

## FOOTING CONSTRUCTION REPORT - ISSUE A

**REF:** 170814

**DATE:** 14<sup>th</sup> December 2018

**OWNER:**

**CLIENT:** WP Property Group

**SITE:** No. 50-52 Windsor Street, Magill

**BUILDING/STRUCTURE:** Proposed Double Storey Articulated Masonry Veneer and "Hebel" Panel Residences (7 of)

Please note: The calculations and details outlined within this report give specific recommendations for the abovementioned building/structure. Amendments to the construction or design must not be made without written approval from the Engineer. Report validity period is twenty four months (based on current Australian Standards and Regulations).

### ATTACHMENTS:

Civil Plans C-1-A, C-2-D, C-3-A, C-4-A, C-5-A, Footing Plans FP-1-A, FP-2-A, Structural Plans SD-1-A, SD-2-A, SD-3-A, SD-4-A, Standard Details (Sheets 1-12), Civil Calculations (CC1/B), Footing Calculations (FC1-FC8), Structural Calculations (SC1-SC6), Soil Borelogs & Borehole Location Plan, Details on the Use of the Footing Construction Report (4 pages), Footings/Slabs Specification (4 Pages), General Siteworks Notes (5 pages), Construction Notes (3 pages), CSIRO Homeowners Guide.

### FOOTING TYPE:

Reinforced concrete raft footings, founded 200mm into natural ground.

### SITE INSPECTIONS:

Inspections will incur additional fees:

1. After excavation of the footing beams prior to the placement of reinforcement.
2. After preparation of the reinforcement prior to the pouring of concrete.
3. As otherwise instructed by the engineer or requested by the client/contractor.

### ADDITIONAL NOTES:

1. This is a Class 'E-D, P (FILL)' Site with a Ys value of approximately 73mm. Due to the effect of trees on the expected soil heave, additional corner reinforcement And lagging is required (refer to standard details) in accordance with a Class 'E-D, P' (FILL/TREES) site, with a Ys value of approximately 115mm.
2. Flexible connections for sewer and stormwater are required on this site.
3. The footing sizes specified have taken tree effects into account however, the owner Must be aware that a precise design for tree effects is outside current knowledge due To the complexity of tree root geometry, variable moisture extraction of the tree and The difficulty in predicting future tree growth. As such, some movement in the building Must be accepted. Trees must be kept well watered so that excessive dessication of The subsurface soils does not occur.
4. Footings are to be continuously trenched or piered 200mm into natural ground.

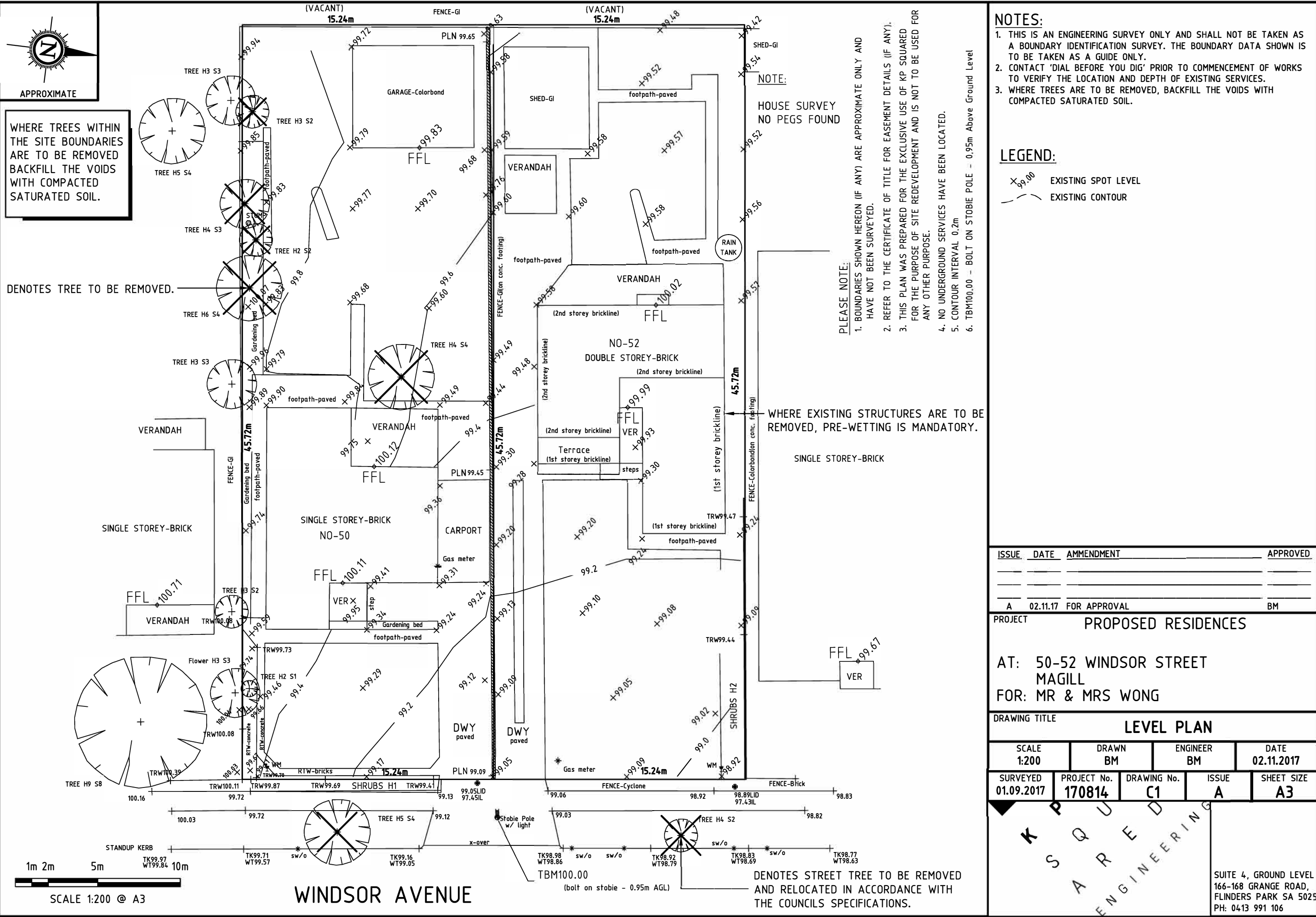
5. Where trenched piers are used, they shall be 1000mm long by the width of footings, Trenched a minimum of 200mm into natural ground.
6. A trench inspection is mandatory for this site to ensure that footings are founded into Firm natural ground.
7. Pre wetting of the building area is mandatory for this site. Refer to site preparation Notes, within the general Site works specification.
8. Due to the reactive nature of the foundation soils adequate site drainage and site Paving will be necessary. The planting of large trees or shrubs adjacent to the Proposed dwelling should be avoided and landscaping should consist of lawns or Gardens where summer watering is maintained.

A handwritten signature in dark blue ink, consisting of a series of loops and curves, representing the name Kosta Paraskevopoulos.

Kosta Paraskevopoulos

Per KP SQUARED ENGINEERING PTY LTD





- NOTES:**
1. THIS IS AN ENGINEERING SURVEY ONLY AND SHALL NOT BE TAKEN AS A BOUNDARY IDENTIFICATION SURVEY. THE BOUNDARY DATA SHOWN IS TO BE TAKEN AS A GUIDE ONLY.
  2. CONTACT 'DIAL BEFORE YOU DIG' PRIOR TO COMMENCEMENT OF WORKS TO VERIFY THE LOCATION AND DEPTH OF EXISTING SERVICES.
  3. WHERE TREES ARE TO BE REMOVED, BACKFILL THE VOIDS WITH COMPACTED SATURATED SOIL.

- LEGEND:**
- X 99.00 EXISTING SPOT LEVEL
  - - - EXISTING CONTOUR

ISSUE	DATE	AMENDMENT	APPROVED
A	02.11.17	FOR APPROVAL	BM

PROJECT **PROPOSED RESIDENCES**

AT: **50-52 WINDSOR STREET**  
**MAGILL**  
FOR: **MR & MRS WONG**

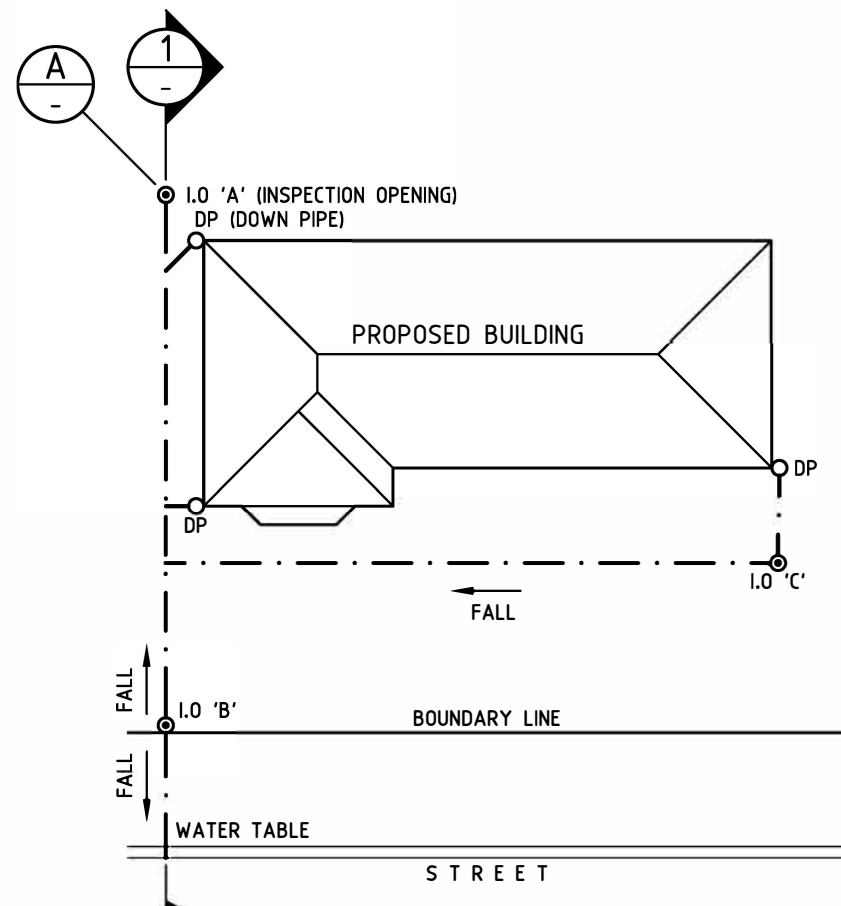
DRAWING TITLE <b>LEVEL PLAN</b>				
SCALE	DRAWN	ENGINEER	DATE	
1:200	BM	BM	02.11.2017	
SURVEYED	PROJECT No.	DRAWING No.	ISSUE	SHEET SIZE
01.09.2017	170814	C1	A	A3

K P S Q U E D  
ENGINEERING

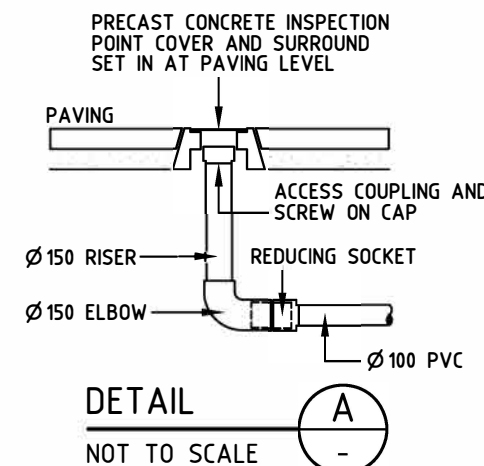
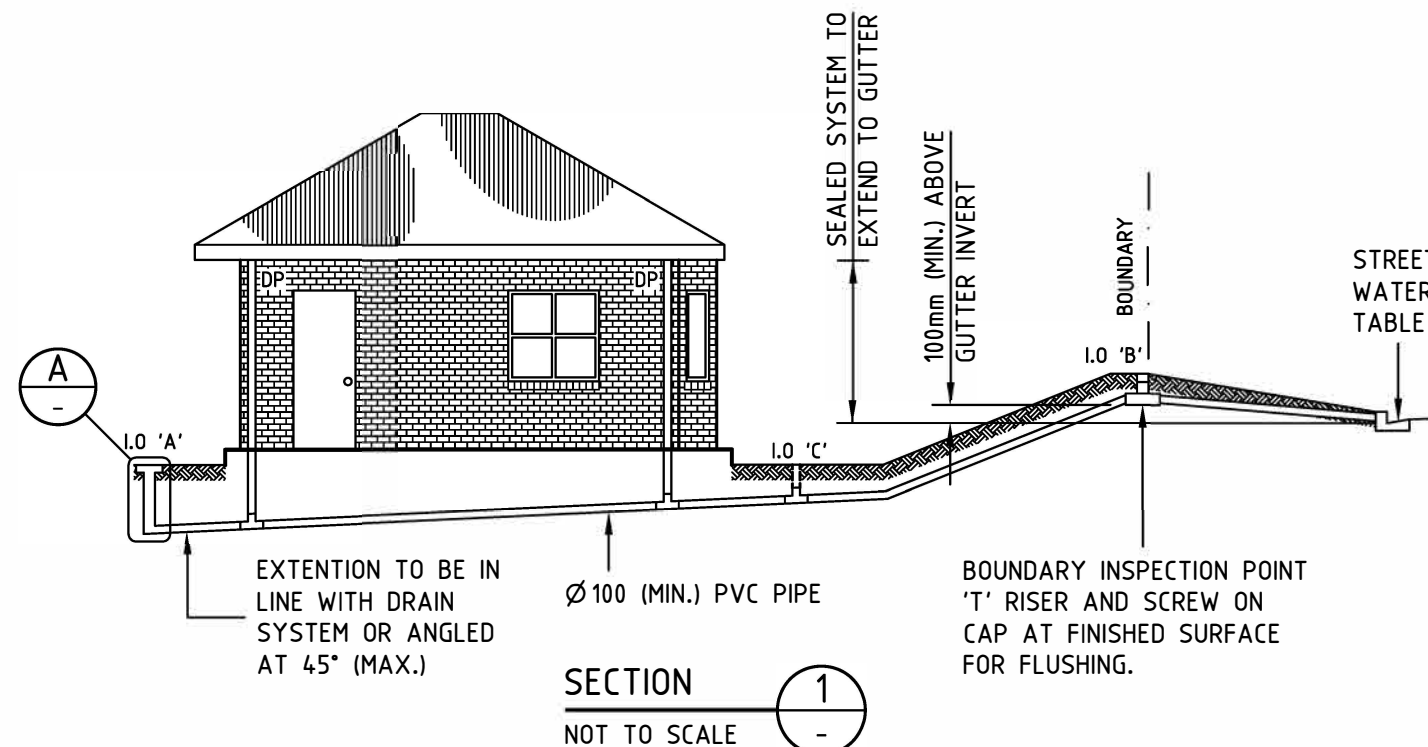
SUITE 4, GROUND LEVEL  
166-168 GRANGE ROAD,  
FLINDERS PARK SA 5025  
PH: 0413 991 106







**TYPICAL DOMESTIC SEALED (PRESSURISED)  
DRAINAGE SYSTEM LAYOUT**  
NOT TO SCALE



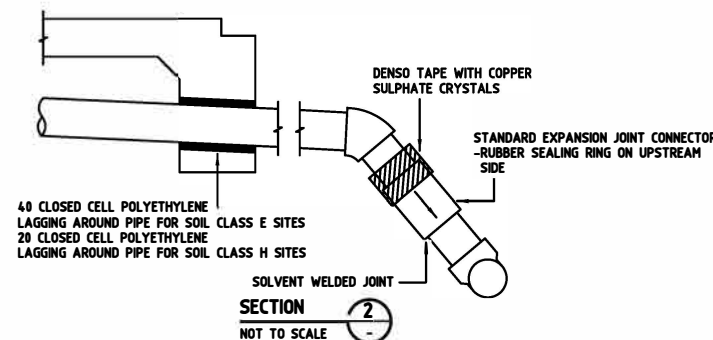
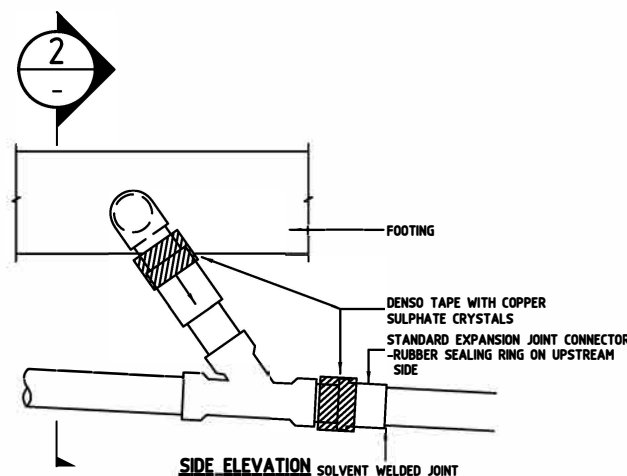
#### GENERAL SEALED SYSTEM NOTES:

1. STORMWATER PIPES TO HAVE A MINIMUM FALL OF 1.0% (1 IN 100) UNLESS NOTED OTHERWISE.
2. DO NOT USE SEAMED SHEET METAL DOWN PIPES OR FITTINGS WITH A PRESSUREISED SYSTEM.
3. NO SURFACE INLETS (SUMPS OR GRATED INLET PITS) PERMITTED INTO SEALED SYSTEM.
4. PROVIDE LEAF GUARDS AT DOWN PIPE INLETS.
5. FLUSHING AND MAINTENANCE IS THE RESPONSIBILITY OF THE OWNER.

#### GENERAL FLEXIBLE CONNECTION NOTES:

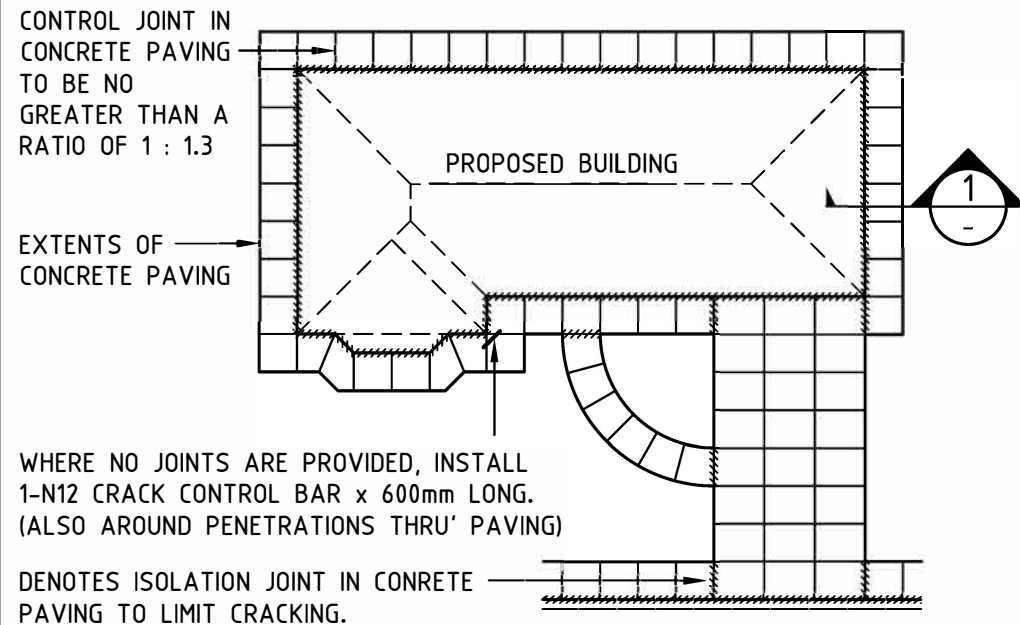
DUE TO THE MOISTURE REACTIVE NATURE OF SOILS ON CLASS 'H' & 'E' SITES, IT IS REQUIRED THAT THE SERVICE PIPES INCLUDE STANDARD EXPANSION TYPE JOINT COUPLINGS. PROVIDE A FLEXIBLE CONNECTION TO PIPE IN ACCORDANCE WITH THE FOLLOWING;

1. CONNECTIONS ARE REQUIRED AT EACH LOCATION WHERE PIPES (50mm OR LARGER) PENETRATE OR PASS BENEATH THE EXTERNAL FOOTING BEAMS.
2. TWO EXPANSION JOINT CONNECTORS ARE REQUIRED, AS DETAILED ABOVE, AT EACH CONNECTION..
3. THE DENSO TAPE MUST BE SPRINKLED WITH COPPER SULPHATE CRYSTALS PRIOR TO WRAPPING AND MUST EXTEND 50mm BEYOND THE JOINT ON EITHER SIDE.
4. DETAILS ARE APPLICABLE TO TO SEWER AND STORMWATER PIPES.
5. REFER TO THE CONSTRUCTION/GEOTECHNICAL REPORT FOR SOIL CLASSIFICATION.



**STORMWATER & SEWER FLEXIBLE SERVICE CONNECTION DETAILS FOR CLASS 'H' & 'E' SITES**  
NOT TO SCALE

PROJECT		PROPOSED RESIDENCES		
AT:		50-52 WINDSOR STREET MAGILL		
FOR:		MR & MRS WONG		
DRAWING TITLE		STORMWATER DETAILS		
SCALE	DRAWN	ENGINEER	DATE	
AS SHOWN	BM	BM	02.11.2017	
SURVEYED	PROJECT No.	DRAWING No.	ISSUE	SHEET SIZE
01.09.2017	170814	C3	A	A3
K S Q U E R E N G I N G				SUITE 4, GROUND LEVEL 166-168 GRANGE ROAD, FLINDERS PARK SA 5025 PH: 0413 991 106



## TYPICAL CONCRETE PAVING LAYOUT AROUND BUILDING

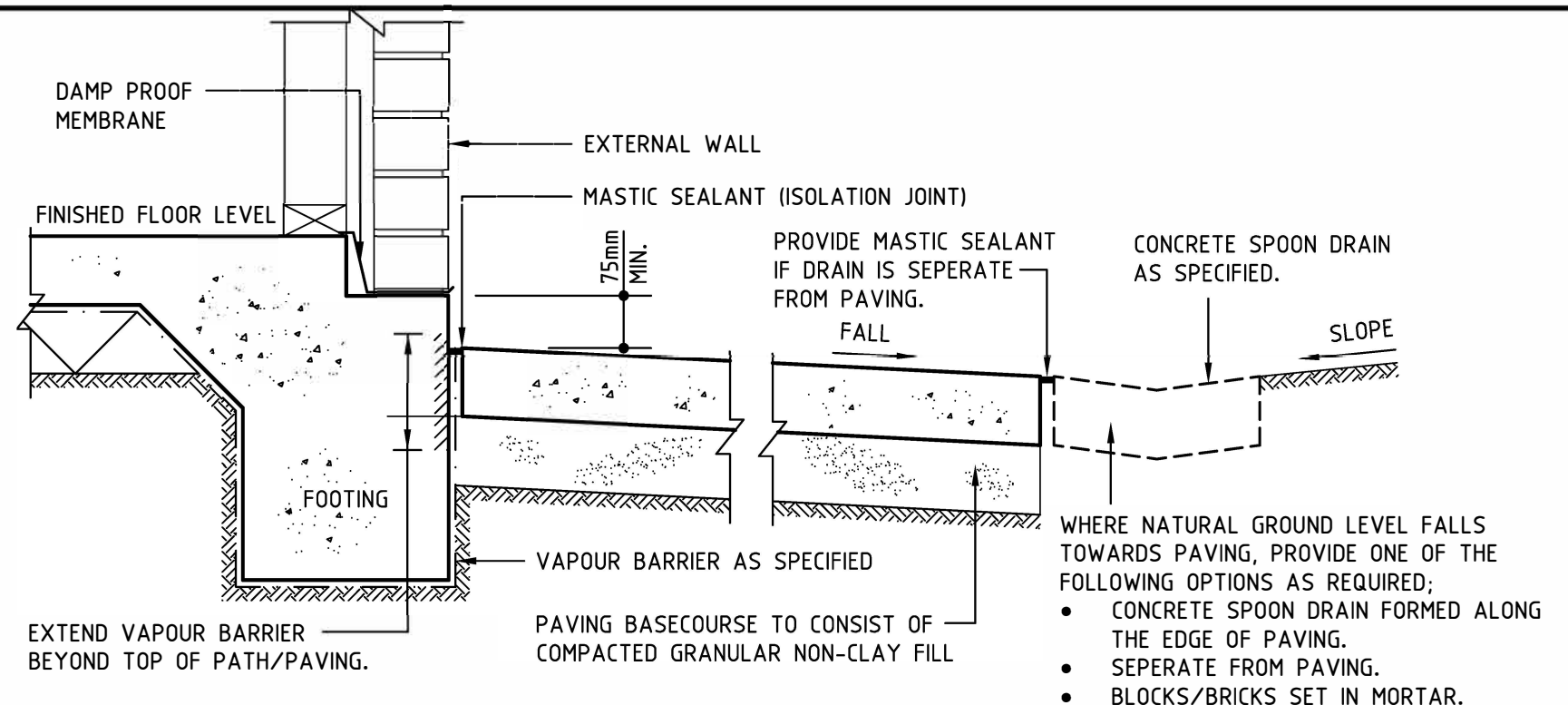
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### GENERAL PAVING NOTES:

- UNLESS NOTED OTHERWISE, PAVED AREAS SHALL HAVE A MINIMUM WIDTH OF 900mm. A PREFERABLE WIDTH OF 1200mm SHOULD BE ADOPTED FOR CLASS 'E-D' SITES.
- WHERE CONCRETE PAVEMENTS ARE ADOPTED, REFER TO THE TABLE BELOW:  

CLASS	TRAFFIC	THICKNESS	FABRIC
CLASS 'A' OR 'S' SITES - MIN. CROSSFALL=1:30	FOOT TRAFFIC [2m]	75mm	SL52
	LIGHT VEHICULAR TRAFFIC [3m]	100mm	SL62
CLASS 'M' SITES - MIN. CROSSFALL=1:20	FOOT TRAFFIC [2m]	75mm	SL52
	LIGHT VEHICULAR TRAFFIC [3m]	100mm	SL62
CLASS 'H' SITES - MIN. CROSSFALL=1:20	FOOT TRAFFIC [2m]	75mm	SL62
	LIGHT VEHICULAR TRAFFIC [4m]	100mm	SL72
CLASS 'E' SITES - MIN. CROSSFALL=1:20	FOOT TRAFFIC [3m]	100mm	SL72
	LIGHT VEHICULAR TRAFFIC [4m]	120mm	SL82

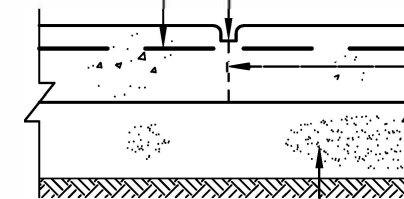
CONCRETE PAVING AND GROUND LEVEL ADJACENT TO THE BUILDING PERIMETER SHALL BE GRADED 50mm OVER 1 METRE (1:20) AWAY FROM THE BUILDING.  
 MINIMUM CROSSFALLS MAY ALSO BE DESIGNED IN ACCORDANCE WITH THE MAXIMUM ALLOWABLE FALLS DENOTED IN 'AS 1428 DESIGN FOR ACCESS & MOBILITY'.  
 [Xm] DENOTES THE MAXIMUM DISTANCE BETWEEN CONTROL JOINTS (NOTING THAT LENGTH OF ADJACENT SIDES SHOULD BE IN THE RATIO OF 1 TO 1.3 MAX).
- BRICK, BLOCK & BITUMEN PAVEMENTS SHALL ADHERE TO CROSSFALLS AS NOTED BELOW FOR CLASS 'A, S, M, H & E' SITES. CONSTRUCTION SHALL BE IN ACCORDANCE WITH THE MANUFACTURERS SPECIFICATIONS.
- WHERE PAVING CONSTRUCTION IS UNDERTAKEN ON CLASS 'H' OR 'E' SITES, IT IS PREFERABLE TO COMMENCE PAVING WORK AT THE END OF WINTER WHEN SITE SOIL IS STILL WET TO HELP LIMIT A REDUCTION IN CROSSFALLS.  
 SHOULD TO BUILDING BE OCCUPIED DURING THE WINTER MONTHS WITH NO PAVING PROVIDED, ENSURE THAT THE SOIL SURFACE TO THE PERIMETER OF THE BUILDING IS MAINTAINED TO A WELL DRAINED STATE UNTIL SUCH TIME THAT PAVING IS INSTALLED.  
 SHOULD IT BE NECESSARY TO CONSTRUCT PAVING ON THESE TYPES OF SOILS DURING OTHER TIMES OF THE YEAR, I.E THE END OF SUMMER, THE CROSSFALLS SHALL BE TWICE OF THAT INDICATED IN NOTE "2".
- SHOULD TO DWELLING BE OCCUPIED DURING THE WINTER MONTHS WITH NO PAVING PROVIDED, ENSURE THAT THE SOIL SURFACE TO THE PERIMETER OF THE BUILDING IS MAINTAINED TO A WELL DRAINED STATE UNTIL SUCH TIME THAT PAVING IS INSTALLED.
- ALL PAVEMENTS MUST BE SET DOWN 75mm BELOW THE REBATE.
- PAVING SHALL BE PREPARED ON A FIRM CLEAN BASE WHERE ALL BUILDING DEBRIS IS REMOVED FROM THE PERIMETER OF THE BUILDING. A COMPACTED QUARRY RUBBLE BASE IS TO BE PROVIDED AS REQUIRED TO ELEVATE PAVING AND ACHIEVE NECESSARY CROSSFALLS.
- PAVEMENTS SHALL NOT BREACH THE DAMP PROOF COURSE OR BUILT-IN DAMP PROOF MEMBRANE UNLESS OTHER ADEQUATE DAMP-PROOFING MEASURES HAVE BEEN TAKEN.
- REACTIVE SOILS MAY CAUSE PAVING TO SEPERATE HORIZONTALLY FROM THE BUILDING PERIMETER. IT IS IMPORTANT THAT ANY GAPS BETWEEN THE BUILDING AND PAVING BE IMMEDIATLEY SEALED WITH A FLEXIBLE MASTIC SEALANT.
- PROVIDE EGDE DRAINS WHERE NECESSARY TO DIVERT RUNOOF CLEAR OF THE BUILDING.
- PROVIDE TERMITE PROTECTION TO AS 3660.1.



## SECTION 1

NOT TO SCALE

PROVIDE 30mm COVER TO REINFORCEMENT. 20mm DEEP TOOLED JOINT.

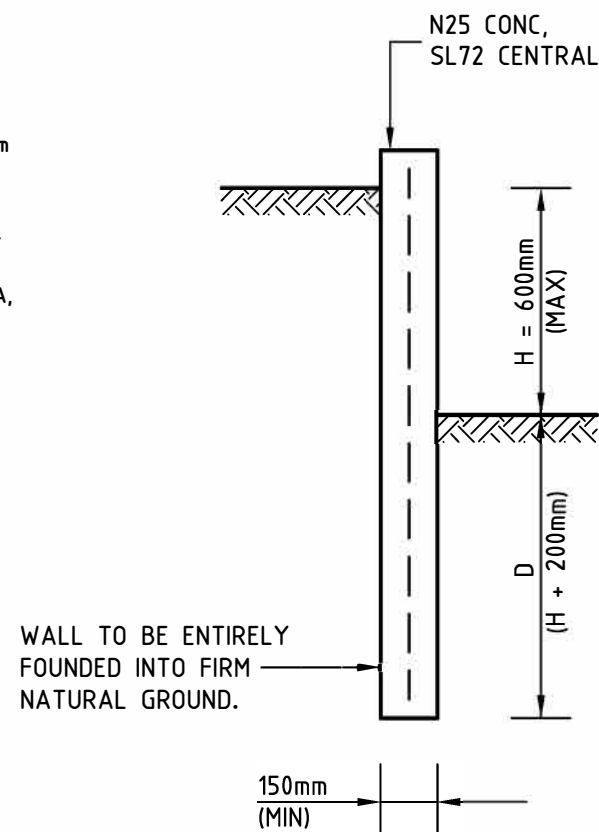


ENSURE THAT WEAKNESS IS FORMED ALONG LINE OF JOINT BY ONE OR BOTH OF THE FOLLOWING OPTIONS;  
 • CUTTING EVERY THIRD CROSS-WIRE OF THE REINFORCEMENT.  
 • FORCING A TROWEL THROUGH THE CONCRETE ALONG THE JOINT TO SEPERATE CONCRETE AGGREGATES.

PAVING BASECOURSE TO CONSIST OF COMPACTED GRANULAR NON-CLAY FILL.

