LISMORE HOSPITAL – STAGE 3C
HEALTH INFRASTRUCTURE NSW

Structural IFC Design Report

21 MARCH 2018

incorporating

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LISMORE BASE HOSPITAL–STAGE 3C NORTH TOWER AND NORTH TOWER EXTENSION

Structural IFC Design Report

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Checker Glenn Barton

Approver Glenn Barton

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Revision Text D

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REVISIONS

Revision	Date	Description	Prepared by	Approved by
A	21/09/2016	Draft – For Review	A Vose	G Barton
B	24/11/2016	Final Issue	A Vose	G Barton
C	20/07/2017	IFC Issue	A Vose	G Barton
D	21/03/2018	3B2 revised to 3C	A Vose	-

CONTENTS

APPENDICES

1 INTRODUCTION

This report sets out the relevant IFC design phase information related to the north tower, stage 3C of the Lismore Base Hospital. The site is located at Little Uralba Street, Lismore, between the new south tower development and the Mental Health Building.

The proposed development, with respect to Arcadis's scope, consists of:

North Tower

- 4 suspended levels of hospital.
- Level 3 consists of part of the existing Block A building slab, a new extension on ground and concrete paving area for truck deliveries etc.

North Tower Extension

- 3 suspended levels of hospital.
- A concrete roof at Level 11 with a steel framed roof over.

Block A

- New steel fire egress stair on the north side of the building
- Demolition of part of the Block A building

South Tower

- New level 3 fire passage link
- Infill of the opening in level 7 for the new CSSD lift and topping to level 6 and 7.

Block C

- Removal of the lift in Block C

This report provides the basis upon which the Structural Design has been prepared, and outlines Arcadis' understanding of the site, along with assumptions used. The current structural concepts and this report are based upon the information available from the Project Brief information provided and detailed in the DMP, Conrad Gargett Architects drawings and other consultant's drawings.

2 SITE

The site for 3C sits directly above and adjacent to the Mental Health building. Refer site plan below. There is a steep batter between these two sites which was created when excavation occurred for the Mental Health building. The retaining system for the batter is a soil nailed structure which was installed during the construction of the Mental Health building around 2006. The capacity of the soil nailed wall to support surcharge loading has been investigated and is addressed in this report. To the south of 3C is the recently constructed 3B1South Tower building.

Figure 1 Site Plan

3 GEOTECHNICAL CONDITIONS

The geotechnical conditions on the site have been previously investigated by Coffey Geotechnics and more extensively by Douglas Partners (DP). The history of these investigations can be found in DP's report 90317.00.R.003 dated September 2016. Recently DP investigated the geology in the vicinity of the North tower project by drilling two boreholes 7 and 8. Refer below for their locations. Refer Appendix C for the relevant North Tower Geotechnical Reports. The natural geology encountered during the field work is consistent with the Lamington volcanic geology.

The geological conditions have been generally characterised as:

- Overlying filling of gravelly clay or sandy gravel to approximately 1m to 1.5m depth,
- Silty clay (in borehole 8) to 2.9m depth,
- Upper basalt flow. In bore 8 very low strength basalt was encountered below the silty clay with the basalt becoming high and very high strength between 7.5m and 8.5 depth. In bore 7 the geology initially comprised extremely high fresh basalt rock fragments within a matrix of stiff clay varying to extremely low strength basalt. Below this layer the flow generally comprised interbedded bands of extremely low, low and high strength basalt.
- A tephra layer was encountered below the upper basalt flow in both boreholes. The tephra in bore 8 was initially very low strength with locally low strength bands and bands of stiff clay to the base of the tephra at 13.6m depth. In bore 7, the tephra layer was typically very low strength to its base of 12.0m depth.
- A lower basalt flow is underlying the tephra layer in both boreholes. It is high strength, becoming very high strength, fresh, slightly fractured. Dark grey basalt was encountered to borehole termination at 20.5m and 18.1m depth in bore 7 and 8 respectively.

Available geotechnical information relating to the soil nailed bank indicates relatively weak, fractured basalt to about RL 22, approximately 5m below the current surface. The existing batter has been previously designed for 10kPa surcharge load allowance as determined from a Douglas Partners review of Coffey Geotechnics report.

Structurally, the option of using bored piles on the northern side footings is a viable option, however, due to the loads and expected bearing pressures, the piles will need to be drilled through the tephra layer. The access of the rig to the site through Little Uralba Street and the current ramp has been confirmed by John Holland (JHG). DP have also investigated the stability of the soiled nail batter with the surcharge of the piling rig (advised by JHG to be 350kPa) with one row of soil nails rendered ineffective. Refer their report 90317.00.R.001 for details. Their results found that an adequate factor of safety was achieved under the short term surcharge loading from the piling rig.

Bored piles will be sleeved permanently through the upper section of the slope (ie above RL 19m so that they do not transmit downward forces into the soil nailed slope.

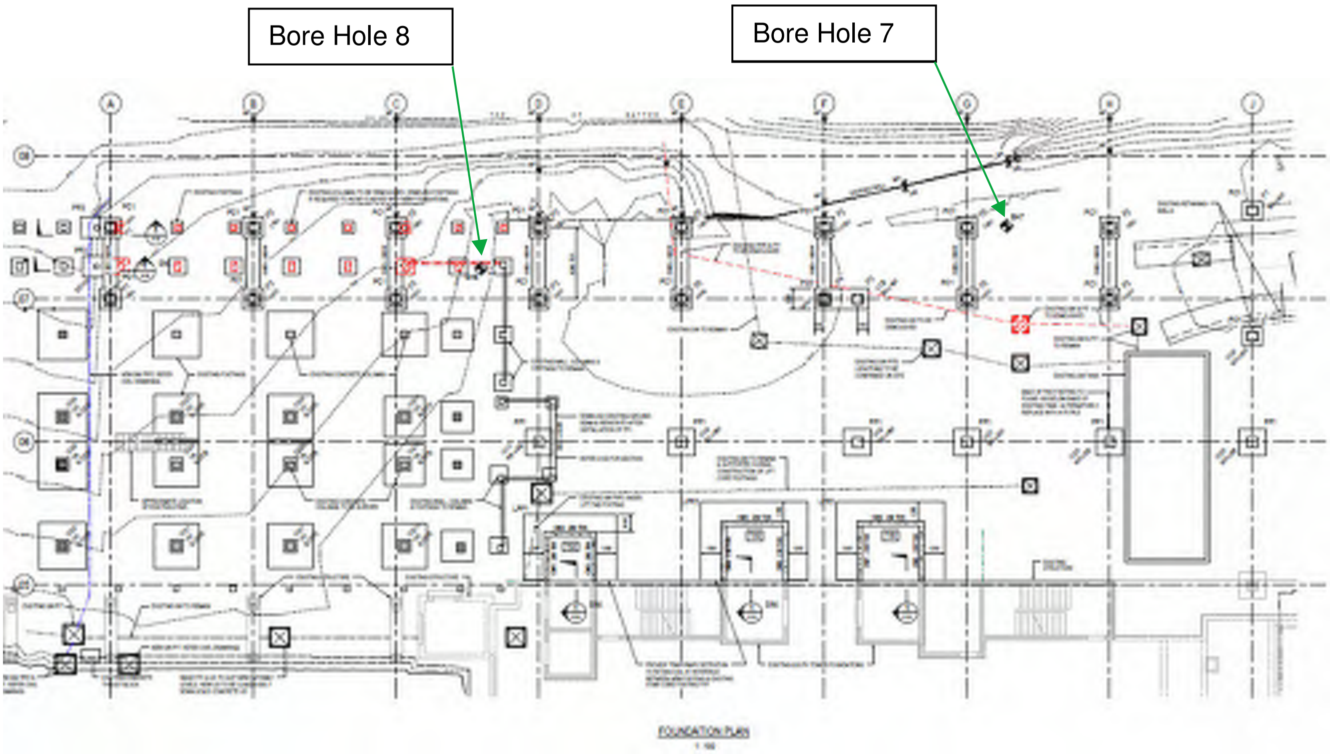


Figure 2

4 PROJECT DESCRIPTION

Stage 3C is a proposed hospital wing to be developed at Lismore Base Hospital at Little Uralba Street, Lismore. The site is located at Little Uralba Street, Lismore, between the new south tower development and the Mental Health Building. The project consists consist of:

North Tower

- 4 suspended levels of hospital.
- Level 3 consist of part of the existing Block A building slab, a new extension on ground and concrete paving area for truck deliveries etc.

North Tower Extension

- 3 suspended levels of hospital.
- A concrete roof at Level 11 with a steel framed roof over.

Block A

- New steel fire egress stair on the north side of the building
- Demolition of part of the Block A building

South Tower

- New level 3 fire passage link
- Infill of the opening in level 7 for the new CSSD lift and topping to level 6 and 7.

Block C

- Removal of the lift in Block C

A list of our structural drawings is given in Appendix E.

5 DESIGN LOADING CRITERIA

5.1 General

The following design loading criteria and approach is what has been envisaged as being the most appropriate for this project based on our experience, site constraints and our understanding of the client's requirements. Subject to construction methodology higher loads may need to be considered for elements supporting construction traffic, temporary works or stored construction materials

5.2 Code and Specification

The structural design of the project must be carried out in accordance with the relevant Australian Standard Codes of Practice including but not limited to the documents outlined in Appendix A, Table 1.0. and relevant parts of Reference documents A14 and A15.

5.3 Loading Criteria

Unless noted otherwise refer Appendix A, Table 3.0 for a loading summary for vertical and lateral imposed actions. Refer to the architectural drawings for the extent of different floor uses, walls and facades. Design loads have been indicated on our loading plans. Refer Appendix B.

5.4 Wind Loading

Estimated wind loads have been calculated making use of the Australian Standard AS1170 Part 2.

CPP have prepared a wind assessment of cladding pressures report for the south tower and this has been used as reference for the new 3C north building.

For the purposes of Code Based Assessment the following parameters have been assumed:

Wind Region:	B
Terrain Category:	3
Importance level	4
Terrain/Height Multiplier (Mz,cat):	Refer Table 4.1(A) of AS1170 Part 2
Wind Directional Multipliers (Md):	0.95
Shielding Multiplier (Ms):	1.0
Topographic Multiplier (Mt):	1.0
For Ultimate Wind Loading:	V2000:

5.5 Earthquake Loading

Earthquake loads are calculated in accordance with Australian Standard AS1170 Part 4, with the following parameters assumed:

Probability Factor (kp):	1.5
Hazard Factor (Z):	0.05
Site Sub-Soil Class:	Be

Structural Ductility Factor (μ):	2.0
Structural Performance Factor (Sp):	0.77
Importance Level:	4
For Ultimate Earthquake Loading:	P: 1/1500

5.6 Deflection Criteria

Refer to Appendix A, Table 2.0.

5.7 Durability

For concrete elements, durability will be achieved by specifying all elements in accordance with section 4 of AS 3600 which sets out requirements for plain, reinforced and post tensioned concrete structures and members with a design life of 50 years. Exposure classifications are as follows.

Exposure Classification	Elements
A2	Internal
B1	In ground and external

Protective coatings to structural steel elements shall comply with AS/NZS 2312 and ISO2063 for the long-term protection category.

6 STRUCTURAL FRAMING SYSTEMS

The structure will be constructed as a concrete framed building, with post tensioned floor plates, reinforced concrete columns and concrete shear walls. At level 3 is a slab on ground. Part of level 4 is constructed in steel framing and bondek to minimise weight and enable steel frames to strut out over the soil nailed batter.

Concrete strengths expected to be used in the structure are:

Slabs:	32MPa to 40MPa
Columns:	40MPa to 50MPa
Walls:	40MPa

6.1 Future Allowance of 3 more Habitable Floors

The foundations, columns and lateral resisting elements have been designed for 3 more habitable floors, ie level 7, 8 and 9 as shown below. Future level 9 has a concrete roof with a steel roof over for water tightness. Figure 3 describes the future allowance of additional floor levels.

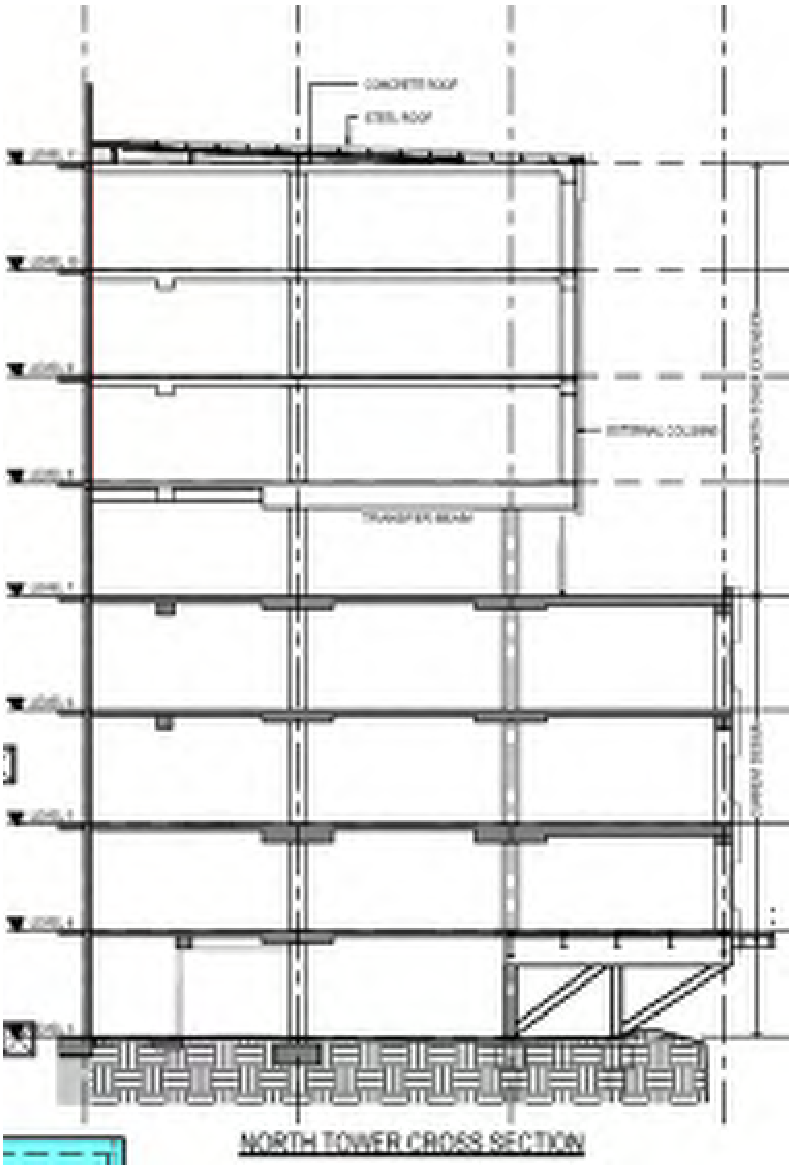


Figure 3

6.2 Foundations

The proposed foundations for this project will comprise a combination of pad footings and piles as indicated below. New pads along grids 5 and 6, east of grid D will support working column loads in the order of 7500kN to 9000kN. Existing pad footings and columns are being utilised west of grid D and will be required to support a working bearing pressure of 400kPa. Bored piles are proposed along grids 7 and 7.5 near the crest of the soiled nailed batter to support working loads in the order of 4000kN to 7800kN.

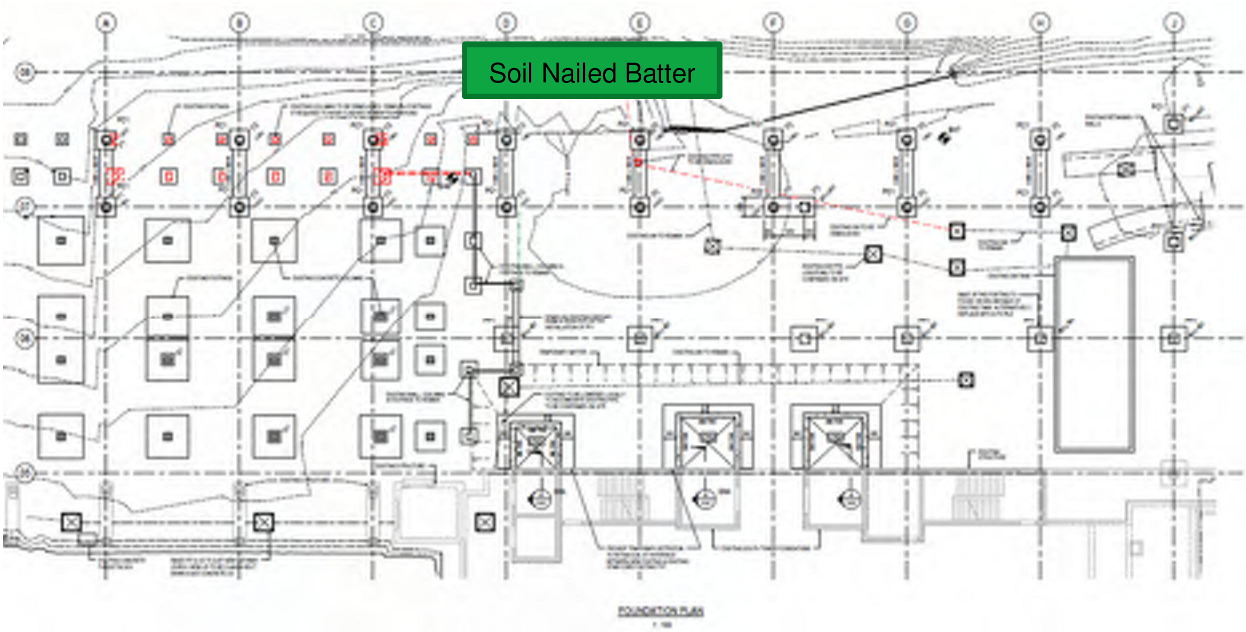


Figure 4

6.3 Columns

Some of the Block A columns and their pad foundations are being retained to support a transfer structure at level 4. These columns are being sleaved in 175mm thick concrete to augment their strength.

The remaining North Tower columns are conventionally reinforced 600 square columns.

6.4 Building Shear Walls

The 3 new lift cores in conjunction with tying the north tower to the south tower at each floor provides the building's lateral resistance.

6.5 Floor Structural System

The column grid is typically 8.4m by 8.4m with a larger column spacing between grid E and F.3 of 10.6m. A post tensioned band beam and slab framing system has been chosen to minimise beam depths and to meet the deflection requirements.

6.6 Floor Vibrations

An analysis of the northern wing of Lismore Hospital has been conducted to determine structural requirements of the building to meet footfall vibration criteria.

Both a post tensioned floor system and a thicker conventionally reinforced system were considered.

The floor system has been analysed to meet the following footfall vibration criteria:

- Medical/ward areas: response factor 2
- MRI machine: information as per “Philips Ingenia 3.0T OmegaHP” specification (dated 01-10-2014)

The MRI machine vibration requirements have been checked for the resonant analysis case for peak acceleration. The vibration limit for transient excitation has been taken as being four times higher (i.e. less sensitive) than for resonant excitation, taking RMS acceleration. This is the case with other similar pieces of equipment, but this needs to be confirmed with the manufacturer.

A specification for the CT scanner titled “Biograph mCT” (dated 10-09-2015) was received, but this document does not include any vibration requirements. We have typically designed medical equipment areas for the vibration requirements of a vibration-sensitive CT scanner titled “SOMATOM Definition Flash” (dated 27-06-2012).

Some non-medical areas (e.g. corridors, offices) have response factors higher than 2, as they are not vibration-sensitive.

It has been assumed that the level 7 structure (to be built at a later date, except for its floor) will be the same layout as level 6. Two analysis cases were used for the assessment of all levels:

1. Non-corridors have a vibration frequency of 1Hz to 1.8Hz
2. Corridors have a vibration frequency of 1Hz to 2.2Hz

Refer to Arcadis’s report “Lismore Hospital Northern Wing Vibration Analysis” dated 8th August 2016, Appendix D for screenshots of vibration output, the constants adopted for the analysis, the medical equipment vibration requirements and for adopted locations of corridors.

6.7 Setdown Flexibility

In order to provide flexibility for the provision of future setdowns, for level 4 to 10 an extra 40mm concrete cover has been incorporated in the depth of the floor slab. This extra topping is poured integrally with the concrete slab. Hence future setdowns can be created by carefully coring and concrete sawing to the depth of the 40mm setdown, without affecting the floors structural integrity.

Level 11 has not incorporated the extra 40mm cover as it is not envisaged that any future setdowns will be required for this level.

6.8 Penetration Requirements for Hydraulic Services

All of the concrete floors have allowed for a 450mm by 300mm penetration to one side of the 600 square internal columns. These are for hydraulic pipes and they will generally be cast in rather than a penetration of this rectangular size. The 450 side of the penetration is parallel to the column face and the 300 side is away from the column face. Only one penetration is permitted as shown on the structural plans, generally either on the west side or the east side at level 4 to 7 and the north side or south side for levels 8 to 10.

Post tensioning tendons will be kept clear of the services zone. Future allowance is made such that if a further penetration is required, the existing zone can be extended by an additional 300mm away from the column face.

APPENDIX A

6.9 Summary of Structural Design Requirements

1.0 Codes and Specifications

Element or Requirement	Codes or Reference Material	Comment
Overall Building Requirements	Building Code of Australia	To meet building requirements
Building Loads	AS/NZS 1170.1 Loading Code Dead and Live AS/NZS 1170.2 Loading Code Wind AS/NZS 1170.4 Loading Code Earthquakes	Also refer Table 3.0
Concrete Elements	AS/NZS 3600 Concrete Structures Code AS/NZS 3610 Formwork for Concrete AS/NZS 3850 Tilt Up Concrete and Precast Concrete Elements for use in Buildings	Also refer technical specifications for Insitu Concrete, Concrete Reinforcement, Concrete Post-Tensioning, Concrete Formwork and Pre-Cast Concrete
Steel Elements	AS/NZS 4100 Steel Structures Code AS/NZS 4600 Cold Formed Steel Structures	Also refer technical specification for Structural Steel
Brick and Block Elements	AS/NZS 3700 Masonry in Buildings	Also refer technical specification for Brick and Block
Earthworks and Shoring Elements	Geotechnical Report by Douglas Partners (Project 90317)	Also refer technical specification for earthworks, piling.
Footings and Piling	AS2159 Piling Code Geotechnical Reports by Douglas Partners (Project 90317)	

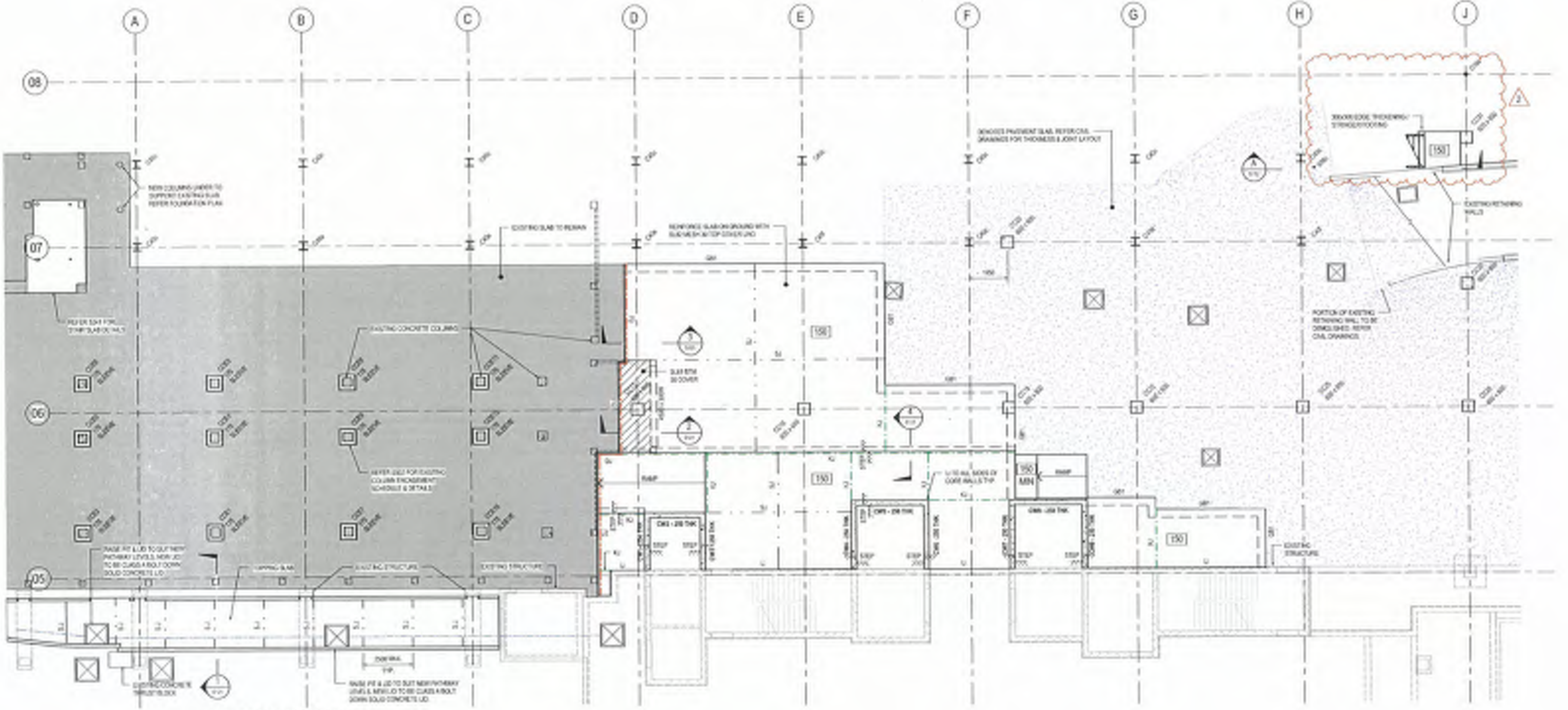
2.0 Design Criteria- Floor Deflection Limits				
Element	**Dead Load**	**Incremental**	**Live**	**DL + LL**
Floors supporting masonry walls	Span/360	Span/1000[1]	Span/500	Span/300 (25mm max)
Compactus areas	N/A	Span/750[2]	N/A	25mm max
Other floor areas	Span/360 (20mm max)	N/A	Span/500	Span/300 (25mm max)
Elements supporting glazing	N/A	15mm[4]	N/A	Span/500 (20mm max)
Transfer Beams	Span/1000	Span/500	N/A	15

1. Areas supporting normal weight masonry partitions.
2. Incremental deflection after compactus installed
3. All deflections are for long term conditions except for the incremental column
4. After glazing is installed.

3.0 Loads (Loading Plans take Precedence)		
Element or Area	**Load**	**Comment**
Dead Load		
Floor Slabs and Beams	Self-weight as calculated	Taken as a density of 2,500kg/m^3
Services, Ceiling, Floor Coverings and Partitions and Access floor allowance.	2.8 kPa	Hospital floors, Office Areas, Lobbies, Retail Areas, Community Facilities
Masonry Partitions	Self-weight as calculated.	Taken as a density of 2,200kg/m^3
Facade	1.0 kPa Minimum or as calculated.	
Live Load		
Lobby and all Stairs	4.0 kPa	
Hospital Floors and Office areas	3.0 kPa	
Store rooms	2.4 kPa /m height	Maximum height of 2.1m
Compactus	4.0 kPa/m height	
Ground Floor Areas to Support Service Vehicles/Fire Tender	15.0 kPa	
Carpark and Ramps (Excluding those to support service vehicles)	2.5 kPa	
Service Vehicle Loading Dock Area and Circulation Zones	10.0 kPa	
Commercial Levels	3.0 kPa	
Mechanical and Electrical Plant Rooms	5.0 kPa generally UNO, 7.5kPa to Roof Level plant.	3kPa only permitted on the existing Block A, level 3
Lift Motor Room	5.0 kPa	
Landscape Areas	18kPa (minimum)	Calculated based on depth of soil with density of 18kN/m^3
Steel roofs (Non-trafficable)	0.25kPa	

APPENDIX B

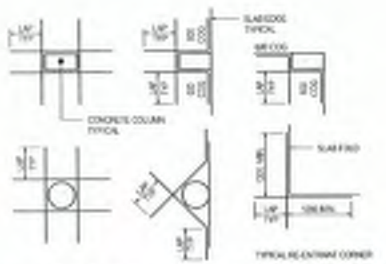
6.10 Structural General Arrangement and Loading Diagram Drawings



LEVEL 3 LINK PASSAGE WAY

LEVEL 3 SLAB PLAN

1 : 100



TYPICAL SLAB ON GROUND TRIMMER BAR DETAILS

NOTES:
1. TRIMMER BARS TO BE 2N12-100 TOP U.N.O.
2. REFER S004 FOR REINFORCEMENT LAP LENGTH SCHEDULES

NOTES

1. REFER S001 DRAWINGS FOR STANDARD NOTES
2. REFER S004 FOR CONCRETE STRENGTHS
3. REFER ARCHITECT FOR FALLS, SETDOWNS etc.
4. REFER ARCHITECT & SERVICES DRAWINGS FOR ALL RISER PENETRATIONS
5. REINFORCE SLAB ON GROUND WITH 1 LAYER OF SL82 MESH 50 TOP COVER
6. SETDOWNS SHOWN ON PLAN NOT TO BE MORE THAN 40mm

LEGEND

REFER S001 DRAWINGS FOR STANDARD NOTES

- DENOTES STEP IN TOP STRUCTURAL LEVEL OR EDGE REBATE
- 200 — DENOTES STRUCTURAL SLAB THICKNESS
- C.J. — DENOTES POUR BREAK CONSTRUCTION JOINT
- D.J. — DENOTES DOWEL JOINT
- K.J. — DENOTES KEY JOINT
- S.J. — DENOTES SAWN JOINT
- M.J. — DENOTES MOVEMENT JOINT
- I.J. — DENOTES ISOLATION JOINT
- DENOTES SLAB / WALL PENETRATION IN PLAN / ELEVATION
- DENOTES SLAB SETDOWN
- DENOTES LOAD BEARING ELEMENT UNDER
- DENOTES CONCRETE INSITU ELEMENT OVER
- DENOTES CONCRETE INSITU ELEMENT UNDER & OVER
- 200 THK — DENOTES STRUCTURAL RC WALL THICKNESS
- SW - 200 THK — DENOTES STRUCTURAL RC SCREEN WALL, REFER S610 FOR ELEVATION DETAILS
- CW1 - 200 THK — DENOTES STRUCTURAL RC CORE WALL, REFER S601-3 FOR ELEVATIONS
- DENOTES IN SCHMORN ELEMENT OVER, REFER S621 FOR TYPE & TYPICAL DETAILS
- DENOTES 1/3 BAT BONDER SLAB (40MPa) CONTINUOUS OVER A MIN. OF 2 SPANS
- GB1 — DENOTES 400 x 400 GROUND BEAM, REFER S121 FOR TYPICAL DETAIL

STEEL COLUMN SCHEDULE	
MARK	SIZE
C45	[illegible]
C45a	[illegible]
C46	[illegible]
C47	[illegible]
C48a	[illegible]
S06	[illegible]

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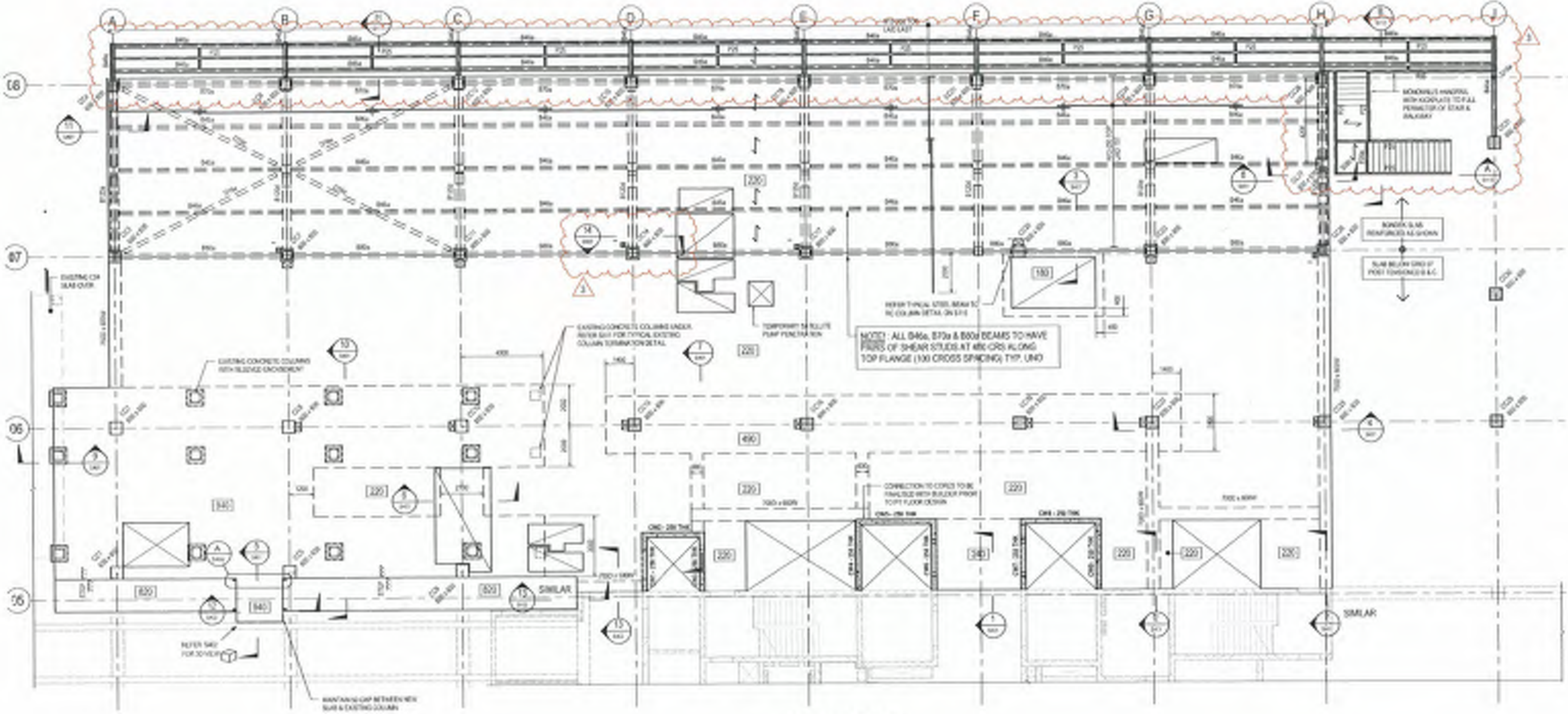
ISSUE | REVISION DESCRIPTION | DATE | APD

CLIENT: HEALTH INFRASTRUCTURE

DRAWING: LEVEL 3 SLAB PLAN

PROJECT: LISMORE BASE HOSPITAL STAGE 3B2



LEVEL 4 SLAB PLAN

1 : 100

TYPICAL SLAB SECTION U.N.O.

