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9 Thanet Street

WC1H 9QL

Basement Impact Assessment Audit

For

London Borough of Camden

Project Number: 12727-21
Revision: F1

April 2019

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Project Partner	E M Brown, BSc MSc CGeol FGS
Project Number	12985-21
Project Name	9 Thanet Street, WC1H 9QL
Planning Reference	2018/2172/P, 2018/2173/L

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Contents

Appendix

1.0 NON-TECHNICAL SUMMARY

1.1. CampbellReith was instructed by London Borough of Camden, (LBC) to carry out an audit on the Basement Impact Assessment submitted as part of the Planning Submission documentation for 9 Thanet Street, WC1H 9QL (planning reference 2018/2172/P and 2018/2173/L). The basement is considered to fall within Category A as defined by the Terms of Reference.

1.2. An initial audit was carried out in accordance with the Terms of Reference set by LBC. The audit reviewed the Basement Impact Assessment for potential impact on land stability and local ground and surface water conditions arising from basement development in accordance with LBC's policies and technical procedures. This audit supersedes the former and considers the additional information that was received in response to the audit.

1.3. It is understood that the proposed development shall take place in a Grade II listed building, which forms the part of a terrace of 10 similar buildings.

1.4. The proposal comprise general excavation of the existing hard-surfaced rear garden to facilitate basement extension, with the proposed garden being in level with the basement floor.

1.5. The BIA screening study has been carried out by well-known firms of engineering consultants using individuals who possess suitable qualifications.

1.6. A supplementary drawing (Reference 18837-S-2050) shows the extent of underpinned foundation, and the additional information provides adequate justification for the stability of the host property and boundary walls being maintained during the proposed works.

1.7. An outline temporary works proposal has now been provided along with calculations to justify the stability of permanent retaining walls for the remaining garden perimeter.

1.8. Proposals for movement monitoring strategy during excavation and construction, including indicative location of the monitoring points and the associated trigger values have been presented within the 'Outline Methodology for Construction Works' prepared by Barden Chapman.

1.9. It is accepted that the surrounding slopes to the development site are stable.

1.10. It is accepted that the development will not impact on the hydrology and wider hydrogeology of the area and is not in an area subject to flooding.

1.11. On the basis of the information presented prior to initial audit and the additional information provided on request, it can be confirmed that the BIA complies with the requirements of CPG: Basements.

2.0 INTRODUCTION

2.1. CampbellReith was instructed by London Borough of Camden (LBC) on 23rd October 2018 to carry out a Category A Audit on the Basement Impact Assessment (BIA) submitted as part of the Planning Submission documentation for 9 Thanet Street, WC1H 9QL. An initial audit was issued in November 2018.

2.2. This audit supersedes the former and is based on a review of the additional information that were furnished on request, including further clarification provided by Barden Chapman via emails dated February 2019 and March 2019 (See Appendix 3). It considers the details of the proposal for potential impact on land stability and local ground and surface water conditions in accordance with LBC's policies and technical procedures.

2.3. A BIA is required for all planning applications with basements in Camden in general accordance with policies and technical procedures contained within

- Guidance for Subterranean Development (GSD). Issue 01. November 2010. Ove Arup & Partners.
- Camden Planning Guidance Basements. March 2018.
- Camden Development Policy (DP) 27: Basements and Lightwells.
- Camden Development Policy (DP) 23: Water.
- Local Plan Policy A5 Basements.

2.4. The BIA should demonstrate that schemes:

a) maintain the structural stability of the building and neighbouring properties;

b) avoid adversely affecting drainage and run off or causing other damage to the water environment;

c) avoid cumulative impacts upon structural stability or the water environment in the local area;

and evaluate the impacts of the proposed basement considering the issues of hydrology, hydrogeology and land stability via the process described by the GSD and to make recommendations for the detailed design.

2.5. LBC's Audit Instruction described the planning proposal as *"The demolition of central supporting wall to lower ground floor replaced with steel support. Demolition rear wall to lower ground floor and replacement with I steel support. Construction of single storey rear extension to lower ground floor following excavation of garden closing up exiting rear exit door to garden. New* *internal layout lower ground floor only."* The Audit Instruction also confirmed that 9 Thanet Street was a Grade II listed building forming a part of a terrace of 10 similar buildings.

2.6. CampbellReith accessed LBC's Planning Portal on 23rd November 2018 and gained access to the following relevant documents for audit purposes:

- BIA – Screening Study (reference no: 18837, dated 27 July 2018, prepared by Barden Chapman)
- Planning Application Drawings consisting of:

  Location Plan (Reference no. 00319143-24799D, dated 03 May 2018)

  Existing Plans and sections (Dwg no: 001 and 005, dated 26 November 2017, prepared by Gemma Dudgeon Interiors)

  Proposed Plans and section (Dwg no: 001a, 005a, dated 10 October 2017, prepared by Gemma Dudgeon Interiors)
- Design Access Statement

2.7. Following the initial audit in November 2018, CampbellReith received additional information from Braden Chapman via emails dated February 2019 and March 2019. The additional information received, along with a copy of the emails, is presented in Appendix 3 and is listed below:

- Outline Methodology for construction works (prepared by Barden Chapman)
- Underpinning wall calculations (dated 07 February 2019, prepared by Barden Chapman)
- Party Wall Sections (Reference no. 18837-S-2050 (P1), prepared by Barden Chapman)
- Temporary Works Bracing Plan and Section (High Level/Low Level) (Reference 18837-Sk7000)

3.0 BASEMENT IMPACT ASSESSMENT AUDIT CHECK LIST

Item	Yes/No/NA	Comment
Are BIA Author(s) credentials satisfactory?	Yes	
Is data required by Cl.233 of the GSD presented?	Yes	Engineers drawings requested during the previous audit have now been furnished and are found to be satisfactory.
Does the description of the proposed development include all aspects of temporary and permanent works which might impact upon geology, hydrogeology and hydrology?	Yes	Additional information have now been furnished on request. Details can be found in Section 4.0.
Are suitable plan/maps included?	Yes	Refer BIA-Screening study.
Do the plans/maps show the whole of the relevant area of study and do they show it in sufficient detail?	Yes	Relevant drawings related to the proposed development have now been presented and are found to be satisfactory.
Land Stability Screening: Have appropriate data sources been consulted? Is justification provided for 'No' answers?	Yes	Refer BIA-Screening study. Justification has now been provided regarding the maintenance of stability of the existing structures during and after the proposed development.
Hydrogeology Screening: Have appropriate data sources been consulted? Is justification provided for 'No' answers?	Yes	Refer BIA-Screening study.
Hydrology Screening: Have appropriate data sources been consulted? Is justification provided for 'No' answers?	Yes	Refer BIA-Screening study.
Is a conceptual model presented?	No	

Item	Yes/No/NA	Comment
Land Stability Scoping Provided? Is scoping consistent with screening outcome?	Yes	Further information related to the underpinning works, including an outline of the construction methodology, has been presented following the initial audit and found to be satisfactory.
Hydrogeology Scoping Provided? Is scoping consistent with screening outcome?	Yes	Refer Section 4.0.
Hydrology Scoping Provided? Is scoping consistent with screening outcome?	No	Not required.
Is factual ground investigation data provided?	No	However, sketches of the foundation inspection pits are presented, and results of in-situ shear vane testing have been presented. The information presented is satisfactory.
Is monitoring data presented?	No	
Is the ground investigation informed by a desk study?	NA	
Has a site walkover been undertaken?	Yes	
Is the presence/absence of adjacent or nearby basements confirmed?	Yes	The adjacent basements are assumed to be similar to that of 9 Thanet Street. This is accepted.
Is a geotechnical interpretation presented?	No	
Does the geotechnical interpretation include information on retaining wall design?	NA	
Are reports on other investigations required by screening and scoping presented?	No	An ‘outline methodology for construction works’ along with the plan and section of the proposed temporary works have now been provided and are found to be satisfactory.

Item	Yes/No/NA	Comment
Are the baseline conditions described, based on the GSD?	No	Refer Section 4.0.
Do the base line conditions consider adjacent or nearby basements?	Yes	The BIA-screening study states that the adjacent basements are similar to that of 9 Thanet Street. Since the property forms a part of a terraced development, the statement is accepted.
Is an Impact Assessment provided?	Yes	The BIA report presented covers only the screening and scoping stages. However, additional information presented following the initial audit nullifies residual impact. Supplementary information related to a monitoring strategy (along with appropriate trigger levels) has been presented, which shall be adopted during and after works. Hence it is accepted that a detailed impact assessment is not required.
Are estimates of ground movement and structural impact presented?	No	The design calculations for the proposed underpinning walls have now been furnished. Based on the drawings and supplementary information presented, it is accepted that the impact of the proposed development is minimal and that a formal ground movement assessment is not required.
Is the Impact Assessment appropriate to the matters identified by screen and scoping?	No	As above.
Has the need for mitigation been considered and are appropriate mitigation methods incorporated in the scheme?	No	Refer Section 4.0.
Has the need for monitoring during construction been considered?	Yes	Supplementary information relating to a monitoring strategy (along with appropriate trigger levels) has been presented, which shall be adopted during and after works. An outline construction methodology has also been presented.
Have the residual (after mitigation) impacts been clearly identified?	Yes	

Item	Yes/No/NA	Comment
Has the scheme demonstrated that the structural stability of the building and neighbouring properties and infrastructure will be maintained?	No	The design calculations for the proposed underpinning walls have now been furnished. A commentary has been provided in the email (dated 07 February 2019) regarding maintenance of the stability of rear garden walls. Based on the drawings and supplementary information presented, it is accepted that the impact of the proposed development is minimal and that a formal ground movement assessment is not required. Further comments can be found in Section 4.
Has the scheme avoided adversely affecting drainage and run-off or causing other damage to the water environment?	Yes	The existing garden is hard surfaced and will remain so after the scheme has been implemented. Hence it is accepted that it will not affect the drainage and run-off.
Has the scheme avoided cumulative impacts upon structural stability or the water environment in the local area?	Yes	Based on the drawings and supplementary information presented, it is accepted that the impact of the proposed development is minimal.
Does report state that damage to surrounding buildings will be no worse than Burland Category 1?	No	As above.
Are non-technical summaries provided?	No	Although a short non-technical summary is provided within the BIA-screening study, it is found to be insufficient and does not list out all required details of the proposed development. However, based on the supplementary information presented it is accepted that additional non-technical summaries are no longer required.

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4.0 DISCUSSION

4.1. The Basement Impact Assessment (BIA) – screening study has been carried out by Barden Chapman Civil and Structural consultants, and the individual concerned in its production is a Chartered Engineer and a Member of the Institution of Civil Engineers.

4.2. The Design and Access Statement provided states that the development proposal is for a Grade II listed building which forms a part of a terrace of 10 similar houses.

4.3. The BIA states that the depth of foundations of neighbouring properties is likely to be at the same depth as 9 Thanet Street. This is accepted.

4.4. The proposal is to extend the existing basement (lower ground floor) by excavating the rear garden up to 1.50m below its current level. The extent of the excavation is not known, however from the architect's drawings provided, it is understood that the extended basement would occupy around 50% of the existing garden area. The remaining garden space would be lowered up to the basement floor level, to create a new rear terraced area.

4.5. The additional information furnished following the initial audit confirms the extent of the underpinning works to the existing property. The outline design calculations for the same have also been presented and are found to be satisfactory. The potential ground movements and instability of the boundary wall, due the level difference between Nos 9 and 10 following the proposed excavation, were raised as a concern in the previous audit. A commentary provided in the email dated 07 February 2019 from Braden Chapman describes how the stability of the existing garden wall will be maintained and the lateral loads supported. This proposal is satisfactory and it is accepted that the concerns regarding instability have been duly addressed.

4.6. An 'Outline Methodology for Construction Works' has been provided. The description of the proposed works states that the rear wall to the lower ground floor will be demolished and replaced with steel supports. Based on the information provided in the construction methodology, the outline design calculations for underpinning and the additional temporary works plan and section, it is accepted that the stability of the proposed excavation works and subsequent construction has been satisfactorily demonstrated.

