STEVE WATSON & PARTNERS

Job No: 2008/743

Tuesday, 20 September 2011

Manly Council
P.O Box 82
Manly NSW 1655

Attention: General Manager

RE: Construction Certificate No. 08/0743/03
164 Condamine Street, Balgowlah

Please find attached a copy of Construction Certificate 08/0743/03 and required attachments issued by Steve Watson & Partners for the above mentioned development in accordance with Section 109C(1)(b) and 81A(2) of the Environmental Planning and Assessment Act 1979.

~~Please find attached a cheque in the amount of $36.00 payable for the registration of the Construction Certificate.~~

L2219

Can you please forward SWP a receipt for the acknowledgment of the lodgement cheque.

If you have any queries please do not hesitate to contact me on (02) 9283 6555.

Regards,

Brad Collits
Steve Watson & Partners

CERTIFIER
$36
R 813444
22.9.11

S:\Jobs\2008 Jobs\2008-743 Bunnings Warehouse Balgowlah\CC03 Docs\20110920 CC03 letter to council.docx

LEVEL 5, 432 KENT STREET, SYDNEY NSW 2000
TEL +61 2 9283 6555 | FAX +61 2 9283 8500
www.swpartners.com.au
ABN 46 102 366 576

STEVE WATSON
& PARTNERS
BUILDING REGULATIONS CONSULTANTS AND CERTIFIERS
FIRE SAFETY ENGINEERS
LEVEL 5, 432 KENT STREET, SYDNEY NSW 2000
TEL +61 2 9283 6555 | FAX +61 2 9283 8500
sydney@swpartners.com.au
www.swpartners.com.au
ABN 48 102 366 576

CONSTRUCTION CERTIFICATE

Issued under the Environmental Planning and Assessment Act 1979 Section 109C(1)(b) and 109F

Construction Certificate No. 08/0743/03

Steve Watson and Partners certify that work completed in accordance with documentation accompanying the application for this certificate (with such modifications verified by me as may be shown on that documentation) will comply with the requirements of this Regulation as are referred to in section 81A (5) of the Environmental Planning and Assessment Act 1979.

Applicant	Name: Bunnings Group Ltd Address: 11 Shirley Street Suburb: Rose Hill State: NSW Postcode: 2142
Location of the Property	Address: 164 Condamine Street Suburb: Balgowlah State: NSW Postcode: 2093 Real Property Description: Lots 1 & 2 DP 533586, Lot 15 DP 532064, Lot 2 DP 562483
~~Building description~~	Basement and carparking structure within Zone A only as indicated in Appendix A Figure 5 of the Remedial Action Plan ref:11022RPT04_V04 dated 12th August 2011 prepared by Environmental Strategies, and Figure 1 of the Site Audit Statement number 0103-1101 dated 15th September 2011.
Building Code of Australia Classification	Class 6 & 7a
Date of Receipt	Date Received: 19th April 2011
Determination	Approved Date of Determination: 20th September 2011
Development Consent	Development Consent Number: 16/10 (Deferred Commencement) Council: Manly Council Date of Determination: 22nd July 2010 Date of Activated Consent: 19th November 2010 S.96 Modification/s Date of Determination: 8th March 2011, 22nd March 2011 & 23rd August 2011

STEVE WATSON & PARTNERS
08/0743/03
Construction Certificate
Accredited Body Certificate

Anthony Ljubicic (BPB0233) on behalf of
Steve Watson and Partners
Accreditation Body: BPB Accreditation no: ABC 1 Date of Endorsement: Tuesday, 20 September 2011

Design documentation approved for Construction Certificate 08/0743/03 for 164 Condamine Street, Balgowlah.

Drawing No.	Drawing Title	Revision	Date	Drawn by
CS.01	General Notes	A	23.08.11	Structural Design Solutions P/L
S1.01	Proposed Bulk Excavation, General Arrangement Plan	D	02.08.11	Structural Design Solutions P/L
S1.02	Proposed Bulk Excavation, Typical Sections	E	02.08.11	Structural Design Solutions P/L
S2.01	Footing, General Arrangement Plan	C	19.08.11	Structural Design Solutions P/L
S2.02	Footing Details, Sheet 1	B	19.08.11	Structural Design Solutions P/L
S2.03	Footing Details, Sheet 2	C	19.08.11	Structural Design Solutions P/L
S2.04	Footing Details, Sheet 3	A	19.08.11	Structural Design Solutions P/L
S3.01	Column Schedule Sheet 1	C	19.08.11	Structural Design Solutions P/L
S3.02	Column Schedule Sheet 2	D	23.08.11	Structural Design Solutions P/L
S3.03	Column Details	C	23.08.11	Structural Design Solutions P/L
S4.04	Precast Wall Details, Sheet 1	A	23.08.11	Structural Design Solutions P/L
S4.05	Precast Wall Details, Sheet 2	A	23.08.11	Structural Design Solutions P/L
S4.06	Precast Wall Details, Sheet 3	A	23.08.11	Structural Design Solutions P/L
S4.07	Precast Wall Details, Sheet 4	A	23.08.11	Structural Design Solutions P/L
S4.08	Core Wall Elevations, Sheet 1	B	23.08.11	Structural Design Solutions P/L
S4.09	Core Wall Elevations, Sheet 2	B	23.08.11	Structural Design Solutions P/L
S4.10	Tank Wall Elevations, Sheet 1	B	23.08.11	Structural Design Solutions P/L
S4.11	Tank Wall Elevations, Sheet 2	B	23.08.11	Structural Design Solutions P/L
S4.12	Typical Concrete Wall Details	A	23.08.11	Structural Design Solutions P/L
S6.01	Carpark Level 02 Slab, General Arrangement Plan	C	19.08.11	Structural Design Solutions P/L
S6.02	Carpark Level 01 Slab, General Arrangement Plan	B	19.08.11	Structural Design Solutions P/L
S6.03	Warehouse Level 01 Slab, General Arrangement Plan	A	22.08.11	Structural Design Solutions P/L
S6.05	Vehicle Access Ramp, General Arrangement Plan	A	23.08.11	Structural Design Solutions P/L
S6.06	Ramp 7 Slab, General Arrangement Plan, Carpark Level 2 to Level 1	A	23.08.11	Structural Design Solutions P/L
S8.01	Slab Sections, Sheet 1, Carpark Level 2	A	26.07.11	Structural Design Solutions P/L
S8.02	Slab Sections, Sheet 2, Carpark Level 2	A	26.07.11	Structural Design Solutions P/L
S8.03	Slab Sections, Sheet 3, Carpark Level 1	A	01.08.11	Structural Design Solutions P/L
S8.04	Slab Sections, Sheet 4, Carpark Level 1	A	02.08.11	Structural Design Solutions P/L
S8.05	Slab Sections, Sheet 5, Carpark Level 1	B	19.08.11	Structural Design Solutions P/L

08/0743/03

Construction
Accredited

Hydraulic documentation approved for Construction Certificate 08/0743/03 for 164 Condamine Street, Balgowlah.

Drawing No.	Drawing Title	Revision	Date	Drawn by
H00 / 1	Hydraulic Services, Cover Sheet and Legend	1	16.08.11	MGP Building and Infrastructure Services
H01 / 3	Hydraulic Services, Parking Level 2	3	20.07.11	MGP Building and Infrastructure Services
H02 / 1	Hydraulic Services, Parking Level 1	1	25.07.11	MGP Building and Infrastructure Services
H03 / 2	Hydraulic Services, Warehouse Level 1	2	16.08.11	MGP Building and Infrastructure Services
H06 1	Hydraulic Services, Details Sheet 1	1	16.08.11	MGP Building and Infrastructure Services
H07 A	Hydraulic Services, Details Sheet 2	A	28.06.11	MGP Building and Infrastructure Services

Documentation relied upon to issue Construction Certificate 08/0743/03 for 164 Condamine Street, Balgowlah.

Item No	Description	Date
1.	Application for Construction Certificate	19.04.11
2.	Existing and proposed fire safety schedule	-
3.	Evidence of Long Service Levy Payment	08.02.11
4.	Structural design certificate from Structural Design Solutions P/L	15.08.11
5.	Hydraulic design certificate (Stormwater) from MGP Building & Infrastructure Services	03.07.11
6.	Hydraulic design certificate (Fire Hydrant / Hose Reel) from MGP Building & Infrastructure Services	26.08.11
7.	Fire Engineering Report rp100218s0001 Revision 2.2 prepared by Norman Disney and Young	19.09.11
8.	Email to F&RNSW as evidence of submission of Fire Engineering Report under Cl.144 of the EP&A Reg.	24.06.11
9.	Documentation required to satisfy relevant DA conditions as per attached DA checklist	-

08/0743/03

Construction Certificate
Accredited Body Cert

Balgowlah Bunnings

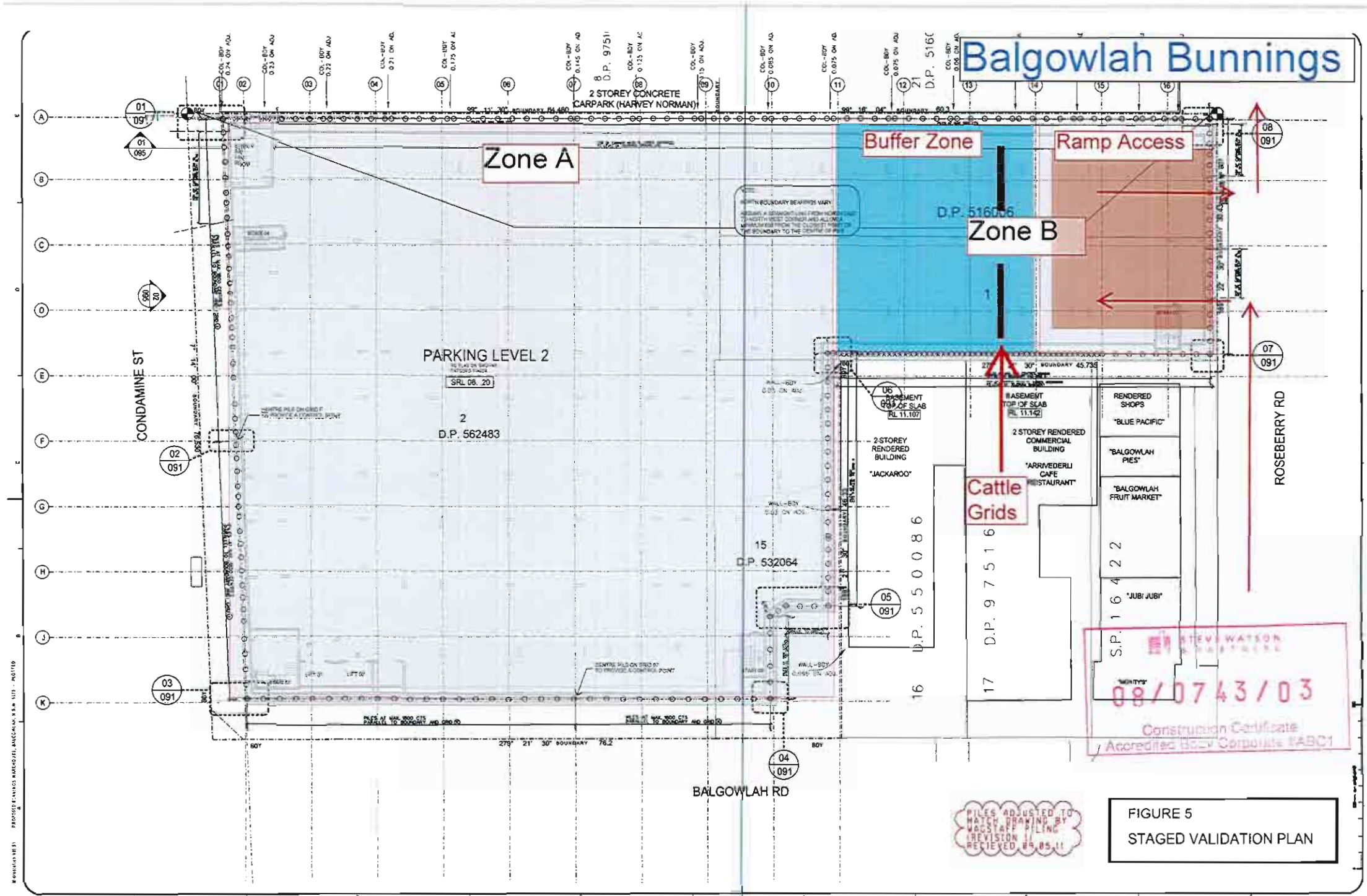


FIGURE 5
STAGED VALIDATION PLAN

NO.	AMENDMENT	DATE	NO.	AMENDMENT	DATE

DESIGN & CONSTRUCT HEAD CONTRACTOR
SOUTHERN CROSS PROJECTS PTY LTD
130 - 133 NEW SOUTH HEAD ROAD
EDGECLIFF NSW 2027
FAX: 02 9365 0011 PH: 02 9365 5111
PRINCIPAL

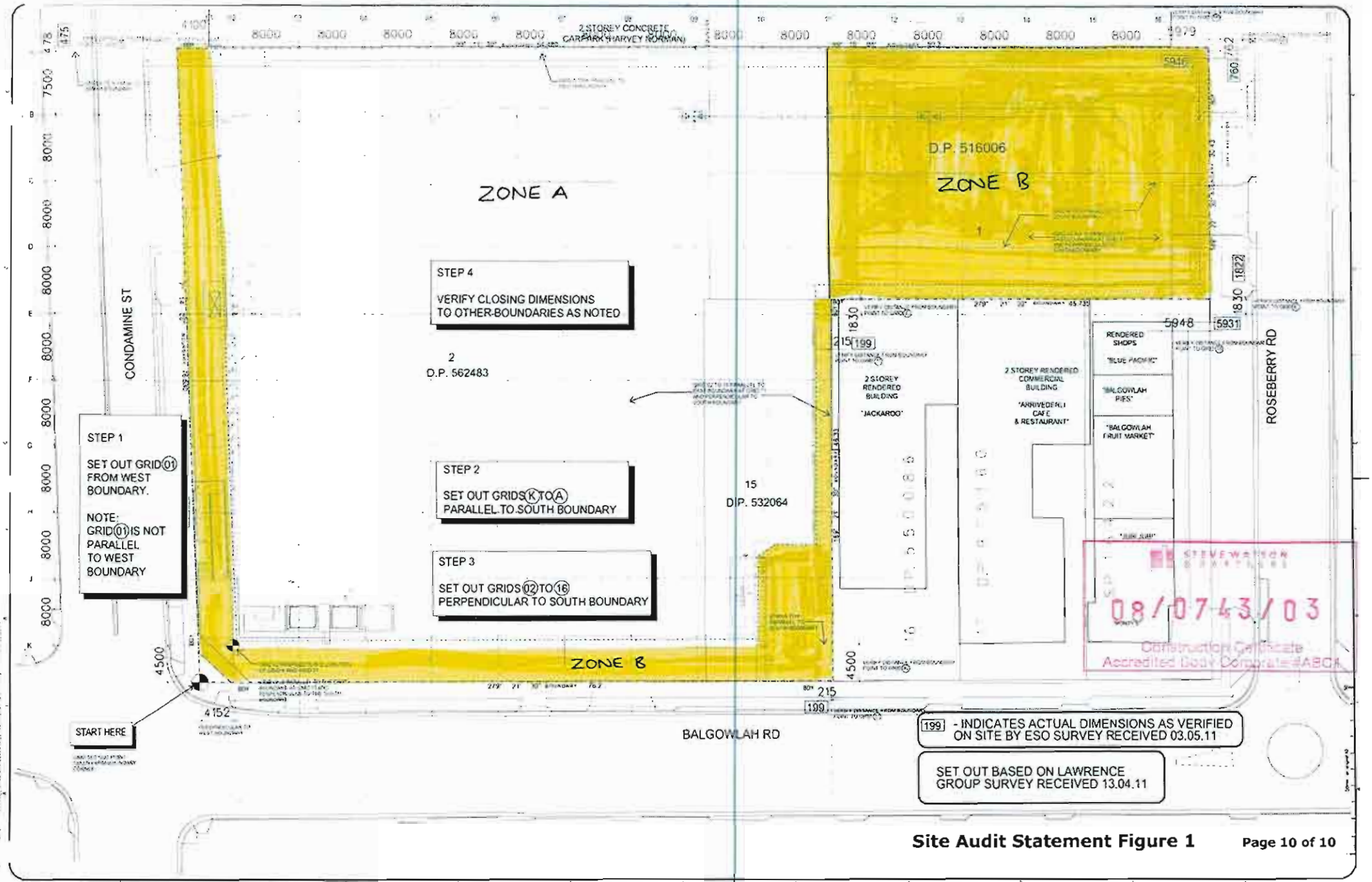
JOHN R. BROGAN & ASSOCIATES
PTY. LIMITED
ARCHITECTS, PLANNERS & COMMERCIAL INTERIOR DESIGNERS
EST - 1972
A.B.N. 85 003 284 759
37 PITT ST, SYDNEY NSW 2000
PH: (02) 9 221 2633 FAX: (02) 9 251 4741
EMAIL: jrb@rogans.com.au

PROPOSED BUNNINGS WAREHOUSE
CNR CONDAMINE ST & BALGOWLAH RD,
BALGOWLAH NSW

PILE SET OUT PLAN

SCALE: 1:200
DATE: OCT 07

PROJ. NO. 1173
DRG NO. 090
AMD NO. P4



Site Audit Statement Figure 1

JOHN R BROGAN & ASSOCIATES PTY LIMITED
ARCHITECTS, PLANNERS & COMMERCIAL INTERIOR DESIGNERS

PROPOSED BUNNINGS WAREHOUSE
CNR CONDAMINE ST & BALGOWLAH RD.
BALGOWLAH NSW

GRID SETOUT PLAN

OCT 07

STEVE WATSON & PARTNERS
LEVEL 5, 432 KENT STREET, SYDNEY NSW 2000
TEL +61 2 9283 6555 FAX +61 2 9283 6500
sydney@swpartners.com.au
www.swpartners.com.au
ABN 48 102 366 576

APPLICATION FOR CONSTRUCTION CERTIFICATE

PART 1 Application and Site Details

Applicant

It is important that we are able to contact you if we need more information.

Please give us as much detail as possible.

Note that a Building Contractor cannot be the applicant for a Construction Certificate or an Occupation Certificate

Mr ☐ Mrs ☐ Miss ☐ Ms ☐ Other ☐

Surname (or Company): Bunnings Group Limited
Given names (or ABN): 26 008 672 179
Address: 11 Shirley St, Rosehill
State: NSW Post Code: 2142
Phone: (02) 9846-7100 Fax: (02) 9846 7530
Mobile: 0414 637 656 E-mail: nmullins@bunnings.com.au

Please ensure you sign the declaration in Part 3 of this application

Location of the Property

We need this to correctly identify the land.

Owner of land / property: Bunnings Group Limited
Address: 164 Condamine St, Balgowlah, NSW
Post Code: 2093
Real Property Description: Lots: 1 & 2, DP: 533586
(eg. Lot/DP/Section, etc) Lot: 15, DP:532064
Lot: 2, DP: 562483

The real property description is mandatory, these details are shown on your rate notices, property deeds etc

PART 2 Work Description

Description of Work

Please describe briefly everything that you want approved.

Building Work

Basement and carparking

Estimated Cost of Work *(inclusive of GST)*

$ 20,784,539.00

Development Consent

Development Consent No: 10/16
Date of Determination: 22/06/2010

RECEIVED
19 APR 2011
STEVE WATSON & PARTNERS

Building Code of Australia Classification	BCA Classification: 6
Principal Contractor's Details *Required for all projects*	Name: Southern Cross Constructions Address: 135-153 New South Head Rd, Edgecliff NSW, 2027 Contact Number: (02) 9363 1111

PART 3 Declaration

ALL THE DETAILS SOUGHT IN THE CHECKLIST IN PART 5 MUST BE PROVIDED.

THE COMPLETED CHECKLIST MUST BE SUBMITTED WITH THIS APPLICATION. FAILURE TO PROVIDE THE REQUIRED DOCUMENTATION OF AN ACCEPTABLE STANDARD WILL RESULT IN YOUR APPLICATION BEING RETURNED.

Declaration *If the applicant is a company or strata title body corporate, a director or authorised delegate must sign this declaration.*	I apply for approval to carry out the development or works described in this application. I declare that all the information in the application and checklist is, to the best of my knowledge, true and correct. I also understand that if the information is incomplete the application may be delayed or rejected or more information may be requested. I acknowledge that if the information provided is misleading any approval granted 'may be void'. Signature [signature] Date: 19 / 04 / 11

FIRE SAFETY SCHEDULE

STEVE WATSON & PARTNERS

164 Condamine Street, Balgowlah CC No. 08/0743/03

Existing Fire Safety Schedule

Nil.

Proposed Fire Safety Schedule

Unit No.	Measure	Standard of Performance
1.	Access panels, doors and hoppers to fire resisting shafts	BCA2010 Clause C3.13 and tested prototypes (AS 1530.4 – 2005)
2.	Automatic Fail Safe Devices	Scheduled devices release upon trip of smoke detection, fire detection and sprinkler activation in accordance with BCA2010 Clause D2.21 and Fire Engineering Report rp100218s0001 Revision 2.2 dated 19th September 2011 prepared by Norman Disney & Young.
3.	Automatic Fire Detection and Alarm System	Fire Engineering Report rp100218s0001 Revision 2.2 dated 19th September 2011 prepared by Norman Disney & Young including; • High sensitivity (not greater than 5% obs/m) below ceiling smoke detectors of the anologue/addressable type shall be installed in accordance with BCA Specification E2.2a Clause 5 (extended spacing i.e 20m) throughout both Warehouse levels including all office and common areas. • The fire detection and alarm system shall transmit coded signals to the main FIP, the Fire Brigade, door controls / electric strikes, emergency sound system and mechanical air handling systems (including High Volume Low Speed Fans); • Local smoke detectors on the carpark side of the sliding doors between the carpark and entry lobbies to automatically close the doors.
4.	Automatic fire suppression systems *(Sprinklers)*	BCA2010 Specification E1.5 and AS 2118.1 – 1999 except as modified by Fire Engineering Report rp100218s0001 Revision 2.2 dated 19th September 2011 prepared by Norman Disney & Young.
5.	Emergency Lighting	BCA2010 Clause E4.2, E4.4 and AS/NZS 2293.1 – 2005
6.	Sound System for Emergency Purposes	Clause 3.22 of AS 1670.1 – 2004 and Fire Engineering Report rp100218s0001 Revision 2.2 dated 19th September 2011 prepared by Norman Disney & Young.
7.	Exit Signs	BCA2010 Clause E4.5, NSW E4.6, E4.8 and AS/NZS 2293.1 – 2005 except as modified by Fire Engineering Report rp100218s0001 Revision 2.2 dated 19th September 2011 prepared by Norman Disney & Young.

8.	Fire control centre	BCA2010 Specification E1.8
9.	Fire Dampers	BCA2010 Clause C3.15 and AS/NZS 1668.1 – 1998 (AS 1682.1-1990 and AS 1682.2-1990)
10.	Fire Doors	BCA2010 Specification C3.4 and AS/NZS 1905.1 – 2005
11.	Fire Hydrants Systems	BCA2010 Clause E1.3 and AS 2419.1 – 2005 including: • Storz hermaphrodite fire hose couplings fitted to all fire hydrants and fire hydrant booster assembly connections as required by Appendix E of AS2419.1-2005. The Storz fittings are to be manufactured to DIN 14303, aluminium alloy delivery couplings, in accordance with Appendix A of AS2419.2-1994. Blank caps must be provided in accordance with Clause 2.8 of AS2419.2-1994.
12.	Fire seals protecting opening in fire resisting components of the building	BCA2010 Clause C3.15, Specification C3.15 and AS 1530.4 –2005 and AS 4072.1 – 2005 and installed in accordance with the tested prototype.
13.	Hose Reel System	BCA2010 Clause E1.4 and AS 2441 – 2005
14.	Lightweight Construction	BCA2010 Specifications C1.8, Clause A2.3 and AS 1530.4-2005
15.	Mechanical Smoke Exhaust System	Fire Engineering Report rp100218s0001 Revision 2.2 dated 19th September 2011 prepared by Norman Disney & Young including; • The fans shall be located within the ceiling space of warehouse level 2, and designed to achieve an extraction rate of at least 1 air change per hour; • The smoke exhaust system shall achieve an extraction rate of 30m³/s; • Smoke exhaust fans shall consist of fire rated fans and cabling; • Manual override controls for fans shall be located at the F.I.P for use by the NSWFB, with signage and compliant Fire Fan Control Panel indication located next to the control at the F.I.P.
16.	Mechanical Air Handling System *(carpark mechanical ventilation system)*	BCA2010 Table E2.2a and Clause 5.5 of AS/NZ 1668.1-1998 and fans with metal blades suitable for operation at normal temperature may be used and the electrical power and control cabling need not be fire rated.
17.	Mechanical air handling system *(automatic shut down of air-handling system)*	BCA2010 Clause E2.2 and AS/NZ 1668.1-1998
18.	Perimeter Vehicle Access for emergency vehicles	BCA2010 Clause C2.4 except as modified by Fire Engineering Report rp100218s0001 Revision 2.2 dated 19th September 2011 prepared by Norman Disney & Young.
19.	Portable Fire Extinguishers	BCA2010 Clause E1.6 and AS 2444 – 2001
20.	Wall Wetting Sprinkler and drencher systems	AS 2118.2 - 2010 and Fire Engineering Report rp100218s0001 Revision 2.2 dated 19th September 2011 prepared by Norman Disney & Young.
21.	Drencher protected glazing in parking levels 1 & 2	Fire Engineering Report rp100218s0001 Revision 2.2 dated 19th September 2011 prepared by Norman Disney & Young.
22.	Warning and Operational signs	BCA2009 Clauses D1.17, E3.3 and Fire Engineering Report rp100218s0001 Revision 2.2 dated 19th September 2011 prepared by Norman Disney & Young for signage to the manual override controls at the F.I.P.

23.	Manual stop button for big fans at customer service desk	Fire Engineering Report rp100218s0001 Revision 2.2 dated 19th September 2011 prepared by Norman Disney & Young.
24.	Fire Engineered Alternative Solution Report addressing; • Reduced FRL's; • Extended travel distances; to a point of choice, to exits, and between exits; • Reduced egress width on warehouse level 2; • Sliding doors not leading to open space and roller shutter to exit; • Performance based smoke exhaust system; • Exit signs higher than 2.7m; • Non-compliant perimeter vehicle access.	Fire Engineering Report rp100218s0001 Revision 2.2 dated 19th September 2011 prepared by Norman Disney & Young.

STEVE WATSON
08/0743/03
Construction Certificate
Accredited Body Corporate #AC[illegible]

LONG SERVICE
BUILDING & CONSTRUCTION

Building and Construction Industi
Long Service Payments Corporatio
Level 1
19-21 Watt Street
Gosford NSW 2250
Locked Bag 3000
Central Coast MC NSW 2252
Tel: 13 14 41
Fax: (02) 9287 5685
Email: info@lspc.nsw.gov.au
www.lspc.nsw.gov.au
ABN 93 646 090 808

8 February 2011

08/0743/03

BUNNINGS GROUP LTD
11 SHIRLEY STREET
ROSEHILL NSW 2142

Levy Receipt

Receipt No
00093465

Received from: (Name of person or organisation paying for levy) | the amount of

BUNNINGS GROUP LTD	$72,746.00

Payment details:

1. Cheque 145558 $72,746.00 BUNNINGS GROUP LTD

being payment for Long Service Levy as detailed below

Levy Payment Form number	0315246
Council/Department/Authority	MANLY COUNCIL
C.C. Number	08/743/01
Work address	164 CONDAMINE STREET BALGOWLAH NSW 2093
Estimated value of work	$20,784,539.00
Levy payable (No exemption)	**$72,745.00**
Total levy paid	**$72,746.00**

Signed: (Signature of authorised person) | Date

8.2.11

103025

STRUCTURAL DESIGN SOLUTIONS
CONSULTING ENGINEERS

Suite 11
50 Great North Rd, Five Dock NSW 2046 Australia
PO Box 245 Five Dock NSW 2046 Australia
Ph: +61 (0) 2 9712 4700 Fax: +61 (0) 2 9712 4733
Email: engineers@structuraldesignsolutions.com.au
ABN 98 111 292 169 – ACN 111 292 169

CONSTRUCTION CERTIFICATE – CC03

15th August 2011

Southern Cross Projects
135-153 New South Head Road,
Edgecliff
NSW 2027

Attention: Mr Liam Linehan

Dear Sir

RE: Bunning's Warehouse - Cnr Condamine and Balgowlah Rd, BALGOWLAH, NSW

We, Structural Design Solutions Pty Ltd, the practicing Structural Engineers hereby advise that we are responsible for the design of the structural elements of the proposed development of the new Bunning's Warehouse, Cnr Condamine and Balgowlah Rd, Balgowlah, NSW.

All structural elements including footings, shoring systems, retaining walls, columns, suspended slabs, beams, stairs and walls have been designed in accordance with the Building Code of Australia and other relevant Australian Standards namely:

- AS1170 Parts 0, 1, 2 & 4 Loading Code
- AS3600 Concrete Structures Code
- AS4100 Steel Structures Code
- AS3700 Masonry code
- Geotechnical Report by Douglas Partners

We also confirming the building has been designed to achieved the FRL's required for Type B Construction, with the exception of the reduced levels addressed by the Fire Engineering Report. In summary,

- the columns on the floors CP2, CP1 & WH1 achieve 120 min
- CP2, CP1, WH1 and WH2 slabs achieve 120 min
- The slab over the vehicle service road achieves 120 min
- All external concrete precast walls are a minimum thickness of 180mm and achieve 240 min
- All insitu walls achieve 120 min

We also confirming the building has been designed in accordance with section 4.1 (g) of the Building Code of Australia and the structural steel roof and columns are not fire rated.

Yours faithfully
STRUCTURAL DESIGN SOLUTIONS PTY LTD

R. Facioni

Robert Facioni
BE, PhD, MIEAust

Suite 9/6 Tilley Lane
Frenchs Forest NSW 2086
T 02 9451 7555
F 02 9451 8555
E info@mgpbis.com.au

mgp
building & infrastructure services pty ltd
abn 83 455 645 810

STORMWATER - STATEMENT of DESIGN COMPLIANCE

PROJECT: 164 CONDAMINE STREET, BALGOWLAH

Pursuant to Clause 11, 12 & 15 of Manly Council DA 16/10.

I, Sam Haddad (MIEAust CPEng NPER-3 Civil)
on behalf of MGP Building & Infrastructure Services Pty Ltd
Suite 9 / 6 Tilley Lane Frenchs Forest 2086
T 02 9451 7555 F 02 9451 8555
E info@mgpbis.com.au

08/0743/03

hereby certify:-

That the rainwater tank, stormwater and on-site detention services for the above development have been ~~designed to comply with the relevant Australian Standards as described in Schedule "A" below:~~

Schedule "A":

a) The relevant Australian Standards

The following Australian Standards: Stormwater Drainage AS 3500 2003
NSW Code of Practice Plumbing & Drainage 2006

Schedule "B":

b) The design is in accordance with the following: Manly Council Specification for On-Site Stormwater Management 2003 and Specification for Stormwater Drainage 2003

c) Stormwater Drawings

H01	Basement P2
H02	Basement P1
H03	Warehouse Level 1
H04	Warehouse Level 2
H05	Roof
H06	Detail Sheet 1
H07	Detail Sheet 2

d) Exclusions: Nil

Signature: Date: 03/07/2011

Sydney WATER Accredited Supplier
AHSCA Corporate Member
IQMS APPROVED COMPANY ISO 9001 Quality Management Systems

Suite 9/6 Tilley Lane
Frenchs Forest NSW 2086
T 02 9451 7555
F 02 9451 8555
E info@mgpbis.com.au

mgp
building & infrastructure services pty ltd
abn 83 455 645 810

FIRE HYDRANT / HOSEREEL - STATEMENT of DESIGN COMPLIANCE

PROJECT: **164 CONDAMINE STREET, BALGOWLAH**

I, Alex Ross of MGP Building & Infrastructure Services Pty Ltd
Suite 9 / 6 Tilley Lane Frenchs Forest 2086
T 02 9451 7555 F 02 9451 8555
E info@mgpbis.com.au

hereby certify:-

That all fire hydrant and fire hose reel services for the above development have been designed to comply with the relevant Australian Standards listed in the Building Code of Australia (Specification A1.3) as described in Schedule "A" below:

Schedule "A":

a) The relevant Australian Standards listed in the Building Code of Australia (Specification A1.3)

The following Australian Standards:	Fire Hydrants	AS 2419.1
	Fire Hose Reels	AS 2441

Schedule "B":

b) Other practices or standards relied upon for this certification: Building fire engineering report

c) Exclusions: Nil

08/0743/03

Assoc Dip Mech Eng
Dip Plumbing
Signature: Date: 26/08/2011

Sydney WATER Accredited Supplier

AHSCA Corporate Member

APPROVED COMPANY ISO 9001 Quality Management Systems

Bradley Collits

From: Bradley Collits
Sent: Friday, 24 June 2011 5:59 PM
To: 'Firesafety NSWFB'
Subject: NFB/06442 - Application for IFSR - Bunnings Warehouse Balgowlah email 1 of 2
Attachments: Application%20for%20Initial%20FS%20Report%20(144)_Ver06_pub_0001.PDF; rp100218s0001_2.1[2.1]_Fire Engineering .pdf; alternative_solution_performance_table.pdf; CC03 App.pdf

Attention Fire Commissioner;

NFB/06442 - Bunnings Warehouse Balgowlah request for Initial Fire Safety Report

Please see attached the following:

- Application for IFSR;
- Alternative Solution Report prepared by NDY;
- Alternative Solution Performance Table completed by NDY;
- CC application form;
- Architectural Drawings (contained in email 2 of 2).

Please Note: Steve Watson & Partners Accredited Body Corporate (ABC1) holds unrestricted accreditation.

Should you have any queries, please do not hesitate to contact me.

Regards,

Brad Collits
Building Regulations Consultant
Steve Watson & Partners Pty Ltd
Level 5, 432 Kent Street, Sydney NSW 2000
Phone: (02) 9283 6555
Fax: (02) 9283 8500
www.swpartners.com.au

Min. 23 days elapsed, no IFSR received.

Regards,

Brad Collits
Building Regulations Consultant
Steve Watson & Partners Pty Ltd
Level 5, 432 Kent Street,
Sydney NSW 2000
Phone: (02) 9283 6555
Fax: (02) 9283 8500
www.swpartners.com.au

STEVE WATSON & PARTNERS
08/0743/03
Construction Certificate
Accredited Body Corporate #ABC1

Bradley Collits

From: Postmaster@fire.nsw.gov.au on behalf of Firesafety NSWFB [Firesafety.NSWFB@fire.nsw.gov.au]
Sent: Friday, 24 June 2011 6:03 PM
To: Bradley Collits
Subject: Re: NFB/06442 - Application for IFSR - Bunnings Warehouse Balgowlah email 1 of 2 (Receipt of Correspondence)

We acknowledge receipt of your correspondence and will respond to your query shortly.

If you have any questions please don't hesitate to contact one of our Fire Safety Officers on 02 9742 7400.

Kind regards

Structural Fire Safety Unit
Fire & Rescue New South Wales
Ph: 02 9742 7400
Fx: 02 9742 7483
Email: firesafety@fire.nsw.gov.au

Report

Norman Disney & Young

Fire Engineering

Bunnings Warehouse, Balgowlah
Southern Cross Projects

CONFIDENTIAL

Revision: 2.2 – FER
Issued: 19 September 2011

NORMAN DISNEY & YOUNG
Consulting Engineers

NDY MANAGEMENT PTY LIMITED TRADING AS NORMAN DISNEY & YOUNG
ABN 29 003 234 571
60 Miller Street
North Sydney NSW 2060

Telephone: +61 2 9928-6800
Facsimile: +61 2 9955-6900

www.ndy.com

OFFICES

Australia:	Sydney, Melbourne, Brisbane, Perth, Canberra, Adelaide
New Zealand:	Auckland, Wellington
United Kingdom:	London, Manchester
UAE:	Dubai
Asia:	Kuala Lumpur

NDY QA SYSTEM

Revision No:	2.2
Revision Date:	19 September 2011
Reason Description:	FER
File Location:	W:\290xx\S29026\002\FE\24_Reports
Filename:	rp100218s0001Client Name: Southern Cross Projects
Client Contact:	Hylton Bloch
Project Co-ordinator:	Mark Evans
Editor:	Eliot Reeves

Authorisation by: Mark Evans

Verification By: Frank Bakker

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EXECUTIVE SUMMARY

This Fire Engineering Report (FER) details the Fire Engineering assessment that has been undertaken to show the suitability of the fire safety systems within the building, and compliance with the nominated Performance Requirements of the Building Code of Australia (BCA).

Bunnings Balgowlah is bounded by Condamine Street, Balgowlah Road, and Roseberry Street, Balgowlah NSW. The lower two storeys consist of car parking for 269 vehicles. The upper two storeys consist of a two storey retail warehouse. The building is arranged as follows:

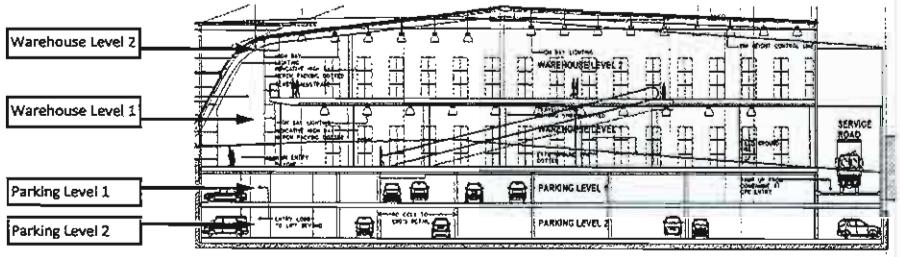
Level	Type occupancy	Classification	Accommodation
Warehouse 2	Retail	6	Retail warehouse, Goods Marshalling, Outdoor Nursery, Office, Cafe, Playground and Amenities
Warehouse 1	Retail	6	Retail warehouse, Goods Receiving and pick-up and Goods Marshalling
Car Park 1	Car park	7a	105 car spaces
Car Park 2	Car park	7a	164 car spaces

Arrangement of levels

A summary of the building attributes is given below:

Attribute	Number or type
Number of storeys contained	4
Rise in storeys	3
Type of construction	B
Effective height (m)	9m approximately

Building attributes



Denotation of levels

The alternative solutions covered by this report are:

Assessment A – Structural Fire Resistance

The Fire Resistance Levels (FRLs) for the building will be rationalised to 120 minutes.

Assessment B – Egress

The egress system will be provided with the following features which are outside the recommendations of the Deemed-to-Satisfy (DtS) provisions of the BCA:

a. Extended distance of travel to a point of choice of exits.

b. Extended distances of travel to an exit.

c. Extended distances between alternate exits.

d. Insufficient egress width.

e. Discharge from a non-fire-isolated exit.

f. Permit the use of non-compliant exit door arrangements that do not lead directly to a road or an open space.

g. Permit the use of non-compliant operation of latches.

Assessment C – Smoke Hazard Management

A performance-based smoke hazard management system will be provided that will meet the Performance Requirement EP2.2 of the BCA.

Assessment D – Exit signage

Exit signage within the warehouse will be installed at 3.45m (to top of sign) above floor level

Assessment E – Fire Brigade access

The building will incorporate reasonable vehicular access that meets the Performance Requirements of the BCA.

The Fire Safety Design is detailed in Section 2 of this report. The assessments are detailed in Section 3 of this report.

It is the responsibility of Southern Cross Pty Ltd to ensure the design solution in this report is implemented in design documentation and constructed accordingly. NDY has not been engaged to review design documents and construction stages for this project.

The Fire Safety Design detailed herein has been developed to form the basis of an alternative solution that will satisfy the Performance Requirements of the BCA.

The report requires the implementation of the fire safety measures listed in this report and compliance with the relevant BCA Deemed-to-Satisfy provisions not assessed by this report.

FRNSW comments on the FEB for Bunnings Warehouse, Balgowlah are provided in Appendix A and have been incorporated into the report.

"The alternative solution complies with the relevant performance requirements of the Building Code of Australia"

Frank Bakker

C10 - BPB 0870

Associate Director / Fire Engineering Manager - QLD

The table below details:

- The number of assessments and the non compliance with the BCA;
- The BCA Deemed to Satisfy Clause;
- The BCA Performance Requirements;
- The IFEG Sub-Systems; and
- The BCA assessment methodology to be used.

Assessment	BCA Clause	IFEG SS	Issue	Performance Requirement	Methodology
A	C1.1	SS C	The FRLs shall be rationalised in the following areas: – Reduce the FRL for the whole building from 180 minutes to 120 minutes.	CP1 CP2	A0.9(b)(ii)
B	D1.4	SS E SS F	The following areas have extended distances of travel that have been addressed via a detailed Fire Engineering analysis: Distances of travel to a PoC of exits: – 29m in lieu of 20m from the office area. Distances of travel to an exit: – Parking Levels 1 and 2. Travel distances will be up to 60m in lieu of 40m to an exit. – Warehouse Level 1. The distance of travel will be up to 70m in lieu of 40m to an exit. – Warehouse Level 2. The distance of travel will be up to 76m in lieu of 40m to an exit. – Outdoor nursery on warehouse level 2.Travel distances will be up to 65m in lieu of 40m to an exit.	DP4 EP2.2	A0.9(b)(ii) A0.9(c)
	D1.5	SS E SS F	The following areas have extended distances between alternate exits that have been addressed via a detailed Fire Engineering analysis: – 120m between alternate exits in Parking Level 1 and Parking Level 2. (measured through original point of choice) – 105m between alternate exits on Warehouse Level 1. – 115m between alternate exits on Warehouse Level 2.	DP4 EP2.2	

Assessment	BCA Clause	IFEG SS	Issue	Performance Requirement	Methodology
	D1.6	SS E SS F	There is insufficient exit width provided on warehouse level 2.	DP4	
	D2.19 & D2.21	SS E SS F	The sliding doors between the Outdoor Nursery and Warehouse Level 2 and the roller shutter between the entry foyer and the warehouse will not be fitted with compliant door hardware.	DP2	
C	E2.2	SS B	A performance based smoke exhaust system shall be provided to the retail areas of the building.	EP2.2	A0.9(b)(ii)
D	E4.8	SS D	The exit signage will be installed at 3.45m above the floor level.	EP4.B	A0.9(c)
E	C2.3 C2.4	SS F	Non-compliant vehicular access will be provided to the building perimeter consisting of the following parameters: - Greater than 18m from the building due to the adjoining buildings located at the corner of Balgowlah Road and Roseberry Road. - Security gate/roller shutter will be across the vehicular access routes. - Built over the parking levels of the building. - A portion of Warehouse Level 2(the office and a plant room) shall be built over the vehicle access in the north-western corner of the site. - A clear width of 6m is not provided around the entire building. - Portions of the available emergency vehicle access routes are less than 6m wide.	CP9	A0.9(b)(II)

Note: The following IFEG SS are referenced above:

SS B – Smoke Development Spread & Spread & Control

SS C – Fire Spread & Impact & Control

SS D – Fire Detection, Warning & Suppression

SS E – Occupant Evacuation & Control

SS F – Fire Services Intervention

Assessment summary (BCA and IFEG parameters)

1 SCOPE OF THE PROJECT

1.1 General

The Fire Engineering assessment demonstrates the suitability of the fire safety systems within the building and compliance with the nominated performance criteria of the Building Code of Australia (BCA).

The level of building fire safety has been determined by a systematic performance based evaluation generally complying with the Australian Building Codes Board, "International Fire Engineering Guidelines".

1.2 Objectives

1.2.1 BCA Objectives

The goal of the BCA is the achievement and maintenance of acceptable standards of structural sufficiency, safety (including safety from fire), health and amenity for the benefit of the community now and in the future.

The BCA extends no further than is necessary in the public interest, is cost effective, easily understood, and is not needlessly onerous in its application.

The client must be familiar with the alternative solutions which comply with the Performance Requirements of the BCA.

1.2.2 Objectives of the Fire Engineering Brief (FEB)

The objectives of the FEB were to:

1. Agree the design objectives of the project brief; and
2. Establish the Concept Design to meet the design objectives; and
3. Agree with stakeholders the assessment methodology necessary to demonstrate compliance with the Performance Requirements.

Following the meeting the FRNSW reviewed and provided comment on the FEB in FRNSW report: NFB/06442-SFSU-FEB-1027115 dated 17 November 2010. Comments from the FRNSW review have been incorporated into this FER. A copy of comments made by FRNSW is provided in Appendix A.

1.2.3 Objectives of the Fire Engineering Report (FER)

The objectives of the FER are to:

1. Assess the compliance of the design against the Performance Requirements of the BCA; and
2. Detail alternate design solutions that satisfy the relevant Performance Requirements of the BCA; and
3. State the recommendations of the fire safety design.

1.3 International Fire Engineering Guidelines (IFEG)

The IFEG were developed for use in fire safety design and reflect best practice. The document provides guidance for the development of fire strategies and engineered solutions that provide acceptable levels of safety.

The document provides guidance in the design and assessment of alternative solutions against the Performance Requirements of the BCA. The methodology set out in the IFEG has generally been adopted in this report.

1.4 Relevant Stakeholders

The Fire Engineering Design Team included the relevant stakeholders:

Role	Team member	Organisation
Client	Hylton Bloch	Southern Cross Projects
Architect	Doug Djordjevic	John R Brogan & Associates
Building owner	Nick Mullins	Bunnings Group Pty Ltd
Principle Certifying Authority (PCA)	Brad Collits Anthony Ljubicic	Steve Watson and Partners
Fire Engineers	Mark Evans Eliot Reeves Frank Bakker	Norman Disney & Young
Fire and Rescue New South Wales (FRNSW)	Team Leader Alternate Solutions	FRNSW

Fire Engineering Design Team

1.5 FEB Revision History

Revision	Rev	Date issued	Comment
First Issue	1	12 February 2010	Draft FEB for Comment
Second Issue	1.1	25 February 2010	FEB (new template)
Third Issue	1.2	27 September 2010	FEB – For Authority Approval

FEB Revision History

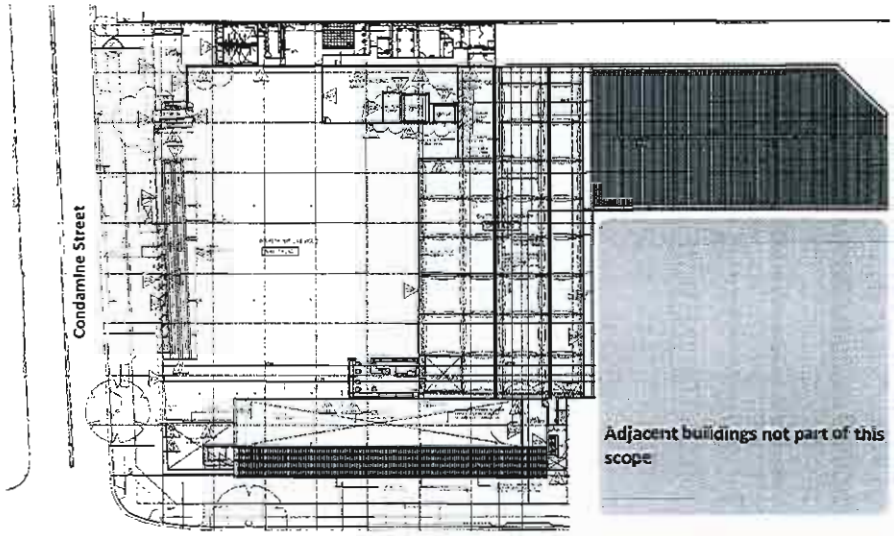
1.6 FER Revision History

Revision	Rev	Date issued	Comment
First Issue	2.0	27 May 2011	Draft FER – for design team issue
Second Issue	2.1	24 June 2011	FER – for approval

Revision History

1.7 Principle Building Characteristics

The development will consist of a four storey building bounded by Condamine Street, Balgowlah Road, and Roseberry Street, Balgowlah NSW. The lower two levels of the development will consist of car parking, and the upper two levels will consist of 2 retail floors and an office area. There is also an outdoor nursery area adjacent to the level 2 retail floor. A site plan of the building is shown below.



Site plan of Bunnings Warehouse, Balgowlah

A summary of the BCA classification is provided in the table below. All information is provided by Steve Watson & Partners.

Part of project	Parking Level 2	Parking level 1	Warehouse level 1	Warehouse level 2
Type of occupancy	Car park	Car park	Warehouse/Retail	Warehouse/Retail
Classification	7a	7a	6	6
Number of storeys contained	4			
Rise in storeys	3			
Type of construction	B			
Effective height (m)	9 m			

BCA classification details

1.7.1 Egress

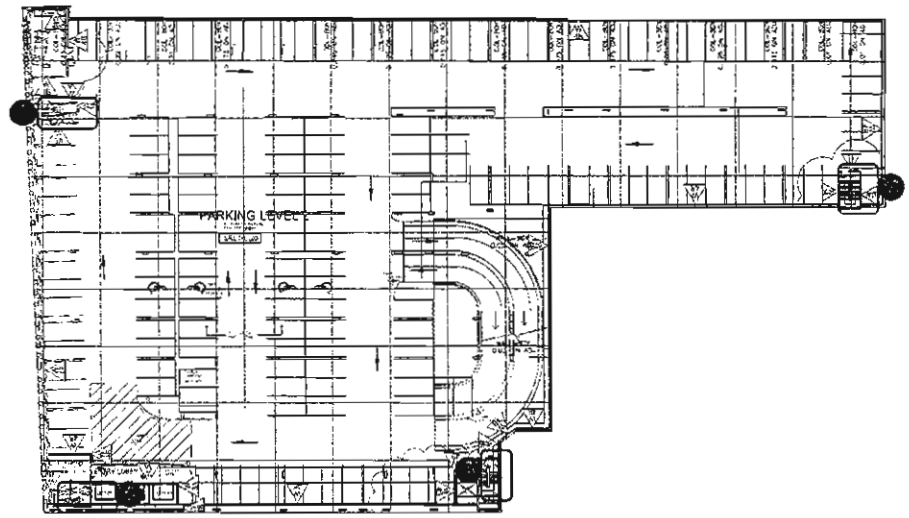
Access and egress from the building is provided via 11 exits distributed throughout the development. All exits are summarised in the table below.

The exits consist of a variety of fire-separated stairs, single swinging doors and glass sliding doors. Access through the building is provided via the travelator which passes through both levels of the warehouse. Access to the retail areas from car park level is by lifts and stairs.

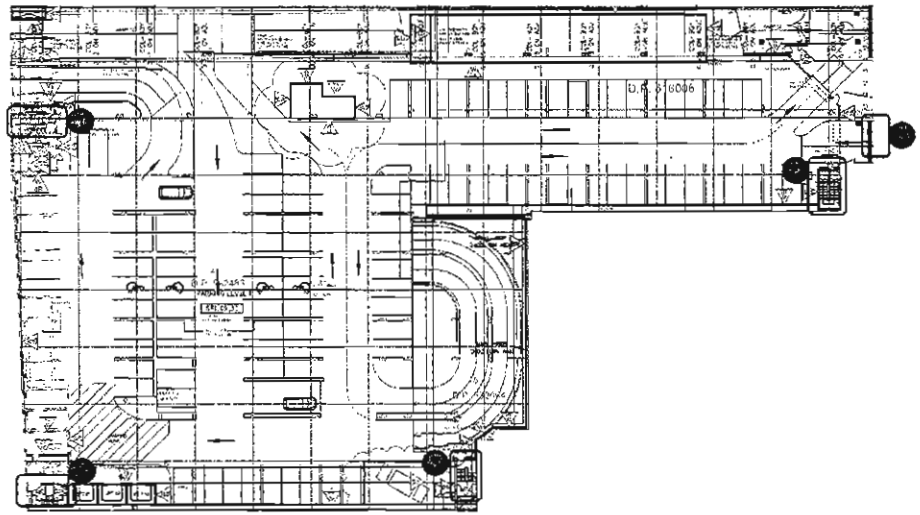
Exit number	Area	Type	Comments
1	Parking level 1 & 2	Fire-separated stair	(Stair 4) Discharges externally at Warehouse Level 1 to Condamine Street
2	Parking level 2	Fire-separated stair	(Stair 7) Discharges externally to Roseberry Street
3	Parking Level 1 & 2	Fire-separated stair	(Stair 8) Discharges externally with egress to Balgowlah Road
4	Parking Levels 1 & 2 and Warehouse Level 1	Non-fire isolated stair	(Stair 1) Discharges to main entry lobby on Warehouse Level 1
5	Parking level 1	External door	External door adjacent vehicle entry off Roseberry Street
6	Warehouse level 1	External door	External door to Stair 5, via exit door to vehicle egress to Condamine Street
7	Warehouse levels 1	External door	External door from Goods Marshalling Area
8	Warehouse level 1	External door	External door from Timber Trade Sales
9	Warehouse level 1 & 2	Fire-separated stair	(Stair 8) discharges externally with egress to Balgowlah Road
10	Warehouse level 1	External sliding doors	Sliding doors from main entry with egress to Condamine Street
11	Warehouse 2	Fire-separated stair	Stair discharges to Warehouse Level 1, with egress to Condamine Street via door adjacent vehicle egress.

Egress details

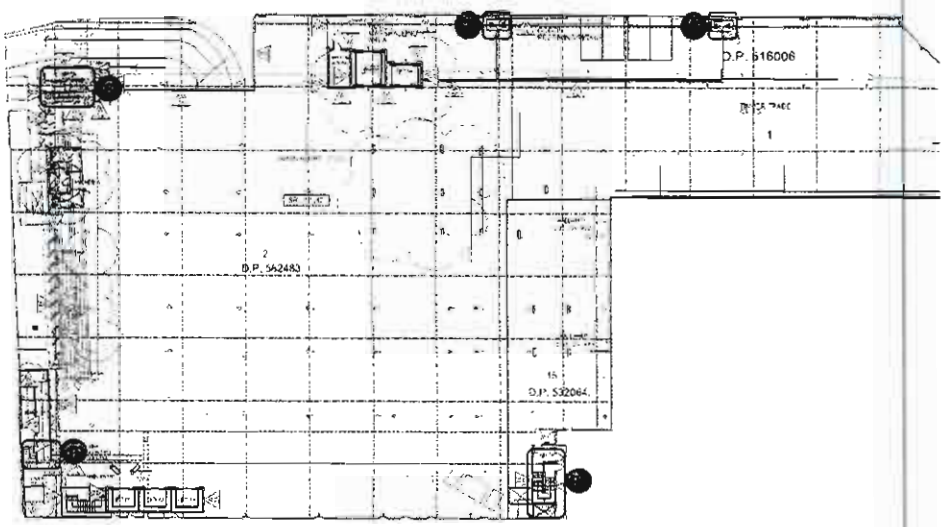
The diagrams on the following pages show the location of the exits described in the egress table above.



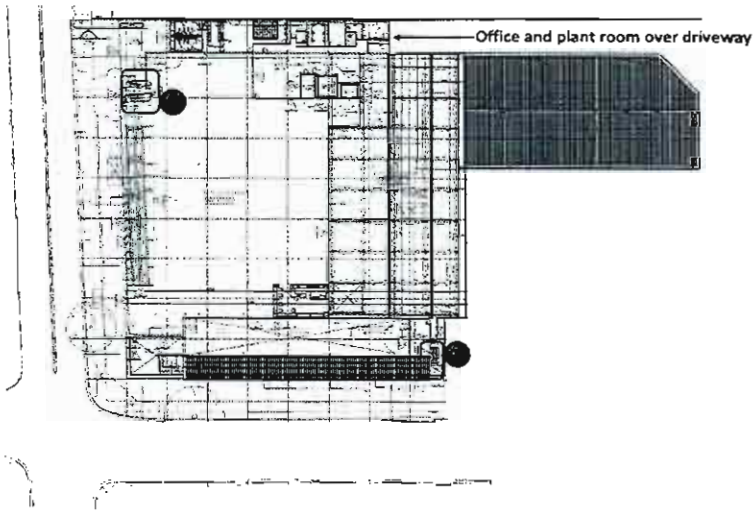
Parking Level 2 Exits



Parking Level 1 Exits



Warehouse Level 1 Exits



Warehouse Level 2 Exits

1.8 Dominant Occupant Characteristics

The characteristics of the building population are as described below.

1.8.1 Distribution

The number of persons accommodated is given in the following table as provided by Steve Watson & Partners, BCA Assessment Report, 2008/743 R1.2, dated June 2011.

The population is based on 2.5 persons per car space in the basement car park (269) plus an allowance for an additional 50 on street car spaces. Therefore, the occupancy of the building will be 798.

Part of Project	Occupancy description		Population size
	CLASS	AREA (M^2)	OCCUPANT NO.
Parking Level 2	7a	6,200	798
Parking Level 1	7a	4,850	The population is calculated at a rate of 2.5 persons per car space in the basement car park (269 spaces) plus an allowance for an additional 50 persons for on street car spaces. 319 × 2.5 =797.5
Warehouse Level 1 – Retail	6	5,200*	
Warehouse Level 2 – Retail	6	3,500	
Nursery Level 2	6	700	
Office Area	6	270	

*Note: Includes Timber Trade Sites and Goods Receiving areas

Building population

1.8.2 State

The occupants of the building are expected to be awake at all times.

All occupants are expected to be fully conscious and sober.

1.8.3 Physical and Mental Attributes

All occupants are to be representative of the general public.

1.8.4 Building Familiarity

From Bennetts (1998) the majority of the occupants are expected to prefer to evacuate via the same route that they entered.

1.8.5 Emergency Training

Security staff and fire wardens will be trained in emergency procedures. Occupants will be instructed on the actions necessary on the activation of the sound system and intercom system for emergency purposes.

1.8.6 Identified Hazards and Measures for Mitigation

The following table identifies potential fire hazards and preventative and protective measures in place.

The build up of hazardous or combustible materials will be limited throughout the development. Good housekeeping will reduce the likelihood of a fire, rapid spread of toxic smoke or explosion.

Area	Hazards identified	Preventative and protective measures
Office	**Ignition sources:** ▪ Electrical faults ▪ Kitchenette ▪ Equipment faults **Fuel load:** ▪ Chairs, tables, rubbish bins ▪ Linings and coverings ▪ Books, folders, paper ▪ Storage cabinets and cupboards	**Preventative measures:** ▪ Security and cleaning staff ▪ Housekeeping **Protective measures:** ▪ Fire hose reels, portable fire extinguishers ▪ Automatic fire sprinkler system ▪ Automatic fire detection
Retail area	**Ignition sources:** ▪ Electrical faults ▪ Heating equipment **Fuel load:** Goods (items for sale freestanding or on racks)	**Preventative measures:** ▪ Presence of other shoppers, staff and Security ▪ Housekeeping **Protective measures:** ▪ Fire hose reels, portable fire extinguishers ▪ Automatic fire sprinkler system ▪ Automatic fire detection
Loading dock	**Ignition sources:** ▪ Electrical faults ▪ Loading truck fault ▪ Heating equipment **Fuel load:** ▪ Delivery stock ▪ Loading trucks	**Preventative measures:** ▪ Staff and security ▪ Housekeeping **Protective measures:** ▪ Fire hose reels, portable fire extinguishers ▪ Automatic fire sprinkler system ▪ Automatic fire detection
Car park	**Ignition sources:** Electrical faults **Fuel load:** Cars	**Preventative measures:** ▪ Staff and security ▪ Housekeeping **Protective measures:** ▪ Fire hose reels, portable fire extinguishers ▪ Automatic fire sprinkler system ▪ Automatic fire detection

Hazards Identified and Preventative and Protective Measures

2 FIRE SAFETY DESIGN REQUIREMENTS

2.1 General

Section 2 outlines the Fire Safety Design for the building. It is designed to be a checklist that can be used as quick reference to identify the necessary fire safety systems and other requirements that shall be included in the building design. No justification for non-compliances with the DtS provisions of the BCA is given here. All non-compliances are justified in Section 3 of this report.

2.2 The Application of the BCA DtS requirements

Any building feature that is not referred to or affected by this report **shall comply** with the 'Deemed-to-Satisfy' provisions of the BCA, relevant Australian Standards, National State and Local Legislation as applicable.

Any changes to the building design or layout during the design or construction process shall be assessed by a suitably qualified Fire Engineer against this FER. All future modifications, changes or layouts to the building need to be reassessed against this FER.

2.3 Summary

The building is defined as a large isolated building. As a result, the BCA sets down a series of recommendations that must be included in the fire safety design. In this case the Fire Brigade access has several features that do not meet the recommendations of the BCA.

A reduction in fire rating will be applied to the external walls including the columns that are required to achieve a fire rating in relation to the location to the boundary. The fire rating of these building elements has been rationalised to 120 minutes in lieu of 180 minutes.

To compensate for certain non-compliances, active fire safety systems shall be installed within the development as a result of this Fire Engineering assessment. These include the use of a fast response sprinkler system installed throughout the building.

The analysis undertaken in this report demonstrates that sufficient provisions are in place throughout the building to provide a performance-based smoke extract system in lieu of a DtS zone smoke control system. The Fire Engineering assessment has demonstrated that in the event of a fire conditions in the warehouse remain tenable for the period of time occupants take to evacuate. The performance-based design will feature a total of 3 smoke extraction fans position in the roof of Warehouse Level 2 to exhaust smoke to atmosphere.

