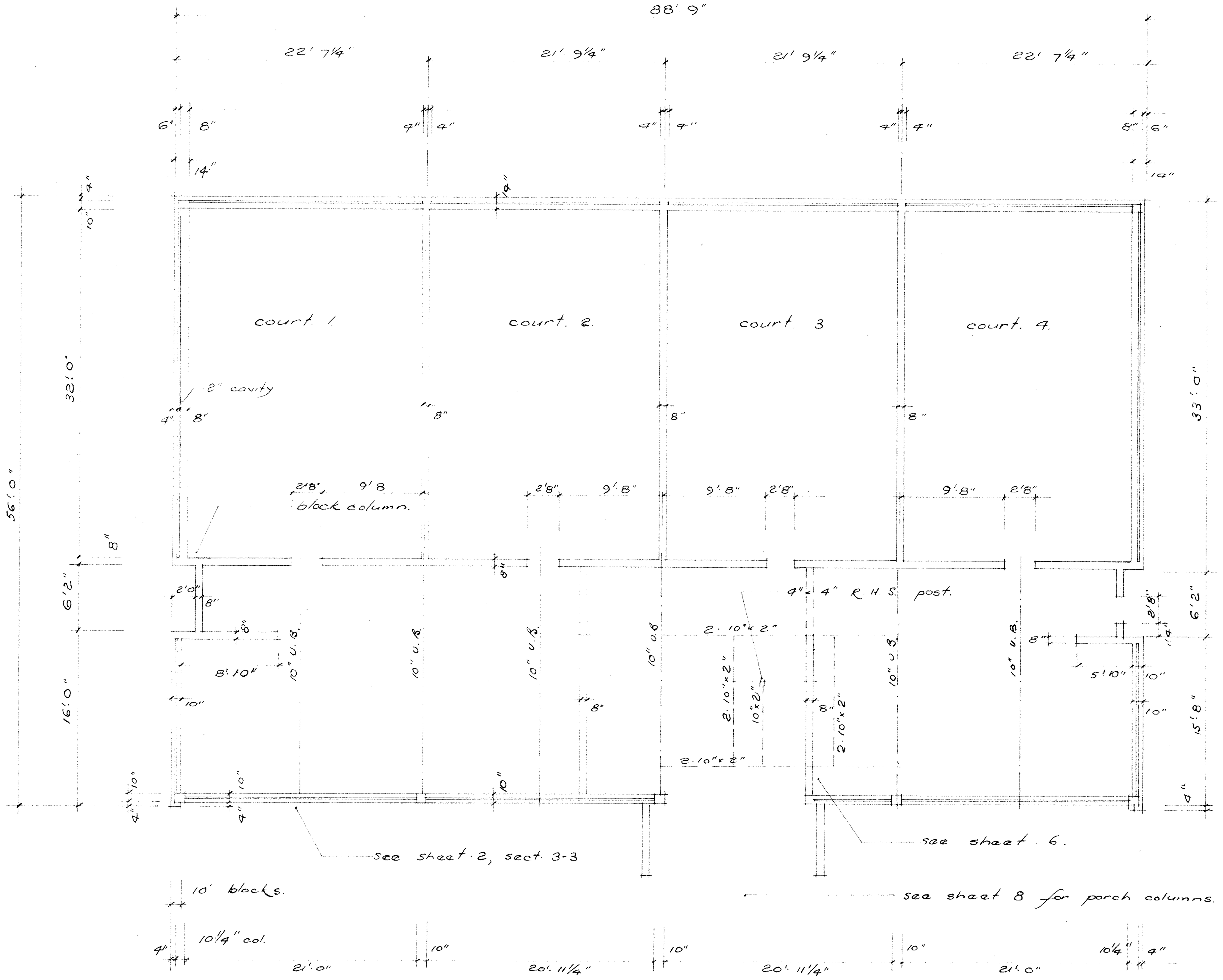
date	24 - 10 - 74
sheet	two of nine sheets

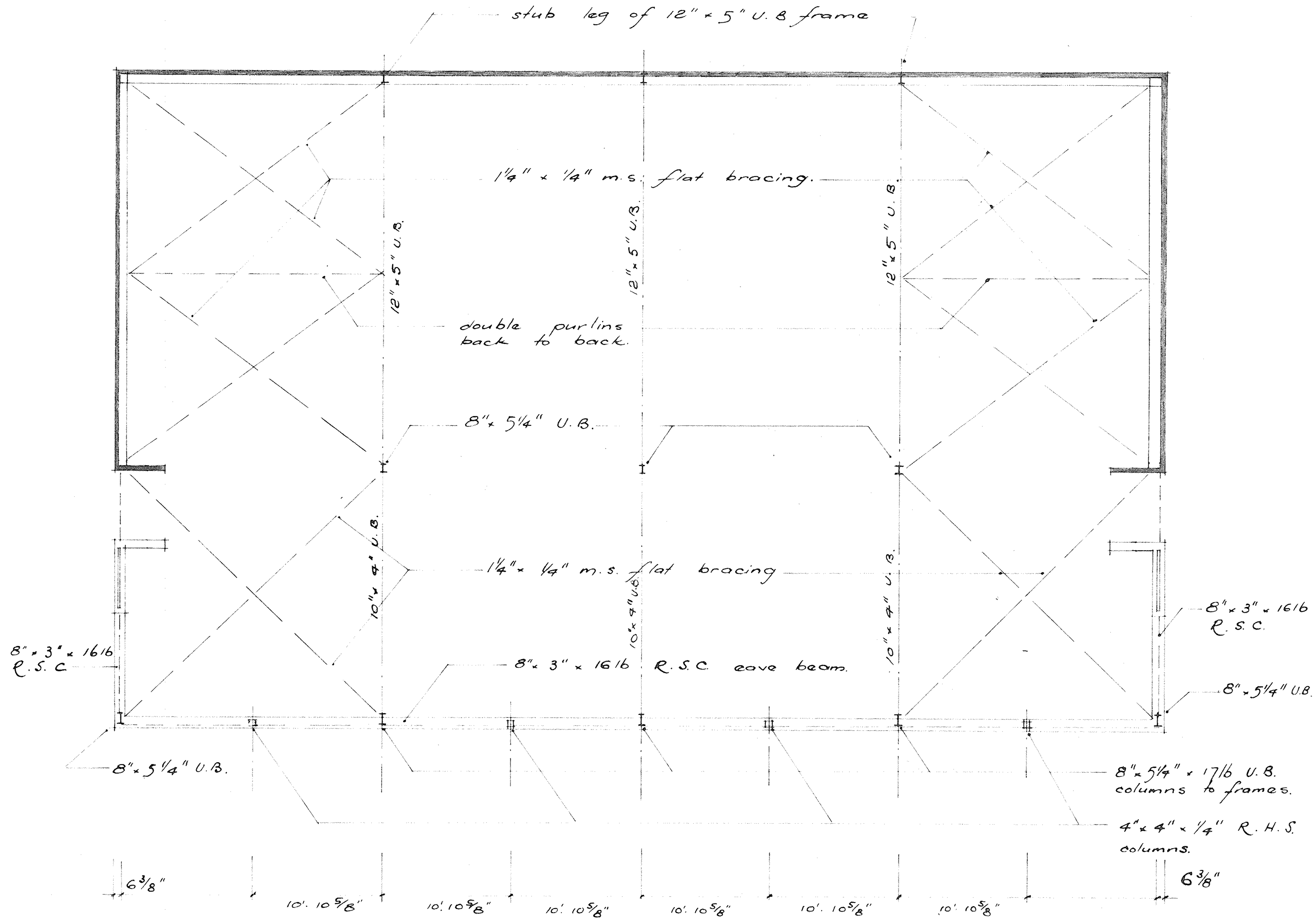
sheet 2 AMENDED

Contractors are to verify all measurements on site and general site conditions



GROUND FLOOR

BLOCK WALLS AND CEILING BEAMS.



PLAN OF ROOF MEMBERS

& FIRST FLOOR COLUMNS.

SQUASH COURTS FOR THE PAPARUA COUNTY COUNCIL

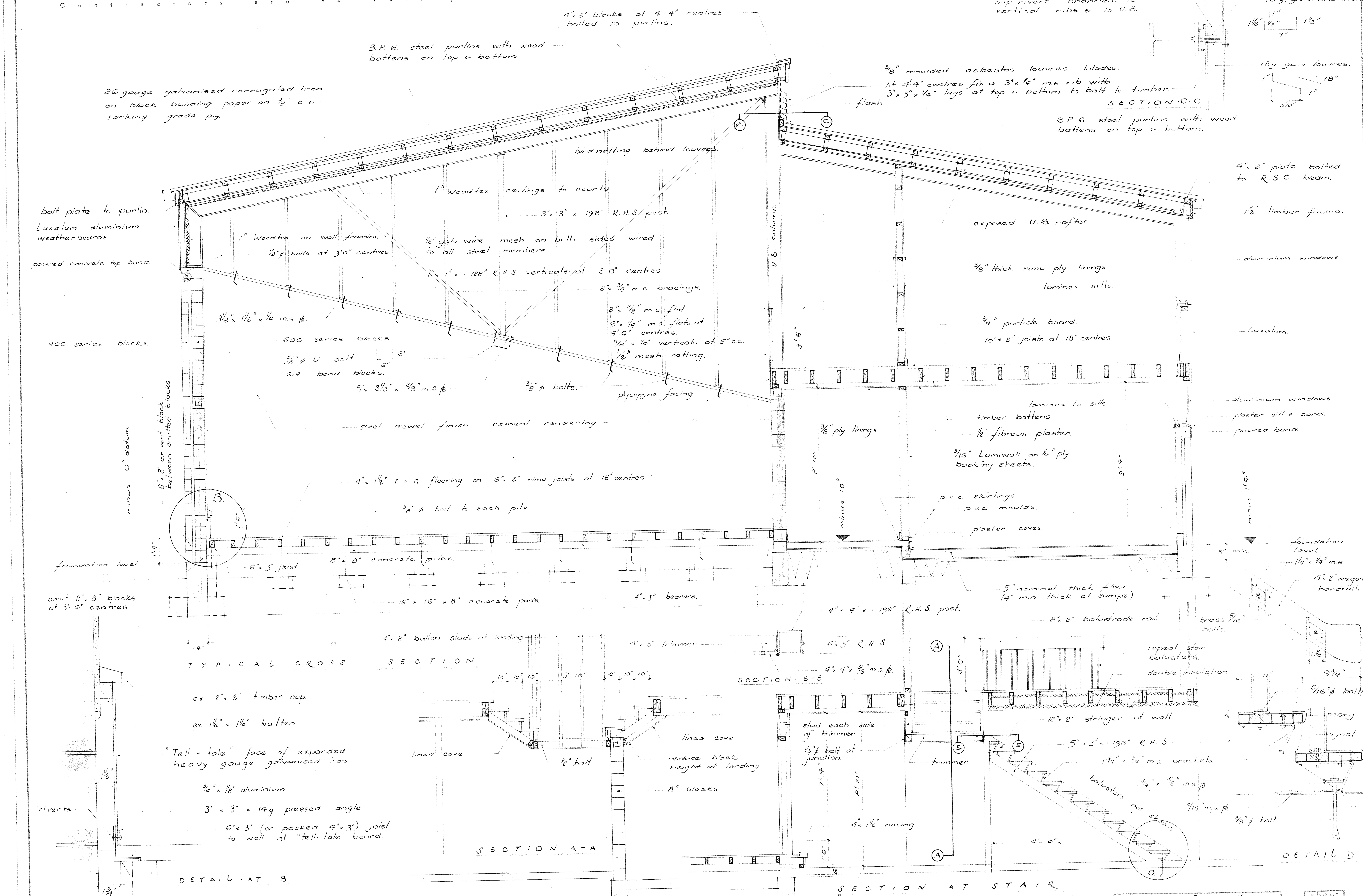
drawn by Lloyd Childs m.n.z.i.d. architectural draughtsman Christchurch

scales	⅛"
date	21 . 10 . 74
sheet	three of nine sheets

sheet 3.