4.7. Although the ground conditions on site have been generally identified based on the BGS borehole data, the thickness of each stratum is not clearly stated. The absence of site investigation information and engineer's drawings previously made it difficult to confirm the founding stratum for the basement. However, the requested information has now been provided. The email correspondence with Barden Chapman also clearly states that the hand shear vane results (details available in BIA report) confirm that the underlying bearing formation has an average shear strength varying between 100kPa and 115kPa. It is accepted that a suitable investigation has been carried out to ascertain the bearing capacity of the formation.

4.8. It is accepted that there are no slope stability concerns regarding the proposed development.

4.9. It was understood that no groundwater was encountered up to 1.40m bgl, during excavation of the foundation inspection pits. Appropriate measures are included in the scoping for surface flow and flooding, to mitigate any ingress of perched groundwater into the excavation. It is accepted that there is no impact to the hydrogeology.

4.10. It is accepted that there is no impact to surface water and the site and the site is not in an area prone to flooding.

5.0 CONCLUSIONS

5.1. The BIA- screening study has been carried out by well-known firms of engineering consultants using individuals who possess suitable qualifications.

5.2. Following the initial audit, supplementary information has been presented and can be found under Appendix 3 of this audit report. The documents provided satisfactorily demonstrate the stability of the existing and proposed structures during and after the course of works.

5.3. Outline design calculations for the proposed underpinning works have been furnished and are found to be satisfactory.

5.4. The site investigation works carried out satisfactorily demonstrate the suitability of the underlying bearing stratum for the works.

5.5. A movement monitoring strategy, including associated trigger levels, has now been presented and is found to be satisfactory.

5.6. It is accepted that the surrounding slopes to the development site are stable.

5.7. It is accepted that the development will not impact on the hydrology and wider hydrogeology of the area and is not in an area subject to flooding.

5.8. On the basis of the information presented prior to initial audit and the additional information provided on request, it can be confirmed that the BIA complies with the requirements of CPG: Basements.

Appendix 1: Residents' Consultation Comments

None available

Appendix 2: Audit Query Tracker

Audit Query Tracker

Query No	Subject	Query	Status	Date closed out
1	Stability	Engineer’s drawings with accurate dimensions of the proposed scheme and the full extent of new/underpinned foundation are required.	Closed	07.02.2019
2	Stability	Outline retaining wall design, both temporary and permanent, plus consideration of structural impacts from excavation to existing wall are required, clearly stating the soil parameters considered during design.	Closed	20.03.2019
3	Stability	A construction methodology that shall be adopted for the scheme is required.	Closed	07.02.2019

Appendix 3: Supplementary Supporting Documents

Emails from Barden Chapman dated February 2019 and March 2019

Outline Methodology for Construction works by Barden Chapman

Outline design calculations for underpinning wall, dated 07 February 2019

Party Wall Plan and Section drawings

Temporary works bracing plan and section

To:
Cc:
Bcc:
Subject: Fw: 12985-21: BIA Audit 9 Thanet St / 12985-34: 99 Priory Road

Graham
----- Forwarded by Graham Kite/CRH on 10/04/2019 10:42 -----

From:	Graham Kite/CRH
To:	"David Barden" <David.Barden@bardenchapman.co.uk>
Cc:	"camdenaudit@campbellreith.com" <camdenaudit@campbellreith.com>, "Gemma Dudgeon" <gemma@gemmadudgeon.com>, "Sild, Thomas" <Thomas.Sild@camden.gov.uk>
Date:	21/03/2019 10:35
Subject:	RE: 12985-21: BIA Audit 9 Thanet St - BardenChapman response to Campbell Reith Queries.

Hi David

Thanks for the email - your responses do close out the remaining queries. In regards to section PW2 , you did previously provide this drawing so my apologies.

FYI the vane strength data from hand shear vanes is normally factored to provide an insitu shear strength. However, a net safe bearing capacity of 100kN/sqm is accepted as reasonable.

We will update the audit report and issue it shortly.

Regards

Graham Kite

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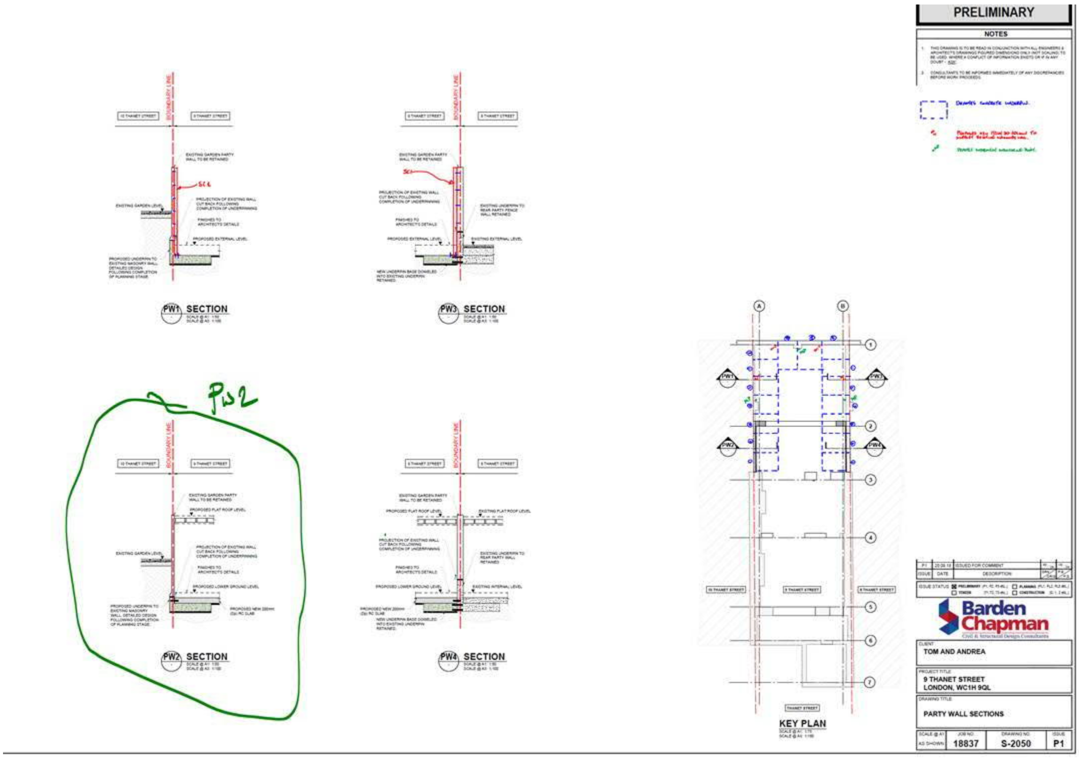
"David Barden" Graham, In response to your queries raised belo... 20/03/2019 08:01:13

From:	"David Barden" <David.Barden@bardenchapman.co.uk>
To:	"GrahamKite@campbellreith.com" <GrahamKite@campbellreith.com>
Cc:	"Gemma Dudgeon" <gemma@gemmadudgeon.com>, "Sild, Thomas" <Thomas.Sild@camden.gov.uk>, "camdenaudit@campbellreith.com" <camdenaudit@campbellreith.com>
Date:	20/03/2019 08:01
Subject:	RE: 12985-21: BIA Audit 9 Thanet St - BardenChapman response to Campbell Reith Queries.

Graham,

In response to your queries raised below, please note BC responses as follows:-

1. PW2 has been provided on Drg 2050, highlighted below, which has already been submitted, am I misunderstanding?



Its

2. In-situ shear van readings were taken during the trial hole investigation works. (So not entirely correct to say no site investigation carried out).
   This is as per detailed on the site visit record sheet, within the BIA scoping and screening report, outlined below.

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8A Ritherdon Road, London. SW17 8QD
Tel: +44 (0)7765 948 685,
Email: info@bardenchapman.co.uk

Barden Chapman
Civil & Structural Design Consultants

SITE VISIT RECORD SHEET

PROJECT TITLE: No 9 Thanet Street, London. WC1H 9QL		JOB NO: 18837
ENGINEER(SIGNATURE): DB.	DATE: 13/09/2018	WEATHER: Dry/Sunny.
PRESENT: David Barden, Gerry Scanlan		

PURPOSE OF SITE VISIIT:

Site Inspection to of Trial Holes carried out at No 9 Thanet Street.

OBSERVATIONS & COMMENTS:

1. 4No trial holes undertaken to expose the footings of the existing building.
2. Please refer to attached sketch for details of trial hole finding following inspection.
3. Please refer to attached for site photographs taken during inspection.
4. In-situ shear van testing was carried out in trial holes 1, 2 & 3 with results as follows:-
   Trial Hole 1:- Cu = 90kN/m², 110kN/m², 140kN/m². Average = 115kN/m².
   Trial Hole 2:- Cu = 100kN/m², 100kN/m², 120kN/m². Average = 105kN/m².
   Trial Hole 3:- Cu = 95kN/m², 90kN/m², 120kN/m². Average = 101kN/m².
5. ABP taken as 2xCu. For building control design calculations conservatively take ABP = 100kN/m².

ACTIONS:

1. Update party wall drawings for inspection information.

COPY TO:	NAME:	FAX NO:
CLIENT	Architect.	
	A.N.O.	
OTHERS	QXXXX	

The average insitu shear strength was recorded as 115kN/sqm, 105kN/sqm and 101kN/sqm, respectively in three separate trial holes.
ABP would be taken as 2xCU, but conservatively in accordance with building control, an ABP of 100kN/sqm shall be used for the foundation design.
The formation will need to be inspected by the permanent works engineer prior to casting the proposed foundations and will not be left to the contractor to prove the bearing formation.

3. The trial holes undertaken on site, indicate that the existing rear house walls of No 8/9/10 Thanet Street are at a level lower than that of the proposed formation for the new rear extension.
   The propose works will therefore not impact the existing foundation angle of influence and therefore any damage to the existing properties is expected to be negligible. (Burland Scale Cat 1 Max).

   The existing party garden walls will be underpinned in a standard sequence in max 1m widths, as is standard for a project of this nature.
   The proposed sequence of underpinning will therefore limit damage to the neighbours party garden walls to maximum of Category 1.

I will follow with a call this morning to ensure everything is fully answered to close out.

Regards,
David Barden

BardenChapman
Civil & Structural Design Consultants

(Mob: +44 (0) 7765 948 685) | David.Barden@bardenchapman.co.uk

From: GrahamKite@campbellreith.com <GrahamKite@campbellreith.com>
Sent: 25 February 2019 14:09
To: David Barden <David.Barden@bardenchapman.co.uk>
Cc: Gemma Dudgeon <gemma@gemmadudgeon.com>; Sild, Thomas <Thomas.Sild@camden.gov.uk>; camdenaudit@campbellreith.com
Subject: 12985-21: BIA Audit 9 Thanet St - BardenChapman response to Campbell Reith Queries.

Hi David

Many thanks for your documents and email. These largely answer our queries. For clarity:

a) please provide the section PW2 (sections PW1, PW3 and PW4 have been provided).

b) since no site investigation has been undertaken, please confirm that the contractor will prove that the bearing formation has an appropriate insitu shear strength and state what that minimum acceptable shear strength will be.

c) please confirm that the proposed works will limit damage to neighbours to a maximum of Category 1.

We will prepare and issue the audit report upon receipt.

Regards

Graham Kite

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From: "David Barden" <David.Barden@bardenchapman.co.uk>
To: "GrahamKite@campbellreith.com" <GrahamKite@campbellreith.com>
Cc: "Gemma Dudgeon" <gemma@gemmadudgeon.com>, "Sild, Thomas" <Thomas.Sild@camden.gov.uk>
Date: 07/02/2019 11:36
Subject: RE: BIA Audit 9 Thanet St - BardenChapman response to Campbell Reith Queries.

Graham,

It has been a little time since we spoke on the phone in relation to the below and apologies for the delay in following up, have just been extremely busy of late.

Following our conversation previously, I was of the understanding that all information required for Thanet Street planning submission had been completed and issued to CR previously on 25/09/18.
To be honest, we were not expecting a further request for additional information as per the attached report and correspondence from Camden LA.

