City Care Milton Street Depot – Vehicle Garage / Bitumen Sprayer
Detailed Engineering Evaluation
PRO_1141_010 EQ2
Quantitative Report

Prepared for (Client)

By Beca Carter Hollings & Ferner Ltd (Beca)

26 September 2013

Revision History

Revision Nº	Prepared By	Description	Date
A	Andrew Franklin	Draft for CCC review	10 September 2013
B	Andrew Franklin	Final	26 September 2013

Document Acceptance

Action	Name	Signed	Date
Prepared by	Andrew Franklin		26 September 2013
Reviewed by	Jonathan Barnett		26 September 2013
Approved by	David Whittaker		26 September 2013
on behalf of	Beca Carter Hollings & Ferner Ltd		

City Care Milton Street Depot Vehicle Garage/Bitumen Sprayer PRO_1141_010 EQ2

Detailed Engineering Evaluation Quantitative Report – SUMMARY
Version 1

Address
245 Milton Street
Sydenham
Christchurch

Background

This is a summary of the Quantitative Assessment report for the building structure, and is based on the document 'Guidance on Detailed Engineering Evaluation of Earthquake Affected Non-residential Buildings in Canterbury – Part 2 Evaluation Procedure' (draft) Revision 7 issued by the Engineering Advisory Group (EAG) in 2012.

A Qualitative Report for Vehicle Garage/Bitumen Sprayer was issued to CCC on 18 September 2012.

The Vehicle Garage/Bitumen Sprayer building is located at the City Care Milton St Depot at 245 Milton Street, Sydenham, Christchurch. It has been assumed to be built between 1976 and 1992, having an approximate internal plan area of 140 m^2. No drawings were made available. Calculations have been undertaken as part of the Quantitative Assessment.

The Vehicle Garage/Bitumen Sprayer is a single storey building, constructed of steel portal frames and precast concrete tilt panel shear walls. The precast walls are located along the eastern side as well as part of the north and south end walls. The western side of the building is open, with the roof and the timber framed part of the two end walls clad with lightweight metal sheeting. Roof strap bracing is present along the timber purlins. The floor is asphaltic concrete, with pad foundations underneath the western steel portal frame columns and post footings under the remaining columns. Strip foundations support the northern and southern end wall precast concrete panels.

The format and content of this report follows a template provided by CCC, which is based on the EAG document.

Key Damage Observed

Visual inspections on 20 July 2012 indicate the building has suffered minor damage. The key damage observed includes:

- Minor diagonal cracks on east precast tilt panels.
- Minor movement between the concrete encased steel columns and the precast concrete tilt panels.

Critical Structural Weaknesses (CSW)

No Critical Structural Weaknesses have been identified.

Indicative Building Strength (from Detailed Assessment)

The building has been assessed to have a seismic capacity in the order of 37*%NBS* using the New Zealand Society for Earthquake Engineering (NZSEE) Detailed Assessment guideline 'Assessment and Improvement of the Structural Performance of Buildings in Earthquakes' (AISPBE), 2006, and is therefore Earthquake Risk and classified as Seismic Grade C.

The structural damage observed is minor and the seismic capacity is not considered to have materially diminished from its pre-earthquake level.

Our assessment has identified the structural components that have governed/limited the building's seismic performance, and their potential failure mechanisms, are as follows:

- End Wall Foundations (transverse), 37*%NBS*, governed by bearing pressure of end walls.

Recommendations

In order that the owner can make an informed decision about the on-going use and occupancy of their building the following information is presented in line with the Department of Building and Housing document 'Guidance for engineers assessing the seismic performance of non-residential and multi-unit residential buildings in greater Christchurch', June 2012.

The building is considered to be Earthquake Risk, having an assessed capacity of between 34% and 67*%NBS*. The risk of collapse of an Earthquake Risk building is considered to be 5 to 10 times greater than that of an equivalent new building.

No significant damage or hazards were identified to the seismic or gravity load resisting system that would reduce its ability to resist further loads and therefore no restrictions on use or occupancy are recommended.

It is recommended that:

- A full damage assessment is carried out for insurance purposes, in particular, we recommended that the steel roof bracing connections be inspected for damage.
- A verticality and level survey could be carried out to determine the extent of settlement of the building for insurance purposes.
- According to the recent CCC Instructions to Engineers document (16 October 2012), Council's insurance provides for repairing damaged elements to a condition substantially as new. We suggest you consult further with your insurance advisor.

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Appendices

1 Background

Beca Carter Hollings & Ferner Ltd (Beca) has been engaged by Christchurch City Council (CCC) to undertake a Quantitative Detailed Engineering Evaluation (DEE) of the Vehicle Garage/Bitumen Sprayer building located at 245 Milton Street, Sydenham, Christchurch.

This report is a Quantitative Assessment of the building structure, and is based on the document 'Guidance on Detailed Engineering Evaluation of Earthquake Affected Non-residential Buildings in Canterbury – Part 2 Evaluation Procedure' (draft) Revision 7 issued by the Engineering Advisory Group (EAG) in 2012.

A quantitative assessment involves analytical calculations of the building's strength and may involve material testing, geotechnical testing and intrusive investigation. The qualitative assessment previously carried out involved inspections of the building, a desktop review of existing structural and geotechnical information, including existing drawings and calculations if available, and an assessment of the level of seismic capacity against current code using the Initial Evaluation Procedure (IEP).

The purpose of these assessments is to determine the likely building performance and damage patterns, to identify any potential Critical Structural Weaknesses (CSW) or collapse hazards, and to make an assessment of the likely building strength in terms of percentage of New Building Standard (*%NBS*).

The building description below is based on our visual inspections, site measurements and intrusive investigations only, as drawings were not available.

The format and content of this report follows a template provided by CCC, which is based on the EAG document.

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 understood that CERA is adopting the Detailed Engineering Evaluation Procedure document (draft) Revision 7 issued by the Engineering Advisory Group in 2012, which sets out a methodology for both qualitative and quantitative assessments. We understand this report will be used in response to CERA Section 51.

The qualitative assessment includes a thorough visual inspection of the building coupled with a desktop review of available documentation such as drawings, specifications and IEP's. The quantitative assessment involves analytical calculation of the building's 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 that was assigned during the state of emergency following the 22 February 2011 earthquake
- 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*.

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.

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 34% 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.

It is understood that any building with a capacity of less than 34*%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 New Zealand Building Code (NZBC) 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.

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.

3 Earthquake Resistance Standards

For this assessment, the building's Ultimate Limit State 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).

No consideration has been given at this stage to checking the level of compliance against the increased Serviceability Limit State requirements.

The likely ultimate 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 building's 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 3.1 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 3.1: NZSEE Risk Classifications Extracted from Table 2.2 of the NZSEE 2006 AISPBE Guidelines

Table 3.1 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. on average 0.2% in any year). It is noted that the current seismic risk in Christchurch results in a 6% risk of exceedance in the next year.

Table 3.1: *%NBS* Compared to Relative Risk of Failure

Building Grade	Percentage of New Building Standard (*%NBS*)	Approx. Risk Relative to a New Building
A+	>100	<1
A	80-100	1-2 times
B	67-80	2-5 times
C	33-67	5-10 times
D	20-33	10-25 times
E	<20	>25 times

4 Building Description

4.1 General

Summary information about the building is given in the following table.

Table 4.1: Building Summary Information

Item	Details	Comment
Building name	Vehicle Garage/Bitumen Sprayer at City Care Milton St Depot	
Street Address	245 Milton Street, Sydenham, Christchurch	
Age	Assumed to have been designed and constructed between 1976 and 1992	No information available, inferred by construction type and condition of structure
Description	Steel portal frames with concrete shear walls along the rear as well as part of the end walls where the remainder is timber framed. The roof has lightweight metal cladding supported by timber purlins.	
Building Footprint / Floor Area	18 m x 8 m / 140 m^2	
No. of storeys / basements	Single storey, no basement	
Occupancy / use	Used for vehicle garage	Importance Level 2
Construction	Steel portal frames, timber end walls and precast concrete wall panels. Concrete encased columns to the east elevation.	
Gravity load resisting system	Gravity loads from the roof are resisted by the timber purlins which are supported by the steel portal frames and timber framed end walls.	From visual inspection only. No drawings available.
Seismic load resisting system	Lateral loads in the transverse direction are resisted by intermediate portal frames and	From visual inspection only. No drawings available.

