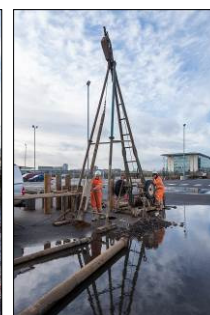

BIA AUDIT RESPONSE

31 Willoughby Road
London
NW3 1RT

Client: Manuela Eleuteri

24 January 2018

J15315



Document control

Project title		31 Willoughby Road, London, NW3 1RT		Project No	J15315
Report title		Audit Response			
Report prepared by					
		Matthew Penfold MSci MSc DIC CGeol FGS Principal Geotechnical Engineer			
Report checked and Approved for issue by					
		Steve Branch BSc MSc CGeol FGS FRGS Managing Director			
Issue No	Status	Amendment Details	Date	Approved for Issue	
1	Final		30 January 2018		

This report has been issued by the GEA office indicated below. Any enquiries regarding the report should be directed to the office indicated or to Steve Branch in our Herts office.



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1.0 INTRODUCTION

We have reviewed the comments made within the Basement Impact Assessment (BIA) Audit by Campbell Reith (ref: 12466-50 Rev D2, dated December 2017) and this report comprises our formal response to the points raised with respect to the outstanding desk study, stability and hydrogeology issues outlined in Query Nos 1, 5 and 7 of the Query Tracker within the Audit report, which can be summarised as follows:

- Provision of an Outline Construction Programme (provided by Areaview Ltd);
- additional ground movement analysis to demonstrate the feasibility of either a two-stage or single stage approach for the proposed basement construction; and
- a hydrogeological assessment undertaken by Chord Environmental Limited.

All other queries have been closed, as per the audit tracker, and are not therefore considered within this report.

1.1 Limitations

The conclusions and recommendations made in this report are limited to those that can be made on the basis of the investigations carried out. The results of the work should be viewed in the context of the range of data sources consulted, the number of locations where the ground was sampled and the number of soil, gas or groundwater samples tested; no liability can be accepted for information in other data sources or conditions not revealed by the sampling or testing. Any comments made on the basis of information obtained from the client or other third parties are given in good faith on the assumption that the information is accurate; no independent validation of such information has been made by GEA.

2.0 BACKGROUND INFORMATION

The site was investigated by GEA in January 2016, with additional site work undertaken in July 2017 and the investigation is detailed in report Ref J15315 Issue 5, dated August 2017, which should be read in conjunction with this report.

The investigation included a desk study, which revealed that prior to the earliest map studied, dated 1873, the site was covered by woodland. By the time of the next map, dated 1896, the area had undergone residential development and the site formed the northern half of a private garden of a house on Gayton Crescent. At some time between 1896 and 1915, the garden of the house on Gayton Crescent was redeveloped and the existing house on the site was built as part of a row of three properties. Between 1970 and 1976, additional properties were built along Willoughby Road to the south and the area has since remained essentially unchanged.

The desk study was followed by two phases of ground investigation, which in total comprised five boreholes advanced by hand held window sampling and open-drive methods to a maximum depth of 10.0 m (75.4 m OD).

The investigations have generally confirmed the expected ground conditions in that, beneath paving and a maximum thickness of 150 mm of unreinforced concrete or topsoil, made ground extends to depths of between 2.4 m to 3.2 m, below which Superficial Deposits were encountered overlying the London Clay Formation.

The made ground generally comprised brown to dark brown, orange-brown and greenish grey silty sandy clay with rootlets and variable amounts of brick, charcoal and ash. Below the made ground, firm greenish grey to orange-brown silty clay with gravel and carbonaceous material was encountered in a number of locations to depths of between 3.5 m and 3.75 m, which has been interpreted as Superficial (Head) Deposits. This, in turn, is underlain by the London Clay, which

was found to comprise an upper layer of firm becoming stiff pale orange-brown to brownish grey silty clay and extended to depths of between 4.0 m and 5.0 m where it was underlain by stiff dark brownish grey silty clay to the full depth of the investigation of 10.0 m. Rare selenite crystals and occasional partings of silt and sand were observed to be present within the London Clay, along with claystones in one location at a depth of approximately 6.5 m.

Groundwater was encountered during drilling at depths of between 3.00 m (82.55 m OD) and 3.30 m (82.10 m OD) and has subsequently been monitored at depths of between 2.34 m (83.21 m OD) and 3.04 m (82.46 m OD).

2.1 Recent Findings / Other Information

2.1.1 Groundwater Monitoring

GEA returned to site in December 2017 to undertake a further round of groundwater monitoring and the results of all of the monitoring are summarised in the table below

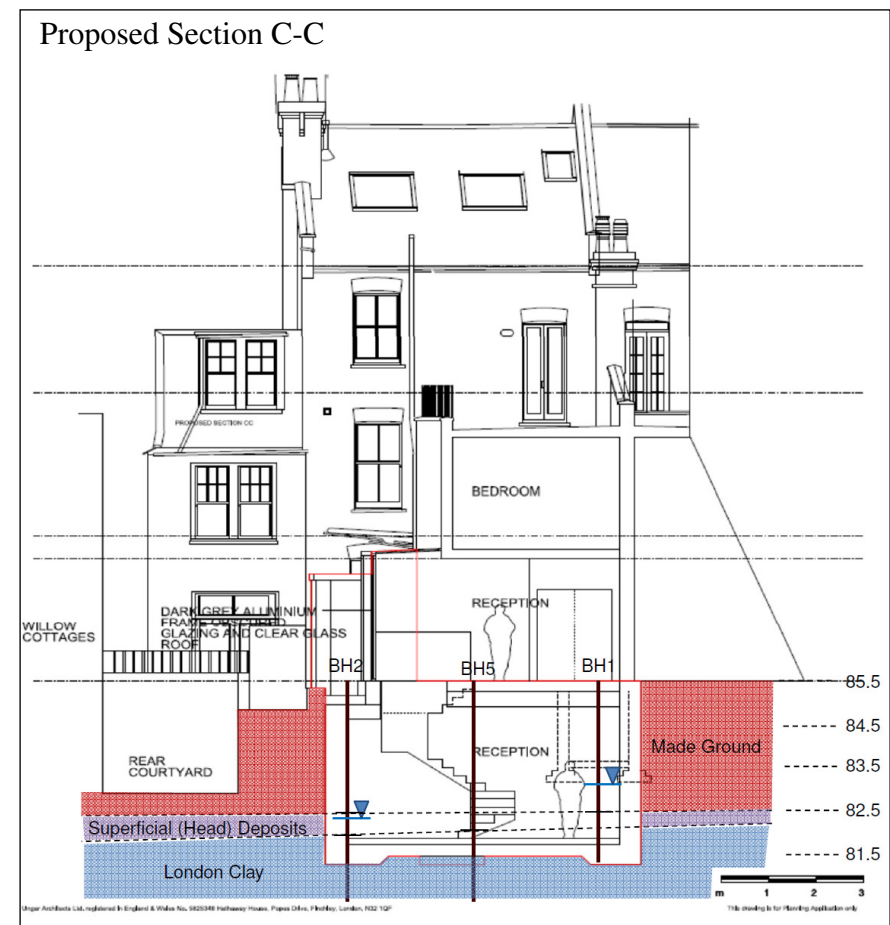
Borehole No	Standpipe depth (m bgl) [m OD]	Depth to groundwater (m bgl) [m OD]					
		02/02/2016	23/02/2016	14/12/2016	05/07/2017	11/07/2017*	19/12/2017
1	3.1 [82.45]	2.55 [83.00]	2.34 [83.21]	Not monitored	2.46 [83.09]	3.00 [82.55]	2.29 [83.26]
2	4.00 [81.50]	3.00 [82.50]	3.04 [82.46]	Not monitored	3.17 [82.33]	3.20 [82.30]	3.04 [82.46]
3	3.00 [82.40]	2.75 [82.65]	2.70 [82.70]	2.75 [82.65]	2.85 [82.55]	2.80 [82.60]	2.66 [82.74]
4	5.00 [80.40]	2.75 [82.65]	2.76 [82.64]	2.75 [82.65]	2.88 [82.52]	2.89 [82.51]	2.83 [82.57]

*Water levels within BH1 not fully recovered from rising head test undertaken on 5th July 2017.

Falling head tests were also undertaken in Borehole Nos 1 to 4, to provide additional information on the permeability of the underlying soils, the findings of which are summarised and interpreted in the hydrogeological assessment undertaken by Chord Environmental Ltd, a copy of which is included in the appendix.

2.1.2 Conceptual Model

In order to provide additional clarification of the ground conditions across the site and in particular the relationship with Willow Cottages, the following short section has been produced to supplement the existing conceptual model included within the previous BIA report.



3.0 Audit Response

Table 1: Audit Query Tracker with GEA responses

Query No	Subject	Query	Status	Details	Response
1	Desk Study	Outline Construction Programme	Open – programme to be provided as per point 5.2 of audit report	An outline construction programme should be provided	Draft document included in Appendix
5	Stability	GMA and damage impact assessment to be based on revised geotechnical parameters and actual site proposals	Open – to be provided as per point 5.5 and 5.6 of audit report*	5.5 – The revised ground movement assessment (GMA) is not considered to adequately address the potential settlement induced by two stages of underpinning, especially considering the first stage will bear within Made Ground / Superficial Deposits. 5.6 – The damage impact assessment should be re-evaluated, considering 5.5 and the comments in Section 4 (of the audit report).	Existing Proposal – Two-Stage Underpinning: The existing proposals allow for the underpinning to be undertaken in two stages, the first extending to a depth of approximately 1.8 m (83.7 m OD) to the level of the existing cellar and the second to the full depth of the proposed basement of 4.1 m (81.4 m OD). Whilst the sequence drawings show the existing foundations extending to a depth of approximately 1.2 m, it should be noted that this is a conservative assumption as the trial pits (see TP2 and 6 in particular) have shown that, with the exception of the rear extension, the foundations of the main house are already at a similar level (84.05 m OD to 83.8 m OD) to the proposed first stage (83.7 m OD). Due to the existing foundation loads, which are estimated to be approx. 160 kN/m, the soils at the proposed Stage 1 level are already subject to similar, if not greater, bearing pressures than those anticipated during the proposed development, such that any additional modelling of this stage is unlikely to produce any meaningful results or show any impact on the adjoining structures. The same cannot, of course, be said for the rear extension, where the existing foundations have been found to bear within the made ground at a much shallower level. However, as the retaining walls to be constructed on this part of the site will not be subject to any significant loading until construction of the new extension above this part of the proposed basement, there is limited scope for any vertical loadings to be applied until the excavations have reached their full depth and the final loadings are applied through the new foundations. In order to demonstrate this, we have carried out additional sensitivity analysis of the two-stage underpinning sequence, the findings of which are summarised in Table 2 below. The net bearing pressures at each stage have been estimated on the basis that the existing foundations apply a bearing pressure of 160 KPa at a depth of approximately 1.2 m and approximately 1.8 m for the existing cellar. This is considered conservative as it assumes an existing foundation width of 1.0 m,

Query No	Subject	Query	Status	Details	Response
					which is an overestimate of the actual foundation widths, such that we are underestimating the existing bearing pressures. Based on simple calculations for a strip footing, the existing bearing pressures at proposed first stage level of 83.7 m OD (excluding the existing cellar) has been estimated as 100 KPa. The net increase in bearing pressure at this level during the first stage of underpinning would therefore be approximately 60 KPa. For the proposed second stage, the existing pressure at proposed formation level (81.4 m OD) has been estimated as approximately 50 KPa beneath the existing cellar and 40 KPa outside the extent of the cellar. The net increase in bearing pressure on the new foundations after completion of the second stage of underpinning will therefore be approximately 50 KPa and 60 KPa respectively. Where the proposed basement will extend beneath the existing extension, the proposed bearing pressure of 100 KPa has been applied through all stages in order to provide a conservative assessment, as in reality the final loadings will not be applied to these foundations until the final stages of the development. The analysis also includes an initial step for each stage, whereby no heave has been allowed for as a result of bulk excavations, so that the short-term settlement of the underpins can be considered in isolation. Whilst this does provide a useful check of any potential impact at these stages of the development, it is unlikely that there will, in reality, be sufficient time for these movements to be fully realised before the bulk excavations start to take place, such that the predicted movements and resultant damage assessment are considered conservative The findings of this additional analysis for each stage of proposed underpinning agree well with the previous GMA within the existing BIA report, in that the predicted level of damage would generally fall within Category 0 (Negligible), with limited areas of Category 1 (Very Slight) damage to a number of individual elevations of the neighbouring properties, most notably the rear elevation of No 29 (highlighted as the most critical structure in Table 2 below). Alternative Proposal – Single-Stage Underpinning: Following a discussion with the consulting engineer with respect to the points raised in the audit, an alternative methodology has also been developed to allow for the works to be completed in a single stage, which completely removes any potential issue of new loads being applied at an intermediate level within the made ground / superficial deposits. Details of these updated proposals are included within the appendix.

Query No	Subject	Query	Status	Details	Response
					Whilst the final stage of this approach is already considered within the existing BIA, we have undertaken additional sensitivity analysis, adopting the same procedures discussed above for the two-stage approach, of the potential short-term movements (with and without heave due to bulk excavation), the findings of which are summarised in Table 2 below. Again, the findings of the analysis presented in Table 2 for the alternative single-stage approach, do not indicate any damage in excess of Category 1 (Very Slight), with the majority of the predicted damage falling within Category 0 (Negligible). Conclusions: In both cases discussed above, it is evident that the most critical stage follows the final stage of the development when the excavations have been extended to their full depth and the final loads are applied, which is the case covered by the previous ground movement analysis contained within the existing BIA report. It is therefore concluded that the existing GMA, supported by the additional analysis summarised in Table 2, adequately addresses the potential ground movements that would occur from either a single or two stage approach, such that no further assessment should be required. Table 2 below comprises a summary of the findings of the sensitivity analysis undertaken in response to the audit comments and relevant contour plots and extracts are included in the appendix for illustrative purposes. The full inputs and outputs have not been included for the purposes of brevity, but can be provided upon request, if this information is deemed to be required. It is important to note that the strength profile adopted within the previous GMA is based on the findings of the first phase of investigations, most notably the limited increase in strength of the underlying London Clay indicated by the findings of BH4 (now confirmed as exhibiting anomalous results, not consistent with the rest of the boreholes and dynamic probe records). Whilst the findings of the subsequent site investigation works have corroborated the engineering assessment that the London Clay attains a 'stiff' consistency at depths of approximately 5.0 m and that a higher strength profile could be adopted, this lower bound profile has been retained in the analysis to provide an extremely conservative assessment of the likely ground movements, such that the predicted movement therefore represent overestimates that are unlikely to be fully realised.

Query No	Subject	Query	Status	Details	Response
7	Hydrogeology	Groundwater flow rate and direction should be ascertained and considered with reference to the proposed structure and the potential impacts on neighbouring structures. Seasonal groundwater levels should be considered and further monitoring undertaken, as required.	Open – to be provided as 5.8 of audit report*	5.8 – The revised BIA provided further hydrogeological assessment, but this has not demonstrated that the proposed basement will not cause groundwater to impact local structures, e.g. Willow Cottages.	In response to the comments raised in the audit report, a further round of groundwater monitoring was undertaken, including falling head tests to provide additional information on the permeability of the underlying soils (see Section 2.1.1 above). This data, along with the information contained within the existing BIA, has then been used to complete a supplementary hydrogeological assessment, a copy of which is included in the appendix. The findings of the assessment confirm the previous conclusions of the BIA, in that, the strata present beneath the site are of low permeability and that these soils cannot support any significant groundwater flow, such that the development will not have an impact on the local groundwater regime that could adversely affect any nearby properties. Reference should be made to the appended hydrogeological assessment provided by John Evans of Chord Environmental Limited (report ref1109/LJE120118, dated January 2018) for detailed response to this query.

*The Audit Query Tracker also refers to audit conclusion 5.10. However, this is assumed to be a mistake as this point relates to the risk of flooding from sewers and is not relevant to either of the above issues.

Table 2: Summary of additional analysis for two-stage and single stage underpinning

Proposed Construction Sequence	Stage	Sub-Stage	Short-term / Total Movements	Formation Level (m OD)	Total Horizontal Movement (mm)	Max Tensile Strain (%) from analysis	Elevation on which max tensile strain occurs	Sensitive Structure Line No	Damage Category
Two-Stage Underpinning	1	Underpinning to stage 1 Level only (before bulk excavation)	Short-term	83.7	0	0.03	Rear Elevations of No 29 Willoughby Road	7	0 - Negligible
		Underpinning + Bulk Excavation to Stage 1 Level	Short-term	83.7	0 to 5	<0.05	Rear Elevations of No 29 Willoughby Road	7	0 - Negligible
	2	Underpinning to Stage 2 Level only (before bulk excavation)	Short-term	81.4	5 to 10	0.07	Rear Elevations of No 29 Willoughby Road	7	1 - Very Slight
		Underpinning + Bulk Excavation to Stage 2 Level	Short-term	81.4	5 to 10	0.06	Rear Elevations of No 33 Willoughby Road and No 29 Willoughby Road	2 & 7	1 - Very Slight
		Underpinning + Bulk Excavation to Stage 2 Level	Total	81.4	5 to 10	0.07	Rear Elevations of No 29 Willoughby Road	7	1 - Very Slight
Single Stage Underpinning	1	Underpinning to Stage 1 Level only (before bulk excavation)	Short-term	81.4	0 to 5.0	0.04	Rear Elevations of No 29 Willoughby Road	7	0 - Negligible
		Underpinning + Bulk Excavation to Stage 1 Level	Short-term	81.4	5 to 10	0.07	Rear Elevations of No 29 Willoughby Road	7	1 - Very Slight
		Underpinning + Bulk Excavation to Stage 1 Level	Total	81.4	5 to 10	0.07	Rear Elevations of No 29 Willoughby Road	7	1 - Very Slight

5.0 CONCLUSIONS

In the case of either two-stage or single-stage underpinning, it is evident that the most critical stage follows the final stage of the development when the excavations have been extended to their full depth and the final loads are applied, which is the case covered by the previous ground movement analysis contained within the existing BIA report.

It is therefore concluded that the existing GMA, supported by the additional analysis summarised in Table 2, adequately addresses the potential ground movements that would occur from either a single or two stage approach, such that no further assessment should be required.

In addition, the hydrogeological assessment undertaken by Chord Environmental Limited, confirms that the development will not have an impact upon the existing groundwater regime, or have the potential to detrimentally affect any nearby properties.



Matthew Penfold MSci MSc DIC CGeol FGS
Principal Geotechnical Engineer

25 January 2018

Appendix

Outline Construction Programme (produced by Areaview Ltd)

Proposed Development (Sequence of construction plans)

Two-Stage Underpinning:

Stage 1 - Short Term Movement (Contour Plots)
& Tabular output of related damage assessment

Stage 2 - Short Term Movement (Contour Plots)
& Tabular output of related damage assessment

Stage 2 - Total Movement (Contour Plots)
& Tabular output of related damage assessment

Single Stage Underpinning:

Short Term Movement (Contour Plots)
& Tabular output of related damage assessment

Total Movement (Contour Plots)
& Tabular output of related damage assessment

Hydrogeological Assessment (ref 1109/LJE120118, dated January 2018)

Proposed Development (Outline Construction Programme and Sequence of construction plans for single stage underpinning)



31 Willoughby Road

Structural Methodology Report

Brief

This document is the structural methodology report carried out for the purposes of the Planning application for the proposals at no. 31 Willoughby Road. It should be noted that this report outlines and suggests the assumed construction at this stage. It should also be noted that, as is standard for works of this type, the main contractor will be fully responsible for the design and erection of all temporary works.

The purpose of the report, with the Basement Impact Assessment prepared by GEA Ltd, is to demonstrate that a subterranean development can be constructed on the particular site having regard to the sites existing structural conditions and geology.

The Basement Impact Assessment prepared by GEA Ltd references to the stages set out in the CPG4 Basement & Lightwells planning document.

Richard Tant Associates

Richard Tant Associates are consulting Civil and Structural Engineers comprising a number of chartered engineers. We have experience in post basement construction and have successfully carried out a number of basements in the Borough Camden from the Basement Impact Assessment stage through to construction on site.

Description of Proposed Basement and Internal Works

31 Willoughby Road is a terraced brick, Victorian, four storey house comprising timber floors and load bearing masonry walls. There is a cellar under part of the property approximately 1.8m deep. There are no signs of significant differential movement and the property appears to be in sound structural condition. It appears the property was originally semi-detached with what now appears to be a 1950's semi-detached property sharing the party wall.

The proposed single storey basement under the existing property extends into the rear garden, where a lightwell will be formed.

The proposed internal works comprise partial removal of the ground floor spine wall and an external wall with a small side extension. No structural works are proposed on the first, second or third floors.

Please refer to the drawings prepared by the Architect Ungar Architects: 109_PLA_BP Rev B, GFP Rev B, FFP, Rev B, SEC AA Rev B, SEC BB Rev B, SEC CC Rev B and the existing survey drawings.

Basement with Ground Floor Extension

The proposal is to form a new single storey basement structure under the footprint of the property with a light well at the rear with an excavation of approximately 4.1m below existing ground level. At the rear a small single storey extension is proposed, built in traditional loadbearing masonry. Please refer to the Architects drawings for the proposed layout and existing survey plans.



31 Willoughby Road

A geotechnical and hydrological report including flood risk assessment has been carried out by GEA Ltd; the bore holes show a significant amount of made ground with a minimum thickness of 2.4m with firm silty clay below underlain with London Clay. Water seepages were encountered at depth of 3m and 3.3m with monitoring showing a minimum depth of 2.3m, we note the GEA report highlights that the groundwater inflow is likely to be very slow and adequately dealt with through sump pumping. Based on this geotechnical information, the new basement construction is to comprise reinforced concrete underpinned retaining walls with an internal cavity drain system. This will be described in more detail throughout this report. Please refer to our drawings 4186-SM01D, SM02E and SM03C.

Structural Stability of the Existing buildings

The proposed basement is to be constructed between reinforced concrete underpinned party walls and reinforced retaining walls. The reinforced concrete underpinned party walls and retaining walls will be designed to retain the ground pressures and water pressures and distribute the vertical load down. Refer to calculation sheets for justification of the retaining walls: 4186-P1C et seq. Refer to the damage assessment section of the GEA report confirming these works are not expected to create any significant differential settlement or have a detrimental effect on the structural stability of the existing building or neighbouring buildings.

Supporting the Proposed Loads

The vertical loads from the proposed basement will be supported via reinforced concrete underpinning or retaining walls into strip footings. The loads from the internal floors will be supported via the new steel frame in turn supported via the new pad and strip footings. Refer to the calculation sheets for justification of the retaining walls: 4186-P1C et seq. The new basement slab will also be designed to accommodate the vertical hydrostatic forces.

Structural Integrity of Surrounding Structures and Utilities

We do not expect there to be any public utilities, tunnels or infrastructure within the area of influence of the proposed basement works apart from the existing foundations mentioned above and therefore we do not expect any impact regarding the structural integrity to these items.

We understand there are reports of local water ingress to adjacent basements. Surveys, via the party wall process, can be carried to further inform of local water ingress to adjacent basements.

Slope Instability

The proposal is to construct the walls in stages that will be temporarily propped until the final base is constructed and cured. No battering back is proposed. We refer to the GEA Basement Impact Assessment where the risk of slope instability is addressed and discharged.

Impact on Drainage and Surface Water

We do not expect there to be any existing public drainage within the area of influence of the proposed basement works. With regards to surface water the basement is mainly below existing hard standing. Refer to the Surface Flow Assessment in the GEA report and site specific Flood Risk Assessment produced by Evans River & Coastal.



31 Willoughby Road

Geological & Hydrological Concerns

The application is informed and supplemented by the hydrological section of the geotechnical report and floor risk assessment carried out by GEA Ltd and identified in their Basement Impact Assessment report. The new basement retaining walls and slab will be designed to accommodate the hydrostatic forces. GEA Ltd have highlighted an allowance should be made for possible dewatering of discrete inflows from the made ground and head deposits. The findings of the site investigation indicate that potential inflows are unlikely to be significant and will be dealt with by using standard capacity sump pumps. Once depleted, further inflows are expected to be slight due to the low permeability of the surrounding soils and correspondingly low rate of potential recharge.