1 : 10

NOTES

LEGEND

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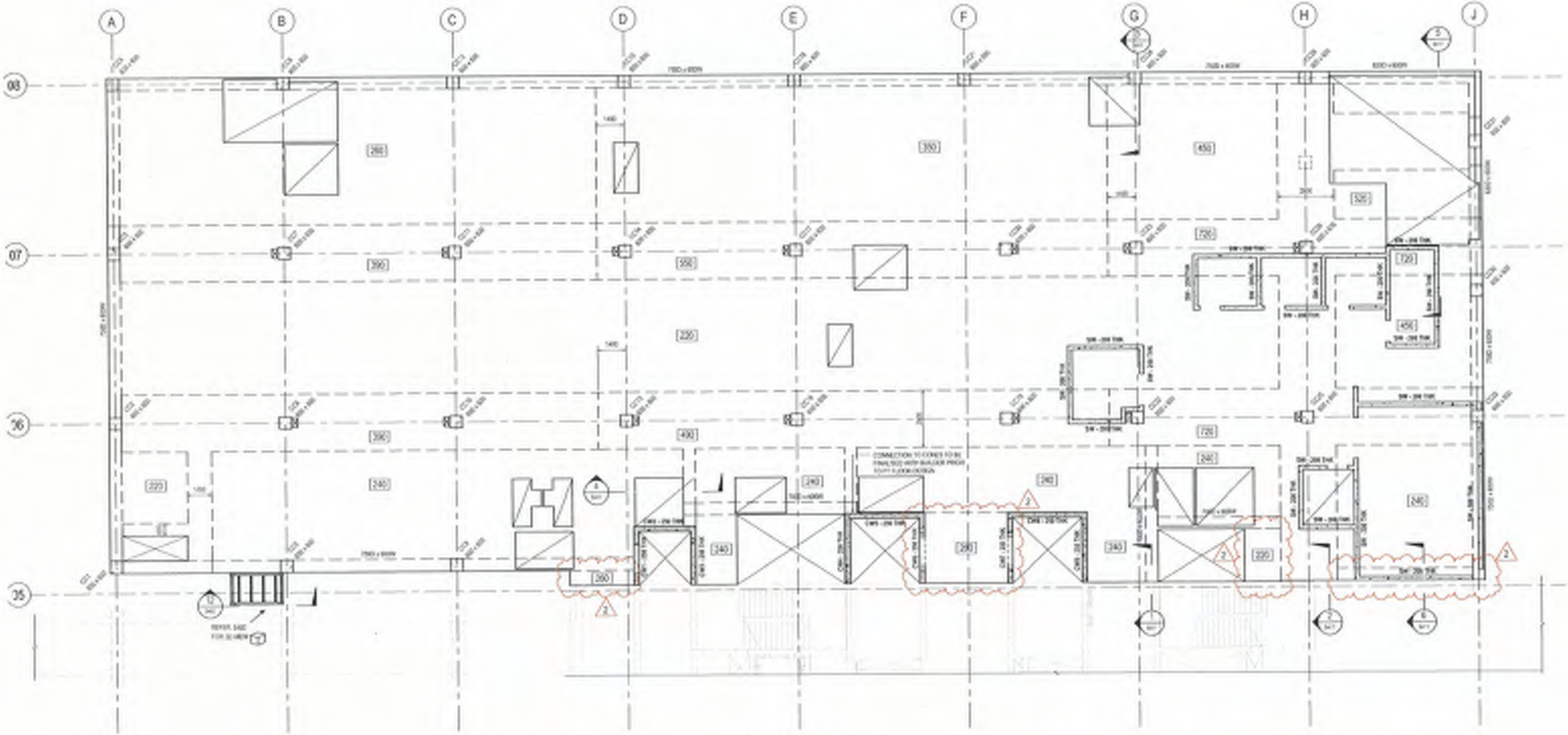
LEVEL 4 GENERAL ARRANGEMENT PLAN

LISMORE BASE HOSPITAL STAGE 3B2



LEVEL 5 SLAB PLAN

1 : 100

BEAM SECTION SIMILAR

TYPICAL SLAB SECTION U.N.O.

1 : 10

NOTES

LEGEND

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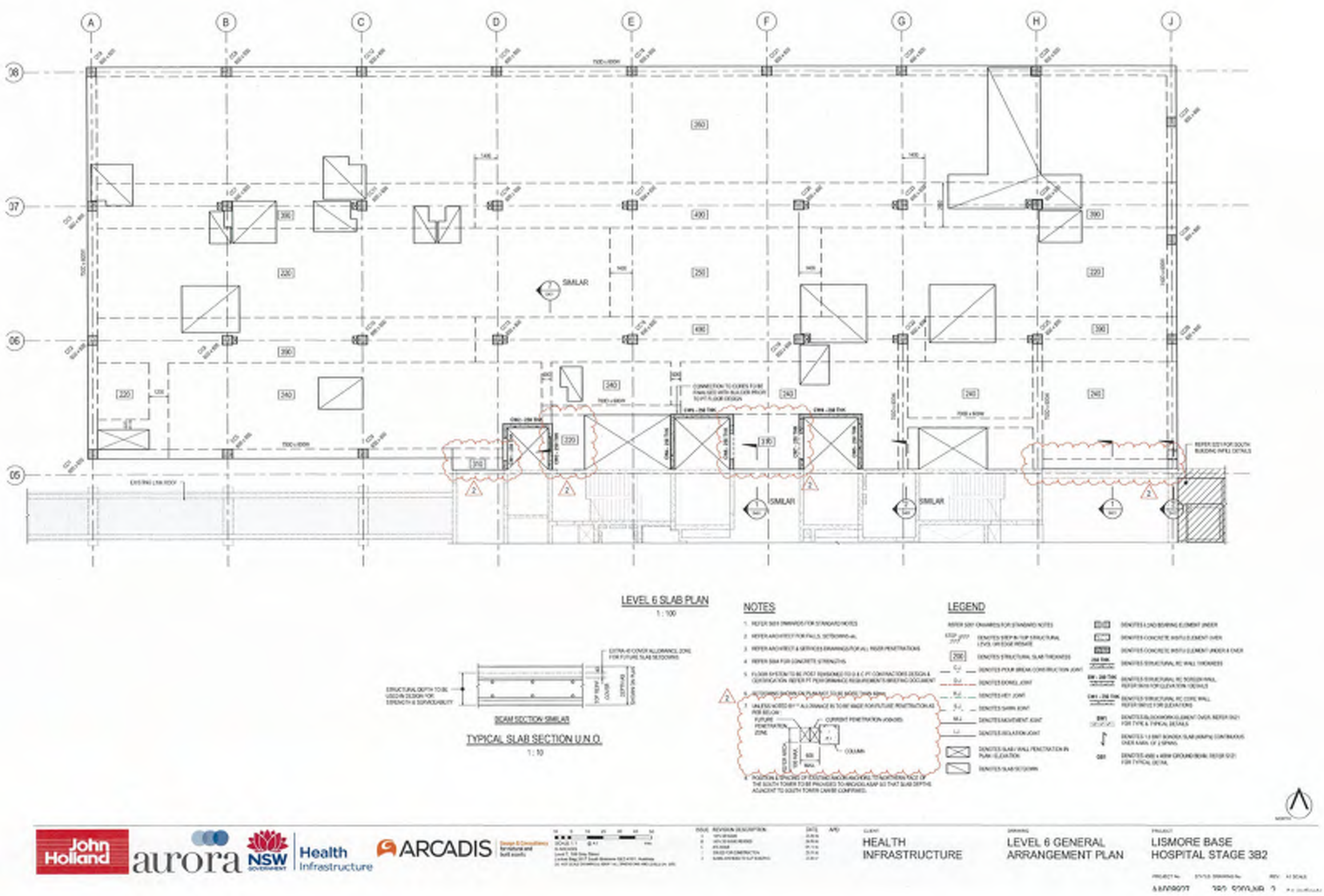
LEVEL 5 GENERAL ARRANGEMENT PLAN

LISMORE BASE HOSPITAL STAGE 3B2


A
B
C
D
E
F
G
H
J
08
07
06
05
SIMILAR
EXISTING LINK ROOF
LEVEL 6 SLAB PLAN
1 : 100
TYPICAL SLAB SECTION U.N.O.
1 : 10
BEAM SECTION SIMILAR
NOTES
1. REFER S001 DRAWINGS FOR STANDARD NOTES
3. REFER ARCHITECT & SERVICES DRAWINGS FOR ALL RISER PENETRATIONS
5. FLOOR SYSTEM TO BE POST TENSIONED TO D & C PT CONTRACTORS DESIGN & CERTIFICATION. REFER PT PERFORMANCE REQUIREMENTS BRIEFING DOCUMENT
CURRENT PENETRATION
COLUMN
LEGEND
DENOTES STRUCTURAL SLAB THICKNESS
DENOTES SLAB SETDOWN
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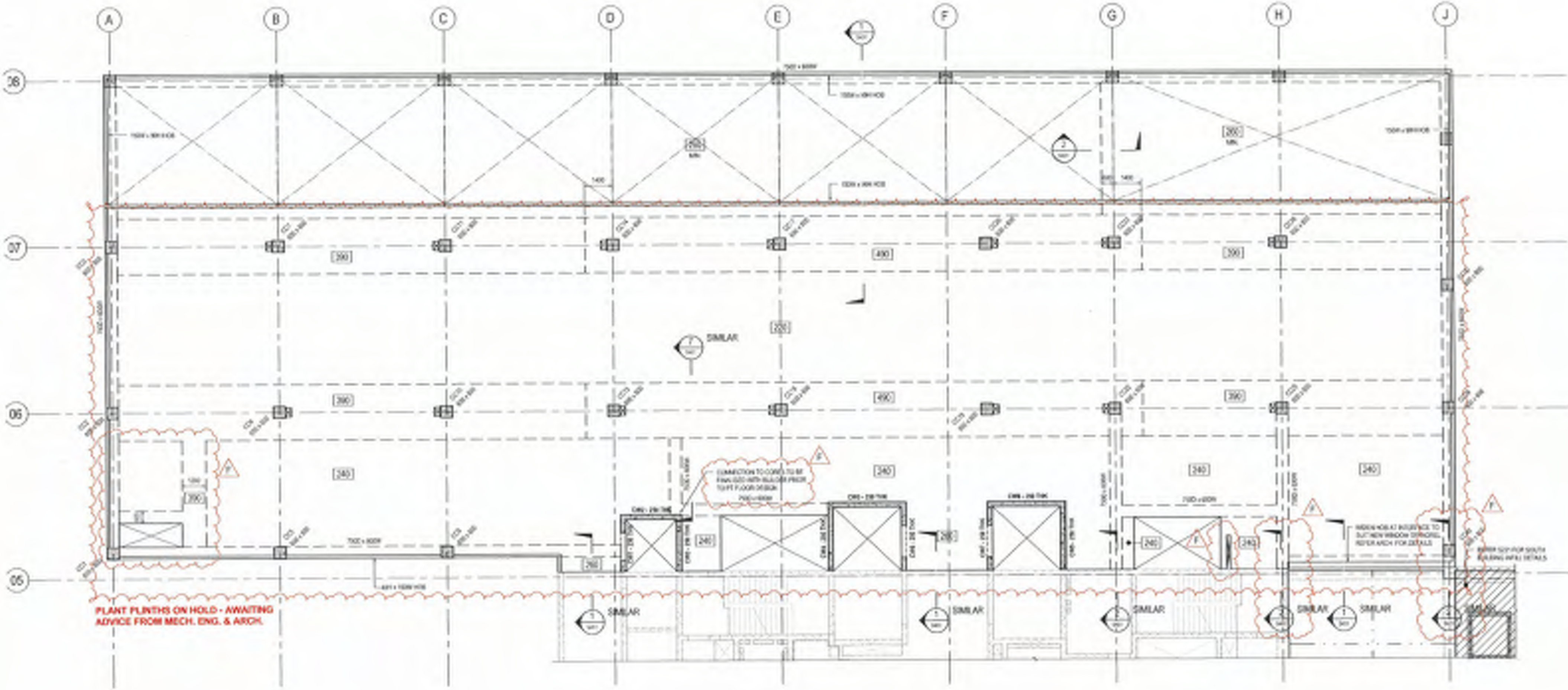
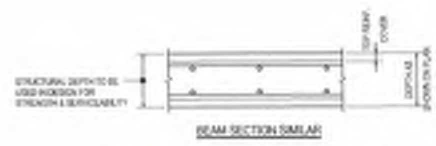
DRAWING
LEVEL 6 GENERAL ARRANGEMENT PLAN
PROJECT
LISMORE BASE HOSPITAL STAGE 3B2



LEVEL 7 SLAB PLAN

1 : 100



TYPICAL SLAB SECTION LEVEL 7 & 11 ONLY

1 : 10

NOTES

1. REFER S001 DRAWINGS FOR STANDARD NOTES.
2. REFER ARCHITECT FOR FALLS, SETDOWNS etc.
3. REFER ARCHITECT & SERVICES DRAWINGS FOR ALL RISER PENETRATIONS.
4. REFER S004 FOR CONCRETE STRENGTHS.
5. FLOOR SYSTEM TO BE POST TENSIONED TO D & C PT CONTRACTORS DESIGN & CERTIFICATION. REFER PT PERFORMANCE REQUIREMENTS BRIEFING DOCUMENT.
6. SETDOWNS SHOWN ON PLAN NOT TO BE MORE THAN 40mm.
7. UNLESS NOTED BY "*" ALLOWANCE IS TO BE MADE FOR FUTURE PENETRATION AS PER BELOW.

FUTURE PENETRATION ZONE — CURRENT PENETRATION — COLUMN

8. POSITION & SPACING OF EXISTING ANCON ANCHORS TO NORTHERN FACE OF THE SOUTH TOWER TO BE PROVIDED TO ARCADIS ASAP SO THAT SLAB DEPTHS ADJACENT TO SOUTH TOWER CAN BE CONFIRMED.

LEGEND

REFER S001 DRAWINGS FOR STANDARD NOTES.

- DENOTES STEP IN TOP STRUCTURAL LEVEL OR EDGE REBATE
- DENOTES STRUCTURAL SLAB THICKNESS
- DENOTES POUR BREAK CONSTRUCTION JOINT
- DENOTES DOWEL JOINT
- DENOTES KEY JOINT
- DENOTES SAWN JOINT
- DENOTES MOVEMENT JOINT
- DENOTES ISOLATION JOINT
- DENOTES SLAB / WALL PENETRATION IN PLAN / ELEVATION
- DENOTES SLAB SETDOWN
- DENOTES LOAD BEARING ELEMENT UNDER
- DENOTES CONCRETE INSITU ELEMENT OVER
- DENOTES CONCRETE INSITU ELEMENT UNDER & OVER
- DENOTES STRUCTURAL RC WALL THICKNESS
- DENOTES STRUCTURAL RC SCREEN WALL. REFER S410 FOR ELEVATION DETAILS
- DENOTES STRUCTURAL RC CORE WALL. REFER S40 FOR ELEVATIONS
- DENOTES BLOCKWORK ELEMENT OVER. REFER S521 FOR TYPE & TYPICAL DETAILS
- DENOTES 1.5 WAY BORDER SLAB CONTINUOUS OVER A MIN. OF 2 SPANS
- GB1 DENOTES GROUND BEAM. REFER S521 FOR TYPICAL DETAIL

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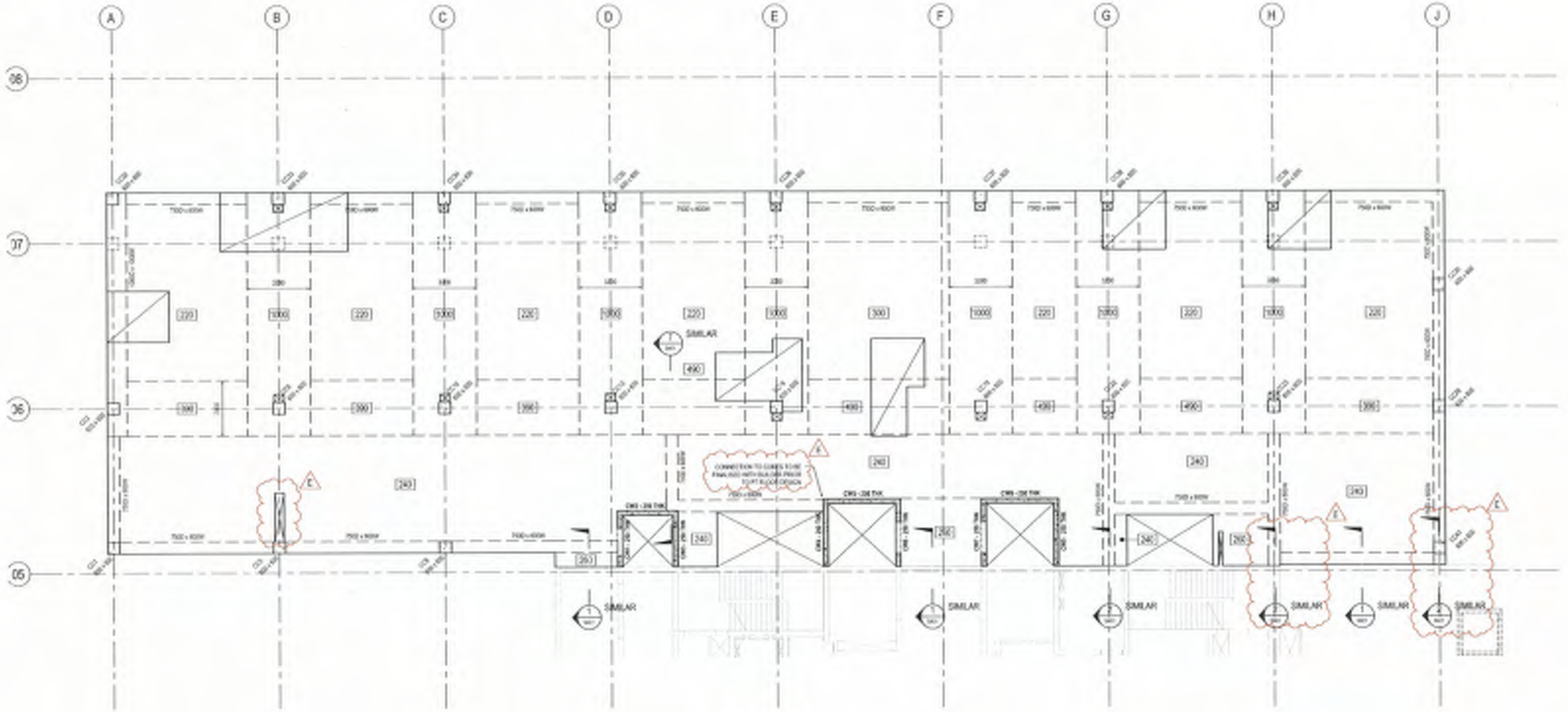
CLIENT: HEALTH INFRASTRUCTURE

DRAWING: LEVEL 7 GENERAL ARRANGEMENT PLAN

PROJECT: LISMORE BASE HOSPITAL STAGE 3B2



LEVEL 8 SLAB PLAN

1 : 100

TYPICAL SLAB SECTION U.N.O.

1 : 10

NOTES

LEGEND

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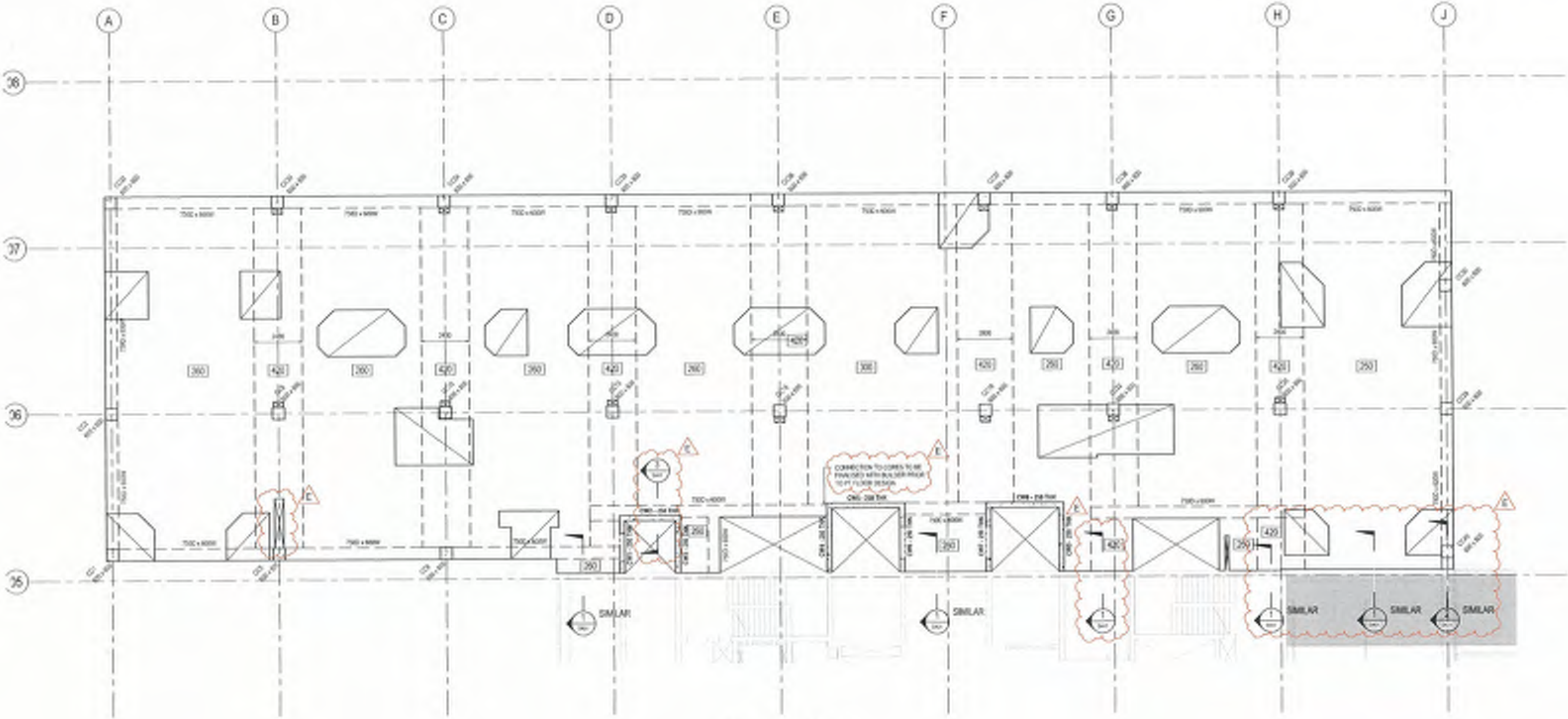
CLIENT: HEALTH INFRASTRUCTURE

DRAWING: NORTH TOWER EXTENSION LEVEL 8 GENERAL ARRANGEMENT PLAN

PROJECT: LISMORE BASE HOSPITAL STAGE 3B2



LEVEL 9 SLAB PLAN

1 : 100

TYPICAL SLAB SECTION U.N.O.

1 : 10

NOTES

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NORTH TOWER EXTENSION LEVEL 9 GENERAL ARRANGEMENT PLAN

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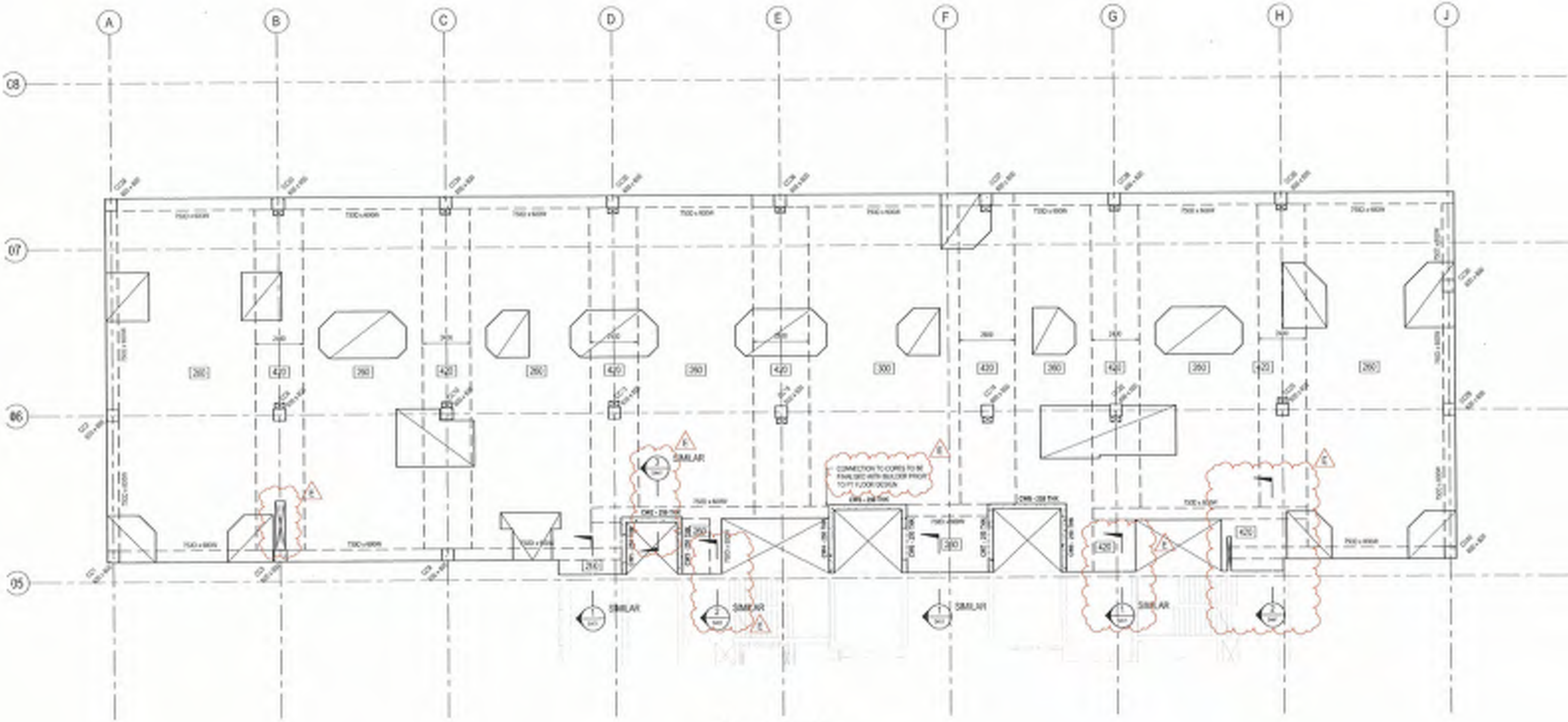
LISMORE BASE HOSPITAL STAGE 3B2

PRELIMINARY



LEVEL 10 SLAB PLAN

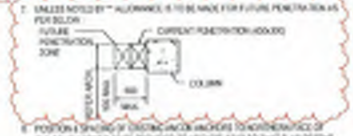
1 : 100

TYPICAL SLAB SECTION U.N.O.