Item	Details	Comment
	the two short end precast concrete shear walls. In the longitudinal direction the rear precast concrete shear wall resists lateral loads. Roof strap bracing transfers the lateral loads from the roof to the frames and concrete walls.	
Foundation system	Pad foundations under steel columns on western side and concrete post foundations under the steel columns on the eastern side. It is assumed that the remaining columns also have concrete post foundations. The short precast wall panel at the northern end has a deep concrete strip footing, which is also assumed for the southern precast wall panel. The ground floor is asphaltic concrete.	From visual inspection and intrusive investigations only. No drawings available.
Stair system	No stairs	
Other notable features	The Vehicle Garage/Bitumen Sprayer is open along the front face. There is a monorail spanning between the rear concrete wall and a steel frame.	The beam has an end plate bolted at the rear concrete wall and bolted to a cleat plate on the underside of the steel frame beam.
External works	N/A	
Construction information	No drawings available	
Likely design standard	NZS4203:1976	Inferred from estimated age of building.
Heritage status	Not heritage listed	
Other	None	

4.2 Structural 'Hot-spots'

Areas in which damage may be expected to occur from earthquake shaking are outlined below:

- Connections between the precast panels and portal frames.
- Connections between the roof bracing and walls and purlins.
- Cracking between the corner concrete column and precast panels.
- Roof bracing.

5 Site Investigations

5.1 Previous Assessments

A Level 2 rapid assessment of the Vehicle Garage / Bitumen Sprayer was undertaken following the June 2011 earthquake, however no damage was reported at this time (refer to Appendix D). It is understood that Opus International Consultants undertook the rapid assessments of the buildings on the Milton St Depot site.

Visual inspections as part of the Level 4 damage assessment were undertaken on 20 July 2012. A Qualitative Report was issued to CCC on 18 September 2012.

5.2 Level 5 Intrusive Investigations

The following intrusive investigations were carried out by CityCare between March and August 2013 as part of the Level 5 quantitative assessment:

- General site measurements and obtaining member setouts and sizes.
- A Ferroscan was completed on the concrete wall panels and concrete encasement.
- Excavation of footings under one portal frame column on the western side of the building.
- Drilling of foundations at the north eastern and south western corners of the building, and beneath one portal frame column on the eastern side of the building.

Refer to Section 10.2 and Appendix C for the results of the intrusive investigations.

6 Damage Assessment

6.1 Damage Summary

The table below provides a summary of damage observed during our Level 4 inspection in July 2012. Refer to Appendix A for photographs.

Table 6.1: Damage Summary

Damage type	Unknown	Minor	Moderate	Major	Comment
settlement of foundations	ü				None observed during visual inspection. Level survey may be required to confirm.
tilt of building	ü				None observed during visual inspection. Verticality survey may be required to confirm.
liquefaction	ü				None observed during visual inspection. Contacts on site stated it had occurred in areas throughout the site. The aerial reconnaissance on 24 Feb 2011 indicates the extent was minor.
settlement of external ground	ü				None observed during visual inspection.
lateral spread / ground cracks	ü				None observed during visual inspection.
frame					No damage observed during visual

Damage type	Unknown	Minor	Moderate	Major	Comment
					inspection.
concrete walls		ü			Minor movement was observed between the concrete rear shear walls and the concrete corner columns. Minor diagonal cracking was observed to the precast concrete wall panels.
cracking to concrete floors					No damage observed during visual inspection.
bracing					No damage observed during visual inspection.
cladding /envelope					No damage observed during visual inspection.
building services	ü				No inspection of services was carried out.
other					

6.2 Surrounding Buildings

The Vehicle Garage/Bitumen Sprayer is adjacent to a row of shops. The eastern concrete wall is parallel to the shop's western block wall and is of similar height to the building (see Photo 2 in Appendix A). The separation between the walls is in the order of 200 mm. From the amount of wall that was able to be viewed during the visual inspection of the Vehicle Garage/Bitumen Sprayer, it does not appear to currently be a hazard to this building.

A plant room of concrete construction and approximately 2.5 m high is adjacent to the southern wall of the Vehicle Garage/Bitumen Sprayer. The separation between the buildings is in the order of 300 mm.

Neither of these buildings is likely to affect the Vehicle Garage/Bitumen Sprayer structure during an earthquake.

6.3 Residual Displacements and General Observations

No evidence of permanent settlement or displacements was observed during our visual inspection, however a global settlement survey may reveal movement that could be described as damage under insurance entitlement.

6.4 Implication of Damage

Based on our limited visual inspection, the structure appears to have only suffered minor damage and therefore we believe the structural capacity has not materially diminished.

7 Generic Issues

The following generic issues referred to in Appendix A of the EAG guideline document have been identified as applicable to the Vehicle Garage/Bitumen Sprayer building:

Single level tilt panel

- Brittle panel connections and cracked panels at the connections.
- Steel bracing connections inadequate.
- Hard-drawn wire mesh reinforcement or inadequate reinforcement contents making panels prone to non-ductile face loading failure.

However, only minor earthquake damage has been observed.

8 Geotechnical Consideration

A geotechnical investigation was carried out by Geoconsult in September 2012, and a report supplied May 2013, in relation in to Temporary Offices at the north western corner of the site. The Vehicle Garage / Bitumen Sprayer is located approximately 200 m from the site of the geotechnical investigation and hence was considered to be of limited use.

During the inspection, no damage to the surrounding ground was noted however liquefaction is known to have occurred in February 2011. The potential for ground conditions having an effect on the structural performance of the building is not considered to be significant.

9 Survey

No level or verticality surveys were carried out as there was no evidence of settlement or displacement observed during the inspection. CCC may wish to undertake a level survey as part of insurance entitlement considerations to determine if the building has suffered any settlement.

10 Detailed Seismic Capacity Assessment

10.1 Assessment Methodology

The building has had its seismic capacity assessed using the Detailed Assessment Procedures in the NZSEE 2006 AISPBE guidelines, based on the site measurements and intrusive investigations undertaken.

The structure has suffered minor damage. The post-damage capacity is considered to be the same as the original capacity.

10.2 Assumptions

The following assumptions were used in our quantitative assessment:

- Structural steel yield strength, fy = 300 MPa
- Steel plate yield strength, fy = 250 MPa
- Reinforcing steel yield strength, fy = 485 MPa (for mesh reinforcing)
- Concrete compressive strength, f'c = 25 MPa
- Timber compressive strength, fc = 20.9 MPa (Radiata Pine assumed)
- Soil ultimate bearing capacity assuming 'good ground' as per NZS 3604 of 240 kPa (includes Φ = 0.8 for Ultimate Limit State earthquake case).
- Soil internal friction angle of 30^{o}.
- Depth of post footing under eastern portal frame columns of 1300 mm

- Roof cross bracing dimensions of 53 mm x 0.9 mm.
- The column concrete encasements are connected to the concrete precast panels along the height of the panels. The precast panel connections cannot be assessed, however we did not note any damage to the visible connections.