To address each of the points raised by CR please see attached and commentary as follows: -

1. Please refer to attached 18837-S-2050 for marked up extent of underpinning to garden walls as requested.
2. Additionally as requested, please see attached outline methodology for the construction works.
3. Please refer to 18837-Sk7000 for outline temporary works scheme for the proposed works.
4. Movement monitoring location are outlined on Drg 18837-S-2050 and details included within the construction methodology.
5. Finally calculations for the underpins & SC1 columns – please note commentary below.

<u>Commentary on stability of rear garden walls.</u>
As a belt and braces approach, 4No new 152UC30 columns will be constructed for the new underpin bases to take the later stability of the rear garden walls.
These steel column would be fully galvanised and chemically fixed to both the underpin and existing garden walls. For aesthetics, the post to be clad in brick.
The SC1's have been conservatively designed to take all lateral loads on the existing walls, providing a belt and braces means of stability for the existing garden walls.
So we trust that this should answer any remaining CR planning queries.

If anything further is required, could you please contact me directly on my mobile, where I would be happy to discuss.

Kind Regards,

David Barden
BE(Hons), Dip Struct Eng, Adv Dip PM, CEng, MICE, MIStructE
Director

Email: David.Barden@bardenchapman.co.uk
Mob: +44 (0) 7765 948 685
25 Sackville Street, London. W1S 3AX

Click here to report this email as spam.[attachment "RNemb12985-21- 9 Thanet Street 30112018-D1.pdf" deleted by Graham Kite/CRH] [attachment "18837-Outline Methodology for Construction Works.pdf" deleted by Graham Kite/CRH] [attachment "18837-S-2050.pdf" deleted by Graham Kite/CRH] [attachment "18837-Sk7000.pdf" deleted by Graham Kite/CRH] [attachment "18837-Design Calcs.pdf" deleted by Graham Kite/CRH]

OUTLINE METHODOLOGY
FOR CONSTRUCTION WORKS

Barden Chapman
Civil & Structural Design Consultants

1. Install monitoring points to garden walls
   1.1. Provide monitoring points to existing wall (3No) at one metre above ground level. Monitoring points are to record both the vertical and horizontal movements of the garden walls during the construction period. Prior to excavation works commencing, the contractor is to take baseline readings at each monitoring point.
   1.2. During the construction works readings shall be recorded as follows: -
      1.2.1. Site Occupation: - Weekly.
      1.2.2. During excavation: - Twice Weekly.
      1.2.3. Until 28 days after final underpin cast: - Weekly.
   1.3. If the monitor readings indicate evidence of movement, the contractor shall refer to trigger values with regard action to be taken.
   1.4. Trigger values.

TRIGGER VALUE	TOTAL VERTICAL MOVEMENTS	TOTAL HORIZONTAL MOVEMENTS
GREEN	MOVEMENT LESS THAN 2mm ACTION – OK TO PROCEED	MOVEMENT LESS THAN 2mm ACTION – OK TO PROCEED
AMBER	EXCEEDS 2mm ACTION – CONTRACTOR TO MONITOR MORE FREQUENTLY, REVIEW CONSTRUCTION METHODS AND START IMPLEMENTING CONTINGENCY MEASURES IF TRENDS INDICATE THE RED TRIGGER MAY SHORTLY BE REACHED	EXCEEDS 2mm ACTION – CONTRACTOR TO MONITOR MORE FREQUENTLY, REVIEW CONSTRUCTION METHODS AND START IMPLEMENTING CONTINGENCY MEASURES IF TRENDS INDICATE THE RED TRIGGER MAY SHORTLY BE REACHED
RED	EXCEEDS 4mm ACTION – CONTRACTOR TO IMPLEMENT MEASURES TO CEASE MOVEMENTS AND STOP WORKS.	EXCEEDS 4mm ACTION – CONTRACTOR TO IMPLEMENT MEASURES TO CEASE MOVEMENTS AND STOP WORKS.

2. Installation of Temporary Works Support.
   2.1. Install (W1) waler at high-level & low-level to existing garden walls using M12 Hilti chemical anchors fixed at 600crs.
   2.2. Install (P1) RMD diagonal & horizontal Push Pull props to high-level and low-level waler.

3. Construct Underpinning to existing garden walls
   3.1. The contractor shall be responsible for ensuring that his operations do not in any way impair the safety or conditions of the existing structures. In addition to the temporary works outlined on Drg 18837-Sk7000, he shall provide any temporary supports required for this purpose.
   3.2. Excavate existing stratum for area marked (1). Underpinning to be carried out in a 1,3,5,2,4 sequence as indicated on the foundation plan. In no case shall width of sections excavated exceed 1000mm and the total sum of unsupported lengths shall not exceed one fifth of the wall length. In no case shall a section be excavated immediately adjacent to one which has been completed.
   3.3. Excavate stratum at the underside of the existing wall footing down to the required new underpin formation level. Existing wall footings to be cleaned and hacked free of soil or loose material.
   3.4. Construct body of underpin to permanent works engineer's drawings.
   3.5. Underpin to be stopped 75mm below underside of existing footing and final pinning up to wall carried out with dry pack mortar well rammed in.
   3.6. Repeat items 2-5 above for all underpinning marked 3,5,2,4 on plan. Excavation of any section of underpinning shall not be commenced until at least 48hrs after completion of any adjacent section of the work. Adjacent concrete to have reached 10N/sqmm strength. The joint between adjacent sections of underpinning walls made by forming rough surface against which the first section is to be cast with 4No H20 dowels hammered 300mm into the excavation face, and thoroughly clean the exposed concrete face and projecting dowels before the adjacent section is cast.

4. Complete extension superstructure & rear garden finishes.
   4.1. Complete extension superstructure to permanent works engineer's details, including extension rear walls at GL 2. Walls to be fully tied to existing garden masonry walls.
   4.2. Remove (P1) props and (W1) waler between GL 2 & GL 3.
   4.3. Complete rear garden finishes to architect's details, leaving temporary hole outs for proposed 4No SC1 columns to be installed to rear garden walls.

5. Install SC1 Columns & remove
   5.1. Mark set out location of 4No new SC1 columns to support existing garden masonry walls.
   5.2. Cut 250mm slot in high-level & low-level (W1) waler at first column installation location. Install SC1 column and chemically fix to RC underpin and existing masonry garden wall.
   5.3. Repeat item 4.2 at 3No remaining SC1 column locations.
   5.4. On completion of installation of SC1 columns, remove remaining W1 walers & P1 props.
   5.5. Make good garden finishes following installation of SC1 columns.

Project Title: No 9 Thanet Street WC1H 9QL Job No: 18837

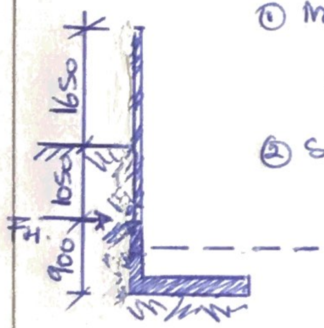
Part of Structure: Underpinning Wall Calculations

Originator: DB Checker: Date: 07.02.19 Sheet No: 1 OF

Calculation Status: Preliminary ☐ Planning ☐ Tender ☐ Construction ☐

Barden Chapman
Civil & Structural Design Consultants

REF.	CALCULATIONS	OUTPUT



① Masonry Wall Loads.

$= 20 \times 0.1 \times (1.65 + 1.05)$ $= 5.4\ kN/m.$

② Surcharge $= 5.0\ kN/m^2.$

1. Consider Loads on Retaining Wall.

① Masonry Vertical Load $= 5.4\ kN/m.$ ✓

② Surcharge $= 5.0\ kN/m^2.$

F_H Due to Retained Soil

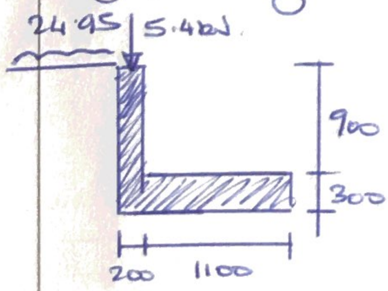
$= 0.5 \gamma K_a h^2$ $= 0.5 \times 19 \times 0.333 \times 1.05^2 = 3.48\ kN/m.$

Note this force cannot be correctly applied in TEDDS.

Therefore apply 1.05m of retained soil as 19×1.05

$= 19.95\ kN/m^2$ overburden pressure for calculation purpose.

② Surcharge $= 5.0 + 19.95$ $= 24.95\ kN/m^2.$ ✓



Rebar = provide H12 @ 150 in both wall & stem.

Refer to TEDDS design output for details.

Proposed reinforced underpin satisfactory.

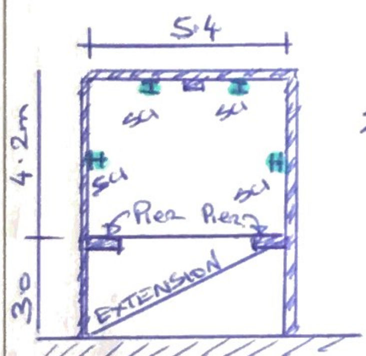
Project Title: Job No:

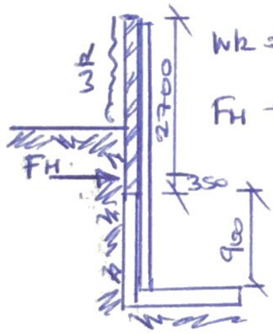
Part of Structure:

Originator: Checker: Date: Sheet No: 2 OF

Calculation Status: Preliminary ☐ Planning ☐ Tender ☐ Construction ☐

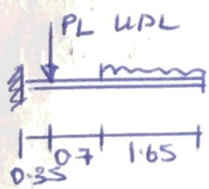
REF.	CALCULATIONS	OUTPUT
2.	Consider stability of Existing masonry garden walls.	
	As a belgium braces approach, provide cantilevered steel posts (galvanised) to the existing garden walls to take lateral loads to the garden walls.	
	Posts designed to take wind load to existing walls.	





$W_k = 1.0\,kN/m^2$ conservatively.

$F_H = 3.48\,kN/m$ (from Pg 1).



$PL = 3.48 \times 4.2/2 = 7.308\,kN$

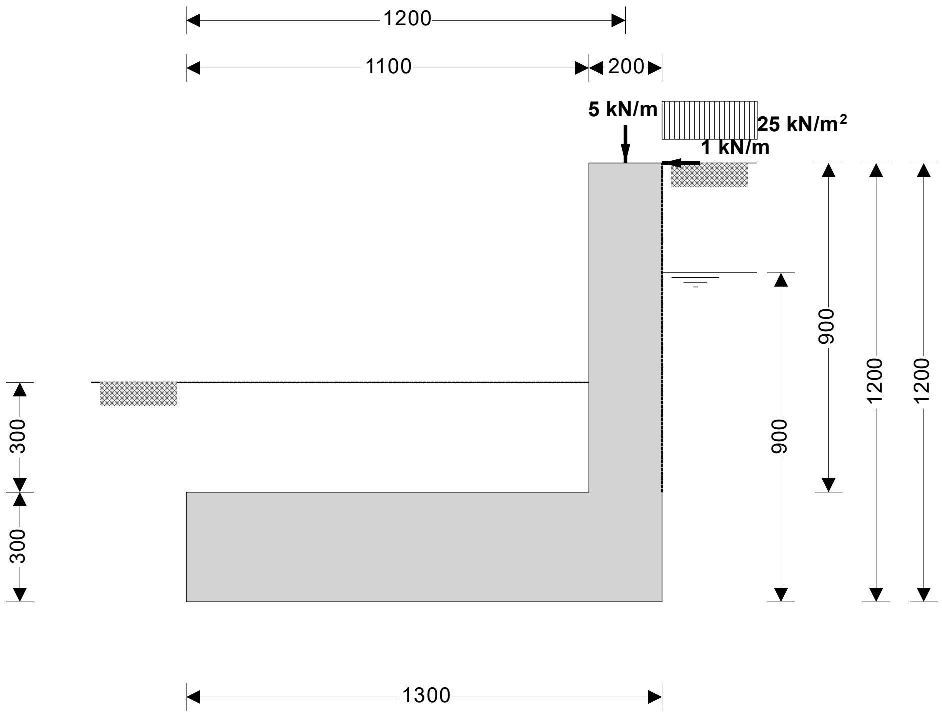
$UDL = 1.0 \times \cancel{2.0}\ 4.2/2 = 2.1\,kN/m$

Please refer to spreadsheet for details.