AMENDED

Contractors are to verify all measurements on site and general site conditions



SQUASH COURTS FOR THE PAPARUA COUNTY COUNCIL

drawn by Lloyd Childs m.n.z.i.d. architectural draughtsman Christchurch

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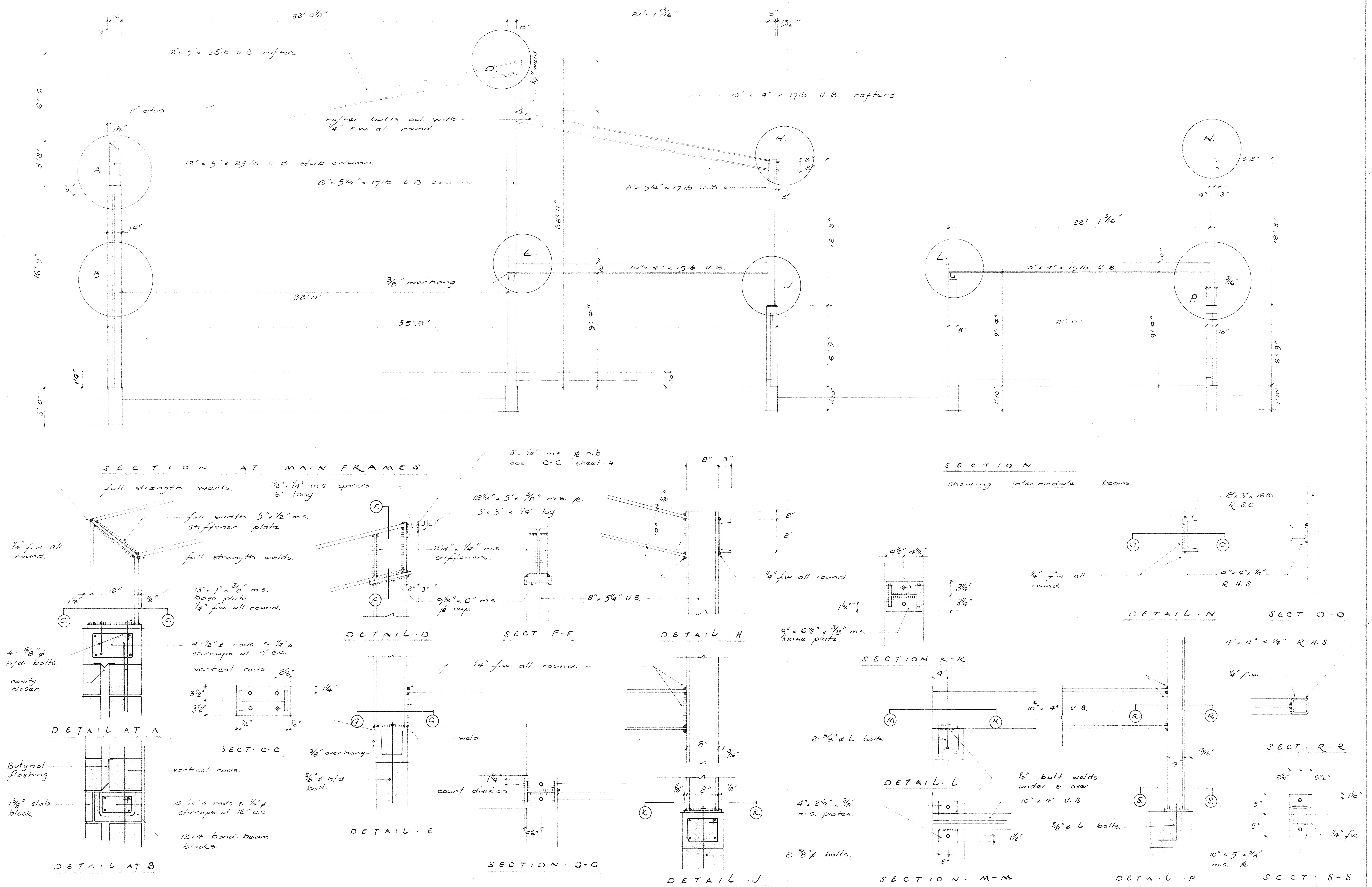
sheet four of nine sheets	

sheet 4. AMENDED

Contractors are to verify all measurements on site and general site conditions



SQUASH COURTS FOR THE PAPARUA COUNTY COUNCIL

drawn by Lloyd Childs m.n.z.i.d. architectural draughtsman Christchurch

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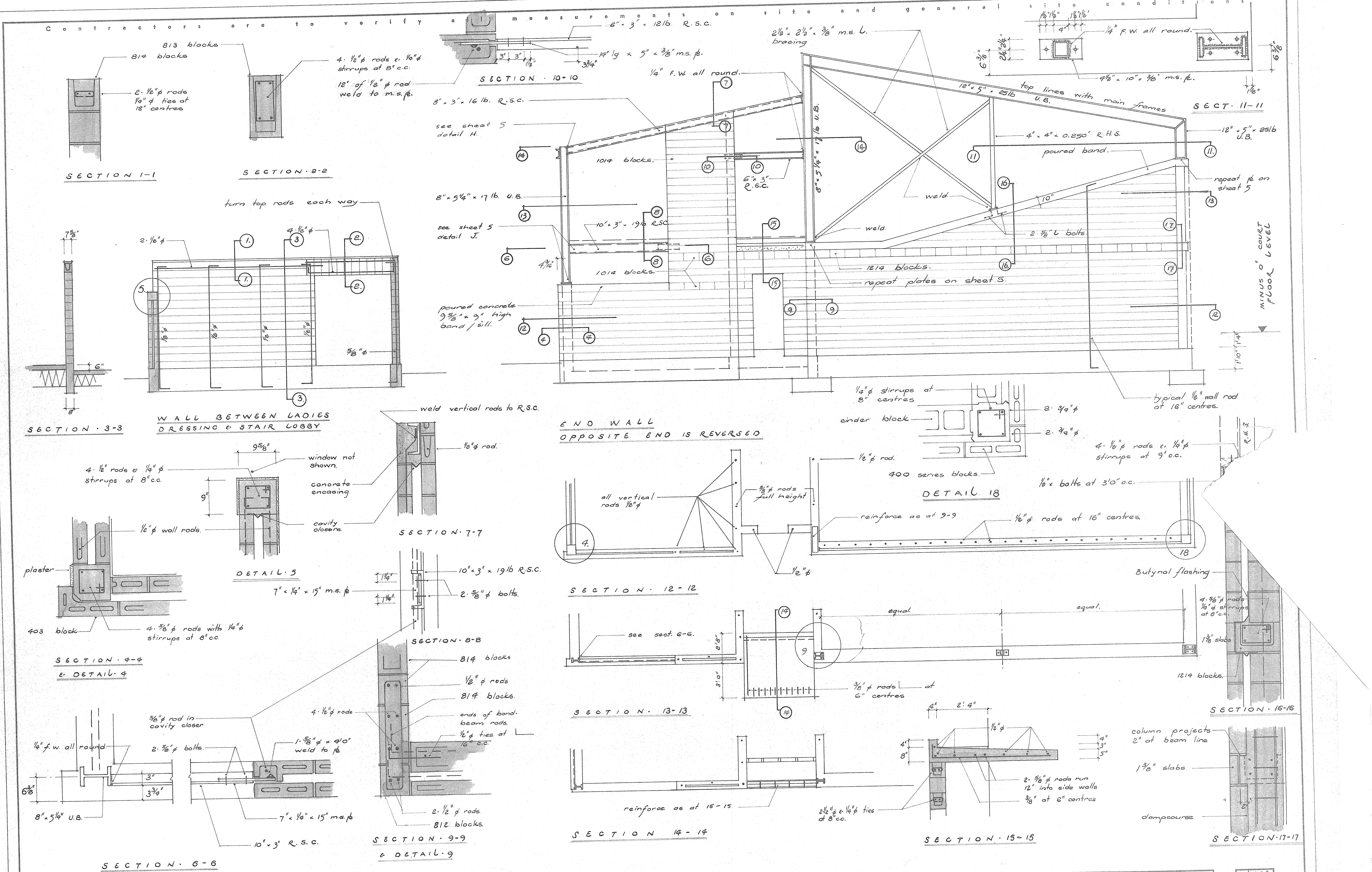
date	24. 10. 74
sheet	five of nine sheets

