

Wall Adjacent to Station
North Street
Emsworth
PO10 7DP



STRUCTURAL ENGINEER'S REPORT
On
Stability of Wall

CLIENT

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CONSULTING ENGINEER

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Ref: 10015-SER-02

Date: 18th June 2014

BRIEF

1. Barron & Partners were appointed by Havant Borough Council, to carry out a Structural Engineer's Report on the structural stability of the wall adjacent to the railway station in North Street Emsworth. This report was issued as 10015-SER-01.
2. Subsequent to our original report we were instructed to carry out a trial hole investigation to determine the structure of the wall. This report 10015-SER-02 details the site investigation and includes two proposed designs for a replacement wall. This report should be read in conjunction with our original report 10015-SER-01.

VISIT

3. The trial hole was excavated on the 18th June 2014.

SITE

4. The wall is located as shown on sheet SER 1.

STRUCTURE

5. The trial hole revealed that the wall is of single skin brick construction approximately 200mm thick.
6. The age of the wall is unknown however it would appear that a retaining wall has been in this location for a substantial number of years, probably since the adjacent railway bridge and underpass was built.

INSPECTION

7. The trial hole inspection was confined to one section of the wall bounding the public highway. The area behind the wall is in private ownership and to avoid unnecessary disturbance to the gardens only a single trial hole was possible.
8. The trial hole revealed that the wall is of single skin brick construction 200mm thick.
9. Due to the constraints of the trial hole and adjoining areas it was not possible to conclusively examine the wall foundation. It is however considered likely that a simple strip footing has been used.

DISCUSSION

10. The retaining wall has an appreciable lean outwards. The amount of movement effectively means that the retaining wall has failed.
11. The trial hole revealed that the wall appears to be of single skin brick construction approximately 200mm thick.
12. The construction of the wall is therefore inadequate to retain the height of fill behind the wall. It is judged that the soil behind the wall is being effectively supported by the root systems of the vegetation present behind the wall.
13. It is therefore considered that the wall is on the edge of failure and may collapse at any time. Water build up behind the wall over the winter period may impose additional pressure on the wall and hence result in failure.
14. The wall should be rebuilt to a design adequate to carry the pressure generated by the retained material behind the wall. Calculations for two suitable designs for a replacement wall are attached to this report.

15. The first design considers an unreinforced brick retaining wall. The second design is for a reinforced cavity brick and block wall.
16. It should be noted that both designs assume that the ground behind the wall is adequately drained. To achieve an economic design water pressure has not been considered in the calculations.
17. The sketches attached to the design calculations should allow indicative prices for the two designs to be obtained. It should be noted however that further details, including drainage ect. will be required for construction.

CONCLUSIONS

18. The investigation revealed that the construction of the wall is inadequate to retain the height of fill behind the wall.
19. The retaining wall has an appreciable lean outwards. The amount of movement effectively means that the retaining wall has failed and may collapse at any time
20. It is therefore recommended that the wall be rebuilt using a suitable design. as the examples attached to this report.

D I Shields (B.Sc., M.Sc., C.Eng., M.I.C.E., M.I. Struct. E., F.Cons.E.)

For Barron & Partners Limited

10015-SER-02 - June 2014

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Contract

Wall Adjacent to Emsworth Station

Job Ref.