## CONCRETE PAVING CONTROL JOINT DETAIL

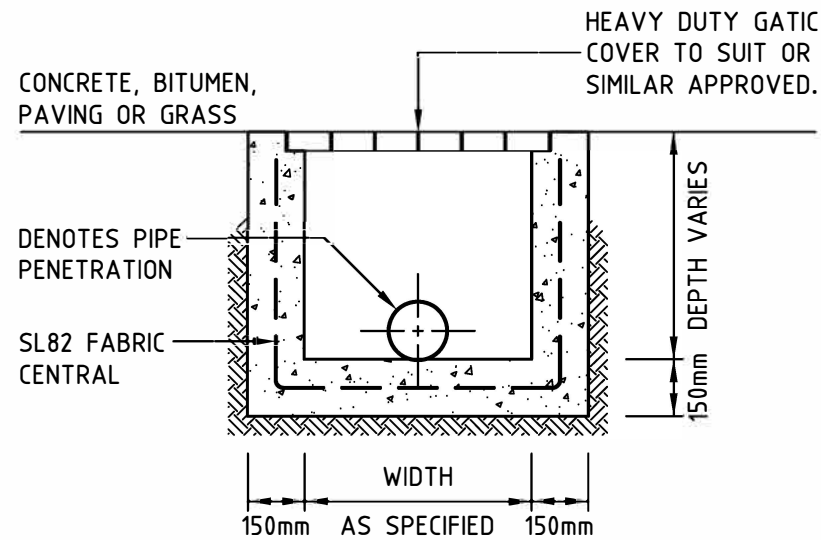
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## CONCRETE PLINTH DETAIL

N.T.S

PROJECT				
PROPOSED RESIDENCES				
AT: 50-52 WINDSOR STREET MAGILL				
FOR: MR & MRS WONG				
DRAWING TITLE				
EARTHWORKS & PAVING DETAILS				
SCALE	DRAWN	ENGINEER	DATE	
AS SHOWN	BM	BM	02.11.2017	
SURVEYED	PROJECT No.	DRAWING No.	ISSUE	SHEET SIZE
01.09.2017	170814	C4	A	A3
K S Q U E D A R E E N G I N E E R I N G				
SUITE 4, GROUND LEVEL 166-168 GRANGE ROAD, FLINDERS PARK SA 5025 PH: 0413 991 106				

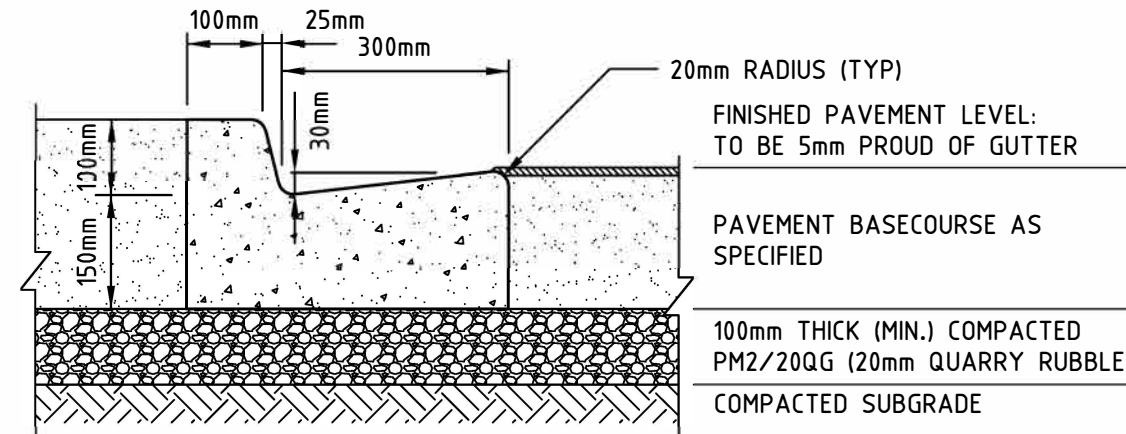


## GRATED SUMP

1:20

### NOTES:

1. REFER TO 'STORMWATER PIT SCHEDULE' FOR PIT DIMENSIONS.
2. PENETRATION FOR PIPES SHALL BE APPROX. 50mm GREATER THAN THE OVERALL DIAMETER OF PIPE. PIPES SHALL BE FINISHED FLUSH WITH THE INTERNAL FACE OF THE SUMP. A STIFF MORTAR MIX SHALL BE PACKED INTO THE SPACE FROM BOTH SIDES OF STRUCTURE. THE INTERNAL FACE SHALL BE FINISHED SMOOTH AND A 150mm THICK BAND ON CONCRETE SHALL BE POURED OUTSIDE THE SUMP TO SEA THE PENETRATION.
3. WHERE SUMPS CONSIST OF MORE THAN ONE PRECAST UNIT, THE JOINTS SHALL BE SEALED WITH BUTYL MASTIC FLEXIBLE PIPE SEALANT AROUND THE OUTSIDE AND A 1:3 SAND CEMENT GROUT ON THE INSIDE OF THE SUMP.

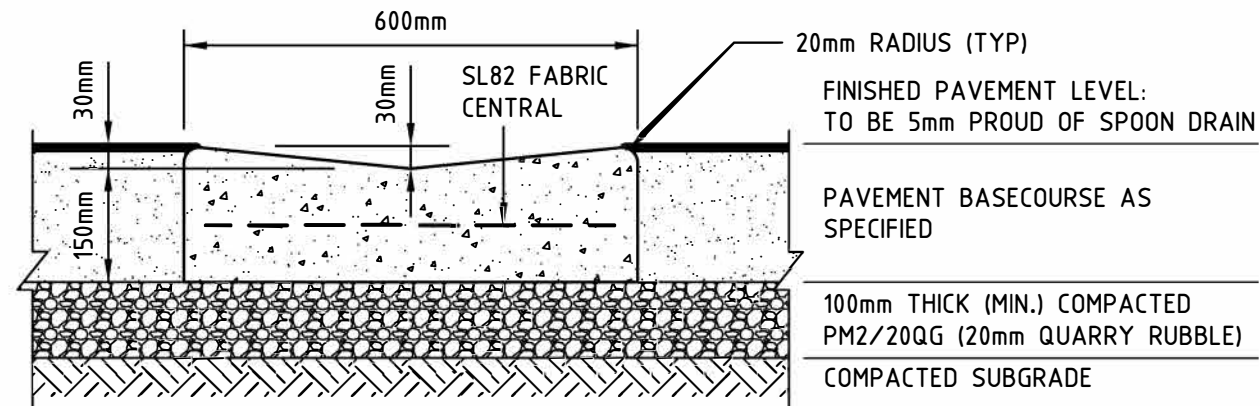


## 100mm HIGH KERB & GUTTER

1:10

### NOTE:

PROVIDE 10mm WIDE x 20mm DEEP TOOLED JOINTS AT 3.0m CRS (MAX.)  
FORCE A TROWEL THOUGH JOINTS DURING CONCRETE POUR TO SEPARATE  
AGGREGATES AND INFLUENCE CRACKING AT THESE LOCATIONS.

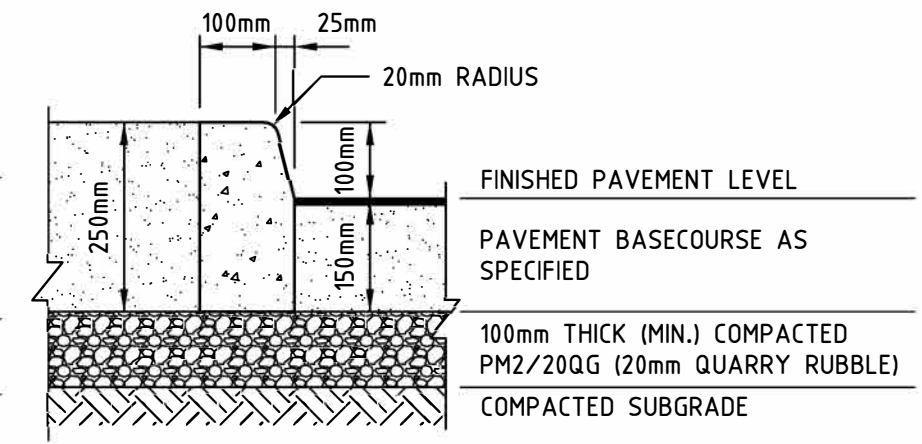


## 600mm WIDE SPOON DRAIN

1:10

### NOTE:

PROVIDE 10mm WIDE x 20mm DEEP TOOLED JOINTS AT 3.0m CRS (MAX.)  
FORCE A TROWEL THOUGH JOINTS TO SEPARATE AGGREGATES AND  
INFLUENCE CRACKING AT THESE LOCATIONS.



## 100mm HIGH KERB

1:10

### NOTE:

PROVIDE 10mm WIDE x 20mm DEEP TOOLED JOINTS AT 3.0m CRS (MAX.)  
FORCE A TROWEL THOUGH JOINTS TO SEPARATE AGGREGATES AND  
INFLUENCE CRACKING AT THESE LOCATIONS.

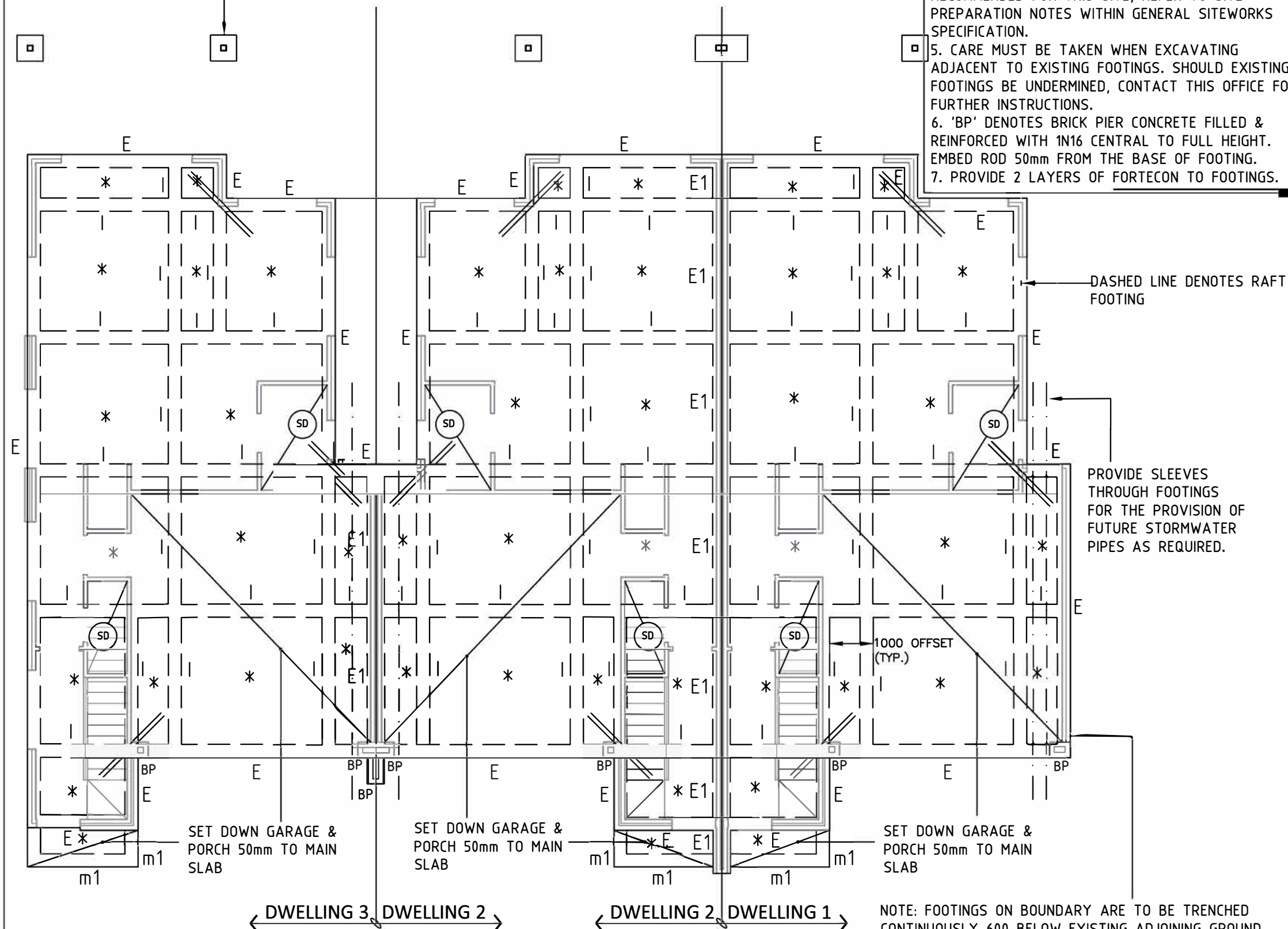
PROJECT				
PROPOSED RESIDENCES				
AT: 50-52 WINDSOR STREET MAGILL FOR: MR & MRS WONG				
DRAWING TITLE				
CIVIL DETAILS				
SCALE AS SHOWN	DRAWN BM	ENGINEER BM	DATE 02.11.2017	
SURVEYED 01.09.2017	PROJECT No. 170814	DRAWING No. C5	ISSUE A	SHEET SIZE A3
K S Q U E D A R E E N G I N E E R I N G				SUITE 4, GROUND LEVEL 166-168 GRANGE ROAD, FLINDERS PARK SA 5025 PH: 0413 991 106

# DWELLINGS 1, 2 & 3

DENOTES 700 SQUARE BY 700 DEEP CONCRETE PAD FOOTINGS FULLY FOUNDED INTO FIRM NATURAL GROUND. REINFORCE PAD FOOTINGS WITH SL72 MESH TOP & BOTTOM. (TYP.). PLEASE NOTE, DUE TO THE REACTIVE NATURE OF THE SOIL PROFILE, SOME DIFFERENTIAL MOVEMENT OF THE PAD FOOTINGS IS EXPECTED.

## NOTES

1. FOOTINGS ARE TO BE CONTINUOUSLY TRENCHED OR PIERED 200mm INTO NATURAL GROUND.
2. A TRENCH INSPECTION IS MANDATORY FOR THIS SITE.
3. WHERE THE DEPTH OF FILL BENEATH A SLAB PANEL EXCEEDS 400mm INCREASE THE SLAB THICKNESS TO 125mm AND REINFORCE WITH ONE LAYER OF SL82 TOP & SL72 BOTTOM.
4. PRE WETTING OF THE BUILDING AREA IS RECOMMENDED FOR THIS SITE, REFER TO SITE PREPARATION NOTES WITHIN GENERAL SITEWORKS SPECIFICATION.
5. CARE MUST BE TAKEN WHEN EXCAVATING ADJACENT TO EXISTING FOOTINGS. SHOULD EXISTING FOOTINGS BE UNDERMINED, CONTACT THIS OFFICE FOR FURTHER INSTRUCTIONS.
6. 'BP' DENOTES BRICK PIER CONCRETE FILLED & REINFORCED WITH 1N16 CENTRAL TO FULL HEIGHT. EMBED ROD 50mm FROM THE BASE OF FOOTING.
7. PROVIDE 2 LAYERS OF FORTECON TO FOOTINGS.



## FOOTING SCHEDULE

FOOTING	WIDTH, W	DEPTH, D	REINFORCEMENT	LIGATURES
E	350	1100	4N20T&4N20B	W10 @1000c/c
I	350	1100	4N20T&4N20B	W10 @1000c/c
m1	350	900	3N16T&3N16B	W8 @1000c/c
E1	400	1100	4N20T&4N20B	W10 @1000c/c

## FOOTING NOTES

1. THIS DRAWING MUST BE READ IN CONJUNCTION WITH THE ARCHITECTURAL DRAWINGS AND DETAILS CONTAINED WITHIN THIS REPORT.
2. MINIMUM CHARACTERISTIC CONCRETE STRENGTH TO BE  $f'c = 20\text{Mpa}$ .
3. SLAB ON GROUND TO BE 125mm THICK & REINFORCED WITH SL82 TOP & SL72 BOTTOM UNLESS NOTED OTHERWISE.
4. SLAB THICKNESS & FOOTING DEPTH MUST BE MAINTAINED AT ALL SETDOWNS (PROVIDE STEPS AS PER STANDARD DETAILS).
5. LAPS IN MESH TO BE ONE FULL SQUARE PLUS 25MM.
6. WHERE BRITTLE FLOOR COVERINGS ARE TO BE USED, PROVIDE SL92T & SL72B.
7. DENOTES TRENCHED PIER, 1000 LONG BY THE WIDTH OF THE FOOTING, FOUNDED A MINIMUM OF 200mm INTO NATURAL GROUND.
8. THE SPACING OF LIGATURES MUST BE REDUCED TO 300c/c BETWEEN TRENCHED PIERS.
9. DENOTES 125 THICK SLAB REINFORCED WITH SL82 TOP & SL72 BOTTOM.
10. THIS IS A CLASS 'E-D, P (FILL, TREES)' SITE - LAGGING & FLEXIBLE CONNECTIONS REQUIRED AS PER THE SITE CLASSIFICATION - REFER TO STANDARD DETAILS.
11. DENOTES ARTICULATION JOINT IN THE HEBEL TO FULL HEIGHT. REFER TO STRUCTURAL DRAWING DETAILS.
12. DENOTES 4N12 DOWELS (2T, 2B) 600 LONG OVERALL, DRILL & EPOXY GROUT 200 INTO EXISTING FOOTING.
13. FLEXIBLE SEWER & STORMWATER CONNECTIONS ARE REQUIRED FOR THIS SITE.
14. THE OWNER'S ATTENTION IS DRAWN TO THE CSIRO'S INFORMATION SHEET 'GUIDE TO HOMEOWNERS ON FOUNDATION MAINTENANCE & FOOTING PERFORMANCE' (COPY IS ATTACHED).
15. INDICATES WET AREAS SET DOWN - GENERALLY 25MM, 50MM IN SHOWER AREA.
16. DENOTES CRACK CONTROL BARS: 3N12 2M LONG OR 2N16.
17. REFER TO ARCHITECTURAL DRAWINGS FOR ALL SETTING OUT AND DIMENSIONS.
18. DENOTES SET DOWN IN ACCORDANCE WITH ARCHITECTURAL DETAILS.

ISSUE	DATE	AMMENDMENT	APPROVED

A 14/12/18 FOR APPROVAL/CONSTRUCTION KP

PROJECT PROPOSED RESIDENCES

AT: 50-52 WINDSOR STREET  
 MAGILL  
 FOR: WP PROPERTY GROUP

DRAWING TITLE FOOTING PLAN

SCALE 1:200	DRWAN MH	ENGINEER MH	DATE 14/12/2018	
CHECKED KP	PROJECT No. 170814	DRAWING No. FP-1	ISSUE A	SHEET SIZE A3

K S Q U E  
 A R E  
 ENGINEERING

SUITE 4, GROUND LEVEL  
 166-168 GRANGE ROAD,  
 FLINDERS PARK SA 5025  
 PH: 0413 991 106



DWELLINGS 4, 5, 6 & 7

NOTES

1. FOOTINGS ARE TO BE CONTINUOUSLY TRENCHED OR PIERED 200mm INTO NATURAL GROUND.
2. A TRENCH INSPECTION IS MANDATORY FOR THIS SITE.
3. WHERE THE DEPTH OF FILL BENEATH A SLAB PANEL EXCEEDS 400mm INCREASE THE SLAB THICKNESS TO 125mm AND REINFORCE WITH ONE LAYER OF SL92 TOP & SL72 BOTTOM.
4. PRE WETTING OF THE BUILDING AREA IS MANDATORY FOR THIS SITE, REFER TO SITE PREPARATION NOTES WITHIN GENERAL SITEWORKS SPECIFICATION.
5. CARE MUST BE TAKEN WHEN EXCAVATING ADJACENT TO EXISTING FOOTINGS. SHOULD EXISTING FOOTINGS BE UNDERMINED, CONTACT THIS OFFICE FOR FURTHER INSTRUCTIONS.
6. 'BP' DENOTES BRICK PIER CONCRETE FILLED & REINFORCED WITH 1N16 ROD CENTRAL TO FULL HEIGHT. EMBED ROD 50mm FROM THE BASE OF FOOTING.
7. PROVIDE 2 LAYERS OF FORTECON TO FOOTINGS.

NOTE: FOOTINGS ON BOUNDARY ARE TO BE TRENCHED CONTINUOUSLY 600 BELOW EXISTING ADJOINING GROUND LEVEL OR 200 INTO NATURAL GROUND, WHICHEVER IS GREATER. PROVIDE SL92 VERTICAL TO EXPOSED EDGE OF FOOTING.

SOLID LINE DENOTES STRIP FOOTING. SET DOWN BELOW PAVING LEVEL.

PROVIDE SLEEVES THROUGH FOOTINGS FOR THE PROVISION OF FUTURE STORMWATER PIPES AS REQUIRED. (TYP.)

PLEASE NOTE DUE TO THE CLOSE PROXIMITY OF THE FOOTINGS, COLLAPSE OF THE SOL BETWEEN THE FOOTINGS MAY OCCUR. SHOULD THIS OCCUR PROVIDE A DOUBLE FOOTINGS.

DASHED LINE DENOTES RAFT FOOTING  
SET DOWN GARAGE 50mm TO MAIN SLAB

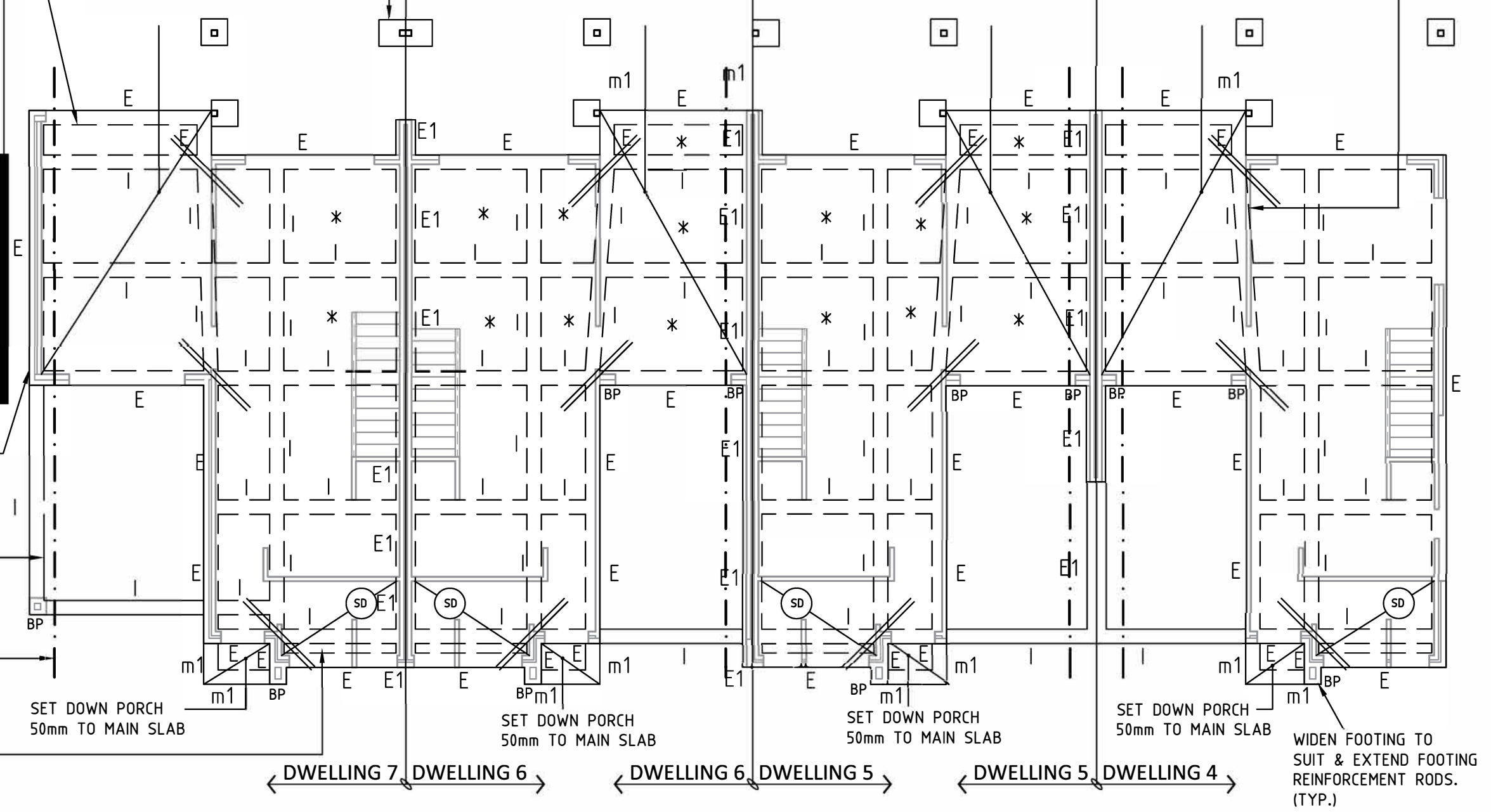
DENOTES 700 SQUARE BY 700 DEEP CONCRETE PAD FOOTINGS FULLY FOUNDED INTO FIRM NATURAL GROUND. REINFORCE PAD FOOTINGS WITH SL72 MESH TOP & BOTTOM. (TYP.). PLEASE NOTE, DUE TO THE REACTIVE NATURE OF THE SOIL PROFILE, SOME DIFFERENTIAL MOVEMENT OF THE PAD FOOTINGS IS EXPECTED.

SET DOWN GARAGE 50mm TO MAIN SLAB

SET DOWN GARAGE 50mm TO MAIN SLAB

SET DOWN GARAGE 50mm TO MAIN SLAB

CRANK EACH FOOTING REINFORCEMENT BAR TO SUIT (TYP.)



WIDEN FOOTING TO SUIT & EXTEND FOOTING REINFORCEMENT RODS. (TYP.)

FOOTING NOTES

1. THIS DRAWING MUST BE READ IN CONJUNCTION WITH THE ARCHITECTURAL DRAWINGS AND DETAILS CONTAINED WITHIN THIS REPORT.
2. MINIMUM CHARACTERISTIC CONCRETE STRENGTH TO BE  $f'c = 20\text{Mpa}$ .
3. SLAB ON GROUND TO BE 100mm THICK & REINFORCED WITH ONE LAYER OF SL82 PLACED 25mm FROM THE TOP FACE UNLESS NOTED OTHERWISE.
4. SLAB THICKNESS & FOOTING DEPTH MUST BE MAINTAINED AT ALL SETDOWNS (PROVIDE STEPS AS PER STANDARD DETAILS).
5. LAPS IN MESH TO BE ONE FULL SQUARE PLUS 25MM.
6. WHERE BRITTLE FLOOR COVERINGS ARE TO BE USED, PROVIDE SL92T & SL72B.
7. DENOTES TRENCHED PIER, 1000 LONG BY THE WIDTH OF THE FOOTING, FOUNDED A MINIMUM OF 200MM INTO NATURAL GROUND.
8. THE SPACING OF LIGATURES MUST BE REDUCED TO  $300c/c$  BETWEEN TRENCHED PIERS.

- \* 9. DENOTES 125 THICK SLAB REINFORCED WITH SL82 TOP & SL72 BOTTOM.
10. THIS IS A CLASS 'E-D, P(FILL TREES)' SITE - LAGGING & FLEXIBLE CONNECTIONS REQUIRED AS PER THE SITE CLASSIFICATION - REFER TO STANDARD DETAILS.
11. DENOTES ARTICULATION JOINT IN THE HEBEL/MASONRY TO FULL HEIGHT. REFER TO STRUCTURAL DRAWINGS FOR DETAILS.
12. DENOTES 4N12 DOWELS (2T,2B) 600 LONG OVERALL, DRILL & EPOXY GROUT 200 INTO EXISTING FOOTING.
13. FLEXIBLE SEWER & STORMWATER CONNECTIONS ARE REQUIRED FOR THIS SITE.
14. THE OWNER'S ATTENTION IS DRAWN TO THE CSIRO'S INFORMATION SHEET 'GUIDE TO HOMEOWNERS ON FOUNDATION MAINTENANCE & FOOTING PERFORMANCE' (COPY IS ATTACHED).
15. INDICATES WET AREAS SET DOWN - GENERALLY 25MM, 50MM IN SHOWER AREA.
16. DENOTES CRACK CONTROL BARS: 3N12 2M LONG OR 2N16.
17. REFER TO ARCHITECTURAL DRAWINGS FOR ALL SETTING OUT AND DIMENSIONS.
18. DENOTES SET DOWN IN ACCORDANCE WITH ARCHITECTURAL DETAILS.

FOOTING SCHEDULE

FOOTING	WIDTH, W	DEPTH, D	REINFORCEMENT	LIGATURES
E	350	1100	4N20T&4N20B	W10 @1000c/c
I	350	1100	4N20T&4N20B	W10 @1000c/c
m1	350	900	3N16T&3N16B	W8 @1000c/c
E1	400	1100	4N20T&4N20B	W10 @1000c/c
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-

ISSUE	DATE	AMENDMENT	APPROVED
A	14/12/18	FOR APPROVAL/CONSTRUCTION	KP

K P U E D  
S Q A R E D  
E N G I N E E R I N G

SUITE 4, GROUND LEVEL  
166-168 GRANGE ROAD,  
FLINDERS PARK SA 5025  
PH: 0413 991 106

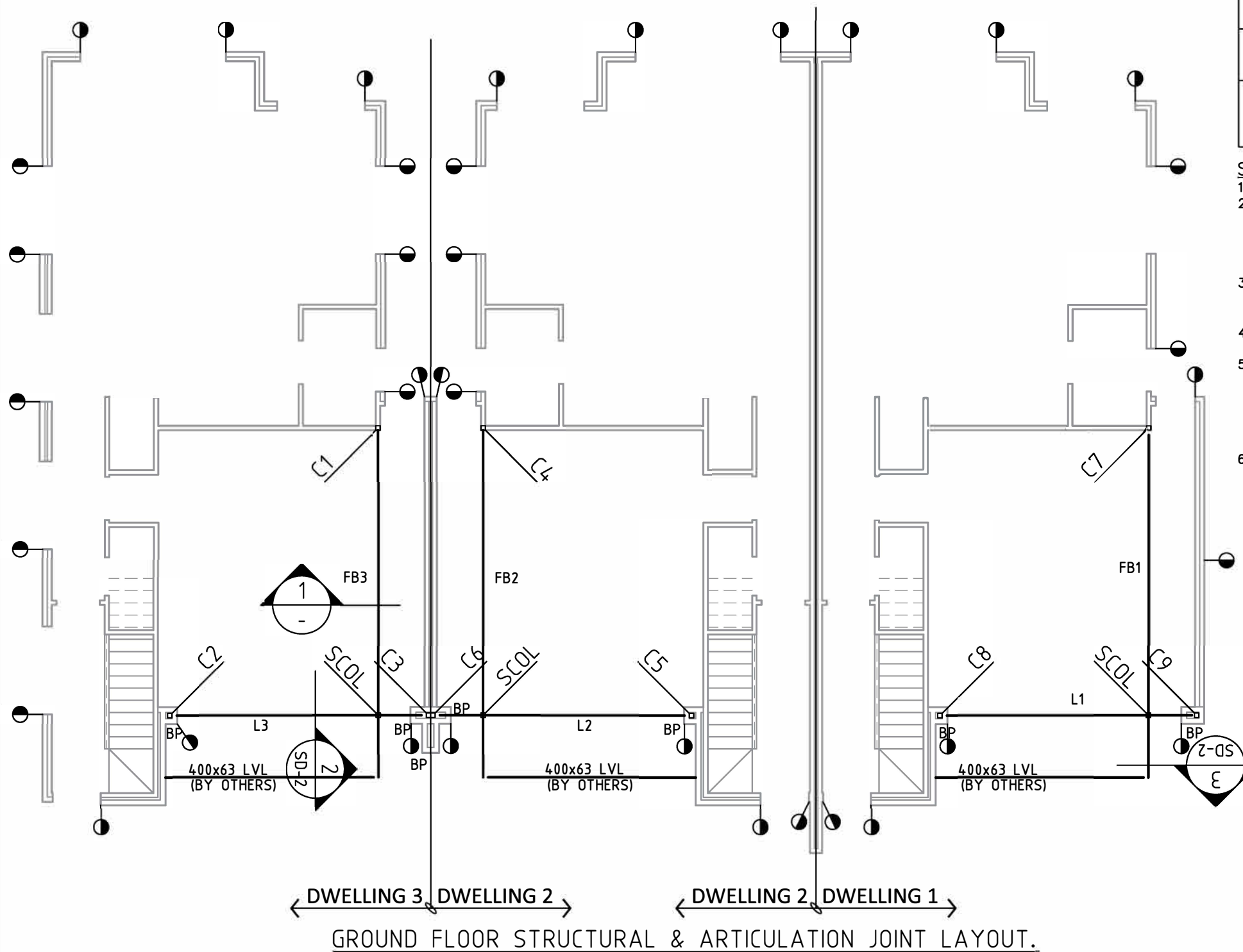
PROJECT  
PROPOSED RESIDENCES  
AT: 50-52 WINDSOR STREET  
MAGILL  
FOR: WP PROPERTY GROUP

DRAWING TITLE FOOTING PLAN				
SCALE 1:100	DRAWN MH	ENGINEER MH	DATE 14/12/2018	
CHECKED KP	PROJECT No. 170814	DRAWING No. FP-2	ISSUE A	SHEET SIZE A3

# DWELLINGS 1, 2 & 3

● DENOTES ARTICULATION JOINT IN THE MASONRY/HEBEL PANEL TO FULL HEIGHT. REFER TO STANDARD DETAILS SHEET 6 OF 12 FOR SPECIFICATIONS. ARTICULATION JOINTS WITHIN THE HEBEL PANEL ARE TO BE INSTALLED IN ACCORDANCE WITH THE MANUFACTURERS SPECIFICATIONS. ARTICULATION JOINTS IN WITHIN THE PARTY/BOUNDARY WALLS ARE TO BE FILLED WITH A FIRE RESISTANCE MATERIAL TO ENSURE A FIRE RESISTANCE LEVEL OF 60 / 60 / 60 IS ACHIEVED.

BP DENOTES BRICK PIER CONCRETE FILLED & REINFORCED WITH 1N16 ROD CENTRAL TO FULL HEIGHT. EMBED ROD 50mm FROM THE BASE OF FOOTING.