1 : 10

NOTES

1. REFER S001 DRAWINGS FOR STANDARD NOTES
2. REFER ARCHITECT FOR FALLS, SETDOWNS etc.
3. REFER ARCHITECT & SERVICES DRAWINGS FOR ALL RISER PENETRATIONS
4. REFER S004 FOR CONCRETE STRENGTHS
5. FLOOR SYSTEM TO BE POST TENSIONED TO D & C PT CONTRACTOR'S DESIGN & CERTIFICATION. REFER PT PERFORMANCE REQUIREMENTS BRIEFING DOCUMENT
6. SETDOWNS SHOWN ON PLAN NOT TO BE MORE THAN 40mm
7. UNLESS NOTED BY "" ALLOWANCE IS TO BE MADE FOR FUTURE PENETRATION AS PER BELOW



8. POSITION & SPACING OF EXISTING ANCHOR ANCHORS TO NORTHERN FACE OF THE SOUTH TOWER TO BE PROVIDED TO ARCADIS ASAP SO THAT SLAB DEPTHS ADJACENT TO SOUTH TOWER CAN BE CONFIRMED

LEGEND

REFER S001 DRAWINGS FOR STANDARD NOTES

- DENOTES STEP & TOP STRUCTURAL LEVEL OR EDGE REBATE
- DENOTES STRUCTURAL SLAB THICKNESS
- DENOTES POUR BREAK CONSTRUCTION JOINT
- DENOTES DOWEL JOINT
- DENOTES KEY JOINT
- DENOTES SAWN JOINT
- DENOTES MOVEMENT JOINT
- DENOTES ISOLATION JOINT
- DENOTES SLAB / WALL PENETRATION IN PLAN / ELEVATION
- DENOTES SLAB SETDOWN
- DENOTES LOADBEARING ELEMENT UNDER
- DENOTES CONCRETE INSITU ELEMENT OVER
- DENOTES CONCRETE INSITU ELEMENT UNDER & OVER
- DENOTES STRUCTURAL RC WALL THICKNESS
- DENOTES STRUCTURAL RC SCREEN WALL. REFER S410 FOR ELEVATION DETAILS
- DENOTES STRUCTURAL RC CORE WALL. REFER S410 FOR ELEVATIONS
- DENOTES BLOCKWORK ELEMENT OVER. REFER S021 FOR TYPE & TYPICAL DETAILS
- DENOTES 1:1 BNT BONDEK SLAB CONTINUOUS OVER A MIN. OF 2 SPANS
- DENOTES GROUND BEAM. REFER FOR TYPICAL DETAIL

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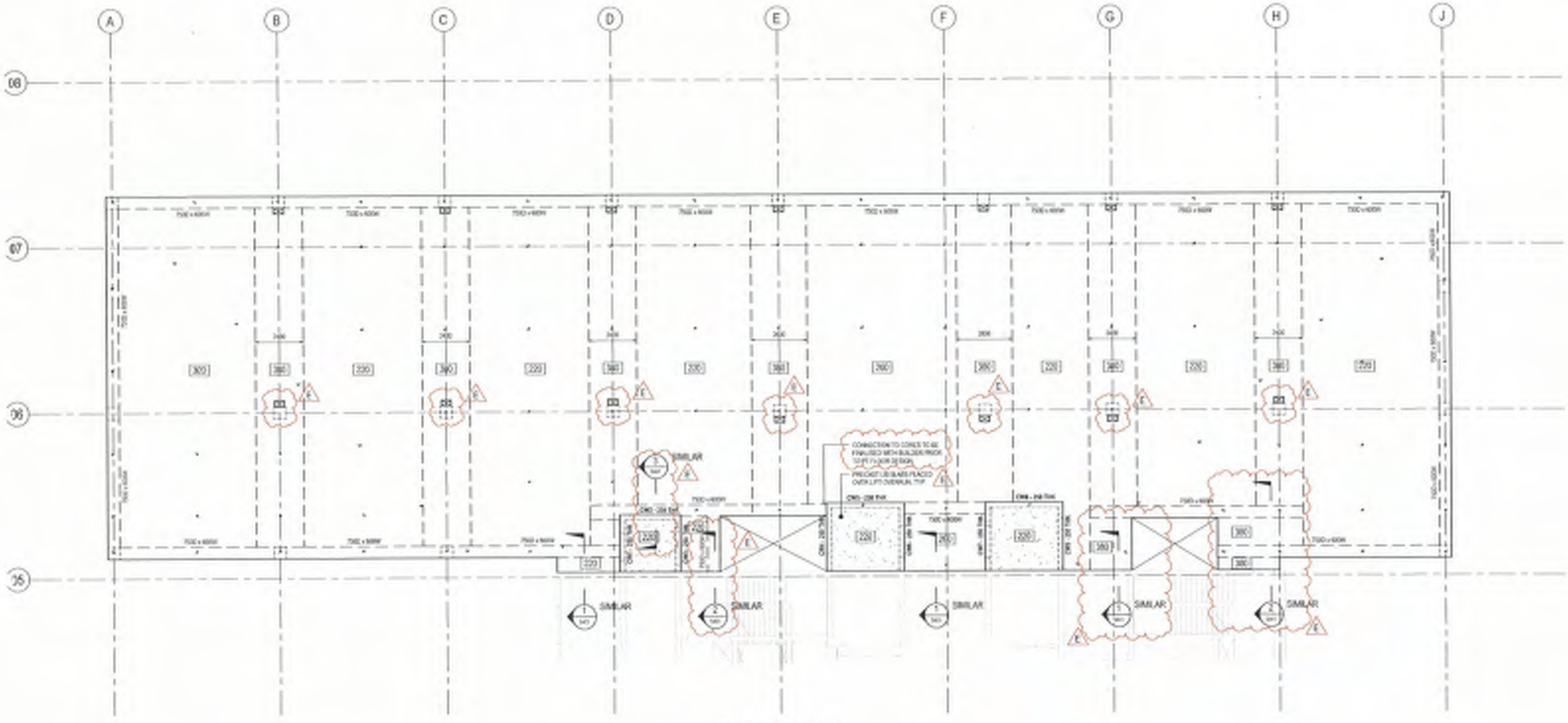
CLIENT: HEALTH INFRASTRUCTURE

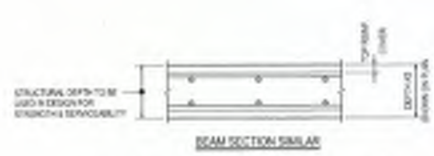
DRAWING: NORTH TOWER EXTENSION LEVEL 10 GENERAL ARRANGEMENT PLAN

PROJECT: LISMORE BASE HOSPITAL STAGE 3B2



LEVEL 11 SLAB PLAN

1 : 100



TYPICAL SLAB SECTION LEVEL 7 & 11 ONLY

1 : 10

NOTES

1. REFER S001 ONWARDS FOR STANDARD NOTES
2. REFER ARCHITECT FOR FALLS, SETDOWNS etc.
3. REFER ARCHITECT & SERVICES DRAWINGS FOR ALL RISER PENETRATIONS
4. REFER S00x FOR CONCRETE STRENGTHS
5. FLOOR SYSTEM TO BE POST TENSIONED TO D & C PT CONTRACTOR'S DESIGN & CERTIFICATION. REFER PT PERFORMANCE REQUIREMENTS BRIEFING DOCUMENT
6. SETDOWNS SHOWN ON PLAN NOT TO BE MORE THAN 40mm
7. UNLESS NOTED BY * ALLOWANCE IS TO BE MADE FOR FUTURE PENETRATION AS PER BELOW:
   FUTURE PENETRATION ZONE — CURRENT PENETRATION — COLUMN — 400 MAX
8. POSITION & SPACING OF EXISTING ANCHORS TO NORTHERN FACE OF THE SOUTH TOWER TO BE PROVIDED TO ARCADIS ASAP SO THAT SLAB DOPING ADJACENT TO SOUTH TOWER CAN BE CONFIRMED

LEGEND

REFER S001 ONWARDS FOR STANDARD NOTES

- DENOTES STEP IN TOP STRUCTURAL LEVEL OR EDGE REBATE
- DENOTES STRUCTURAL SLAB THICKNESS
- DENOTES POUR BREAK CONSTRUCTION JOINT
- DENOTES DOWEL JOINT
- DENOTES KEY JOINT
- DENOTES SAWN JOINT
- DENOTES MOVEMENT JOINT
- DENOTES ISOLATION JOINT
- DENOTES SLAB / WALL PENETRATION IN PLAN / ELEVATION
- DENOTES SLAB SETDOWN
- DENOTES LOAD BEARING ELEMENT UNDER
- DENOTES CONCRETE INSITU ELEMENT OVER
- DENOTES CONCRETE INSITU ELEMENT UNDER & OVER
- DENOTES STRUCTURAL RC WALL THICKNESS
- DENOTES STRUCTURAL RC SCREEN WALL, REFER S8XX FOR ELEVATION DETAILS
- DENOTES STRUCTURAL RC CORE WALL, REFER S8XX FOR ELEVATIONS
- DENOTES BLOCKWORK ELEMENT OVER, REFER S0X FOR TYPE & TYPICAL DETAILS
- DENOTES GROUND BEAM, REFER S7X FOR TYPICAL DETAIL

PRELIMINARY

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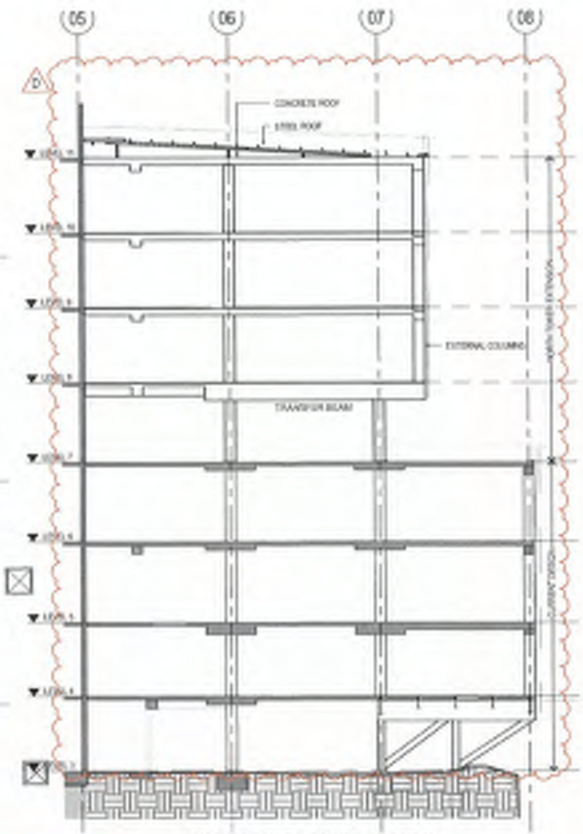
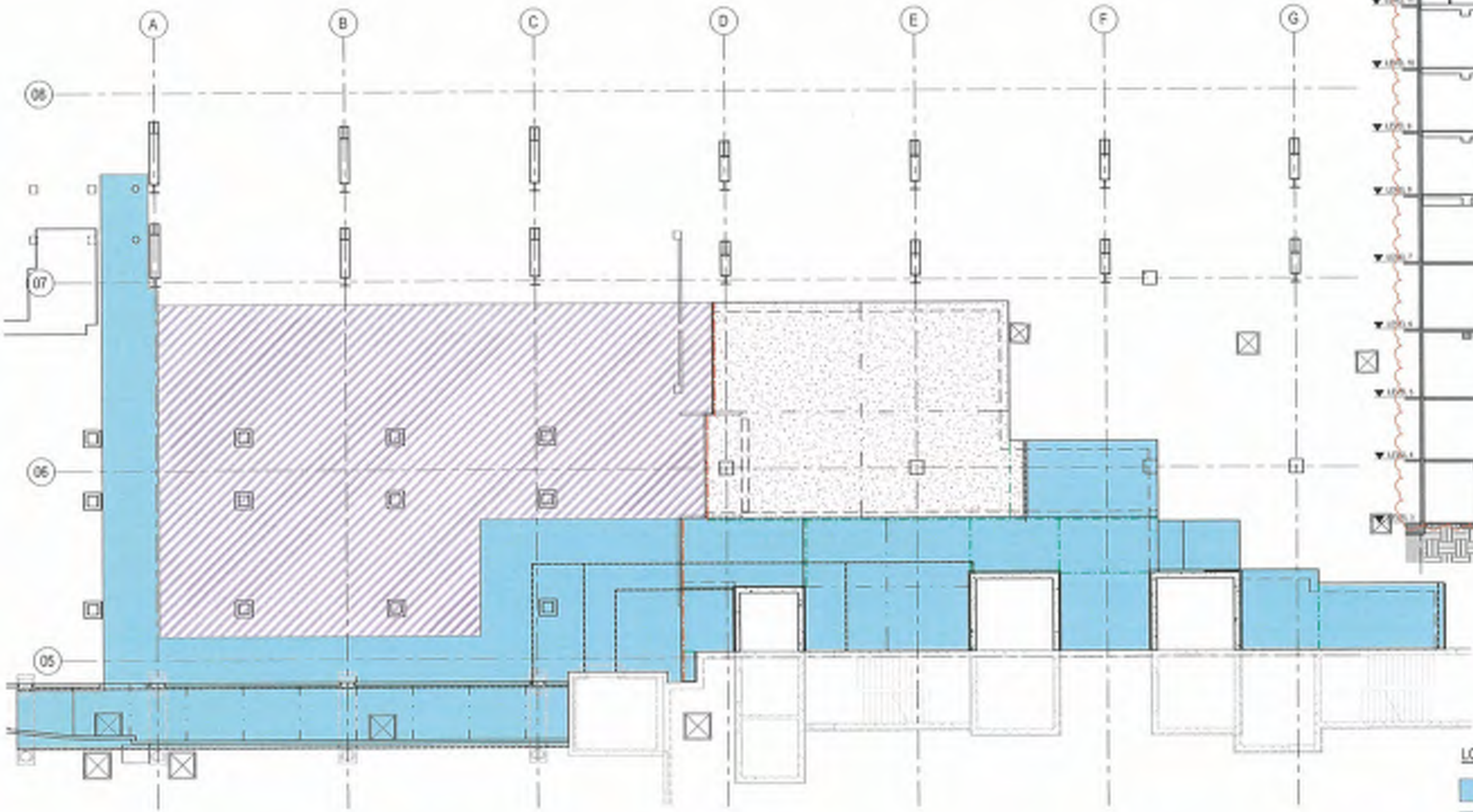
CLIENT: HEALTH INFRASTRUCTURE

DRAWING: NORTH TOWER EXTENSION LEVEL 11 GENERAL ARRANGEMENT PLAN

PROJECT: LISMORE BASE HOSPITAL STAGE 3B2



NORTH TOWER CROSS SECTION



LEVEL 3 LOADING PLAN

1 : 100

LOADING PLAN LEGEND FOR LEVELS 3, 4, 5 & 6

- PLANT ROOM LIVE LOADING (EXISTING SLAB)
- PLANT ROOM LIVE LOADING (NEW SLAB)
- CONCRETE WALL LOADING
- FACADE LOADING TO EXTERNAL BUILDING EDGES

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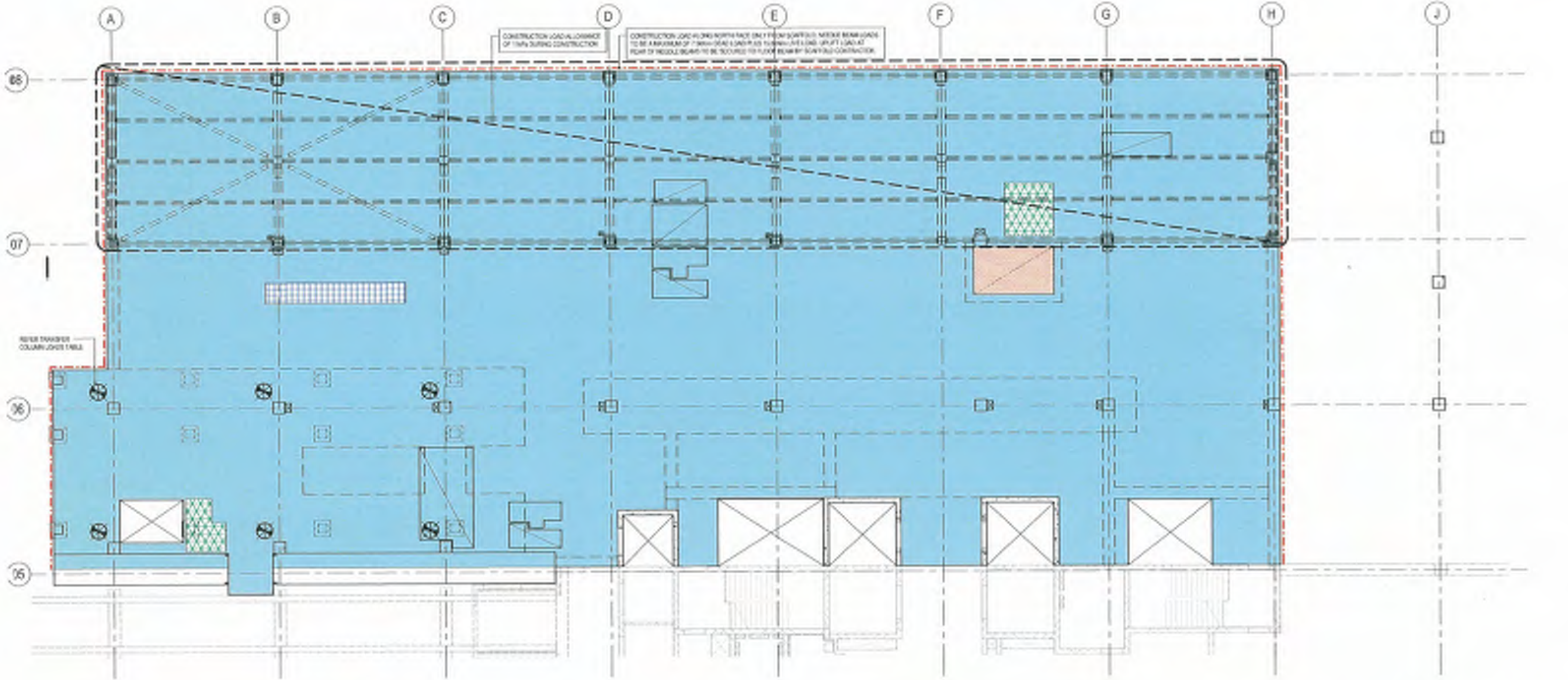
CLIENT: HEALTH INFRASTRUCTURE

DRAWING: LEVEL 3 LOADING PLAN

PROJECT: LISMORE BASE HOSPITAL STAGE 3B2



LEVEL 4 LOADING PLAN

1 : 100

TRANSFER COLUMN LOADS		
GRID LOCATION	DEAD LOAD	LIVE LOAD
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]

LOADING PLAN LEGEND FOR LEVELS 3, 4, 5 & 6

- GENERAL – SUPERIMPOSED DEAD LOAD [illegible] LIVE LOAD [illegible]; CORRIDORS – SUPERIMPOSED DEAD LOAD [illegible] LIVE LOAD [illegible] (REFER ARCHITECTURAL DRAWINGS FOR CORRIDOR LOCATIONS)
- COMPACTUS LOADING [illegible]
- COLD ROOM LOADING [illegible]
- STORE ROOM LOADING [illegible]
- MRI / CT SCANNER ROOM LOADING [illegible]
- PLANT ROOM LIVE LOADING (EXISTING SLAB) [illegible]
- PLANT ROOM LIVE LOADING (NEW SLAB) [illegible]
- CONCRETE WALL LOADING [illegible]
- FACADE LOADING TO EXTERNAL BUILDING EDGES [illegible]

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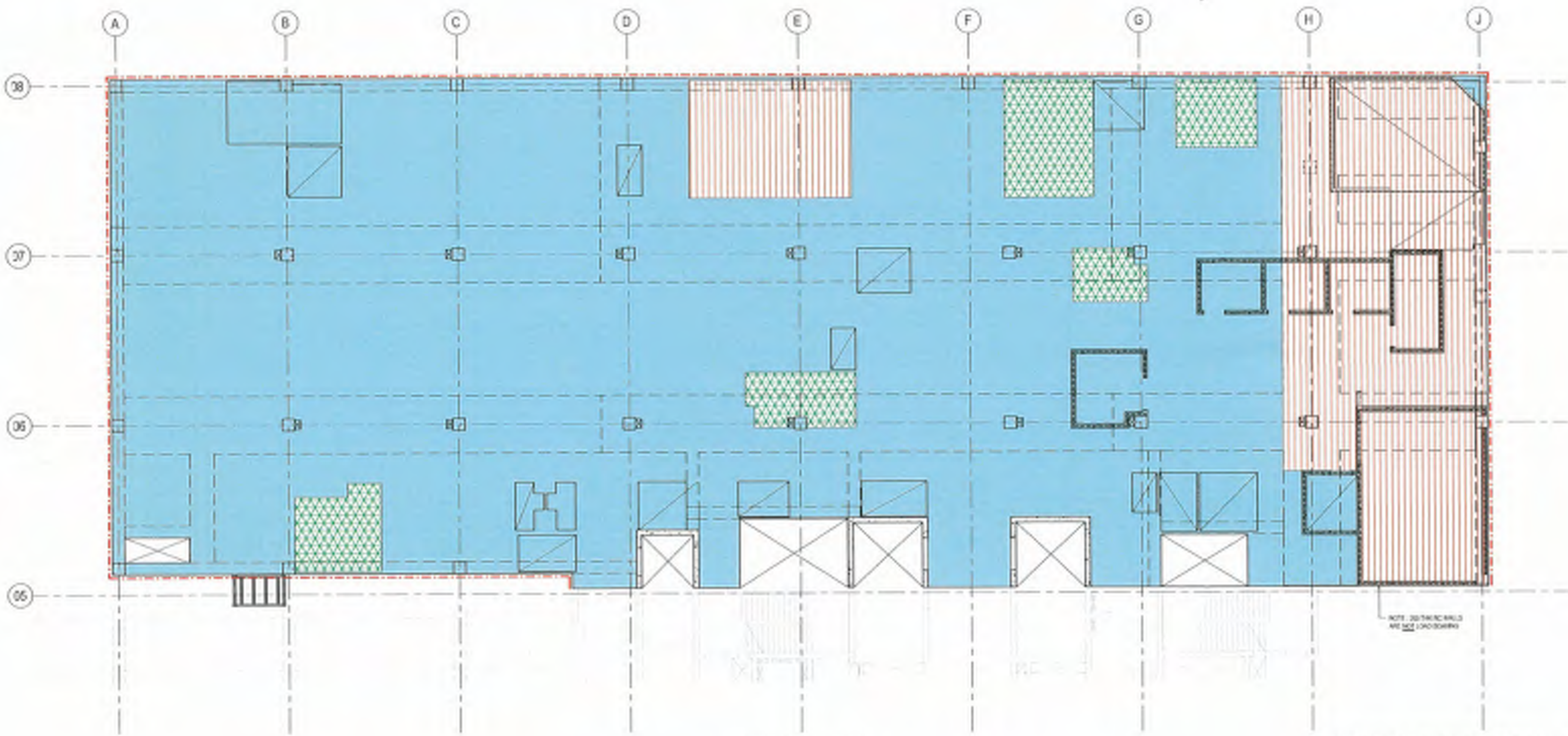
CLIENT: HEALTH INFRASTRUCTURE

DRAWING: LEVEL 4 LOADING PLAN

PROJECT: LISMORE BASE HOSPITAL STAGE 3B2



LEVEL 5 LOADING PLAN

1 : 100

LOADING PLAN LEGEND FOR LEVELS 3, 4, 5 & 6

DRAWING	LEVEL 5 LOADING PLAN
CLIENT	HEALTH INFRASTRUCTURE
PROJECT	LISMORE BASE HOSPITAL STAGE 3B2

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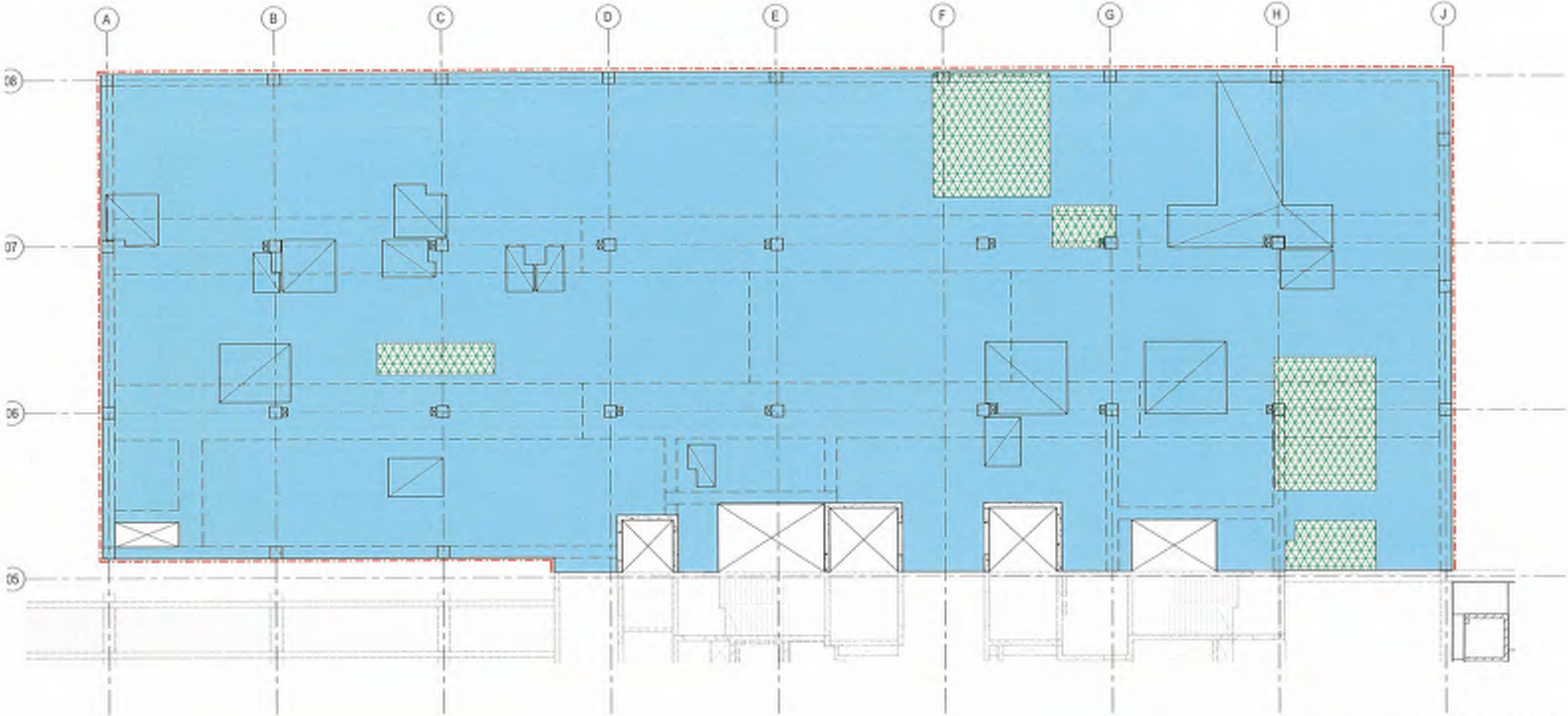
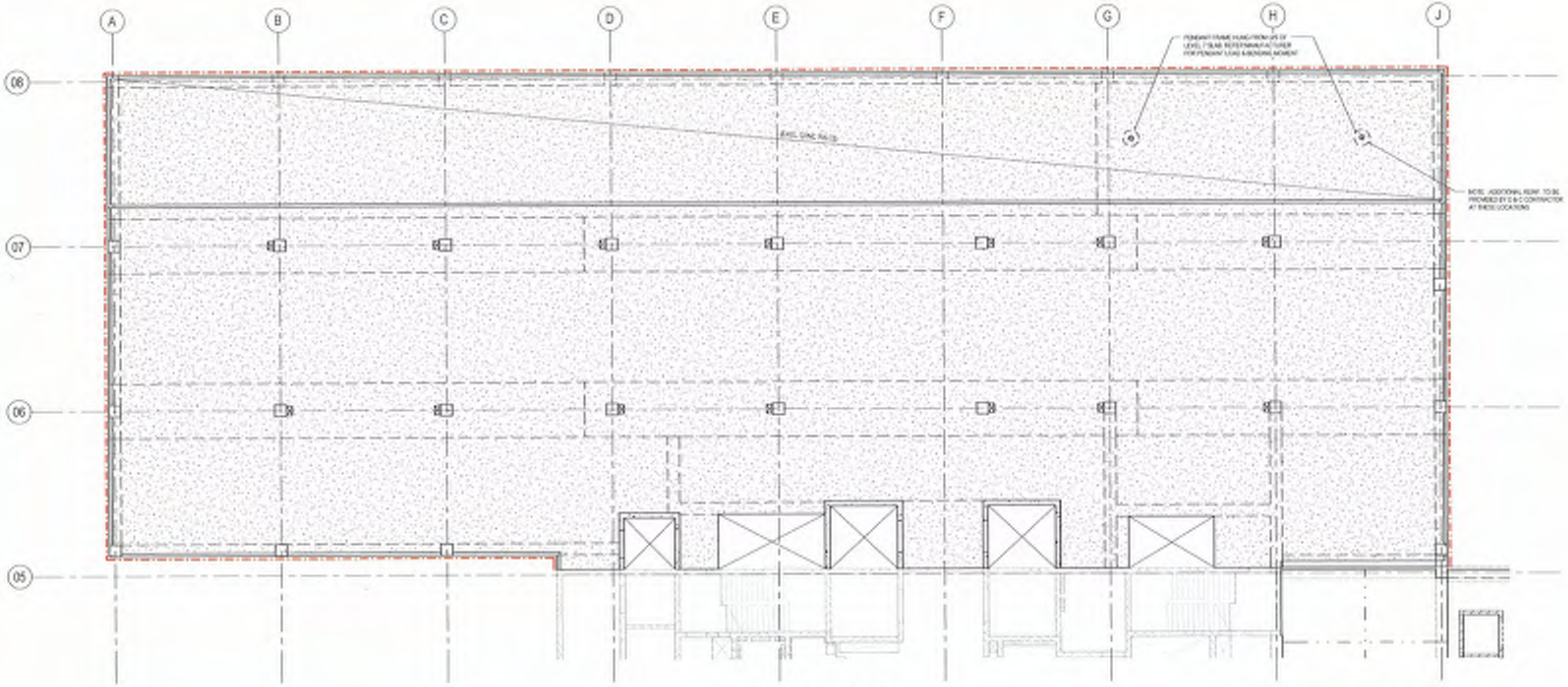


LEVEL 6 LOADING PLAN

1 : 100

John Holland / aurora / NSW Government Health Infrastructure / ARCADIS	CLIENT: HEALTH INFRASTRUCTURE	DRAWING: LEVEL 6 LOADING PLAN	PROJECT: LISMORE BASE HOSPITAL STAGE 3B2



LEVEL 7 LOADING PLAN

1 : 100

NOTE: NO ALLOWANCE FOR FUTURE TOPPING

LOADS TO BE CONFIRMED BY JHG.
PLINTHS & PLANT LOADS TO BE PROVIDED BY WOOD & GRIEVE ENGINEERS

TRANSFER COLUMN LOADS		
COLUMN MARK	DEAD LOAD	LIVE LOAD
ST40	540kN	120kN

LOADING PLAN LEGEND FOR LEVEL 7 ONLY

- PLANT ROOM LIVE LOADING – LIVE LOAD = 5kPa / PLINTHS = 3kPa – SUPERIMPOSED DEAD LOAD = 1.2kPa
- CONCRETE WALL LOADING – 15kN/m
- FACADE LOADING TO EXTERNAL BUILDING CODES – 4kN/m

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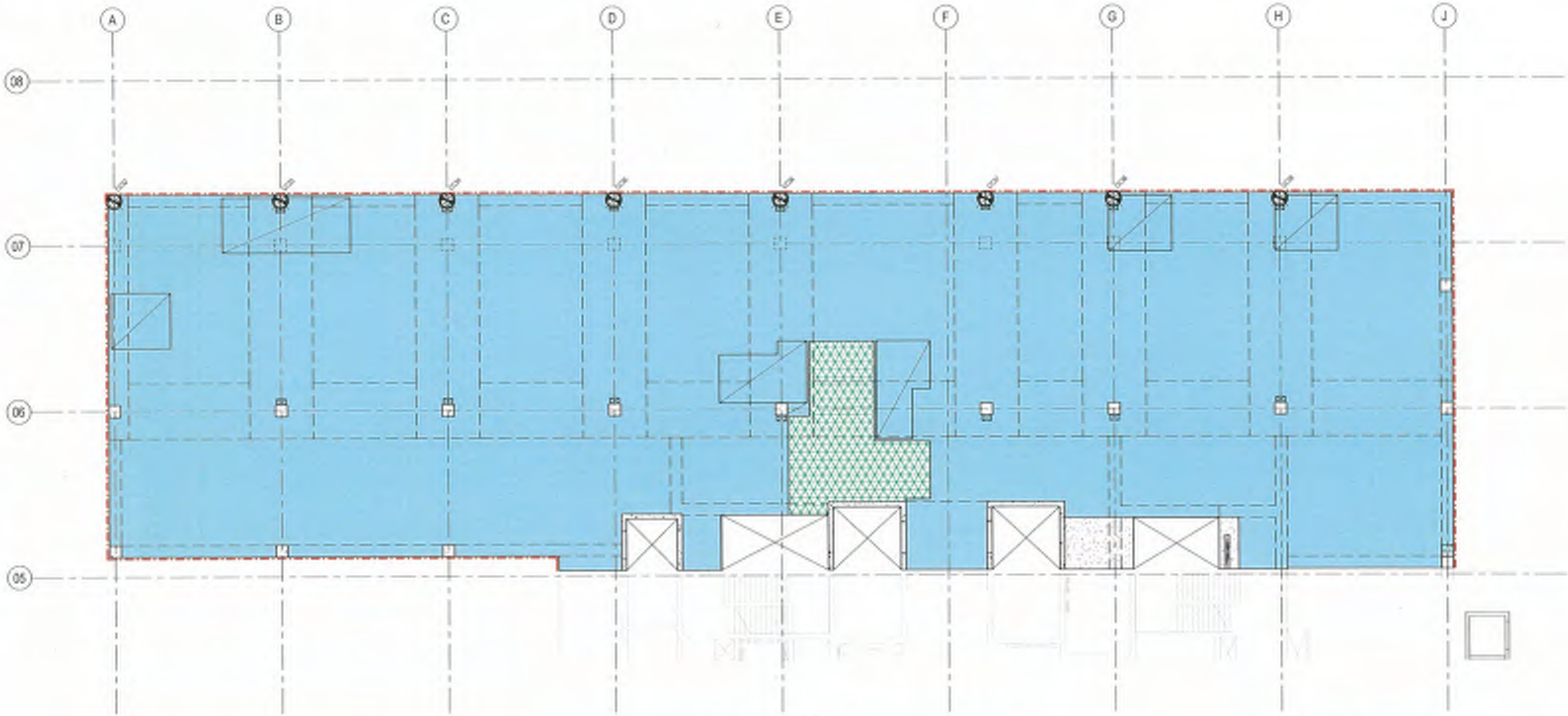
CLIENT: HEALTH INFRASTRUCTURE

DRAWING: LEVEL 7 LOADING PLAN

PROJECT: LISMORE BASE HOSPITAL STAGE 3B2



LEVEL 8 LOADING PLAN

1 : 100

TRANSFER COLUMN LOADS		
COLUMN MARK	DEAD LOAD	LIVE LOAD
CC02	1100kN	200kN
CC03	1750kN	400kN
CC04	1750kN	400kN
CC05	1750kN	400kN
CC06	2600kN	450kN
CC07	1800kN	400kN
CC08	1600kN	350kN
CC09	1750kN	400kN
CC40	540kN	120kN

LOADING PLAN LEGEND FOR LEVELS 8-10

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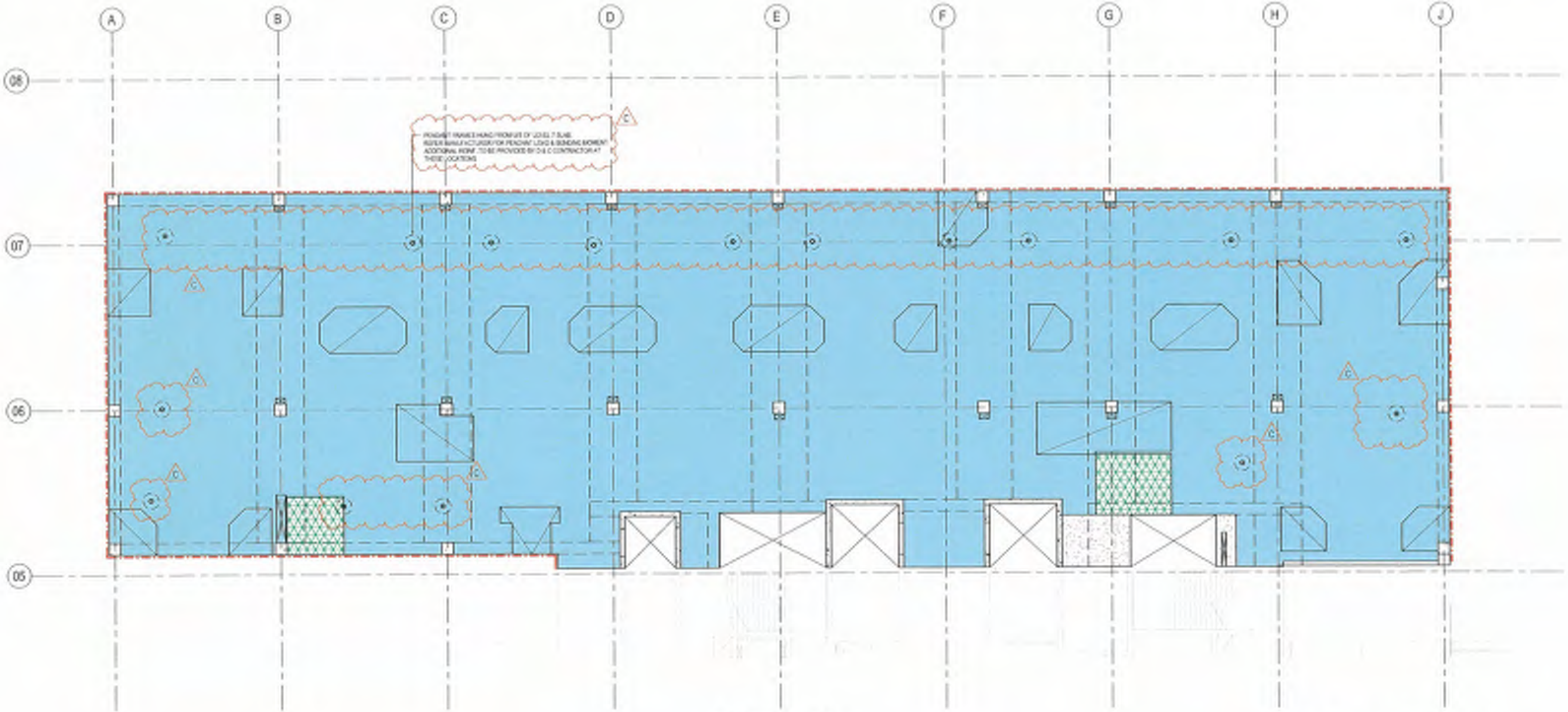
CLIENT: HEALTH INFRASTRUCTURE