sheet 5. AMENDED



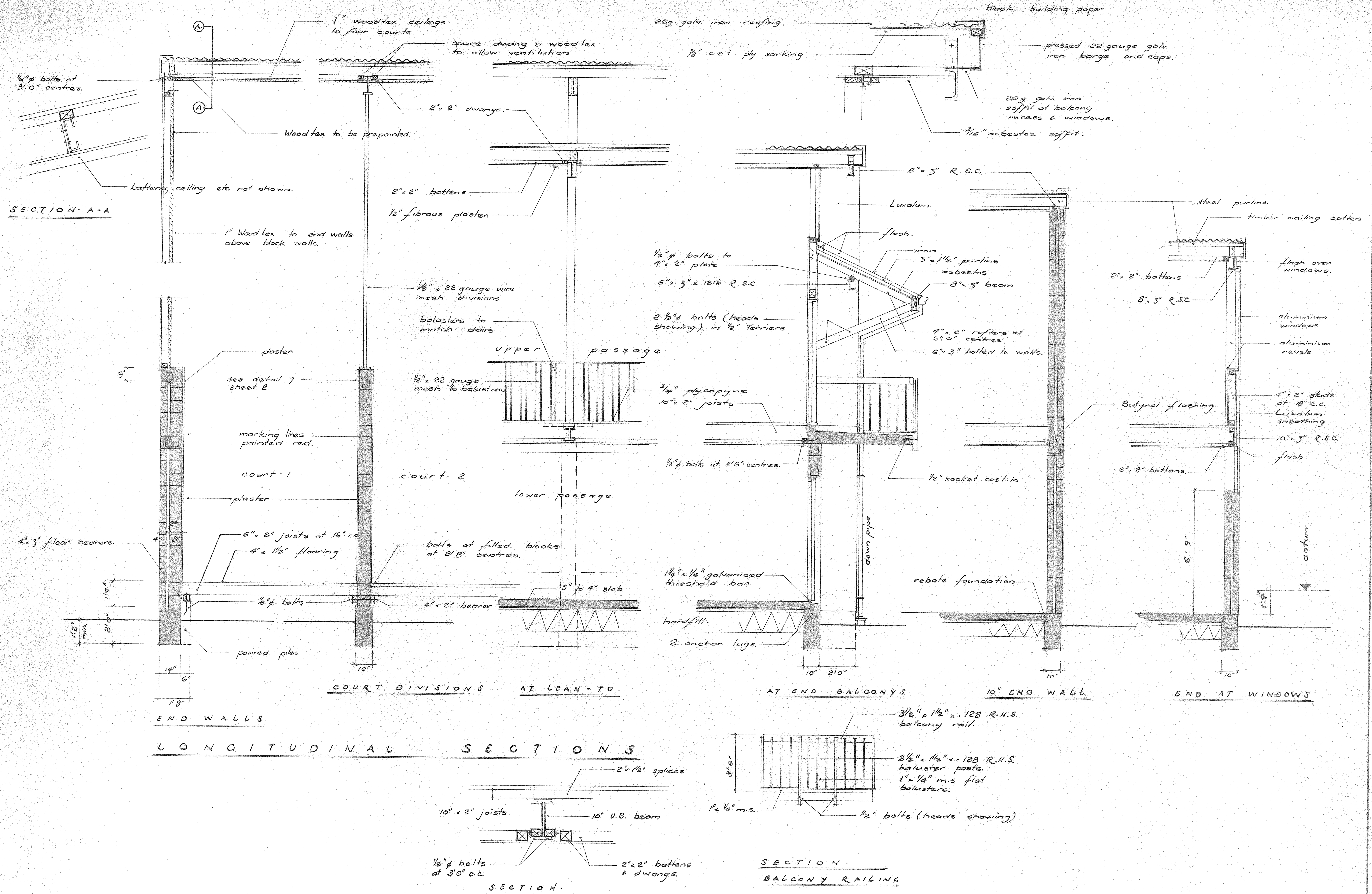
. SQUASH COURTS FOR THE PAPARUA COUNTY COUNCIL

drawn by Lloyd Childs m.n.z.i.d. architectural draughtsman Christchurch

scales	¼", ½" & 1"
date	24. 10. 74
sheet	six of nine sheets

sheet 6 AMENDED

Contractors are to verify all measurements on site and general site conditions



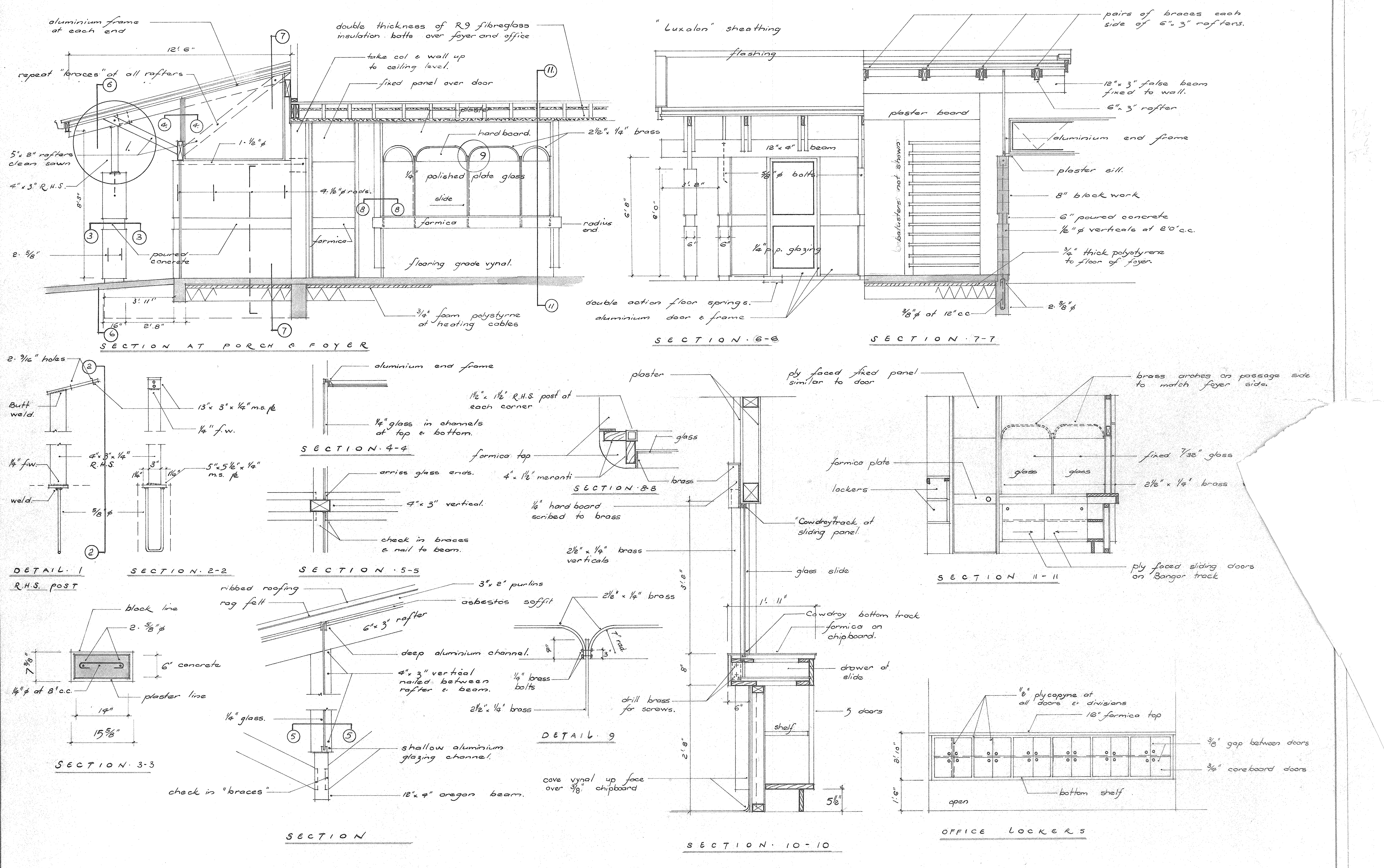
SQUASH COURTS FOR THE PAPARUA COUNTY COUNCIL

drawn by Lloyd Childs m.n.z.i.d. architectural draughtsman Christchurch

scales	⅜" = 1"
date	24 10 74
sheet	seven of nine sheets

sheet 7. AMENDED

Contractors are to verify all measurements on site and general site conditions



SQUASH COURTS FOR THE PAPARUA COUNTY COUNCIL

drawn by Lloyd Childs m.n.z.i.d. architectural draughtsman Christchurch

scales	3/8" & 1"
date	25. 10. 74
sheet	eight of nine sheets

sheet 8. AMENDED

P.C.C. 19566 19

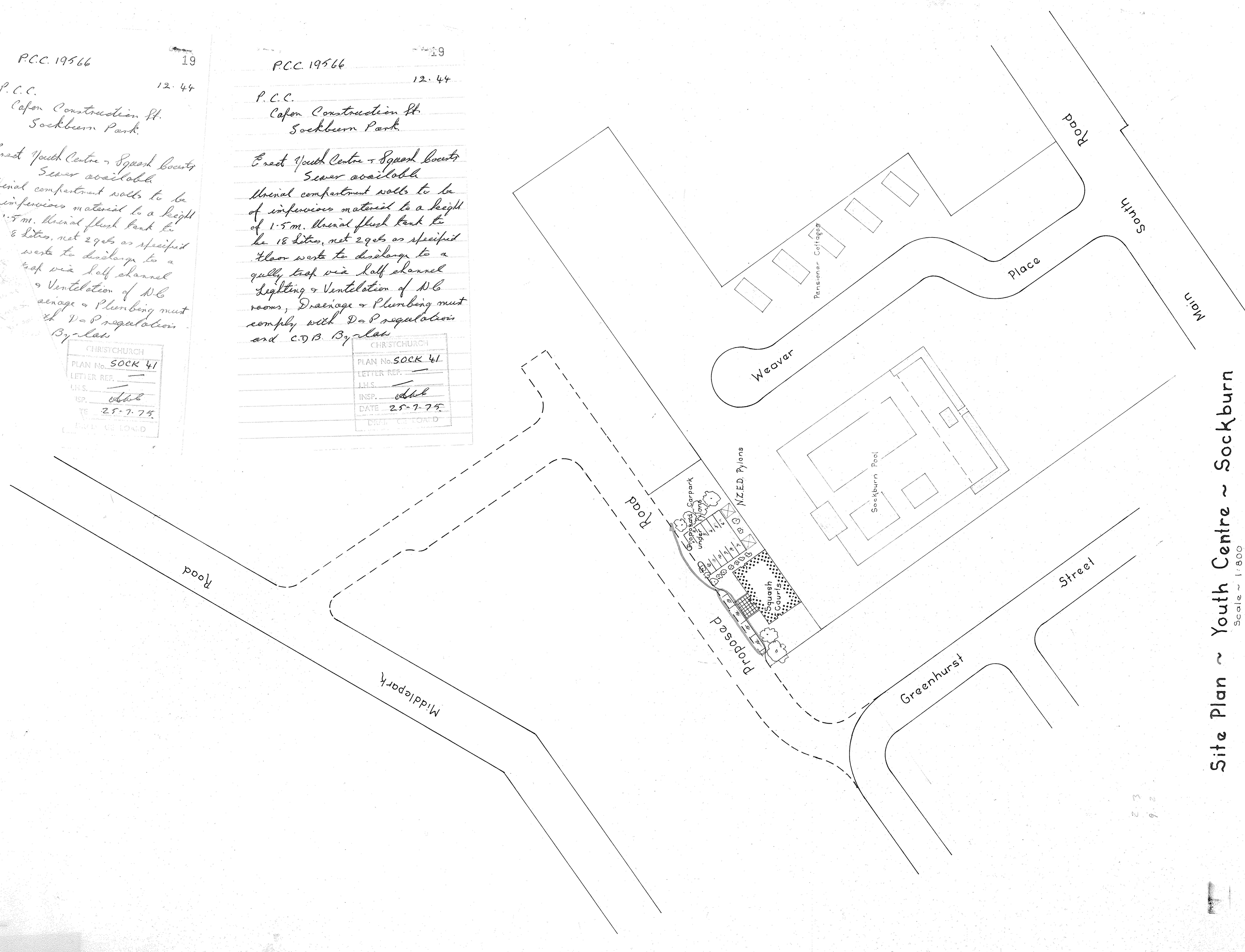
12. 44

P.C.C.
Cafon Construction Ltd.
Sockburn Park.