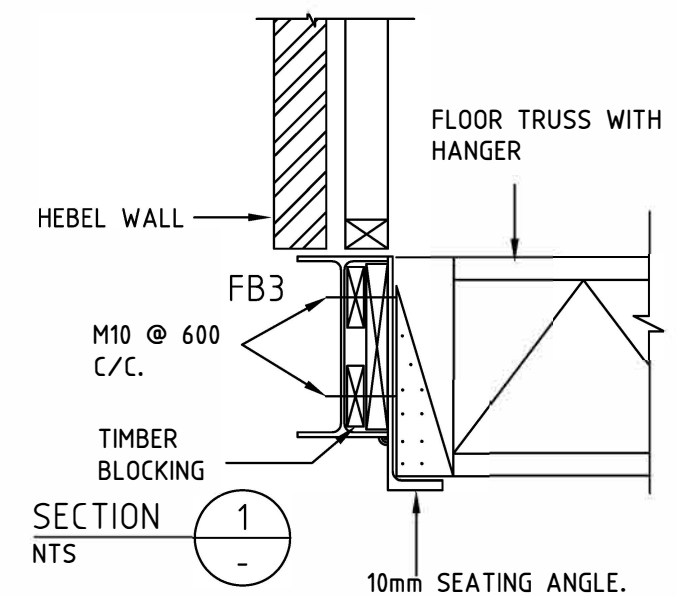


## STEELWORK/MEMBER SCHEDULE

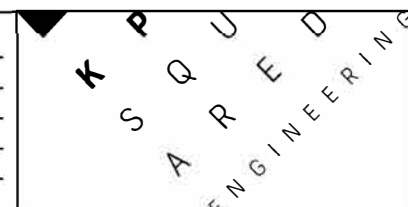
MARK	MEMBER	REMARKS
FB1-FB3	310 UB46	REFER TO SECTION 1 FOR CONNECTION DETAILS TO FLOOR TRUSSES. REFER TO SECTION 2 FOR CONNECTION DETAILS TO L1-L3. REFER TO SECTION 3 FOR CONNECTION DETAILS TO 400x63 LVL. REFER TO COLUMN REMARKS & TYPICAL COLUMN ELEVATIONS FOR CONNECTION DETAILS TO COLUMNS.
L1-L3	300PFC 10MMPLATE	WELD 6mm FILLET WELD, WELD 300mm EACH END, WELD 100mm MISS 100mm. REFER TO SECTION 2 FOR CONNECTION DETAILS TO FB1-FB3. REFER TO COLUMN REMARKS & TYPICAL COLUMN ELEVATIONS FOR CONNECTION DETAILS TO COLUMNS.
SCOL	89 x 89 x 3.5 SHS (G350)	STUB COLUMN. REFER TO SECTION 2 FOR CONNECTION DETAILS.
C1-C9	89 x 89 x 3.5 SHS (G350)	10 CAP/CLEAT PLATES 3M16 BOLTS TO BEAMS OVER. 10 BASE PLATE 2M16 CHEMICAL ANCHORS INTO CONCRETE FOOTING/SLAB. REFER TO TYPICAL COLUMN ELEVATIONS FOR CONNECTION DETAILS TO COLUMNS.

## STEEL WORK NOTES:

- ALL WORKMANSHIP & MATERIALS SHALL BE IN ACCORDANCE WITH AS4100 & AS4600.
- ALL STEEL, UNLESS OTHERWISE SHOWN ON THE DRAWINGS, SHALL BE OF THE FOLLOWING GRADES:  
ALL HOT ROLLED STEEL MEMBERS.....300  
ALL RHS AND SHS.....350  
ALL BOLTS TO BE GRADE 8.8/S. UNO
- UNLESS OTHERWISE SHOWN ON DRAWINGS ALL WELDS TO BE 6mm FILLET WELDS ALL ROUND, WELD CATEGORY GP (GENERAL PURPOSE) UNLESS INDICATED AS WELD CATEGORY SP (SPECIAL PURPOSE).
- ALL BOLTS, NUTS AND WASHERS SHALL BE HOT-DIP GALVANISED IN ACCORDANCE WITH THE REQUIREMENTS OF AS1214.
- THE MINIMUM DISTANCE FROM THE CENTER OF A FASTENER TO THE EDGE OF A PLATE OR THE FLANGE OF A ROLLED SECTION SHALL BE AS FOLLOWS:  
SHEARED OR HAND FRAME CUT EDGE.....1.75D  
ROLLED PLATE, MACHINE FLAME CUT EDGE.....1.50D  
ROLLED EDGE OF A ROLLED SECTION.....1.25D  
(D = NOMINAL DIAMETER OF FASTENER)
- ALL EXPOSED STEELWORK SHALL BE COATED WITH INORGANIC ZINC SILICATE. ALL OTHER STEEL WORK SHALL BE COATED WITH RED OXIDE ZINC PHOSPHATE.



ISSUE	DATE	AMENDMENT	APPROVED
A	14/12/18	FOR APPROVAL/CONSTRUCTION	KP

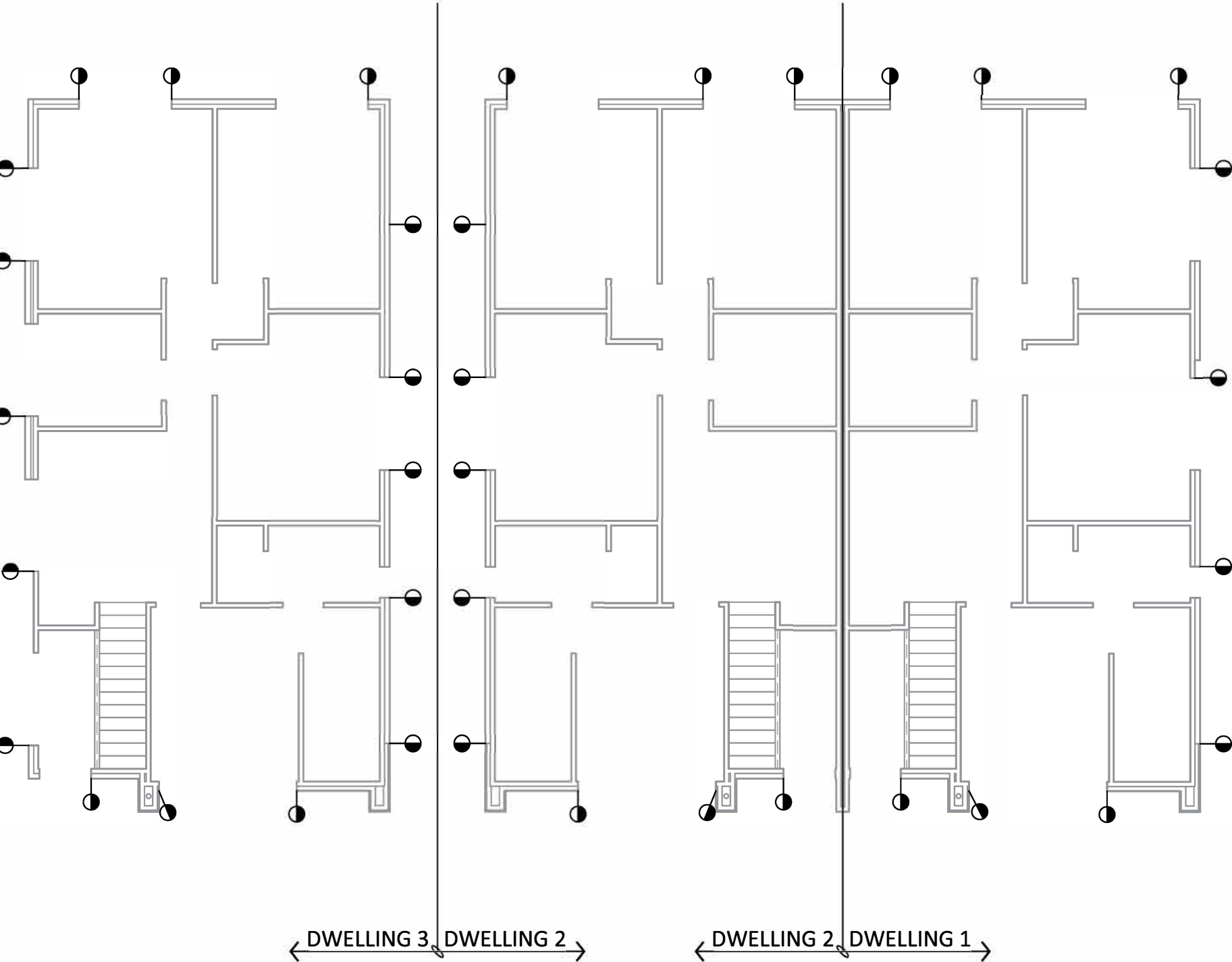


SUITE 4, GROUND LEVEL  
166-168 GRANGE ROAD,  
FLINDERS PARK SA 5025  
PH: 0413 991 106

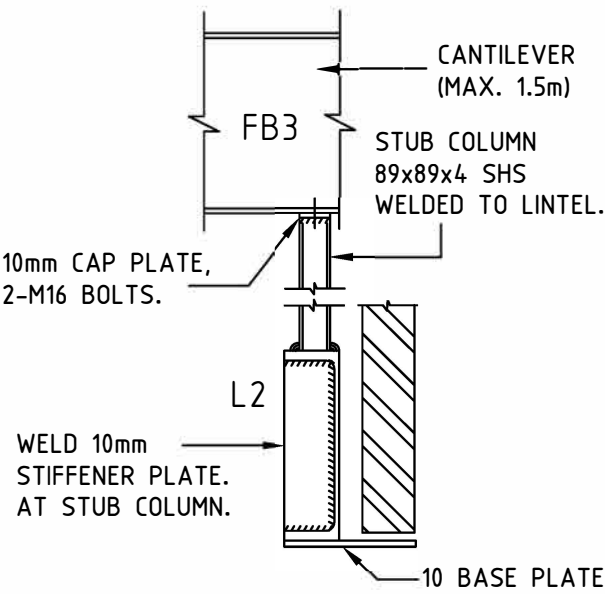
PROJECT PROPOSED RESIDENCES  
AT: 50-52 WINDSOR STREET  
MAGILL  
FOR: WP PROPERTY GROUP

DRAWING TITLE				
STRUCTURAL PLAN				
SCALE 1:100	DRAWN MH	ENGINEER MH	DATE 14/12/2018	
CHECKED KP	PROJECT No. 170814	DRAWING No. SD-1	ISSUE A	SHEET SIZE A3

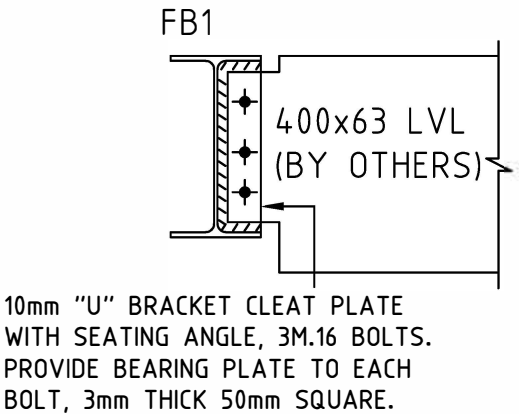
DWELLINGS 1, 2 & 3



UPPER FLOOR ARTICULATION JOINT LAYOUT.



SECTION 2  
NTS SD-1



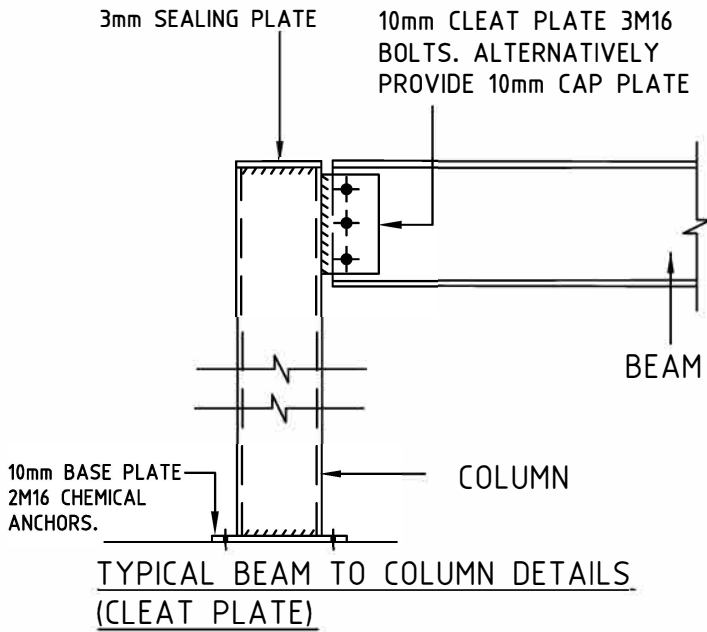
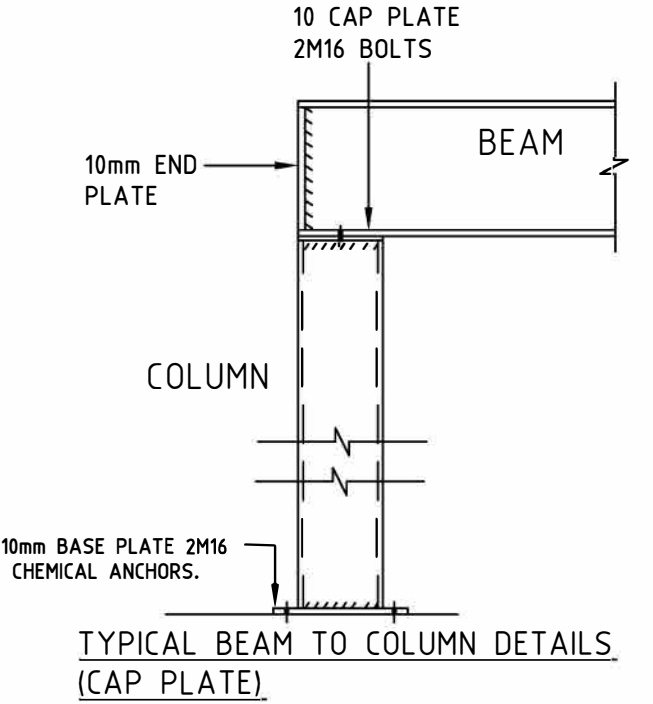
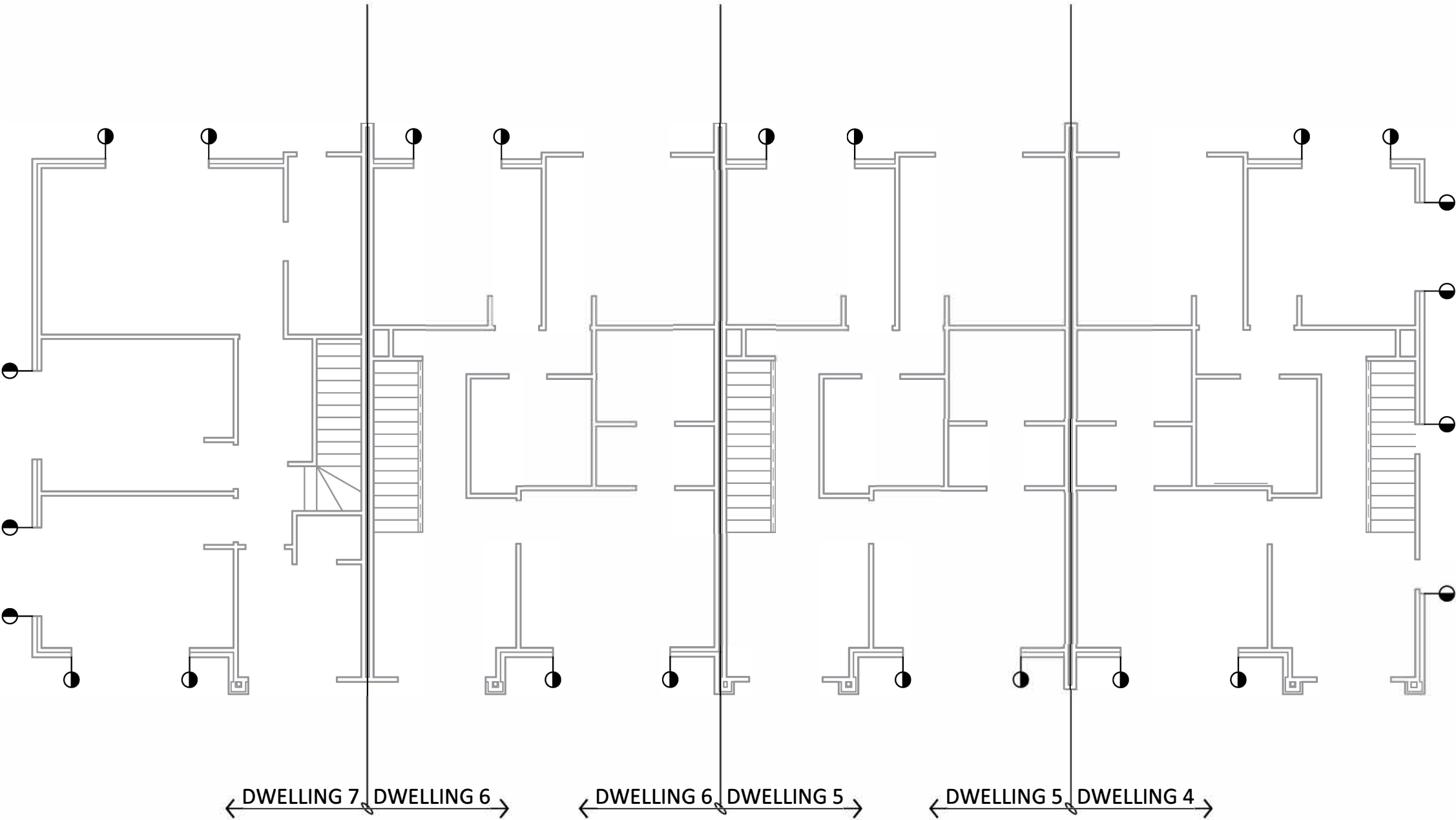
SECTION 3  
NTS SD-1

ISSUE	DATE	AMENDMENT	APPROVED	PROJECT		DRAWING TITLE			
				PROPOSED RESIDENCES		STRUCTURAL PLAN			
				AT: 50-52 WINDSOR STREET		SCALE	DRAWN	ENGINEER	DATE
				MAGILL		1:100	MH	MH	14/12/2018
				FOR: WP PROPERTY GROUP		CHECKED	PROJECT No.	DRAWING No.	ISSUE
A	14/12/18	FOR APPROVAL/CONSTRUCTION	KP			KP	170814	SD-2	A
						SHEET SIZE			
						A3			





DWELLINGS 4, 5, 6 & 7



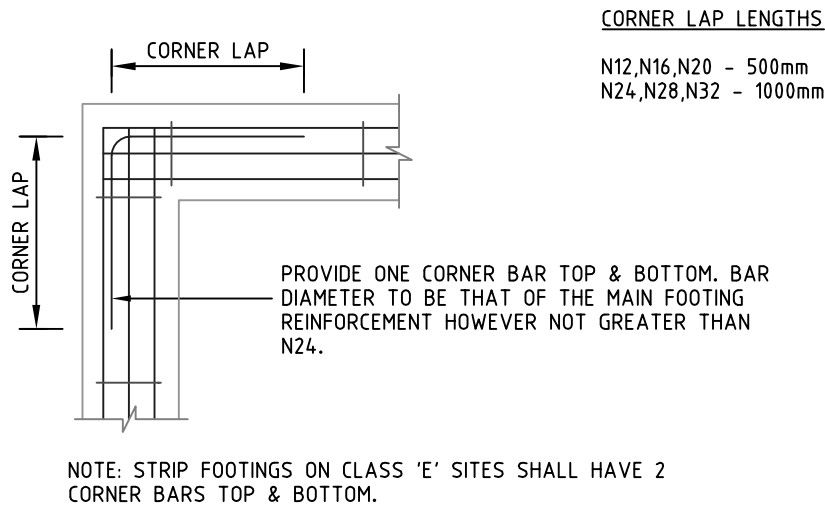
ISSUE				DATE		AMENDMENT		APPROVED	
A				14/12/18		FOR APPROVAL/CONSTRUCTION		KP	

		SUITE 4, GROUND LEVEL 166-168 GRANGE ROAD, FLINDERS PARK SA 5025 PH: 0413 991 106		PROJECT PROPOSED RESIDENCES AT: 50-52 WINDSOR STREET MAGILL FOR: WP PROPERTY GROUP		DRAWING TITLE STRUCTURAL PLAN			
SCALE 1:100		DRAWN MH		ENGINEER MH		DATE 14/12/2018			
CHECKED KP		PROJECT No. 170814		DRAWING No. SD-4		ISSUE A		SHEET SIZE A3	

STANDARD DETAILS

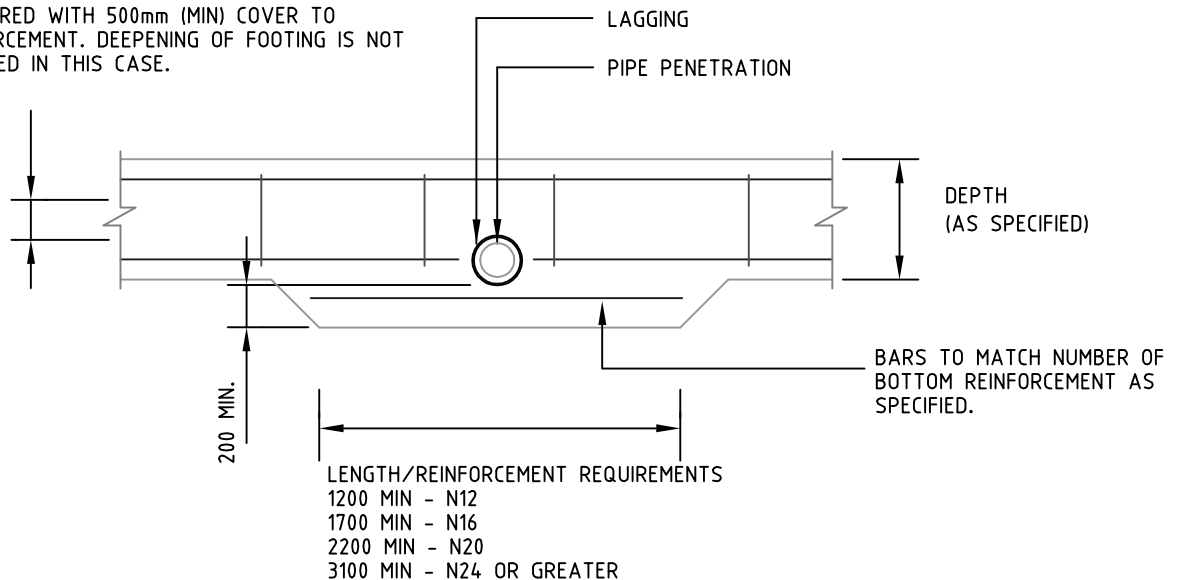
CORNER REINFORCEMENT & SERVICE  
PENETRATION DETAILS

NOT TO SCALE



CORNER REINFORCEMENT - ALL SITES

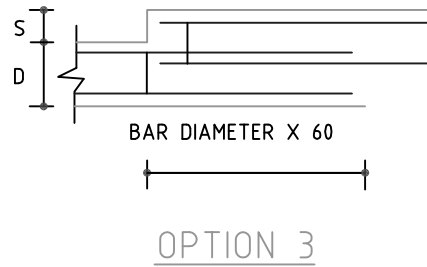
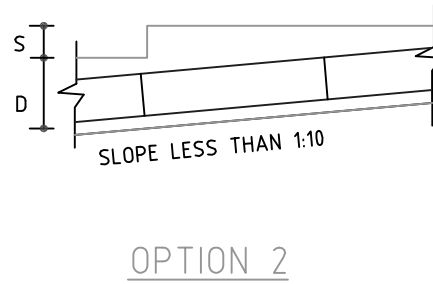
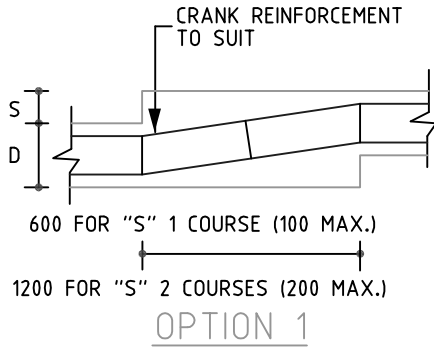
PENETRATIONS AT MIDDLE THIRD OF FOOTING ARE PREFERRED WITH 500mm (MIN) COVER TO REINFORCEMENT. DEEPENING OF FOOTING IS NOT REQUIRED IN THIS CASE.



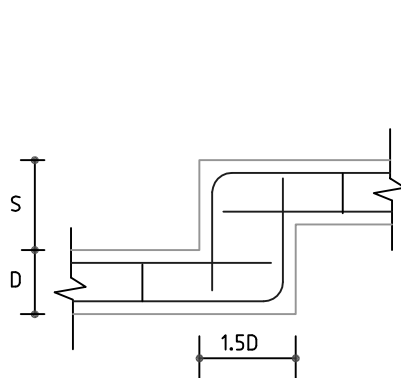
CLASS - S,M - 20mm THICK LAGGING (CLOSED CELL NOT NECESSARY)  
 CLASS - H,E - 20mm THICK CLOSED CELL POLYETHYLENE LAGGING  
 CLASS - P - 40mm THICK CLOSED CELL POLYETHYLENE LAGGING  
 NOTE: THE MOST STRINGENT CLASS ALWAYS APPLIES

FOOTING SERVICE PENETRATION DETAIL

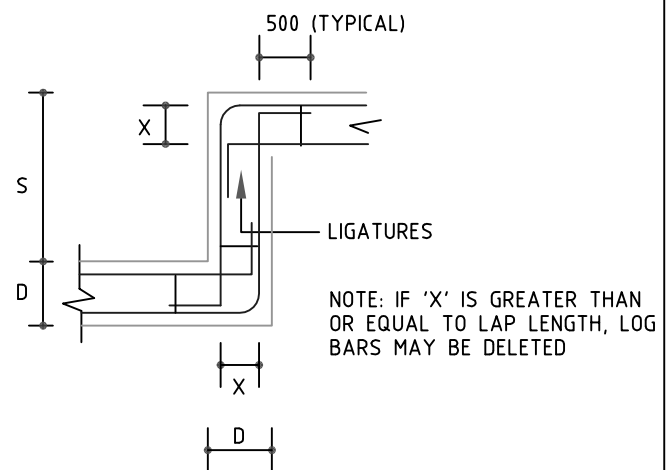
NOT TO SCALE



STEP 'S' 2 COURSES - (200 OR LESS)

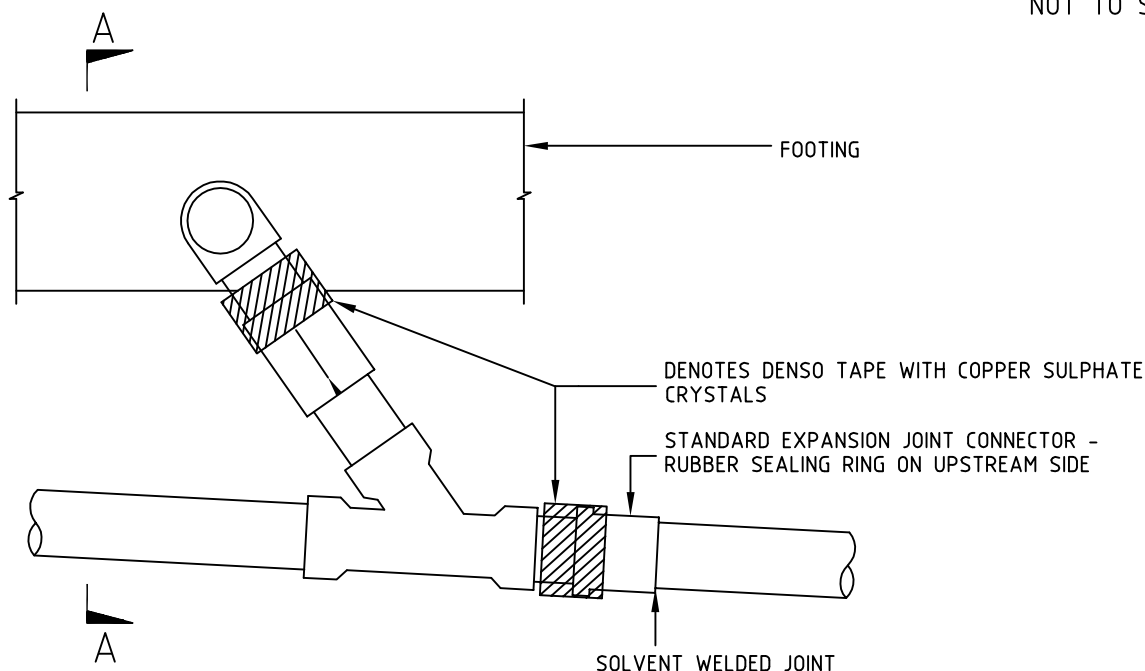


STEP 'S' GREATER THAN 200,  
LESS THAN '2D'

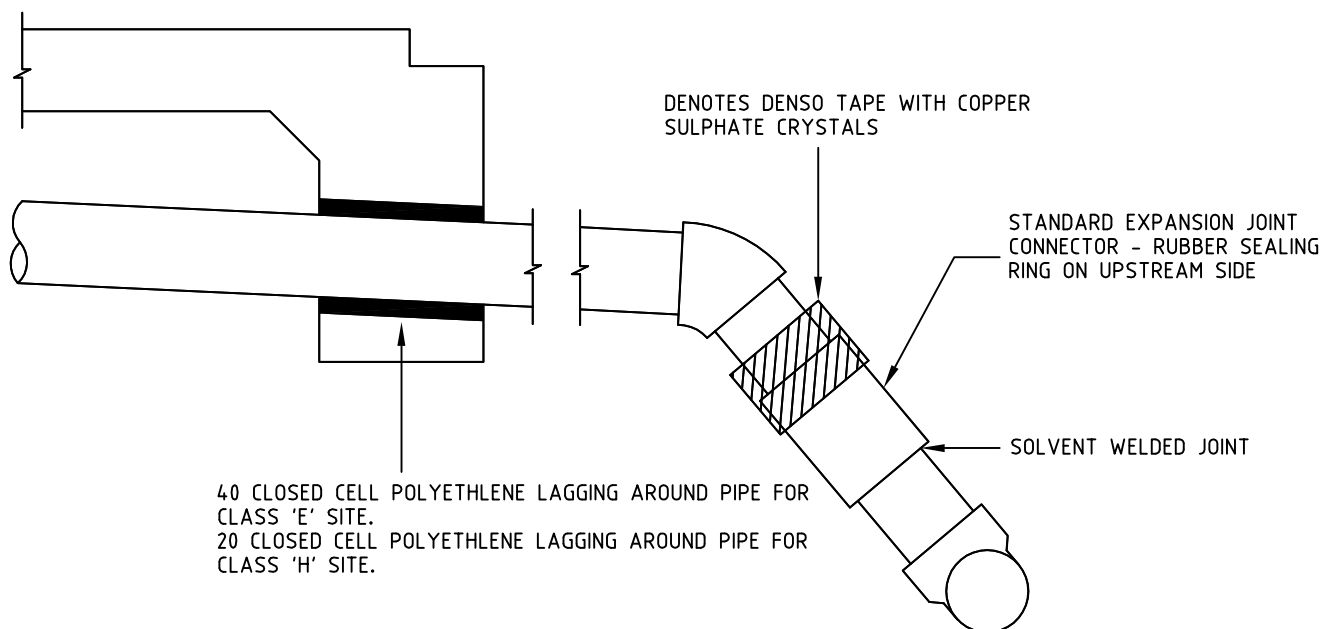


STEP 'S' GREATER THAN '2D'  
(DROP PIER)

NOT TO SCALE



SIDE ELEVATION



SECTION A-A

**NOTES**

DUE TO THE MOISTURE REACTION NATURE OF SOILS ON CLASS H, E SITES, IT IS REQUIRED THAT THE SERVICE PIPES INCLUDE STANDARD EXPANSION TYPE JOINT COUPLINGS. PROVIDE A FLEXIBLE CONNECTION TO PIPES IN ACCORDANCE WITH THE FOLLOWING:

1. CONNECTIONS ARE REQUIRED AT EACH LOCATION WHERE ANY PIPES (65MM OR LARGER) PENETRATE OR PASS BENEATH THE EXTERNAL FOOTING BEAMS.
2. TWO EXPANSION JOINT CONNECTORS ARE REQUIRED AT EACH CONNECTION.
3. DENSO TAPE MUST BE SPRINKLED WITH COPPER SULPHATE CRYSTALS BEFORE WRAPPING & MUST EXTEND 50MM PAST JOINT EITHER SIDE.
4. DETAILS APPLICABLE TO SEWER & STORMWATER PIPES.

