

Structural Schematic Design Report

STC50 Alterations Wharf 4/5 Walsh Bay

Prepared for Sydney Theatre Company / 4 November 2016

151640

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1.0 Background

TTW has been engaged by the Sydney Theatre Company (STC) to provide structural engineering input as part of the design team through schematic design development phase of their proposed STC50 development at Walsh Bay.

The existing structure of Wharf 4/5 and Shore Sheds is all timber, originally constructed in the 1920's as cargo wharfs and storage sheds. The original structure has undergone various alterations, upgrades and repairs. In the past decade most of the engineering advice for upgrades and repairs has been provided by GHD for Wharf 4/5 and by TTW for Pier 2/3.

The original two-level structure was mostly built from hardwood. It consists of a sub-structure of piles, headstocks and girders supporting a concrete deck around the perimeter of the Pier; a timber deck inside the building; and a superstructure consisting of floor trusses and roof trusses.

The schematic structural design for STC50 is shown on the preliminary sketch drawings enclosed in Appendix A. This information has been provided for pricing of the structural items in the updated cost plan. It includes coordinated and developed advice regarding pile replacement; new mezzanine floor structures; performance space floor slab to achieve acoustic performance; and steel roof framing where columns are to be removed. No advice has been provided regarding ongoing maintenance requirements for the timber structure.

2.0 Available Information

The following documents were provided to us:

- Walsh Bay Wharf 4/5 Structural Stability and Maintenance Review Volume 1 June 2005 by GHD
- Walsh Bay Wharf 4/5 Structural Stability and Maintenance Review Volume 2 June 2005 by GHD. This includes a Geotechnical Report by GHD-Longmac dated 7 Dec 2004
- Report for Walsh Bay 4/5 Maintenance Plan Advice December 2010 by GHD
- Pile Layout Plans dated February 2011 showing piles to be repaired in year 1 to 4 by GHD (enclosed in Appendix B).
- Schedule of completed repair work

We have not sighted any condition surveys or termite inspections of the superstructure timber.

3.0 Sub-Structure

An idealized geotechnical section along the Wharf is shown in Fig 1 and cross sections in Fig 2. During the original construction of the Wharf, fill material appears to have been placed within the Pier footprint to create a “fill mound” as shown in the cross sections. The alluvium beneath the fill mound comprises two distinct units. A very soft layer unit up to 6m thick overlies medium dense sand up to 12m thick which overlies sandstone bedrock.

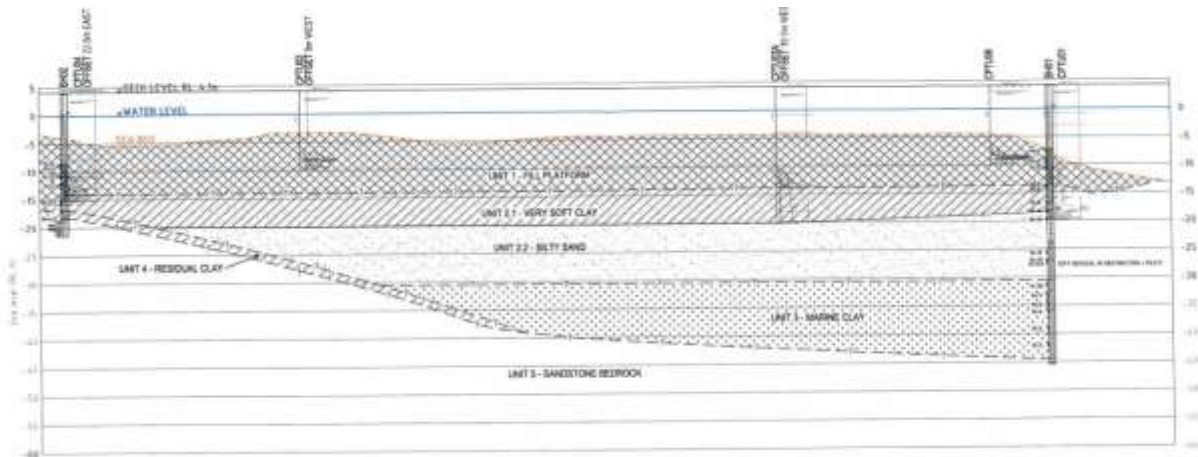


Fig 1: Long Section of Ground Conditions beneath Pier [from GHD LM report 7 Dec 2004]

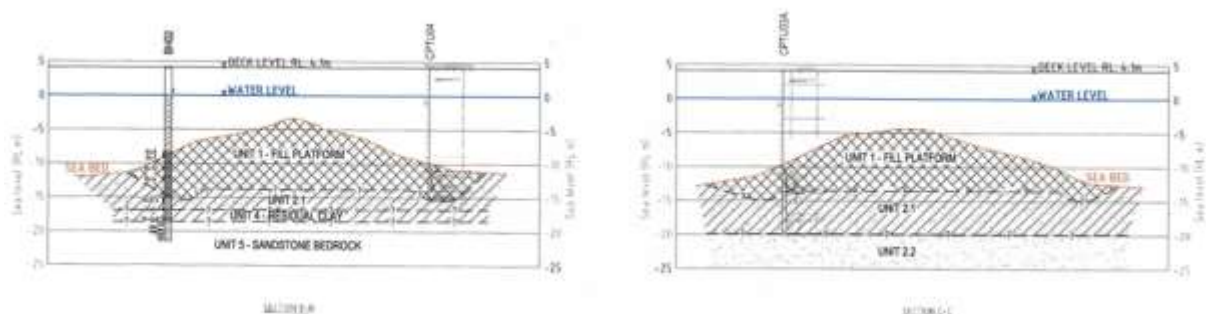


Fig 2: Cross Sections of Ground Conditions beneath Pier [from GHD LM report 7 Dec 2004]

The original timber piles are set out on a 10ft by 10ft grid in the Pier, with between one and four original piles at each grid location. In the maintenance work carried out on the Pier some of the piles have been regarded as redundant and not repaired as the floor load for the recent use of the Wharf is much less than the floor load required for its original function as a cargo wharf. The approach taken by GHD for Wharf 4/5 is to treat the piles on grids E, G, J and L as redundant (refer their pile layout plans in Appendix B).

The portion of the timber piles subject to most degradation is at the water level. As part of the maintenance work piles are either repaired or replaced. If replaced only the length of pile from the 'mud line' up to the underside of the Pier deck is replaced. For heritage reasons the outer two rows of piles are always replaced with timber piles. All other pile replacements utilize a steel tube.

The aspects of the proposed STC development that will result in increased pile loads are:

- Removal of posts supporting the roof which results in increased loads on neighboring posts
- Addition of floors levels: Mezzanine, Level 2, and Level 3.
- Addition of acoustic double slab at Level 2 for the two theatres and rehearsal spaces

The information referred to in section 2.0 is not clear in terms of which piles have been repaired/replaced. Until we are able to inspect the piles insitu we suggest the following allowances be made. In assessing loads on existing piles we have excluded load from Level 1 mezzanine floors.

Grid H: allow for 5 new jack-up piles

Grid F: allow for 10 new jack-up piles

Grid K: allow for 10 new jack-up piles

Changes to the building below Level 1 which may occur as part of the Walsh Bay Arts Precinct Project (WBAPP) may also significantly alter pile loads. There may end up being situations where loads at particular pile grids are significantly affected by both the STC50 development and the WBAPP.

4.0 Level 1 Workshop

A portion of the existing roof is proposed to be raised. This requires removal of one existing post and the addition of four new posts and new roof framing. In addition to the primary framing there will be additional secondary steel for support of rigging points. Refer preliminary drawings in Appendix A.

5.0 Level 1 Rehearsals

Acoustic requirements for the rehearsal spaces will require new double concrete slabs to be constructed over the existing Level 1 floor structure. Timber framed ramps will be required up to the circa 300mm high double slab floor level. The acoustic floor construction has been developed and coordinated by the design to minimize the structural impact.

Four existing posts are to be removed. This requires new roof framing. In addition to the primary framing there will be additional secondary steel for support of pipe grids, rigging points, and other in-ceiling elements.

Refer to Appendix A for preliminary drawings and typical acoustic floor details.

6.0 Level 2 Administration & Function

The new Level 2 floor structures are of lightweight construction consisting of steel floor beams, steel joists, and timber flooring to minimize the additional load applied to the existing columns and piles. There are other miscellaneous new floors for plant, storage, theatre and rehearsal support, and Theatre 1 balcony seating, which are similar in structure.

The structural intent is to locate new columns over existing posts so to prevent overloading existing floor structure. Where this was not achievable, additional steel beams strengthening is proposed to the soffit of existing Level 1. A high level of development and coordination was conducted by the team to minimize this type of framing to limit impact on tenancy beneath.

Refer to Appendix A for preliminary drawings.

7.0 Wharf 1 and 2 Theatres

Acoustic requirements for the rehearsal spaces will require new double concrete slabs to be constructed over the existing Level 1 floor structure. Timber framed ramps will be required up to the circa 300mm high double slab floor level.