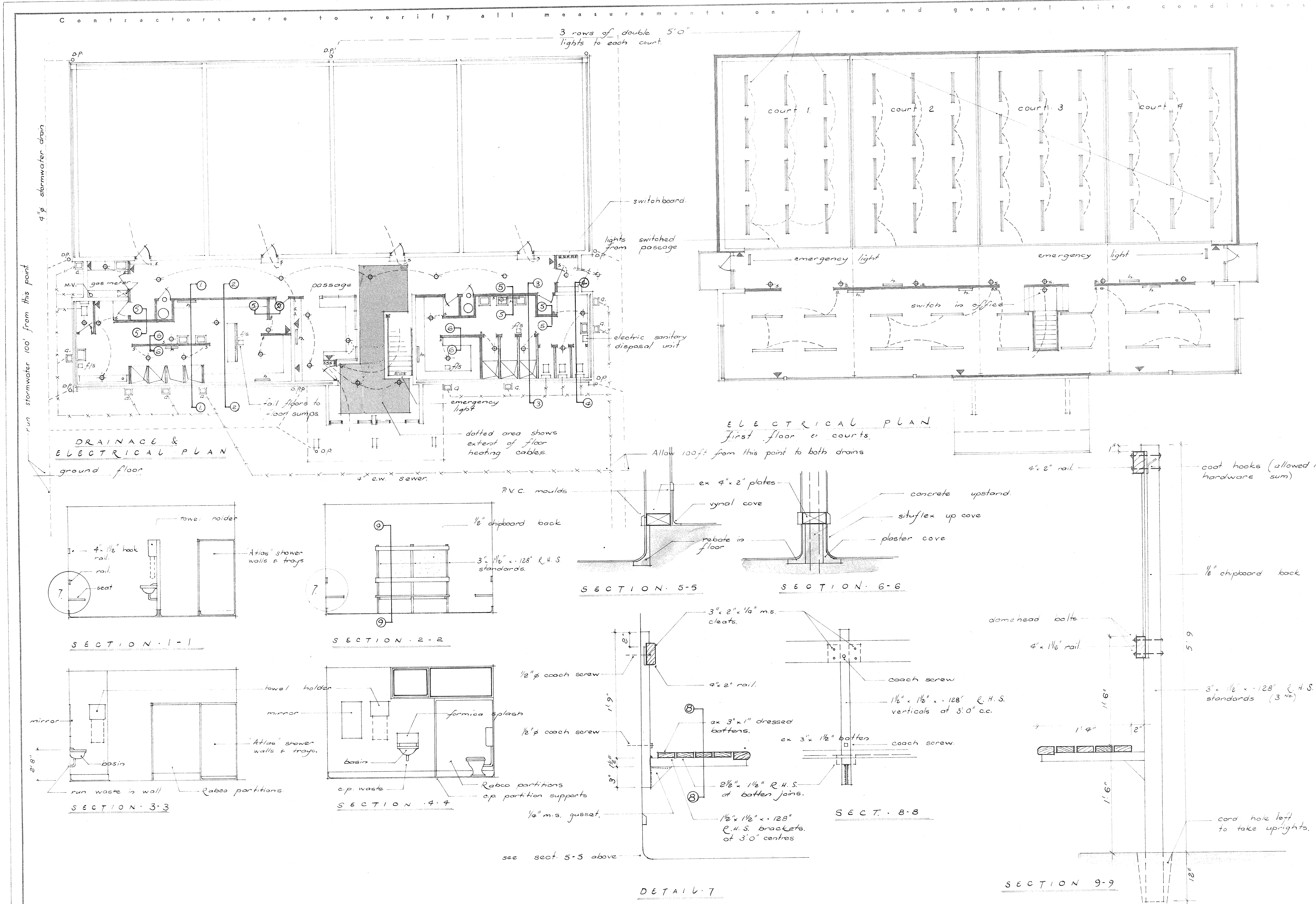
Erect Youth Centre & Squash Courts
Sewer available
Urinal compartment walls to be of impervious material to a height of 1.5m. Urinal flush tank to be 18 litres, net 2 gals as specified. Floor waste to discharge to a gully trap via half channel. Lighting & Ventilation of W.C rooms; Drainage & Plumbing must comply with D.o.P regulations and C.D.B. By-laws

CHRISTCHURCH
PLAN No. SOCK 41
LETTER REF. —
I.H.S. —
INSP. [illegible]
DATE 25-7-75

P.C.C. 19566 19
12. 44
P.C.C.
Cafon Construction Ltd.
Sockburn Park.
Erect Youth Centre & Squash Courts
Sewer available
Urinal compartment walls to be impervious material to a height 1.5m. Urinal flush tank to 8 litres, net 2 gals as specified waste to discharge to a trap via half channel & Ventilation of W.C. ainage & Plumbing must th D.o.P regulations By-laws
CHRISTCHURCH
PLAN No. SOCK 41
LETTER REF. —
I.H.S. —
INSP. [illegible]
25-7-75



Site Plan ~ Youth Centre ~ Sockburn
Scale ~ 1:800



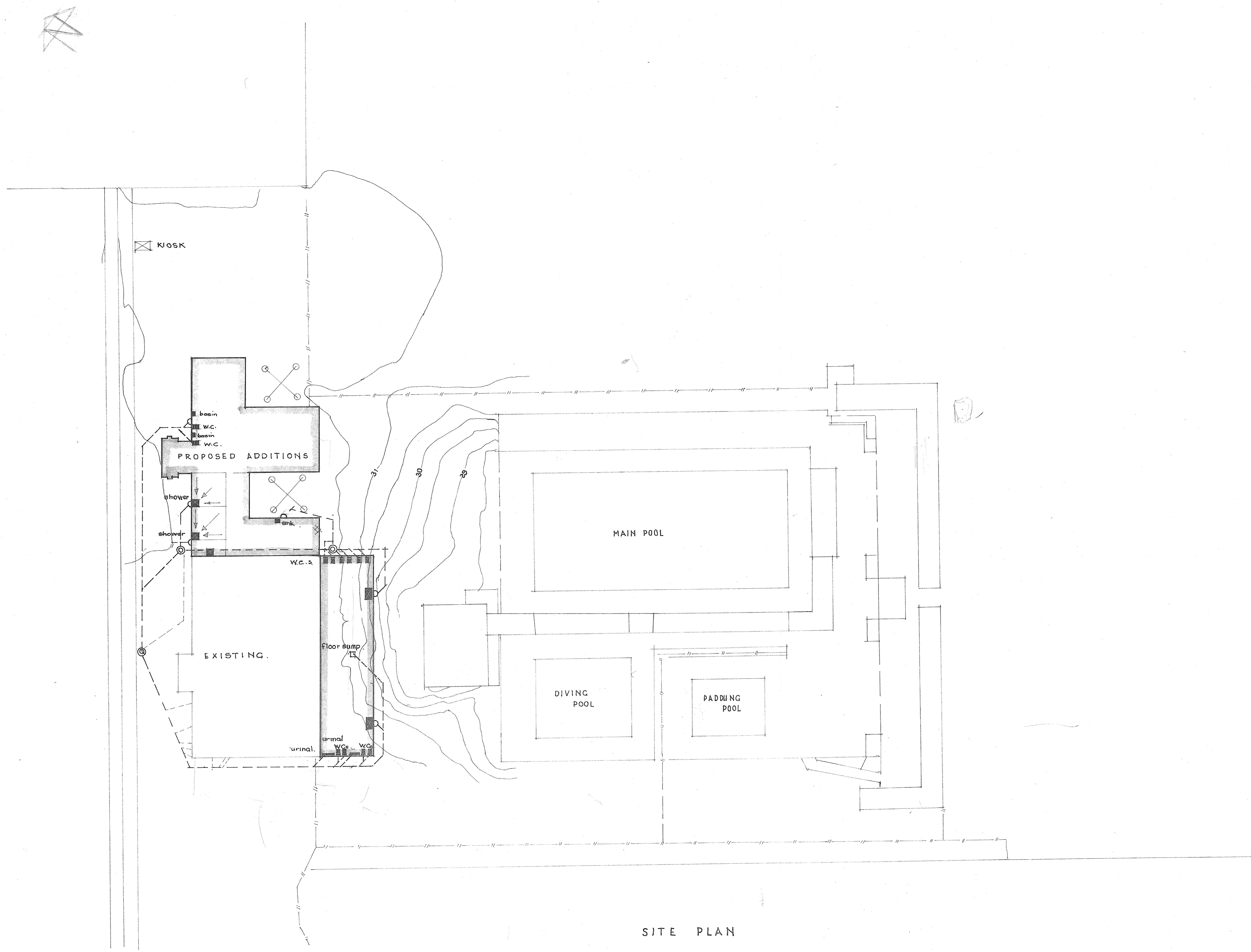
SQUASH COURTS FOR THE PAPARUA COUNTY COUNCIL

drawn by Lloyd Childs m.n.z.i.d. architectural draughtsman Christchurch

scales	⅛", ¼", & 1½"
date	21. 10. 74
sheet	nine of nine sheets

sheet 9 AMENDED

contractors to verify all dimensions on site before commencing any work or making any shop drawings