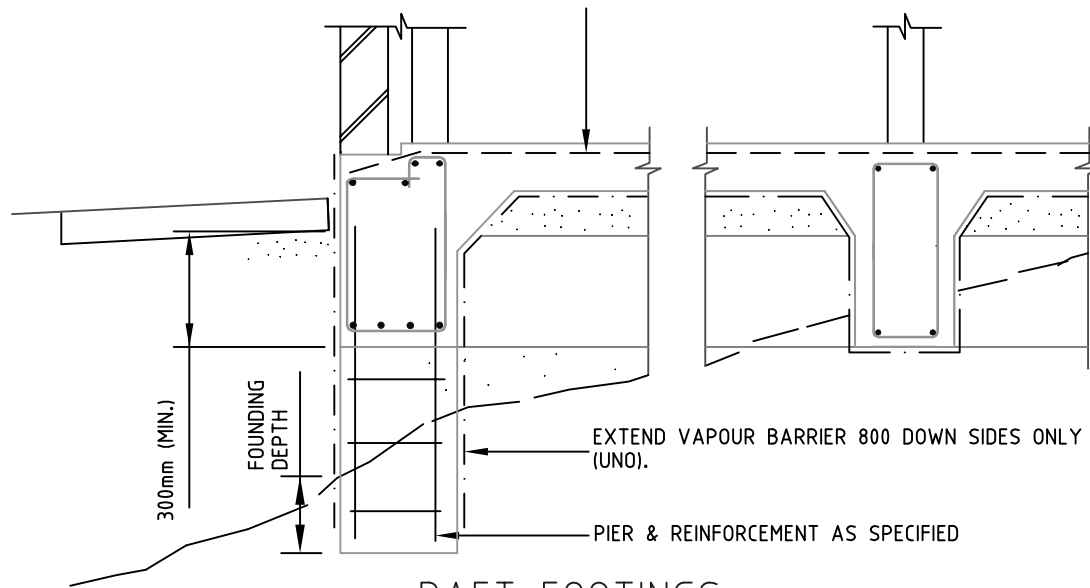


STANDARD DETAILS

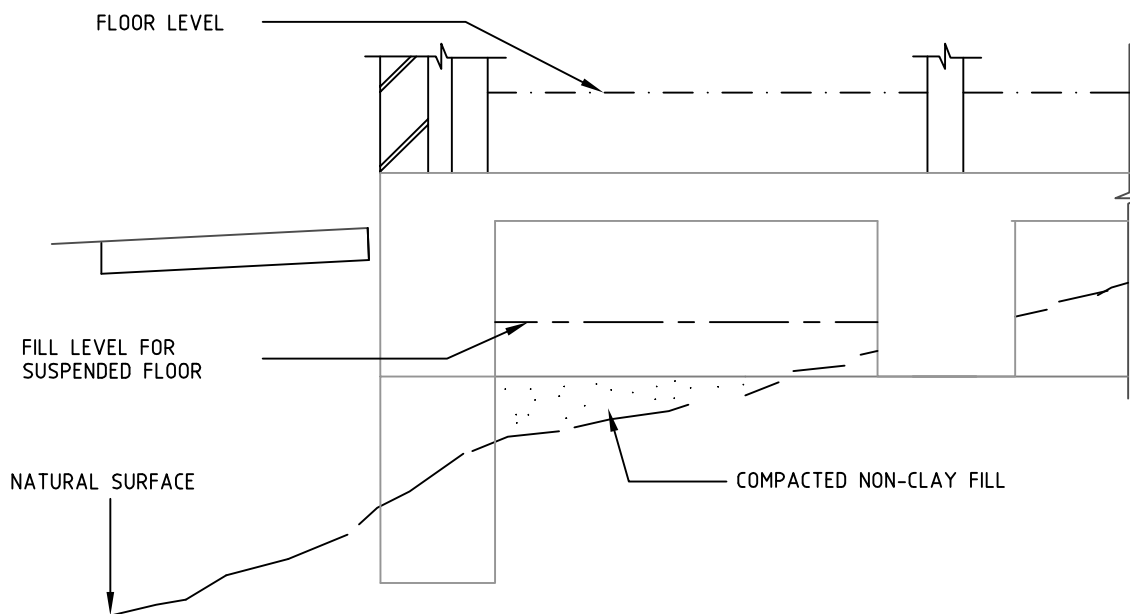
FOOTING DETAILS ON CUT & FILLED SITES

NOT TO SCALE

WHERE SLABS ARE POURED ON NON-CERTIFIED  
FILL GREATER THAN 400mm, ADOPT 125 (UNO)  
THICK SLAB REINFORCED WITH SL72 T&B (UNO).



RAFT FOOTINGS



STRIP FOOTINGS

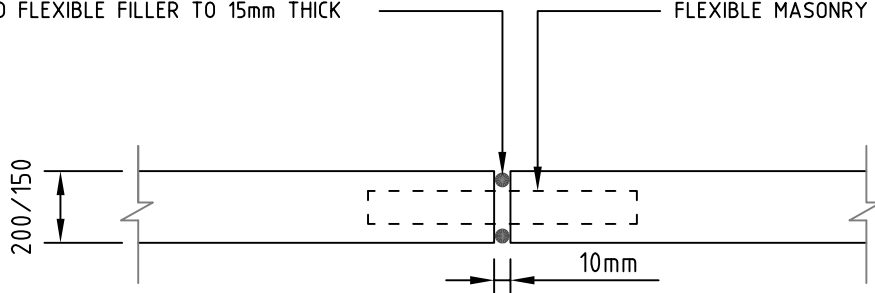
NOTES

1. TRENCHED/BORED PIERS GREATER THAN 1000 DEEP BELOW FOOTING LEVEL MUST BE POURED AT LEAST 24 HOURS PRIOR TO MAIN POUR.
2. PIERS GREATER THAN 1000 DEEP MUST BE REINFORCED WITH 6N12 VERTICAL RODS (UNO).
3. SPACING OF LIGATURES BETWEEN PIERS TO BE REDUCED TO 300C/C (UNO).

NOT TO SCALE

FILL JOINT WITH BACKING ROD & MASTIC OR AN APPROVED FLEXIBLE FILLER TO 15mm THICK

FLEXIBLE MASONRY ANCHORS



## ARTICULATION JOINT DETAIL IN AAC BLOCK WALL

APPROVED WATER-PROOF SEALANT

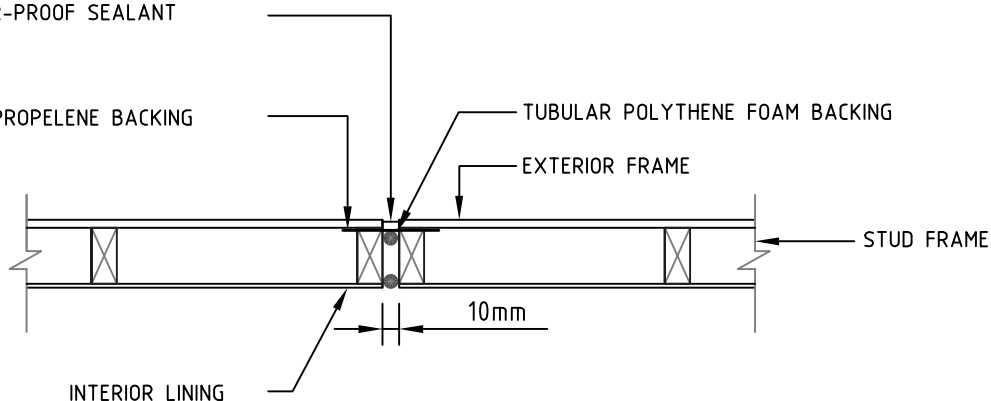
POLYPROPELENE BACKING

TUBULAR POLYTHENE FOAM BACKING

EXTERIOR FRAME

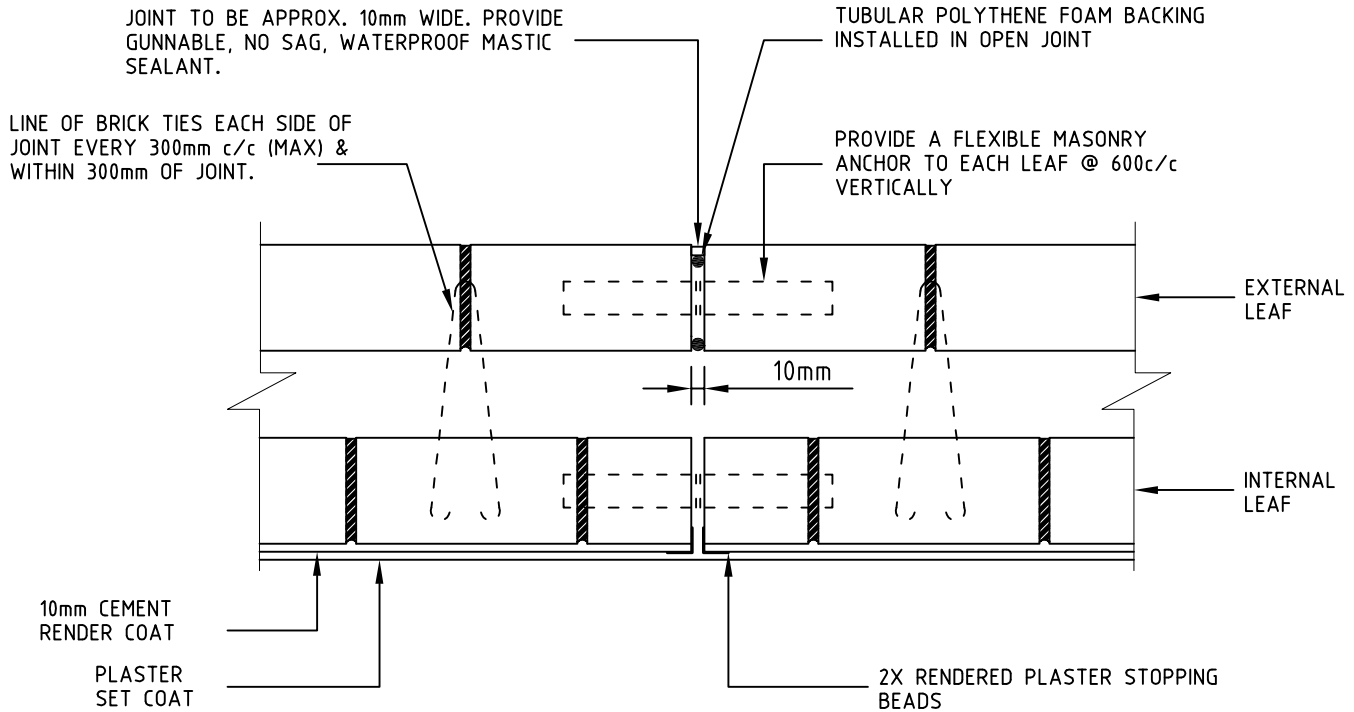
STUD FRAME

INTERIOR LINING

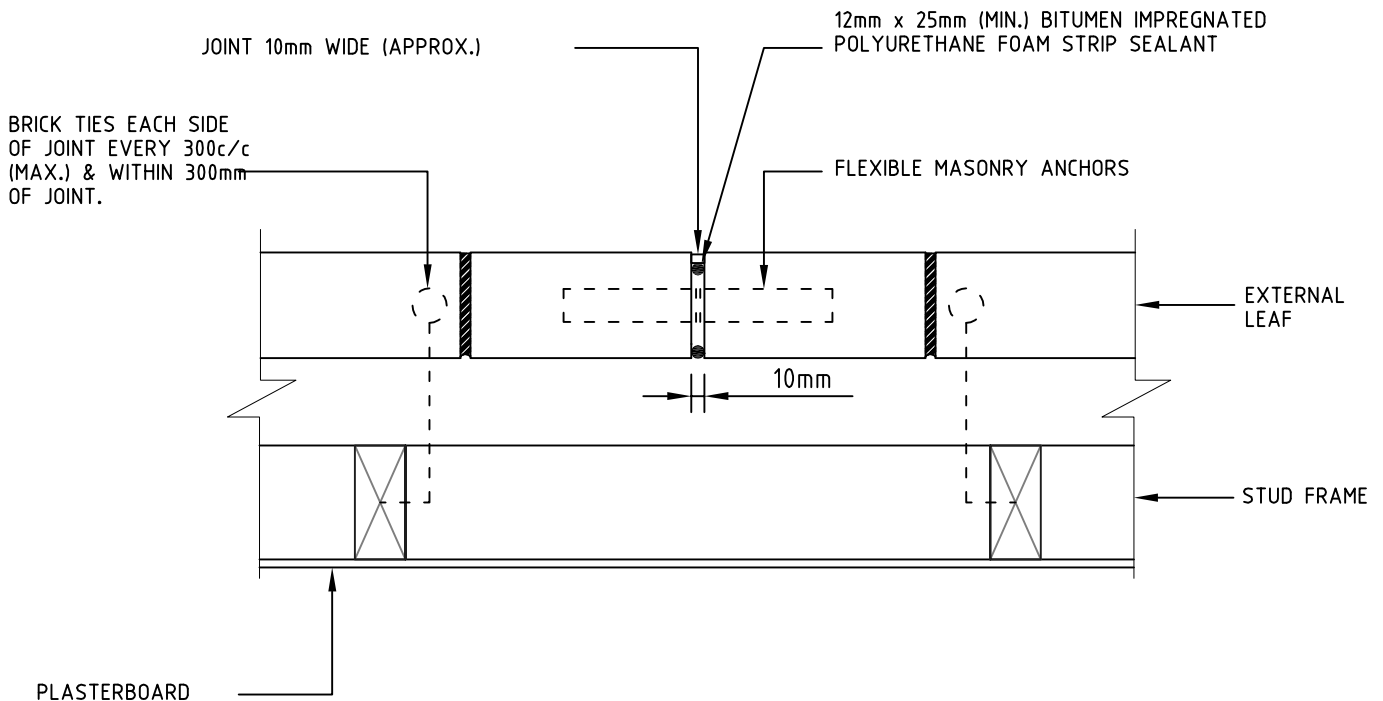


## LIGHTWEIGHT WALL CONSTRUCTION

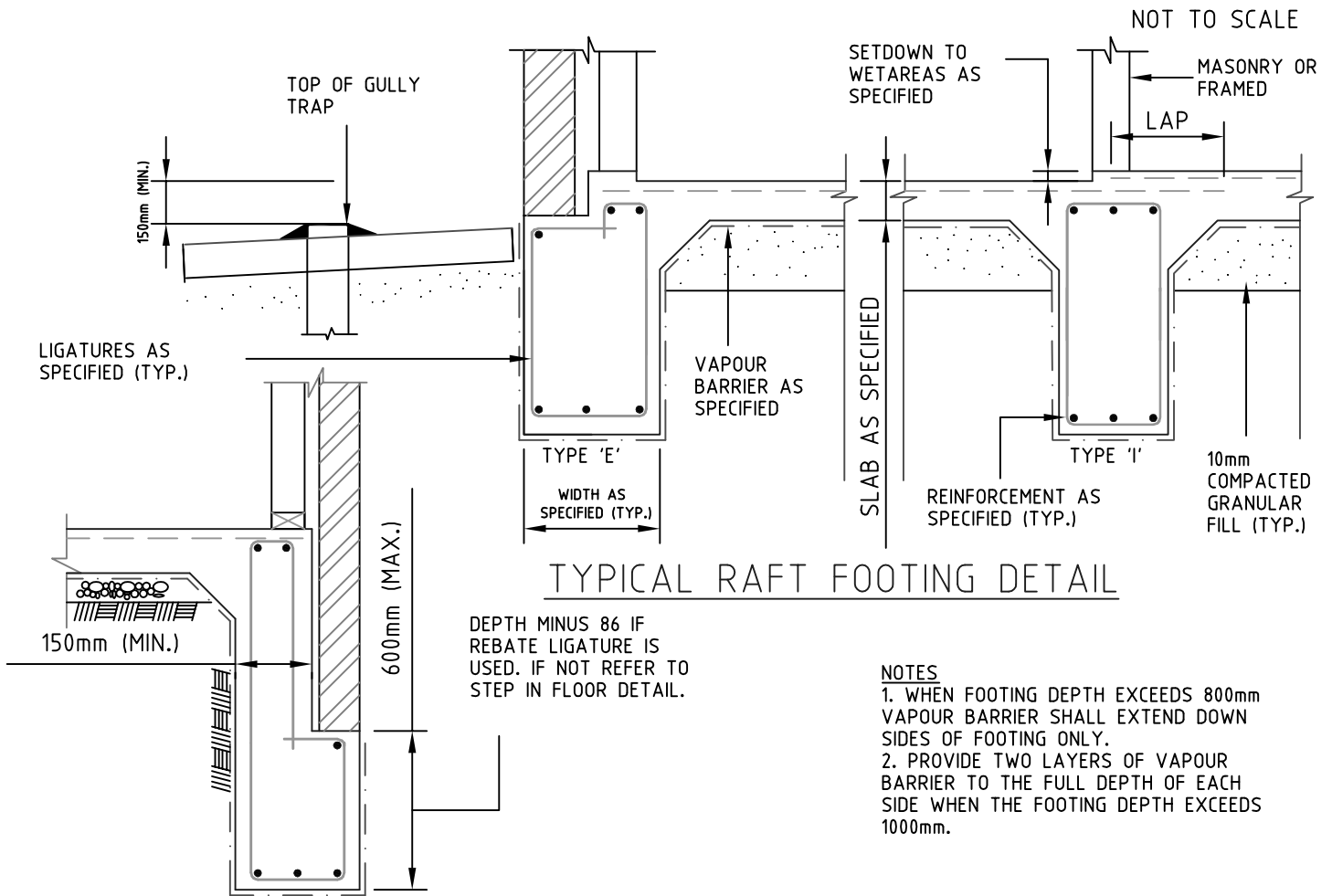
NOT TO SCALE



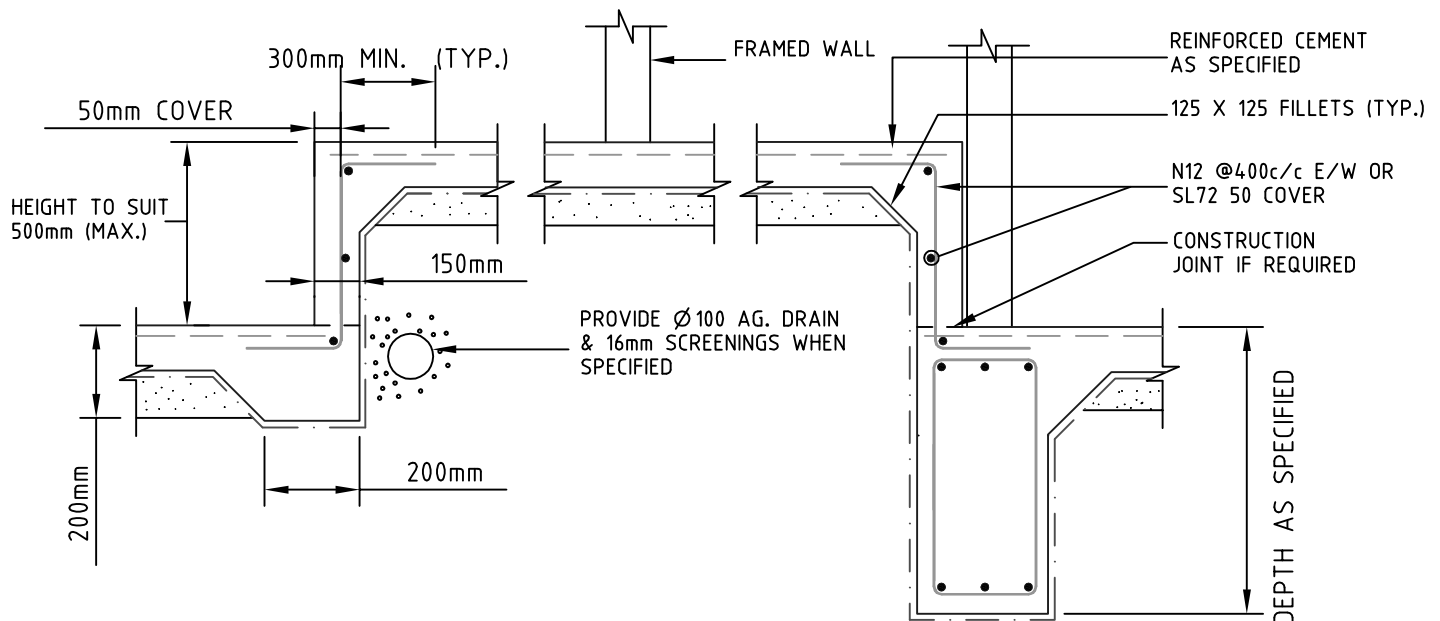
## SOLID MASONRY CONSTRUCTION



## MASONRY VENEER CONSTRUCTION



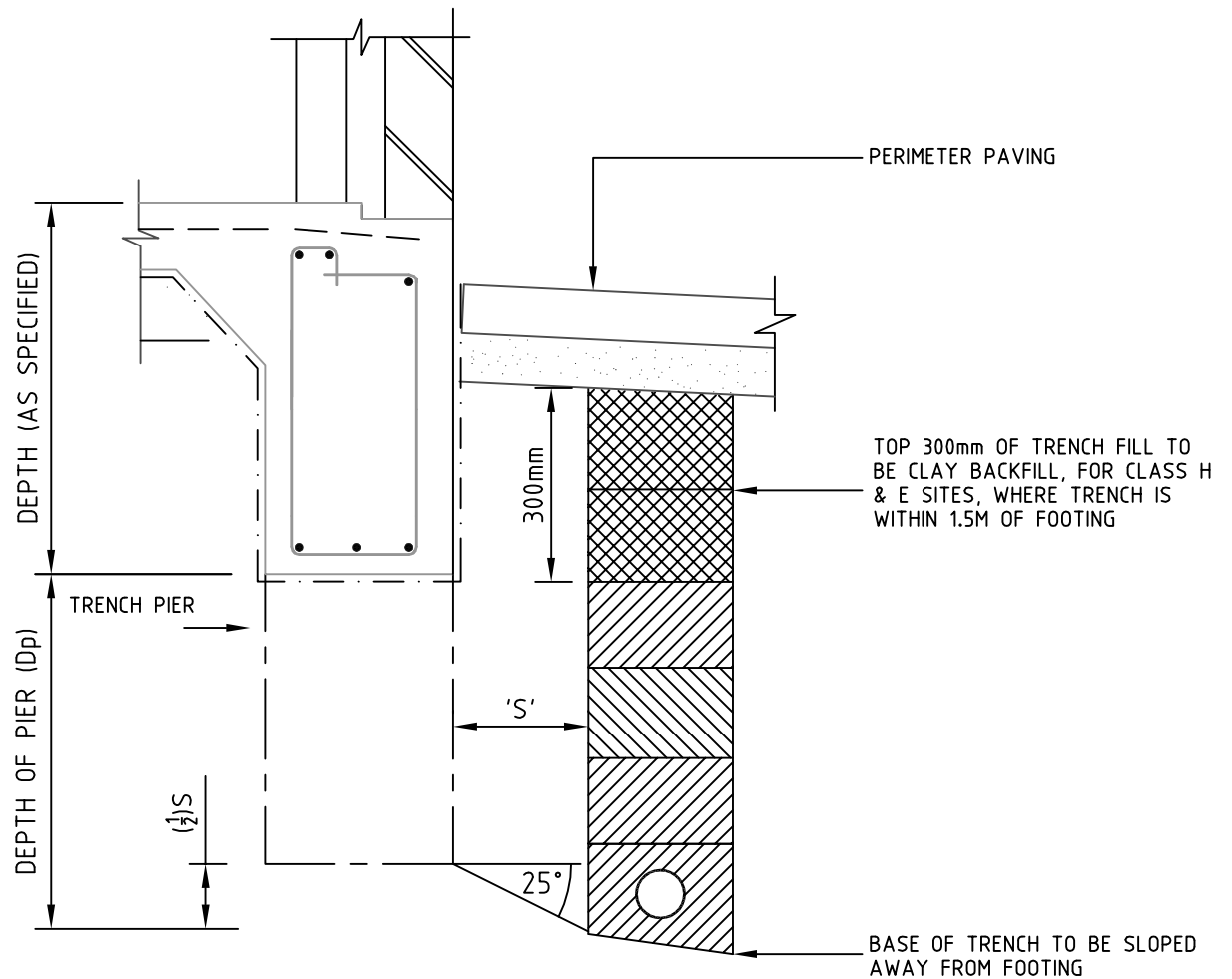
**DEEP EDGE REBATE DETAIL**



**STEPS IN FLOORS**



NOT TO SCALE

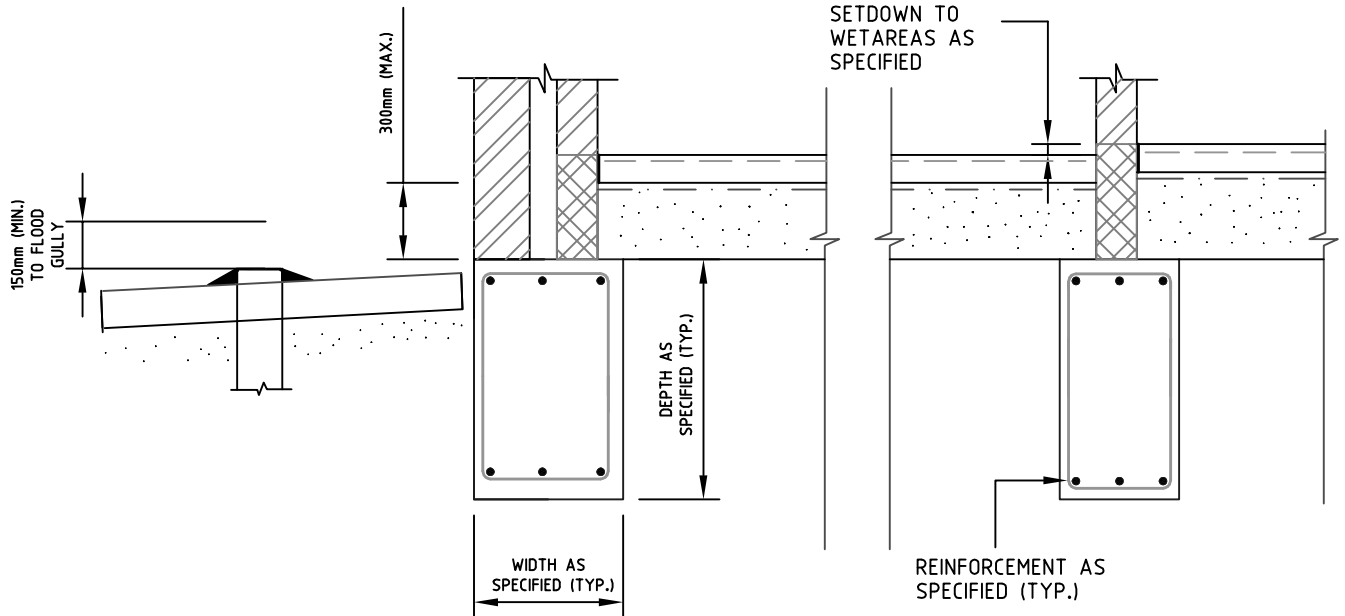


## FOOTING REQUIREMENTS ADJACENT PIPE TRENCHES

### NOTES

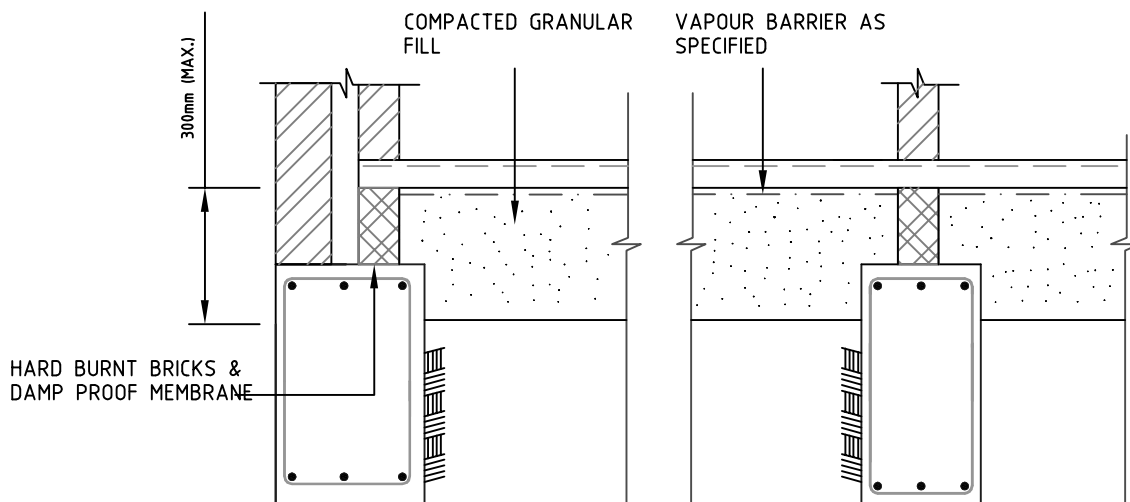
1. WHEN THE DEPTH 'Dp' EXCEEDS DISTANCE  $(\frac{1}{2})S$  PROVIDE A MINIMUM OF 1000 LONG MASS CONCRETE PIERS. PIERS TO BE THE WIDTH OF THE FOOTING BEAM SPACED AT 3000 (MAX.) CENTRES TO THE DEPTH AS SHOWN. SPACING OF LIGATURES IN THE FOOTING BEAMS MUST BE REDUCED TO 300c/c BETWEEN PIERS.
2. ALTERNATIVELY, THE TRENCH MAY BE BACKFILLED WITH GRANULAR MATERIAL (NON CLAY) IN 150mm (MAX.) LAYERS. EACH LAYER MUST BE COMPACTED TO A DENSITY OF 95% IN ACCORDANCE WITH AS 1289.

NOT TO SCALE



NOTE: NOT RECOMMENDED ON CLASS H & E SITES UNLESS NOTED OTHERWISE FOR CARPORTS.

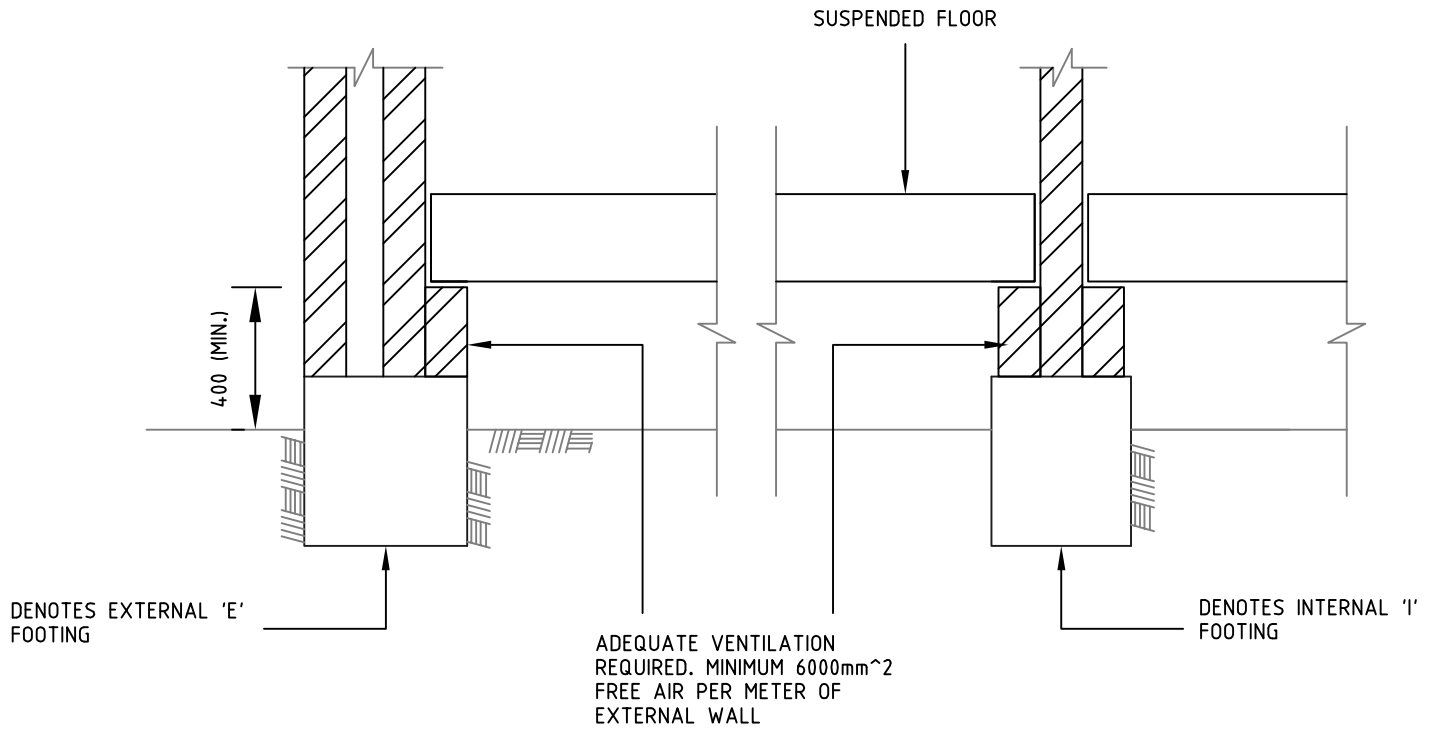
## FLOATING SLAB DETAIL



NOTE: NOT RECOMMENDED ON CLASS H & E SITES.