Impact on Trees

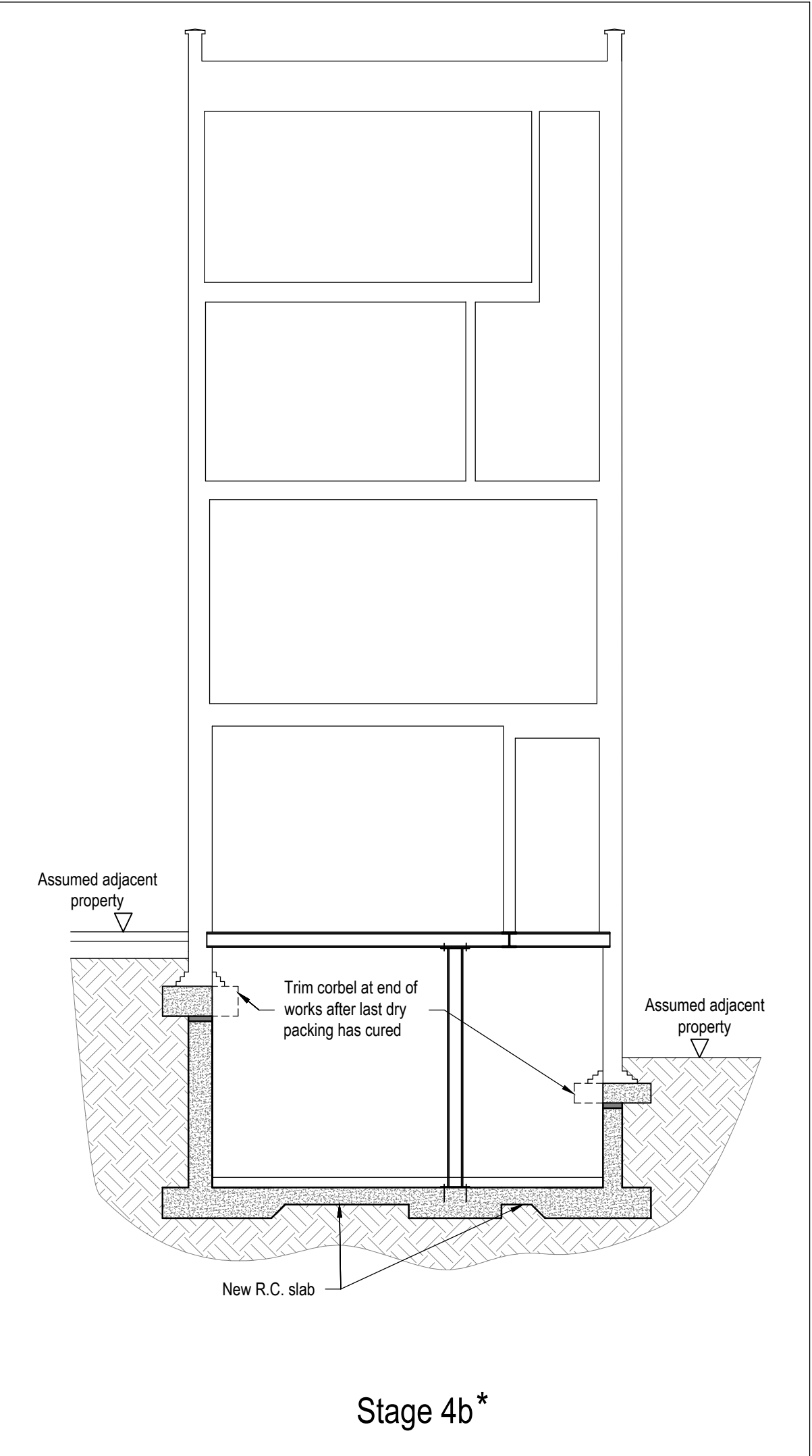
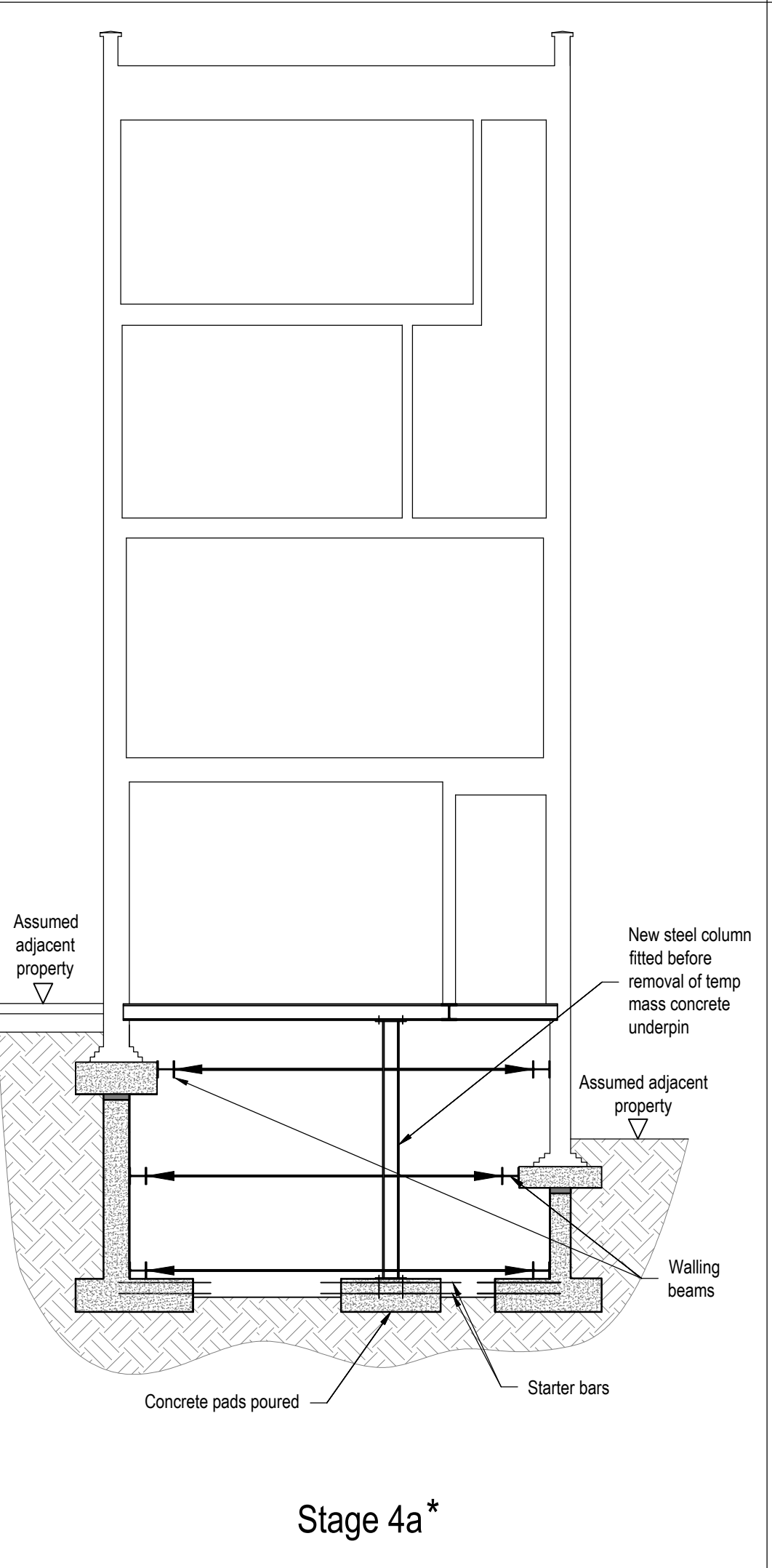
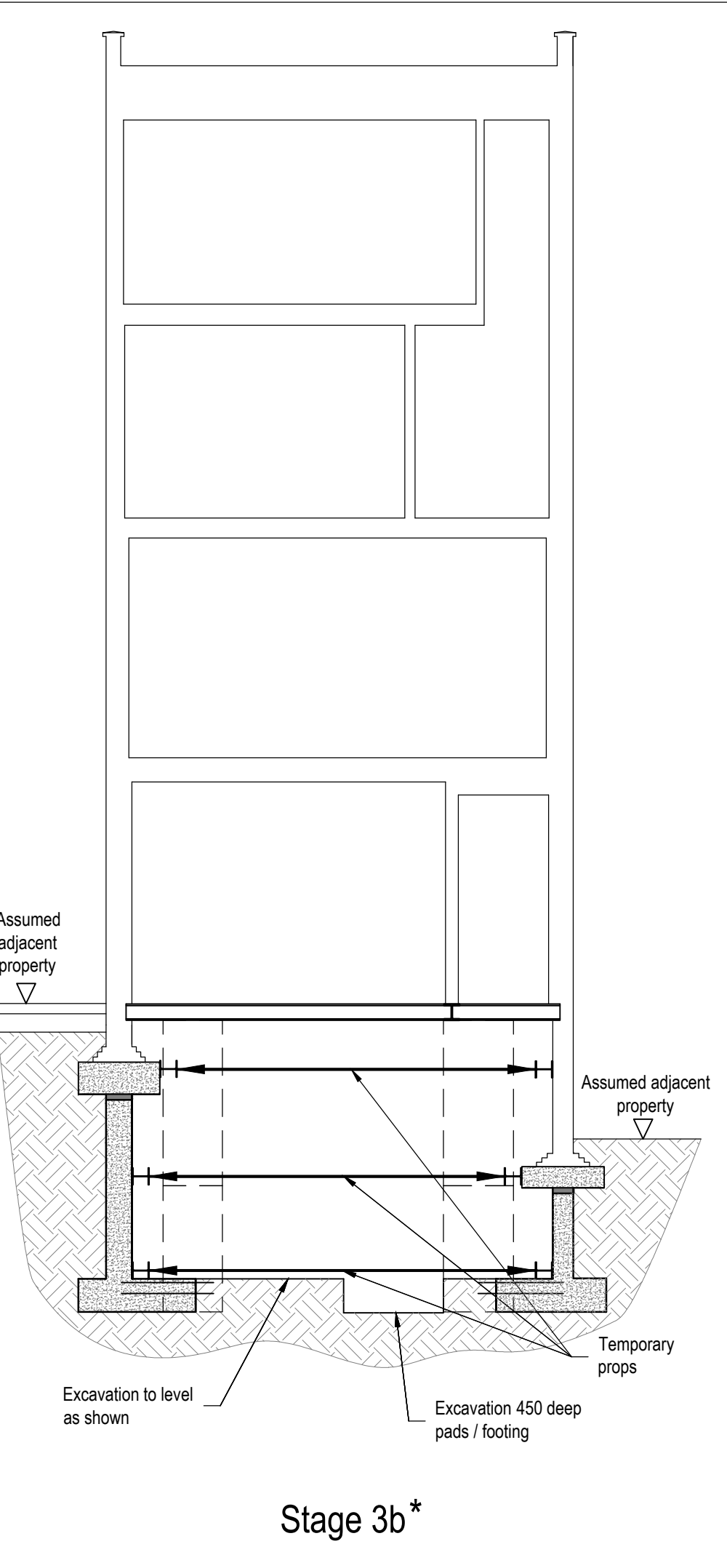
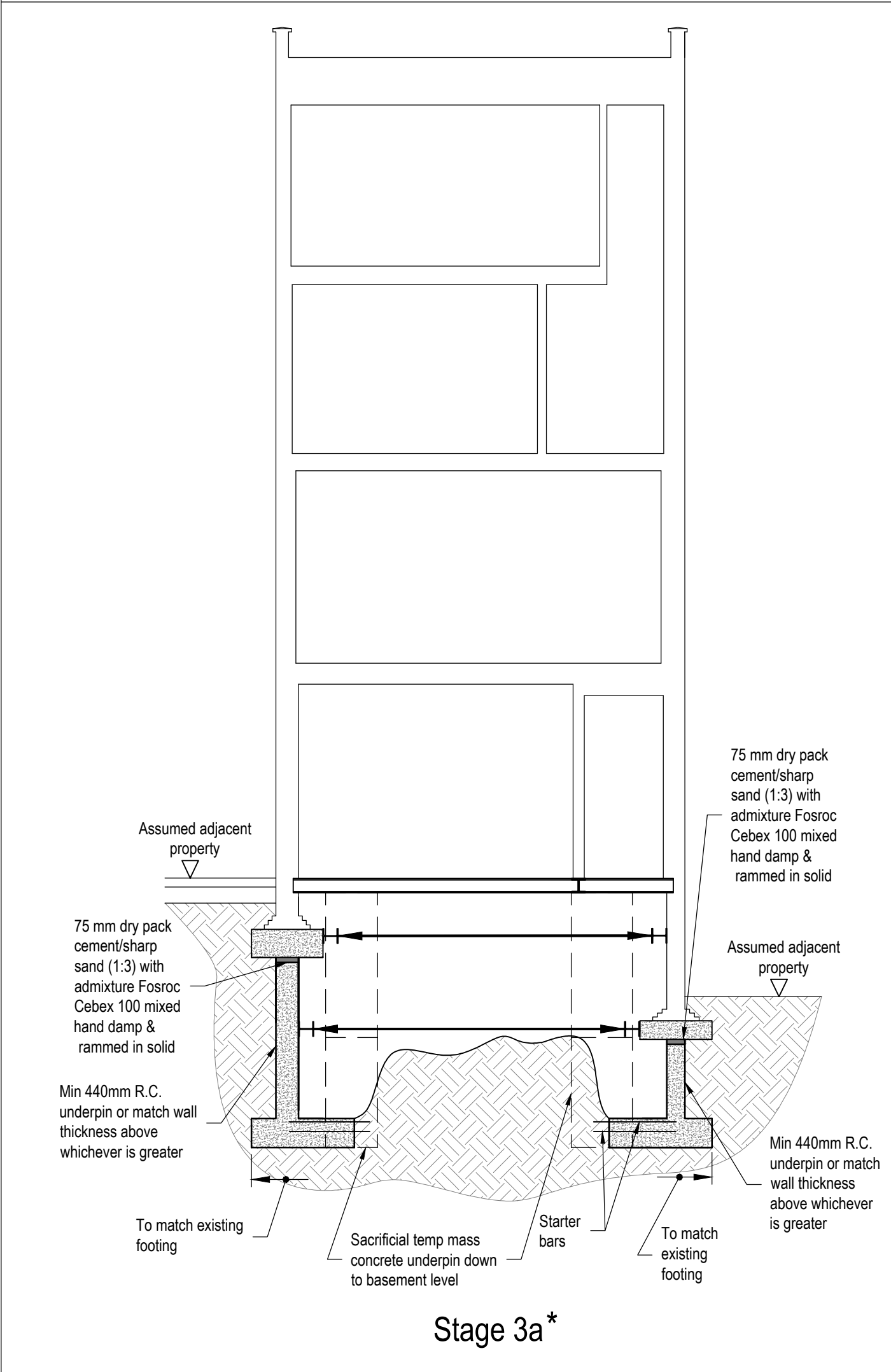
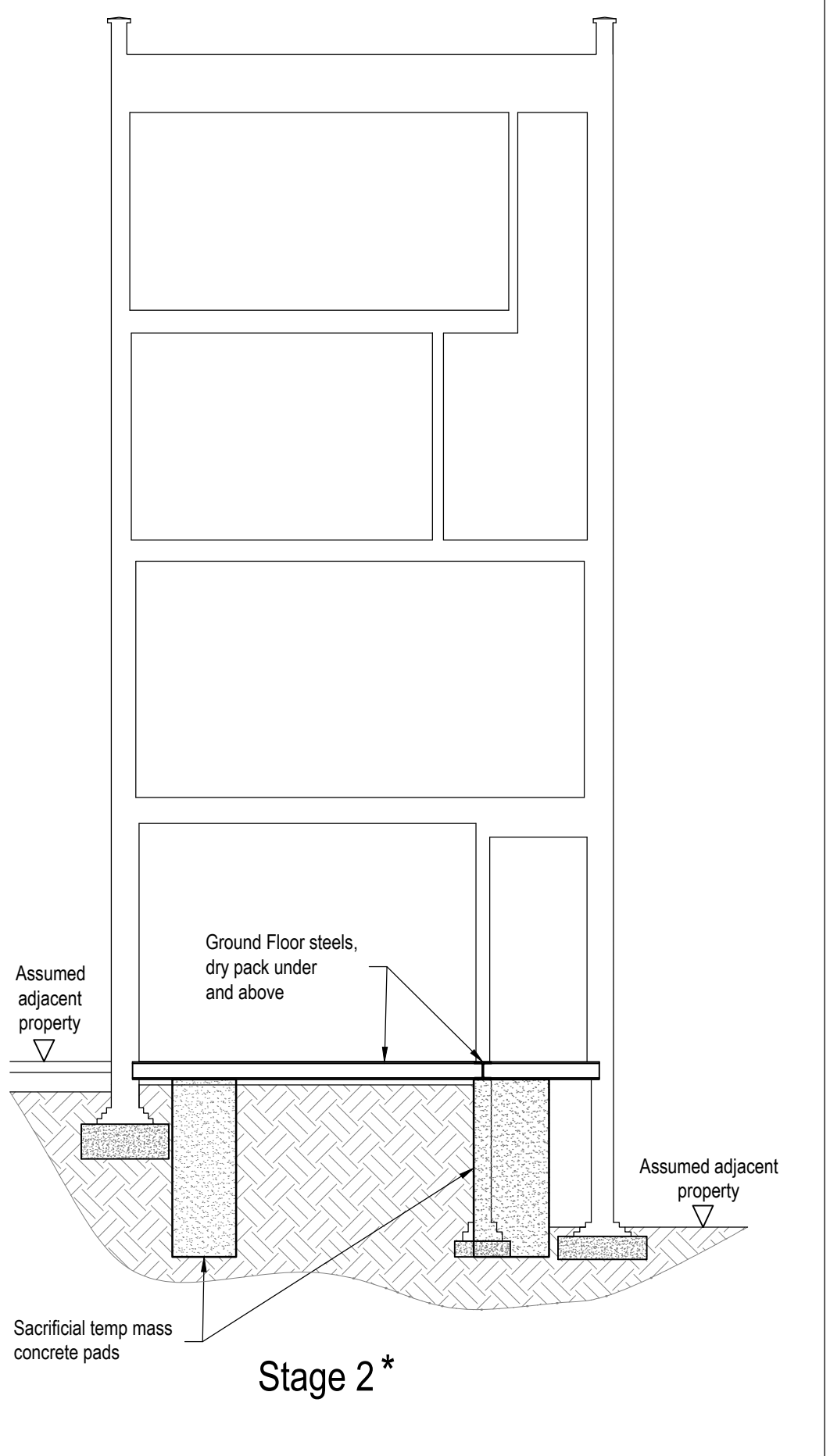
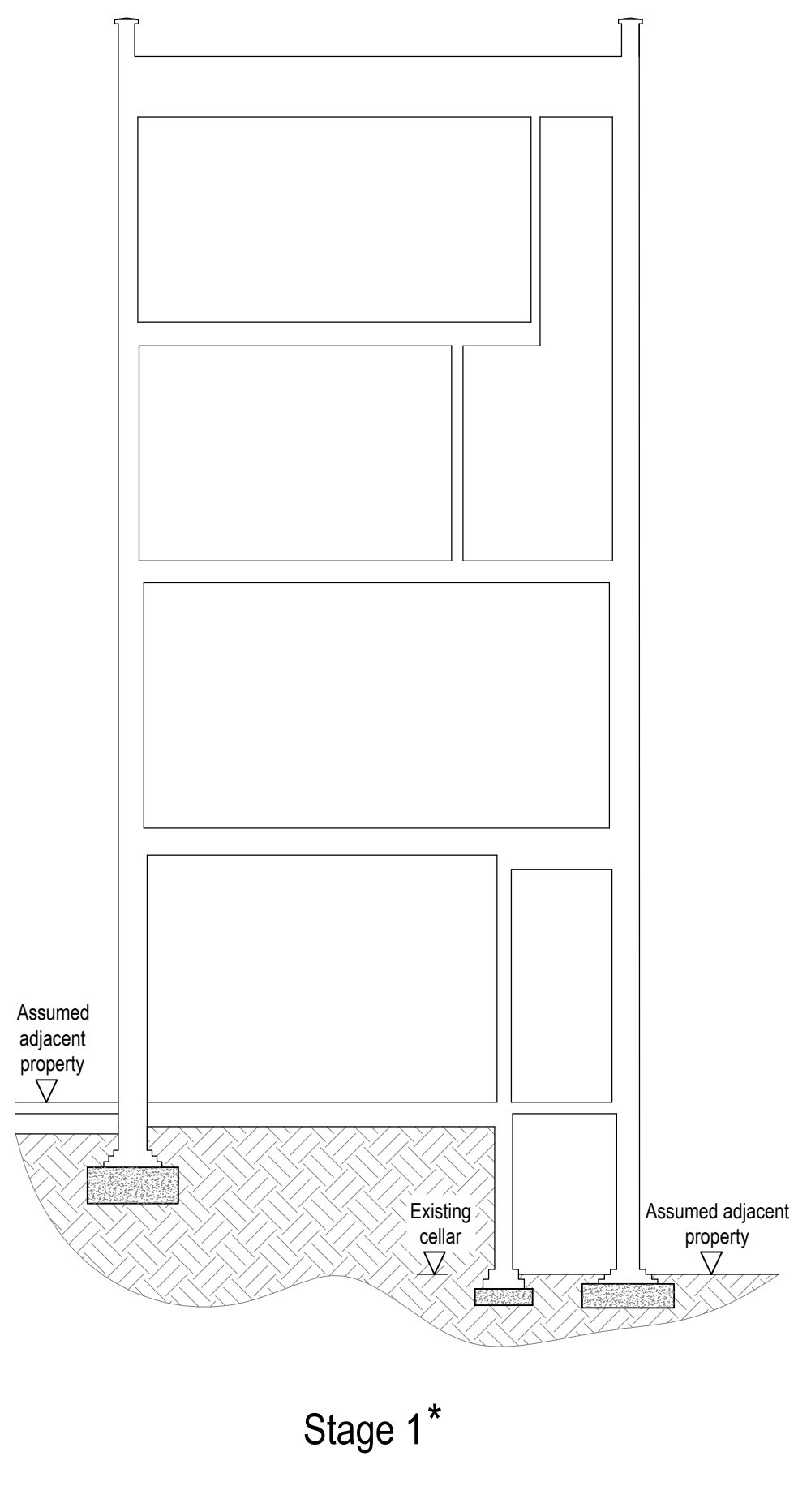
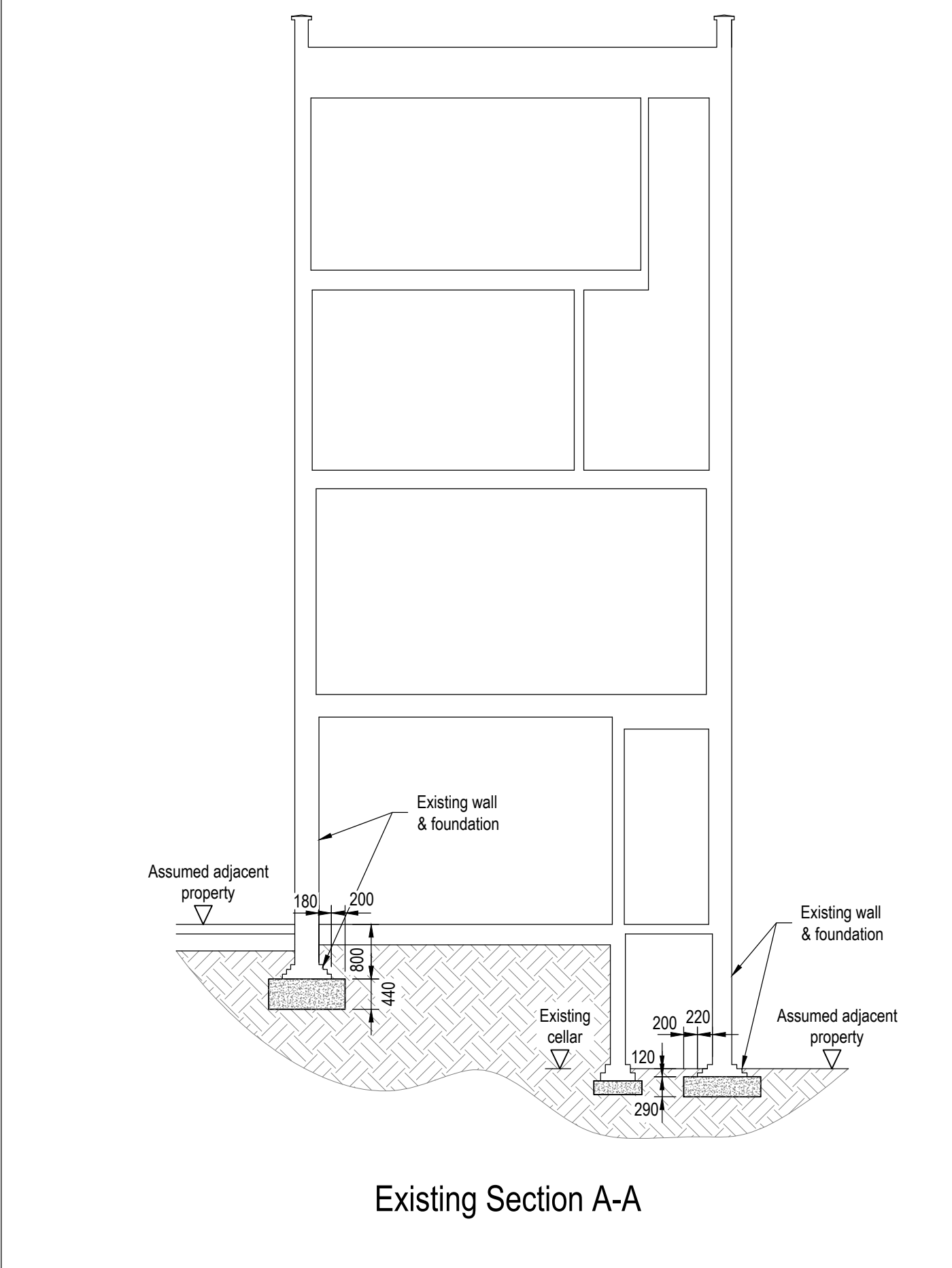
There is a tree at the rear of the property, Phelps Associates, an Arboricultural consultancy are involved and have prepared a protection plan for this tree.

Temporary Works

Please refer to the proposed drawings: 4186-SM01D, 02E, and 03C enclosed, for details of the temporary works. When the contractor is appointed he will be fully responsible for the temporary works including the design and erection.

This report has been produced for the sole use of Camden Council and for their use only and should not be relied upon by any third party. No responsibility is undertaken to any third party without the prior written consent of Richard Tant Associates.

Richard Tant BEng(Hons) CEng MStructE for Richard Tant Associates.



* : refer to notes in plan sequence, drg. 4186-SM02

Suggested Method of Works

This suggested method is a suggestion only and the contractor may submit alternative proposals. The method of works and all temporary works including design and erection are to be the full responsibility of the main contractor.

Notes.