The active fire safety systems installed within the building to assist in occupant egress and fire-fighting include:

A fast-response automatic sprinkler protection system installed throughout the building;

1. Smoke extract fans positioned in the ceiling space of Warehouse Level 2 forming part of a performance-based automatic smoke extract system;
2. A smoke detection system designed in accordance with BCA Section E2.2a Clause S (extended spacing). Detector shall have a sensitivity of 5% obs/m;
3. An occupant warning system designed in accordance with AS 1670.1;
4. Fire hydrant system to AS 2419.1 and BCA E1.3;
5. Fire hose reel system to AS2441 and BCA E1.4;
6. Fire extinguishers to AS 2444 and BCA E1.6;
7. Emergency lighting to AS 2293.1 and BCA E4.2

2.4 Fire Resistance Levels (FRLs)

a. The minimum FRL for the building will be generally 120 minutes (see table below) However, the table below does not apply to the walls described in point c. below.

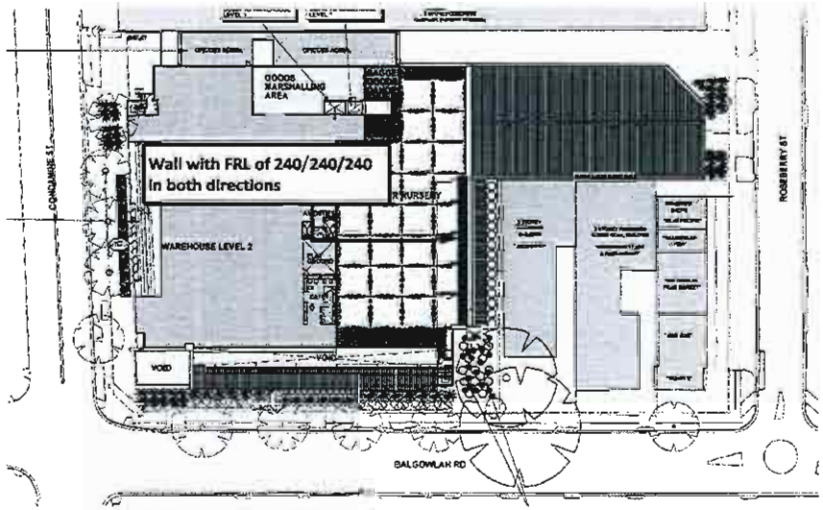
b. The structure of the office level including floor and columns will achieve an FRL recommended by specification C1.1 Table 4 for Type B construction.

The table below identifies the necessary protection required to building construction. The FRL is specified as follows: structural adequacy / integrity / insulation. E.g. 120/120/120 indicates that the building elements should be provided with 120 minutes structural adequacy, integrity and insulation.

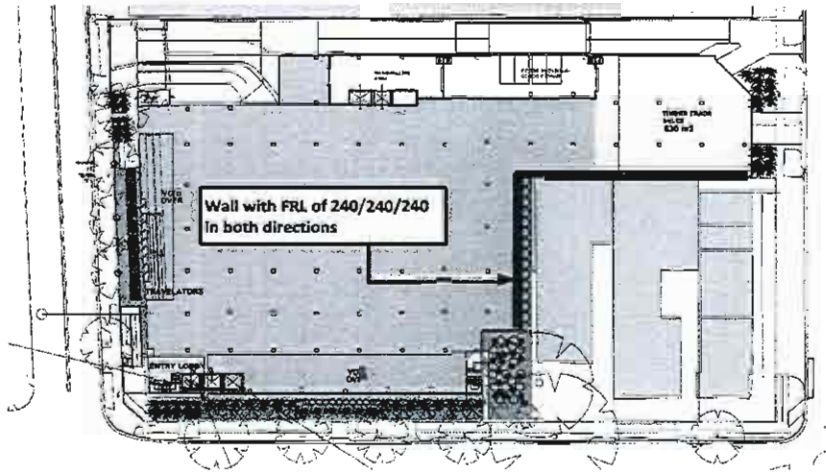
BUILDING ELEMENT	AREA Car parking levels	Warehouse levels
External wall – including incorporated columns etc (distance from fire source feature) –		
Load-bearing		
<1.5m – 3m	120 / 120 / 120	120 / 120 / 120
3 – 9m	120/90/60	120/90/60
9 – 18m	120/60/-	120/60/-
>18m	-/-/-	-/-/-
non-load-bearing		
>1.5m	-/120/120	-/120/120
1.5 – 3m	-/120/120	-/120/90
>3m	-/-/-	-/-/-
External column (distance from fire source feature) –		
Not incorporated in an external wall		
<3m	120/-/-	120/-/-
>3m	-/-/-	-/-/-
Common walls and fire walls (floors) –		
Car Parking Level 1 and 2 slabs	-/-/-	
Warehouse Level 1 slab	120 / 120 / 120	
Warehouse Level 2 slab	-/-/-	
Office area above access road	120 / 120 / 120	
Internal walls		
Fire-resisting stair shaft		
– load-bearing	120 / 120 / 120	120 / 120 / 120
– non-load-bearing	-/120/120	-/120/120
Other internal load bearing wall/columns	120/-/-	120/-/-
Roof (including internal structure that only supports the roof – external columns may be subject to FRL)	N/A	-/-/-

Structural fire protection requirements

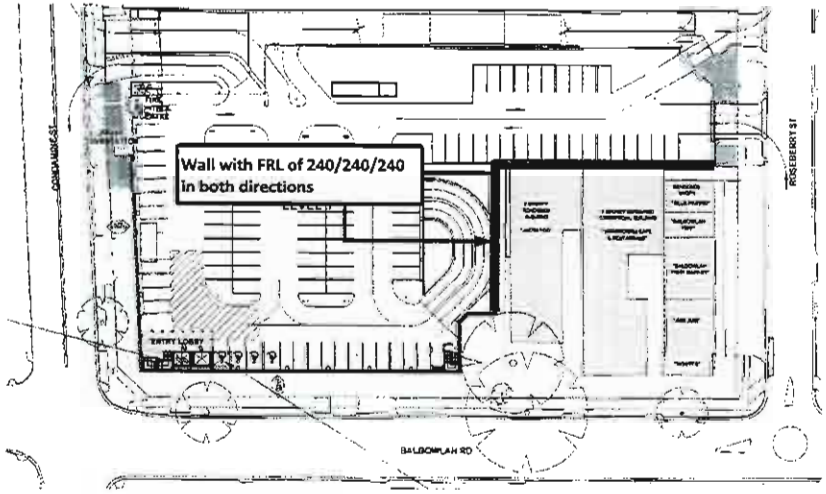
c. At the request of FRNSW, the following walls exposed to adjacent buildings will be provided with a FRL of 240/240/240 in both directions. Any columns within 3m of the boundary will be provided with an FRL of 240/240/240. See indicative mark-ups below:



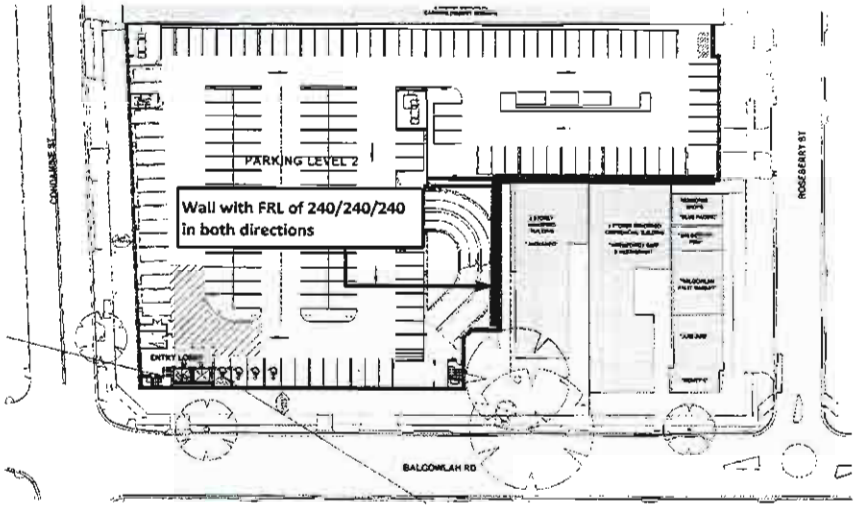
Warehouse Level 2 – Indicative diagram showing FRL of walls adjacent other buildings



Warehouse Level 1 – Indicative diagram showing FRL of walls adjacent other buildings



Parking Level 1 – Indicative diagram showing FRL of walls adjacent other buildings

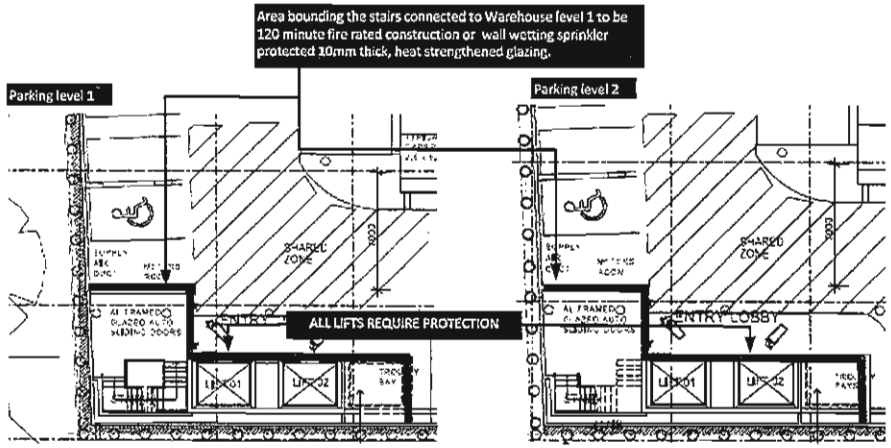


Parking Level 1 – Indicative diagram showing FRL of walls adjacent other buildings

2.4.2 Compartmentation

The access stairs and lifts on Parking Level 1 and Parking Level 2 shall be separated from the car park areas by bounding construction consisting of either a 120 minute fire wall, or by sprinkler protected glazing.

The diagram below shows the indicative areas that require protection.



Indicative diagram showing areas requiring compartmentation or wall wetting sprinklers

2.4.3 Sprinkler Protected Glazing

Where glazing is used in lieu of fire-rated construction, the following design parameters shall be in place:

a. Wall wetting sprinklers shall be provided in accordance with AS 2118 on the fire load side only i.e. the car park side.

b. The glass shall be installed to provide a flush vertical surface over the total wall area. The maximum permitted depth of transoms, mullions or other projections is 20 mm to ensure adequate water run down over the glass.

c. Sprinkler protected glazing shall consist of toughened or heat strengthened safety glass with a minimum thickness of 10 mm. The glass shall be held in place with metal framing and incorporate a gasket or silicon system which permits the framing to deflect (due to thermal expansion) sufficiently without causing glass failure.

d. All glazed door openings within the glazed wall shall be wired fail-safe, such that they close upon general fire alarm, loss of power, or local smoke detection on the car park side. A smoke detector will be provided within 1.5m of a glazed door.

e. Glazing protected by wall wetting sprinklers shall comprise no dressings that may reduce the effectiveness of the system e.g. posters etc.

f. A 1m sterile (no fire load) gap shall be provided around the glazing on the car park side. Bollards shall be located on the car park side of the glazing to keep fuel loads at a reasonable distance.

Redundancy

The sprinkler systems in Car Park 1 and Car Park 2 are provided from separate valve sets. As such, the wall wetting sprinklers will not be provided from a separate valve set to the general sprinkler system in the car parks.

The wall wetting sprinklers are interconnected between Car Park 1 and Car Park 2. To provide a level of redundancy, the wall wetting sprinklers will be designed so that when either car park level is isolated independently, the wall wetting sprinkler system remains operational on both levels.

For example, if the sprinkler system is isolated for maintenance on Car Park Level 1, the Car Park Level 2 sprinkler system, the wall wetting sprinklers on Car Park Level 1 and wall wetting sprinklers on Car Park Level 2 will remain operational.

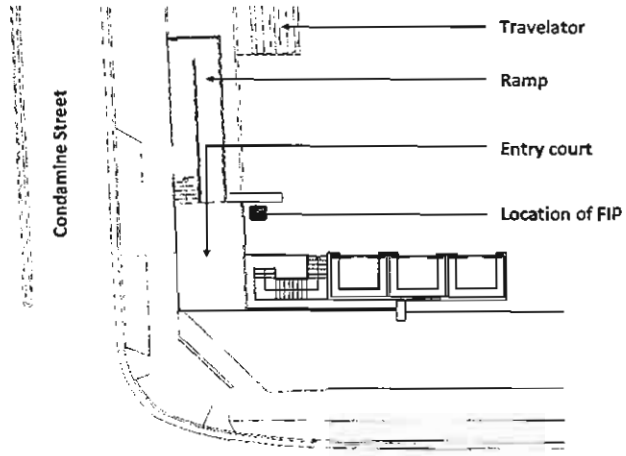
As a result, it is the responsibility of building management to ensure that the Car Park Level 1 and Car Park Level 2 sprinkler systems are not isolated at the same time.

2.5 Active Fire Safety Systems

2.5.1 Fire Indicator Panel (FIP)

a. The Fire Indicator Panel (FIP) shall be located within the main entrance as shown below:

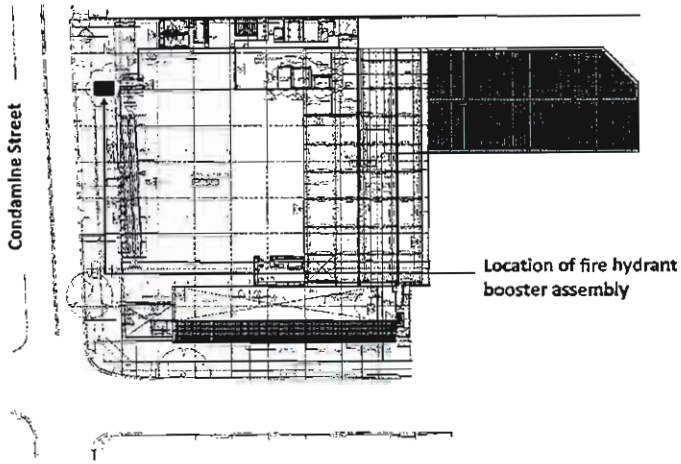
b. Mimic panels will be located in the sprinkler valve room and in the Managers office.



Location of FIP in main entrance to Bunnings Warehouse, Balgowlah

2.5.2 Fire Hydrant and Hose Reel System

a. Fire hydrants and the booster assembly will be located and installed in accordance with Clause E1.3 of the BCA and AS2419.1-2005 as indicated on the drawing below:



Location of fire hydrant booster assembly

b. Storz hermaphrodite fire hose couplings must be fitted to all fire hydrants and fire hydrant booster assembly connections as required by Appendix E of AS2419.1-2005. The Storz fittings must be manufactured to DIN 14303, aluminium alloy delivery couplings, in accordance with Appendix A of AS2419.2 – 1994. Blank caps must be provided in accordance with Clause 2.8 of AS2419.2-1994.

c. Fire hydrants shall be a minimum of 10m from any substation.

d. Fire hose reels and fire extinguishers will be provided throughout the development installed to meet the minimum requirements of the BCA and AS2441 and AS2444 respectively.

e. The hydraulic consultant must ensure compliant fire-rated construction (if required) is provided behind the hydrant booster in accordance with AS 2419.1 – 2005.

2.5.3 Automatic Fire Sprinkler System

a. A fast response sprinkler system installed in accordance with the recommendations of AS2118.1 is required to be installed throughout the building.

b. All sprinkler heads shall be provided with a response time index (RTI) no greater than 50 $(m/s)^{1/2}$.

c. The activation temperature of sprinklers in the roof of Warehouse Level 2 shall be 93°C.

d. All other sprinklers shall have an activation temperature of 68°C.

e. A Grade 3 water supply shall be provided for the building as per the recommendations of the BCA and relevant Australian Standards

2.5.4 Sound System for Emergency Purposes

a. The building occupant warning system shall comply with the requirements of Clause 3.22 of AS 1670.1. The evacuation signal shall consist of a non-verbal message and operate simultaneously throughout the building.

b. The occupant warning system shall activate upon a signal from either the automatic smoke detection system or automatic fire sprinkler system.

2.5.5 Fire Detection and Alarm System

a. High sensitivity (not greater than 5% obs/m) below ceiling smoke detectors of the analogue/addressable type shall be installed in accordance with BCA Section E2.2a Clause 5 (extended spacing) throughout both Warehouse Levels including all office and common areas to provide early fire detection and alarm.

b. The fire detection and alarm system shall transmit coded signals to the main FIP panel, Fire Brigade, door closing controls, emergency sound system and mechanical air handling systems (including High Volume Low Speed [HVLS] fans).

c. All mechanical air handling systems should shut down in accordance with AS1668.1 on fire detection. HVLS fans will also be provided with a manual stop button at customer services.

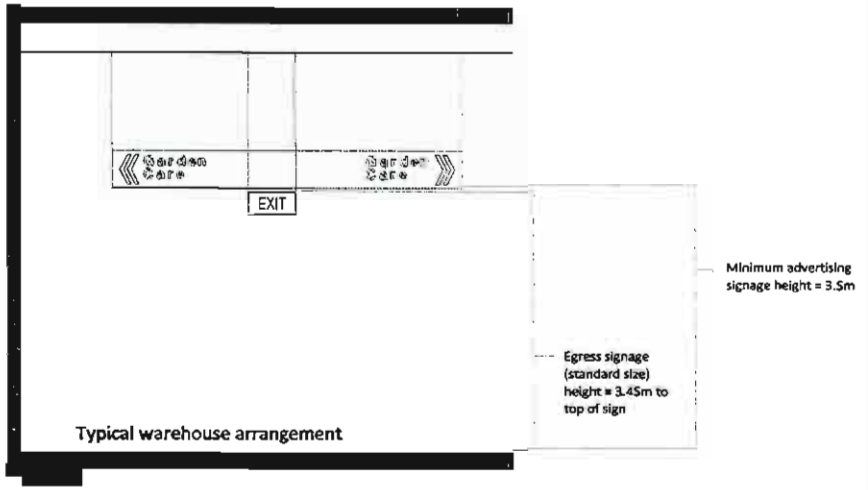
2.5.6 Emergency Lighting and Exit Signage

a. Emergency lighting and exit signage must be installed throughout the building in accordance with AS/NZS 2293 and BCA and must be clearly visible at all times while the building is occupied.

b. Exit signage within the warehouse will be situated at a height of 3.45m (to the top of the sign) above finished floor level.

c. Exit signage will be provided above all exit doors at the height specified in AS/NZS 2293.

d. Jumbo exit signs will not be provided.



Indicative arrangement of signage in Warehouse Level 01 and Warehouse Level 02

2.5.7 Automatic Mechanical Smoke Exhaust

a. Smoke extraction fans shall be used to provide smoke hazard management and will activate automatically upon detection or sprinkler operation.

b. Smoke exhaust fans shall consist of fire rated fans and cabling.

c. The fans shall be located within the ceiling space of Warehouse Level 2, and are designed to achieve an extraction rate of at least 1 air change per hour.

d. The smoke exhaust system shall achieve an extraction rate of 30m³/s.

e. Manual override controls for these fans shall be located at the Fire Indicator Panel for use by the fire brigade. Appropriate signage and compliant Fire Fan Control Panel indication shall also be located next to the control at the FIP to assist the user.

f. Make up air shall be evenly distributed and provided at low level. It is expected that sufficient make up air will be provided via the entrance doors and leakage in the building.

g. On sprinkler operation in the car park, the car park extract system will continue to run or ramp to full speed in accordance with Clause 5.5 of 1668.1. Car park extract fans need not be fire rated and do not require fire-rated power cabling and control cabling.

h. The car park extract and warehouse extract systems may operate independently. Therefore a fire in the warehouse need not operate smoke extract in the car park and vice versa.

i. Hot Air Layer Extract (HALE) fans may be combined with smoke extract fans provided they meet the requirements for smoke extract fans.

2.6 Egress

All exit doors necessary for occupant evacuation. Any doors which may be locked will unlock on general fire alarm and shall be wired to fail safe (unlock) with the exception of the main entrance roller shutter door.

2.6.1 Number of exits

A sufficient number of exits are provided in the warehouse to accommodate the evacuation of the expected number of occupants.

2.6.2 Doorways and doors and operation latches

a. Sliding and roller doors that do not lead directly to a road or open space are provided in the following areas:
   - Sliding doors between parking levels 1 and 2 and the stair entry lobbies;
   - Sliding doors between the outdoor nursery and warehouse level 2; and
   - A roller door between the main entry lobby and warehouse level 1.

b. The sliding doors between the outdoor nursery and the warehouse are to open on general fire alarm. The sliding doors must be able to be opened manually under the force of not more than 110N if there is a malfunction or failure of the power source.

2.7 Fire Brigade Access

Assessment E demonstrates that access for Fire Brigade vehicles meets the Performance Requirements of the BCA.

a. The current access arrangements are acceptable provided that, where Fire Brigade access routes are built upon by roller shutters and / or gates , the roller shutter or gate must have a mechanism that allows the Fire Brigade to open the shutters. This might be by use of a 003 key or a key provided at local stations.

b. Confirmation has been provided by the structural engineer that the load bearing capacity of the vehicular access is sufficient for Fire Brigade vehicles (Appendix 8).

c. Confirmation has been provided by the architect that an unobstructed height of at least 4.5m is provided on Fire Brigade access routes around the site in accordance with Section S.S of Policy No 4 of the FRNSW (Appendix C). This was discussed and agreed with FRNSW at a meeting on 7 June 2011

2.8 Approval and Certification

2.8.1 Commissioning and Certification

All responsible contractors shall ensure that the installed fire safety systems have been commissioned tested and results recorded. Commissioning results shall be forwarded to the Principal Certifying Authority for approval.

2.8.2 Relevant Information for FRNSW Review

Relevant certificates, inspections reports, commissioning results and as-built drawings shall be obtained from the responsible contractors and consultants by Southern Cross. Information shall contain operational Performance Requirements, design standards and reference the Fire Engineering Report (where relevant), and any other determination made by an approval authority.

This information shall be made available for review by the FRNSW for the purposes of EP&A Regulation 2000, Clause 152.

3 ASSESSMENTS

3.1 Assessment A – Rationalisation of Fire Ratings

3.1.1 Brief

Assess the appropriateness of providing rationalised fire ratings throughout the building.

3.1.2 BCA Performance Requirements

CP1, CP2.

Refer to BCA for Performance Requirements.

3.1.3 BCA Deemed-to–Satisfy (DtS) Provisions

C1.1 – Type of Construction and Specification C1.1 Table 4 Type B Constructions: FRL of Building Elements.

Refer to BCA for Deemed-to-Satisfy Provisions.

3.1.4 Non Conformance of Design

The FRL will be rationalised as follows:

1. The whole building will be provided with an FRL of 120 minutes.
2. The office/mezzanine level (including load-bearing walls and columns supporting the office/mezzanine) will not be fire-rated.

3.1.5 Analysis Methodology

The fire safety strategy has been developed using both the BCA Performance Requirements and the International Fire Engineering Guidelines sub systems.

Compliance with the Performance Requirements will be achieved in accordance with A0.5(b)(i) 'complies with the Performance Requirements'.

Fire severity will be determined against the Performance Requirements using BCA section A0.9(b)(ii) 'Verification Methods as the appropriate authority accepts for determining compliance with the Performance Requirements'.

The International Fire Engineering Guidelines Sub Systems are:

a. Sub System B – Smoke Development & Spread & Control.

b. Sub System C – Fire Spread & Impact & Control.

3.1.6 Acceptance Criteria

The assessment will be formed of three parts:

Part 1 – General reduction of FRL for whole building

The analysis is acceptable provided that calculated equivalent fire duration is less than the fire resistance provided to the structure i.e. less than 120 minutes.

Part 2 – Occupant escape time and Fire Brigade intervention

Using the results from Parts 1 and 2, Assessments B – Exit system and egress distance analysis, and Assessment E – Vehicular access, a time line will be constructed to estimate the time the Fire Brigade are given for intervention.

3.1.7 Analysis

3.1.7.1 BCA Fire Resistance Level

The BCA requires that certain building elements are provided with a FRL relative to the building class and type of construction. Class 6 (retail) buildings built of Type B construction are required to be provided with a maximum FRL of 180 minutes for certain building components.

In this case it has been demonstrated via a quantitative analysis that a maximum FRL of 120 minutes will provided an equivalent level of performance to the DtS provisions, i.e. maintain structural stability and prevent spread of fire.

3.1.7.2 Part 1 – General reduction of FRL for whole building

Time Equivalence of Fire Severity (Equivalent Fire Severity (EFS) Method)

Time equivalence of fire severity calculations assume a total burnout of the expectant fire load in the fire compartment. Studies undertaken by Poon (1995) detail the transition that a fire undergoes due to the constraints of the fuel package and ventilation parameters. The early stages of the fire are fuelled by the available oxygen within the compartment. Post flashover, the fire is fuelled by incoming ventilation. As such, the critical factor when measuring the severity of a compartment fire is the availability of ventilation.

Each type of fire severity assessment acknowledges that where a fire is highly ventilated, the rate at which the fire consumes the fire load is increased. In addition, heat built up within the structure is limited since a large quantity of heat is able to dissipate through openings in the compartment. As a result, the time period through which the fire takes place is reduced when compared to a similar compartment with limited ventilation. Considering the effect of fuel load and available ventilation it is therefore reasonable to reduce the level of fire resistance required for that structure.

Fire Growth and Fire Suppression

Time equivalence calculations are based upon a total compartment burnout. Flashover is unlikely to occur within either of the retail warehouse levels due to the large size and high ceiling height of these areas. Furthermore, sprinkler protection of the entire building will limit fire growth and reduce the risk of flashover. Therefore, the quantity of heat delivered to the structure is also limited.

Additionally, Clifton (2000) noted that fires in large enclosures do not burn at the same intensity at all locations simultaneously. Bennetts *et al.* (2000) demonstrated that limited ventilation in regions remote from the external openings of a compartment could not support burning. Hence, regardless of the fire start location, the fire tends to migrate to the external openings before progressing backward into the compartment. Thomas et al (1992) observed similar behaviour during the 140 William Street research project at BHP Melbourne Research Laboratories.

Although unlikely, should an uncontrolled fire develop in the building, the work of Clifton (1996) and others demonstrates that a fire will not burn throughout every region of a compartment simultaneously. Again, the effect of heat on the structure is limited.

By considering complete simultaneous compartment burn-out and no sprinkler protection, the calculation of equivalent time of fire severity is conservative. The subsequent reduction in FRL is therefore reasonable.

Fire Location and Fire Load

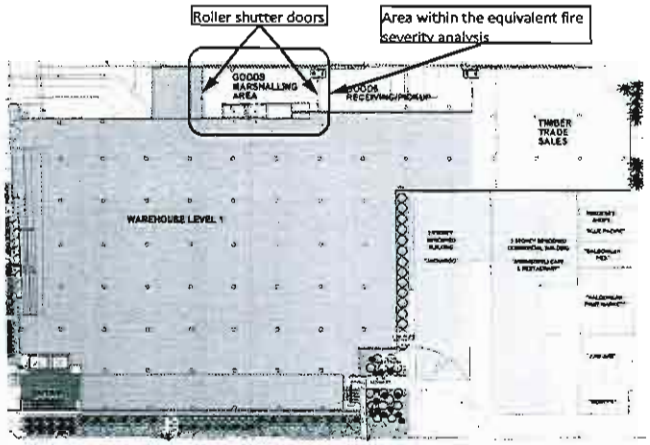
Fire Location

As discussed above the equivalent fire severity method assumes that a fire occurs involving the total area of the fire compartment. However, it is not practical to assume a fully involved fire within the main warehouse trading area, the fire is assumed to occur within an area of the building containing a high density of fuel load.

The Goods Marshalling area has been chosen as the worst credible fire scenario for the equivalent fire severity analysis due this area being:

- A storage area containing a high density of fuel load;
- An area that is smaller than the warehouse and is more likely to undergo flashover (despite the high ceiling height); and
- This area is provided with less natural ventilation than the Goods Receiving area and is therefore expected to have a longer fire duration.

As such, the fire severity assessment will consider a fully involved fire in the Goods Marshalling area. See diagram on following page.



Area used in Equivalent Fire Severity analysis

Fuel Load

The International Fire Engineering Guidelines (IFEGs) provide average fuel load densities relative to the use and function of the building.

For a retail building the IFEGs recommend a range of fuel loads relative to the percent fractile. For the purposes of this analysis a 90% fractile fuel load of 1,100MJ/m² has been used. This is as a conservative assumption as this methodology assumes that 90% of retail premises will have a fuel load less that 1,100 MJ/m².

Equivalent Fire Severity

The assessment of the rationalised FRLs utilises the following empirical expressions, subject to the limitations associated with the respective expressions, the method providing the highest result (minutes) will be used within the discussion.

CIB Method

The empirical expression for equivalent fire severity, t_e, is taken from Thomas (1986)and is given as follows:

$t_e = e_f k_b w$

e_f is the fire load (MJ/m² of floor area)

k_b is a parameter to account for different compartment linings

w is the ventilation factor, dependant on the room dimensions and configuration

Where the exact properties of lining materials are unknown a value of $k_b = 0.067$ is suggested. This value is more conservative than the value suggested for concrete and plasterboard which would generally be expected in such an area.

The ventilation factor, w, is calculated utilising the following formula:

$$w = \frac{A_f}{\sqrt{A_v A_t \sqrt{H_v}}}$$

A_f is the floor area of the compartment (m²)

A_v is the total opening area in walls (m²) $w \geq 0.08$

A_t is the total area of the internal bounding surfaces (m²)

H_v is the average height of the openings (m)

Law Method

The Law method has been taken from Buchanan (2001) and is given as follows:

$$t_e = \frac{A_f e_f}{\Delta H_c \sqrt{A_v (A_t - A_v)}}$$

where ΔH_c is the calorific value of the fuel

Eurocode Method

An empirical expression for equivalent fire severity, t_e, is taken from Eurocode as reproduced in Buchanan (2001), and is given as follows:

$t_e = e_f k_b w_f$

Where e_f is the fire load (MJ/m² floor area)

k_b is a conversion factor

w_f is the ventilation factor which is dependent on the room dimensions and configuration.

The ventilation factor, w_f, is calculated utilising the following formula:

$$w_f = \left(\frac{6.0}{H}\right)^{0.3}\left[0.62 + \frac{90(0.4-\alpha_v)^4}{1+b_v\alpha_h}\right] > 0.5$$

α_v = A_v/A_f $0.05 \le \alpha_v \le 0.25$

α_h = A_h/A_f $\alpha_h \le 0.20$

b_v = $12.5\,(1+10\alpha_v - \alpha_v^2)$

A_f is the floor area of the fire cell (m²)

A_v is the area of the vertical window and door openings (m²)

A_h is the area of horizontal openings in the roof (m²) and

H is the height of the fire cell (m)

Calculation Assumptions

- A fire load of 1,100 MJ/m² is recommended by Table 3.4.1b of the IFEG for the 90% fractile for retail;
- Ventilation will be provided via the two roller shutter openings to this area; and
- Sprinkler protection is not included within the analysis.

Critical parameters for the goods receiving area

Width: 21m

Length: 10m

Height: 5.5m

Total area of ventilation (two roller shutters): 4 x 4 + 3 x 4 = 28m²

Material of construction: concrete

Fire load density: 1,100 MJ/m²

Calorific value of the fuel load: 16MJ/kg

3.1.8 Results

3.1.8.1 Part 1: General Reduction in Building FRL from 180 to 120 minutes

The results of the equivalent fire severity analysis are shown in the table below.

Assessment method	Equivalent fire severity results
CIB	**79 minutes**
Law	101 minutes
Eurocode	**67 minutes**

Equivalent Fire Severity Results

The results of the equivalent fire severity analysis (see Appendix D) have demonstrated that the worst case fire duration within the Goods Marshalling area is 101 minutes. **The analysis ignores sprinkler protection in this area.** In reality sprinklers will operate and control the fire and prevent flashover.

A fire in the Goods Marshalling area is likely to cause the greatest threat to the structure of the building due to the fuel loading within this area and the ventilation available within this area.

Based on these results and the conservative assumptions (i.e. high fire load and no sprinkler protection) employed within the assessment methodology the reduced FRL for the building is reasonable.

3.1.8.2 Part 2 – Occupant escape time and FRNSW intervention

The following table will be used to construct a time line of fire progress, occupant escape and Fire Brigade intervention.

Event	Timeline	Time (seconds)	Source
Fire ignition	A	0	
Smoke detector activation	B	91	Assessment B
Operation of second row of sprinklers with standard response bulb (fast response to be installed)	C	334	Assessment B
Occupant escape: Required safe escape time (RSET)	D	412	Assessment B
Available safe escape time in worst case (visibility only)	E	430	Assessment B
Fire Brigade arrival at kerb time (from Forestville Station – worst case)	F	2161	Assessment E
Maximum expected fire duration (worst case with limited ventilation and no sprinkler protection)	G	6060	Assessment A
Fire protection to structure	H	7200	Section 2.3

Indicative timeline based on results from assessments

Using the results from this section, Assessment B, Assessment E and the FBIM, the following timeline has been be drawn:

Illustration showing time line of occupant escape and Fire Brigade intervention

The timeline above illustrates that, in the worst case, FRNSW are given 75 minutes to extinguish the fire and perform search and rescue operations.

75 minutes is a reasonable time for FRNSW to extinguish the fire and complete search and rescue operations.

3.1.9 Conclusion

The primary analysis looks at a complete burnout of the Goods Marshalling area using a fire load of 1,100 MJ/m^2. The results show the maximum duration of a fire is expected to be 101 minutes. Based on this it is reasonable to reduce the FRL of the warehouse from 180 minutes to 120 minutes.

The second part of the analysis demonstrates that, in the worst case, FRNSW are provided with 75 minutes from their arrival time to extinguish the fire and perform search and rescue operations. This is reasonable.

Performance requirement, CP1	Comment
A building must have elements which will, to the degree necessary, maintain structural stability during a fire appropriate to–	
(a) the function or use of the building; and	A fire load of 1,100MJ/m^2 provides a representation of the function and use of the building.
(b) the fire load; and	The fire load chosen is based on recommendations of the IFEG.
(c) the potential fire intensity; and	As per (c)
(d) the fire hazard; and	The fire was located in the Goods Marshalling area to represent the worst case scenario.
(e) the height of the building; and	Flashover is unlikely to occur in a building with a high ceiling. However, the analysis has modelled a complete compartment burnout.
(f) its proximity to other property; and	The separation distances from nearby structure meets the requirements of the DtS provisions.
(g) any active fire safety systems installed in the building; and	Sprinkler protection has not been considered in the compartment burnout analysis. Despite this, the fire duration is less than 120 minutes.
(h) the size of any fire compartment; and	The fire was located in the goods marshalling area to represent the worst case scenario.
(i) fire brigade intervention; and	The reduction in the FRL is not reliant upon Fire Brigade intervention.
(j) other elements they support; and	The analysis demonstrates that building elements provided with an FRL of 120 minutes will be sufficiently protected
(k) the evacuation time.	It has been calculated that RSET < ASET in Assessment B.

Comparison of design against Performance Requirement CP1

Performance Requirement, CP2	Comment
(a) A building must have elements which will, to the degree necessary, avoid the spread of fire –	
(i) to exits; and	The building is provided with an automatic smoke exhaust system which will limit smoke/fire spread to exits.
(ii) to Sole Occupancy Units and public corridors; and	N/A
(iii) between buildings; and	N/A
(iv) in a building	It has been demonstrated that the rationalisation of the fire ratings to building elements is reasonable.
(b) Avoidance of the spread of fire referred to in (a) must be appropriate to –	
(i) the function or use of the building; and	A fire load of 1,100 MJ/m^2 provides a representation of the function and use of the building.
(ii) the fire load; and	A fire load of 1,100 MJ/m^2 was used in the analysis
(iii) the potential fire intensity; and	As per (b)(i)
(iv) the fire hazard; and	The fire was located in the goods marshalling area to represent the worst case scenario.
(v) the number of storeys in the building; and	The analysis demonstrates that rationalising the structural FRL is reasonable and is not influenced by the number of storeys
(vi) its proximity to other property; and	N/A
(vii) any active fire safety systems installed in the building; and	All active fire safety systems not referenced in this report shall be installed in accordance within the DtS requirements of the BCA.
(viii) the size of any fire compartment; and	The fire was located in the goods marshalling area to represent the worst case scenario.
(ix) fire brigade intervention; and	The reduction in the FRL is not reliant upon Fire Brigade intervention. Catastrophic structural collapse is not expected therefore Fire Brigade intervention is able to be in accordance with standard operating procedure.
(x) other elements they support; and	The analysis demonstrates that building elements will be sufficiently protected to allow occupant escape.
(xi) the evacuation time.	Occupant evacuation will be complete before a fire in the warehouse threatens the structure.

Comparison of design against Performance Requirement CP2

3.2 Assessment B – Exit System and Egress Distance Analysis

3.2.1 Brief

Assess the appropriateness of the exit system to provide for safe occupant evacuation from the building.

3.2.2 BCA Performance Requirements

DP2, DP4, EP2.2

Refer to the BCA for performance requirements.

3.2.3 BCA Deemed-to-Satisfy Provisions

D1.4 Exit travel distances.

D1.5 Distance between alternative exits.

D1.6 Dimensions of exits and paths of travel to exits.

D2.19 Doorways and doors.

D2.21 Operation of latch.

Refer to BCA for Deemed to Satisfy Provisions.

3.2.4 Non Conformance of Design to Deemed to Satisfy Provisions

Distance of travel to a Point of Choice (PoC) of exits

The travel distance to a PoC of exits from the office area will be up to 29m in lieu of 20m.

Distances of travel to an exit

1. The travel distance on Parking Level 1 and Parking Level 2 will be up to 60m in lieu of 40m to an exit.
2. The travel distance on Warehouse Level 1 will be up to 70m in lieu of 40m to an exit.
3. The travel distance on Warehouse Level 2 will be up to 76m in lieu of 40m to an exit.
4. The travel distance from the Outdoor Nursery on Warehouse Level 2 will be up to 65m in lieu of 40m to an exit.
5. The travel distance from the office area will be up to 58m in lieu of 40m to an exit.

Distance between alternative exits

1. The travel distance between alternate exits from basement Car Parking levels 1 and 2 will be up to 120m in lieu of 60m.
2. The travel distance between alternate exits on the Warehouse Level 1 will be up to 105m in lieu of 60m.
3. The travel distance between alternate exits on the Warehouse Level 2will be up to 115m in lieu of 60m.

Dimensions of exits

Warehouse Level 2 shall be provided with an aggregate egress width of 2m in lieu of 4.5m.

Doorways and doors and operation latches

Sliding and roller doors that do not lead directly to a road or open space are to be provided between parking levels 1 and 2 and the entry lobby's;

1. Sliding doors between the Outdoor Nursery and Warehouse Level 2; and
2. A roller door between the main entry lobby and Warehouse Level 1.
3. The sliding doors and roller doors will have non-compliant operation of latches.

3.2.5 Analysis Methodology

The fire safety strategy has been developed using both the BCA Performance Provisions and the International Fire Engineering Guidelines Sub Systems.

Compliance with the Performance Requirements has been achieved in accordance with A0.5(b)(i) 'complies with the Performance Requirements'.

The proposed exit system has been assessed against the performance provisions using BCA section A0.9(b)(ii) 'Verification Methods as the appropriate authority accepts for determining compliance with the Performance Requirements'; and

The International Fire Engineering Guidelines Sub Systems considered include:

1. Sub System B – Smoke Development Spread & Spread & Control; and
2. Sub System E – Occupant Evacuation & Control.

3.2.6 Acceptance Criteria

For the issues associated with extended travel distance and insufficient egress width the analysis is acceptable if it can be shown that the Available Safe Egress Time (ASET) is greater than the Required Safe Egress Time (RSET). This shall be examined through a quantitative analysis. The ASET is taken as the time at which the tenability criteria are compromised during the fire scenario.

The non-conformances associated with the door hardware are assessed via a qualitative discussion.

3.2.6.1 Tenability

Whilst escaping from a fire affected building, the occupants should not be subjected to undue hazard from smoke and heat. Excessive exposure to the products of fire can lead to occupant disorientation and, in the worst case, incapacitation. The following sections give the design limits from CIBSE Guide E (CIBSE, 2010) for short-term occupant exposure that will be used in the assessment of the ASET.

Smoke

The smoke produced by typical building contents will normally cause loss of adequate visibility before debilitating toxic conditions occur. It is therefore usual to design so that adequate visibility is maintained, and the toxic impact of smoke can usually be neglected. The following design criteria are suggested by CIBSE Guide E:

1. Maintain a clear layer height of at least 2.0 – 3.5m; and
2. Where there is a clearly defined escape route, occupant visibility should not be reduced below 10m.

Bunnings, Balgowlah is a large retail warehouse store with high ceiling. The ASET will therefore be assessed on the basis of visibility; there is no need to consider the toxic impact of smoke.

Heat

Excessive levels of heat radiation can induce severe burns and skin pain. Prolonged exposure to a radiant heat flux exceeding 2.5kW/m^2 can cause severe pain. This heat flux is equivalent to a smoke layer temperature of 200°C at 2.0m.

It is equally important to consider the affects of convection within the fire compartment. Occupants may be unable to escape when forced to inhale air of an excessive temperature. CIBSE Guide E states that occupants are able to tolerate convection exposure of 100°C for 30 minutes.

3.2.6.2 Summary of Design Limits

The table below outlines the limits of tenability that will be used to assess the ASET at Bunnings, Balgowlah.

Fire product	Tenability limit	Value	Comment
Smoke	Clear layer height	2.0m	-
	Visibility	10.0m	-
Heat	Smoke layer temperature	100°C	The convection temperature represents the most conservative tenability limit in terms of heat exposure

Tenability design limits

3.2.7 Analysis

3.2.7.1 Introduction

The analysis of the exit system will consist of a qualitative and a quantitative analysis.

The quantitative analysis is applicable to issues associated extended travel distances in the warehouse levels and car park levels. The quantitative analysis incorporates:

- Distances of travel to an exit;
- Distances of travel between exits; and
- Areas of insufficient aggregate egress width.

3.2.7.2 Quantitative Analysis

The quantitative analysis consists of an absolute analysis comparing the Available Safe Egress Time (ASET), to the Required Safe Egress Time (RSET) for the warehouse and the car park.

WAREHOUSE LEVELS

Available Safe Escape Time (ASET)

Fire Dynamics Simulator (FDS) Version 5 (McGrattan *et al., 2008)*

The assessment uses the Computation Fluid Dynamics (CFD) program Fire Dynamics Simulator (FDS), developed by the National Institute of Standards and Technology (NIST).

Smokeview (Forney, 2008) from NIST, is used to visualise the numerical calculations from FDS. Smokeview displays time dependent tracer particle flow, animated contour slices of temperatures, pressures and surface data.

The mixture fraction is an important factor in the FDS model. Common materials stored within retail areas typically consist of non-combustible polyurethane, paint and timber. The FDS reference guide provides soot yield values of 0.1 for polyurethane and 0.01 for wood. The FDS models used here have a soot yield of 0.1, i.e. worst case. This value is conservative as it assumes the materials within the warehouse consist entirely of polyurethane.

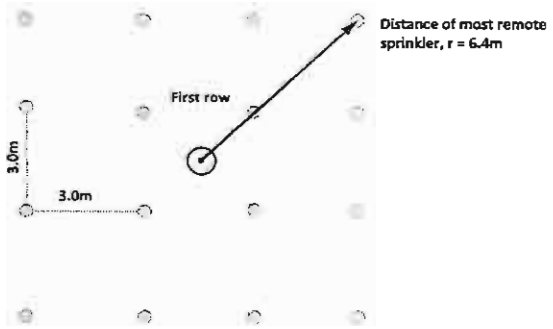
Using FDS, a CFD model of the warehouse levels has been generated (refer to Appendix E for FDS input files).

Mechanical Ventilation

Mechanical smoke exhaust will be provided at high level within the roof space of Warehouse Level 2 at a rate of 30m³/s. Smoke exhaust has been modelled as three smoke exhaust grilles measuring 4m² in area and with an exhaust velocity of 2.5m/s (i.e. total = 30m³/s). Activation of smoke exhaust within the FDS model is assumed to occur at sprinkler activation. This is a conservative assumption since the mechanical smoke exhaust system will activate either on smoke detection or sprinkler activation. The time to smoke detection for an ultra-fast t^2 fire on Warehouse Level 1 (under void) of this building is 92 seconds.

Sprinkler activation time

It is acknowledged that the operation of the first sprinkler may not control the size of the fire. Therefore, the analysis assumes that the fire size is controlled at the moment when the most remote head in the second rectangular row (third circular row of sprinklers) operates. The diagram below illustrates this principle.



Operation of most remote head in second row operates to control fire size

The time to sprinkler activation has been determined for an ordinary hazard class sprinkler system (3m x 3m spacing) and an ultra-fast t^2 fire (representative of 3.0m racked storage) utilising the Fire Engineering software package FPE Tool.

The following inputs are used in the calculation:

Sprinkler bulb height above floor level:	9.5m (height of Warehouse Level 2 ceiling above Warehouse Level 1slab i.e. over the void)
Activation temperature:	93°C
Ambient temperature:	20°C
Response Time Index (RTI):	200 $m^{\frac{1}{2}}s^{\frac{1}{2}}$ (standard response sprinkler – note: fast response heads to be installed)
Fire type:	Ultra-fast t^2
Distance from fire axis, r	6.4m

For this arrangement, sprinkler activation occurs after 326 seconds.

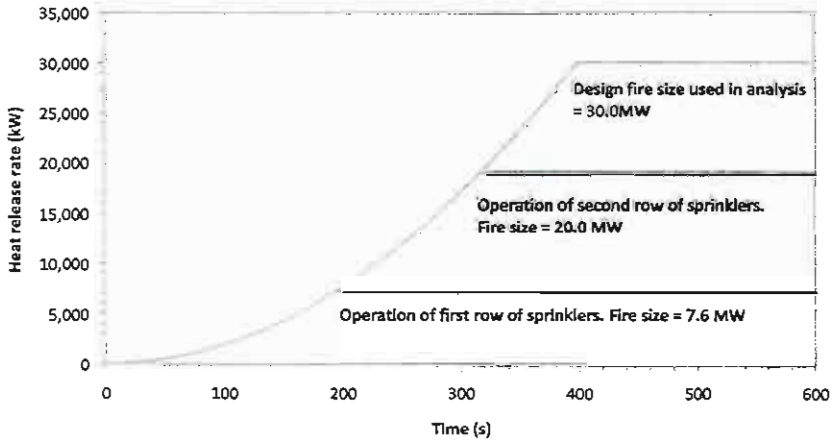
Using an RTI value of 200 $m^{\frac{1}{2}}s^{\frac{1}{2}}$, radial distance of 6.4m from the fire source and ceiling height of 9.5m produce a conservative sprinkler activation time.

By completing the analysis for the first row of sprinklers (where r = 2.1) the activation time is 201 seconds.

Design Fire

During discussions, FRNSW noted that the design of the smoke hazard management system was to consider an extreme worst case scenario providing a level of redundancy and a high factor of safety.

The following plot tracks the growth of an ultra-fast t^2 fire until it is controlled by the operation of sprinklers at 326 seconds (second rectangular row) and 201 seconds (first row). The diagram also shows the design fire size used in the analysis:



Ultra-fast design fire controlled at operation of fire and second row of sprinklers

To provide a conservative solution and add additional redundancy (over the inherent redundancy in all design calculations used), the design fire used within the FDS analysis will be a 30MW fire which is approximately times the value of the fire size at the operation of the first row of sprinklers and 1.5 times the value of the fire at the operation of the second row of sprinklers. **The design fire scenario is extremely conservative.**

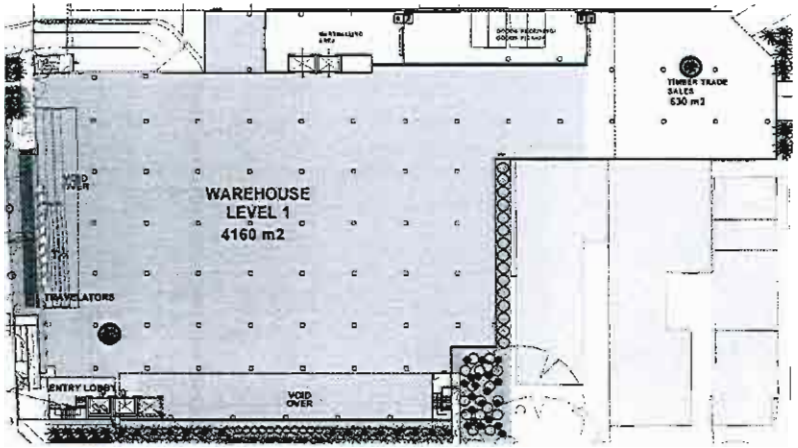
Additionally, BS 7346 states that a 30MW fire is equivalent to almost 8 sprinkler controlled car fires and therefore represents an extremely conservative design fire.

The fires shown in the figure above are also based on a fire located on Warehouse Level 1 directly beneath the Warehouse Level 2 floor slab activating the second row of the sprinklers above warehouse level 2 i.e. the sprinklers that are assumed to activate are two storey above the fire.

Therefore, considering each of the design parameters discussed above, the use of a 30MW design fire within the FDS analysis is extremely conservative.

Fire scenario

The 30 MW ultra-fast growing fire will be positioned in the locations as shown in the diagram below:



- Design fire scenario 01 and 02 - Design fire scenario 03

Fire scenario locations on Warehouse Level 1

The following table describes each fire scenario

Scenario	Detail
Fire scenario 01	30MW Ultra-fast t^3 fire located in Timber Trade area (most remote location from the void). Smoke exhaust initiates on smoke detection at a rate $30m^3/s$.
Fire scenario 02	30MW Ultra-fast t^3 fire located in Timber Trade area (most remote location from the void). Smoke exhaust is set to $0.0m^3/s$ to simulate complete failure of the smoke exhaust system.
Fire scenario 03	30MW Ultra-fast t^3 fire located next to the main entrance. Smoke exhaust is set to $0.0m^3/s$ to simulate complete failure of the smoke exhaust system.

Design fire scenarios

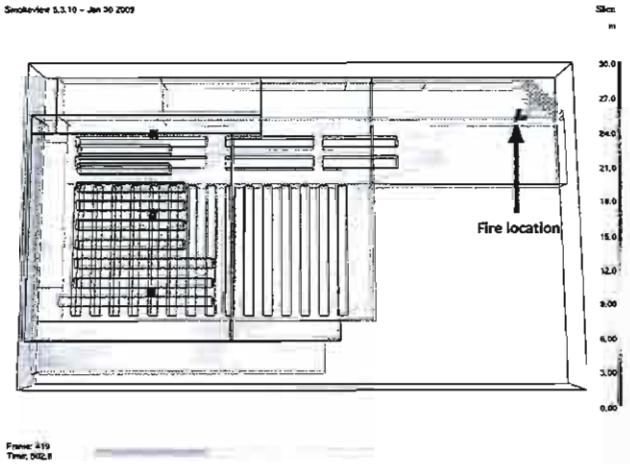
The location of the fire in scenario 01 is positioned in the most remote location from the void. This will maximise entrainment into the ceiling flow and plume and thus generate a larger volume of smoke. This fire location therefore has the greatest impact upon occupant visibility.

FIRE SCENARIO 01 – 30MW fire in racking with smoke exhaust fans operational

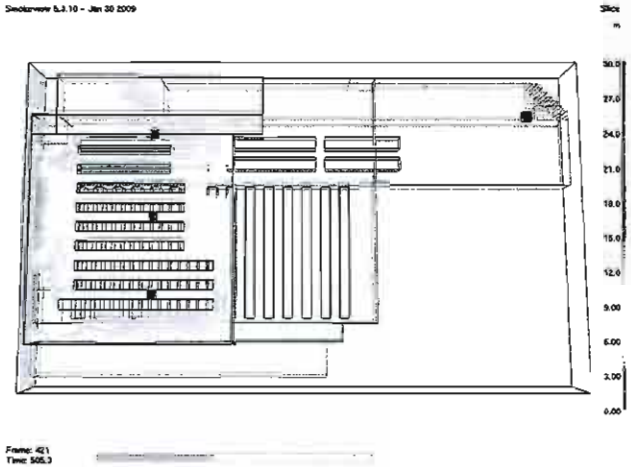
VISIBILTIY

The images below show the time at which the tenability criteria for visibility is breached at 2.0m above Warehouse Level 01 and Warehouse Level 02

Visibility at 2.0m above Warehouse Level 01



Visibility at 2.0m above Warehouse Level 02



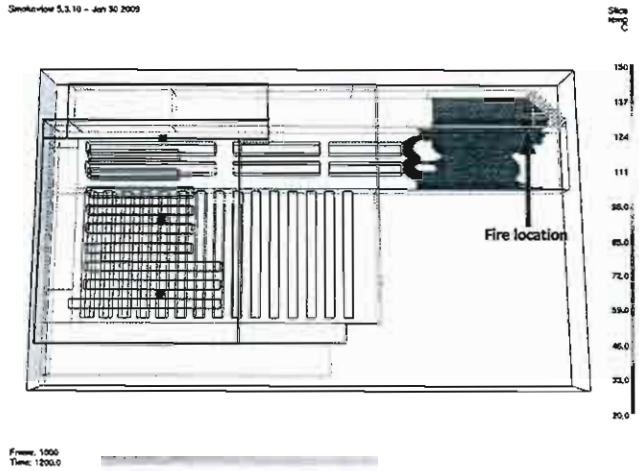
Visibility is maintained until 502 seconds on Warehouse Level 01 and 505 seconds on Warehouse Level 02.

TEMPERATURE

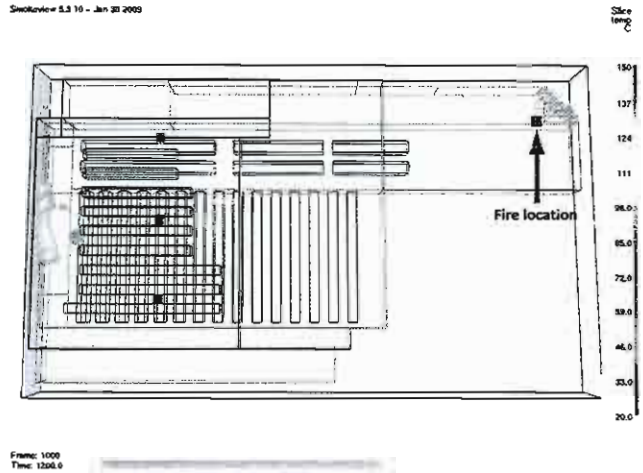
The images below show that the tenability criterion for temperature is not breached at 2.0m above Warehouse Level 01 and Warehouse Level 02.

Red areas indicate where the temperature is greater than or equal to 100°C. The tenability limit for temperature is not exceeded throughout the analysis.

Temperature at 2.0m above Warehouse Level 01



Temperature at 2.0m above Warehouse Level 02

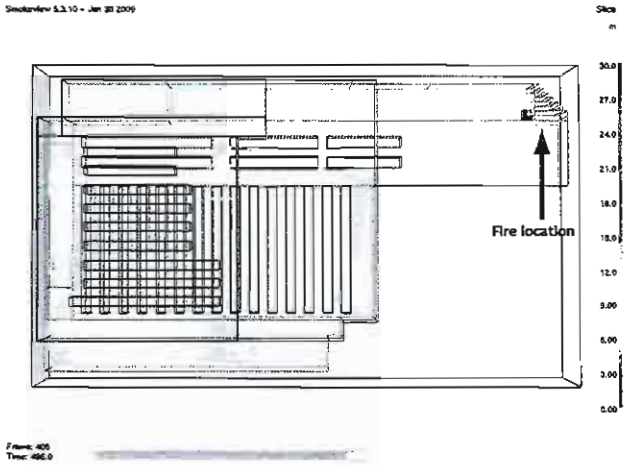


FIRE SCENARIO 02 – 30MW fire in racking with no smoke exhaust

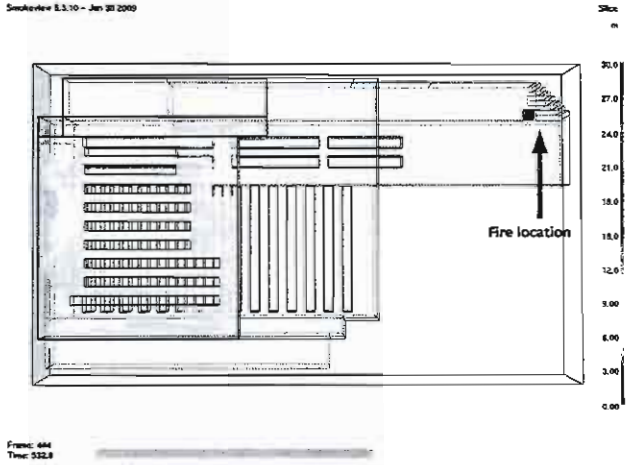
VISIBILTIY

The images below show the time at which the tenability criteria for visibility is breached at 2.0m above Warehouse Level 01 and Warehouse Level 02

Visibility at 2.0m above Warehouse Level 01



Visibility at 2.0m above Warehouse Level 02

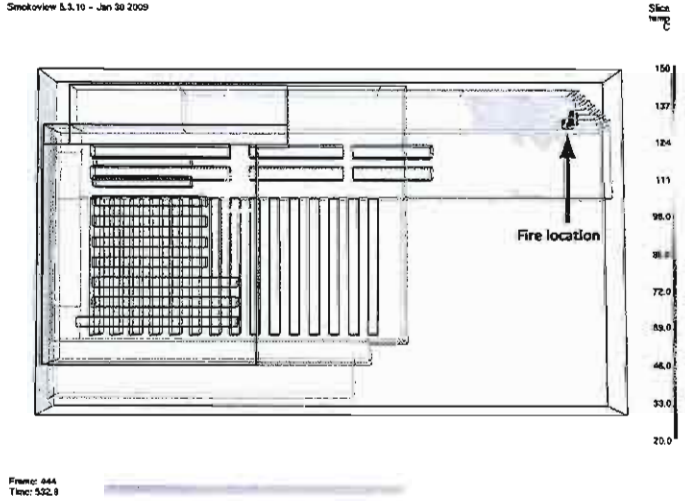


Visibility is maintained until 486 seconds on Warehouse Level 01 and 533 seconds on Warehouse Level 02.

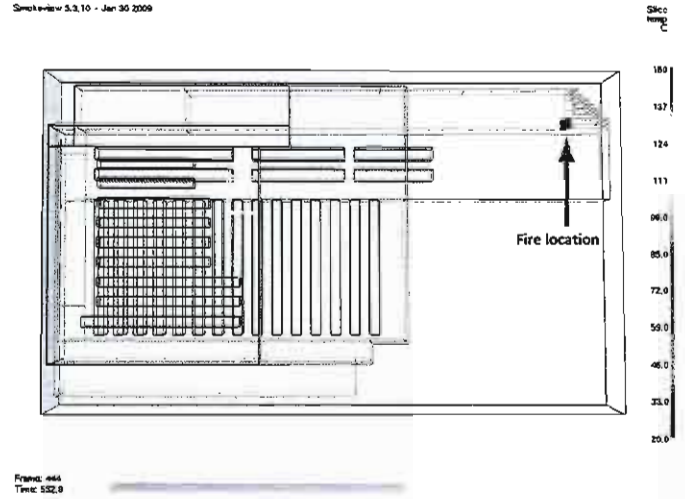
TEMPERATURE

The images below show that the tenability criterion for temperature is not breached at 2.0m above Warehouse Level 01 and Warehouse Level 02.