## SLAB POURED AFTER BRICK BUILD-UP

NOT TO SCALE



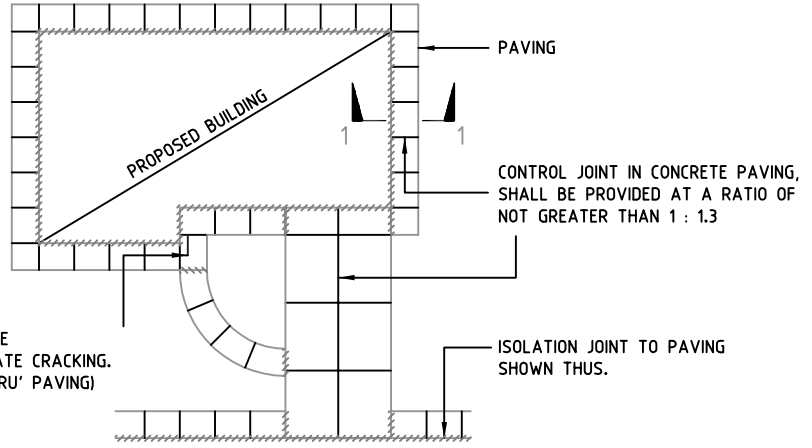
SUSPENDED FLOOR

NOTES

1. PAVING MUST NOT BRIDGE THE DAMP PROOF MEMBRANE (DPM).
2. PAVING SHALL BE GRADED SUFFICIENTLY TO ENSURE ALL WATER CAN DRAIN CLEAR FROM THE BUILDING
3. PROVIDE EDGE DRAINS WHERE NECESSARY TO DIVERT RUNOFF CLEAR OF THE BUILDING
4. REFER TO CRG (SECTION 6) FOR PAVING SPECIFICATIONS INCLUDING FALLS, THICKNESSES AND REINFORCEMENT
5. PROVIDE TERMITE PROTECTION TO AS 3660.1

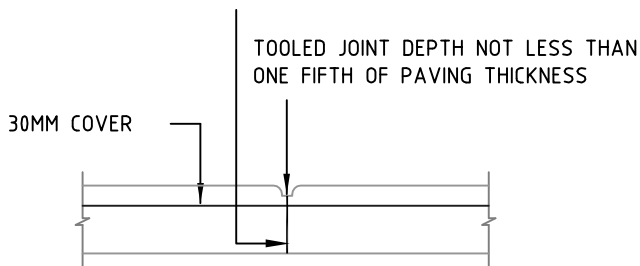
NOT TO SCALE

PROVIDE N12 TRIMMING BAR WHERE NO JOINT PROVIDED TO ACCOMMODATE CRACKING. (ALSO AROUND PENETRATIONS THRU' PAVING)

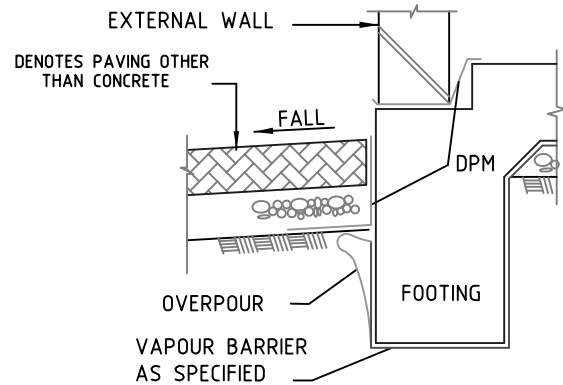


ENSURE THAT WEAKNESS IS FORMED ALONG LINE OF JOINT BY CHOPPING OR FORCING TROWEL THROUGH CONCRETE ALONG LINE TO SEPARATE CONCRETE AGGREGATES

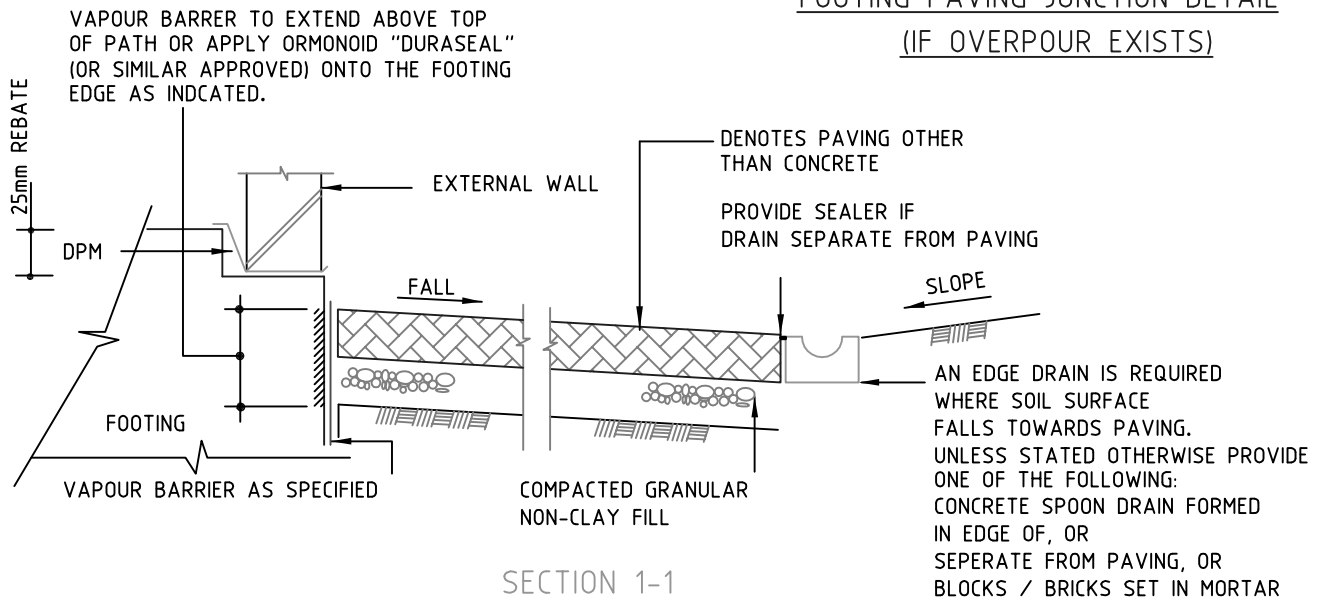
PLAN OF PAVING AROUND BUILDING



SECTION THROUGH CONTROL IN CONCRETE PAVING



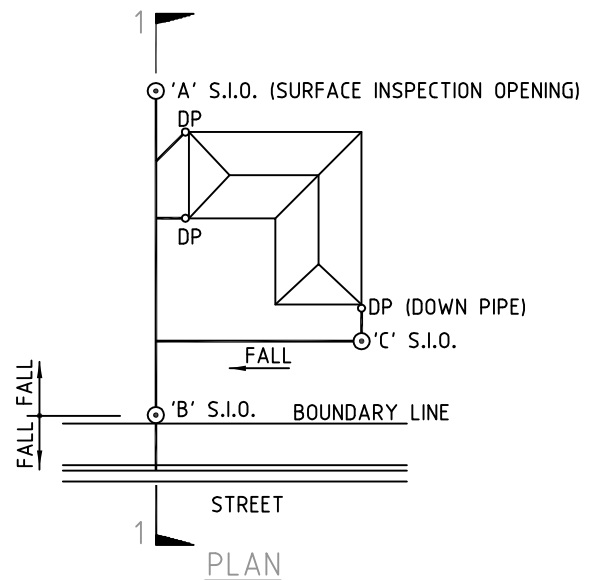
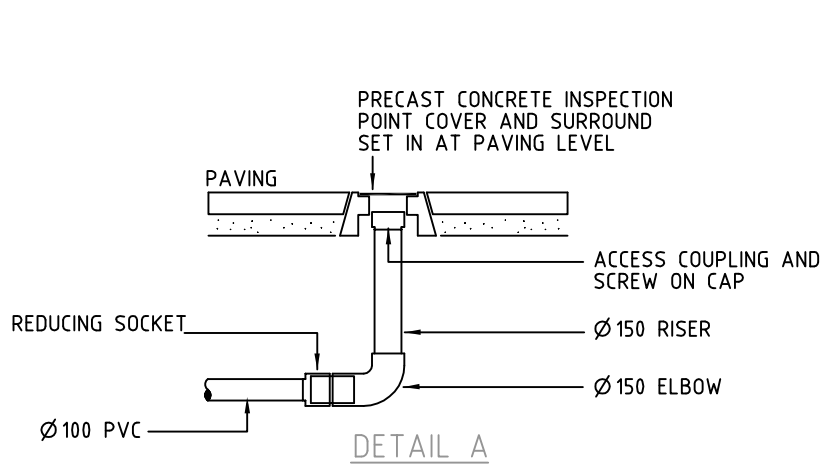
FOOTING PAVING JUNCTION DETAIL (IF OVERPOUR EXISTS)



SECTION 1-1

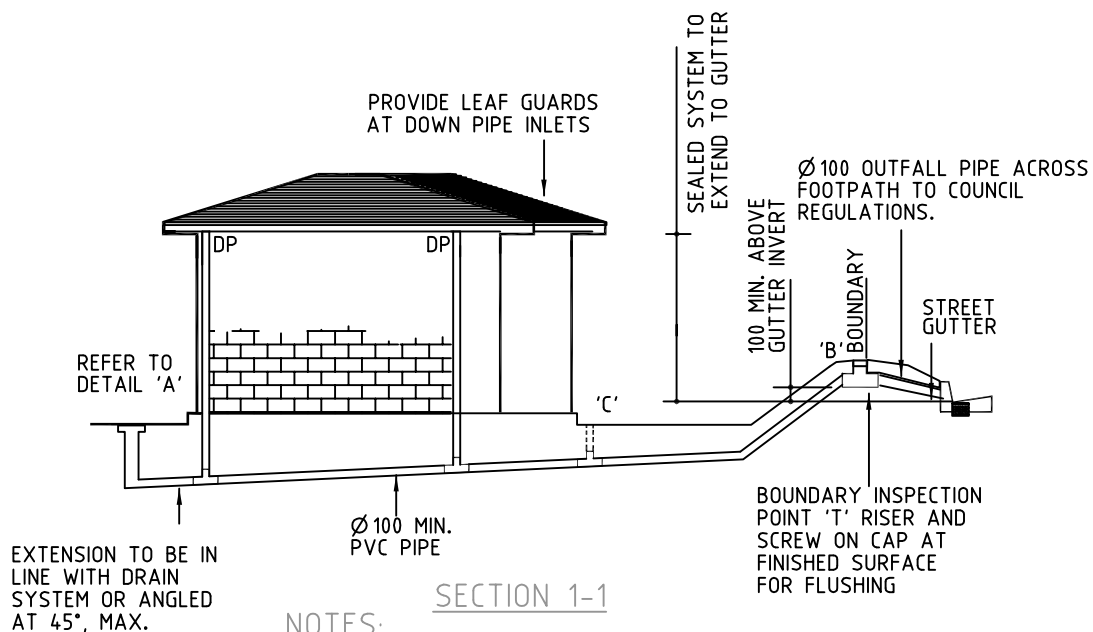
FOOTING PAVING JUNCTION DETAIL

NOT TO SCALE



NOTES:

'C' DENOTES RISER AND SCREW ON INSPECTION CAP AT FINISH SURFACE LEVEL  
OR CLEANING EYE IN DOWNPIPE FOR RODDING (AND / OR FLUSHING) PURPOSES  
AT 'DEAD END' BRANCHES  
STORMWATER PIPES TO HAVE A MIN. FALL OF 1.0% (1 IN 100)



NOTES:

1. DO NOT USE SEAMED SHEET METAL DOWN PIPES OR FITTINGS WITH A PRESSURISED SYSTEM.
2. NO SURFACE INLETS (SUMPS OR GRATED INLET PITS) PERMITTED INTO SEALED SYSTEM
3. SEALED SYSTEM TO BE CONSTRUCTED TO PRESSURE LINE STANDARD (SOLVENT WELDED JOINTS FOR PVC PIPES) STATIC TESTED BEFORE BACKFILLING.
4. FLUSHING AND MAINTENANCE IS THE RESPONSIBILITY OF THE OWNER

## DOMESTIC SEALED DRAINAGE SYSTEM (PRESSURISED)

## STORMWATER PUMP DESIGN

Project 50-52 Windsor Street,  
Magill

Page CC1/B  
Job No. 171014  
Date SEP '18  
Eng BM

Design for 1:100 ARI -  $i = 137 \text{ mm/hr}$  (10 minute duration)

Total Site Area,  $A = 572 \text{ m}^2$  (Excluding Roof Area)

### Post-Development

Impervious Area -  $A_i = 388 \text{ m}^2$   $C_i = 0.9$   
Pervious Area -  $A_p = 184 \text{ m}^2$   $C_p = 0.1$   
 $C_n = [(C_i \times A_i) + (C_p \times A_p)]/A$   
 $C_n = 0.64$

Flow Rate -  $Q_{20} = (C_n \times i \times A)/3600$   
 **$Q_{20} = 13.99 \text{ Litres/sec}$**

Volume =  $Q_{\text{Total}} \times 10\text{min} \times 60\text{sec}$   
**Volume = 8393.5 Litres**

**KP SQUARED ENGINEERING HEAVE CALCULATION**

REF: 170814  
DATE: DEC'18  
SHEET: FC1

**Heave Calculations**

Horizons	HOLE 1		HOLE 2		HOLE 3	
	Depth	lpt	Depth	lpt	Depth	lpt
1	0.30	0.005	0.10	0.005	0.20	0.005
2	1.00	0.040	0.90	0.040	0.90	0.040
3	2.00	0.030	1.60	0.030	1.70	0.030
4	2.50	0.025	1.80	0.025	2.00	0.025
5	4.00	0.020	4.00	0.025	4.00	0.025
6						
7						
8						
9						
10						
	Y <sub>s</sub> = 65.7		Y <sub>s</sub> = 73.1		Y <sub>s</sub> = 69.4	

Max. Y<sub>s</sub>= 73.1 mm      Design      Y<sub>m</sub> = 51.2 mm CH  
36.6 mm EH

Tree effects ( y / n )      Y      Change in pF at base      0.78      (If '0' ,then Y<sub>s</sub>=Y<sub>st</sub>)

HOLE 1	HOLE 2	HOLE 3
Y <sub>st</sub> = 102.5	Y <sub>st</sub> = 114.1	Y <sub>st</sub> = 110.5

Max Y<sub>st</sub>= 114.1 mm      Design      Y<sub>mt</sub> = 79.9 mm CH  
36.6 mm EH

**Use Design Y<sub>mt</sub> = Y<sub>t</sub> + Y<sub>m</sub> = 41.1 + 51.2 = 92.3 (Based on AS 2870 2011)**

Calculations are in accordance with the requirements of "AS2870 2011" as amended and the "Special provisions for the design of residential slabs and footings for South Australian conditions" issued by the I E Aust.

Notes / Comments :

**KP SQUARED ENGINEERING HEAVE CALCULATION**

REF: 170814  
DATE: DEC'18  
SHEET: FC2

**Heave Calculations**

Horizons	HOLE 4		HOLE 5		HOLE 6	
	Depth	lpt	Depth	lpt	Depth	lpt
1	0.10	0.005	0.30	0.005	0.60	0.020
2	0.80	0.040	1.00	0.040	0.80	0.005
3	1.80	0.030	1.30	0.025	1.30	0.040
4	2.40	0.025	4.00	0.025	1.65	0.030
5	4.00	0.025			1.80	0.025
6					4.00	0.025
7						
8						
9						
10						
	Y <sub>s</sub> = 72.9		Y <sub>s</sub> = 63.6		Y <sub>s</sub> = 60.7	

Max. Y<sub>s</sub>= 72.9 mm      Design      Y<sub>m</sub> = 51.0 mm CH  
36.4 mm EH

Tree effects ( y / n )      Y      Change in pF at base      0.78      (If '0' ,then Y<sub>s</sub>=Y<sub>st</sub>)

HOLE 4	HOLE 5	HOLE 6
Y <sub>st</sub> = 114.0	Y <sub>st</sub> = 103.8	Y <sub>st</sub> = 101.0

Max Y<sub>st</sub>= 114.0 mm      Design      Y<sub>mt</sub> = 79.8 mm CH  
36.4 mm EH

**Use Design Y<sub>mt</sub> = Y<sub>t</sub> + Y<sub>m</sub> = 41.2 + 51.1 = 92.2 (Based on AS 2870 2011)**

Calculations are in accordance with the requirements of "AS2870 2011" as amended and the "Special provisions for the design of residential slabs and footings for South Australian conditions" issued by the I E Aust.

Notes / Comments :



**KP SQUARED ENGINEERING HEAVE CALCULATION**

REF: 170814  
DATE: DEC'18  
SHEET: FC3

**Heave Calculations**

	HOLE 7		HOLE 8		HOLE 9	
Horizons	Depth	lpt	Depth	lpt	Depth	lpt
1	0.20	0.005	0.20	0.005	0.20	0.005
2	0.70	0.040	0.70	0.040	0.70	0.040
3	1.20	0.025	1.00	0.025	1.00	0.025
4	1.60	0.030	1.60	0.030	1.80	0.030
5	2.00	0.025	1.90	0.020	2.40	0.025
6	2.10	0.020	4.00	0.020	4.00	0.020
7	4.00	0.020				
8						
9						
10						
	Y <sub>s</sub> = 61.9		Y <sub>s</sub> = 61.4		Y <sub>s</sub> = 64.5	

Max. Y<sub>s</sub>= 64.5 mm      Design      Y<sub>m</sub> = 45.2 mm CH  
32.3 mm EH

Tree effects ( y / n )      Y      Change in pF at base      0.60      (If '0', then Y<sub>s</sub>=Y<sub>st</sub>)

HOLE 7	HOLE 8	HOLE 9
Y <sub>st</sub> = 88.2	Y <sub>st</sub> = 87.4	Y <sub>st</sub> = 92.0

Max Y<sub>st</sub>= 92.0 mm      Design      Y<sub>mt</sub> = 64.4 mm CH  
32.3 mm EH

**Use Design Y<sub>mt</sub> = Y<sub>t</sub> + Y<sub>m</sub> = 27.5 + 45.2 = 72.7 (Based on AS 2870 2011)**

Calculations are in accordance with the requirements of "AS2870 2011" as amended and the "Special provisions for the design of residential slabs and footings for South Australian conditions" issued by the I E Aust.

Notes / Comments :

**KP SQUARED ENGINEERING HEAVE CALCULATION**

REF: 170814  
DATE: DEC'18  
SHEET: FC4

**Heave Calculations**

	HOLE 10		HOLE 11		HOLE 12	
Horizons	Depth	lpt	Depth	lpt	Depth	lpt
1	0.50	0.005	0.50	0.010	0.30	0.010
2	0.70	0.005	0.70	0.005	0.45	0.005
3	1.60	0.040	1.80	0.040	1.20	0.040
4	2.00	0.030	2.10	0.025	1.70	0.025
5	2.30	0.025	4.00	0.025	2.00	0.025
6	2.50	0.020			4.00	0.025
7	4.00	0.020				
8						
9						
10						
	Y <sub>s</sub> = 55.4		Y <sub>s</sub> = 61.1		Y <sub>s</sub> = 62.3	

Max. Y<sub>s</sub>= 62.3 mm      Design      Y<sub>m</sub> = 43.6 mm CH  
31.1 mm EH

Tree effects ( y / n )      Y      Change in pF at base      0.60      (If '0' ,then Y<sub>s</sub>=Y<sub>st</sub>)

HOLE 10	HOLE 11	HOLE 12
Y <sub>st</sub> = 83.5	Y <sub>st</sub> = 93.5	Y <sub>st</sub> = 93.4

Max Y<sub>st</sub>= 93.5 mm      Design      Y<sub>mt</sub> = 65.5 mm CH  
31.1 mm EH

**Use Design Y<sub>mt</sub> = Y<sub>t</sub> + Y<sub>m</sub> = 32.5 + 43.6 = 76.1 (Based on AS 2870 2011)**

Calculations are in accordance with the requirements of "AS2870 2011" as amended and the "Special provisions for the design of residential slabs and footings for South Australian conditions" issued by the I E Aust.

Notes / Comments :

**KP SQUARED ENGINEERING HEAVE CALCULATION**

REF: 170814  
DATE: DEC'18  
SHEET: FC5

**Heave Calculations**

	HOLE 13					
Horizons	Depth	lpt	Depth	lpt	Depth	lpt
1	0.45	0.010				
2	0.55	0.005				
3	1.00	0.040				
4	1.40	0.025				
5	1.65	0.030				
6	1.80	0.025				
7	4.00	0.025				
8						
9						
10						
	Y <sub>s</sub> =	57.7	Y <sub>s</sub> =	0.0	Y <sub>s</sub> =	0.0

Max. Y<sub>s</sub>= 57.7 mm      Design      Y<sub>m</sub> = 40.4 mm CH  
28.9 mm EH

Tree effects ( y / n )      Y      Change in pF at base      0.60      (If '0' ,then Y<sub>s</sub>=Y<sub>st</sub>)

HOLE 13	0	0
Y <sub>st</sub> = 88.4	Y <sub>st</sub> = 0.0	Y <sub>st</sub> = 0.0

Max Y<sub>st</sub>= 88.4 mm      Design      Y<sub>mt</sub> = 61.9 mm CH  
28.9 mm EH

**Use Design Y<sub>mt</sub> = Y<sub>t</sub> + Y<sub>m</sub> = 30.7 + 40.5 = 71.1 (Based on AS 2870 2011)**

Calculations are in accordance with the requirements of "AS2870 2011" as amended and the "Special provisions for the design of residential slabs and footings for South Australian conditions" issued by the I E Aust.

Notes / Comments :

**FOOTING COMPUTATIONS**

SITE : 50-52 WINDSOR STREET, MAGILL

Ref.: 170814

Date: DEC'18

Design: MH

PAGE: FC6

**DESIGN ASSUMPTIONS**

(1) Building Construction : Double Storey ▼

Walls: Masonry Veneer ▼

Roof: Sheeted ▼

(2)  $D_{\text{Allowable}}$  : L/600 < 20mm(3)  $m = 1.5L/a$ **DESIGN RECTANGLE A**

Length (L1) 13.84 m

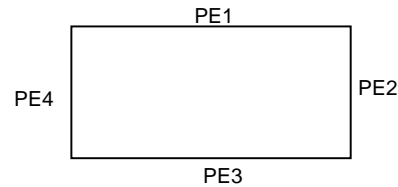
Width (L2) 7.94 m

Beams Parallel to L1 3

Beams Parallel to L2 5

Area of Beams 0.30

Assumed Beam Size 300 x 1000 ▼

**LOADING**

<b>Udl</b>	100 Ground Slab	0	kPa
	Live Load	1.5	kPa
	Finishes, Partitions	1	kPa
	Internal Footings	0.00	kPa
	<b>Total</b>	<b>2.5</b>	<b>kPa</b>

**Edge Loading**

PE1	External Wall: Veneer	2.7 x 2.4 kPa	6.48	kN/m
	External Wall: Hebel	2.7 x 1.0 kPa	2.7	kN/m
	Roof: Sheeted	4 x 0.4 kPa	1.6	kN/m
	Floor: Timber	4 x 1.55 kPa	6.2	kN/m
	Footing Self Weight		0	kN/m
	Total		17.0	kN/m
PE2	External Wall: Veneer	2.7 x 2.4 kPa	6.48	kN/m
	External Wall: Hebel	2.7 x 1.0 kPa	2.7	kN/m
	Roof Sheeted	2.7 x 0.4 kPa	1.08	kN/m
	Floor Timber	2.7 x 1.55 kPa	4.185	kN/m
	Footing Self Weight		0	kN/m
	Total		14.4	kN/m
PE3	External Wall: Veneer	2.7 x 2.4 kPa	6.48	kN/m
	External Wall: Hebel	2.7 x 1.0 kPa	2.7	kN/m
	Roof: Sheeted	4 x 0.4 kPa	1.6	kN/m
	Floor: Timber	4 x 1.55 kPa	6.2	kN/m
	Footing Self Weight		0	kN/m
	Total		17.0	kN/m
PE4	External Wall: Veneer	2.7 x 2.4 kPa	6.48	kN/m
	External Wall: Hebel	2.7 x 2.4 kPa	6.48	kN/m
	Roof Sheeted	2.7 x 0.4 kPa	1.08	kN/m
	Floor Timber	2.7 x 1.55 kPa	4.185	kN/m
	Footing Self Weight		0	kN/m
	Total		18.2	kN/m

Checked.....

Date...../...../.....

## INPUT DATA

Footings Analysis by: **SLOG**

PAGE NO.: FC7

Site: 50-52 WINDSOR STREET, MAGILL  
Reference: 170814  
Date: 13/12/2018

### Structure geometry

Length of Structure L:	13.84 m
Breadth of Structure:	7.94 m
No. beams parallel to Long Span:	3
No. beams parallel to Short Span:	5
Deflection Ratio $\Delta/L$ :	400
Maximum Allowable Deflection $\Delta$ :	30 mm
Depth Footing not Embedded:	0.2 m

### Soil Properties

Soil Heave $Y_m$ :	92 mm
Depth of suction change $H_s$ :	4 m
Mound stiffness $k$ :	1642 kPa/m

### Structure loads

Edge Load on West End:	14.4 kN/m
Edge Load on East End:	14.4 kN/m
Edge Load on North Side:	17 kN/m
Edge Load on South Side:	17 kN/m
North-South Centre Load:	0 kN/m
East-West Centre Load:	0 kN/m
Uniform distributed load:	2.5 kPa

### Raft Footing Properties

Sub-Beam Width	300 mm
Top Concrete Cover:	50 mm
Bottom Concrete Cover:	50 mm
Slab Thickness:	100 mm
Area Slab Steel:	179 mm <sup>2</sup> /m
Steel Grade $f_{sy}$ :	500 MPa
Concrete Compressive Strength $f'_c$ :	20 MPa
Concrete Tensile Strength Hogging:	1.8 MPa
Concrete Tensile Strength Sagging:	2.7 MPa
Young's Modulus of Concrete:	15000 MPa
Requested $\mu_u/\mu_{cr}$ Ratio Hogging:	1.5
Requested $\mu_u/\mu_{cr}$ Ratio Sagging:	1.2

### Additional Properties

Soil Edge Heave:	37 mm
Beam Side Friction:	0 kPa

**OUTPUT - Raft Footing**Footing Analysis by: **SLOG**

PAGE NO.: FC8

Site: 50-52 WINDSOR STREET, MAGILL

Reference: 170814

Date: 13/12/2018

**Required Capacities per Beam**

	Long Span		Short Span	
Centre Heave				
Ultimate Negative Moment:	-406.1	kNm	-338.8	kNm
Ultimate Positive Moment:	0.0	kNm	0.0	kNm
Max Shear:	99.8	kN	-101.9	kN
Required Stiffness:	228.397	MNm <sup>2</sup>	84.583	MNm <sup>2</sup>
Edge Heave				
Ultimate Negative Moment:	-6.5	kNm	-10.6	kNm
Ultimate Positive Moment:	0.6	kNm	0.8	kNm
Max Shear:	-5.6	kN	28.2	kN
Required Stiffness:	2.647	MNm <sup>2</sup>	2.768	MNm <sup>2</sup>

**RAFT REQUIREMENTS**

Sub-beams:	300	mm wide x	1070	mm deep
Slab:	100	mm	179	mm <sup>2</sup> /m
Subbeam top bars:	634	mm <sup>2</sup>		
Subbeam bottom bars:	467	mm <sup>2</sup>		
Concrete:	20	MPa		

**Actual Capacities per Beam**

	Centre Heave		Edge Heave	
Sub-beam depth:	1070	mm	1070	mm
Minimum top bars	634	mm <sup>2</sup>		
Minimum bottom bars			467	mm <sup>2</sup>
Ultimate Moment Mu:	406.1	kNm	236.4	kNm
Cracking Moment M <sub>cr</sub> :	187.3	kNm	195.3	kNm
Mu/M* =	1.25		375.80	
Mu/M <sub>cr</sub> =	2.17		1.21	
Stiffness:	229.707	MNm <sup>2</sup>	684.982	MNm <sup>2</sup>

### FLOOR BEAMS FB1-FB3

CALCULATE UNIFORM LOADS;

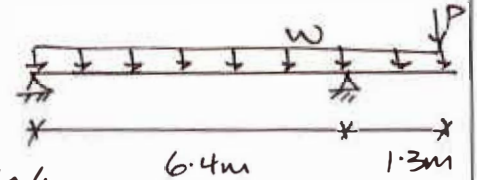
- DL → sheet roof =  $0.4 \text{ kPa} \times 3.5 \text{ m} = 1.4 \text{ kN/m}$   
 → hebel wall =  $1.5 \text{ kPa} \times 3 \text{ m} = 4.5 \text{ kN/m}$   
 → timber floor =  $0.6 \text{ kPa} \times 3 \text{ m} = 1.8 \text{ kN/m}$   
 → snt =  $0.3 \text{ kN/m}$

$$\underline{DL = 8 \text{ kN/m}}$$

- UL → roof =  $0.75 \text{ kPa} \times 3.5 \text{ m} = 0.9 \text{ kN/m}$   
 → floor =  $1.5 \text{ kPa} \times 3 \text{ m} = 4.5 \text{ kN/m}$

$$\underline{UL = 5.4 \text{ kN/m}}$$

$$W = 13.4 \text{ kN/m} \quad u^* = 17.7 \text{ kN/m}$$



CALCULATE POINT LOAD;

- DL → sheet roof =  $0.4 \text{ kPa} \times 3 \text{ m} = 1.2 \text{ kN/m}$   
 → hebel wall =  $1.5 \text{ kPa} \times 3 \text{ m} = 4.5 \text{ kN/m}$   
 → timber floor =  $0.6 \text{ kPa} \times 1 \text{ m} = 0.6 \text{ kN/m}$   
 → snt =  $0.1 \text{ kN/m}$

$$\underline{DL = 6.4 \text{ kN/m}}$$

- UL → roof =  $0.75 \text{ kPa} \times 3 \text{ m} = 0.75 \text{ kN/m}$   
 → floor =  $1.5 \text{ kPa} \times 1 \text{ m} = 1.5 \text{ kN/m}$

$$\underline{UL = 2.3 \text{ kN/m}}$$

P. T. D

$$w = 8.7 \text{ kN/m} \quad w^* = 11.1 \text{ kN/m}$$

$$P = 20 \text{ kN} \quad P^* = 25.5 \text{ kN}$$

DESIGN FOR SIMPLE SPAN THEN CHECK CANTILEVER.

$$M^* = 90.6 \text{ kNm}$$

$$I_x > (L_{300}) 68.6 \times 10^6 \text{ mm}^4$$

$$\rightarrow \text{try } 310 \text{ UK } 46 \quad (I_x = 100 \times 10^6 \text{ mm}^4)$$

$$\phi M_b = \phi M_s = 197 \text{ kNm} > M^*$$

$$\delta_{all} (L_{300}) = 21.3 \text{ mm}$$

$$\delta_{max} = 14.6 \text{ mm}$$

$\rightarrow$  CHECK  
ADOPT CANTILEVER.

$$M^* = 48.1 \text{ kNm} < \phi M_b / \phi M_s$$

$$\delta_{all} (L_{300}) = 4.3 \text{ mm}$$

$$\delta_{max} = 1 \text{ mm}$$

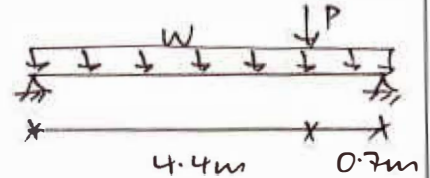
$\rightarrow$  ADOPT 310 UK 46.



LINTELS LI-L3

SPAN = 5,100 mm

$P = 74.2 \text{ kN}$   $P^* = 96.4 \text{ kN}$ .



CALCULATE UNIFORM LOADS;

DL  $\rightarrow$  masonry =  $4.4 \text{ kPa} \times 0.6 \text{ m} = 2.6 \text{ kNm}$ .

$\rightarrow$  surf =  $0.3 \text{ kNm}$ .

DL = 2.9 kNm.

$W = 2.9 \text{ kNm}$   $W^* = 3.5 \text{ kNm}$ .

$M^* = 65.6 \text{ kNm}$ .

$\rightarrow$  try 250 PFC ( $I_x = 45.1 \times 10^6 \text{ mm}^4$ )

$\phi M_b = \phi M_s = 114 \text{ kNm} > M^*$

$\delta_{all} (L_{500}) = 10.2 \text{ mm}$ .

$\delta_{max} = 7.9 \text{ mm}$

$\rightarrow$  ADOPT 250 PFC.

LINTEL L4

SPAN = 2,500 mm

$P = 61.6 \text{ kN}$   $P^* = 81.4 \text{ kN}$

CALCULATE UNIFORM LOAD;

$w = 2.9 \text{ kN/m}$   $w^* = 3.5 \text{ kN/m}$

$M^* = 24.2 \text{ kNm}$

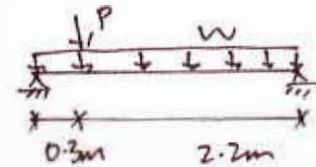
$\rightarrow$  try  $\begin{matrix} 250 \times 12 \\ \text{I} \\ 200 \times 10 \end{matrix}$  ( $I_x = 35.9 \times 10^6 \text{ mm}^4$ )

$\phi M_b = 34 \text{ kNm} > M^*$

$\delta_{all} (L/500) = 5 \text{ mm}$

$\delta_{max} = 0.7 \text{ mm}$

$\rightarrow$  ADOPT  $\begin{matrix} 250 \times 12 \\ \text{I} \\ 200 \times 10 \end{matrix}$



REF : 170814

DATE: Dec'18

DESIGN: KP

PAGE: SC5

NOTES : (1) All Loadings to AS1170  
(2) All Steelwork to AS4100

**DESIGN : LINTELS, L5-L7**

Max span = 2500 mm

DL .....	Timber Cladding	0	x 6.75 kPa =	0	kN/m
	Brick Wall	0.3	x 4.4 kPa =	1.32	kN/m
	Roof Tiled	0	x 0.85 kPa =	0	kN/m
	Sheeted	4	x 0.4 kPa =	1.6	kN/m
	Floor	1	x 1.0 kPa =	1	kN/m
	Self Weight			0.4	kN/m
	<b>Total</b>			<b>4.3</b>	<b>kN/m</b>
LL.....	Roof (Area = 10 m <sup>2</sup> )			1.20	kN/m
	Domestic	0	x 1.5 kPa =	0.00	kN/m
	Balcony		x 3.0 kPa =	0	kN/m
	<b>Total</b>			<b>1.2</b>	<b>kN/m</b>

**Beam**

$$w^* = 7.20 \text{ kN/m} \quad M^* = 5.6 \text{ kNm}$$

$$I_{\text{req}} = 2.8\text{E}+6 \text{ mm}^4 \quad (I/500)$$

**INPUT DATA****Web Plate**

$$b = 200 \text{ mm}$$

$$t = 10 \text{ mm}$$

**Flange Plate**

$$b = 200 \text{ mm}$$

$$t = 10 \text{ mm}$$

$$\text{Area} = 4000 \text{ mm}^2$$

$$\text{Neu Axis} = 10 \text{ mm}$$

**MATERIAL PROPERTIES**

$$f_y = 300 \text{ MPa}$$

$$E = 200.0\text{E}+3 \text{ MPa}$$

$$G = 80.0\text{E}+3 \text{ MPa}$$

**Section Properties**

$$\bar{y} = 152.5 \text{ mm}$$

$$I_{xx} = 17.7\text{E}+6 \text{ mm}^4 \quad \text{OK!}$$

$$I_{yy} = 6.7\text{E}+6 \text{ mm}^4$$

$$Z_{x(\text{top})} = 116.1\text{E}+3 \text{ mm}^3$$

$$Z_{x(\text{bottom})} = 308.0\text{E}+3 \text{ mm}^3$$

$$I_w = 0$$

$$J = 133.3\text{E}+3 \text{ mm}^3$$

$$S = 210.0\text{E}+3 \text{ mm}^3$$

$$d_f = 205.0 \text{ mm}$$

$$\alpha = 1$$

$$y_0 = 52.5 \text{ mm}$$

$$\beta_x = -144.5$$

**Section Capacity**  $M^* < \phi M_{sx}$ 

$$M_{sx} = f_y Z_{ex}$$

$$\lambda_e = 21 \text{ 9/10}$$

$$\lambda_{ep} = 8 \quad \text{Table 5.2}$$

$$\lambda_{ey} = 22$$

$$Z_e = 116.5\text{E}+3$$

$$M_s = 34.9\text{E}+6$$

$$\phi M_s = 31.5 \text{ kNm} \quad \text{OK!}$$

$$\alpha_m = 1.13$$

$$\beta_m = 0$$

$$k_t = 1$$

$$k_f = 1$$

$$k_r = 1$$

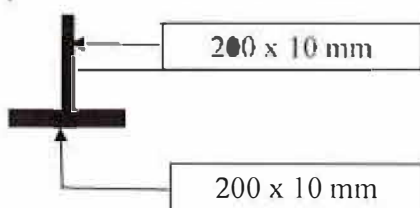
$$I_e = 2500 \text{ mm}$$

$$M_o = 61.43 \text{ kNm}$$

$$\alpha_s = 0.75$$

$$M_b = 29.7\text{E}+6$$

$$\phi M_b = 26.7 \text{ kNm} \quad \text{OK!}$$



200 x 10

**WEB PLATE**

200 x 10

**FLANGE PLATE (200 mm bearing)**

(Weld, 6 mm fillet weld, 300 mm each end, then miss 240mm weld 100 mm)

Checked.....