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REV	AMENDMENTS	BY	DATE	CHECKED
C	Single underpinning - stages renumbered.	AR	23.1.18	RT
B	Shape of underpinning amended.	AR	9.8.17	RT
A	Existing footings updated.	AR	12.12.16	RT

PROJECT
31 Willoughby Road

TITLE
Suggested Method of Works 2

ARCHITECTS
Ungar Architects

DRAWING No.
4186-SM03C

DATE
30.03.2015

SCALE
As shown @ A1

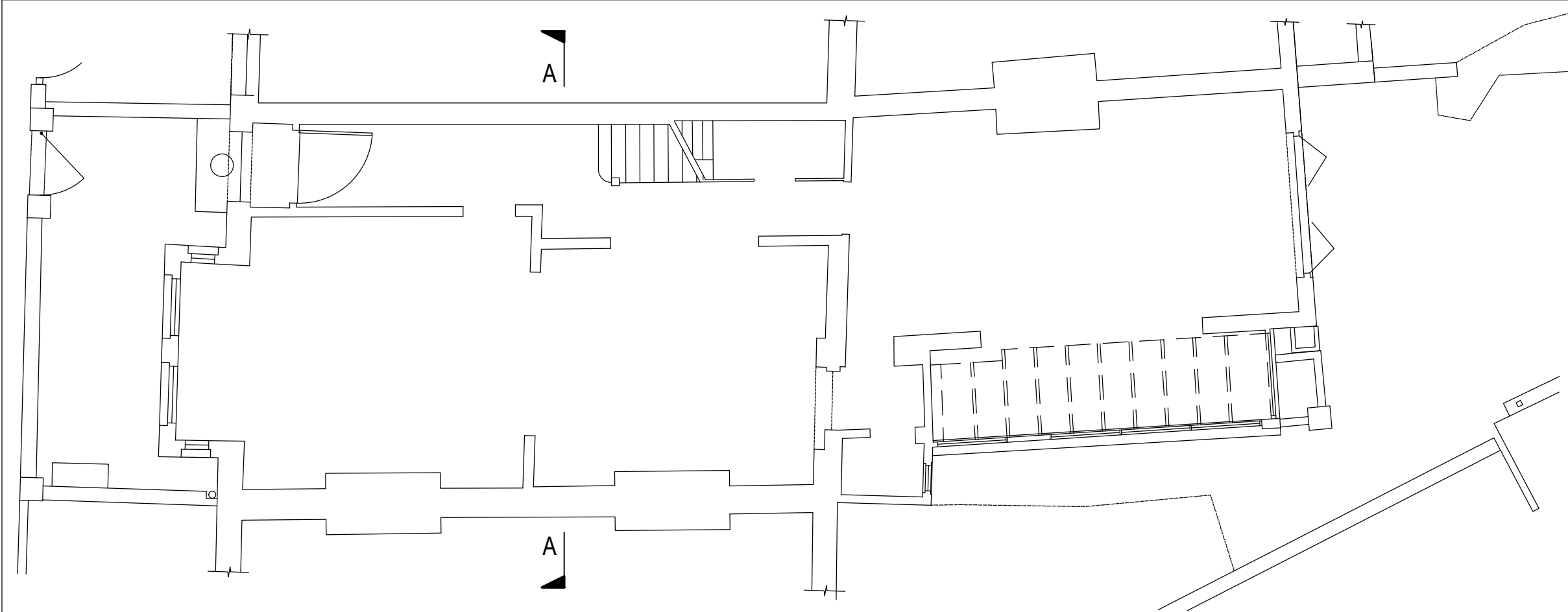
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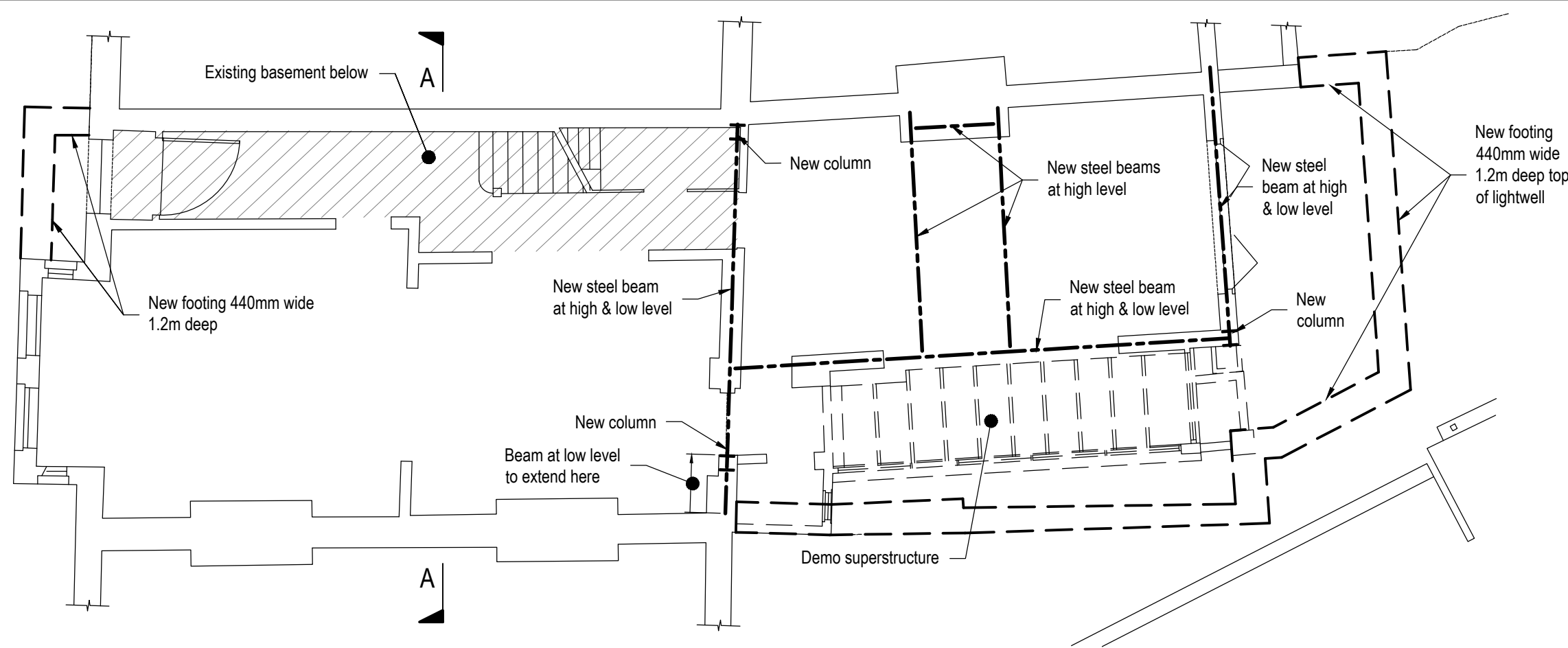
REVIEWED
-

Richard Tant Associates
Consulting Civil & Structural Engineers

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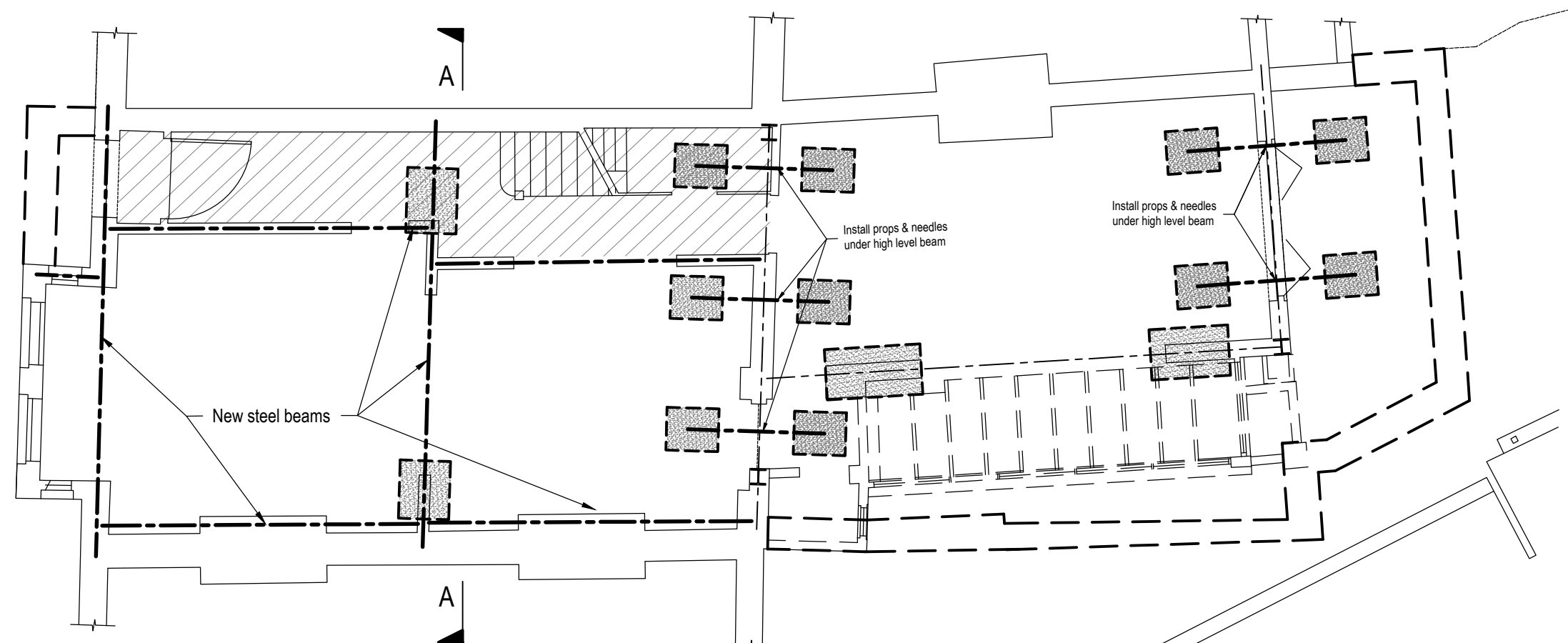


Existing Ground Floor



Stage 1:

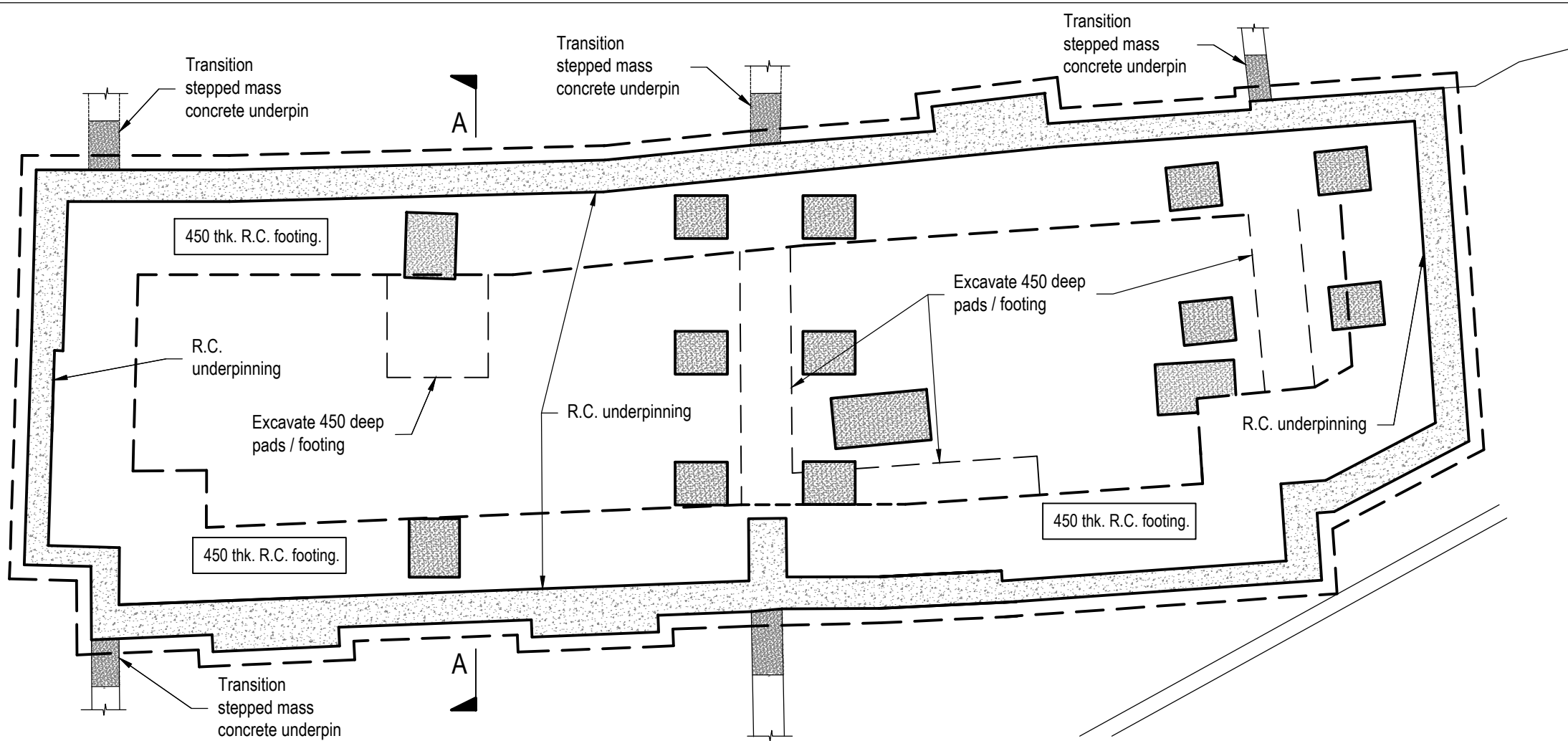
- Disconnect, make safe and remove any underground services.
- Existing rear structure (as shown) carefully demolish and remove: c. slabs, walls including footing.
- Install mass concrete footing in front and rear lightwell.
- Install steelwork wrapped in polythene, cast in concrete to allow easier concrete removal.



- Sacrificial temp mass concrete pads.

Stage 2:

- Install Ground Floor steels, dry pack under and above.
- Cast sacrificial temp mass concrete pads.
- Install props & needles under high level beams.

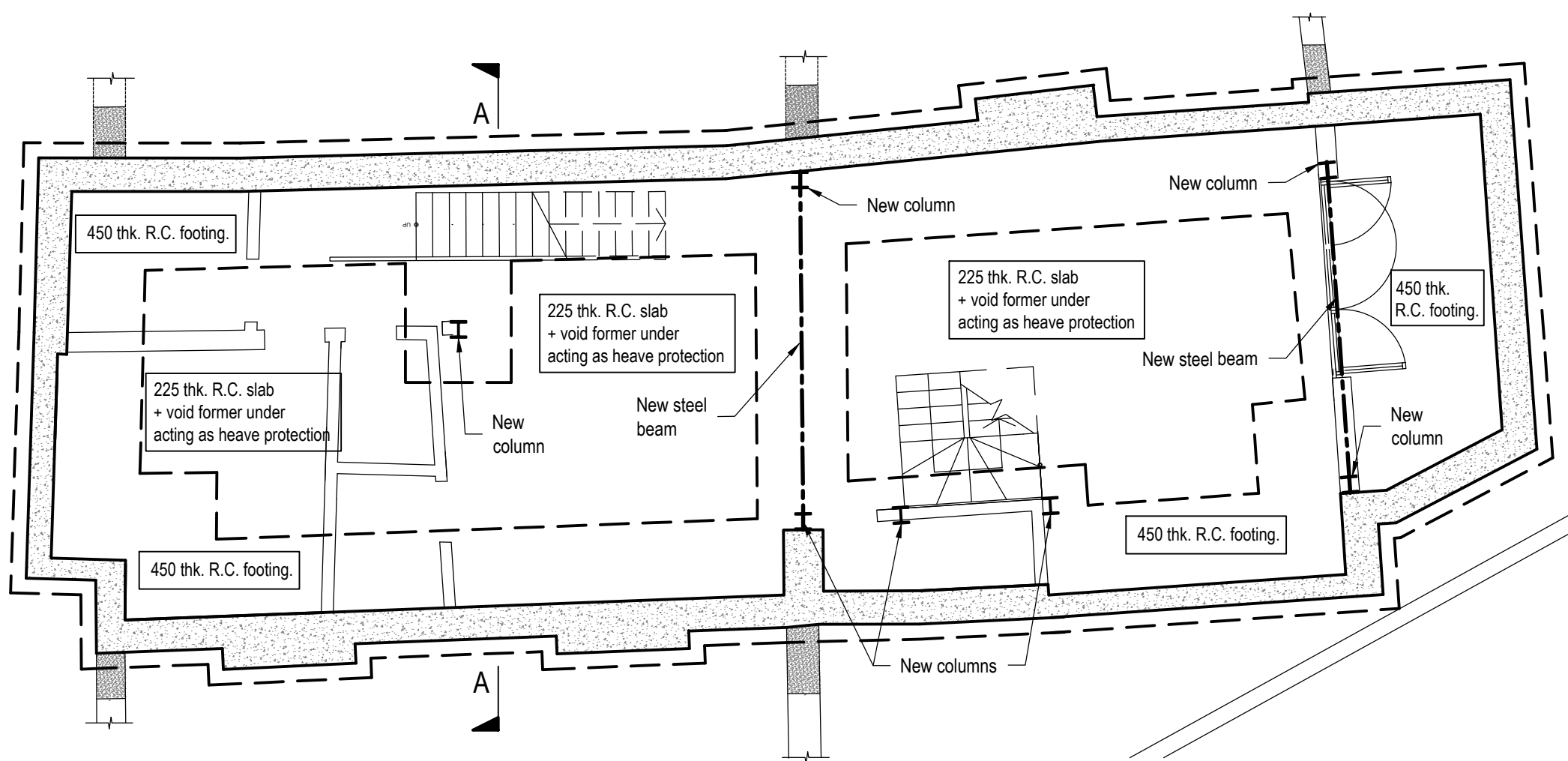


- Min 440mm R.C. underpin or match wall / footing thickness above whichever is greater.

- Sacrificial temp mass concrete underpin.

Stage 3 (underpin):

- Install mass concrete sacrificial underpin down to basement level.
- Install R.C. underpin down to basement level.
- Excavate to basement level & fit horizontal props with walling beams.
- Excavate 450 deep pads / footing.



Stage 4:

- Pour pads / strips / fit steels / cast R.C. walls.
- Remove sacrificial pins.
- Cast slab.
- After concrete has cured and achieved design strength carefully trim back projections & remove temporary works.
- Install partition walls & finishes: insulation, waterproofing etc.- refer to Architects details.

Notes.

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Suggested Method of Works

This suggested method is a suggestion only and the contractor may submit alternative proposals. The method of works and all temporary works including design and erection are to be the full responsibility of the main contractor.

E	Single underpinning - stages renumbered.	AR	23.1.18	RT
D	Stage 4 & 5 - external perimeter of footing added.	AR	9.8.17	RT
C	Rear lightwell updated.	AR	15.12.16	RT
B	Front lightwell removed.	AR	12.12.16	RT
A	Plans updated to Architect's requirements.	AR	26.04.16	RT
REV	AMENDMENTS	BY	DATE	CHECKED

PROJECT
31 Willoughby Road

TITLE
Suggested Method of Works 1

ARCHITECTS
Ungar Architects

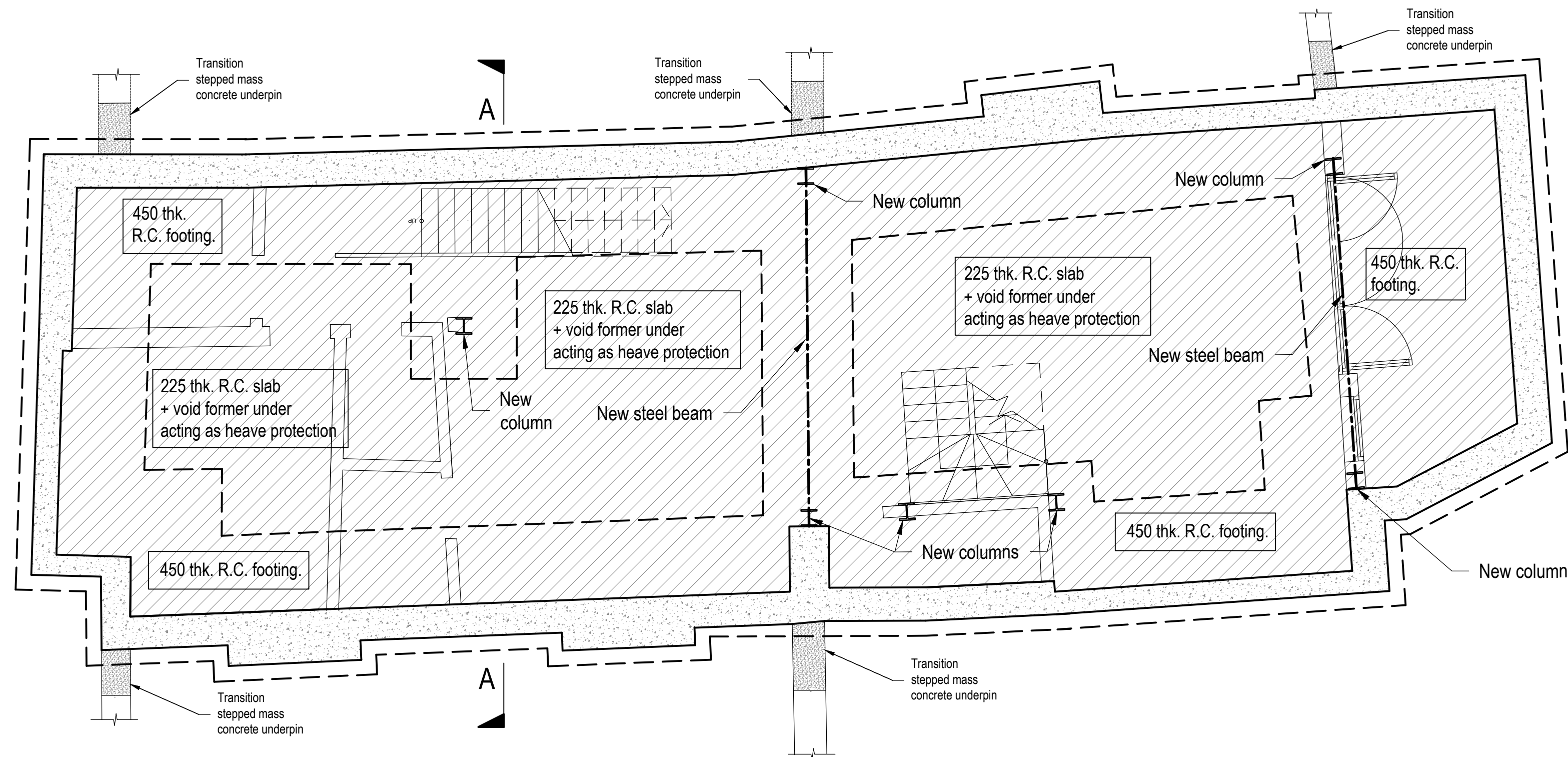
DRAWING No.
4186-SM02E

DATE
30.03.2015
SCALE
As shown @ A1
DRAWN
AR
CHECKED
RT
REVIEWED
-

Richard Tant Associates
Consulting Civil & Structural Engineers
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info@richardtantassociates.com

Notes.

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Legend:

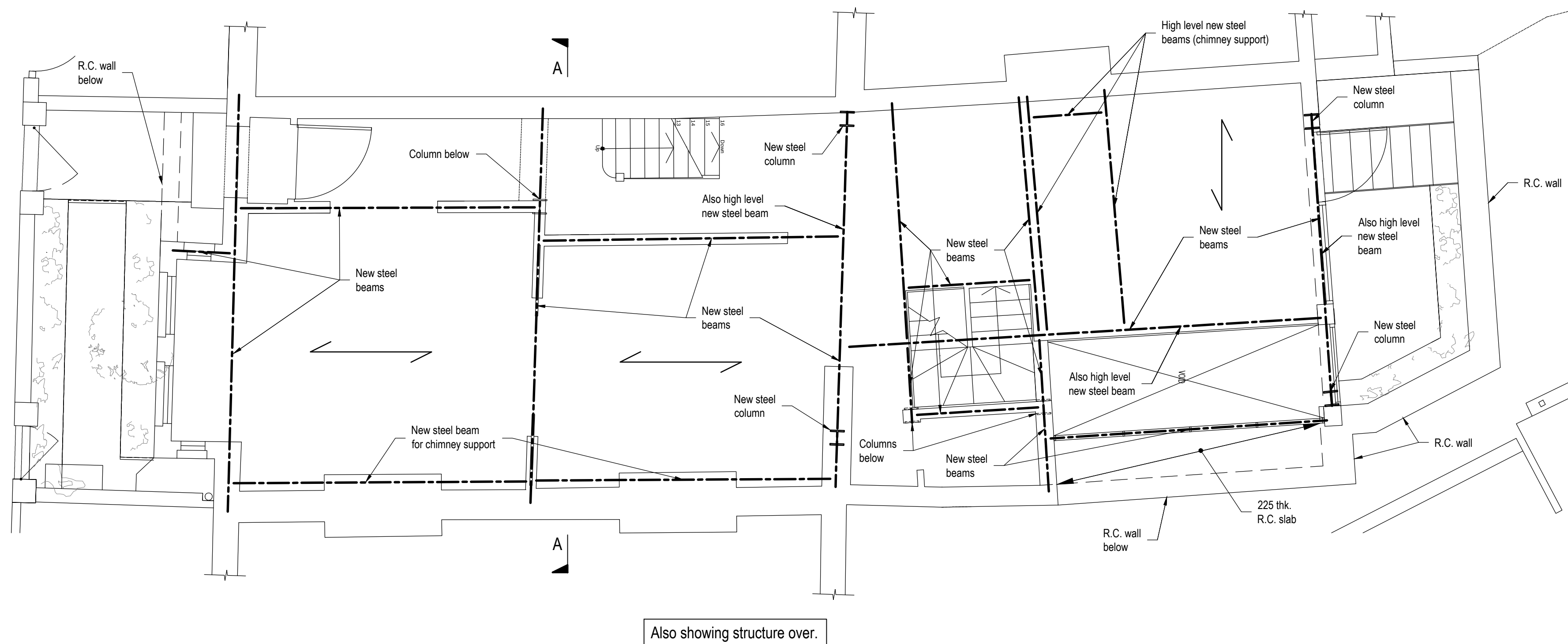
 - Mass concrete underpinning - wall thickness no less than masonry wall above.