Six existing posts are to be removed and roof is to be popped within a similar zone. This requires new roof framing and strengthening as shown on the preliminary drawings in Appendix A. In addition to the primary framing there will be additional secondary steel for support of pipe grids, rigging points, lighting bridges, sky-fold doors and other in-ceiling elements. Refer to Appendix A for framing

Refer to Appendix A for preliminary drawings, typical acoustic floor details, and typical lighting bridge section showing additional secondary framing.

8.0 Fire Protection

Typically throughout for theatre type use, the BCA consultant has advised that structure supporting floors requires fire protection to 60FRL. Some key structural elements have been reviewed subject to a typical floor loading. For new floor structures, the structure is to fire protected using fire-rated board or intumescent paint. For existing timber structure, members are protected by charring. Where the existing timber structure is inadequate for fire, additional fire-rated steel strengthening has been proposed.

Generally throughout Wharf 4/5, the triangular steel haunches support the Level 1 timber bearers will required fire protection. Intumescent paint is suggested to maintain the heritage significance. This is required regardless of the STC50 project.

Refer to Appendix A for preliminary drawings and further comments regarding fire protection.

9.0 Heritage Policies

The underlying structural design intent is to treat the existing structure and heritage fabric with a high priority and to minimise the structural impact whilst expressing the existing structure where possible. Different structural approaches and systems have been considered, with the least invasive adopted.

With the proposed upgrade and alterations it is inevitable that loading on the existing structure would increase. At locations where existing structural members become overloaded, where possible the existing structure is utilised by strengthening with steel plates and members in a manner acknowledging their heritage, rather than removing and replacing with new.

For the proposed performance and theatre type building use and increased number of occupants, a number of acoustic and fire safety related design aspects require upgrading. Similar to the structural alterations and strengthening, a number of approaches and systems were considered. Where achievable, the existing timber structure was reviewed and deemed adequate to provide the required insulation and protection. For existing structural elements that require fire protection, intumescent paint is specified for its minimalist impact on the existing form.

The structural design of the Walsh Bay Arts Precinct and STC50 alterations acknowledges the history and heritage aspects of the existing structure and environment in which it is located. Structural solutions will continue to be considered and adopted based on the most minimalist impact on the existing structure and heritage fabric. Existing structure will be sensitively re-used where possible, and all new structure will be detailed to compliment and express the existing.

Prepared by
**TAYLOR THOMSON WHITTING
(NSW) PTY LTD**



GEOFF BILLS
Associate

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Authorised By
**TAYLOR THOMSON WHITTING
(NSW) PTY LTD**



DAVID CAROLAN
Director

Appendix A

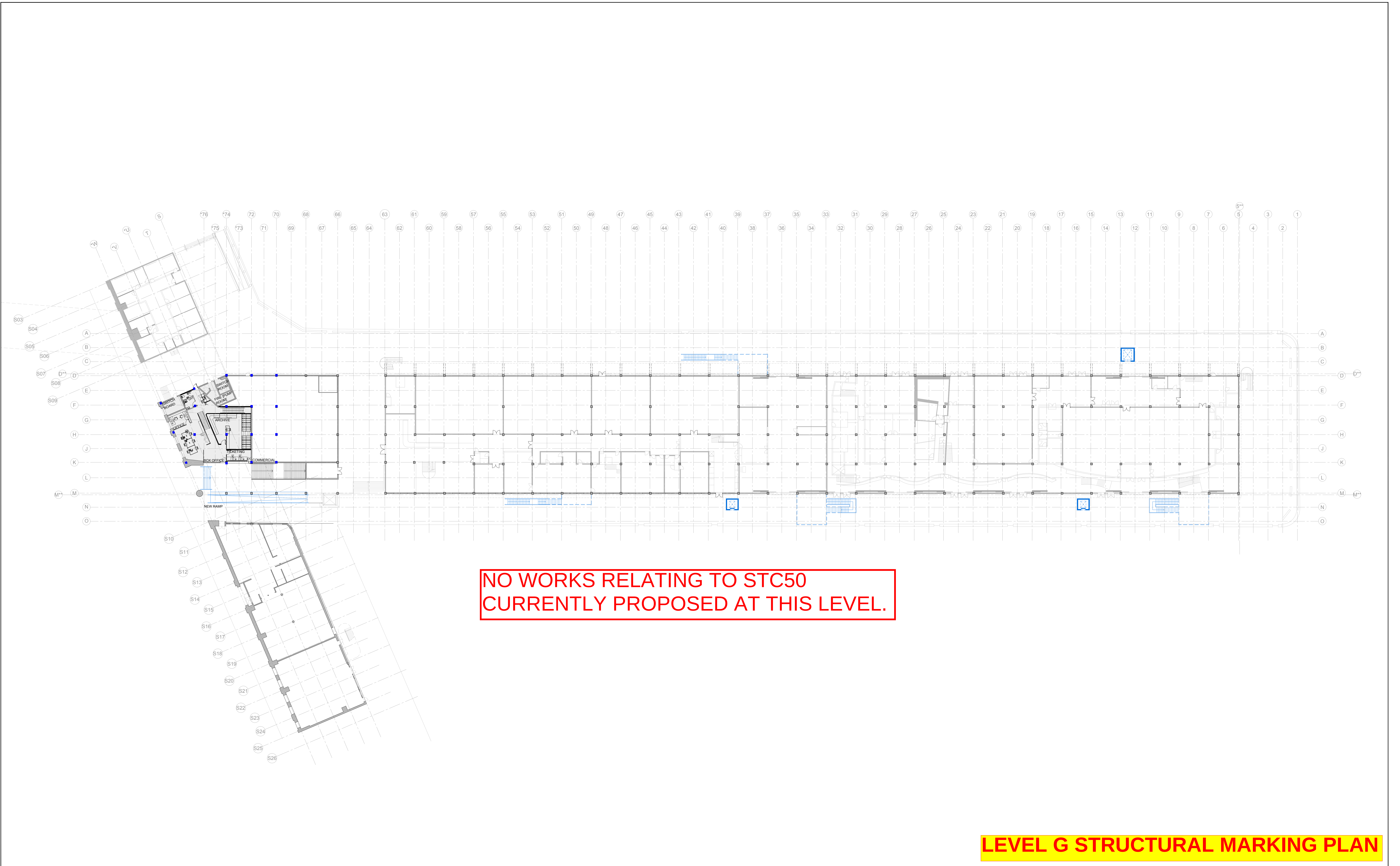
Preliminary Structural Drawings

STC50 ALTERATIONS WHARF 4/5 WALSH BAY PRELIMINARY STRUCTURAL SKETCHES



612 9439 7288 | 48 Chandos Street St Leonards NSW 2065

REV P2
04.11.16



LEVEL G STRUCTURAL MARKING PLAN

REFERENCE MAP

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CONSULTANT

ACCESS CONSULTANT
ACCESSIBILITY SOLUTIONS
P: 9655 1940
E: marnie@accessibility.com.au

ACOUSTIC CONSULTANT
CHARCOALBLUE
P: 03 9417 6524
E: eric.lawrence@charcoalblue.com

ACOUSTIC CONSULTANT
ARUP
P: 9320 9982
E: chris.held@arup.com

BCA CONSULTANT
BLACKETT MACGUIRE + GOLDSMITH
P: 9211 7777
E: brian@bmplg.com.au

CONSTRUCTION MANAGEMENT
CADENCE
P: 9557 8866
E: jayden@cadenceaustr.com

ELECTRICAL ENGINEER
ARUP
P: 9320 9982
E: eric.sere@arup.com

ESD CONSULTANT
ARUP
P: 9320 9982
E: tm.algood@arup.com

FIRE SERVICES ENGINEER
ARUP
P: 9320 9982
E: nick.howard@arup.com

HERITAGE CONSULTANT
TROPMAN AND TROPMAN ARCHITECTS
P: 9251 3250
E: tropman@tropmanarchitects.com.au

MECHANICAL ENGINEER
ARUP
P: 9320 9982
E: robert.sadman@arup.com

PROJECT MANAGEMENT
ROOT PROJECTS AUSTRALIA
P: 8272 9300
E: fiona@rootprojects.com.au

QUANTITY SURVEYOR
MBM
P: 9270 1000
E: dm@mbmpl.com.au

SPECIALIST LIGHTING
ARUP
P: 9320 9982
E: rebecca.cadom@arup.com

STATUTORY PLANNER
MG PLANNING
P: 9719 3118
E: tim@mgplanning.com.au

STRUCTURAL ENGINEER
TAYLOR THOMSON WHITTING
P: 9439 7288
E: josh@tthw.com.au

SURVEYOR
LTS LOCKLEY
P: 9365 7336
E: glenn@lockley.com.au

THEATRE CONSULTANT
CHARCOALBLUE
P: 03 9417 6524
E: eric.lawrence@charcoalblue.com