Date...../...../.....

FLOOR BEAMS FB4, FB5.

$$w = 13.4 \text{ kN/m} \quad w^* = 17.7 \text{ kN/m}$$

$$P = 20 \text{ kN} \quad P^* = 25.5 \text{ kN}$$

DESIGN FOR CANTILEVER (WORST CASE).

$$M^* = 119.1 \text{ kNm}$$

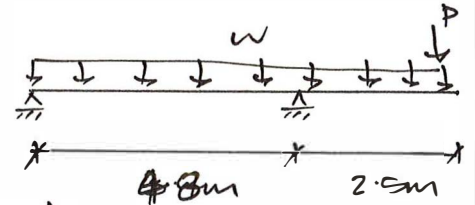
$$\text{TRY } 310 \text{ UBS } 46 \quad (I_x = 120 \times 10^6 \text{ mm}^4)$$

$$\phi M_b = \phi M_s = 197 \text{ kNm} > M^*$$

$$\delta_{all} (L/300) = 8.3 \text{ mm}$$

$$\delta_{max} = 8.5 \text{ mm} \rightarrow \text{OK FOR } 360 \text{ UBS } 57$$

→ ADOPT 360 UBS 57.





## TECHNICAL SERVICES

Soil Sampling and Logging \*Engineering Level Surveys  
Percolation Tests \*Environmental Soil Sampling \*Groundwater Wells

STS Technical Services, 8 Duncan Road, Dry Creek SA 5094  
Telephone 08 8262 9580 – Facsimile 08 8262 9579

Email: stssa.stssa.com.au ABN 68 007 952 203

### SURFACE BORE LOG

DATE: 13/11/2018

JOB NO: STS1119

CR2  
1 OF 1

DATE DRILLED: 08/11/2018

TO BE READ IN CONJUNCTION WITH BOREHOLE LOCATION PLAN

SITE: 50 WINDSOR AVENUE MAGILL SA

### VISUAL ASSESSMENT OF PROPERTIES

BORE 1	BORE 2	BORE 3	BORE 4	COLOUR	CONSISTENCY, TEXTURE & STRUCTURE	SOIL DESCRIPTION	U.S.C.	M.C.	BEAR- ING	EST Ipt (AVE)
0.00-0.30	0.00-0.10	0.00-0.20	0.00-0.10	Brown	Loose, Granular	Clayey SAND VLP	SC	B	M	0.005
0.30-1.00	0.10-0.90	0.20-0.90	0.10-0.80	Red, Brown	Hard, Granular	CLAY, Sandy HP	CH	B	M	0.040
1.00-2.00	0.90-1.60	0.90-1.70	0.80-1.80	Cream, Red, Brown	Stiff, Granular	CLAY, Sandy, Limey, Stones HP	CH	B	M	0.030
2.00-2.50	1.60-1.80	1.70-2.00	1.80-2.40	Orange, Red, Brown	Stiff, Granular	CLAY, Sandy, Limey, Gravel, Impenetrable @ Base on Gravel MHP	CL- CH/GC	B	H	0.025
2.50-3.00				Brown	Friable, Granular	CLAY, Sandy, Gravel MP	CL-GC	B	M	0.020

REMARKS:

CLASSIFICATION:

TYPE: RB3(a)

CLASSIFIER

- \*\*The classification nominated on this borelog relates to the site soil profile at the time of testing. It does not allow for future earthworks and does not incorporate any possible effects from trees, either existing or future.
- \*The calcareous clay soils present within the soil profile may lose strength upon wetting and adequate site drainage is essential.

#### REFERENCES USED:

SOIL MAPS: Soil Association Map of the Adelaide Region

#### NEARBY BORELOGS:

SAMPLE METHOD: Driven push tube using high pressure hydraulic hand-held hammer



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Telephone 08 8262 9580 – Facsimile 08 8262 9579

Email: stssa.stssa.com.au ABN 68 007 952 203

### SURFACE BORE LOG

DATE: 13/11/2018  
JOB NO: STS1119

CR2  
1 OF 1

DATE DRILLED: 08/11/2018

TO BE READ IN CONJUNCTION WITH BOREHOLE LOCATION PLAN

SITE: 50 WINDSOR AVENUE MAGILL SA

### VISUAL ASSESSMENT OF PROPERTIES

BORE 5	BORE 6	COLOUR	CONSISTENCY, TEXTURE & STRUCTURE	SOIL DESCRIPTION	U.S.C.	M.C.	BEARING	EST lpt (AVE)
	0.00-0.60	Dark Grey, Brown	Friable, Firm, Granular	(FILL) CLAY, Sandy, Minor Gravel MP	CL-GC	B/N	M	0.020
0.00-0.30	0.60-0.80	Brown	Loose, Granular	Clayey SAND VLP	SC	B	M	0.005
0.30-1.00	0.80-1.30	Red, Brown	Hard, Granular	CLAY, Sandy HP	CH	B	M	0.040
	1.30-1.65	Cream, Red, Brown	Stiff, Granular	CLAY, Sandy, Limey, Stones HP	CH	B	M	0.030
1.00-1.30	1.65-1.80	Orange, Red, Brown	Stiff, Granular	CLAY, Sandy, Limey, Gravel, Impenetrable @ Base on Gravel MHP	CL-CH/ GC	B	H	0.025

REMARKS:	CLASSIFICATION:	TYPE: RB3/AL	CLASSIFIER:
1. The classification nominated on this borelog relates to the site soil profile at the time of testing. It does not allow for future earthworks and does not incorporate any possible effects from trees, either existing or future.		<b>REFERENCES USED:</b> SOIL MAPS: Soil Association Map of the Adelaide Region <b>NEARBY BORELOGS:</b> SAMPLE METHOD: Driven push tube using high pressure hydraulic hand-held hammer	



## TECHNICAL SERVICES

Soil Sampling and Logging \*Engineering Level Surveys  
Percolation Tests \*Environmental Soil Sampling \*Groundwater Wells

STS Technical Services, 8 Duncan Road, Dry Creek SA 5094  
Telephone 08 8262 9580 – Facsimile 08 8262 9579

Email: stssa.stssa.com.au ABN 68 007 952 203

### SURFACE BORE LOG

DATE: 05/11/2018  
JOB NO: STS1119

CR2  
1 OF 1

DATE DRILLED: 30/10/2018

TO BE READ IN CONJUNCTION WITH BOREHOLE LOCATION PLAN

SITE: 52 WINDSOR AVENUE MAGILL SA

DEPTH IN METRES				VISUAL ASSESSMENT OF PROPERTIES						
BORE 7	BORE 8	BORE 9	BORE 10	COLOUR	CONSISTENCY, TEXTURE & STRUCTURE	SOIL DESCRIPTION	U.S.C.	M.C.	BEARING	EST Ipt (AVE)
			0.00-0.50	Brown	Loose, Friable, Granular	(FILL) Clayey SAND, Gravel VLP	SC-GM	B	M	0005
0.00-0.20	0.00-0.20	0.00-0.20	0.50-0.70	Brown	Loose, Granular	Clayey SAND VLP	SC	B	M	0.005
0.20-0.70	0.20-0.70	0.20-0.70	0.70-1.60	Red, Brown	Stiff, Granular	CLAY, Sandy HP	CH	B	M	0.040
0.70-1.20	0.70-1.00	0.70-1.00		Cream, Red, Brown	Firm, Granular	CLAY, Sandy, Limey, Calcareous MHP	CL-CH/GC	B	MH*	0.025
1.20-1.60	1.00-1.60	1.00-1.80	1.60-2.00	Red, Brown, Cream	Firm, Granular	CLAY, Sandy, Limey HP	CH	B	M	0.030
1.60-2.00		1.80-2.40	2.00-2.30	Orange, Grey, Brown	Firm, Granular	CLAY, Sandy, Limey, Calcareous MHP	CL-CH/GC	B	M*	0.025
2.00-2.10	1.60-1.90	2.40-3.00	2.30-2.50	Brown	Friable, Granular	CLAY, Sandy, Stones, Impenetrable @ Base on Stones @ BH1, BH2 & BH4 MP	CL-GC	B	H	0.020

REMARKS:	CLASSIFICATION:	TYPE: RB3(a)	CLASSIFIER:
<p>1. The classification nominated on this borelog relates to the site soil profile at the time of testing. It does not allow for future earthworks and does not incorporate any possible effects from trees, either existing or future.</p> <p>2. *The calcareous clay soils present within the soil profile may lose strength upon wetting and adequate site drainage is essential.</p>		<p>REFERENCES USED:</p> <p>SOIL MAPS: Soil Association Map of the Adelaide Region</p> <p>NEARBY BORELOGS:</p> <p>SAMPLE METHOD: Driven push tube using high pressure hydraulic hand-held hammer.</p>	





## TECHNICAL SERVICES

Soil Sampling and Logging \*Engineering Level Surveys  
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### SURFACE BORE LOG

DATE: 05/11/2018

JOB NO: STS1119

CR2  
1 OF 1

DATE DRILLED: 30/10/2018

TO BE READ IN CONJUNCTION WITH BOREHOLE LOCATION PLAN

SITE: 52 WINDSOR AVENUE MAGILL SA

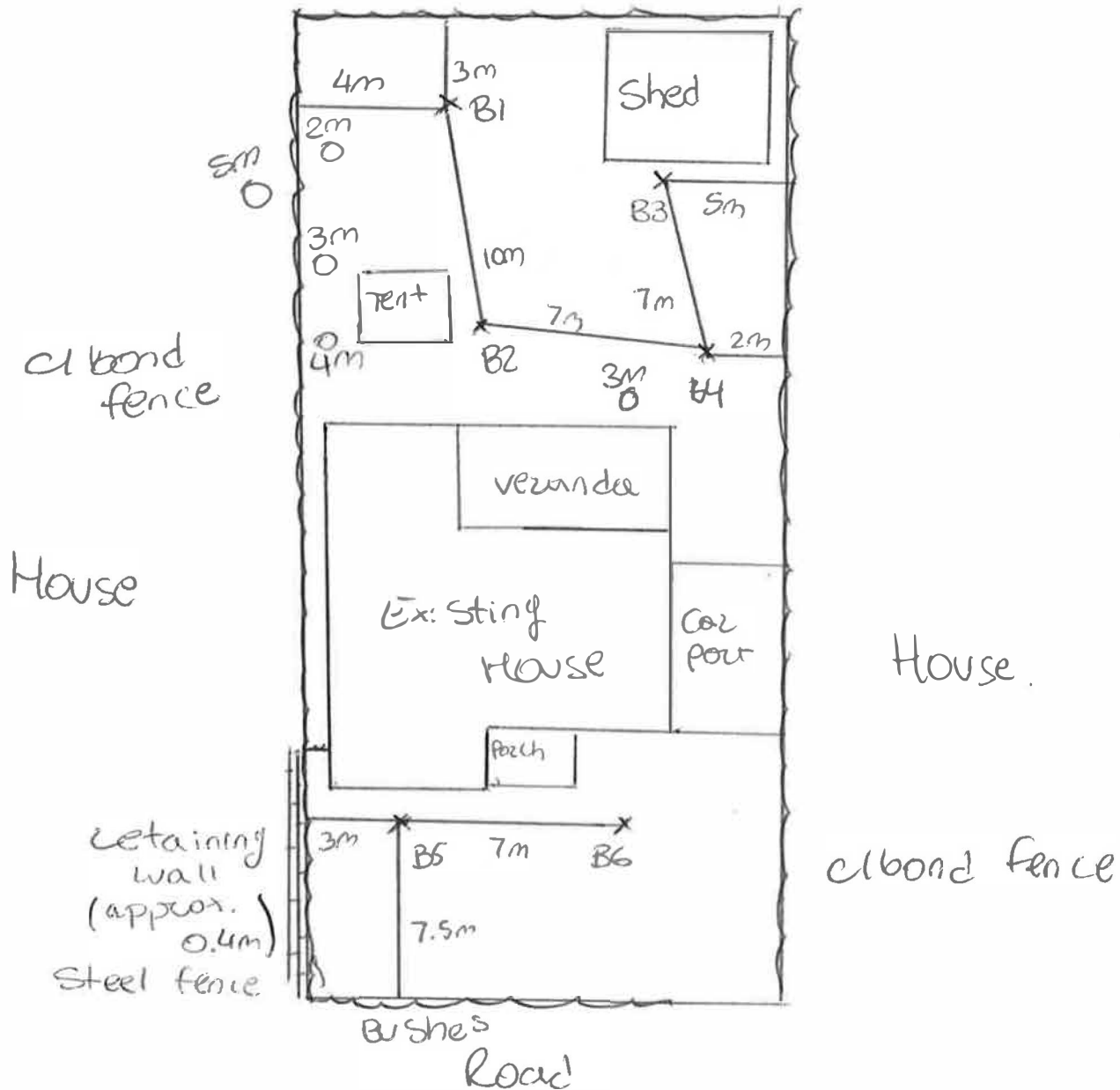
DEPTH IN METRES				VISUAL ASSESSMENT OF PROPERTIES						
11 BORE	12 BORE	13 BORE		COLOUR	CONSISTENCY, TEXTURE & STRUCTURE	SOIL DESCRIPTION	U.S.C.	M.C.	BEAR -ING	EST Ipt (AVE)
0.00-0.50	0.00-0.30	0.00-0.45		Brown	Loose, Friable, Granular	(FILL) CLAY, Gravel, Sandy, Bricks LP	CL-GC	B	M	0.010
0.50-0.70	0.30-0.45	0.45-0.55		Brown	Loose, Granular	Clayey SAND VLP	SC	B	M	0.005
0.70-1.80	0.45-1.20	0.55-1.00		Red, Brown	Stiff, Granular	CLAY, Sandy HP	CH	B	M	0.040
	1.20-1.70	1.00-1.40		Cream, Red, Brown	Firm, Granular	CLAY, Sandy, Limey, Calcareous MHP	CL-CH/GC	B	MH*	0.025
		1.40-1.65		Red, Brown, Cream	Firm, Granular	CLAY, Sandy, Limey HP	CH	B	M	0.030
1.80-2.10	1.70-2.00	1.65-1.80		Orange, Grey, Brown	Firm, Granular	CLAY, Sandy, Limey, Calcareous, Stones, Impenetrable @ Base on Stones	CL-CH/GC	B	M*	0.025

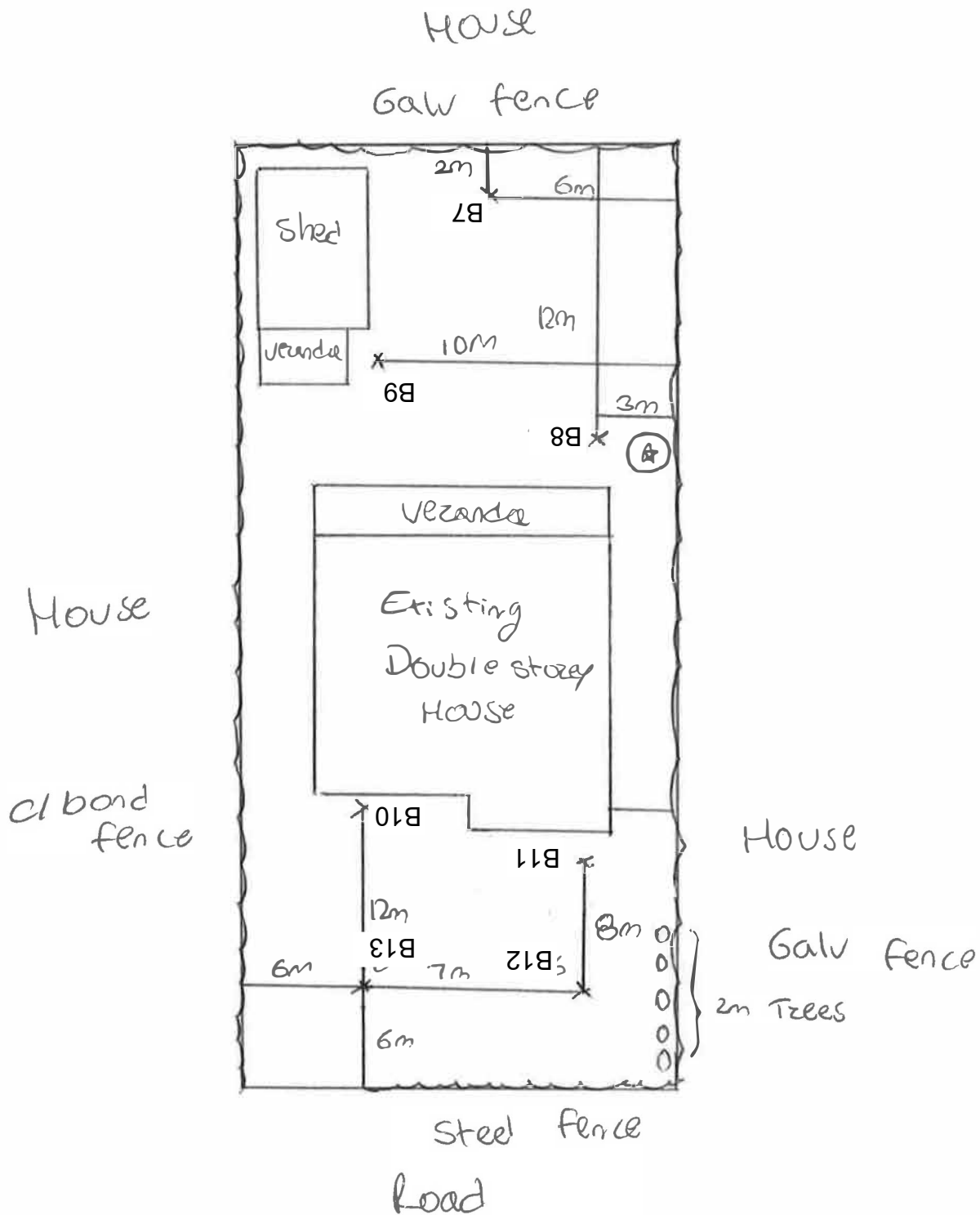
REMARKS:	CLASSIFICATION:	TYPE: RB3(a)	CLASSIFIER:
<ol style="list-style-type: none"> <li>The classification nominated on this borelog relates to the site soil profile at the time of testing. It does not allow for future earthworks and does not incorporate any possible effects from trees, either existing or future.</li> <li>*The calcareous clay soils present within the soil profile may lose strength upon wetting and adequate site drainage is essential.</li> </ol>		<p>REFERENCES USED:</p> <p>SOIL MAPS: Soil Association Map of the Adelaide Region</p> <p>NEARBY BORELOGS:</p> <p>SAMPLE METHOD: Driven push tube using high pressure hydraulic hand-held hammer.</p>	

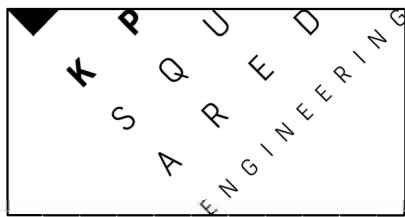


House  
Galv fence

N 50 Windsor Avenue







SUITE 4, GROUND LEVEL  
166-168 GRANGE ROAD,  
FLINDERS PARK SA 5025  
PH: 0413 991 106

DATE: DEC '18  
JOB NO: 170814

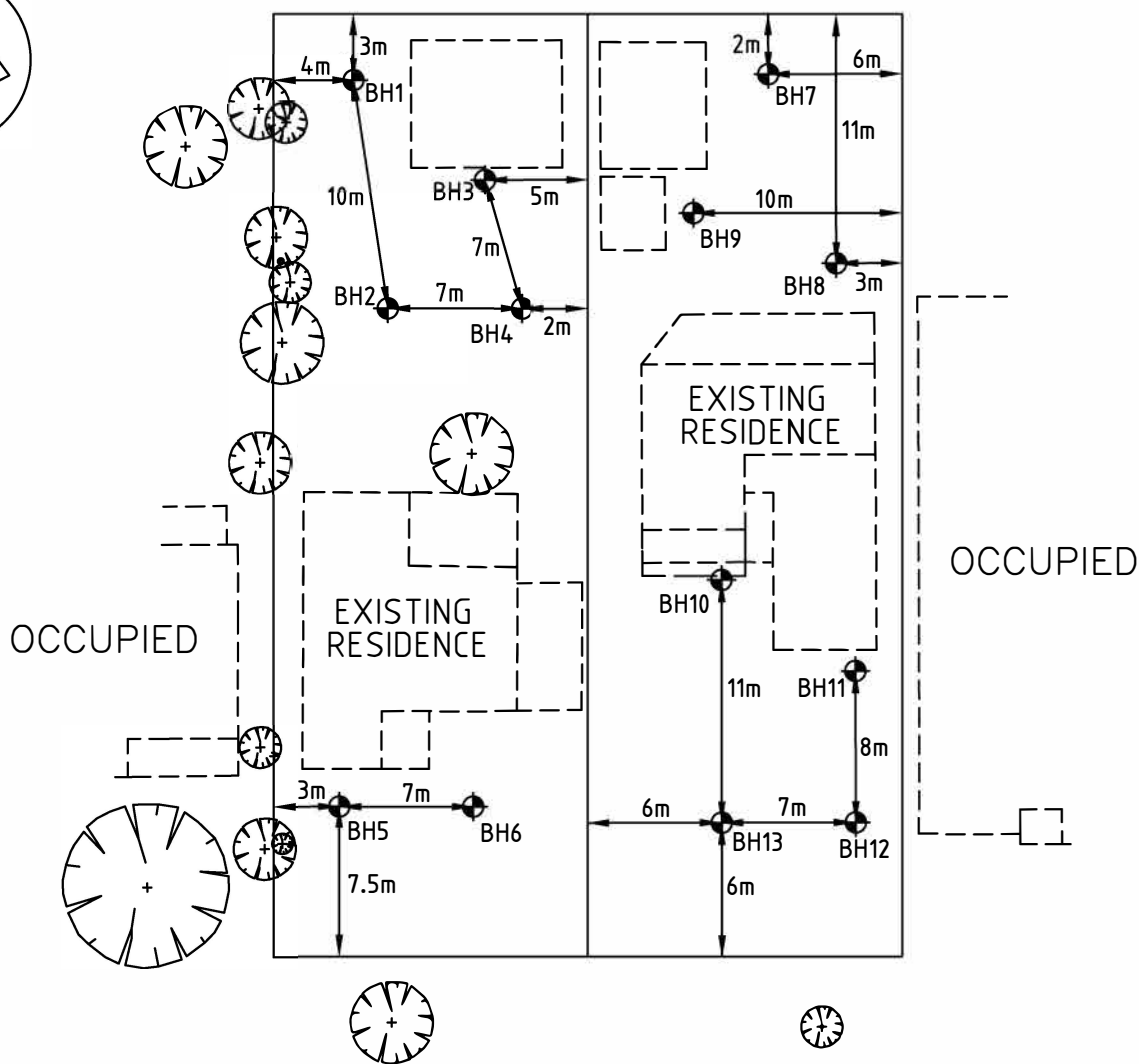
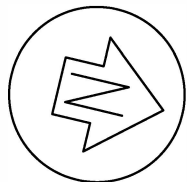
BHLP-1

### BOREHOLE LOCATION PLAN

50-52 WINDSOR STREET

MAGILL

WHERE EXISTING STRUCTURES ARE TO BE  
REMOVED, PRE-WETTING IS MANDATORY.



#### NOTES

##### 1. CORE DEPTHS

H1- 3.0m H5-1.3m H9-3.0m H13-1.8m  
H2-1.8m H6-1.8m H10-2.5m  
H3-2.0m H7-2.1m H11-2.1m  
H4-2.4m H8-1.9m H12-2.0m

##### 2. WATER TABLE

BORE 1 BORE 2 BORE 3 BORE 4 BORE 5 BORE 6  
BORE 7 BORE 8 BORE 9 BORE 10 BORE 11 BORE 12  
BORE 13

##### 3. APPROX. FALL OF SITE

				✓	
1:10	1:15	1:20	1:25	OTHER	NEAR LEVEL

FALL OF SITE SHOWN IS APPROX. AND MUST  
NOT BE USED FOR COSTING PURPOSES.

##### 4. SURFACE

	✓			✓			✓		✓		✓
DRY	MOIST	WET	SOFT	FIRM	LOOSE	HARD	GRAVEL	SAND	TREES	PAVED	GRASS

##### 5. RESISTANCE (AVE.)

	✓	✓
LOW	MEDIUM	HIGH

##### 6. BOTTOM RESISTANCE

	✓	✓
LOW	MEDIUM	HIGH

7. DATE DRILLED. ..30../..10../..18..  
..08../..11../..18..

##### 8. UNUSUAL FEATURES

JOB NO: STS1119

TAT: .....

DATE: 08/11/18

DUE DATE: .....

AGENT: KP SQUARED

OWNER: .....

SOIL / PERCOLATION / PENETROMETER: .....

PLANS: YES / NO

SITE LOCATION: Magill, 50 Windsor Avenue

NO. &amp; DEPTH OF BORES REQUESTED: 6 - 3m



## TECHNICAL SERVICES

Soil Sampling and Logging \* Engineering Level Surveys  
Percolation Tests \* Environmental Soil Sampling \* Groundwater Wells

CR2-1

Page 1 of 2

### DRILLER'S NOTES

Drillers Initials: DA-DV Date Drilled: 08/11/18 Tick and /or make notes

### GROUND SURFACE

Surface Moisture Content	<input type="checkbox"/> Dry	<input checked="" type="checkbox"/> Moist	<input type="checkbox"/> Wet
Show location on	<input checked="" type="checkbox"/> Grass	<input checked="" type="checkbox"/> Trees	<input checked="" type="checkbox"/> Gravel
Plan if relevant	<input type="checkbox"/> Yes	<input checked="" type="checkbox"/> No	
Surface Vegetation			
Surface Cracks	<input type="checkbox"/> Soft	<input type="checkbox"/> Loose	<input checked="" type="checkbox"/> Firm
Surface Soil Strength			<input type="checkbox"/> Hard

### UNUSUAL FEATURES

Heap / even Filling	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Rock Outcrops	<input type="checkbox"/> Yes	<input checked="" type="checkbox"/> No
Pits / Cellar / Underground Tank	<input type="checkbox"/> Yes	<input checked="" type="checkbox"/> No
Excavations	<input type="checkbox"/> Yes	<input checked="" type="checkbox"/> No
Drainage Channels	<input type="checkbox"/> Yes	<input checked="" type="checkbox"/> No
Trees	<input checked="" type="checkbox"/> Yes	<input type="checkbox"/> No
Cracks in existing Structures	<input type="checkbox"/> Yes	<input checked="" type="checkbox"/> No
Other (Specify)	<input type="checkbox"/> Yes	<input checked="" type="checkbox"/> No

### SLOPE (Show on Plan)

Level ☒ Fall .....

### WATER TABLE

Water Struck ☐ Yes ☒ No

Depth of Water Table on  
Completion of Drilling

Bore No	1	2	3	4	5	6	7	8	9	10	11	12
Depth												

### BOREHOLE INFORMATION

		1	2	3	4	5	6	7	8	9	10	11	12
Overall Resistance	Low												
	Medium	✓	✓	✓	✓	✓	✓						
	High												
Bottom Resistance	Low												
	Medium	✓											
	High	✓	✓	✓	✓	✓	✓						
Depth Drilled (in meters)		3	1.8	2	2.4	1.3	1.8						
Core Recovery	100%	✓	✓		✓								
	Stretched				200								
	Core Loss			100		200	400						

Auger

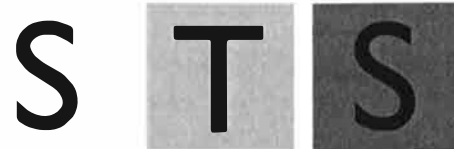
Comment:

JOB NO: STB1119

TAT: .....

DATE: 30/10/18

DUE DATE: .....



## TECHNICAL SERVICES

Soil Sampling and Logging \* Engineering Level Surveys  
Percolation Tests \* Environmental Soil Sampling \* Groundwater Wells

AGENT: KP SQUARED

OWNER: .....

SOIL / PERCOLATION / PENETROMETER: .....

PLANS: YES / NO

SITE LOCATION: Mayill, 52 Windsor Avenue

NO. & DEPTH OF BORES REQUESTED: 7-3m

CR2-1

Page 1 of 2

### DRILLER'S NOTES

Drillers Initials: DA-IV

Date Drilled: 30.10.18

Tick and /or make notes

### GROUND SURFACE

Show location on

Plan if relevant

Surface Moisture Content

Surface Vegetation

Surface Cracks

Surface Soil Strength

☐ Dry

☒ Moist

☐ Wet

☒ Grass

☒ Trees

☒ Gravel

☐ Yes

☒ No

☐ Soft

☐ Loose

☒ Firm

☐ Hard

### UNUSUAL FEATURES

~~Head~~ / even Filling

Rock Outcrops

Pits / Cellar / Underground Tank

Excavations

Drainage Channels

Trees

Cracks in existing Structures

Other (Specify)

☒ Yes

☐ No

☐ Yes

☒ No

☐ Yes

☒ No

☐ Yes

☒ No

☐ Yes

☒ No

☒ Yes

☐ No

☒ Yes

☐ No

☐ Yes

☒ No

### SLOPE (Show on Plan)

Level ☒

Fall .....

### WATER TABLE

Water Struck

☐ Yes

☒ No

Depth of Water Table on  
Completion of Drilling

Bore No	1	2	3	4	5	6	7	8	9	10	11	12
Depth												

### BOREHOLE INFORMATION

		1	2	3	4	5	6	7	8	9	10	11	12
Overall Resistance	Low												
	Medium	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>								
	High					<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>					
Bottom Resistance	Low												
	Medium												
	High	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>					
Depth Drilled (in meters)		2.1	1.9	3	2.5	2.1	2	1.8					
Core Recovery	100%	<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>								
	Stretched	100		300									
	Core Loss		400			100	200	450					

Auger

Comment:

## 1. GENERAL

The surface soil borehole log is based on visual-tactile logging of the drilled core. The soil characteristics are generally estimated; however samples from 1 in 50 sites are subjected to shrink-swell tests conducted by a NATA accredited laboratory to verify estimated values.

One must not place sole reliance on the surface soil borehole logs as a means of being an absolute representation of all sub-surface features existing on the site. Nor can the density and difficulty of excavation be estimated by interpretation of the surface soil borehole log.

The soil borehole logs are usually based upon 40 mm diameter continuous core samples in one or more locations on the site in accordance with AS 2870-2011 *Residential slabs and footings*. It is not possible by this means to detect all subsurface features which may exist and the Owner is advised to seek information from Local Council, Department of Health and other statutory Authorities regarding any unnatural features (e.g. wells, mineshafts, filled areas etc) land use (e.g. toxic waste, waste disposal etc), or other features typical to the area (e.g. landslide, springs etc).

This office uses not only the borehole log information but may take into account such matters as the known geology of the area taken from published soil maps, the known performance of existing structures in the general area and engineering judgment to make an assessment of soil classification for design purposes.

## 2. UNIFIED SOIL CLASSIFICATION SYSTEM (USCS)

Clean Gravels	GW	Well-graded gravels and gravel-sand mixtures, little or no fines.
	GP	Poorly graded gravels or gravel-sand mixtures, little or no fines.
Gravels with fines	GM	Silty gravels, gravel-sand-silt mixtures.
	GC	Clayey gravels, gravel-sand-clay mixtures.
Clean sands	SW	Well graded sands and gravelly sands, little or no fines.
	SP	Poorly graded sands and gravelly sands, little or no fines.
Sands with Fines	SM	Silty sands, sand-silt mixtures.
	SC	Clayey sands, sand-clay mixtures.
Silts and Clays (Liquid Limit <50%)	ML	Inorganic silts, very fine sands, rock flour, silty or clayey fine sands.
	CL	Inorganic clays of low to medium plasticity, gravelly/sandy/silty/lean clays.
	OL	Organic silts and organic silty clays of low plasticity.
Silts and Clays (Liquid Limit >50%)	MH	Inorganic silts, micaceous or diatomaceous fine sands or silts, elastic silts.
	CH	Inorganic clays or high plasticity, fat clays.
	OH	Organic clays of medium to high plasticity.
Highly Organic Soils	Pt	Peat, muck, and other highly organic soils.