152UC30 Columns satisfactory for stability of Ex walls.

RETAINING WALL ANALYSIS (BS 8002:1994)

TEDDS calculation version 1.2.01.06



Wall details

Retaining wall type	**Unpropped cantilever**
Height of retaining wall stem	h_{stem} = **900** mm
Thickness of wall stem	t_{wall} = **200** mm
Length of toe	l_{toe} = **1100** mm
Length of heel	l_{heel} = **0** mm
Overall length of base	$l_{base} = l_{toe} + l_{heel} + t_{wall}$ = **1300** mm
Thickness of base	t_{base} = **300** mm
Depth of downstand	d_{ds} = **0** mm
Position of downstand	l_{ds} = **950** mm
Thickness of downstand	t_{ds} = **300** mm
Height of retaining wall	$h_{wall} = h_{stem} + t_{base} + d_{ds}$ = **1200** mm
Depth of cover in front of wall	d_{cover} = **300** mm
Depth of unplanned excavation	d_{exc} = **0** mm
Height of ground water behind wall	h_{water} = **900** mm
Height of saturated fill above base	$h_{sat} = \max(h_{water} - t_{base} - d_{ds}, 0\text{ mm})$ = **600** mm
Density of wall construction	γ_{wall} = **23.6** kN/m^3
Density of base construction	γ_{base} = **23.6** kN/m^3
Angle of rear face of wall	α = **90.0** deg
Angle of soil surface behind wall	β = **0.0** deg
Effective height at virtual back of wall	$h_{eff} = h_{wall} + l_{heel} \times \tan(\beta)$ = **1200** mm

Retained material details

Mobilisation factor	M = **1.5**
Moist density of retained material	γ_m = **19.0** kN/m^3

Saturated density of retained material — γ_s = **21.5** kN/m^3

Design shear strength — ϕ' = **24.2** deg

Angle of wall friction — δ = **18.6** deg

Base material details

Moist density — γ_{mb} = **21.0** kN/m^3

Design shear strength — ϕ'_b = **24.2** deg

Design base friction — δ_b = **18.6** deg

Allowable bearing pressure — $P_{bearing}$ = **100** kN/m^2

Using Coulomb theory

Active pressure coefficient for retained material

$$K_a = \sin(\alpha + \phi')^2 / (\sin(\alpha)^2 \times \sin(\alpha - \delta) \times [1 + \sqrt{(\sin(\phi' + \delta) \times \sin(\phi' - \beta) / (\sin(\alpha - \delta) \times \sin(\alpha + \beta)))}]^2) = \mathbf{0.369}$$

Passive pressure coefficient for base material

$$K_p = \sin(90 - \phi'_b)^2 / (\sin(90 - \delta_b) \times [1 - \sqrt{(\sin(\phi'_b + \delta_b) \times \sin(\phi'_b) / (\sin(90 + \delta_b)))}]^2) = \mathbf{4.187}$$

At-rest pressure

At-rest pressure for retained material — $K_0 = 1 - \sin(\phi') = \mathbf{0.590}$

Loading details

Surcharge load on plan — Surcharge = **25.0** kN/m^2

Applied vertical dead load on wall — W_{dead} = **5.4** kN/m

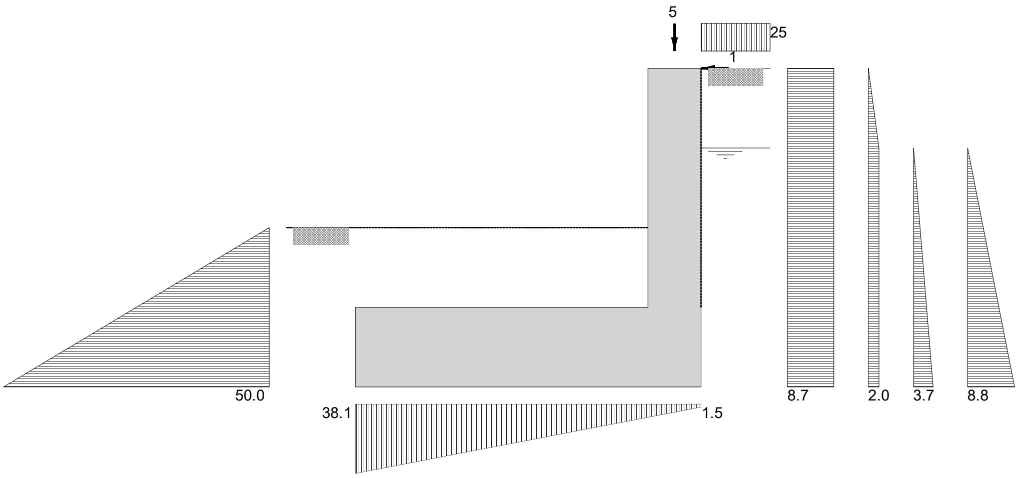
Applied vertical live load on wall — W_{live} = **0.0** kN/m

Position of applied vertical load on wall — l_{load} = **1200** mm

Applied horizontal dead load on wall — F_{dead} = **0.0** kN/m

Applied horizontal live load on wall — F_{live} = **0.6** kN/m

Height of applied horizontal load on wall — h_{load} = **1200** mm



Loads shown in kN/m, pressures shown in kN/m^2

Vertical forces on wall

Wall stem — $w_{wall} = h_{stem} \times t_{wall} \times \gamma_{wall}$ = **4.2** kN/m

Wall base — $w_{base} = l_{base} \times t_{base} \times \gamma_{base}$ = **9.2** kN/m

Soil in front of wall — $w_p = l_{toe} \times d_{cover} \times \gamma_{mb}$ = **6.9** kN/m

Applied vertical load — $W_v = W_{dead} + W_{live}$ = **5.4** kN/m

Total vertical load — $W_{total} = w_{wall} + w_{base} + w_p + W_v$ = **25.8** kN/m

Horizontal forces on wall

Surcharge — $F_{sur} = K_a \times \cos(90 - \alpha + \delta) \times \text{Surcharge} \times h_{eff} = \mathbf{10.5}$ kN/m

Moist backfill above water table — $F_{m\_a} = 0.5 \times K_a \times \cos(90 - \alpha + \delta) \times \gamma_m \times (h_{eff} - h_{water})^2 = \mathbf{0.3}$ kN/m

Moist backfill below water table — $F_{m\_b} = K_a \times \cos(90 - \alpha + \delta) \times \gamma_m \times (h_{eff} - h_{water}) \times h_{water} = \mathbf{1.8}$ kN/m

Saturated backfill — $F_s = 0.5 \times K_a \times \cos(90 - \alpha + \delta) \times (\gamma_s - \gamma_{water}) \times h_{water}^2 = \mathbf{1.7}$ kN/m

Water — $F_{water} = 0.5 \times h_{water}^2 \times \gamma_{water} = \mathbf{4}$ kN/m

Applied horizontal load — $F_h = F_{dead} + F_{live} = \mathbf{0.6}$ kN/m

Total horizontal load — $F_{total} = F_{sur} + F_{m\_a} + F_{m\_b} + F_s + F_{water} + F_h = \mathbf{18.8}$ kN/m

Calculate stability against sliding

Passive resistance of soil in front of wall — $F_p = 0.5 \times K_p \times \cos(\delta_b) \times (d_{cover} + t_{base} + d_{ds} - d_{exc})^2 \times \gamma_{mb} = \mathbf{15}$ kN/m

Resistance to sliding — $F_{res} = F_p + (W_{total} - w_p) \times \tan(\delta_b) = \mathbf{21.3}$ kN/m

PASS - Resistance force is greater than sliding force

Overturning moments

Surcharge — $M_{sur} = F_{sur} \times (h_{eff} - 2 \times d_{ds}) / 2 = \mathbf{6.3}$ kNm/m

Moist backfill above water table — $M_{m\_a} = F_{m\_a} \times (h_{eff} + 2 \times h_{water} - 3 \times d_{ds}) / 3 = \mathbf{0.3}$ kNm/m

Moist backfill below water table — $M_{m\_b} = F_{m\_b} \times (h_{water} - 2 \times d_{ds}) / 2 = \mathbf{0.8}$ kNm/m

Saturated backfill — $M_s = F_s \times (h_{water} - 3 \times d_{ds}) / 3 = \mathbf{0.5}$ kNm/m

Water — $M_{water} = F_{water} \times (h_{water} - 3 \times d_{ds}) / 3 = \mathbf{1.2}$ kNm/m

Applied horizontal load — $M_{hor} = F_h \times h_{load} = \mathbf{0.7}$ kNm/m

Total overturning moment — $M_{ot} = M_{sur} + M_{m\_a} + M_{m\_b} + M_s + M_{water} + M_{hor} = \mathbf{9.8}$ kNm/m

Restoring moments

Wall stem — $M_{wall} = w_{wall} \times (l_{toe} + t_{wall} / 2) = \mathbf{5.1}$ kNm/m

Wall base — $M_{base} = w_{base} \times l_{base} / 2 = \mathbf{6}$ kNm/m

Design vertical dead load — $M_{dead} = W_{dead} \times l_{load} = \mathbf{6.5}$ kNm/m

Total restoring moment — $M_{rest} = M_{wall} + M_{base} + M_{dead} = \mathbf{17.6}$ kNm/m

Check stability against overturning

Total overturning moment — $M_{ot} = \mathbf{9.8}$ kNm/m

Total restoring moment — $M_{rest} = \mathbf{17.6}$ kNm/m

PASS - Restoring moment is greater than overturning moment

Check bearing pressure

Soil in front of wall — $M_{p\_r} = w_p \times l_{toe} / 2 = \mathbf{3.8}$ kNm/m

Total moment for bearing — $M_{total} = M_{rest} - M_{ot} + M_{p\_r} = \mathbf{11.6}$ kNm/m

Total vertical reaction — $R = W_{total} = \mathbf{25.8}$ kN/m

Distance to reaction — $x_{bar} = M_{total} / R = \mathbf{450}$ mm

Eccentricity of reaction — $e = \text{abs}((l_{base} / 2) - x_{bar}) = \mathbf{200}$ mm

Reaction acts within middle third of base

Bearing pressure at toe — $p_{toe} = (R / l_{base}) + (6 \times R \times e / l_{base}^2) = \mathbf{38.1}$ kN/m^2

Bearing pressure at heel — $p_{heel} = (R / l_{base}) - (6 \times R \times e / l_{base}^2) = \mathbf{1.5}$ kN/m^2

PASS - Maximum bearing pressure is less than allowable bearing pressure

RETAINING WALL DESIGN (BS 8002:1994)

TEDDS calculation version 1.2.01.06

Ultimate limit state load factors

Dead load factor	γ_{f_d} = **1.4**
Live load factor	γ_{f_l} = **1.6**
Earth and water pressure factor	γ_{f_e} = **1.4**

Factored vertical forces on wall

Wall stem	$w_{wall\_f} = \gamma_{f\_d} \times h_{stem} \times t_{wall} \times \gamma_{wall}$ = **5.9** kN/m
Wall base	$w_{base\_f} = \gamma_{f\_d} \times l_{base} \times t_{base} \times \gamma_{base}$ = **12.9** kN/m
Soil in front of wall	$w_{p\_f} = \gamma_{f\_d} \times l_{toe} \times d_{cover} \times \gamma_{mb}$ = **9.7** kN/m
Applied vertical load	$W_{v\_f} = \gamma_{f\_d} \times W_{dead} + \gamma_{f\_l} \times W_{live}$ = **7.6** kN/m
Total vertical load	$W_{total\_f} = w_{wall\_f} + w_{base\_f} + w_{p\_f} + W_{v\_f}$ = **36.1** kN/m