The following information has been provided by CCC (Refer Appendix C):

- Portal frame knee height of 3.9 m.
- Portal frame ridge height of 4.2 m.
- Portal frame column and rafter overall depth of 205 mm, web depth of 189 mm and flange width of 132 mm. Based on these dimensions, a 200UB22.3 was adopted.
- Column concrete encasement size of 355 mm x 260 mm.
- End wall timber rafter size of 190 mm x 45 mm.
- Precast concrete panel thickness of 100 mm.
- Pad footing size under western portal frame columns of 1600 mm x 800 mm x 650 mm.
- Strip footing size under northern and southern end wall precast panels of 1900 mm x 400 mm x 1300 mm. This is based on the information provided from site investigations and is believed to be the minimum dimensions of the foundation. Should further investigations show a greater extent of foundations, the *%NBS* will be higher.
- Dimensions of post footing size under eastern portal frame columns, measured on the inside of the building of 280 mm x 640 mm. Since external access is not available to the eastern side (refer to Section 6.2), it is assumed that the foundation is symmetrical about the precast panel, resulting in an assumed foundation size of 660 mm (including 100 mm for precast panel width) x 640 mm.
- Reinforcement for precast concrete panels is 8 mm diameter bar, spaced at 150 mm centres vertically and horizontally and located centrally. This was determined from a Ferroscan. For calculation purposes this was assumed to be 661 mesh.
- Reinforcement in the portal frame column encasement is four 36 mm diameter vertical bars with 6-8 mm stirrups at 200 mm spacing.

10.3 Critical Structural Weaknesses

No Critical Structural Weaknesses have been identified.

Significant plan irregularity was considered to be a Critical Structural Weakness in the IEP, however the Quantitative Assessment found additional torsional effects not to be critical and therefore plan irregularity is no longer considered a Critical Structural Weakness.

10.4 Seismic Parameters

The seismic design parameters based on current design requirements from NZS 1170.5:2004 and the NZBC clause B1 for this building are:

- Site soil class: D – NZS 1170.5:2004, Clause 3.1.3, Soft Soil
- Site hazard factor, Z = 0.3 – NZBC, Clause B1 Structure, Amendment 11 effective from 19 May 2011
- Return period factor Ru = 1 – NZS 1170.5:2004, Table 3.5, Importance Level 2 structure with a 50 year design life.
- Near fault factor N(T,D) = 1 – NZS 1170.5:2004, Clause 3.1.6, Distance more than 20 km from fault line.

10.5 Results of Seismic Assessment

The results of our quantitative assessment indicate the building has a seismic capacity in the order of 37*%NBS*. This is lower than the IEP assessment of 42*%NBS* in the previous Qualitative Report. Table 10.1 presents the evaluated seismic capacity in terms of *%NBS* of the individual structural systems and components in each building direction.

Table 10.1: Summary of Seismic Assessment of Structural Systems

Item	Loading Direction	Ductility, μ	Seismic Capacity	Notes
Overall *%NBS* adopted from DEE	**Transverse**		**37*%NBS***	**Governed by end wall foundations**
Portal frames	Transverse	1.25	91*%NBS*	Governed by Drift
Portal frame base plate connection	Transverse	1.25	>100*%NBS*	Base plate/gusset plate bending
End wall timber rafters	Transverse	1.25	>100*%NBS*	Governed by compression
Precast end (north/south) walls	Both	1.0 due to mesh reinforcement	>100*%NBS*	Governed by Out of plane flexure
Precast eastern wall	Both	1.0 due to mesh reinforcement	>100*%NBS*	Governed by Out of plane flexure
Connection between end wall rafter and end wall precast panel	Transverse	1.25	>100*%NBS*	Concrete pull-out
Roof bracing	Both	1.25	>100*%NBS*	Tension
Foundations beneath end (north/south) walls	Transverse Longitudinal	1.25 1.25	37*%NBS* >100*%NBS*	Governed by Bearing Pressure Governed by Bearing Pressure
Foundations beneath eastern steel portal frame columns	Transverse Longitudinal	1.25 1.25	70*%NBS* >100*%NBS*	Governed by Bearing Pressure Governed by Bearing Pressure
Foundations beneath western steel portal frame columns	Transverse	1.25	>100*%NBS*	Governed by Bearing Pressure

Note: Ductility factors are in accordance with values recommended in the NZSEE 2006 AISPBE guidelines. All section sizes were provided based by CCC investigations, refer Appendix C.

10.6 Discussion of results

The key findings of the assessment are as follows:

- End Wall Foundations (transverse), 37*%NBS*, governed by bearing pressure of end walls.

Based on the results of our Quantitative Assessment, the Vehicle Garage/Bitumen Sprayer is considered Earthquake Risk as the seismic capacity was assessed to be between 34*%NBS* and 67*%NBS*, and is classified as Seismic Grade C.

11 Recommendations

11.1 Occupancy

In order that the owner can make an informed decision about the on-going use and occupancy of their building the following information is presented in line with the Department of Building and Housing document 'Guidance for engineers assessing the seismic performance of non-residential and multi-unit residential buildings in greater Christchurch', June 2012.

The building is considered to be earthquake risk, having an assessed capacity of between 34% and 67*%NBS*. The risk of collapse of an earthquake risk building is considered to be 5 to 10 times greater than that of an equivalent new building.

No significant damage or hazards were identified to the seismic or gravity load resisting system that would reduce its ability to resist further loads and therefore no restrictions on use or occupancy are recommended.

11.2 Further Investigations, Survey or Geotechnical Work

It is recommended that:

- A full damage assessment is carried out for insurance purposes, in particular, we recommended that the steel roof bracing connections be inspected for damage.
- A verticality and level survey could be carried out to determine the extent of settlement of the building for insurance purposes.

11.3 Damage Reinstatement

According to the recent CCC Instructions to Engineers document (16 October 2012), Council's insurance provides for repairing damaged elements to a condition substantially as new. We suggest you consult further with your insurance advisor.

12 Design Features Report

Minor repairs are required. A repair methodology has not been prepared at this stage. No new load paths are expected as a result of the repairs required.

13 Limitations

The following limitations apply to this engagement:

- Beca and its employees and agents are not able to give any warranty or guarantee that all defects, damage, conditions or qualities have been identified.
- Inspections are primarily limited to visible structural components. Appropriate locations for invasive inspection, were requested based on damage patterns observed in visible elements, and review of structural system. As such, there will be concealed structural elements that will not be directly inspected.

- The inspections are limited to building structural components only.
- Inspection of building services, pipework, pavement, and fire safety systems is excluded from the scope of this report.
- Inspection of the glazing system, linings, carpets, claddings, finishes, suspended ceilings, partitions, tenant fit-out, or the general water tightness envelope is excluded from the scope of this report.
- The assessment of the lateral load capacity of the building is limited by the extent and accuracy of the intrusive investigations and site measurements undertaken. Assumptions have been made in respect of the geotechnical conditions at the site and any aspects or material properties. Where these assumptions are considered material to the outcome further investigations may be recommended. It is noted the assessment has not been exhaustive, our analysis and calculations have focused on representative areas only to determine the level of provision made. At this stage we have not undertaken any checks of the gravity system, wind load capacity.
- The information in this report provides a snapshot of building damage at the time the detailed inspection was carried out. Additional inspections required as a result of significant aftershocks are outside the scope of this work.

This report is of defined scope and is for reliance by CCC only, and only for this commission. Beca should be consulted where any question regarding the interpretation or completeness of our inspection or reporting arises.