## 3. MOISTURE CONTENT

Relative to the Plastic Limit (PL) of the soil for cohesive soils or relative to the optimum moisture content of the soil (OMC) for cohesion less soils, i.e. non plastic.

WB Well below  
B Below  
N Near  
A Above  
WA Well above

#### 4. **BEARING STRENGTH**

The descriptive term used relates to the in-situ strength at the time of logging.

It must be noted that site works and changes in soil moisture may significantly affect the bearing strength. It must also be noted that as the soils are disturbed in the drilling and sampling process the bearing strength in-situ may be different from that logged.

Term	Description	Allowable Bearing Capacity (kPa)
VL	Very low (loose granular material or soft, possibly collapsing soil)	< 50
L	Low (firm)	50 to 100
M	Medium (stiff)	100 to 200
H	High (very stiff to hard)	> 200

#### 5. **SITE CLASSIFICATION BASED ON SITE REACTIVITY**

Class	Foundation	Character
A	Most sand and rock sites with little or no ground movement from moisture changes	Stable
S	Slightly reactive clay sites, which may experience only slight ground movement from moisture changes	
M	Moderately reactive clay or silt sites, which may experience moderate ground movement from moisture changes	Reactive
H1	Highly reactive clay sites, which may experience high ground movement from moisture changes	
H2	Highly reactive clay sites, which may experience very high ground movement from moisture changes	
E	Extremely reactive sites, which may experience extreme ground movement from moisture changes	
A	Sand	Controlled Fill
A to P	Material other than sand	
P	Mine subsidence Uncontrolled fill Landslip Soft soils Collapsing soils	Problem

*Note: For sites with deep seated moisture changes characteristic of dry climates and corresponding to a design depth of suction change equal to or greater than 4 m, the classification shall be M-D, H1-D, H2-D or E-D as appropriate. For example, M represents a moderately reactive site with shallow moisture changes and M-D represents a moderately reactive site with deep moisture changes.*

#### 6. **PLASTICITY**

NP Non plastic.  
VLP Very low plasticity.  
LP Low plasticity.  
MP Medium plasticity.  
HP High plasticity.  
VHP Very high plasticity.

## 7. **REACTIVITY**

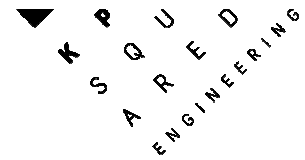
The reactivity of the soil is defined as the potential for undergoing changes in volume with changes in the soil moisture content.

The reactivity is measured in terms of Shrinkage Index ( $I_{ps}$ ).

Term	Description	Shrinkage Index ( $I_{ps}$ )
VL	Very low	0.5% or less
L	Low	1%
M	Medium	2%
H	High	3% to 4%
VH	Very high	4.5% or greater

Characteristic surface movement ( $y_s$ ) mm	Site classification in accordance with Table 2.3 AS2870-2011
$0 < y_s \leq 20$	S
$20 < y_s \leq 40$	M
$40 < y_s \leq 60$	H1
$60 < y_s \leq 75$	H2
$y_s > 75$	E





## **DETAILS ON THE USE OF THE FOOTING CONSTRUCTION REPORT**

### **GENERAL**

This report is a Construction report which provides specific recommendations for the proposed building. It is essential that this report be read in conjunction with all the drawings, details and specifications. Changes to the design or construction cannot be made without further written advice from the Engineer.

The details outlined within this report contain advice designed to minimise distress to the building. It is an important document and should be kept in a safe place. This report must be supplied to subsequent owners so that they are aware of the consequences of making any changes to the building, site, garden and adjacent areas. Without this information, they may institute changes to site management that could jeopardize the long term serviceability of the building.

This Construction Report has been prepared at the request of the Owner. It is a condition of the use of this report that the owner accepts the basis on which the footing design has been prepared, refer below, and that the Owner ensures that the Engineer is advised of the time to attend each of the recommended site inspections.

The Owner must read the entire report carefully as it contains important information, relating not only to the construction of the footings, but also to the obligations, liabilities and requirements for site management. If the Owner requires a different type of footing to that recommended, or stiffer footings to reduce movement, this office must be notified prior to the commencement of construction, and advice will be given accordingly. If there are any aspects of the report that are not understood, please contact the Engineer.

The Engineer may (and the Owner hereby authorizes the Engineer to):

Issue instructions (including an instruction to cease construction) on behalf of the Owner to any person engaged in the construction of the building, or any part thereof, to ensure construction of the building in accordance with this Construction Report and any modification thereof. If any modification as aforesaid may be likely to result in additional construction costs exceeding \$ 2000.00 the Engineer may issue an instruction to cease construction in order to obtain the approval of the Owner for such modification.

Make such modifications to the Construction Report as the Engineer may deem necessary during the course of construction.

The Owner shall be responsible for, and indemnify the Engineer against, all and any costs and charges and all claims and demands made for any additional costs incurred by reason of any act, requirement or instruction of the Engineer made or given pursuant to clause.

The Engineer shall not be liable for any defect in or damage to the building arising from footing inadequacy or movement of the building, including its footing, caused by or contributed to by any breach of the terms, conditions and recommendations committed, permitted or allowed by the Owner.

Where more than one person is named as the Owner, all these terms, conditions and recommendations shall bind all such persons jointly and each such person severally, and any instruction or information given to the Engineer by any one such person shall be deemed to be given by all other such persons.

For the purposes of these conditions any builder or supervisor (and any of their respective servants or agents) engaged in the construction of the building shall be deemed to be an agent of the Owner.

### **FOOTING PERFORMANCE**

This report is based on the following information. The intention of the footing design is to prevent cracking exceeding the Category and damage degree as slight (Refer tables 1 & 2). In the event of leaking water or sewer pipes, or deviation from the site management requirements outlined in this report, the above Category of damage becomes inapplicable.

It must be understood that reactive clays move due to moisture changes. Relatively stable clays may move significantly if they are subjected to extreme moisture changes (for example too much or too little garden watering). Therefore, it is difficult and not economical to design footings for extreme conditions. The Owner must maintain reasonable moisture conditions at the site.

It is impossible to design a footing system that totally prevents movement, unless there is no financial limit. Some minor non-structural/ aesthetic cracking will occur in a large number of buildings. Limits of performance are outlined in Tables 1 and 2. Occasional Category 2 behaviour may occur, for most situations Category 0 and 1 should be the limit. Significant cracking in masonry with widths over 5mm (Category 3) generally do not jeopardize the structural integrity of the wall and only presents an aesthetic problem.

As it is impossible to design an immovable footing system, it is very difficult to provide remedial measures that will prevent further movements if distress does occur. As such, extreme remedial measures should not be undertaken for minor problems.

Footings are designed to reduce the risk of foundation (i.e. soil or rock) conditions causing distress to the building or structure. The footing design does not completely eliminate all cracking or other distress.

The definition of the failure of the footing is a crack width of 5mm, or some other distress as defined in the Australian Standard 2870 "Residential Slabs and Footings" (AS 2870).

The definition of distress is any movement, damage, cracking, collapse or other condition which reduces the safety, aesthetics or serviceability of the building or structure.

The design and construction of footings is to achieve a small but finite probability of failure as in most cases it is not economic to construct footings which eliminate the possibility of cracking. The industry accepted probability of failure is 5%. What this means is that there is a probability that 1 in 20 buildings will experience a crack of 5mm width during their design life. This risk is a community and industry based standard as defined by AS 2870. Should the owner want a lower risk of distress, this can be achieved but at increased expense. This must be specifically requested. The risk of distress and failure is effected by a number environment factors. The risk is based on normal site and environment conditions. Abnormal conditions such as, leaking water or sewer pipes or deviation from the site management contained in this report, will increase the risk of damage to the building, and the above category of damage becomes inapplicable. Many of these factors are directly under the control of the Owner.

The specified footings are the most economical which will provide the desired performance and which comply with all relevant building codes and industry practice.

#### ADDITIONS TO EXISTING BUILDINGS

Additions made to an existing building have additional considerations which must be considered. The existing building footings and the footings of the addition are independant structures. Even though some connection may be made between the two footing systems, the footings will move independently/differentially. As such, cracking may occur at the junction of the two and control joints will open and / or close. The addition will not normally stabilise the existing building, whether or not the addition is built.

On reactive clay sites, the planting of trees should be avoided for protection against the possibility of damage. The attachment of floor surfacing to concrete slabs that have not fully dried can cause problems via moisture reactions with glues or concrete shrinkage. Drying times vary, and up to 6 months may be required. Concrete shrinks as it dries and this results in some cracking, often around 1mm in width. This has little effect on structural performance of the slab but could effect some brittle floor coverings if installed too soon.

**TABLE 1**

<b>CLASSIFICATION OF DAMAGE WALLS</b>		
<b>DESCRIPTION OF TYPICAL DAMAGE AND REQUIRED REPAIR</b>	<b>APPROXIMATE CRACK WIDTH LIMIT</b>	<b>CATEGORY AND DEGREE OF DAMAGE</b>
Hairline cracks.	Less than 0.1mm	0 - Negligible
Fine cracks which do not need repair.	Less than 1.0mm	1 - Very slight
Cracks noticeable but easily filled. Doors and windows may stick slightly.	Less than 5.0mm	2 - Slight
Cracks can be repaired and possible a small amount of wall will need to be replaced. Doors and windows stick. Service pipes can fracture. Weather-tightness often impaired.	5mm to 15mm (or a number of cracks 3mm to 5mm in one group)	3 - Moderate
Extensive repair work involving breaking-out and replacing sections of walls, especially over doors and window. Window and door frames distort. Walls lean or bulge noticeably with some loss of bearing in beams. Service pipes disrupted.	15mm to 25mm but also depends on number of cracks	4 - Severe

**TABLE 2**

<b>CLASSIFICATION OF DAMAGE - CONCRETE FLOORS</b>			
DESCRIPTION OF TYPICAL DAMAGE	APPROXIMATE CRACK WIDTH LIMIT IN FLOOR	CHANGE IN OFFSET FROM A 3M STRAIGHT EDGE CENTERED OVER DEFECT	CATEGORY AND DEGREE OF DAMAGE
Hairline cracks, insignificant movement of slabs from level.	Less than 0.3mm	Less than 8mm	0 - Negligible
Fine but noticeable cracks. Slab reasonably level.	Less than 1.0mm	Less than 10mm	1 - Very slight
Distinct cracks. Slabs noticeably curved or changed in level.	Less than 2.0mm	Less than 15mm	2 - Slight
Wide cracks. Obvious curvature or change in level.	2mm to 4mm	15mm to 25mm	3 - Moderate
Gaps in slab. Disturbing curvature or change in level.	4mm to 10mm	Less than 25mm	4 - Severe

**NOTES TO TABLES 1 AND 2:**

Crack width is only one factor in assessing category of damage and should not be used on its own as a direct measure of that damage.

In assessing the degree of damage, account shall be taken of the location in the building or structure where it occurs, and also of the function of the building or structure.

Local deviation of slope, from the horizontal or vertical, of more than 1/100 will normally be clearly visible, Overall-deviations in excess of 1/150 are undesirable.

Account should be taken of the past history of damage in order to assess whether it is stable or likely to increase.

The straight edge is centered over the defect, usually a crack, and supported at its ends by equal height spacers. The change in offset is then measured relative to the straight edge.

**SOIL BORELOGS**

The soil profiles (indicated by the test bores) is what forms the basis of the footing recommendations. The soil profile is particular to the test location and the soil samples obtained may not reveal all the soil variations on the site. Soil profiles may vary substantially between each core.

Assessment of subsurface soils apart from the determination of the 'soil heave' value, is excluded.

It is important that any variations or discrepancies in soil type, colour, or horizon depth, as compared to the test bores shall be referred to the Engineer immediately. Sole reliance cannot be placed on the surface soil borelogs as a means of being an absolute representation of all sub-surface features existing on the site. The density and difficulty of excavating cannot be estimated by interpretation of the surface soil borelog.

The footings have been selected on the basis of the recognised characteristics of the soil profile. These characteristics have been visually assessed and related to know performance of the soils under optimum conditions of site development and use. It is assumed that aspects of site drainage, paving and landscaping have been, or will be, implemented. Where any or all of these aspects do not form part of the building contract, it is a mandatory requirement that they be carried out within a period of 4 months from date of completion of the building provided always that adequate temporary drainage is installed.

## **SITE INSPECTIONS**

### **GENERAL**

Inspections exclude Architectural details, the checking of levels, layout dimensions, squareness and relationship to site boundaries.

The inspections listed below are strongly recommended. It is stressed that incorrect construction, detected at a later stage, may result in increased costs for remedial work.

Ensure that construction of the building is not allowed to proceed beyond any stage at which an inspection is required, unless the Engineer has approved the work at that stage.

The owner shall ensure that any instruction given by the Engineer is undertaken.

### **STAGES FOR INSPECTIONS**

Once primary earthworks are complete, where the depth of excavation and/or filling exceeds 600mm. The inspection shall be limited to a visual assessment of the earthworks, and any approval shall be conditional upon the Owner completing the final earthworks to the correct levels and slopes at a later stage. Where the Engineer considers that additional testing or investigation is required as a result of the earthworks, work shall not proceed until the additional services have been completed. Any such additional testing, investigation and reporting shall incur additional fees.

After completion of excavation for footings and prior to the placement of any vapour barrier (if required) or reinforcement. Where footing construction is staged, an inspection must be carried out at each stage.

After preparation of the reinforcement prior to pouring any concrete. After completion of excavation for main sewers to ensure that the trenches, as constructed, do not affect the footing as designed. Checking sewers for compliance with the requirements of statutory authorities is excluded. After completion of brickwork or similar to ensure that the articulation joints have been placed at the specified locations. Checking construction details which are not visible is excluded and no responsibility is taken for any problem arising from such.

Upon completion of the installation of paving, stormwater drains, pipes and structures. The checking of sections which are not visible is excluded and no responsibility is taken for any problem arising from such sections. Maintenance of ground slopes to ensure continued proper drainage will be required subsequent to the inspection, and shall remain the Owner's responsibility.

## FOOTINGS/SLABS SPECIFICATION

### GENERAL NOTES

The specific type of construction is nominated on the cover sheet of the footing construction report. The standard details shown are typical only, and specific items (eg footing dimensions, number of bars) are to be noted as in the Construction Report.

Where specific requirements or details provided in the Construction Report, or on the drawings, conflict with these general specifications, the report and/or drawings shall take precedence.

### CONCRETE

Construction methods, materials, tolerances and finishes must comply with AS 3600 SAA Concrete Structures Code and all other relevant Australian Standards, the Building Code of Australia and any specific requirements of the Local Council.

Concrete grade shall be as follows:

- . Slabs on ground, footings protected by vapour barrier and residential strip / pad footings shall be grade N20 (i.e. 20 MPa).
- . Suspended slabs, beams and columns and non- residential footings unprotected by vapour barrier shall be grade N25 (i.e. 25 MPa).
- . Members in exposed exterior environments shall be grade N32 (i.e. 32 MPa).
- . Maximum aggregate 20mm.
- . Slump limit 80mm.

For sites located within 1 km of the sea or corrosive water (including areas west of the corrosion line marked on the wind speed map) where surfaces such as verandahs, balconies, and carports are exposed, the surface shall be protected with a suitable approved topping, sealer, tiles (etc) or the concrete grade must be not less than N40 (i.e. 40 MPa).

Concrete shall be supplied in accordance with AS 1379 SAA Ready-mixed Concrete Code. Site mixed concrete shall not be used.

Sulphate-resisting cement (Type D - AS 1315) shall be used when specified, or when it is known by the Owner, Builder, Local Council, or concrete supplier that this cement should be used at the site.

Chemical admixtures may be used, provided the concrete supplier accepts responsibility for their use.

### **PLACEMENT OF CONCRETE**

Concrete shall be placed as close as possible to its final position, and the pour must proceed in one continuous operation, to ensure that no more than 45 minutes elapse before placing fresh concrete against previously placed, in order to eliminate 'cold joints'.

All concrete must be mechanically vibrated to ensure that it is properly compacted, and all excess air voids have been removed. Care must be taken to make sure that the concrete does not become segregated by local over-vibration.

Construction joints will not be permitted in the footings without written approval from the Engineer, except where noted on the detail drawings. Where a raft footing system has been specified it is required that the footing be poured at the same time (i.e. integrally) with the floor slab. Should it be necessary to pour the footing beams separately to the floor slab, the beams shall be poured to a level exposing the top reinforcement by approximately 50mm. The spacing of ligatures must be reduced to a maximum of 300 mm centers should this be the case. Where construction joints are used, the concrete surface shall be formed up vertically and the hardened surface of the first pour shall be thoroughly cleaned of all loose aggregate dirt, etc. The hardened concrete shall be thoroughly wetted and a neat slurry shall be applied to its surfaces in a thin layer cement immediately prior to pouring fresh concrete.

The construction of a slab shall achieve the following dimensional tolerances:

The cover to the reinforcement from the surface in contact with the ground shall be within +40mm and – 20mm of the specified cover, except that the bottom cover to beams may be increased where the beams are deeper than specified.

The cover to the reinforcement from the internal surface shall be within +20mm and -10mm of the specified cover.

The surface shall be generally within +10mm of level.

A steel trowelled finish with a tolerance of +/-5mm from a 3m straight edge shall be used in the absence of any specification.

The surface finishes shall be suitable for the specified floor coverings to be provided without further treatment.

The thickness of the slab and the width and depth of the beam shall not be less than the specified dimension.

## **CURING**

Curing of the slab shall commence as soon as possible after the pour and must be within 4 hours of the concrete pour.

Curing may be achieved by covering the slab with polyethene sheeting for a minimum of 7 days, or by spraying with an approved curing compound, subject to compatibility with the proposed surface finishes.

## **HOT WEATHER CONCRETING**

When the forecast temperature exceeds 36 degrees Celsius concrete must not be poured.

When the forecast temperature is between 32 and 36 degrees Celsius concrete can only be poured if the following Conditions are adhered to:

If the concrete is completed prior to the air temperature reaching 32 degrees Celsius.

When the site is protected from hot drying winds.

When the slab surface is covered with plastic sheeting, or hessian (kept wet), within 2 hours of finishing.

## **REINFORCEMENT**

Reinforcement designation:

- R - Plain round structural bar to AS1302.**
- Y - Hot rolled deformed bar to AS1302.**
- F - Hard drawn wire fabric to AS1304.**
- W - Hard drawn wire bar to AS1303.**
- RF - Ribbed Fabric to AS1302.**
- N - Hot rolled deformed bar to AS4671**
- SL - Square ribbed fabric to AS4671**
- RL - Rectangular ribbed fabric to AS4671**

Reinforcement is to be supported on concrete blocks or bar chairs, or suspended from formwork.

Reinforcement shall be placed evenly, straight and adequately tied (by wire) to prevent any movement and to hold it in the correct position during the pouring of concrete.

Fabric shall be supported on concrete blocks or bar chairs, placed under the intersection of cross wires at 800mm x 800mm (maximum centres).

At external corners, and intersections of external and internal footings, the reinforcement shall be lapped with a bent bar, or separate corner bars, as indicated on the details.

Minimum rod lap lengths :

<b>Bar Size</b>	<b>Lap Length (mm)</b>
<b>N12</b>	<b>500</b>
<b>N16</b>	<b>750</b>
<b>N20</b>	<b>1000</b>
<b>N24</b>	<b>1450</b>
<b>N28</b>	<b>1800</b>
<b>N32</b>	<b>2150</b>
<b>N36</b>	<b>2600</b>

Fabric shall be lapped one full square plus 25mm at all joins.

Where brittle floor coverings are to be used (such as tiled areas), additional measures are required to control the effect of shrinkage cracking.

Additional measures to control the effect of shrinkage cracking include the following:

A flexible grout bed shall be provided, 'Resaflex' or similar.

The placement of floor covering shall be delayed. Note: A minimum of 6 months drying of the concrete is usually required before the placement of brittle floor covering.

Installation of control joints within the brittle floor coverings where the area exceeds 20m<sup>2</sup>.

2 layers of SL72T (or 1 layer of SL92T)

## **COVER**

Clear cover to concrete reinforcement, (including fitments and wire ties) shall be:

- . Slab on fill - 30mm bottom and sides, 20mm top
- . Footings protected by vapour barrier - 40mm bottom and sides, 20mm top
- . Residential footings unprotected by vapour barrier - 40mm top, 50mm bottom and sides
- . Non-residential footings unprotected by vapour barrier - 50mm top, bottom and sides

If a footing beam is 'over-excavated', keep the reinforcing 'cage' towards the top portion of the footing beam.

## **VAPOUR BARRIER/PLASTIC**

The vapour barrier shall be branded continuously "AS2870 Concrete Underlay, 0.2mm High Impact resistance". The vapour barrier shall be provided throughout the underside of all habitable areas and shall be continuous under all footing beams and slabs as shown on the typical detail sheets.

All joints shall be lapped a minimum of 300mm and sealed with a 50mm wide strip of pressure-sensitive waterproof tape. All service penetrations shall be securely flashed and taped. Perforation of the vapour barrier shall be sealed before placing concrete.

Where the depth of the footing trench is greater 800mm, the vapour barrier shall extend 800mm down the sides only.

Where the depth of the footing trench is greater than 1000mm, provide two layers of vapour barrier to the full depth each side.

Where strip footings are continuous beyond the slab (eg carports, footings), the sides and base of the strip footings shall be lined with a vapour barrier for a distance of not less than 800mm beyond the edge of the slab, unless the depth exceeds 800 mm.

The vapour barrier is not mandatory under exposed slabs (carports, verandahs, etc) where they are poured separately to the footing beams. Where future enclosure of carport etc, is proposed, it is required to provide the vapour barrier.

## **LEVEL PINS**

Level pins which puncture the vapour barrier can be used in the footing trenches but not in the area of the floor slab. Level pins shall have 30mm cover to all reinforcing.

Pins used to support service pipes must be driven 30mm(min) below the finished floor level, and be fully taped to the pipe.

## **SERVICE PENETRATIONS AND FLEXIBLE CONNECTIONS**

Service penetrations are permitted through footings subject to the following:  
50mm (min) to be provided between the pipe and reinforcement.

Pipes shall be located in the middle third of the footing beam. Penetrations outside this area may require additional concrete depth or reinforcement. Where reinforcement is cut to suit the location of pipes, additional reinforcement shall be provided, correctly placed and lapped with the main reinforcement. Where the pipe is close to the bottom bars and adequate cover is not available, additional excavation must occur below the pipe and the bottom rods placed and lapped so as to provide the correct cover.

Pipes embedded within the floor slab shall have 100mm of cover over the pipe. Where this cannot be achieved the minimum cover may be reduced to 40mm provided that the reinforcing fabric is continuous over the pipe, and the sand/rubble base is excavated to provide 100mm of concrete all around the remainder of the pipe.

Holes provided for service penetrations through the floor slab shall not exceed 600mm square.

## **EDGE REBATES**

Edge rebates shall be provided to all masonry cavity or veneer walls.

The minimum rebate depth shall be 25mm. This may be increased to suit masonry coursing. The maximum rebate depth is 100mm.

Rebates are not required in the following construction:

- single leaf masonry walls
- timber frame clad walls
- walls on strip footings.

## **HEATING CABLES AND PIPES**

Electric heating cables may be embedded in the slab without any increase in thickness.

Hydronic heating pipes may be embedded in the slab, if the slab thickness is increased by 25mm. An additional layer of fabric (SL42 or larger) is to be provided under the pipes. The main fabric shall be placed with 20mm cover to the top face.

## **SLABS ON FILL**

Fill placed under a slab, (existing on site or placed during siteworks) except where the slab has been designed as suspended, shall consist of controlled fill or rolled fill.

Controlled fill is material that has been placed and compacted within a defined moisture range, in layers by Compaction equipment to defined density requirement. Except as provided below, controlled fill shall be placed in accordance with engineering principles. One test for each 100m<sup>2</sup> of building area ( or 3 tests minimum per visit - whichever is greater) is required for every 600mm layer.

Sand fill, well compacted in not more than 300mm layers by a vibrating plate or vibrating roller, shall be deemed to comply with this requirement. Sand fill shall achieve a blow count of at least greater than 7 per 300mm using a penetrometer to AS 1289.F3.3.

Non-sand fill well compacted in not more than 150mm layers by a mechanical roller, shall be deemed to comply with this requirement. Non-sand fill shall be compacted to 95% maximum dry density when tested in accordance with AS 1289 E.1.1. (standard).

The fill shall be tested to ensure that it has been compacted to the specified density, OR

The slab shall be increased in thickness to 125mm and reinforced with an additional layer of fabric placed with 30mm cover to the vapour barrier.

## **TERMITE PROTECTION**

Termite protection systems shall be in accordance with AS3660.1.



## **EARTHWORKS**

Unless otherwise specified, selected approved site materials, excluding topsoil or organic-bearing soil, may be used for compacted filling. Where site materials are unsuitable due to their nature or moisture content, quarry rubble or other approved filling material may be used. The specified standard of compaction shall be provided to an area extending not less than 1m beyond the perimeter of the building, and shall also be provided beneath any filled pavements.

Care must be taken when using vibrating and/or impact rollers if there are buildings close to the area being compacted.

Where the surface slope of an area which is to receive filling is steeper than 1 (vertical) in 8 (horizontal), a series of level benches shall be excavated along the contour over the whole of the area which will receive filling. This will stabilise the fill against downhill slip.

The footings specified in the construction report have been proportioned assuming that the contractor will achieve the specified compaction, no footing beam shall be founded in the filling unless the Engineer has checked its compaction standard and given his written acceptance of its compliance with the specifications.

If shallow filling is existing or placed without the use of appropriate compaction equipment, the filling will be assumed to be incapable of supporting any building load. Accordingly any concrete slab over such filling will have increased thickness and reinforcement while trenched/bored piers founded into firm natural ground may also be specified for the footings (including waffle type). The Engineer may waive this requirement if on inspection and/or checking of the filling shows it will be able to support the design loads. Settlement of uncompacted fill can lead to damage to buildings, services, pavements, etc.

## **EXCAVATOR**

It is imperative that the owner provide sufficient supervision of the cut and fill operation in order to ensure that satisfactory completion of the siteworks and drainage scheme proposal are adhered to.

Vegetation and roots must be scraped off and removed from the building area at the commencement of cutting and filling. Where trees and large shrubs are removed, the surrounding soils must be watered to raise the moisture content to that of the other soils under the proposed building.

Where bank heights do not exceed 2.0m and the natural slope of the site does not exceed 1 in 5, the batter slopes recommended in table A3 may be used.

## **DESIRABLE BATTER SLOPES**

<b>MATERIAL</b>	<b>SURFACE SLOPE (MAX)</b>
Heavy clay	1 vertical to 1.0 horizontal
Sands and cohesionless soils	1 vertical to 2.0 horizontal
Sandy silts and silty clays	1 vertical to 1.5 horizontal
Weathered rock in good condition	1 vertical to 0.5 horizontal
Sound rock	Nearly vertical

The extent of the cut and fill outside the building line shall not be exceeded with respect to the following requirements. Generally cut or fill within the property (ie not on boundary) should not exceed 900mm unless a suitable retaining wall is specified.

Cut or fill on the boundary shall not exceed 600mm, unless a suitable retaining wall is specified and shall not undermine any structure that exists on an adjacent property.

Filling used under a slab, (whether existing on site or placed during site works) except where the slab has been designed as suspended, shall consist of controlled fill or rolled fill.

Controlled fill is material that has been placed and compacted, within a defined moisture range, in layers by compaction equipment to a defined density requirement. Except as provided below, controlled fill shall be placed in accordance with engineering principles. One test for each 100m<sup>2</sup> of building area (or 3 tests minimum per visit - whichever is greater) is required for every 600mm layer.

Sand fill, well compacted in not more than 300mm layers by a vibrating plate or vibrating roller, shall be

deemed to comply with this requirement. Sand fill shall achieve a blow count of at least greater than per 300mm using a penetrometer to AS 1289.F3.3.

Non-sand fill well compacted in not more than 150mm layers by a mechanical roller, shall be deemed to

comply with this requirement. Non-sand fill shall be compacted to 95% maximum dry density when tested in accordance with AS 1289 E.1.1.(standard).

Rolled fill consists of material compacted in layers of repeated rolling by an excavator. Rolled fill shall not exceed 300mm compacted in layers not more than 150mm.

Embankments shall be protected from damage arising from surface erosion or ground water flow.

Slopes and grades of the cut bench or platform shown on the drainage plan are to be strictly adhered to, to allow for the site to be drained. In particular, a temporary toe may need to be cut in the ground at the base of cut banks to provide a drain. This drain should fall sufficiently to the low side so that water does not pond. On sites where erosion may be a critical problem provision of trench drains above the cut bank may be required to prevent erosion during the construction phase.

If a retaining wall has been specified, the cut or fill must not exceed the design height/requirements of the wall.

### **SITE PREPARATION**

After completion of primary earthworks the site must be prepared for footing construction. Ideally, for raft construction, or strip footings where the soil surface under the floors is sealed, soils beneath the building area should be kept in as moist a condition as possible. For strip footings where the soil surface under the floors is not sealed, the building area should be kept as dry as possible.

For concrete floors provide a working surface of a minimum compacted thickness of 100mm (50mm for waffle rafts) of quarry rubble or other approved material. The selected material must be free of any sharp aggregate which could damage the vapour barrier. If sharp aggregate is evident on the surface a blinding layer of sand is recommended.

On class H or E sites pre-wetting of soil under slabs is most advantageous, especially if construction occurs in summer or autumn. In some cases pre-wetting of the site will be mandatory, but in all cases (except as noted in 3.1) it is a desirable procedure aimed at reducing the future heave of reactive clays. Similarly, pre-wetting of the site is mandatory where a new structure is proposed to be constructed over a site which had previously been occupied by a building with suspended ground floors (eg timber floors, concrete slabs on brick build up, etc). Pre-wetting can best be achieved by watering the site before under-floor fill is placed, using garden sprinklers for a minimum of 2 hours daily for 10 to 14 days immediately prior to commencement of construction. The amount of pre-wetting will vary considerably depending on seasonal and soil conditions, and it may be possible to eliminate watering if construction commences after prolonged rain, or during late winter or spring. Care must be taken to ensure that the soil does not become too saturated, otherwise siteworks may become difficult. After watering, the under-floor filling must be placed within a period of not more than 3 days.

### **TERMITE PROTECTION**

Termite Protection System shall be provided in accordance with AS3660.1.

The system provided can only minimise the likelihood of termite infestation and it is stressed that termites can bridge or breach barrier systems.

Regular inspections in accordance with the code must be carried out by the owner.

### **SITE DRAINAGE**

Due to differential moisture variations (ie wetting or drying) being the main cause of movement in clay soils, the provision of effective drainage is of great importance as it reduces the possibility of footings having to cope with extreme soil movements. The following outlines common causes of moisture variations.

### **WETTING UP**

Leaking sewer, water or stormwater pipes.

Downpipes discharging too close to the building.

Sloping sites and inadequate drainage causing water to pond or collect close to the building.

Seepage on sloping sites caused by water travelling on the topsoil-clay, or soil-rock, interface. Cut-off drains are required in this situation.

Garden or lawn watering immediately adjacent to the footings. As a general rule this is not acceptable and

must not be done without the explicit approval of the Engineer.  
 Over-watering of gardens and lawns.  
 Inadequate soakage trenches.  
 Flooding during, and after, building construction.

## DRYING OUT

The non-provision of paving, particularly on the north and west sides of the building, coupled with the non-establishment of a garden.

A change from an established garden situation to a native garden coupled with a substantially reduced level of watering.

The most common cause of drying out is that caused by trees being planted too close to the footings. Trees and large shrubs require substantial amount of water, and if the soil near the tree dries out, the roots will extend in search of soil moisture. Clays will shrink as they dry, and they may cause the building to settle.

Removal of large trees creates the opposite problem. As soil moisture is gradually restored, clays swell and may lift footings.

Many factors determine the extent of clay-drying by trees and the more important are the soil type, the size and number of trees and their species. Trees obtain moisture from the soil through roots which spread sideways and the drying zone is influenced by the extent of these roots. For single trees, the drying zone is usually one-half to twice the tree height, but the zone may be larger for groups or rows of trees. Although it is known that the species can influence the extent and severity of the drying zone, little definite information is available. Some Australian trees are particularly efficient in extracting water from very dry soils and can be more dangerous than non-Australian species. The effect of tree drying on the amount of movement is also related to the reactivity of the clay. To minimise the risk of damage, trees (especially groups of trees) shall not be planted near the building on a reactive clay site, and the following limits shall comply:

$d = 1.5 \text{ h}$  for class E sites

$d = 1.0 \text{ h}$  for class H sites

$d = 0.75 \text{ h}$  for class M sites

$d$  is the distance of the tree from the building, and  $h$  is the mature height of the tree. These values shall be increased by 50% if the trees are in a dense group. These suggested limits mean that on the average suburban block, trees that grow higher than 8 to 9m are often impractical unless the owner accepts the risk of some damage to the building.

Due to the above factors the following work must be carried out, to minimise the detrimental effects of moisture variations.

Establish lawns and gardens around the building as soon as possible, and certainly within a maximum of 4 months from completion of the building.

Ensure all roof stormwater is discharged to the street where possible or alternatively discharged on the low side of the site not less than 6m from the building, but not so as to concentrate a flow of water onto neighbouring property. A contour and drainage plan will be provided if requested.

Large garden beds should not be located near the building. This will avoid the possibility of introducing too much moisture to the foundation soil by overwatering. The area near the building should be planned for paths or covered with gravel and plastic sheeting. Gardens and lawns should be watered adequately but not excessively. Uniform, consistent watering can be important to prevent damage to the foundation during dry spells such as droughts or dry summers.

After footings have been completed the site surface adjacent to the footings shall be graded by cutting and/or filling to provide a fall away from the building for a distance of not less than 1.0m. Any channel formed must be graded to discharge all run-off away from the building area. Generally any cut area shall be drained via a surface drain at the base of the cut embankment discharging to the low side of the site. On steep or large sites where significant catchment area is present uphill from the building, a surface drain must also be constructed across the top of the embankment. Water must not pond adjacent to footings. If ponding occurs this water must be pumped out immediately and the above grading and drainage implemented at once.