SITE PLAN

ARCH GOODWIN DESIGN LTD
132 tuam street christchurch
phone 792-494 p.o. box 4299

PROPOSED ADDITIONS & ALTERATIONS SQUASH COURT BUILDING
SOCKBURN PARK for PAPARUA COUNTY COUNCIL

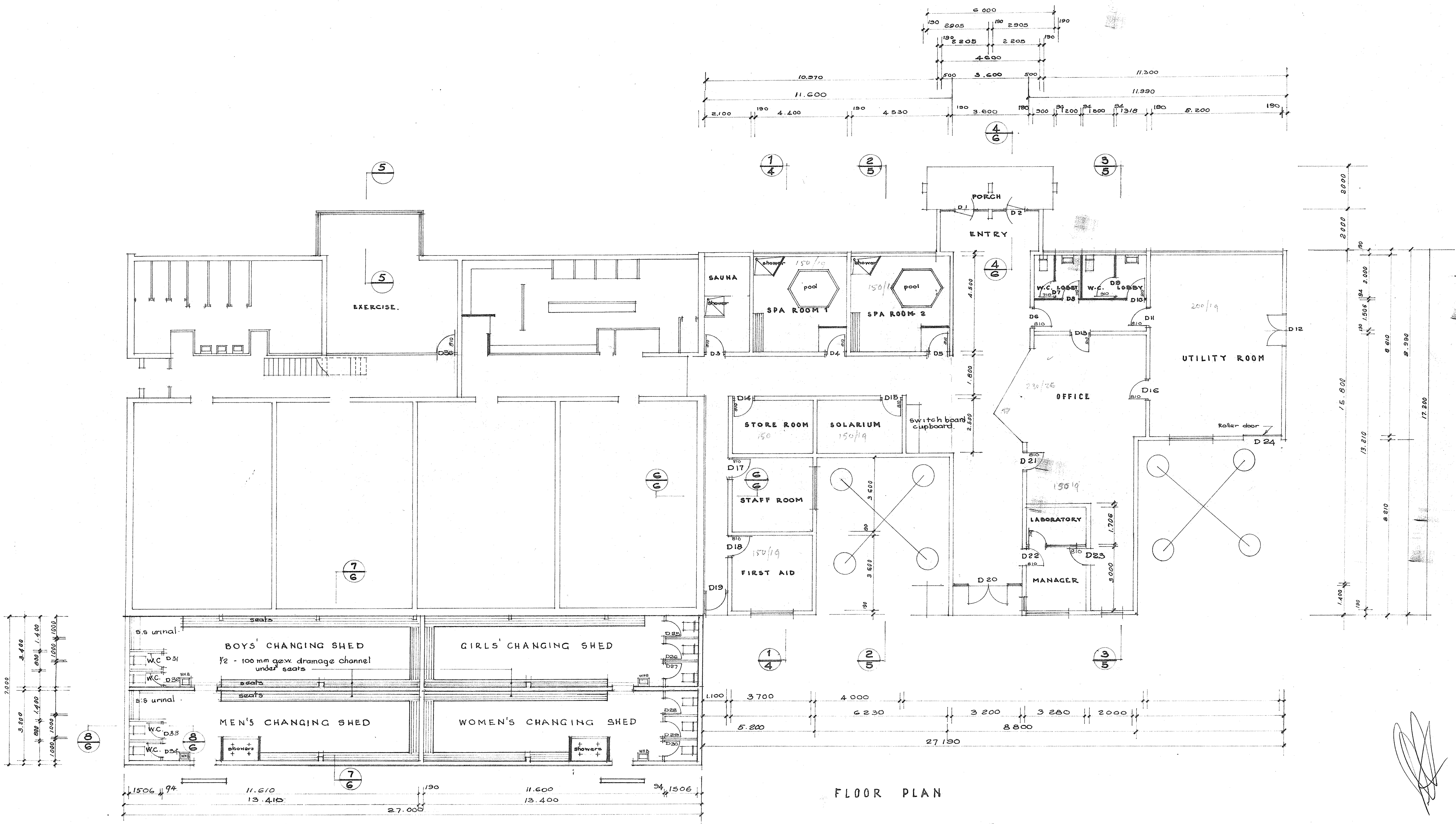
dr: ag
tr: ag
ck: ag

scales: 1 : 250
date: 18. 4. 85

85/32

A1

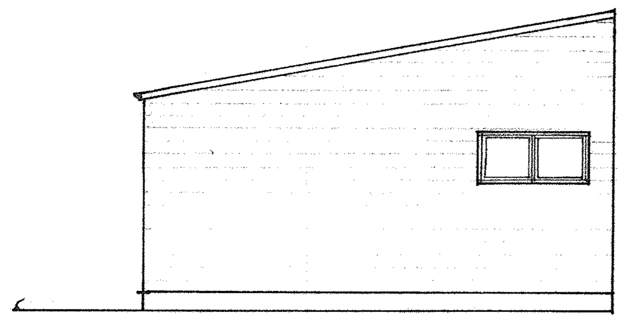
contractors to verify all dimensions on site before commencing any work or making any shop drawings



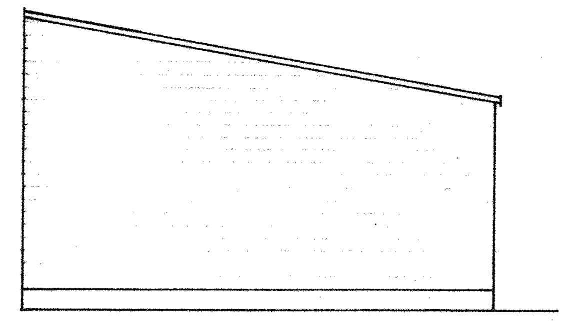
FLOOR PLAN

ARCH GOODWIN DESIGN LTD 132 tuam street christchurch phone 792-494 p.o. box 4299	PROPOSED ADDITIONS & ALTERATIONS SQUASH COURT BUILDING SOCKBURN PARK for PAPARUA COUNTY COUNCIL	dr: ag tr: ag ck: ag	scales: 1:100 date: 18.4.85	85/32	A2

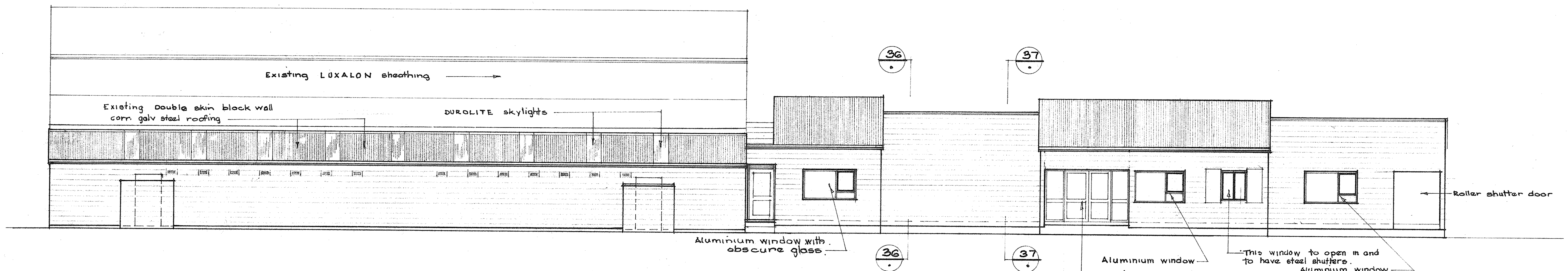
contractors to verify all dimensions on site before commencing any work or making any shop drawings