Appendix A

Photographs

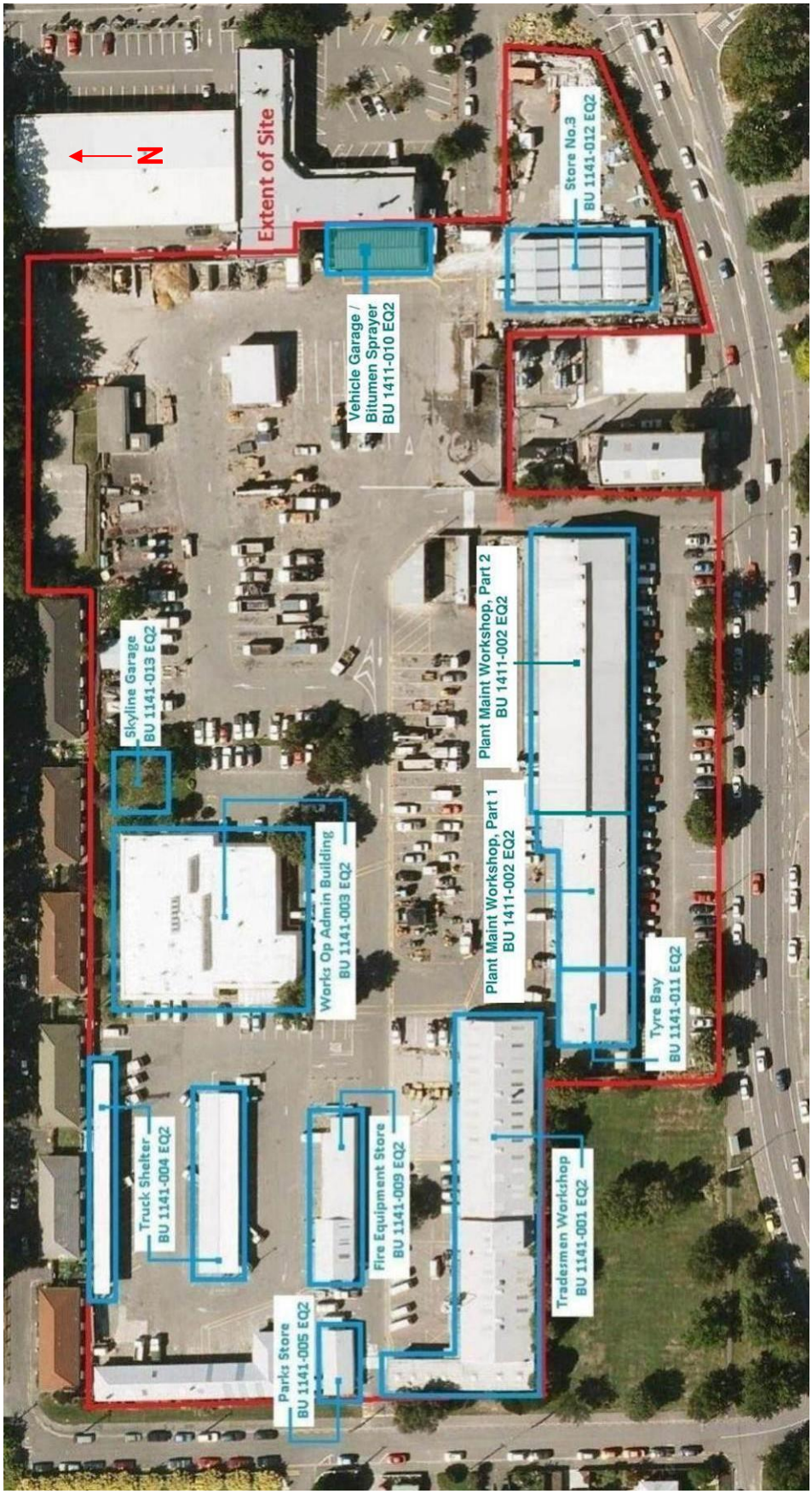


Figure A1: Site Plan (North is to the left of page)

Photo 1: Exterior view of west elevation.

Photo 2: Exterior view of north elevation with adjacent blockwall.

Photo 3: Interior view at south end.

Photo 4: Interior view.

Photo 5: Typical western portal frame column foundation.

Photo 6: Internal concrete column and precast tilt panel.

Damage Description: Movement between precast panel and concrete column.

Photo 7: East precast tilt panel wall damage
Damage Description: Diagonal cracking observed to the precast panel

Appendix B

CERA DEE Summary Data

Detailed Engineering Evaluation Summary Data V1.11

Location

Building Name:	Vehicle Garage/Bitumen Sprayer			Reviewer:	David Whittaker
	Unit	No:	Street	CPEng No:	123089
Building Address:	Milton Street Depot	245	Milton Street	Company:	Beca
Legal Description:				Company project number:	5323355
				Company phone number:	03 3663521
	Degrees	Min	Sec		
GPS south:				Date of submission:	26/09/2013
GPS east:				Inspection Date:	20/07/2012
				Revision:	B
Building Unique Identifier (CCC):	PRO_1141_010 EQ2			Is there a full report with this summary?	yes

Site

Site slope:	flat	Max retaining height (m):	0
Soil type:		Soil Profile (if available):	NA
Site Class (to NZS1170.5):	D		
Proximity to waterway (m, if <100m):		If Ground improvement on site, describe:	
Proximity to cliff top (m, if < 100m):			
Proximity to cliff base (m,if <100m):		Approx site elevation (m):	0.00

Building

No. of storeys above ground:	1	single storey = 1		Ground floor elevation (Absolute) (m):	
Ground floor split?	no			Ground floor elevation above ground (m):	0.00
Storeys below ground	0				
Foundation type:	other (describe)			if Foundation type is other, describe:	Pad footings, post footings and strip footings with asphalt ground floor
Building height (m):	4.00			height from ground to level of uppermost seismic mass (for IEP only) (m):	4
Floor footprint area (approx):	140				
Age of Building (years):	36			Date of design:	1976-1992
Strengthening present?	no			If so, when (year)?	
				And what load level (%g)?	
Use (ground floor):	other (specify)			Brief strengthening description:	
Use (upper floors):					
Use notes (if required):	Storage shed				
Importance level (to NZS1170.5):	IL2				

Gravity Structure

Gravity System:	frame system		
Roof:	timber framed	rafter type, purlin type and cladding	Steel rafters, timber purlins metal sheeting
Floors:	other (note)	describe sytem	asphalt
Beams:	steel non-composite	beam and connector type	
Columns:	structural steel	typical dimensions (mm x mm)	
Walls:	non-load bearing	0	

Lateral load resisting structure

Lateral system along:	single level tilt panel		**Note: Define along and across in detailed report!**	note total length of wall at ground (m):	18
Ductility assumed, μ:	1.00			wall thickness (m):	0.1
Period along:	0.40	0.00		estimate or calculation?	estimated
Total deflection (ULS) (mm):				estimate or calculation?	
maximum interstorey deflection (ULS) (mm):				estimate or calculation?	
Lateral system across:	welded and bolted steel moment frame			note typical bay length (m)	6
Ductility assumed, μ:	1.25				
Period across:	0.91	0.00		estimate or calculation?	calculated
Total deflection (ULS) (mm):				estimate or calculation?	
maximum interstorey deflection (ULS) (mm):				estimate or calculation?	

Separations:

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

Non-structural elements

Stairs:	other (specify)	describe	None
Wall cladding:	profiled metal	describe	Lightweight metal
Roof Cladding:	Metal	describe	Lightweight metal
Glazing:	other (specify)		None
Ceilings:	none		
Services(list):	Electricity		

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:	Site performance:	Good	Describe damage:	No site damage was observed
(refer DEE Table 4-2)				
	Settlement:	none observed	notes (if applicable):	
	Differential settlement:	none observed	notes (if applicable):	
	Liquefaction:	0-2 m³/100m³	notes (if applicable):	estimated from aerial photo
	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:	No significant structural damage
	Describe (summary):	No significant structural damage		
Across	Damage ratio:	0%	$Damage\_Ratio = \frac{(\%NBS\ (before) - \%NBS\ (after))}{\%NBS\ (before)}$	
	Describe (summary):	No significant structural damage		
Diaphragms	Damage?:	no	Describe:	
CSWs:	Damage?:	no	Describe:	
Pounding:	Damage?:	no	Describe:	
Non-structural:	Damage?:	no	Describe:	

Recommendations

	Level of repair/strengthening required:	minor structural		Describe:	minor shear cracks to panels
	Building Consent required:	no		Describe:	
	Interim occupancy recommendations:	full occupancy		Describe:	
Along	Assessed %NBS before:	100%	#### %NBS from IEP below	If IEP not used, please detail assessment methodology:	Force-based Quantitative Assessment
	Assessed %NBS after:	100%			
Across	Assessed %NBS before:	37%	#### %NBS from IEP below		
	Assessed %NBS after:	37%			

IEP **Use of this method is not mandatory - more detailed analysis may give a different answer, which would take precedence. Do not fill in fields if not using IEP.**

Period of design of building (from above): 1976-1992 — h_n from above: 4m

Seismic Zone, if designed between 1965 and 1992: — not required for this age of building / not required for this age of building

	along	across
Period (from above):	0.4	0.91
(%NBS)nom from Fig 3.3:		

Note:1 for specifically design public buildings, to the code of the day: pre-1965 = 1.25; 1965-1976, Zone A =1.33; 1965-1976, Zone B = 1.2; all else 1.0
Note 2: for RC buildings designed between 1976-1984, use 1.2
Note 3: for buildngs designed prior to 1935 use 0.8, except in Wellington (1.0)

	along	across
Final (%NBS)$_{nom}$:	**0%**	**0%**

2.2 Near Fault Scaling Factor — Near Fault scaling factor, from NZS1170.5, cl 3.1.6:

	along	across
Near Fault scaling factor (1/N(T,D), **Factor A**:	#DIV/0!	#DIV/0!