DRAWING: NORTH TOWER EXTENSION LEVEL 8 LOADING PLAN

PROJECT: LISMORE BASE HOSPITAL STAGE 3B2



LEVEL 9 LOADING PLAN

1 : 100

TRANSFER COLUMN LOADS		
COLUMN MARK	DEAD LOAD	LIVE LOAD
[illegible]	[illegible]	[illegible]

LOADING PLAN LEGEND FOR LEVELS 8-10

PRELIMINARY

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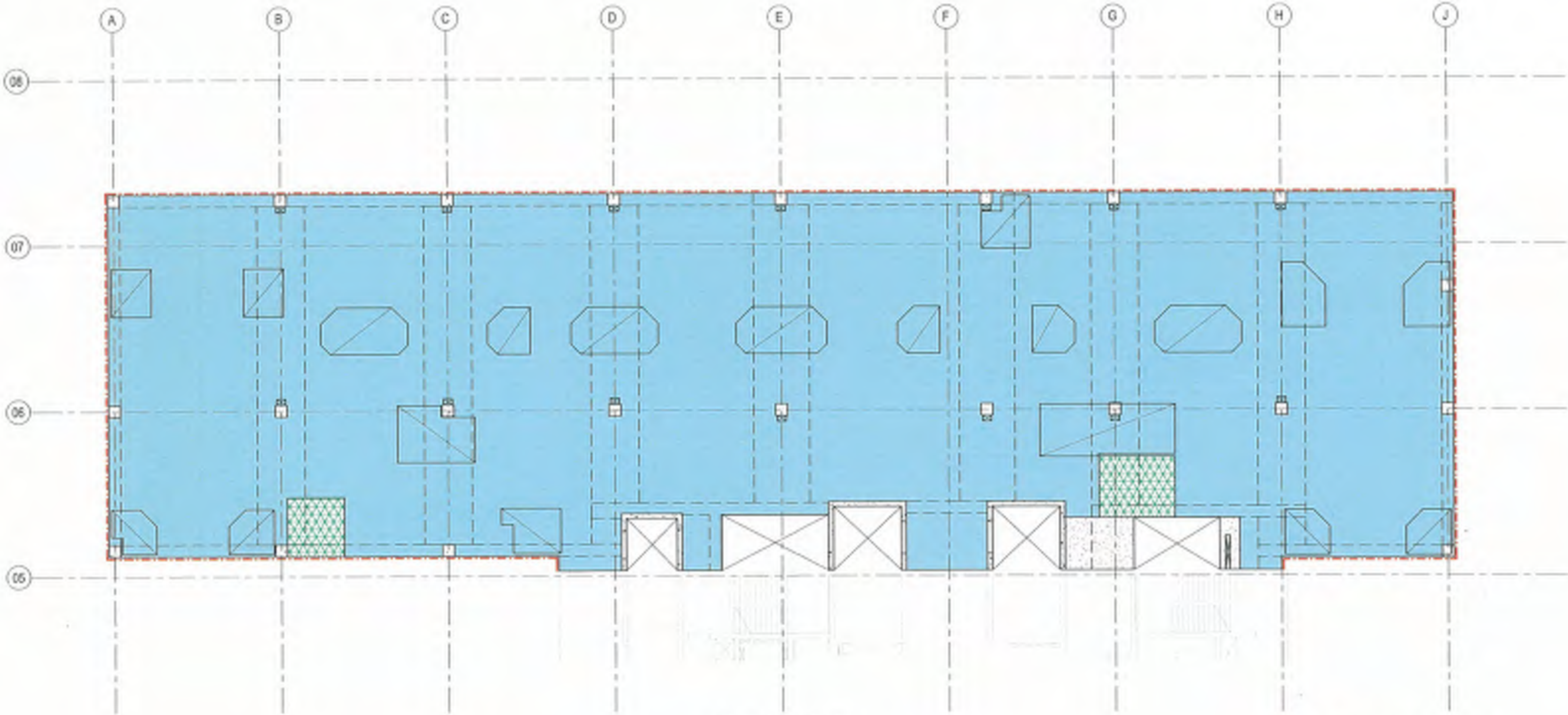
CLIENT: HEALTH INFRASTRUCTURE

DRAWING: NORTH TOWER EXTENSION LEVEL 9 LOADING PLAN

PROJECT: LISMORE BASE HOSPITAL STAGE 3B2



LEVEL 10 LOADING PLAN

1 : 100

LOADING PLAN LEGEND FOR LEVELS 8-10

PRELIMINARY

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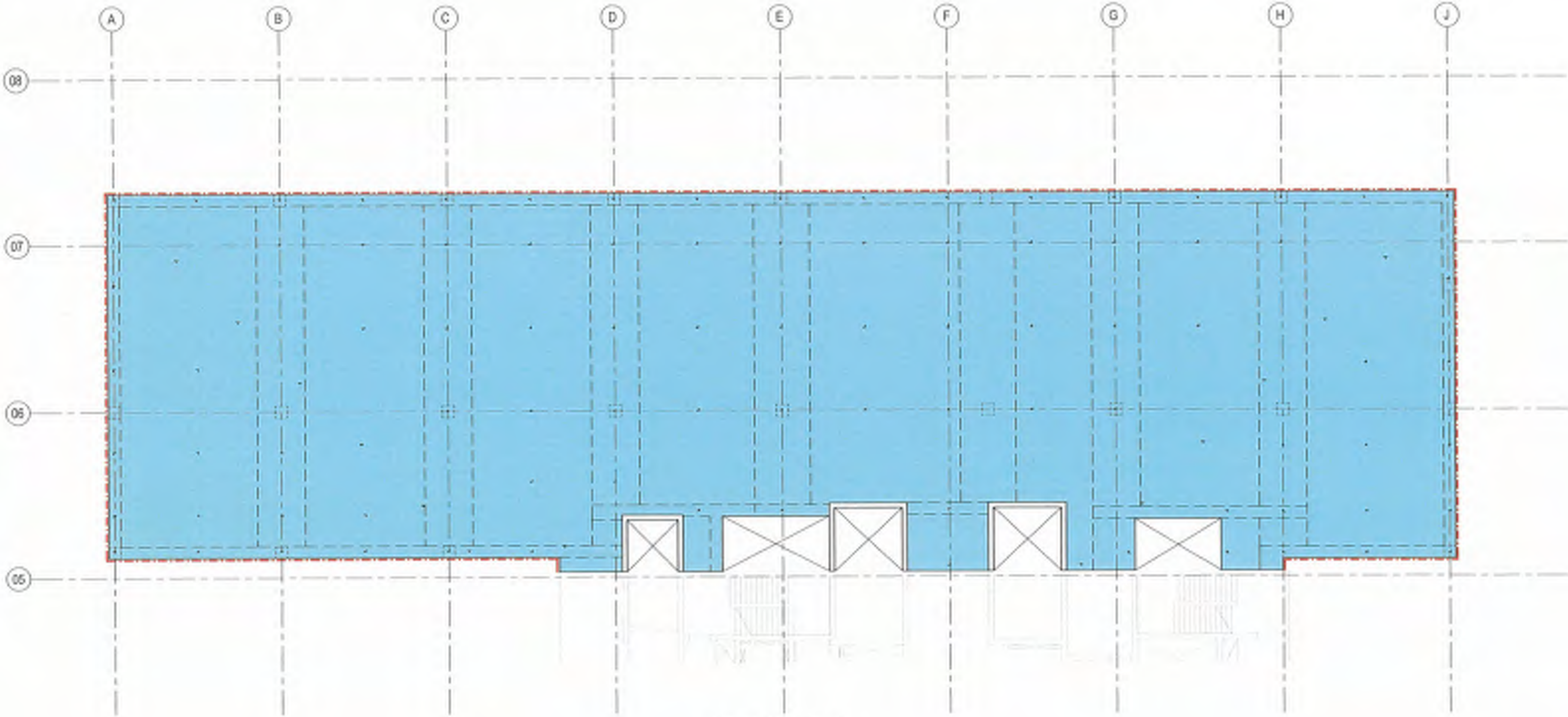
CLIENT: HEALTH INFRASTRUCTURE

DRAWING: NORTH TOWER EXTENSION LEVEL 10 LOADING PLAN

PROJECT: LISMORE BASE HOSPITAL STAGE 3B2



LEVEL 11 LOADING PLAN

1 : 100

PRELIMINARY

LOADING PLAN LEGEND FOR LEVEL 11 ONLY

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CLIENT: HEALTH INFRASTRUCTURE

DRAWING: NORTH TOWER EXTENSION LEVEL 11 LOADING PLAN

PROJECT: LISMORE BASE HOSPITAL STAGE 3B2

APPENDIX C

6.11 Relevant North Tower Geotechnical Reports

90317.00.R.001(2) Slope Stability Analysis Report

90317.00.R.02(00) Piled Foundations Geotechnical Parameters

90317.00.R.003(00) Report on Geotechnical Investigation, Proposed Maternity Ward Building (3B2), Little Uralba Street, Lismore

Douglas Partners
Geotechnics / Environment / Groundwater

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Arcadis Pty Ltd
Level 7, 199 Grey Street
SOUTH BRISBANE QLD 4101

Project 90317.00
7 October 2016
R.001.Rev2
BM/DQ

Attention: Mr Glenn Barton

Email: Glenn.Barton@arcadis.com

Dear Sirs

Slope Stability Analysis Report
Proposed Building 3B2, Lismore Hospital
Little Uralba Street, Lismore

1. Introduction

This letter report presents the results of slope stability analysis carried out to assess the impact of a piling rig at the top of an existing soil nailed slope within the Lismore Base Hospital complex located on Little Uralba Street, Lismore. The report was prepared for Arcadis Pty Ltd, the project structural engineers also for John Holland Group Pty Ltd, who is the builder for the proposed Building 3B2 project.

It is understood that the proposed Building 3B2 will comprise the construction of a new seven storey hospital building above a previously soil nailed slope. The new building column loads near the crest of the slope are being proposed to be supported on piles and so slope stability analysis was required to assess the impact of a piling rig at the crest of the slope.

The scope of Douglas Partners Pty Ltd (DP) analysis works was outlined in our proposal number GLD150259 dated 9 December 2015.

The following documentation provided to DP was used to undertake this preliminary analysis:

- *"Report on Geotechnical Assessment of Foundation Options, Proposed Stage 3B2 Building, Lismore Base Hospital"*, DP Project No. 84988.00, dated September 2015.
- *"Report on Geotechnical Investigation, Proposed Eleven Storey Building, Lismore Base Hospital, Little Uralba Street, Lismore"*, DP Project No.80243.00, dated July 2013.
- "*Soil Nail Wall Option Design Report, Lismore Base Hospital, Southern Boundary Retention*" by Coffey Geotechnics, reference GEOTALST01618AE-AC, dated 10 January 2007.
- "*Soil Nail Wall Specifications, Lismore Base Hospital, Southern Boundary Retention*" by Coffey Geotechnics, reference GEOTALST01618AE-AD, dated 31 January 2007.
- "*Variation to Soil Nail Wall Option Design to Account for Site Conditions*" by Coffey Geotechnics, reference GEOTALST01618AE-AE, dated 14 March 2007.

- Borehole logs 7 and 8 and Drawing Nos 1 and 3 from DP's current geotechnical investigation for the Proposed Building 3B2, DP Project No. 90317.00.
- Email from Anora Foundations to JHG dated 5 August 2016, indicating Soilmec SR40 piling rig dimensions and applied bearing pressure.

Coffey Geotechnics have previously carried out slope stability analysis and designed the currently installed soil nails which support the existing battered slope. The Coffey Geotechnics analysis and soil nail design was for the long term slope stability condition.

2. Site Description and Ground Conditions

The site for the proposed piling is above the crest of a 5 m to 7.5 m high soil nailed batter slope which is located in the southern area of the hospital complex. The slope is east to west trending and varies between 45 to 65 degrees in angle. The location of the slope is indicated by Section B-B' on Drawing 1 attached.

Ground surface levels on site vary from RL24.5 m to RL27.5 m increasing in an easterly direction along the top of the slope toward Little Uralba Street. Geological Cross Section B-B' on Drawing 3 attached, indicates the slope of the site and also the interpreted geological profile.

Borehole 7 and 8 drilled close to the crest of the slope, provide the basis for the interpreted geological profile indicated on Geological Cross Section B-B' (ie. Drawing 3), which comprises, existing gravelly and clayey filling overlying firm to stiff clay or high strength basalt over alternating horizons of very low strength to very high strength basalt rock, until termination of the bores in very high strength basalt at 18 m and 20 m depth.

3. Slope Stability Analysis

3.1 Model and Methodology

A geotechnical model was prepared from the results of Boreholes 7 and 8 which were extrapolated to form Geological Cross Section B-B'.

The general geological profile used in the model comprised:

- 0 m to 1 m - 1.5 m depth – loose gravel or firm to stiff clay filling;
- 1 m to 3 m depth – firm to stiff silty clay (Bore 8 only)
- 1.5 m - 3 m to 9 m depth – layers of very low strength to very high strength Basalt;
- 9 m to 13.5 m – 15 m depth – very low strength Tephra Basalt;
- Greater than 13.5 m – 15 m depth – very high strength Basalt.

The proposed piling rig surcharge pressure of UDL of 250kPa (as supplied by Anora Piling) was also input into the model.

Four slope stability cross sections were assembled at building grids B, D, G, and J which represent the variation in slope profile and soil nail patterns along the battered slope. The subsurface profile for each cross section was estimated from Section 'B-B', and the previously installed soil nail patterns as derived from previous Coffey and DP reports. The piling rig surcharge was then modelled at the approximate location required to install bored piles along Building Grid 7.5.

A fifth slope stability case was modelled to show the effect of cutting through a complete column of soil nails whilst piling.

Long term slope stability case was also modelled where the current soil nails are replaced by new building foundation piles. Building grid J was modelled for the long term case as this would appear to be the most likely location where soil nails may be cut through during piling.

Slope stability was then carried out using the computer program, *SLOPE/W* Version 8.0.10, developed by Geo-Slope International. The *SLOPE/W* analysis was carried out using the Morgenstern Price method to calculate the factor of safety (FOS) against circular failure surface by examining moment equilibrium about an assumed centre of rotation.

3.2 Material Parameters

The construction loading condition of the piling rig at the crest of the battered slope was modelled with undrained material parameters which are suitable for use in the short term global stability analysis.

The range of soil and rock parameters given in Table 1 below represent estimated lower and upper bound parameters for each layer, which were derived from the past experience and published information.

Table 1: Adopted Short Term Geotechnical Parameters

Material	Bulk Density (kN/m^3)	Cohesion (kPa)	Friction Angle (°)	Poisson's Ratio ν
Gravelly Filling	17-18	0	30-32	0.5
Clay Filling	17-18	45-50	0	0.5
Firm Clay	17-18	35-50	0	0.5
Stiff Clay	19-20	75-100	0	0.5
VLS Basalt	20-21	200-450	0	0.5
HS Basalt	23-24	1000-1200	0	0.5
Shotcrete Facing	20	200	0	0.5

The long term condition with piles installed through the slope which was modelled with drained parameters which are suitable for use in the long term global stability analysis.

The range of soil and rock parameters given in Table 2 below represent the estimated lower and upper bound parameters for each layer, which were derived from the past experience and published information.

Table 2: Adopted Long Term Geotechnical Parameters

Material	Bulk Density (kN/m^3)	Cohesion (kPa)	Friction Angle (°)	Poisson's Ratio ν
Gravelly Filling	17-18	0	30-32	0.3
Clay Filling	17-18	1-3	24-25	0.3
Firm Clay	17-18	1-3	24-25	0.3
Stiff Clay	19-20	3-5	26-28	0.3
VLS Basalt	20-21	100-150	31-33	0
HS Basalt	23-24	750-900	40-45	0
Shotcrete Facing	20	200	0	0

3.3 Results of Slope Stability Analysis

The soil and rock parameters indicated in Table 1 were used to carry out sensitivity analysis in the short term slope stability analysis modelling.

The results of the *SLOPE/W* analysis for the short term conditions are indicated on Figures 1 to 10 attached, and the calculated factors of safety are shown in Table 3 below.

Table 3: Summary of Results for the Short Term Global Slope Stability Analyses

Grid	Slope State	Parameters	Factor of Safety	Figure No.
B	5 m high slope with 3 rows of soil nails	Lower	1.5	1
		Upper	2.0	2
D	7.5 m high slope with 3 rows of soil nails	Lower	1.3	3
		Upper	1.7	4
G	7.5 m high slope with 2 rows of soil nails	Lower	1.3	5
		Upper	1.4	6
J	7.5 m high slope with 5 rows of soil nails	Lower	1.2	7
		Upper	1.3	8
J	7.5 m high slope with no soil nails	Lower	1.2	9
		Upper	1.3	10

The results of the short term analysis indicate the following:

- A FoS of 1.2 to 1.5 was estimated against global instability for the soil nailed slope cross sections when surcharged by the nominated piling rig.

- A FoS of 1.2 to 1.3 was achieved where the highest slope cross section at Grid J was modelled with no soil nail support when surcharged by nominated piling rig, in the short term condition.

A FOS of 1.2 is normally considered acceptable for short term conditions for slopes during construction and has been adopted for the purposes of this assessment.

The soil and rock parameters indicated in Table 2 were used to carry out sensitivity analysis in the long term slope stability analysis modelling.

The results of the *SLOPE/W* analysis for the long term condition are indicated on Figures 11 to 16 attached, and the calculated factors of safety are shown in Table 4 below.

Table 4: Summary of Results for the Short Term Global Slope Stability Analyses

Grid	Slope State	Parameters	Factor of Safety	Figure No.
J	7.5 m high slope with no soil nails, one pile (long tem)	Lower	4.4	11
		Upper	4.8	12
J	7.5 m high slope with no soil nails, two piles (long tem)	Lower	4.2	13
		Upper	4.8	14
J	7.5 m high slope with no soil nails, two piles and pad footing (long tem)	Lower	4.2	15
		Upper	4.8	16

A FOS of 4.4 was achieved where the piles replace the soil nail support at the highest slope cross section at Grid J in the long term (i.e. permanent) condition.

A FOS of 1.5 is normally considered acceptable for long term conditions for civil engineering slopes.

4. Limitations

Douglas Partners (DP) has prepared this geotechnical analysis report for the Proposed Building 3B2, Lismore Hospital at Little Uralba Street, Lismore in accordance with DP's proposal GLD150259 dated 9 December 2015. The work was carried out under DP's Conditions of Engagement. This report is provided for the exclusive use of Arcadis Pty Ltd for this project only and for the purposes as described in the report. It should not be used by or relied upon for other projects or purposes on the same or other site or by a third party. Any party so relying upon this report beyond its exclusive use and purpose as stated above, and without the express written consent of DP, does so entirely at its own risk and without recourse to DP for any loss or damage. In preparing this report DP has necessarily relied upon information provided by the client and/or their agents.
The results provided in the report are indicative of the sub-surface conditions on the site only at the specific sampling and/or testing locations, and then only to the depths investigated and at the time the work was carried out. Sub-surface conditions can change abruptly due to variable geological

processes and also as a result of human influences. Such changes may occur after DP's field testing has been completed.

DP's advice is based upon the conditions encountered during this investigation. The accuracy of the advice provided by DP in this report may be affected by undetected variations in ground conditions across the site between and beyond the sampling and/or testing locations. The advice may also be limited by budget constraints imposed by others or by site accessibility.

This report must be read in conjunction with all of the attached and should be kept in its entirety without separation of individual pages or sections. DP cannot be held responsible for interpretations or conclusions made by others unless they are supported by an expressed statement, interpretation, outcome or conclusion stated in this report.

This report, or sections from this report, should not be used as part of a specification for a project, without review and agreement by DP. This is because this report has been written as advice and opinion rather than instructions for construction. The scope for work for this investigation/report did not include the assessment of surface or sub-surface materials or groundwater for contaminants, within or adjacent to the site. Should evidence of filling of unknown origin be noted in the report, and in particular the presence of building demolition materials, it should be recognised that there may be some risk that such filling may contain contaminants and hazardous building materials.

The contents of this report do not constitute formal design components such as are required, by the Health and Safety Legislation and Regulations, to be included in a Safety Report specifying the hazards likely to be encountered during construction and the controls required to mitigate risk. This design process requires risk assessment to be undertaken, with such assessment being dependent upon factors relating to likelihood of occurrence and consequences of damage to property and to life. This, in turn, requires project data and analysis presently beyond the knowledge and project role respectively of DP. DP may be able, however, to assist the client in carrying out a risk assessment of potential hazards contained in the Comments section of this report, as an extension to the current scope of works, if so requested, and provided that suitable additional information is made available to DP. Any such risk assessment would, however, be necessarily restricted to the (geotechnical / environmental / groundwater) components set out in this report and to their application by the project designers to project design, construction, maintenance and demolition.

Please contact the undersigned if you have any questions on this matter.

Yours faithfully
Douglas Partners Pty Ltd

Ben Middleton
Geotechnical Engineer

Reviewed by

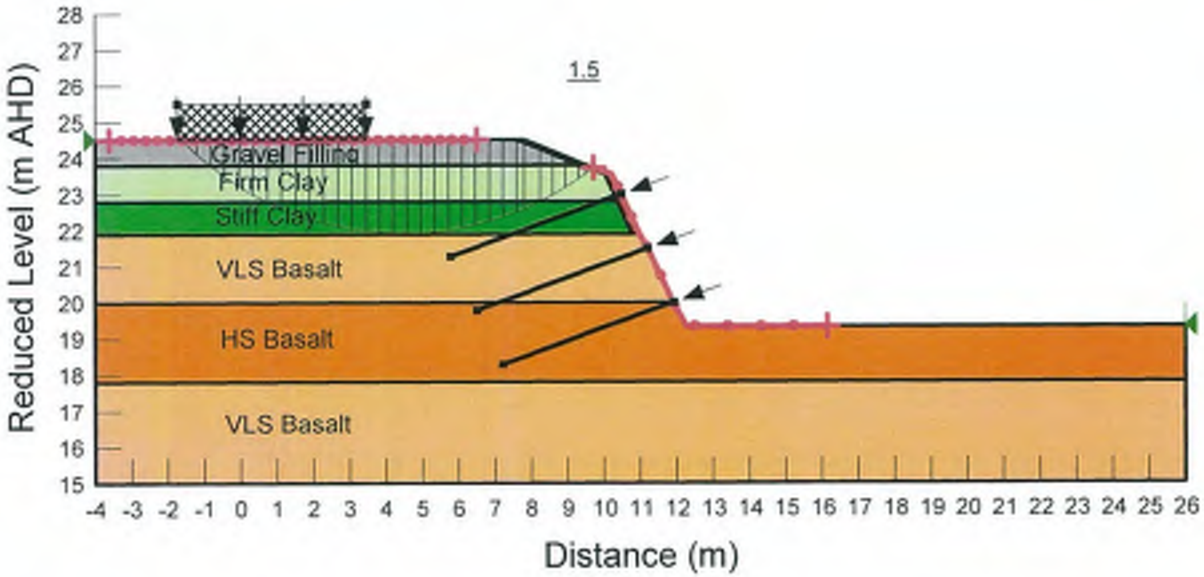
D. Qualischefski

David Qualischefski
Principal

Attachments: About this Report
SLOPE/W Slip Circle Plots – Figures 1 to 13
Borehole Logs 7 and 8
Drawings 1 and 3

90317.00 - Lismore Base Hosptial Stage 3B2
Piling Rig Stability

SECTION B - S-LOW



Name: Gravel Filling
Unit Weight: 17 kN/m³
Cohesion': 0 kPa
Phi': 30 °

Name: Firm clay
Unit Weight: 18 kN/m³
Cohesion': 35 kPa

Name: VLS Basalt
Unit Weight: 21 kN/m³
Cohesion': 200 kPa

Name: HS Basalt
Unit Weight: 24 kN/m³
Cohesion': 1,000 kPa

Name: Stiff Clay
Unit Weight: 19 kN/m³
Cohesion': 75 kPa

Name: Shotcrete
Unit Weight: 20 kN/m³
Cohesion': 200 kPa

Figure 1

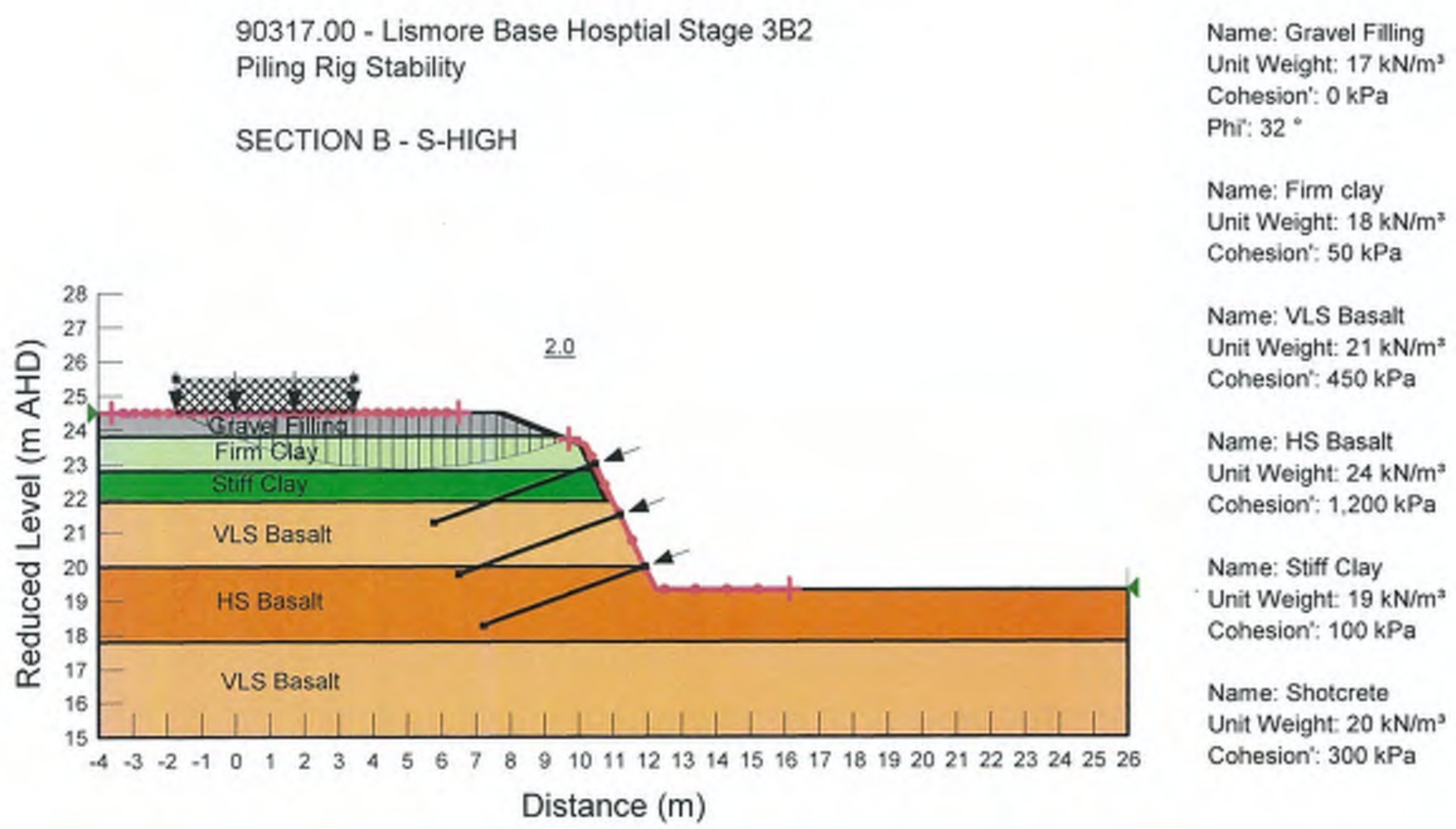

90317.00 - Lismore Base Hosptial Stage 3B2
Piling Rig Stability
SECTION B - S-HIGH
2.0
Gravel Filling
Firm Clay
Stiff Clay
VLS Basalt
HS Basalt
VLS Basalt
Reduced Level (m AHD)
28
27
26
25
24
23
22
21
20
19
18
17
16
15
-4 -3 -2 -1 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26
Distance (m)
Name: Gravel Filling
Unit Weight: 17 kN/m³
Cohesion': 0 kPa
Phi': 32 °
Name: Firm clay
Unit Weight: 18 kN/m³
Cohesion': 50 kPa
Name: VLS Basalt
Unit Weight: 21 kN/m³
Cohesion': 450 kPa
Name: HS Basalt
Unit Weight: 24 kN/m³
Cohesion': 1,200 kPa
Name: Stiff Clay
Unit Weight: 19 kN/m³
Cohesion': 100 kPa
Name: Shotcrete
Unit Weight: 20 kN/m³
Cohesion': 300 kPa

Figure 2

90317.00 - Lismore Base Hosptial Stage 3B2
Piling Rig Stability

SECTION D - (S-LOW)

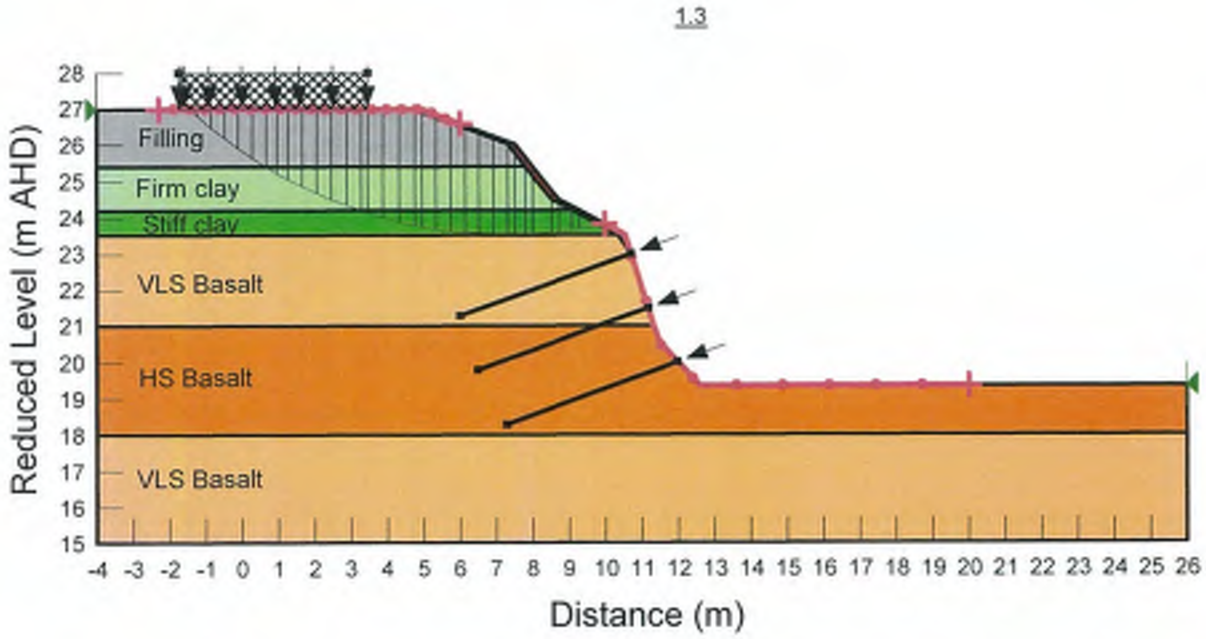


Figure 3

Model: Undrained (Phi=0)
Unit Weight: 21 kN/m³
Cohesion': 200 kPa

Name: Gravel Filling
Model: Mohr-Coulomb
Unit Weight: 17 kN/m³
Cohesion': 0 kPa
Phi': 30 °

Name: Firm silty clay
Model: Undrained (Phi=0)
Unit Weight: 18 kN/m³
Cohesion': 35 kPa

Name: Stiff silty clay
Model: Undrained (Phi=0)
Unit Weight: 19 kN/m³
Cohesion': 75 kPa

Name: HS Basalt
Model: Undrained (Phi=0)
Unit Weight: 24 kN/m³
Cohesion': 1,000 kPa

Name: Shotcrete
Model: Undrained (Phi=0)
Unit Weight: 20 kN/m³
Cohesion': 200 kPa