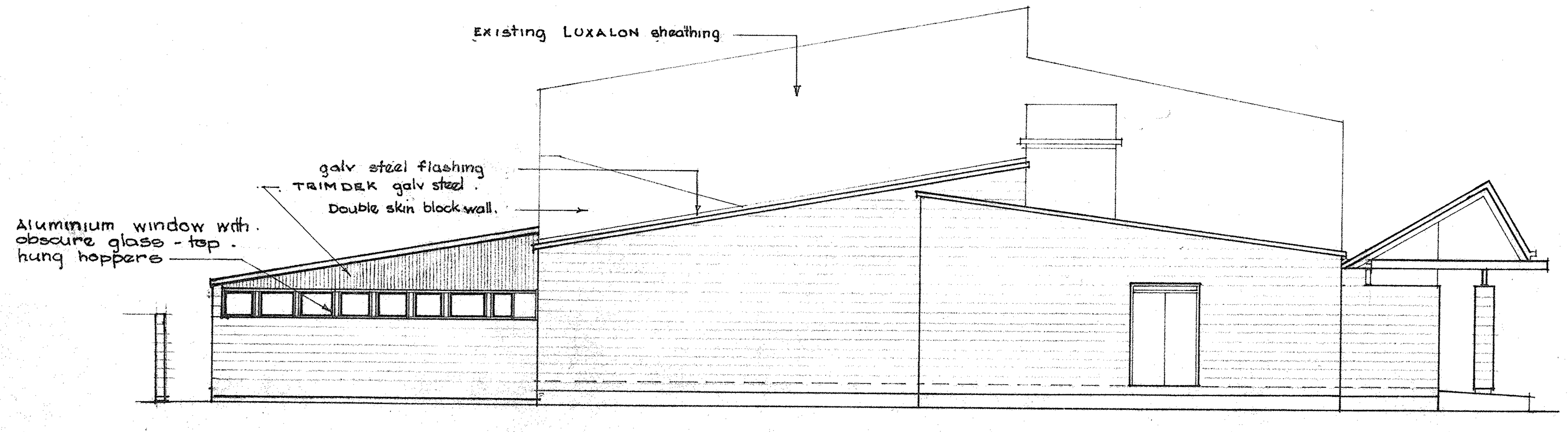
ELEVATION 36



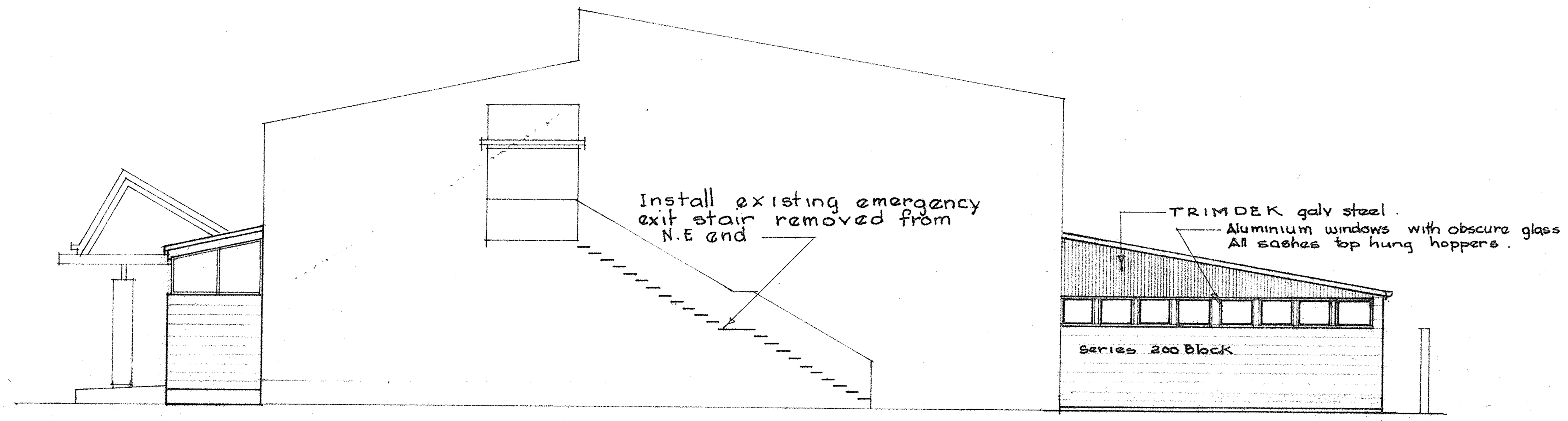
ELEVATION 37



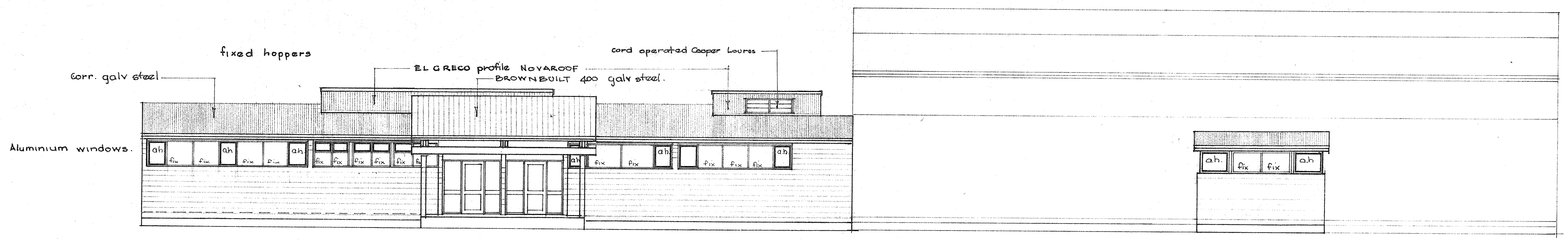
SOUTH EAST ELEVATION



NORTH EAST ELEVATION



SOUTH WEST ELEVATION



NORTH WEST ELEVATION

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132 tuam street christchurch
phone 792-494 p.o. box 4299

PROPOSED ADDITIONS & ALTERATIONS SQUASH COURT BUILDING
SOCKBURN PARK for PAPARUA COUNTY COUNCIL

dr: ag
tr: ag
ck: ag

scales: 1:100
date: 18.4.85

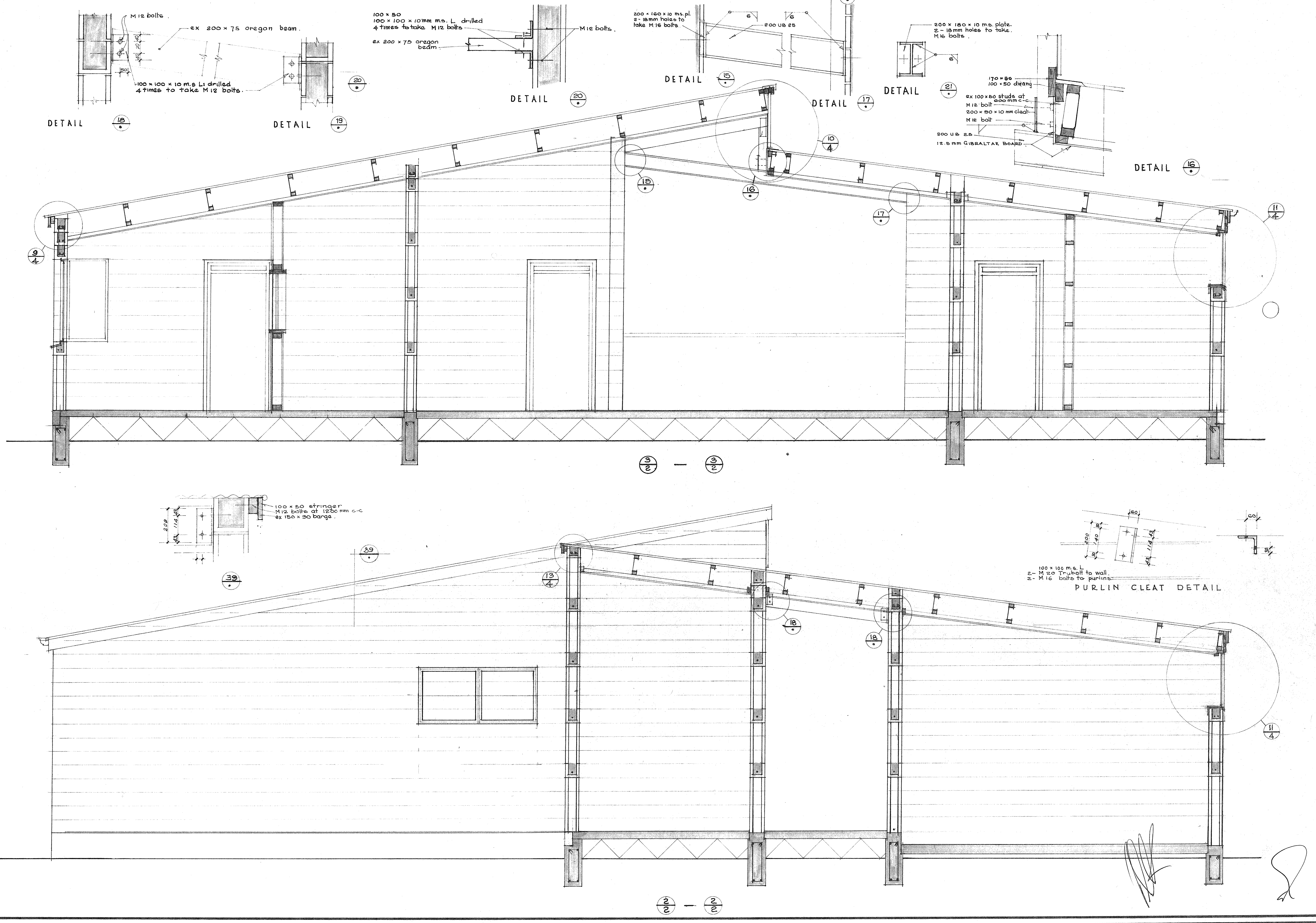
85/32

A3

contractors to verify all dimensions on site before commencing any work or making any shop drawings

AG ARCH GOODWIN DESIGN LTD 132 tuam street christchurch phone 792-494 p.o. box 4299	PROPOSED ADDITIONS & ALTERATIONS SQUASH COURT BUILDING SOCKBURN PARK for PAPARUA COUNTY COUNCIL	dr: ag tr: ag ck: ag	scales: 1:25 1:10 date:	85/32	A4

contractors to verify all dimensions on site before commencing any work or making any shop drawings



ARCH GOODWIN DESIGN LTD 132 tuam street christchurch phone 792-494 p.o. box 4299	PROPOSED ADDITIONS & ALTERATIONS SQUASH COURT BUILDING SOCKBURN PARK for PAPARUA COUNTY COUNCIL	dr: ag tr: ag ck: ag	scales: 1:25 1:10 date: 18. 4. 85	85/32	A5

contractors to verify all dimensions on site before commencing any work or making any shop drawings

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PROPOSED ADDITIONS & ALTERATIONS SQUASH COURT BUILDING
SOCKBURN PARK for PAPARUA COUNTY COUNCIL

dr: ag tr: ag ck: ag	scales: 1:25 1:10 1:5 date: 18.4.85	85/32	A6

contractors to verify all dimensions on site before commencing any work or making any shop drawings

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PROPOSED ADDITIONS & ALTERATIONS SQUASH COURT BUILDING
SOCKBURN PARK for PAPARUA COUNTY COUNCIL

dr:ag tr:ag ck:ag	scales: 1:50 1:100 date: 18.4.85	85/32	A7

contractors to verify all dimensions on site before commencing any work or making any shop drawings

ARCH GOODWIN DESIGN LTD 132 tuam street christchurch phone 792-494 p.o. box 4299	PROPOSED ADDITIONS & ALTERATIONS SQUASH COURT BUILDING SOCKBURN PARK for PAPARUA COUNTY COUNCIL	dr: ag tr: ag ck: ag	scales: 1:50 1:10 date: 18.4.85	85/32	A8

contractors to verify all dimensions on site before commencing any work or making any shop drawings

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132 tuam street christchurch
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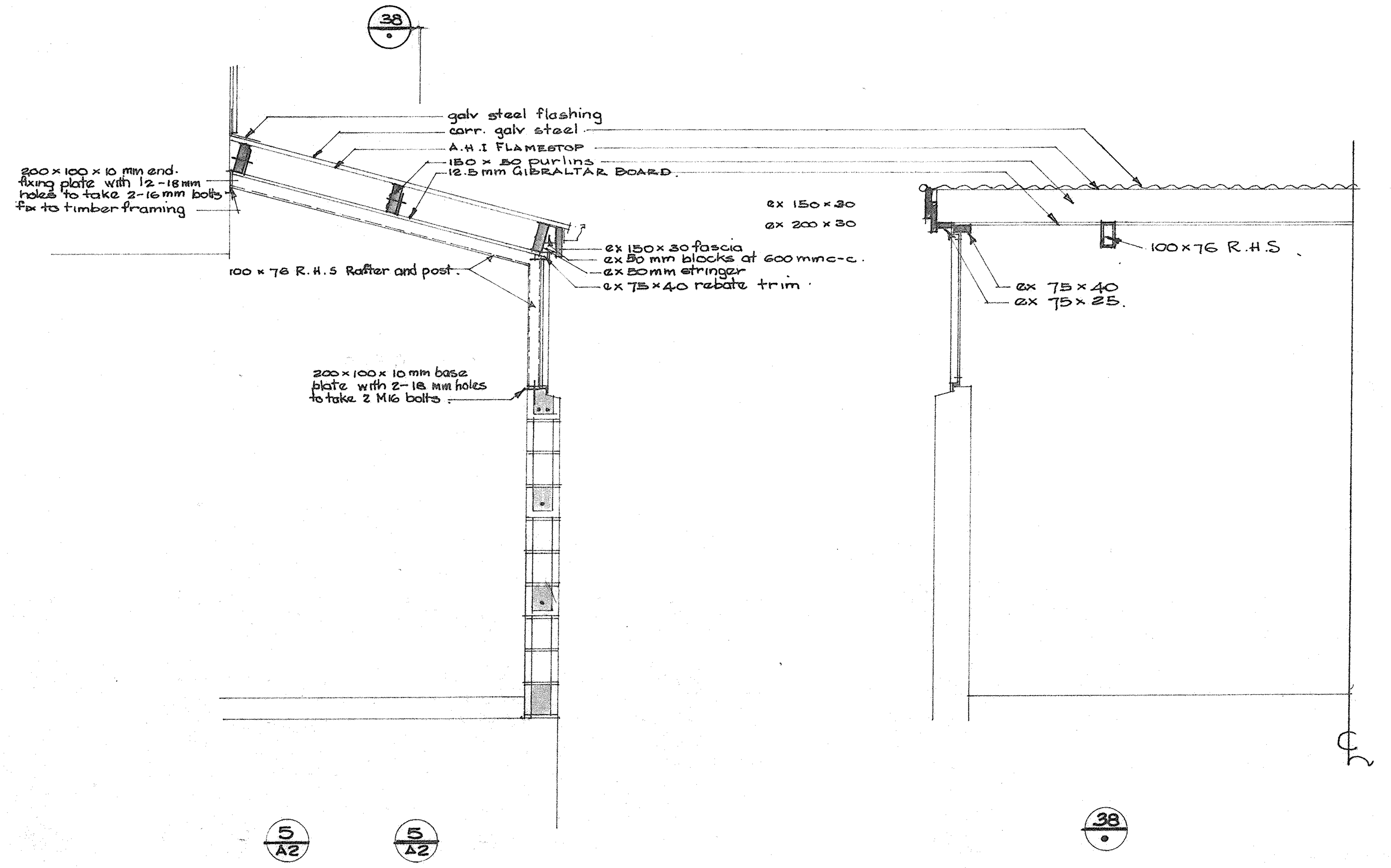
PROPOSED ADDITIONS & ALTERATIONS SQUASH COURT BUILDING
SOCKBURN PARK for PAPARUA COUNTY COUNCIL