10015

Calc. by

DIS

Date

June 2014

Checked by

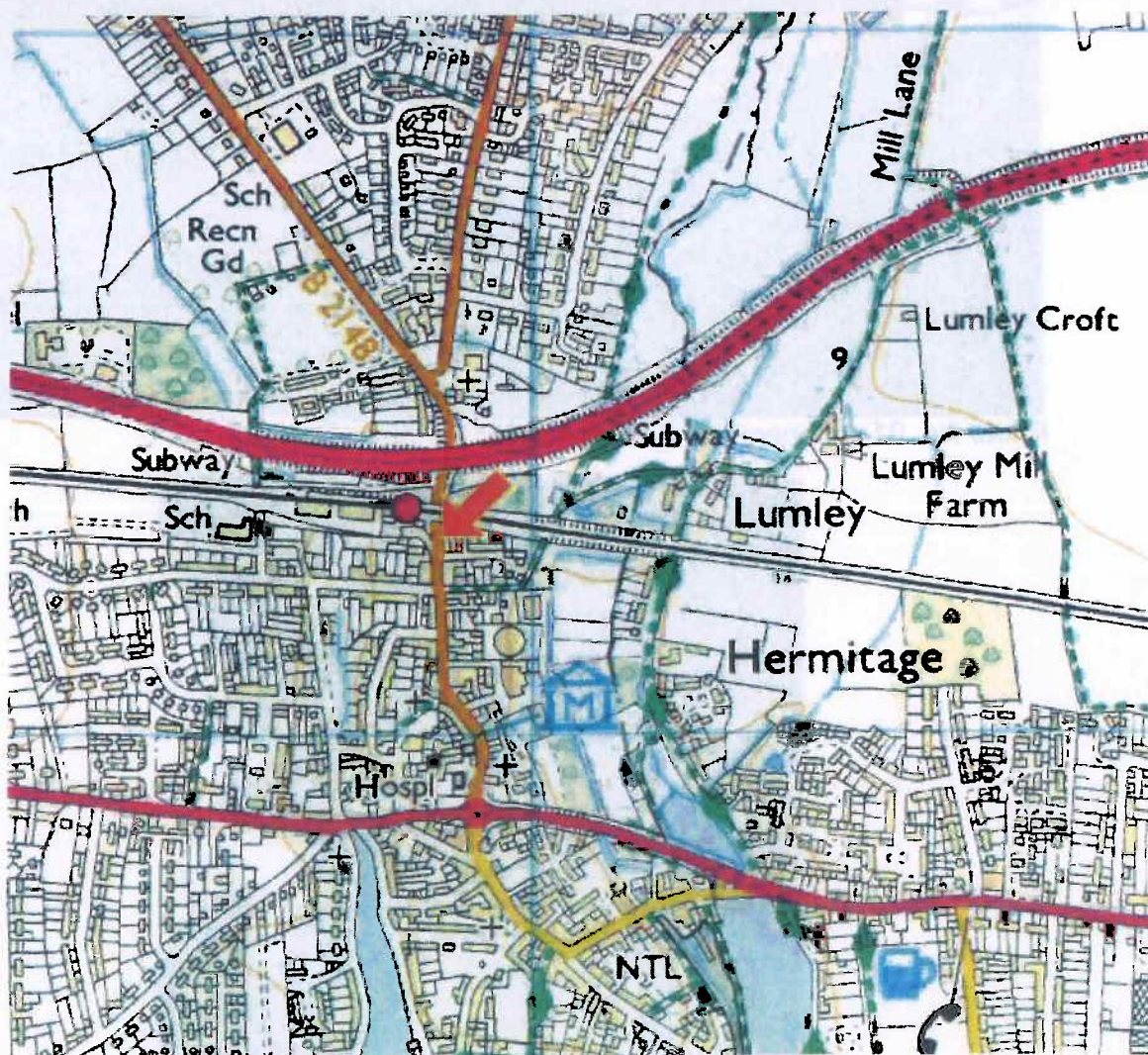
Drg Ref.

Part of
Structure

Site Location Plan

Sheet No.