90317.00 - Lismore Base Hosptial Stage 3B2
Piling Rig Stability

SECTION D - (S-HIGH)

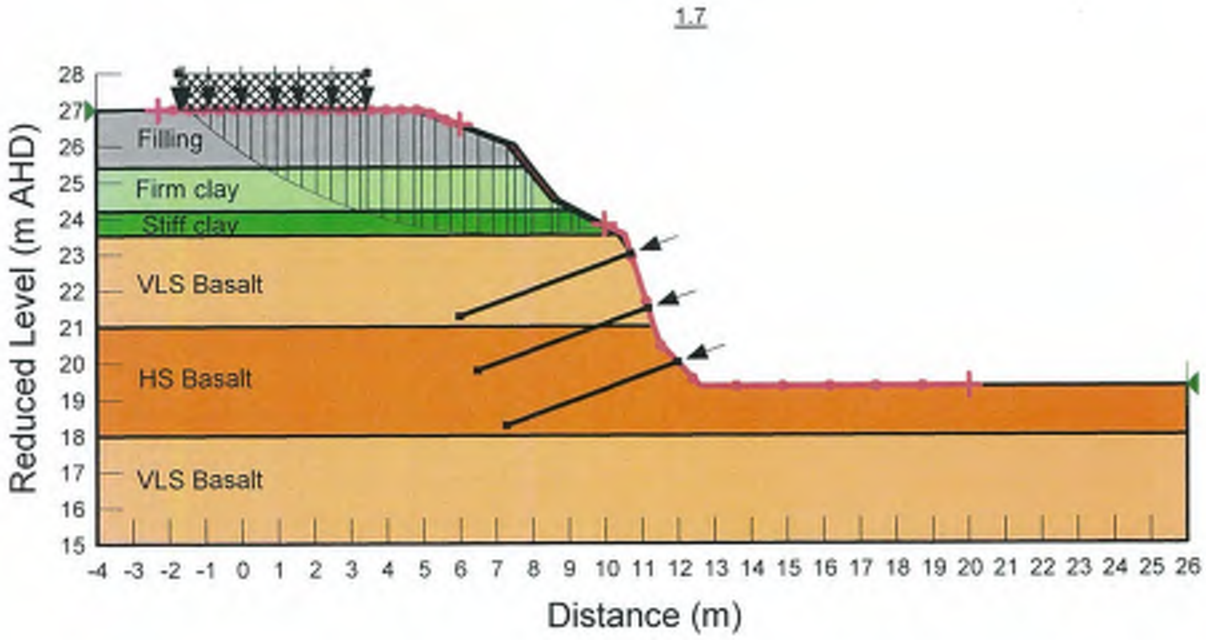


Figure 4

Cohesion': 450 kPa

Name: Gravel Filling
Model: Mohr-Coulomb
Unit Weight: 17 kN/m³
Cohesion': 0 kPa
Phi': 32 °

Name: Firm silty clay
Model: Undrained (Phi=0)
Unit Weight: 18 kN/m³
Cohesion': 50 kPa

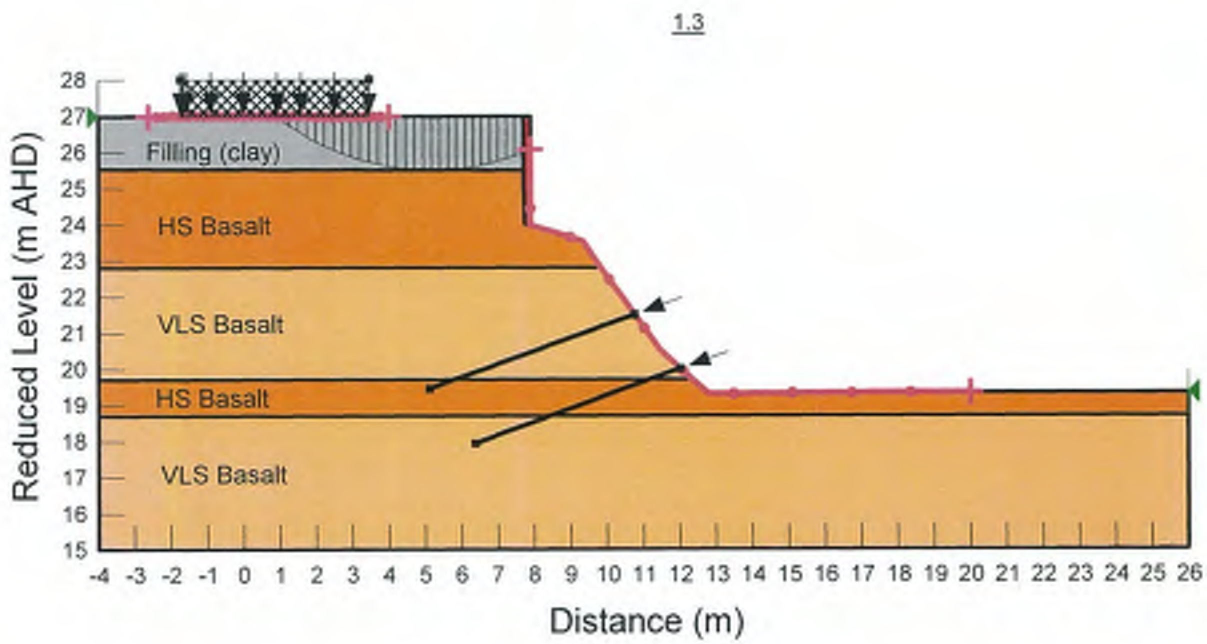
Name: Stiff silty clay
Model: Undrained (Phi=0)
Unit Weight: 19 kN/m³
Cohesion': 100 kPa

Name: HS Basalt
Model: Undrained (Phi=0)
Unit Weight: 24 kN/m³
Cohesion': 1,200 kPa

Name: Shotcrete
Model: Undrained (Phi=0)
Unit Weight: 20 kN/m³
Cohesion': 300 kPa

90317.00 - Lismore Base Hosptial Stage 3B2
Piling Rig Stability

SECTION G - S-LOW



Name: Clay Filling
Model: Undrained (Phi=0)
Unit Weight: 18 kN/m³
Cohesion': 45 kPa

Name: VLS Basalt
Model: Undrained (Phi=0)
Unit Weight: 21 kN/m³
Cohesion': 200 kPa

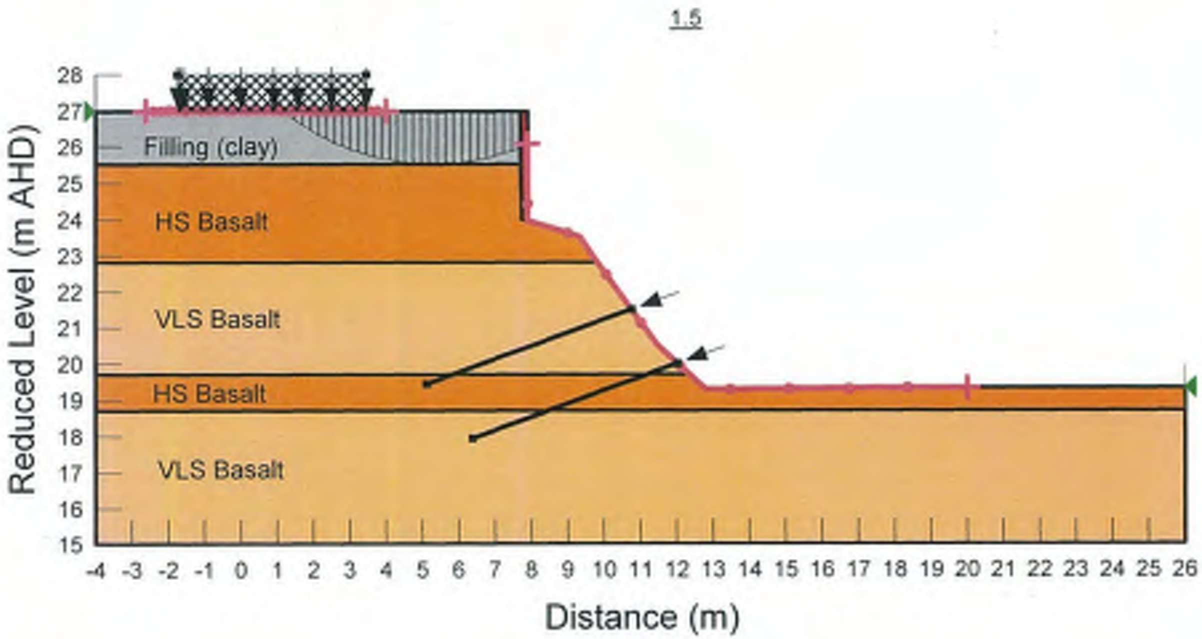
Name: HS Basalt
Model: Undrained (Phi=0)
Unit Weight: 24 kN/m³
Cohesion': 1,000 kPa

Name: Shotcrete
Model: Undrained (Phi=0)
Unit Weight: 20 kN/m³
Cohesion': 200 kPa

Figure 5

90317.00 - Lismore Base Hosptial Stage 3B2
Piling Rig Stability

SECTION G - S-HIGH



Name: Clay Filling
Model: Undrained (Phi=0)
Unit Weight: 18 kN/m³
Cohesion': 50 kPa

Name: VLS Basalt
Model: Undrained (Phi=0)
Unit Weight: 21 kN/m³
Cohesion': 450 kPa

Name: HS Basalt
Model: Undrained (Phi=0)
Unit Weight: 24 kN/m³
Cohesion': 1,200 kPa

Name: Shotcrete
Model: Undrained (Phi=0)
Unit Weight: 20 kN/m³
Cohesion': 300 kPa

Figure 6

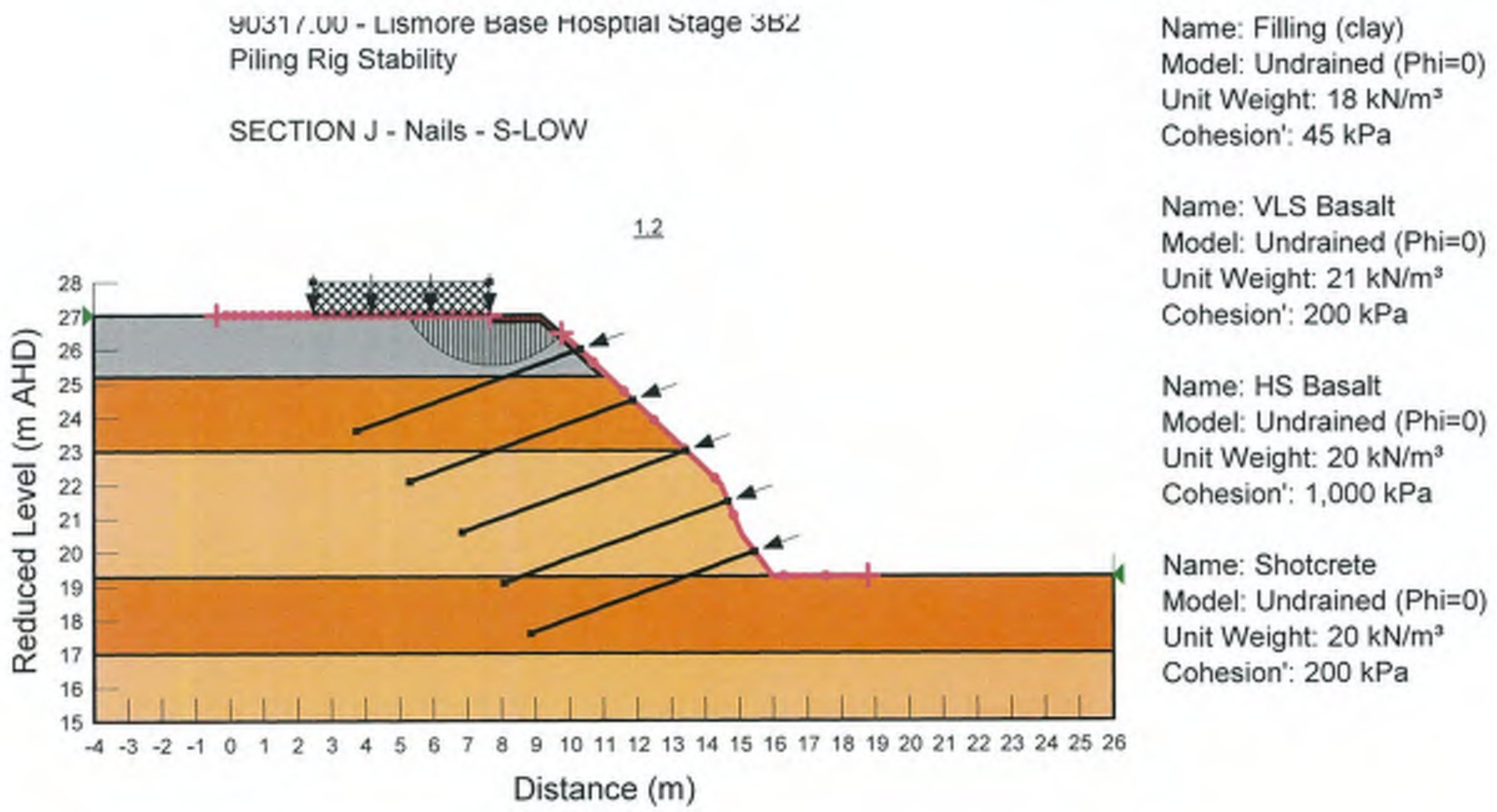
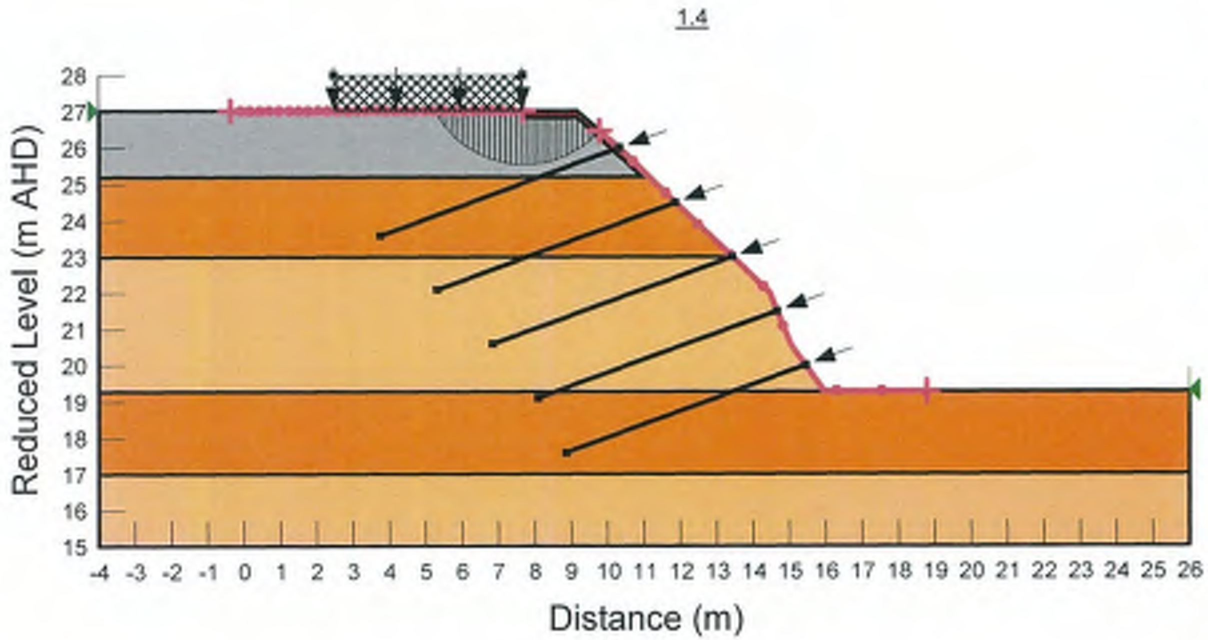

90317.00 - Lismore Base Hosptial Stage 3B2
Piling Rig Stability
SECTION J - Nails - S-LOW
1.2
Reduced Level (m AHD)
Distance (m)
Name: Filling (clay)
Model: Undrained (Phi=0)
Unit Weight: 18 kN/m³
Cohesion': 45 kPa
Name: VLS Basalt
Model: Undrained (Phi=0)
Unit Weight: 21 kN/m³
Cohesion': 200 kPa
Name: HS Basalt
Model: Undrained (Phi=0)
Unit Weight: 20 kN/m³
Cohesion': 1,000 kPa
Name: Shotcrete
Model: Undrained (Phi=0)
Unit Weight: 20 kN/m³
Cohesion': 200 kPa

Figure 7

90317.00 - Lismore Base Hosptial Stage 3B2
Piling Rig Stability

SECTION J - Nails - S-HIGH



Name: Filling (clay)
Model: Undrained (Phi=0)
Unit Weight: 18 kN/m³
Cohesion': 50 kPa

Name: VLS Basalt
Model: Undrained (Phi=0)
Unit Weight: 21 kN/m³
Cohesion': 450 kPa

Name: HS Basalt
Model: Undrained (Phi=0)
Unit Weight: 20 kN/m³
Cohesion': 1,200 kPa

Name: Shotcrete
Model: Undrained (Phi=0)
Unit Weight: 20 kN/m³
Cohesion': 300 kPa

Figure 8

90317.00 - Lismore Base Hosptial Stage 3B2
Piling Rig Stability

SECTION J - No nails - S-LOW

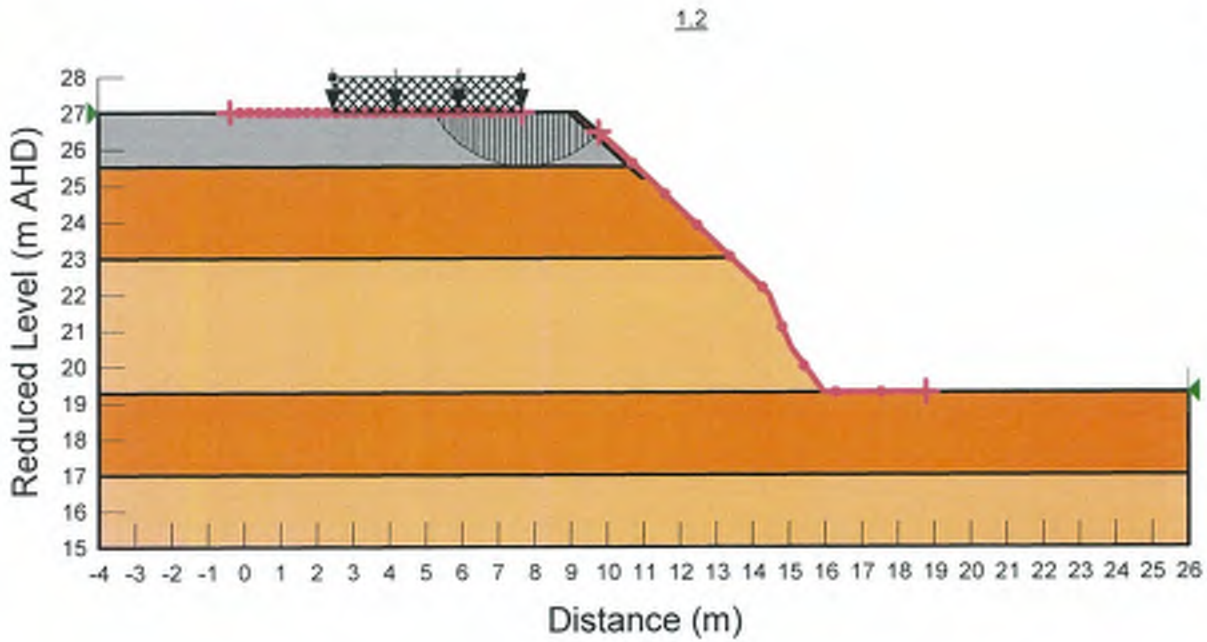


Figure 9

Name: Filling (clay)
Model: Undrained (Phi=0)
Unit Weight: 18 kN/m³
Cohesion': 45 kPa

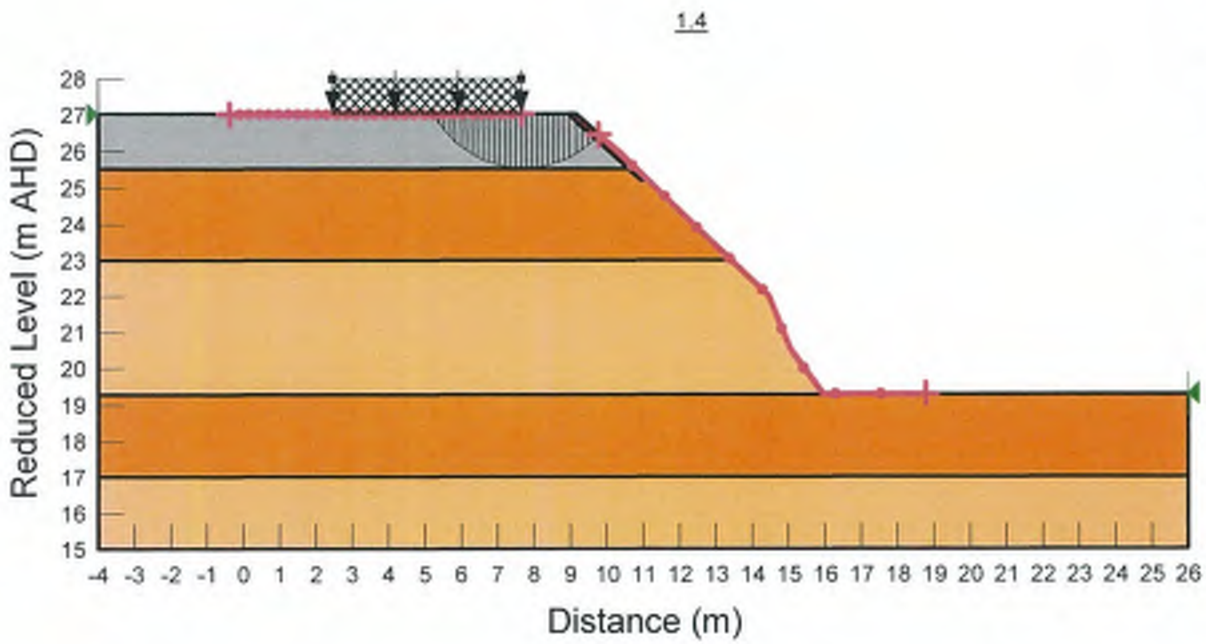
Name: VLS Basalt
Model: Undrained (Phi=0)
Unit Weight: 21 kN/m³
Cohesion': 200 kPa

Name: HS Basalt
Model: Undrained (Phi=0)
Unit Weight: 20 kN/m³
Cohesion': 1,000 kPa

Name: Shotcrete
Model: Undrained (Phi=0)
Unit Weight: 20 kN/m³
Cohesion': 200 kPa

90317.00 - Lismore Base Hospital Stage 3B2
Piling Rig Stability

SECTION J - No Nails - S-HIGH



Name: Filling (clay)
Model: Undrained (Phi=0)
Unit Weight: 18 kN/m³
Cohesion': 50 kPa

Name: VLS Basalt
Model: Undrained (Phi=0)
Unit Weight: 21 kN/m³
Cohesion': 450 kPa

Name: HS Basalt
Model: Undrained (Phi=0)
Unit Weight: 20 kN/m³
Cohesion': 1,200 kPa

Name: Shotcrete
Model: Undrained (Phi=0)
Unit Weight: 20 kN/m³
Cohesion': 300 kPa

Figure 10

90317.00 - Lismore Base Hosptial Stage 3B2
Piling Rig Stability

SECTION J - No nails - S-LOW - Pile

Cohesion': 1 kPa
Phi': 24 °

Name: VLS Basalt
Model: Mohr-Coulomb
Unit Weight: 21 kN/m³
Cohesion': 100 kPa
Phi': 31 °

Name: HS Basalt
Model: Mohr-Coulomb
Unit Weight: 24 kN/m³
Cohesion': 750 kPa
Phi': 40 °

Name: Shotcrete
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion': 200 kPa
Phi': 0 °

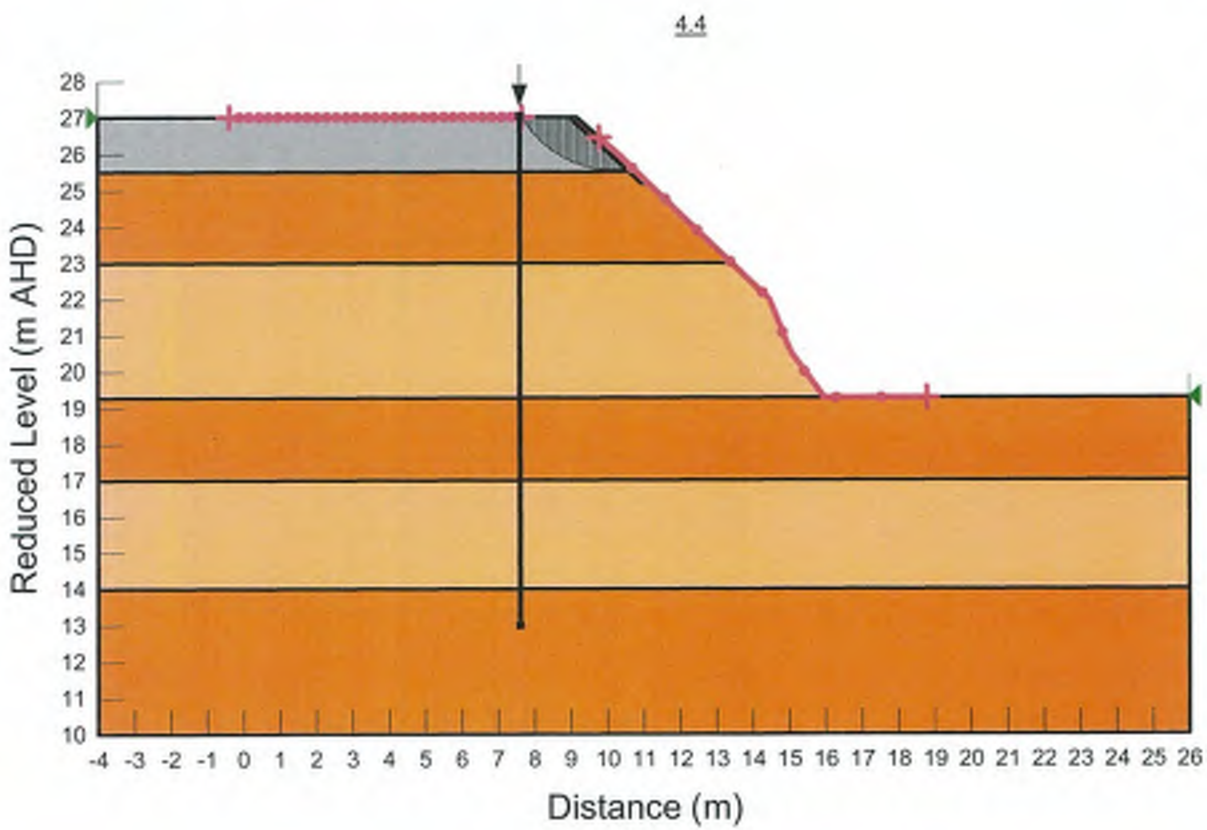
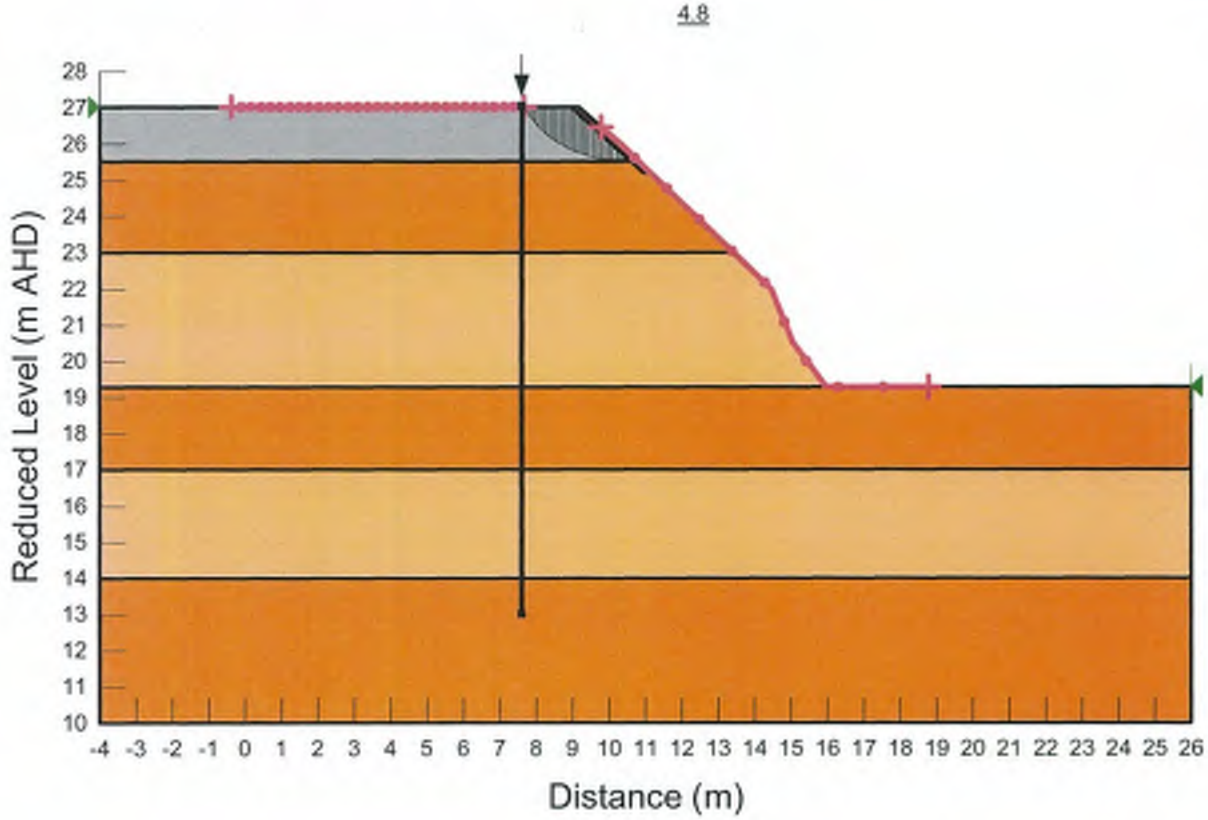


Figure 11

90317.00 - Lismore Base Hosptial Stage 3B2
Piling Rig Stability

SECTION J - No nails - S-HIGH - Pile



Cohesion': 3 kPa
Phi': 25 °

Name: VLS Basalt
Model: Mohr-Coulomb
Unit Weight: 21 kN/m³
Cohesion': 150 kPa
Phi': 33 °

Name: HS Basalt
Model: Mohr-Coulomb
Unit Weight: 24 kN/m³
Cohesion': 900 kPa
Phi': 45 °

Name: Shotcrete
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion': 200 kPa
Phi': 0 °

Figure 12

90317.00 - Lismore Base Hosptial Stage 3B2
Piling Rig Stability

SECTION J - No nails - S-LOW - 2 Pile

Model: Mohr-Coulomb
Unit Weight: 18 kN/m³
Cohesion': 1 kPa
Phi': 24 °

Name: VLS Basalt
Model: Mohr-Coulomb
Unit Weight: 21 kN/m³
Cohesion': 100 kPa
Phi': 31 °

Name: HS Basalt
Model: Mohr-Coulomb
Unit Weight: 24 kN/m³
Cohesion': 750 kPa
Phi': 40 °

Name: Shotcrete
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion': 200 kPa
Phi': 0 °