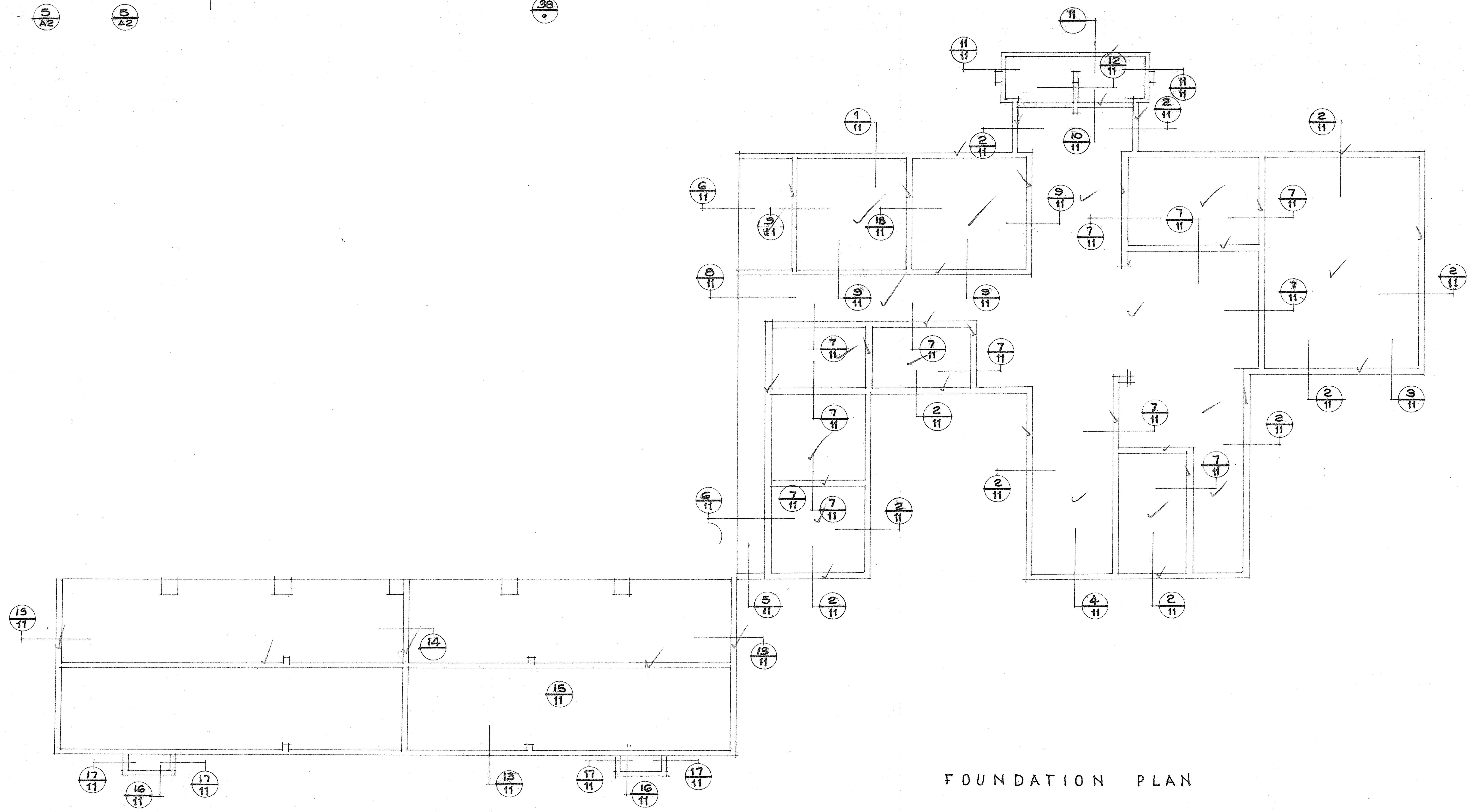
dr: ag
tr: ag
ck: ag

scales: 1:50 1:20 1:10
date: 18. 4. 85

85/32

A9





FOUNDATION PLAN

ARCH GOODWIN DESIGN LTD 132 tuam street christchurch phone 792-494 p.o. box 4299	PROPOSED ADDITIONS & ALTERATIONS SQUASH COURT BUILDING SOCKBURN PARK for PAPARUA COUNTY COUNCIL	dr: ag tr: ag ck: ag	scales: 1:100 1:50 date: 18.4.85	85/32	A10

contractors to verify all dimensions on site before commencing any work or making any shop drawings

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PROPOSED ADDITIONS & ALTERATIONS SQUASH COURT BUILDING
SOCKBURN PARK for PAPARUA COUNTY COUNCIL