WASTE CONSULTANT
ARUP
P: 9320 9982
E: scott.hargison@arup.com

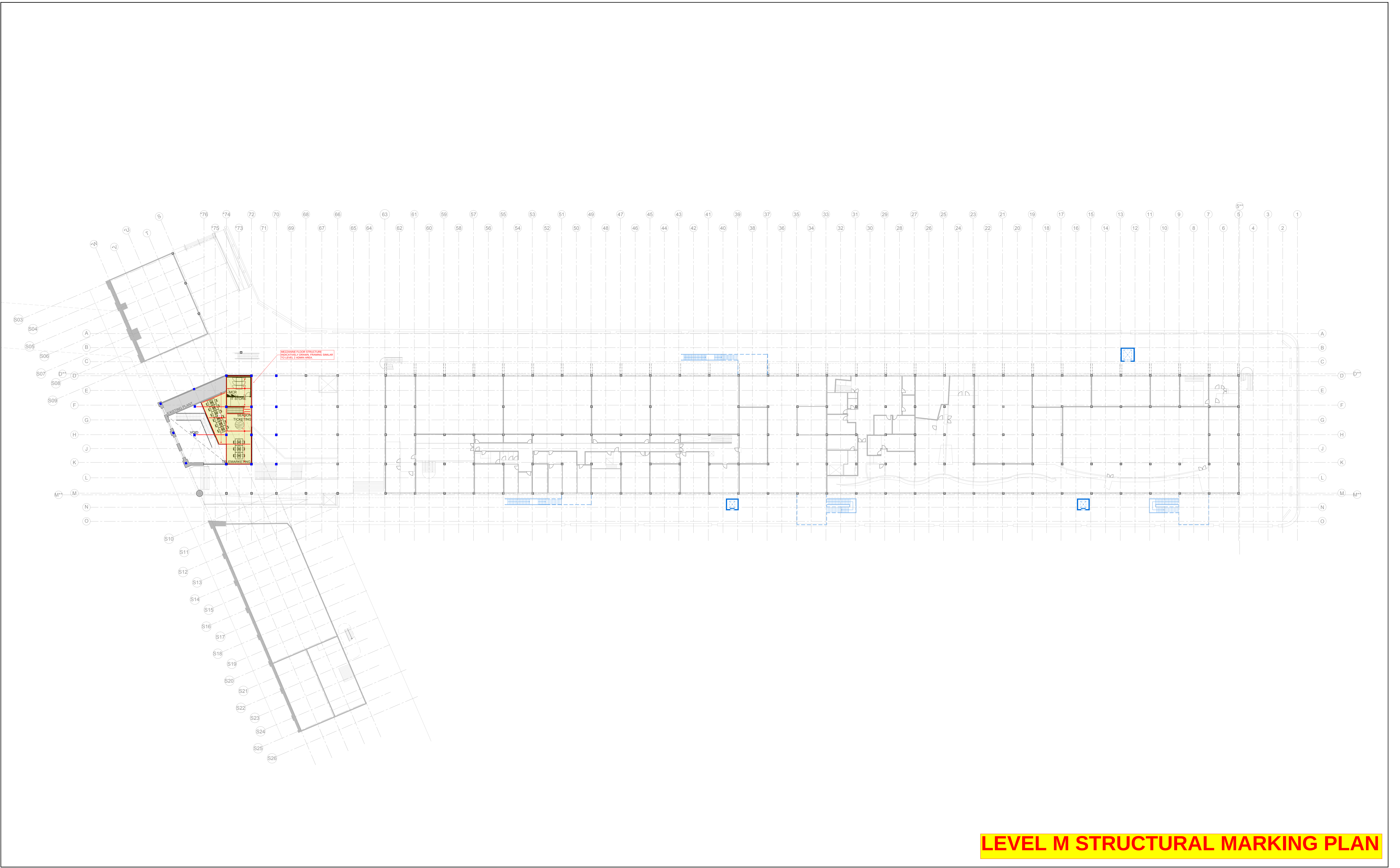
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SYDNEY THEATRE COMPANY

The Wharf, Pier 4
Hickson Road, Walsh Bay

TTW Taylor Thomson Whitting

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LEVEL M STRUCTURAL MARKING PLAN

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CLIENT

SYDNEY THEATRE COMPANY

The Wharf, Pier 4
Hickson Road, Walsh Bay

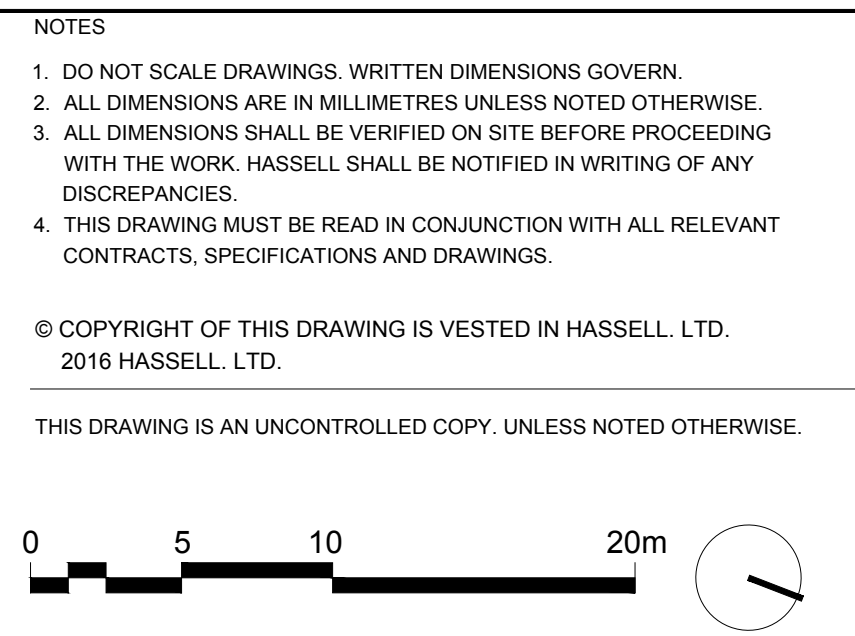
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**NOTE: NOT ALL NEW COLUMNS HAVE BEEN SHOWN.
REFER TO LEVEL 2 PLAN FOR DETAILS AND SETOUT.**



LEVEL 1 STRUCTURAL MARKING PLAN



CONSULTANT					
ACCESS CONSULTANT	CONSTRUCTION MANAGEMENT	HERITAGE CONSULTANT	MECHANICAL ENGINEER	STATUTORY PLANNER	VERTICAL TRANSPORT
ADVISORY SOLUTIONS P. 9695 1400 E. jayanne@advisory.com.au	C557 8866 E. jayanne@advisory.com.au	TROPICAN AND TROPICAN ARCHITECTS P. 9320 3250 E. tropican@tropicandtropicanarchitects.com.au	P. 9320 9982 E. mark@tropicandtropican.com.au	MP PLANNING P. 07 9719 5118 E. helen@mpplanning.com.au	ARUP P. 9320 9982 E. scott.lawson@arup.com
AQUACULTURAL CONSULTANT	ELECTRICAL ENGINEER	HYDRAULIC CONSULTANT	PROJECT MANAGEMENT	STRUCTURAL ENGINEER	WASTE CONSULTANT
CHAROUBILLE P. 03 9417 6524 E. eric.lawrence@charoubille.com	ARUP P. 9320 9982 E. eric.sereel@arup.com	ARUP P. 9320 9982 E. nick.howard@arup.com	ROOT PROJECTS AUSTRALIA P. 8272 9300 E. fiona@rootprojects.com.au	TAYLOR THOMSON WHITTING P. 9439 7828 E. geoff.bills@ttw.com.au	ARUP P. 9320 9982 E. jayanne.manning@arup.com
AQUACULTURAL CONSULTANT	ESD CONSULTANT	ICT AND AV ENGINEER	QUANTITY SURVEYOR	SURVEYOR	
ARUP P. 9320 9982 E. chris.feld@arup.com	ARUP P. 9320 9982 E. tim.eneo@arup.com	ARUP P. 9320 9982 E. eric.sereel@arup.com	MM P. 9270 1000 E. dm@mmpl.com.au	LTS LOCKLEY P. 9385 7336 E. glenn@ltslockley.com.au	
BCA CONSULTANT	FIRE SERVICES ENGINEER	KITCHEN CONSULTANT	SMALLER LIGHTING	THEATRE CONSULTANT	
BLACKETT MACQUEE + GOLDSMITH P. 9211 7777 E. nick.howard@arup.com	ARUP P. 9320 9982 E. eric.sereel@arup.com	SANGSTER DESIGN GROUP P. 9320 9146 E. sarah@sangstergroup.com.au	ARUP P. 9320 9982 E. rebecca.gordon@arup.com	ARUP P. 03 9417 6524 E. eric.lawrence@charoubille.com	