Temperature at 2.0m above Warehouse Level 01



Temperature at 2.0m above Warehouse Level 02

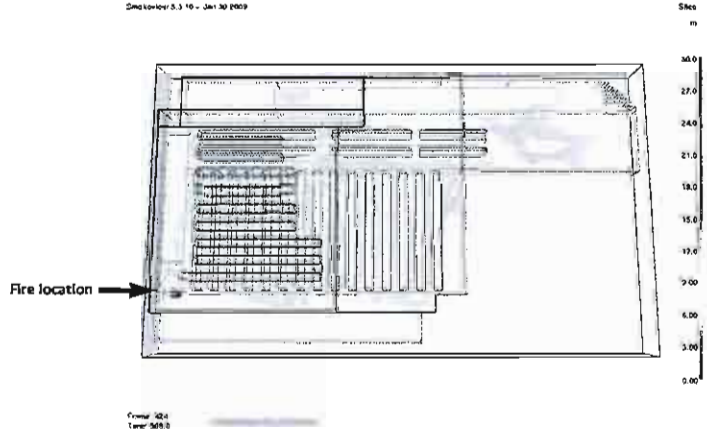


FIRE SCENARIO 03 – 30MW fire at main entrance with no smoke exhaust

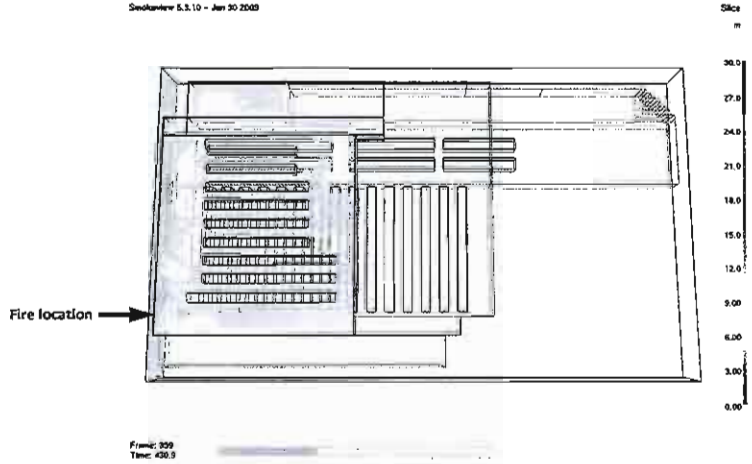
VISIBILTIY

The images below show the time at which the tenability criterion for visibility is breached at 2.0m above Warehouse Level 01 and Warehouse Level 02

Visibility at 2.0m above Warehouse Level 01



Visibility at 2.0m above Warehouse Level 02

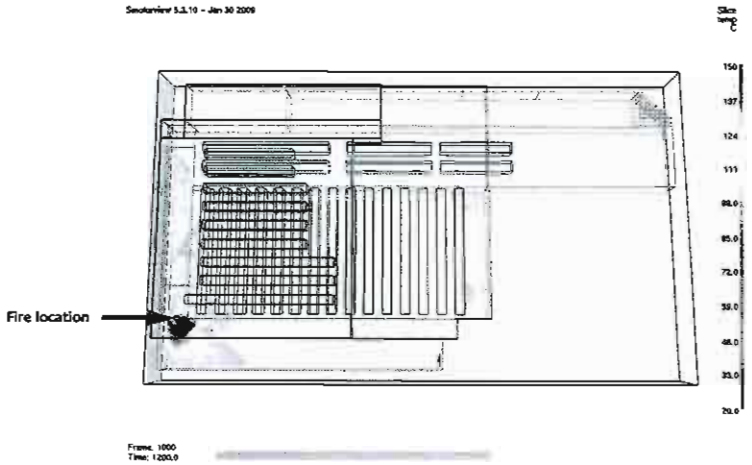


Visibility is maintained until 508 seconds on Warehouse Level 01 and 430 seconds on Warehouse Level 02. This result can be attributed to the position of the escalator void in relation to the fire next to the main entrance.

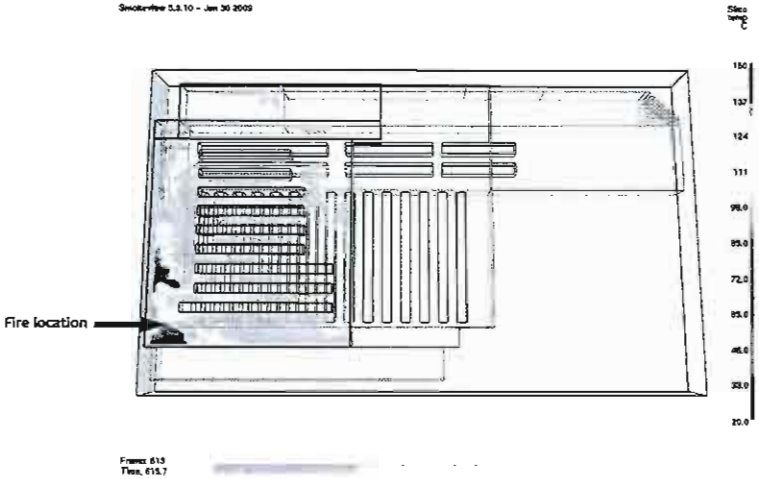
TEMPERATURE

The images below show that the tenability criterion for temperature is not breached at 2.0m above Warehouse Level 01 and Warehouse Level 02.

Temperature at 2.0m above Warehouse Level 01



Temperature at 2.0m above Warehouse Level 02



Areas shown in the figure above indicate where the temperature is greater than or equal to 100°C. The tenability limit is exceeded on warehouse level 2 after 615 seconds.

ASET RESULTS FOR WAREHOUSE LEVELS

Based upon the FDS analysis it can be seen that temperatures inside the warehouse reach the tenability criteria on warehouse level 2 for Scenario 3 only, however the visibility limit has been reached prior to this occurring. Therefore the ASET is based upon visibility.

For the worst case, visibility is reduced to below 10m in after **430 seconds** on Warehouse Level 02 for fire scenario 03.

The ASET results are summarised in the table below:

		ASET (s)	
Scenario	Level	Visibility	Temperature
Fire scenario 01	Warehouse 01	502	Conditions tenable throughout analysis
	Warehouse 02	505	
Fire scenario 02	Warehouse 01	486	
	Warehouse 02	532	
Fire scenario 03	Warehouse 01	508	
	Warehouse 02	430	615

ASET results

Required Safe Escape Time (RSET)

The components of the RSET are:

T_{RSET} = $t_d + t_p + t_e$

where:

t_d = time to detection

t_p = occupant pre-movement time

t_e = travel time

Time to detection

Time for smoke detector operation has been calculated using FPE Tool. The input parameters are as follows:

Smoke detector height above floor level:	9.0m (i.e. operation of a detector at top of the void)
Activation temperature:	33°C
Ambient temperature:	20°C
Fire type:	Ultra-fast t^2
Distance from fire axis	14.1m (max distance for extended spacing of 20m)

For this arrangement, smoke detector activation occurs after **88 seconds**.

This time to detection is extremely conservative. A more reasonable detection time is based upon a detector height of 5.0m (the ceiling height above the vast majority of Warehouse 01 and all of Warehouse 02). This equates to a detection time of 57 seconds.

Occupant Pre-Movement Time

Pre-movement time is time period between occupants acknowledging there is an emergency and the point in time at which they begin the travel phase of the evacuation towards an exit. British Standard PD 7974 recommends that for a retail area with no voice alarm, a pre-movement time **180 seconds** is reasonable.

FRNSW have requested that the travel time to reach an exit considers a scenario where occupants travel to the playground and then to the nearest exit. It is reasonable to assume that although parents may leave children unattended in the playground, parents are unlikely to change level. As such, the travel distance used in the analysis will be 120m which represents the distance from the most remote point on Warehouse Level 2 to the play ground and then to the nearest exit. This distance takes into account the racking layout and is 44m further than the largest extended travel distance of 76m.

Travel Time

The evacuation time is based on studies by Fruin (1987). The calculations employ the occupant numbers displayed within Section 1.8 of this report. For conservatism a walking speed of 0.8m/s has been used within the determination of the travel time.

It is assumed that 85% of the total numbers of occupants (798 persons) are above ground with the remaining 15% located in the car park. As such, 678 persons are located in the warehouse levels.

The exits available for the calculation of the travel time are as follows:

Level	Total number of exits	Number of exits available in the event of fire	Total exit width
Warehouse 2	2 x 900mm	2 x 900mm	1800mm
Warehouse 1	4 x 900mm 1 x 1500mm (main entry)	4 x 900mm Discounted due to fire effects	3600mm
		Total	5400mm

Exit width available during evacuation (discounting boundary layer)

The SFPE Handbook (1995) states that there is a boundary layer affect of 150mm either side of the exit as occupants flow through. Taking this into account the escape width is 5400 – (6 x 300) = 3600mm.

Appendix F contains Annex D of PD 7974-6 (2004) which gives guidance on travel speeds and flow rates – references from PD 7974 are also provided for information. The following table, extracted from Annex D, summaries a series of studies on maximum flow rates.

Source	Maximum design flow rate (persons/m/s)	Comments
Approved Document B	1.33	Guidance to UK Building Regulations – value derived.
SCICON report	1.37	Data from football crowds
Guide to Safety at Sports Grounds	1.82	Based on Japanese data and derived from 60 persons/0.55m/min unit exit width calculation
Hankin and Wright	1.48	Commuters on the London Underground
Fruin	1.37	Max flow is a peak regimented 'funnelled' flow under pressure
Daly	1.43	For underground stations
Fire and Buildings, The Aqua Group	1.5	General design text
SFPE Handbook (Nelson and Mowrer	1.3	2 x 0.15m boundary layers deducted from width of exit
Polus et al	1.25 – 1.58	Pedestrian movement on sidewalks in Israel

Extract from PD 7974-6 showing various occupant flow rates

Based upon the table above a flow rate through exits of 1.3 persons/m/s from the SFPE is reasonable. All but one of the sources specify a greater flow rate than 1.3 persons/m/s. A 2 x 150mm boundary layer per exit has also been utilised from the SFPE Handbook.

Total no. of occupants	678	people (85% of total population)	
Walking speed	0.8	m/s	
Flow rate through door	1.3	persons/s/m effective width	
Total number of single exits	6	Doors assumed at least 900mm wide	
Total number of glazed auto-sliding doors	0	Main entrance discounted	
Total effective width of exits (assuming 150mm boundary layer either side of door)	3.6	m	
Max travel Distance	120	m	
Min travel Distance	0	m	
Travel time furthest person	150	seconds	= 120.00 / 0.80
Travel time closest person	0.00	seconds	= 0.00 / 0.80
No. of people able to evacuate before last occupant arrives	702	people	= (150 - 0.00) x 3.60 x 1.00
Number of people queuing to evacuate when last occupant arrives	0	people	= 678 - 702
Queuing time	0	seconds	= 93 / (1.00 x 3.6)
Total travel time	**150**	**seconds**	

RSET RESULTS FOR WAREHOUSE LEVELS

Based upon the above analysis the total RSET = t_d (88s) + t_p (180s) + t_e (150s) = **418s**

This is the worst credible case RSET.

CAR PARK LEVELS

Available Safe Escape Time (ASET)

Consolidated Model of Fire and Smoke Transport, CFAST (NIST, 2010)

The Consolidated Model of Fire and Smoke Transport, CFAST, is a computer program that fire investigators, safety officials, engineers, architects and builders can use to simulate the impact of past or potential fires and smoke in a specific building environment. CFAST is a two-zone fire model used to calculate the evolving distribution of smoke, fire gases and temperature throughout compartments of a building during a fire.

CFAST will be used to calculate the time in the car park when the tenability criteria for visibility and temperature are breach.

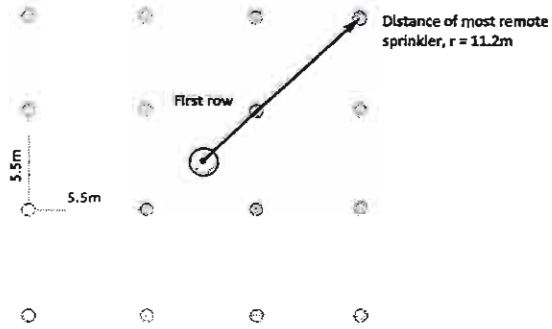
Ventilation

On fire detection the mechanical ventilation system in the car park will ramp to full capacity. In addition, areas of the car park are open-sided which will allow smoke to vent to atmosphere.

Mechanical ventilation and the open areas of the car park have not been included in the CFAST model.

Sprinkler activation time

It is acknowledged that the operation of the first row of sprinklers may not control the fire. Therefore, the analysis assumes that the fire size is controlled at the moment when the most remote head in the second rectangular row (third circular row of sprinklers) operates. The diagram below illustrates this principle.



Operation of most remote head in second row operates to control fire size – Car park levels

Sprinklers in the car park are positioned on a 5.5m x 5.5m grid.

The time to sprinkler activation has been calculated using a fast fire growth parameter which is reasonable for a car park using FPE Tool. A fast fire growth parameter is reasonable on the basis that an ultra-fast growth rate is used for the warehouse. A car park does not contain racked storage and so a fire will not grow as quickly in this area.

The following inputs are used in FPE Tool calculation:

Sprinkler bulb height above floor level:	2.4m
Activation temperature:	68°C
Ambient temperature:	20°C
Response Time Index (RTI):	50 $m^{\frac{1}{2}}s^{\frac{1}{2}}$
Fire type:	Fast t^2
Distance from fire axis, r	11.2m

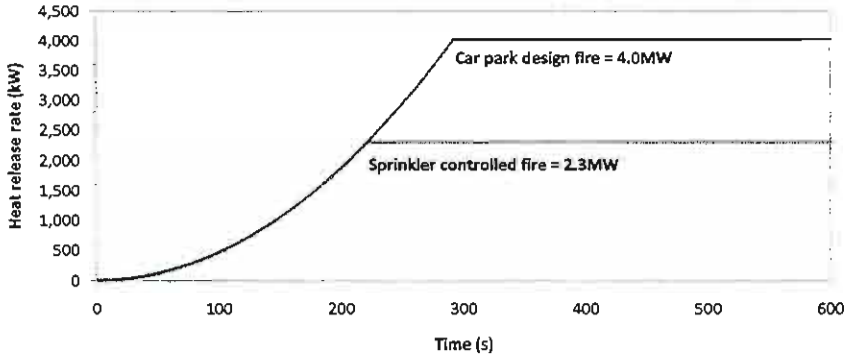
For this arrangement, sprinkler activation occurs after **221** seconds.

Using a radial distance of 11.2m from the fire source produces a conservative sprinkler activation time.

Note: the first row of sprinklers (r = 3.5m) operate at 133 seconds.

Design Fire

The following plot tracks the growth of a fast t^2 fire until it is controlled by the operation of sprinklers at 203 seconds (second rectangular row). The diagram also shows the design fire size used in the analysis:



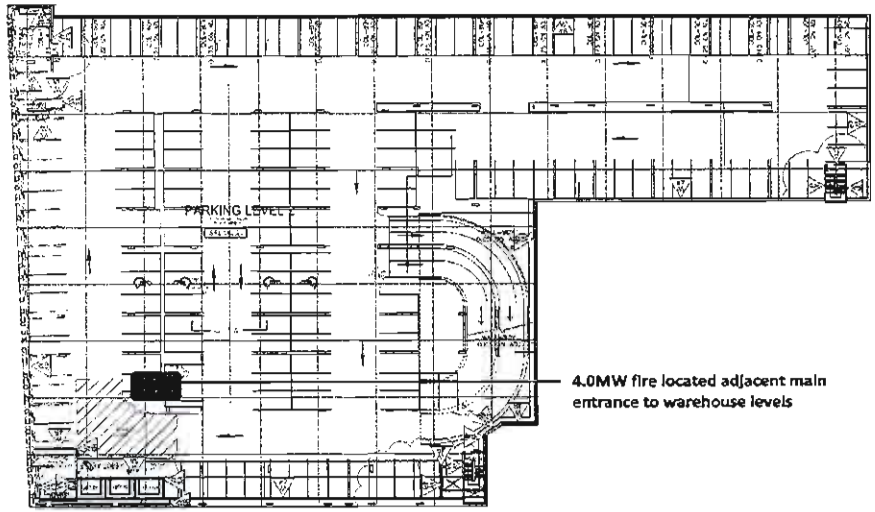
Fast car park fire controlled at sprinkler operation and design fire used in analysis

To provide a conservative solution and add additional redundancy (over the inherent redundancy in all design calculations used), the design fire used within the CFAST analysis will be a 4.0MW as recommended by BS 7346 for a sprinkler controlled car fire. **The design fire scenario is extremely conservative.**

Therefore, considering each of the design parameters discussed above, the use of a 4.0MW design fire within the CFAST analysis is extremely conservative.

Fire scenario

The 4.0 MW fast fire will be positioned as shown in the diagram below:



Fire scenario location in Car Parking Level 2

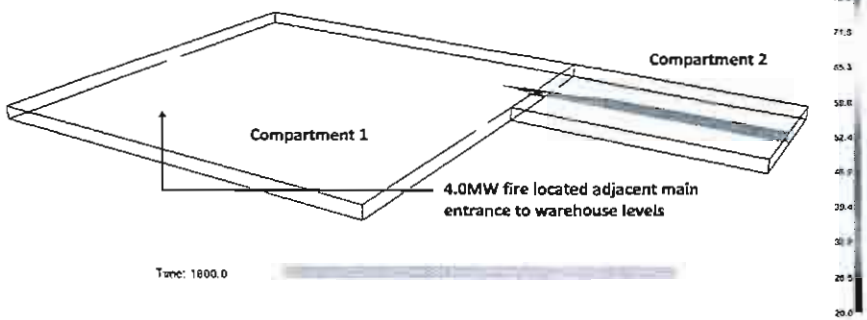
The following table describes the fire scenario

Scenario	Detail
Fire scenario A	4.0MW fast t^2 fire located adjacent to main route to the warehouse. Smoke exhaust and openings were not modeled.

Design fire scenarios

FIRE SCENARIO A – 4.0MW fire no smoke exhaust

The figure below shows a snap shot of the CFAST model at the end of the analysis. All CFAST results are attached in Appendix G.



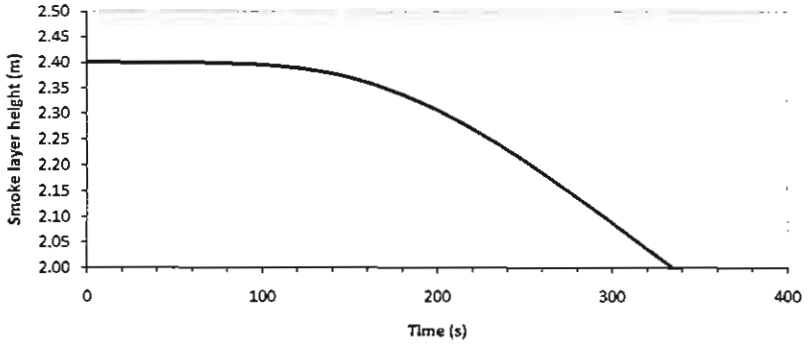
Snapshot of CFAST model showing 4.0 MW fast car park fire

Temperature

From the snapshot above it can be seen that the temperature does not exceed 100°C for the entire analysis.

Visibility

The tenability limit for temperature of 2.0m above finished floor level is breached after 340 seconds in compartment 2.



Clear layer height in compartment 2

ASET RESULTS FOR CAR PARK LEVELS

Based upon the CFAST analysis it can be seen that temperature inside the car park does not reach the tenability limit of 100°C. However, the visibility limit is reached in the car park at 330 seconds. Therefore the ASET is based upon visibility.

The ASET results are summarised in the table below:

		ASET (s)	
Scenario	Level	Visibility	Temperature
Fire scenario A	Car park	330	Conditions tenable throughout analysis

ASET results for car park

Required Safe Escape Time (RSET)

The components of the RSET are:

T_{RSET} = $t_d + t_p + t_e$

where:

t_d = time to detection

t_p = occupant pre-movement time

t_e = travel time

Time to detection

Time for operation of the first row of sprinklers has been calculated at 133 seconds

Occupant Pre-Movement Time

A reasonable pre-movement time in the car park is 60 seconds as this area is largely open plan. If a fire were to occur occupants would be able to see smoke from a fire early and understand the necessity to evacuate.

Travel Time

The evacuation time is based on studies by Fruin (1987). The calculations employ the occupant numbers displayed within Section 1.8 of this report. For conservatism a walking speed of 0.8m/s has been used within the determination of the travel time.

It is assumed that 15% of the total numbers of building occupants (798 persons) are located in the car park i.e. 120 persons. However, all 120 persons will be located in Car Parking 2 for a conservative solution.

The exits available for the calculation of the travel time are as follows:

Level	Total number of exits	Number of exits available in the event of fire	Total exit width
Car Parking 2	4 x 900mm	3 x 900mm	2700mm

Exit width available during evacuation (discounting boundary layer)

Using a boundary layer of 2 x 150mm and a flow rate of 1.3 persons/m/s the travel time is calculated below:

Total no. of occupants	120	people (15% of total population)	
Walking speed	0.8	m/s	
Flow rate through door	1.3	persons/s/m effective width	
Total number of single exits	3	Doors assumed at least 900mm wide	
Total number of glazed auto-sliding doors	0	One exit discounted	
Total effective width of exits (assuming 150mm boundary layer either side of door)	1.8	m	
Max travel Distance	60	m	
Min travel Distance	0	m	
Travel time furthest person	75	seconds	= 60.00 / 0.80
Travel time closest person	0.00	seconds	= 0.00 / 0.80
No of people able to evacuate before last occupant arrives	175	people	= (75.00 - 0.00) x 1.80 x 1.30
Number of people queuing to evacuate when last occupant arrives	0	people	= 120 - 175
Queuing time	0	seconds	= 0 / (1.00 x 3.6)
Total travel time	**75**	**seconds**	

RSET RESULTS FOR CAR PARK LEVELS

Based upon the above analysis the total RSET = t_d (133s) + t_p (60s) + t_e (75s) = **268s**

This is the worst credible case RSET.

RSET versus ASET

CAR PARKING LEVELS		
Worst case RSET	Worst case ASET	Satisfies acceptance criteria? RSET < ASET
268 seconds	330 seconds	YES

3.2.9.1 Qualitative Analysis

Non-compliant operation of latches This occurs in the following areas:

- The sliding doors between the outdoor nursery and the warehouse area;
- The sliding doors between the car park and the lobby stairs on Parking Levels 01 and 02; and
- The roller shutter between the entry foyer and the warehouse retail area – occurs after hours only.

The use of non-compliant door hardware is reasonable since the sliding doors are designed to fail safe open on fire detection or power failure. As such, the sliding doors will always be available for use and will not impede the escape of occupants.

It is reasonable to provide a roller shutter at the main entrance since it will be held in the open position at all material times. Occupants will therefore be able to use the exit if required to do so. The operation and use of the roller shutter will be documented in all management in use plans.

Outside of material (i.e. trading) times the only occupants expected within the building will be staff and security. Staff and security personnel will be familiar with the layout of the building including the location of the exits. Furthermore, due to the low number of occupants expected within the building after normal trading hours, no queuing is expected to occur at the exit doors.

A sufficient number of exits are provided throughout the building to safely evacuate the number of occupants expected in the building. This is supported by the absolute analysis included in the quantitative analysis part of this assessment where the ASET > RSET.

3.2.10 Results

The results of the RSET versus ASET for the warehouse and car park analyses are given below.

WAREHOUSE LEVELS		
Worst case RSET	**Worst case ASET**	**Satisfies acceptance criteria? RSET < ASET**
430 seconds	412 seconds	YES

CAR PARKING LEVELS		
Worst case RSET	**Worst case ASET**	**Satisfies acceptance criteria? RSET < ASET**
268 seconds	330 seconds	YES

3.2.11 Discussion

Warehouse

The results show that the RSET is less than the worst case ASET. Occupants are therefore able to escape the warehouse whilst conditions are tenable.

The analysis of the ASET for the warehouse is conservative for the following reasons:

1. The fire size is based upon the operation of standard response sprinkler (RTI 200 $m^{1/2}s^{1/2}$) mounted at 10m above the fire. The analysis also assumes that the first row of sprinklers fall and that the fire is controlled by the most remote sprinkler in the second row.

   In reality, the warehouse will be fitted throughout with fast response sprinklers (RTI 50 $m^{1/2}s^{1/2}$). It is more likely that the first row of sprinkler heads will control the fire and that the sprinkler heads that activate will be mounted on the underside of the Warehouse Level 01 at a height of 5.5m. If the fire occurs under the void the sprinklers will operate later, however occupants will become aware of the fire earlier (greater visibility through void) and begin to make their escape sooner.
2. The fire size at sprinkler operation was calculated as 19.0MW. However, a 30.0MW fire was used in the analysis to add additional conservatism to the analysis.
3. Fire Scenarios 1 was positioned in the most remote location from the void. This location allows for a large volume of air to be entrained into the plume resulting in generation of the most smoke.

The analysis of the RSET is conservative for the following reasons:

1. 85% (of the full capacity) of occupants are assumed to be in the warehouse levels at the time of fire.
2. The detection time is based upon the activation of a smoke detector at 9.0m above Warehouse Level 01. Considering the position of the worst case fire scenario, detectors mounted at 5.5m on the underside of Warehouse Level 01 will activate. Using FPE Tool and substituting 5.5m for 10.0m results in a detection time of 55seconds which is 36 seconds less than the figure used in the analysis.
3. The occupant pre-movement time is assumed to be 180 seconds. However, this is conservative since Bunnings staff are likely to be fire safety trained therefore be able to assist occupants in their evacuation upon activation of the fire alarm.
4. A reasonable flow rate of 1.3 persons/s/m has been used.
5. The main exit was discounted in the analysis

Car park

The results show that the RSET is less than the worst case ASET. Occupants are therefore able to escape the car park whilst conditions are tenable.

The analysis utilised a 4.0MW sprinkler controlled design fire whereas it was demonstrated that the fire is more likely to be controlled to 2.3MW by the car park sprinklers.

In addition, one exit was discounted in the analysis.

Factor of safety

Based upon the levels of conservatism that have been built into the analysis as shown above, the factor of safety in the design is expected to be greater than that shown by the table of results. In addition, the design fire is highly conservative as demonstrated by the approach.

Furthermore, the IFEGs state in Section 1.2.10.2 that factors of safety should only be applied at the end of the analysis, and not throughout the analysis as this could lead to overly conservative outcomes. This Fire Engineering assessment has built in factors of safety at each step of the calculation sequence. Based upon these levels of conservatism the factor of safety in the design is at least 1.5.

3.2.12 Conclusion

The egress arrangements at Bunnings, Balgowlah have been evaluated using a performance-based Fire Engineering assessment. Modelling of several large design fires has confirmed that the conditions in the warehouse and car park remain tenable throughout occupant escape. The results of the absolute analysis show that in all cases, the RSET is less than the ASET.

As a result, the egress arrangements at Bunnings, Balgowlah are reasonable and therefore the alternative solution meets Performance Requirements DP2, DP4 and EP2.2

Performance Requirement Clause – DP2	Comment
Exits must be provided from a building to allow occupants to evacuate safely, with their number, location and dimensions being appropriate to:	
(a) walking surfaces with safe gradients; and	All walking surfaces and gradients are to meet the recommendations of the DtS provisions of the BCA.
(b) any doors installed to avoid the risk of occupants - (i) having their egress impeded; or (ii) being trapped in the building	The alternative solution demonstrates that a sufficient number of doors are provided throughout the store to provide for occupant escape. Occupants are not at risk of being locked or trapped within the building.
(c) any stair and ramps with - (i) slip-resistant walking surfaces on – (A) ramps; and (B) stairways treads or near the edge of the nosing; and (ii) suitable handrails where necessary to assist and provide stability to people using the stairway or ramp; and (iii) suitable landings to avoid undue fatigue; and (iv) landings where a door opens from or onto the stairway or ramp so that the door does not create an obstruction; and (v) in the case of a stairway, suitable safe passage in relation to the nature, volume and frequency of likely usage.	All walking surfaces and gradients are to meet the recommendations of the DtS provisions of the BCA.

Performance Requirement DP2

Performance Requirement Clause –DP4	Comment
Exits must be provided from a building to allow occupants to evacuate safely, with their number, location and dimensions being appropriate to:	
(a) the travel distance; and	The alternative solution demonstrates that the extended travel distances in the warehouse and car park are reasonable.
(b) the number, mobility and other characteristics of occupants; and	As a worst case scenario all 798 occupants were used within the evacuation calculations.
(c) the function or use of the building; and	The building use and function is reflected in the worst credible design fires for this assessment.
(d) the height of the building; and	The height of the building was taken into account when developing the design fires for the alternative solution
(e) whether the exit is from above or below ground level	One exit was discounted in each evacuation calculation to provide a robust solution.

Performance Requirement DP4

Performance Requirement Clause – EP2.2	Comment
(a) In the event of a fire in a building, the conditions on any evacuation route must be maintained for the period of time occupants take to evacuate the part of the building so that:	
(i) the temperature will not endanger human life; and	The results of Assessment B demonstrate that the tenability criteria for temperature are not breached throughout the analysis.
(ii) the level of visibility will enable the evacuation route to be determined; and	The alternative solution demonstrates that the level of visibility meet the acceptance criteria.
(iii) the level of toxicity will not endanger human life	It was not necessary to assess the toxicity since the smoke produced by typical building contents will normally cause loss of adequate visibility before debilitating toxic conditions occur
(b) the period of time occupants take to evacuate referred to in (a) must be appropriate to:	
(i) the number, mobility and other characteristics of the occupants; and	The number of occupants is based on information provided by the PCA. Building occupants are representative of the general public.
(ii) the function or use of the building; and	The building use and function has been considered within the ASET and RSET parts of the analysis.
(iii) the travel distance and other characteristics of the building; and	At the request of the FRNSW a maximum travel distance of 120m has been incorporated into the alternative solution.
(iv) the fire load; and	The design fires utilised in the analysis is highly conservative and is based on the first row of the sprinkler system failing within an additional level of safety built in.
(v) the potential fire intensity; and	The design fires utilised in the analysis is highly conservative and is based on the first row of the sprinkler system failing within an additional level of safety built in.
(vi) the fire hazard; and	The design fires utilised in the analysis is highly conservative and is based on the first row of the sprinkler system failing within an additional level of safety built in.
(vii) any active fire safety systems installed in the building; and	Active fire safety systems installed within the building meet the requirements of the BCA.
(viii) Fire Brigade intervention	The FBIM time is reasonable (see Assessment F). Fire fighters will utilise PPE and breathing apparatus to undertaken fire fighting operations where required.
Performance Requirement EP2.2	

3.3 Assessment C – Smoke Hazard Management

3.3.1 Brief

Assess the appropriateness of the performance-based smoke exhaust system that does not meet the recommendations of the DtS provisions of the BCA.

3.3.2 BCA Performance Requirement

EP2.2

Refer to BCA for Performance Requirements.

3.3.3 BCA Deemed-to-Satisfy Provisions

E2.2 Smoke Hazard Management, General requirements

Refer to BCA for Deemed-to-Satisfy Provisions.

3.3.4 Non Conformance of Design to Deemed-to-Satisfy Provisions

A performance-based designed automatic smoke exhaust system will be provided throughout the building.

3.3.5 Analysis Methodology

The fire safety strategy has been developed using both the BCA Performance Requirements and the International Fire Engineering Guidelines Sub Systems.

Compliance with the Performance Requirements will be achieved in accordance with A0.5(b)(i) 'complies with the Performance Requirements'.

The non compliant smoke exhaust system will assessed against the Performance Requirements using BCA section A0.9(b)(ii) 'Verification methods as the appropriate authority accepts for determining compliance with the Performance Requirements'.

The International Fire Engineering Guidelines Sub Systems considered is SS B – Smoke Development & Spread & Control.

3.3.6 Acceptance Criteria

The rationalised automatic smoke exhaust system will be assessed via a quantitative analysis using the acceptance criteria analysis in Assessment B.

3.3.7 Analysis and Results

The analysis and results for the performance-based smoke control system are contained within the egress analysis section of this report. Refer to Assessment B for the analysis and results. Recommendations regarding the smoke extract systems in the warehouse and car park levels are given in Section 2.

3.3.8 Conclusion

Assessment B has shown that sufficient measures are in place to maintain the tenability within the retail warehouse for a sufficient period of time to permit safe occupant evacuate.

Assessment B therefore demonstrates compliance with Performance Requirement EP2.2.

A comparison of the alternative solution to EP2.2 is given in the conclusion of Assessment B.

3.4 Assessment D – Exit Signage

3.4.1 Brief

Assess the appropriateness of the emergency exit signage height.

3.4.2 BCA Performance Requirements

EP4.2

Refer to the BCA for Performance Requirements.

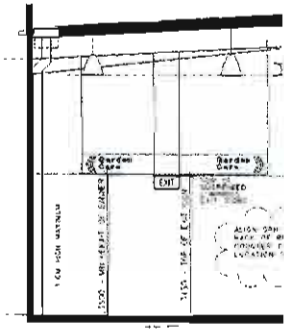
3.4.3 BCA Deemed-to-Satisfy Provisions

E4.8 – Design and operation of exit signage

Refer to BCA for Deemed-to-Satisfy provision.

3.4.4 Non Conformance of Design to Deemed-to-Satisfy Provisions

Exit signage will be installed at a height 3.45m in the warehouse areas. Signage over doors will comply with the requirements of the BCA and AS2293.



Exit signage height

3.4.5 Analysis Methodology

The Fire Strategy has been developed using both the BCA Performance Provisions and the International Fire Engineering Guidelines Sub Systems.

Compliance with the Performance Requirements has been achieved in accordance with A0.5(b)(i) "complies with the Performance Requirements".

Egress signage has been assessed against the performance provisions using BCA sections A0.9(a) 'Evidence to support that the use of a material form of construction or design meets a Performance Requirement or a Deemed-to-Satisfy Provision as described in A2.2'.

The International Fire Engineering Guidelines Sub Systems considered include SS D – Fire Detection, Warning & Suppression

3.4.6 Acceptance Criteria

Locating exit signage at 3.45m above finished floor level is reasonable in egress routes provided it can be demonstrated that the egress signage is visible at the RSET.

Note: signage above perimeter exit doors will be at a height that meets the recommendations of AS2293.1.

3.4.7 Analysis

Exit and directional signs within the warehouse will be installed 3.45m above floor level. This overhead clearance is required for transporting of items within the building. In the event of a fire the high mounted exit signage may not be visible to occupants due to the descending smoke layer. Escape signage will feature pictorial elements that are at least 150mm in size. From AS2293.1 this type of exit signage is visible from 24m. Signage over final exit doors will be mounted at a height compliant with AS2293.1.

Exit signage at perimeter exits will be installed as recommended by AS 2293.1

Using a CFD model, the visibility has been measured at 3.5m above the finished floor level for Warehouse Level 1 and 2. The analysis places a horizontal slice across the floor plate of the warehouse thus determining the visibility conditions at 3.5m above floor level at the point of the RSET.

The egress distance analysis assumes an extreme worst case scenario where the fire is controlled on the operation of the second tow of sprinklers i.e. 30MW. The use of such a design fire was to provide a high level of redundancy and therefore a high factor of safety.

However, it is unreasonable to assess the visibility of exit signage under such conditions since a more realistic fire scenario is a fire controlled by the fires row of sprinklers. The design fire for this assessment is defined below.

Sprinkler activation time

The time to sprinkler activation has been calculated using an ultra-fast fire growth parameter which is in the FPE Tool.

The following inputs are used in this calculation:

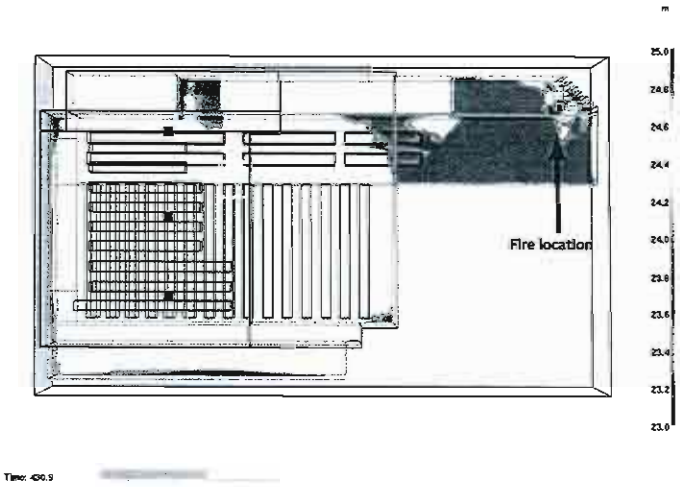
Sprinkler bulb height above floor level:	5.5m (Warehouse Level 1 slab to underside of Timber Sales roof)
Activation temperature:	93°C
Ambient temperature:	20°C
Response Time Index (RTI):	50 $m^{½} s^{½}$
Fire type:	ultra-fast t^2
Distance from fire axis, r	2.1 (first row of sprinklers on 3m x 3m grid)

For this arrangement, sprinkler activation occurs after 113 seconds.

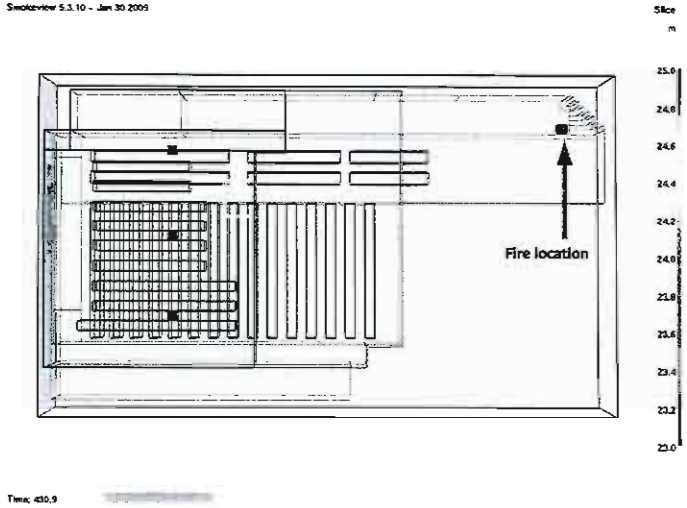
The size of an ultra-fast t^2 fire at 113 seconds is 2.4MW. This design fire will be rounded up to 4.0MW for the analysis to provide a robust solution (a safety factor greater than 1.5).

Using this design fire size, a horizontal slice file has been placed 3.5m above finished floor level (actual signage position is 3.45m i.e. a conservative assumption). The time at which the descending smoke layer reduces visibility to 24m has been examined at the RSET (430 seconds) from Assessment B.

3.4.8 Results



Visibility at 3.5m above Warehouse Level 1 at RSET (430 seconds)



Visibility at 3.5m above Warehouse Level 2 at RSET (430 seconds)

The slices files at 3.5m above Warehouse Level 01 and Warehouse Level 02 show the visibility conditions within the warehouse at the RSET.

It should be noted that the slices file are taken at the time of RSET i.e. when the last person has exited the building. Occupants will take directional cues from the escape signage during the pre-movement stage of escape. Since pre-movement is 3 minutes before the travel phase, conditions in the warehouse, when occupants actually need to use the signage, will be better than shown in the visibility slices files. Although the results have shown in this case that the visibility will be reasonable on level 1 and unaffected on level 2 at the time of the RSET.

3.4.9 Conclusion

The above analysis demonstrates that positioning the exit signage 3.45m above floor level is reasonable. For a reasonable fire scenario and a very conservative estimate of RSET, visibility at 3.5m above floor level is greater than 24m for the vast majority of the warehouse at the time of occupant escape.

The above assessment has therefore demonstrated compliance with Performance Requirement EP4.2.

Performance Requirement Clause – EP4.2	Comment
To facilitate evacuation, suitable signs or other means of identification must, to the degree necessary	
(a) be provided to identify the location of exits; and	The analysis has shown that sufficient measures are in place to provide for visible exit signage throughout occupant escape. In addition, signage above doors will meet the recommendations of AS2293.1.
(b) guide occupants to exits; and	Refer to (a)
(c) be clearly visible to occupants; and	Refer to (a)
(d) operate in the event of a power failure of the main lighting system for sufficient time for occupants to safely evacuate.	Exit lights and signage are to comply with AS2293 in terms of their operation in the event of power failure.

Performance Requirement EP4.2

3.5 Assessment E – Vehicular Access

3.5.1 Brief

Assess the appropriateness of the vehicular perimeter access.

3.5.2 BCA Performance Requirements

CP9

Refer to the BCA for performance requirements.

3.5.3 BCA Deemed-to-Satisfy Provisions

C2.3 Large isolated buildings

C2.4 Requirements for open spaces and vehicular access.

Refer to BCA for Deemed to Satisfy Provisions.

3.5.4 Non Conformance of Design to Deemed to Satisfy Provisions

Vehicular access features the following design features that do not meet the recommendations of the BCA:

- Access is greater than 18m from the building due to the adjoining buildings located to the corner of Balgowlah Road and Roseberry Street.
- Portions of the office and a plant room on Warehouse Level 2 are built over the vehicle access in the north west corner of the site.
- Portions of the Fire Brigade access route are less than 6m wide (but at least 4m in width).
- Fire Brigade access routes are built over the parking level of the building.
- Portions of the Fire Brigade access are built upon by roller shutters on the entries to Condamine Street and Roseberry Street.

3.5.5 Analysis Methodology

The fire safety strategy has been developed using both the BCA Performance Provisions and the International Fire Engineering Guidelines Sub Systems.

Compliance with the Performance Requirements has been achieved in accordance with A0.5(b)(i) 'complies with the Performance Requirements'.

The vehicular access system has been assessed against the Performance Requirement using BCA section A0.9(b)(ii) such other Verification Methods as the appropriate authority accepts for determining compliance with the Performance Requirements.

The International Fire Engineering Guidelines Sub Systems considered in the analysis include:

- SS F – Fire Services Intervention.
- Fire Brigade Intervention Model

3.5.6 Acceptance Criteria

The qualitative analysis of perimeter vehicular access will be acceptable if it can be demonstrated that:

1. The building is provided with an appropriate level of protection by the active fire safety systems; and
2. The perimeter access to the building is sufficient to provide reasonable access to the Fire Brigade.

3.5.7 Analysis

3.5.7.1 Fire Brigade Access

The BCA intent is to enable the Fire Brigade to intervene in the event of a fire. Fire appliances should have access from the public road system. Access routes should have a width, height and load-bearing capacity that will allow the passage and parking of Fire Brigade vehicles.

Vehicular access located greater than 18m from the building is not expected to adversely affect the Fire Brigade intervention since personnel are able to access the building via the perimeter emergency exits. The building will be provided with internal hydrants that will assist Fire Brigade operations.

Vehicle access is not provided to parts of the eastern and southern side of the building due to existing buildings positioned in these areas. However, adequate access is provided either side of these locations along Balgowlah Road and Roseberry Street. Should a fire occur in the timber sales area or the south eastern corner of the warehouse level 1, it is unlikely that lack of vehicle access to these areas would hinder Fire Brigade operations.

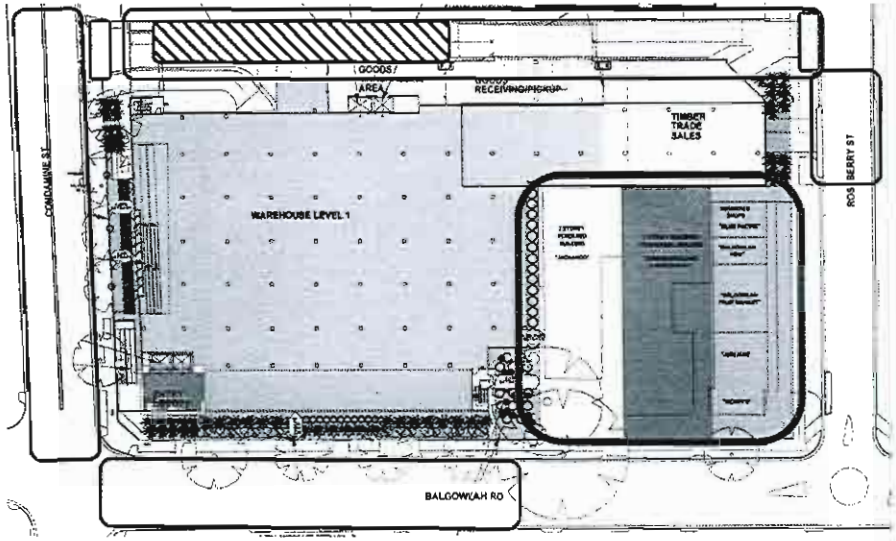
There are 'pinch-points' where the access route for Brigade vehicles is less than 6m. However, at least 4m of width is provided – a diagram is provided on the next page. Despite these 'pinch-points' FRNSW are provided with good access to the entry and egress point around the building.

Generally, considering the active fire safety systems within the building. (which includes fast response sprinkler protection),reasonable fire brigade access is provided to the building. However, the office level will be built over parts of the Fire Brigade access to the rear of the building over the service road. This portion of the building will be provided with a 120 minute fire rating therefore in the event of a fire within this area structural collapse of the building onto a fire appliance parked under this portion is not expected.

Where access is built upon by roller shutter, a mechanism will be provided that meets the operational requirements of the FRNSW (i.e. openable via 003 keys; or keys must be provided at local stations).

A figure showing Fire Brigade access is provided on the following page.

Fire Brigade access was discussed with FRNSW and agreed during a meeting at Greenacre on 7 June 2011.



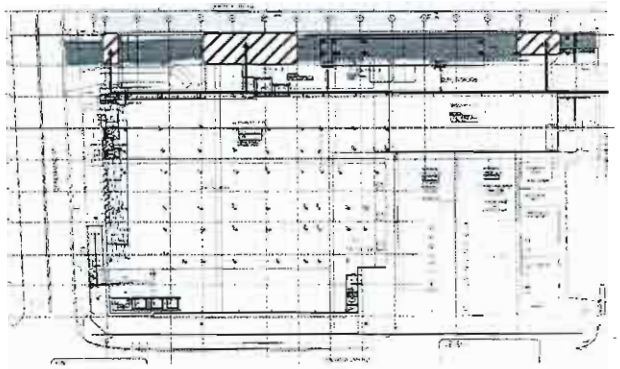
Plant room and office (provided with FRL) area built over vehicular access

Vehicular access 6m wide and less than 18m from the building

No vehicular access available in these areas

Roller shutter provided with mechanism suitable for FRNSW access

Fire Brigade Access details



Pinch point – at least 4m width provided to access route

'Pinch points' along Fire Brigade access routes

3.5.7.2 Fire Brigade Intervention Model (FBIM)

The FBIM is located in Appendix H. See also timeline analysis in Section 3.1.

The nearest Fire Stations to Bunnings Balgowlah are Manly Fire Station and Dee Why Fire Station. The following diagrams show the locations of each station (shown as B respectively) and the distance from Bunnings Balgowlah (shown as A). All information and images are extracted from Google Maps.

Manly fire station to Bunnings, Balgowlah (2,100m)

Dee Why fire station to Bunnings, Balgowlah (5,800m)

The Fire Brigade arrival at kerb times at Bunnings, Balgowlah are given below:

Manly fire station: 469 seconds

Dee Why fire station: 1663 seconds

3.5.8 Conclusion

The analysis demonstrates that Fire Brigade vehicular access is reasonable and satisfies the Performance Requirement CP9.

The table below compares the design to the Performance Requirement CP9.

Performance Requirement Clause – CP9	Comment
Access must be provided to and around a building, to the degree necessary for brigade vehicles and personnel to facilitate Fire Brigade intervention appropriate to -	
(a) the function and use of the building; and	The available access for Fire Brigade vehicles is reasonable for this type of building. The building is provided with a fast response sprinkler system
(b) the fire load; and	The fire load considered in the alternative solution is suitable for this type of building.
(c) the potential fire intensity; and	The fire intensity considered in the alternative solution is suitable for this type of building.
(d) the fire hazard; and	The fire hazard considered in the alternative solution is suitable for this type of building.
(e) any active fire safety systems installed in the building; and	The building will be installed with a fast response sprinkler system, smoke exhaust, automatic fire detection and a fire hydrant and hose reel system.
(f) the size of any fire compartment	Fire Brigade access is reasonable despite the size of the fire compartments at the warehouse.

Performance Requirement CP9

4 REDUNDANCY AND ASSUMPTIONS

4.1 Redundancy

4.1.1 General

The design includes backup systems such as portable extinguishers, fire hydrants and fire hose reels. These systems are included in the overall fire safety design for redundancy purposes.

Sufficient alternative measures are present to provide an acceptable level of safety if main systems such as smoke detection do fail. Recommendations include inadequate levels of maintenance, emergency procedures and staff training in the use of fire safety equipment, which will increase both the reliability of primary systems, and the use of alternate systems.

4.1.2 Effect of Fire Sprinklers

Automatic sprinklers may control fires by opening a number of sprinkler heads and pre-wetting surrounding fuel to prevent fire spread.

The majority of fires reported to the brigade are in the categories; confined to object of origin, confined to part of room or area of origin and, confined to room of origin. The cumulative percentages are:

From Thomas (undated) commercial buildings with

- Sprinklers present and operated 94%
- Sprinklers not present 76%

The presence of sprinklers is beneficial in reducing the likelihood of fire spread beyond the room of origin. It is noted that virtually all of the fires that spread beyond the room of origin, in both residential and commercial buildings, spread through the building and a small but significant proportion of these spread beyond the building of origin.

The reliability of sprinkler systems is given in the table below and has been obtained from NSW Fire Brigade annual statistical report 2001/2002. It must also be noted that the primary cause identified for sprinkler failure is failure of the water supply.

Sprinkler performance	Public assembly	Educational	Institutional	Residential	Shop store office	Basic industry, utility	Storage	Other	Total
Equipment operated, performance									
Extinguished fire	8	0	7	16	15	6	5	0	57
Prevented spread, but did not extinguish	3	1	0	5	6	4	1	1	21
Did not prevent spread	1	0	0	0	1	0	0	0	2
Other	0	0	0	0	0	1	0	0	1
Total	12	1	7	21	22	11	6	1	81
Equipment should have operated but did not	0	0	0	1	0	1	0	0	2
Equipment present but fire too small to require operation	8	1	1	8	14	5	2	1	40
No equipment present in room or space of fire origin	243	167	128	2803	333	139	211	254	4278
Other	1	2	0	4	0	2	3	1	13
Total	264	171	136	2837	369	158	222	257	4414

Sprinkler performance by property type (building fires only)

4.2 Assumptions

The following list the assumptions made in the alternative solution

4.2.1 General Assumptions

The following general assumptions have been made:

- All persons of reduced mobility or unable to evacuate on their own will be assisted whilst leaving the building. The management team will be responsible for producing an evacuation plan.
- Arson has not been considered in the analysis. As such, modelling of a fire scenarios is based on the occurrence of a single fire at any one time
- It is assumed no refuelling activities are to be performed in any part of the car park
- Mixing of the upper and lower layers will not be taken into account during the CFAST fire modelling
- Descending of smoke due to the cooling process is not be modelled in CFAST.

4.2.2 Design Assumptions

- Smoke detector activation has been modelled as activating at a maximum sensitivity level of 5% obs/m or at 13°C above ambient.
- Delayed smoke detector activation times due to restrictive air flow through the detector, i.e. construction of detector housing, has not been modelled.
- Bounding construction forming part of the room of fire origin will be based concrete floors and plasterboard or glazed windows for the wall linings.
- Any make-up air requirements will be at low level and generally via open entry doors and building leakage.
- A fuel load of 1,100MJ/m² will be assumed for the warehouse areas.
- A 30MW Ultra Fast t^2 fire will be used for the base assessment of egress.
- A 30MW Ultra Fast t^2 fire will be used for sensitivity scenarios involving the smoke extract fans assuming to fail.

5 LIABILITY AND LIMITATIONS

5.1 Liability

This report is applicable to Bunnings Warehouse, Balgowlah which is a new building.

The Fire Engineering analysis contained in this report demonstrates that the level of life safety offered by the alternative solution meets the performance criteria of the BCA.

The report has been developed in accordance with the procedures detailed in International Fire Engineering Guidelines.

It should, however, be recognised that this does not provide a guarantee that a fire will not occur with potential to cause casualties or damage.

Norman Disney & Young shall not be held liable for any loss or damage resulting from any defect of the building or its services or equipment or for any non compliance of the building or its services or equipment with any legislative or operational requirement, whether or not such defect or non-compliance is referred to or reported upon in this report, unless such defect or non-compliance should have been apparent to a competent engineer undertaking the assessment of the type undertaken for the purpose of preparation of this report.

The fire safety assessment and recommendations has been based on the building architectural layouts and occupant information provided as detailed in the "Information Sources" section of this report. Any change in this information to suit future building works or re-organisation will require further analysis to confirm compliance with the regulations and our report.

5.2 Limitations

The report does not provide guidance in respect of areas, which are used for bulk storage, processing of flammable liquids, explosive materials, multiple fire ignitions or sabotage of existing fire safety systems.

Norman Disney & Young have compiled this report based on the following activities perusal of the information listed in Information Sources Section

Potential incendiary risks are limited in the scope of engineering design. Conventional building design can only provide limited protection against malicious attack; for example, large scale incendiary and multiple ignition sources can potentially overwhelm some fire safety systems.

Strategies such as security, housekeeping and other management procedures should be used to address arson events.

6 INFORMATION SOURCES

6.1 General

- Building Code of Australia 2010 – Volume One, Class 2 to Class 9 Buildings', Australian Building Codes Board, 2010 (BCA).
- FRNSW comments on the FEB dated 17/11/2010
- Guide to the Building Code of Australia 2010 Australian Building Codes Board, 2010.
- Australian Building Codes Board, 'International Fire Engineering Guidelines', Edition 2005, dated March 2005.
- Steve Watson & Partners BCA Assessment Report 2008/941 R1.2. dated June 2011.
- Architectural drawings as listed below by John R. Brogan & Associates Pty Ltd.

6.2 Drawings

Architectural drawings as listed below by John R. Brogan & Associates Pty Ltd.

Drawing Number	Description	Revision
1173-100	Floor plan – Parking level 2	P9
1173-101	Floor plan – Parking level 1	P10
1173-102	Floor plan – Warehouse level 1	P10
1173-103	Floor plan – Warehouse level 2	P8
1173-110	Floor plan – Roof plan	P2
1173-120	Sections 1/3	P2
1173-121	Sections 2/3	P2
1173-122	Sections 3/3	P2
1173-131	Elevations	P2

Architectural Drawings

6.3 References

BENJAMIN, D. 2011. *Impact of a High Volume Low Speed fan on sprinkler performance in rock storage fires*[online]. Norwood, MA:FM Global Research Division. [Accessed 13 January 2011]. Available from: http://www.fmglobal.com/assets/pdf/HVLS_10611.pdf

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BUCHANAN. 2001. *Structural Design for Fire Safety*. Chichester: John Wiley & Sons.

BRITISH STANDARD INSITITUTE. 2003. *PD 7974-1 Applicotion of fire safety engineering principles to the design of buildings – Part 1: Initiation and development of fire within the enclosure of origin*. London: BSI

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7 APPENDICES

APPENDIX A – FRNSW comments on the FEB

NSW FIRE BRIGADES

COMMUNITY SAFETY DIRECTORATE
STRUCTURAL FIRE SAFETY UNIT
Amarina Avenue Greenacre NSW 2190
Locked Bag 12 Greenacre NSW 2190

www.fire.nsw.gov.au info@fire.nsw.gov.au ABN 12 593 473 110

Your Reference:	S29026-001-fe rp03577s	Telephone:	(02) 9742 7400
File No:	NFB/06442-SFSU-FEB-1027115	Facsimile:	(02) 9742 7483
Contact Officer:	Team Leader Alternative Solutions	Email:	firesafety.nswfb@fire.nsw.gov.au

17 November 2010

Norman Disney & Young

Email: m.evans@ndy.com

Attention: Mark Evans

Cc. Steve Watson and Partners

Email: bcollits@swpartners.com.au

Dear Sir,

RE: Comments on Fire Engineering Brief for BUNNINGS BALGOWLAH, 164 CONDAMINE STREET BALGOWLAH.

Reference is made to your correspondence dated 28 September 2010, regarding the above premises, requesting the NSW Fire Brigades (NSWFB) to provide comment pursuant to the International Fire Engineering Guidelines (IFEG).

The NSWFB notes the following alternative solutions intended to meet the Performance Requirements contained in the following Category 2 Fire Safety Provisions: EP1.3 and EP2.2.

The following documentation and information was forwarded to the NSWFB:

(a) A copy of the Conditions of the Consent Authority; Not Supplied;

(b) Plans and specifications for the building including drawings numbered ; 030; 031; 032; 100; 101; 102; 103; 104; 110; 120; 121; 130; 131; 200 dated 19 January 2010 and F-002; F-003; F-004 and F-005 dated 26 June 2010;

(c) A Fire Engineering Brief Report (FEBR) numbered: s29026-001-fe rp03577s dated 27 September 2010, FEB Revision No. C, prepared by Michael Greenwood and reviewed by Mark Evans of Norman Disney & Young;

(d) The nominated assessment method used to establish compliance with the performance requirement is Clauses A0.9 (b) (ii) and A0.9 (c) of the Building Code of Australia (BCA).

On the basis of the above documentation, the NSWFB provides the following comments:

(a) (i) ALTERNATIVE SOLUTION - ASSESSMENT 1

That the alternative solution regarding the proposed rationalisation of Fire Resistance Levels will meet Performance Requirements CP1 and CP2 as it is intended to meet - **Conditionally Satisfied;**

Recommended Conditions:

The NSWFB would consider the general reduction in FRL from 180 to 120 minutes based on the following:

1. Fire safety systems within the building (active and passive);
2. Egress provisions general as well as from high hazard areas;
3. Burnout calculations of high hazard areas;
4. Flashover potential (Peak Heat Release Rate requirements) and mitigation measures;
5. A time line fire scenario as detailed below with clear details of the measures in place to mitigate fire spread and impact:

   1- Start -> 2-Object -> 3-Area -> 4- Compartment -> 5-Building -> 6-Boundary ->7-Adjacent Building; and

   1-First Attack ->2-Sprinklers ->3&4 – Sprinklers & Exhaust & Fire Brigade ->5-Fire Brigade ->6-Fire Brigade and Building Setback ->7-Building Separation.

The removal of the FRL to the supporting columns under the office and plant would be considered if the following is demonstrated:

1. A fire in the area underneath the structure is to stand with no collapse for the time taken for occupant egress from the office, and Fire Brigade search and rescue of the office.

Further to the above, the NSWFB consider the following points are to be evaluated and demonstrated within the FER:

1. Details of the breech of routine conditions, hazardous conditions, extreme conditions and critical conditions as highlighted in the AFAC Fire Brigade Intervention Model;
2. A structural engineer is to review and provide written advice as to the concurrence of the fire engineering evaluation;
3. Reliability and Grade of water supply to be detailed in the FER. i.e. on site water storage;
4. Detail the management in use program for the sprinkler system maintenance should isolation of the system be required;
5. Wall wetting sprinkler system to be supplied by independent water supply in accordance with the requirements of AS2118.2;
6. For the scenarios presented, consideration should be given to the activation of the smoke exhaust system. The burning characteristics should revert from ventilation controlled to fuel controlled as there will be adequate ventilation throughout the building compartment via the make-up air to sustain burning.

(see analysis in 3.1.7). This should be considered with the evaluation and detailed in the FER;

7. The proposed fire load of 300MJ/m² (as per IFEG Table 3.4.1a for Hardware-Fabrication) is in the opinion of the NSWFB not a realistic value for the density of the potential fuel load which could be stored within the Goods Receiving area of a Bunnings occupied tenancy. The NSWFB recommend fuel load densities in line with Table 3.4.1(b) (Retail) of the IFEG should be evaluated and presented in the FER. i.e. percentile values of 80% should be considered as a minimum;
8. The Clifton (1996) concept proposed to be used for the behavioural pattern of burning for the fuel load is to be clearly detailed, if this concept is suited to this type of building and tenancy, and arrangement of fuel load and hazard.

(a) (ii) ALTERNATIVE SOLUTION - ASSESSMENT 2

That the alternative solution regarding Exposure Hazards will meet Performance Requirement CP2 as it is intended to meet - **Conditionally Satisfied;**

Recommended Conditions

The NSWFB would consider the reduced distance of the openings to the boundary based on the following:

1. The methodology proposed for the Performance Analysis as indicated in Clause 3.2.6 assumes a Fire Brigade response time with water application on the fire within 20 min. This assumption is to be verified with data from the Fire Brigade FBIM model and to satisfy the time specified;
2. The assessment is to detail the density of the material proposed for the sky light to justify the use of 0.75 emissivity constant value. The value of 0.75 is to represent glass bricks (grey body emitter). It is the opinion of the NSWFB should the roof light fail during an event of fire, the value of emissivity should reflect the value of a black body radiator. i.e. 0.9 to 1.0.

(a) (iii) ALTERNATIVE SOLUTION - ASSESSMENT 3

That the alternative solution regarding the Egress and Extended Travel Distances will meet Performance Requirements EP2.2 and DP4 as it is intended to meet - **Conditionally Satisfied;**

Recommended Conditions

The NSWFB would consider extended travel distances and a rationalised smoke hazard management system based on the following:

1. The total travel distance (to an exit) does not exceed 80m;
2. The distance between exits does not exceed 80m when calculated through a second point of choice whereby short circuiting of the travel can occur due to the isles and general floor plate;
3. The maximum travel distance is based on the provision of the fire safety systems and the absolute assessment satisfying the acceptance criteria. Where the travel distance is proposed to exceed 80m, a detailed fire safety study and hazard assessment is to be presented;

4. The limitation of 80m is based on the travel distance for fire fighters to an exit following activation of the Breathing - Apparatus low air warning alarm and the time it takes for the fire fighters to get to a place of safety.

ASET Determination

The Available Safe Egress Time is to consider the following fire scenarios as per NFPA 5000. This is based on NSWFB experience and available references.

Design Fire 1

Design Fire Scenario 1, which is an occupancy specific design scenario representative of a typical fire for the occupancy, shall explicitly specify the following:

1. Occupant activity;
2. Number and location of occupants;
3. Room size;
4. Furnishings and contents;
5. fuel properties and ignition sources;
6. ventilation conditions;
7. First items ignited and its location.

Further to the above the NSWFB recommend the following details to be considered:

1. Based on the NSWFB evaluation, the preference is for design fire 1 to be located in the area of the paint section. The fire growth rate is to be appropriately justified for each scenario unless otherwise detailed.
2. The redundancy scenario is to be based on partial failure of the sprinkler system (provided the sprinkler system reliability is proven).
3. The NSWFB recommends a further sensitivity scenario, where the Big Ass Fans are provided, failure of the fans to shutdown is to be presented in the FER. The fire is to be based on the worst credible scenario as identified above.