 - Min 440mm R.C. underpin or match wall / footing thickness above whichever is greater.

 - R.C. ground bearing slab / footing.

Proposed Basement

Scale 1 : 50



Proposed Ground Floor

Scale 1 : 50

REV.	AMENDMENTS	BY	DATE	CHECKED
D	Basement - external perimeter of footing added.	AR	9.8.17	RT
C	Front garden & rear lightwell updated.	AR	15.12.16	RT
B	Front lightwell removed.	AR	12.12.16	RT
A	Plans updated to Architect's requirements.	AR	26.04.16	RT

PROJECT	31 Willoughby Road
---------	--------------------

TITLE	Proposed Basement & Ground Floor
-------	----------------------------------

ARCHITECTS	Ungar Architects
------------	------------------

DRAWING No.	4186-SM01D
DATE	30.03.2015
SCALE	As shown @ A1
DRAWN	AR
CHECKED	RT
REVIEWED	-

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Job No.

Sheet No.

Rev.

4186

P1

C
8.8.17

Member/Location

Job Title

31 WILLOUGHBY ROAD

Org. Ref.

RETAINING WALL CALC

Made by

RT

Date

DEC 2016

Chd.

RETAINING / UNDERPIN DESIGNBEARING PRESSURE CHECKATTRACTS 6m OF 215 WALL, 6m OF 440 WALL, 4.1 R.C. WALL
2.5 BASEMENT SLAB, 2.5 ROOF

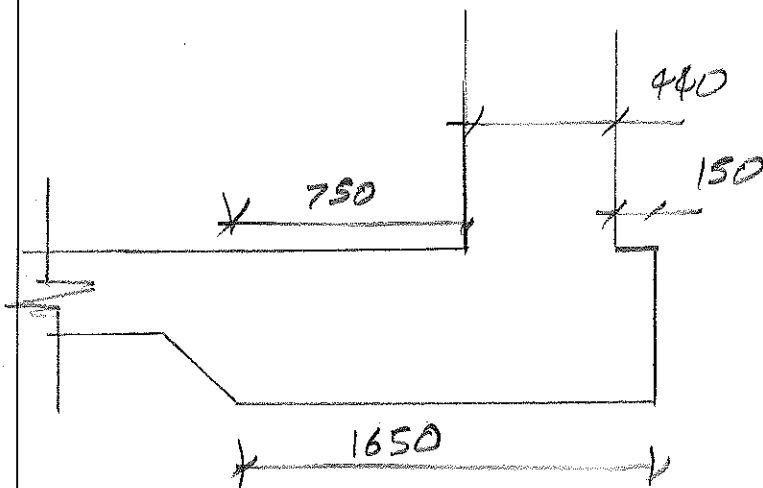
∴ DEAD LOAD kN/m

$$\begin{aligned}
 6 \times 5 &= 30 \\
 6 \times 10 &= 60 \\
 4.2 \times 0.44 \times 21.5 &= 45 \\
 2.5 \times 0.225 \times 21.5 &= 14 \\
 2.5 \times 1.6 &= 4
 \end{aligned}$$

153 kN/m

∴ LIVE LOAD kN/m

$$\begin{aligned}
 2.5 \times 2.5 &= 6 \\
 0.75 \times 2.5 &= 2
 \end{aligned}$$

8 kN/m

$$\sigma = \frac{161}{1.65} = 98 \text{ kN/m}^2$$

FROM GEA REPORT SAFE BEARING CAP: 100 kN/m²

∴ BEARING STRESS O.K. ✓

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Job No.

Sheet No.

Rev.

4186

P2

A

Member/Location

Job Title

31 WILKINS ROAD

Org. Ref.

RETAINING WALL CALCS

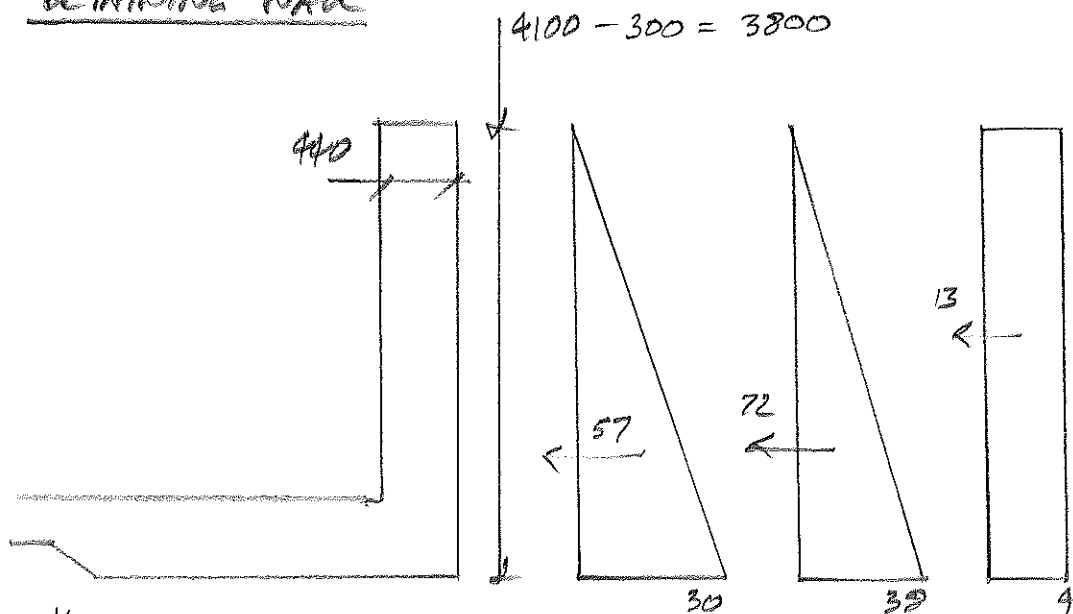
Made by

PT

Date

DEC 2016

Chd.

RETAINING WALL

$$K_0 = 0.8$$

$$\text{ACTIVE/RESIST} \quad \text{SOIL} = 3.8 \times 10 \times 0.8 = 30.4 \text{ kN/m}^2$$

$$\text{WATER} = 3.8 \times 10 = 38 \text{ kN/m}^2$$

$$\text{SURCHARGE} = 5 \times 0.8 = 4$$

$$\therefore \text{MAX CANT B.M.} = (72 + 57) \times 1.3 + 13 \times 1.9 = 192 \text{ kNm/m} \quad \text{CHAR}$$

$$\times 1.5 = 289 \text{ kNm/m} \quad \text{ULT}$$

$$K = \frac{289}{1000 \times 390^3 \times 40} = 0.05$$

$$A_s = \frac{289}{0.95 \times 460 \times 0.93 \times 390} = 1824 \text{ mm}^2/\text{m}$$

FOR DEFLECTION PROVIDE B25-150 BOTH FACES.

$$\text{SPAN}/d = 9.7 \quad \text{M.F.} = 1.4 \neq 1.2$$

$\therefore$ O.K. ✓

PROVIDE B25-150 BOTH FACES ✓

Two-Stage Underpinning:
Stage 1 - Short Term Movement (Contour Plots)
& Tabular output of related damage assessment

Job No.	Sheet No.	Rev.
J15315		
Drg. Ref.		
Made by MP	Date	Checked

Analysis Options

Analysis: Boussinesq
Global Poisson's ratio: 0.50
Maximum allowable ratio between values of E: 1.5
Horizontal rigid boundary level: 35.00 [m OD]
Displacements at load centroids: Yes

Soil ProfilesSoil Profile 1

Layer	Level at top	Number of intermediate displacement levels	Youngs Modulus	Poissons ratio	Non-linear curve
	[mOD]		Top [kN/m ²]	Btm [kN/m ²]	
1	85.500	3	7500.0	7500.0	0.50000 None
2	82.500	1	15000.	15000.	0.50000 None
3	82.000	40	20000.	100000.	0.50000 None

Soil Zones

Zone	Name	X coordinates min max	Y coordinates min max	Profile
1	Soil Zone 1	-20.00000 40.00000	-20.00000 26.00000	Soil Profile 1

Load Data

Load ref.	Name	Shape	Orientation of Plane	Centre of load (Global)	Load position Angle of local x from	Width x or Radius	Length y	Polygon Coordinates	Rectangle of tolerance	Number of rectangles	Normal (local z)	Load value Tangential (local x) (local y)
				X Y Z (level)	[Degrees]	[m]	[m]	[m] [m] [m] [m]	[%]		[kN/m ²]	[kN/m ²] [kN/m ²]
1	Basement Excavation	Polygonal	Horizontal	N/A N/A N/A 83.70000	N/A	N/A	N/A	(3,1) (18,1) (20,2.3) (20,5.5) (12,5.25) (12,4) (3,4)	10.000	3	0.0	N/A N/A
2	Existing Cellar	Polygonal	Horizontal	N/A N/A 83.70000	N/A	N/A	N/A	(3,4) (12,4) (12,6.25) (3,6)	10.000	1	0.0	N/A N/A
3	Underpinning	Polygonal	Horizontal	N/A N/A 83.70000	N/A	N/A	N/A	(2,6) (2,0) (12,0) (12,1)	10.000	2	60.000	N/A N/A
4	Underpinning	Polygonal	Horizontal	N/A N/A 83.70000	N/A	N/A	N/A	(12,0) (18,0) (21,2) (21,6.5) (19,6.5) (19,5.5) (20,5.5)	10.000	10	100.00	N/A N/A
5	Underpinning	Polygonal	Horizontal	N/A N/A 83.70000	N/A	N/A	N/A	(20,2.3) (18,1) (12,1) (19,6.5) (12,6.25) (12,5.25)	10.000	1	60.000	N/A N/A

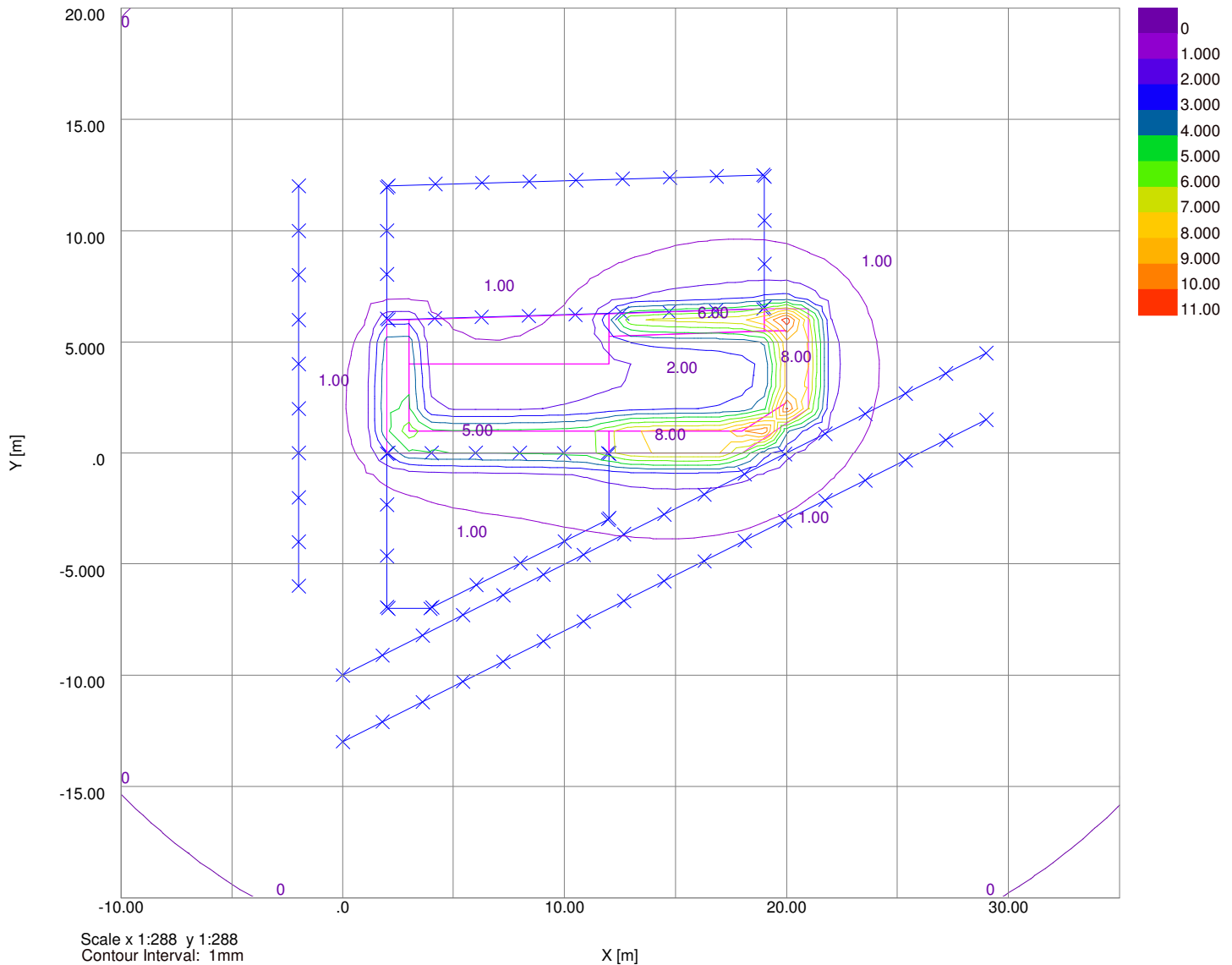
Polygonal Loads' Rectangles

No.	Centre of load X Y	Angle of local x from global X [Degrees]	Width x [m]	Depth y [m]
Load 1 : Basement Excavation				
(Edge 1 optimal)				
1	7.50000 2.50000	0.0	9.0000	3.0000
2	15.00000 3.17188	0.0	6.0000	4.3438
3	19.00000 3.55938	0.0	2.0000	3.8187
Load 2 : Existing Cellar				
(Edge 1 optimal)				
1	7.50000 5.06250	0.0	9.0000	2.1250
Load 3 : Underpinning				
(Edge 1 optimal)				
1	2.50000 3.50000	-90.000	5.0000	1.0000
2	7.00000 0.50000	-90.000	1.0000	10.000
Load 4 : Underpinning				
(Edge 1 optimal)				
1	15.00000 0.50000	0.0	6.0000	1.0000
2	18.14286 0.59405	0.0	0.28571	0.99762
3	18.42857 0.78214	0.0	0.28571	0.99286
4	18.71429 0.97024	0.0	0.28571	0.98810
5	19.00000 1.15833	0.0	0.28571	0.98333
6	19.28571 1.34643	0.0	0.28571	0.97857
7	19.57143 1.53452	0.0	0.28571	0.97381
8	19.85714 1.72262	0.0	0.28571	0.96905
9	20.50000 4.08333	0.0	1.0000	4.8333
10	19.50000 6.00000	0.0	1.0000	1.0000
Load 5 : Underpinning				
(Edge 1 optimal)				
1	15.50000 5.87500	-177.95	6.9688	0.99936

Displacement Data

Ref.	Type	Name	Direction of Extrusion	First point X Y Z (level)	Second point X Y Z (level)	No. of intrvl across extrusion/line	Extrusion Depth [m]	No. of intrvl along extrusion	Calculate	Show Detailed results
1	Grid	Grid 1	Global X	-20.00000 -20.00000 85.50000	N/A 26.00000 85.50000	46	60.00000	60	Yes	No
2	Grid	Grid 2	Global X	-20.00000 -20.00000 84.00000	N/A 26.00000 84.00000	46	60.00000	60	Yes	No
3	Line	Line 1	N/A	2.05000 0.00000 84.00000	11.95000 0.00000 84.00000	5	N/A	N/A	Yes	No
4	Line	Line 2	N/A	12.00000 -0.05000 84.00000	-2.95000 84.00000	1	N/A	N/A	Yes	No
5	Line	Line 3	N/A	11.95000 -3.00000 84.00000	4.05000 -6.95000 84.00000	4	N/A	N/A	Yes	No
6	Line	Line 4	N/A	3.95000 -7.00000 84.00000	2.05000 -7.00000 84.00000	1	N/A	N/A	Yes	No
7	Line	Line 5	N/A	2.00000 -6.95000 84.00000	2.00000 -0.05000 84.00000	3	N/A	N/A	Yes	No
8	Line	Line 6	N/A	2.05000 6.00000 84.00000	18.95000 6.50000 84.00000	8	N/A	N/A	Yes	No
9	Line	Line 7	N/A	19.00000 6.55000 84.00000	19.00000 12.45000 84.00000	3	N/A	N/A	Yes	No
10	Line	Line 8	N/A	18.95000 12.50000 84.00000	2.05000 12.00000 84.00000	8	N/A	N/A	Yes	No
11	Line	Line 9	N/A	2.00000 11.95000 84.00000	2.00000 6.05000 84.00000	3	N/A	N/A	Yes	No
12	Line	Line 10	N/A	-2.00000 -6.00000 85.00000	-2.00000 12.00000 85.00000	9	N/A	N/A	Yes	No
13	Line	Line 11	N/A	0.00000 -10.00000 83.00000	29.00000 4.50000 83.00000	16	N/A	N/A	Yes	No
14	Line	Line 12	N/A	0.00000 -13.00000 83.00000	29.00000 1.50000 83.00000	16	N/A	N/A	Yes	No

Settlement Contours : Grid 1 at 85.5000m





31 Willoughby Road
Combined Movements & Damage Assessment
1st Stage - Short-term (no heave) - No horizontal movement

Job No.	Sheet No.	Rev.
J15315		
Drg. Ref.		
Made by MP	Date 24-Jan-2018	Checked

Problem Type

Problem Type : Tunnelling and Embedded Wall Excavations

Displacement Data

Type	Name	Direction of extrusion	Point/Line/Line for extrusion						No. of intervals across extrusion/line	Extrusion depth	No. of intervals along extrusion	Calculate	Surface type for tunnels
			First point			Second point							
			X [m]	Y [m]	Z (level)	X [m]	Y [m]	Z (level)					
Grid	Grid 1	Global X	-20.00000	-20.00000	85.50000	-	26.00000	85.50000	46	60.00000	60	Yes	Surface
Grid	Grid 2	Global X	-20.00000	-20.00000	84.00000	-	26.00000	84.00000	46	60.00000	60	Yes	Surface
Line	Line 1	-	2.05000	0.00000	84.00000	11.95000	0.00000	84.00000	5	-	-	Yes	Surface
Line	Line 2	-	12.00000	-0.05000	84.00000	12.00000	-2.95000	84.00000	1	-	-	Yes	Surface
Line	Line 3	-	11.95000	-3.00000	84.00000	4.05000	-6.95000	84.00000	4	-	-	Yes	Surface
Line	Line 4	-	3.95000	-7.00000	84.00000	2.05000	-7.00000	84.00000	1	-	-	Yes	Surface
Line	Line 5	-	2.00000	-6.95000	84.00000	2.00000	-0.05000	84.00000	3	-	-	Yes	Surface
Line	Line 6	-	2.05000	6.00000	84.00000	18.95000	6.50000	84.00000	8	-	-	Yes	Surface
Line	Line 7	-	19.00000	6.55000	84.00000	19.00000	12.45000	84.00000	3	-	-	Yes	Surface
Line	Line 8	-	18.95000	12.50000	84.00000	2.05000	12.00000	84.00000	8	-	-	Yes	Surface
Line	Line 9	-	2.00000	11.95000	84.00000	2.00000	6.05000	84.00000	3	-	-	Yes	Surface
Line	Line 10	-	-2.00000	-6.00000	85.00000	-2.00000	12.00000	85.00000	9	-	-	Yes	Surface
Line	Line 11	-	0.00000	-10.00000	83.00000	29.00000	4.50000	83.00000	16	-	-	Yes	Surface
Line	Line 12	-	0.00000	-13.00000	83.00000	29.00000	1.50000	83.00000	16	-	-	Yes	Surface

Vertical Ground Movement Curves (Excavations)

Curve Name: No vertical ground movement
Coordinates: [Distance from wall / wall depth or max. excavation depth (x), Depth / wall depth or max. excavation depth (y), Settlement / wall depth or max. excavation depth (z) (%)]
[0.000,0.000,0.000] [1.000,0.000,0.000] [0.000,1.000,0.000] [1.000,1.000,0.000]
Curve Fitting Method: Polynomial
x Order: 1
y Order: 0
Polynomial: z = 0.0x + 0.0
Coeff. of Determination: -2147483648.E+2147483647

Horizontal Ground Movement Curves (Excavations)

Curve Name: No horizontal ground movement
Coordinates: [Distance from wall / wall depth or max. excavation depth (x), Depth / wall depth or max. excavation depth (y), Horizontal movement / wall depth or max. excavation depth (z) (%)]
[0.000,0.000,0.000] [1.000,0.000,0.000] [0.000,1.000,0.000] [1.000,1.000,0.000]
Curve Fitting Method: Polynomial
x Order: 0
y Order: 0
Polynomial: z = 0.0
Coeff. of Determination: -2147483648.E+2147483647

Polygonal Excavations

Excavation Name: New Excavation
Surface level [m]: 85.500
Contribution: Positive
Enabled: Yes
Surface movement curves which are selected are applied between surface and [m]: 81.400

Corner	x	y	Base Level	Stiffened	Previous Side	Next Side
	[m]	[m]	[m]	d	p1	p2*
				[m]	[%]	[%]
1	2.0000	0.0	81.400	No	-	-
2	18.000	0.0	81.400	No	-	-
3	21.000	2.0000	81.400	No	-	-
4	21.000	6.5000	81.400	No	-	-
5	2.0000	6.0000	81.400	No	-	-

Side	Corner 1	Corner 2	Ground Movement Curve	
	x	y	x	y
	[m]	[m]	[m]	[m]
1	2.0000	0.0	18.000	0.0
2	18.000	0.0	21.000	2.0000
3	21.000	2.0000	21.000	6.5000
4	21.000	6.5000	2.0000	6.0000
5	2.0000	6.0000	2.0000	0.0

No vertical ground movement
No horizontal ground movement
No vertical ground movement
No horizontal ground movement
No vertical ground movement
No horizontal ground movement
No vertical ground movement
No horizontal ground movement

Damage Category Strains

Name	0 (Negligible)	1 (Very Slight)	2 (Slight)	3 (Moderate)
	to	to	to	to
Burland Strain Limits	1 (Very Slight)	2 (Slight)	3 (Moderate)	4 (Severe)
	0.0	500.00E-6	750.00E-6	0.0015000

Specific Structures - Geometry

Structure Name	Sub-Structure Name	Displacement Line	Start Distance Along Line	End Distance Along Line	Vertical Offsets from Line for Vertical Movement Calculations	Vertical Displacement Limit Sensitivity	Damage Category Strains	Poisson's Ratio	E/G
No 33	Party Wall (1)	Line 1	0.00000	9.89900	0.0	0.10000	Burland Strain Limits	0.20000	2.6000
No 33	Rear Elevation (2)	Line 2	0.00000	2.90000	0.0	0.10000	Burland Strain Limits	0.20000	2.6000
No 33	Far Elevation (3)	Line 3	0.00000	8.83200	0.0	0.10000	Burland Strain Limits	0.20000	2.6000
No 33	Far Elevation (4)	Line 4	0.00000	1.90000	0.0	0.10000	Burland Strain Limits	0.20000	2.6000
No 33	Frontage (5)	Line 5	0.00000	6.90000	0.0	0.10000	Burland Strain Limits	0.20000	2.6000
No 29	Party Wall (6)	Line 6	0.00000	16.90700	0.0	0.10000	Burland Strain Limits	0.20000	2.6000
No 29	Rear Elevation (7)	Line 7	0.00000	5.89900	0.0	0.10000	Burland Strain Limits	0.20000	2.6000
No 29	Far Elevation (8)	Line 8	0.00000	16.90700	0.0	0.10000	Burland Strain Limits	0.20000	2.6000
No 29	Frontage (9)	Line 9	0.00000	5.89900	0.0	0.10000	Burland Strain Limits	0.20000	2.6000
Willoughby Road	Roadway (10)	Line 10	0.00000	18.00000	0.0	0.10000	Burland Strain Limits	0.20000	2.6000
Willow Cottages	Retaining Wall (11)	Line 11	0.00000	32.42200	0.0	0.10000	Burland Strain Limits	0.20000	2.6000



31 Willoughby Road
Combined Movements & Damage Assessment
1st Stage - Short-term (no heave) - No horizontal movement

Job No.	Sheet No.	Rev.
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Drg. Ref.		
Made by MP	Date 24-Jan-2018	Checked

Structure Name	Sub-Structure Name	Displacement Line	Start Distance Along Line	End Distance Along Line	Vertical Offsets from Line for Vertical	Vertical Displacement Limit Sensitivity	Damage Category	Strains	Poisson's Ratio	E/G
Willow Cottages	Rear Elevation	Line 12	0.00000	32.42200	0.0	0.10000	Burland Strain Limits		0.20000	2.6000

Specific Structures - Bending Parameters

Structure Name	Sub-Structure Name	Height	Default Properties	Hogging			Sagging		
				2nd Moment of Area (per unit width)	Distance of Bending Strain from N.A.	Distance of N.A. from Edge of Beam in Tension	2nd Moment of Area (per unit width)	Distance of Bending Strain from N.A.	Distance of N.A. from Edge of Beam in Tension
No 33	Party Wall (1)	[m]	8.0000 Yes	[m ³]	[m]	[m]	[m ³]	[m]	[m]
No 33	Rear Elevation (2)	8.0000	Yes	170.67	8.0000	8.0000	42.667	4.0000	4.0000
No 33	Far Elevation (3)	8.0000	Yes	170.67	8.0000	8.0000	42.667	4.0000	4.0000
No 33	Far Elevation (4)	8.0000	Yes	170.67	8.0000	8.0000	42.667	4.0000	4.0000
No 33	Frontage (5)	8.0000	Yes	170.67	8.0000	8.0000	42.667	4.0000	4.0000
No 29	Party Wall (6)	12.000	Yes	576.00	12.000	12.000	144.00	6.0000	6.0000
No 29	Rear Elevation (7)	12.000	Yes	576.00	12.000	12.000	144.00	6.0000	6.0000
No 29	Far Elevation (8)	12.000	Yes	576.00	12.000	12.000	144.00	6.0000	6.0000
No 29	Frontage (9)	12.000	Yes	576.00	12.000	12.000	144.00	6.0000	6.0000
Willoughby Road	Roadway (10)	0.50000	Yes	0.041667	0.50000	0.50000	0.010417	0.25000	0.25000
Willow Cottages	Retaining Wall (11)	2.5000	Yes	5.2083	2.5000	2.5000	1.3021	1.2500	1.2500
Willow Cottages	Rear Elevation	8.0000	Yes	170.67	8.0000	8.0000	42.667	4.0000	4.0000

Building Segment Combinations

Structure Name	Sub-Structure Name	Vertical Offset from Line for Vertical Movement Calculations	Segment Start	Length	Curvature	Combined Segment
No structures have segments combined.						