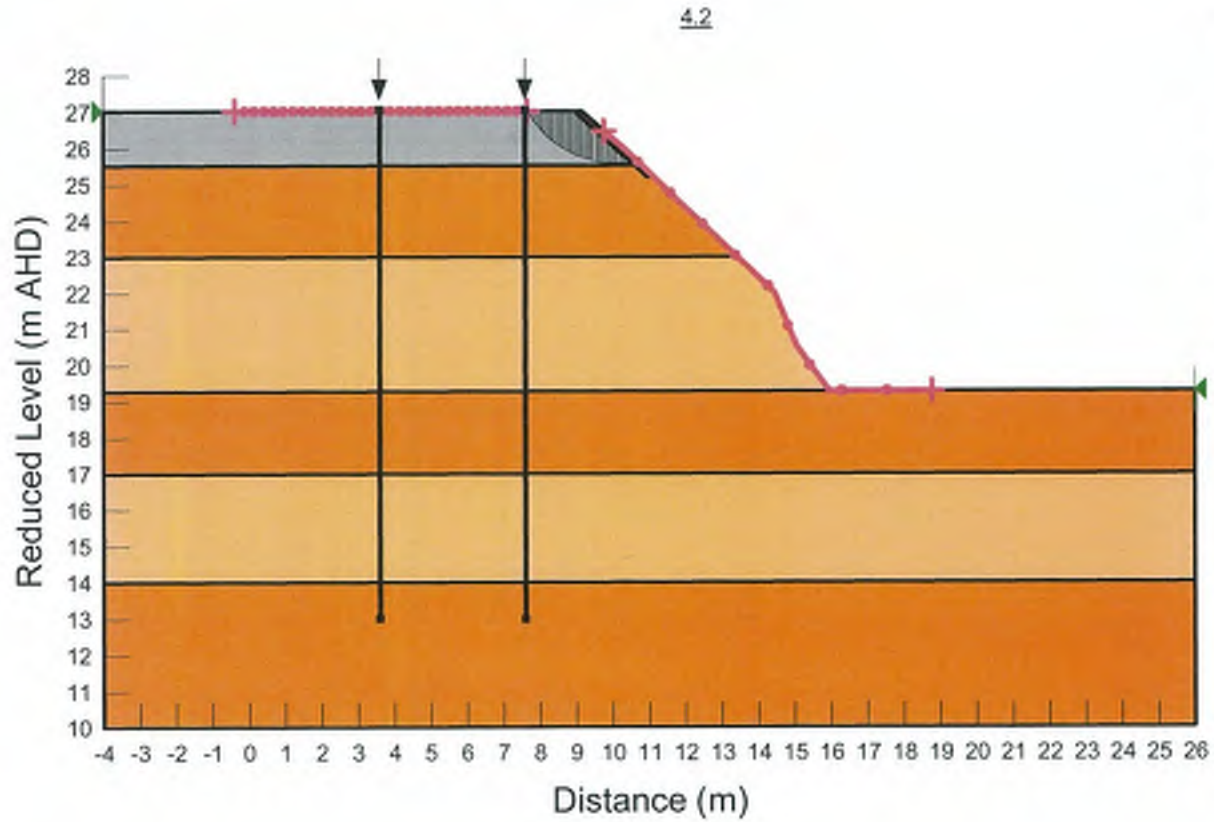


Figure 13

90317.00 - Lismore Base Hosptial Stage 3B2
Piling Rig Stability

SECTION J - No nails - S-HIGH - 2 Pile

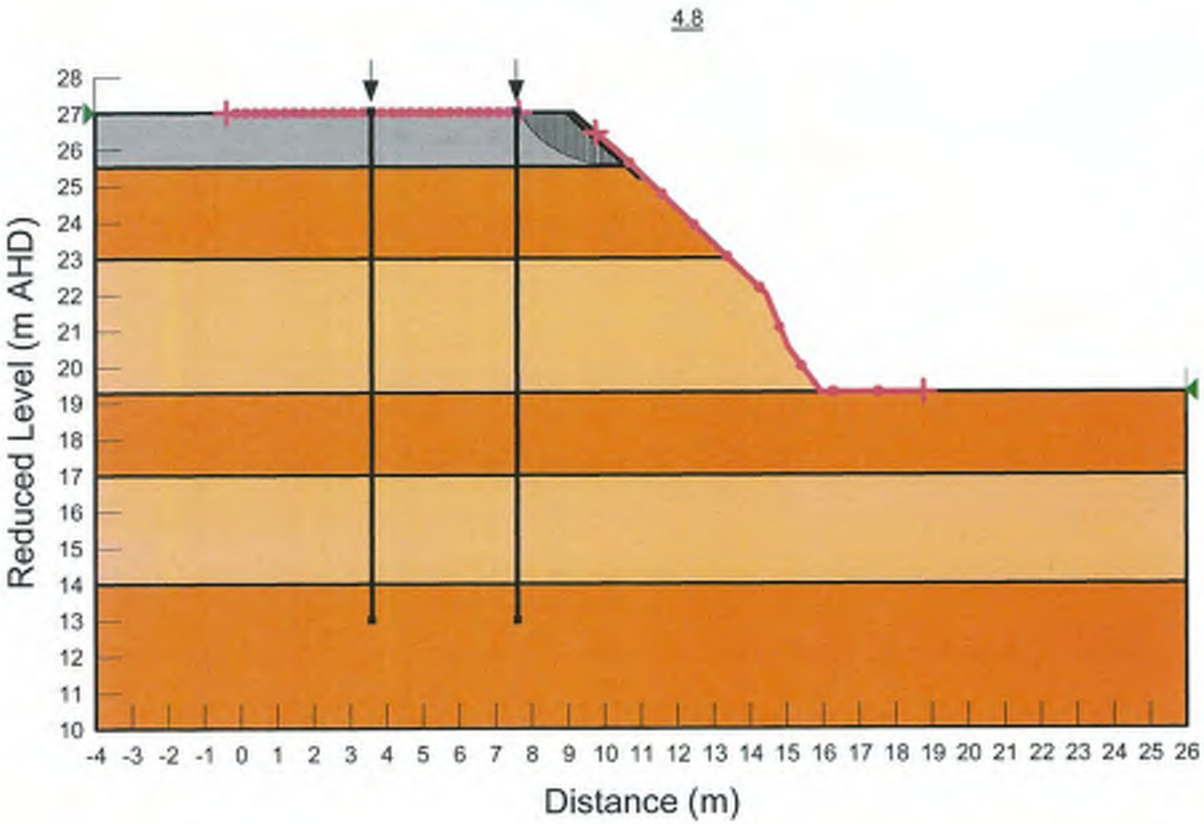


Figure 14

Model: Mohr-Coulomb
Unit Weight: 18 kN/m³
Cohesion': 3 kPa
Phi': 25 °

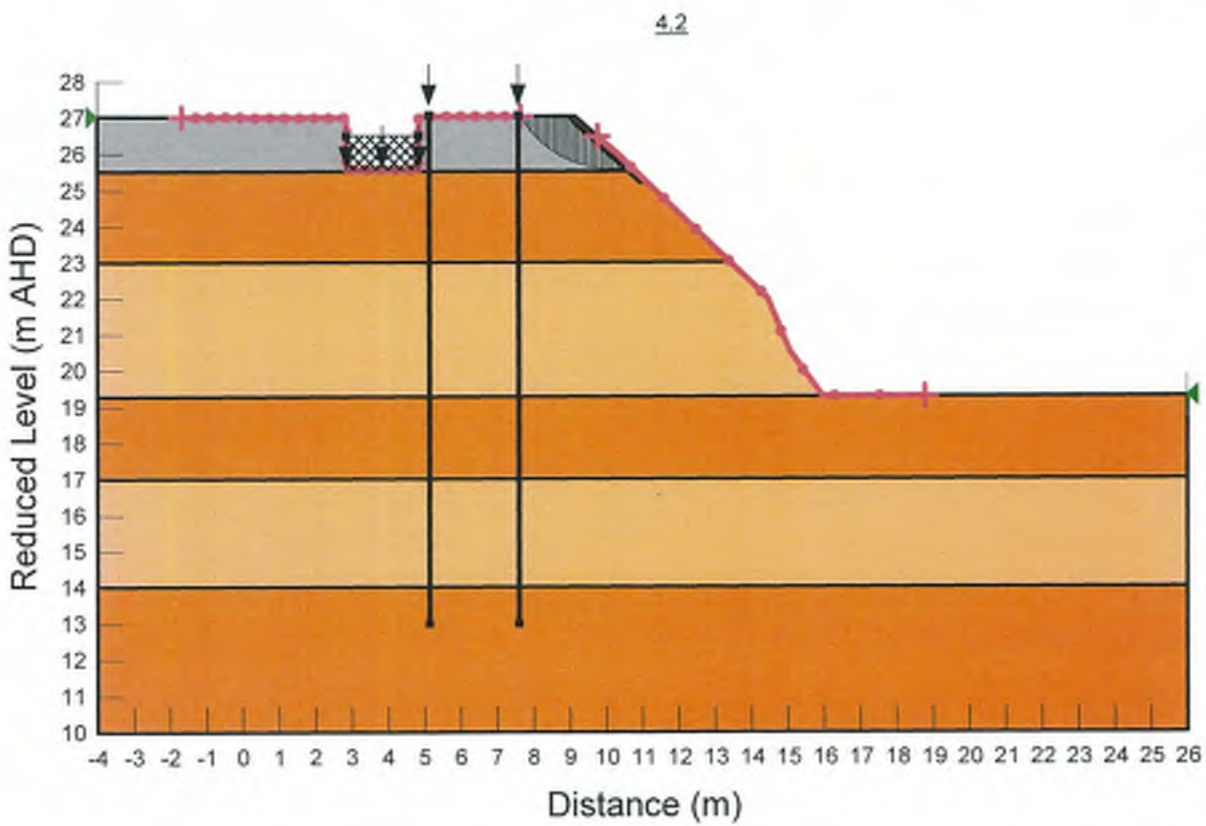
Name: VLS Basalt
Model: Mohr-Coulomb
Unit Weight: 21 kN/m³
Cohesion': 150 kPa
Phi': 33 °

Name: HS Basalt
Model: Mohr-Coulomb
Unit Weight: 24 kN/m³
Cohesion': 900 kPa
Phi': 45 °

Name: Shotcrete
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion': 200 kPa
Phi': 0 °

90317.00 - Lismore Base Hosptial Stage 3B2
Piling Rig Stability

SECTION J - No nails - S-LOW - 2 Pile w/ Footing



Cohesion': 1 kPa
Phi': 24 °

Name: VLS Basalt
Model: Mohr-Coulomb
Unit Weight: 21 kN/m³
Cohesion': 100 kPa
Phi': 31 °

Name: HS Basalt
Model: Mohr-Coulomb
Unit Weight: 24 kN/m³
Cohesion': 750 kPa
Phi': 40 °

Name: Shotcrete
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion': 200 kPa
Phi': 0 °

Figure 15

90317.00 - Lismore Base Hosptial Stage 3B2
Piling Rig Stability

SECTION J - No nails - S-HIGH - 2 Pile w/ Footing

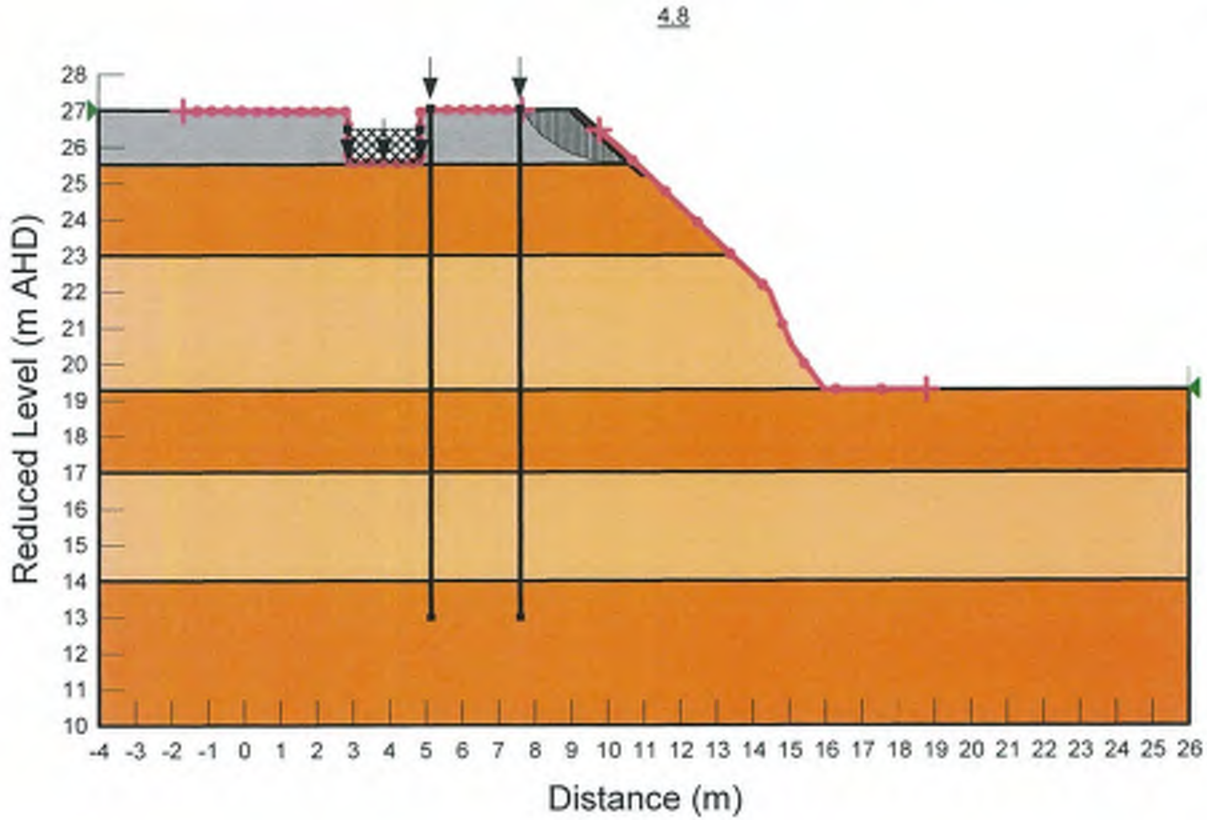


Figure 16

Cohesion': 3 kPa
Phi': 25 °

Name: VLS Basalt
Model: Mohr-Coulomb
Unit Weight: 21 kN/m³
Cohesion': 150 kPa
Phi': 33 °

Name: HS Basalt
Model: Mohr-Coulomb
Unit Weight: 24 kN/m³
Cohesion': 900 kPa
Phi': 45 °

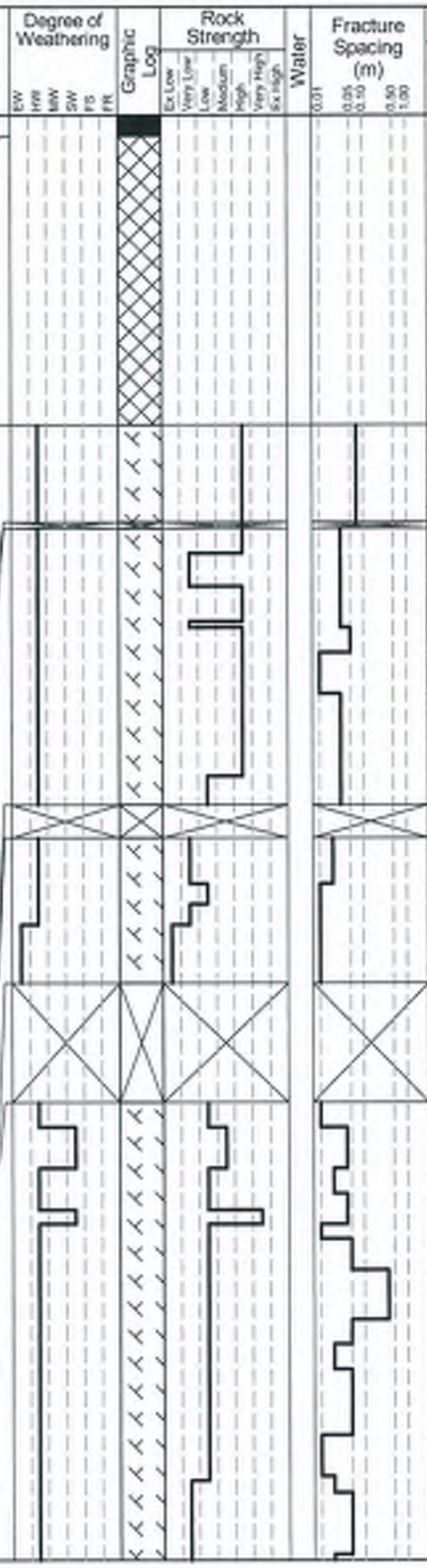
Name: Shotcrete
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion': 200 kPa
Phi': 0 °

BOREHOLE LOG

CLIENT: John Holland Pty Ltd
PROJECT: Proposed Maternity (3B2) Building
LOCATION: Little Uralba Street, Lismore

SURFACE LEVEL: 26.62 AHD
EASTING: 528520
NORTHING: 6813177
DIP/AZIMUTH: 90°/--

BORE No: 7
PROJECT No: 90317
DATE: 30/5 - 1/6/2016
SHEET 1 OF 3



Depth (m)	Description of Strata	Discontinuities (B - Bedding, J - Joint, S - Shear, F - Fault)	Type	Core Rec. %	RQD %	Test Results & Comments
0.1	ASPHALT					
1.5	FILLING - compacted orange brown gravelly clay. Gravel of sub-rounded to rounded quartz and basalt		S			5,4,3 N = 7
1.97	BASALT - high strength fresh dark grey basalt fragments set within a matrix of highly weathered, orange brown clay and extremely weathered rock seams. Fractures randomly orientated and up to approximately 30mm thick	1.5m: high fractured, joints typically at 60° and 10°, pl, ro, fe, st 1.73m: J @ 20° pl, sm, cl, 1.9m: fractured between 1.9m and 1.97m	C C	100 100	0 0	PL(A) = 13.09 FR Fragment tested
2.0	CORELOSS	1.97m: CORE LOSS: 30mm				
3.34	BASALT - high strength fresh dark grey basalt fragments set within a matrix of highly weathered, orange brown clay and extremely weathered rock seams. Fractures randomly orientated and up to approximately 30mm thick - very low strength, highly weathered band at 2.12m to 2.18m depth - very low strength, highly weathered band at 2.45m to 2.48m depth - becoming very low strength, highly weathered orange brown and grey basalt below 3.2 m depth	2m: high fractured joints typically at 10°, 30° and 90°, pl, sm, clay, inv between 1mm and 7mm thick 2.24m: J @ 5° pl, sm, cl, int 10mm thick 2.33m: J @ 20° pl, sm, cl, int 5mm thick 2.6m: fragmented between 2.6m and 2.7m 2.8m: highly fractured joints typically @ 40°, pl, sm, cl, inf approx 2mm thick	C C C	100 100 72	0 0 0	PL(A) = 4.19 PL(D) = 2.05 FR Fragment tested PL(A) = 5.43 FR Fragment tested PL(D) = 4.01 PL(D) = 0.27
3.5	CORE LOSS	3.34m: CORE LOSS: 160mm				
4.2	BASALT - low strength, highly weathered orange brown and grey basalt - becoming extremely low strength, extremely weathered grey and orange brown basalt below 3.82 m depth	3.5m: highly fractured between 3.5m and 3.72m, joints typically @ 0°, pl, sm, fe, stn 3.72m: J @ 0°, pl, sm, fo, stn 3.82m: J @ 40° pl, sm cl, inf 4.09m: highly fractured between 4.09m and 4.2m	C	87	12	
4.78	CORE LOSS	4.2m: CORE LOSS: 580mm	C	50	0	PL(D) = 0.74
7.0	BASALT - very low strength, highly weathered, orange brown and grey basalt - becoming medium strength, moderately weathered and grey below 4.9m depth with some very low strength, highly weathered bands - high strength, slightly weathered grey basalt band between 5.3m and 5.5m - becoming very low strength, highly weathered below 6.61m depth	4.78m: highly fractured between 4.78 and 4.9m joints typically 5° pl, sm, fe, stn 4.9m: J @ 5°, pl, sm, fe, stn 5m: DIF 5.05m: J @ 5°pl, sm, fe, stn 5.13m: highly fractured between 5.13 and 5.22m 5.37m: high fractured to 5.44m 5.47m: J @ 15°, pl, sm, cl, vn 5.58m: DIF 5.83m: J @ 0°, un, ro, fe, stn 5.95m: high fractured	C C C S C C C	100 100 100 71 100 100	0 34 0 0 0 0	PL(D) = 0.19 PL(D) = 3.54 PL(D) = 1.25 30/70mm PL(D) = 0.04

RIG: P160-Track Rig **DRILLER:** North Coast Drilling **LOGGED:** AS **CASING:** 2.5
TYPE OF BORING: Auger to 1.5m, then NMLC coring to base of hole
WATER OBSERVATIONS: Groundwater @ 5.68m depth when measured on 2 June 2016
REMARKS:

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: John Holland Pty Ltd
PROJECT: Proposed Maternity (3B2) Building
LOCATION: Little Uralba Street, Lismore

SURFACE LEVEL: 26.62 AHD
EASTING: 528520
NORTHING: 6813177
DIP/AZIMUTH: 90°/--

BORE No: 7
PROJECT No: 90317
DATE: 30/5 - 1/6/2016
SHEET 2 OF 3

Depth (m)	Description of Strata
	BASALT - high strength, slightly weathered, highly fractured grey basalt. Fractures typically 3 to 5mm thick
7.95	CORELOSS
8.3	BASALT - low strength, highly weathered grey and prange brown basalt
9.06	BASALTIC TEPHRA - very low strength, highly weathered purple grey and orange brown basalt CORELOSS
9.89	BASALTIC TEPHRA - very low strength, highly weathered purple grey and orange brown basalt - becoming very low strength highly weathered below 10.9m depth
12.06	BASALT - low strength, highly weathered, orange brown and grey basalt below 9.89 m depth - becoming very low strength, highly weathered below 12.3 m depth - becoming low strength, highly weathered below 13.0m depth - becoming high strength, slightly weathered dark grey basalt below
14.0	

RL: 19, 18, 17, 16, 15, 14, 13

Degree of Weathering: EW HW MW SW FS FR
Rock Strength: Ex Low, Very Low, Low, Medium, High, Very High, Ex High
Fracture Spacing (m): 0.01, 0.05, 0.10, 0.50, 1.00

Discontinuities (B - Bedding, J - Joint, S - Shear, F - Fault)

- between 5.95 and 6.07m
- 6.12m: J @ 0°, pl, sm, fe, stn
- 6.18m: DIF
- 6.39m: highly fractured between 6.39m and 6.67m
- 6.74m: J @ 10°, pl, sm, fe, stn
- 6.82m: highly fractured between 6.82 and 6.97m clay infill between joints to between 1mm and 3mm thick
- 7m: highly fractured between 7.0m and 7.45m, joints typically @ 0°, 5° and 90° pl, sm, cl inf
- 7.95m: CORE LOSS: 350mm
- 8.45m: J @ 0°, pl, sm, st
- 8.64m: J @ 0°, pl, sm, fe, stained
- 8.72m: J @ 5°, pl, sm, cl, ven
- 8.8m: J @ 0°, pl, sm, cl, vn
- 8.84m: J @ 5°, pl, sm, cl, vn
- 8.99m: DIF
- 9.13m: CORE LOSS: 760mm
- 9.94m: J @ 0°, fl, sm, cln
- 10.09m: DIF
- 10.36m: J @ 0°, pl, sm, cln
- 10.88m: J @ 45°, st, ro, fe, stn
- 11m: DIF
- 11.34m: J @ 0°, pl, sm, cln
- 11.87m: J @ 0°, st, rb, cln
- 11.95m: DIF
- 12.03m: J @ 0° st, ro, cln
- 12.2m: J @ 0°, st, ro, un
- 12.28m: J @ 0°, pl, sm, cln
- 12.65m: DIF
- 13m: DIF
- 13.16m: J @ 45°, pl, sm, fe, stn
- 13.21m: J @ 0°, pl, sm, fe, stn
- 13.32m: J @ 0°, ro, st, stn
- 13.36m: J @ 0°, ro, fe, stn
- 13.43m: J @ 0°, st, fe,

Sampling & In Situ Testing

Type	Core Rec. %	RQD %	Test Results & Comments
C	100	0	PL(D) = 1.47
C	100	0	PL(A) = 0.18 PL(D) = 0.06
C	100	21.5	
C	8	8	
C	100	42	PL(A) = 0.12 PL(D) = 0.06
C	100	75	
C	100	100	PL(A) = 0.08 PL(D) = 0.02
C	100	78	PL(A) = 0.07 PL(D) = 0.05
C	100	56	PL(A) = 0.1 PL(D) = 0.13 PL(A) = 0.15 PL(D) = 0.15
C	100	41	PL(A) = 2.29 PL(D) = 1.65

RIG: P160-Track Rig **DRILLER:** North Coast Drilling **LOGGED:** AS **CASING:** 2.5
TYPE OF BORING: Auger to 1.5m, then NMLC coring to base of hole
WATER OBSERVATIONS: Groundwater @ 5.68m depth when measured on 2 June 2016
REMARKS:

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: John Holland Pty Ltd
PROJECT: Proposed Maternity (3B2) Building
LOCATION: Little Uralba Street, Lismore

SURFACE LEVEL: 26.62 AHD
EASTING: 528520
NORTHING: 6813177
DIP/AZIMUTH: 90°/--

BORE No: 7
PROJECT No: 90317
DATE: 30/5 - 1/6/2016
SHEET 3 OF 3

RL	Depth (m)	Description of Strata	Discontinuities (B - Bedding, J - Joint, S - Shear, F - Fault)	Type	Core Rec. %	RQD %	Test Results & Comments
		13.73m depth	stn	C	100	41	
12		BASALT - low strength, highly weathered, orange brown and grey basalt below 9.89 m depth	13.5m: J @ 0°, pl, sm, cln 13.7m: J @ 0°, sm, fe, stn 13.74m: J @ 5°, un, ro, fe, stn 13.84m: J @ 0°, fc, sm, cln 13.936m: J @ 0°, pl, cln	C C	100	12	PL(A) = 1.61 PL(D) = 1.34 PL(D) = 0.77
	14.94 15 15.0	SILTY CLAY - stiff, dark grey and orange brown silty clay	14.15m: J @ 0°, ro, cl, vn				PL(A) = 1.92 PL(D) = 1.55
11	16	BASALT - very high strength, slightly weathered dark grey basalt	14.29m: J @ 5°, st, ro, fe, stn 14.36m: J @ 0°, cn, ro, stn 14.41m: J @ 0°, un, ro, cln 14.45m: 14.45m to 14.47m CZ 14.54m: J @ 45°, st, sn, cln 14.6m: 14.6m to 14.68m CZ	C	100	95	PL(A) = 4.14 PL(D) = 3.51
10	17		14.73m: J @ 45°, st, stn, cln 14.81m: 14.81m to 14.83m CZ 14.94m: J @ 0°, st, sm, cl, vn 15.05m: J @ st, ro, cln 15.45m: J @ 45° ivf quartz 16m: DIF	C	100	100	
9 8 7	18 19 20		16.05m: J @ 5°, vn, st, cln 16.46m: DIF 16.59m: J @ 5°, pl, sm, cl, vfn 18.66m: J @ 45° pl, sm, cln 19.22m: J @ 0°, pl, sm, cln	C	100	100	PL(A) = 3.51 PL(D) = 3.53 PL(A) = 3.24 PL(D) = 3.91 PL(A) = 3.1 PL(D) = 3.43
6	20.05	Bore discontinued at 20.05m. Target depth reched					

RIG: P160-Track Rig **DRILLER:** North Coast Drilling **LOGGED:** AS **CASING:** 2.5
TYPE OF BORING: Auger to 1.5m, then NMLC coring to base of hole
WATER OBSERVATIONS: Groundwater @ 5.68m depth when measured on 2 June 2016
REMARKS:

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U,	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: John Holland Pty Ltd
PROJECT: Proposed Maternity (3B2) Building
LOCATION: Little Uralba Street, Lismore

SURFACE LEVEL: 26.37 AHD
EASTING: 528492
NORTHING: 6813164
DIP/AZIMUTH: 90°/--

BORE No: 8
PROJECT No: 90317
DATE: 2 - 3/6/2016
SHEET 1 OF 3

RL	Depth (m)	Description of Strata	Discontinuities (B - Bedding, J - Joint, S - Shear, F - Fault)	Type	Core Rec. %	RQD %	Test Results & Comments
	0.05	ASPHALT					
26		FILLING - compact dark brown and grey sandy gravel with some clay filling		S			3,2,4 N = 6
25	1.0	SILTY CLAY - firm red brown silty clay, moist		A			
24		- becoming stiff, yellow brown and red brown below 1.9m		S			8,7,7 N = 14
23	2.9	BASALT - very low strength, highly weathered yellow brown orange brown and grey basalt		D			
				S			30/130mm
22				D			PL(A) = 0.68
21				S			30/30mm
	5.5	BASALT -very high strength, slightly weathered, highly fractured grey basalt with abundant clay infilled fractures throughout	5.81m: crush zone	C	88	0	PL(D) = 4.39 Rock chips tested for point load
	5.9 / 5.95	CORE LOSS	5.9m: CORE LOSS: 50mm	C	100	0	PL(A) = 6.5 PL(D) = 4.75
20		- slightly weathered below 5.95m with interbedded very low and low strength, highly weathered bands typically between 3mm and 50mm thick	6.2m: high fractured 6.3m: J @ 90°, un, ro, cl, vn 6.5m: J @ 90°, st, ro, cl, vn	C	100	30	PL(A) = 5.89 PL(D) = 4.45
	7.0		6.63m: J @ 45°, pl, sm, cl, vn 6.74m: J @ 30°, pl, sm,	C	100	21	PL(A) = 3.66

RIG: P160-Track Rig **DRILLER:** North Coast Drilling **LOGGED:** AS **CASING:** 2.5
TYPE OF BORING: Auger to 2.0m, then washbore to 5.5m depth and NMLC coring to the base of the hole
WATER OBSERVATIONS: No groundwater observation possible
REMARKS:

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U,	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: John Holland Pty Ltd
PROJECT: Proposed Maternity (3B2) Building
LOCATION: Little Uralba Street, Lismore

SURFACE LEVEL: 26.37 AHD
EASTING: 528492
NORTHING: 6813164
DIP/AZIMUTH: 90°/--

BORE No: 8
PROJECT No: 90317
DATE: 2 - 3/6/2016
SHEET 2 OF 3

Depth (m)	Description of Strata
	BASALT - slightly weathered below 5.95m with interbedded very low and low strength, highly weathered bands typically between 3mm and 50mm thick - becoming medium strength, moderately weathered below 7.5m depth
8.56	BASALTIC TEPHRA - very low strength, highly weathered purple grey basaltic tephra - becoming pale grey orange brown and red brown below 10.25m - becoming low strength, highly weathered and fractured below 11m
11.19	CORE LOSS
11.37	BASALTIC TEPHRA - very stiff purple grey basaltic tephra - becoming low strength below 11.8m - becoming very low strength below 12.05 - becoming very low strength highly weathered below 12.78m
13.56	BASALT - medium strength, moderately weathered, fractured grey and orange brown basalt with micro fractures throughout
14.0	

RL: 19, 18, 17, 16, 15, 14, 13

Depth (m): 8, 9, 10, 11, 12, 13

Degree of Weathering: EW HW MW SW FS FR

Rock Strength: Ex Low, Very Low, Low, Medium, High, Very High, Ex High

Fracture Spacing (m): 0.01, 0.05, 0.10, 0.50, 1.00

Discontinuities (B - Bedding, J - Joint, S - Shear, F - Fault)

cl
6.78m: J @ 0°, un, ro, cl, vn
6.89m: crush zone
6.97m: J @ st, ro, cl, vn
7.07m: J @ 30°, pl, sm, vn
7.15m: fragmented
7.4m: fragmented
8.2m: J @ 0°, st, ro, cl
8.29m: high fractured
8.32m: J @ 5° rn, ro, cl
8.34m: J @ 5°, pl, sm cln
8.47m: J @ 0°, un, ro, cl, vn
8.53m: J @ 0°, st, ro, cln
8.6m: J @ 45°, pl, sm, cln
8.74m: J 45° st, ro, fe, stn
8.8m: fragmented
9.55m: fractured
9.56m: J @ 45° pl, ro, cln
9.85m: J @ 0°, pl, sm, cln
9.91m: J @ 0°, st, vn, fe, stn
10m: DIF
10.2m: J @ 0°, un, rd, cl, vn
10.9m: J @ 0°, pl, sm, cn
11.07m: J @ 5°, pl, sm, cn
11.15m: J @ 0°, un, ro, cl, vn
11.19m: CORE LOSS: 180mm
11.47m: J @ 45°, un, ro, cl, vn
11.6m: J @ 0°, un, ro, cl, vn
11.66m: J @ 0°, un, ro, fe, stn
11.77m: J @ 0° st, ro, cln
11.79m: J @ 0°, st, ro, cln
12.05m: DIF
12.23m: J @ 0°, pl, sm, cln
12.37m: J @ 0°, st, ro, cln
12.5m: J @ °, ro, cl, vn
12.65m: fragmented
12.8m: J @ 0° pl, sm, fe, stn
12.84m: J @ 0° st, rn, cln.
12.91m: fragmented
13.27m: J @ 20°, st, ro, cln, vn

Sampling & In Situ Testing

Type	Core Rec. %	RQD %	Test Results & Comments
			PL(D) = 1.08
C	100	21	PL(D) = 0.06
C	100	0	PL(D) = 0.18
C	100	0	PL(A) = 0.04 PL(D) = 0.08
P			pp=510kPa
C	100	85	PL(A) = 0.06 PL(D) = 0.01 PL(A) = 0.03 PL(D) = 0.02
C	82	20	PL(A) = 0.46 PL(D) = 0.21
P			pp=240kPa
C	100	78	
C	100	0	PL(A) = 0.13 PL(D) = 0.05
C	100	57	PL(A) = 0.15 PL(D) = 0.07

RIG: P160-Track Rig **DRILLER:** North Coast Drilling **LOGGED:** AS **CASING:** 2.5

TYPE OF BORING: Auger to 2.0m, then washbore to 5.5m depth and NMLC coring to the base of the hole

WATER OBSERVATIONS: No groundwater observation possible

REMARKS:

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U,	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: John Holland Pty Ltd
PROJECT: Proposed Maternity (3B2) Building
LOCATION: Little Uralba Street, Lismore