SER1



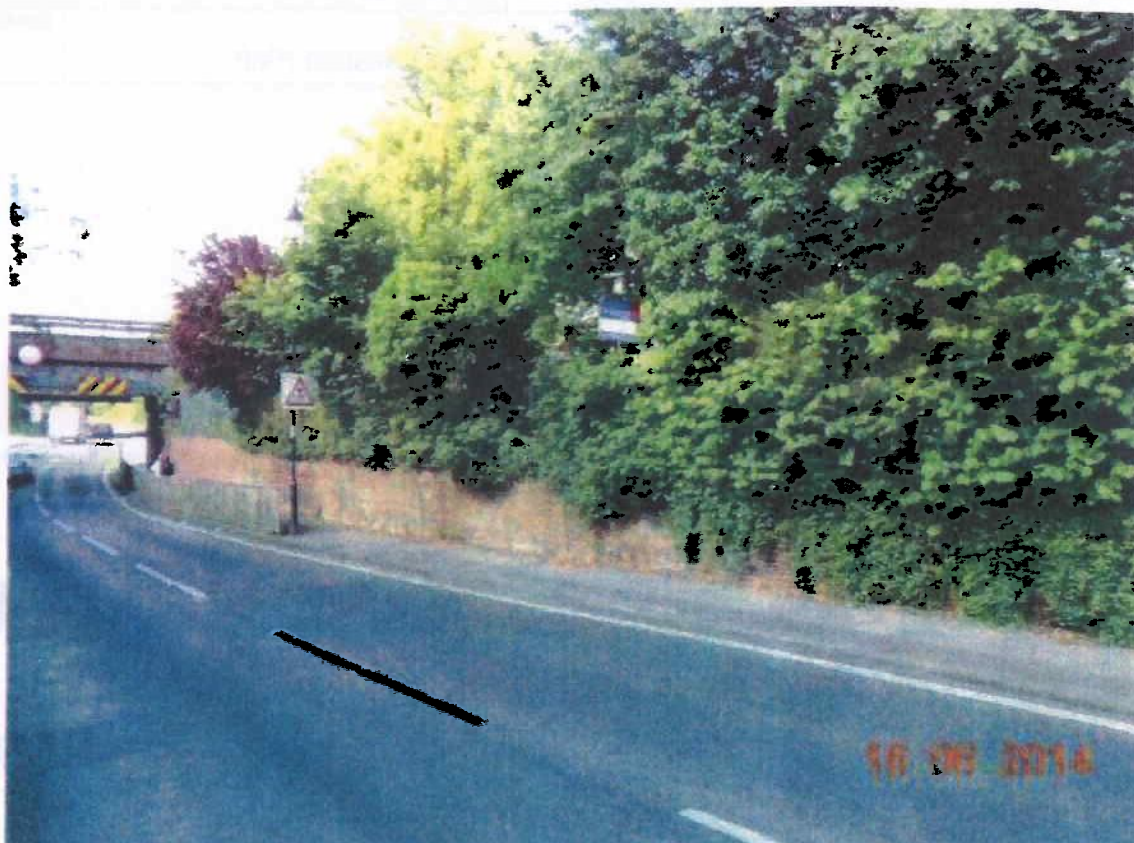


Photo No. 01 – General view at the front of the wall.



Photo No. 02 – Lean outwards as at June 2014



Photo No. 03 – Area where trial hole excavated behind wall



Photo No. 04 – Trial hole excavated behind wall

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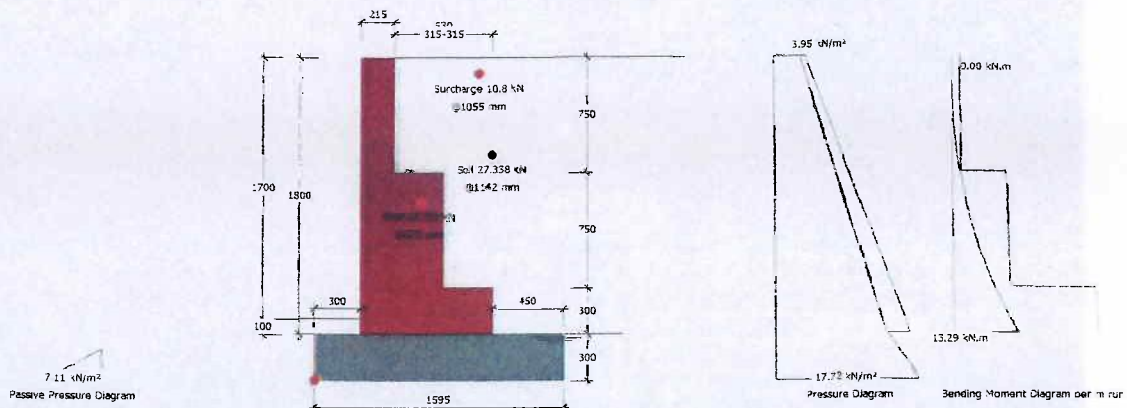
Sheet : 1

Made by : DIS

Date : 2014 / Ver. 2014.05

Checked : MG

Approved :

MasterKey : Retaining Wall Design to BS 8002, BS 5628 : 1992 and BS 8110 : 1997**Masonry Retaining Wall****Gravity Masonry Retaining Wall with Un-Reinforced Concrete Base****Summary of Design Data**