Factored horizontal at-rest forces on wall

Surcharge	$F_{sur\_f} = \gamma_{f\_l} \times K_0 \times \text{Surcharge} \times h_{eff}$ = **28.3** kN/m
Moist backfill above water table	$F_{m\_a\_f} = \gamma_{f\_e} \times 0.5 \times K_0 \times \gamma_m \times (h_{eff} - h_{water})^2$ = **0.7** kN/m
Moist backfill below water table	$F_{m\_b\_f} = \gamma_{f\_e} \times K_0 \times \gamma_m \times (h_{eff} - h_{water}) \times h_{water}$ = **4.2** kN/m
Saturated backfill	$F_{s\_f} = \gamma_{f\_e} \times 0.5 \times K_0 \times (\gamma_s - \gamma_{water}) \times h_{water}^2$ = **3.9** kN/m
Water	$F_{water\_f} = \gamma_{f\_e} \times 0.5 \times h_{water}^2 \times \gamma_{water}$ = **5.6** kN/m
Applied horizontal load	$F_{h\_f} = \gamma_{f\_e} \times F_{dead} + \gamma_{f\_l} \times F_{live}$ = **0.9** kN/m
Total horizontal load	$F_{total\_f} = F_{sur\_f} + F_{m\_a\_f} + F_{m\_b\_f} + F_{s\_f} + F_{water\_f} + F_{h\_f}$ = **43.6** kN/m
Passive resistance of soil in front of wall	$F_{p\_f} = \gamma_{f\_e} \times 0.5 \times K_p \times \cos(\delta_b) \times (d_{cover} + t_{base} + d_{ds} - d_{exc})^2 \times \gamma_{mb}$ = **21** kN/m

Factored overturning moments

Surcharge	$M_{sur\_f} = F_{sur\_f} \times (h_{eff} - 2 \times d_{ds}) / 2$ = **17** kNm/m
Moist backfill above water table	$M_{m\_a\_f} = F_{m\_a\_f} \times (h_{eff} + 2 \times h_{water} - 3 \times d_{ds}) / 3$ = **0.7** kNm/m
Moist backfill below water table	$M_{m\_b\_f} = F_{m\_b\_f} \times (h_{water} - 2 \times d_{ds}) / 2$ = **1.9** kNm/m
Saturated backfill	$M_{s\_f} = F_{s\_f} \times (h_{water} - 3 \times d_{ds}) / 3$ = **1.2** kNm/m
Water	$M_{water\_f} = F_{water\_f} \times (h_{water} - 3 \times d_{ds}) / 3$ = **1.7** kNm/m
Applied horizontal load	$M_{hor\_f} = F_{h\_f} \times h_{load}$ = **1.1** kNm/m
Total overturning moment	$M_{ot\_f} = M_{sur\_f} + M_{m\_a\_f} + M_{m\_b\_f} + M_{s\_f} + M_{water\_f} + M_{hor\_f}$ = **23.5** kNm/m

Restoring moments

Wall stem	$M_{wall\_f} = w_{wall\_f} \times (l_{toe} + t_{wall} / 2)$ = **7.1** kNm/m
Wall base	$M_{base\_f} = w_{base\_f} \times l_{base} / 2$ = **8.4** kNm/m
Soil in front of wall	$M_{p\_r\_f} = w_{p\_f} \times l_{toe} / 2$ = **5.3** kNm/m
Design vertical load	$M_{v\_f} = W_{v\_f} \times l_{load}$ = **9.1** kNm/m
Total restoring moment	$M_{rest\_f} = M_{wall\_f} + M_{base\_f} + M_{p\_r\_f} + M_{v\_f}$ = **29.9** kNm/m

Factored bearing pressure

Total moment for bearing	$M_{total\_f} = M_{rest\_f} - M_{ot\_f}$ = **6.4** kNm/m
Total vertical reaction	$R_f = W_{total\_f}$ = **36.1** kN/m
Distance to reaction	$x_{bar\_f} = M_{total\_f} / R_f$ = **177** mm
Eccentricity of reaction	$e_f = \text{abs}((l_{base} / 2) - x_{bar\_f})$ = **473** mm
	Reaction acts outside middle third of base
Bearing pressure at toe	$p_{toe\_f} = R_f / (1.5 \times x_{bar\_f})$ = **135.7** kN/m^2
Bearing pressure at heel	p_{heel_f} = 0 kN/m^2 = **0** kN/m^2

Rate of change of base reaction	$rate = p_{toe\_f} / (3 \times x_{bar\_f})$ = **255.07** kN/m²/m
Bearing pressure at stem / toe	$p_{stem\_toe\_f} = \max(p_{toe\_f} - (rate \times l_{toe}), 0\ kN/m^2)$ = **0** kN/m²
Bearing pressure at mid stem	$p_{stem\_mid\_f} = \max(p_{toe\_f} - (rate \times (l_{toe} + t_{wall} / 2)), 0\ kN/m^2)$ = **0** kN/m²
Bearing pressure at stem / heel	$p_{stem\_heel\_f} = \max(p_{toe\_f} - (rate \times (l_{toe} + t_{wall})), 0\ kN/m^2)$ = **0** kN/m²

Design of reinforced concrete retaining wall toe (BS 8002:1994)

Material properties

Characteristic strength of concrete	f_{cu} = **30** N/mm²
Characteristic strength of reinforcement	f_y = **500** N/mm²

Base details

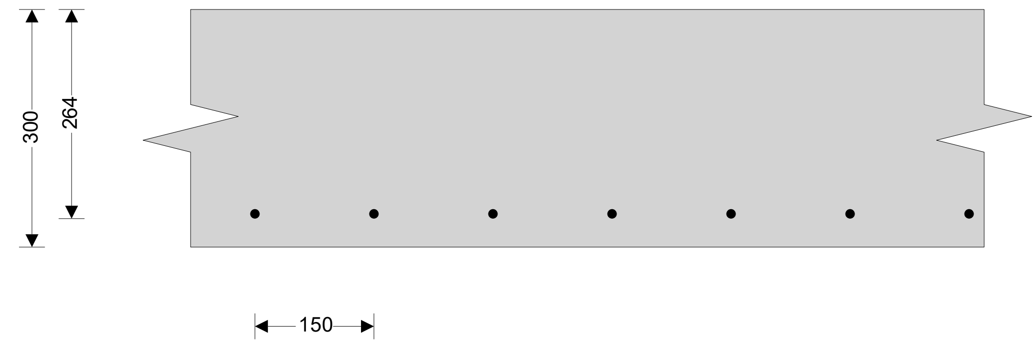
Minimum area of reinforcement	k = **0.13** %
Cover to reinforcement in toe	c_{toe} = **30** mm

Calculate shear for toe design

Shear from bearing pressure	$V_{toe\_bear} = 3 \times p_{toe\_f} \times x_{bar\_f} / 2$ = **36.1** kN/m
Shear from weight of base	$V_{toe\_wt\_base} = \gamma_{f\_d} \times \gamma_{base} \times l_{toe} \times t_{base}$ = **10.9** kN/m
Shear from weight of soil	$V_{toe\_wt\_soil} = W_{p\_f} - (\gamma_{f\_d} \times \gamma_m \times l_{toe} \times d_{exc})$ = **9.7** kN/m
Total shear for toe design	$V_{toe} = V_{toe\_bear} - V_{toe\_wt\_base} - V_{toe\_wt\_soil}$ = **15.5** kN/m

Calculate moment for toe design

Moment from bearing pressure	$M_{toe\_bear} = 3 \times p_{toe\_f} \times x_{bar\_f} \times (l_{toe} - x_{bar\_f} + t_{wall} / 2) / 2$ = **36.9** kNm/m
Moment from weight of base	$M_{toe\_wt\_base} = (\gamma_{f\_d} \times \gamma_{base} \times t_{base} \times (l_{toe} + t_{wall} / 2)^2 / 2)$ = **7.1** kNm/m
Moment from weight of soil	$M_{toe\_wt\_soil} = (W_{p\_f} - (\gamma_{f\_d} \times \gamma_m \times l_{toe} \times d_{exc})) \times (l_{toe} + t_{wall}) / 2$ = **6.3** kNm/m
Total moment for toe design	$M_{toe} = M_{toe\_bear} - M_{toe\_wt\_base} - M_{toe\_wt\_soil}$ = **23.5** kNm/m



Check toe in bending

Width of toe	b = **1000** mm/m
Depth of reinforcement	$d_{toe} = t_{base} - c_{toe} - (\phi_{toe} / 2)$ = **264.0** mm
Constant	$K_{toe} = M_{toe} / (b \times d_{toe}^2 \times f_{cu})$ = **0.011**
	Compression reinforcement is not required
Lever arm	$z_{toe} = \min(0.5 + \sqrt{(0.25 - (\min(K_{toe}, 0.225) / 0.9))}, 0.95) \times d_{toe}$
	z_{toe} = **251** mm
Area of tension reinforcement required	$A_{s\_toe\_des} = M_{toe} / (0.87 \times f_y \times z_{toe})$ = **215** mm²/m
Minimum area of tension reinforcement	$A_{s\_toe\_min} = k \times b \times t_{base}$ = **390** mm²/m
Area of tension reinforcement required	$A_{s\_toe\_req} = \max(A_{s\_toe\_des}, A_{s\_toe\_min})$ = **390** mm²/m
Reinforcement provided	**12 mm dia.bars @ 150 mm centres**
Area of reinforcement provided	$A_{s\_toe\_prov}$ = **754** mm²/m

PASS - Reinforcement provided at the retaining wall toe is adequate

Check shear resistance at toe

Design shear stress $v_{toe} = V_{toe} / (b \times d_{toe}) = \mathbf{0.059}$ N/mm^2

Allowable shear stress $v_{adm} = \min(0.8 \times \sqrt{(f_{cu} / 1 \text{ N/mm}^2)}, 5) \times 1 \text{ N/mm}^2 = \mathbf{4.382}$ N/mm^2

PASS - Design shear stress is less than maximum shear stress

From BS8110:Part 1:1997 – Table 3.8

Design concrete shear stress $v_{c\_toe} = \mathbf{0.491}$ N/mm^2

$v_{toe} < v_{c\_toe}$ - No shear reinforcement required

Design of reinforced concrete retaining wall stem (BS 8002:1994)

Material properties

Characteristic strength of concrete $f_{cu} = \mathbf{30}$ N/mm^2

Characteristic strength of reinforcement $f_y = \mathbf{500}$ N/mm^2

Wall details

Minimum area of reinforcement $k = \mathbf{0.13}$ %

Cover to reinforcement in stem $c_{stem} = \mathbf{30}$ mm

Cover to reinforcement in wall $c_{wall} = \mathbf{30}$ mm

Factored horizontal at-rest forces on stem

Surcharge $F_{s\_sur\_f} = \gamma_{f\_l} \times K_0 \times \text{Surcharge} \times (h_{eff} - t_{base} - d_{ds}) = \mathbf{21.2}$ kN/m

Moist backfill above water table $F_{s\_m\_a\_f} = 0.5 \times \gamma_{f\_e} \times K_0 \times \gamma_m \times (h_{eff} - t_{base} - d_{ds} - h_{sat})^2 = \mathbf{0.7}$ kN/m

Moist backfill below water table $F_{s\_m\_b\_f} = \gamma_{f\_e} \times K_0 \times \gamma_m \times (h_{eff} - t_{base} - d_{ds} - h_{sat}) \times h_{sat} = \mathbf{2.8}$ kN/m

Saturated backfill $F_{s\_s\_f} = 0.5 \times \gamma_{f\_e} \times K_0 \times (\gamma_s - \gamma_{water}) \times h_{sat}^2 = \mathbf{1.7}$ kN/m

Water $F_{s\_water\_f} = 0.5 \times \gamma_{f\_e} \times \gamma_{water} \times h_{sat}^2 = \mathbf{2.5}$ kN/m

Applied horizontal load $F_{s\_h\_f} = \gamma_{f\_d} \times F_{dead} + \gamma_{f\_l} \times F_{live} = \mathbf{0.9}$ kN/m