SURFACE LEVEL: 26.37 AHD
EASTING: 528492
NORTHING: 6813164
DIP/AZIMUTH: 90°/--

BORE No: 8
PROJECT No: 90317
DATE: 2 - 3/6/2016
SHEET 3 OF 3

Depth (m)	Description of Strata	Discontinuities (B - Bedding, J - Joint, S - Shear, F - Fault)	Type	Core Rec. %	RQD %	Test Results & Comments
	BASALT - medium strength, moderately weathered, fractured grey and orange brown basalt with micro fractures throughout	13.56m: highly fractured 13.7m: J @ 0°, pl, sm, cln 13.78m: J @ 0°, un, ro, cln 13.85m: J @ 0°, pl, sm, cln 13.97m: J @ 0° un, ro, cln 14.04m: J @ 0° st, ro, cln	C	100	0	PL(A) = 0.04 PL(A) = 0.23 PL(A) = 3.89 PL(D) = 0.92
	- becoming high strength, slightly weathered and dark grey below 14.77m depth - becoming very high strength below 15.5m depth	14.21m: j @ 0°, pl, sm, fe, stn 14.28m: high fractured 14.58m: highly fractured 14.76m: J @ 0°, pl, sn, cln 14.85m: J @ 0°, pl, sn, cln 14.88m: J @ 0°, pl, sn, cln 14.94m: J @ 0°, pl, sm, cln 15m: DIF 15.69m: J @ 0°, pl, sn, cln 15.74m: J @ 0°, pl, sn, cln 16.05m: J @ 10°, pl, sn, cln 16.31m: J @ 5°, pl, sn, cln 16.58m: J @ 0°pl, sm, cln 16.96m: DIF 17.2m: J @ 0°st, ro, cln 17.95m: DIF	C	100	97	PL(A) = 4.83 PL(D) = 1.32 PL(A) = 4.51 PL(D) = 1.57 PL(A) = 5.16 PL(A) = 1.44 PL(D) = 1.81 PL(D) = 3.54
18.1	Bore discontinued at 18.1m. Target depth reched					

RIG: P160-Track Rig **DRILLER:** North Coast Drilling **LOGGED:** AS **CASING:** 2.5
TYPE OF BORING: Auger to 2.0m, then washbore to 5.5m depth and NMLC coring to the base of the hole
WATER OBSERVATIONS: No groundwater observation possible
REMARKS:

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U,	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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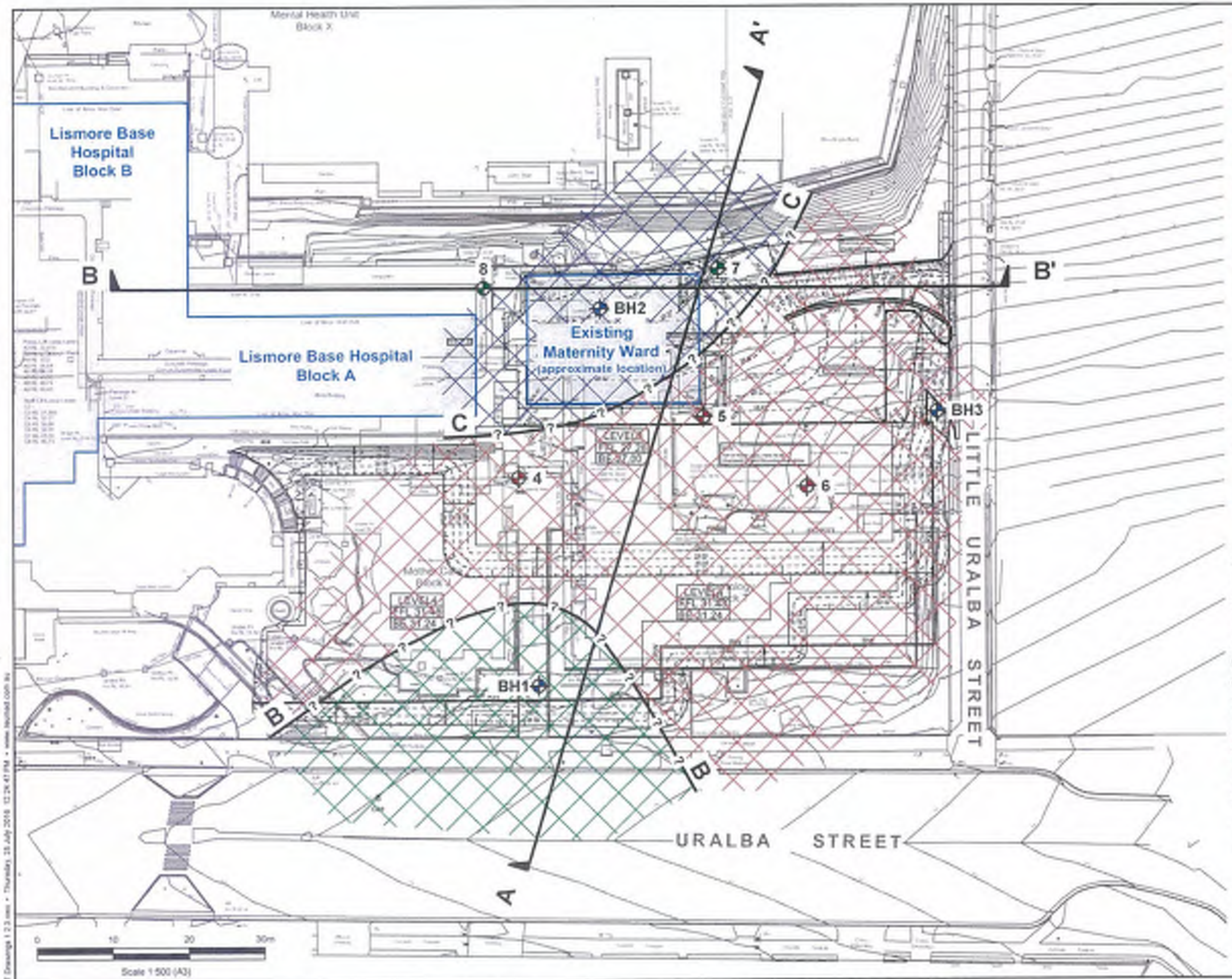

Locality Plan

LEGEND:-

- Bores 7 and 8 Designation and Approximate Location. Undertaken by DP June 2016 - Reference 90317.00.
- Bores 4, 5 and 6 Designation and Approximate Location. Undertaken by DP May 2013 - Reference 80248.00.
- Borehole BH1, BH2 and BH3 Designation and Approximate Location. Undertaken by Coffey Geotechnics Pty Ltd January 2013 - Report Reference GEOTALST01618AN.
- A – A' Geological Cross-Section Location (See Drawing 2).
- B – B' Geological Cross-Section Location (See Drawing 3).
- B —?—?— B / C —?—?— C Denote Interpreted Weathering Extents of Basalt and Tephra.
- Zone 1
- Zone 2
- Zone 3

NOTE:-

1. Plan adapted from drawing 3A-C23-P1.dwg not dated supplied by client.
2. Test locations are approximate only and are shown with reference to existing site features.
3. Black and white reproduction of this colour original may reduce its effectiveness and lead to incorrect interpretation.

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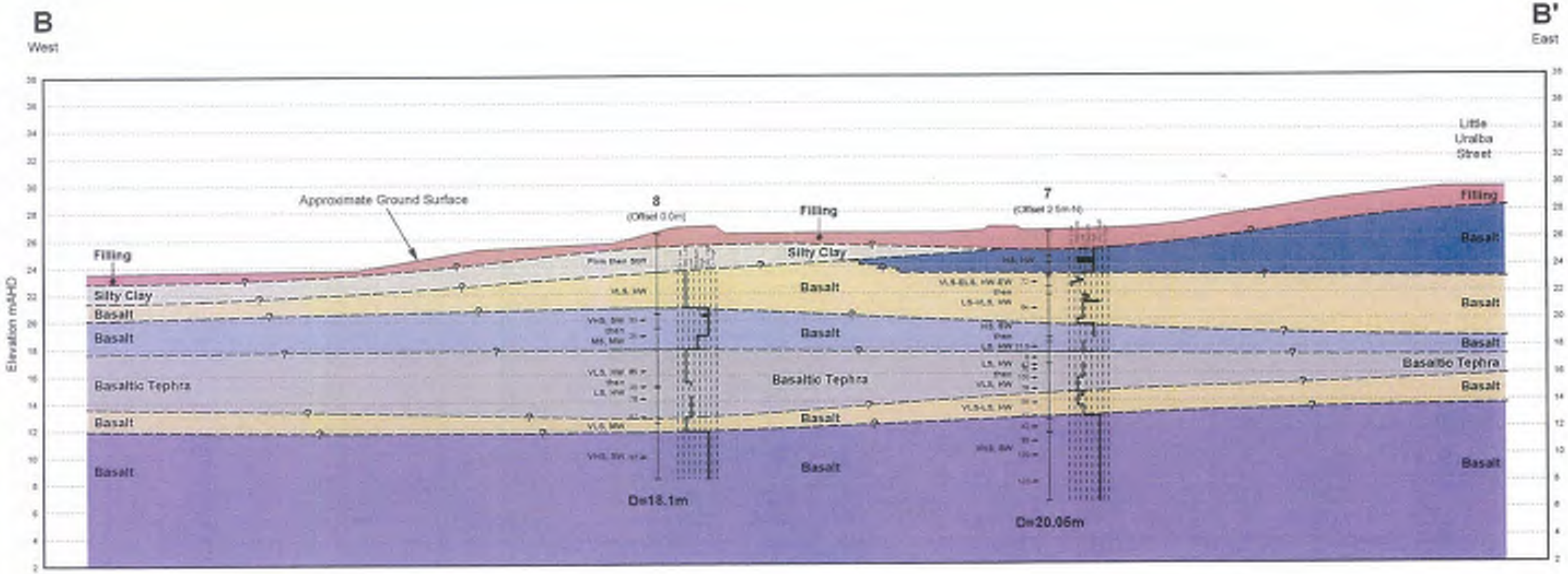
Geotechnics / Environment / Groundwater

CLIENT: John Holland Group Pty Ltd		TITLE: Site Locality and Test Locations Plan Proposed Building 3B2 Lismore Base Hospital, Little Uralba Street, Lismore NSW	PROJECT No: 90317.00
OFFICE: Brisbane	DRAWN BY: LDW		DRAWING No: 1
SCALE: As shown	DATE: 29 July 2016		REVISION: 0



LEGEND:-

BH1 — Bore Designation

(Offset 24.7m SE) — Offset Distance and Direction

Top of Borehole

10 → Rock Quality Designation (RQD - Refer to Bore Logs)

Inferred Geological Contact

Water Level (If Encountered)

Rock Strength (Refer to Bore Logs)

D=19.95m — Bottom of Borehole

KEY:-

- Filling
- Silty CLAY - firm then stiff
- Basalt - high strength (HS) highly weathered (HW)
- Basalt - very low strength (VLS) to low strength (LS) extremely weathered (EW) to highly weathered (HW)
- Basalt - very high strength (VHS) to low strength (LS) slightly weathered (SW) to highly weathered (HW)
- Basaltic Tephra - very low strength (VLS) to low strength (LS) highly weathered (HW)
- Basalt - very high strength (VHS) slightly weathered (SW)

NOTES:-

1. Stratum lines are based on interpretation of the subsurface conditions disclosed in the explorations and interpolation between adjacent explorations. Actual conditions could vary from the subsurface condition interpretations presented on this summary cross-section.
2. See report text for descriptions of geological units.
3. For cross-section location see the Site Locality and Test Locations Plan (Drawing 1).
4. Black and white reproduction of this colour original may reduce its effectiveness and lead to incorrect interpretation.

Douglas Partners Geotechnics / Environment / Groundwater	CLIENT: John Holland Group Pty Ltd	TITLE: **Geological Cross-Section B-B'**	PROJECT No: 90317.00
	OFFICE: Brisbane — DRAWN BY: LDW	**Proposed Building 3B2**	DRAWING No: 3
	SCALE: As shown — DATE: 29 July 2016	**Lismore Base Hospital, Little Uralba Street, Lismore NSW**	REVISION: 0

Douglas Partners
Geotechnics / Environment / Groundwater

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John Holland Group Pty Ltd
PO Box 556
FORTITUDE VALLEY QLD 4006

Project 90317.00
7 September 2016
R.02.Rev00
DQ:ja

Attention: Mr Daniel Schaefer

Email: daniel.schaefer@jhg.com.au

Dear Sirs

Piled Foundations Geotechnical Parameters
Proposed Building 3B2, Lismore Base Hospital
Little Uralba Street, Lismore

1. Introduction

It is understood that the proposed Building 3B2 will comprise the construction of a new seven storey hospital building above a soil nailed slope. The new building column loads near the crest of the slope will be supported on bored piles which will be founded beneath the toe of the adjacent soil nailed slope so as not to impact on the long term slope stability.

A proposed foundation plan for Building 3B2 was prepared by Arcadis Pty Ltd (the project structural engineers), and indicates bored piles along Building Grids 7.5 and 7, and pad footings along all building grids south of Grid 7. Building column loads are in the order of 4800 kN to 6250 kN along Grids 7 and 7.5.

Drawings 1 and 3 are attached and indicate test locations (Drawing 1), and a Geological Cross Section B-B' (Drawing 3) which indicates the interpreted ground surface profile near the crest of the soil nail supported slope.

Ground surface levels on site vary from RL24.5 m to RL27.5 m increasing in an easterly direction along the top of the slope toward Little Uralba Street. Drawing 3 indicates the slope of the site and also the interpreted geological profile.

Boreholes 7 and 8 drilled close to the crest of the slope, provide the basis for the interpreted geological profile indicated on Drawing 3, which comprises, existing gravelly and clayey filling overlying firm to stiff clay or high strength basalt over alternating horizons of very low strength to very high strength basalt, until termination of the bores in very high strength basalt at 18 m and 20 m depth.

Based on an earlier geotechnical investigation by DP at the site in 2013 and limited groundwater monitoring, it is anticipated that groundwater could be at about 6.45 m to 7 m depth further up slope from the current site. It should be noted, however, that groundwater depths and ground moisture conditions are affected by climatic conditions and soil permeability, and will therefore vary with time. This is particularly the case on this site where groundwater conditions will be controlled by elevation, fracturing and clay seams.

2. Bored Pile Design Geotechnical Parameters

Bored piles will need to be sleeved permanently through the upper section of the slope (ie. above RL19 m) so they do not transmit downward forces into the currently soil nail supported slope.

Bored piles founding a minimum of one pile diameter into the nominated founding strata and below the basaltic tephra layer (see Bores 7 and 8, and Drawing 3 attached), can be designed using the ultimate geotechnical strengths ($R_{d,ug}$) given in Table 1.

Pile capacities and suitable pile types should be confirmed by prospective piling contractors. Contractors should also be made aware of the potential for groundwater inflow at depth.

Table 1: Bored Pile Design Geotechnical Parameters (Ultimate Unfactored)

Material	Ultimate Unfactored Shaft Adhesion (MPa)	Ultimate Unfactored End Bearing (MPa)
High strength (or stronger) slightly fractured to fractured basalt	0.8	25
Very high strength slightly fractured to unbroken basalt	2	60

Where limit state methods are used to design the piles, the ultimate geotechnical strength ($R_{d,ug}$) must be multiplied by a suitable geotechnical strength reduction factor (ϕ_g) to obtain the design geotechnical strength ($R_{d,g}$). The geotechnical strength reduction factor is dependent upon several factors which were unknown at the time of preparation of this report, including incorporation of pile testing (if any) into the construction sequence and method of pile testing. As a guide, where the average risk rating is assessed to be high, there is no pile testing and the system has low redundancy, a ϕ_g value of 0.45 would apply. Guidance on the choice of ϕ_g factor is provided in Section 4 of AS2159-2009.

Where working stress methods are used to design piles and no pile testing is carried out, the above ultimate values should be divided by a factor of safety of 2.5.

Experience indicates that settlements of properly designed and constructed piles designed using suitably factored shaft adhesion and end bearing values, are unlikely to exceed 1% of the pile diameter.

It should be noted that the ability to drill bored piles in rock is not only dependent on the characteristics of the rock (strength, fracture spacing etc) but also the type (power and size) of the drilling rig and the size (diameter) of piles. Bored pile installation in high strength or stronger rock will require the use of heavy drilling plant such as Casagrande, Soilmec or Bauer rigs with more than about 220 kNm of drilling torque. It is recommended that the drilling contractors allow for slow drilling rates, the use of coring buckets, very high bit wear and also confirm the size of equipment required prior to commencing works on the site.

3. Verification of Design Pressures

It is essential that both pile and foundation excavations be inspected by experienced geotechnical personnel to ensure the design parameters adopted are suitable for the ground conditions and to ensure that there is no soft or loose material remaining at the base of the excavations or smear on the side walls.

4. Limitations

Douglas Partners (DP) has prepared this report for this project at Little Uralba Street, Lismore in accordance with DP's proposal GLD150259 dated 9 December 2015. The work was carried out under DP's Conditions of Engagement. This report is provided for the exclusive use of John Holland Group Pty Ltd for this project only and for the purposes as described in the report. It should not be used by or relied upon for other projects or purposes on the same or other site or by a third party. Any party so relying upon this report beyond its exclusive use and purpose as stated above, and without the express written consent of DP, does so entirely at its own risk and without recourse to DP for any loss or damage. In preparing this report DP has necessarily relied upon information provided by the client and/or their agents.

The results provided in the report are indicative of the sub-surface conditions on the site only at the specific sampling and/or testing locations, and then only to the depths investigated and at the time the work was carried out. Sub-surface conditions can change abruptly due to variable geological processes and also as a result of human influences. Such changes may occur after DP's field testing has been completed.

DP's advice is based upon the conditions encountered during this investigation. The accuracy of the advice provided by DP in this report may be affected by undetected variations in ground conditions across the site between and beyond the sampling and/or testing locations. The advice may also be limited by budget constraints imposed by others or by site accessibility.

This report must be read in conjunction with all of the attached and should be kept in its entirety without separation of individual pages or sections. DP cannot be held responsible for interpretations or conclusions made by others unless they are supported by an expressed statement, interpretation, outcome or conclusion stated in this report.

This report, or sections from this report, should not be used as part of a specification for a project, without review and agreement by DP. This is because this report has been written as advice and opinion rather than instructions for construction.

The scope for work for this investigation/report did not include the assessment of surface or sub-surface materials or groundwater for contaminants, within or adjacent to the site. Should evidence of filling of unknown origin be noted in the report, and in particular the presence of building demolition materials, it should be recognised that there may be some risk that such filling may contain contaminants and hazardous building materials.

We trust this information is suitable for your requirements at this time, please contact the undersigned if we can be of further assistance.

Yours faithfully
Douglas Partners Pty Ltd

Reviewed by

D. Qualischefski

David Qualischefski
Principal

Bruce Stewart
Principal

Attachments:
- About this Report
- Soil Descriptions
- Rock Descriptions
- Sampling Methods
- Symbols & Abbreviations
- Proposed Foundation Plans
- Drawings 1 and 3
- Borehole Logs 7 and 8

About this Report

Douglas Partners

Introduction

These notes have been provided to amplify DP's report in regard to classification methods, field procedures and the comments section. Not all are necessarily relevant to all reports.

DP's reports are based on information gained from limited subsurface excavations and sampling, supplemented by knowledge of local geology and experience. For this reason, they must be regarded as interpretive rather than factual documents, limited to some extent by the scope of information on which they rely.

Copyright

Borehole and Test Pit Logs

The borehole and test pit logs presented in this report are an engineering and/or geological interpretation of the subsurface conditions, and their reliability will depend to some extent on frequency of sampling and the method of drilling or excavation. Ideally, continuous undisturbed sampling or core drilling will provide the most reliable assessment, but this is not always practicable or possible to justify on economic grounds. In any case the boreholes and test pits represent only a very small sample of the total subsurface profile.

Interpretation of the information and its application to design and construction should therefore take into account the spacing of boreholes or pits, the frequency of sampling, and the possibility of other than 'straight line' variations between the test locations.

Groundwater

Where groundwater levels are measured in boreholes there are several potential problems, namely:

- In low permeability soils groundwater may enter the hole very slowly or perhaps not at all during the time the hole is left open;
- A localised, perched water table may lead to an erroneous indication of the true water table;
- Water table levels will vary from time to time with seasons or recent weather changes. They may not be the same at the time of construction as are indicated in the report; and
- The use of water or mud as a drilling fluid will mask any groundwater inflow. Water has to be blown out of the hole and drilling mud must first be washed out of the hole if water measurements are to be made.

More reliable measurements can be made by installing standpipes which are read at intervals over several days, or perhaps weeks for low permeability soils. Piezometers, sealed in a particular stratum, may be advisable in low permeability soils or where there may be interference from a perched water table.

Reports

The report has been prepared by qualified personnel, is based on the information obtained from field and laboratory testing, and has been undertaken to current engineering standards of interpretation and analysis. Where the report has been prepared for a specific design proposal, the information and interpretation may not be relevant if the design proposal is changed. If this happens, DP will be pleased to review the report and the sufficiency of the investigation work.

Every care is taken with the report as it relates to interpretation of subsurface conditions, discussion of geotechnical and environmental aspects, and recommendations or suggestions for design and construction. However, DP cannot always anticipate or assume responsibility for:

- Unexpected variations in ground conditions. The potential for this will depend partly on borehole or pit spacing and sampling frequency;
- Changes in policy or interpretations of policy by statutory authorities; or
- The actions of contractors responding to commercial pressures.

If these occur, DP will be pleased to assist with investigations or advice to resolve the matter.

About this Report

Site Anomalies

In the event that conditions encountered on site during construction appear to vary from those which were expected from the information contained in the report, DP requests that it be immediately notified. Most problems are much more readily resolved when conditions are exposed rather than at some later stage, well after the event.

Information for Contractual Purposes

Where information obtained from this report is provided for tendering purposes, it is recommended that all information, including the written report and discussion, be made available. In circumstances where the discussion or comments section is not relevant to the contractual situation, it may be appropriate to prepare a specially edited document. DP would be pleased to assist in this regard and/or to make additional report copies available for contract purposes at a nominal charge.

Site Inspection

The company will always be pleased to provide engineering inspection services for geotechnical and environmental aspects of work to which this report is related. This could range from a site visit to confirm that conditions exposed are as expected, to full time engineering presence on site.

Soil Descriptions

Description and Classification Methods

The methods of description and classification of soils and rocks used in this report are based on Australian Standard AS 1726, Geotechnical Site Investigations Code. In general, the descriptions include strength or density, colour, structure, soil or rock type and inclusions.

Soil Types

Soil types are described according to the predominant particle size, qualified by the grading of other particles present:

Type	Particle size (mm)
Boulder	>200
Cobble	63 - 200
Gravel	2.36 - 63
Sand	0.075 - 2.36
Silt	0.002 - 0.075
Clay	<0.002

The sand and gravel sizes can be further subdivided as follows:

Type	Particle size (mm)
Coarse gravel	20 - 63
Medium gravel	6 - 20
Fine gravel	2.36 - 6
Coarse sand	0.6 - 2.36
Medium sand	0.2 - 0.6
Fine sand	0.075 - 0.2

The proportions of secondary constituents of soils are described as:

Term	Proportion	Example
And	Specify	Clay (60%) and Sand (40%)
Adjective	20 - 35%	Sandy Clay
Slightly	12 - 20%	Slightly Sandy Clay
With some	5 - 12%	Clay with some sand
With a trace of	0 - 5%	Clay with a trace of sand

Definitions of grading terms used are:

- Well graded - a good representation of all particle sizes
- Poorly graded - an excess or deficiency of particular sizes within the specified range
- Uniformly graded - an excess of a particular particle size
- Gap graded - a deficiency of a particular particle size with the range

Cohesive Soils

Cohesive soils, such as clays, are classified on the basis of undrained shear strength. The strength may be measured by laboratory testing, or estimated by field tests or engineering examination. The strength terms are defined as follows:

Description	Abbreviation	Undrained shear strength (kPa)
Very soft	vs	<12
Soft	s	12 - 25
Firm	f	25 - 50
Stiff	st	50 - 100
Very stiff	vst	100 - 200
Hard	h	>200

Cohesionless Soils

Cohesionless soils, such as clean sands, are classified on the basis of relative density, generally from the results of standard penetration tests (SPT), cone penetration tests (CPT) or dynamic penetrometers (PSP). The relative density terms are given below:

Relative Density	Abbreviation	SPT N value	CPT qc value (MPa)
Very loose	vl	<4	<2
Loose	l	4 - 10	2 -5
Medium dense	md	10 - 30	5 - 15
Dense	d	30 - 50	15 - 25
Very dense	vd	>50	>25

Soil Descriptions

Soil Origin

It is often difficult to accurately determine the origin of a soil. Soils can generally be classified as:

- Residual soil - derived from in-situ weathering of the underlying rock;
- Transported soils - formed somewhere else and transported by nature to the site; or
- Filling - moved by man.

Transported soils may be further subdivided into:

- Alluvium - river deposits
- Lacustrine - lake deposits
- Aeolian - wind deposits
- Littoral - beach deposits
- Estuarine - tidal river deposits
- Talus - scree or coarse colluvium
- Slopewash or Colluvium - transported downslope by gravity assisted by water. Often includes angular rock fragments and boulders.

Rock Descriptions

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Rock Strength

Rock strength is defined by the Point Load Strength Index ($Is_{(50)}$) and refers to the strength of the rock substance and not the strength of the overall rock mass, which may be considerably weaker due to defects. The test procedure is described by Australian Standard 4133.4.1 - 1993. The terms used to describe rock strength are as follows:

Term	Abbreviation	Point Load Index $Is_{(50)}$ MPa	Approx Unconfined Compressive Strength MPa*
Extremely low	EL	<0.03	<0.6
Very low	VL	0.03 - 0.1	0.6 - 2
Low	L	0.1 - 0.3	2 - 6
Medium	M	0.3 - 1.0	6 - 20
High	H	1 - 3	20 - 60
Very high	VH	3 - 10	60 - 200
Extremely high	EH	>10	>200

* Assumes a ratio of 20:1 for UCS to $Is_{(50)}$

Degree of Weathering

The degree of weathering of rock is classified as follows:

Term	Abbreviation	Description
Extremely weathered	EW	Rock substance has soil properties, i.e. it can be remoulded and classified as a soil but the texture of the original rock is still evident.
Highly weathered	HW	Limonite staining or bleaching affects whole of rock substance and other signs of decomposition are evident. Porosity and strength may be altered as a result of iron leaching or deposition. Colour and strength of original fresh rock is not recognisable
Moderately weathered	MW	Staining and discolouration of rock substance has taken place
Slightly weathered	SW	Rock substance is slightly discoloured but shows little or no change of strength from fresh rock
Fresh stained	Fs	Rock substance unaffected by weathering but staining visible along defects
Fresh	Fr	No signs of decomposition or staining

Degree of Fracturing

The following classification applies to the spacing of natural fractures in diamond drill cores. It includes bedding plane partings, joints and other defects, but excludes drilling breaks.

Term	Description
Fragmented	Fragments of <20 mm
Highly Fractured	Core lengths of 20-40 mm with some fragments
Fractured	Core lengths of 40-200 mm with some shorter and longer sections
Slightly Fractured	Core lengths of 200-1000 mm with some shorter and loner sections
Unbroken	Core lengths mostly > 1000 mm

Rock Descriptions

Rock Quality Designation

The quality of the cored rock can be measured using the Rock Quality Designation (RQD) index, defined as:

$$\text{RQD \%} = \frac{\text{cumulative length of 'sound' core sections} \geq 100 \text{ mm long}}{\text{total drilled length of section being assessed}}$$

where 'sound' rock is assessed to be rock of low strength or better. The RQD applies only to natural fractures. If the core is broken by drilling or handling (i.e. drilling breaks) then the broken pieces are fitted back together and are not included in the calculation of RQD.

Stratification Spacing

For sedimentary rocks the following terms may be used to describe the spacing of bedding partings:

Term	Separation of Stratification Planes
Thinly laminated	< 6 mm
Laminated	6 mm to 20 mm
Very thinly bedded	20 mm to 60 mm
Thinly bedded	60 mm to 0.2 m
Medium bedded	0.2 m to 0.6 m
Thickly bedded	0.6 m to 2 m
Very thickly bedded	> 2 m

Sampling

Sampling is carried out during drilling or test pitting to allow engineering examination (and laboratory testing where required) of the soil or rock.

Disturbed samples taken during drilling provide information on colour, type, inclusions and, depending upon the degree of disturbance, some information on strength and structure.

Undisturbed samples are taken by pushing a thin-walled sample tube into the soil and withdrawing it to obtain a sample of the soil in a relatively undisturbed state. Such samples yield information on structure and strength, and are necessary for laboratory determination of shear strength and compressibility. Undisturbed sampling is generally effective only in cohesive soils.

Test Pits

Test pits are usually excavated with a backhoe or an excavator, allowing close examination of the in-situ soil if it is safe to enter into the pit. The depth of excavation is limited to about 3 m for a backhoe and up to 6 m for a large excavator. A potential disadvantage of this investigation method is the larger area of disturbance to the site.

Large Diameter Augers

Boreholes can be drilled using a rotating plate or short spiral auger, generally 300 mm or larger in diameter commonly mounted on a standard piling rig. The cuttings are returned to the surface at intervals (generally not more than 0.5 m) and are disturbed but usually unchanged in moisture content. Identification of soil strata is generally much more reliable than with continuous spiral flight augers, and is usually supplemented by occasional undisturbed tube samples.

Continuous Spiral Flight Augers

The borehole is advanced using 90-115 mm diameter continuous spiral flight augers which are withdrawn at intervals to allow sampling or in-situ testing. This is a relatively economical means of drilling in clays and sands above the water table. Samples are returned to the surface, or may be collected after withdrawal of the auger flights, but they are disturbed and may be mixed with soils from the sides of the hole. Information from the drilling (as distinct from specific sampling by SPTs or undisturbed samples) is of relatively low reliability, due to the remoulding, possible mixing or softening of samples by groundwater.

Non-core Rotary Drilling

The borehole is advanced using a rotary bit, with water or drilling mud being pumped down the drill rods and returned up the annulus, carrying the drill cuttings. Only major changes in stratification can be determined from the cuttings, together with some information from the rate of penetration. Where drilling mud is used this can mask the cuttings and reliable identification is only possible from separate sampling such as SPTs.

Continuous Core Drilling

A continuous core sample can be obtained using a diamond tipped core barrel, usually with a 50 mm internal diameter. Provided full core recovery is achieved (which is not always possible in weak rocks and granular soils), this technique provides a very reliable method of investigation.

Standard Penetration Tests

Standard penetration tests (SPT) are used as a means of estimating the density or strength of soils and also of obtaining a relatively undisturbed sample. The test procedure is described in Australian Standard 1289, Methods of Testing Soils for Engineering Purposes - Test 6.3.1.

The test is carried out in a borehole by driving a 50 mm diameter split sample tube under the impact of a 63 kg hammer with a free fall of 760 mm. It is normal for the tube to be driven in three successive 150 mm increments and the 'N' value is taken as the number of blows for the last 300 mm. In dense sands, very hard clays or weak rock, the full 450 mm penetration may not be practicable and the test is discontinued.

The test results are reported in the following form.

- In the case where full penetration is obtained with successive blow counts for each 150 mm of, say, 4, 6 and 7 as:

  4,6,7
  N=13

- In the case where the test is discontinued before the full penetration depth, say after 15 blows for the first 150 mm and 30 blows for the next 40 mm as:

  15, 30/40 mm

The results of the SPT tests can be related empirically to the engineering properties of the soils.

Dynamic Cone Penetrometer Tests / Perth Sand Penetrometer Tests

Dynamic penetrometer tests (DCP or PSP) are carried out by driving a steel rod into the ground using a standard weight of hammer falling a specified distance. As the rod penetrates the soil the number of blows required to penetrate each successive 150 mm depth are recorded. Normally there is a depth limitation of 1.2 m, but this may be extended in certain conditions by the use of extension rods. Two types of penetrometer are commonly used.

- Perth sand penetrometer - a 16 mm diameter flat ended rod is driven using a 9 kg hammer dropping 600 mm (AS 1289, Test 6.3.3). This test was developed for testing the density of sands and is mainly used in granular soils and filling.
- Cone penetrometer - a 16 mm diameter rod with a 20 mm diameter cone end is driven using a 9 kg hammer dropping 510 mm (AS 1289, Test 6.3.2). This test was developed initially for pavement subgrade investigations, and correlations of the test results with California Bearing Ratio have been published by various road authorities.

Symbols & Abbreviations

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Introduction

These notes summarise abbreviations commonly used on borehole logs and test pit reports.

Drilling or Excavation Methods

C	Core Drilling
R	Rotary drilling
SFA	Spiral flight augers
NMLC	Diamond core - 52 mm dia
NQ	Diamond core - 47 mm dia
HQ	Diamond core - 63 mm dia
PQ	Diamond core - 81 mm dia

Water

▷	Water seep
▽	Water level

Sampling and Testing

A	Auger sample
B	Bulk sample
D	Disturbed sample
E	Environmental sample
U_{50}	Undisturbed tube sample (50mm)
W	Water sample
pp	pocket penetrometer (kPa)
PID	Photo ionisation detector
PL	Point load strength Is(50) MPa
S	Standard Penetration Test
V	Shear vane (kPa)

Description of Defects in Rock

The abbreviated descriptions of the defects should be in the following order: Depth, Type, Orientation, Coating, Shape, Roughness and Other. Drilling and handling breaks are not usually included on the logs.