Utility Strain Calculation Options

Neglect beneficial contribution of axial strains : No

Specific Building Damage Results - Horizontal Displacements

Structure: No 33 | Sub-structure: Party Wall (1)

Dist.	Coordinates			Displacements		
	x	y	z	Horizontal displacement along the Line	Horizontal displacement perpendicular to Line	
[m]	[m]	[m]	[m]	[mm]	[mm]	
0.0	2.05000	0.00000	84.00000	0.0	0.0	0.0 d
1.9800	4.03000	0.00000	84.00000	0.0	0.0	0.0 d
3.9600	6.01000	0.00000	84.00000	0.0	0.0	0.0 d
5.9400	7.99000	0.00000	84.00000	0.0	0.0	0.0 d
7.9200	9.97000	0.00000	84.00000	0.0	0.0	0.0 d
9.9000	11.95000	0.00000	84.00000	0.0	0.0	0.0 d
d - Displacements include imported displacements.						

Structure: No 33 | Sub-structure: Rear Elevation (2)

Dist.	Coordinates			Displacements		
	x	y	z	Horizontal displacement along the Line	Horizontal displacement perpendicular to Line	
[m]	[m]	[m]	[m]	[mm]	[mm]	
0.0	12.00000	-0.05000	84.00000	0.0	0.0	0.0 d
2.9000	12.00000	-2.95000	84.00000	0.0	0.0	0.0 d
d - Displacements include imported displacements.						

Structure: No 33 | Sub-structure: Far Elevation (3)

Dist.	Coordinates			Displacements		
	x	y	z	Horizontal displacement along the Line	Horizontal displacement perpendicular to Line	
[m]	[m]	[m]	[m]	[mm]	[mm]	
0.0	11.95000	-3.00000	84.00000	0.0	0.0	0.0 d
2.2081	9.97500	-3.98750	84.00000	0.0	0.0	0.0 d
4.4162	8.00000	-4.97500	84.00000	0.0	0.0	0.0 d
6.6244	6.02500	-5.96250	84.00000	0.0	0.0	0.0 d
8.8325	4.05000	-6.95000	84.00000	0.0	0.0	0.0 d
d - Displacements include imported displacements.						

Structure: No 33 | Sub-structure: Far Elevation (4)

Dist.	Coordinates			Displacements		
	x	y	z	Horizontal displacement along the Line	Horizontal displacement perpendicular to Line	
[m]	[m]	[m]	[m]	[mm]	[mm]	
0.0	3.95000	-7.00000	84.00000	0.0	0.0	0.0 d
1.9000	2.05000	-7.00000	84.00000	0.0	0.0	0.0 d
d - Displacements include imported displacements.						

Structure: No 33 | Sub-structure: Frontage (5)

Dist.	Coordinates			Displacements		
	x	y	z	Horizontal displacement along the Line	Horizontal displacement perpendicular to Line	
[m]	[m]	[m]	[m]	[mm]	[mm]	
0.0	2.00000	-6.95000	84.00000	0.0	0.0	0.0 d
2.3000	2.00000	-4.65000	84.00000	0.0	0.0	0.0 d
4.6000	2.00000	-2.35000	84.00000	0.0	0.0	0.0 d
6.9000	2.00000	-0.05000	84.00000	0.0	0.0	0.0 d
d - Displacements include imported displacements.						



31 Willoughby Road
Combined Movements & Damage Assessment
1st Stage - Short-term (no heave) - No horizontal movement

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Dist.	Coordinates			Displacements	
	x	y	z	Horizontal displacement along the Line	Horizontal displacement perpendicular to Line
Structure: No 29 Sub-structure: Party Wall (6)					
Dist.	x	y	z	x	y
				Horizontal displacement along the Line	Horizontal displacement perpendicular to Line
[m]	[m]	[m]	[m]	[mm]	[mm]
0.0	2.05000	6.00000	84.00000	0.0	0.0
2.1134	4.16250	6.06250	84.00000	0.0	0.0
4.2268	6.27500	6.12500	84.00000	0.0	0.0
6.3403	8.38750	6.18750	84.00000	0.0	0.0
8.4537	10.50000	6.25000	84.00000	0.0	0.0
10.567	12.61250	6.31250	84.00000	0.0	0.0
12.681	14.72500	6.37500	84.00000	0.0	0.0
14.794	16.83750	6.43750	84.00000	0.0	0.0
16.907	18.95000	6.50000	84.00000	0.0	0.0

d - Displacements include imported displacements.

Structure: No 29 Sub-structure: Rear Elevation (7)					
Dist.	x	y	z	x	y
				Horizontal displacement along the Line	Horizontal displacement perpendicular to Line
[m]	[m]	[m]	[m]	[mm]	[mm]
0.0	19.00000	6.55000	84.00000	0.0	0.0
1.9667	19.00000	8.51667	84.00000	0.0	0.0
3.9333	19.00000	10.48333	84.00000	0.0	0.0
5.9000	19.00000	12.45000	84.00000	0.0	0.0

d - Displacements include imported displacements.

Structure: No 29 Sub-structure: Far Elevation (8)					
Dist.	x	y	z	x	y
				Horizontal displacement along the Line	Horizontal displacement perpendicular to Line
[m]	[m]	[m]	[m]	[mm]	[mm]
0.0	18.95000	12.50000	84.00000	0.0	0.0
2.1134	16.83750	12.43750	84.00000	0.0	0.0
4.2268	14.72500	12.37500	84.00000	0.0	0.0
6.3403	12.61250	12.31250	84.00000	0.0	0.0
8.4537	10.50000	12.25000	84.00000	0.0	0.0
10.567	8.38750	12.18750	84.00000	0.0	0.0
12.681	6.27500	12.12500	84.00000	0.0	0.0
14.794	4.16250	12.06250	84.00000	0.0	0.0
16.907	2.05000	12.00000	84.00000	0.0	0.0

d - Displacements include imported displacements.

Structure: No 29 Sub-structure: Frontage (9)					
Dist.	x	y	z	x	y
				Horizontal displacement along the Line	Horizontal displacement perpendicular to Line
[m]	[m]	[m]	[m]	[mm]	[mm]
0.0	2.00000	11.95000	84.00000	0.0	0.0
1.9667	2.00000	9.98333	84.00000	0.0	0.0
3.9333	2.00000	8.01667	84.00000	0.0	0.0
5.9000	2.00000	6.05000	84.00000	0.0	0.0

d - Displacements include imported displacements.

Structure: Willoughby Road Sub-structure: Roadway (10)					
Dist.	x	y	z	x	y
				Horizontal displacement along the Line	Horizontal displacement perpendicular to Line
[m]	[m]	[m]	[m]	[mm]	[mm]
0.0	-2.00000	-6.00000	85.00000	0.0	0.0
2.0000	-2.00000	-4.00000	85.00000	0.0	0.0
4.0000	-2.00000	-2.00000	85.00000	0.0	0.0
6.0000	-2.00000	0.00000	85.00000	0.0	0.0
8.0000	-2.00000	2.00000	85.00000	0.0	0.0
10.000	-2.00000	4.00000	85.00000	0.0	0.0
12.000	-2.00000	6.00000	85.00000	0.0	0.0
14.000	-2.00000	8.00000	85.00000	0.0	0.0
16.000	-2.00000	10.00000	85.00000	0.0	0.0
18.000	-2.00000	12.00000	85.00000	0.0	0.0

d - Displacements include imported displacements.

Structure: Willow Cottages Sub-structure: Retaining Wall (11)					
Dist.	x	y	z	x	y
				Horizontal displacement along the Line	Horizontal displacement perpendicular to Line
[m]	[m]	[m]	[m]	[mm]	[mm]
0.0	0.00000	-10.00000	83.00000	0.0	0.0
2.0264	1.81250	-9.09375	83.00000	0.0	0.0
4.0529	3.62500	-8.18750	83.00000	0.0	0.0
6.0793	5.43750	-7.28125	83.00000	0.0	0.0
8.1057	7.25000	-6.37500	83.00000	0.0	0.0
10.132	9.06250	-5.46875	83.00000	0.0	0.0
12.159	10.87500	-4.56250	83.00000	0.0	0.0
14.185	12.68750	-3.65625	83.00000	0.0	0.0
16.211	14.50000	-2.75000	83.00000	0.0	0.0
18.238	16.31250	-1.84375	83.00000	0.0	0.0
20.264	18.12500	-0.93750	83.00000	0.0	0.0
22.291	19.93750	-0.03125	83.00000	0.0	0.0
24.317	21.75000	0.87500	83.00000	0.0	0.0
26.344	23.56250	1.78125	83.00000	0.0	0.0
28.370	25.37500	2.68750	83.00000	0.0	0.0
30.397	27.18750	3.59375	83.00000	0.0	0.0
32.423	29.00000	4.50000	83.00000	0.0	0.0

d - Displacements include imported displacements.

Structure: Willow Cottages Sub-structure: Rear Elevation					
Dist.	x	y	z	x	y
				Horizontal displacement along the Line	Horizontal displacement perpendicular to Line
[m]	[m]	[m]	[m]	[mm]	[mm]
0.0	0.00000	-13.00000	83.00000	0.0	0.0



31 Willoughby Road

Combined Movements & Damage Assessment

1st Stage - Short-term (no heave) - No horizontal movement

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Dist.	Coordinates			Displacements	
	x	y	z	Horizontal displacement along the	Horizontal displacement perpendicular
2.0264	1.81250	-12.09375	83.00000	0.0	0.0 d
4.0529	3.62500	-11.18750	83.00000	0.0	0.0 d
6.0793	5.43750	-10.28125	83.00000	0.0	0.0 d
8.1057	7.25000	-9.37500	83.00000	0.0	0.0 d
10.132	9.06250	-8.46875	83.00000	0.0	0.0 d
12.159	10.87500	-7.56250	83.00000	0.0	0.0 d
14.185	12.68750	-6.65625	83.00000	0.0	0.0 d
16.211	14.50000	-5.75000	83.00000	0.0	0.0 d
18.238	16.31250	-4.84375	83.00000	0.0	0.0 d
20.264	18.12500	-3.93750	83.00000	0.0	0.0 d
22.291	19.93750	-3.03125	83.00000	0.0	0.0 d
24.317	21.75000	-2.12500	83.00000	0.0	0.0 d
26.344	23.56250	-1.21875	83.00000	0.0	0.0 d
28.370	25.37500	-0.31250	83.00000	0.0	0.0 d
30.397	27.18750	0.59375	83.00000	0.0	0.0 d
32.423	29.00000	1.50000	83.00000	0.0	0.0 d

d - Displacements include imported displacements.

Specific Building Damage Results - Vertical Displacements

Structure: No 33 | Sub-structure: Party Wall (1)

Dist.	Coordinates			Displacements
	x	y	z	
	[m]	[m]	[m]	[mm]

Vertical Offset 1				
0.0	2.05000	0.00000	84.00000	3.8667 d
1.9800	4.03000	0.00000	84.00000	4.9685 d
3.9600	6.01000	0.00000	84.00000	5.0382 d
5.9400	7.99000	0.00000	84.00000	5.1203 d
7.9200	9.97000	0.00000	84.00000	5.2782 d
9.9000	11.95000	0.00000	84.00000	6.1210 d

d - Displacements include imported displacements.

Structure: No 33 | Sub-structure: Rear Elevation (2)

Dist.	Coordinates			Displacements
	x	y	z	
	[m]	[m]	[m]	[mm]

Vertical Offset 1				
0.0	12.00000	-0.05000	84.00000	4.5579 d
2.9000	12.00000	-2.95000	84.00000	1.1859 d

d - Displacements include imported displacements.

Structure: No 33 | Sub-structure: Far Elevation (3)

Dist.	Coordinates			Displacements
	x	y	z	
	[m]	[m]	[m]	[mm]

Vertical Offset 1				
0.0	11.95000	-3.00000	84.00000	1.1686 d
2.2081	9.97500	-3.98750	84.00000	0.85636 d
4.4162	8.00000	-4.97500	84.00000	0.63931 d
6.6244	6.02500	-5.96250	84.00000	0.47358 d
8.8325	4.05000	-6.95000	84.00000	0.34197 d

d - Displacements include imported displacements.

Structure: No 33 | Sub-structure: Far Eleavtion (4)

Dist.	Coordinates			Displacements
	x	y	z	
	[m]	[m]	[m]	[mm]

Vertical Offset 1				
0.0	3.95000	-7.00000	84.00000	0.33611 d
1.9000	2.05000	-7.00000	84.00000	0.28379 d

d - Displacements include imported displacements.

Structure: No 33 | Sub-structure: Frontage (5)

Dist.	Coordinates			Displacements
	x	y	z	
	[m]	[m]	[m]	[mm]

Vertical Offset 1				
0.0	2.00000	-6.95000	84.00000	0.28498 d
2.3000	2.00000	-4.65000	84.00000	0.44450 d
4.6000	2.00000	-2.35000	84.00000	0.75245 d
6.9000	2.00000	-0.05000	84.00000	2.2509 d

d - Displacements include imported displacements.

Structure: No 29 | Sub-structure: Party Wall (6)

Dist.	Coordinates			Displacements
	x	y	z	
	[m]	[m]	[m]	[mm]

Vertical Offset 1				
0.0	2.05000	6.00000	84.00000	3.4042 d
2.1134	4.16250	6.06250	84.00000	1.0360 d
4.2268	6.27500	6.12500	84.00000	0.84956 d
6.3403	8.38750	6.18750	84.00000	0.90072 d
8.4537	10.50000	6.25000	84.00000	1.1605 d
10.567	12.61250	6.31250	84.00000	3.1945 d
12.681	14.72500	6.37500	84.00000	4.1599 d
14.794	16.83750	6.43750	84.00000	4.8215 d
16.907	18.95000	6.50000	84.00000	5.6573 d

d - Displacements include imported displacements.

Structure: No 29 | Sub-structure: Rear Elevation (7)

Dist.	Coordinates			Displacements
	x	y	z	
	[m]	[m]	[m]	[mm]

Vertical Offset 1				
0.0	19.00000	6.55000	84.00000	4.5038 d
1.9667	19.00000	8.51667	84.00000	1.3745 d
3.9333	19.00000	10.48333	84.00000	0.77293 d
5.9000	19.00000	12.45000	84.00000	0.48292 d

d - Displacements include imported displacements.

Structure: No 29 | Sub-structure: Far Elevation (8)

Dist.	Coordinates			Displacements
	x	y	z	



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[m]	[m]	[m]	[m]	[mm]
Vertical Offset 1				
0.0	18.95000	12.50000	84.00000	0.47836 d
2.1134	16.83750	12.43750	84.00000	0.49992 d
4.2268	14.72500	12.37500	84.00000	0.48691 d
6.3403	12.61250	12.31250	84.00000	0.44906 d
8.4537	10.50000	12.25000	84.00000	0.39972 d
10.567	8.38750	12.18750	84.00000	0.35216 d
12.681	6.27500	12.12500	84.00000	0.31252 d
14.794	4.16250	12.06250	84.00000	0.27800 d
16.907	2.05000	12.00000	84.00000	0.24101 d
d - Displacements include imported displacements.				

Structure: No 29 | Sub-structure: Frontage (9)

Dist.	Coordinates		Displacements	
	x	y	z	z
[m]	[m]	[m]	[m]	[mm]

Vertical Offset 1				
0.0	2.00000	11.95000	84.00000	0.24220 d
1.9667	2.00000	9.98333	84.00000	0.35511 d
3.9333	2.00000	8.01667	84.00000	0.57276 d
5.9000	2.00000	6.05000	84.00000	1.8153 d
d - Displacements include imported displacements.				

Structure: Willoughby Road | Sub-structure: Roadway (10)

Dist.	Coordinates		Displacements	
	x	y	z	z
[m]	[m]	[m]	[m]	[mm]

Vertical Offset 1				
0.0	-2.00000	-6.00000	85.00000	0.20054 d
2.0000	-2.00000	-4.00000	85.00000	0.27056 d
4.0000	-2.00000	-2.00000	85.00000	0.35574 d
6.0000	-2.00000	0.00000	85.00000	0.43941 d
8.0000	-2.00000	2.00000	85.00000	0.48327 d
10.000	-2.00000	4.00000	85.00000	0.46176 d
12.000	-2.00000	6.00000	85.00000	0.38620 d
14.000	-2.00000	8.00000	85.00000	0.29297 d
16.000	-2.00000	10.00000	85.00000	0.21312 d
18.000	-2.00000	12.00000	85.00000	0.15335 d
d - Displacements include imported displacements.				

Structure: Willow Cottages | Sub-structure: Retaining Wall (11)

Dist.	Coordinates		Displacements	
	x	y	z	z
[m]	[m]	[m]	[m]	[mm]

Vertical Offset 1				
0.0	0.00000	-10.00000	83.00000	0.13805 d
2.0264	1.81250	-9.09375	83.00000	0.19557 d
4.0529	3.62500	-8.18750	83.00000	0.27042 d
6.0793	5.43750	-7.28125	83.00000	0.36520 d
8.1057	7.25000	-6.37500	83.00000	0.48254 d
10.132	9.06250	-5.46875	83.00000	0.62862 d
12.159	10.87500	-4.56250	83.00000	0.81862 d
14.185	12.68750	-3.65625	83.00000	1.0807 d
16.211	14.50000	-2.75000	83.00000	1.4489 d
18.238	16.31250	-1.84375	83.00000	1.9634 d
20.264	18.12500	-0.93750	83.00000	2.6824 d
22.291	19.93750	-0.03125	83.00000	2.6386 d
24.317	21.75000	0.87500	83.00000	1.9861 d
26.344	23.56250	1.78125	83.00000	1.1867 d
28.370	25.37500	2.68750	83.00000	0.73140 d
30.397	27.18750	3.59375	83.00000	0.46534 d
32.423	29.00000	4.50000	83.00000	0.30323 d
d - Displacements include imported displacements.				

Structure: Willow Cottages | Sub-structure: Rear Elevation

Dist.	Coordinates		Displacements	
	x	y	z	z
[m]	[m]	[m]	[m]	[mm]

Vertical Offset 1				
0.0	0.00000	-13.00000	83.00000	0.079774 d
2.0264	1.81250	-12.09375	83.00000	0.11347 d
4.0529	3.62500	-11.18750	83.00000	0.15581 d
6.0793	5.43750	-10.28125	83.00000	0.20802 d
8.1057	7.25000	-9.37500	83.00000	0.27119 d
10.132	9.06250	-8.46875	83.00000	0.34671 d
12.159	10.87500	-7.56250	83.00000	0.43682 d
14.185	12.68750	-6.65625	83.00000	0.54427 d
16.211	14.50000	-5.75000	83.00000	0.66953 d
18.238	16.31250	-4.84375	83.00000	0.80454 d
20.264	18.12500	-3.93750	83.00000	0.92360 d
22.291	19.93750	-3.03125	83.00000	0.97599 d
24.317	21.75000	-2.12500	83.00000	0.91776 d
26.344	23.56250	-1.21875	83.00000	0.76479 d
28.370	25.37500	-0.31250	83.00000	0.57997 d
30.397	27.18750	0.59375	83.00000	0.41791 d
32.423	29.00000	1.50000	83.00000	0.29421 d
d - Displacements include imported displacements.				

Specific Building Damage Results - All Segments

Structure: No 33 | Sub-structure: Party Wall (1)

Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category	
[m]		[m]	[m]		[%]	[%]	[%]			[m]		
0.0		1	0.0	4.9958	Sagging	0.012346	0.0	0.011223	0.0	-556.48E-6	3031.1	0
		2	4.9958	4.9032	Hogging	0.0086179	0.0	0.0084152	0.0	-425.64E-6	4681.9	0
(Negligible)												
(Negligible)												

Tensile horizontal strains are +ve, compressive horizontal strains are -ve.

Structure: No 33 | Sub-structure: Rear Elevation (2)

Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category
[m]		[m]	[m]		[%]	[%]	[%]			[m]	



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[m] 0.0	1	[m] 0.0	[m] 2.9000	None	[%] 0.0	[%] 0.0	[%] 0.0	0.0	0.0011628	-	[m] 0	(Negligible)
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.												
Structure: No 33 Sub-structure: Far Elevation (3)												
Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category	
[m] 0.0	1	[m] 0.0	[m] 8.8320	Hogging	[%] 0.0013107	[%] 0.0	[%] 0.0012158	0.0	141.41E-6	[m] 45921.	0	(Negligible)
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.												
Structure: No 33 Sub-structure: Far Eleavtion (4)												
Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category	
[m] 0.0	1	[m] 0.0	[m] 1.9000	None	[%] 0.0	[%] 0.0	[%] 0.0	0.0	27.534E-6	-	[m] 0	(Negligible)
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.												
Structure: No 33 Sub-structure: Frontage (5)												
Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category	
[m] 0.0	1	[m] 0.0	[m] 0.49482	Hogging	[%] 0.0	[%] 0.0	[%] 0.0	0.0	-69.358E-6	[m] 47192.	0	(Negligible)
	2	0.49482	6.4052	Hogging	0.012489	0.0	0.011996	0.0	-651.50E-6	3645.7	0	(Negligible)
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.												
Structure: No 29 Sub-structure: Party Wall (6)												
Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category	
[m] 0.0	1	[m] 0.0	[m] 10.147	Hogging	[%] 0.022649	[%] 0.0	[%] 0.021656	0.0	0.0011205	[m] 1674.2	0	(Negligible)
	2	10.147	4.3784	Sagging	0.0055442	0.0	0.0053612	0.0	-962.41E-6	11935.	0	(Negligible)
	3	14.526	2.3815	Hogging	815.84E-6	0.0	813.78E-6	0.0	-395.43E-6	15218.	0	(Negligible)
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.												
Structure: No 29 Sub-structure: Rear Elevation (7)												
Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category	
[m] 0.0	1	[m] 0.0	[m] 5.4692	Hogging	[%] 0.031028	[%] 0.0	[%] 0.030621	0.0	0.0015912	[m] 1255.1	0	(Negligible)
	2	5.4692	0.42977	None	0.0	0.0	0.0	0.0	147.46E-6	15970.	0	(Negligible)
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.												
Structure: No 29 Sub-structure: Far Elevation (8)												
Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category	
[m] 0.0	1	[m] 0.0	[m] 8.4549	Sagging	[%] 564.64E-6	[%] 0.0	[%] 542.91E-6	0.0	23.345E-6	[m] 120670.	0	(Negligible)
	2	8.4549	6.0703	Hogging	110.35E-6	0.0	108.54E-6	0.0	22.504E-6	789610.	0	(Negligible)
	3	14.525	2.3817	Sagging	11.574E-6	0.0	11.480E-6	0.0	17.501E-6	1.0236E+6	0	(Negligible)
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.												
Structure: No 29 Sub-structure: Frontage (9)												
Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category	
[m] 0.0	1	[m] 0.0	[m] 0.53572	None	[%] 0.0	[%] 0.0	[%] 0.0	0.0	-57.411E-6	[m] 30854.	0	(Negligible)
	2	0.53572	5.3633	Hogging	0.012522	0.0	0.012363	0.0	-631.80E-6	3081.4	0	(Negligible)
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.												
Structure: Willoughby Road Sub-structure: Roadway (10)												
Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category	
[m] 0.0	1	[m] 0.0	[m] 3.2275	Hogging	[%] 177.74E-6	[%] 0.0	[%] 240.43E-6	0.0	-42.594E-6	[m] 206790.	0	(Negligible)
	2	3.2275	10.218	Sagging	0.0015830	0.0	460.52E-6	0.0	46.619E-6	71550.	0	(Negligible)
	3	13.445	4.5548	Hogging	281.17E-6	0.0	311.74E-6	0.0	46.619E-6	183880.	0	(Negligible)
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.												