Design Fire 2

Design Fire Scenario 2, which is an ultra-fast developing fire in the primary means of egress, addressing the concerns regarding a reduction in the number of available means of egress, shall explicitly specify the following:

1. The primary scenario is to be a worst credible scenario based on the 4th sprinkler in the first radial row or the nearest 2nd radial row.
2. The redundancy scenario is recommended to include failure of the FIP whereby the Occupancy Warning System is activated via the sprinkler system and the Smoke Hazard Management System does not activate.
3. The redundancy and sensitivity scenarios are based on NFPA 5000 design fire 8 with each active fire safety system independently rendered ineffective.
4. The worst credible fire scenarios are to demonstrate that with a factor of safety of 1.5 applied to the RSET, the ASET remains greater than the RSET.
5. The redundancy and sensitivity scenarios are to demonstrate equivalency.
6. The proposal of 5MW fires for all three scenarios is not supported. It is the opinion of the NSWFB that the design fires of 5MW proposed to be used in line

with the requirements of BCA Section E2.2b, is a guide used for the design of Smoke Exhaust Systems only and not to be used as an input into a fire model. The model should determine the growth of the fire using the technical data with the activation of the fire safety systems or other fire safety equipment.

RSET Determination

The determination of the RSET values is to consider the following:

1. Queue driven evaluation and travel distance evaluation are to be undertaken. (Queue driven is to be based on design fire scenario 2).
2. Travel distance evaluation is to be based on 50% of the occupants exiting the front door.
3. Travel from the most remote point to the children play area then to the exit is to be evaluated as the greatest travel distance for sensitivity should this distance exceed 80m.
4. A travel speed of 0.8m/s is recommended
5. Occupant numbers are recommended to be based on 5m2 per-person of the usable floor area.
6. It is recommended that the Fire Engineering Report clearly detail the fire brigade intervention analysis and that key conditions within the building from the CFD analysis be detailed.
7. These conditions include a slice file detailing the X and Y plane through the fire and cross section of the warehouse as well as the Z plane at 1.5m from ground level. The slice files are to detail the following:
   (i) the time of fire brigade arrival;
   (ii) the time of fire brigade entry for search and rescue;
   (iii) the time period that routine conditions occur and where;
   (iv) the time period that hazardous conditions occur and where;
   (v) the time period that extreme conditions occur and where, as well as;
   (vi) the time period that critical conditions occur and where.

(a) (iv) ALTERNATIVE SOLUTION - ASSESSMENT 4

That the alternative solution regarding the Smoke Hazard Management System will meet Performance Requirement EP2.2 as it is intended to meet - **Conditionally Satisfied**;

Recommended Conditions

The NSWFB is conditionally satisfied provided the comments on the proposed Alternative Solution 3 are appropriately addressed.

(a) (v) ALTERNATIVE SOLUTION - ASSESSMENT 5

That the alternative solution regarding the Exit Signage will meet Performance Requirement EP4.2 as it is intended to meet - **Conditionally Satisfied**;

Recommended Conditions

The NSWFB would consider exit signs within the general floor plate (not at perimeter egress points) to exceed 2.7m on the basis of the following:

1. An evaluation of the occupant egress and reliance on the floor plate signs and perimeter signs occurrence based on a general fire scenario occurring centrally within the building.
2. It is expected that the occupants will be in proximity to the perimeter exit signs prior to the floor plate signs being obscured by the smoke layer.
3. Advertising signs are not to obstruct the visibility of the signs.
4. The obscuration level of the exit signs at the proposed height is to be evaluated and a detailed comparison to the level of the smoke layer with the ASET is to be presented in the FER for this assessment.

(a) (vi) ALTERNATIVE SOLUTION - ASSESSMENT 6

That the alternative solution regarding the Vehicle Perimeter Access will meet Performance Requirement CP9 as it is intended to meet - **Conditionally Satisfied**;

Recommended Conditions

The NSWFB would consider the reduced perimeter access based on the following:

1. Details required in the FER of the minimum FRL for the wall separation between the Bunnings building and the adjoining buildings fronting Balgowlah Road. It is the opinion of the NSWFB, in consideration of restricted access to the full perimeter of the Bunnings building, a minimum of four (4) hours fire separation is recommended to all affected walls.
2. The above assessment is taken into consideration with the details provided in Assessment 1.
3. The analysis has not provided details of the assessment strategy or how the AFAC FBIM would be applied, nor has any assumption or proposed use of charts within the FBIM been disclosed. It is recommended that these details be provided.
4. The proposed alternative solution is conditionally satisfied provided the perimeter vehicular access is verified to comply with NSWFB Policy #4 with regards to point loads as well as ramp gradients.

(b) That the fire hydrants in the proposed fire hydrant system will be accessible for use by the NSWFB – **Conditionally satisfied subject to the hydrants and booster assembly being located and installed in accordance with Clause E1.3 of the Building Code of Australia and AS 2419.1 - 2005**; and

(c) That the couplings in the system will be compatible with those of the fire appliances and equipment used by the NSWFB – **Conditionally satisfied subject to the fire hydrant booster assembly connections and all fire hydrant valves being fitted with Storz aluminium alloy delivery couplings manufactured and installed in accordance with Clauses 7.1 and 8.5.11.1 of AS 2419.1-2005.**

Further guidance material in relation to NSWFB requirements for hydrant system connectors can be found at: www.nswfb.gov.au

(d) It is the opinion of the NSWFB that the fire hydrant and sprinkler systems designed to comply with the requirements of Clause 4.4.1 of AS2118.1 – 1999 **and** which share hydraulic fire service infrastructure (i.e. booster assemblies, booster connections, pump sets and on site fire mains) do not comply with the requirements of the following clauses of the Building Code of Australia (BCA):

1. Clause E1.3 Fire Hydrants requires fire hydrant systems to be installed in accordance with AS2419.1;
2. Clause E1.5 and Specification E1.5 requires sprinkler systems to comply with AS2118.1 (other parts of AS2118 are referenced and may be used for specific classes of building).
3. AS2118.6 is the only standard the BCA references for combined hydrant and sprinkler systems. It is the position of the NSWFB that fire hydrant and sprinkler systems designed to comply with the requirements of Clause 4.4.1 of AS2118.1 – 1999 **and** which share hydraulic fire service infrastructure (i.e. booster assemblies, booster connections, pump sets and on site fire mains) do not comply with the requirements of the following clauses of the Building Code of Australia (BCA). It is recommended that this detail be conveyed to the hydraulic and sprinkler designers;
4. The application of Clause 4.4.1 of AS2118.1 – 1999 permits the dispensation of certain requirements of AS2419.1 not otherwise permitted by the BCA; and
5. It is recommended that this detail be conveyed to the hydraulic and sprinkler designers.

In addition, the installation of fire hydrant and sprinkler systems configured to meet the requirements of Clause 4.4.1 of AS2118.1 – 1999, and which share hydraulic fire service infrastructure, introduce significant operational issues to NSWFB personnel attending premises for the purposes of managing a fire incident. A number of these issues will directly impact upon the NSWFB ability to safely and efficiently resolve a fire incident.

Furthermore, the NSWFB recommend the FER detail the following:

1. Reliability and grade of water supply is to be addressed;
2. Details of the hazards in regards to what the manufacturing and warehousing will be to assist in the evaluation of the fire scenarios;
3. The location and accessibility of the FIP and associated control equipment.
4. Booster, hydrant and specific information related to the hydrant design location;
5. Full schematic diagram of the hydrant system, providing details of the isolation valves and hydrant points;
6. Building exits;
7. The configuration and location of the sprinkler booster in relation to the water storage tank and pump rooms is required; and
8. Location of the Main Electrical Switch Room and any alternative power supply system is to be detailed in the FER, and identified with signage adjacent to the FIP and on the Hydrant Block Plan;

(e) NSWFB satisfaction with the subject Fire Engineering Report (FER) will be conditional on the following:

1. Consistency of documentation (consistent with the FEB and IFEG);
2. Outcomes and results satisfying the agreed Acceptance Criteria; and
3. Stakeholder comments being addressed and agreed on by the stakeholders involved.

Your attention is drawn to Clause 144 of the EP&A Reg. In part, Clause 144 stipulates a necessity for the certifying authority to be furnished with an Initial Fire Safety Report for the building from the NSWFB. The Certifying Authority is advised to make application to the NSWFB for an Initial Fire Safety Report within 7 days after receiving an application for Construction Certificate. Please note that a complete application will need to be supplied at the time of your application. A complete application includes the following documents:

1. Completed NSWFB Application for Initial Fire Safety Report;
2. Copy of Application for Construction Certificate;
3. Building Plans and Specifications (including schematic diagrams and draft block plans of any hydrant and sprinkler systems);
4. PCA referral letter which includes details of:
   a. performance requirements that the alternative solution is intended to meet
   b. assessment methods to be used to establish compliance with those performance requirements;
   c. indicates whether relevant plans (including those in item #3 above) are an attachment or are contained within the Fire Engineering Report; and
5. Completed NSWFB Alternative Solution Summary Table; and
6. Fire Engineering Report which is formatted following the International Fire Engineering Guidelines.

Should you have any further enquiries regarding any of the above matters please do not hesitate to contact the Structural Fire Safety Unit.

Yours faithfully

Electronically approved for release.

For Commissioner

APPENDIX B – Confirmation from structural engineer regarding fire appliance loadings

April McDermott

From: Robert Facioni [robert@structuraldesignsolutions.com.au]
Sent: Monday, 20 June 2011 6:13 PM
To: Eliot Reeves
Cc: Mark Evans
Subject: RE: Bunnings Balgowlah: Fire Brigade Access routes

Eliot

Further to our discussions earlier, I can confirm that the Northern Ramp is in fact designed for an SM1600 Vehicle in accordance with the AS5100 and service vehicles.
We have also reviewed the "FRNSW Policy No.4" and will be designing the ramp to cater for the Static and Dynamic point loads specified in that document.

Regards
Robert

Robert Facioni
BE, PhD, MIEAust, RPEQ, RBP (vic)
Director

Mobile - 0410 636 177; +61 410 636 177

STRUCTURAL DESIGN SOLUTIONS (NSW)
Suite11, 50 Great North Rd, Five Dock, NSW 2046
PO Box 245, Five Dock, NSW 2046
Ph +61 2 9712 4700 Fax +61 2 9712 4733

STRUCTURAL DESIGN SOLUTIONS (QLD)
10, 106 The Esplanade, Burleigh Heads, QLD 4220
PO Box 1145, Broadbeach, QLD 4218
Ph +61 7 5659 1265 Fax +61 7 3112 4286

-----Original Message-----
From: Eliot Reeves [mailto:E.Reeves@ndy.com]
Sent: Friday, 17 June 2011 4:11 PM
To: robert@structuraldesignsolutions.com.au
Cc: Mark Evans
Subject: Bunnings Balgowlah: Fire Brigade Access routes

Robert

For inclusion in the Fire Engineering Report for the above project we need a statement from the Structural Engineer confirming that the Fire Brigade access routes for the meet the recommendations of Fire and Rescue New South Wales Policy No. 4 Guidelines for Emergency Vehicle Access. This specifically relates to the ramp adjacent to Harvey Norman.

A copy of FRNSW Policy No.4 is attached for reference.

By return can you please confirm the above?

Many thanks.

Best regards

Norman Disney& Young

Eliot Reeves BEng(Hons) MSc(Eng) AFIreE
Senior Fire Engineer
NORMAN DISNEY & YOUNG Level 1, 60 Miller Street, North Sydney, NSW 2060, Australia
T +61 2 9928 6800 : D +61 2 9928 6963 M +61 410 491 677 . F +61 2 9955 6900
www.ndy.com

APPENDIX C – Confirmation of clearance heights on vehicular access routes

Mark Evans

From: John R. Brogan & Associates Pty. Ltd. [jrb@brogans.com.au]
Sent: Wednesday, 22 June 2011 6:07 PM
To: Eliot Reeves; bisenhood@southerncrossgroup.net; ddevries@southerncrossgroup.net; hytonb@southerncrossgroup.net; llinehan@southerncrossgroup.net; mattf@southerncrossgroup.net
Cc: Mark Evans
Subject: BUNNINGS BALGOWLAH - EMERGENCY VEHICLE ACCESS PATH
Attachments: 1173_BCA_FB_102_110622.pdf

JOHN R BROGAN & ASSOCIATES PTY. LTD
ARCHITECTS, PLANNERS & COMMERCIAL INTERIOR DESIGNERS
Phone (612) 9221 2833 Fax (612) 9251 4741

Eliot
We confirm a typical head height of 5.0 m or greater is achieved above the emergency vehicle access path in the current design. As previously noted, there are a couple of 'pinch points' along the access path with a width of less than 6m, as described on the attached marked up plan.

Please contact me if you need to clarify or discuss.

regards
Doug

John R Brogan & Associates P/L
Doug Djordjevic
Level 7, 37 Pitt Street =20
SYDNEY NSW 2000
Ph.: (02) 9221.2833
Fx: (02) 9251.4741

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APPENDIX D – Equivalent time of fire severity calculations

NDY Equivalent Fire Severity v.2.0

Project: Bunnings Warehouse, Balgowlah
Scenario: Compartment burn out: Goods receiving
Engineer: Eliot Reeves
Reference: "Structural Design for Fire Safety", Buchanan, (Chapter 5)

General

initial temperature	293 K
time step	0.5 mins

Inputs (Compartment Characteristics)

Compartment		Ventilation	
		Vertical	
l1 =	21 m	Hv =	4 m
l2 =	10 m	B =	7 m
Hr =	5.5 m	Horizontal	
		Wh =	0 m
		Bh =	0 m
Wall Material	concrete		
Heat of combustion, delta Hc	16 MJ/kg		
Fuel load energy density, qf	1100 MJ/m^2		

Material properties

Material	Concrete	Gypsum
Density, p	2200 kg/m^3	700 kg/m^3
specific heat, cp	880 J/kg°C	1700 J/kg°C
Thermal conductivity, k	1.6 W/mK	0.2 W/mK
Thermal inertia of conc.	1760 Ws0.5/m^{2}K	488 Ws0.5/m^{2}K

Calculation factors

Floor area, Af	210 m^2
Area of internal surfaces, At	761 m^2
Area of vertical window, Av	28 m^2
Area of horizontal window, Ah	0 m^2

CIB Formula

Ventilation factor, w	1.02 m$^{-1/2}$
b	1574.2
Lining factor, kc	0.07 min.m$^{2.25}$/MJ
Equivalent fire severity, te	78.3 minutes

Law Formula

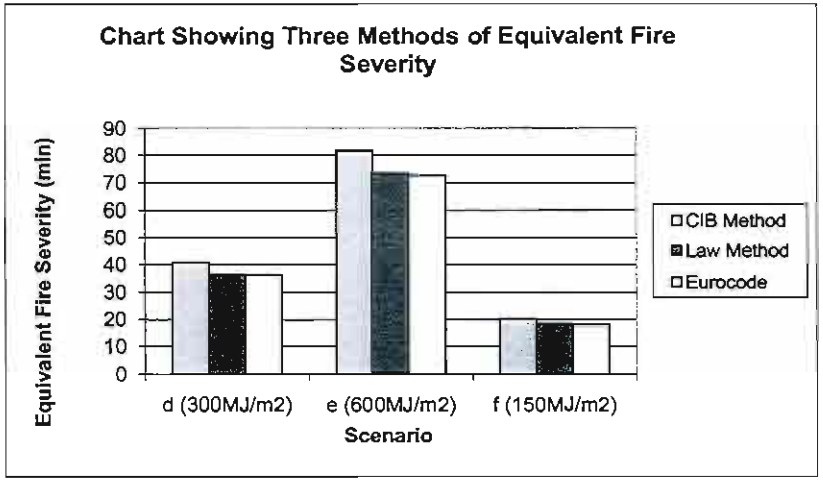
Calc. Factor 1	231000
Calc. Factor 2	2292.2
Equivalent fire severity, te	100.8 minutes

Eurocode Formula

horizontal openings	
alpha v	0.133
alpha h	0.00
bv	28.94
Ventilation factor, w	1.104 m$^{-0.3}$
b	1574.2
Lining factor, kb	0.055 min.m$^{2.25}$/MJ
Equivalent fire severity, te	66.8 minutes

Summary of Equivalent Fire Severity

Time		Scenario a	b	c	d (300MJ/m^2)	e (600MJ/m	f (150MJ/m2)
EFS	CIB Method				40.8	81.5	20.4
	Law Method				36.7	73.4	18.4
	Eurocode				36.3	72.6	18.1



```
&HEAD CHID='Scenariol',TITLE=time to untenable conditions. Fire
Location=Furthest point from the void, Fire size=30MW, Soot yield=
0.1, Exhaust Rate=30m³/s /
&TIME TWFIN=1200. /
&DUMP DT_PL3D=50 /
/&MISC RESTART=.TRUE. /
************************************************************
INDEX:

Outputs

Meshes

Reaction

Fire

Exhaust

Obtructions

      - Walls
      - Slabs


************************************************************

OUTPUTS

Visibility Slices

Vertical slices through the fire

&SLCF PBX=17.5, QUANTITY='visibility' / Slice through the fire
&SLCF PBY=15.5, QUANTITY='visibility' / Slice through the fire
&SLCF PBY=30.0, QUANTITY='visibility' /

Horizontal slices above the fire

&SLCF PBZ=2, QUANTITY='visibility' /
&SLCF PBZ=7.5, QUANTITY='visibility' /

Temperature Slices

Vertical slices through the fire

&SLCF PBZ=2.0, QUANTITY='TEMPERATURE' /
&SLCF PBZ=7.5, QUANTITY='TEMPERATURE' /
&SLCF PBX=17.5, QUANTITY='TEMPERATURE' /
&SLCF PBY=15.5, QUANTITY='TEMPERATURE' /
&SLCF PBY=30.0, QUANTITY='TEMPERATURE' /

Horizontal slices above the fire


************************************************************

MESH

&MESH IJK=225,135,20, XB=-1.0, 111.5, -2.5, 65.0, 0.0, 10.0,  / 0.5m
x 0.5m x 0.5m

************************************************************
Fire Properties

&REAC ID         = 'POLYURETHANE'
```

```
      SOOT_YIELD = 0.10
      N          = 1.0
      C          = 6.3
      H          = 7.1
      O          = 2.1  /

************************************************************
Fire Location and size/growth rate

&SURF ID='BURNER', HRRPUA=7500, RAMP_Q='BURNER RAMP', COLOR='RED' /
&VENT XB=103, 105, 55, 57, 1.0, 1.0, SURF_ID='BURNER' /
&OBST XB=103, 105, 55, 57, 0.0, 1.0, COLOR=BLACK /


&RAMP ID= 'BURNER RAMP', T= 0, F= 0.0000/
&RAMP ID= 'BURNER RAMP', T= 10, F= 0.0006/
&RAMP ID= 'BDRNER RAMP', T= 20, F= 0.0025/
&RAMP ID= 'BURNER RAMP', T= 30, F= 0.0056/
&RAMP ID= 'BURNER RAMP', T= 40, F= 0.0100/
&RAMP ID= 'BURNER RAMP', T= 50, F= 0.0156/
&RAMP ID= 'BURNER RAMP', T= 60, F= 0.0225/
&RAMP ID= 'BURNER RAMP', T= 70, F= 0.0306/
&RAMP ID= 'BURNER RAMP', T= 80, F= 0.0400/
&RAMP ID= 'BURNER RAMP', T= 90, F= 0.0506/
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&RAMP ID= 'BURNER RAMP', T= 110, F= 0.0756/
&RAMP ID= 'BURNER RAMP', T= 120, F= 0.0900/
&RAMP ID= 'BURNER RAMP', T= 130, F= 0.1057/
&RAMP ID= 'BURNER RAMP', T= 140, F= 0.1225/
&RAMP ID= 'BURNER RAMP', T= 150, F= 0.1407/
&RAMP ID= 'BURNER RAMP', T= 160, F= 0.1600/
&RAMP ID= 'BURNER RAMP', T= 170, F= 0.1807/
&RAMP ID= 'BURNER RAMP', T= 180, F= 0.2026/
&RAMP ID= 'BURNER RAMP', T= 190, F= 0.2257/
&RAMP ID= 'BURNER RAMP', T= 200, F= 0.2501/
&RAMP ID= 'BURNER RAMP', T= 210, F= 0.2757/
&RAMP ID= 'BURNER RAMP', T= 220, F= 0.3026/
&RAMP ID= 'BURNER RAMP', T= 230, F= 0.3307/
&RAMP ID= 'BURNER RAMP', T= 240, F= 0.3601/
&RAMP ID= 'BURNER RAMP', T= 250, F= 0.3907/
&RAMP ID= 'BURNER RAMP', T= 260, F= 0.4226/
&RAMP ID= 'BURNER RAMP', T= 270, F= 0.4558/
&RAMP ID= 'BURNER RAMP', T= 280, F= 0.4901/
&RAMP ID= 'BURNER RAMP', T= 290, F= 0.5258/
&RAMP ID= 'BURNER RAMP', T= 300, F= 0.5627/
&RAMP ID= 'BURNER RAMP', T= 310, F= 0.6008/
&RAMP ID= 'BURNER RAMP', T= 320, F= 0.6402/
&RAMP ID= 'BURNER RAMP', T= 330, F= 0.6808/
&RAMP ID= 'BURNER RAMP', T= 340, F= 0.7227/
&RAMP ID= 'BURNER RAMP', T= 350, F= 0.7659/
&RAMP ID= 'BURNER RAMP', T= 360, F= 0.8102/
&RAMP ID= 'BURNER RAMP', T= 370, F= 0.8559/
&RAMP ID= 'BURNER RAMP', T= 380, F= 0.9028/
&RAMP ID= 'BURNER RAMP', T= 390, F= 0.9509/
&RAMP ID= 'BURNER RAMP', T= 400, F= 1.0000/
&RAMP ID= 'BURNER RAMP', T= 1200, F= 1.0000/
************************************************************

VENTS

&VENT MB='XMAX', SURF_ID='OPEN' / DOMAIN
&VENT MB='YMIN', SURF_ID='OPEN' / DOMAIN
&VENT MB='YMAX', SURF_ID='OPEN' / DOMAIN
&VENT MB='ZMIN', SURF_ID='OPEN' / DOMAIN
&VENT MB='ZMAX', SURF_ID='OPEN' / DOMAIN
```

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Smoke Exhaust Rate & Location

&SURF ID='exhaust',  VEL=2.5, COLOR=RED /

&VENT XB=24.0, 26.0, 16.0, 18.0, 9.5, 9.5, SURF_ID='exhaust',
DEVC_ID='fan'  /
&VENT XB=24.0, 26.0, 32.0, 34.0, 9.5, 9.5, SURF_ID='exhaust',
DEVC_ID='fan'  /
&VENT XB=24.0, 26.0, 49.0, 51.0, 9.5, 9.5, SURF_ID='exhaust',
DEVC_ID='fan'  /

&DEVC ID='fan', XYZ=25.0, 17.0, 9.5, QUANTITY='TIME', SETPOINT=91,
INITIAL_STATE=.FALSE. /
&DEVC ID='fan', XYZ=25.0, 33.0, 9.5, QUANTITY='TIME', SETPOINT=91,
INITIAL_STATE=.FALSE. /
&DEVC ID='fan', XYZ=25.0, 50.0, 9.5, QUANTITY='TIME', SETPOINT=91,
INITIAL_STATE=.FALSE. /


************************************************************

MATERIALS

&MATL ID='CONCRETE', FYI='concrete flooring', CONDUCTIVITY=1,
SPECIFIC_HEAT=0.88, DENSITY=2100, /
&SURF ID='CONCRETE', MATL_ID='CONCRETE', COLOR='GRAY', THICKNESS=0.4,
/

************************************************************
OBSTRUCTIONS

Ground level slab

&OBST XB=0.0, 60.0, 0.0, 7.0, 0.0, 0.0, COLOR=GRAY, SURF_ID=CONCRETE
/ floor
&OBST XB=0.0, 63.0, 7.0, 11.0, 0.0, 0.0, COLOR=GRAY, SURF_ID=CONCRETE
/ floor
&OBST XB=0.0, 70.0, 11.0, 40.0, 0.0, 0.0, COLOR=GRAY,
SURF_ID=CONCRETE / floor
&OBST XB=0.0, 111.0, 40.0, 54.0, 0.0, 0.0, COLOR=GRAY,
SURF_ID=CONCRETE / floor
&OBST XB=26.0, 104.0, 54.0, 62.0, 0.0, 0.0, COLOR=GRAY,
SURF_ID=CONCRETE / floor

&OBST XB=104.0, 111.0, 54.0, 56.0, 0.0, 0.0, COLOR=GRAY,
SURF_ID=CONCRETE / floor
&OBST XB=104.0, 110.0, 56.0, 57.0, 0.0, 0.0, COLOR=GRAY,
SURF_ID=CONCRETE / floor
&OBST XB=104.0, 109.0, 57.0, 58.0, 0.0, 0.0, COLOR=GRAY,
SURF_ID=CONCRETE / floor
&OBST XB=104.0, 108.0, 58.0, 59.0, 0.0, 0.0, COLOR=GRAY,
SURF_ID=CONCRETE / floor
&OBST XB=104.0, 107.0, 59.0, 60.0, 0.0, 0.0, COLOR=GRAY,
SURF_ID=CONCRETE / floor
&OBST XB=104.0, 106.0, 60.0, 61.0, 0.0, 0.0, COLOR=GRAY,
SURF_ID=CONCRETE / floor
&OBST XB=104.0, 105.0, 61.0, 62.0, 0.0, 0.0, COLOR=GRAY,
SURF_ID=CONCRETE / floor

First Floor Slab
```

```
&OBST XB=0.0, 60.0, 0.0, 7.0, 5.5, 5.5, RGB=105,105,105,
SURF_ID=CONCRETE / floor
&OBST XB=0.0, 63.0, 7.0, 11.0, 5.5, 5.5, RGB=105,105,105,
SURF_ID=CONCRETE / floor
&OBST XB=0.0, 70.0, 11.0, 40.0, 5.5, 5.5, RGB=105,105,105,
SURF_ID=CONCRETE / floor
&OBST XB=0.0, 111.0, 40.0, 54.0, 5.5, 5.5, RGB=105,105,105,
SURF_ID=CONCRETE / floor
&OBST XB=26.0, 104.0, 54.0, 62.0, 5.5, 5.5, RGB=105,105,105,
SURF_ID=CONCRETE / floor

&OBST XB=104.0, 111.0, 54.0, 56.0, 5.5, 5.5, RGB=105,105,105,
SURF_ID=CONCRETE / floor
&OBST XB=104.0, 110.0, 56.0, 57.0, 5.5, 5.5, RGB=105,105,105,
SURF_ID=CONCRETE / floor
&OBST XB=104.0, 109.0, 57.0, 58.0, 5.5, 5.5, RGB=105,105,105,
SURF_ID=CONCRETE / floor
&OBST XB=104.0, 108.0, 58.0, 59.0, 5.5, 5.5, RGB=105,105,105,
SURF_ID=CONCRETE / floor
&OBST XB=104.0, 107.0, 59.0, 60.0, 5.5, 5.5, RGB=105,105,105,
SURF_ID=CONCRETE / floor
&OBST XB=104.0, 106.0, 60.0, 61.0, 5.5, 5.5, RGB=105,105,105,
SURF_ID=CONCRETE / floor
&OBST XB=104.0, 105.0, 61.0, 62.0, 5.5, 5.5, RGB=105,105,105,
SURF_ID=CONCRETE / floor

&OBST XB=05.0, 26.0, 54.0, 62.0, 5.5, 5.5, RGB=105,105,105,
SURF_ID=CONCRETE / floor


Roof

&OBST XB=0.0, 41.0, 7.0, 50.0, 9.5, 10, RGB=128,0,0, SURF_ID=CONCRETE
/ floor
&OBST XB=0.0, 47.0, 50.0, 54.0, 9.5, 10, RGB=128,0,0,
SURF_ID=CONCRETE / floor
&OBST XB=5.0, 47.0, 50.0, 62.0, 9.5, 10, RGB=128,0,0,
SURF_ID=CONCRETE / floor


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BOUNDING WALLS - Starting at point 0.0 and working anti-clockwise

&OBST XB=0.0, 60.0, 0.0, 0.0, 0.0, 5.5, RGB=0,128,0, SURF_ID=CONCRETE
/
&OBST XB=60.0, 60.0, 0.0, 7.0, 0.0, 5.5, RGB=0,128,0,
SURF_ID=CONCRETE /
&OBST XB=60.0, 63.0, 7.0, 7.0, 0.0, 9.5, RGB=0,128,0,
SURF_ID=CONCRETE /
&OBST XB=63.0, 63.0, 7.0, 11.0, 0.0, 9.5, RGB=0,128,0,
SURF_ID=CONCRETE /
&OBST XB=63.0, 70.0, 11.0, 11.0, 0.0, 9.5, RGB=0,128,0,
SURF_ID=CONCRETE /
&OBST XB=70.0, 70.0, 11.0, 40.0, 0.0, 9.5, RGB=0,128,0,
SURF_ID=CONCRETE /
&OBST XB=70.0, 70.0, 40.0, 62.0, 5.5, 9.5, RGB=0,128,0,
SURF_ID=CONCRETE /
&OBST XB=65.0, 70.0, 62.0, 62.0, 5.5, 9.5, RGB=0,128,0,
SURF_ID=CONCRETE /

&OBST XB=70.0, 111.0, 40.0, 40.0, 0.0, 5.5, RGB=0,128,0,
SURF_ID=CONCREIE /
&OBST XB=111.0, 111.0, 40.0, 55.0, 0.0, 5.5, RGB=0,128,0,
SURF_ID=CONCRETE /

&OBST XB=111.0, 111.0, 55.0, 56.0, 0.0, 5.5, RGB=0,128,0,
SURF_ID=CONCRETE /
&OBST XB=110.0, 111.0, 56.0, 56.0, 0.0, 5.5, RGB=0,128,0,
SURF_ID=CONCRETE /
&OBST XB=110.0, 110.0, 56.0, 57.0, 0.0, 5.5, RGB=0,128,0,
SURF_ID=CONCRETE /
&OBST XB=109.0, 110.0, 57.0, 57.0, 0.0, 5.5, RGB=0,128,0,
SURF_ID=CONCRETE /
&OBST XB=109.0, 109.0, 57.0, 58.0, 0.0, 5.5, RGB=0,128,0,
SURF_ID=CONCRETE /
&OBST XB=108.0, 109.0, 58.0, 58.0, 0.0, 5.5, RGB=0,128,0,
SURF_ID=CONCRETE /
&OBST XB=108.0, 108.0, 58.0, 59.0, 0.0, 5.5, RGB=0,128,0,
SURF_ID=CONCRETE /
&OBST XB=107.0, 108.0, 59.0, 59.0, 0.0, 5.5, RGB=0,128,0,
SURF_ID=CONCRETE /
&OBST XB=107.0, 107.0, 59.0, 60.0, 0.0, 5.5, RGB=0,128,0,
SURF_ID=CONCRETE /
&OBST XB=106.0, 107.0, 60.0, 60.0, 0.0, 5.5, RGB=0,128,0,
SURF_ID=CONCRETE /
&OBST XB=106.0, 107.0, 60.0, 60.0, 0.0, 5.5, RGB=0,128,0,
SURF_ID=CONCRETE /
&OBST XB=106.0, 106.0, 60.0, 61.0, 0.0, 5.5, RGB=0,128,0,
SURF_ID=CONCRETE /
&OBST XB=105.0, 106.0, 61.0, 61.0, 0.0, 5.5, RGB=0,128,0,
SURF_ID=CONCRETE /
&OBST XB=105.0, 105.0, 61.0, 62.0, 0.0, 5.5, RGB=0,128,0,
SURF_ID=CONCRETE /
&OBST XB=104.0, 105.0, 62.0, 62.0, 0.0, 5.5, RGB=0,128,0,
SURF_ID=CONCRETE /

&OBST XB=82.0, 105.0, 62.0, 62.0, 0.0, 5.5, RGB=0,128,0,
SURF_ID=CONCRETE /
&OBST XB=26.0, 65.0, 62.0, 62.0, 0.0, 9.5, RGB=0,128,0,
SURF_ID=CONCRETE /
&OBST XB=26.0, 26.0, 54.0, 62.0, 0.0, 5.5, RGB=0,128,0,
SURF_ID=CONCRETE /
&OBST XB=5.0, 26.0, 54.0, 54.0, 0.0, 5.5, RGB=0,128,0,
SURF_ID=CONCRETE /
&OBST XB=0.0, 5.0, 54.0, 54.0, 0.0, 9.5, RGB=0,128,0,
SURF_ID=CONCRETE /
&OBST XB=0.0, 0.0, 7.0, 54.0, 0.0, 9.5, RGB=0,128,0, SURF_ID=CONCRETE
/
&OBST XB=0.0, 0.0, 0.0, 7.0, 0.0, 5.5, RGB=0,128,0, SURF_ID=CONCRETE
/

&OBST XB=5.0, 5.0, 54.0, 62.0, 5.5, 9.5, RGB=0,128,0,
SURF_ID=CONCRETE /
&OBST XB=5.0, 26.0, 62.0, 62.0, 5.5, 9.5, RGB=0,128,0,
SURF_ID=CONCRETE /

&OBST XB=0.0, 60.0, 7.0, 7.0, 5.5, 9.5, RGB=0,128,0, SURF_ID=CONCRETE
/

First level

&OBST XB=41.0, 41.0, 7.0, 50.0, 5.5, 9.5, RGB=0,128,0,
SURF_ID=CONCRETE /
&OBST XB=41.0, 47.0, 50.0, 50.0, 5.5, 9.5, RGB=0,128,0,
SURF_ID=CONCRETE /
&OBST XB=47.0, 47.0, 50.0, 62.0, 5.5, 9.5, RGB=0,128,0,
SURF_ID=CONCRETE /


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INTERNAL WALL

Ground Level

&OBST XB=35.0, 35.0, 55.0, 62.0, 0.0, 5.5, RGB=189,252,201 / Goods
receving/marshaling
&OBST XB=35.0, 82.0, 55.0, 55.0, 0.0, 5.5, RGB=189,252,201 / Goods
receving/marshaling
&OBST XB=82.0, 82.0, 55.0, 55.0, 0.0, 5.5, RGB=189,252,201 / Goods
receving/marshaling

Level 1

&OBST XB=26.0, 26.0, 54.0, 62.0, 5.5, 9.5, RGB=189,252,201 / Goods
receving/marshaling
&OBST XB=26.0, 47.0, 54.0, 54.0, 5.5, 9.5, RGB=189,252,201 / Goods
receving/marshaling

&OBST XB=35.0, 41.0, 37.0, 44.0, 5.5, 9.5, RGB=189,252,201 /
Playground


***************

RACKING

Warehosue Level 1

Section 1 - From Left to Right

&OBST XB= 7.0, 09.0, 12.0, 40.0, 0.0, 3.0, COLOR=BROWN /
&OBST XB= 11.0, 13.0, 12.0, 40.0, 0.0, 3.0, COLOR=BROWN /
&OBST XB= 15.0, 17.0, 12.0, 40.0, 0.0, 3.0, COLOR=BROWN /
&OBST XB= 19.0, 21.0, 12.0, 40.0, 0.0, 3.0, COLOR=BROWN /
&OBST XB= 23.0, 25.0, 12.0, 40.0, 0.0, 3.0, COLOR=BROWN /
&OBST XB= 27.0, 29.0, 12.0, 40.0, 0.0, 3.0, COLOR=BROWN /
&OBST XB= 31.0, 33.0, 12.0, 40.0, 0.0, 3.0, COLOR=BROWN /
&OBST XB= 35.0, 37.0, 12.0, 40.0, 0.0, 3.0, COLOR=BROWN /
&OBST XB= 39.0, 41.0, 12.0, 40.0, 0.0, 3.0, COLOR=BROWN /
&OBST XB= 43.0, 45.0, 12.0, 40.0, 0.0, 3.0, COLOR=BROWN /
&OBST XB= 47.0, 49.0, 12.0, 40.0, 0.0, 3.0, COLOR=BROWN /
&OBST XB= 51.0, 53.0, 12.0, 40.0, 0.0, 3.0, COLOR=BROWN /
&OBST XB= 55.0, 57.0, 12.0, 40.0, 0.0, 3.0, COLOR=BROWN /
&OBST XB= 59.0, 61.0, 12.0, 40.0, 0.0, 3.0, COLOR=BROWN /
&OBST XB= 63.0, 65.0, 12.0, 40.0, 0.0, 3.0, COLOR=BROWN /


Section 2 - From Left to Right

&OBST XB= 07.0, 35.0, 44.0, 46.5, 0.0, 3.0, COLOR=BROWN /
&OBST XB= 07.0, 35.0, 48.5, 51.0, 0.0, 3.0, COLOR=BROWN /
&OBST XB= 39.0, 58.0, 44.0, 46.5, 0.0, 3.0, COLOR=BROWN /
&OBST XB= 39.0, 58.0, 48.5, 51.0, 0.0, 3.0, COLOR=BROWN /
&OBST XB= 60.0, 76.0, 44.0, 46.5, 0.0, 3.0, COLOR=BROWN /
&OBST XB= 60.0, 76.0, 48.5, 51.0, 0.0, 3.0, COLOR=BROWN /

Warehosue Level 2

&OBST XB= 06.0, 37.0, 14.0, 16.0, 5.5, 8.0, COLOR=BROWN /
&OBST XB= 09.0, 37.0, 18.0, 20.0, 5.5, 8.0, COLOR=BROWN /
&OBST XB= 09.0, 37.0, 22.0, 24.0, 5.5, 8.0, COLOR=BROWN /
&OBST XB= 09.0, 31.0, 26.0, 28.0, 5.5, 8.0, COLOR=BROWN /
&OBST XB= 09.0, 31.0, 30.0, 32.0, 5.5, 8.0, COLOR=BROWN /
&OBST XB= 09.0, 31.0, 34.0, 36.0, 5.5, 8.0, COLOR=BROWN /
&OBST XB= 09.0, 31.0, 38.0, 40.0, 5.5, 8.0, COLOR=BROWN /
&OBST XB= 09.0, 28.0, 42.0, 44.0, 5.5, 8.0, COLOR=BROWN /
&OBST XB= 09.0, 28.0, 42.0, 44.0, 5.5, 8.0, COLOR=BROWN /
&OBST XB= 09.0, 28.0, 46.0, 48.0, 5.5, 8.0, COLOR=BROWN /


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TRAVELATOR VOID

&HOLE XB=0.50, 6.00, 18.0, 49.0, 5.0, 6.0 /


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&TAIL / END FILE
```

```
&HEAD CHID='Scenario2',TITLE=time to untenable conditions. Fire
Location=Furthest point from the void, Fire size=30MW, Soot yield=
0.1, Exhaust Rate=0m³/s /
&TIME TWFIN=1200. /
&DUMP DT_PL3D=50 /
/&MISC RESTART=.TRUE. /
************************************************************
INDEX:

Outputs

Meshes

Reaction

Fire

Exhaust

Obtructions

      - Walls
      - Slabs


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OUTPUTS

Visibility Slices

Vertical slices through the fire

&SLCF PBX=17.5, QUANTITY='visibility' / Slice through the fire
&SLCF PBY=15.5, QUANTITY='visibility' / Slice through the fire
&SLCF PBY=30.0, QUANTITY='visibility' /

Horizontal slices above the fire

&SLCF PBZ=2, QUANTITY='visibility' /
&SLCF PBZ=7.5, QUANTITY='visibility' /

Temperature Slices

Vertical slices through the fire

&SLCF PBZ=2.0, QUANTITY='TEMPERATURE' /
&SLCF PBZ=7.5, QUANTITY='TEMPERATURE' /
&SLCF PBX=17.5, QUANTITY='TEMPERATURE' /
&SLCF PBY=15.5, QUANTITY='TEMPERATURE' /
&SLCF PBY=30.0, QUANTITY='TEMPERATURE' /

Horizontal slices above the fire


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MESH

&MESH IJK=225,135,20, XB=-1.0, 111.5, -2.5, 65.0, 0.0, 10.0,  / 0.5m
x 0.5m x 0.5m

************************************************************
Fire Properties

&REAC ID         = 'POLYURETHANE'
      SOOT_YIELD = 0.10
      N          = 1.0
      C          = 6.3
      H          = 7.1
      O          = 2.1  /

************************************************************
Fire Location and size/growth rate

&SURF ID='BURNER', HRRPUA=7500, RAMP_Q='BURNER RAMP', COLOR='RED' /
&VENT XB=103, 105, 55, 57, 1.0, 1.0, SURF_ID='BURNER' /
&OBST XB=103, 105, 55, 57, 0.0, 1.0, COLOR=BLACK /


&RAMP ID= 'BURNER RAMP', T= 0, F= 0.0000/
&RAMP ID= 'BURNER RAMP', T= 10, F= 0.0006/
&RAMP ID= 'BURNER RAMP', T= 20, F= 0.0025/
&RAMP ID= 'BURNER RAMP', T= 30, F= 0.0056/
&RAMP ID= 'BURNER RAMP', T= 40, F= 0.0100/
&RAMP ID= 'BURNER RAMP', T= 50, F= 0.0156/
&RAMP ID= 'BURNER RAMP', T= 60, F= 0.0225/
&RAMP ID= 'BURNER RAMP', T= 70, F= 0.0306/
&RAMP ID= 'BURNER RAMP', T= 80, F= 0.0400/
&RAMP ID= 'BURNER RAMP', T= 90, F= 0.0506/
&RAMP ID= 'BURNER RAMP', T= 100, F= 0.0625/
&RAMP ID= 'BURNER RAMP', T= 110, F= 0.0756/
&RAMP ID= 'BURNER RAMP', T= 120, F= 0.0900/
&RAMP ID= 'BURNER RAMP', T= 130, F= 0.1057/
&RAMP ID= 'BURNER RAMP', T= 140, F= 0.1225/
&RAMP ID= 'BURNER RAMP', T= 150, F= 0.1407/
&RAMP ID= 'BURNER RAMP', T= 160, F= 0.1600/
&RAMP ID= 'BURNER RAMP', T= 170, F= 0.1807/
&RAMP ID= 'BURNER RAMP', T= 180, F= 0.2026/
&RAMP ID= 'BURNER RAMP', T= 190, F= 0.2257/
&RAMP ID= 'BURNER RAMP', T= 200, F= 0.2501/
&RAMP ID= 'BURNER RAMP', T= 210, F= 0.2757/
&RAMP ID= 'BURNER RAMP', T= 220, F= 0.3026/
&RAMP ID= 'BURNER RAMP', T= 230, F= 0.3307/
&RAMP ID= 'BURNER RAMP', T= 240, F= 0.3601/
&RAMP ID= 'BURNER RAMP', T= 250, F= 0.3907/
&RAMP ID= 'BURNER RAMP', T= 260, F= 0.4226/
&RAMP ID= 'BURNER RAMP', T= 270, F= 0.4558/
&RAMP ID= 'BURNER RAMP', T= 280, F= 0.4901/
&RAMP ID= 'BURNER RAMP', T= 290, F= 0.5258/
&RAMP ID= 'BURNER RAMP', T= 300, F= 0.5627/
&RAMP ID= 'BURNER RAMP', T= 310, F= 0.6008/
&RAMP ID= 'BURNER RAMP', T= 320, F= 0.6402/
&RAMP ID= 'BURNER RAMP', T= 330, F= 0.6808/
&RAMP ID= 'BURNER RAMP', T= 340, F= 0.7227/
&RAMP ID= 'BURNER RAMP', T= 350, F= 0.7659/
&RAMP ID= 'BURNER RAMP', T= 360, F= 0.8102/
&RAMP ID= 'BURNER RAMP', T= 370, F= 0.8559/
&RAMP ID= 'BURNER RAMP', T= 380, F= 0.9028/
&RAMP ID= 'BURNER RAMP', T= 390, F= 0.9509/
&RAMP ID= 'BURNER RAMP', T= 400, F= 1.0000/
&RAMP ID= 'BURNER RAMP', T= 1200, F= 1.0000/
************************************************************

VENTS

&VENT MB='XMAX', SURF_ID='OPEN' / DOMAIN
&VENT MB='YMIN', SURF_ID='OPEN' / DOMAIN
&VENT MB='YMAX', SURF_ID='OPEN' / DOMAIN
&VENT MB='ZMIN', SURF_ID='OPEN' / DOMAIN
&VENT MB='ZMAX', SURF_ID='OPEN' / DOMAIN
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Smoke Exhaust Rate & Location

&SURF ID='exhaust',  VEL=2.5, COLOR=RED /

/&VENT XB=24.0, 26.0, 16.0, 18.0, 9.5, 9.5, SURF_ID='exhaust',
DEVC_ID='fan'  /
/&VENT XB=24.0, 26.0, 32.0, 34.0, 9.5, 9.5, SURF_ID='exhaust',
DEVC_ID='fan'  /
/&VENT XB=24.0, 26.0, 49.0, 51.0, 9.5, 9.5, SURF_ID='exhaust',
DEVC_ID='fan'  /

/&DEVC ID='fan', XB=24.0, 26.0, 16.0, 18.0, 9.5, 9.5,
QUANTITY='TIME', SETPOINT=91, INITIAL_STATE=.FALSE. /
/&DEVC ID='fan', XB=24.0, 26.0, 32.0, 34.0, 9.5, 9.5,
QUANTITY='TIME', SETPOINT=91, INITIAL_STATE=.FALSE. /
/&DEVC ID='fan', XB=24.0, 26.0, 49.0, 51.0, 9.5, 9.5,
QUANTITY='TIME', SETPOINT=91, INITIAL_STATE=.FALSE. /


************************************************************

MATERIALS

&MATL ID='CONCRETE', FYI='concrete flooring', CONDUCTIVITY=1,
SPECIFIC_HEAT=0.88, DENSITY=2100, /
&SURF ID='CONCRETE', MATL_ID='CONCRETE', COLOR='GRAY', THICKNESS=0.4,
/

************************************************************
OBSTRUCTIONS

Ground level slab

&OBST XB=0.0, 60.0, 0.0, 7.0, 0.0, 0.0, COLOR=GRAY, SURF_ID=CONCRETE
/ floor
&OBST XB=0.0, 63.0, 7.0, 11.0, 0.0, 0.0, COLOR=GRAY, SURF_ID=CONCRETE
/ floor
&OBST XB=0.0, 70.0, 11.0, 40.0, 0.0, 0.0, COLOR=GRAY,
SURF_ID=CONCRETE / floor
&OBST XB=0.0, 111.0, 40.0, 54.0, 0.0, 0.0, COLOR=GRAY,
SURF_ID=CONCRETE / floor
&OBST XB=26.0, 104.0, 54.0, 62.0, 0.0, 0.0, COLOR=GRAY,
SURF_ID=CONCRETE / floor

&OBST XB=104.0, 111.0, 54.0, 56.0, 0.0, 0.0, COLOR=GRAY,
SURF_ID=CONCRETE / floor
&OBST XB=104.0, 110.0, 56.0, 57.0, 0.0, 0.0, COLOR=GRAY,
SURF_ID=CONCRETE / floor
&OBST XB=104.0, 109.0, 57.0, 58.0, 0.0, 0.0, COLOR=GRAY,
SURF_ID=CONCRETE / floor
&OBST XB=104.0, 108.0, 58.0, 59.0, 0.0, 0.0, COLOR=GRAY,
SURF_ID=CONCRETE / floor
&OBST XB=104.0, 107.0, 59.0, 60.0, 0.0, 0.0, COLOR=GRAY,
SURF_ID=CONCRETE / floor
&OBST XB=104.0, 106.0, 60.0, 61.0, 0.0, 0.0, COLOR=GRAY,
SURF_ID=CONCRETE / floor
&OBST XB=104.0, 105.0, 61.0, 62.0, 0.0, 0.0, COLOR=GRAY,
SURF_ID=CONCRETE / floor

First Floor Slab

&OBST XB=0.0, 60.0, 0.0, 7.0, 5.5, 5.5, RGB=105,105,105,
SURF_ID=CONCRETE / floor
&OBST XB=0.0, 63.0, 7.0, 11.0, 5.5, 5.5, RGB=105,105,105,
SURF_ID=CONCRETE / floor
&OBST XB=0.0, 70.0, 11.0, 40.0, 5.5, 5.5, RGB=105,105,105,
SURF_ID=CONCRETE / floor
&OBST XB=0.0, 111.0, 40.0, 54.0, 5.5, 5.5, RGB=105,105,105,
SURF_ID=CONCRETE / floor
&OBST XB=26.0, 104.0, 54.0, 62.0, 5.5, 5.5, RGB=105,105,105,
SURF_ID=CONCRETE / floor

&OBST XB=104.0, 111.0, 54.0, 56.0, 5.5, 5.5, RGB=105,105,105,
SURF_ID=CONCRETE / floor
&OBST XB=104.0, 110.0, 56.0, 57.0, 5.5, 5.5, RGB=105,105,105,
SURF_ID=CONCRETE / floor
&OBST XB=104.0, 109.0, 57.0, 58.0, 5.5, 5.5, RGB=105,105,105,
SURF_ID=CONCRETE / floor
&OBST XB=104.0, 108.0, 58.0, 59.0, 5.5, 5.5, RGB=105,105,105,
SURF_ID=CONCRETE / floor
&OBST XB=104.0, 107.0, 59.0, 60.0, 5.5, 5.5, RGB=105,105,105,
SURF_ID=CONCRETE / floor
&OBST XB=104.0, 106.0, 60.0, 61.0, 5.5, 5.5, RGB=105,105,105,
SURF_ID=CONCRETE / floor
&OBST XB=104.0, 105.0, 61.0, 62.0, 5.5, 5.5, RGB=105,105,105,
SURF_ID=CONCRETE / floor

&OBST XB=05.0, 26.0, 54.0, 62.0, 5.5, 5.5, RGB=105,105,105,
SURF_ID=CONCRETE / floor


Roof

&OBST XB=0.0, 41.0, 7.0, 50.0, 9.5, 10, RGB=128,0,0, SURF_ID=CONCRETE
/ floor
&OBST XB=0.0, 47.0, 50.0, 54.0, 9.5, 10, RGB=128,0,0,
SURF_ID=CONCRETE / floor
&OBST XB=5.0, 47.0, 50.0, 62.0, 9.5, 10, RGB=128,0,0,
SURF_ID=CONCRETE / floor


**************

BOUNDING WALLS - Starting at point 0.0 and working anti-clockwise

&OBST XB=0.0, 60.0, 0.0, 0.0, 0.0, 5.5, RGB=0,128,0, SURF_ID=CONCRETE
/
&OBST XB=60.0, 60.0, 0.0, 7.0, 0.0, 5.5, RGB=0,128,0,
SURF_ID=CONCRETE /
&OBST XB=60.0, 63.0, 7.0, 7.0, 0.0, 9.5, RGB=0,128,0,
SURF_ID=CONCRETE /
&OBST XB=63.0, 63.0, 7.0, 11.0, 0.0, 9.5, RGB=0,128,0,
SURF_ID=CONCRETE /
&OBST XB=63.0, 70.0, 11.0, 11.0, 0.0, 9.5, RGB=0,128,0,
SURF_ID=CONCRETE /
&OBST XB=70.0, 70.0, 11.0, 40.0, 0.0, 9.5, RGB=0,128,0,
SURF_ID=CONCRETE /
&OBST XB=70.0, 70.0, 40.0, 62.0, 5.5, 9.5, RGB=0,128,0,
SURF_ID=CONCRETE /
&OBST XB=65.0, 70.0, 62.0, 62.0, 5.5, 9.5, RGB=0,128,0,
SURF_ID=CONCRETE /

&OBST XB=70.0, 111.0, 40.0, 40.0, 0.0, 5.5, RGB=0,128,0,
SURF_ID=CONCRETE /
&OBST XB=111.0, 111.0, 40.0, 55.0, 0.0, 5.5, RGB=0,128,0,
SURF_ID=CONCRETE /
```

```
&OBST XB=111.0, 111.0, 55.0, 56.0, 0.0, 5.5, RGB=0,128,0,
SURF_ID=CONCRETE /
&OBST XB=110.0, 111.0, 56.0, 56.0, 0.0, 5.5, RGB=0,128,0,
SURF_ID=CONCRETE /
&OBST XB=110.0, 110.0, 56.0, 57.0, 0.0, 5.5, RGB=0,128,0,
SURF_ID=CONCRETE /
&OBST XB=109.0, 110.0, 57.0, 57.0, 0.0, 5.5, RGB=0,128,0,
SURF_ID=CONCRETE /
&OBST XB=109.0, 109.0, 57.0, 58.0, 0.0, 5.5, RGB=0,128,0,
SURF_ID=CONCRETE /
&OBST XB=108.0, 109.0, 58.0, 58.0, 0.0, 5.5, RGB=0,128,0,
SURF_ID=CONCRETE /
&OBST XB=108.0, 108.0, 58.0, 59.0, 0.0, 5.5, RGB=0,128,0,
SURF_ID=CONCRETE /
&OBST XB=107.0, 108.0, 59.0, 59.0, 0.0, 5.5, RGB=0,128,0,
SURF_ID=CONCRETE /
&OBST XB=107.0, 107.0, 59.0, 60.0, 0.0, 5.5, RGB=0,128,0,
SURF_ID=CONCRETE /
&OBST XB=106.0, 107.0, 60.0, 60.0, 0.0, 5.5, RGB=0,128,0,
SURF_ID=CONCRETE /
&OBST XB=106.0, 107.0, 60.0, 60.0, 0.0, 5.5, RGB=0,128,0,
SURF_ID=CONCRETE /
&OBST XB=106.0, 106.0, 60.0, 61.0, 0.0, 5.5, RGB=0,128,0,
SURF_ID=CONCRETE /
&OBST XB=105.0, 106.0, 61.0, 61.0, 0.0, 5.5, RGB=0,128,0,
SURF_ID=CONCRETE /
&OBST XB=105.0, 105.0, 61.0, 62.0, 0.0, 5.5, RGB=0,128,0,
SURF_ID=CONCRETE /
&OBST XB=104.0, 105.0, 62.0, 62.0, 0.0, 5.5, RGB=0,128,0,
SURF_ID=CONCRETE /

&OBST XB=82.0, 105.0, 62.0, 62.0, 0.0, 5.5, RGB=0,128,0,
SURF_ID=CONCRETE /
&OBST XB=26.0, 65.0, 62.0, 62.0, 0.0, 9.5, RGB=0,128,0,
SURF_ID=CONCRETE /
&OBST XB=26.0, 26.0, 54.0, 62.0, 0.0, 5.5, RGB=0,128,0,
SURF_ID=CONCRETE /
&OBST XB=5.0, 26.0, 54.0, 54.0, 0.0, 5.5, RGB=0,128,0,
SURF_ID=CONCRETE /
&OBST XB=0.0, 5.0, 54.0, 54.0, 0.0, 9.5, RGB=0,128,0,
SURF_ID=CONCRETE /
&OBST XB=0.0, 0.0, 7.0, 54.0, 0.0, 9.5, RGB=0,128,0, SURF_ID=CONCRETE
/
&OBST XB=0.0, 0.0, 0.0, 7.0, 0.0, 5.5, RGB=0,128,0, SURF_ID=CONCRETE
/

&OBST XB=5.0, 5.0, 54.0, 62.0, 5.5, 9.5, RGB=0,128,0,
SURF_ID=CONCRETE /
&OBST XB=5.0, 26.0, 62.0, 62.0, 5.5, 9.5, RGB=0,128,0,
SURF_ID=CONCRETE /

&OBST XB=0.0, 60.0, 7.0, 7.0, 5.5, 9.5, RGB=0,128,0, SURF_ID=CONCRETE
/

First level

&OBST XB=41.0, 41.0, 7.0, 50.0, 5.5, 9.5, RGB=0,128,0,
SURF_ID=CONCRETE /
&OBST XB=41.0, 47.0, 50.0, 50.0, 5.5, 9.5, RGB=0,128,0,
SURF_ID=CONCRETE /
&OBST XB=47.0, 47.0, 50.0, 62.0, 5.5, 9.5, RGB=0,128,0,
SURF_ID=CONCRETE /


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INTERNAL WALL

Ground Level

&OBST XB=35.0, 35.0, 55.0, 62.0, 0.0, 5.5, RGB=189,252,201 / Goods
receving/marshaling
&OBST XB=35.0, 82.0, 55.0, 55.0, 0.0, 5.5, RGB=189,252,201 / Goods
receving/marshaling
&OBST XB=82.0, 82.0, 55.0, 55.0, 0.0, 5.5, RGB=189,252,201 / Goods
receving/marshaling

Level 1

&OBST XB=26.0, 26.0, 54.0, 62.0, 5.5, 9.5, RGB=189,252,201 / Goods
receving/marshaling
&OBST XB=26.0, 47.0, 54.0, 54.0, 5.5, 9.5, RGB=189,252,201 / Goods
receving/marshaling

&OBST XB=35.0, 41.0, 37.0, 44.0, 5.5, 9.5, RGB=189,252,201 /
Playground


**********

RACKING

Warehosue Level 1

Section 1 - From Left to Right

&OBST XB= 7.0, 09.0, 12.0, 40.0, 0.0, 3.0, COLOR=BROWN /
&OBST XB= 11.0, 13.0, 12.0, 40.0, 0.0, 3.0, COLOR=BROWN /
&OBST XB= 15.0, 17.0, 12.0, 40.0, 0.0, 3.0, COLOR=BROWN /
&OBST XB= 19.0, 21.0, 12.0, 40.0, 0.0, 3.0, COLOR=BROWN /
&OBST XB= 23.0, 25.0, 12.0, 40.0, 0.0, 3.0, COLOR=BROWN /
&OBST XB= 27.0, 29.0, 12.0, 40.0, 0.0, 3.0, COLOR=BROWN /
&OBST XB= 31.0, 33.0, 12.0, 40.0, 0.0, 3.0, COLOR=BROWN /
&OBST XB= 35.0, 37.0, 12.0, 40.0, 0.0, 3.0, COLOR=BROWN /
&OBST XB= 39.0, 41.0, 12.0, 40.0, 0.0, 3.0, COLOR=BROWN /
&OBST XB= 43.0, 45.0, 12.0, 40.0, 0.0, 3.0, COLOR=BROWN /
&OBST XB= 47.0, 49.0, 12.0, 40.0, 0.0, 3.0, COLOR=BROWN /
&OBST XB= 51.0, 53.0, 12.0, 40.0, 0.0, 3.0, COLOR=BROWN /
&OBST XB= 55.0, 57.0, 12.0, 40.0, 0.0, 3.0, COLOR=BROWN /
&OBST XB= 59.0, 61.0, 12.0, 40.0, 0.0, 3.0, COLOR=BROWN /
&OBST XB= 63.0, 65.0, 12.0, 40.0, 0.0, 3.0, COLOR=BROWN /


Section 2 - From Left to Right

&OBST XB= 07.0, 35.0, 44.0, 46.5, 0.0, 3.0, COLOR=BROWN /
&OBST XB= 07.0, 35.0, 48.5, 51.0, 0.0, 3.0, COLOR=BROWN /
&OBST XB= 39.0, 58.0, 44.0, 46.5, 0.0, 3.0, COLOR=BROWN /
&OBST XB= 39.0, 58.0, 48.5, 51.0, 0.0, 3.0, COLOR=BROWN /
&OBST XB= 60.0, 76.0, 44.0, 46.5, 0.0, 3.0, COLOR=BROWN /
&OBST XB= 60.0, 76.0, 48.5, 51.0, 0.0, 3.0, COLOR=BROWN /

Warehosue Level 2

&OBST XB= 06.0, 37.0, 14.0, 16.0, 5.5, 8.0, COLOR=BROWN /
&OBST XB= 09.0, 37.0, 18.0, 20.0, 5.5, 8.0, COLOR=BROWN /
&OBST XB= 09.0, 37.0, 22.0, 24.0, 5.5, 8.0, COLOR=BROWN /
&OBST XB= 09.0, 31.0, 26.0, 28.0, 5.5, 8.0, COLOR=BROWN /
&OBST XB= 09.0, 31.0, 30.0, 32.0, 5.5, 8.0, COLOR=BROWN /
&OBST XB= 09.0, 31.0, 34.0, 36.0, 5.5, 8.0, COLOR=BROWN /
&OBST XB= 09.0, 31.0, 38.0, 40.0, 5.5, 8.0, COLOR=BROWN /
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&OBST XB= 09.0, 28.0, 42.0, 44.0, 5.5, 8.0, COLOR=BROWN /
&OBST XB= 09.0, 28.0, 42.0, 44.0, 5.5, 8.0, COLOR=BROWN /
&OBST XB= 09.0, 28.0, 46.0, 48.0, 5.5, 8.0, COLOR=BROWN /

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TRAVELATOR VOID

&HOLE XB=0.50, 6.00, 18.0, 49.0, 5.0, 6.0 /


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&TAIL / END FILE
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```
&HEAD CHID='Scenario3',TITLE=time to untenable conditions. Fire
Location=Near to main entrance and void, Fire size=30MW, Soot yield=
0.1, Exhaust Rate=0m³/s /
&TIME TWFIN=0. /
&DUMP DT_PL3D=50 /
/&MISC RESTART=.TRUE. /
************************************************************
INDEX:

Outputs

Meshes

Reaction

Fire

Exhaust

Obtructions

      - Walls
      - Slabs


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OUTPUTS

Visibility Slices

Vertical slices through the fire

&SLCF PBX=17.5, QUANTITY='visibility' / Slice through the fire
&SLCF PBY=15.5, QUANTITY='visibility' / Slice through the fire
&SLCF PBY=30.0, QUANTITY='visibility' /