2.3 Hazard Scaling Factor — Hazard factor Z for site from AS1170.5, Table 3.3:
Z_{1992}, from NZS4203:1992
Hazard scaling factor, **Factor B:** #DIV/0!

2.4 Return Period Scaling Factor — Building Importance level (from above): 2
Return Period Scaling factor from Table 3.1, **Factor C**:

2.5 Ductility Scaling Factor

	along	across
Assessed ductility (less than max in Table 3.2)		
Ductility scaling factor: =1 from 1976 onwards; or =k_μ, if pre-1976, fromTable 3.3:		
Ductility Scaling Factor, **Factor D**:	1.00	1.00

2.6 Structural Performance Scaling Factor:

Sp:		
Structural Performance Scaling Factor **Factor E**:	#DIV/0!	#DIV/0!

2.7 Baseline %NBS, (NBS%)$_b$ = (%NBS)$_{nom}$ x A x B x C x D x E

%NBS$_b$:	**#DIV/0!**	**#DIV/0!**

Global Critical Structural Weaknesses: (refer to NZSEE IEP Table 3.4)

3.1. Plan Irregularity, factor A: 1

3.2. Vertical irregularity, Factor B: 1

3.3. Short columns, Factor C: 1

3.4. Pounding potential
Pounding effect D1, from Table to right
Height Difference effect D2, from Table to right
Therefore, Factor D: 0

3.5. Site Characteristics 1

Table for selection of D1	Severe	Significant	Insignificant/none
Separation	0<sep<.005H	.005<sep<.01H	Sep>.01H
Alignment of floors within 20% of H	**0.7**	**0.8**	**1**
Alignment of floors not within 20% of H	**0.4**	**0.7**	**0.8**

Table for Selection of D2	Severe	Significant	Insignificant/none
Separation	0<sep<.005H	.005<sep<.01H	Sep>.01H
Height difference > 4 storeys	0.4	0.7	1
Height difference 2 to 4 storeys	0.7	0.9	1
Height difference < 2 storeys	1	1	1

3.6. Other factors, Factor F — For ≤ 3 storeys, max value =2.5, otherwise max valule =1.5, no minimum

	Along	Across
Rationale for choice of F factor, if not 1		

Detail Critical Structural Weaknesses: (refer to DEE Procedure section 6)
List any: Refer also section 6.3.1 of DEE for discussion of F factor modification for other critical structural weaknesses

3.7. Overall Performance Achievement ratio (PAR)

	0.00	**0.00**

4.3 PAR x (%NBS)b: — PAR x Baselline %NBS:

	#DIV/0!	**#DIV/0!**

4.4 Percentage New Building Standard (%NBS), (before) **#DIV/0!**

Official Use only:
Accepted By
Date:

Appendix C

Site Survey Results

Calculation Sheet

Job Name: City Care - Milton St. Bitumen Sprayer/Vehicle Garage **Job No:** 5323355/118

Subject: Investigations/Site measure **Page No:** 1 of 4

By: SR **Date:** 20/11/2012

Investigations/Site measure

Refer to Sketches on page 2 -4 for required investigations

1. Confirm size of roof bracing SEE PHOTO'S 1-1A

   Confirm roof bracing connection ASSUME NAILED/SCREWED TO PURLINS

2. Confirm rafter size 235 x 45 TIMBER

3. Confrim endframe rafter size and connection to concrete wall 190 x 45 ANGLE BRACKET NAILED TO RAFTER BOLTED TO CONCRETE SEE PHOTO'S 3- 3C

4. Confrim purlin size, spacing and material 235 x 45 TIMBER SEE PLAN 1

5. Carry out site measure of building and mark up on pages 2-4

6. Confirm endframe column size 190 x 90 TIMBER

7. Confirm column size 205 x 132

8. X-ray precast panels and confirm reinforcement size and spacing

9. Confirm concrete column dimensions 355 x 260

10. Confirm concrete panel thickness 100mm

11. Confirm concrete panel thickness 100mm

12. Confrim precast panel to column connection STEEL PORTAL HAS TAG'S WELDED WHICH ARE SET INTO CONCRETE PANEL COLUMN SITE POURED AFTER SEE PHOTO'S 12- 12D

13. Confrim size and spacing of endframe 190 x 45 PLAN 3

14. Confirm weight and location of gantry crane UNIT APROX 60 KG MAX LIFTING WEIGHT 1000 KG. SEE PLAN 1 FOR LOCATION

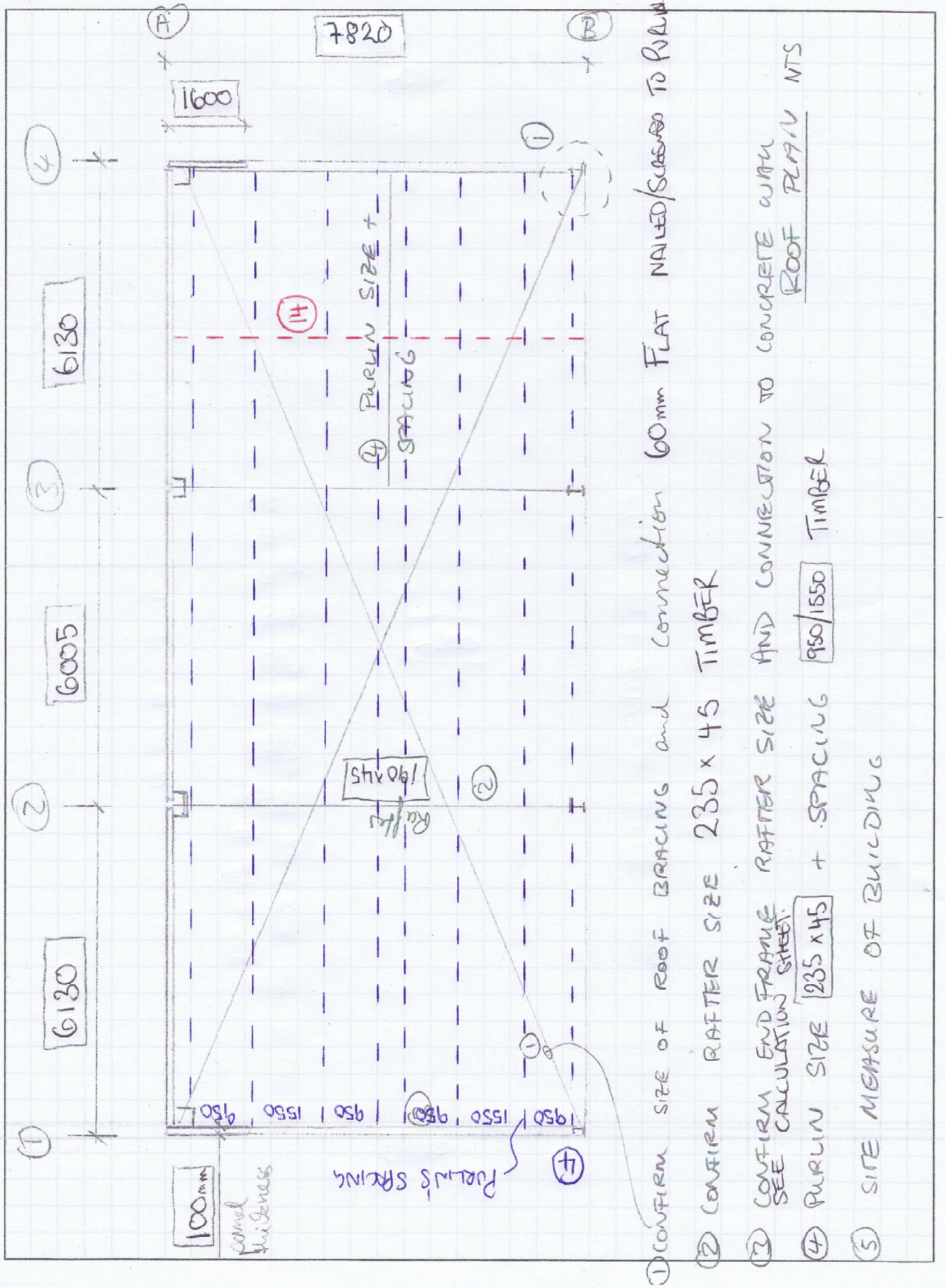
15 COLUMN SIZE 100 SQ SEE PLAN 3 STEEL.