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SYDNEY THEATRE COMPANY
The Wharf, Pier 4
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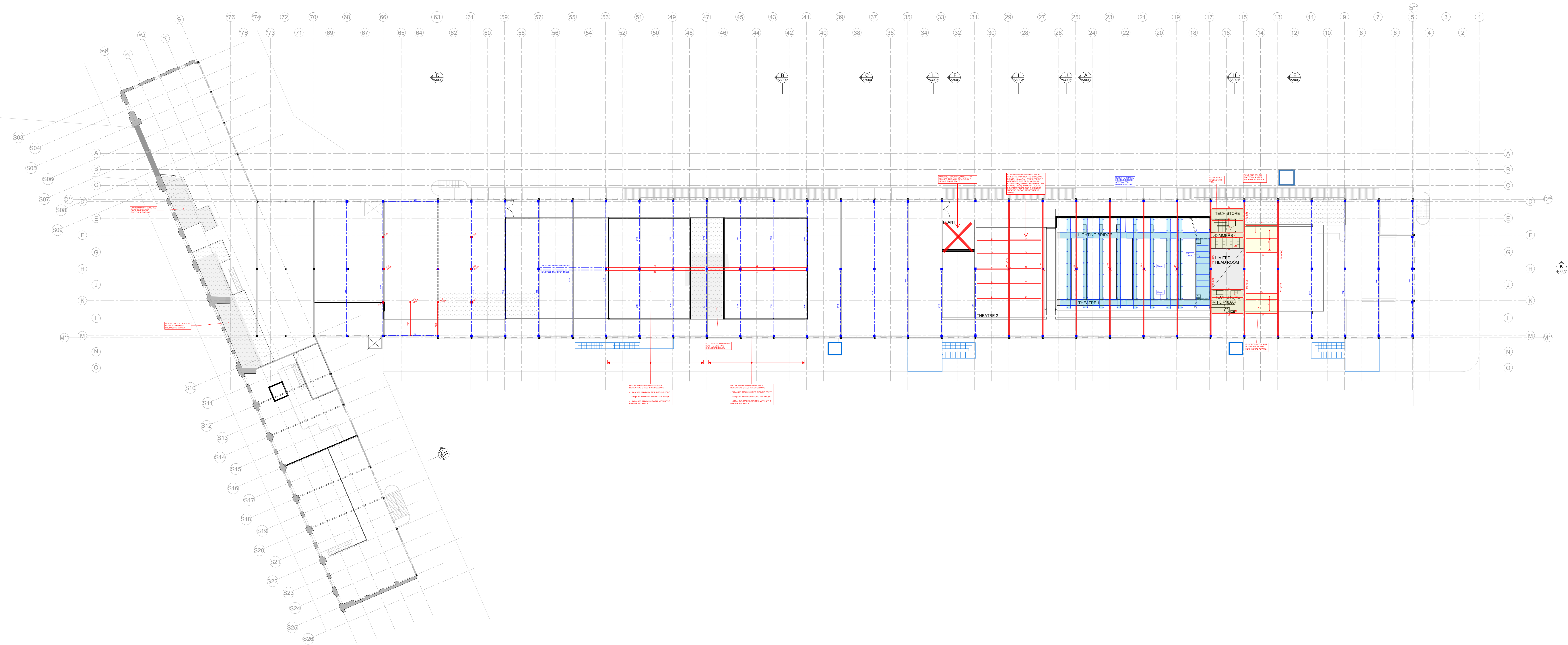
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RIGGING FROM ROOF STRUCTURE

1. GENERAL RIGGING FROM EXISTING WHARF 4/5 ROOF TRUSSES IN AREAS NOT LISTED BELOW: A SINGLE 500KG SWL RIGGING POINT ALONG ANY TRUSS IS ACCEPTABLE.
2. RIGGING FROM RAISED WORKSHOP ROOF STRUCTURE: REFER TO ROOF STRUCTURE MARKING PLAN FOR COMMENTS.
3. RIGGING FROM ROOF STRUCTURE ABOVE REHEARSAL SPACE: REFER TO LEVEL 3 STRUCTURE MARKING PLAN FOR COMMENTS.
4. RIGGING FROM ROOF STRUCTUE ABOVE THEATRE SPACE: REFER TO LEVEL 3 AND ROOF STRUCTURE MARKING PLAN AND TYPICAL SECTIONS FOR COMMENTS.



LEVEL 3 STRUCTURAL MARKING PLAN

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ACCESSIBILITY SOLUTIONS P: 9655 1940 E: mark@accessibility.com.au	CADENCE P: 9557 8886 E: jordan@cadence.com.au	TROPICAN AND TROPICAN ARCHITECTS P: 9251 3250 E: tropican@tropicanarchitects.com.au	ARUP P: 9320 9982 E: robert.lashman@arup.com	MG PLANNING P: 9719 3118 E: tim@mgplanning.com.au	ARUP P: 9320 9982 E: scott.hargison@arup.com	SYDNEY THEATRE COMPANY The Wharf, Pier 4 Hickson Road, Walsh Bay
ACOUSTIC CONSULTANT	ELECTRICAL ENGINEER	HYDRAULIC CONSULTANT	PROJECT MANAGEMENT	STRUCTURAL ENGINEER	WASTE CONSULTANT	
CHARCOALBLUE P: 03 9417 6524 E: eric.lawrence@charcoalblue.com	ARUP P: 9320 9982 E: eric.sawyer@arup.com	ROOT PROJECTS AUSTRALIA P: 8272 9300 E: josh@rootprojects.com.au	ARUP P: 9320 9982 E: rocco@rootprojects.com.au	TAYLOR THOMSON WHITTING P: 9439 7288 E: josh@tthw.com.au	ARUP P: 9320 9982 E: jayanne.manning@arup.com	
ACOUSTIC CONSULTANT	ESD CONSULTANT	ICT AND AV ENGINEER	QUANTITY SURVEYOR	SURVEYOR		
ARUP P: 9320 9982 E: chris.held@arup.com	ARUP P: 9320 9982 E: tim.algood@arup.com	ARUP P: 9320 9982 E: eric.sawyer@arup.com	MBM P: 9270 1000 E: dm@mbm.com.au	LTS LOCKLEY P: 9365 7336 E: glenn@lockley.com.au		
BCA CONSULTANT	FIRE SERVICES ENGINEER	KITCHEN CONSULTANT	SPECIALIST LIGHTING	THEATRE CONSULTANT		
BLACKETT MAGUIRE + GOLDSMITH P: 9211 7777 E: brian@omplugs.com.au	ARUP P: 9320 9982 E: nick.howard@arup.com	ARUP P: 9320 9982 E: john@gaugardesign.com.au	ARUP P: 9320 9982 E: rebecca.cadom@arup.com	CHARCOALBLUE P: 03 9417 6524 E: eric.lawrence@charcoalblue.com		

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Hickson Road, Walsh Bay

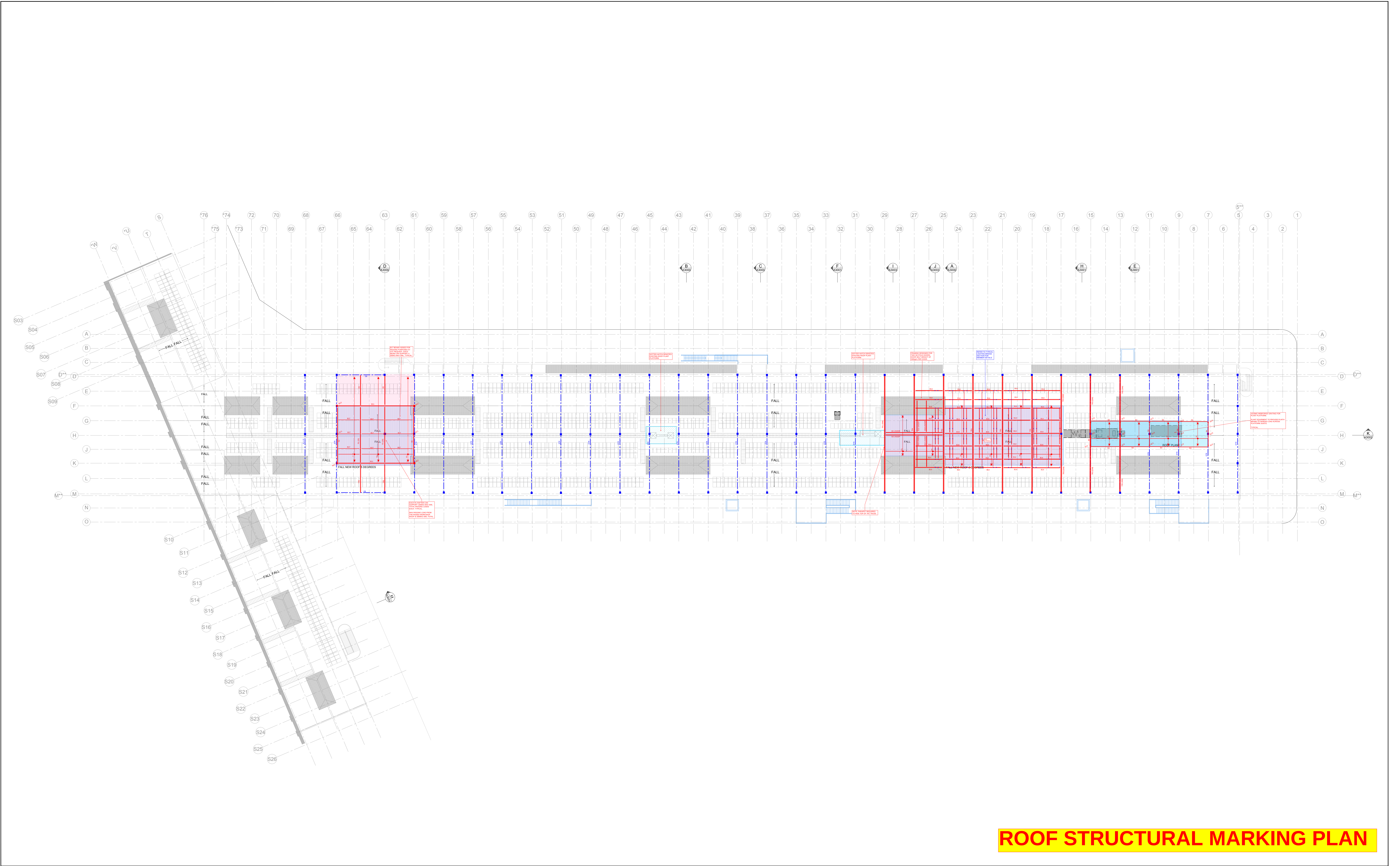
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ROOF STRUCTURAL MARKING PLAN