Horizontal slices above the fire

&SLCF PBZ=2, QUANTITY='visibility' /
&SLCF PBZ=7.5, QUANTITY='visibility' /

Temperature Slices

Vertical slices through the fire

&SLCF PBZ=2.0, QUANTITY='TEMPERATURE' /
&SLCF PBZ=7.5, QUANTITY='TEMPERATURE' /
&SLCF PBX=17.5, QUANTITY='TEMPERATURE' /
&SLCF PBY=15.5, QUANTITY='TEMPERATURE' /
&SLCF PBY=30.0, QUANTITY='TEMPERATURE' /

Horizontal slices above the fire


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MESH

&MESH IJK=225,135,20, XB=-1.0, 111.5, -2.5, 65.0, 0.0, 10.0,  / 0.5m
x 0.5m x 0.5m

************************************************************
Fire Properties

&REAC ID         = 'POLYURETHANE'
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```
      SOOT_YIELD = 0.10
      N          = 1.0
      C          = 6.3
      H          = 7.1
      O          = 2.1  /

************************************************************
Fire Location and size/growth rate

&SURF ID='BURNER', HRRPUA=7500, RAMP_Q='BURNER RAMP', COLOR='RED' /
&VENT XB=02, 04, 10, 12, 1.0, 1.0, SURF_ID='BURNER' /
&OBST XB=02, 04, 10, 12, 0.0, 1.0, COLOR=BLACK /


&RAMP ID= 'BURNER RAMP', T= 0, F= 0.0000/
&RAMP ID= 'BURNER RAMP', T= 10, F= 0.0006/
&RAMP ID= 'BURNER RAMP', T= 20, F= 0.0025/
&RAMP ID= 'BURNER RAMP', T= 30, F= 0.0056/
&RAMP ID= 'BURNER RAMP', T= 40, F= 0.0100/
&RAMP ID= 'BURNER RAMP', T= 50, F= 0.0156/
&RAMP ID= 'BURNER RAMP', T= 60, F= 0.0225/
&RAMP ID= 'BURNER RAMP', T= 70, F= 0.0306/
&RAMP ID= 'BURNER RAMP', T= 80, F= 0.0400/
&RAMP ID= 'BURNER RAMP', T= 90, F= 0.0506/
&RAMP ID= 'BURNER RAMP', T= 100, F= 0.0625/
&RAMP ID= 'BURNER RAMP', T= 110, F= 0.0756/
&RAMP ID= 'BURNER RAMP', T= 120, F= 0.0900/
&RAMP ID= 'BURNER RAMP', T= 130, F= 0.1057/
&RAMP ID= 'BURNER RAMP', T= 140, F= 0.1225/
&RAMP ID= 'BURNER RAMP', T= 150, F= 0.1407/
&RAMP ID= 'BURNER RAMP', T= 160, F= 0.1600/
&RAMP ID= 'BURNER RAMP', T= 170, F= 0.1807/
&RAMP ID= 'BURNER RAMP', T= 180, F= 0.2026/
&RAMP ID= 'BURNER RAMP', T= 190, F= 0.2257/
&RAMP ID= 'BURNER RAMP', T= 200, F= 0.2501/
&RAMP ID= 'BURNER RAMP', T= 210, F= 0.2757/
&RAMP ID= 'BURNER RAMP', T= 220, F= 0.3026/
&RAMP ID= 'BURNER RAMP', T= 230, F= 0.3307/
&RAMP ID= 'BURNER RAMP', T= 240, F= 0.3601/
&RAMP ID= 'BURNER RAMP', T= 250, F= 0.3907/
&RAMP ID= 'BURNER RAMP', T= 260, F= 0.4226/
&RAMP ID= 'BURNER RAMP', T= 270, F= 0.4558/
&RAMP ID= 'BURNER RAMP', T= 280, F= 0.4901/
&RAMP ID= 'BURNER RAMP', T= 290, F= 0.5258/
&RAMP ID= 'BURNER RAMP', T= 300, F= 0.5627/
&RAMP ID= 'BURNER RAMP', T= 310, F= 0.6008/
&RAMP ID= 'BURNER RAMP', T= 320, F= 0.6402/
&RAMP ID= 'BURNER RAMP', T= 330, F= 0.6808/
&RAMP ID= 'BURNER RAMP', T= 340, F= 0.7227/
&RAMP ID= 'BURNER RAMP', T= 350, F= 0.7659/
&RAMP ID= 'BURNER RAMP', T= 360, F= 0.8102/
&RAMP ID= 'BURNER RAMP', T= 370, F= 0.8559/
&RAMP ID= 'BURNER RAMP', T= 380, F= 0.9028/
&RAMP ID= 'BURNER RAMP', T= 390, F= 0.9509/
&RAMP ID= 'BURNER RAMP', T= 400, F= 1.0000/
&RAMP ID= 'BURNER RAMP', T= 1200, F= 1.0000/
************************************************************

VENTS

&VENT MB='XMAX', SURF_ID='OPEN' / DOMAIN
&VENT MB='YMIN', SURF_ID='OPEN' / DOMAIN
&VENT MB='YMAX', SURF_ID='OPEN' / DOMAIN
&VENT MB='ZMIN', SURF_ID='OPEN' / DOMAIN
&VENT MB='ZMAX', SURF_ID='OPEN' / DOMAIN
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Smoke Exhaust Rate & Location

&SURF ID='exhaust',  VEL=2.5, COLOR=RED /

/&VENT XB=24.0, 26.0, 16.0, 18.0, 9.5, 9.5, SURF_ID='exhaust',
DEVC_ID='fan'  /
/&VENT XB=24.0, 26.0, 32.0, 34.0, 9.5, 9.5, SURF_ID='exhaust',
DEVC_ID='fan'  /
/&VENT XB=24.0, 26.0, 49.0, 51.0, 9.5, 9.5, SURF_ID='exhaust',
DEVC_ID='fan'  /

/&DEVC ID='fan', XB=24.0, 26.0, 16.0, 18.0, 9.5, 9.5,
QUANTITY='TIME', SETPOINT=91, INITIAL_STATE=.FALSE. /
/&DEVC ID='fan', XB=24.0, 26.0, 32.0, 34.0, 9.5, 9.5,
QUANTITY='TIME', SETPOINT=91, INITIAL_STATE=.FALSE. /
/&DEVC ID='fan', XB=24.0, 26.0, 49.0, 51.0, 9.5, 9.5,
QUANTITY='TIME', SETPOINT=91, INITIAL_STATE=.FALSE. /


************************************************************

MATERIALS

&MATL ID='CONCRETE', FYI='concrete flooring', CONDUCTIVITY=1,
SPECIFIC_HEAT=0.88, DENSITY=2100, /
&SURF ID='CONCRETE', MATL_ID='CONCRETE', COLOR='GRAY', THICKNESS=0.4,
/

************************************************************
OBSTRUCTIONS

Ground level slab

&OBST XB=0.0, 60.0, 0.0, 7.0, 0.0, 0.0, COLOR=GRAY, SURF_ID=CONCRETE
/ floor
&OBST XB=0.0, 63.0, 7.0, 11.0, 0.0, 0.0, COLOR=GRAY, SURF_ID=CONCRETE
/ floor
&OBST XB=0.0, 70.0, 11.0, 40.0, 0.0, 0.0, COLOR=GRAY,
SURF_ID=CONCRETE / floor
&OBST XB=0.0, 111.0, 40.0, 54.0, 0.0, 0.0, COLOR=GRAY,
SURF_ID=CONCRETE / floor
&OBST XB=26.0, 104.0, 54.0, 62.0, 0.0, 0.0, COLOR=GRAY,
SURF_ID=CONCRETE / floor

&OBST XB=104.0, 111.0, 54.0, 56.0, 0.0, 0.0, COLOR=GRAY,
SURF_ID=CONCRETE / floor
&OBST XB=104.0, 110.0, 56.0, 57.0, 0.0, 0.0, COLOR=GRAY,
SURF_ID=CONCRETE / floor
&OBST XB=104.0, 109.0, 57.0, 58.0, 0.0, 0.0, COLOR=GRAY,
SURF_ID=CONCRETE / floor
&OBST XB=104.0, 108.0, 58.0, 59.0, 0.0, 0.0, COLOR=GRAY,
SURF_ID=CONCRETE / floor
&OBST XB=104.0, 107.0, 59.0, 60.0, 0.0, 0.0, COLOR=GRAY,
SURF_ID=CONCRETE / floor
&OBST XB=104.0, 106.0, 60.0, 61.0, 0.0, 0.0, COLOR=GRAY,
SURF_ID=CONCRETE / floor
&OBST XB=104.0, 105.0, 61.0, 62.0, 0.0, 0.0, COLOR=GRAY,
SURF_ID=CONCRETE / floor

First Floor Slab
```

```
&OBST XB=0.0, 60.0, 0.0, 7.0, 5.5, 5.5, RGB=105,105,105,
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&OBST XB=0.0, 63.0, 7.0, 11.0, 5.5, 5.5, RGB=105,105,105,
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&OBST XB=0.0, 70.0, 11.0, 40.0, 5.5, 5.5, RGB=105,105,105,
SURF_ID=CONCRETE / floor
&OBST XB=0.0, 111.0, 40.0, 54.0, 5.5, 5.5, RGB=105,105,105,
SURF_ID=CONCRETE / floor
&OBST XB=26.0, 104.0, 54.0, 62.0, 5.5, 5.5, RGB=105,105,105,
SURF_ID=CONCRETE / floor

&OBST XB=104.0, 111.0, 54.0, 56.0, 5.5, 5.5, RGB=105,105,105,
SURF_ID=CONCRETE / floor
&OBST XB=104.0, 110.0, 56.0, 57.0, 5.5, 5.5, RGB=105,105,105,
SURF_ID=CONCRETE / floor
&OBST XB=104.0, 109.0, 57.0, 58.0, 5.5, 5.5, RGB=105,105,105,
SURF_ID=CONCRETE / floor
&OBST XB=104.0, 108.0, 58.0, 59.0, 5.5, 5.5, RGB=105,105,105,
SURF_ID=CONCRETE / floor
&OBST XB=104.0, 107.0, 59.0, 60.0, 5.5, 5.5, RGB=105,105,105,
SURF_ID=CONCRETE / floor
&OBST XB=104.0, 106.0, 60.0, 61.0, 5.5, 5.5, RGB=105,105,105,
SURF_ID=CONCRETE / floor
&OBST XB=104.0, 105.0, 61.0, 62.0, 5.5, 5.5, RGB=105,105,105,
SURF_ID=CONCRETE / floor

&OBST XB=05.0, 26.0, 54.0, 62.0, 5.5, 5.5, RGB=105,105,105,
SURF_ID=CONCRETE / floor


Roof

&OBST XB=0.0, 41.0, 7.0, 50.0, 9.5, 10, RGB=128,0,0, SURF_ID=CONCRETE
/ floor
&OBST XB=0.0, 47.0, 50.0, 54.0, 9.5, 10, RGB=128,0,0,
SURF_ID=CONCRETE / floor
&OBST XB=5.0, 47.0, 50.0, 62.0, 9.5, 10, RGB=128,0,0,
SURF_ID=CONCRETE / floor


***************

BOUNDING WALLS - Starting at point 0.0 and working anti-clockwise

&OBST XB=0.0, 60.0, 0.0, 0.0, 0.0, 5.5, RGB=0,128,0, SURF_ID=CONCRETE
/
&OBST XB=60.0, 60.0, 0.0, 7.0, 0.0, 5.5, RGB=0,128,0,
SURF_ID=CONCRETE /
&OBST XB=60.0, 63.0, 7.0, 7.0, 0.0, 9.5, RGB=0,128,0,
SURF_ID=CONCRETE /
&OBST XB=63.0, 63.0, 7.0, 11.0, 0.0, 9.5, RGB=0,128,0,
SURF_ID=CONCRETE /
&OBST XB=63.0, 70.0, 11.0, 11.0, 0.0, 9.5, RGB=0,128,0,
SURF_ID=CONCRETE /
&OBST XB=70.0, 70.0, 11.0, 40.0, 0.0, 9.5, RGB=0,128,0,
SURF_ID=CONCRETE /
&OBST XB=70.0, 70.0, 40.0, 62.0, 5.5, 9.5, RGB=0,128,0,
SURF_ID=CONCRETE /
&OBST XB=65.0, 70.0, 62.0, 62.0, 5.5, 9.5, RGB=0,128,0,
SURF_ID=CONCRETE /

&OBST XB=70.0, 111.0, 40.0, 40.0, 0.0, 5.5, RGB=0,128,0,
SURF_ID=CONCRETE /
&OBST XB=111.0, 111.0, 40.0, 55.0, 0.0, 5.5, RGB=0,128,0,
SURF_ID=CONCRETE /

&OBST XB=111.0, 111.0, 55.0, 56.0, 0.0, 5.5, RGB=0,128,0,
SURF_ID=CONCRETE /
&OBST XB=110.0, 111.0, 56.0, 56.0, 0.0, 5.5, RGB=0,128,0,
SURF_ID=CONCRETE /
&OBST XB=110.0, 110.0, 56.0, 57.0, 0.0, 5.5, RGB=0,128,0,
SURF_ID=CONCRETE /
&OBST XB=109.0, 110.0, 57.0, 57.0, 0.0, 5.5, RGB=0,128,0,
SURF_ID=CONCRETE /
&OBST XB=109.0, 109.0, 57.0, 58.0, 0.0, 5.5, RGB=0,128,0,
SURF_ID=CONCRETE /
&OBST XB=108.0, 109.0, 58.0, 58.0, 0.0, 5.5, RGB=0,128,0,
SURF_ID=CONCRETE /
&OBST XB=108.0, 108.0, 58.0, 59.0, 0.0, 5.5, RGB=0,128,0,
SURF_ID=CONCRETE /
&OBST XB=107.0, 108.0, 59.0, 59.0, 0.0, 5.5, RGB=0,128,0,
SURF_ID=CONCRETE /
&OBST XB=107.0, 107.0, 59.0, 60.0, 0.0, 5.5, RGB=0,128,0,
SURF_ID=CONCRETE /
&OBST XB=106.0, 107.0, 60.0, 60.0, 0.0, 5.5, RGB=0,128,0,
SURF_ID=CONCRETE /
&OBST XB=106.0, 107.0, 60.0, 60.0, 0.0, 5.5, RGB=0,128,0,
SURF_ID=CONCRETE /
&OBST XB=106.0, 106.0, 60.0, 61.0, 0.0, 5.5, RGB=0,128,0,
SURF_ID=CONCRETE /
&OBST XB=105.0, 106.0, 61.0, 61.0, 0.0, 5.5, RGB=0,128,0,
SURF_ID=CONCRETE /
&OBST XB=105.0, 105.0, 61.0, 62.0, 0.0, 5.5, RGB=0,128,0,
SURF_ID=CONCRETE /
&OBST XB=104.0, 105.0, 62.0, 62.0, 0.0, 5.5, RGB=0,128,0,
SURF_ID=CONCRETE /

&OBST XB=82.0, 105.0, 62.0, 62.0, 0.0, 5.5, RGB=0,128,0,
SURF_ID=CONCRETE /
&OBST XB=26.0, 65.0, 62.0, 62.0, 0.0, 9.5, RGB=0,128,0,
SURF_ID=CONCRETE /
&OBST XB=26.0, 26.0, 54.0, 62.0, 0.0, 5.5, RGB=0,128,0,
SURF_ID=CONCRETE /
&OBST XB=5.0, 26.0, 54.0, 54.0, 0.0, 5.5, RGB=0,128,0,
SURF_ID=CONCRETE /
&OBST XB=0.0, 5.0, 54.0, 54.0, 0.0, 9.5, RGB=0,128,0,
SURF_ID=CONCRETE /
&OBST XB=0.0, 0.0, 7.0, 54.0, 0.0, 9.5, RGB=0,128,0, SURF_ID=CONCRETE
/
&OBST XB=0.0, 0.0, 0.0, 7.0, 0.0, 5.5, RGB=0,128,0, SURF_ID=CONCRETE
/

&OBST XB=5.0, 5.0, 54.0, 62.0, 5.5, 9.5, RGB=0,128,0,
SURF_ID=CONCRETE /
&OBST XB=5.0, 26.0, 62.0, 62.0, 5.5, 9.5, RGB=0,128,0,
SURF_ID=CONCRETE /

&OBST XB=0.0, 60.0, 7.0, 7.0, 5.5, 9.5, RGB=0,128,0, SURF_ID=CONCRETE
/

First level

&OBST XB=41.0, 41.0, 7.0, 50.0, 5.5, 9.5, RGB=0,128,0,
SURF_ID=CONCRETE /
&OBST XB=41.0, 47.0, 50.0, 50.0, 5.5, 9.5, RGB=0,128,0,
SURF_ID=CONCRETE /
&OBST XB=47.0, 47.0, 50.0, 62.0, 5.5, 9.5, RGB=0,128,0,
SURF_ID=CONCRETE /


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INTERNAL WALL

Ground Level

&OBST XB=35.0, 35.0, 55.0, 62.0, 0.0, 5.5, RGB=189,252,201 / Goods
receving/marshaling
&OBST XB=35.0, 82.0, 55.0, 55.0, 0.0, 5.5, RGB=189,252,201 / Goods
receving/marshaling
&OBST XB=82.0, 82.0, 55.0, 55.0, 0.0, 5.5, RGB=189,252,201 / Goods
receving/marshaling

Level 1

&OBST XB=26.0, 26.0, 54.0, 62.0, 5.5, 9.5, RGB=189,252,201 / Goods
receving/marshaling
&OBST XB=26.0, 47.0, 54.0, 54.0, 5.5, 9.5, RGB=189,252,201 / Goods
receving/marshaling

&OBST XB=35.0, 41.0, 37.0, 44.0, 5.5, 9.5, RGB=189,252,201 /
Playground


***************

RACKING

Warehosue Level 1

Section 1 - From Left to Right

&OBST XB= 7.0, 09.0, 12.0, 40.0, 0.0, 3.0, COLOR=BROWN /
&OBST XB= 11.0, 13.0, 12.0, 40.0, 0.0, 3.0, COLOR=BROWN /
&OBST XB= 15.0, 17.0, 12.0, 40.0, 0.0, 3.0, COLOR=BROWN /
&OBST XB= 19.0, 21.0, 12.0, 40.0, 0.0, 3.0, COLOR=BROWN /
&OBST XB= 23.0, 25.0, 12.0, 40.0, 0.0, 3.0, COLOR=BROWN /
&OBST XB= 27.0, 29.0, 12.0, 40.0, 0.0, 3.0, COLOR=BROWN /
&OBST XB= 31.0, 33.0, 12.0, 40.0, 0.0, 3.0, COLOR=BROWN /
&OBST XB= 35.0, 37.0, 12.0, 40.0, 0.0, 3.0, COLOR=BROWN /
&OBST XB= 39.0, 41.0, 12.0, 40.0, 0.0, 3.0, COLOR=BROWN /
&OBST XB= 43.0, 45.0, 12.0, 40.0, 0.0, 3.0, COLOR=BROWN /
&OBST XB= 47.0, 49.0, 12.0, 40.0, 0.0, 3.0, COLOR=BROWN /
&OBST XB= 51.0, 53.0, 12.0, 40.0, 0.0, 3.0, COLOR=BROWN /
&OBST XB= 55.0, 57.0, 12.0, 40.0, 0.0, 3.0, COLOR=BROWN /
&OBST XB= 59.0, 61.0, 12.0, 40.0, 0.0, 3.0, COLOR=BROWN /
&OBST XB= 63.0, 65.0, 12.0, 40.0, 0.0, 3.0, COLOR=BROWN /


Section 2 - From Left to Right

&OBST XB= 07.0, 35.0, 44.0, 46.5, 0.0, 3.0, COLOR=BROWN /
&OBST XB= 07.0, 35.0, 48.5, 51.0, 0.0, 3.0, COLOR=BROWN /
&OBST XB= 39.0, 58.0, 44.0, 46.5, 0.0, 3.0, COLOR=BROWN /
&OBST XB= 39.0, 58.0, 48.5, 51.0, 0.0, 3.0, COLOR=BROWN /
&OBST XB= 60.0, 76.0, 44.0, 46.5, 0.0, 3.0, COLOR=BROWN /
&OBST XB= 60.0, 76.0, 48.5, 51.0, 0.0, 3.0, COLOR=BROWN /

Warehosue Level 2

&OBST XB= 06.0, 37.0, 14.0, 16.0, 5.5, 8.0, COLOR=BROWN /
&OBST XB= 09.0, 37.0, 18.0, 20.0, 5.5, 8.0, COLOR=BROWN /
&OBST XB= 09.0, 37.0, 22.0, 24.0, 5.5, 8.0, COLOR=BROWN /
&OBST XB= 09.0, 31.0, 26.0, 28.0, 5.5, 8.0, COLOR=BROWN /
&OBST XB= 09.0, 31.0, 30.0, 32.0, 5.5, 8.0, COLOR=BROWN /
&OBST XB= 09.0, 31.0, 34.0, 36.0, 5.5, 8.0, COLOR=BROWN /
&OBST XB= 09.0, 31.0, 38.0, 40.0, 5.5, 8.0, COLOR=BROWN /
&OBST XB= 09.0, 28.0, 42.0, 44.0, 5.5, 8.0, COLOR=BROWN /
&OBST XB= 09.0, 28.0, 42.0, 44.0, 5.5, 8.0, COLOR=BROWN /
&OBST XB= 09.0, 28.0, 46.0, 48.0, 5.5, 8.0, COLOR=BROWN /


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TRAVELATOR VOID

&HOLE XB=0.50, 6.00, 18.0, 49.0, 5.0, 6.0 /


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&TAIL / END FILE
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```
&HEAD CHID='Exit Signage',TITLE=time to untenable conditions. Fire
Location=Furthest point from the void, Fire size=4MW, Soot yield=0.1,
Exhaust Rate=30m³/s /
&TIME TWFIN=1200. /
&DUMP DT_PL3D=50 /
/&MISC RESTART=.TRUE. /
************************************************************
INDEX:

Outputs

Meshes

Reaction

Fire

Exhaust

Obtructions

      - Walls
      - Slabs


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OUTPUTS

Visibility Slices

Vertical slices through the fire

&SLCF PBX=17.5, QUANTITY='visibility' / Slice through the fire
&SLCF PBY=15.5, QUANTITY='visibility' / Slice through the fire
&SLCF PBY=30.0, QUANTITY='visibility' /

Horizontal slices above the fire

&SLCF PBZ=2, QUANTITY='visibility' /
&SLCF PBZ=7.5, QUANTITY='visibility' /
&SLCF PBZ=3.5, QUANTITY='visibility' /
&SLCF PBZ=9, QUANTITY='visibility' /

Temperature Slices

Vertical slices through the fire

&SLCF PBZ=2.0, QUANTITY='TEMPERATURE' /
&SLCF PBZ=7.5, QUANTITY='TEMPERATURE' /
&SLCF PBX=17.5, QUANTITY='TEMPERATURE' /
&SLCF PBY=15.5, QUANTITY='TEMPERATURE' /
&SLCF PBY=30.0, QUANTITY='TEMPERATURE' /

Horizontal slices above the fire


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MESH

&MESH IJK=225,135,20, XB=-1.0, 111.5, -2.5, 65.0, 0.0, 10.0,  / 0.5m
x 0.5m x 0.5m

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Fire Properties
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```
&REAC ID          = 'POLYURETHANE'
      SOOT_YIELD = 0.10
      N           = 1.0
      C           = 6.3
      H           = 7.1
      O           = 2.1 /

************************************************************
Fire Location and size/growth rate

&SURF ID='BURNER', HRRPUA=1000, RAMP_Q='BURNER RAMP', COLOR='RED' /
&VENT XB=103, 105, 55, 57, 1.0, 1.0, SURF_ID='BURNER' /
&OBST XB=103, 105, 55, 57, 0.0, 1.0, COLOR=BLACK /


&RAMP ID= 'BURNER RAMP', T= 0, F= 0.0000/
&RAMP ID= 'BURNER RAMP', T= 10, F= 0.0047/
&RAMP ID= 'BURNER RAMP', T= 20, F= 0.0188/
&RAMP ID= 'BURNER RAMP', T= 30, F= 0.0422/
&RAMP ID= 'BURNER RAMP', T= 40, F= 0.0750/
&RAMP ID= 'BURNER RAMP', T= 50, F= 0.1172/
&RAMP ID= 'BURNER RAMP', T= 60, F= 0.1688/
&RAMP ID= 'BURNER RAMP', T= 70, F= 0.2298/
&RAMP ID= 'BURNER RAMP', T= 80, F= 0.3001/
&RAMP ID= 'BURNER RAMP', T= 90, F= 0.3798/
&RAMP ID= 'BURNER RAMP', T= 100, F= 0.4689/
&RAMP ID= 'BURNER RAMP', T= 110, F= 0.5674/
&RAMP ID= 'BURNER RAMP', T= 120, F= 0.6752/
&RAMP ID= 'BURNER RAMP', T= 130, F= 0.7924/
&RAMP ID= 'BURNER RAMP', T= 140, F= 0.9190/
&RAMP ID= 'BURNER RAMP', T= 150, F= 1.0000/
&RAMP ID= 'BURNER RAMP', T= 1200, F= 1.0000/



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VENTS

&VENT MB='XMAX', SURF_ID='OPEN' / DOMAIN
&VENT MB='YMIN', SURF_ID='OPEN' / DOMAIN
&VENT MB='YMAX', SURF_ID='OPEN' / DOMAIN
&VENT MB='ZMIN', SURF_ID='OPEN' / DOMAIN
&VENT MB='ZMAX', SURF_ID='OPEN' / DOMAIN



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Smoke Exhaust Rate & Location

&SURF ID='exhaust',  VEL=2.5, COLOR=RED /

&VENT XB=24.0, 26.0, 16.0, 18.0, 9.5, 9.5, SURF_ID='exhaust',
DEVC_ID='fan'  /
&VENT XB=24.0, 26.0, 32.0, 34.0, 9.5, 9.5, SURF_ID='exhaust',
DEVC_ID='fan'  /
&VENT XB=24.0, 26.0, 49.0, 51.0, 9.5, 9.5, SURF_ID='exhaust',
DEVC_ID='fan'  /

&DEVC ID='fan', XYZ=25.0, 17.0, 9.5, QUANTITY='TIME', SETPOINT=91,
INITIAL_STATE=.FALSE. /
&DEVC ID='fan', XYZ=25.0, 33.0, 9.5, QUANTITY='TIME', SETPOINT=91,
INITIAL_STATE=.FALSE. /
```

```
&DEVC ID='fan', XYZ=25.0, 50.0, 9.5, QUANTITY='TIME', SETPOINT=91,
INITIAL_STATE=.FALSE. /


************************************************************

MATERIALS

&MATL ID='CONCRETE', FYI='concrete flooring', CONDUCTIVITY=1,
SPECIFIC_HEAT=0.88, DENSITY=2100, /
&SURF ID='CONCRETE', MATL_ID='CONCRETE', COLOR='GRAY', THICKNESS=0.4,
/

************************************************************
OBSTRUCTIONS

Ground level slab

&OBST XB=0.0, 60.0, 0.0, 7.0, 0.0, 0.0, COLOR=GRAY, SURF_ID=CONCRETE
/ floor
&OBST XB=0.0, 63.0, 7.0, 11.0, 0.0, 0.0, COLOR=GRAY, SURF_ID=CONCRETE
/ floor
&OBST XB=0.0, 70.0, 11.0, 40.0, 0.0, 0.0, COLOR=GRAY,
SURF_ID=CONCRETE / floor
&OBST XB=0.0, 111.0, 40.0, 54.0, 0.0, 0.0, COLOR=GRAY,
SURF_ID=CONCRETE / floor
&OBST XB=26.0, 104.0, 54.0, 62.0, 0.0, 0.0, COLOR=GRAY,
SURF_ID=CONCRETE / floor

&OBST XB=104.0, 111.0, 54.0, 56.0, 0.0, 0.0, COLOR=GRAY,
SURF_ID=CONCRETE / floor
&OBST XB=104.0, 110.0, 56.0, 57.0, 0.0, 0.0, COLOR=GRAY,
SURF_ID=CONCRETE / floor
&OBST XB=104.0, 109.0, 57.0, 58.0, 0.0, 0.0, COLOR=GRAY,
SURF_ID=CONCRETE / floor
&OBST XB=104.0, 108.0, 58.0, 59.0, 0.0, 0.0, COLOR=GRAY,
SURF_ID=CONCRETE / floor
&OBST XB=104.0, 107.0, 59.0, 60.0, 0.0, 0.0, COLOR=GRAY,
SURF_ID=CONCRETE / floor
&OBST XB=104.0, 106.0, 60.0, 61.0, 0.0, 0.0, COLOR=GRAY,
SURF_ID=CONCRETE / floor
&OBST XB=104.0, 105.0, 61.0, 62.0, 0.0, 0.0, COLOR=GRAY,
SURF_ID=CONCRETE / floor

First Floor Slab

&OBST XB=0.0, 60.0, 0.0, 7.0, 5.5, 5.5, RGB=105,105,105,
SURF_ID=CONCRETE / floor
&OBST XB=0.0, 63.0, 7.0, 11.0, 5.5, 5.5, RGB=105,105,105,
SURF_ID=CONCRETE / floor
&OBST XB=0.0, 70.0, 11.0, 40.0, 5.5, 5.5, RGB=105,105,105,
SURF_ID=CONCRETE / floor
&OBST XB=0.0, 111.0, 40.0, 54.0, 5.5, 5.5, RGB=105,105,105,
SURF_ID=CONCRETE / floor
&OBST XB=26.0, 104.0, 54.0, 62.0, 5.5, 5.5, RGB=105,105,105,
SURF_ID=CONCRETE / floor

&OBST XB=104.0, 111.0, 54.0, 56.0, 5.5, 5.5, RGB=105,105,105,
SURF_ID=CONCRETE / floor
&OBST XB=104.0, 110.0, 56.0, 57.0, 5.5, 5.5, RGB=105,105,105,
SURF_ID=CONCRETE / floor
&OBST XB=104.0, 109.0, 57.0, 58.0, 5.5, 5.5, RGB=105,105,105,
SURF_ID=CONCRETE / floor
&OBST XB=104.0, 108.0, 58.0, 59.0, 5.5, 5.5, RGB=105,105,105,
SURF_ID=CONCRETE / floor
&OBST XB=104.0, 107.0, 59.0, 60.0, 5.5, 5.5, RGB=105,105,105,
SURF_ID=CONCRETE / floor
&OBST XB=104.0, 106.0, 60.0, 61.0, 5.5, 5.5, RGB=105,105,105,
SURF_ID=CONCRETE / floor
&OBST XB=104.0, 105.0, 61.0, 62.0, 5.5, 5.5, RGB=105,105,105,
SURF_ID=CONCRETE / floor

&OBST XB=05.0, 26.0, 54.0, 62.0, 5.5, 5.5, RGB=105,105,105,
SURF_ID=CONCRETE / floor


Roof

&OBST XB=0.0, 41.0, 7.0, 50.0, 9.5, 10, RGB=128,0,0, SURF_ID=CONCRETE
/ floor
&OBST XB=0.0, 47.0, 50.0, 54.0, 9.5, 10, RGB=128,0,0,
SURF_ID=CONCRETE / floor
&OBST XB=5.0, 47.0, 50.0, 62.0, 9.5, 10, RGB=128,0,0,
SURF_ID=CONCRETE / floor


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BOUNDING WALLS - Starting at point 0.0 and working anti-clockwise

&OBST XB=0.0, 60.0, 0.0, 0.0, 0.0, 5.5, RGB=0,128,0, SURF_ID=CONCRETE
/
&OBST XB=60.0, 60.0, 0.0, 7.0, 0.0, 5.5, RGB=0,128,0,
SURF_ID=CONCRETE /
&OBST XB=60.0, 63.0, 7.0, 7.0, 0.0, 9.5, RGB=0,128,0,
SURF_ID=CONCRETE /
&OBST XB=63.0, 63.0, 7.0, 11.0, 0.0, 9.5, RGB=0,128,0,
SURF_ID=CONCRETE /
&OBST XB=63.0, 70.0, 11.0, 11.0, 0.0, 9.5, RGB=0,128,0,
SURF_ID=CONCRETE /
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First level

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**********

INTERNAL WALL

Ground Level

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receving/marshaling

Level 1

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receving/marshaling
```

```
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Playground


**********

RACKING

Warehosue Level 1

Section 1 - From Left to Right

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Section 2 - From Left to Right