Beca CALCULATION SHEET ABN 85 004 974 341

JOB TITLE: City Care – Milton St. – Bitumen Sprays JOB NO: 5322255/118

SUBJECT: INVESTIGATIONS PAGE NO: 2 OF 4

DESIGNER/DATE: SR CHECKED/DATE: SECTION: FILE: DE



MILTON PLAN 1

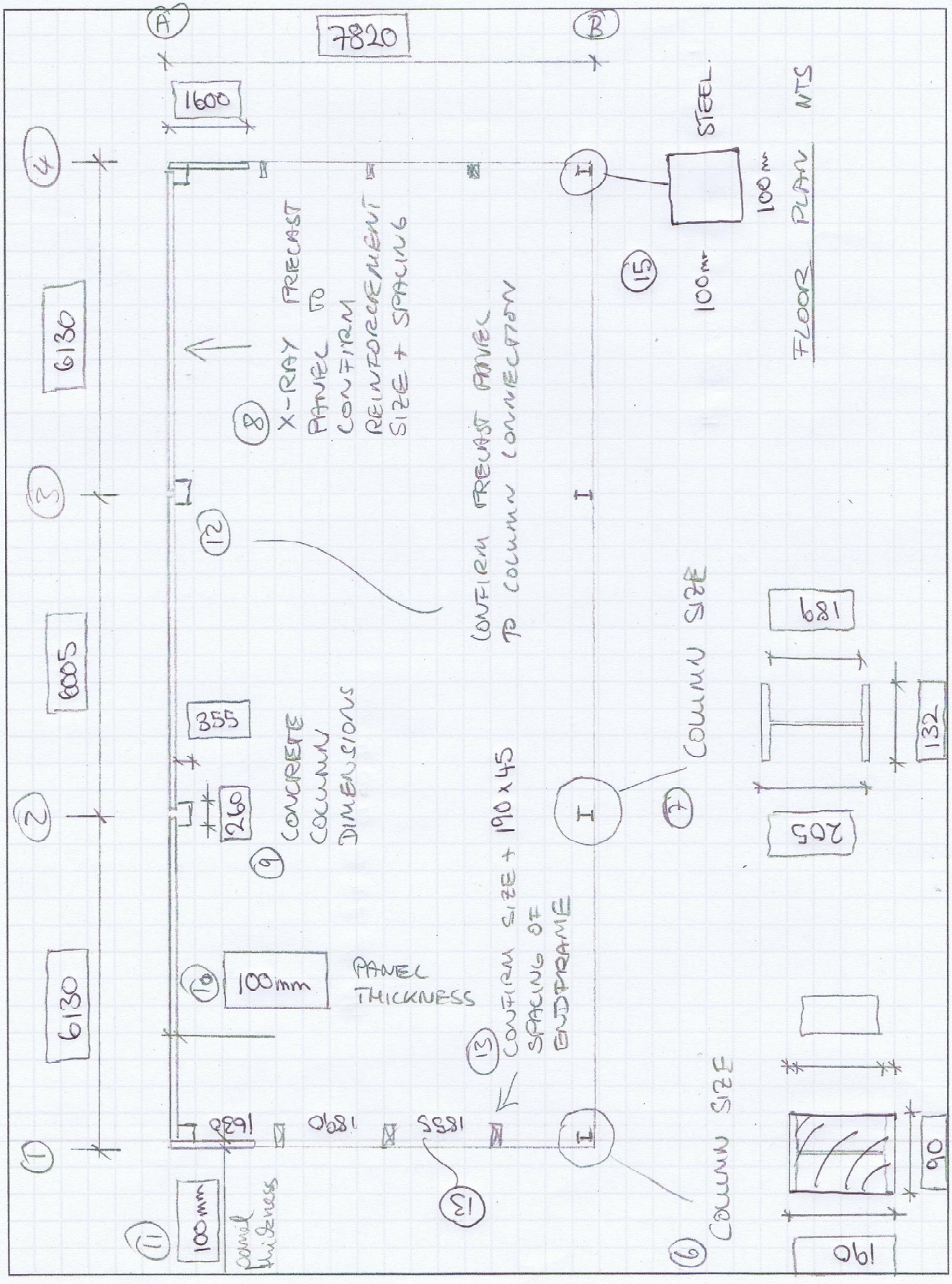
Beca CALCULATION SHEET

ABN 85 004 974 341

JOB TITLE: City Care – Milton St. – Bitumen Sprays JOB NO: 5323255/118

SUBJECT: INVESTIGATIONS PAGE NO: 3 OF 4

DESIGNER/DATE: SR CHECKED/DATE: SECTION: FILE: DE ___



MILTON PLAN 3

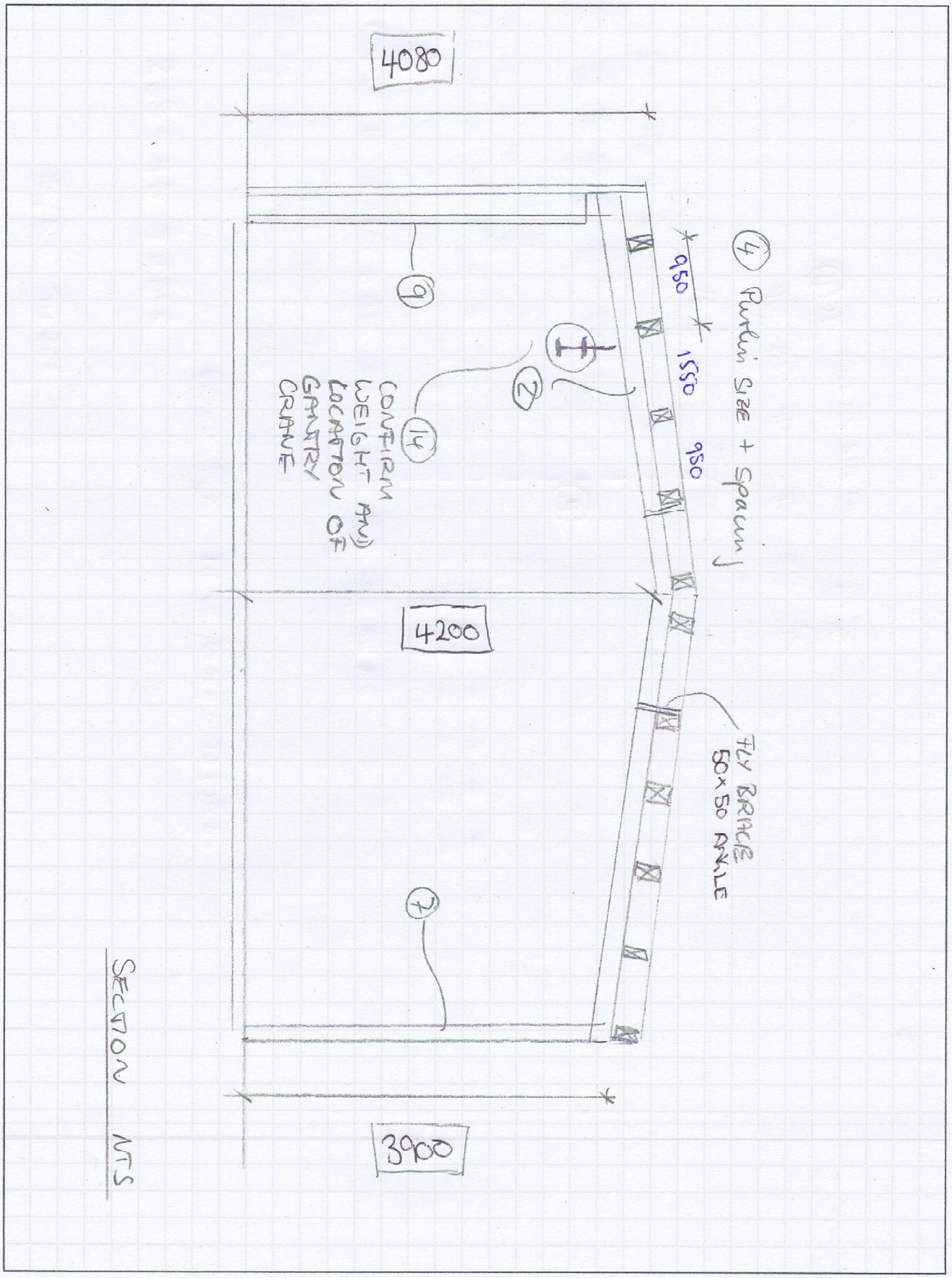
Beca CALCULATION SHEET ABN 85 004 974 341

MILTON PLAN 2

JOB TITLE: CITY CORE - MILTON ST - BITUMEN SPRAYER JOB NO: 532355/118

SUBJECT: INVESTIGATIONS PAGE NO: 4 OF 4

DESIGNER/DATE: SR CHECKED/DATE: SECTION: FILE: DE ___



Andrew Franklin

From: Laura Chen
Sent: Tuesday, 16 July 2013 9:02 AM
To: Andrew Franklin
Subject: FW: Milton Street
Attachments: 201307160748.pdf

Regards
Laura

-----Original Message-----
From: Sam Brown
Sent: Tuesday, 16 July 2013 6:55 AM
To: Jonathan Barnett; Hollie Friesen; Laura Chen
Subject: FW: Milton Street