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CONSULTANT

ACCESS CONSULTANT
ACCESSIBILITY SOLUTIONS
P: 9655 1940
E: mark@accessibilitysolutions.com.au

ACOUSTIC CONSULTANT
CHARCOALBLUE
P: 03 9417 6524
E: eric.lawrence@charcoalblue.com

ACOUSTIC CONSULTANT
ARUP
P: 9320 9982
E: chris.held@arup.com

BCA CONSULTANT
BLACKETT MAGUIRE + GOLDSMITH
P: 9211 7777
E: brian@bmplg.com.au

CONSTRUCTION MANAGEMENT
CADENCE
P: 9557 8866
E: jayden@cadenceaustr.com

ELECTRICAL ENGINEER
ARUP
P: 9320 9982
E: eric.sere@arup.com

ESD CONSULTANT
ARUP
P: 9320 9982
E: tm.algood@arup.com

FIRE SERVICES ENGINEER
ARUP
P: 9320 9982
E: rick.howard@arup.com

HERITAGE CONSULTANT
TROPICAN AND TROPICAN ARCHITECTS
P: 9251 3250
E: tropican@tropicanarchitects.com.au

MECHANICAL ENGINEER
ARUP
P: 9320 9982
E: robert.sadman@arup.com

PROJECT MANAGEMENT
ROOT PROJECTS AUSTRALIA
P: 8272 9300
E: root@rootprojects.com.au

QUANTITY SURVEYOR
MBM
P: 9270 1000
E: dm@mbmproject.com.au

KITCHEN CONSULTANT
SANDRIST DESIGN GROUP
P: 9630 0146
E: john@sandristdesign.com.au

SPECIALIST LIGHTING
ARUP
P: 9320 9982
E: rebecca.cadom@arup.com

STATUTORY PLANNER
MG PLANNING
P: 9719 3118
E: tim@mgplanning.com.au

STRUCTURAL ENGINEER
TAYLOR THOMSON WHITTING
P: 9439 7288
E: greg@ttw.com.au

SURVEYOR
LTS LOCKLEY
P: 9365 7336
E: glenn@lockley.com.au

THEATRE CONSULTANT
CHARCOALBLUE
P: 03 9417 6524
E: eric.lawrence@charcoalblue.com

WASTE CONSULTANT
ARUP
P: 9320 9982
E: scott.hargison@arup.com

WASTE CONSULTANT
ARUP
P: 9320 9982
E: jayanne.manning@arup.com

CLIENT

SYDNEY THEATRE COMPANY

The Wharf, Pier 4
Hickson Road, Walsh Bay

PROJECT TEAM

TTW Taylor Thomson Whitting

612 9439 7288 | 48 Chandos Street St Leonards NSW 2065

NO STRENGTHENING EXPECTED TO BE REQUIRED FOR EXISTING TRUSS WEBS UNLESS DEFECTS FOUND DURING CONDITION SURVEY.

100x100x5 SHS FOR RUNWAY BEAM CONNECTION. TYPICAL.

250x150x5 RHS

150x150x5 SHS U.N.O. (250x150x9RHS FOR TRUSS ON GRID 29).

NOTE: TRUSS ON GRID 29 HAS AN ADDITIONAL 250UB25 RAFTER TO SUPPORT LOWER ROOF SIMILAR TO TR2.

STRENGTHEN TOP CHORD WITH A 180PFC EACH SIDE OF EXISTING TIMBER CHORD AND BOLT THROUGH AT REGULAR CENTRES. (2 PFCs TOTAL). TYPICAL.

STRENGTHEN TOP CHORD WITH A 10x200 CONTINUOUS FLAT PLATE EACH SIDE OF EXISTING TIMBER CHORD AND BOLT THROUGH AT REGULAR CENTRES. (2 PLATES TOTAL). TYPICAL.

STRENGTHEN BOTTOM CHORD WITH A 10x240 CONTINUOUS FLAT PLATE EACH SIDE OF EXISTING TIMBER CHORD AND BOLT THROUGH AT REGULAR CENTRES. (2 PLATES TOTAL). TYPICAL.

EX TIMBER POST

NOTE: LIGHTING BRIDGE, RUNWAY BEAM, ETC., STEELWORK NOT SHOWN FOR CLARITY.

TYPICAL TR1 ELEVATION

NO STRENGTHENING EXPECTED TO BE REQUIRED FOR EXISTING TRUSS WEBS UNLESS DEFECTS FOUND DURING CONDITION SURVEY.

100x100x5 SHS FOR RUNWAY BEAM CONNECTION. TYPICAL.

250x150x5 RHS

250UB25

B3 BEAMS, REFER PLAN.

STRENGTHEN TOP CHORD WITH A 180PFC EACH SIDE OF EXISTING TIMBER CHORD AND BOLT THROUGH AT REGULAR CENTRES. (2 PFCs TOTAL). TYPICAL.

STRENGTHEN TOP CHORD WITH A 12x200 CONTINUOUS FLAT PLATE EACH SIDE OF EXISTING TIMBER CHORD AND BOLT THROUGH AT REGULAR CENTRES. (2 PLATES TOTAL). TYPICAL.

250x150x9 RHS

STRENGTHEN BOTTOM CHORD WITH A 20x240 CONTINUOUS FLAT PLATE EACH SIDE OF EXISTING TIMBER CHORD AND BOLT THROUGH AT REGULAR CENTRES. (2 PLATES TOTAL). TYPICAL.

EX TIMBER POST

NOTE: LIGHTING BRIDGE, RUNWAY BEAM, ETC., STEELWORK NOT SHOWN FOR CLARITY.

TYPICAL TR2 ELEVATION

NO STRENGTHENING EXPECTED TO BE
REQUIRED FOR EXISTING TRUSS WEBS
UNLESS DEFECTS FOUND DURING
CONDITION SURVEY.

250x150x5 RHS

250UB25

B3 BEAMS.
REFER PLAN.