Calculate shear for stem design

Shear at base of stem $V_{stem} = F_{s\_sur\_f} + F_{s\_m\_a\_f} + F_{s\_m\_b\_f} + F_{s\_s\_f} + F_{s\_water\_f} + F_{s\_h\_f} = \mathbf{29.9}$ kN/m

Calculate moment for stem design

Surcharge $M_{s\_sur} = F_{s\_sur\_f} \times (h_{stem} + t_{base}) / 2 = \mathbf{12.7}$ kNm/m

Moist backfill above water table $M_{s\_m\_a} = F_{s\_m\_a\_f} \times (2 \times h_{sat} + h_{eff} - d_{ds} + t_{base} / 2) / 3 = \mathbf{0.6}$ kNm/m

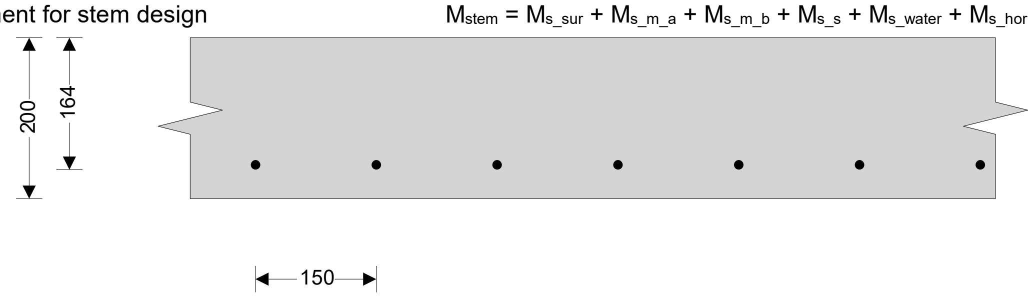
Moist backfill below water table $M_{s\_m\_b} = F_{s\_m\_b\_f} \times h_{sat} / 2 = \mathbf{0.8}$ kNm/m

Saturated backfill $M_{s\_s} = F_{s\_s\_f} \times h_{sat} / 3 = \mathbf{0.3}$ kNm/m

Water $M_{s\_water} = F_{s\_water\_f} \times h_{sat} / 3 = \mathbf{0.5}$ kNm/m

Applied horizontal load $M_{s\_hor} = F_{s\_h\_f} \times (h_{load} - t_{base} / 2) = \mathbf{1}$ kNm/m

Total moment for stem design $M_{stem} = M_{s\_sur} + M_{s\_m\_a} + M_{s\_m\_b} + M_{s\_s} + M_{s\_water} + M_{s\_hor} = \mathbf{16}$ kNm/m



Check wall stem in bending

Width of wall stem $b = \mathbf{1000}$ mm/m

Depth of reinforcement $d_{stem} = t_{wall} - c_{stem} - (\phi_{stem} / 2) = \mathbf{164.0}$ mm

Constant $K_{stem} = M_{stem} / (b \times d_{stem}^2 \times f_{cu}) = \mathbf{0.020}$

Compression reinforcement is not required

Lever arm $z_{stem} = \min(0.5 + \sqrt{(0.25 - (\min(K_{stem}, 0.225) / 0.9))},0.95) \times d_{stem}$

$z_{stem} =$ **156** mm

Area of tension reinforcement required $A_{s\_stem\_des} = M_{stem} / (0.87 \times f_y \times z_{stem}) =$ **236** mm^2/m

Minimum area of tension reinforcement $A_{s\_stem\_min} = k \times b \times t_{wall} =$ **260** mm^2/m

Area of tension reinforcement required $A_{s\_stem\_req} = \mathrm{Max}(A_{s\_stem\_des}, A_{s\_stem\_min}) =$ **260** mm^2/m

Reinforcement provided **12 mm dia.bars @ 150 mm centres**

Area of reinforcement provided $A_{s\_stem\_prov} =$ **754** mm^2/m

PASS - Reinforcement provided at the retaining wall stem is adequate

Check shear resistance at wall stem

Design shear stress $v_{stem} = V_{stem} / (b \times d_{stem}) =$ **0.182** N/mm^2

Allowable shear stress $v_{adm} = \min(0.8 \times \sqrt{(f_{cu} / 1 \text{ N/mm}^2)}, 5) \times 1 \text{ N/mm}^2 =$ **4.382** N/mm^2

PASS - Design shear stress is less than maximum shear stress

From BS8110:Part 1:1997 – Table 3.8

Design concrete shear stress $v_{c\_stem} =$ **0.648** N/mm^2

$v_{stem} < v_{c\_stem}$ - No shear reinforcement required

Check retaining wall deflection

Basic span/effective depth ratio $ratio_{bas} =$ **7**

Design service stress $f_s = 2 \times f_y \times A_{s\_stem\_req} / (3 \times A_{s\_stem\_prov}) =$ **114.9** N/mm^2

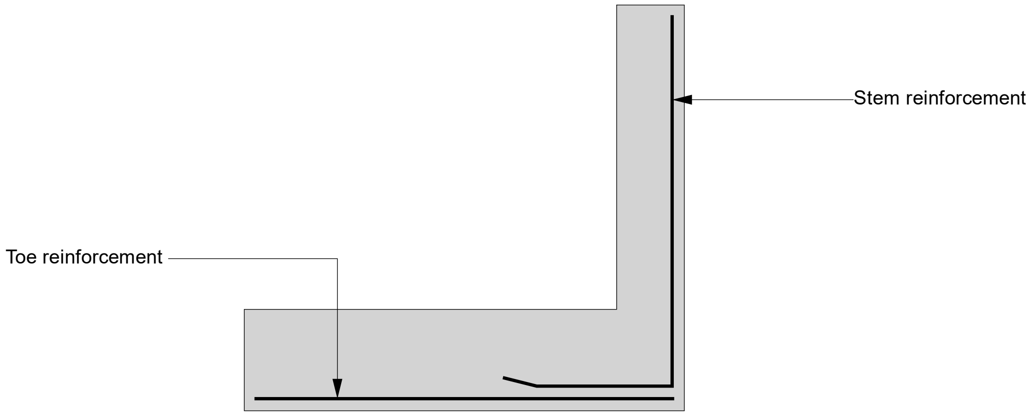
Modification factor $factor_{tens} = \min(0.55 + (477 \text{ N/mm}^2 - f_s)/(120 \times (0.9 \text{ N/mm}^2 + (M_{stem}/(b \times d_{stem}^2)))),2) =$ **2.00**

Maximum span/effective depth ratio $ratio_{max} = ratio_{bas} \times factor_{tens} =$ **14.00**

Actual span/effective depth ratio $ratio_{act} = h_{stem} / d_{stem} =$ **5.49**

PASS - Span to depth ratio is acceptable

Indicative retaining wall reinforcement diagram



Toe bars - 12 mm dia.@ 150 mm centres - (754 mm^2/m)

Stem bars - 12 mm dia.@ 150 mm centres - (754 mm^2/m)

	Project		Steel Beam Design		
	Client		Made by	Date	Job No
	Description				
			Checked	Revision	Page No
Originated from Steel Beam © 2000-2007 Chris Buczkowski	Unregistered Copy for Evaluation				

Design in accordance with BS 5950 : Part 1 : 1990

Cantilever beam

Analysis

Span (m)	2.700

Choose steel section: 152x152x30

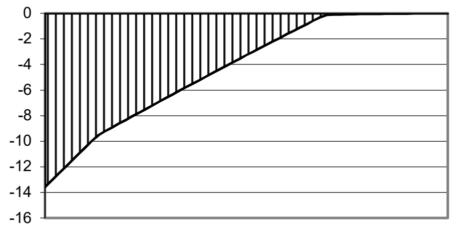
○ UB
◉ UC
○ RSJ
○ PFC

Design Status		capacity ratio
Vertical shear	**PASS**	0.05
Moment	**PASS**	0.15
Buckling	**PASS**	0.16
Deflection	**PASS**	0.28

Load Factors	
Dead	1.4
Imposed	1.6

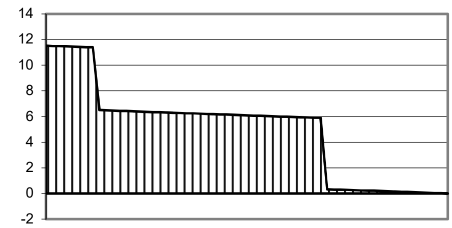
E (N/mm²)	205000
Ix (cm^4)	1748

LOADING	Dead kN	Imposed kN	Position m	Length m
UDL			-	-
Point load	3.48		0.350	-
Point load				-
Point load				-
Point load				-
Partial UDL		3.46	1.875	
Partial UDL				



Bending Moment Diagram

RESULTS			
M max	F_V max	Max. deflection (mm)	
		Imposed only	Total load
kNm	kN		
-13.59	11.52	-3.52	-4.22



Shear Force Diagram

Design

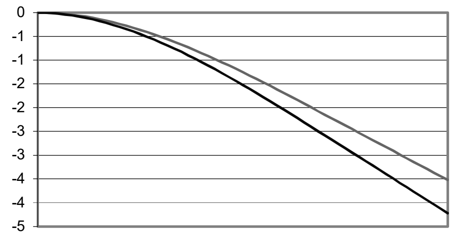
Design Strength	
p_y N/mm²	355

○ grade S275
◉ grade S355

section classification
Compact

Shear Capacity	
Area A_v	capacity P_v
mm²	kN
1024.4	218.20

cl. 4.2.3



Deflection Diagram

Moment Capacity	Position	Moment	Fv	M_{cx}	Unity Factor
	m	kNm	kN	kNm	
Critical section	0.000	-13.59	11.52	88.04	0.15

* low shear

Lateral torsional buckling

Equivalent Uniform Moment		kNm
Maximum moment	M_A	-13.00
Uniform factor	m	1.00
Buckling moment	M_{bar}	-13.00

cl. 4.3.7.2

Z_x (cm³)	222
S_x (cm³)	248

Slenderness Ratio				
Effective length			radius of gyration	slenderness
L	factor	L_E		
m		m	r_y (cm)	λ
2.700	0.70	1.890	3.83	49.35

cl. 4.3.7.5

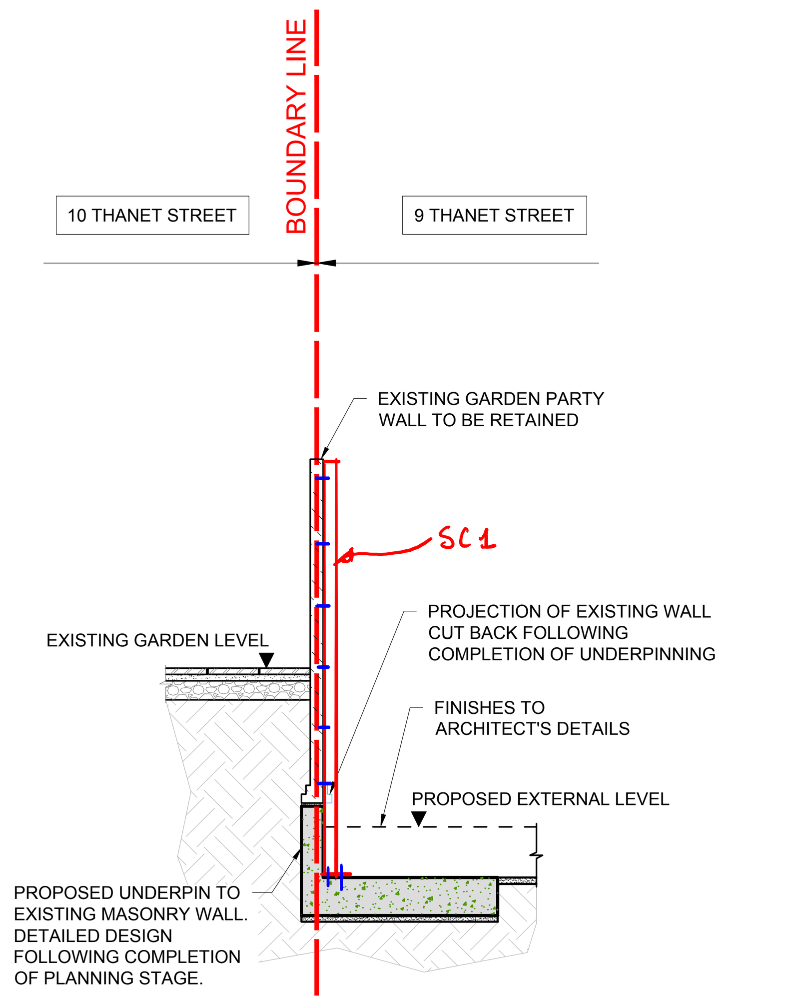
cl. B.2.4	limiting slenderness	λ_{Lo}	30.20
cl. 4.3.7.6	correction factor	n	**1.00**
	buckling parameter	u	0.849
	torsional index	x	16
cl. B.2.5 (d)	slenderness factor	v	0.907
cl. B.2.5	equivalent slenderness	λ_{LT}	38.01
cl. B.2.3	Perry coefficient	η_{LT}	0.055
	Plastic moment capacity	M_p	88.04
cl. B.2.2	Elastic critical moment	M_E	347.26
	Buckling index	ϕ_B	227.15
cl. B.2.1	**Buckling capacity**	M_b	82.15