Is this all you need from the intrusive investigation?

If it is I'll let Citycare know they can fill in the holes.

Thanks
Sam

-----Original Message-----
From: Malcolm Campbell [mailto:malcolm.campbell[redacted]
Sent: Tuesday, 16 July 2013 7:55 a.m.
To: Sam Brown
Subject: Milton Street

Good Morning Sam

Attached is the plan for the truck shelter, the bitumen shed is the foundation is 1.3 deep, 0.300 wide, from the back corner 1.600 long. The length of the concrete foundation was found by drilling holes 0.200 deep in a straight line. Hope this is okay. Can we fill in the holes now that this is completed.

Regards
Malcolm Campbell
Service Manager

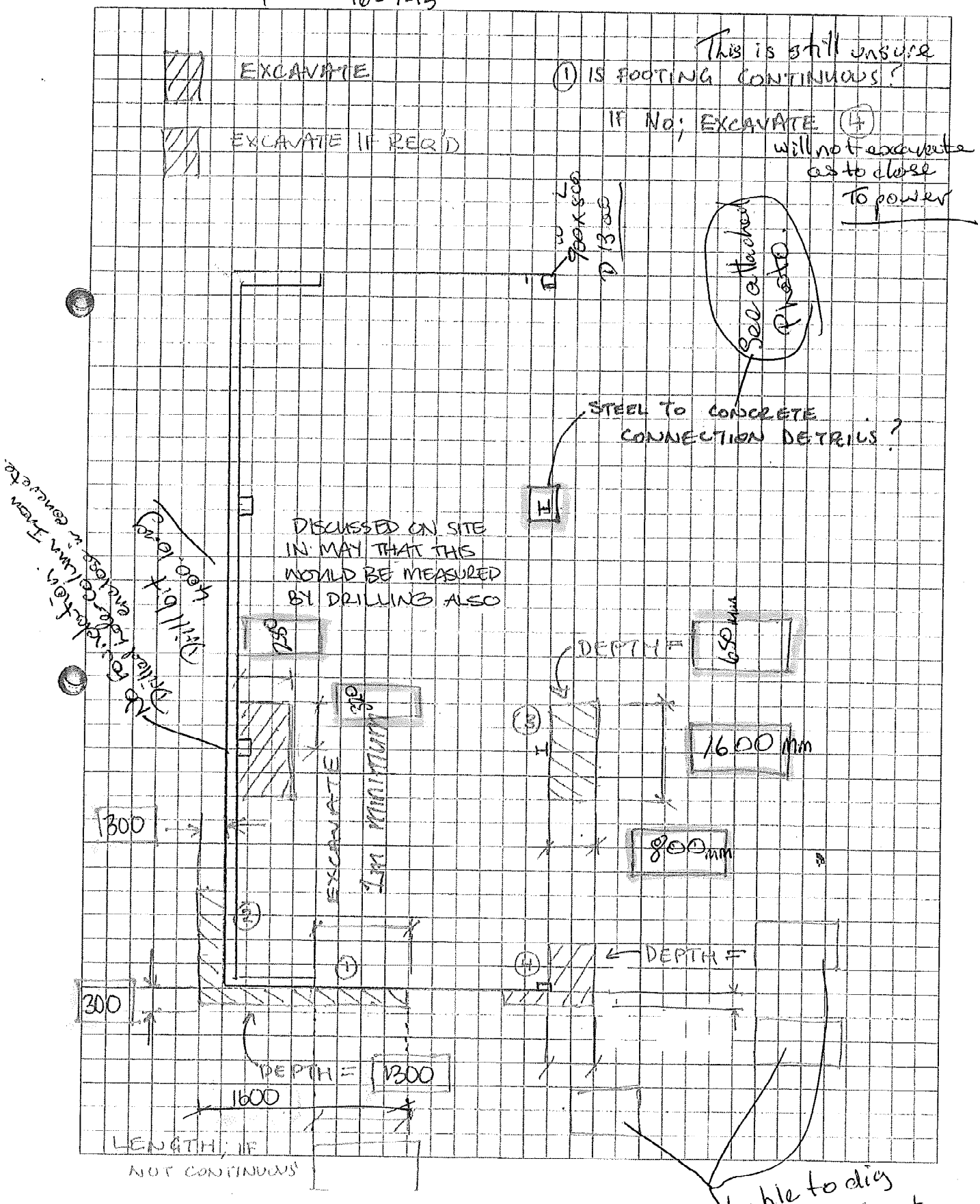
D: [redacted]
M: [redacted]
T: [redacted]
F: [redacted]
City Care Ltd
46 Birmingham Drive
PO Box 7669, Middleton
Christchurch 8024
www.citycare.co.nz

Behave Safe. It's not OK to be hurt at work

Beca CALCULATION SHEET

ABN 85 004 974 341

JOB TITLE: CITY CARE - MILTON ST - BITUMEN SPRAYER
JOB NO: 5323355/11B
SUBJECT: FOUNDATION INVERTIGATIONS
PAGE NO: 1 OF:
DESIGNER/DATE: ~~AT~~ 3-4-13 CHECK DATE: 16-7-13
SECTION: FILE:



Appendix D

Previous Reports and Assessments

-06

Christchurch Eq RAPID Assessment Form - LEVEL 2

Inspector Initials	MK	Date	23/06/2011	Final Posting (e.g. UNSAFE)	G1
Territorial Authority	Christchurch City	Time	11 15		

Building Name: Milton St Depot
Short Name: 14 Johnson St
Address: Vehicle garage
BU 1141 - 010 EQ2
GPS Co-ordinates: S° E°
Contact Name:
Contact Phone:
Storeys at and above ground level: 1
Below ground level:
Total gross floor area (m²):
Year built:
No of residential Units:
Photo Taken: Yes ✓ No

Type of Construction

- [✓] Timber frame (metal cladding & roof)
- [ ] Steel frame
- [ ] Tilt-up concrete
- [ ] Concrete frame
- [ ] RC frame with masonry infill
- [ ] Concrete shear wall
- [ ] Unreinforced masonry
- [ ] Reinforced masonry
- [ ] Confined masonry
- [ ] Other:

Primary Occupancy

- [ ] Dwelling
- [ ] Other residential
- [ ] Public assembly
- [ ] School
- [ ] Religious
- [ ] Commercial/ Offices
- [✓] Industrial
- [ ] Government
- [ ] Heritage Listed
- [ ] Other

Investigate the building for the conditions listed on page 1 and 2, and check the appropriate column. A sketch may be added on page 3

Overall Hazards / Damage	Minor/None	Moderate	Severe	Comments
Collapse, partial collapse, off foundation	✓			
Building or storey leaning	✓			
Wall or other structural damage	✓			
Overhead falling hazard	✓			
Ground movement, settlement, slips	✓			
Neighbouring building hazard	✓			
Electrical, gas, sewerage, water, hazmats	✓			

Record any existing placard on this building:

Existing Placard Type (e.g. UNSAFE): green

Choose a new posting based on the new evaluation and team judgement. Severe conditions affecting the whole building are grounds for an UNSAFE posting. Localised Severe and overall Moderate conditions may require a RESTRICTED USE. Place INSPECTED placard at main entrance. Post all other placards at every significant entrance. Transfer the chosen posting to the top of this page.

INSPECTED *GREEN*		RESTRICTED USE *YELLOW*		UNSAFE *RED*		
G1 ✓	G2	Y1	Y2	R1	R2	R3

Record any restriction on use or entry:

Further Action Recommended:

Tick the boxes below only if further actions are recommended

- [ ] Barricades are needed (state location):
- [ ] Detailed engineering evaluation recommended
  - [ ] Structural
  - [ ] Geotechnical
  - [ ] Other:
- [ ] Other recommendations:

Estimated Overall Building Damage (Exclude Contents)

None	[ ]		
0-1 %	[✓]	31-60 %	[ ]
2-10 %	[ ]	61-99 %	[ ]
11-30 %	[ ]	100 %	[ ]

Sign here on completion: M. Kaczorska

Date & Time: 23/06/2011

ID:

Inspection ID: _____ *(Office Use Only)*

PROP1:

Structural Hazards/ Damage	Minor/None	Moderate	Severe	Comments
Foundations	☐	☐	☐	
Roofs, floors (vertical load)	☑	☐	☐	
Columns, pilasters, corbels	☑	☐	☐	
Diaphragms, horizontal bracing	☐ N/A	☐	☐	
Pre-cast connections	☐ N/A	☐	☐	
Beam	☑	☐	☐	
Non-structural Hazards / Damage				
Parapets, ornamentation	☑	☐	☐	
Cladding, glazing	☑	☐	☐	
Ceilings, light fixtures	☑	☐	☐	
Interior walls, partitions	☐ N/A	☐	☐	
Elevators	☐ N/A	☐	☐	
Stairs/ Exits	☐ N/A	☐	☐	
Utilities (eg. gas, electricity, water)	☐ not checked	☐	☐	
Other	☐	☐	☐	
Geotechnical Hazards / Damage				
Slope failure, debris	☑	☐	☐	
Ground movement, fissures	☑	☐	☐	
Soil bulging, liquefaction minor	☑	☐	☐	

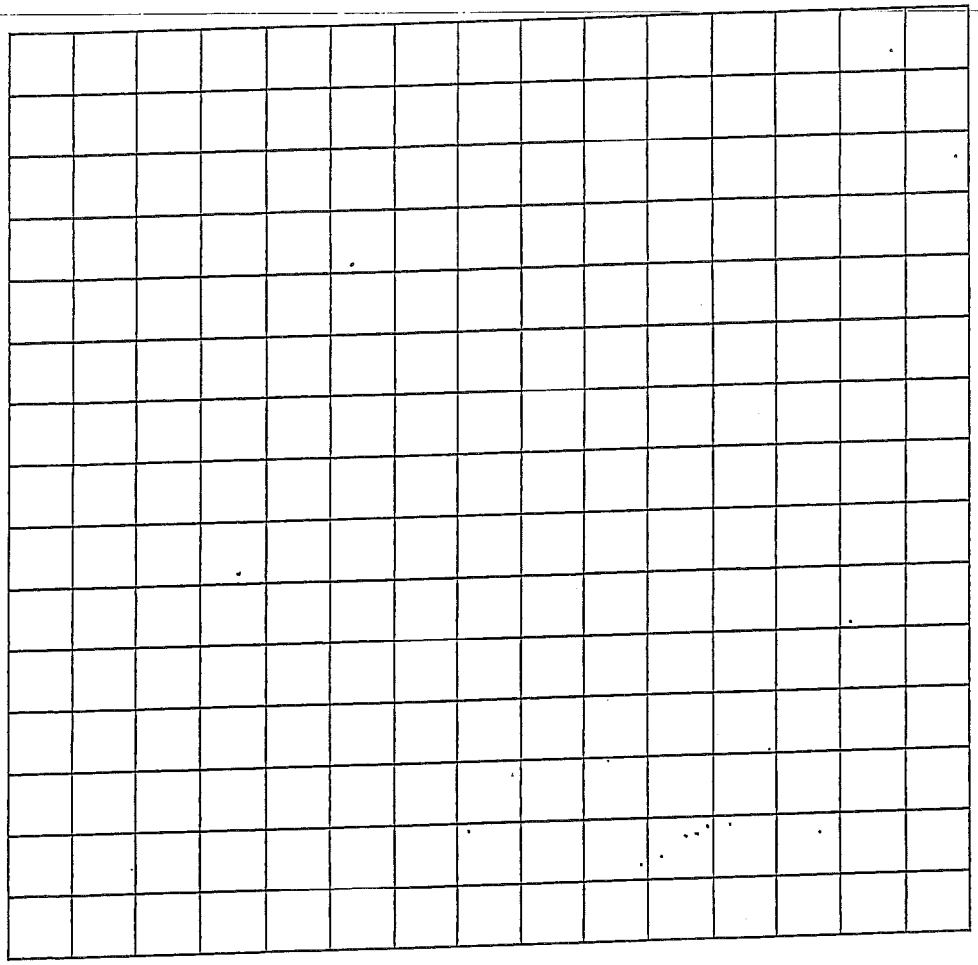
General Comment

Usability Category

Damage Intensity	Posting	Usability Category	Remarks
Light damage *Low risk*	Inspected (Green)	G1. Occupiable, no immediate further investigation required	
		G2. Occupiable, repairs required	
Medium damage *Medium risk*	Restricted Use (Yellow)	Y1. Short term entry	
		Y2. No entry to parts until repaired or demolished	
Heavy damage *High risk*	Unsafe (Red)	R1. Significant damage: repairs, strengthening possible	
		R2. Severe damage: demolition likely	
		R3. At risk from adjacent premises or from ground failure	

 Inspection ID: _____ *(Office Use Only)*

Sketch (optional)
Provide a sketch of the entire building or damage points. Indicate damage points.



Recommendations for Repair and Reconstruction or Demolition (Optional)

 Inspection ID:_____ (Office Use Only)