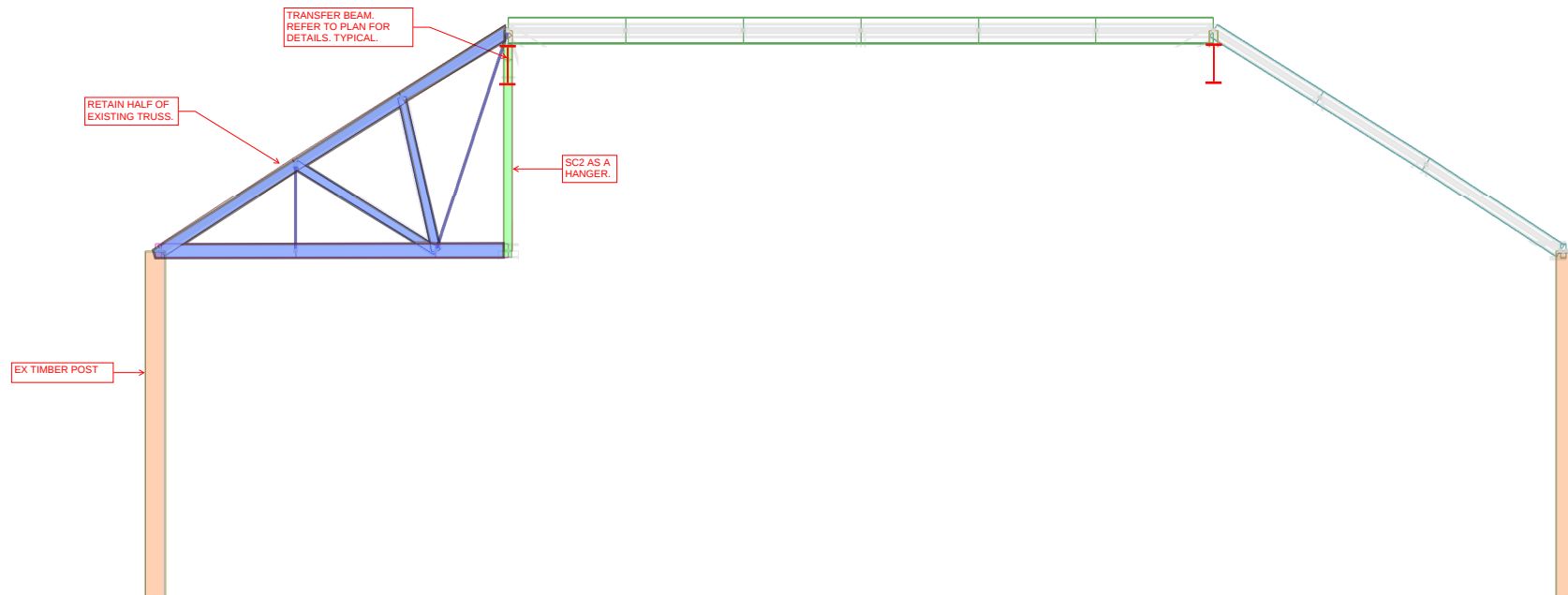
STRENGTHEN TOP CHORD WITH A
180PFC EACH SIDE OF EXISTING
TIMBER CHORD AND BOLT
THROUGH AT REGULAR CENTRES.
(2 PFCs TOTAL). TYPICAL.

STRENGTHEN BOTTOM CHORD WITH A 10x240
CONTINUOUS FLAT PLATE EACH SIDE OF
EXISTING TIMBER CHORD AND BOLT THROUGH
AT REGULAR CENTRES. (2 PLATES TOTAL).
TYPICAL.

EX TIMBER POST

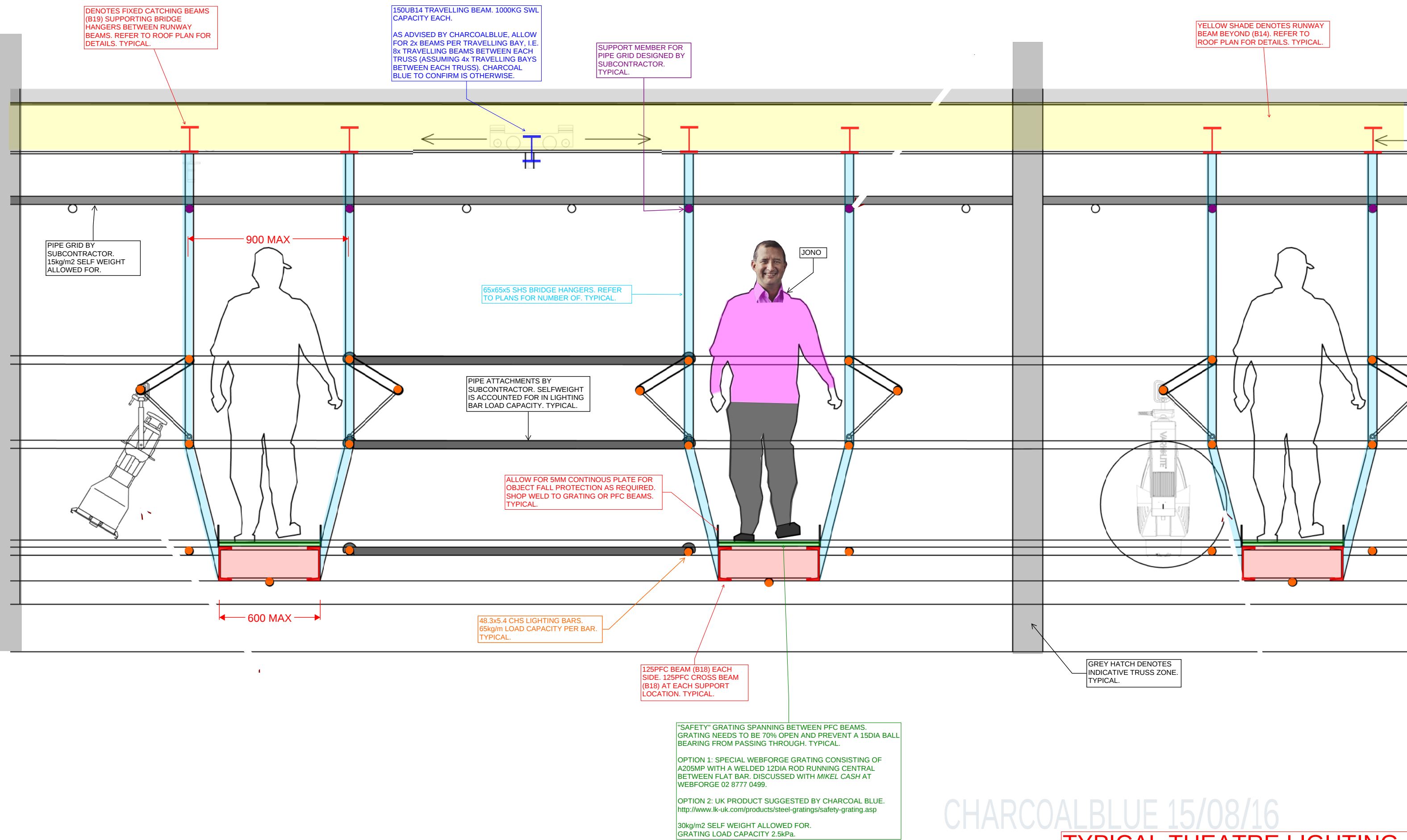
NOTE: LIGHTING BRIDGE, RUNWAY BEAM, ETC.,
STEELWORK NOT SHOWN FOR CLARITY.

TYPICAL TR4 ELEVATION



TYPICAL TR5 ELEVATION

FRAMING HAS BEEN DESIGNED TO SUPPORT A MAXIMUM LOAD OF 4000KG TOTAL BETWEEN EACH TRUSS AT ONE TIME. THIS INCLUDES LOADS HUNG FROM RUNWAY BEAMS, TRAVELLING BEAMS, LIGHTING BARS, PIPE GRID, AND FLOOR OF LIGHTING BRIDGES. LOAD CAN INCLUDE EQUIPMENT, MATERIALS, AND PEOPLE. THE ALLOWED LOADING EXCLUDES THE SELF WEIGHT OF THE PIPE GRID AND STEEL FRAMIGN SHOWN BELOW.