31 Willoughby Road

Combined Movements & Damage Assessment

1st Stage - Short-term (no heave) - No horizontal movement

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Vertical Offset from Line for Vertical Movement	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category
Structure: Willow Cottages Sub-structure: Retaining Wall (11)											
Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category
[m]		[m]	[m]		[%]	[%]	[%]			[m]	
0.0	1	0.0	17.719	Hogging	0.0027161	0.0	0.0035089	0.0	-253.87E-6	27634.	0 (Negligible)
	2	17.719	7.4760	Sagging	0.012361	0.0	0.017269	0.0	394.49E-6	7736.7	0 (Negligible)
	3	25.195	7.2267	Hogging	0.0044253	0.0	0.0064077	0.0	394.49E-6	19913.	0 (Negligible)
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.											
Structure: Willow Cottages Sub-structure: Rear Elevation											
Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category
[m]		[m]	[m]		[%]	[%]	[%]			[m]	
0.0	1	2.0264	14.578	Hogging	620.67E-6	0.0	717.29E-6	0.0	-66.624E-6	245100.	0 (Negligible)
	2	16.604	11.204	Sagging	0.0027859	0.0	0.0039940	0.0	91.204E-6	43118.	0 (Negligible)
	3	27.808	4.6136	Hogging	522.47E-6	0.0	511.59E-6	0.0	91.204E-6	97144.	0 (Negligible)
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.											
Specific Building Damage Results - Critical Values for All Segments within Each Sub-Structure											
Structure: No 33 Sub-structure: Party Wall (1)											
Vertical Offset from Line for Vertical Movement Calculations	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category	
[m]	[%]	[%]		[mm]	[%]			[m]	[m]		
0.0	0.012346	0.0	-556.48E-6	6.1205	0.011223	0.0	-556.48E-6	4681.9	3031.1	0 (Negligible)	
Structure: No 33 Sub-structure: Rear Elevation (2)											
Vertical Offset from Line for Vertical Movement Calculations	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category	
[m]	[%]	[%]		[mm]	[%]			[m]	[m]		
0.0	0.0	0.0	0.0011628	4.5579	0.0	0.0	0.0011628	-	-	0 (Negligible)	
Structure: No 33 Sub-structure: Far Elevation (3)											
Vertical Offset from Line for Vertical Movement Calculations	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category	
[m]	[%]	[%]		[mm]	[%]			[m]	[m]		
0.0	0.0013107	0.0	141.41E-6	1.1686	0.0012158	0.0	141.41E-6	45921.	-	0 (Negligible)	
Structure: No 33 Sub-structure: Far Elevation (4)											
Vertical Offset from Line for Vertical Movement Calculations	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category	
[m]	[%]	[%]		[mm]	[%]			[m]	[m]		
0.0	0.0	0.0	27.534E-6	0.33611	0.0	0.0	27.534E-6	-	-	0 (Negligible)	
Structure: No 33 Sub-structure: Frontage (5)											
Vertical Offset from Line for Vertical Movement Calculations	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category	
[m]	[%]	[%]		[mm]	[%]			[m]	[m]		
0.0	0.012489	0.0	-651.50E-6	2.2509	0.011996	0.0	-651.50E-6	3645.7	-	0 (Negligible)	
Structure: No 29 Sub-structure: Party Wall (6)											
Vertical Offset from Line for Vertical Movement Calculations	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category	
[m]	[%]	[%]		[mm]	[%]			[m]	[m]		
0.0	0.022649	0.0	0.0011205	5.6571	0.021656	0.0	0.0011205	1674.2	11935.	0 (Negligible)	
Structure: No 29 Sub-structure: Rear Elevation (7)											
Vertical Offset from Line for Vertical Movement Calculations	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category	
[m]	[%]	[%]		[mm]	[%]			[m]	[m]		
0.0	0.031028	0.0	0.0015912	4.5038	0.030621	0.0	0.0015912	1255.1	-	0 (Negligible)	
Structure: No 29 Sub-structure: Far Elevation (8)											
Vertical	Deflection Ratio	Average	Max Slope	Max	Max	Max Gradient	Max Gradient	Min	Min	Damage Category	

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Offset from Line for Vertical Movement Calculations	Ratio	Horizontal Strain	Settlement	Tensile Strain	of Horizontal Displacement Curve	of Vertical Displacement Curve	Radius of Curvature (Hogging)	Radius of Curvature (Sagging)		
[m] 0.0	[%] 564.64E-6	[%] 0.0	23.345E-6	[mm] 0.49979	[%] 542.91E-6	0.0	23.345E-6	[m] 789610.	[m] 120670.0 (Negligible)	
Structure: No 29 Sub-structure: Frontage (9)										
Vertical Offset from Line for Vertical Movement Calculations	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category
[m] 0.0	[%] 0.012522	[%] 0.0	-631.80E-6	[mm] 1.8147	[%] 0.012363	0.0	-631.80E-6	[m] 3081.4	[m] -	0 (Negligible)
Structure: Willoughby Road Sub-structure: Roadway (10)										
Vertical Offset from Line for Vertical Movement Calculations	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category
[m] 0.0	[%] 0.0015830	[%] 0.0	46.619E-6	[mm] 0.48272	[%] 460.52E-6	0.0	46.619E-6	[m] 183880.	[m] 71550.0	0 (Negligible)
Structure: Willow Cottages Sub-structure: Retaining Wall (11)										
Vertical Offset from Line for Vertical Movement Calculations	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category
[m] 0.0	[%] 0.012361	[%] 0.0	394.49E-6	[mm] 2.6819	[%] 0.017269	0.0	394.49E-6	[m] 19913.	[m] 7736.7	0 (Negligible)
Structure: Willow Cottages Sub-structure: Rear Elevation										
Vertical Offset from Line for Vertical Movement Calculations	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category
[m] 0.0	[%] 0.0027859	[%] 0.0	91.204E-6	[mm] 0.97527	[%] 0.0039940	0.0	91.204E-6	[m] 97144.	[m] 43118.0	0 (Negligible)

Specific Building Damage Results - Critical Segments within Each Structure

Structure Name	Parameter	Critical Sub-Structure	Critical Segment	Start	End	Curvature	Max Slope	Max Settlement	Max Tensile Strain	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category
No 33	Max Slope	Rear Elevation (2)		[m] 1	[m] 0.0	2.9000 Sagging	0.0011628	[mm] 4.5579	[%] 0.0	-	-	0 (Negligible)
	Max Settlement	Party Wall (1)		2	4.9958	9.8990 Hogging	425.64E-6	6.1205	0.0084152	4681.9	-	0 (Negligible)
	Max Tensile Strain	Frontage (5)		2	0.49482	6.9000 Hogging	651.50E-6	2.2509	0.011996	3645.7	-	0 (Negligible)
	Min Radius of Curvature (Hogging)	Frontage (5)		2	0.49482	6.9000 Hogging	651.50E-6	2.2509	0.011996	3645.7	-	0 (Negligible)
	Min Radius of Curvature (Sagging)	Party Wall (1)		1	0.0	4.9958 Sagging	556.48E-6	5.0811	0.011223	-	3031.1	0 (Negligible)
No 29	Max Slope	Rear Elevation (7)		1	0.0	5.4692 Hogging	0.0015912	4.5038	0.030621	1255.1	-	0 (Negligible)
	Max Settlement	Party Wall (6)		3	14.526	16.907 Hogging	395.43E-6	5.6571	813.78E-6	15218.	-	0 (Negligible)
	Max Tensile Strain	Rear Elevation (7)		1	0.0	5.4692 Hogging	0.0015912	4.5038	0.030621	1255.1	-	0 (Negligible)
	Min Radius of Curvature (Hogging)	Rear Elevation (7)		1	0.0	5.4692 Hogging	0.0015912	4.5038	0.030621	1255.1	-	0 (Negligible)
	Min Radius of Curvature (Sagging)	Party Wall (6)		2	10.147	14.526 Sagging	962.41E-6	4.7375	0.0053612	-	11935.	0 (Negligible)
Willoughby Road	Max Slope	Roadway (10)		2	3.2275	13.445 Sagging	46.619E-6	0.48272	460.52E-6	-	71550.0	0 (Negligible)
	Max Settlement	Roadway (10)		2	3.2275	13.445 Sagging	46.619E-6	0.48272	460.52E-6	-	71550.0	0 (Negligible)
	Max Tensile Strain	Roadway (10)		2	3.2275	13.445 Sagging	46.619E-6	0.48272	460.52E-6	-	71550.0	0 (Negligible)
	Min Radius of Curvature (Hogging)	Roadway (10)		3	13.445	18.000 Hogging	46.619E-6	0.31883	311.74E-6	183880.	-	0 (Negligible)
	Min Radius of Curvature (Sagging)	Roadway (10)		2	3.2275	13.445 Sagging	46.619E-6	0.48272	460.52E-6	-	71550.	0 (Negligible)
Willow Cottages	Max Slope	Retaining Wall (11)		2	17.719	25.195 Sagging	394.49E-6	2.6819	0.017269	-	7736.7	0 (Negligible)
	Max Settlement	Retaining Wall (11)		2	17.719	25.195 Sagging	394.49E-6	2.6819	0.017269	-	7736.7	0 (Negligible)
	Max Tensile Strain	Retaining Wall (11)		2	17.719	25.195 Sagging	394.49E-6	2.6819	0.017269	-	7736.7	0 (Negligible)
	Min Radius of Curvature (Hogging)	Retaining Wall (11)		3	25.195	32.422 Hogging	394.49E-6	1.6398	0.0064077	19913.	-	0 (Negligible)
	Min Radius of Curvature (Sagging)	Retaining Wall (11)		2	17.719	25.195 Sagging	394.49E-6	2.6819	0.017269	-	7736.7	0 (Negligible)
Willow Cottages	Max Slope	Rear Elevation		2	16.604	27.808 Sagging	91.204E-6	0.97527	0.0039940	-	43118.0	0 (Negligible)
	Max Settlement	Rear Elevation		2	16.604	27.808 Sagging	91.204E-6	0.97527	0.0039940	-	43118.0	0 (Negligible)
	Max Tensile Strain	Rear Elevation		2	16.604	27.808 Sagging	91.204E-6	0.97527	0.0039940	-	43118.0	0 (Negligible)
	Min Radius of Curvature (Hogging)	Rear Elevation		3	27.808	32.422 Hogging	91.204E-6	0.63120	511.59E-6	97144.	-	0 (Negligible)
	Min Radius of Curvature (Sagging)	Rear Elevation		2	16.604	27.808 Sagging	91.204E-6	0.97527	0.0039940	-	43118.	0 (Negligible)

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Analysis Options

Analysis: Boussinesq
Global Poisson's ratio: 0.50
Maximum allowable ratio between values of E: 1.5
Horizontal rigid boundary level: 35.00 [m OD]
Displacements at load centroids: Yes

Soil ProfilesSoil Profile 1

Layer	Level at top	Number of intermediate displacement levels	Youngs Modulus	Poissons ratio	Non-linear curve
	[mOD]		Top [kN/m ²]	Btm [kN/m ²]	
1	85.500	3	7500.0	7500.0	0.50000 None
2	82.500	1	15000.	15000.	0.50000 None
3	82.000	40	20000.	100000.	0.50000 None

Soil Zones

Zone	Name	X coordinates min max	Y coordinates min max	Profile
1	Soil Zone 1	-20.00000 40.00000	-20.00000 26.00000	Soil Profile 1

Load Data

Load ref.	Name	Shape	Orientation of Plane	Centre of load (Global)	Load position Angle of local x from	Width x or Radius	Length y	Polygon Coordinates	Rectangle of tolerance	Number of rectangles	Normal (local z)	Load value Tangential (local x) (local y)
				X Y Z (level)	[Degrees]	[m]	[m]	[m] [m] [m] [m]	[%]		[kN/m ²]	[kN/m ²] [kN/m ²]
1	Basement Excavation	Polygonal	Horizontal	N/A N/A N/A 83.70000	N/A	N/A	N/A	(3,1) (18,1) (20,2.3) (20,5.5) (12,5.25) (12,4) (3,4)	10.000	3	-30.000	N/A N/A
2	Existing Cellar	Polygonal	Horizontal	N/A N/A 83.70000	N/A	N/A	N/A	(3,4) (12,4) (12,6.25) (3,6)	10.000	1	0.0	N/A N/A
3	Underpinning	Polygonal	Horizontal	N/A N/A 83.70000	N/A	N/A	N/A	(2,6) (2,0) (12,0) (12,1)	10.000	2	60.000	N/A N/A
4	Underpinning	Polygonal	Horizontal	N/A N/A 83.70000	N/A	N/A	N/A	(12,0) (18,0) (21,2) (21,6.5) (19,6.5) (19,5.5) (20,5.5)	10.000	10	100.00	N/A N/A
5	Underpinning	Polygonal	Horizontal	N/A N/A 83.70000	N/A	N/A	N/A	(20,2.3) (18,1) (12,1) (19,6.5) (12,6.25) (12,5.25)	10.000	1	60.000	N/A N/A

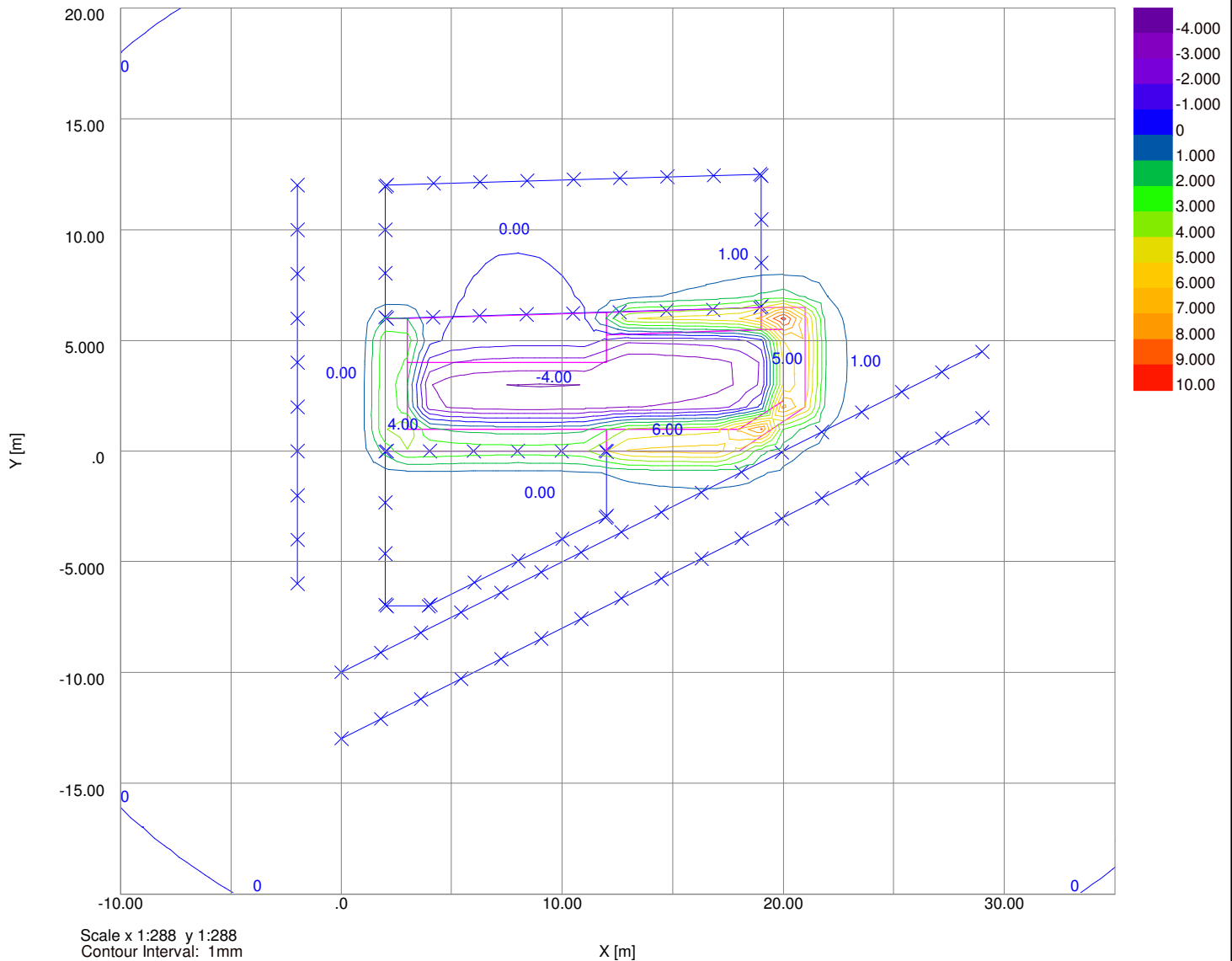
Polygonal Loads' Rectangles

No.	Centre of load X Y	Angle of local x from global X [Degrees]	Width x [m]	Depth y [m]
Load 1 : Basement Excavation				
(Edge 1 optimal)				
1	7.50000 2.50000	0.0	9.0000	3.0000
2	15.00000 3.17188	0.0	6.0000	4.3438
3	19.00000 3.55938	0.0	2.0000	3.8187
Load 2 : Existing Cellar				
(Edge 1 optimal)				
1	7.50000 5.06250	0.0	9.0000	2.1250
Load 3 : Underpinning				
(Edge 1 optimal)				
1	2.50000 3.50000	-90.000	5.0000	1.0000
2	7.00000 0.50000	-90.000	1.0000	10.000
Load 4 : Underpinning				
(Edge 1 optimal)				
1	15.00000 0.50000	0.0	6.0000	1.0000
2	18.14286 0.59405	0.0	0.28571	0.99762
3	18.42857 0.78214	0.0	0.28571	0.99286
4	18.71429 0.97024	0.0	0.28571	0.98810
5	19.00000 1.15833	0.0	0.28571	0.98333
6	19.28571 1.34643	0.0	0.28571	0.97857
7	19.57143 1.53452	0.0	0.28571	0.97381
8	19.85714 1.72262	0.0	0.28571	0.96905
9	20.50000 4.08333	0.0	1.0000	4.8333
10	19.50000 6.00000	0.0	1.0000	1.0000
Load 5 : Underpinning				
(Edge 1 optimal)				
1	15.50000 5.87500	-177.95	6.9688	0.99936

Displacement Data

Ref.	Type	Name	Direction of Extrusion	First point X Y Z (level)	Second point X Y Z (level)	No. of intrvl across extrusion/line	Extrusion Depth [m]	No. of intrvl along extrusion	Calculate	Show Detailed results
1	Grid	Grid 1	Global X	-20.00000 -20.00000 85.50000	N/A 26.00000 85.50000	46	60.00000	60	Yes	No
2	Grid	Grid 2	Global X	-20.00000 -20.00000 84.00000	N/A 26.00000 84.00000	46	60.00000	60	Yes	No
3	Line	Line 1	N/A	2.05000 0.00000 84.00000	11.95000 0.00000 84.00000	5	N/A	N/A	Yes	No
4	Line	Line 2	N/A	12.00000 -0.05000 84.00000	2.95000 84.00000	1	N/A	N/A	Yes	No
5	Line	Line 3	N/A	11.95000 -3.00000 84.00000	4.05000 -6.95000 84.00000	4	N/A	N/A	Yes	No
6	Line	Line 4	N/A	3.95000 -7.00000 84.00000	2.05000 -7.00000 84.00000	1	N/A	N/A	Yes	No
7	Line	Line 5	N/A	2.00000 -6.95000 84.00000	2.00000 -0.05000 84.00000	3	N/A	N/A	Yes	No
8	Line	Line 6	N/A	2.05000 6.00000 84.00000	18.95000 6.50000 84.00000	8	N/A	N/A	Yes	No
9	Line	Line 7	N/A	19.00000 6.55000 84.00000	19.00000 12.45000 84.00000	3	N/A	N/A	Yes	No
10	Line	Line 8	N/A	18.95000 12.50000 84.00000	2.05000 12.00000 84.00000	8	N/A	N/A	Yes	No
11	Line	Line 9	N/A	2.00000 11.95000 84.00000	2.00000 6.05000 84.00000	3	N/A	N/A	Yes	No
12	Line	Line 10	N/A	-2.00000 -6.00000 85.00000	-2.00000 12.00000 85.00000	9	N/A	N/A	Yes	No
13	Line	Line 11	N/A	0.00000 -10.00000 83.00000	29.00000 4.50000 83.00000	16	N/A	N/A	Yes	No
14	Line	Line 12	N/A	0.00000 -13.00000 83.00000	29.00000 1.50000 83.00000	16	N/A	N/A	Yes	No

Settlement Contours : Grid 1 at 85.5000m



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Problem Type

Problem Type : Tunnelling and Embedded Wall Excavations

Displacement Data

Type	Name	Direction of extrusion	Point/Line/Line for extrusion						No. of intervals across extrusion/line	Extrusion depth	No. of intervals along extrusion	Calculate	Surface type for tunnels
			First point			Second point							
			X [m]	Y [m]	Z (level) [m]	X [m]	Y [m]	Z (level) [m]					
Grid	Grid 1	Global X	-20.00000	-20.00000	85.50000	-	26.00000	85.50000	46	60.00000	60	Yes	Surface
Grid	Grid 2	Global X	-20.00000	-20.00000	84.00000	-	26.00000	84.00000	46	60.00000	60	Yes	Surface
Line	Line 1	-	2.05000	0.00000	84.00000	11.95000	0.00000	84.00000	5	-	-	Yes	Surface
Line	Line 2	-	12.00000	-0.05000	84.00000	12.00000	-2.95000	84.00000	1	-	-	Yes	Surface
Line	Line 3	-	11.95000	-3.00000	84.00000	4.05000	-6.95000	84.00000	4	-	-	Yes	Surface
Line	Line 4	-	3.95000	-7.00000	84.00000	2.05000	-7.00000	84.00000	1	-	-	Yes	Surface
Line	Line 5	-	2.00000	-6.95000	84.00000	2.00000	-0.05000	84.00000	3	-	-	Yes	Surface
Line	Line 6	-	2.05000	6.00000	84.00000	18.95000	6.50000	84.00000	8	-	-	Yes	Surface
Line	Line 7	-	19.00000	6.55000	84.00000	19.00000	12.45000	84.00000	3	-	-	Yes	Surface
Line	Line 8	-	18.95000	12.50000	84.00000	2.05000	12.00000	84.00000	8	-	-	Yes	Surface
Line	Line 9	-	2.00000	11.95000	84.00000	2.00000	6.05000	84.00000	3	-	-	Yes	Surface
Line	Line 10	-	-2.00000	-6.00000	85.00000	-2.00000	12.00000	85.00000	9	-	-	Yes	Surface
Line	Line 11	-	0.00000	-10.00000	83.00000	29.00000	4.50000	83.00000	16	-	-	Yes	Surface
Line	Line 12	-	0.00000	-13.00000	83.00000	29.00000	1.50000	83.00000	16	-	-	Yes	Surface

Vertical Ground Movement Curves (Excavations)

Curve Name: No vertical ground movement
Coordinates: [Distance from wall / wall depth or max. excavation depth (x), Depth / wall depth or max. excavation depth (y), Settlement / wall depth or max. excavation depth (z) (%)]
 [0.000,0.000,0.000] [1.000,0.000,0.000] [0.000,1.000,0.000] [1.000,1.000,0.000]
Curve Fitting Method: Polynomial
x Order: 1
y Order: 0
Polynomial: z = 0.0x + 0.0
Coeff. of Determination: -2147483648.E+2147483647

Horizontal Ground Movement Curves (Excavations)

Curve Name: No horizontal ground movement
Coordinates: [Distance from wall / wall depth or max. excavation depth (x), Depth / wall depth or max. excavation depth (y), Horizontal movement / wall depth or max. excavation depth (z) (%)]
 [0.000,0.000,0.000] [1.000,0.000,0.000] [0.000,1.000,0.000] [1.000,1.000,0.000]
Curve Fitting Method: Polynomial
x Order: 0
y Order: 0
Polynomial: z = 0.0
Coeff. of Determination: -2147483648.E+2147483647

Polygonal Excavations

Excavation Name: New Excavation
Surface level [m]: 85.500
Contribution: Positive
Enabled: Yes
Surface movement curves which are selected are applied between surface and [m]: 81.400

Corner	x	y	Base Level	Stiffened	Previous Side	Next Side
	[m]	[m]	[m]	d	p1 p2*	d p1 p2*
				[m]	[%]	[m] [%] [%]
1	2.0000	0.0	81.400	No	- - -	- - -
2	18.000	0.0	81.400	No	- - -	- - -
3	21.000	2.0000	81.400	No	- - -	- - -
4	21.000	6.5000	81.400	No	- - -	- - -
5	2.0000	6.0000	81.400	No	- - -	- - -

Side	Corner 1	Corner 2	Ground Movement Curve	
	x y	x y	Vertical	Horizontal
	[m] [m]	[m] [m]		
1	2.0000 0.0	18.000 0.0	No vertical ground movement	No horizontal ground movement
2	18.000 0.0	21.000 2.0000	No vertical ground movement	No horizontal ground movement
3	21.000 2.0000	21.000 6.5000	No vertical ground movement	No horizontal ground movement
4	21.000 6.5000	2.0000 6.0000	No vertical ground movement	No horizontal ground movement
5	2.0000 6.0000	2.0000 0.0	No vertical ground movement	No horizontal ground movement

Damage Category Strains

Name	0 (Negligible)	1 (Very Slight)	2 (Slight)	3 (Moderate)
	to	to	to	to
Burland Strain Limits	1 (Very Slight)	2 (Slight)	3 (Moderate)	4 (Severe)
	0.0	500.00E-6	750.00E-6	0.0015000

Specific Structures - Geometry

Structure Name	Sub-Structure Name	Displacement Line	Start Distance Along Line	End Distance Along Line	Vertical Offsets from Line for Vertical Movement Calculations	Vertical Displacement Limit Sensitivity	Damage Category Strains	Poisson's Ratio	E/G
			[m]	[m]	[m]	[mm]			
No 33	Party Wall (1)	Line 1	0.00000	9.89900	0.0	0.10000	Burland Strain Limits	0.20000	2.6000
No 33	Rear Elevation (2)	Line 2	0.00000	2.90000	0.0	0.10000	Burland Strain Limits	0.20000	2.6000
No 33	Far Elevation (3)	Line 3	0.00000	8.83200	0.0	0.10000	Burland Strain Limits	0.20000	2.6000
No 33	Far Elevation (4)	Line 4	0.00000	1.90000	0.0	0.10000	Burland Strain Limits	0.20000	2.6000
No 33	Frontage (5)	Line 5	0.00000	6.90000	0.0	0.10000	Burland Strain Limits	0.20000	2.6000
No 29	Party Wall (6)	Line 6	0.00000	16.90700	0.0	0.10000	Burland Strain Limits	0.20000	2.6000
No 29	Rear Elevation (7)	Line 7	0.00000	5.89900	0.0	0.10000	Burland Strain Limits	0.20000	2.6000
No 29	Far Elevation (8)	Line 8	0.00000	16.90700	0.0	0.10000	Burland Strain Limits	0.20000	2.6000
No 29	Frontage (9)	Line 9	0.00000	5.89900	0.0	0.10000	Burland Strain Limits	0.20000	2.6000
Willoughby Road	Roadway (10)	Line 10	0.00000	18.00000	0.0	0.10000	Burland Strain Limits	0.20000	2.6000
Willow Cottages	Retaining Wall (11)	Line 11	0.00000	32.42200	0.0	0.10000	Burland Strain Limits	0.20000	2.6000