Defect Type

B	Bedding plane
Cs	Clay seam
Cv	Cleavage
Cz	Crushed zone
Ds	Decomposed seam
F	Fault
J	Joint
Lam	lamination
Pt	Parting
Sz	Sheared Zone
V	Vein

Orientation

The inclination of defects is always measured from the perpendicular to the core axis.

h	horizontal
v	vertical
sh	sub-horizontal
sv	sub-vertical

Coating or Infilling Term

cln	clean
co	coating
he	healed
inf	infilled
stn	stained
ti	tight
vn	veneer

Coating Descriptor

ca	calcite
cbs	carbonaceous
cly	clay
fe	iron oxide
mn	manganese
slt	silty

Shape

cu	curved
ir	irregular
pl	planar
st	stepped
un	undulating

Roughness

po	polished
ro	rough
sl	slickensided
sm	smooth
vr	very rough

Other

fg	fragmented
bnd	band
qtz	quartz

Symbols & Abbreviations

Graphic Symbols for Soil and Rock

General

- Asphalt
- Road base
- Concrete
- Filling

Soils

- Topsoil
- Peat
- Clay
- Silty clay
- Sandy clay
- Gravelly clay
- Shaly clay
- Silt
- Clayey silt
- Sandy silt
- Sand
- Clayey sand
- Silty sand
- Gravel
- Sandy gravel
- Cobbles, boulders
- Talus

Sedimentary Rocks

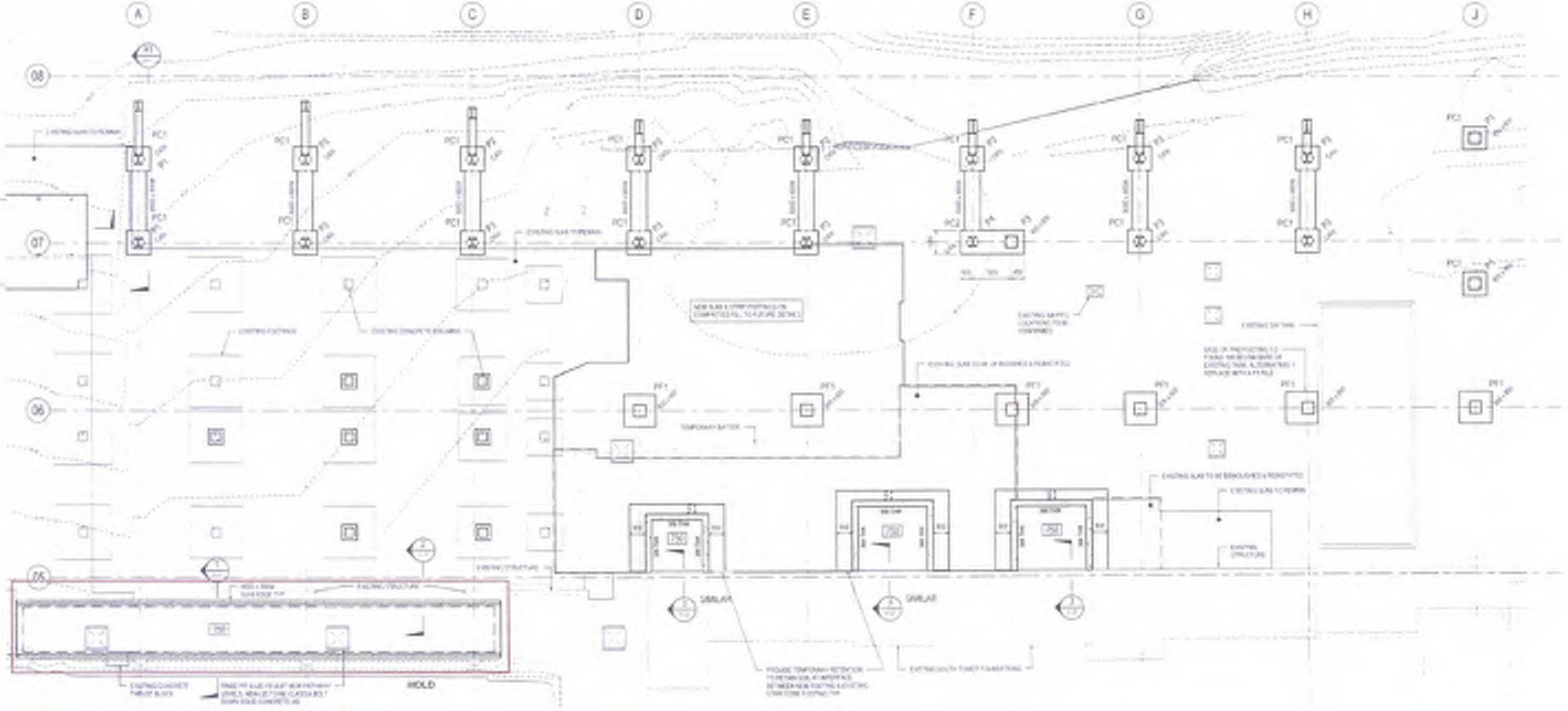
- Boulder conglomerate
- Conglomerate
- Conglomeratic sandstone
- Sandstone
- Siltstone
- Laminite
- Mudstone, claystone, shale
- Coal
- Limestone

Metamorphic Rocks

- Slate, phyllite, schist
- Gneiss
- Quartzite

Igneous Rocks

- Granite
- Dolerite, basalt, andesite
- Dacite, epidote
- Tuff, breccia
- Porphyry



LEVEL 3 LINK PASSAGE WAY

FOUNDATION PLAN

1 : 100

PRELIMINARY

FOOTING SCHEDULE

MARK	SIZE
PC1	[illegible]
PC2	[illegible]
PF1	[illegible]

PILE SCHEDULE

MARK	PILE DIA	PILE REINF	PILE f'c	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

PILE SCHEDULE ALTERNATIVE (750 DIA.)

MARK	PILE DIA	PILE REINF	PILE f'c	[illegible]	[illegible]
[illegible]	750	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	750	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	750	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	750	[illegible]	[illegible]	[illegible]	[illegible]

STEEL COLUMN SCHEDULE

MARK	SIZE
[illegible]	[illegible]

RC COLUMN SCHEDULE

LEVEL	SIZE	REINFORCEMENT	f'c
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]

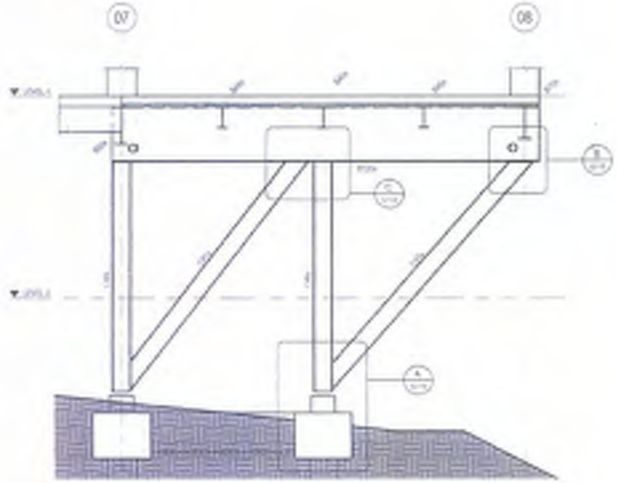
John Holland | aurora | NSW Government | Health Infrastructure | ARCADIS

CLIENT: HEALTH INFRASTRUCTURE

DRAWING: LEVEL 3 FOUNDATION PLAN

PROJECT: LISMORE BASE HOSPITAL STAGE 3B2

AA008927 DD 3B2_S131-NB D 1 : 100



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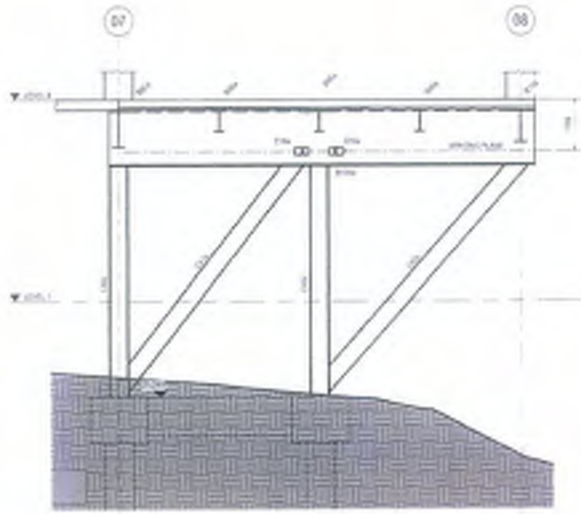
1 : 50



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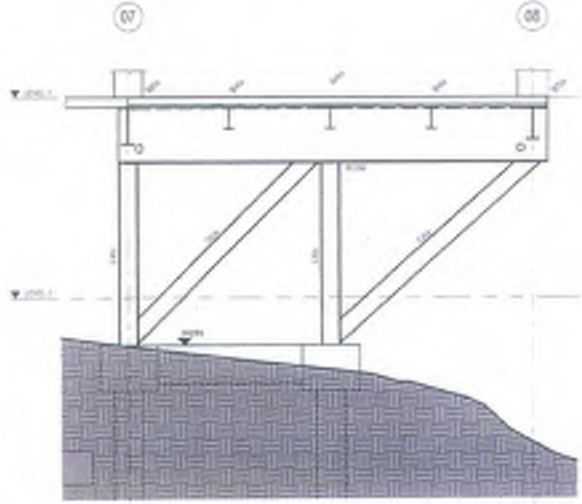

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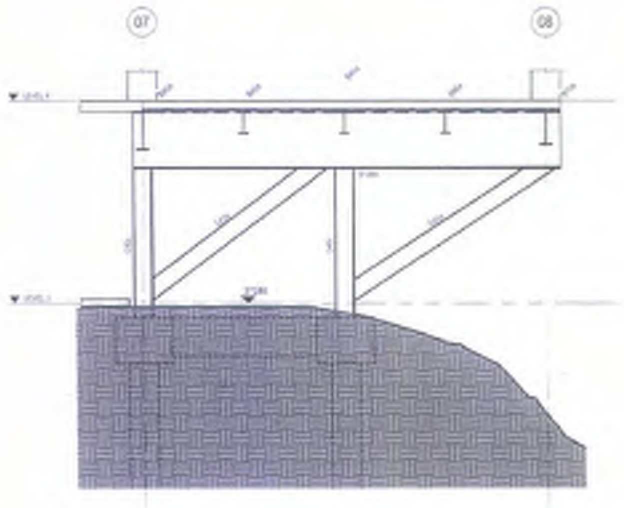

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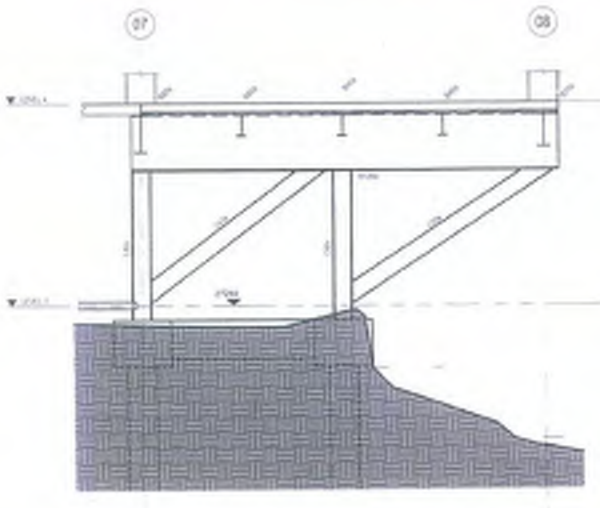

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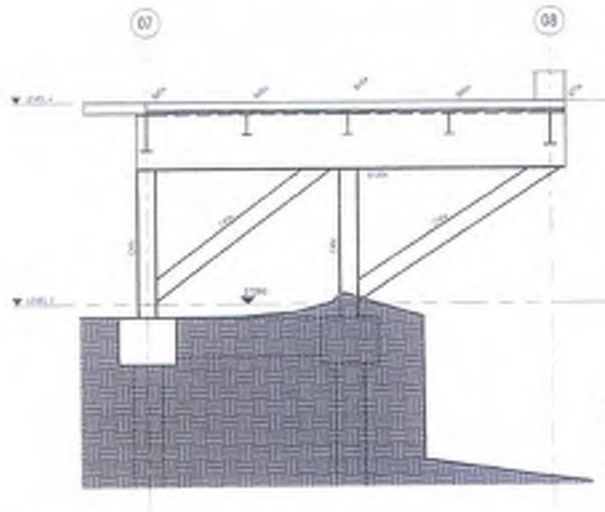

SECTION ALONG GRID F
1 : 50

PRELIMINARY

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HEALTH INFRASTRUCTURE

LEVEL 3 TO LEVEL 4
STEEL FRAMING
ELEVATIONS SHEET 1

LISMORE BASE
HOSPITAL STAGE 3B2

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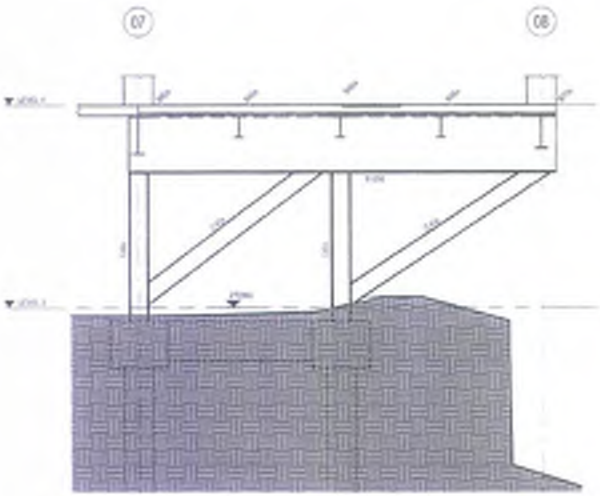

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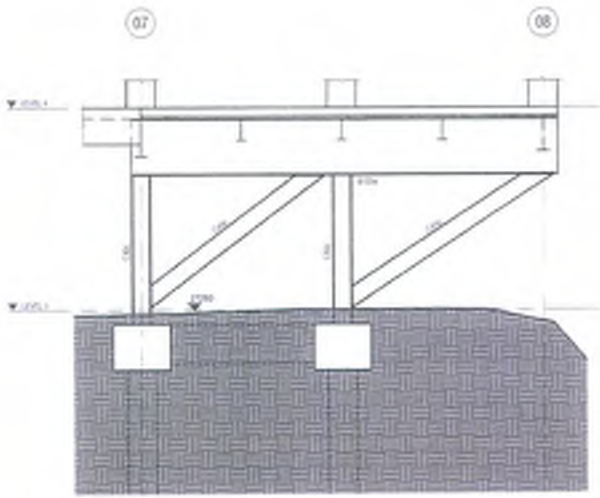

SECTION ALONG GRID H

1 : 50

PRELIMINARY

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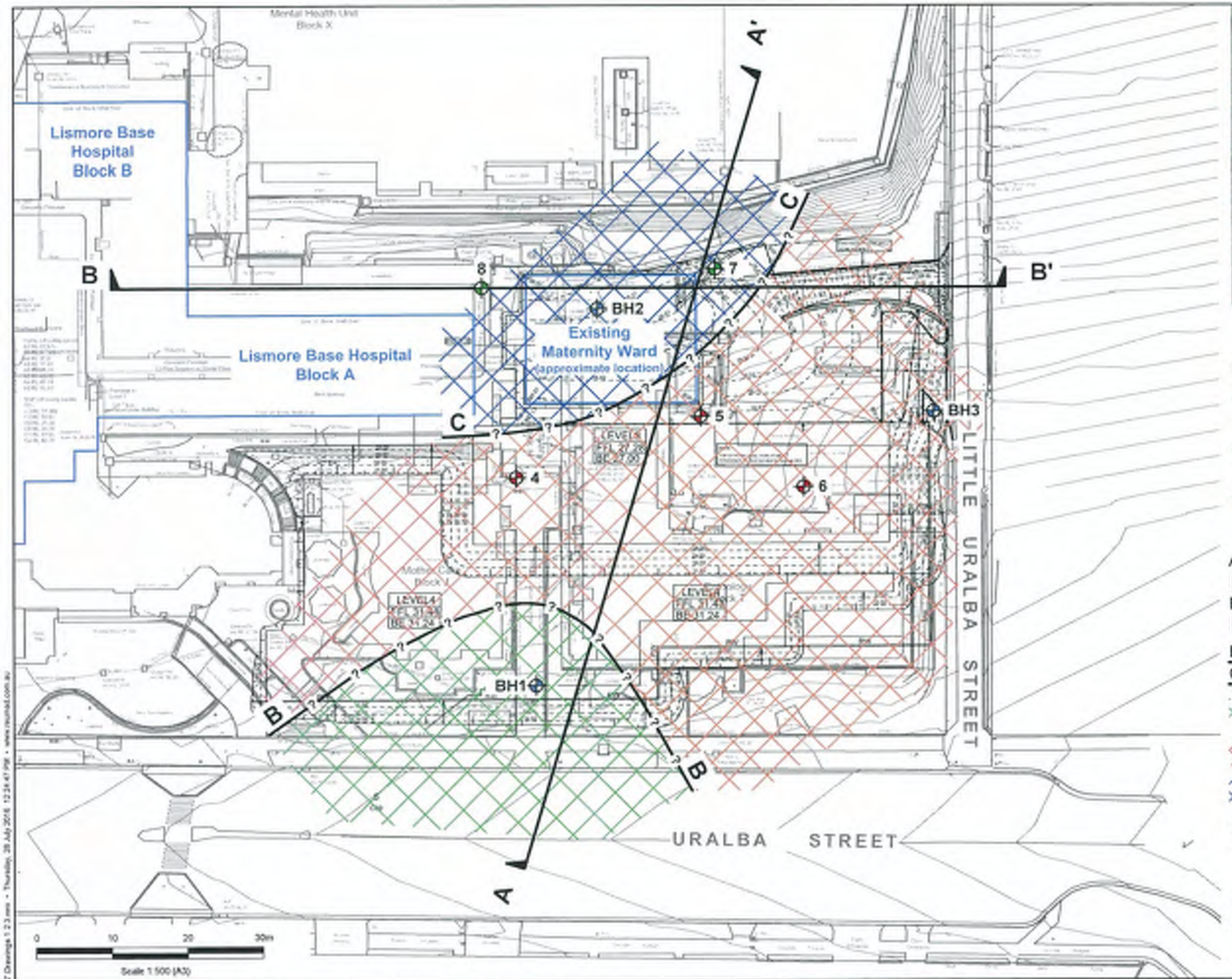
HEALTH INFRASTRUCTURE

LEVEL 3 TO LEVEL 4 STEEL FRAMING ELEVATIONS SHEET 2

LISMORE BASE HOSPITAL STAGE 3B2

AA008927 DD 3B2_S112-NB A 1 : 50



Locality Plan

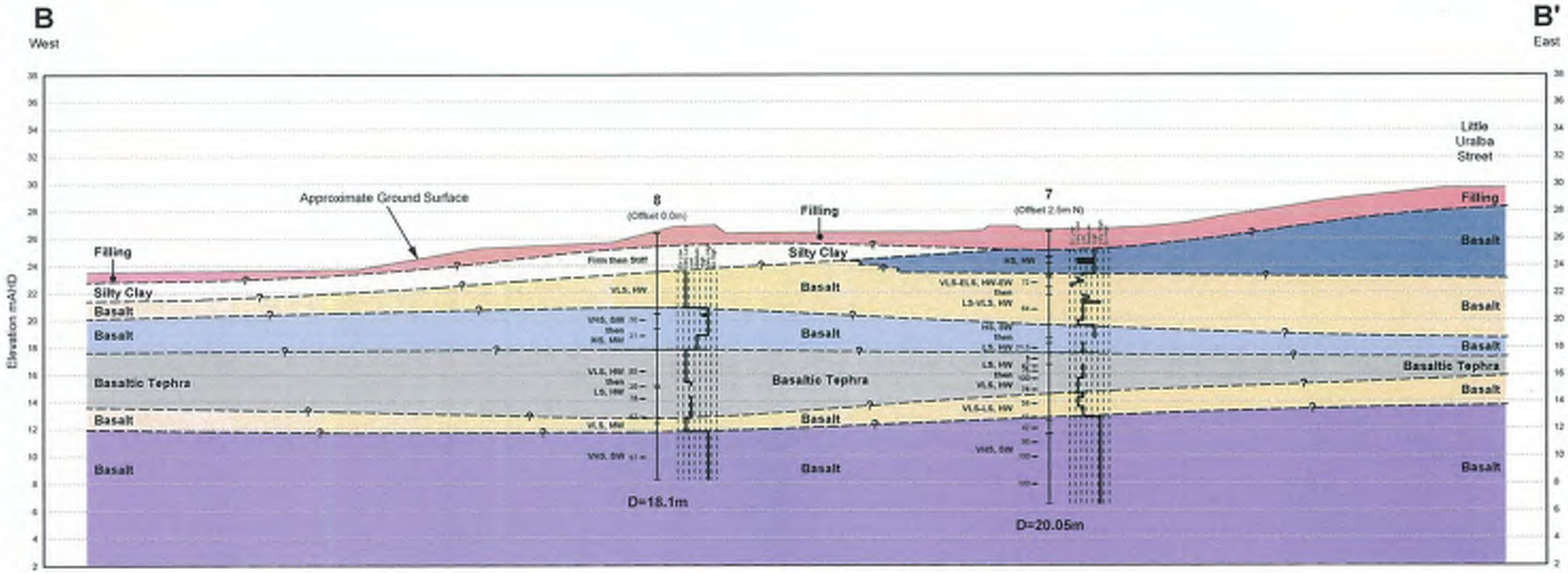
LEGEND:-

- Bores 7 and 8 Designation and Approximate Location. Undertaken by DP June 2016 - Reference 90317.00.
- Bores 4, 5 and 6 Designation and Approximate Location. Undertaken by DP May 2013 - Reference 80248.00.
- Borehole BH1, BH2 and BH3 Designation and Approximate Location. Undertaken by Coffey Geotechnics Pty Ltd January 2013 - Report Reference GEOTALST01618AN.
- A – A' Geological Cross-Section Location (See Drawing 2).
- B – B' Geological Cross-Section Location (See Drawing 3).
- B—?—?—B / C—?—?—C Denote Interpreted Weathering Extents of Basalt and Tephra.
- Zone 1
- Zone 2
- Zone 3

NOTE:-

1. Plan adapted from drawing 3A-C23-P1.dwg not dated supplied by client.
2. Test locations are approximate only and are shown with reference to existing site features.
3. Black and white reproduction of this colour original may reduce its effectiveness and lead to incorrect interpretation.

Douglas Partners Geotechnics / Environment / Groundwater	CLIENT: NSW Health Infrastructure		TITLE: Site Locality and Test Locations Plan Proposed Eleven Storey Building Lismore Base Hospital, Uralba Street, Lismore NSW	PROJECT No: 90317.00
	OFFICE: Brisbane	DRAWN BY: LDW		DRAWING No: 1
	SCALE: As shown	DATE: 29 July 2016		REVISION: 0



LEGEND:-

- BH1 — Bore Designation
- (Offset 24.7m SE) — Offset Distance and Direction
- Top of Borehole
- 10 → Rock Quality Designation (RQD - Refer to Bore Logs)
- Inferred Geological Contact
- Water Level (If Encountered)
- Rock Strength (Refer to Bore Logs)
- Bottom of Borehole
- D=19.95m

KEY:-

- Filling
- Silty CLAY - firm then stiff
- Basalt - high strength (HS) highly weathered (HW)
- Basalt - very low strength (VLS) to low strength (LS) extremely weathered (EW) to highly weathered (HW)
- Basalt - very high strength (VHS) to low strength (LS) slightly weathered (SW) to highly weathered (HW)
- Basaltic Tephra - very low strength (VLS) to low strength (LS) highly weathered (HW)
- Basalt - very high strength (VHS) slightly weathered (SW)

NOTES:-

1. Stratum lines are based on interpretation of the subsurface conditions disclosed in the explorations and interpolation between adjacent explorations. Actual conditions could vary from the subsurface condition interpretations presented on this summary cross-section.
2. See report text for descriptions of geological units.
3. For cross-section location see the Site Locality and Test Locations Plan (Drawing 1).
4. Black and white reproduction of this colour original may reduce its effectiveness and lead to incorrect interpretation.

Douglas Partners
Geotechnics / Environment / Groundwater

CLIENT: NSW Health Infrastructure		TITLE: Geological Cross-Section B-B'	PROJECT No: 90317.00
OFFICE: Brisbane	DRAWN BY: LDW	Proposed Eleven Storey Building	DRAWING No: 3
SCALE: As shown	DATE: 29 July 2016	Lismore Base Hospital, Uralba Street, Lismore NSW	REVISION: 0

BOREHOLE LOG

CLIENT: John Holland Pty Ltd
PROJECT: Proposed Maternity (3B2) Building
LOCATION: Little Uralba Street, Lismore

SURFACE LEVEL: 26.62 AHD
EASTING: 528520
NORTHING: 6813177
DIP/AZIMUTH: 90°/--

BORE No: 7
PROJECT No: 90317
DATE: 30/5 - 1/6/2016
SHEET 1 OF 3

Depth (m)	Description of Strata	Discontinuities (B - Bedding, J - Joint, S - Shear, F - Fault)
0.1	ASPHALT	
1.5	FILLING - compacted orange brown gravelly clay. Gravel of sub-rounded to rounded quartz and basalt	
3.2	BASALT - high strength fresh dark grey basalt fragments set within a matrix of highly weathered, orange brown clay and extremely weathered rock seams. Fractures randomly orientated and up to approximately 30mm thick - very low strength, highly weathered bands at 2.12m to 2.18m and 2.45m to 2.48m depth	1.5m: J, 60° and 10°, pl, ro, fe, st 1.73m: J, 20° pl, sm, cl, 1.97m: CORE LOSS: 30mm 2m: J, 10°, 30° and 90°, pl, sm, clay, inv between 1mm and 7mm thick 2.24m: J, 5° pl, sm, cl, int 10mm thick 2.33m: J, 20° pl, sm, cl, int 5mm thick 2.8m: J, 40°, pl, sm, cl, inf approx 2mm thick
3.5 / 4.2	BASALT - low then very low strength, highly weathered orange brown and grey basalt - extremely low strength, extremely weathered grey and orange brown basalt below 3.92 m depth	3.34m: CORE LOSS: 160mm 3.5m: J, 0°, pl, sm, fe, stn 3.72m: J, 0°, pl, sm, fe, stn 3.82m: J, 40° pl, sm cl, inf 4.2m: CORE LOSS: 580mm
4.78 – 7.0	BASALT - generally low strength, highly weathered, orange brown and grey basalt - medium or high strength,slightly weathered bands from 4.9m to 5.1m and 5.3m to 5.5m depth - very low strength below 6.61m depth	4.78m: J, 5° pl, sm, fe, stn 4.9m: J, 5°, pl, sm, fe, stn 5.06m: J, 5°pl, sm, fe, stn 5.47m: J, 15°, pl, sm, cly vn 5.83m: J, 0°, un, ro, fe, stn 6.12m: J, 0°, pl, sm, fe, stn 6.74m: J, 10°, pl, sm, fe, stn

Sampling & In Situ Testing

Type	Core Rec. %	RQD %	Test Results & Comments
S			5,4,3 N = 7
C	100	0	PL(A) = 13.09 FR Fragment tested
C	100	0	
C	100	0	
C	100	0	PL(A) = 4.19 PL(D) = 2.05 FR Fragment tested
C	72	0	PL(A) = 5.43 FR Fragment tested PL(D) = 4.01 PL(D) = 0.27
C	87	12	
C	50	0	PL(D) = 0.74
C	100	0	PL(D) = 0.19
C	100	34	PL(D) = 3.54 PL(D) = 1.25
C	100	0	
S			30/70mm
C	71	0	PL(D) = 0.04
C	100	0	
C	100	0	

RIG: P160-Track Rig **DRILLER:** North Coast Drilling **LOGGED:** AS **CASING:** 2.5
TYPE OF BORING: Auger to 1.5m, then NMLC coring to base of hole
WATER OBSERVATIONS: Groundwater @ 5.68m depth when measured on 2 June 2016
REMARKS:

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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BOREHOLE LOG

CLIENT: John Holland Pty Ltd
PROJECT: Proposed Maternity (3B2) Building
LOCATION: Little Uralba Street, Lismore

SURFACE LEVEL: 26.62 AHD
EASTING: 528520
NORTHING: 6813177
DIP/AZIMUTH: 90°/--

BORE No: 7
PROJECT No: 90317
DATE: 30/5 - 1/6/2016
SHEET 2 **OF** 3

Depth (m)	Description of Strata	Discontinuities (B - Bedding, J - Joint, S - Shear, F - Fault)	Type	Core Rec. %	RQD %	Test Results & Comments
	BASALT - high strength, slightly weathered, highly fractured grey basalt. Fractures typically 3 to 5mm thick	7m: J, 0°, 5° and 90° pl, sm, cl inf	C	100	0	PL(D) = 1.47
			C	100	0	
8	- core loss possibly corresponds with clay infill in highly fractured zone	7.95m: CORE LOSS: 350mm				PL(A) = 0.18 PL(D) = 0.06
8.3	BASALT - low strength, highly weathered, fractured, grey and orange brown basalt	8.45m: J, 0°, pl, sm, st 8.64m: J, 0°, pl, sm, fe stn 8.72m: J, 5°, pl, sm, cl vn 8.8m: J, 0°, pl, sm, cly vn 8.84m: J, 5°, pl, sm, cly vn	C	100	21.5	
9.06	BASALTIC TEPHRA - very low to low strength, highly weathered, fractured, purple grey and orange brown basaltic tephra	9.13m: CORE LOSS: 760mm	C	8	8	
9.89		9.94m: J, 0°, fl, sm	C	100	42	PL(A) = 0.12 PL(D) = 0.06
10		10.36m: J, 0°, pl, sm	C	100	75	
11	- very low strength, highly weathered below 10.9m depth	10.88m: J, 45°, st, ro, fe, stn	C	100	100	PL(A) = 0.08 PL(D) = 0.02
		11.34m: J, 0°, pl, sm				PL(A) = 0.07 PL(D) = 0.05
		11.87m: J, 0°, st, rb 12.03m: J, 0° st, ro	C	100	78	
12.06	BASALT - very low and low strength, highly weathered, orange brown and grey basalt	12.2m: J, 0°, st, ro, un 12.28m: J, 0°, pl, sm				PL(A) = 0.1 PL(D) = 0.13
13			C	100	56	PL(A) = 0.15 PL(D) = 0.15
		13.16m: J, 45°, pl, sm, fe, stn 13.21m: J, 0°, pl, sm, fe, stn 13.32m: J, 0°, ro, st, stn 13.36m: J, 0°, ro, fe, stn 13.43m: J, 0°, st, fe, stn 13.5m: J, 0°, pl, sm 13.7m: J, 0°, sm, fe, stn	C	100	41	PL(A) = 2.29 PL(D) = 1.65
13.73						

RIG: P160-Track Rig **DRILLER:** North Coast Drilling **LOGGED:** AS **CASING:** 2.5
TYPE OF BORING: Auger to 1.5m, then NMLC coring to base of hole
WATER OBSERVATIONS: Groundwater @ 5.68m depth when measured on 2 June 2016
REMARKS:

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U,	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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BOREHOLE LOG

CLIENT:	John Holland Pty Ltd	**SURFACE LEVEL:**	26.62 AHD	**BORE No:**	7
PROJECT:	Proposed Maternity (3B2) Building	**EASTING:**	528520	**PROJECT No:**	90317
LOCATION:	Little Uralba Street, Lismore	**NORTHING:**	6813177	**DATE:**	30/5 - 1/6/2016
		DIP/AZIMUTH:	90°/--	**SHEET**	3 OF 3

Depth (m)	Description of Strata	Discontinuities (B - Bedding, J - Joint, S - Shear, F - Fault)	Type	Core Rec. %	RQD %	Test Results & Comments
	BASALT - high strength, slightly weathered then fresh stained, fractured, orange brown and grey basalt *(continued)*	13.74m: J, 5°, un, ro, fe, stn	C	100	41	
		13.84m: J, 0°, fc, sm 13.936m: J, 0°, pl 14.15m: J, 0°, ro, cly vn 14.29m: J, 5°, st, ro, fe, stn 14.36m: J, 0°, cn, ro, stn 14.41m: J, 0°, un, ro, 14.45m: 14.45m to 14.47m CZ	C C	100	12	PL(A) = 1.61 PL(D) = 1.34 PL(D) = 0.77
14.94 – 15.0	SILTY CLAY - stiff, dark grey and orange brown silty clay					
15.0	BASALT - very high strength, fresh stained, slgihtly fractured to unbroken, dark grey basalt	14.54m: J, 45°, st, sm 14.6m: Cz 14.73m: J, 45°, st, stn, 14.81m: Cz 14.94m: J, 0°, st, sm, cly vn 15.05m: J, st, ro 15.45m: J, 45° V qtz 16.05m: J, 5°, vn, st	C	100	95	PL(A) = 1.92 PL(D) = 1.55 PL(A) = 4.14 PL(D) = 3.51
		16.59m: J, 5°, pl, sm, cl, vln	C	100	100	
		18.66m: J, 45° pl, sm 19.22m: J, 0°, pl, sm	C	100	100	PL(A) = 3.51 PL(D) = 3.53 PL(A) = 3.24 PL(D) = 3.91 PL(A) = 3.1 PL(D) = 3.43
20.05	Bore discontinued at 20.05m. Target depth reched					

RIG: P160-Track Rig **DRILLER:** North Coast Drilling **LOGGED:** AS **CASING:** 2.5

TYPE OF BORING: Auger to 1.5m, then NMLC coring to base of hole

WATER OBSERVATIONS: Groundwater @ 5.68m depth when measured on 2 June 2016

REMARKS:

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U,	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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