Notes

Material Densities (kN/m³)

Concrete grade

Surcharge and Water Table

All dimensions are in mm and all forces are per metre run

Dry Soil 18.00, Saturated Soil 20.80, Submerged Soil 10.80

Concrete 24.00, Masonry 20.00

fcu 30 N/mm², Permissible tensile stress 0.250 N/mm²

Surcharge 10.00 kN/m², Water table level 0 mm

Soil Properties

Soil bearing pressure

Back Soil Friction and Cohesion

Base Friction and Cohesion

Front Soil Friction and Cohesion

Allowable pressure @ front 100.00 kN/m², @ back 100.00 kN/m²

 $\phi = \text{Atn}(\tan(30)/1.2) = 25.69^\circ$ $\delta = \text{Atn}(0.75 \times \tan(\text{Atn}(\tan(30)/1.2))) = 19.84^\circ$ $\phi = \text{Atn}(\tan(30)/1.2) = 25.69^\circ$ **Loading Cases** G_{Soil} - Soil Self Weight, G_{Wall} - Wall & Base Self Weight, F_{Heel} - Vertical Loads over Heel. P_a - Active Earth Pressure, $P_{\text{surcharge}}$ - Earth pressure from surcharge, P_p - Passive Earth PressureCase 1: Geotechnical Design $1.00 G_{\text{Soil}} + 1.00 G_{\text{Wall}} + 1.00 F_{\text{Heel}} + 1.00 P_a + 1.00 P_{\text{surcharge}} + 1.00 P_p$ Case 2: Structural Ultimate Design $1.40 G_{\text{Soil}} + 1.40 G_{\text{Wall}} + 1.60 F_{\text{Heel}} + 1.00 P_a + 1.00 P_{\text{surcharge}} + 1.00 P_p$ **Geotechnical Design****Wall Stability - Virtual Back Pressure**

Case 1 Overturning/Stabilising

16.411/56.025

0.293

OK

Wall Sliding - Virtual Back Pressure $F_x / (R_{\text{Friction}} + R_{\text{Passive}})$

20.248/(21.494+0.680)

0.913

OK

Soil Pressure

Virtual Back (No uplift)

Max(55.954/100, 18.737/100) kN/m²

0.560

OK

Wall Back (No uplift)

Max(63.256/100, 11.435/100) kN/m²

0.633

OK

Structural Design**Masonry Wall Details**Partial Safety Factor ($\gamma_{\text{mc}}/\gamma_{\text{mf}}$)

Normal manufacturing, Normal construction

3.5/3 Table 4a/4b

Material

Clay bricks with water absorption less than 7%

Units and Mortar Strength

5 N/mm², Mortar designation (i)

Compressive Strength (fk)

Standard format bricks, $\gamma = 20$ kN/m³

2.5 N/mm²

Table 2

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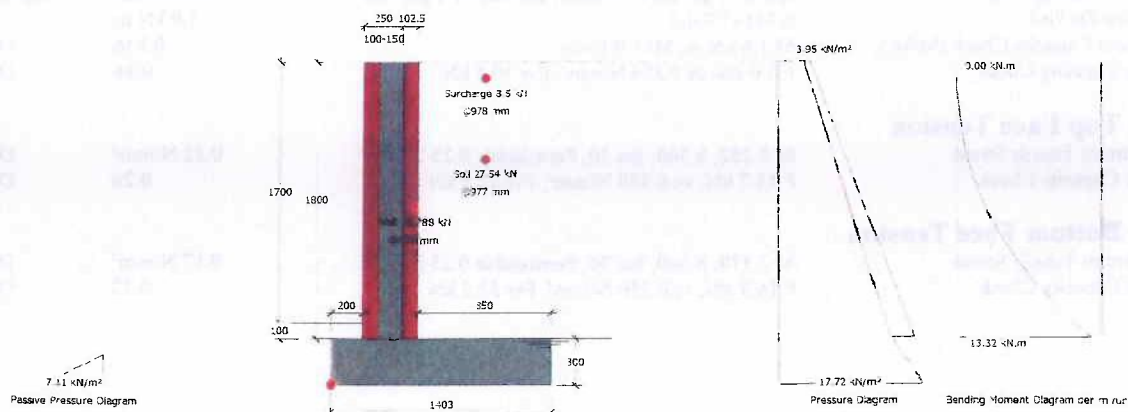
Sheet : 1