31 Willoughby Road
Combined Movements & Damage Assessment
1st Stage - Short-term (with heave) - 5 mm limit on overall horizontal movements

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Structure Name	Sub-Structure Name	Displacement Line	Start Distance Along Line	End Distance Along Line	Vertical Offsets from Line for Vertical	Vertical Displacement Limit Sensitivity	Damage Category	Strains	Poisson's Ratio	E/G
Willow Cottages	Rear Elevation	Line 12	0.00000	32.42200	0.0	0.10000	Burland Strain Limits		0.20000	2.6000
Specific Structures - Bending Parameters										
Structure Name	Sub-Structure Name	Height	Default Properties	Hogging			Sagging			
				2nd Moment of Area (per unit width)	Distance of Bending Strain from N.A.	Distance of N.A. from Edge of Beam in Tension	2nd Moment of Area (per unit width)	Distance of Bending Strain from N.A.	Distance of N.A. from Edge of Beam in Tension	
No 33	Party Wall (1)	[m]	8.0000 Yes	[m³]	[m]	[m]	[m³]	[m]	[m]	
No 33	Rear Elevation (2)	8.0000 Yes		170.67	8.0000	8.0000	42.667	4.0000	4.0000	
No 33	Far Elevation (3)	8.0000 Yes		170.67	8.0000	8.0000	42.667	4.0000	4.0000	
No 33	Far Eleavtion (4)	8.0000 Yes		170.67	8.0000	8.0000	42.667	4.0000	4.0000	
No 33	Frontage (5)	8.0000 Yes		170.67	8.0000	8.0000	42.667	4.0000	4.0000	
No 29	Party Wall (6)	12.000 Yes		576.00	12.000	12.000	144.00	6.0000	6.0000	
No 29	Rear Elevation (7)	12.000 Yes		576.00	12.000	12.000	144.00	6.0000	6.0000	
No 29	Far Elevation (8)	12.000 Yes		576.00	12.000	12.000	144.00	6.0000	6.0000	
No 29	Frontage (9)	12.000 Yes		576.00	12.000	12.000	144.00	6.0000	6.0000	
Willoughby Road	Roadway (10)	0.50000 Yes		0.041667	0.50000	0.50000	0.010417	0.25000	0.25000	
Willow Cottages	Retaining Wall (11)	2.5000 Yes		5.2083	2.5000	2.5000	1.3021	1.2500	1.2500	
Willow Cottages	Rear Elevation	8.0000 Yes		170.67	8.0000	8.0000	42.667	4.0000	4.0000	
Building Segment Combinations										
Structure Name	Sub-Structure Name	Vertical Offset from Line for Vertical Movement Calculations	Segment Start	Length	Curvature	Combined Segment				
No structures have segments combined.										
Utility Strain Calculation Options										
Neglect beneficial contribution of axial strains : No										
Warnings										
1	Sub-structure 6 crosses at least one excavation. Its building damage results in that area should be treated with caution.									
Errors										
None										
Specific Building Damage Results - Horizontal Displacements										
Structure: No 33 Sub-structure: Party Wall (1)										
Dist.	Coordinates			Displacements						
	x	y	z	x	y		Horizontal displacement along the Line	Horizontal displacement perpendicular to Line		
	[m]	[m]	[m]	[mm]	[mm]		[mm]	[mm]		
	0.0	2.05000	0.00000	84.00000	0.0	0.0	0.0	0.0	d	
1.9800	4.03000	0.00000	84.00000	0.0	0.0		0.0	0.0	d	
3.9600	6.01000	0.00000	84.00000	0.0	0.0		0.0	0.0	d	
5.9400	7.99000	0.00000	84.00000	0.0	0.0		0.0	0.0	d	
7.9200	9.97000	0.00000	84.00000	0.0	0.0		0.0	0.0	d	
9.9000	11.95000	0.00000	84.00000	0.0	0.0		0.0	0.0	d	
d - Displacements include imported displacements.										
Structure: No 33 Sub-structure: Rear Elevation (2)										
Dist.	Coordinates			Displacements						
	x	y	z	x	y		Horizontal displacement along the Line	Horizontal displacement perpendicular to Line		
	[m]	[m]	[m]	[mm]	[mm]		[mm]	[mm]		
	0.0	12.00000	-0.05000	84.00000	0.0	0.0	0.0	0.0	d	
2.9000	12.00000	-2.95000	84.00000	0.0	0.0		0.0	0.0	d	
d - Displacements include imported displacements.										
Structure: No 33 Sub-structure: Far Elevation (3)										
Dist.	Coordinates			Displacements						
	x	y	z	x	y		Horizontal displacement along the Line	Horizontal displacement perpendicular to Line		
	[m]	[m]	[m]	[mm]	[mm]		[mm]	[mm]		
	0.0	11.95000	-3.00000	84.00000	0.0	0.0	0.0	0.0	d	
2.2081	9.97500	-3.98750	84.00000	0.0	0.0		0.0	0.0	d	
4.4162	8.00000	-4.97500	84.00000	0.0	0.0		0.0	0.0	d	
6.6244	6.02500	-5.96250	84.00000	0.0	0.0		0.0	0.0	d	
8.8325	4.05000	-6.95000	84.00000	0.0	0.0		0.0	0.0	d	
d - Displacements include imported displacements.										
Structure: No 33 Sub-structure: Far Eleavtion (4)										
Dist.	Coordinates			Displacements						
	x	y	z	x	y		Horizontal displacement along the Line	Horizontal displacement perpendicular to Line		
	[m]	[m]	[m]	[mm]	[mm]		[mm]	[mm]		
	0.0	3.95000	-7.00000	84.00000	0.0	0.0	0.0	0.0	d	
1.9000	2.05000	-7.00000	84.00000	0.0	0.0		0.0	0.0	d	
d - Displacements include imported displacements.										
Structure: No 33 Sub-structure: Frontage (5)										



31 Willoughby Road

Combined Movements & Damage Assessment

1st Stage - Short-term (with heave) - 5 mm limit on overall horizontal movements

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Dist.	Coordinates			Displacements	
	x	y	z	x	y
				Horizontal displacement along the Line	Horizontal displacement perpendicular to Line
	[m]	[m]	[m]	[mm]	[mm]
0.0	2.00000	-6.95000	84.00000	0.0	0.0
2.3000	2.00000	-4.85000	84.00000	0.0	0.0
4.6000	2.00000	-2.35000	84.00000	0.0	0.0
6.9000	2.00000	-0.05000	84.00000	0.0	0.0

d - Displacements include imported displacements.

Structure: No 29 | Sub-structure: Party Wall (6)

Dist.	Coordinates			Displacements	
	x	y	z	x	y
				Horizontal displacement along the Line	Horizontal displacement perpendicular to Line
	[m]	[m]	[m]	[mm]	[mm]
0.0	2.05000	6.00000	84.00000	0.0	0.0
2.1134	4.16250	6.06250	84.00000	0.0	0.0
4.2268	6.27500	6.12500	84.00000	0.0	0.0
6.3403	8.38750	6.18750	84.00000	0.0	0.0
8.4537	10.50000	6.25000	84.00000	0.0	0.0
10.567	12.61250	6.31250	84.00000	0.0	0.0
12.681	14.72500	6.37500	84.00000	0.0	0.0
14.794	16.83750	6.43750	84.00000	0.0	0.0
16.907	18.95000	6.50000	84.00000	0.0	0.0

d - Displacements include imported displacements.

Structure: No 29 | Sub-structure: Rear Elevation (7)

Dist.	Coordinates			Displacements	
	x	y	z	x	y
				Horizontal displacement along the Line	Horizontal displacement perpendicular to Line
	[m]	[m]	[m]	[mm]	[mm]
0.0	19.00000	6.55000	84.00000	0.0	0.0
1.9667	19.00000	8.51667	84.00000	0.0	0.0
3.9333	19.00000	10.48333	84.00000	0.0	0.0
5.9000	19.00000	12.45000	84.00000	0.0	0.0

d - Displacements include imported displacements.

Structure: No 29 | Sub-structure: Far Elevation (8)

Dist.	Coordinates			Displacements	
	x	y	z	x	y
				Horizontal displacement along the Line	Horizontal displacement perpendicular to Line
	[m]	[m]	[m]	[mm]	[mm]
0.0	19.95000	12.50000	84.00000	0.0	0.0
2.1134	16.83750	12.43750	84.00000	0.0	0.0
4.2268	14.72500	12.37500	84.00000	0.0	0.0
6.3403	12.61250	12.31250	84.00000	0.0	0.0
8.4537	10.50000	12.25000	84.00000	0.0	0.0
10.567	8.38750	12.18750	84.00000	0.0	0.0
12.681	6.27500	12.12500	84.00000	0.0	0.0
14.794	4.16250	12.06250	84.00000	0.0	0.0
16.907	2.05000	12.00000	84.00000	0.0	0.0

d - Displacements include imported displacements.

Structure: No 29 | Sub-structure: Frontage (9)

Dist.	Coordinates			Displacements	
	x	y	z	x	y
				Horizontal displacement along the Line	Horizontal displacement perpendicular to Line
	[m]	[m]	[m]	[mm]	[mm]
0.0	2.00000	11.95000	84.00000	0.0	0.0
1.9667	2.00000	9.98333	84.00000	0.0	0.0
3.9333	2.00000	8.01667	84.00000	0.0	0.0
5.9000	2.00000	6.05000	84.00000	0.0	0.0

d - Displacements include imported displacements.

Structure: Willoughby Road | Sub-structure: Roadway (10)

Dist.	Coordinates			Displacements	
	x	y	z	x	y
				Horizontal displacement along the Line	Horizontal displacement perpendicular to Line
	[m]	[m]	[m]	[mm]	[mm]
0.0	-2.00000	-6.00000	85.00000	0.0	0.0
2.0000	-2.00000	-4.00000	85.00000	0.0	0.0
4.0000	-2.00000	-2.00000	85.00000	0.0	0.0
6.0000	-2.00000	0.00000	85.00000	0.0	0.0
8.0000	-2.00000	2.00000	85.00000	0.0	0.0
10.000	-2.00000	4.00000	85.00000	0.0	0.0
12.000	-2.00000	6.00000	85.00000	0.0	0.0
14.000	-2.00000	8.00000	85.00000	0.0	0.0
16.000	-2.00000	10.00000	85.00000	0.0	0.0
18.000	-2.00000	12.00000	85.00000	0.0	0.0

d - Displacements include imported displacements.

Structure: Willow Cottages | Sub-structure: Retaining Wall (11)

Dist.	Coordinates			Displacements	
	x	y	z	x	y
				Horizontal displacement along the Line	Horizontal displacement perpendicular to Line
	[m]	[m]	[m]	[mm]	[mm]
0.0	0.00000	-10.00000	83.00000	0.0	0.0
2.0264	1.81250	-9.09375	83.00000	0.0	0.0
4.0529	3.62500	-8.18750	83.00000	0.0	0.0
6.0793	5.43750	-7.28125	83.00000	0.0	0.0
8.1057	7.25000	-6.37500	83.00000	0.0	0.0
10.132	9.06250	-5.46875	83.00000	0.0	0.0
12.159	10.87500	-4.56250	83.00000	0.0	0.0
14.185	12.68750	-3.65625	83.00000	0.0	0.0
16.211	14.50000	-2.75000	83.00000	0.0	0.0
18.238	16.31250	-1.84375	83.00000	0.0	0.0
20.264	18.12500	-0.93750	83.00000	0.0	0.0
22.291	19.93750	-0.03125	83.00000	0.0	0.0
24.317	21.75000	0.87500	83.00000	0.0	0.0
26.344	23.56250	1.78125	83.00000	0.0	0.0
28.370	25.37500	2.68750	83.00000	0.0	0.0
30.397	27.18750	3.59375	83.00000	0.0	0.0

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Structure: Willow Cottages | Sub-structure: Rear Elevation

Specific Building Damage Results - Vertical Displacements

Structure: No 33 | Sub-structure: Party Wall (1)

Vertical Offset 1					
0.0	2.05000	0.00000	84.00000	3.8667	d
1.9800	4.03000	0.00000	84.00000	4.9685	d
3.9600	6.01000	0.00000	84.00000	5.0382	d
5.9400	7.99000	0.00000	84.00000	5.1203	d
7.9200	9.97000	0.00000	84.00000	5.2782	d
9.9000	11.95000	0.00000	84.00000	6.1210	d

d - Displacements include imported displacements

Structure: No 33 | Sub-structure: Rear Elevation (2)

```
Vertical Offset 1
0.0 12.00000 -0.05000 84.00000 4.5579 d
2.9000 12.00000 -2.95000 84.00000 1.1859 d
d - Displacements include imported displacements.
```

Structure: No 33 | Sub-structure: Far Elevation (3)

```

Vertical Offset 1
0.0 11.950000 -3.00000 84.00000 1.1686 d
2.2081 9.97500 -3.98750 84.00000 0.85636 d
4.4162 8.00000 -4.97500 84.00000 0.63931 d
6.6244 6.02500 -5.96250 84.00000 0.47358 d
8.8325 4.05000 -6.95000 84.00000 0.34197 d
d - Displacements include imported displacements.

```

Structure: No 33 | Sub-structure: Far Eleavtion (4)

Vertical Offset 1

0.0	3.95000	-7.00000	84.00000	0.33611	d
1.9000	2.05000	-7.00000	84.00000	0.28379	d

d - Displacements include imported displacements.

Structure: No 33 | Sub-structure: Frontage (5)

```

Vertical Offset 1
0.0 2.00000 -6.95000 84.00000 0.28498 d
2.3000 2.00000 -4.65000 84.00000 0.44450 d
4.6000 2.00000 -2.35000 84.00000 0.75245 d
6.9000 2.00000 -0.05000 84.00000 2.2509 d
d - Displacements include imported displacements.

```

Structure: No 29 | Sub-structure: Party Wall (6)

Vertical Offset 1					
0.0	2.05000	6.00000	84.00000	3.4042 d	
2.1134	4.16250	6.06250	84.00000	1.0360 d	
4.2268	6.27500	6.12500	84.00000	0.84956 d	
6.3403	8.38750	6.18750	84.00000	0.90072 d	
8.4537	10.50000	6.25000	84.00000	1.1605 d	
10.567	12.61250	6.31250	84.00000	3.1945 d	
12.680	14.72500	6.37500	84.00000	4.1590 d	
14.794	16.83750	6.43750	84.00000	4.8215 d	
16.907	18.95000	6.50000	84.00000	5.6573 d	

d - Displacements include imported displacements.

Structure: No 29 | Sub-structure: Rear Elevation (7)

Dist.	Coordinates			Displacements
	x	y	z	z
[m]	[m]	[m]	[m]	[mm]



31 Willoughby Road

Combined Movements & Damage Assessment

1st Stage - Short-term (with heave) - 5 mm limit on overall horizontal movements

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Vertical Offset 1
0.0 19.00000 6.55000 84.00000 4.5038 d
1.9667 19.00000 8.51667 84.00000 1.3745 d
3.9333 19.00000 10.48333 84.00000 0.77293 d
5.9000 19.00000 12.45000 84.00000 0.48292 d
d - Displacements include imported displacements.

Structure: No 29 | Sub-structure: Far Elevation (8)

Dist.	Coordinates		Displacements
	x	y	z
	[m]	[m]	[mm]

Vertical Offset 1
0.0 18.95000 12.50000 84.00000 0.47836 d
2.1134 16.83750 12.43750 84.00000 0.49992 d
4.2268 14.72500 12.37500 84.00000 0.48691 d
6.3403 12.61250 12.31250 84.00000 0.44906 d
8.4537 10.50000 12.25000 84.00000 0.39972 d
10.567 8.38750 12.18750 84.00000 0.35216 d
12.681 6.27500 12.12500 84.00000 0.31252 d
14.794 4.16250 12.06250 84.00000 0.27800 d
16.907 2.05000 12.00000 84.00000 0.24101 d
d - Displacements include imported displacements.

Structure: No 29 | Sub-structure: Frontage (9)

Dist.	Coordinates		Displacements
	x	y	z
	[m]	[m]	[mm]

Vertical Offset 1
0.0 2.00000 11.95000 84.00000 0.24220 d
1.9667 2.00000 9.98333 84.00000 0.35511 d
3.9333 2.00000 8.01667 84.00000 0.57276 d
5.9000 2.00000 6.05000 84.00000 1.8153 d
d - Displacements include imported displacements.

Structure: Willoughby Road | Sub-structure: Roadway (10)

Dist.	Coordinates		Displacements
	x	y	z
	[m]	[m]	[mm]

Vertical Offset 1
0.0 -2.00000 -6.00000 85.00000 0.20054 d
2.0000 -2.00000 -4.00000 85.00000 0.27056 d
4.0000 -2.00000 -2.00000 85.00000 0.35574 d
6.0000 -2.00000 0.00000 85.00000 0.43941 d
8.0000 -2.00000 2.00000 85.00000 0.48327 d
10.000 -2.00000 4.00000 85.00000 0.46176 d
12.000 -2.00000 6.00000 85.00000 0.38620 d
14.000 -2.00000 8.00000 85.00000 0.29297 d
16.000 -2.00000 10.00000 85.00000 0.21312 d
18.000 -2.00000 12.00000 85.00000 0.15335 d
d - Displacements include imported displacements.

Structure: Willow Cottages | Sub-structure: Retaining Wall (11)

Dist.	Coordinates		Displacements
	x	y	z
	[m]	[m]	[mm]

Vertical Offset 1
0.0 0.00000 -10.00000 83.00000 0.13805 d
2.0264 1.81250 -9.09375 83.00000 0.19557 d
4.0529 3.62500 -8.18750 83.00000 0.27042 d
6.0793 5.43750 -7.28125 83.00000 0.36520 d
8.1057 7.25000 -6.37500 83.00000 0.48254 d
10.132 9.06250 -5.46875 83.00000 0.62862 d
12.159 10.87500 -4.56250 83.00000 0.81862 d
14.185 12.68750 -3.65625 83.00000 1.0807 d
16.211 14.50000 -2.75000 83.00000 1.4489 d
18.238 16.31250 -1.84375 83.00000 1.9634 d
20.264 18.12500 -0.93750 83.00000 2.6824 d
22.291 19.93750 -0.03125 83.00000 2.6386 d
24.317 21.75000 0.87500 83.00000 1.9861 d
26.344 23.56250 1.78125 83.00000 1.1867 d
28.370 25.37500 2.68750 83.00000 0.73140 d
30.397 27.18750 3.59375 83.00000 0.46534 d
32.423 29.00000 4.50000 83.00000 0.30323 d
d - Displacements include imported displacements.

Structure: Willow Cottages | Sub-structure: Rear Elevation

Dist.	Coordinates		Displacements
	x	y	z
	[m]	[m]	[mm]

Vertical Offset 1
0.0 0.00000 -13.00000 83.00000 0.079774 d
2.0264 1.81250 -12.09375 83.00000 0.11347 d
4.0529 3.62500 -11.18750 83.00000 0.15581 d
6.0793 5.43750 -10.28125 83.00000 0.20802 d
8.1057 7.25000 -9.37500 83.00000 0.27119 d
10.132 9.06250 -8.46875 83.00000 0.34671 d
12.159 10.87500 -7.56250 83.00000 0.43682 d
14.185 12.68750 -6.65625 83.00000 0.54427 d
16.211 14.50000 -5.75000 83.00000 0.66953 d
18.238 16.31250 -4.84375 83.00000 0.80454 d
20.264 18.12500 -3.93750 83.00000 0.92360 d
22.291 19.93750 -3.03125 83.00000 0.97599 d
24.317 21.75000 -2.12500 83.00000 0.91776 d
26.344 23.56250 -1.21875 83.00000 0.76479 d
28.370 25.37500 -0.31250 83.00000 0.57997 d
30.397 27.18750 0.59375 83.00000 0.41791 d
32.423 29.00000 1.50000 83.00000 0.29421 d
d - Displacements include imported displacements.

Specific Building Damage Results - All Segments

Structure: No 33 | Sub-structure: Party Wall (1)

Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category
[m]		[m]			[%]	[%]	[%]			[m]	
0.0	1	0.0	4.9958	Sagging	0.012346	0.0	0.011223	0.0	-556.48E-6	3031.1	0

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Vertical Offset from Line for Vertical Movement	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category
		2	4.9958	4.9032 Hogging	0.0086179	0.0	0.0084152	0.0	-425.64E-6	4681.9	(Negligible) 0
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.											
Structure: No 33 Sub-structure: Rear Elevation (2)											
Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category
[m] 0.0		[m] 1	[m] 0.0	2.9000 None	[%] 0.0	[%] 0.0	[%] 0.0	0.0	0.0011628	-	0 (Negligible)
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.											
Structure: No 33 Sub-structure: Far Elevation (3)											
Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category
[m] 0.0		[m] 1	[m] 0.0	8.8320 Hogging	[%] 0.0013107	[%] 0.0	[%] 0.0012158	0.0	141.41E-6	[m] 45921.	0 (Negligible)
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.											
Structure: No 33 Sub-structure: Far Elevation (4)											
Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category
[m] 0.0		[m] 1	[m] 0.0	1.9000 None	[%] 0.0	[%] 0.0	[%] 0.0	0.0	27.534E-6	-	0 (Negligible)
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.											
Structure: No 33 Sub-structure: Frontage (5)											
Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category
[m] 0.0		[m] 1	[m] 0.0	0.49482 Hogging	[%] 0.0	[%] 0.0	[%] 0.0	0.0	-69.358E-6	[m] 47192.	0 (Negligible)
		2	0.49482	6.4052 Hogging	0.012489	0.0	0.011996	0.0	-651.50E-6	3645.7	0 (Negligible)
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.											
Structure: No 29 Sub-structure: Party Wall (6)											
Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category
[m] 0.0		[m] 1	[m] 0.0	10.147 Hogging	[%] 0.022649	[%] 0.0	[%] 0.021656	0.0	0.0011205	[m] 1674.2	0 (Negligible)
		2	10.147	4.3784 Sagging	0.0055442	0.0	0.0053612	0.0	-962.41E-6	11935.	0 (Negligible)
		3	14.526	2.3815 Hogging	815.84E-6	0.0	813.78E-6	0.0	-395.43E-6	15218.	0 (Negligible)
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.											
Structure: No 29 Sub-structure: Rear Elevation (7)											
Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category
[m] 0.0		[m] 1	[m] 0.0	5.4692 Hogging	[%] 0.031028	[%] 0.0	[%] 0.030621	0.0	0.0015912	[m] 1255.1	0 (Negligible)
		2	5.4692	0.42977 None	0.0	0.0	0.0	0.0	147.46E-6	15970.	0 (Negligible)
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.											
Structure: No 29 Sub-structure: Far Elevation (8)											
Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category
[m] 0.0		[m] 1	[m] 0.0	8.4549 Sagging	[%] 564.64E-6	[%] 0.0	[%] 542.91E-6	0.0	23.345E-6	[m] 120670.	0 (Negligible)
		2	8.4549	6.0703 Hogging	110.35E-6	0.0	108.54E-6	0.0	22.504E-6	789610.	0 (Negligible)
		3	14.525	2.3817 Sagging	11.574E-6	0.0	11.480E-6	0.0	17.501E-6	1.0236E+6	0 (Negligible)
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.											
Structure: No 29 Sub-structure: Frontage (9)											
Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category
[m] 0.0		[m] 1	[m] 0.0	0.53572 None	[%] 0.0	[%] 0.0	[%] 0.0	0.0	-57.411E-6	[m] 30854.	0 (Negligible)
		2	0.53572	5.3633 Hogging	0.012522	0.0	0.012363	0.0	-631.80E-6	3081.4	0 (Negligible)
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.											
Structure: Willoughby Road Sub-structure: Roadway (10)											
Vertical Offset	Segment	Start	Length	Curvature	Deflection	Average	Max	Max Gradient	Max Gradient	Min	Damage



31 Willoughby Road

Combined Movements & Damage Assessment

1st Stage - Short-term (with heave) - 5 mm limit on overall horizontal movements

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from Line for Vertical Movement Calculations				Ratio	Horizontal Strain	Tensile Strain	of Horizontal Displacement Curve	of Vertical Displacement Curve	Radius of Curvature	Category
[m] 0.0		[m]	[m]	[%]	[%]	[%]			[m]	
1	0.0	3.2275	Hogging	177.74E-6	0.0	240.43E-6	0.0	-42.594E-6	206790.	0 (Negligible)
2	3.2275	10.218	Sagging	0.0015830	0.0	460.52E-6	0.0	46.619E-6	71550.	0 (Negligible)
3	13.445	4.5548	Hogging	281.17E-6	0.0	311.74E-6	0.0	46.619E-6	183880.	0 (Negligible)

Tensile horizontal strains are +ve, compressive horizontal strains are -ve.

Structure: Willow Cottages | Sub-structure: Retaining Wall (11)

Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category
[m] 0.0		[m]	[m]		[%]		[%]			[m]	
	1	0.0	17.719	Hogging	0.0027161	0.0	0.0035089	0.0	-253.87E-6	27634.	0 (Negligible)
	2	17.719	7.4760	Sagging	0.012361	0.0	0.017269	0.0	394.49E-6	7736.7	0 (Negligible)
	3	25.195	7.2267	Hogging	0.0044253	0.0	0.0064077	0.0	394.49E-6	19913.	0 (Negligible)

Tensile horizontal strains are +ve, compressive horizontal strains are -ve.

Structure: Willow Cottages | Sub-structure: Rear Elevation

Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category
[m] 0.0		[m]	[m]		[%]	[%]	[%]			[m]	
1	2.0264	14.578	Hogging	620.67E-6	0.0	717.29E-6	0.0	-66.624E-6	245100.	0 (Negligible)	
2	16.604	11.204	Sagging	0.0027859	0.0	0.0039940	0.0	91.204E-6	43118.	0 (Negligible)	
3	27.808	4.6136	Hogging	522.47E-6	0.0	511.59E-6	0.0	91.204E-6	97144.	0 (Negligible)	

Tensile horizontal strains are +ve, compressive horizontal strains are -ve.