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Warehosue Level 2

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**********

TRAVELATOR VOID

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**********

&TAIL / END FILE
```

Due to the long periods reported and their extreme variability, very conservative default times should be used. For occupants close to the fire, within a private dwelling, it is considered that design pre-movement times could be as short as 5 min to 10 min for well-managed situations (where occupants have well-maintained smoke detectors and a family fire game plan) [22]. In practice, flaming fires can produce lethal conditions within this time period so individual response times must be shorter in many cases, but there is an annual rate of approximately 6 000 smoke exposure injuries in dwellings.

For sleeping and unfamiliar scenarios such as hotels, it is considered that occupants cannot be relied upon to evacuate efficiently without management intervention. Even for a well-managed occupancy with a well-designed warning system, it is suggested that default 1st percentile pre-movement time should be 15 min. For managed occupancies, somewhat shorter times may be appropriate if occupants are well trained.

C.5 D and E medical care, transportation

Medical day centres and clinics are considered as a form of awake and unfamiliar. Hospitals, nursing homes and old peoples' homes are considered as a form of sleeping and unfamiliar. Where occupants are disabled, pre-movement times can depend upon the availability of staff to assist evacuation. Buildings associated with transportation (railway or bus stations and airports) are considered a form of awake and unfamiliar. These are often very complex spaces so particular consideration should be given to staff training and wayfinding issues for other occupants.

Annex D (normative)
Guidance on travel speeds and flow rates

D.1 Horizontal travel speeds

Unimpeded walking speeds are typically quoted as being around 1.2 m/s. For example, Pauls in [11] quotes 1.25 m/s, based on empirical studies in office buildings. Nelson and Mowrer [10] quote 1.19 m/s – their method is derived from the work of Fruin [36], Pauls in [11], and Predtechenskii and Milinskii [37].

Ando *et al.* [38] studied travellers in railway stations, and found that unimpeded walking speed varied with age and sex. The speed/age distributions for males and females were unimodal and positivaly skewed, both peaking at around 20 years of age (males at about 1.6 m/s and females at about 1.3 m/s).

Thompson and Marchant [26] developed new techniques for analysing video footage of crowd movement, and derived a method for modelling the movement of individual people based on the inter-personal distance between them. (This became the basis of the SIMULEX model). From this work, Thompson and Marchant [26] suggested that the "interference threshold" is 1.6 m, such that when the separation between individuals is greater than this, their walking velocity is unaffected. They quote unimpeded walking speeds of around 1.7 m/s for males and 0.8 m/s for females (the median value being 1.4 m/s). According to this model, the velocity decreases as the interpersonal distance decreases (below 1.6 m), reaching zero when the individuals are tightly packed, such that the interpersonal distance is equal to their body-depth.

Guidance on the effects occupant density on walking speeds is presented in Nelson and Mowrer [10]. If the population density is less than 0.54 persons/m^2 of exit route, individuals move at their own pace, independent of the speed of others. Movement ceases when population density exceeds 3.8 persons/m^2. Between these limits, speed is given by equation (D.1):

$$S = k - akD \qquad \text{(D.1)}$$

where:

S = speed along the line of travel;
D = density in persons/m^2;
k = 1.4 for horizontal travel;
a = 0.266.

D.2 Vertical travel speeds

Ando *et al.* [38] quoted unimpeded velocities on stairs of about 0.8 m/s for travel downwards and 0.7 m/s for travel upwards.

Fruin [36] (cited in Gwynne *et al.* [28]) presented a range of values for travel speed on stairs, according to age and sex. For travel downwards, these ranged from 1.01 m/s for males under 30 years, to 0.595 m/s for females aged over 50. For travel upwards, they ranged from 0.67 m/s for males under 30, to 0.485 m/s for females over 50. Fruin's figures are calculated from observations made on two staircases, one with 7 inch risers and 11.25 inch treads, and one with 6 inch risers and 12 inch treads. Travel speeds up and down were faster for the stairs with the smaller rise height.

Nelson and Mowrer [10] present travel speeds for four different stair designs (of rise height between Metrificate 6.5 and 7.5 inches, and tread between 10 and 13 inches). They give travel speeds ranging from 0.85 m/s to 1.05 m/s, with speed increasing as rise height decreases. There was no differentiation between upwards and downwards travel, nor were the data broken down by sex and age.

The effects of density on vertical travel speeds is given by equation (A.1) using different constants for k as shown in Table D.1.

Table D.1 — Constants for equation (A.1) (effects of density on travel speed), maximum unimpeded travel speeds (m/s) and flow rates (persons/s/m of effective width) for horizontal and stair travel

Exit route element mm		k	speed	flow
Corridor, aisle, ramp, doorway		1.40	1.19	1.3
Riser mm	Tread mm			
191	254	1.00	0.85	0.94
178	279	1.08	0.95	1.01
165	305	1.16	1.00	1.09
165	330	1.23	1.05	1.16

D.3 Maximum flow rates

Table D.2 shows a summary of maximum exit flow rates from the literature (reproduced from Thompson and Marchant [26]. Table D.3 shows the implicit flow rates in ADB.

Approved Document B (ADB) [1], provides guidance on meeting the requirements of the England and Wales Building Regulations with regard to fire safety, including means of escape. The third column of the table shows the implicit maximum flow rate capacity for the stated population to pass through the exits assuming the population passes through in 2.5 min.

The maximum design sustained flow capacity implicit in ADB (and in BS 5588-0) for an enclosure with a population in excess of 220 is 1.33 persons/m/s, where the width is the clear width. This contrasts with the more conservative value in Nelson and Mowrer of 1.3 persons/m/s, where 2 × 0.15 m boundary layers are subtracted from the actual width to provide the effective width. For example, a one metre wide doorway would provide a maximum design flow rate of 0.91 persons/m/s.

Paula has suggested that the derivation of the higher flow rate limits shown in Table D.2 may not be truly representative of actual building evacuations. The more conservative Nelson and Mowrer data have therefore been used for the worked example shown here. Different flow rates are given for stair than for horizontal escape routes in Nelson and Mowrer, while no allowance for reduced flow rates on stairs is made in ADB (or in the Scotland and Ireland Guidance Documents).

Using the ADB design flow rates, the time required for occupants to flow out of a prescriptively designed enclosure containing a maximum design population is 150 s (2.5 min). For the worked example case which has a population of 900 and four available exits each 1.125 m in width, the Nelson and Mowrer [10] method gives a design flow time of 210 s (3.5 min).

Table D.2 — Summary of maximum flow rates (reproduced from Thompson and Marchant [26])

Source	Maximum design flow persons/m/s	Ultimate flow capacity persons/m/s	Comments
Check Scot and NI 5588-11 Approved Document B	1.33[a]		Standard British code for buildings
SCICON report	1.37		Data from football crowds
Guide to Safety at Sports Grounds	1.82[b]		Based on Japanese data and derived from 60 persons/0·55 m/min unit exit width calculation
Hankin and Wright	1.48	1.92	Commuters on the London Underground
Fruin	1.37	4.37	Max. flow is a peak regimented, "funnelled" flow under pressure
Daly	1.43		For underground stations
Ando *et al.*		1.7 – 1.8	Japanese commuters at railway stations
Fire and Buildings, The Aqua Group	1.5		General design text
Predtechenskii and Milinskii		1.83	"emergency conditions" for adults in mid-season dress
SFPE handbook (Nelson and Mowrer)	1.3[c]		2 × 0·15 m boundary layers deducted from width of exit
Polus *et al.*	1.25 – 1.58	1.58	Pedestrian movement on sidewalks in Israel

[a] Derived from exit capacities.
[b] Unit exit width method.
[c] Effective width method.

Table D.3 — Maximum flow capacities from ADB [17]

Maximum number of persons	Minimum width mm	Maximum flow capacity persons/s/m
50	750	0.44
110	850	0.86
220	1 050	1.40
More than 220	5 per person	1.33

Below the maximum flow capacity, flow rates depend upon occupant density and travel speeds. The formula for specific flow (number of persons evacuating past a point per metre of effective width per second) is shown in equation (D.2):

$$F_S = SD \qquad \text{(D.2)}$$

where:

F_S = specific flow;
D = density;
S = speed.

Combining equations (D.1) and (D.2) gives (D.3):

$$F_S = (1 - aD)kD \qquad \text{(D.3)}$$

where k is obtained from Table D.1.

As population density increases, specific flow increases up to a maximum density of 1.9 persons/m^2. At higher densities, the flow rate falls off to zero at 3.77 persons/m^2.

Maximum specific flow rates for stairs are shown in Table D.1.

APPENDIX H – Fire Brigade Intervention Model (FBIM)

Version: 01.00-6/2006

Bunnings Warehouse Balgowlah
Scenario - Fire Brigade Intervention Model (FBIM)
Country - Australia

Job No. s29026-002-fe
Date 27/05/2011
Designer Michael Greenwood

Determining Nearest Fire Station in NSW

References:
1. Australian Fire Authorities Council, 'Fire Brigade Intervention Model', Edition 2004
2. Metropolitan Fire & Emergency Services Board, 'Guideline GL-17 General Provisions', MFESB, Dated 24 June 2003
3. ABCB, 'International Fire Safety Engineering Guidelines', Edition 2005, Chapter 1.9

Multimap ——————> http://www.multimap.com/map/home.cgi?db=AU&client=public&advanced=
Coordinate Converter —> http://www.dcb.gov.au/erin/tools/geo2amg.html
Aus Street Directory —> http://www.street-directory.com.au/sd_new/home.cgi

Input Data

Site AMG Co-ordinates
Easting - 339445.7485 "E" <—— enter Easting here
Northing - 6259831.777 "N" <—— enter Northing here

Building Name	Bunnings Warehouse, Balgowlah
Site Address	164 Condamine Street
Suburb	Balgowlah
Post Code	2093
State	New South Wales

Output Results

Station Name	Station Address	Suburb	Post Code	AMG's E	AMG's N
MANLY	128 Sydney Rd	FAIRLIGHT	2094	3402	62591
DEE WHY	38 Fisher Rd (Cnr Lewis St)	DEE WHY	2099	3412	62644
MOSMAN	730 Military Rd	MOSMAN	2088	3375	62553
FORESTVILLE	8 Cook St	FORESTVILLE	2087	3350	62629

Station Name	Radial Distance (km)
MANLY	1.05
DEE WHY	4.89
MOSMAN	4.93
FORESTVILLE	5.40

Response Time

Region Classification: Major city outer suburb
Detection Time: 60 sec
Accuracy: 90%

Station Name	Alarm Activation Time (sec)	Fire Fighter Response (sec)	Travel Time to Scene (sec)	Arrival on Kerb (sec)
MANLY	60	Included in table F2	409	469
DEE WHY	60	Included in table F2	1903	1963
MOSMAN	60	Included in table F2	1918	1978
FORESTVILLE	60	Included in table F2	2101	2161

W:\s29026\s29026002\fe\02_design_calc\stocns\FBIM Balgowlah.xlsm
FBIM NSW

STEVE WATSON & PARTNERS

DEVELOPMENT CONSENT CHECKLIST REQUIREMENTS FOR CERTIFICATION

PROJECT: Bunnings Warehouse - Balgowlah | SWP JOB NUMBER: 2008/743 | DA # 16/10

This checklist identifies the requirements necessary to permit Construction and Occupation Certificates (CC's and OC's) to be issued by SWP under Part 4a of the EP&A Act.
The checklist must be read in conjunction with the Development Consent and any S96 modifications
The applicant must manage compliance with the Consent and provide the nominated deliverables at each stage

Note that the conditions cannot be set aside except by a formal S96 application to Council

S96 #1 08.03.11
S96 #2 22.03.11
S96 #3 23.08.11
S96 #4 dated

SWP USE ONLY

Keep notes for items in progress
Identify what was received from whom in each box to close out requirem
Put a flag in the MIR columns if an inspection is needed
Otherwise columns can stay blank until items are received.

DA #	Issue	Deliverables prior to CC	Deliverables prior to commencement of works	Deliverables during construction	Deliverables prior OC	Independent approval required if so who?	Notes	Status Early Works CC1 (Demo only)	Status Early Works CC2 (Excavation, piling / shoring)	Status Main Works CC3 (Basement structure - in Zone A ONLY)
ANS22	Carparking	Design Certification from Traffic / Civil Engineer to AS2890.1-2004 for the carpark to be provided to SWP.			Completion statement by Traffic / Civil Engineer to AS2890.1-2004 for the carpark to be provided to SWP.					Design Certificate 20110042 from MGP.
ANS33	Driveway widths	Access and egress driveway widths as outlined in this conditioned to be detailed on the Civil plans and a Design Certificate for the driveways to AS2890.1-2004 is to be provided to SWP.								Certificate 20110042 from MGP received 08.07.11 and JRB cert dated 24.06.11.
ANS46	Contamination Site Validation Zone A	Copy of RAP version 4 ref 11022RP04_v04 dated 12 Aug 2011 to be provided to SWP. Evidence of Council approval and copy of the Validation and Monitoring report to be provided to SWP.				Council	Copy of RAP dated 12.08.11 received. Copy of SAR received 16.09.11 saved in job file.			Email from Council dated 15.09.11, SAS for Zone A dated 15.09.11.
10	Structural Engineers design and drawings	Structural Engineering drawings and Design Certification to be provided to SWP for CC issue.							Structural drawings and design cert dated 12.04.11 received.	Structural certificate and drawings in CC03 package.

08/0743/03
Construction Certificate
Accredited Body Consulate #ABC21

DA #	Issue	Deliverables prior to CC	Deliverables prior to commencement of works	Deliverables during construction	Deliverables prior OC	Independent approval required if so who?	Notes	Status Early Works CC1 (Demo only)	Status Early Works CC2 (Excavation, piling / shoring)	Status Main Works CC3 (Basement structure - in Zone A ONLY)
11	Stormwater management	Evidence of Council approval of the Stormwater management plan is to be provided to SWP with the approved plan.				Council				Email from Council dated 16.08.11, Design cert from MGP dated 03.07.11, and plan in CC03 package.
12	OSD	Evidence of Council approval of the onsite stormwater detention system is to be provided to SWP with the approved plans.				Council				Email from Council dated 16.08.11, Design cert from MGP dated 03.07.11, and plan in CC03 package.
15	Rainwater tanks	Design Certificate from Hydraulic Engineer for the rainwater tank to be provided to SWP referencing the nominated standards.								Design Certificate from MGP dated 23.06.11.
23	Driveway / access ramps / carparking	Design Certificate from Traffic / Civil Engineer to be provided to SWP referencing compliance with AS/NZS2890.1:2004.			Completion statement by Traffic / Civil Engineer to AS2890.1-2004 to be provided to SWP.		See also ANS22			Design Certificate 20110042 from MGP.
24	Surfaced and sealed	Surface details of driveways, carpark and pedestrian paths to be provided to SWP.								Email from SCP dated 01.09.11.
26	Vehicular movements in a forward direction	Vehicular movement paths plans and design Certificate from Traffic / Civil Engineer to be provided to SWP.					Condition also satisfies ANS24.			Swept path diagrams received 08.07.11. Design Certificate 20110042 from MGP.

DA #	Issue	Deliverables prior to CC	Deliverables prior to commencement of works	Deliverables during construction	Deliverables prior OC	Independent approval required if so who?
30	Waste Management plan	Waste management plan in accordance with Many DCP 2000 detailing both demo and construction wastes to be provided to SWP.				

Notes	Status Early Works CC1 (Demo only)	Status Early Works CC2 (Excavation, piling / shoring)	Status Main Works CC3 (Basement structure - In Zone A ONLY)
	WMP for demo dated 04.02.11.	WMP by Bingo Group.	WMP by Bingo Group.

Satisfaction of DA Conditions

Prior to CC *Prior to OC*

Checked by _____ *sign and dated* _____

Verified by _____ *sign and dated* _____

#23,26,AN533,AN52

Suite 9/6 Tilley Lane
Frenchs Forest NSW 2086
T 02 9451 7555
F 02 9451 8555
E mail@mgpartners.com.au

mgp
building & infrastructure services pty ltd
abn 83 455 645 810

2011 0042

Southern Cross Group
135-153 New South Head Road
Edgecliff NSW 2027

Attention: Mr Matthew McEwan

Dear Sir

RE: BUNNINGS BALGOWLAH
ACCESS RAMP AND DRIVEWAY

The design of the driveway/access ramp grades, access and car parking facilities comply with the Australian/New Zealand Standard AS/NZS 2890.1:2004 -Parking facilities - off street car parking.

Yours faithfully

For and on behalf of MGP Pty Ltd

Sam Haddad

MIEAust CPEng NPER

08/0743/03

plumbo ergo sum

Sydney WATER Accredited Supplier

AHSCA Corporate Member

IQMS APPROVED COMPANY ISO 9001 Quality Management Systems

AWPM Key Personnel Sydney Water - WSC

#ANS33

EST · 1927

JOHN R. BROGAN & ASSOCIATES
ARCHITECTS, PLANNERS & COMMERCIAL INTERIOR DESIGNERS

37 PITT STREET SYDNEY NSW 2000
TEL (02) 9221 2833 FAX (02) 9251 4741

24 June 2011

DESIGN STATEMENT FOR ARCHITECTURAL ITEMS

Project	:	Bunnings Warehouse Balgowlah
Address	:	164 Condamine St Balgowlah Lots 1 & 2 in DP 533586, Lot 15 in DP 532064, Lot 2 in DP 562483
DA Consent No.#	:	16/2010, 03 Aug 2010
Section 96 Approvals	:	09 March 20111 16/10 N:Admin 12 April 2011 NS

DA Condition No.#: ANS 33 - Driveway widths shall be provided as per AS 2890.1
Access driveway at Condamine St shall have min 8m wide entry & 6m wide exit, separated by 1m wide median
Access driveway at Roseberry St shall have min 6m wide entry & exit with min 1m separation median

It is hereby certified that the layout of the vehicle crossings to Condamine St and Balgowlah Rd satisfy the requirements of the Nominated Standard of Performance and DA Condition No#'s ANS 33

Criteria and/or System	**Standard of performance**
1. General Vehicle Access requirements	2890.1 & 2890.2

I am a properly qualified person and have a good working knowledge of the relevant codes and standards referred to above. My qualifications and accreditations are listed below:

n. mordevic

Doug Djordjevic.
B. Arch, UNSW, (Hons.)
Registered Architect in NSW, registration number 6925.
RAIA
John R Brogan & Associates Pty Limited

GB/0743/03

DD:lc:36221

#ANS46.
SAS attached.
Full SAR saved in jobs file.

Bradley Collits

From: Ben Isenhood [bisenhood@southerncrossgroup.net]
Sent: Friday, 16 September 2011 2:46 PM
To: Bradley Collits
Cc: Liam Linehan; Matt Fisk; Peter Munnings
Subject: FW: 164 Condamine - DA 16/2011 - Staged Validation - Approval of Validatation and Monitoring Report for Zone A

Hi Brad,

See below Councils satisfaction for **DA Condition ANS46** !....Please issue our Stage 3 Construction Certificate.

Thanks Mate

Regards
Ben

From: Steven Gillies [mailto:Steven.Gillies@manly.nsw.gov.au]
Sent: Friday, 16 September 2011 2:40 PM
To: Ben Isenhood
Subject: 164 Condamine - DA 16/2011 - Staged Validation - Approval of Validatation and Monitoring Report for Zone A

Good Afternoon Ben,

The Environmental Health Unit has reviewed the following documents prepared by Cavvanba Consulting Pty Ltd:

Site Audit Report – September 2011 ref: 11081
Site Audit Statement -number: 0103-1101 15 Dated: 15/9/11

Please be advised that no objection is raised to the issue of a stage 2 Construction Certificate for works to be undertaken within zone A.

Kind regards,

Steven Gillies
Environmental Health Officer
Manly Council

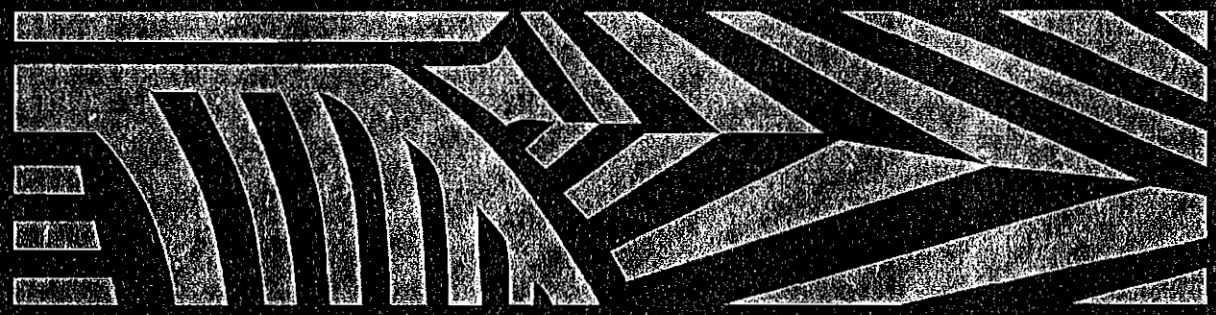
Land Use and Sustainability
Manly Council

1 Belgrave Street Manly NSW 2095 | PO Box 82 Manly NSW 1655 | Direct 9976 1594
Switch 9976 1500 | Fax 9976 1400 | steven.gillies@manly.nsw.gov.au | www.manly.nsw.gov.au

Site Audit Report 0103 - 1101

Balgowlah Road, Balgowlah NSW

September 2011, Ref. 11081



CAVVANBA
consulting

Cavvanba Consulting Pty Ltd
1/66 Centennial Circuit
PO Box 2191
Byron Bay NSW 2481

ABN: 37 929 679 095
t: (02) 6685 7811
f: (02) 6685 5083
inbox@cavvanba.com

NSW Site Auditor Scheme
SITE AUDIT STATEMENT

NSW GOVERNMENT | Environment, Climate Change & Water

A site audit statement summarises the findings of a site audit. For full details of the site auditor's findings, evaluations and conclusions, refer to the associated site audit report.

This form was approved under the Contaminated Land Management Act 1997 on 1st June 2010. For more information about completing this form, go to Part IV.

PART I: Site audit identification

Site audit statement number: 0103 - 1101

This site audit is a:

☒ statutory audit

☐ ~~non-statutory audit~~

within the meaning of the *Contaminated Land Management (CLM) Act* 1997

Site auditor details: (as accredited under the CLM Act)

Name:	Marc Christian Salmon	Company:	Cavvanba Consulting Pty Ltd
Address:	1 / 66 Centennial Circuit		
	Byron Bay NSW	Postcode:	2481
Telephone:	(02) 6685 7811	Facsimile:	(02) 6685 5083

Site details:

Address: 164 - 172 Condamine Street and 1A Roseberry Street

Balgowlah NSW Postcode: 2093

Property description (attach a list if several properties are included in the site audit):

Part of lots: Lot 2 DP562483, Lot 15 DP 532064, and Lot 1 and Lot 2 DP533586, as shown in the attached Site Audit Figure 1

Local Government Area:	Manly Shire
Area of site (e.g. ha):	Approximately 5,950 m^2 (Zone A)
Current zoning:	4 (industrial)

To the best of my knowledge, the site:

☐ ~~is~~

☒ is not

the subject of a declaration, order, agreement, proposal or notice under the CLM Act or the *Environmentally Hazardous Chemicals (EHC) Act* 1985.

Site audit commissioned by:

Name:	Mr. Nick Mullins	Company:	Bunnings Group Limited
Address:	11 Shirley Street Rosehill NSW	Postcode:	2142
Telephone:	02 9846 7270	Facsimile:	02 9846 7530

~~Name and phone number of contact person (if different from above):~~

Purpose of site audit

A ☒ To determine land use suitability (specify intended use/s):

commercial/industrial.

~~Or~~

~~B(i)~~ ☐ ~~To determine the nature and extent of contamination, and/or~~

~~B(ii)~~ ~~To determine the appropriateness of:~~

☐ ~~an investigation report: Remediation and Validation Reports~~

☐ ~~remedial action plan, and/or~~

☐ ~~management plan, and/or~~

~~B(iii)~~ ☐ ~~To determine if the land can be made suitable for a particular use or uses by implementation of a specified:~~

☐ ~~remedial action plan, and/or~~

☐ ~~management plan~~

~~(please specify intended use/s):~~

Information sources for site audit

Consultancy(ies) which conducted the site investigation(s) and/or remediation:

Environmental Investigation Services;

Environmental Strategies;

Aargus; and

P. Clifton & Associates.

Title(s) of report(s) reviewed:

Assessments

- Aargus (June 2011b) *Validation Plan, Corner Condamine Street and Balgowlah Road, Balgowlah NSW*, (Ref. ES4234/6), letter report;
- Aargus (September 2011c) *Validation Report for Zone A, Condamine Street and Balgowlah Road, Balgowlah NSW*, version 2, (Ref. ES4234/6);
- Aargus (September 2011d), *Re: Site Auditor Response, 0103-1101-09, Balgowlah Road, Balgowlah NSW*, (Ref. ES4234/6), letter report;
- Aargus (September 2011e), *Re: Site Auditor Response, 0103-1101-010, Balgowlah Road, Balgowlah NSW*, (Ref. ES4234/6), letter report;

- Aargus (September 2011f), *Re: Site Auditor Response, 0103-1101-011, Balgowlah Road, Balgowlah NSW*, (Ref. ES4234/6), letter report;

- Environmental Investigation Services (EIS) (June 2008) *Environmental Site Assessment of Soil and Groundwater, Proposed Commercial Development, Cnr Condamine Street and Balgowlah Road, Balgowlah NSW,* (Ref. E2209091KRPT);

- EIS (July 2009a) *Additional Environmental Site Assessment of Soil and Groundwater, Proposed Commercial Development, Cnr Condamine Street and Balgowlah Road, Balgowlah NSW* (Ref. E2209091Krpt2);

- EIS (July 2009b) *Environmental Site Assessment of Soil and Groundwater, Proposed Commercial Development, 1A Roseberry Street, Balgowlah NSW*, (Ref. E2209091Krpt3); and

- EIS (July 2009c) *Addendum to Environmental Site Assessment, Cnr Condamine Street & Balgowlah Road, Balgowlah*, (Ref. E22091K-Let), letter report.

RAPs

- Aargus (February 2011a) *Remediation Action Plan, Condamine Street & Balgowlah Road, Balgowlah NSW*, (Ref. ES4046);

- Environmental Strategies (ES) (April 2011c) *Underground Storage Tank Remedial Action Plan, 164 Balgowlah Road, Balgowlah, New South Wales* (Ref. 11022RP04_v01); and

- ES (May 2011d) *Remedial Action Plan, 164 Balgowlah Road, Balgowlah, New South Wales* (Ref. 11022RP04_v03).

OH&S Plans

- ACE Demolition & Excavation (March 2011a) *Safe Work Method Statement, Part 1 to Part 5*, (Ref. SWMS No. 1, Revision 1, 10/03/2011);

- ACE Demolition & Excavation (April 2011b) *Safe Work Method Statement, Part 1 to Part 5*, (Ref. SWMS No. 1, Revision 2, 18/04/2011);

- ES (March 2011a) *Occupational Health and Safety Plan - Contaminated Soil CC01: Partial Excavation of Potentially Contaminated Soil, 164 Condamine Street, Balgowlah NSW 2093*, (Ref. 10022RP01_v05 OHS Plan);

- ES (April 2011b) *Occupational Health and Safety Plan - Contaminated Soil & Groundwater (OHSP – CC02), 164 Condamine Street, Balgowlah NSW 2093, CC02 – Excavation of Potentially Contaminated Fill and Exposure of Potentially Contaminated Groundwater*, (Ref. 10022RP02_v02);

- Southern Cross Projects (SCP) (December 2010) *Project Safety Management Plan, Bunnings Warehouse Balgowlah, 164 Condamine Street, Balgowlah NSW 2093*;

- SCP (March 2011a) *Construction Management Program, Bunnings Warehouse Balgowlah, 164 Condamine Street, Balgowlah NSW 2093*;

- SCP (March 2011b) *Contaminant Control Plan, Bunnings Balgowlah*;

- SCP (March 2011c) *Site Contamination Management Plan, Procedures and Methodologies*;

- SCP (April 2011d) *Project Safety Management Plan, Bunnings Warehouse Balgowlah, 164 Condamine Street, Balgowlah NSW 2093*; and
- SCP (April 2011e) *Proposed Excavation Sequencing, Demolition Plan*.

Asbestos reports

- P. Clifton & Associates (PCA) (4 May 2011a) *Re: Inspection of asbestos contaminated soil, Bunnings construction site, Cnr Condamine Street & Balgowlah Road, Balgowlah NSW*, (Ref. PCA2645-2011_LET01_4May11);
- PCA (13 May 2011b) *Re: Airborne asbestos fibre monitoring report, Bunnings construction site, Cnr Condamine Street & Balgowlah Road, Balgowlah NSW*, (Ref. PCA2645-2011_AMLET01_13May11);
- PCA (14 May 2011c) *Re: Airborne asbestos fibre monitoring report, Bunnings construction site, Cnr Condamine Street & Balgowlah Road, Balgowlah NSW*, (Ref. PCA2645-2011_AMLET02_14May11);
- PCA (16 May 2011d) *Re: Airborne asbestos fibre monitoring report, Bunnings construction site, Cnr Condamine Street & Balgowlah Road, Balgowlah NSW*, (Ref. PCA2645-2011_AMLET03_16May11);
- PCA (16 May 2011e) *Re: Visual asbestos removal clearance certification, Bunnings construction site, Cnr Condamine Street & Balgowlah Road, Balgowlah NSW*, (Ref. PCA2645-2011_CLRLET01_16May11);
- PCA (17 May 2011f) *Re: Letter report on in-situ classification of subsoil at Bunnings construction site, Cnr Condamine Street & Balgowlah Road, Balgowlah NSW*, (Ref. PCA2645-2011_VENMCLASSLET01_16May11);
- Safe Work & Environments (SWE) (6 April 2011) *Control monitoring for airborne asbestos fibres results,* (Ref. MDD-S101142-AsbestosAirMonitoringResults-050411);
- SWE (7 April 2011b) *Control monitoring for airborne asbestos fibres results*, (Ref. MDD-S101142-AsbestosAirMonitoringResults-060411);
- SWE (8 April 2011c) *Control monitoring for airborne asbestos fibres results*, (Ref. MDD-S101142-AsbestosAirMonitoringResults-070411);
- SWE (10 April 2011d) *Control monitoring for airborne asbestos fibres results,* (Ref. S101142-AsbestosAirMonitoringResults-080411);
- SWE (10 April 2011e) *Clearance certificate for asbestos removal corner Balgowlah and Condamine Streets, Balgowlah, NSW 2093,* (Ref. S101142-ClearanceCertificate-080411);
- SWE (12 April 2011f) *Control monitoring for airborne asbestos fibres results*, (Ref. S101142-AsbestosAirMonitoringResults-110411); and
- SWE (12 April 2011g) *Clearance certificate for asbestos removal Bunnings site/former vehicle dealership facility, Cnr Condamine Street and Balgowlah Road, Balgowlah, NSW 2093,* (Ref. S101142-ClearanceCertificate-120411).

Other information reviewed (including previous site audit reports and statements relating to the site):

Relevant published soil and geological maps, topographic maps, etc.

Site audit report

- Cavvanba Consulting (September 2011) *Site Audit Report 0103 – 1101, Balgowlah Road, Balgowlah NSW*, (Ref. 11081).

PART II: Auditor's findings

Please complete either Section A or Section B, not both. (*Strike out the irrelevant section.*)

Use Section A where site investigation and/or remediation has been completed and a conclusion can be drawn on the suitability of land use(s).

Use Section B where the audit is to determine the nature and extent of contamination and/or the appropriateness of an investigation or remedial action or management plan and/or whether the site can be made suitable for a specified land use or uses subject to the successful implementation of a remedial action or management plan.

~~**Section A**~~

☒ **I certify that, in my opinion, the site is SUITABLE for the following use(s)** (*tick all appropriate uses and strike out those not applicable*):

- ☐ ~~Residential, including substantial vegetable garden and poultry~~
- ☐ ~~Residential, including substantial vegetable garden, excluding poultry~~
- ☐ ~~Residential with accessible soil, including garden (minimal home grown produce contributing less than 10% fruit and vegetable intake), excluding poultry~~
- ☐ ~~Day care centre, preschool, primary school~~
- ☐ ~~Residential with minimal opportunity for soil access, including units~~
- ☐ ~~Secondary school~~
- ☐ ~~Park, recreational open space, playing field~~
- ☒ Commercial/industrial
- ☐ ~~Other (specify intended use/s):~~

~~**subject to compliance with the following environmental management plan in light of contamination remaining on the site:**~~

~~**Or**~~

☐ ~~**I certify that, in my opinion, the site is NOT SUITABLE for any use due to the risk of harm from contamination.**~~

Overall comments

Elevated metals, including lead, were detected above the groundwater reporting concentrations in GW1 in Zone B (part of site but not the subject of this SAS). Results appear inconsistent with previous site data, however the well was destroyed before confirmation sampling and analysis could be conducted. Additional assessment of groundwater in Zone B is required to confirm if groundwater impacts exist.

Section B

Purpose of the plan which is the subject of the audit:

Long term site environmental management plan for the management and monitoring of onsite containment of contaminated soil.

I certify that, in my opinion:

☐ the nature and extent of the contamination HAS/HAS NOT* been appropriately determined

AND/OR

☐ the investigation/remedial action plan/management plan* IS/IS NOT* appropriate for the purpose stated above

AND/OR

☐ the site CAN BE MADE SUITABLE for the following uses (tick all appropriate uses and strike out those not applicable):

- ☐ Residential, including substantial vegetable garden and poultry
- ☐ Residential, including substantial vegetable garden, excluding poultry
- ☐ Residential with accessible soil, including garden (minimal home grown produce contributing less than 10% fruit and vegetable intake), excluding poultry
- ☐ Day care centre, preschool, primary school
- ☐ Residential with minimal opportunity for soil access, including units
- ☐ Secondary school
- ☐ Park, recreational open space, playing field
- ☐ Commercial/industrial
- ☐ Other (please specify):

if the site is

- ☐ remediated
- ☐ managed

in accordance with the following remedial action plan/management plan (insert title, date and author of plan):

Subject to compliance with the following condition(s)

Overall comments:

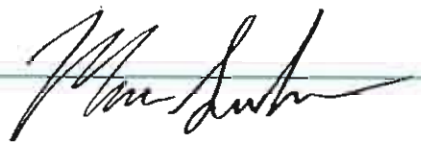
PART III: Auditor's declaration

I am accredited as a site auditor by the NSW Environment Protection Authority under the *Contaminated Land Management Act* 1997 (Accreditation No. 0103).

I certify that:

- I have completed the site audit free of any conflicts of interest as defined in the *Contaminated Land Management Act* 1997, and
- with due regard to relevant laws and guidelines, I have examined and am familiar with the reports and information referred to in Part I of this site audit, and
- on the basis of inquiries I have made of those individuals immediately responsible for making those reports and obtaining the information referred to in this statement, those reports and that information are, to the best of my knowledge, true, accurate and complete, and
- this statement is, to the best of my knowledge, true, accurate and complete.

I am aware that there are penalties under the *Contaminated Land Management Act* 1997 for wilfully making false or misleading statements.

Signed:  Date: 15 September 2011

Attached: Site Audit Statement Figure 1: Zone A and Zone B.

PART IV: Explanatory notes

To be complete, a site audit statement form must be issued with all four parts.

How to complete this form

Part I identifies the auditor, the site, the purpose of the audit and the information used by the auditor in making the site audit findings.

Part II contains the auditor's opinion of the suitability of the site for specified uses or of the appropriateness of an investigation, or remedial action or management plan which may enable a particular use. It sets out succinct and definitive information to assist decision-making about the use(s) of the site or a plan or proposal to manage or remediate the site.

The auditor is to complete either Section A or Section B of Part II, **not** both.

In **Section A** the auditor may conclude that the land is suitable for a specified use(s) OR not suitable for any beneficial use due to the risk of harm from contamination.

By certifying that the site is suitable, an auditor declares that, at the time of completion of the site audit, no further remediation or investigation of the site was needed to render the site fit for the specified use(s). Any **condition** imposed should be limited to implementation of an environmental management plan to help ensure the site remains safe for the specified use(s). The plan should be legally enforceable: for example a requirement of a notice under the Contaminated Land Management Act 1997 (CLM Act) or a development consent condition issued by a planning authority. There should also be appropriate public notification of the plan, e.g. on a certificate issued under s.149 of the Environmental Planning and Assessment Act 1979.

Auditors may also include **comments** which are key observations in light of the audit which are not directly related to the suitability of the site for the use(s). These observations may cover aspects relating to the broader environmental context to aid decision-making in relation to the site.

In **Section B** the auditor draws conclusions on the nature and extent of contamination, and/or suitability of plans relating to the investigation, remediation or management of the land, and/or whether land can be made suitable for a particular land use or uses upon implementation of a remedial action or management plan.

By certifying that a site can be made suitable for a use or uses if remediated or managed in accordance with a specified plan, the auditor declares that, at the time the audit was completed, there was sufficient information satisfying guidelines made or approved under the CLM Act to determine that implementation of the plan was feasible and would enable the specified use(s) of the site in the future.

For a site that can be made suitable, any **conditions** specified by the auditor in Section B should be limited to minor modifications or additions to the specified plan. However, if the auditor considers that further audits of the site (e.g. to validate remediation) are required, the auditor must note this as a condition in the site audit statement.

Auditors may also include **comments** which are observations in light of the audit which provide a more complete understanding of the environmental context to aid decision-making in relation to the site.

In **Part III** the auditor certifies his/her standing as an accredited auditor under the CLM Act and makes other relevant declarations.

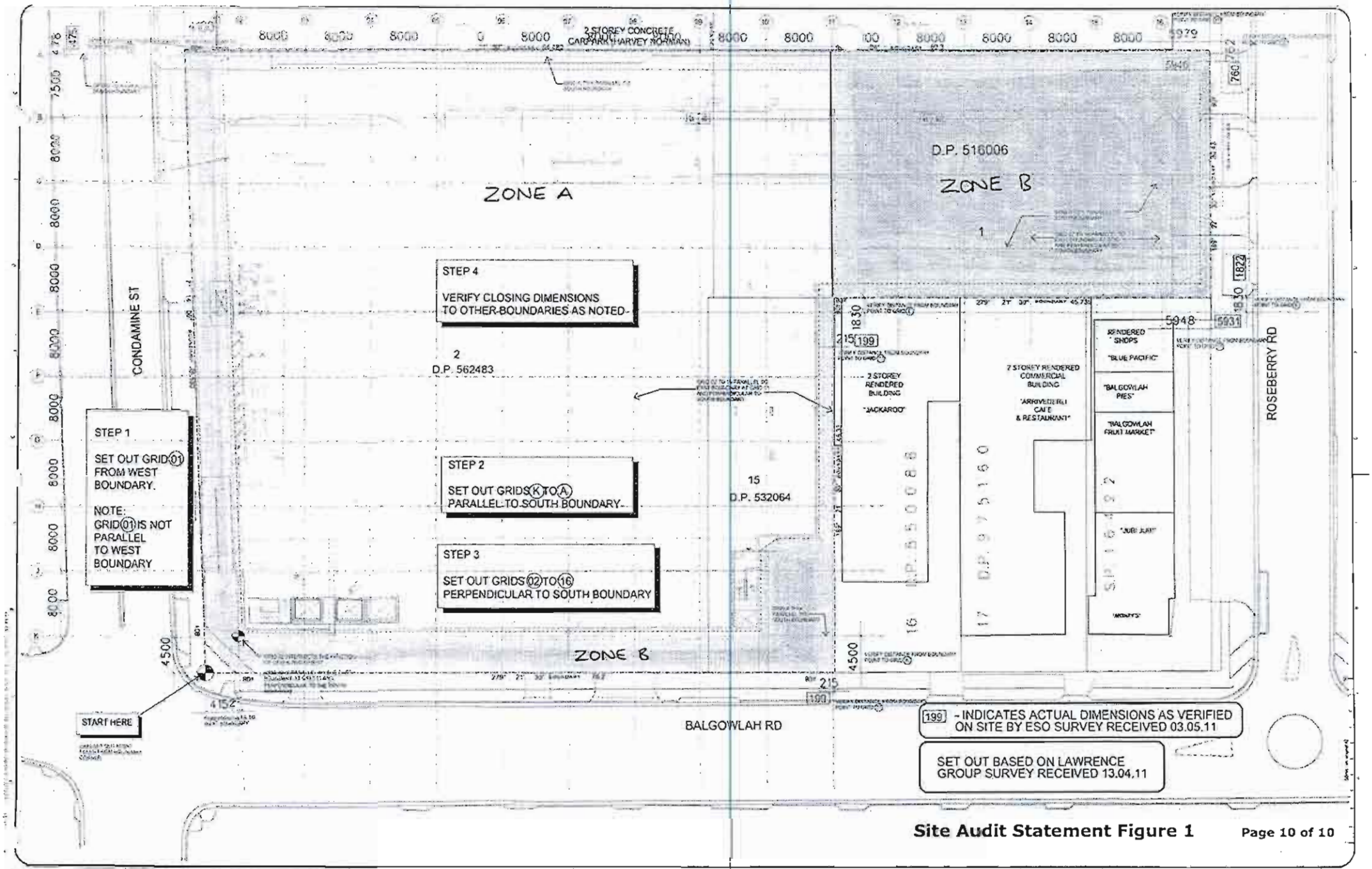
Where to send completed forms

In addition to furnishing a copy of the audit statement to the person(s) who commissioned the site audit, statutory site audit statements must be sent to:

Department of Environment and Conservation (NSW)
Contaminated Sites Section
PO Box A290, SYDNEY SOUTH NSW 1232
Fax: (02) 9995 5930

AND

the **local council** for the land which is the subject of the audit.



Site Audit Statement Figure 1

JOHN R. BROGAN & ASSOCIATES PTY. LIMITED
ARCHITECTS, PLANNERS & COMMERCIAL INTERIOR DESIGNERS

PROPOSED BUNNINGS WAREHOUSE
CNR CONDAMINE ST & BALGOWLAH RD,
BALGOWLAH NSW

GRID SETOUT PLAN

Site Audit Report

Site Audit Statement 0103 - 1101

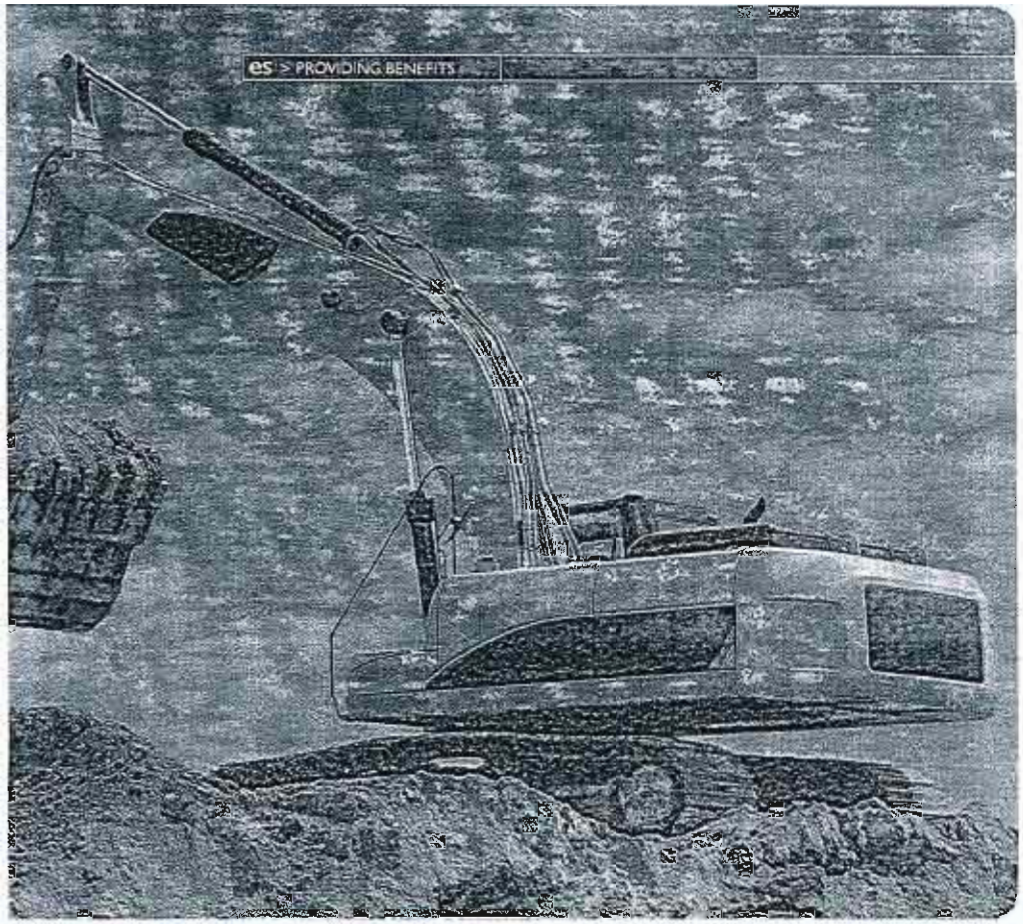
EnvironmentalStrategies
PROVIDING BENEFITS

Remedial Action Plan

164 Balgowlah Road
Balgowlah, New South Wales

Ref: 11022RP04_v04

Prepared for Southern Cross Projects > August 2011



www.environmentalstrategies.com.au

QA

Issue/Revision	Issue 1	Revision 1	Revision 2	Revision 2
Remarks	Draft for client review	Final	Final	Final
Date	15th March 2011	18 April 2011	18th May 2011	12 August 2011
Prepared by	Toby Scrivener	Katia Rinaldi	Toby Scrivener	Katia Rinaldi
Signature				
Checked by				
Signature				
Authorised by				
Signature				
Project Number	11022	11022	11022	11022
File Reference	11022RP04_v01	11022RP04_v02	11022RP04_v03	11022RP04_v04

Contents

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Appendices

LIMITATIONS

This Remedial Action Plan (RAP) is based on the objectives outlined in Section 2.2. Environmental Strategies Pty Ltd (ES) prepared this RAP in a manner consistent with the normal level of care and expertise exercised by members of the environmental assessment profession.

This RAP relates only to the objectives stated and does not relate to any other work undertaken for the Client. It is based on the information provided by third-parties and site conditions at the time of writing. The conditions stated in this report may change with time and space. The absence of any identified hazardous or toxic materials on the subject property should not be interpreted as a guarantee that such materials do not exist on the site.

All conclusions regarding the property area are the professional opinions of ES, subject to the qualifications in the report. While normal assessments of data reliability have been made, ES assumes no responsibility or liability for errors in any data obtained from regulatory agencies, statements from sources outside of ES, or developments resulting from situations outside the scope of this project. The client acknowledges that this report is for the exclusive use of the client.

1 Executive Summary

Environmental Strategies Pty Ltd (ES) was commissioned by Southern Cross Projects (SCP) to prepare this Remedial Action Plan (RAP) for the site located at 164 Balgowlah Road, Balgowlah, NSW. Remediation of the site will comprise the excavation of soils at the site to the final completion depth of approximately 6m below current ground level to allow for two levels of basement car parking and includes the removal of previously identified soil hotspots and fill materials, and the removal of underground storage tanks and associated infrastructure. Remediation of the site will comprise the removal of the four (4) existing underground storage tanks (USTs), bowsers and associated infrastructure. Remediation will generally comprise excavation, waste classification and appropriate disposal off site as the soils are surplus to requirements. Hydrocarbon contaminated soil associated with the UST areas may require bioremediation prior to removal from the site.

Objectives of the investigation

The objective of this RAP is to determine the most practical solution for removing the soil hotspots and the USTs, bowsers and associated infrastructure, and any associated impacted materials for the site to be made suitable for commercial land use and for the development of the site to proceed.

In order for the site to comply with the Department of Environment and Conservation (DEC, now the Department of Environment, Climate Change and Water DECCW) (2006) guidelines for, PAH, asbestos and metals and the NSW EPA (1994) *Guidelines for Assesing Service Station Sites* for TPH and BTEX in soil, any impacted material identified following removal of soil hotspots or the USTs and associated infrastructure and any impacted material surrounding the USTs will need to be excavated and removed from the site. The material is required to be classified in accordance with the DECCW (2009) *Woste Classification Guidelines* prior to removal from the site and disposed of to an appropriately licensed land fill.

Scope of works

A brief summary of the scope of works proposed for remediation of the site is as follows:

A brief summary of the scope of works proposed for remediation of the site is as follows:

- Conduct a dangerous good search to locate tanks on the site, and, if possible, conduct ground penetrating radar (GPR) survey of the approximate locations of the USTs to determine their location and layout.
- Demolition of all buildings to slab level (ground level) by demolition contractors commissioned by SCP;
- Localised ground leveling (benching) from the boundaries of the site to the building line and preparing hardstand areas for piling;
- Stockpiling and isolation of spoil for assessment and validation prior to off-site disposal;
- Excavation of soil hotspots identified in previous investigations;
- Excavation and decommissioning of USTs and associated infrastructure;
- Excavation of impacted soil from both areas under the supervision of an environmental consultant until visual, detection equipment (PID) and olfactory indicators assess the contamination had been removed;

- Soils identified as contaminated are to be classified under the NSW DECC (2008) Waste Classification Guidelines and disposed off-site;
- Validation of excavations to ensure impact had been removed to satisfy the developed site specific remediation criteria;
- Excavation and classification of all other soils requiring removal off site;
- Collection of any imported material to be used for backfilling the excavations (if necessary);
- Sampling of the four existing groundwater wells at least twice after the completion of soil remediation works; and
- Preparation of a validation report.

2 Purpose and Objectives

2.1 Purpose of the RAP

The purpose of the RAP is to provide a detailed plan of activities, procedures and objectives to ensure the effective and controlled remediation of the UST areas. It describes the procedures and standards to be followed throughout the project to facilitate successful remediation / management of the UST areas and ensure protection of human health and the environment.

2.2 Objectives

The primary objectives of the remediation program at the site are to:

- Render the site suitable for planned future commercial used (Bunnings warehouse with two levels of basement carparking);
- Decommission and remove the USTs and associated linework and bowsers;
- Remediate impacted soil in the vicinity of the USTs, to minimise potential ecological and human health risk associated with soil contamination at the site
- Excavate and dispose of impacted fill and soils;
- Establish safeguards required to complete the remediation in an environmentally responsible manner;
- Identify and obtain the necessary approvals and licenses required from regulatory authorities;
- Reduce potential pathways of exposure to chemicals of concern for human health and ecological receptors; and
- Ensure the protection of the community and local environment.

In meeting these objectives, and consistent with the requirements of the NSW EPA (2000) *Contaminated Sites: Guidelines for Consultants Reporting on Contaminated Sites*, this RAP outlines:

- Remediation goals that ensure the remediated areas will be suitable for the ongoing commercial land use;
- Procedures and plans to be implemented to reduce the risks to acceptable levels for the proposed site use;
- Environmental safeguards required to completed the remediation in an environmentally acceptable manner; and
- The necessary approvals required by regulatory authorities.

2.3 Reports Relied Upon

The information provided in the following reports, not prepared by ES, has been relied upon in preparation of this RAP:

- Aargus (February 2011) Remediation Action Plan, Condamine Street & Balgowlah Road, Balgowlah NSW, (Ref. ES4046);
- EIS (July 2009a) Additional Environmental Site Assessment of Soil and Groundwater, Proposed Commercial Development, Cnr Condamine Street and Balgowlah Road NSW, (Ref. E2209091Krpt2);

- EIS (July 2009b) Environmental Site Assessment of Soil and Groundwater Proposed Commercial Development, 1A Roseberry Street, Balgowlah NSW, (Ref. E2209091Krpt3);
- EIS (2009c) Addendum to Environmental Site Assessment, Cnr Condamine Street & Balgowlah Road, Balgowlah, (Ref. E22091K-Let), letter report; and
- EIS (June 2008) Environmental Site Assessment of Soil and Groundwater, Proposed Commercial Development, Cnr Condamine Street and Balgowlah Road, Balgowlah NSW, (Ref. E2209091KRPT).

3 Background

3.1 Site Description

The site is located at 169 Balgowlah Road, Balgowlah, NSW, and is shown on Figure 1, Appendix A. The site is known as Lot 2 in DP562483, Lot 2 in DP 533586, Lot 1 in DP 533586 and Lot 1S in DP 532064.

The area of the site is approximately 7,116m^2. The centre of the site has approximate geographical coordinates of latitude 33°47'23.67"S and longitude 151°14'59.17"E.

Figure 2a, 2b and 2c, Appendix A shows the previous site layout and shows the sampling locations investigated on the site.

The site is located within the Local Government Area of Manly Council.

ES conducted a review of the Manly Council LEP on 13th April 2011 for the current site zoning. The information provided on the LEP indicated that the site is zoned INDUSTRIAL.

The site has previously been used for mixed commercial/residential purposes including, mechanical repair workshop and car showroom.

3.2 Description of Proposed Development

The proposed development involves the demolition of the existing infrastructure, followed by the construction of a commercial warehouse building with two basement car parking levels.

4 Site Condition and Surrounding Environment

4.1 Site Condition

The site condition and surrounding environment observed during a site inspection conducted by ES on 7 April 2011, is summarised in Table 1 below:

Table 1: Summary of Site Condition

Observation	
Topography	The site is located between 15 and 17 m above Australian Height Datum (m AHD). External to the buildings, the site has a gentle slope to the northeast, which was consistent with the surrounding area.
Conditions at Site Boundary	At the time of the site visit the buildings on the site were being demolished and the hardstand removed. It was apparent that the entire site was either concrete or bitumen sealed up to the site boundary.
Visible Signs of Contamination	Access to the majority of the site area was not available during the site visit due to the demolition works. No signs of staining were observed in the north-eastern corner where access was allowed.
Visible Signs of Plant Stress	There was no vegetation on the site at the time of the site visit.
Presence of Drums, Tanks Wastes and Fill Material	From the previous investigations conducted on the site, it is apparent that there are at least three (3) USTs in the central eastern portion of the site, one (1) UST on the western boundary of the site at Roseberry St, one (1) more potential UST located in the south-eastern portion of the site (see Figure 2, Appendix A).
Odours	Odours were not noted during the site inspection.
Condition of Buildings and Roads	At the time of the site visit the buildings on the site were being demolished and the hardstand removed.
Quality of Surface Water	Surface water was not observed on the site.
Details of any Relevant Local Sensitive Environment	The nearest water body to the Site is the Burnt Bridge Creek approximately 150m to the north of the Site. Stormwater from the local and surrounding areas would flow towards the creek.

The surrounding land use observed during the site visit was as follows:

- North: Industrial;
- East: Roseberry Street & residential, then industrial;
- South: Balgowlah Road, then residential; and
- West: Condamine Street, then residential and open space.

4.2 Geology

The following was reported in the Aargus RAP (2011) regarding geology for the site:

'The Geologicol Map of Sydney (Geological Series Sheet 9130, Scale 1:100,000, 1983), published by the Deportment of Mineral Resources indicates the residual soils within the site to be underlain by Quoternory Age soils consisting of medium to fine grained "morine" sand with podsol. These are further underlain by the Howkesbury Sandstone."

The generol soil profile within the site comprised of:

- *Povement – concrete or ospholt*
- *Fill – Silty clay ond silty sand with traces of ash, slog, gravels, concrete and/or glass between 0.09-2.2m BGL.*
- *Noturol – Silty Sand and Clayey Sand, underlain by Silty clayey sand, sandy clay and sand.*
- *Bedrock – sondstone.'*

4.3 Hydrogeology

The following was reported in the Aargus RAP (2011) regarding hydrogeology for the site:

'A search of the Department of Water and Energy records for the existence of registered bores around the Site was conducted. It was found that there were eight (8) bores within a 1km radius of the site. Two bores had standing water levels of 7m and 8m respectively. The bores were used for monitoring, irrigation, domestic and test purposes.

From this and other information it was estimated that regional groundwater is likely to flow in a north to north-easterly direction towards Burnt Bridge Creek'.

Groundwater was monitored in four (4) wells across the site (EIS 2009) and was generally observed to occur at depth in the natural silty sand and clayey sand. Depth to groundwater ranged from 4.48m below grade in the north-eastern corner of the site to 5.79m below grade in the south-western corner of the site.

5 Previous Investigations of the Site

The following reports have been prepared for the site:

- Aargus (February 2011) Remediation Action Plan, Condamine Street & Balgowlah Road, Balgowlah NSW, (Ref. ES4046);
- EIS (July 2009a) Additional Environmental Site Assessment of Soil and Groundwater, Proposed Commercial Development, Cnr Condamine Street and Balgowlah Road NSW, (Ref. E2209091Krpt2);
- EIS (July 2009b) Environmental Site Assessment of Soil and Groundwater Proposed Commercial Development, 1A Roseberry Street, Balgowlah NSW, (Ref. E2209091Krpt3);
- EIS (2009c) Addendum to Environmental Site Assessment, Cnr Condamine Street & Balgowlah Road, Balgowlah, (Ref. E22091K-Let), letter report; and
- EIS (June 2008) Environmental Site Assessment of Soil and Groundwater, Proposed Commercial Development, Cnr Condamine Street and Balgowlah Road, Balgowlah NSW, (Ref. E2209091KRPT).

The results of these investigations are summarised in the following sections and analytical results presented in Tables 2 to 5, Appendix B. Previous sampling locations are shown on Figure 2a, 2b and 2c, Appendix A.

Only the EIS (July 2009a) and EIS (2009b) reports were made available to ES at the time of preparing this RAP.

5.1 EIS (July 2009a)

The scope of work completed during this investigation included a review of the history of the site (Cnr Condamine St and Balgowlah Rd), a search of WorkCover Dangerous Goods Licenses for the site and an intrusive soil and groundwater investigation.

The history indicated the following:

- The site had been occupied by various commercial buildings since at least 1961;
- Prior to 1961 the site was occupied by various residential buildings, shed and a warehouse;
- The site has been under various leases and ownership including Dairy Farmers, blacksmiths, manufacturers and Inder Motors Pty Limited.

Potential contamination sources identified on the site included:

- USTs located in the central and east section of the site;
- Imported fill material; and

- Asbestos associated with previous demolition of buildings potentially containing hazardous materials.

The soil assessment included the drilling of fifteen (15) boreholes across the site (BH1-7, BH101-108, BH201, BH202, and BH204-210). Of these boreholes, nine (9) fill samples and five (5) natural soil samples were analysed for the presence of TPH, PAHs, heavy metals and asbestos.

Four (4) groundwater wells (BH1, BH4, BH5 and BH7) were installed to a depth of approximately 10.5m below grade. The groundwater samples were analysed for the presence of heavy metals, TPH and BTEX.

The soil profile was generally as follows:

- Fill: depth varied from 0.09m to 2.2m below grade and comprised silty clay and silt sand with traces of ash, gravels, concrete fragments and glass;
- Natural: depth varied to depths of 4.2m to 10.5m below grade and comprised silty sand and clayey sand underlain by silty clayey sand and sand;
- Bedrock: fine-medium grained sandstone.

Groundwater was encountered at depths ranging from 4.48m to 6.35m below grade.

Groundwater was calculated to flow to the north and east.

The soil results indicated the following:

- One soil sample exceeded the commercial/industrial HIL-F criteria for BaP (BH210, 0.2-0.4m); and
- All other soil samples were within the soil investigation criteria for the site, including asbestos, which was reported to have been detected in previous investigations conducted on the site (these investigations were not available to ES at the time of preparing this report).

Groundwater results indicated the following:

- Zinc and copper were detected in concentrations exceeding the hardness corrected criteria for the site; and
- All other groundwater samples were within the groundwater investigation criteria for the site, including hydrocarbons.

5.2 EIS (July 2009b)

The scope of work completed during this investigation included a review of the history of the site (1a Roseberry St), a search of WorkCover Dangerous Goods Licenses for the site and an intrusive soil and groundwater investigation.

A UST, 10,000L in capacity was identified on the eastern boundary of the site.

Potential contamination sources identified on the site included:

- USTs located in the central and east section of the site;
- Imported fill material; and
- Asbestos associated with previous demolition of buildings potentially containing hazardous materials.

The soil assessment included the drilling of eight (8) boreholes across the site (BH211-216 and BH301-302). Soil samples were analysed for the presence of heavy metals, VOCs, PAHs, OC/OPPs and asbestos.

Groundwater grab samples were collected directly from two (2) boreholes drilled adjacent to the UST (BH301 and BH302) without the installation of permanent wells. Groundwater samples were analysed for the presence of heavy metals, VOCs, PAHs, and phenols.

The soil profile was generally as follows:

- Fill: depth varied from 0.4m to 1.3m below grade and comprised silty sand with traces of organic material, slag, ash and igneous gravel;
- Natural: depth varied to depths of 1.5m to 7m below grade and comprised silty sand and clayey sand underlain by silty clayey sand and sand;
- Bedrock: not encountered.

Groundwater was encountered at depths ranging from 3.75m to 5.3m below grade.

Groundwater was calculated to flow to the north and east.

All soil samples were within the soil investigation criteria for the site, including asbestos.

Zinc and TPH C_{10}-C_{14} were detected in groundwater samples above laboratory detection limits. The zinc concentrations marginally exceeded the ANZECC (2000) 95% Level of Protection (freshwater species), whist the TPH C_{10}-C_{14} concentrations were below the site criteria.

6 Site Characterisation

6.1 Assessment of Type of Environmental Contamination

6.1.1 Soil

Of 28 fill samples and 8 natural soil samples analysed by EIS, contaminants that were identified in soil at concentrations above the DEC (2006) *'Guidelines for the NSW Site Auditor Scheme'* Appendix II Column 4 – Commercial or industrial land use or the NSW EPA (1994) *'Contaminated Sites: Guidelines for Assessing Service Station Sites'* are summarised in Table 6 below and presented on Figure 3, Appendix A.

Table 6: Locations of Commercial/Industrial Assessment Criteria in Soil

Sample Location	Sample Depth (m bgl)	Analyte	Analyte Concentration (mg/kg)	Location
BH105	0.4 to 0.6m	asbestos	Chrysotile asbestos identified	Central western boundary adjacent to Condamine St.
BH210	0.2 to 0.4m	benzo(a)pyrene	6.4	Central eastern portion of the site.

6.1.2 Groundwater

The concentrations of metals in groundwater samples analysed from the site were suggested to be at background levels by EIS (2009a). The following metals, however, were present in concentrations marginally exceeding the ANZECC (2000) *95% Level of Protection (freshwater species) Trigger Values* in the following samples:

- Zinc in samples from BH1, BH4, BH5 and BH7;
- Copper in samples from BH5, BH5 and BH7;
- Cadmium in BH1; and
- Lead in BH5 and BH7.

One grab sample collected from BH302 (a borehole, not a permanent well) had a concentration of TPH C_{10}-C_{14} above the laboratory detection limits but below the site criteria for TPH .

Locations of these exceedances are presented on Figure 4, Appendix A.

6.1.3 Infrastructure

In addition to the locations of soil and groundwater reported to exceed the assessment criteria, ES notes that the EIS (2009) report refers to the following potential sources of contamination:

- Three USTs in the central eastern portion of the site;
- Three bowsers in the central eastern portion of the site;
- A potential UST to the south of the above USTs;
- A UST on the western boundary of Roseberry St; and
- Two bowsers associated with the suspected UST located to the south of the above USTs.

Full assessment of the potential for soil contamination from these features has not as yet been completed. Therefore despite only minor detections of soil contamination on site, as noted in Section 6.1.1, additional volumes of impacted soil are likely to be present in the vicinity of these features.

6.2 Assessment of Extent of Soil and Groundwater Contamination and Data Gaps

- While the numbers of sampling locations completed by EIS are generally in accordance with the requirements of the NSW EPA (1995) *Sampling Design Guidelines*, there has been minimal targeted sampling around the locations of USTs and bowsers. It is not known how many USTs are actually present on the site.
- Groundwater sampling has indicated that there is minimal, if any, hydrocarbon impact from the present of underground petroleum storage systems on the site. This indicates that there may be only minor impact to the soil surrounding the USTs, bowsers and associated infrastructure.
- Chrysotile asbestos fibres were positively identified at BH105, but not within any of the other 27 fill samples taken. One piece of bonded asbestos board was reported by EIS.
- Benzo(a)pyrene exceeding the adopted guideline criteria was only identified at one location (BH210).

6.2.1 Assessment of the Chemical Degradation Products

The chemical degradation products of the contaminants in soil and groundwater near the USTs and drainage infrastructure are considered to be of lesser ecological and human health risk than the parent compounds and are therefore considered not to be significant.

6.2.2 Assessment of Possible Exposure Routes and Exposed Populations

Exposure routes for soil contaminants include dermal, ingestion and inhalation.

Exposed populations may include the following:

- Human:
  - workers on the site, users of groundwater (actual and potential) in the local area and future site occupants.
- Ecological – earthworms, small reptiles, stygofauna.

As no volatile compounds have been detected in soil and groundwater on the site, there is only a minimal risk of vapour intrusion into buildings on the site. Should volatile contamination be identified and not fully removed, an assessment of the potential risk of vapour intrusion would be completed to determine the risk, if any, to site workers or the proposed site end use.

7 Remediation Acceptance Criteria

7.1 Remediation Goal

The goal of the remediation program will be to render the site suitable for commercial industrial land use, and will require:

- Evaluating soil and/or groundwater quality in the vicinity of as yet unassessed potential sources of contamination such that the suitability of these areas for continued commercial /industrial use is confirmed;
- Addressing the identified soil contamination such that these areas will be made suitable for continued commercial /industrial use by removal of impacted materials;
- Ensuring that any fuel delivery infrastructure to be decommissioned as part of the remediation works is completed in accordance with the relevant WorkCover NSW guidelines, Australian Standards and the Protection of the Environment Operations (Underground Petroleum Storage Systems) Regulation 2008;
- Ensuring that any waste materials generated as part of the remediation works are disposed of in accordance with the DECCW (2009) *Waste Classification Guidelines*;
- Ensuring any excavated natural soils which are free from contamination impact are assessed and removed off site as Excavated Natural Material (ENM) where possible;
- Validation of the USTs in accordance with the Underground Petroleum Storage Tank Regulations (2008) and the associated guidelines; and
- Validating any remediation works in accordance with the relevant Department of Environment, Climate Change and Water (DECCW) guidelines, including documentation of the validation.

7.2 Soil Acceptance Criteria

The selected remediation acceptance criteria (RAC) for soils for the above goals are based on the:

- DEC (2006) *'Guidelines for the NSW Site Auditor Scheme'* Appendix II Column 4 – Commercial or industrial land use; and
- NSW EPA (1994) *'Contominated Sites: Guidelines for Assessing Service Station Sites'*.

Table 7 below lists the analytes and the RAC:

Table 7: Remediation Acceptance Criteria – Soil

Analyte	DEC (2006)	NSW EPA (1994)
Benzene	–	1
Toluene	–	1.4
Ethylbenzene	–	3.1
Xylene	–	14
TPH C_6–C_9	–	65
TPH C_{10}–C_{40}	–	1,000
Arsenic	500	–
Cadmium	100	–
Chromium	500	–
Copper	5,000	–
Lead	1,500	–
Nickel	3,000	–
Zinc	35,000	–
Mercury	75	–
Benzo(a)pyrene	5	–
Total PAH	100	–
PCBs (total)	50	–
Asbestos	No detectable asbestos	–

7.3 Rationale for and Appropriateness of the Selection of Criteria

The soil criteria have been chosen based on the proposed development of the site for commercial purposes. Should the site be redeveloped for a more sensitive land use such as Residential with Gardens and Accessible Soil, the chosen criteria for metals and PAH will no longer be appropriate and further investigation of the site may be required.

7.4 Imported Fill Material

Given the requirement for two levels of basement car parking it is unlikely that soil materials will be imported into the site. However, any soil imported to the site will be obtained from reputable suppliers and will be certified Virgin Excavated Natural Material (VENM) or Excavated Natural Material (ENM). To validate imported fill, one sample per 100m^3 will be collected and analysed for asbestos, metals, TPH, benzene/toluene/ethyl benzene/xylene (BTEX), organochlorine pesticides (OCPs), PAHs and PCBs as contained in the NSW EPA (1994) guidelines. Prior to the importation of VENM or ENM, a thorough historical review of the source site will be undertaken to determine the appropriateness of the validation testing suite. This review may result in a more comprehensive sampling and analysis programme to that presented above, which will be submitted for prior approval by the site auditor. Any material imported as ENM must be certified as suitable in accordance with the NSW DECCW (2009) *Waste Classification Guidelines* and the associated exemption regarding ENM.

7.5 Groundwater Quality

The site is to be remediated for continued commercial/industrial redevelopment with no reliance on the groundwater or surface water for consumption or recreation. Groundwater remediation is not

part of the proposed scope for this RAP, although a round of groundwater monitoring is proposed to ensure there is no impact to groundwater resulting from the remedial work. The applicable groundwater criteria comprise the ANZECC (2000) Guidelines for Fresh and Marine Water Quality trigger values for the protection of 95% of species – freshwater) and are presented in Table 8. Concentrations below the criteria are automatically considered to be acceptable.

Table 8: Remediation Acceptance Criteria - Water

Analyte	Fresh water (95% LoP) (µg/L)	Drinking Water (µg/L)
TPH		
TPH C_6 – C_9	-	-
TPH C_{10} – C_{14}	-	-
TPH C_{15} – C_{28}	-	-
TPH C_{29} – C_{36}	-	-
BTEX		
Benzene	950	1
Toluene	-	800
Ethylbenzene	-	300
Meta-xylene	-	600[2]
Ortho-xylene	350	
Para-xylene	200	
Metals		
Arsenic	2.3	7
Cadmium	5.5	2
Chromium	27.4	50
Copper	1.3	2,000
Nickel	70	20
Lead	4.4	10
Zinc	15	-
Mercury	0.4	1
PAHs		
Naphthalene	16	-
Benzo(a)pyrene	-	0.01

Table notes:

1. Aquatic ecosystem criteria from Australian New Zealand Environment and Conservation Council (ANZECC) / Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ) (2000) *Australian and New Zealand Guidelines for Fresh and Marine Water Quality*, including Table 3.4.1 and Section 8.3.7. EPA specify that the 95% species protection levels are to be applied for slightly to moderately-disturbed ecosystems (most urban catchments) and the 99% species protection levels for pristine or vulnerable ecosystems or where the contaminants are intractable (e.g. bioaccumulative).
2. Total xylenes

It is noted that NHMRC/NRMMC (2004) does not specify values for TPH compounds in groundwater. Similarly ANZECC (2000) *Water Quality Guidelines for Fresh and Marine Water* does not provide high reliability trigger values for TPH compounds in water, only a low reliability value of 7µg/L for TPH compounds is included. Given that laboratory methods for TPH analysis in groundwater lack the required precision to achieve a detection limit of 7µg/L, ES has instead adopted the laboratory detection limits as screening criteria for TPH compounds in groundwater (i.e. 10 µg/L for TPH C_6–C_9 and 250 µg/L for TPH C_{10}–C_{40}).

8 Remediation Action Plan

8.1 Extent of Remediation Required

The extent of soil remediation is limited to the following areas identified during the previous investigations by EIS, and shown on Figure 4a, 4b and 4c of Appendix A:

- Area 1: Decommissioning of the three (3) USTs, bowsers and associated pipework located in the central eastern portion of the site. The remediation of any associated soil contamination in the vicinity of the UST will also be required. Neither the size of the tanks nor the volume of impacted soils have been determined in the previous investigations;
- Area 2: Decommissioning of the potential USTs and two (2) bowsers and associated pipework located to the south of the three (3) USTs above. The remediation of any associated soil contamination in the vicinity of the UST will also be required. Neither the size of the tanks nor the volume of impacted soils have been determined in the previous investigations;
- Area 3: Decommissioning of the one (1) UST and associated pipework located on the western boundary of Roseberry St. The remediation of any associated soil contamination in the vicinity of the UST will also be required. The volume of impacted soils have been determined in the previous investigations;
- Area 4: Asbestos in soil at BH10S (0.4-0.6m). It is unknown where the asbestos fragment has originated from. The volume of soil impacted with asbestos cannot be estimated with only one location; and
- Area 5: Benzo(a)pyrene in soil at BH210 (0.2-0.4m). The volume of soil impacted with benzo(a)pyrene cannot be estimated with only one location.

While the volume of impacted soil associated with Areas 1 to 5 may be estimated through additional testing prior to remediation, it has been agreed in consultation with SCP, that further delineation will not be completed, rather impacted soil will be managed at the time of decommissioning.

8.2 Remediation Options -Soil

The following remediation options are viable for the soil contamination identified on site:

- Do nothing option;
- In-situ decommissioning of the USTs and dismantling of the associated linework and bowsers;
- Decommissioning of the USTs, associated linework and impacted soil by excavation and removal from site;
- Decommissioning of the USTs and associated linework by Excavation and removal from site and bioremediation of impacted soil for on-site reuse; and

- Excavation and disposal of contaminated hot spots.

The following sections discuss the approach, the advantages and disadvantages of each option.

8.2.1 Do Nothing

Using this approach no remedial action is taken. The USTs and associated linework are not decommissioned and contamination present in the impacted soils and groundwater is left to biodegrade naturally (a process likely to require decades or longer).

The advantages of this option are that no cost will be incurred.

The disadvantages of this option are that it is unlikely to be acceptable to the stakeholders (Auditor, DECCW, Manly Council) because of the on-going potential for fuel in the USTs and potentially impacted soil to contaminated groundwater underlying the site and contaminant vapour intrusion into the building. The contamination source will also continue to be an on-going liability to the site owner under the 'do-nothing' approach.

This option is not considered suitable for the site as the areas of the USTs and linework are within the proposed redevelopment footprint, and require removal for future construction works. Do-nothing is not a viable remediation option where active construction works are proposed and contamination is readily accessible.

8.2.2 *In-situ* decommissioning of the USTs;

Adopting this approach involves the:

- Exposure and decommissioning of the USTs by filling the tanks and associated line work with sand or slurry; and
- Maintaining the impacted soil in both areas in place to biodegrade naturally.

As with the 'do-nothing' option, the disadvantages of this option are that it is unlikely to be acceptable to the stakeholders (Auditor, DECCW, Manly Council) because of the on-going potential for impacted soil to contaminated groundwater underlying the site and contaminant vapour intrusion into the building. Additionally in accordance with WorkCover NSW requirements and Australian Standard AS4976-2008 *'The Removal and Disposal of Underground Petroleum Storage Tanks'*, *in-situ* abandonment of USTs is only considered acceptable *'in special circumstances, e.g. where removal will cause serious risk to adjoining tanks or underground structures'*. As the proposed redevelopment plan will involve demolition of the majority of the existing buildings *in-situ* abandonment of the USTs present on site is therefore not an acceptable remediation option.

This option is not considered suitable for the site as the areas of the USTs and linework are within the proposed redevelopment footprint, and will therefore and require removal for future construction works. In-situ decommissioning is not a viable remediation option where active construction works are proposed and contamination is readily accessible.

8.2.3 Excavation and Removal of USTs and Impacted Soil from Site

This option involves the:

- Exposure and decommissioning of the USTs and associated linework, followed by removal of the USTs from the subsurface;
- Excavation and off- site disposal of impacted soil in the vicinity of those areas.

All works in relation to exposure, removal and disposal of the USTs must be undertaken by a WorkCover NSW licensed demolition contractor. Additionally removed USTs and associated fuel lines must be disposed in accordance with AS4976-2008 *'The Removal and Disposal of Underground Petroleum Storage Tanks'*. Decommissioning must be undertaken in accordance with the Protection of the Environment Operations (Underground Petroleum Storage Systems) Regulation 2008. This regulation requires a validation report to be completed on the decommissioning of any UST systems. The validation report is to be completed in accordance with the requirements for a validation report in the Underground Petroleum Storage Systems guideline and the NSW EPA (2000) *Contaminated Sites: Guidelines for Consultants Reporting on Contaminated Sites*.

Adopting this approach, potentially impacted soil is excavated to the farthest extent practicable and removed from site for ultimate disposal. The material is expected to be impacted with petroleum, diesel and possibly oil. Potential contaminants of concern include TPH, BTEX, PAHs, VOCs, phenols and lead.

SCP will need to ensure that an appropriately licensed landfill is available to receive the excavated material. This option will also require the receipt of waste disposal dockets from the receiving landfill with copies provided to the he environmental consultant as evidence of appropriate disposal of the material. The environmental consultant will be required to provide waste classification for the material, in accordance with NSW DECCW (2009) *Waste Classification Guidelines*, prior to off-site disposal.

Given that current site data indicates the presence of the USTs has resulted in minor, if any, impacts to groundwater, the advantage of this option is potentially complete removal of soil contamination from the site, and hence removal of any on-going liability. The disadvantage of this option is the cost associated with disposal of impacted soil to landfill and the UST in accordance with WorkCover NSW Requirements.

8.2.4 Off-site Disposal of USTs and Bioremediation of Impacted Soil

This option involves the:

- Exposure and decommissioning of the USTs and associated linework, followed by removal of the USTs from the subsurface;
- Excavation of impacted soil in the vicinity of these areas and on-site bio-remediation of the material until testing demonstrates it is suitable for reuse on a commercial/industrial site.

All works in relation to exposure, removal and disposal of the USTs must be undertaken by a WorkCover NSW licensed demolition contractor. Additionally removed USTs and associated fuel lines must be disposed in accordance with AS4976-2008 *'The Removal and Disposal of Underground Petroleum Storage Tanks'*. Decommissioning must be undertaken in accordance with the Protection of the Environment Operations (Underground Petroleum Storage Systems) Regulation 2008 is also required. This regulation requires a validation report to be completed on the decommissioning of any UST systems. The validation report is to be completed in accordance with the requirements for a validation report in the Underground Petroleum Storage Systems guidelines and the NSW EPA (2000) *Contaminated Sites: Guidelines for Consultants Reporting on Contaminated Sites*.

Once soils are excavated they would remain on-site and be regularly aerated to allow the petroleum hydrocarbon compounds to biodegrade and volatilise until their concentration in soil is below the adopted site criteria. As the site is located in a residential area, controls will be required to prevent the generation of dust from the exposed soil. The bioremediation area will also be required to be securely bunded and appropriate stormwater controls put in place to prevent surface water runoff from entering the surrounding environment.

Regular sampling of the excavated material would be required to monitor the reduction in concentration of petroleum hydrocarbon compounds until the material is deemed suitable for reuse on site.

Soils impacted with asbestos would be disposed off-site as asbestos waste to an appropriately licensed landfill.

Advantages of this option include the reduced cost involved with retaining impacted material on site where possible (reduced off-site disposal costs and reduced costs of importing fill), and improved sustainability due to the re-use of site derived material. Disadvantages of this option include the extended period of time and space on site that may be required for treatment of contaminants from the soil.

8.2.5 Excavation and Disposals of Impacted Materials (non-UST related)

This option involves the:

- Excavation of potentially impacted materials;
- Stockpiling and assessment of materials; and
- Waste classification and disposal off site.

All works must be undertaken by a WorkCover NSW licensed demolition contractor.

Once potentially impacted materials are excavated they would be stockpiled and sampled for waste classification purposes.

Soils impacted with asbestos would be disposed off-site as asbestos waste to an appropriately licensed landfill.

Advantages of this option are that treatment options for immobilisation of asbestos or benzo(a)pyrene are expensive and not necessary as the material requires to be removed from site for the development of basement car parking.

8.3 Recommended Remediation Option - Soil

The recommended remediation option is the excavation and removal of impacted materials, and the excavation and removal of the USTs, associated linework and any impacted soils. This option removes the risk of human or ecological contact with the impacted material that would remain if adopting the 'do-nothing' or in-situ abandonment approaches. The recommended option also allows for contamination source removal from the ground and disposal to landfill of impacted soil. There is minimal risk posed to the surrounding environment by removing the material from site.

In addition, approximately 6m of material requires to be removed from site for the development. Natural soils assessed to be free from potential contamination impact will be disposed off site as Excavated Natural Material where possible.

Should contamination exist below the level of the basement car park, this will be chased out (to the extent practicable) and validated. Where contamination cannot be removed further, assessment of the residual contamination will be undertaken.

9 Remediation Program

9.1 Overview

Remediation of UST and associated infrastructure must be carried out as follows:

- Decommissioning of the USTs, associated infrastructure and bowsers by removal;
- Upon removal of the USTs and associated fuel lines, excavation of impacted soil from both areas until visual, olfactory and field screening (photoionisation detector) indicators assess the contamination had been removed;
- Soils identified as contaminated are to be classified under the NSW DECCW (2009) *Waste Classification Guidelines* and disposed off-site;
- Validation of excavations (see Section 11 below) to ensure impact has been removed to satisfy the developed remediation acceptance criteria;
- Should validation samples fail, further excavation and subsequent validation shall be carried out; and
- On-going groundwater monitoring until sufficient evidence is available to determine whether remediation is required and what would be the most appropriate technology.

Remediation of other contamination must be carried out as follows:

- Soils identified in contaminated AREA 4 and AREA 5 are to be stockpiled separately and classified under the NSW DECC (2009) Waste Classification Guidelines and disposed off-site;
- Validation of excavations to ensure impact had been removed to satisfy the developed site specific remediation criteria;
- Should validation samples fail, further excavation and subsequent validation shall be carried out;
- All other fill material is to be stockpiled separate from natural materials and classified under the NSW DECC (2009) Waste Classification Guidelines and disposed off-site; and
- All natural materials assessed to be free from contamination (through validation and visual assessment) to be stockpiled and disposed as ENM where possible.

A representative of the environmental consultant will supervise all remediation and validation works and compile report/s required to remediate the site.

9.2 General

It is understood by ES that site works will progress in a number of stages to achieve consent, these are:

- **CC01 – Demolition & Partial Excavation (Stage 1)** The first stage shall be the demolition of existing and partial excavation. During this stage, the existing structures, fixtures, concrete pavements and slabs will be full demolished and removed from site. Closely following the demolition at each area, localized ground leveling (benching) from the boundaries of the site to the building line will be done, along with preparing hardstand areas in anticipation of piling commencement. With the localized grading, All spoil will be safely stockpiled and isolated on site, to be properly validated under the Remediation Action Plan. This material will be removed during Stage 2 – Excavation. These works shall run for four (4) weeks in duration.
- **CC02 – Shoring & Excavation (Stage 2)** The second stage will include piling, shoring and bulk & detail excavation. Specific tasks shall include removal of the underground petroleum storage tanks, the drilling and concreting of piles to the perimeter of the building line followed by partial excavation to lower ground levels. Following that, ground anchors will be installed followed by sprayed shotcrete installed as permanent soil retention.
- These tasks are repeated sequentially, until the lower basement level is reached. Detail excavation for pad footings, lift pits and services will be completed after that. During this stage of works, the soil remediation and site validation will be progressively completed in accordance with the Remediation Action Plan, including the issuance of final clearance reports from the accredited Site Auditor. These works shall run for fourteen (14) weeks.
- **CC03 – Car Park Structure (Stage 3)** In the third stage of the project, the basement car park structure will be completed. Tasks include, forming up and pouring concrete to car park basement slab, forming up and pouring concrete to columns, walls and suspended slabs, up to in preparation for main structure works at Ground Level. These works shall run for thirteen (13) weeks.
- **CC04 – Main Structure Building Works** In the fourth stage of the project, the building structure and internal fit out shall be completed. Tasks included in this phase are: forming up retail slabs and columns, erecting roofing, installing windows and shop fronts, roughing in and installing services to the building, installing finishing items such as shade sails, joinery, playground and café areas and the like; and finally the merchandise display racking installed to the retail floor areas. These works shall run for thirty three (33) weeks.
- **CC05 – External Works & Landscaping** In the fifth stage of the project, the external works for the project will be completed. This will include forming the external service roads, completing in-ground drainage and services, forming kerbs, gutters and driveway cross-overs, installing fencing, gates and signage, and then hard and soft landscaping works. These works shall run for sixteen (16) weeks.

This RAP covers site works require for CC01 and CC02. The works will generally be conducted as follows:

- Preparation works and site establishment, including environmental and workplace health and safety controls;
- Undertaking of works related to CC01 including addressing AREA 4 and AREA 5;

- Undertaking of works related to CC02 for the decommissioning of USTs, associate linework and bowsers in accordance with AS4976-2008 *'The Removal and Disposal of Underground Petroleum Storage Tanks'*;
- Excavation of impacted soil from the resulting excavations;
- Assessment of potential bioremediation of the excavated, impacted material for disposal. This will include ensuring there is sufficient room on the site for effective bioremediation to occur, ensuring there are odour suppressants on site and ensuring there is effective dust control on site and ensuring runoff from stormwater is captured and silt controls are in place so that the local surface waters are not impacted;
- Transport of excavated impacted soil to an appropriately licensed landfill for disposal;
- Validation of walls and floor of the final excavations to demonstrate removal of the impacted soil; and
- Classification of materials of off-site disposal in accordance with the NSW DECCW (2009) *Waste Classification Guideline* or confirm as ENM.

9.3 Preparation and Establishment

A number of important planning steps need to be undertaken prior to the commencement of remediation works on the site. The remediation works are assessed to be Category 2 remediation works and therefore Council must be provided with 30 days notice of the commencement of remediation.

Remediation of the site will be in accordance with Southern Cross Projects' Standard operating Procedures as defined in the Southern Cross Projects (SCP) (March 2011a) *Construction Management Program, Bunnings Warehouse Balgowlah, 164 Condamine Street, Balgowlah NSW 2093.*

Once the above planning works have been completed, the following site establishment works are required prior to remediation:

- Installation of environmental and workplace health and safety controls; and
- Location of underground services and termination or diversion as required.

9.4 Decommissioning of USTs, bowsers and associated linework

All works in relation to exposure, removal and disposal of the UST and associated fuel lines must be undertaken by a WorkCover NSW licensed demolition contractor. Additionally removed UST and associated fuel lines must be disposed in accordance with AS4976-2008 *'The Removal and Disposal of Underground Petroleum Storage Tanks'* and DECCW (2008) *'Guidelines for Implementing the Protection of Environment Operations (Underground Petroleum Storage Systems) Regulation 2008.*

This will require that notification is provided to WorkCover NSW by the contractor or site owner within seven days of tank abandonment.

All possible product should be removed from the tanks prior to removal from the subsurface. Bowsers and other linework associated with the USTs will also require purging, disconnection and removals. Operational controls should ensure that product spills during decommissioning are prevented.

Given the limited understanding of the location of USTs and associated linework, an environmental consultant should be present when demolition works occur in areas where USTs are believed to be present.

9.5 Excavation of Contamination

Excavation of the impacted soil will be carried out under the supervision of a suitably qualified and experienced representative of the environmental consultant.

Excavation of contaminated soil may be required in Areas 1 to 3 as shown on Figure 4, Appendix A. It is expected that the bulk of the contamination will be removed by excavation to a depth of up to 5m below grade in the location of the USTs, and up to 2m depth in the vicinity of the bowsers, although some over excavation may be necessary if impacted material is observed beyond these depths.

A soil movement/stockpile tracking register will be maintained by the SCP foreman on site for all excavated material.

Any on site stockpiling or remediation should be conducted in accordance with Manly Council's Contaminated Land Policy (August 2003) notably Appendix 5 Site management Plan for Remedial Works.

A soil validation program, as described in Section 11 will then be undertaken to validate the excavation side walls and base. If during site earthworks or excavation, offensive or noxious odours and/or evidence of gross contamination are observed, site works will stop and the environmental supervisor will be contacted to evaluate.

9.6 Fencing of Excavations

Whilst the excavation remains open, the site is unattended and/or the works are not active, high visibility fencing will be placed around the boundary of the excavations to alert any people on site to the presence of the excavation.

9.7 Management of Contaminated Soil

Depending on the volume and nature of the contaminated soil excavated from Areas 1 to 3, and any other areas requiring remediation, this material may be bioremediated on site but ultimately will be disposed to landfill.

Any fill or impacted materials to be disposed off site must be sampled in accordance with the NSW EPA (1995) *Sampling Design Guidelines* and classified in accordance with the DECCW (2009) *Waste Classification Guidelines*. The material must then be disposed to an appropriately licensed landfill and a copy of the tip dockets provided to the environmental consultant. It is noted that in

accordance with the DECCW (2009) guidelines if the waste does not fall into a pre-classified category and has not undergone chemical analysis then it must be managed as '*hazardous waste*'.

For material to be bioremediated, the material should be stockpiled in a bunded, sealed or plastic lined area for the duration of these works. The material will require regular spreading and turning to accelerate bioremediation processes, and application of odour suppressants will be required to mitigate the potential for off-site impacts. Additional stormwater controls may be required around the bioremediation area depending on the section of the site designated for use. Routine sampling should also be undertaken to assess whether the contaminant concentrations are reducing and when levels are acceptable for onsite reuse.

9.8 Imported Fill

It is not planned to import fill as the site is planned to have a double basement level excavated.

9.9 Underground Storage Tanks

If further artefacts are detected, appropriate controls will be enacted, including management to prevent release of liquids or gases, appropriate disposal of any wastes, validation as required to demonstrate appropriate remediation.

9.10 Unexpected Contamination

If during any site earthworks or excavation, evidence of gross contamination not previously detected is observed, site works are to cease in that area and action taken to appropriately delineate the contamination. This material must be validated and remediated in accordance with provisions of this RAP, under the supervision of suitably qualified environmental consultant. An unexpected findings protocol will be developed for site works.

9.11 Contingency Plans

Whilst the remediation goal is to remove all impacted soil from the site, several contingencies have been allowed for in completion of the RAP, specifically:

- if material is identified on site that is not suitable for off-site disposal;
- if it is not possible to remove all contaminated soil/line work due to geotechnical constraints, i.e. if contamination exists all the way to the site boundary it may not be possible to remove it all without a batter slope, the remaining impacted material will be managed to minimise exposure to site users; and
- if the presence of additional tanks are identified on site underlying the southern end of the main building.

Contingency plans for these three scenarios are presented in the following sections and it should be noted that Auditor agreement should be sought prior to the adoption of any contingency plan.

Contingency plans for groundwater are not presented as further work is currently required to allow sufficient understanding of the groundwater impacts to allow derivation of remediation options.

When groundwater remediation options are determined, appropriate contingency options will be included.

9.11.1 Material Not Suitable for Off Site Disposal

When material is identified on site that is not suitable for off site disposal, generally this material is classified as 'Hazardous Waste'. Management options for hazardous waste may include, but are not limited to:

- On-site stabilisation prior to off-site disposal: - this may involve the addition of cement or other inert substance to the hazardous waste, such that the mixed material will be sufficiently stable for off-site disposal by a licenced waste transporter to an appropriately licenced landfill; or
- On-site encapsulation - this would involve on-site containment of the hazardous waste in a purpose-built containment structure, designed to isolate the material from exposure to site users and the environment. A site management plan (SMP) would also be required to ensure that the contamination is appropriately managed for the future use of the site.

Adoption of any strategy for the management of hazardous waste will require management by a suitably qualified environmental consultant and will increase the time allowed for completion of the remedial work to allow for liaison with relevant authorities, contractors and landfill disposal or storage sites.

9.11.2 Geotechnical Constraints Prevent complete Removal of line work or contaminated soil

If it not possible to remove all the line work identified, due to geotechnical and/or access constraints, it is proposed to leave the pipe work in-situ and 'validate' those areas through a program of soil sampling in its vicinity. The scope of such a program would be dependent on the site specific nature of the pipe work to be left in place, however would intend to demonstrate that soils above, below and to the sides of the pipe work are not impacted by fuel contamination. Push tube sampling from tight access drilling rigs could be used to drill bores in the vicinity of the pipe work to remain *in-situ*. The frequency of sampling locations, number of samples and analysis program would be undertaken in accordance with NSW EPA (1994) *'Contaminated Sites: Guidelines for Assessing Service Station Sites'* where practical.

9.11.3 Additional Tanks

Should demolition of the buildings on site result in identification of the presence of additional USTs (or associated linework) to those already identified at the site then the following management will be applied:

- Decommissioning and removal of the UST (and/or associated line work), associated linework and contaminated soil in accordance with Sections 9, 10 and 11;

- The frequency of sampling locations, number of samples and analysis program should be undertaken in accordance with NSW EPA (1994) *'Contaminated Sites: Guidelines for Assessing Service Station Sites'* where practical.

10 Data Quality Objectives of the Validation Sampling Plan

The data quality objectives (DQOs) were derived in accordance with *AS 4482.1-1997*.

The DQO process is a seven step method to optimise the design of the sampling and analysis plan to ensure that all objectives of the investigation are met. The seven steps are outlined as follows:

- **Step 1:** State the Problem – concisely describe the problem to be studied. Review prior studies and existing information to gain a sufficient understanding to define the problem.
- **Step 2:** Identify the Decision –identify what questions the study will attempt to resolve, and what actions may result.
- **Step 3:** Identify the Inputs to the Decision –identify the information that needs to be obtained and the measurements that need to be taken to resolve the decision statement.
- **Step 4:** Define the Study Boundaries –specify the time periods and spatial area to which decisions will apply. Determine when and where data should be collected.
- **Step 5:** Develop a Decision Rule –define the statistical parameter of interest, specify the action level, and integrate the previous DQO outputs into a single statement that describes the logical basis for choosing among alternative actions.
- **Step 6:** Specify Tolerable Limits on Decision Errors –define the decision maker's tolerable decision error rates based on a consideration of the consequences of making an incorrect decision.
- **Step 7:** Optimise the Design –evaluate information from the previous steps and generate alternative data collection designs. Choose the most resource-effective design that meets all DQOs.

The DQOs for the proposed remediation are as follows:

Table 9: Data Quality Objectives for the Validation Sampling Program

State the Problem	The site proposed for redevelopment has historically been used as a car showroom and mechanical repairs workshop. Multiple USTs with linework, bowsers have been identified on the site. The USTs are required to be removed from the site along with any residual contaminated soil surrounding them in order to make the site suitable for the continued commercial land use. Localised asbestos and benzo(a)pyrene hotspot contamination has been identified within the fill material on site.
Identify the Decision	The following decisions will need to be made during the remediation works: -have all hazardous substances been removed from the site? -has all the infrastructure associated with the storage and delivery of fuel and other fluids been removed from the site? -has impacted soil underlying the identified infrastructure been removed such the remaining soil is suitable for commercial landuse? -have any other hotspots of impacted soil identified in other areas of the site been removed such the remaining soil is suitable for commercial landuse? -has impacted soil that presents an on-going risk to groundwater been removed?
Identify the Inputs to the Decision	Based on previous investigations on the site and a review of previous site history the potential contaminants of concern (COC) in the soil and groundwater on the site are BTEX, TPH, PAH, VOCs, metals and asbestos. The inputs into the decision will be: ▪ Results of a site inspection by the Environmental Consultant of the interior of the buildings following departure of the tenant; ▪ Results of PID field screening of soil samples collected as part of the additional investigation works and remedial excavations; ▪ Results of laboratory testing for COC in soil and groundwater samples collected as part of the additional investigation works; and ▪ Visual inspection of the walls and floors of the final remedial excavations.
Define the Study Boundaries	The study boundaries include the native bedrock and the legal site boundary of 164 Balgowlah Road, Balgowlah NSW as shown in Figure 2, Appendix A. The areas requiring remediation or further assessment are shown in Figure 4, Appendix A. The vertical extent of active remediation works is expected to extend to a depth of up to 5m below grade in the location of the USTs, and up to 2m depth in the vicinity of the bowsers.
Develop a Decision Rule	Results of testing on soil validation samples will be assessed against the following criteria (as specified in Section 7): ▪ DEC (2006) *'Guidelines for the NSW Site Auditor Scheme'* Appendix II Column 4 – Commercial or industrial land use; and ▪ NSW EPA (1994) *'Contaminated Sites: Guidelines for Assessing Service Station Sites'*. It is noted that the assessment of validation data may be based on the 95% Upper Confidence Limit (UCL), for heavy metals and PAHs only provided that:

	• The standard deviation of the dataset is less than 50% of the assessment criterion; and • No single result is more than 2.5 times the assessment criterion. The 95% UCL should not be used for assessment of volatile contaminants (i.e. TPH, BTEX or VOC compounds). Results of testing on groundwater samples will be assessed against the following guidelines as specified in Section 7: • ANZECC (2000) Guidelines for Fresh and Marine Water Quality trigger values for the protection of 95% of species
Specify Tolerable Limits on Decision Errors	The acceptable limits for field and laboratory QA/QA results are as follows: • Relative percent difference (%RPD) for field duplicates is less than 50% for all analytes. • Recovery of matrix spikes and surrogate spikes between 70 and 130% or 50% RPD for matrix spike duplicate RPDs for organics only; and • 70 to 130% recovery on trip spike samples. Where acceptable limits for field duplicates are not met, a discussion on low biased error will be provided.
Optimise the Design	Validation data will be collected in accordance with the Validation Plan specified in Section 11. This is presented as the most cost-effective validation plan which meets guideline structures. The design of investigations to address data gaps has been targeted at those gaps.

11 Validation Program

The objective of the validation program is to ensure that soil contaminated above the remediation criteria is excavated, and disposed off-site with contaminant concentrations in the walls and bases of the excavations complying with the remediation criteria.

11.1 Validation Sampling

Following removal of impacted soil from Areas 1 to 5 based on field observations and monitoring, soil validation samples will be collected from the floor and walls of the resulting excavations. Groundwater samples will also be collected from the monitoring well network following the completion of soil remediation works.

Table 10 details the validation sampling plan field and laboratory sample analysis requirements.

Table 10: Validation Sampling Plan

Feature under remediation	Sampling Density	Field Screening	Laboratory Analysis
USTs and small excavations	1 sample per 8.5m lineal metres of wall, or a minimum of 1 sample per wall. Additional samples may be required where multiple layers, potentially impacted, are encountered along wall. 1 sample per 72.75 m^2 of base (i.e. 8.5 m x 8.5m), or a minimum of 1 sample per base	PID all samples	Heavy metals TPH BTEX PAHs VOCs Asbestos Phenols
Linework	1 sample per 5 lineal metres of trench wall where the trench wall is greater than 0.5m high. 1 sample per 5 lineal metres of trench base	PID all samples	Heavy metals TPH BTEX PAHs VOCs asbestos
Backfill sands, or other UST impacted material for off-site disposal	Minimum of 1 sample per tank, or 1 sample per 2Sm^3	-	Heavy metals (total and leachable) TPH BTEX PAHs (total and leachable) VOCs
Fill Material Stockpiles	Minimum of 1 sample per 100m^3 or minimum of 3 samples per stockpile	-	Heavy metals TPH BTEX PAHs Asbestos
Natural Materials	1 sample per 500m3 to confirm absence of contamination to meet Excavated Natural Material general exemption	-	Heavy metals TPH PAHs
Groundwater wells	1 sample per well	pH, Electrical Conductivity, Dissolved Oxygen, and Oxidation Reduction Potential - all samples	Heavy metals TPH BTEX VOCs PAHs

Validation sampling of the excavations will be in accordance with the NSW EPA (1994) *'Guidelines for the Assessment of Service Station Sites'*. This will comprise collecting soil samples from the walls and base of the excavation at a frequency of sample per 8.5 lineal metres. If the excavation is less than 8.5 m in length a minimum of 1 sample from each wall and 1 sample from the base of the excavation should be collected. Additional samples will be taken from separate geological layers apparent in the soil profile and from the base as necessary.

Validation of the site will be conducted in 2 stages to allow the development of the site to progress. Zone A will be completed and validated first, followed by Zone B. The zones are identified in Appendix A, Figure S.

11.2 Validation Soil Sampling Methodology

Samples will be collected in accordance with standard operating procedures, based on the NEPM, Australian Standard AS4482.1-2005 and AS4482.2-1999 and DECCW requirements. Samples will be collected from excavations using decontaminated trowels or directly from excavator buckets where depth prevents entering the excavation. This will include use of appropriate sample containers and preservation, filling containers quickly to minimise the loss of volatiles and ensuring containers are filled to minimise headspace. Samples will be placed in chilled containers, and refrigerated if not dispatched to the laboratory on the day of sampling. All samples will be analysed within holding times.

A small volume of the each sample will be placed in a clean labelled zip-lock bag for field screened using a calibrated photoionisation detector (PID) to detect the presence of volatile hydrocarbons.

11.3 Groundwater Sampling Methodology

Samples will be collected in accordance with standard operating procedures, based on the NEPM, Australian Standard AS4482.1-2005 and AS4482.2-1999 and DECCW requirements. Samples will be collected using low flow methods wherever possible, sampling wells once field parameters stabilise to within 10%. Should well yield be insufficient for low flow sampling bailers will be used.

11.4 Decontamination Procedures