Made by : DIS

Date : 2014 / Ver. 2014.05

Checked : MG

Approved :

MasterKey : Retaining Wall Design to BS 8002, BS 5628 : 1992 and BS 8110 : 1997**Masonry Retaining Wall****Reinforced Masonry Cavity Filled Retaining Wall with Reinforced Concrete Base****Summary of Design Data****Notes**

Material Densities (kN/m³)

Concrete grade

Concrete covers (mm)

Reinforcement design

Surcharge and Water Table

† The Engineer must satisfy him/herself to the reinforcement detailing requirements of the relevant codes of practice

All dimensions are in mm and all forces are per metre run

Dry Soil 18.00, Saturated Soil 20.80, Submerged Soil 10.80

Concrete 24.00, Masonry 20.00

fcu 30 N/mm², Permissible tensile stress 0.250 N/mm²

Cavity inner cover 30 mm, Cavity outer cover 115 mm, Base cover 50 mm

fy 460 N/mm², fyb 460 N/mm² designed to BS 8110: 1997

Surcharge 10.00 kN/m², Water table level 0 mm

Soil Properties

Soil bearing pressure

Back Soil Friction and Cohesion

Base Friction and Cohesion

Front Soil Friction and Cohesion

Allowable pressure @ front 100.00 kN/m², @ back 100.00 kN/m²

 $\phi = \text{Atn}(\tan(30)/1.2) = 25.69^\circ$ $\delta = \text{Atn}(0.75 \times \tan(\text{Atn}(\tan(30)/1.2))) = 19.84^\circ$ $\phi = \text{Atn}(\tan(30)/1.2) = 25.69^\circ$ **Loading Cases** G_{Soil} - Soil Self Weight, G_{Wall} - Wall & Base Self Weight, $F_{V_{\text{Heel}}}$ - Vertical Loads over Heel, P_a - Active Earth Pressure, $P_{\text{surcharge}}$ - Earth pressure from surcharge, P_p - Passive Earth PressureCase 1: Geotechnical Design $1.00 G_{\text{Soil}} + 1.00 G_{\text{Wall}} + 1.00 F_{V_{\text{Heel}}} + 1.00 P_a + 1.00 P_{\text{surcharge}} + 1.00 P_p$ Case 2: Structural Ultimate Design $1.40 G_{\text{Soil}} + 1.40 G_{\text{Wall}} + 1.60 F_{V_{\text{Heel}}} + 1.00 P_a + 1.00 P_{\text{surcharge}} + 1.00 P_p$ **Geotechnical Design****Wall Stability - Virtual Back Pressure**

Case 1 Overturning/Stabilising 16.411/47.081 0.349 OK

Wall Sliding - Virtual Back Pressure $F_x / (R_{\text{Friction}} + R_{\text{Passive}})$ 20.248/(21.226+0.680) 0.924 OK**Soil Pressure**

Virtual Back (No uplift) Max(74.219/100, 9.667/100) kN/m² 0.742 OK

Wall Back (No uplift) Max(83.804/100, 0.081/100) kN/m² 0.838 OK

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Wall Design (Inner Face Tension)

Critical Section	Critical @ 1050 mm from base, Case 2		
Section Properties @ 1050 mm	t=215 mm, Area=2150 cm ² , Zb=7704 cm ³		
Flexural Strength fkb	fkb=0.7, gd=0.015 N/mm ² , fkb=fkb+0.9 gd. γ_{mf}	0.741 N/mm ²	Table 3
Mr=fkb.Zb/ γ_{mf}	0.741x7704/3	1.9 kN.m	
Moment Capacity Check (M/Mr)	M 1.6 kN.m, Mr 1.9 kN.m	0.846	OK
Shear Capacity Check	F 5.0 kN, fv 0.358 N/mm ² , Fvr 30.8 kN	0.16	OK