Deflection

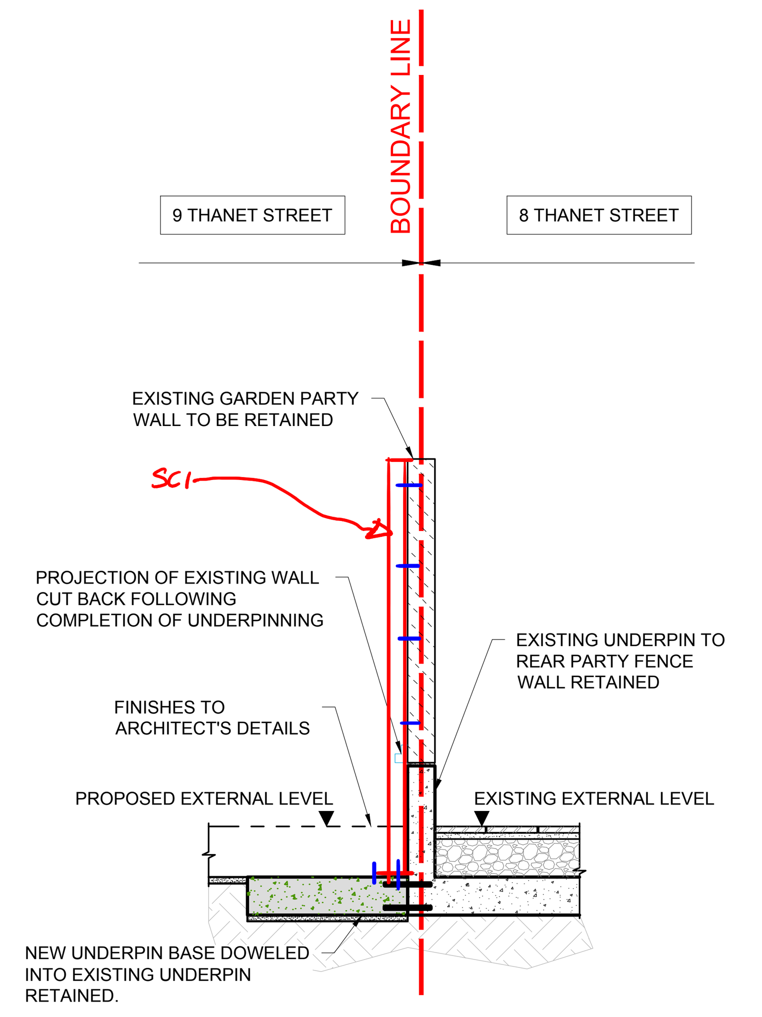
Deflection Limits		Allowable
span/deflection ratios		mm
Imposed Loads	180	15.0
Total Loads	180	15.0

table 5

Section used:	**UC**	**152x152x30**



PW1 SECTION
SCALE @ A1: 1:50
SCALE @ A3: 1:100



PW3 SECTION
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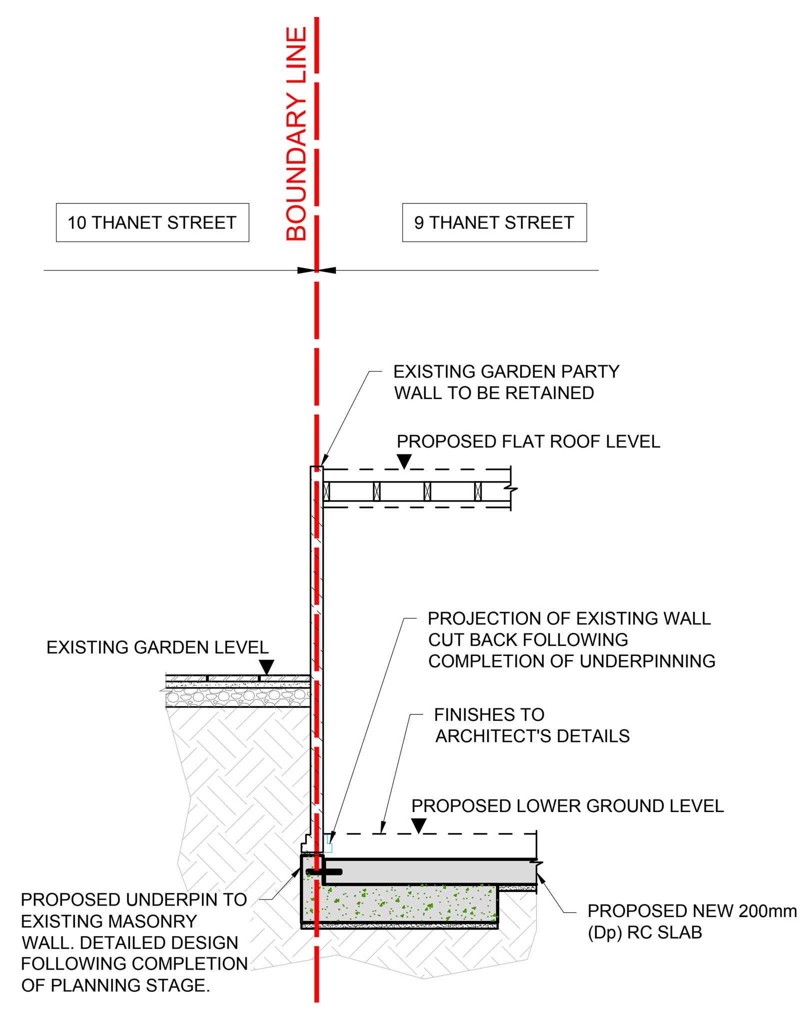
SCALE @ A3: 1:100



PW2 SECTION
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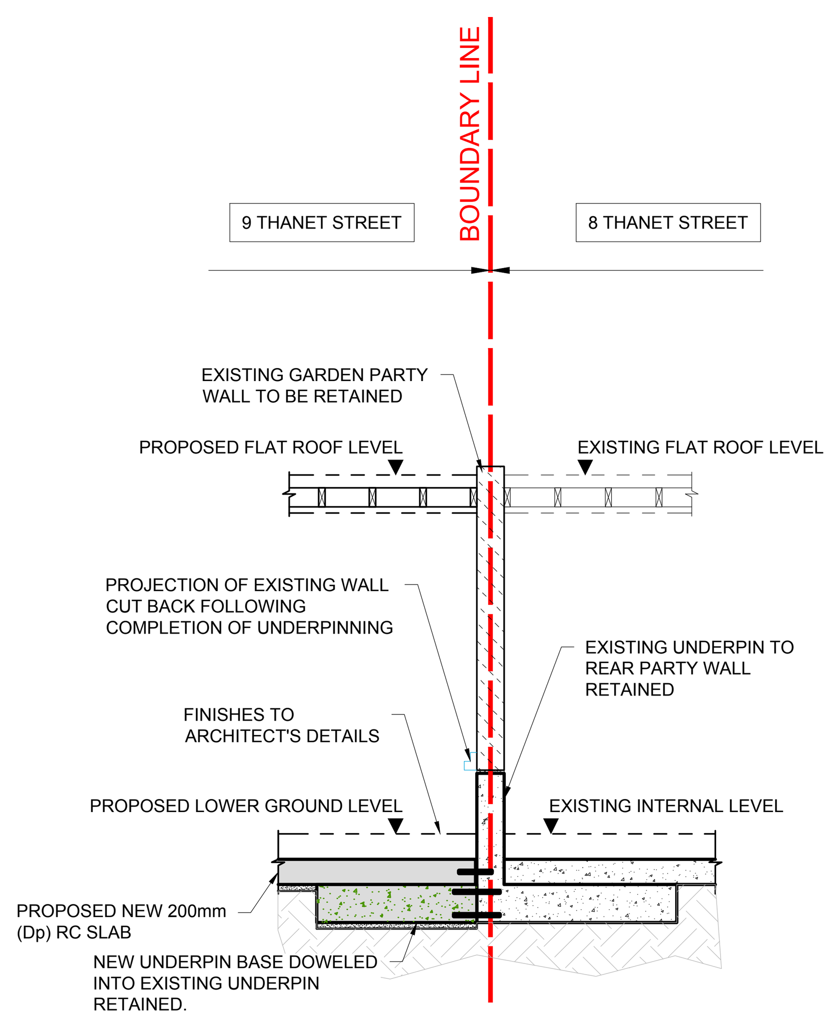

PW4 SECTION
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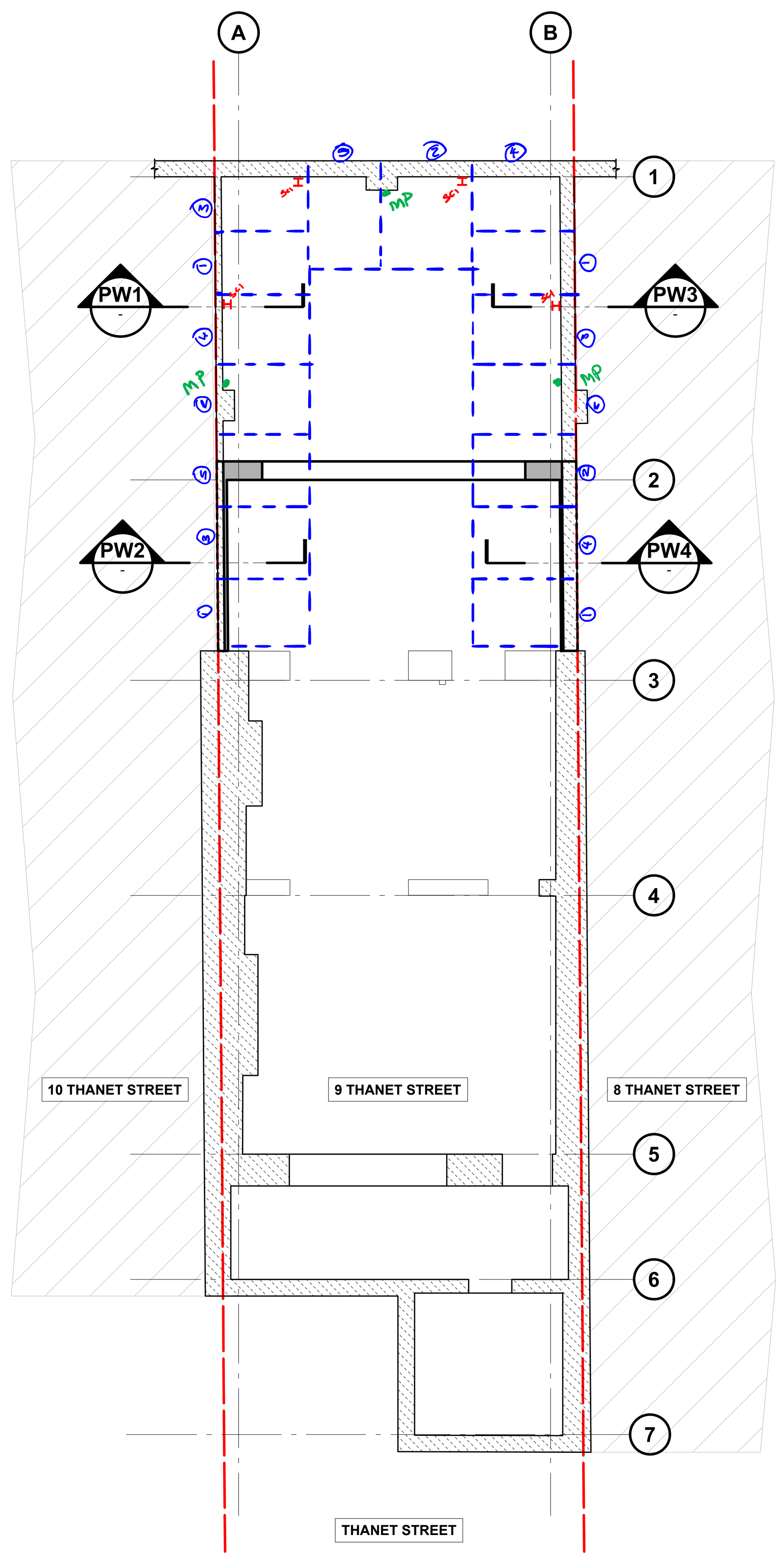

KEY PLAN
SCALE @ A1: 1:75
SCALE @ A3: 1:150

PRELIMINARY

NOTES

1. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL ENGINEERS & ARCHITECT'S DRAWINGS.FIGURED DIMENSIONS ONLY (NOT SCALING) TO BE USED. WHERE A CONFLICT OF INFORMATION EXISTS OR IF IN ANY DOUBT - `ASK'.
2. CONSULTANTS TO BE INFORMED IMMEDIATELY OF ANY DISCREPANCIES BEFORE WORK PROCEEDS.