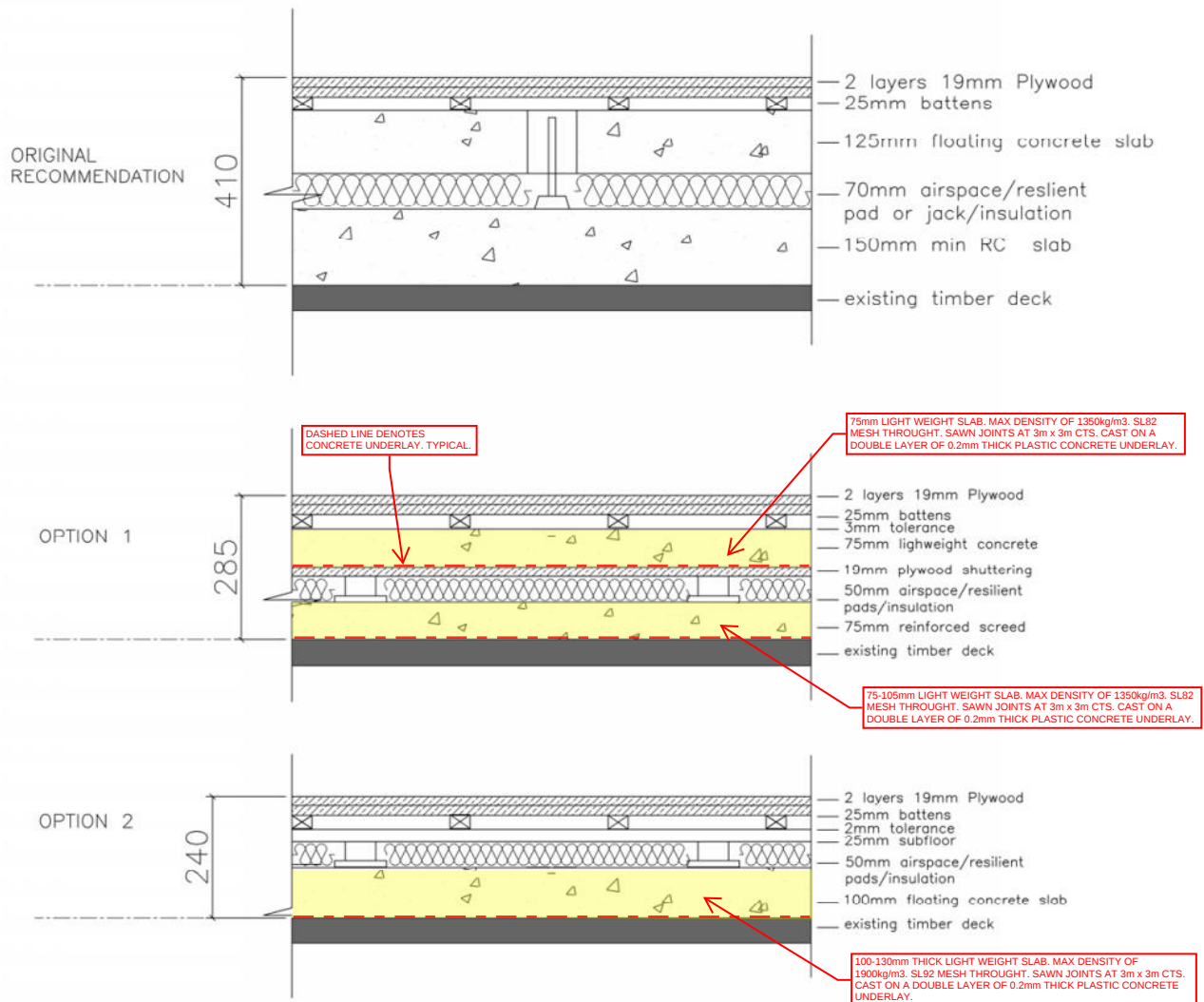
CHARCOALBLUE 15/08/16

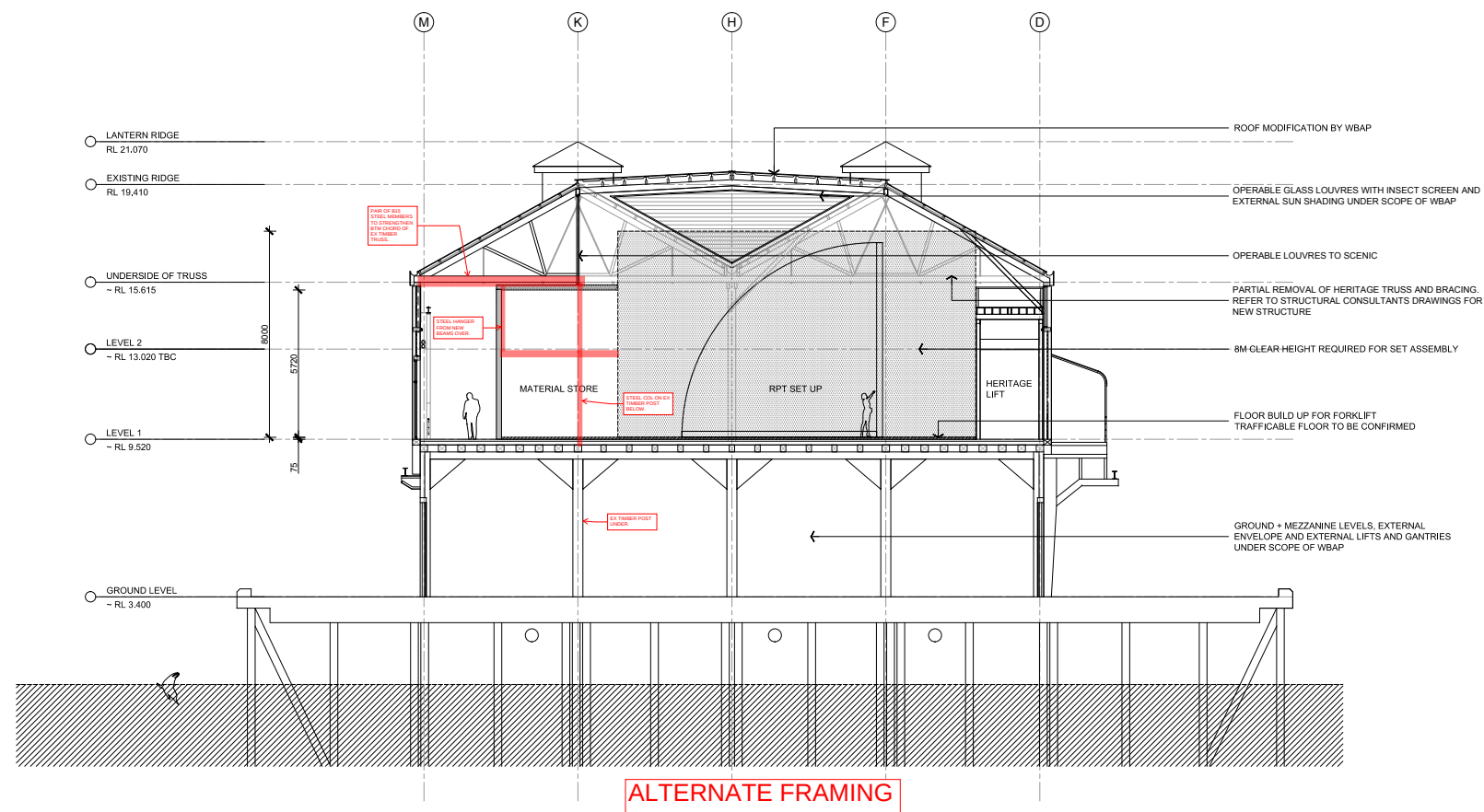
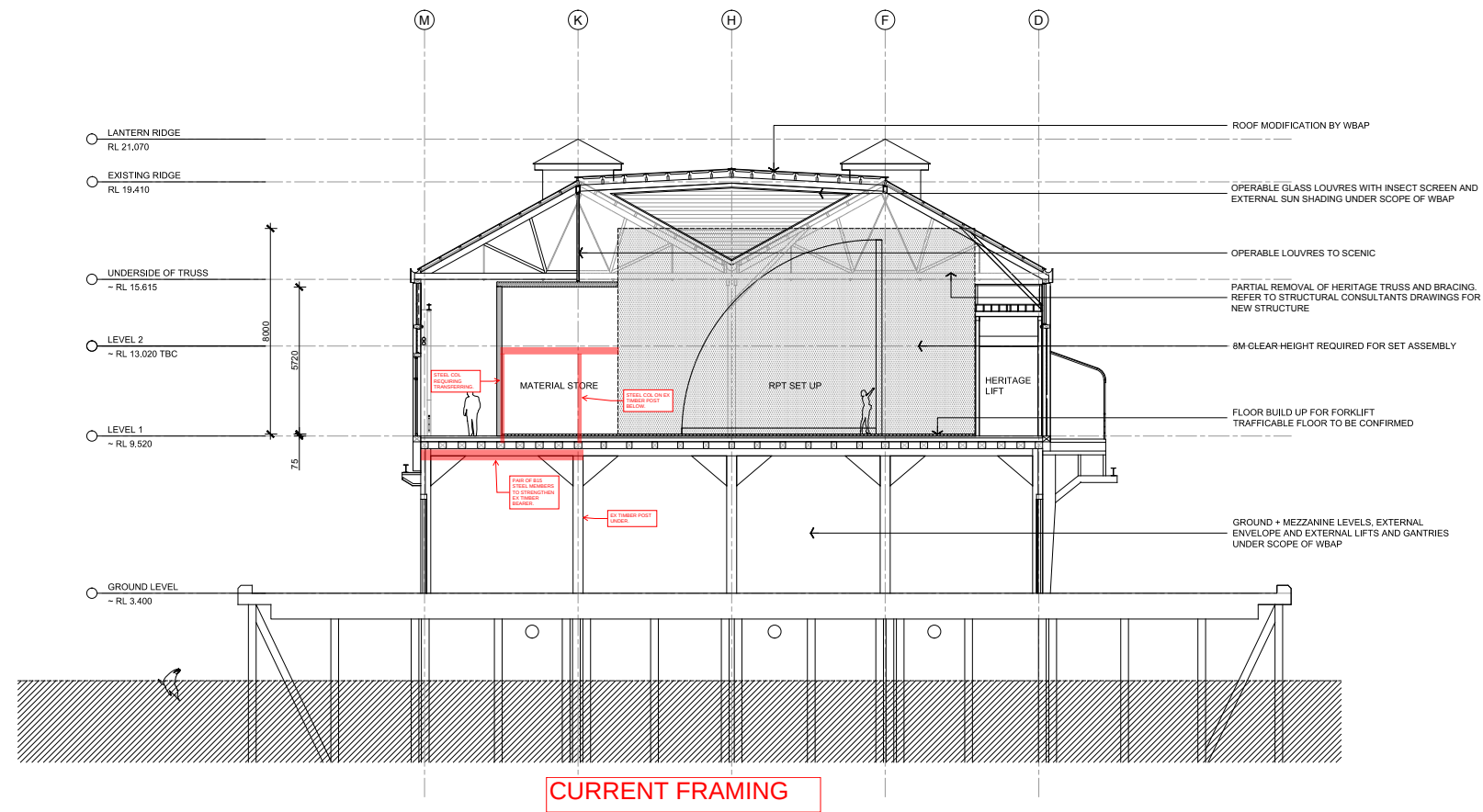
TYPICAL THEATRE LIGHTING
BRIDGE STEELWORK

ACOUSTIC FLOOR OPTIONS BY CHARCOAL BLUE

NOTES:

1. STRUCTURAL COMMENTS IN RED BELOW.
2. MAXIMUM ALLOWED SELF WEIGHT OF CONCRETE IN EITHER OPTION IS TO BE 250kg/m².
3. ADVICE FOR LIGHT WEIGHT CONCRETE RECEIVED FROM ABRAMS MARKETING PTY LTD (CONTACT KEVIN ABRAMS 0419 221 590).