Base Top Face Tension

Maximum Tensile Stress	M 3.252, h 300, fcu 30, Permissible 0.25 N/mm ²	0.22 N/mm ²	OK
Shear Capacity Check	F 13.7 kN, vc 0.350 N/mm ² , Fvr 52.5 kN	0.26	OK

Base Bottom Face Tension

Maximum Tensile Stress	M 2.579, h 300, fcu 30, Permissible 0.25 N/mm ²	0.17 N/mm ²	OK
Shear Capacity Check	F 16.9 kN, vc 0.350 N/mm ² , Fvr 52.5 kN	0.32	OK

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Structural Design**Outer Leaf Details**

Partial Safety Factor (γ_{mc}/γ_{mf})	Normal manufacturing, Normal construction	3.5/3	Table 4a/4b
Material	Clay bricks with water absorption less than 7%		
Units and Mortar Strength	5 N/mm ² , Mortar designation (i)		
Compressive Strength (fk)	Standard format bricks, $\gamma=20$ kN/m ³	2.5 N/mm ²	Table 2

Inner Leaf Details

Partial Safety Factor (γ_{mc}/γ_{mf})	Normal manufacturing, Normal construction	3.5/3	Table 4a/4b
Material	Calcium silicate bricks, $\gamma=20$ kN/m ³		
Units and Mortar Strength	5 N/mm ² , Mortar designation (i)		
Compressive Strength (fk)	Standard format bricks	2.5 N/mm ²	Table 3

Wall Design (Inner Steel)

Critical Section	Critical @ 0 mm from base, Case 2		
Steel Provided (Cover)	Dist. B5@300 (30 mm in cavity)		
	Main B7@175 (30 mm in cavity)	220 mm ²	OK
Leverarm $z=fn(d,b,As,fy,fk)$	217 mm, 1000 mm, 220 mm ² , 460 N/mm ² , 2.5 N/mm ²	164 mm	
$Mr=fn(above,\gamma_{mf},\gamma_{ms})$	3.00, 1.15	14.4 kN.m	
Moment Capacity Check (M/Mr)	M 13.3 kN.m, Mr 14.4 kN.m	0.925	OK
Shear Capacity Check	F 18.6 kN, fv 0.616 N/mm ² , Fvr 53.3 kN	0.35	OK

Base Top Steel Design

Steel Provided (Cover)	Main B8@125 (50 mm) Dist. B8@125 (58 mm)	402 mm ²	OK
Compression Steel Provided (Cover)	Main B8@125 (50 mm) Dist. B8@125 (58 mm)	402 mm ²	
Leverarm $z=fn(d,b,As,fy,Fcu)$	246 mm, 1000 mm, 402 mm ² , 460 N/mm ² , 30 N/mm ²	234 mm	
$Mr=fn(above,As',d',x,x/d)$	402 mm ² , 54 mm, 15 mm, 0.06	41.1 kN.m	
Moment Capacity Check (M/Mr)	M 14.8 kN.m, Mr 41.1 kN.m	0.359	OK
Shear Capacity Check	F 21.0 kN, vc 0.415 N/mm ² , Fvr 102.0 kN	0.21	OK

Base Bottom Steel Design

Steel Provided (Cover)	Main B8@125 (50 mm) Dist. B8@125 (58 mm)	402 mm ²	OK
Compression Steel Provided (Cover)	Main B8@125 (50 mm) Dist. B8@125 (58 mm)	402 mm ²	
Leverarm $z=fn(d,b,As,fy,Fcu)$	246 mm, 1000 mm, 402 mm ² , 460 N/mm ² , 30 N/mm ²	234 mm	
$Mr=fn(above,As',d',x,x/d)$	402 mm ² , 54 mm, 15 mm, 0.06	41.1 kN.m	
Moment Capacity Check (M/Mr)	M 4.4 kN.m, Mr 41.1 kN.m	0.107	OK
Shear Capacity Check	F 18.8 kN, vc 0.415 N/mm ² , Fvr 102.0 kN	0.18	OK



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Havant
BOROUGH COUNCIL

Title:

97-109 NORTH STREET

DANGEROUS WALL ISSUE

'ACCESS PROVISIONS'

Drawn By:

Scale:

Scale: 1:500

Drawing No:

Cleaner, Safer, More Prosperous

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