DENOTES CONCRETE UNDERPIN.

H PROPOSED NEW 152UC30 COLUMN TO SUPPORT EXISTING MASONRY WALL.

MP DENOTES MOVEMENT MONITORING POINT.

ISSUE	DATE	DESCRIPTION	DRN / ORIG	P.E. / P.D.
P1	20.09.18	ISSUED FOR COMMENT	BB / DB	DB / DB

ISSUE STATUS: ☒ PRELIMINARY (P1, P2, P3 etc.,) ☐ PLANNING (PL1, PL2, PL3 etc.,) ☐ TENDER (T1,T2, T3 etc.,) ☐ CONSTRUCTION (0, 1, 2 etc.,)

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Civil & Structural Design Consultants

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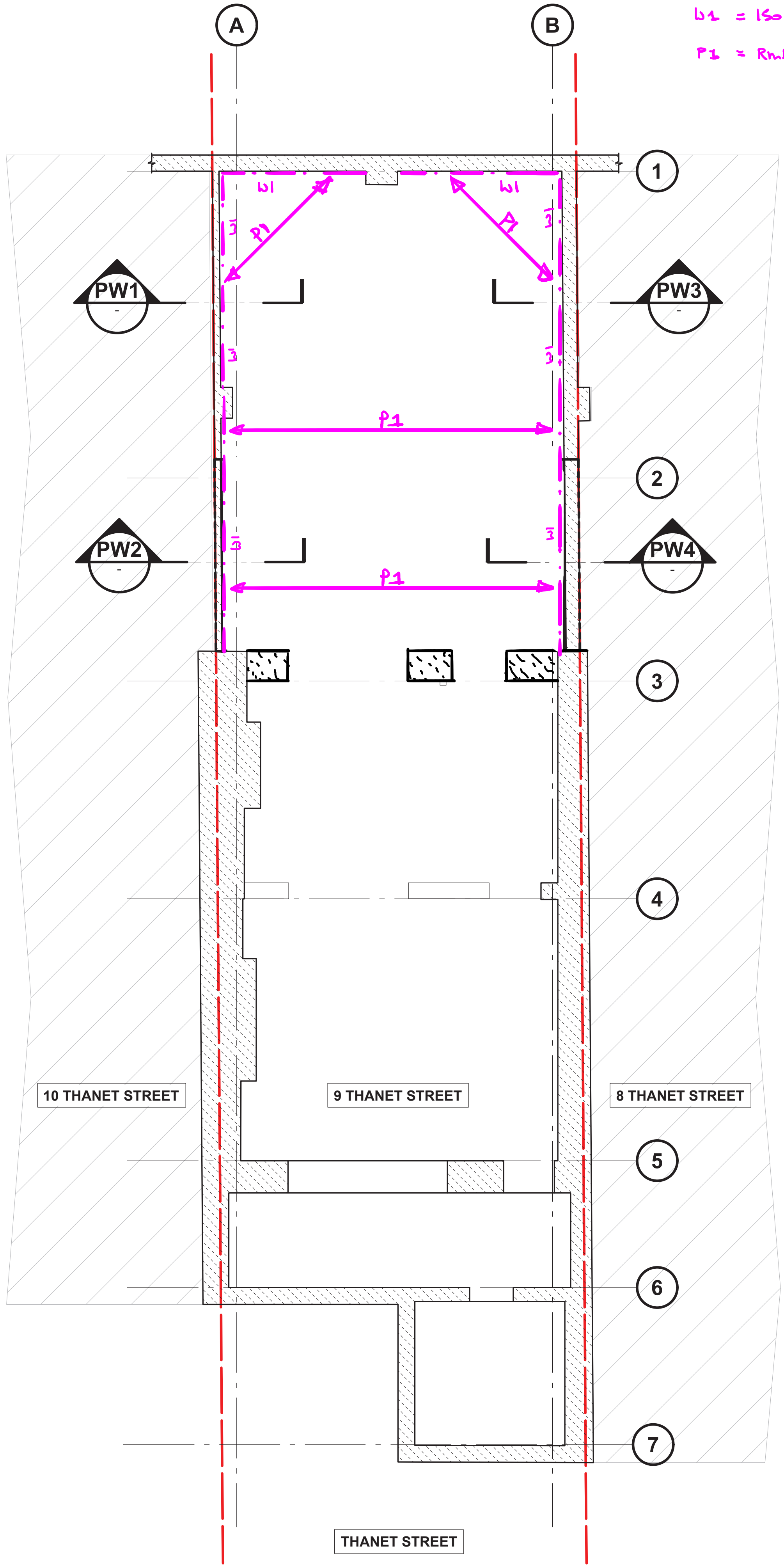
DRAWING TITLE
PARTY WALL SECTIONS

SCALE @ A1	JOB NO.	DRAWING NO.	ISSUE
AS SHOWN	18837	S-2050	P1

TW MEMBER SCHEDULE

W1 = 150x90 PFC WALER

P1 = RMD PUSH PULL PROP.

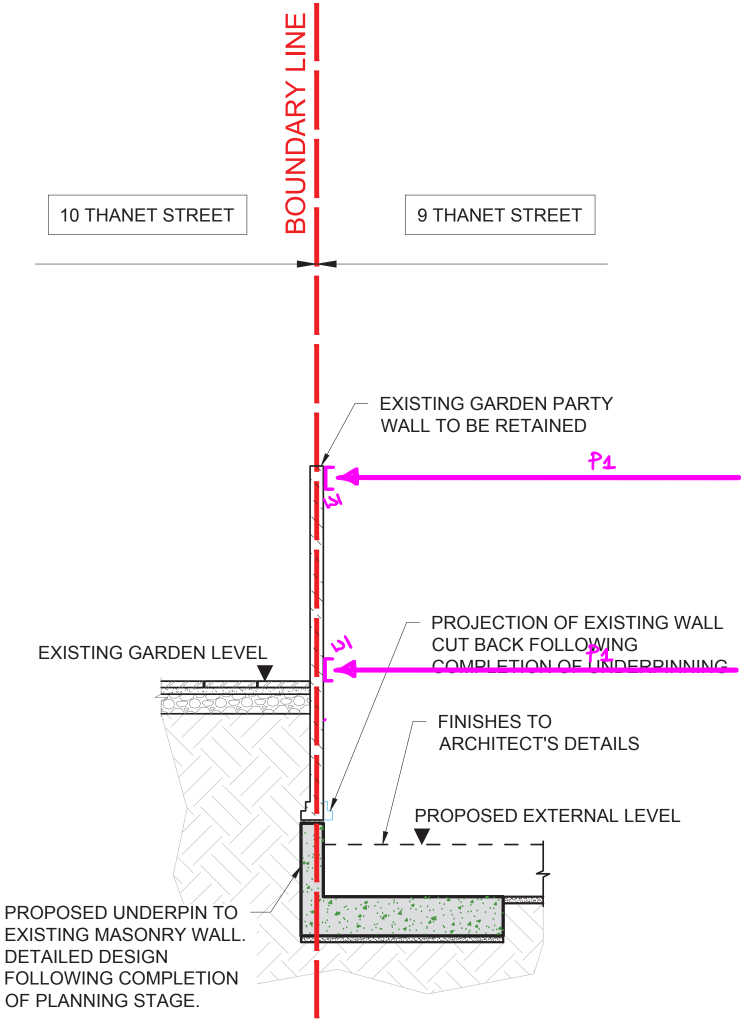


18837-Sk7000 - High Level/Low Level Temporary Works Bracing Plan

TW MEMBER SCHEDULE

W1 = 150x90 PFC WALER

P1 = RMD PUSH PULL PROP



PW1 - **SECTION**

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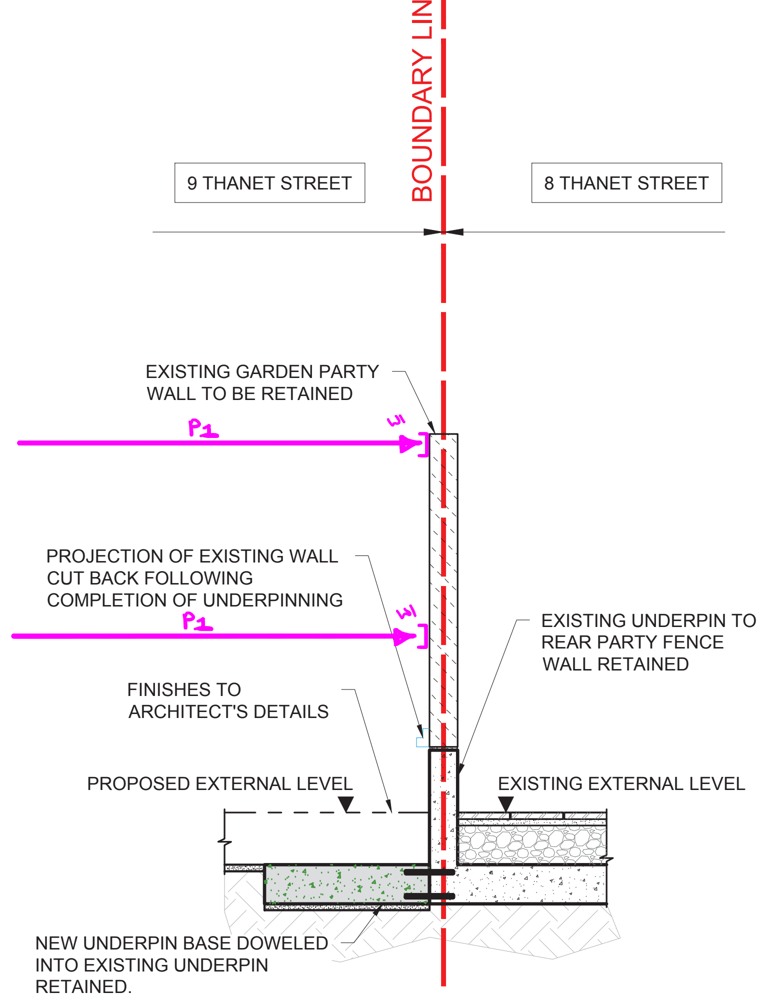
SCALE @ A3: 1:100



PW3 - **SECTION**

SCALE @ A1: 1:50
SCALE @ A3: 1:100

18837-Sk7000 - High Level/Low Level Temporary Works Bracing Plan

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