Due to constraints of site and building levels, the cover to underground pipes may be less than the manufacturer's specification. This is necessary to prevent very significant cost increases in site works which would otherwise be required. Some damage (which shall be repaired immediately) may occur to pipes if trenching for other services is undertaken, or if vehicles travel over garden areas.

Modifications to site levels can be made if the owner does not accept these conditions.

Where site drainage designs are not included with this report, they shall be prepared by others experienced in site drainage, and shall comply with the details and requirements of this report.

## SUB-SURFACE DRAINAGE

Where specified in the recommendations or shown on the site drainage plan, sub- surface drainage shall be installed in accordance with any details provided. Note: potential seepage or sub-surface drainage problems cannot always be recognised from the results of the site investigation. All of the potential problems with respect to sub-surface water flow or seepage may not be evident at the time of the investigation, or even at the time of construction, however, it may become evident after the building has been occupied for the first winter.

## **PAVING REQUIREMENTS**

Pavements shall be not less than 900mm in width (and preferably 1200mm in width for class E sites). Concrete pavements shall comply with table A4. (Refer also 5.4)

### **CONCRETE PAVEMENTS**

		FOOT TRAFFIC ONLY		LIGHT VEHICLE TRAFFIC	
SOIL CLASSIFICATION	MINIMUM* CROSS FALL	THICKNESS (mm)	REINFORCEMENT	THICKNESS (mm)	REINFORCEMENT
A or S	1 in 30	75	SL52 [2m]	100	SL62 [3m]
M	1 in 20	75	SL52 [2m]	100	SL62 [3m]
H	1 in 20	75	SL62 [2m]	110	SL72 [4m]
E	1 in 20	100	SL62 [3m]	120	SL72 [4m]

The paving and the ground in the immediate vicinity of the building shall be graded to slope 50mm away from the building area, a distance of 1 metre from the house.

\*The minimum cross fall may be dictated by the maximum allowable stated in AS 1428 Design for Access & Mobility.

[ ] Indicates maximum distance between control joints (noting that length of adjacent sides should be in the ratio of 1 to 1.3maximum)

Control joints shall be provided in accordance with the details attached.

Alternative pavements may be provided, eg brick or block pavers, hotmix, etc. Construction must be in accordance with the manufacturer's or supplier's specifications, with minimum cross falls as noted above.

Where the class of soil is H or E it is recommended that paving be constructed at the end of winter, when the site soils are wet, so that crossfalls constructed in the paving will not reduce. It is important, however, if the house is occupied during a winter period and no paving provided, that the soil surface around the perimeter of the house is maintained in a well drained state until such time as paving is installed.

If, on these soils, it is necessary to construct paving at other times of the year, eg the end of summer, the crossfall provided should be not less than twice that is indicated in the table above.

Pavements shall have a minimum set down below the rebate of 75mm.

Paving shall be constructed on a firm clean base. Ensure that all building debris is removed from the perimeter of the building. Provide a compacted quarry rubble base if necessary to elevate paving and achieve the necessary crossfall.

The paving shall not be constructed above any damp-proof course or built-in damp- proof membrane, unless other adequate damp-proofing measures are taken.

On reactive soil sites it may be found that paving separates horizontally from the perimeter of the building. It is important that any gaps between the building and paving be immediately sealed with a flexible mastic sealant.

## **BUILDING CONSTRUCTION AND ARTICULATION**

It should be realised that there are many factors which affect the performance of the building. Visible cracking can be caused by shrinkage and warping of timbers, crazing of plaster, contraction and expansion of masonry and shrinkage of concrete, as well as the most commonly attributed cause via footing distortion. Generally minor cracking is of no significance and will not detract from the performance or durability of the building. It is uneconomical if not impossible to eliminate all such imperfections.

It is generally recommended that masonry walls be articulated at all or some openings. Articulation involves the incorporation of movement joints (control joints). The provision of all control joints at locations specified in the report is mandatory. Where no control joints are specified for footing movement requirements, control joints must be provided in walls longer than 12m.

Where new masonry abuts existing masonry, full height mastic filled control joints shall be used.

Because it is very difficult to prevent tilting of an extension relative to the existing building, the extension must be constructed so as to permit relative movement between the new and the existing building. This provision for relative movement applies to all work including roofs, floors, tiling, wall and ceiling finishes, etc.

## **SERVICES**

Service trenches must be positioned so that the distance between the trench and the edge of the footing is not less than the depth of the trench below the base of the footing. If this cannot be achieved the footings must be pierced as indicated on the detail sheets.

Service penetrations are permitted through footings subject to the requirements in the Construction Report.

All service trenches both inside and outside the perimeter of the building must be carefully backfilled with approved material, and compacted.

The trenches should be sloped away from the building, and should be backfilled with clay in the top 300mm within 1.5m of the building, and where pipes pass under the footings, the trench should be backfilled with clay or concrete to prevent the ingress of water beneath the footing.

On class H or E sites special care must be taken to ensure that flexible service connections are used so as to allow for differential soil movement. An expansion coupling must be provided immediately outside the building, where the sewer connection penetrate the footing beam and at the junction of the branch to the main sewer pipe.

On class H, E or P (filled sites) sites, a flexible junction must be provided where downpipes connect into the underground stormwater drainage pipes. A sleeved fitting is adequate, but this should be sealed with silicone on class H or E sites.

Where pipes pass through a footing beam they must be lagged (ie wrapped) in accordance with the following:

- |            |  |
|------------|--|
| Class S, M | - Provide 20mm thick lagging (not necessarily closed cell) |
| Class H, P | - Provide 20mm thick closed cell polyethylene lagging.     |
| Class E    | - Provide 40mm thick closed cell polyethylene lagging.     |

## CONSTRUCTION NOTES

### GENERAL

These notes must be read together with the architectural drawings, the specifications and the Footing Construction Report.

All dimensions and levels shall be confirmed with the architectural drawings and/or checked on site.

Engineering drawings must not be scaled.

The builder and/or agent shall be responsible for maintaining the stability of all structures and any elements until their completion and shall ensure that no part of structures or any elements are overstressed by excessive loading.

### CONCRETE

Concrete construction to comply with AS 3600.

Concrete grade shall be as follows:

- . Grade N20 (ie 20 MPa) to slab on ground, footings protected by vapour barrier and residential strip / pad footings.
- . Grade N25 to suspended slabs, beams, columns and non- residential footings unprotected by vapour barrier.
- . Grade N32 to members exposed to exterior environments.
- . Maximum aggregate 20mm.
- . Slump limit 80mm.

For sites located within 1 km of the sea or corrosive water (including areas west of the corrosion line marked on The wind speed map), exposed surfaces such as verandahs, balconies and carports, shall be protected with a suitable

Topping, sealer, tiles, or the concrete grade must be a minimum of N40.

Construction joints to be thoroughly scabbled of all poorly compacted material. Vertical joints to be poured against shuttering.

All concrete is to be properly cured by keeping all exposed surfaces in a moist, damp condition for at least the first 7 days after placing or by spraying with an approved curing compound, (depending on compatibility with proposed surface finishes).

Minimum stripping times:

- . Slab-soffit 14 days, props 21 days
- . Beams-sides 3 days, soffit 21 days
- . Columns and Walls - (unloaded) 3 days

Reinforcement designations are as follows:

- . **R - Plain round structural bar to AS1302**
- . **N - Hot rolled deformed bar to AS4671**
- . **Y - Hot rolled deformed bar to AS1302**
- . **SL - Square ribbed fabric to AS4671**
- . **F - Hard drawn wire fabric to AS1304**
- . **RL - Rectangular ribbed fabric to AS4671**
- . **W - Hard drawn wire bar to AS1303**
- . **RF - Ribbed fabric AS1302**

Provide 0.2mm High Impact Resistance branded polythene membrane to AS2870 to underside of floor slabs on ground, all laps to be 300mm and sealed with a 50mm wide strip of pressure-sensitive waterproof tape.

All filling must be of non-clay material compacted in 200mm layers to 98% maximum dry density.

Minimum reinforcement lap length shall be:

Bar Size	Lap Length (mm)
<b>N12</b>	<b>500</b>
<b>N16</b>	<b>750</b>
<b>N20</b>	<b>1000</b>
<b>N24</b>	<b>1450</b>
<b>N28</b>	<b>1800</b>
<b>N32</b>	<b>2150</b>
<b>N36</b>	<b>2600</b>

Laps to slab mesh to be one (1) full mesh panel plus 25mm.

Clear concrete cover to reinforcement, (including fitments and wire ties), shall be:

- . Slab on fill - 30mm bottom and sides, 20mm top.
- . Footings protected by vapour barrier - 40mm bottom and sides, 20mm top.
- . Residential footings unprotected by vapour barrier - 40mm top, 50mm bottom and sides.

- Non-residential footings unprotected by damp-proof membrane - 50mm top, bottom and sides
- Suspended slabs, beams and columns - 20mm internal, 40mm external.

Concrete is to be kept free of load bearing brickwork by two (2) layers of a suitable membrane.  
 Brickwork must not be built on concrete slabs or beams until formwork and supporting have been removed.  
 Tension cracks may occur in slabs, apply suitable sealant for exposed surfaces.  
 Provide 10mm isolation joints where concrete is adjacent steelwork/masonry. Provide suitable filler and sealant.

## MASONRY

Masonry construction is to comply with AS 3700.

Minimum characteristic unconfined compressive strength of units to be as follows:

Clay Bricks	40MPa
Concrete Bricks	10MPa
Concrete Hollow Blocks	15MPa
Mortar: Brickwork	1 : 0.25 : 3 (Cement : Lime : Sand)
Brickwork	1 : 0.5 : 4.5

Infill concrete grout to reinforced masonry to be grade 15, slump 230 +/- 30, 10mm aggregate.  
 For Hollow block retaining walls, all cores are to be grouted.  
 Grouting to reinforced masonry shall be compacted by rodding with a plain round bar.  
 All air pockets and bubbles must be displaced during compaction. However, care must be taken to avoid damaging or dislodging the masonry or reinforcement while compacting the grout.

## STEELWORK

All to comply with AS 4100, AS/NZ 1538 and AS 2327.  
 All welding to comply with AS 1554, parts 1, 2 & 3.  
 All fillet welds to be 6mm (category SP unless noted otherwise) extending the full length of the edges in contact, except where plate thicknesses are less than 6mm, use a weld size to match.  
 All bolts shall be H D Bolts, nuts and all other bolts and washers required for the erection of the steelwork, holes for H D Bolts to be 3mm oversize, holes for other bolts to be no more than 2mm oversize.  
 All bolting shall comply with AS4100 and be grade 8.8/S uno.  
 All base plates, H D bolts and columns in contact with ground to have concrete cover of 75mm minimum.  
 Minimum edge distance (taken from centre of fastener) shall be:

- Sheared or hand flame cut edge - 1.75D
- Rolled plate, machine flame cut sawn or planed edge - 1.50D
- Rolled edge of a rolled section - 1.25D

(Where 'D' is the nominal diameter of the fastener).

Steelwork to be concrete encased must first be wrapped with SL41 mesh. The reinforcement is to be placed 25mm from the steelwork.

Provide a 10mm clearance between vertical faces of steelwork and adjacent masonry walls. Provide W6 ties between steelwork and masonry at 600 c/c (max).

All steelwork to be adequately propped and braced during construction until all permanent bracing, masonry and cladding has been erected.

All cold formed sections are to be constructed in accordance with the manufacturers specifications.

Steelwork Protective coatings to be:

- Exposed external steelwork less than 1km from the sea, or corrosive water or in areas west of the corrosion line marked on the wind speed map. : Hot-Dip Galvanized, and painted with an approved system.
- Exposed external steelwork (not exposed to corrosive environment) : Hot-Dip Galvanized, 'Dimet' treated or one coat sprayed Inorganic zinc silicate paint over class 2.5 abrasive blast surface.
- Steelwork acting as downpipe or gutter : Hot-Dip Galvanized.
- Internal steelwork (not exposed to moisture or corrosive environment) : Red oxide zinc chromate primer (Rozc) over wire brush surface.

Two (2) copies of shop detail drawings must be submitted to the engineer to review and approve prior to the commencement of fabrication. The review does not cover dimensions.

## TIMBER

All to comply with AS 1720 and AS 1684.

## EARTHWORKS

All to comply with AS3798 Guidelines.

## **SURFACE PROTECTIVE COATINGS**

All structural members and surfaces, ie. beams, columns, walls, floors, ceilings, roofs both internally and externally shall be coated with an approved protective coating to suit their intended use/exposure environment, which is to be applied in strict accordance with the manufactures recommendations and specifications.

## **TERMITE PROTECTION**

Termite protection system shall be in accordance with AS3660.1.

## **SITE INSPECTIONS**

Must be carried out at the following stages:

After site preparation and trenching for the footing beams.

After the placement of reinforcement, prior to the pouring of any concrete.



# Foundation Maintenance and Footing Performance: A Homeowner's Guide



BTF 18  
replaces  
Information  
Sheet 10/91

Buildings can and often do move. This movement can be up, down, lateral or rotational. The fundamental cause of movement in buildings can usually be related to one or more problems in the foundation soil. It is important for the homeowner to identify the soil type in order to ascertain the measures that should be put in place in order to ensure that problems in the foundation soil can be prevented, thus protecting against building movement.

This Building Technology File is designed to identify causes of soil-related building movement, and to suggest methods of prevention of resultant cracking in buildings.

## Soil Types

The types of soils usually present under the topsoil in land zoned for residential buildings can be split into two approximate groups – granular and clay. Quite often, foundation soil is a mixture of both types. The general problems associated with soils having granular content are usually caused by erosion. Clay soils are subject to saturation and swell/shrink problems.

Classifications for a given area can generally be obtained by application to the local authority, but these are sometimes unreliable and if there is doubt, a geotechnical report should be commissioned. As most buildings suffering movement problems are founded on clay soils, there is an emphasis on classification of soils according to the amount of swell and shrinkage they experience with variations of water content. The table below is Table 2.1 from AS 2870, the Residential Slab and Footing Code.

## Causes of Movement

### Settlement due to construction

There are two types of settlement that occur as a result of construction:

- Immediate settlement occurs when a building is first placed on its foundation soil, as a result of compaction of the soil under the weight of the structure. The cohesive quality of clay soil mitigates against this, but granular (particularly sandy) soil is susceptible.
- Consolidation settlement is a feature of clay soil and may take place because of the expulsion of moisture from the soil or because of the soil's lack of resistance to local compressive or shear stresses. This will usually take place during the first few months after construction, but has been known to take many years in exceptional cases.

These problems are the province of the builder and should be taken into consideration as part of the preparation of the site for construction. Building Technology File 19 (BTF 19) deals with these problems.

### Erosion

All soils are prone to erosion, but sandy soil is particularly susceptible to being washed away. Even clay with a sand component of say 10% or more can suffer from erosion.

### Saturation

This is particularly a problem in clay soils. Saturation creates a bog-like suspension of the soil that causes it to lose virtually all of its bearing capacity. To a lesser degree, sand is affected by saturation because saturated sand may undergo a reduction in volume – particularly imported sand fill for bedding and blinding layers. However, this usually occurs as immediate settlement and should normally be the province of the builder.

### Seasonal swelling and shrinkage of soil

All clays react to the presence of water by slowly absorbing it, making the soil increase in volume (see table below). The degree of increase varies considerably between different clays, as does the degree of decrease during the subsequent drying out caused by fair weather periods. Because of the low absorption and expulsion rate, this phenomenon will not usually be noticeable unless there are prolonged rainy or dry periods, usually of weeks or months, depending on the land and soil characteristics.

The swelling of soil creates an upward force on the footings of the building, and shrinkage creates subsidence that takes away the support needed by the footing to retain equilibrium.

### Shear failure

This phenomenon occurs when the foundation soil does not have sufficient strength to support the weight of the footing. There are two major post-construction causes:

- Significant load increase.
- Reduction of lateral support of the soil under the footing due to erosion or excavation.
- In clay soil, shear failure can be caused by saturation of the soil adjacent to or under the footing.

## GENERAL DEFINITIONS OF SITE CLASSES

Class	Foundation
A	Most sand and rock sites with little or no ground movement from moisture changes
S	Slightly reactive clay sites with only slight ground movement from moisture changes
M	Moderately reactive clay or silt sites, which can experience moderate ground movement from moisture changes
H	Highly reactive clay sites, which can experience high ground movement from moisture changes
E	Extremely reactive sites, which can experience extreme ground movement from moisture changes
A to P	Filled sites
P	Sites which include soft soils, such as soft clay or silt or loose sands; landslip; mine subsidence; collapsing soils; soils subject to erosion; reactive sites subject to abnormal moisture conditions or sites which cannot be classified otherwise

### Tree root growth

Trees and shrubs that are allowed to grow in the vicinity of footings can cause foundation soil movement in two ways:

- Roots that grow under footings may increase in cross-sectional size, exerting upward pressure on footings.
- Roots in the vicinity of footings will absorb much of the moisture in the foundation soil, causing shrinkage or subsidence.

## Unevenness of Movement

The types of ground movement described above usually occur unevenly throughout the building's foundation soil. Settlement due to construction tends to be uneven because of:

- Differing compaction of foundation soil prior to construction.
- Differing moisture content of foundation soil prior to construction.

Movement due to non-construction causes is usually more uneven still. Erosion can undermine a footing that traverses the flow or can create the conditions for shear failure by eroding soil adjacent to a footing that runs in the same direction as the flow.

Saturation of clay foundation soil may occur where subfloor walls create a dam that makes water pond. It can also occur wherever there is a source of water near footings in clay soil. This leads to a severe reduction in the strength of the soil which may create local shear failure.

Seasonal swelling and shrinkage of clay soil affects the perimeter of the building first, then gradually spreads to the interior. The swelling process will usually begin at the uphill extreme of the building, or on the weather side where the land is flat. Swelling gradually reaches the interior soil as absorption continues. Shrinkage usually begins where the sun's heat is greatest.

## Effects of Uneven Soil Movement on Structures

### Erosion and saturation

Erosion removes the support from under footings, tending to create subsidence of the part of the structure under which it occurs. Brickwork walls will resist the stress created by this removal of support by bridging the gap or cantilevering until the bricks or the mortar bedding fail. Older masonry has little resistance. Evidence of failure varies according to circumstances and symptoms may include:

- Step cracking in the mortar beds in the body of the wall or above/below openings such as doors or windows.
- Vertical cracking in the bricks (usually but not necessarily in line with the vertical beds or perpendes).

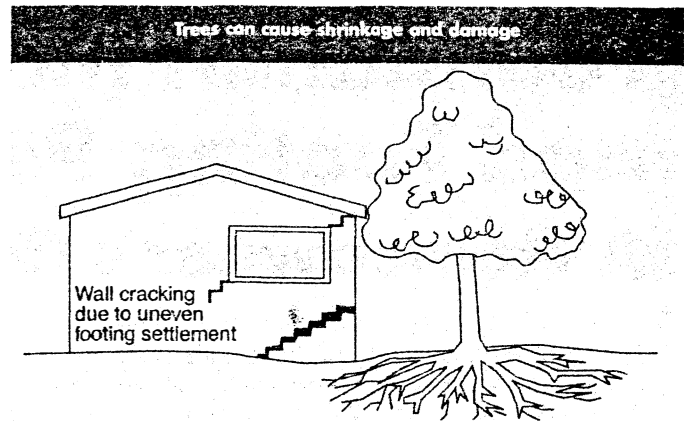
Isolated piers affected by erosion or saturation of foundations will eventually lose contact with the bearers they support and may tilt or fall over. The floors that have lost this support will become bouncy, sometimes rattling ornaments etc.

### Seasonal swelling/shrinkage in clay

Swelling foundation soil due to rainy periods first lifts the most exposed extremities of the footing system, then the remainder of the perimeter footings while gradually permeating inside the building footprint to lift internal footings. This swelling first tends to create a dish effect, because the external footings are pushed higher than the internal ones.

The first noticeable symptom may be that the floor appears slightly dished. This is often accompanied by some doors binding on the floor or the door head, together with some cracking of cornice mitres. In buildings with timber flooring supported by bearers and joists, the floor can be bouncy. Externally there may be visible dishing of the hip or ridge lines.

As the moisture absorption process completes its journey to the innermost areas of the building, the internal footings will rise. If the spread of moisture is roughly even, it may be that the symptoms will temporarily disappear, but it is more likely that swelling will be uneven, creating a difference rather than a disappearance in symptoms. In buildings with timber flooring supported by bearers and joists, the isolated piers will rise more easily than the strip footings or piers under walls, creating noticeable doming of flooring.



As the weather pattern changes and the soil begins to dry out, the external footings will be first affected, beginning with the locations where the sun's effect is strongest. This has the effect of lowering the external footings. The doming is accentuated and cracking reduces or disappears where it occurred because of dishing, but other cracks open up. The roof lines may become convex.

Doming and dishing are also affected by weather in other ways. In areas where warm, wet summers and cooler dry winters prevail, water migration tends to be toward the interior and doming will be accentuated, whereas where summers are dry and winters are cold and wet, migration tends to be toward the exterior and the underlying propensity is toward dishing.

### Movement caused by tree roots

In general, growing roots will exert an upward pressure on footings, whereas soil subject to drying because of tree or shrub roots will tend to remove support from under footings by inducing shrinkage.

### Complications caused by the structure itself

Most forces that the soil causes to be exerted on structures are vertical – i.e. either up or down. However, because these forces are seldom spread evenly around the footings, and because the building resists uneven movement because of its rigidity, forces are exerted from one part of the building to another. The net result of all these forces is usually rotational. This resultant force often complicates the diagnosis because the visible symptoms do not simply reflect the original cause. A common symptom is binding of doors on the vertical member of the frame.

### Effects on full masonry structures

Brickwork will resist cracking where it can. It will attempt to span areas that lose support because of subsided foundations or raised points. It is therefore usual to see cracking at weak points, such as openings for windows or doors.

In the event of construction settlement, cracking will usually remain unchanged after the process of settlement has ceased.

With local shear or erosion, cracking will usually continue to develop until the original cause has been remedied, or until the subsidence has completely neutralised the affected portion of footing and the structure has stabilised on other footings that remain effective.

In the case of swell/shrink effects, the brickwork will in some cases return to its original position after completion of a cycle, however it is more likely that the rotational effect will not be exactly reversed, and it is also usual that brickwork will settle in its new position and will resist the forces trying to return it to its original position. This means that in a case where swelling takes place after construction and cracking occurs, the cracking is likely to at least partly remain after the shrink segment of the cycle is complete. Thus, each time the cycle is repeated, the likelihood is that the cracking will become wider until the sections of brickwork become virtually independent.

With repeated cycles, once the cracking is established, if there is no other complication, it is normal for the incidence of cracking to stabilise, as the building has the articulation it needs to cope with the problem. This is by no means always the case, however, and monitoring of cracks in walls and floors should always be treated seriously.

Upheaval caused by growth of tree roots under footings is not a simple vertical shear stress. There is a tendency for the root to also exert lateral forces that attempt to separate sections of brickwork after initial cracking has occurred.

The normal structural arrangement is that the inner leaf of brickwork in the external walls and at least some of the internal walls (depending on the roof type) comprise the load-bearing structure on which any upper floors, ceilings and the roof are supported. In these cases, it is internally visible cracking that should be the main focus of attention, however there are a few examples of dwellings whose external leaf of masonry plays some supporting role, so this should be checked if there is any doubt. In any case, externally visible cracking is important as a guide to stresses on the structure generally, and it should also be remembered that the external walls must be capable of supporting themselves.

#### Effects on framed structures

Timber or steel framed buildings are less likely to exhibit cracking due to swell/shrink than masonry buildings because of their flexibility. Also, the doming/dishing effects tend to be lower because of the lighter weight of walls. The main risks to framed buildings are encountered because of the isolated pier footings used under walls. Where erosion or saturation cause a footing to fall away, this can double the span which a wall must bridge. This additional stress can create cracking in wall linings, particularly where there is a weak point in the structure caused by a door or window opening. It is, however, unlikely that framed structures will be so stressed as to suffer serious damage without first exhibiting some or all of the above symptoms for a considerable period. The same warning period should apply in the case of upheaval. It should be noted, however, that where framed buildings are supported by strip footings there is only one leaf of brickwork and therefore the externally visible walls are the supporting structure for the building. In this case, the subfloor masonry walls can be expected to behave as full brickwork walls.

#### Effects on brick veneer structures

Because the load-bearing structure of a brick veneer building is the frame that makes up the interior leaf of the external walls plus perhaps the internal walls, depending on the type of roof, the building can be expected to behave as a framed structure, except that the external masonry will behave in a similar way to the external leaf of a full masonry structure.

### Water Service and Drainage

Where a water service pipe, a sewer or stormwater drainage pipe is in the vicinity of a building, a water leak can cause erosion, swelling or saturation of susceptible soil. Even a minuscule leak can be enough to saturate a clay foundation. A leaking tap near a building can have the same effect. In addition, trenches containing pipes can become watercourses even though backfilled, particularly where broken rubble is used as fill. Water that runs along these trenches can be responsible for serious erosion, interstrata seepage into subfloor areas and saturation.

Pipe leakage and trench water flows also encourage tree and shrub roots to the source of water, complicating and exacerbating the problem.

Poor roof plumbing can result in large volumes of rainwater being concentrated in a small area of soil:

- Incorrect falls in roof guttering may result in overflows, as may gutters blocked with leaves etc.

- Corroded guttering or downpipes can spill water to ground.
- Downpipes not positively connected to a proper stormwater collection system will direct a concentration of water to soil that is directly adjacent to footings, sometimes causing large-scale problems such as erosion, saturation and migration of water under the building.

### Seriousness of Cracking

In general, most cracking found in masonry walls is a cosmetic nuisance only and can be kept in repair or even ignored. The table below is a reproduction of Table C1 of AS 2870.

AS 2870 also publishes figures relating to cracking in concrete floors, however because wall cracking will usually reach the critical point significantly earlier than cracking in slabs, this table is not reproduced here.

### Prevention/Cure

#### Plumbing

Where building movement is caused by water service, roof plumbing, sewer or stormwater failure, the remedy is to repair the problem. It is prudent, however, to consider also rerouting pipes away from the building where possible, and relocating taps to positions where any leakage will not direct water to the building vicinity. Even where gully traps are present, there is sometimes sufficient spill to create erosion or saturation, particularly in modern installations using smaller diameter PVC fixtures. Indeed, some gully traps are not situated directly under the taps that are installed to charge them, with the result that water from the tap may enter the backfilled trench that houses the sewer piping. If the trench has been poorly backfilled, the water will either pond or flow along the bottom of the trench. As these trenches usually run alongside the footings and can be at a similar depth, it is not hard to see how any water that is thus directed into a trench can easily affect the foundation's ability to support footings or even gain entry to the subfloor area.

#### Ground drainage

In all soils there is the capacity for water to travel on the surface and below it. Surface water flows can be established by inspection during and after heavy or prolonged rain. If necessary, a grated drain system connected to the stormwater collection system is usually an easy solution.

It is, however, sometimes necessary when attempting to prevent water migration that testing be carried out to establish watertable height and subsoil water flows. This subject is referred to in BTF 19 and may properly be regarded as an area for an expert consultant.

#### Protection of the building perimeter

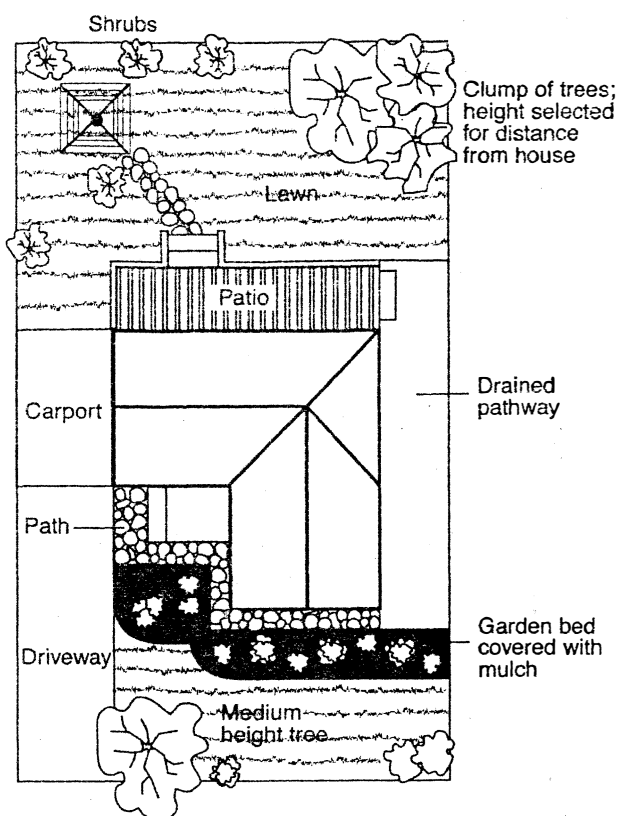
It is essential to remember that the soil that affects footings extends well beyond the actual building line. Watering of garden plants, shrubs and trees causes some of the most serious water problems.

For this reason, particularly where problems exist or are likely to occur, it is recommended that an apron of paving be installed around as much of the building perimeter as necessary. This paving

### CLASSIFICATION OF DAMAGE WITH REFERENCE TO WALLS

Description of typical damage and required repair	Approximate crack width limit (see Note 3)	Damage category
Hairline cracks	<0.1 mm	0
Fine cracks which do not need repair	<1 mm	1
Cracks noticeable but easily filled. Doors and windows stick slightly	<5 mm	2
Cracks can be repaired and possibly a small amount of wall will need to be replaced. Doors and windows stick. Service pipes can fracture. Weathertightness often impaired	5–15 mm (or a number of cracks 3 mm or more in one group)	3
Extensive repair work involving breaking-out and replacing sections of walls, especially over doors and windows. Window and door frames distort. Walls lean or bulge noticeably, some loss of bearing in beams. Service pipes disrupted	15–25 mm but also depend on number of cracks	4

### Gardens for a reactive site



- Water that is transmitted into masonry, metal or timber building elements causes damage and/or decay to those elements.
- High subfloor humidity and moisture content create an ideal environment for various pests, including termites and spiders.
- Where high moisture levels are transmitted to the flooring and walls, an increase in the dust mite count can ensue within the living areas. Dust mites, as well as dampness in general, can be a health hazard to inhabitants, particularly those who are abnormally susceptible to respiratory ailments.

#### The garden

The ideal vegetation layout is to have lawn or plants that require only light watering immediately adjacent to the drainage or paving edge, then more demanding plants, shrubs and trees spread out in that order.

Overwatering due to misuse of automatic watering systems is a common cause of saturation and water migration under footings. If it is necessary to use these systems, it is important to remove garden beds to a completely safe distance from buildings.

#### Existing trees

Where a tree is causing a problem of soil drying or there is the existence or threat of upheaval of footings, if the offending roots are subsidiary and their removal will not significantly damage the tree, they should be severed and a concrete or metal barrier placed vertically in the soil to prevent future root growth in the direction of the building. If it is not possible to remove the relevant roots without damage to the tree, an application to remove the tree should be made to the local authority. A prudent plan is to transplant likely offenders before they become a problem.

#### Information on trees, plants and shrubs

State departments overseeing agriculture can give information regarding root patterns, volume of water needed and safe distance from buildings of most species. Botanic gardens are also sources of information. For information on plant roots and drains, see Building Technology File 17.

#### Excavation

Excavation around footings must be properly engineered. Soil supporting footings can only be safely excavated at an angle that allows the soil under the footing to remain stable. This angle is called the angle of repose (or friction) and varies significantly between soil types and conditions. Removal of soil within the angle of repose will cause subsidence.

### Remediation

Where erosion has occurred that has washed away soil adjacent to footings, soil of the same classification should be introduced and compacted to the same density. Where footings have been undermined, augmentation or other specialist work may be required. Remediation of footings and foundations is generally the realm of a specialist consultant.

Where isolated footings rise and fall because of swell/shrink effect, the homeowner may be tempted to alleviate floor bounce by filling the gap that has appeared between the bearer and the pier with blocking. The danger here is that when the next swell segment of the cycle occurs, the extra blocking will push the floor up into an accentuated dome and may also cause local shear failure in the soil. If it is necessary to use blocking, it should be by a pair of fine wedges and monitoring should be carried out fortnightly.

**This BTF was prepared by John Lewer FAIB, MIAMA, Partner, Construction Diagnostics.**

should extend outwards a minimum of 900 mm (more in highly reactive soil) and should have a minimum fall away from the building of 1:60. The finished paving should be no less than 100 mm below brick vent bases.

It is prudent to relocate drainage pipes away from this paving, if possible, to avoid complications from future leakage. If this is not practical, earthenware pipes should be replaced by PVC and backfilling should be of the same soil type as the surrounding soil and compacted to the same density.

Except in areas where freezing of water is an issue, it is wise to remove taps in the building area and relocate them well away from the building – preferably not uphill from it (see BTF 19).

It may be desirable to install a grated drain at the outside edge of the paving on the uphill side of the building. If subsoil drainage is needed this can be installed under the surface drain.

#### Condensation

In buildings with a subfloor void such as where bearers and joists support flooring, insufficient ventilation creates ideal conditions for condensation, particularly where there is little clearance between the floor and the ground. Condensation adds to the moisture already present in the subfloor and significantly slows the process of drying out. Installation of an adequate subfloor ventilation system, either natural or mechanical, is desirable.

**Warning:** Although this Building Technology File deals with cracking in buildings, it should be said that subfloor moisture can result in the development of other problems, notably:

The information in this and other issues in the series was derived from various sources and was believed to be correct when published.

The information is advisory. It is provided in good faith and not claimed to be an exhaustive treatment of the relevant subject.

Further professional advice needs to be obtained before taking any action based on the information provided.

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