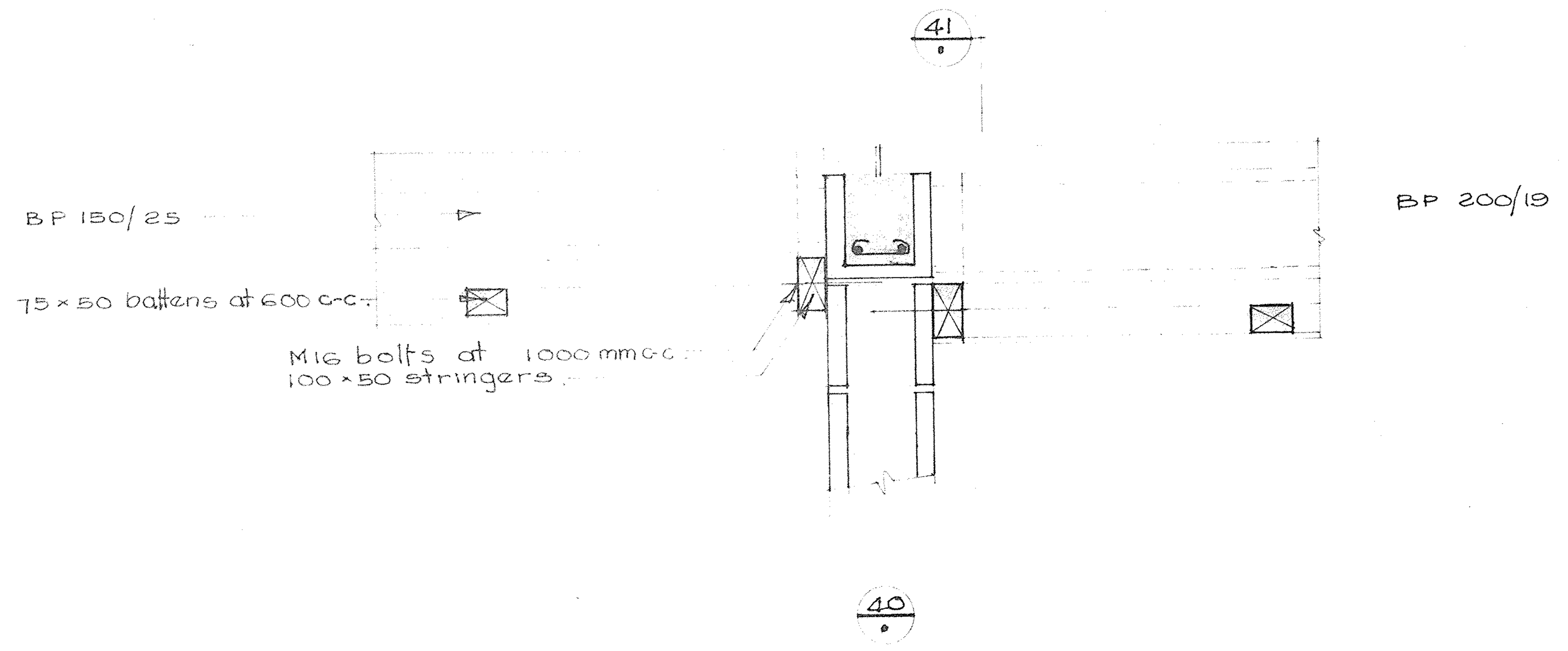
dr: ag
tr: ag
ck: ag

scales: 1:10
date: 18.4.85

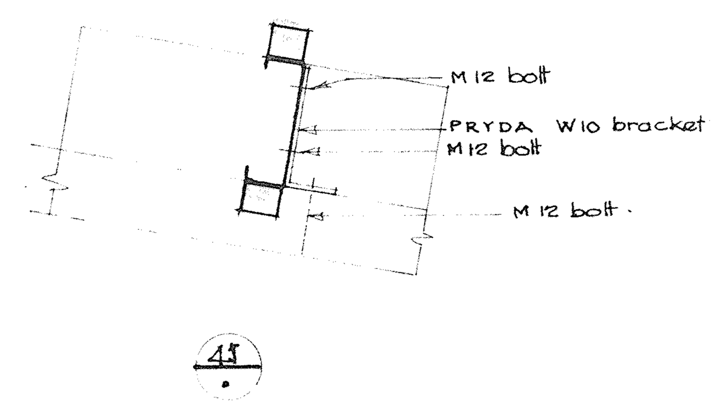
85/32

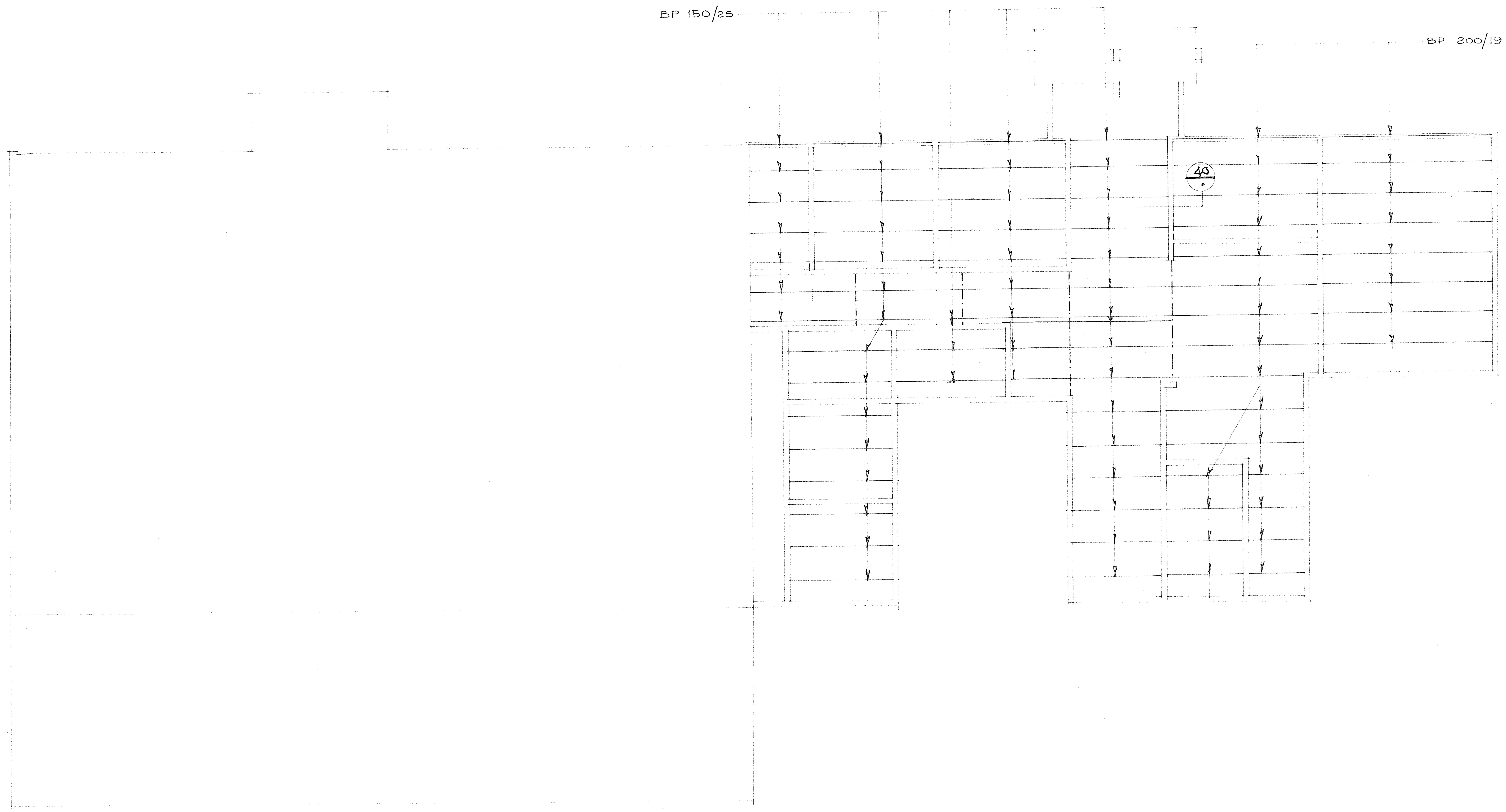
A11

contractors to verify all dimensions on site before commencing any work or making any shop drawings



ALTERNATIVE METHOD of FIXING PURLINS





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132 tuam street christchurch
phone 792-494 p.o. box 4299

PROPOSED ADDITIONS & ALTERATIONS SQUASH COURT BUILDING
SOCKBURN PARK for PAPARUA COUNTY COUNCIL

dr: ag tr: ag ck: ag	scales: 1:100 1:10 date: 18.4.85	85/32		A12

Appendix D

Basis of Design

1. Basis of Design

1.1 General

The basic assumptions, design codes and references, practice advisory, material strengths and properties, and loading data used in the analysis and design are presented below.

1.2 Codes, Standards and Design manual

New Zealand Standard

- NZS 1170.0:2002 Structural Design Actions Part 0: General Principles
- NZS 1170.1:2002 Structural Design Actions Part 1: Permanent, Imposed and Other Actions
- NZS 1170.5:2004 Structural Design Actions Part 5: Earthquake Actions – New Zealand and the NZBC Clause B1 Structure
- NZS 4230: 2004 Design of Reinforced Concrete Masonry Structures
- New Zealand Society of Earthquake Engineering Guidelines for Assessment and Improvement of the Structural Performance of Buildings in Earthquakes
- Assessment and Improvement of Unreinforced Masonry Buildings for Earthquake Performance
- NZS 3404: Part 1:1997 Steel Structures Standard
- Timber Design Guide by Andrew Buchanan, University of Canterbury, 3rd Edition 2007

1.3 Materials

The material strengths and properties used in the analysis of the existing structures are as follows:

1.3.1 Steel

- Portal frames, angles, flat bars 250 MPa
- Square Hollow Section (SHS and RHSS) 250 MPa

1.3.2 Concrete Compressive Strength

- Masonry (f'm): 15 MPa

1.3.3 Steel Reinforcement

- Yield Strength (fy) 300 MPa

1.4 Assessment Load Criteria

1.4.1 Basic Assessment Information:

Properties of the structure that will be used in the structural assessment are:

Height of building:

Squash Courts	8.23 m
Changing Shed	3.50 m
Administration building	5.00 m

Dimensions of the building:

Squash Courts	17.0m x 27.0m (see structural plan)
Changing Shed	7.0m x 27.0m (see floor plan – Drawing No. A2)
Administration building	17.20 x 27.19m (see floor plan – Drawing No. A2)
Site Location:	2-10 Takaro Avenue, Sockburn, Christchurch, New Zealand
Importance level:	2 (Office type)

1.4.2 Dead Loads

Dead load to be considered as specified in New Zealand Code (NZS 1170.1:2002)

The weights of various materials being considered in the assessment are as follows:

Floor Dead Load	
Timber floor	0.35 kN/m^2
Partition	0.5 kN/m^2
Steel sheet, flat galvanized	
Per millimetre thickness	0.08 kN/m^2
150mm thick masonry wall	1.76 kN/m^2
200mm thick masonry wall	2.56 kN/m^2
Unit weight of timbers @ 12% moisture content	0.60 kN/m^2
Unit weight of concrete	24 kN/m^3
Unit weight of steel	76.9 kN/m^3

1.4.3 Live Loads

Live loads to be considered as indicated in New Zealand Code (NZS 1170.1:2002)

Offices for general use	3.0 kN/m^2
Roof Live Load (maintenance and repair)	0.25 kN/m^2 or 1.80/A + 0.12

1.4.4 Snow Load

There is no snow load used in the analysis.

1.4.5 Wind Load

Wind loading is not considered in the analysis.

1.4.6 Seismic Load

Earthquake loads shall be calculated using New Zealand Code.

Site Classification	D
Seismic Zone factor (Z)	
(Table 3.3, NZS 1170.5:2004 and NZBC Clause B1 Structure)	0.30 (Christchurch)
Annual Probability of Exceedance	
(Table 3.3, NZS 1170.0:2002)	1/500 (ULS) Importance Level 2
Annual Probability of Exceedance	
(Table 3.3, NZS 1170.0:2002)	1/25 (SLS)
Return Period Factor (Ru)	
(Table 3.5, NZS 1170.5:2004)	1.0 (ULS)
Return Period Factor (Rs)	
(Table 3.5, NZS 1170.5:2004 and NZBC Clause B1 Structure)	0.33 (SLS)
Ductility Factor (μ)	1.25
Performance Factor (Sp)	0.925
Gravitational Constant (g)	9.81 m/sec^2
Liquefaction Potential	TBC by Geotechnical Engineer

1.4.7 Site Description

The site is located within Sockburn, a flat suburb in western Christchurch.

1.4.7.1 Ground Conditions

To be updated by Geotechnical Engineer.

1.4.7.2 Seismicity

Based from the Detailed Engineering Evaluation Qualitative Report, the site is approximately 14km from the nearest fault line, Greendale (2010) Fault.

1.4.8 Concrete Cover for Reinforcement

To be determined (if possible) from existing drawings.

1.4.9 Loading Cases and Combination

The load cases and load combinations considered are shown below:

Primary Load Cases

1. Permanent action (Dead Load) DL
2. Imposed action (Live Load) LL
3. Earthquake load EQ

Ultimate Limit State Combination (Strength)

1. 1.35DL
2. 1.20DL + 1.50LL
3. 1.20DL + 1.50 Ψl LL
4. DL + Ψc LL + EQx + 0.30EQy
5. DL + Ψc LL + EQx - 0.30EQy
6. DL + Ψc LL - EQx + 0.30EQy
7. DL + Ψc LL - EQx - 0.30EQy
8. DL + Ψc LL + EQy + 0.30EQx
9. DL + Ψc LL + EQy - 0.30EQx
10. DL + Ψc LL - EQy + 0.30EQx
11. DL + Ψc LL - EQy - 0.30EQx
12. DL + EQx + 0.3EQy
13. DL + EQx – 0.3EQy
14. DL – EQx + 0.3EQy
15. DL – EQx – 0.3EQy
16. DL + EQy + 0.3EQx
17. DL + EQy – 0.3EQx
18. DL – EQy + 0.3EQx
19. DL – EQy – 0.3EQx

Where: Short term factor (Ψs) = 0.70. Long term factor (Ψl) = 0.40

GHD

Level 11, Guardian Trust House
15 Willeston street, Wellington 6011
T: 64 4 472 0799   F: 64 4 472 0833   E: wgtnmail@ghd.com

Document Status

Rev No.	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
FINAL – 11/4/13	Dioselo Cagandahan	Stephen Lee		Nick Waddingtom		11/4/13