STC50 ALTERNATE FRAMING
BETWEEN 57-63 AND J-L

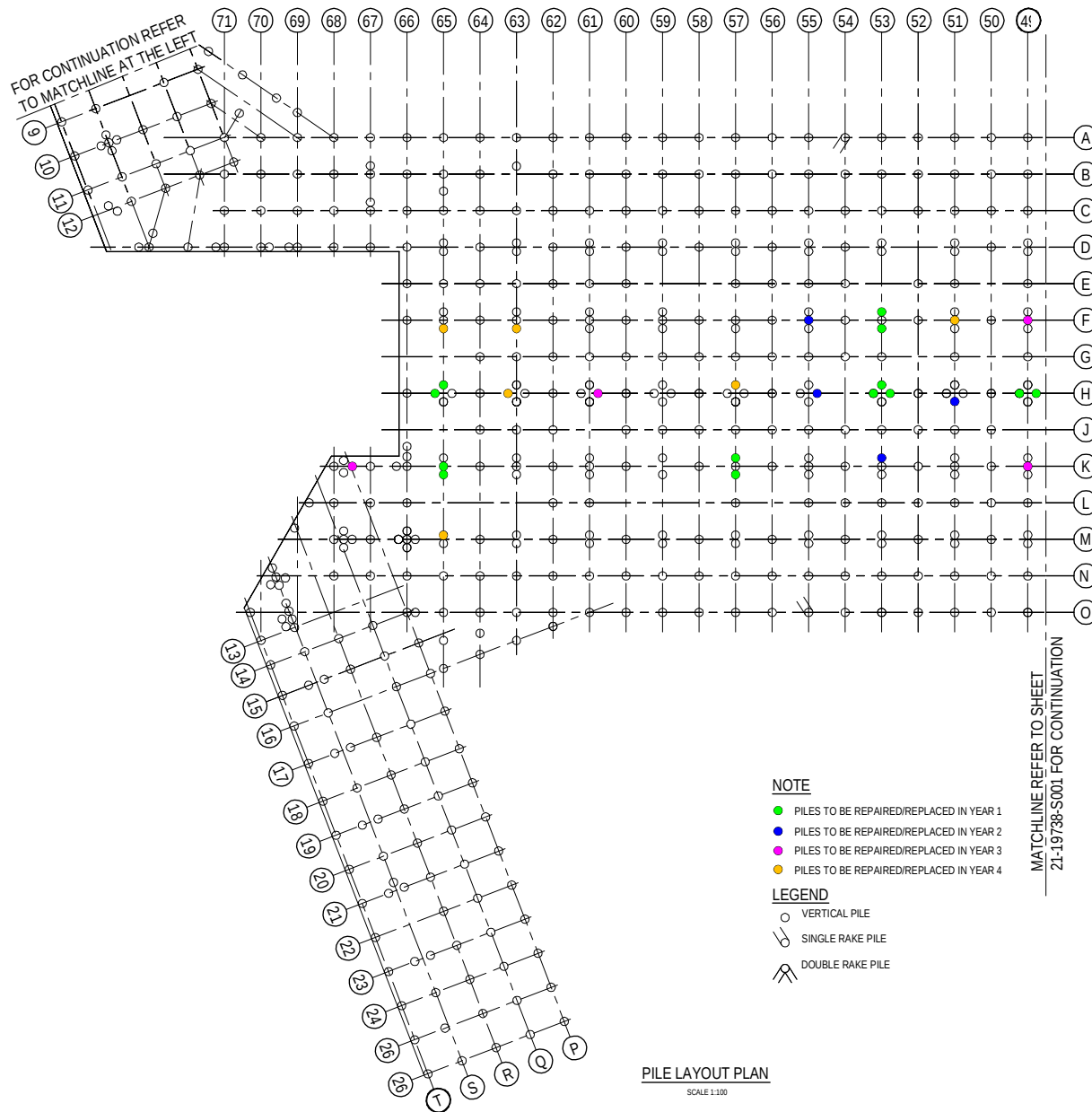
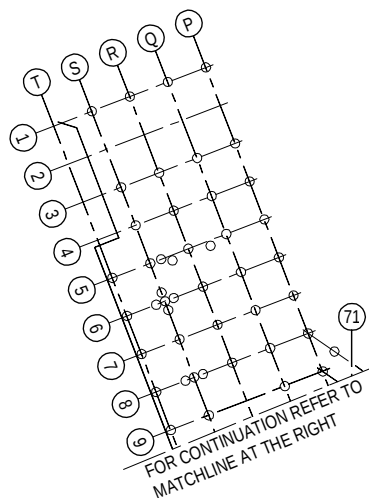
TTW-GB 09.09.16

MEMBER SCHEDULE

MARK	SIZE	COMMENTS
SC1	150x150x4SHS OR 150UC23	
SC2	150x150x5SHS OR 150UC30	
SC3	101x5 CHS	
SC4		
EC1	EX TIMBER POST	
B1	310UC118	
B2	310UC137	
B3	610UB125	
B4	250UB31	
B5	200PFC	
B6	250PFC	
B7	200x100x6RHS	
B8	250UC73	
B9	250UC89	
B10	800WB168	
B11	700WB130	
B12	310UB32	
B13	300PFC	
B14	310UB40	
B15	380PFC	
B16	250x250x6SHS	
B17	250UB25	
B18	125PFC	
B19	150UB18	
B20	530UB92	
B21	200UC59	
B22	200x200x9 SHS	
H1		
J1	200UB18 TYPICAL. 250x150 (F17) FOR ADMIN FLOOR.	JOISTS AT 600 MAX CTS (500CTS FOR ADMIN FLOOR)
J2	200UB22	JOISTS AT 600 MAX CTS
J3	200UB25	JOISTS AT 600 MAX CTS
J4	250UB31	JOISTS AT 1500 MAX CTS
P1	Z15019 or 240x100 (F8)	PURLINS AT 1200 MAX CTS. 1x ROW OF BRIDGING MIDSPAN FOR Z-PURLINS. TIMBER PURLINS TO MATCH EXISTING.
R1	410UB54	20mm PRECAMBER
R2	250UB31	
TR1	REFER TYPICAL ELEVATION	
TR2	REFER TYPICAL ELEVATION	
TR3	REFER TYPICAL ELEVATION	
TR4	REFER TYPICAL ELEVATION	
TR5	REFER TYPICAL ELEVATION	
NOTE:		
- ALL STEELWORK SUPPORTING FLOORS REQUIRES FIRE-RATING TO 60MINS. CAN BE IN THE FORM OF INTUMESCENT PAINT, FIRE-SPRAY, FIRE BOARD, ETC - ALL STEEL TO BE GRADE 300 UNLESS NOTED OTHERWISE - TIMBER JOISTS HAVE BEEN SIZED FOR CHARRING TO ACHIEVE 60FRL.		

Appendix B

GHD Pile Layout Plans



NOTE

- PILES TO BE REPAIRED/REPLACED IN YEAR 1
- PILES TO BE REPAIRED/REPLACED IN YEAR 2
- PILES TO BE REPAIRED/REPLACED IN YEAR 3
- PILES TO BE REPAIRED/REPLACED IN YEAR 4

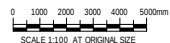
LEGEND

- VERTICAL PILE
- SINGLE RAKE PILE
- ∨ DOUBLE RAKE PILE

MATCHLINE REFER TO SHEET
21-19738-S001 FOR CONTINUATION

PRELIMINARY

No	Revision	Note	* Indicates signatures on original issue of drawing or last revision of drawing	Drawn	Job Manager	Project Director	Date
A	ISSUED FOR MAINTENANCE ADVICE			JB	DWM	JY	11.02.11



DO NOT SCALE

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Drawn	J. DE JESUS	Designer	D. MOLLOY
Drafting Check		Design Check	
Approved (Project Director)		Date	
Scale	1 : 100	This Drawing must not be used for Construction unless signed as Approved	

Client	NSW PUBLIC WORKS
Project	WALSH BAY 4/5
Title	PILE LAYOUT PLAN
	SHEET 2/2
Original Size	A1
Drawing No:	21-19738-S002

Rev: A