Decontamination procedures for sampling equipment, personnel and the general site must be in accordance with the Australian Standard AS4482.1 – 2005 and the NEPM guidelines (Schedule B (9)). If samples are to be collected with the aid of an excavator, then the bucket will be cleaned prior to the commencement of work and at the completion of site work. A portable high pressure water cleaner will be used for decontamination. Disposable tubing will be used for groundwater sampling wherever possible and equipment will be decontaminated between sample locations.

11.5 Sample Dispatch and Field Documentation

Samples will be managed in accordance with standard operating procedures, based on the NEPM, Australian Standard AS4482.1-2005 and DECCW requirements. This will include appropriate sample logs to describe the media collected, use of chain of custody procedures, and dispatching samples with appropriate preservation.

11.6 Laboratory Methods – Soil

Table 11a lists the analytical methods used by the laboratory. All analysis must be completed by a laboratory accredited by the NATA for the methods used:

Table 11a: Laboratory Methods

Analyte		Method	EQL (mg/kg)
Metals			
	As	E022.2: 0.5g digested in nitric/hydrochloric acid. Analysis by ICP-MS.	1
	Ca		0.1
	Cr		1
	Cu		2
	Ni		1
	Pb		2
	Zn	E026.2: 0.5g digested with nitric/hydrochloric acid. Analysis by CV-ICP-MS or FIMS.	5
	Hg		0.05
BTEX			
	Benzene	E002.2: 8-10g soil extracted with 20ml methanol. Analysis by P&T/GC/PID/MSD.	0.2
	Toluene		0.5
	Ethylbenzene		0.5
	Xylene		1.5
TPH			
	C6-C9	E003.2: 8-10g soil extracted with 20ml methanol.	10
	C10-C14	E006.2: 8-10g soil extracted with 20ml DCM/Acetone/Hexane (10:45:45). Analysis by GC/FID.	50
	C15-C28		100
	C28-C36		100
PAHs			
	Benzo(a)pyrene	E007.2: 8-10g soil extracted with 20ml DCM/Acetone/Hexane (10:45:45). Analysis by GC/MS.	0.5
	Total PAHs		
Phenol		GC.12: soil samples are extracted with dichloromethane / acetone and analysed by GC-MS	10
Asbestos			

11.7 Laboratory Methods – Groundwater

Table 11b lists the analytical methods used by the laboratory. All analysis must be completed by a laboratory accredited by the NATA for the methods used:

Table 11b: Laboratory Methods

Analyte	Method	EQL (mg/L)
BTEX		
Benzene	E002.1: Direct injection into P&T/GC/PID/MSD.	1
Toluene		1
Ethylbenzene		1
Xylene		3
TPH		
C_6-C_9	E003.1: Direct injection into P&T/GC/FID.	50(µg/L)
C_{10}-C_{14}	E004.1: Triple extraction with DCM. Analysis by GC/FID.	50(µg/L)
C_{15}-C_{28}		200(µg/L)
C_{29}-C_{36}		200(µg/L)
Metals		
As	E022.1: Filtered HNO_3 preserved sample directly analysed by ICP-MS.	1
Ca		0.1
Cr		1
Cu		1
Ni		1
Pb		1
Zn		5
Hg	E026.1: Analysis by CV-ICP-MS or FIMS following BrCl pre-treatment.	0.1
PAHs	E004.1: Triple extraction with DCM. Analysis by GC/FID.	1 - 2
VOCs	E016.1: Direct analysis by P&T/GC/MS. (NB).	

11.8 Quality Assurance/ Quality Control Program

A field QA/QC program must be conducted in accordance with the NEPM, Australian Standard AS4482.1-2005 and DECCW requirements to measure the precision of the field and laboratory analyses and to determine the accuracy of the analytical results. All samples will be analysed by NATA accredited laboratories. Field QA will include compliance with appropriate standard operating procedures. QC samples will be undertaken at the frequencies shown below:

Precision

- Field duplicates ≥ 5%
- Inter-laboratory duplicates ≥ 5%
- Laboratory duplicates ≥ 10%

Accuracy

- Surrogate spikes All organics by GC

- Matrix spikes ≥ 1/media type
- Laboratory control samples ≥ 1/lab batch

Representativeness

- Rinsate samples ≥ 1/field batch
- Trip blanks ≥ 1/field batch (volatiles)
- Trip spikes ≥ 1/field batch (volatiles)
- Laboratory blanks ≥ 1/lab batch

11.8.1 Field QA/QC - Soil

The following procedures will be followed during fieldwork to ensure quality control:

- Soil samples will be collected in laboratory supplied 125ml glass jars with Teflon seals.
- Samples will be collected with clean new nitrile gloves to prevent cross-contamination.
- Samples will be placed in an ice-filled esky to keep them below 4°C in accordance with US EPA SW 846.
- Samples will be transferred to the laboratory under a completed chain-of-custody.
- One laboratory prepared trip blank (soil) and one laboratory prepared trip spike (water) will be analysed for each day of sampling.
- One rinsate sample will be collected by running deionised water over a fresh pair of nitrile gloves to allow assessment of potential cross contamination from sampling materials should the need arise.

11.9 Validation Criteria

See Section 9.8.

11.10 Reporting Requirements

A validation report will be prepared by an appropriately qualified environmental consultant at the completion of remediation works. The report will be prepared in accordance with the NSW EPA (2000) *Guidelines for Consultants Reporting on Contaminated Sites*.

Following excavation and validation of Zone A (Appendix A, Figure 5), the environmental consultant will provide a letter of validation to the Auditor summarising the following:

- The validation process for Zone A and how this has met the requirements of the DQO;
- The validation sample locations and depths;
- The validation sample results;

- Assessment of validation results against that site acceptance criteria; and
- A statement identifying whether remediation has been achieved and whether the site is suitable for the proposed use.

A full site validation report will be provided when Zone B is complete. The report will document remediation and validation program activities including the results of any further excavation and/or validation required by the results of the initial validation analysis, an evaluation of the results against the remedial goals and an investigation demonstrating compliance with the conditions of this RAP.

The report will also include the results of the QA/QC program, and copies of documentation validating the appropriate handling, disposal and treatment of contaminated soil and water in accordance with DECCW requirements.

The validation report will include a record of the volume of material excavated from site and the volume accepted at the disposal site. The report will also include a statement on the suitability of the site for the continued commercial land use. It should be noted that should contamination remain on site, a site management plan will be required. That plan will need to be endorsed by the Auditor, and will need to be acceptable to Council.

12 Remediation Management Plan

The remediation program must be conducted with due regard to the environment and statutory obligations. Management and monitoring of operational controls during site works will include practices and procedures during the excavation and stockpiling phase of works.

All environmental controls (e.g. sediment, surface water, dust, odours, noise) must be employed in accordance with the Southern Cross Projects (2011) (December 2010) *Project Safety Management Plan, Bunnings Warehouse Balgowlah, 164 Condamine Street, Balgowlah NSW* 2093.

Table 13.1 Council Development Conditions

Condition	Requirement	Reason	Action	Responsibility
ANS08	**Site Contamination - Additional Information** Any new information that comes to light during demolition or construction which has the potential to alter previous conclusions about site contamination and remediation must be notified to Council and the accredited certifier immediately.	To ensure compliance with legislation and to protect public and environmental health and safety.	Unexpected Finds Protocol (this document, Section 5.1.4) with reporting to SCP site manager	Ongoing assessment of findings – all site workers Notification to Council – SCP Project/Site manager or environmental consultant
ANS09	**Site Contamination - Remediation Variation** The applicant shall inform Council in writing of any proposed variation to the remediation works. Council shall approve these variations in writing prior to commencement of works. Should variations be requested during variation, works must cease until approval of any changes or variations is granted by Council. Council shall provide a determination to the variations in writing prior to commencement of the varied works.	To ensure compliance with legislation and to protect public and environmental health and safety.	Ongoing assessment of works by SCP, the environmental consultant and ACE	Notification to Council – SCP Project/Site manager/ environmental consultant or ACE
ANS10	**Site Contamination - Remediation Monitoring Results** Results of the monitoring of any field parameters such as soil, groundwater, surface water, dust or noise measurements shall be made available to Council Officers on request throughout the remediation works.	To ensure compliance with legislation and to protect public and environmental health and safety.	All monitoring information to be recorded and available to Council as requested	Sub contractors undertaking environmental monitoring including the environmental consultant and ACE. SCP site manager.
ANS13 (Proposed to Council under Section 96)	**Site Contamination – Site Validation** After completion of Remediation work within Zone A, a copy of the Validation and Monitoring Report prepared by a suitably qualified contaminated land consultant shall be submitted to the Council and approved prior to the issue of Stage 1 Construction Certificate for works to be undertaken within Zone A. The validation report shall be in accordance with the EPA Guidelines, consultants reporting on contaminated sites, and shall certify the suitability of Zone A for the proposed development.	To ensure compliance with legislation and to protect public and environmental health and safety	Validation reports to be prepared by the environmental consultant	Environmental consultant.

13 Regulatory Approvals

13.1 Manly Council Conditions of Consent

The conditions from Manly Council's Notice of Determination (16/10, 04/08/2010) which are applicable to the remedial works and have been addressed through the SCP Project Safety Management Plan, as detailed in Table 13.1 below:

Condition	Requirement	Reason	Action	Responsibility
ANS15	**Groundwater** A Groundwater Management Plan is to be provided prior to the issue of Construction Certificate. The Plan must demonstrate how contaminated groundwater resulting from the construction dewatering will be appropriately disposed of. This plan should include any proposed treatment to be applied to the water prior to being discharged and copies of any relevant approvals from the respective authorities. Council requires the groundwater at this site to be sampled and analysed for pH and any contaminants of concern. The analytical results must comply with ANZECC Guidelines for 95% Protection of Freshwater. This Groundwater Management Plan shall be received by the consent authority and approved prior to the issue of Construction Certificate. A copy is to be submitted to Council.		Groundwater Management Plan completed by Environmental consultant. Refer to SCP PSMP Appendix S(c).	SCP and Environmental consultant
ANS16	**Acid Sulphate Soils - Management Plan** An Acid Sulphate Soil Management Plan developed by a suitably qualified Environmental Scientist is to be submitted to the consent authority for approval and a copy provide to Council prior to the issue of construction certificate.	To ensure compliance with legislation and to protect public end environmental health and safety,	Acid Sulphate Soil Management Plan completed by ES. Refer to SCP PSMP Appendix S (d)	SCP and Environmental consultant
ANS45	**Removal of Underground Storage Tanks** In relation to the removal of the Underground Storage Tanks, a Site Validation Report in accordance with the Protection of the Environment Operations Act 1997 and Protection of the Environment Operations (Underground Petroleum Storage Systems) Regulation 2008 must be submitted and approved by Council prior to the issue of Occupation Certificate.	To protect public and environmental health and safety and comply with legislation.	To be completed by the environmental consultant following removal and validation of USTs. To be approved by SCP.	Environmental consultant and SCP.

Condition	Requirement	Reason	Action	Responsibility
	After completion of remediation works within Zone B, a copy of the Validation and Monitoring Report prepared by a suitably qualified contaminated land consultant shall be submitted to council and approved prior to the issue of Stage 2 Construction Certificate for works to be undertaken within Zone B. The validation report shall be accordance with the EPA Guidelines, consultants reporting on contaminated sites, and shall certify the suitability of Zone B for proposed development.			
ANS14 (Proposed to Council under Section 96)	**Site Contamination – Validation Report Review** Works the subject of this development consent shall not commence until the land appurtenant to the consent has been remediated and validated in accordance with the Remedial Action Plan. The Remediation of the Site may be staged in accordance with Zone A (Stage 1) and Zone B (Stage 2) as indicated in the correspondence from Aargus Australia dated 7th July 2011, including the accompanying marked up pile set up plan Drw prepared by John R Brogan & associates Pty Ltd and dated October 2007. A Validation Report must be prepared by a contaminated land consultant for each stage. An accredited site Auditor under the Contaminated Land Management Act 1997 shall review the Validation Report and issue a statutory site audit statement that clearly states that the land within the Zone considered in that stage is suitable for the proposed development. The accredited Auditor shall consult with Council prior to finalizing and issuing the site Audit Statement. The accredited Site auditor shall provide council with a copy of the site audit report and statutory site audit statement, confirming the suitability of the land within the Zone considered in that stage for the proposed development prior to the issuing of the staged construction certificate.	To ensure compliance with legislation and to protect public and environmental health and safety	Validation reports to be prepared by the environmental consultant	Environmental consultant.

Condition	Requirement	Reason	Action	Responsibility
	The Code of Practice and Guide referred to above are known collectively as the Worksafe Code of Practice and Guidance Notes on Asbestos.			
1	**Site Contamination - General** All works associated with the contaminated land must be in accordance with the requirements of: • Contaminated Land Management Act, 1997; • Protection of the Environment Operations Act, 1997; • Protection of the Environment Operations (Underground Petroleum Storage Systems) • Regulation, 2008; • State Environmental Planning Policy 55 Remediation of Land; • Occupational Health and Safety Act, 2000; • Requirements of Workcover NSW.	To ensure compliance with legislation and to protect public and environmental health and safety.	Specific compliance actions incorporated into SCP PSMP, this document and ACE SWMS.	All – all works to be conducted in accordance with SCP PSMP.
2	**Site Contamination - Underground Petroleum Storage Systems** All Underground Petroleum Storage Tanks must be removed in accordance with the: • Protection of the Environment Operations Act, 1997: • Protection of the Environment Operations (Underground Petroleum Storage systems Regulation, 2006.	To ensure compliance with legislation and to protect public and environmental health and safety.	Refer to SCP PSMP Appendix 6.	SCP, ACE and Environmental consultant
4	**Management of Hazardous Wastes** Hazardous wastes must be contained, managed and disposed of in a responsible manner in accordance with the Protection of the Environment and Operations Act 1997	Compliance with the provisions of the Protection of the Environment and Operations Act, 1997	Refer to SCP PSMP Appendix 5e – Waste Handling and disposal and PSMP Appendix 8 ACE SWMS	All – all works to be conducted in accordance with SCP PSMP.

Condition	Requirement	Reason	Action	Responsibility
22 (2MS01) and 63(4MS04)	Where construction or excavation activity requires the disturbance of the soil surface and existing vegetation, details including drawings and specifications must be submitted to Council accompanying the Construction Certificate, which provide adequate measures for erosion and sediment control. As a minimum, control techniques are to be in accordance with Manly Council Guidelines on Erosion and Sediment Control, or a suitable and effective alternative method. Sediment control plan to be maintained until completion of the development	To protect the environment from the effects of sedimentation and erosion from development sites	Completed by SCP. Refer to SCP PSMP Appendix 9	SCP
38 (3CD07)	A Remedial Action Plan must be submitted to Council prior to the removal of any Underground Petroleum Storage Tank. All Underground Petroleum Storage Tanks must be removed in accordance with the: • Protection of the Environment Operations Act 1997; • Protection of the Environment Operations (Underground Petroleum Storage Systems) Regulation 2008.	To protect public and environmental health and comply with legislation	A RAP for the removal of the USTs is available in SCP PSMP Appendix 6.	SCP
51 (4CD07)	Anyone who removes, repairs or disturbs bonded or a friable asbestos material must hold a current removal licence from Workcover NSW. Before starting work, a work site specific permit approving each asbestos project must be obtained from Workcover NSW. A permit will not be granted without a current Workcover licence. All removal, repair or disturbance of or to asbestos material must comply with the following: • The Occupational Health and Safety Act 2000; • The Occupational Health and Safety Regulation 2001; • The Code of Practice for the Safe Removal of Asbestos [NOHSC: 2002 (1998)]: • The Guide to the Control of Asbestos Hazards in Buildings and Structures [NOHSC: 3002 (1998)] http://www.nohsc.gov.au/]; and • The Workcover NSW Guidelines for licensed Asbestos Removal Contractors.	To ensure the health of site workers and the public	Unexpected Finds Protocol (this document, Section 5.1.4)	SCP site manager/foreman

Condition	Requirement	Reason	Action	Responsibility
5	**Management of Air Pollution** The use of the premises must not give rise to air pollution impurities in contravention of the Protection of the Environment Operations Act, 1997 and must be controlled in accordance with this Act.	To ensure compliance with legislation and to protect public health and amenity	Refer to this document, Section 5.1 and 5.3	Works to be conducted in accordance with Section 5.1 and 5.3 and the SCP PSMP.
6	**Management of offensive noise** The ongoing use of the premises/property must not give rise to 'offenive noise' and defined under the provisions of the Protection of the Environment Operations Act ,1997.	To ensure compliance with legislation and to protect public health and amenity	Refer to SCP PSMP Appendix 4: System Procedure 13 Noise Management	Works to be conducted in accordance with SCP PSMP.
7	**Management of other pollutants** The operations of the premises must be conducted in a manner that does not pollute waters as defined by the Protection of the Environment Operations Act 1997	To ensure compliance with legislation and to protect public health and amenity	Refer to SCP PSMP Appendix 9 (Sediment and erosion control) and Groundwater Management Plan (SCP PSMP Appendix 5(c)).	Works to be conducted in accordance with SCP PSMP.

13.2 State Environmental Planning Policy 55 (SEPP 55) – Remediation of Lands

Planning framework for the remediation of contaminated land within NSW is contained within SEPP 55. A review of SEPP 55 indicated that the proposed works are classified as 'Category 2' remediation works. Accordingly Development Consent is not required for the remediation programme, however Manly Council must be notified in writing of proposed remediation works at least 30 days prior to commencement.

13.3 Protection of the Environment Operations (POEO) Act 1997

13.3.1 Transport of Waste

Under Section 48 of the POEO Act Schedule 1, Clause 48, the transport of more than 200 kilograms of waste, which includes any combination of hazardous waste, restricted solid waste, liquid waste, clinical and related waste or friable asbestos waste requires licensing. Should this scale of waste transport be required as part of the remediation works, it should be ensured that the transport contractor is appropriately licenced by DECCW to conduct this activity.

13.3.2 UPSS Regulations

Clause 174ZF of the Occupational Health and Safety Regulation 2001 describes the requirements for cleaning or decommissioning plant, equipment and containers as follows:

'an underground tank must be made free from dangerous goods or otherwise made safe if it has not had dangerous goods placed in or taken from it for a continuous period of twelve months.'

Code of Practice: Storage and handling of dangerous goods (NSW WorkCover Authority 2005) states that where:

'two years have elapsed since any dangerous goods were last put in or taken from a tank, the person responsible for the site must remove any remaining dangerous goods, and abandon the tank in compliance with the following industry best practices –

- *AS1940–2004: Storage and handling of flammable and combustible liquids*
- *AS4976–2008: Removal and disposal of underground petroleum storage tanks.'*

The Code of Practice also requires the person responsible to notify WorkCover within seven days of the

- tank abandonment. The notification must include:
- information on tank size, location and method of abandonment
- an as-built site plan that clearly identifies the location of the abandoned tank in relation to other
- tanks and buildings onsite and the site boundaries

- a copy of a letter from a duly qualified contractor confirming the abandonment.

The validation process assists in developing proactive actions which can minimise the chances of contaminating local water and soil resources and ensure the sustainability of the operation.

The details contained in a validation report will depend on:

- the degree of any contamination originally present
- the type of remediation processes that have been carried out, where applicable
- the ongoing or future land use.

The process of validation must confirm statistically that the remediated site complies with the clean-up criteria set for the site and that contamination will not compromise the ongoing or future use of the site. To meet the requirements of the UPSS Regulation, this must be documented in a report.

A site validation report, as required by the Regulation, must contain:

- a description of the scale and nature of any contamination originally present
- a description of the remedial methods used, including objectives, where applicable
- a statement about the site's ongoing or future use
- a description of the extent of any remaining contamination and how this was assessed
- a site plan delineating the area being validated and any contamination remaining after site works
- a clear conclusion on the suitability of the site for its ongoing or future use.

The validation report must specify the boundaries of the area subject to any detailed investigations. It should be noted that the Regulation defines a 'storage site' as the premises where a UPSS is located and thus the site validation report must provide a conclusion about the suitability of the entire premises.

The area potentially influenced by contamination from a UPSS may range from the immediate vicinity of the system, such as the tank pit only, to the entire site and even areas offsite. As a result, the validation report should consider other potentially contaminating factors beyond the tank pit, such as leaking pipework and workshop activities.

For example, sampling only from the walls and bottom of the tank pit (tank pit validation) is insufficient to identify contamination at a UPSS site as it assumes that:

- where there is contamination of a UPSS, it will be found in the tank pit
- where no contamination is found in the tank pit, the site must be clean.

These assumptions do not take into account preferential pathways where hydrocarbon migrates along conduits of least resistance through an impermeable material, such as cracks and fissures. Pathways may also be created where hydrocarbon contamination acts as a solvent. Therefore samples collected only from the walls and bottom of the tank pit may not necessarily represent the contamination status of a UPSS site.

In addition to demonstrating the site's suitability for use, a site validation report should consider whether environmental receptors, including groundwater and surface water, have been compromised. The potential for contamination migrating offsite must also be considered in the report (DECC 2009).

The site validation report must be provided to the relevant local authority to support future planning decisions about the land uses which are suitable on the site. The person responsible for the UPSS, as nominated in the site's Environment Protection Plan, must ensure the report is submitted appropriately and in a timely fashion.

13.4 Manly Council Contaminated Lands Policy—August 2003

Council will require a validation and monitoring report to be submitted after remediation works have been completed, and prior to the commencement of building construction works. This will normally be achieved by Council placing a condition on any consent granted requiring the submission of a validation and monitoring report prior to the issuing of a construction certificate.

Alternately, Council may issue deferred commencement consent for the proposed use, requiring the remediation and validation to be undertaken prior to other work commencing.

The objectives of a validation and monitoring report are to:

- Confirm statistically that the remediated site complies with the cleanup criteria set for the site.
- Demonstrate that the objectives stated in the RAP have been achieved, and
- Ensure that any conditions of development consent have been complied with.

Ideally, the same consultant that conducted the site investigation and remediation process should conduct validation.

The validation and monitoring report will require a site audit (carried out by a NSW EPA accredited auditor).

It is the responsibility of those remediating a site to ensure compliance with all relevant environmental legislation and regulations.

13.5 Asbestos Containing Materials

Work consisting of remediation of materials containing asbestos must be conducted in accordance with the Occupational Health and Safety (OHS) Regulation 2001. This will require application for a work permit from WorkCover NSW at least 7 days prior to the work commencing.

All asbestos remediation work conducted on the site must be undertaken by an AS1 licenced contractor. Monitoring of asbestos in the ambient may also be required.

All waste containing asbestos must be disposed of as 'Special Waste – Asbestos Waste' at a landfill licenced to receive asbestos waste.

13.6 Dust and Odour Control

To maintain acceptable limits of odour and dust emissions during site works, no release of odour or dust should occur beyond the boundaries of the site. Visual observation of site activities by the site manager should trigger the need for application of water for dust suppression, cleaning of roads and regular sweeping as required. Water used for dust suppression will not be permitted to escape off-site or into any stormwater system.

A potential for nuisance odours exists from the potentially impacted soil. Controls to be applied include:

- Using hydrocarbon surfactant sprays to reduce odours; and
- Covering odorous material as practical.

13.7 Material Transporting

Trucks will be loaded in a designated area. The earthworks and transport contractor shall ensure that there is no material tracked out onto the street and that the load is securely covered. In addition, all site vehicles must leave the site in a forward direction.

All appropriate road rules shall be observed and state roads will be selected as far as practicable over local roads when deciding on the transport route to the off-site material disposal location.

In accordance with the Protection of the Environment Operations Act 1997 (Section 48), the transporting of waste which includes hazardous waste, restricted solid waste, liquid waste, clinical and related waste or friable asbestos waste (or any combination of them) a license is required by the waste transporter.

The transporter of waste must:

- Before transporting the waste, certify that any part of the waste transport certificate for the waste that is required to be completed by the transporter has been completed accurately;
- Before transporting the waste, ensure that there is a consignment authorisation that authorises the transport of the waste; and
- Carry in the vehicle transporting the waste the waste transport certificate for the waste.

14 Occupational Health and Safety

This health and safety plan contains procedures and requirements that are to be implemented as a minimum during the remediation works.

The objectives of the health and safety plan are:

- To apply standard procedures that reduce risks resulting from the above works;
- To ensure all employees are provided with appropriate training, equipment and support to consistently perform their duties in a safe manner; and
- To have procedures to protect other site workers and the general public.

These objectives will be achieved by:

- Assignment of responsibilities;
- An evaluation of hazards;
- Establishment of personal protection standards and mandatory safety practices and procedures; and
- Provision for contingencies that may arise while operations are being conducted at the site.

This health and safety plan does not provide safety information specific to construction and other demolition or excavation activities carried out by contractors, such as the safe operation, maintenance and inspection of plant, etc. Contractors will be required to prepare their own Safe Work Method Statements for their work activities. All parties working on the site shall comply with all applicable Health and Safety legislation, regulations, codes and guidelines.

Separate documents have been produced to address health and Safety issues associated with the contamination and remedial actions proposed. These are detailed in:

- *Occupational Health & Safety Plan – Contaminoted Soil: CC01 – Partial Excavation of Potentially Contominated Fill* Environmental Strategies March 2011;
- *Occupational Health & Safety Plan – Contaminated Soil and Groundwater (OHSP-CC02): CC02 – Excavation of Potentially Contaminated Fill and Exposure of Potentially Contominoted Groundwater.* Environmental Strategies April 2011;
- *Safe Work Method Statement.* ACE Demolition and Excavation.

These documents are available in the SCP Project Safety Management Plan for the site.

15 References

1:100,000 Geological Survey of NSW Map for Sydney (Geological Series Sheet 9130 Edition 1, 1983)

1:100,000 Soil Landscape Series Sheet 9139 Sydney 1989

Aargus (February 2011) Remediation Action Plan, Condamine Street & Balgowlah Road, Balgowlah NSW, (Ref. ES4046);

AS4482.1 – 2005 Guide to the Sampling and Investigation of Potentially Contaminated Soil Part 1

AS4482.2 – 1999 Guide to the Sampling and Investigation of Potentially. Contaminated Soil Part 2: Volatile Substances

Australia and New Zealand Environment and Conservation Council (ANZECC) (2000) *'National Water Quality Monitoring Strategy: Water Quality and Monitoring Guidelines'*.

EIS (June 2008) Environmental Site Assessment of Soil and Groundwater, Proposed Commercial Development, Cnr Condamine Street and Balgowlah Road, Balgowlah NSW, (Ref. E2209091KRPT);

EIS (July 2009a) Additional Environmental Site Assessment of Soil and Groundwater, Proposed Commercial Development, Cnr Condamine Street and Balgowlah Road NSW, (Ref. E2209091Krpt2);

EIS (July 2009b) Environmental Site Assessment of Soil and Groundwater Proposed Commercial Development, 1A Roseberry Street, Balgowlah NSW, (Ref. E2209091Krpt3); and

EIS (2009c) Addendum to Environmental Site Assessment, Cnr Condamine Street & Balgowlah Road, Balgowlah, (Ref. E22091K-Let), letter report.

NEPM guidelines (Schedule B (9))

NSW EPA (2000) *'Contaminated Sites: Guidelines for Consultants Reporting on Contaminated Sites'*

NSW EPA (1994) *'Contaminated Sites: Guidelines for Assessing Service Station Sites'*

DEC (2006) *'Contaminated Sites: Guidelines for the NSW Site Auditor Scheme'*

DECC (2009) *Guidelines on the Duty to Report Contamination under the Contaminated Land Management Act 1997*

DECCW (2009) *Waste Classification Guidelines*

Environmental Strategies March 2011*Occupational Health & Safety Plan – Contaminated Soil: CC01 – Partial Excavation of Potentially Contaminated Fill*

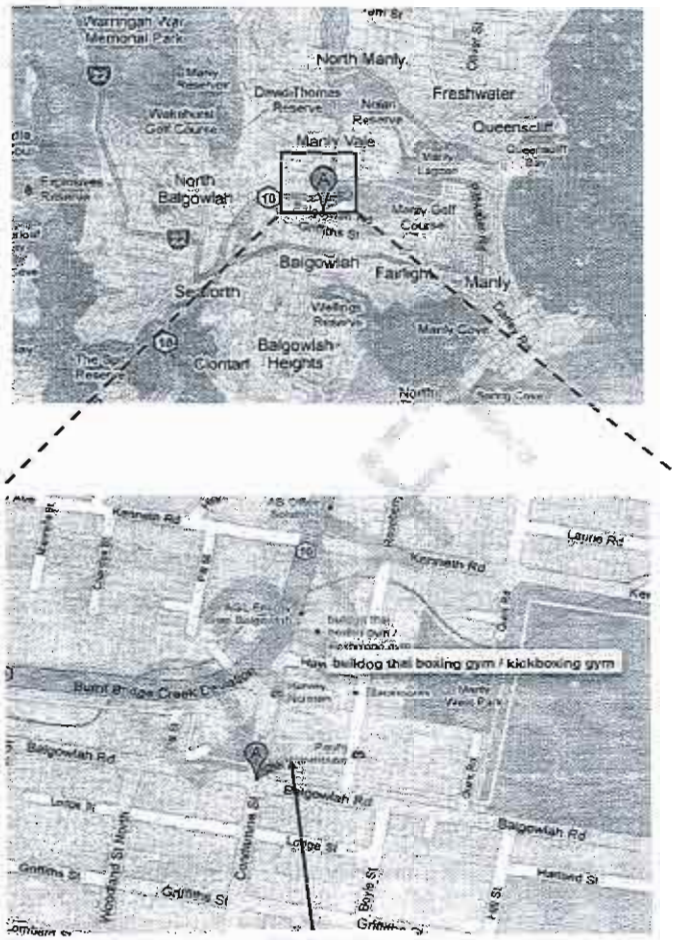
Environmental Strategies April 2011*Occupational Health & Safety Plan – Contaminated Soil and Groundwater (OHSP-CC02): CC02 – Excavation of Potentially Contaminated Fill and Exposure of Potentially Contaminated Groundwater.*;

ACE Demolition and Excavation Pty Ltd *Safe Work Method Statement.*

SCP April 2011 *Project Safety Management Plan*

Appendix A: Figures

LOCALITY MAP

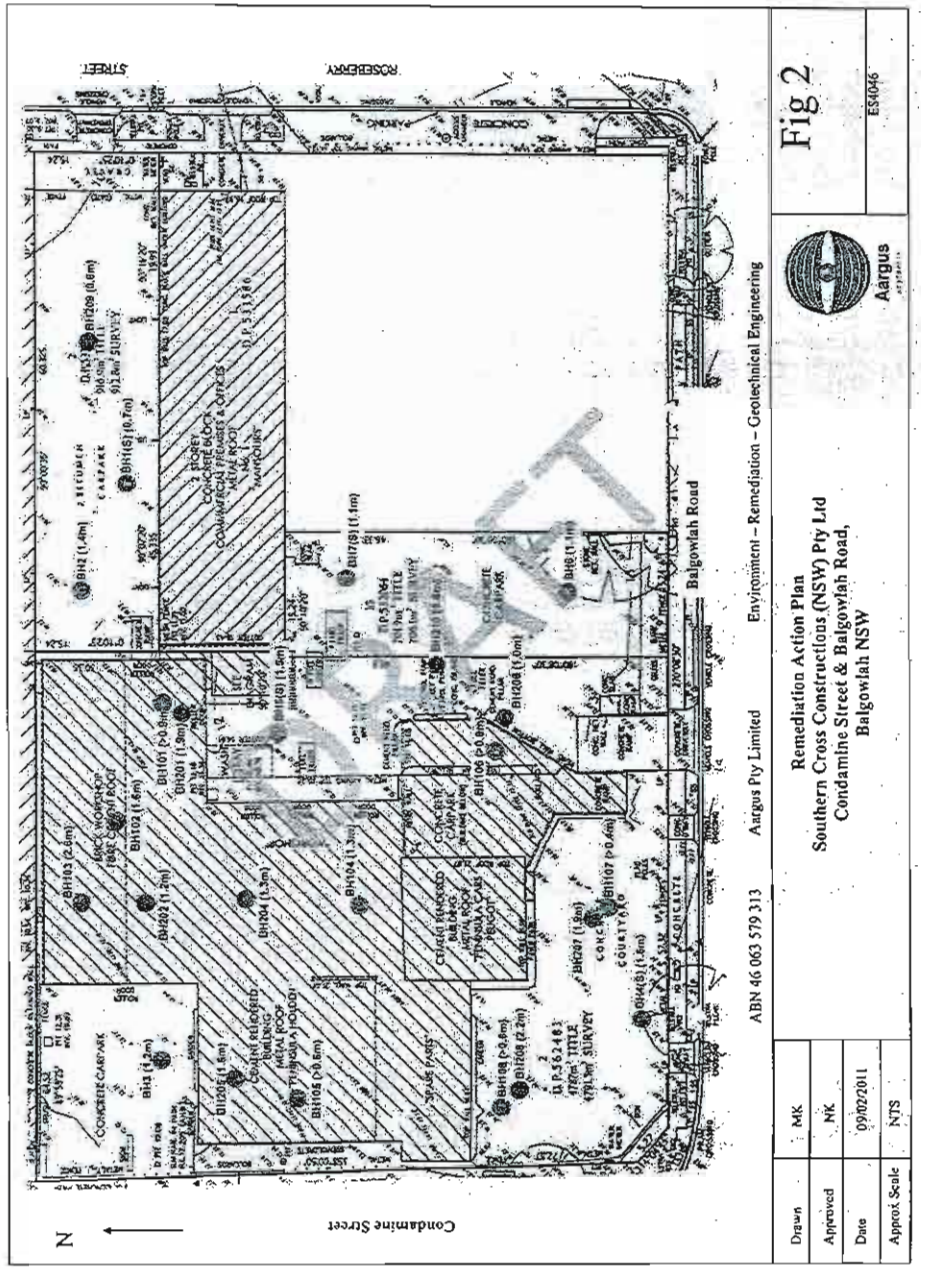


Reference: Whereis.com (2008)

ABN 46 063 579 313	Aargus Pty Limited	Environment – Chemicals – Business Development

Drawn	MK	**Remediation Action Plan Southern Cross Constructions (NSW) Pty Ltd Condamine Street & Balgowlah Road, Balgowlah NSW**	Aargus	Figure 1
Approved	mk			
Date	09/02/2011			Job No: ES4046
Scale	N/A			

SITE PLAN



Remediation Action Plan
Southern Cross Constructions (NSW) Pty Ltd
Condamine Street & Balgowlah Road,
Balgowlah NSW

ABN 46 063 579 313 Aargus Pty Limited Environment – Remediation – Geotechnical Engineering

Aargus

Fig 2

ES4046

Drawn	MK		
Approved	NK		
Date	09/02/2011		
Approx Scale	NTS		

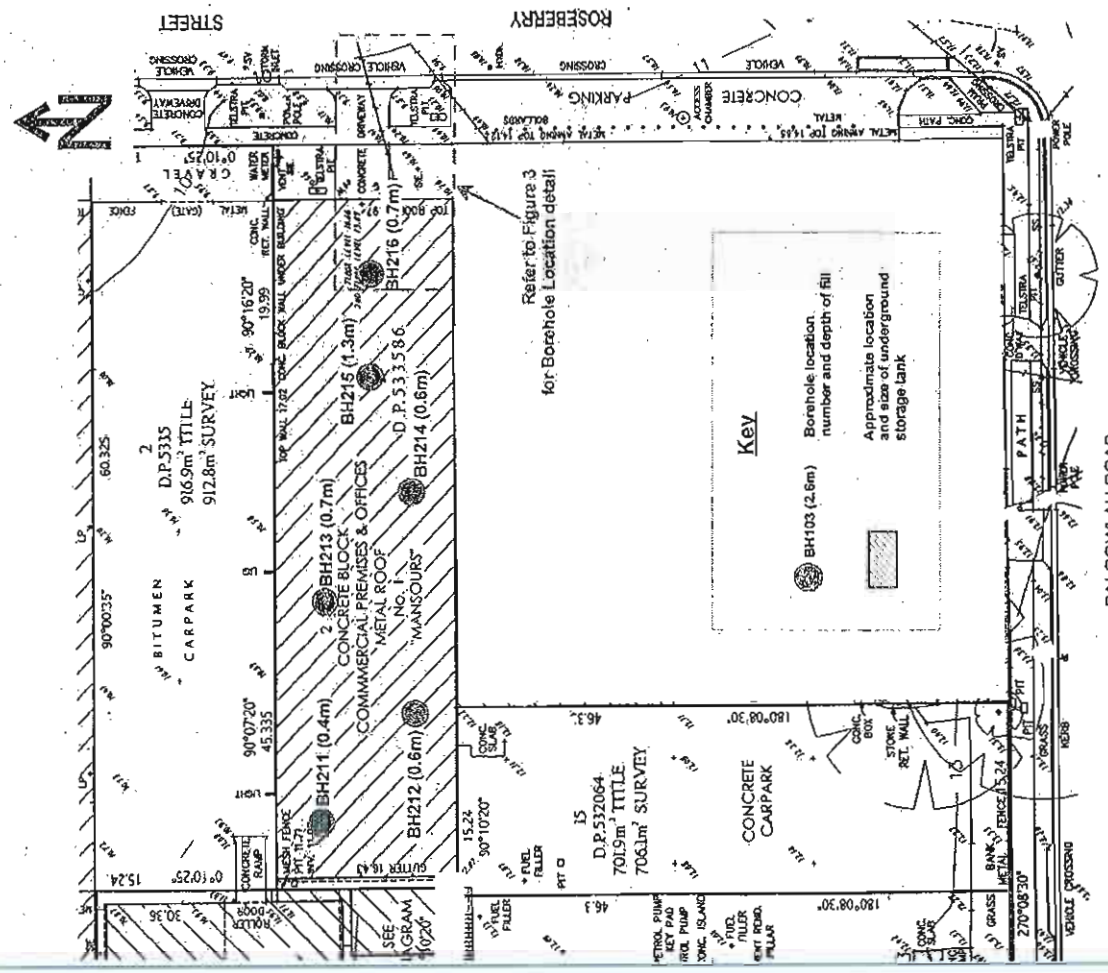


Figure 2b: Site Layout and Sample Locations - Eastern Portion

Job No: E22091K
Figure: 2

ENVIRONMENTAL INVESTIGATION SERVICES

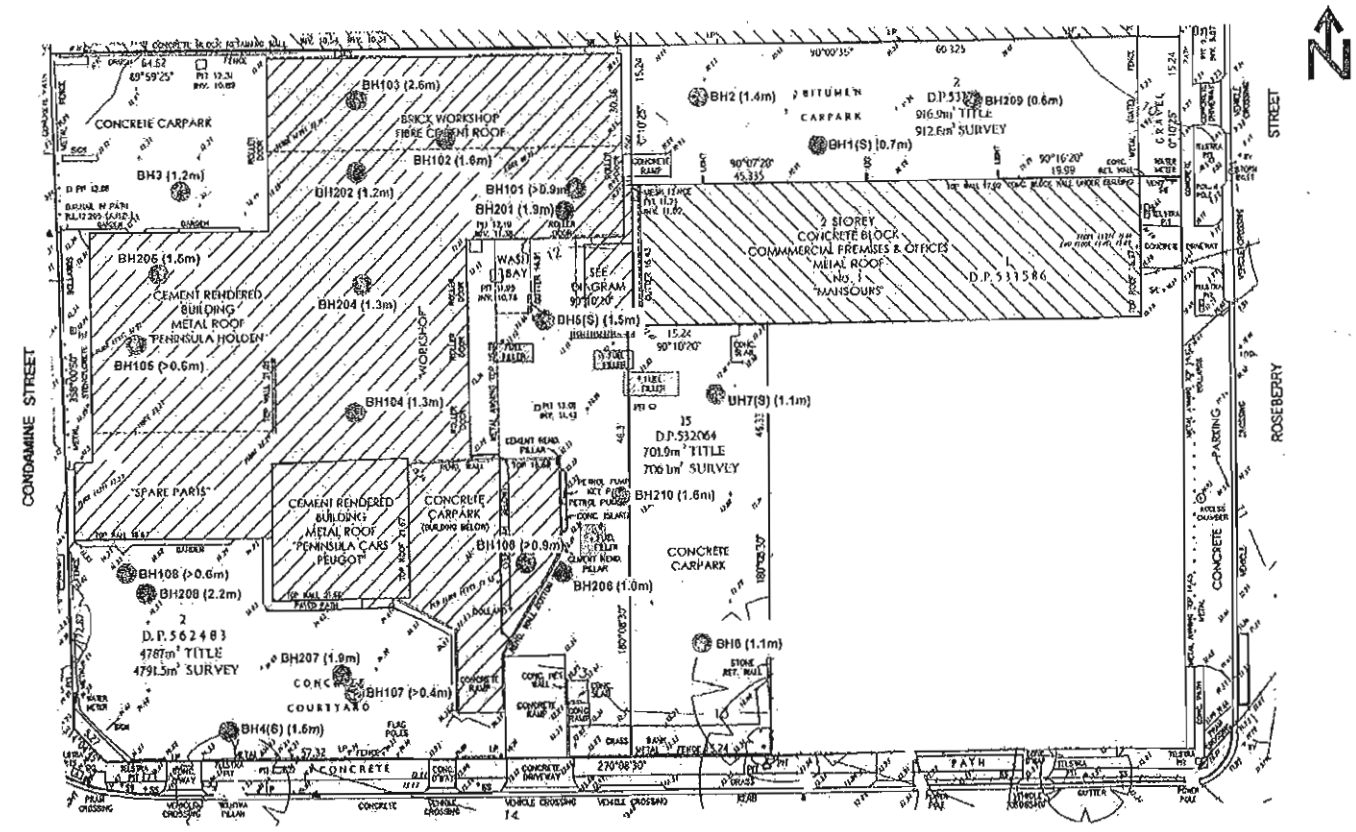
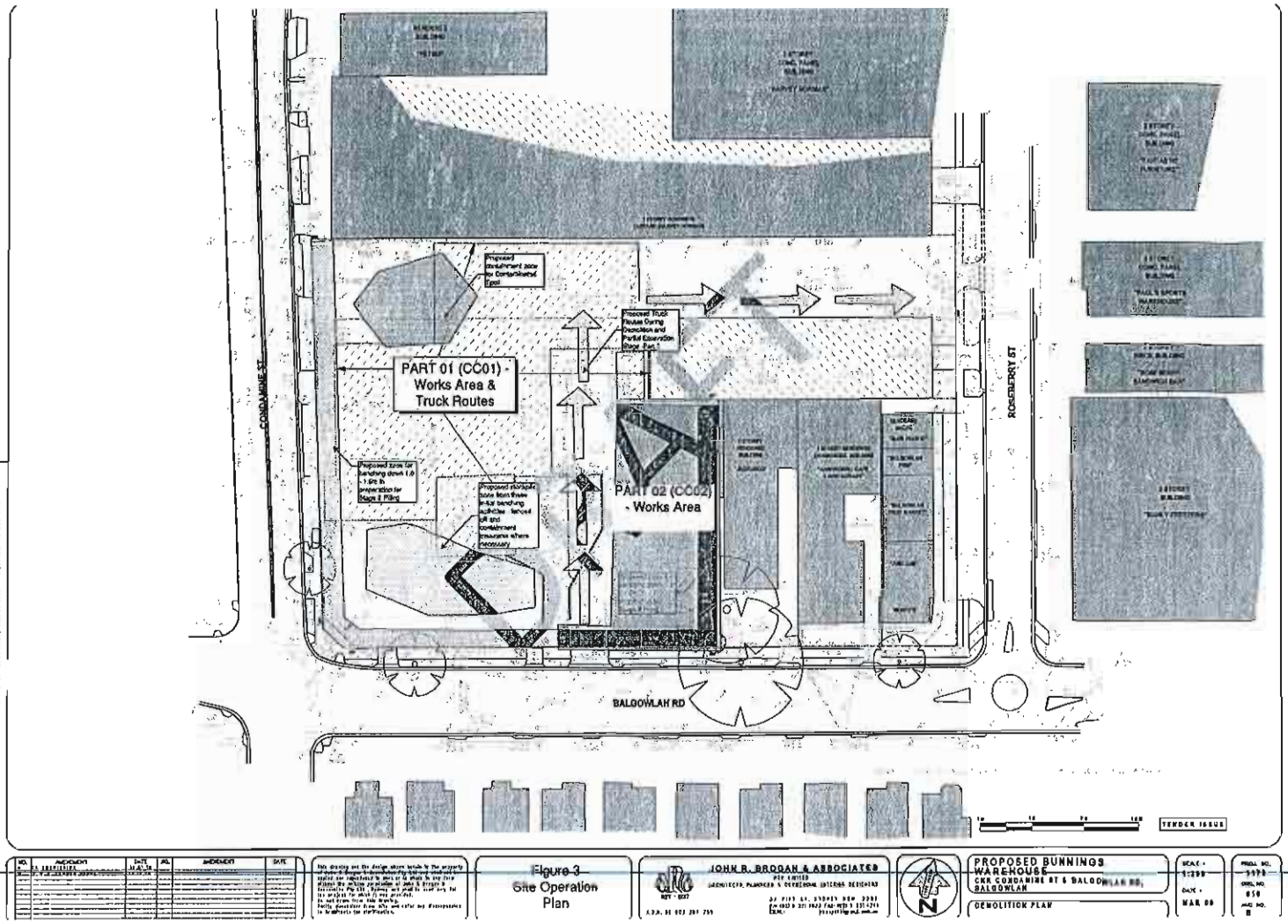
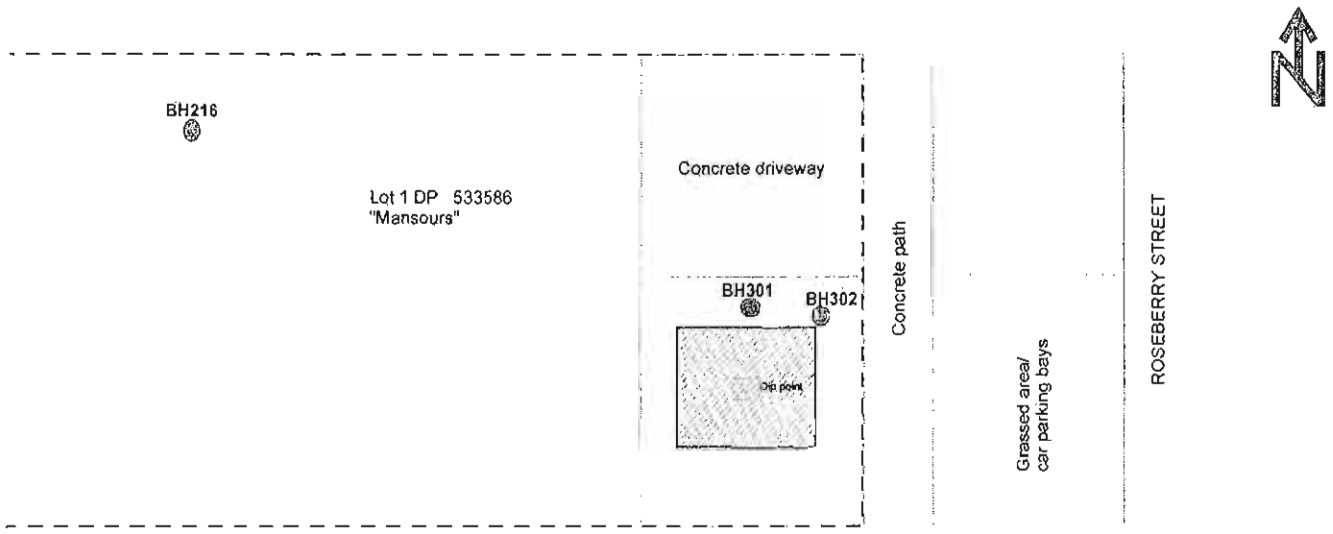


Figure 2a
Site Layout and Sampling Locations - Main Portion

Job No: E22091K
Figure: 2

ENVIRONMENTAL INVESTIGATION SERVICES





Key

- BH103 — Borehole location number
- Approximate location and size of underground storage tank
- Site Boundary

Approximate Scale (m)

0 1 2 3 4 5

Note: Reference should be mede to the text for a full understanding of this plan

Figure 2c
Site Layout and Sampling Locations - Western Portion

PROPOSED COMMERCIAL DEVELOPMENT
1A ROSEBERRY STREET
BALGOWLAH NSW

Job No: E22091K
Figure: 3

ENVIRONMENTAL INVESTIGATION SERVICES

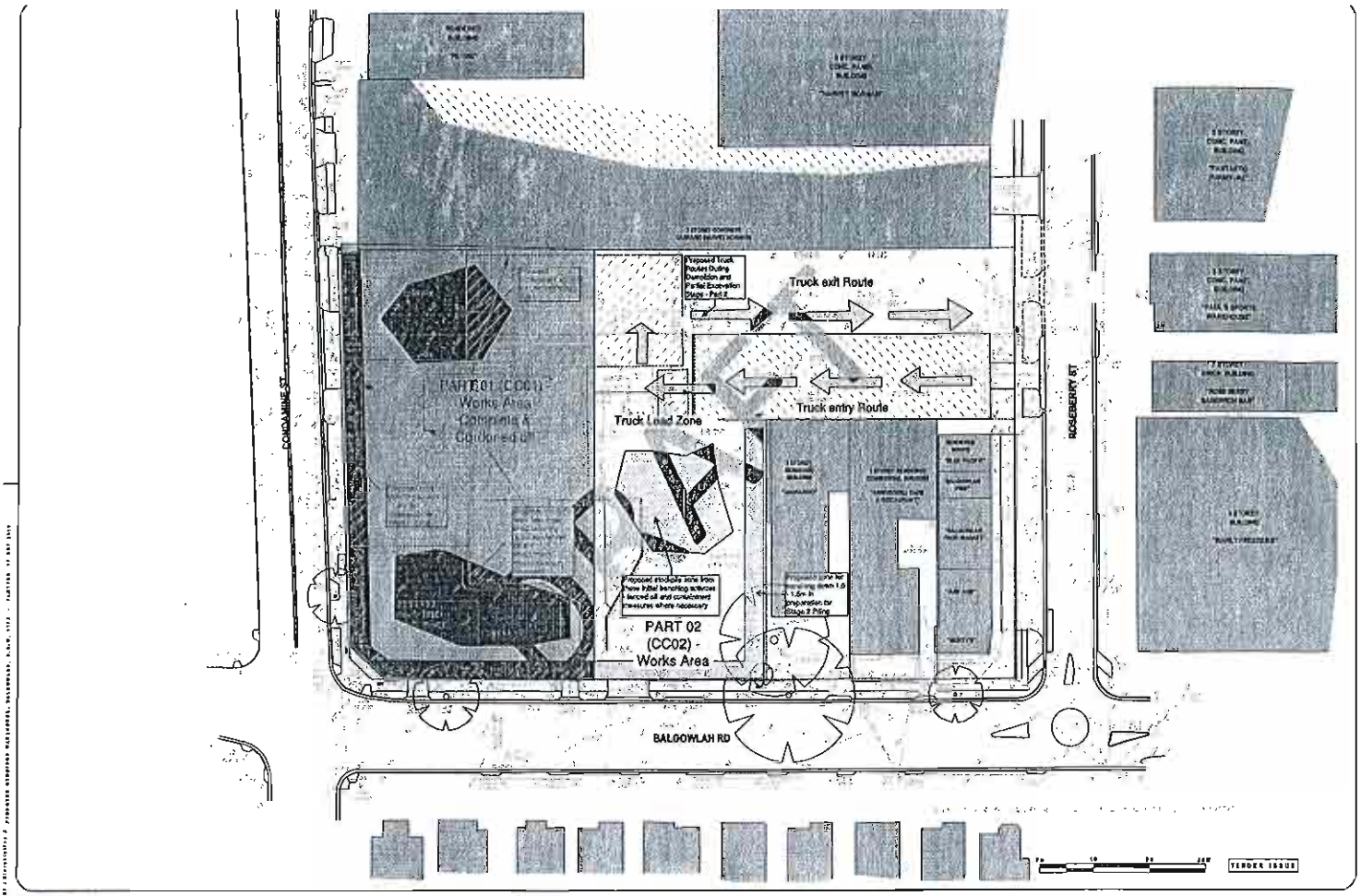


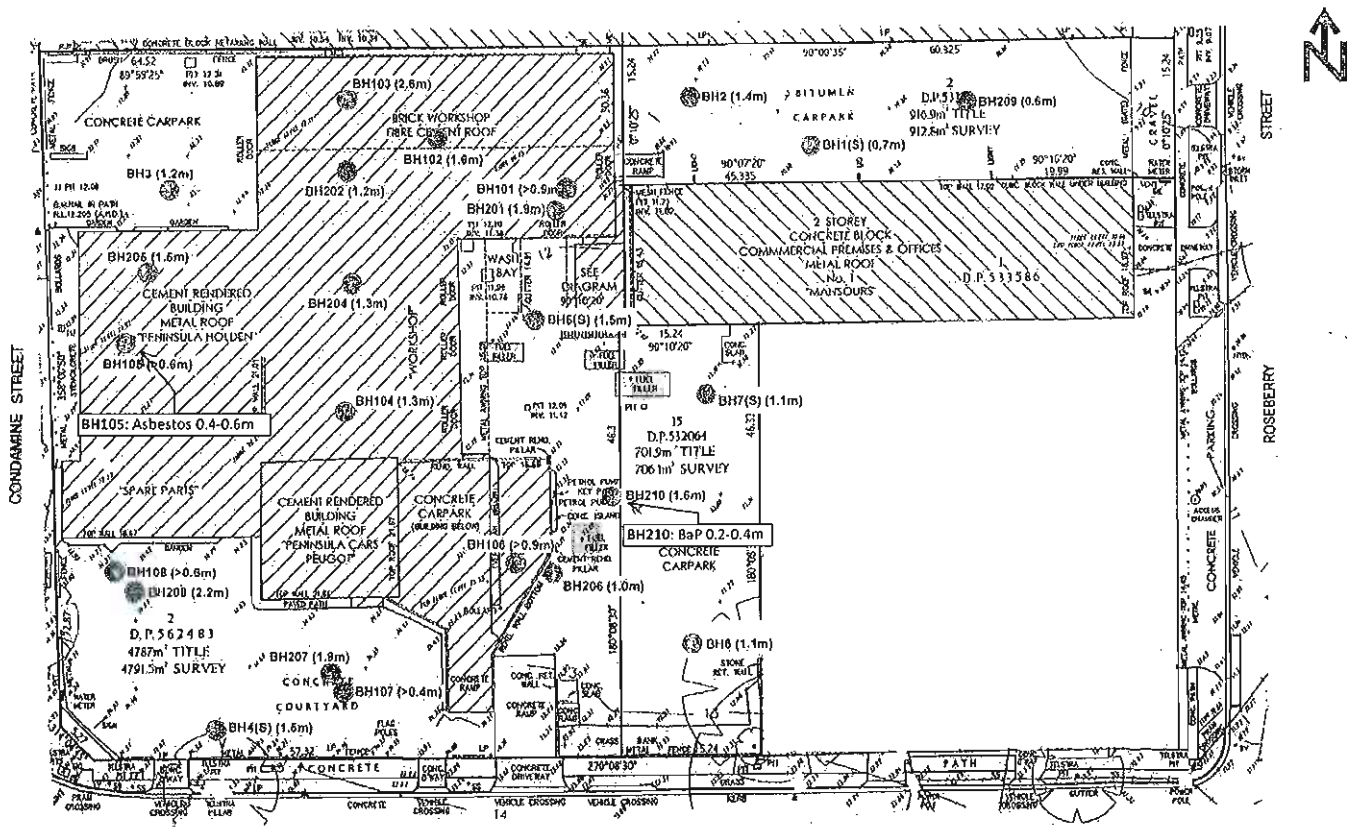
Figure 4
Site Operation Plan

JOHN R. BROGAN & ASSOCIATES
PTY. LIMITED
ARCHITECTS, PLANNERS & COMMERCIAL INTERIOR DESIGNERS

PROPOSED BUNNINGS WAREHOUSE
CNR CONDAMINE ST & BALGOWLAH RD, BALGOWLAH

DEMOLITION PLAN

MAR 08



Approximate Scale (m)
0 4 8 12 16 20

Key

BH103 (2.6m) Borehole location number and depth of fill

BH(S) Borehole with groundwater monitoring well

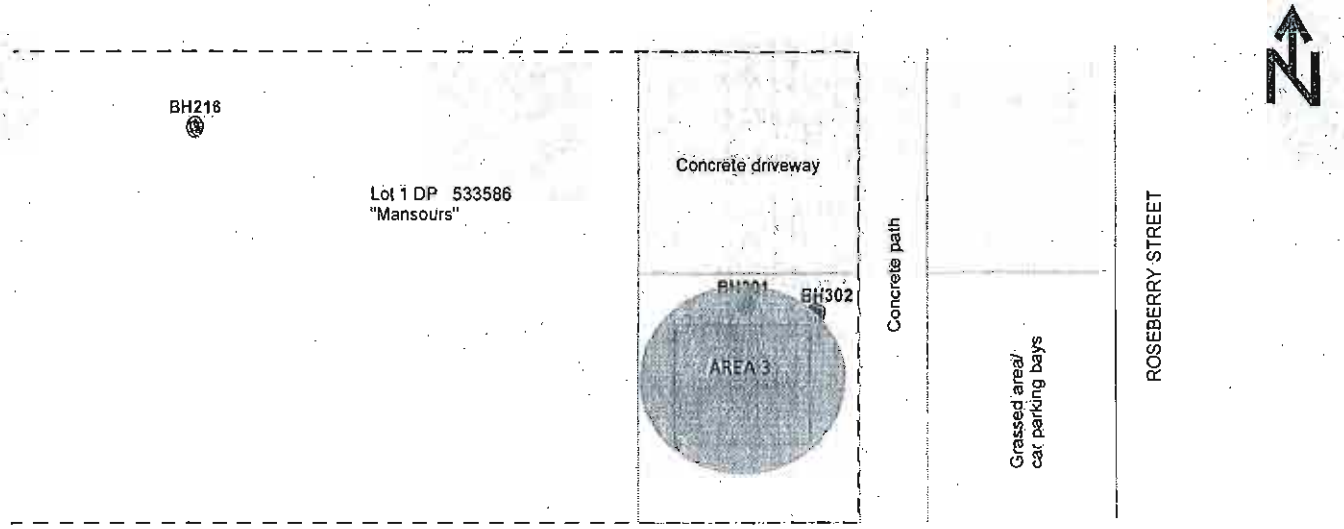
Approximate location and size of underground storage tank

Note: Reference should be made to the text for a full understanding of this plan

Figure 3b
Soil Exceedences

EIS
ENVIRONMENTAL INVESTIGATION SERVICES

Job No: E22091K
Figure: 2



Key

BH103 — Borehole location number

Approximate location and size of underground storage tank

Site Boundary

Soil Remediation Areas

Approximate Scale (m)

0 1 2 3 4 5

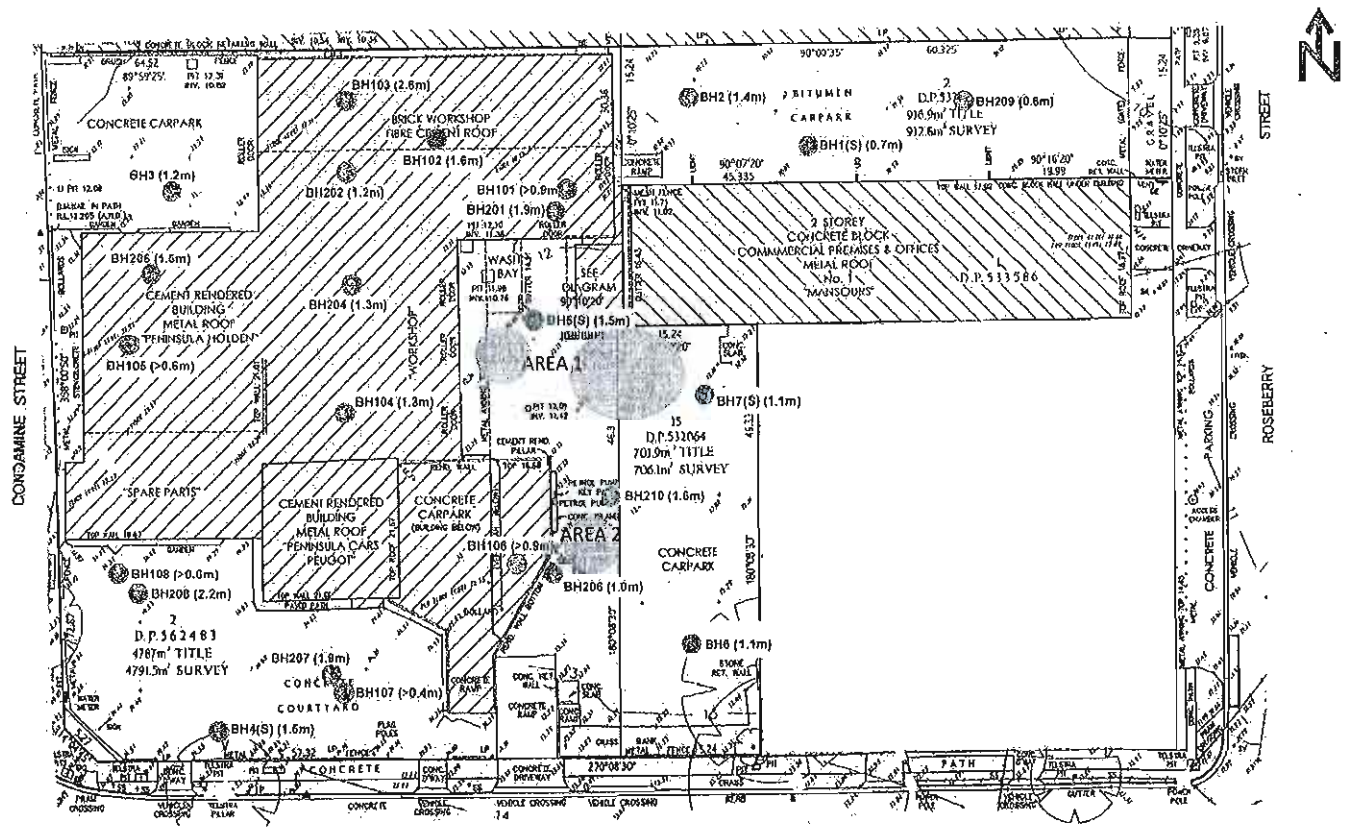
Note: Reference should be made to the text for a full understanding of this plan

Figure 4b
Soil Remediation Areas

PROPOSED COMMERCIAL DEVELOPMENT
1A ROSEBERRY STREET
BALGOWLAH NSW

Job No: E22091K
Figure: 3

ENVIRONMENTAL INVESTIGATION SERVICES



Approximate Scale (m)

0 4 8 12 16 20

Key

BH103 (2.6m) — Borehole location number and depth of fill

BH(S) — Borehole with groundwater monitoring well

Approximate location and size of underground storage tank

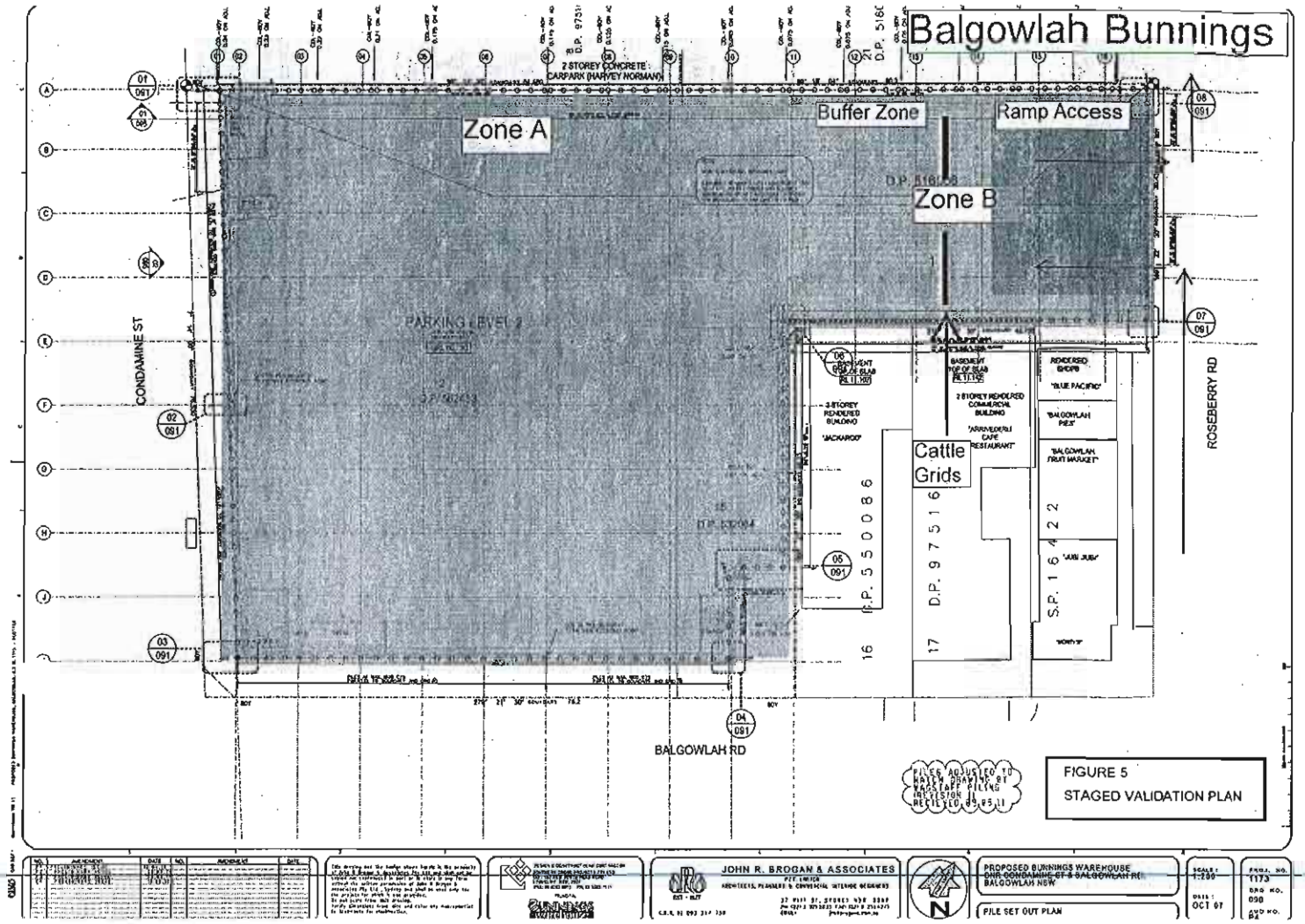
Soil Remediation Areas

Note: Reference should be made to the text for a full understanding of this plan

Figure 4a
Soil Remediation Areas

ENVIRONMENTAL INVESTIGATION SERVICES

Job No: E22091K
Figure: 2



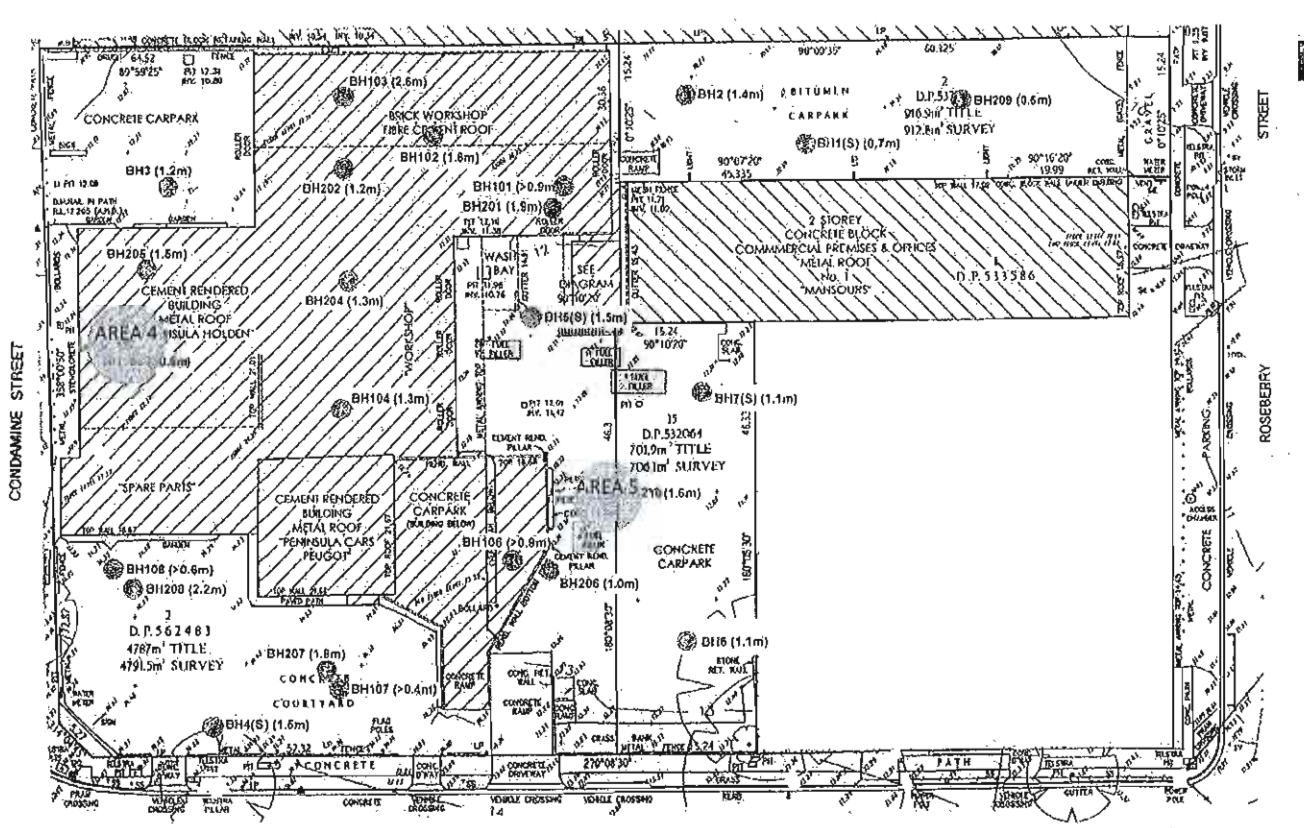


Figure 4c
Soil Remediation Areas

Note. Reference should be made to the text for a full understanding of this plan

ENVIRONMENTAL INVESTIGATION SERVICES

Job No: E22091K
Figure: 2

#11, 12 & 15

Bradley Collits

From: Liam Linehan [llinehan@southerncrossgroup.net]
Sent: Monday, 22 August 2011 5:15 PM
To: Bradley Collits
Cc: Tom Shannon; Ben Isenhood
Subject: FW: Bunnings Balgowlah - Development Consent 16/10 conditions 11, 12 and 15 of consent.

Brad

Further to your email on 10th August regards CC03 documentation please find attached confirmation from Council with regard to preapproval from Council for condition 11,12 and 15. In addition you should have received three sets of hydraulic drawings and a disc last week. I am still working on the structural documentation you requested.

Regards

Liam Linehan | Project Manager

Southern Cross Projects
135-153 New South Head Road Edgecliff, NSW 2027
T 02 99499299 F 02 99076420 M 0410 003 431
E llinehan@southerncrossgroup.net W southerncrossprojects.com.au

Spoke to Alex Ross 26.08.11, he confirmed the plans provided to SHP are those satisfactory to Council.

New South Wales
135-153 New South Head Road,
Edgecliff NSW 2027
T 02 9363 1111 F 02 9363 0011
W southerncrossprojects.com.au

Queensland
23 Sanders Street,
Upper Mount Gravatt QLD 4122
T 07 3216 8486 F 07 3216 8743
W southerncrossprojects.com.au

Western Australia
Suite 5, 18-22 Riseley Street,
Ardross WA 6153
T 08 9316 2007 F 08 9316 3009
W southerncrossprojects.com.au

From: Alex Ross [mailto:aross@mgpbis.com.au]
Sent: Tuesday, 16 August 2011 9:40 AM
To: Liam Linehan; Ben Isenhood
Cc: Sam Haddad
Subject: Fwd: Bunnings Balgowlah - Development Consent 16/10 conditions 11, 12 and 15 of consent.

Liam,

Please find below correspondence from Manly Council in relation to the site stormwater drainage to satisfy council DA conditions 11,12 and 15.

Regards,

Alex Ross
mgp
mgp building and infrastructure services pty limited

T 02 9451 7555
F 02 9451 8555
M 0432 322 033
E aross@mgpbis.com.au
W www.mgpbis.com.au

hydraulic | fire | civil | sydney water services

Begin forwarded message:

From: David Stray <stray.david@manly.nsw.gov.au>
Subject: Bunnings Balgowlah - Development Consent 16/10 conditions 11, 12 and 15 of consent.
Date: 16 August 2011 8:37:38 AM AEST
To: "aross@mgpbis.com.au" <aross@mgpbis.com.au>
Cc: Maran Muthiah <Maran.Muthiah@manly.nsw.gov.au>

Alex,
Thank you for forwarding the Engineering Certification and detail drawings of the proposed storm water system on 28 July 2011. The documentation has been view by Council's Engineer and is considered to satisfy condition 11(2DS010, 12(2DS02) and 15(2DS07).

Regards

David Stray

Manager Development Assessment
Land Use & Sustainability Division
Manly Council

1 Belgrave Street Manly NSW 2095 | PO Box 82 Manly NSW 1655 | Ph. 02 9976 1400 |
Switch 9976 1500 | Fax 9976 1400 | david.stray@manly.nsw.gov.au | www.manly.nsw.gov.au

Suite 9/6 Tilley Lane
Frenchs Forest NSW 2086
T 02 9451 7555
F 02 9451 8555
E info@mgpbis.com.au

mgp
building & infrastructure services pty ltd
abn 83 455 645 810

STORMWATER - STATEMENT of DESIGN COMPLIANCE

PROJECT: **164 CONDAMINE STREET, BALGOWLAH**

Pursuant to Clause 11, 12 & 15 of Manly Council DA 16/10.

I, Sam **Haddad** (MIEAust CPEng NPER-3 Civil)
on behalf of **MGP Building & Infrastructure Services Pty Ltd**
Suite 9 / 6 Tilley Lane Frenchs Forest 2086
T 02 9451 7555 F 02 9451 8555
E info@mgpbis.com.au

hereby certify:-

That the rainwater tank, stormwater and on-site detention services for the above development have been designed to comply with the relevant Australian Standards as described in Schedule "A" below:

Schedule "A":

a) The relevant Australian Standards

The following Australian Standards: **Stormwater Drainage** **AS 3500 2003**
NSW Code of Practice Plumbing & Drainage 2006

Schedule "B":

b) The design is in accordance with the following: Manly Council Specification for On-Site Stormwater Management 2003 and Specification for Stormwater Drainage 2003

c) Stormwater Drawings

H01	Basement P2
H02	Basement P1
H03	Warehouse Level 1
H04	Warehouse Level 2
H05	Roof
H06	Detail Sheet 1
H07	Detail Sheet 2

d) Exclusions: Nil

Signature: 

Date: 03/07/2011

Sydney WATER Accredited Supplier

AHSCA Corporate Member

IQNet APPROVED COMPANY ISO 9001 Quality Management Systems

Suite 9/6 Tilley Lane
Frenchs Forest NSW 2086
T 02 9451 7555
F 02 9451 8555
E info@mgpbis.com.au

#15

mgp building & infrastructure services pty ltd
abn 83 455 645 810

RAINWATER TANK - STATEMENT of DESIGN COMPLIANCE

PROJECT: **164 CONDAMINE STREET, BALGOWLAH**

Pursuant to Clause 15 of Manly Council DA 16/10.

I, Alex Ross of MGP Building & Infrastructure Services Pty Ltd
Suite 9 / 6 Tilley Lane Frenchs Forest 2086
T 02 9451 7555 F 02 9451 8555
E info@mgpbis.com.au

hereby certify:-

That the rainwater tank services for the above development have been designed to comply with the relevant Australian Standards as described in Schedule "A" below:

Schedule "A":

a) The relevant Australian Standards

The following Australian Standards: Stormwater Drainage AS 3500 2003
NSW Code of Practice Plumbing & Drainage 2006

Schedule "B":

b) Other practices or standards relied upon for this certification: Nil

c) Exclusions: Nil

Signature:

Date: 23/06/2011

Sydney WATER Accredited Supplier

AHSCA Corporate Member

IQNS APPROVED COMPANY ISO 9001 Quality Management Systems

#24.

Bradley Collits

From: Ben Isenhood [bisenhood@southerncrossgroup.net]
Sent: Thursday, 1 September 2011 9:56 AM
To: Bradley Collits
Cc: Liam Linehan
Subject: DA Condition Item 24 - Surfaced & Sealed

Brad,

As requested see below Curing Compound for DA Item 24

Curing Compound – ***Pavecure W***

The Finish to P1 is by Coving Trowel with WH1 & WH2 being a Burnished Finish.

Regards

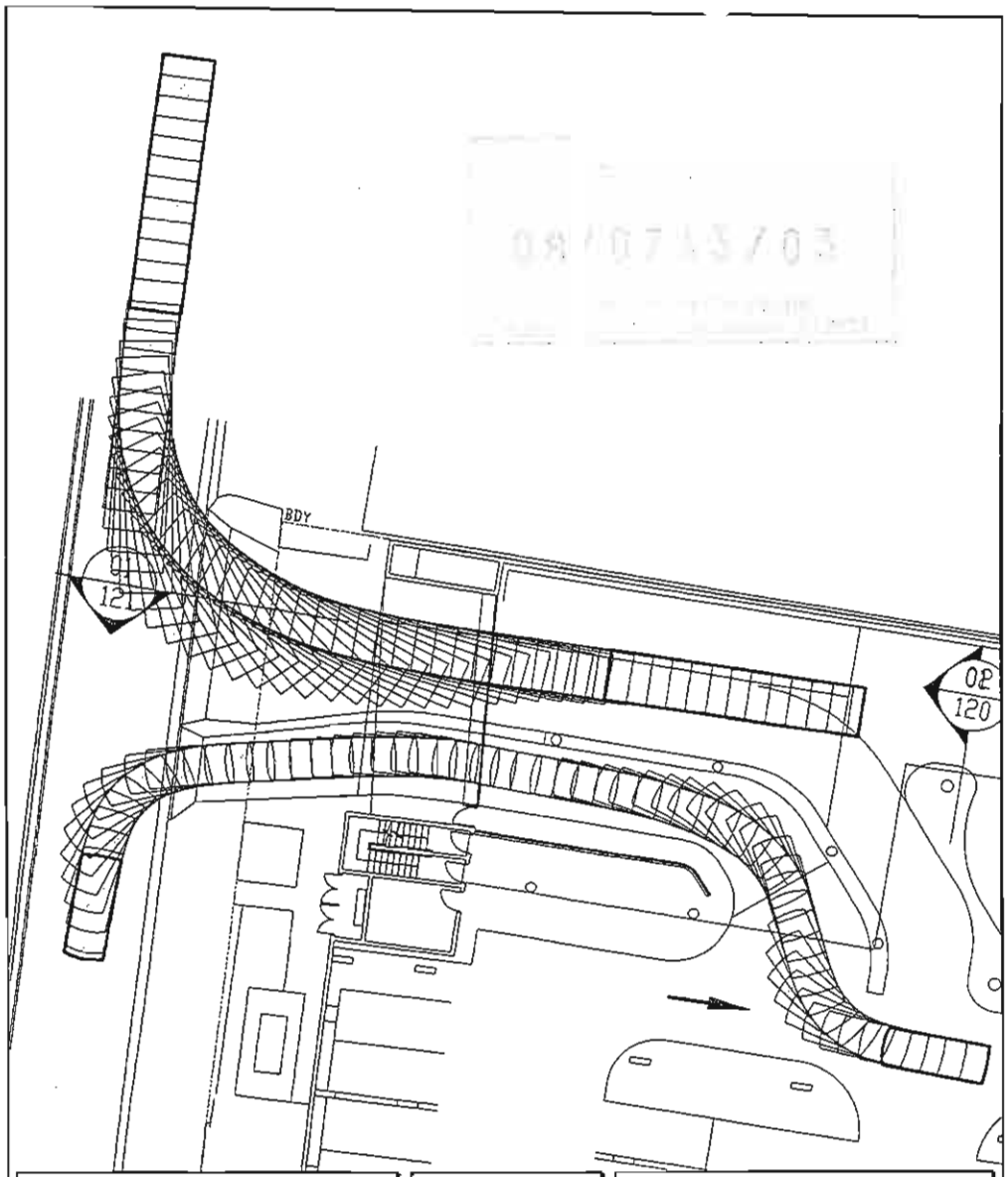
Ben Isenhood | Site Manager

Southern Cross Projects

135-153 New South Head Road, Edgecliff NSW 2027

T 02 9363 1111 F 02 9363 0011 M 0431 233 705

E bisenhood@southerncrossgroup.net W southerncrossprojects.com.au

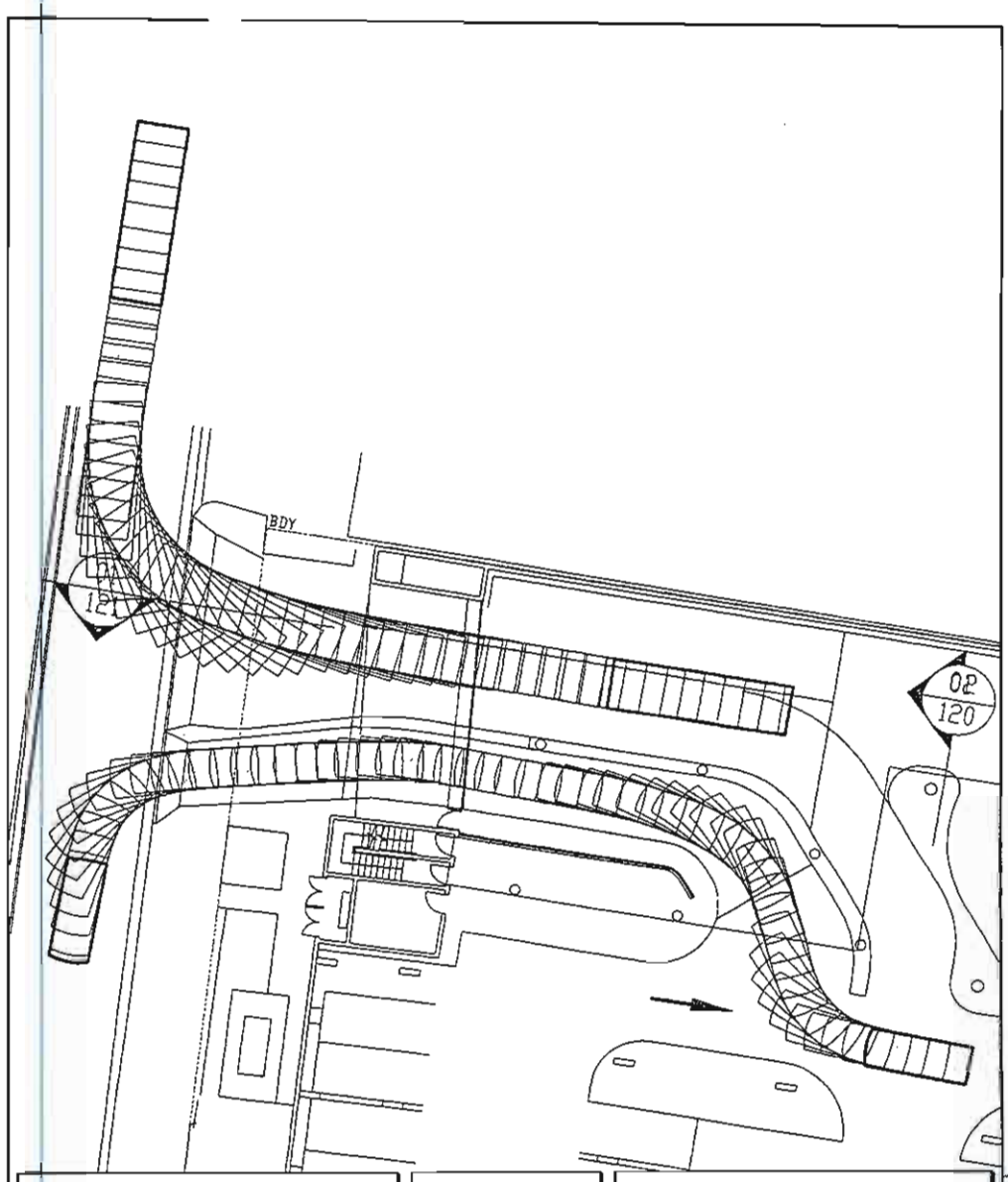


LEGEND

This drawing has been prepared using vehicle modelling computer software AutoTrack V5.00a in conjunction with AutoCAD 2000. The vehicle used is based upon vehicle data provided by Austroads and incorporates a reasonable degree of tolerance. However, it is not possible to account for all vehicle types/characteristics and/or driver ability.

SWEPT PATH ANALYSIS OF A 12.5m RIGID VEHICLE ENTERING & A 99th PERCENTILE VEHICLE EXITING THE SITE

SP 1



LEGEND

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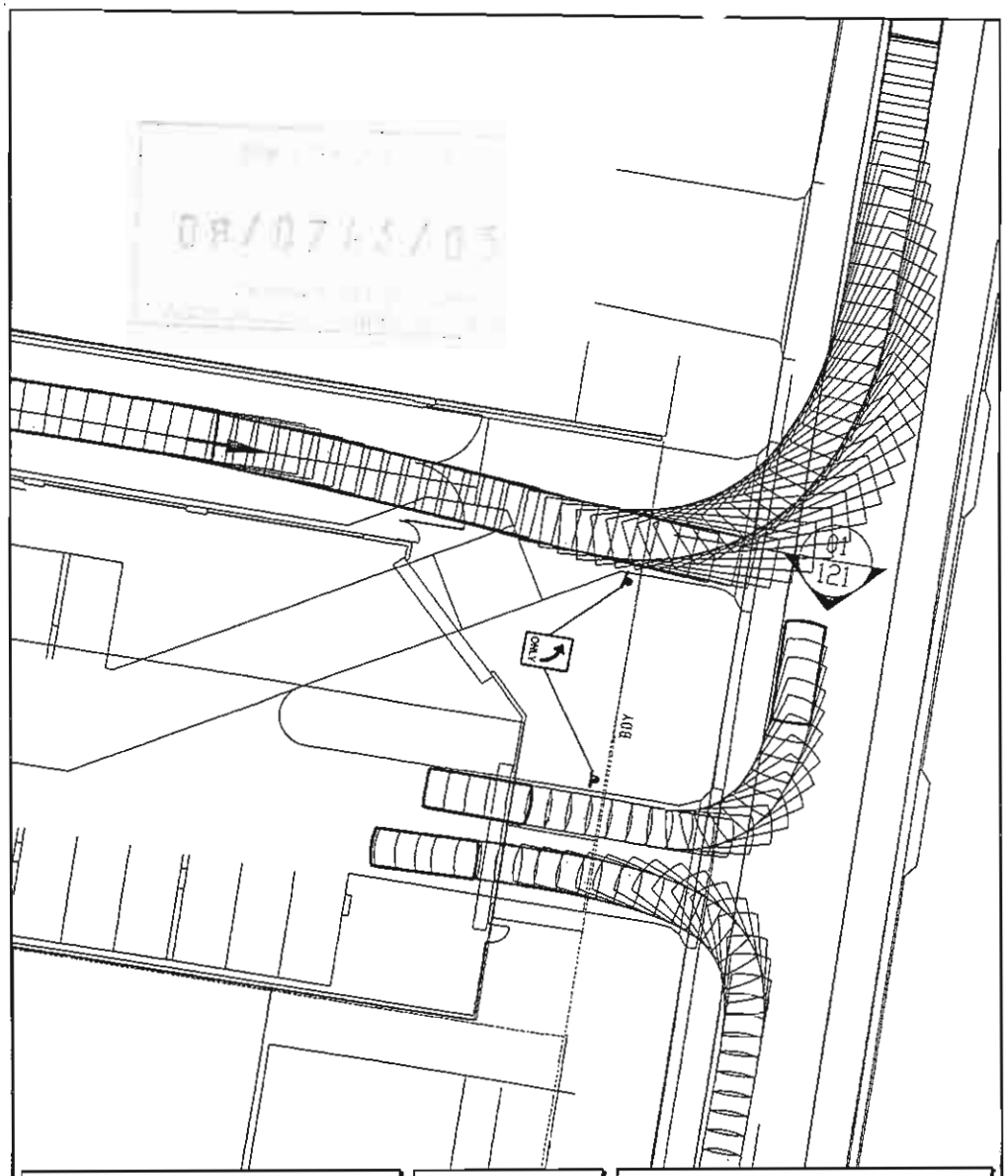
SWEPT PATH ANALYSIS OF AN 8.8m RIGID VEHICLE ENTERING & A 99th PERCENTILE VEHICLE EXITING THE SITE

SP 2



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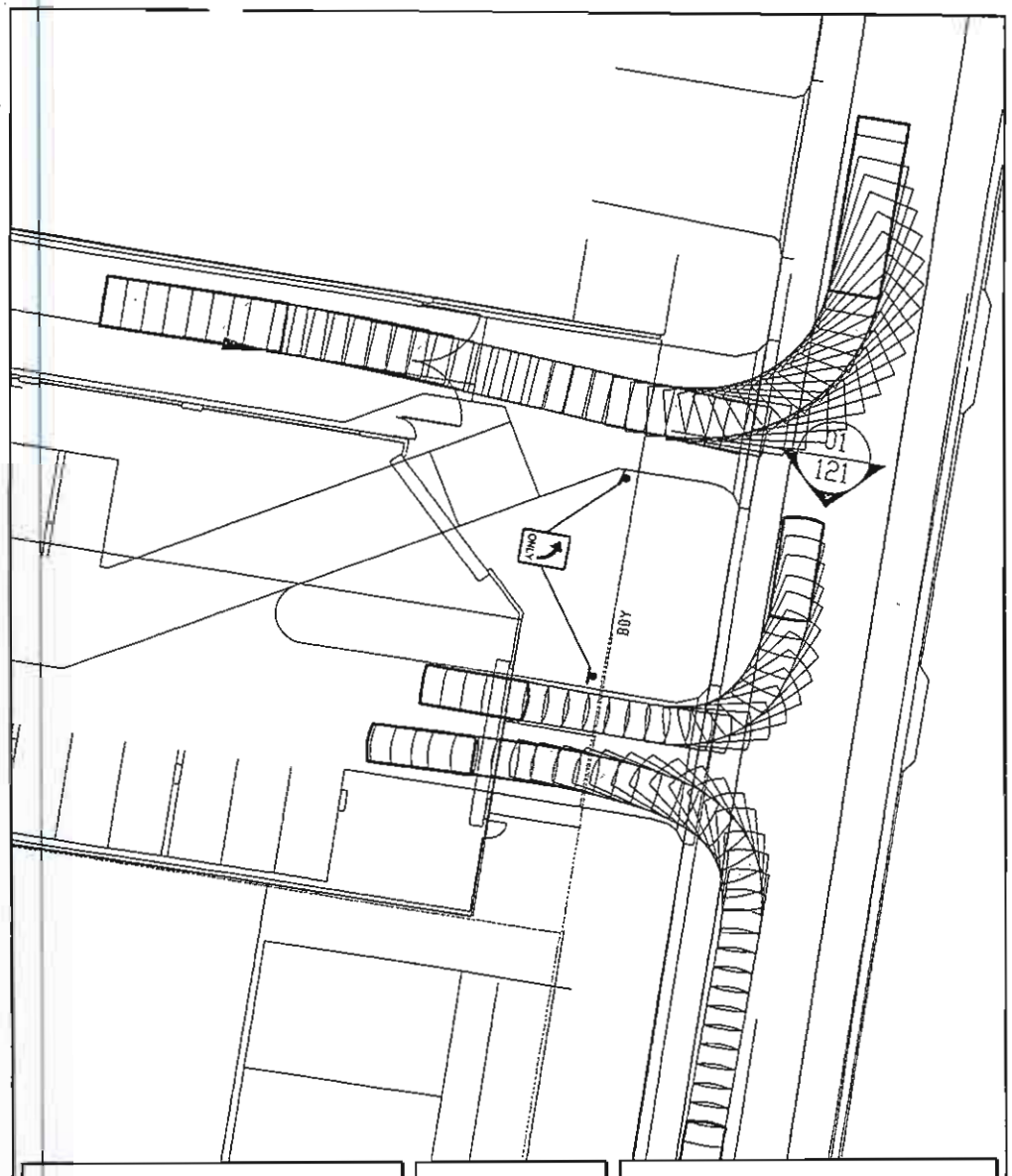
SWEPT PATH ANALYSIS OF A 99th PERCENTILE VEHICLE ENTERING AND A 12.5m RIGID VEHICLE EXITING THE SITE

SP 3



LEGEND

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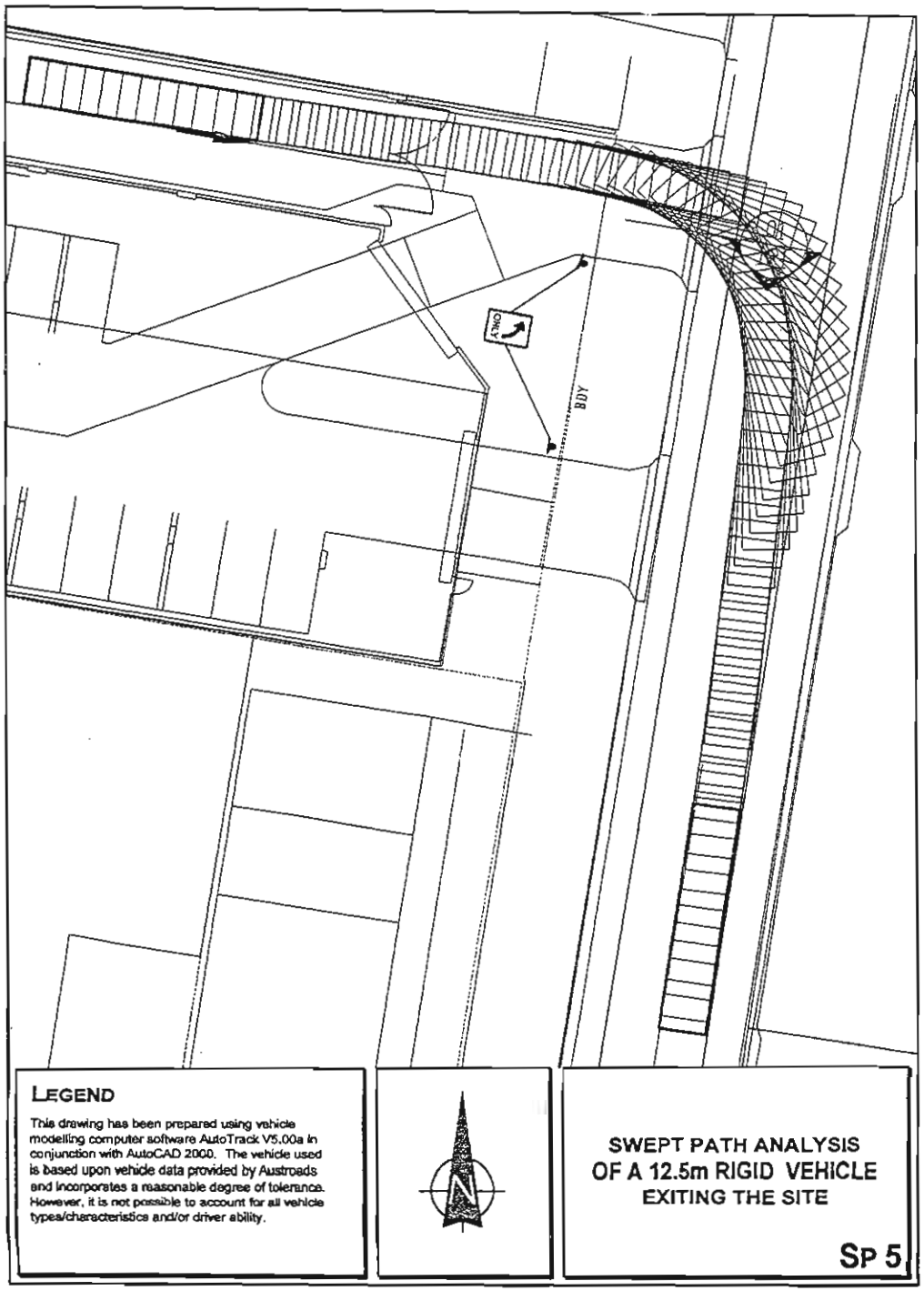
SWEPT PATH ANALYSIS OF A 99th PERCENTILE VEHICLE ENTERING AND AN 8.8m RIGID VEHICLE EXITING THE SITE

SP 4



LEGEND

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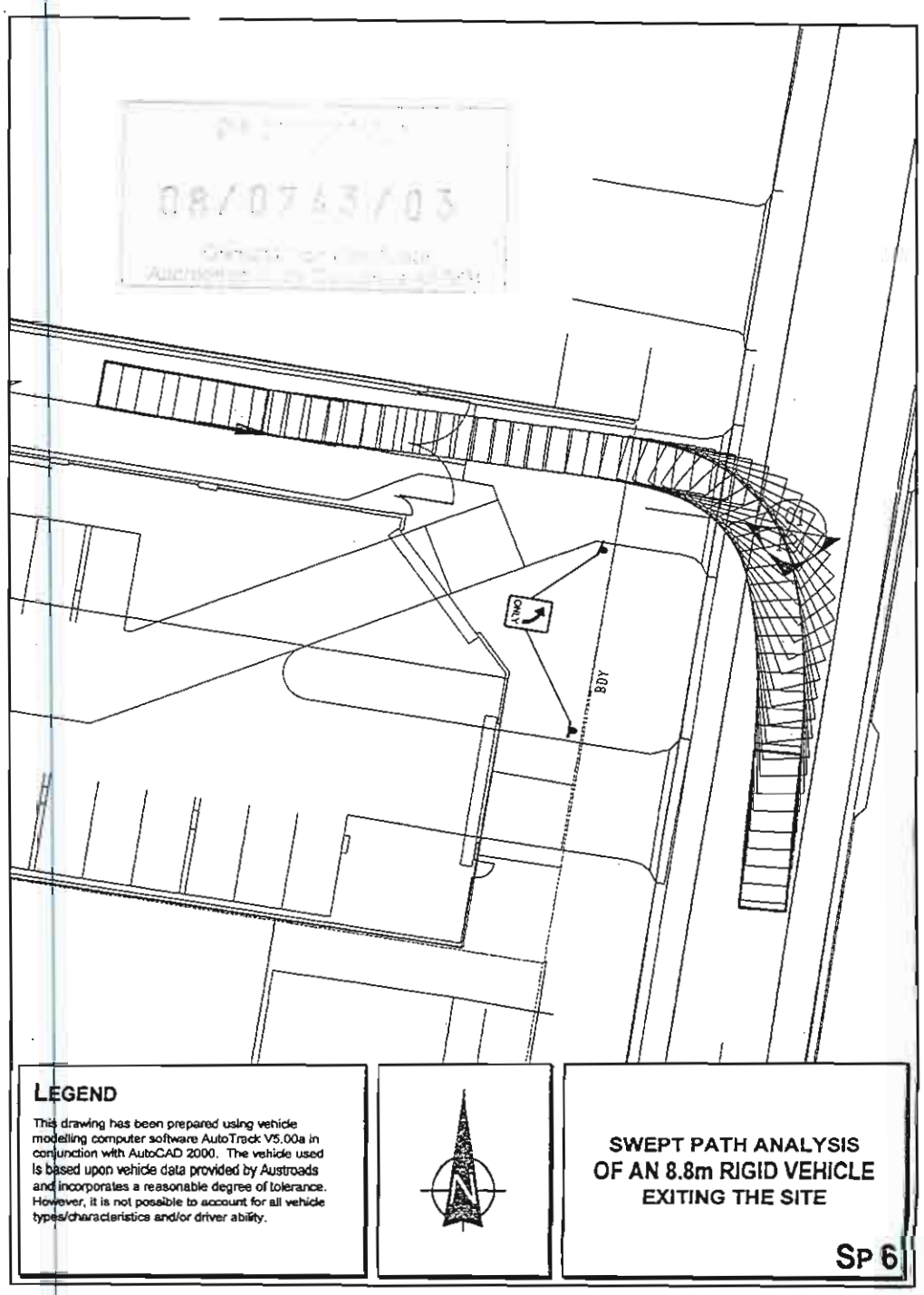
SWEPT PATH ANALYSIS OF A 12.5m RIGID VEHICLE EXITING THE SITE

SP 5



LEGEND

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SWEPT PATH ANALYSIS OF AN 8.8m RIGID VEHICLE EXITING THE SITE

SP 6

Bingo Skip Bins
Bingo Recycling Centres
Bingo Excavations
PO Box 7, Enfield NSW 2136
Tel: 9737 0308 Fax: 9737 0351
enquiries@bingogroup.com.au
www.bingogroup.com.au

#30

cleaning up

CONFIDENTIAL

Waste Management & Recycling Plan

Client: **Southern Cross Constructions**
Project: **164 Condamine St, Balgowlah**

Bingo Group offers a complete, comprehensive solution to the management and recycling of wastes to assure compliance with clients' waste management policy.

Bingo Recycling Centre Homebush Bay and Bingo Recycling Centre St Peters combine bin storage, waste collection, waste recycling and waste transfer to service the building and construction industry and domestic waste management needs in the Sydney metropolitan area. Wastes collected by Bingo Skip Bins are taken directly to either facility where approximately 85 - 90% of wastes are converted to recovered resources.

Bingo Recycling Centre Homebush Bay	Bingo Recycling Centre St Peters
3 Burroway Rd, Homebush Bay	6-10 Burrows Rd South, St Peters
DECCW Licence No. 12696	DECCW Licence No. 13142

As can be expected waste materials inwards vary considerably and are delivered to the Recycling Centres in tipping and non-tipping vehicles or in skip bins. Of the wastes inwards approximately 85 - 90% is recovered and recycled as materials outwards and the balance 10 - 15% to landfill. Waste materials inwards are processed to achieve the maximum recovery of resources and the minimum of un-recoverable material for offsite disposal.

Typical Composition of Bingo's Wastes Inwards

Wastes Inwards	Percentage (approx.)
Heavy Recyclable Materials	45%
Light Recyclable Materials	35%
Metals	10%
Non-Recyclable Materials	10%
Total	100%

Heavy Recyclable Materials:

- Soil
- Dirt
- Sand
- Rubble
- Brick
- Concrete
- Tiles
- Stone
- Asphalt

Light Recyclable Materials:

- Timber
- Green Waste
- Cardboard / Paper
- Plastic / Polystyrene
- Plasterboard / Gyprock

Metals:

- Ferrous (steel, black iron)
- Non-Ferrous (copper, wire, aluminium, stainless)

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At the Resource Recovery Facility a simple and effective waste processing procedure is applied. See Materials Flow Diagram (below). Wastes inwards unloaded onto the sorting area where the waste is raked with a hydraulic excavator to expose the contents and where recyclable materials are hand and machine sorted. The raking process separates the waste into four streams for further processing.

Stream #1 Non-recyclable materials. These wastes pass to a holding area for off-site disposal.

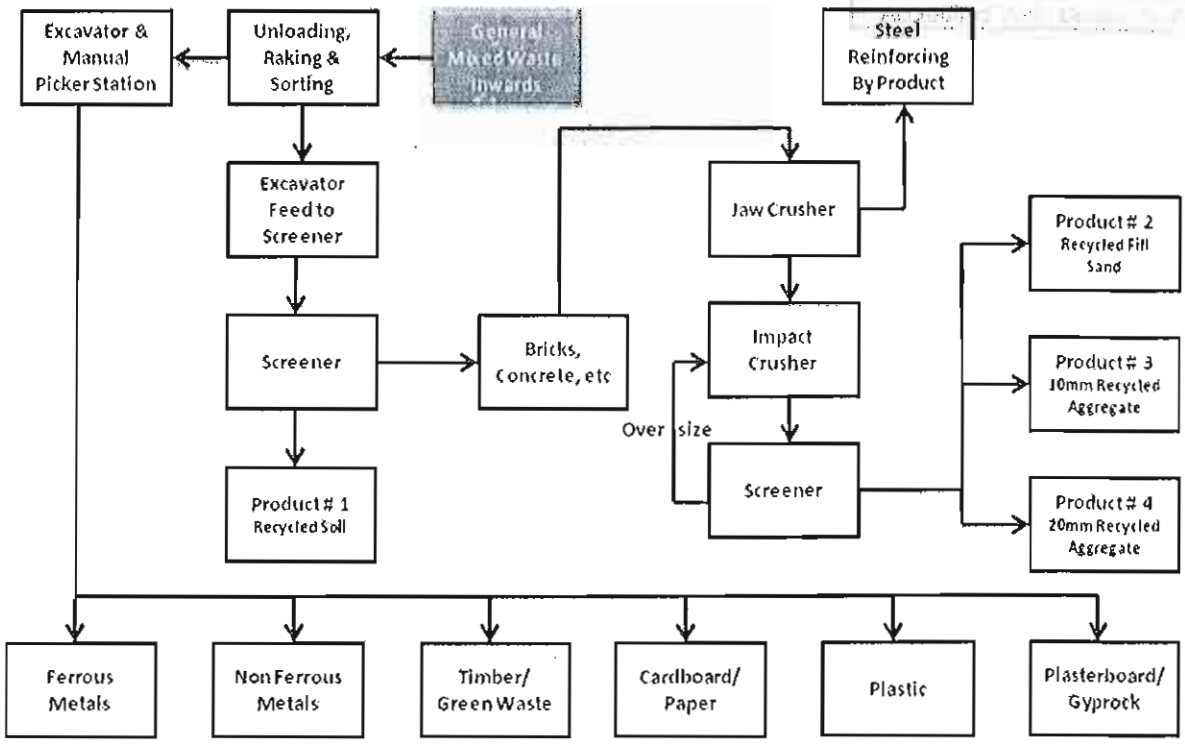
Stream #2 Metals and light recyclable materials are removed and stored for off-site recycling.

Stream #3 Large sized heavy weight brick, concrete and rubble pieces. These wastes pass to the crushers where they are crushed and re-enforcing fabric removed. The output from the crushers passes to the screener where products of different size are separated and stored in stockpiles. Re-enforcing fabric is collected and stored in the general steel bin for off-site recycling.

Stream #4 Small sized heavy weight soil, sand, brick, concrete and rubble. These wastes pass to the screener where the soil is separated form the brick, concrete and rubble. The brick, concrete and rubble then pass through Stream #3.

Stream #1 wastes are currently not recyclable and are removed from the land for off-site disposal. Stream #2 wastes, recovered metals and light recyclable materials are recycled off-site. Stream #3 and Stream #4 wastes are processed on site by crushing and screening to form saleable products such as soil, sand, and aggregates. These products are retained on site until sold.

Bingo Recycling Centre
Waste Transfer & Materials Recovery Facility
Flow Diagram



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In summary, Bingo Skip Bins take all their mixed waste skip bins directly to Bingo Recycling Centres. From there the waste is sorted and separated into the following material classes for processing and recycling.

Type of Material	Where Processed / Recycled	How Processed / Recycled
Heavy Recyclable Materials (soil, dirt, sand, rubble, concrete, brick, tiles, asphalt, stone)	Bingo Recycling Centres	Re-processed into recycled products (such as recycled soil, fill sand, aggregates, roadbase) by crushing and screening.
Timber / Green Waste	Bingo Recycling Centres	Re-processed into woodchip and mulch by shredding.
Metal / Steel	Sell & Parker	Sent to appropriate recycling plants.
Cardboard / Paper / Plastic	Cardboard King	Sent to appropriate recycling plants.
Plasterboard / Gyprock	ReGyp	Sent to appropriate recycling plants.
General Waste	SITA Landfill / Huntley Heritage	n/a

- **Bingo Recycling Centres**
  3 Burroway Road, Homebush Bay NSW 2127
  6-10 Burrows Road South, St Peters NSW 2044
- **Sell & Parker**
  45 Tattersall Road, Blacktown NSW 2148
- **Cardboard King**
  8 Kommer Place, St Marys NSW 2760
- **ReGyp**
  Lot 1221, Captain Cook Drive, Kurnell NSW 2231
- **SITA Landfill**
  1725 Elizabeth Drive, Kemps Creek NSW 2178
- **Huntley Heritage**
  Lot 2, Avondale Road, Dapto NSW 2530

Matt Dalley Demolition
PO Box 1021
Mascot, NSW 1460
Phone: 1300 30 66 88
Fax: 1300 55 33 04

Demolition at
Corner of Condamine Street & Balgowlah Road, Balgowlah

WASTE MANAGEMENT PLAN

Address: Corner of Condamine Street & Balgowlah Road, Balgowlah

Date: 04-02-11

Client: SOUTHERN CROSS CONSTRUCTIONS

Man Dalley Demolition Pty Ltd
PO Box 1021, Mascot, NSW 1460
Phone: 1300 30 66 88 Fax: 1300 55 33 04
Email: demo@dalleydemo.com.au

Matt Dalley Demolition Pty Ltd

Demolition at
Corner Condamine Street & Balgowlah Road, Balogowlah
WASTE MANAGEMENT PLAN

Matt Dalley Demolition
PO Box 1021
Mascot, NSW 1460
Phone: 1300 30 66 88
Fax: 1300 55 33 04

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Developed by: Glen Bryant		Approved by: Matt Dalley		

#30

Matt Dalley Demolition
PO Box 1021
Mascot, NSW 1460
Phone: 1300 30 66 88
Fax: 1300 55 33 04

1 Introduction:

This information is supplied for the management and disposal of material produced from the demolition of the above project. All demolished material will be carted by truck to either the appropriate recycling facility or disposed of at an appropriate tipping facility.

In light of the Waste Minimisation Act 1995, Matt Dalley Demolition will, to the best of our ability, ensure that demolished material is sorted and separated on-site prior to carting so that;

- Waste disposal is minimised
- Recycling of material is maximised
- Quality recycled products may be produced by the appropriate recycler
- A minimum target of 90% project recycling is achieved

Matt Dalley Demolition Pty Ltd

Demolition at
Corner Condamine Street & Balgowlah Road, Balogowlah
WASTE MANAGEMENT PLAN

Matt Dalley Demolition
PO Box 1021
Mascot, NSW 1460
Phone: 1300 30 66 88
Fax: 1300 55 33 04

2 Breakdown of Materials and Quantities

Material	Approx Quantity	Waste Management
Concrete	4000 T	100% Recycled
Brick	1000 T	100% Recycled
Steel / Tin	30 T	100% Recycled
Timber and General Waste	250 T	Land Fill
Asbestos and SMF	11 T	Land Fill at EPA approved Tipping Facility
Bitumen	100 T	100% Recycled
Sandstone	0 T	Land fill

Matt Dalley Demolition
PO Box 1021
Mascot, NSW 1460
Phone: 1300 30 66 88
Fax: 1300 55 33 04

3 Waste Management Records

Dockets from the appropriate waste contractor for each load that is recycled or disposed will be collected and filed for our records. Driver runs will also be recorded on a daily basis and filed for our records. Copies can be provided on request.

Matt Dalley Demolition Pty Ltd

Demolition at
Corner Condamine Street & Balgowlah Road, Balogowlah
WASTE MANAGEMENT PLAN

Matt Dalley Demolition
PO Box 1021
Mascot, NSW 1460
Phone: 1300 30 66 88
Fax: 1300 55 33 04

4 Waste Management Contractors

Material produced from the demolition works of the above project will be carted by the listed waste contractors to the following recycler or tipping facility.

Waste Contractor	Address	Waste Contractor Type	Material
Boral Quarries	Cnr Widmere & Davis Rd Wetherill Park	Recycler	Concrete/Brick
One Steel	53-57 Riverside Rd Chippingnorton	Recycler	All Types of Metal
Reefway Environmental	O'Riordan St, Alexandria	Tipping Facility	Mixed Wastes
Sita Environment	Elizabeth Drive, Kemps Creek	EPA Approved Tipping Facility	Mixed Wastes and Hazardous Materials
Blacktown Waste	920 Richmond Road Marsden Park	Tipping Facility	Mixed Wastes
Kurnell	Captain Cook Drive Kurnell	Tipping Facility	Mixed Wastes
Holtz	Captain Cook drive Kurnell	Tipping Facility	VEMN
Dial a Dump	Albert St, St Peters	DECC Approved	Solid waste