Specific Building Damage Results - Critical Values for All Segments within Each Sub-Structure

Structure: No 33 | Sub-structure: Party Wall (1)

Vertical Offset from Line for Vertical Movement Calculations	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category
[m] 0.0	[%]	[%]		[mm]	[%]			[m]	[m]	
0.012346	0.0	-556.48E-6	6.1205	0.011223	0.0	-556.48E-6	4681.9	3031.1	0	0 (Negligible)

Structure: No 33 | Sub-structure: Rear Elevation (2)

Vertical Offset from Line for Vertical Movement Calculations	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category
[m] 0.0	[%]	[%]		[mm]	[%]			[m]	[m]	
0.0	0.0	0.0	0.0011628	4.5579	0.0	0.0	0.0011628	-	-	0 (Negligible)

Structure: No 33 | Sub-structure: Far Elevation (3)

Vertical Offset from Line for Vertical Movement Calculations	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category
[m] 0.0	[%]	[%]		[mm]	[%]			[m]	[m]	
0.0013107	0.0	141.41E-6	1.1686	0.0012158	0.0	141.41E-6	45921.	-	-	0 (Negligible)

Structure: No 33 | Sub-structure: Far Eleavtion (4)

Vertical Offset from Line for Vertical Movement Calculations	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category
[m] 0.0	[%]	[%]		[mm]	[%]			[m]	[m]	
0.0	0.0	0.0	27.534E-6	0.33611	0.0	0.0	27.534E-6	-	-	0 (Negligible)

Structure: No 33 | Sub-structure: Frontage (5)

Vertical Offset from Line for Vertical Movement Calculations	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category
[m] 0.0	[%]	[%]		[mm]	[%]			[m]	[m]	
0.012489	0.0	-651.50E-6	2.2509	0.011996	0.0	-651.50E-6	3645.7	-	-	0 (Negligible)

Structure: No 29 | Sub-structure: Party Wall (6)

Vertical Offset from Line for Vertical Movement Calculations	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category
[m] 0.0	[%]	[%]		[mm]	[%]			[m]	[m]	
0.022649	0.0	0.0011205	5.6571	0.021656	0.0	0.0011205	1674.2	11935.	0	0 (Negligible)

Structure: No 29 | Sub-structure: Rear Elevation (7)



31 Willoughby Road

Combined Movements & Damage Assessment

1st Stage - Short-term (with heave) - 5 mm limit on overall horizontal movements

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Vertical Offset from Line for Vertical Movement Calculations	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category
[m] 0.0	[%] 0.031028	[%] 0.0	0.0015912	[mm] 4.5038	[%] 0.030621	0.0	0.0015912	[m] 1255.1	[m] -	0 (Negligible)

Structure: No 29 | Sub-structure: Far Elevation (8)

Vertical Offset from Line for Vertical Movement Calculations	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category
[m] 0.0	[%] 564.64E-6	[%] 0.0	23.345E-6	[mm] 0.49979	[%] 542.91E-6	0.0	23.345E-6	[m] 789610.	[m] 120670.	0 (Negligible)

Structure: No 29 | Sub-structure: Frontage (9)

Vertical Offset from Line for Vertical Movement Calculations	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category
[m] 0.0	[%] 0.012522	[%] 0.0	-631.80E-6	[mm] 1.8147	[%] 0.012363	0.0	-631.80E-6	[m] 3081.4	[m] -	0 (Negligible)

Structure: Willoughby Road | Sub-structure: Roadway (10)

Vertical Offset from Line for Vertical Movement Calculations	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category
[m] 0.0	[%] 0.0015830	[%] 0.0	46.619E-6	[mm] 0.48272	[%] 460.52E-6	0.0	46.619E-6	[m] 183880.	[m] 71550.	0 (Negligible)

Structure: Willow Cottages | Sub-structure: Retaining Wall (11)

Vertical Offset from Line for Vertical Movement Calculations	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category
[m] 0.0	[%] 0.012361	[%] 0.0	394.49E-6	[mm] 2.6819	[%] 0.017269	0.0	394.49E-6	[m] 19913.	[m] 7736.7	0 (Negligible)

Structure: Willow Cottages | Sub-structure: Rear Elevation

Vertical Offset from Line for Vertical Movement Calculations	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category
[m] 0.0	[%] 0.0027859	[%] 0.0	91.204E-6	[mm] 0.97527	[%] 0.0039940	0.0	91.204E-6	[m] 97144.	[m] 43118.	0 (Negligible)

Specific Building Damage Results - Critical Segments within Each Structure

Structure Name	Parameter	Critical Sub-Structure	Critical Segment	Start	End	Curvature	Max Slope	Max Settlement	Max Tensile Strain	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category
No 33	Max Slope	Rear Elevation (2)		[m] 1	[m] 0.0	2.9000	Sagging	0.0011628	[mm] 4.5579	[%] 0.0	-	0 (Negligible)
	Max Settlement	Party Wall (1)		2	4.9958	9.8990	Hogging	425.64E-6	6.1205	0.0084152	4681.9	- 0 (Negligible)
	Max Tensile Strain	Frontage (5)		2	0.49482	6.9000	Hogging	651.50E-6	2.2509	0.011996	3645.7	- 0 (Negligible)
	Min Radius of Curvature (Hogging)	Frontage (5)		2	0.49482	6.9000	Hogging	651.50E-6	2.2509	0.011996	3645.7	- 0 (Negligible)
	Min Radius of Curvature (Sagging)	Party Wall (1)		1	0.0	4.9958	Sagging	556.48E-6	5.0811	0.011223	-	3031.1 0 (Negligible)
No 29	Max Slope	Rear Elevation (7)		1	0.0	5.4692	Hogging	0.0015912	4.5038	0.030621	1255.1	- 0 (Negligible)
	Max Settlement	Party Wall (6)		3	14.526	16.907	Hogging	395.43E-6	5.6571	813.78E-6	15218.	- 0 (Negligible)
	Max Tensile Strain	Rear Elevation (7)		1	0.0	5.4692	Hogging	0.0015912	4.5038	0.030621	1255.1	- 0 (Negligible)
	Min Radius of Curvature (Hogging)	Rear Elevation (7)		1	0.0	5.4692	Hogging	0.0015912	4.5038	0.030621	1255.1	- 0 (Negligible)
	Min Radius of Curvature (Sagging)	Party Wall (6)		2	10.147	14.526	Sagging	962.41E-6	4.7375	0.0053612	-	11935. 0 (Negligible)
Willoughby Road	Max Slope	Roadway (10)		2	3.2275	13.445	Sagging	46.619E-6	0.48272	460.52E-6	-	71550. 0 (Negligible)
	Max Settlement	Roadway (10)		2	3.2275	13.445	Sagging	46.619E-6	0.48272	460.52E-6	-	71550. 0 (Negligible)
	Max Tensile Strain	Roadway (10)		2	3.2275	13.445	Sagging	46.619E-6	0.48272	460.52E-6	-	71550. 0 (Negligible)
	Min Radius of Curvature (Hogging)	Roadway (10)		3	13.445	18.000	Hogging	46.619E-6	0.31883	311.74E-6	183880.	- 0 (Negligible)
	Min Radius of Curvature (Sagging)	Roadway (10)		2	3.2275	13.445	Sagging	46.619E-6	0.48272	460.52E-6	-	71550. 0 (Negligible)
Willow Cottages	Max Slope	Retaining Wall (11)		2	17.719	25.195	Sagging	394.49E-6	2.6819	0.017269	-	7736.7 0 (Negligible)
	Max Settlement	Retaining Wall (11)		2	17.719	25.195	Sagging	394.49E-6	2.6819	0.017269	-	7736.7 0 (Negligible)
	Max Tensile Strain	Retaining Wall (11)		2	17.719	25.195	Sagging	394.49E-6	2.6819	0.017269	-	7736.7 0 (Negligible)
	Min Radius of Curvature (Hogging)	Retaining Wall (11)		3	25.195	32.422	Hogging	394.49E-6	1.6398	0.0064077	19913.	- 0 (Negligible)
	Min Radius of Curvature (Sagging)	Retaining Wall (11)		2	17.719	25.195	Sagging	394.49E-6	2.6819	0.017269	-	7736.7 0 (Negligible)
Willow Cottages	Max Slope	Rear Elevation		2	16.604	27.808	Sagging	91.204E-6	0.97527	0.0039940	-	43118. 0 (Negligible)
	Max Settlement	Rear Elevation		2	16.604	27.808	Sagging	91.204E-6	0.97527	0.0039940	-	43118. 0 (Negligible)
	Max Tensile Strain	Rear Elevation		2	16.604	27.808	Sagging	91.204E-6	0.97527	0.0039940	-	43118. 0 (Negligible)



31 Willoughby Road

Combined Movements & Damage Assessment

1st Stage - Short-term (with heave) - 5 mm limit on overall horizontal movements

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Structure Name	Parameter	Critical Sub-Structure	Critical Segment	Start	End	Curvature	Max Slope	Max Settlement	Max Tensile Strain	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category
	Min Radius of Curvature (Hogging)	Rear Elevation	3	27.808	32.422	Hogging	91.204E-6	0.63120	511.59E-6	97144.	-	0 (Negligible)
	Min Radius of Curvature (Sagging)	Rear Elevation	2	16.604	27.808	Sagging	91.204E-6	0.97527	0.0039940	-	43118.	0 (Negligible)

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Problem Type

Problem Type : Tunnelling and Embedded Wall Excavations

Displacement Data

Type	Name	Direction of extrusion	Point/Line/Line for extrusion						No. of intervals across extrusion/line	Extrusion depth	No. of intervals along extrusion	Calculate	Surface type for tunnels	
			First point			Second point								
			X [m]	Y [m]	Z (level)	X [m]	Y [m]	Z (level)						
Grid	Grid 1	Global X	-20.00000	-20.00000	85.50000	-	26.00000	85.50000	-	46	60.00000	60	Yes	Surface
Grid	Grid 2	Global X	-20.00000	-20.00000	84.00000	-	26.00000	84.00000	-	46	60.00000	60	Yes	Surface
Line	Line 1	-	2.05000	0.00000	84.00000	11.95000	0.00000	84.00000	5	-	-	-	Yes	Surface
Line	Line 2	-	12.00000	-0.05000	84.00000	12.00000	-2.95000	84.00000	1	-	-	-	Yes	Surface
Line	Line 3	-	11.95000	-3.00000	84.00000	4.05000	-6.95000	84.00000	4	-	-	-	Yes	Surface
Line	Line 4	-	3.95000	-7.00000	84.00000	2.05000	-7.00000	84.00000	1	-	-	-	Yes	Surface
Line	Line 5	-	2.00000	-6.95000	84.00000	2.00000	-0.05000	84.00000	3	-	-	-	Yes	Surface
Line	Line 6	-	2.05000	6.00000	84.00000	18.95000	6.50000	84.00000	8	-	-	-	Yes	Surface
Line	Line 7	-	19.00000	6.55000	84.00000	19.00000	12.45000	84.00000	3	-	-	-	Yes	Surface
Line	Line 8	-	18.95000	12.50000	84.00000	2.05000	12.00000	84.00000	8	-	-	-	Yes	Surface
Line	Line 9	-	2.00000	11.95000	84.00000	2.00000	6.05000	84.00000	3	-	-	-	Yes	Surface
Line	Line 10	-	-2.00000	-6.00000	85.00000	-2.00000	12.00000	85.00000	9	-	-	-	Yes	Surface
Line	Line 11	-	0.00000	-10.00000	83.00000	29.00000	4.50000	83.00000	16	-	-	-	Yes	Surface
Line	Line 12	-	0.00000	-13.00000	83.00000	29.00000	1.50000	83.00000	16	-	-	-	Yes	Surface

Vertical Ground Movement Curves (Excavations)

Curve Name: No vertical ground movement
Coordinates: [Distance from wall / wall depth or max. excavation depth (x), Depth / wall depth or max. excavation depth (y), Settlement / wall depth or max. excavation depth (z) (%)]
 [0.000,0.000,0.000] [1.000,0.000,0.000] [0.000,1.000,0.000] [1.000,1.000,0.000]
Curve Fitting Method: Polynomial
x Order: 1
y Order: 0
Polynomial: z = 0.0x + 0.0
Coeff. of Determination: -2147483648.E+2147483647

Horizontal Ground Movement Curves (Excavations)

Curve Name: GEA Curve for 5 mm of horizontal deflection (after CIRIA 580 Fig. 2.11(a))
Coordinates: [Distance from wall / wall depth or max. excavation depth (x), Depth / wall depth or max. excavation depth (y), Horizontal movement / wall depth or max. excavation depth (z) (%)]
 [0.000,0.000,0.121] [4.000,0.000,0.000]
Curve Fitting Method: Polynomial
x Order: 1
y Order: 0
Polynomial: z = -3.03E-2x + 1.21E-1
Coeff. of Determination: 1.00

Polygonal Excavations

Excavation Name: New Excavation
Surface level [m]: 85.500
Contribution: Positive
Enabled: Yes
Surface movement curves which are selected are applied between surface and [m]: 81.400

Corner	x	y	Base Level	Stiffened	Previous Side	Next Side
	[m]	[m]	[m]	d	p1 p2*	d p1 p2*
1	2.0000	0.0	81.400	No	- - -	- - -
2	18.000	0.0	81.400	No	- - -	- - -
3	21.000	2.0000	81.400	No	- - -	- - -
4	21.000	6.5000	81.400	No	- - -	- - -
5	2.0000	6.0000	81.400	No	- - -	- - -

Side	Corner 1	Corner 2	Ground Movement Curve	
	x y	x y	Vertical	Horizontal
	[m] [m]	[m] [m]		
1	2.0000 0.0	18.000 0.0	No vertical ground movement	GEA Curve for 5 mm of horizontal deflection (after CIRIA 580 Fig. 2.11(a))
2	18.000 0.0	21.000 2.0000	No vertical ground movement	GEA Curve for 5 mm of horizontal deflection (after CIRIA 580 Fig. 2.11(a))
3	21.000 2.0000	21.000 6.5000	No vertical ground movement	GEA Curve for 5 mm of horizontal deflection (after CIRIA 580 Fig. 2.11(a))
4	21.000 6.5000	2.0000 6.0000	No vertical ground movement	GEA Curve for 5 mm of horizontal deflection (after CIRIA 580 Fig. 2.11(a))
5	2.0000 6.0000	2.0000 0.0	No vertical ground movement	GEA Curve for 5 mm of horizontal deflection (after CIRIA 580 Fig. 2.11(a))

Damage Category Strains

Name	0 (Negligible) to 1 (Very Slight)	1 (Very Slight) to 2 (Slight)	2 (Slight) to 3 (Moderate)	3 (Moderate) to 4 (Severe)
Burland Strain Limits	0.0	500.00E-6	750.00E-6	0.0015000

Specific Structures - Geometry

Structure Name	Sub-Structure Name	Displacement Line	Start Distance Along Line	End Distance Along Line	Vertical Offsets from Line for Vertical Movement Calculations	Vertical Displacement Limit	Damage Category Strains	Poisson's Ratio	E/G
			[m]	[m]	[m]	[mm]			
No 33	Party Wall (1)	Line 1	0.00000	9.89900	0.0	0.10000	Burland Strain Limits	0.20000	2.6000
No 33	Rear Elevation (2)	Line 2	0.00000	2.90000	0.0	0.10000	Burland Strain Limits	0.20000	2.6000
No 33	Far Elevation (3)	Line 3	0.00000	8.83200	0.0	0.10000	Burland Strain Limits	0.20000	2.6000
No 33	Far Elevation (4)	Line 4	0.00000	1.90000	0.0	0.10000	Burland Strain Limits	0.20000	2.6000

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Structure Name	Sub-Structure Name	Displacement Line	Start Distance Along Line	End Distance Along Line	Vertical Offsets from Line for Vertical	Vertical Displacement Limit	Damage Category	Strains	Poisson's Ratio	E/G
No 33	Frontage (5)	Line 5	0.00000	6.90000	0.0	0.10000	Burland Strain Limits	0.20000	2.6000	
No 29	Party Wall (6)	Line 6	0.00000	16.90700	0.0	0.10000	Burland Strain Limits	0.20000	2.6000	
No 29	Rear Elevation (7)	Line 7	0.00000	5.89900	0.0	0.10000	Burland Strain Limits	0.20000	2.6000	
No 29	Far Elevation (8)	Line 8	0.00000	16.90700	0.0	0.10000	Burland Strain Limits	0.20000	2.6000	
No 29	Frontage (9)	Line 9	0.00000	5.89900	0.0	0.10000	Burland Strain Limits	0.20000	2.6000	
Willoughby Road	Roadway (10)	Line 10	0.00000	18.00000	0.0	0.10000	Burland Strain Limits	0.20000	2.6000	
Willow Cottages	Retaining Wall (11)	Line 11	0.00000	32.42200	0.0	0.10000	Burland Strain Limits	0.20000	2.6000	
Willow Cottages	Rear Elevation	Line 12	0.00000	32.42200	0.0	0.10000	Burland Strain Limits	0.20000	2.6000	

Specific Structures - Bending Parameters

Structure Name	Sub-Structure Name	Height	Default Properties	Hogging			Sagging		
				2nd Moment of Area (per unit width)	Distance of Bending Strain from N.A.	Distance of N.A. from Edge of Beam in Tension	2nd Moment of Area (per unit width)	Distance of Bending Strain from N.A.	Distance of N.A. from Edge of Beam in Tension
No 33	Party Wall (1)	[m]	8.0000 Yes	[m ⁴]	[m]	[m]	[m ⁴]	[m]	[m]
No 33	Rear Elevation (2)	8.0000	Yes	170.67	8.0000	8.0000	42.667	4.0000	4.0000
No 33	Far Elevation (3)	8.0000	Yes	170.67	8.0000	8.0000	42.667	4.0000	4.0000
No 33	Far Elevation (4)	8.0000	Yes	170.67	8.0000	8.0000	42.667	4.0000	4.0000
No 33	Frontage (5)	8.0000	Yes	170.67	8.0000	8.0000	42.667	4.0000	4.0000
No 29	Party Wall (6)	12.000	Yes	576.00	12.000	12.000	144.00	6.0000	6.0000
No 29	Rear Elevation (7)	12.000	Yes	576.00	12.000	12.000	144.00	6.0000	6.0000
No 29	Far Elevation (8)	12.000	Yes	576.00	12.000	12.000	144.00	6.0000	6.0000
No 29	Frontage (9)	12.000	Yes	576.00	12.000	12.000	144.00	6.0000	6.0000
Willoughby Road	Roadway (10)	0.50000	Yes	0.041667	0.50000	0.50000	0.010417	0.25000	0.25000
Willow Cottages	Retaining Wall (11)	2.5000	Yes	5.2083	2.5000	2.5000	1.3021	1.2500	1.2500
Willow Cottages	Rear Elevation	8.0000	Yes	170.67	8.0000	8.0000	42.667	4.0000	4.0000

Building Segment Combinations

Structure Name	Sub-Structure Name	Vertical Offset from Line for Vertical Movement Calculations	Segment Start	Length	Curvature	Combined Segment
No structures have segments combined.						

Utility Strain Calculation Options

Neglect beneficial contribution of axial strains : No

Warnings

- Sub-structure 6 crosses at least one excavation. Its building damage results in that area should be treated with caution.

Errors

None

Specific Building Damage Results - Horizontal Displacements

Structure: No 33 | Sub-structure: Party Wall (1)

Dist.	Coordinates			Displacements		
	x	y	z	x	y	
				Horizontal displacement along the Line	Horizontal displacement perpendicular to Line	
	[m]	[m]	[m]	[mm]	[mm]	
0.0	2.05000	0.00000	84.00000	0.0	4.9610	d
1.9800	4.03000	0.00000	84.00000	0.0	4.9610	d
3.9600	6.01000	0.00000	84.00000	0.0	4.9610	d
5.9400	7.99000	0.00000	84.00000	0.0	4.9610	d
7.9200	9.97000	0.00000	84.00000	0.0	4.9610	d
9.9000	11.95000	0.00000	84.00000	0.0	4.9610	d

d - Displacements include imported displacements.

Structure: No 33 | Sub-structure: Rear Elevation (2)

Dist.	Coordinates			Displacements		
	x	y	z	x	y	
				Horizontal displacement along the Line	Horizontal displacement perpendicular to Line	
	[m]	[m]	[m]	[mm]	[mm]	
0.0	12.00000	-0.05000	84.00000	0.0	4.9459	0.0 d
2.9000	12.00000	-2.95000	84.00000	0.0	4.0686	0.0 d

d - Displacements include imported displacements.

Structure: No 33 | Sub-structure: Far Elevation (3)

Dist.	Coordinates			Displacements		
	x	y	z	x	y	
				Horizontal displacement along the Line	Horizontal displacement perpendicular to Line	
	[m]	[m]	[m]	[mm]	[mm]	
0.0	11.95000	-3.00000	84.00000	0.0	4.0535	-3.6256 d
2.2081	9.97500	-3.98750	84.00000	0.0	3.7548	-3.3584 d
4.4162	8.00000	-4.97500	84.00000	0.0	3.4561	-3.0912 d
6.6244	6.02500	-5.96250	84.00000	0.0	3.1573	-2.8240 d
8.8325	4.05000	-6.95000	84.00000	0.0	2.8586	-2.5568 d

d - Displacements include imported displacements.

Structure: No 33 | Sub-structure: Far Elevation (4)

Dist.	Coordinates			Displacements		
	x	y	z	x	y	
				Horizontal displacement	Horizontal displacement	

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along the Line						perpendicular to Line	
[m]	[m]	[m]	[m]	[mm]	[mm]	[mm]	[mm]
0.0	3.95000	-7.00000	84.00000	0.0	2.8435	0.0	-2.8435 d
1.9000	2.05000	-7.00000	84.00000	0.0	2.8435	0.0	-2.8435 d

d - Displacements include imported displacements.

Structure: No 33 | Sub-structure: Frontage (5)

Dist.	Coordinates			Displacements		Horizontal displacement along the Line	Horizontal displacement perpendicular to Line
	x	y	z	x	y		
	[m]	[m]	[m]	[mm]	[mm]	[mm]	[mm]
	0.0	2.00000	-6.95000	84.00000	0.0	2.8586	2.8586
2.3000	2.00000	-4.45000	84.00000	0.0	3.5544	3.5544	0.0 d
4.6000	2.00000	-2.35000	84.00000	0.0	4.2501	4.2501	0.0 d
6.9000	2.00000	-0.05000	84.00000	0.0	4.9459	4.9459	0.0 d

d - Displacements include imported displacements.

Structure: No 29 | Sub-structure: Party Wall (6)

Dist.	Coordinates			Displacements		Horizontal displacement along the Line	Horizontal displacement perpendicular to Line
	x	y	z	x	y		
	[m]	[m]	[m]	[mm]	[mm]	[mm]	[mm]
	0.0	2.05000	6.00000	84.00000	0.0	0.0	0.0 d
2.1134	4.16250	6.06250	84.00000	0.13046	-4.9576	-0.016204	-4.9593 d
4.2268	6.27500	6.12500	84.00000	0.13041	-4.9555	-0.016197	-4.9572 d
6.3403	8.38750	6.18750	84.00000	0.13035	-4.9534	-0.016191	-4.9551 d
8.4537	10.50000	6.25000	84.00000	0.13030	-4.9513	-0.016184	-4.9530 d
10.567	12.61250	6.31250	84.00000	0.13024	-4.9492	-0.016177	-4.9509 d
12.681	14.72500	6.37500	84.00000	0.13019	-4.9472	-0.016170	-4.9488 d
14.794	16.83750	6.43750	84.00000	0.13013	-4.9451	-0.016163	-4.9467 d
16.907	18.95000	6.50000	84.00000	0.13008	-4.9430	-0.016157	-4.9447 d

d - Displacements include imported displacements.

Structure: No 29 | Sub-structure: Rear Elevation (7)

Dist.	Coordinates			Displacements		Horizontal displacement along the Line	Horizontal displacement perpendicular to Line
	x	y	z	x	y		
	[m]	[m]	[m]	[mm]	[mm]	[mm]	[mm]
	0.0	19.00000	6.55000	84.00000	0.12969	-4.9283	-4.9283
1.9667	19.00000	8.51667	84.00000	0.11405	-4.3338	-4.3338	-0.11405 d
3.9333	19.00000	10.48333	84.00000	0.098401	-3.7392	-3.7392	-0.098401 d
5.9000	19.00000	12.45000	84.00000	0.082756	-3.1447	-3.1447	-0.082756 d

d - Displacements include imported displacements.

Structure: No 29 | Sub-structure: Far Elevation (8)

Dist.	Coordinates			Displacements		Horizontal displacement along the Line	Horizontal displacement perpendicular to Line
	x	y	z	x	y		
	[m]	[m]	[m]	[mm]	[mm]	[mm]	[mm]
	0.0	18.95000	12.00000	84.00000	0.082348	-3.1292	0.010228
2.1134	16.83750	12.43750	84.00000	0.082403	-3.1313	0.010235	3.1324 d
4.2268	14.72500	12.37500	84.00000	0.082458	-3.1334	0.010242	3.1345 d
6.3403	12.61250	12.31250	84.00000	0.082513	-3.1355	0.010249	3.1366 d
8.4537	10.50000	12.25000	84.00000	0.082568	-3.1376	0.010255	3.1387 d
10.567	8.38750	12.18750	84.00000	0.082623	-3.1397	0.010262	3.1407 d
12.681	6.27500	12.12500	84.00000	0.082678	-3.1418	0.010269	3.1428 d
14.794	4.16250	12.06250	84.00000	0.082733	-3.1438	0.010276	3.1449 d
16.907	2.05000	12.00000	84.00000	0.082788	-3.1459	0.010283	3.1470 d

d - Displacements include imported displacements.

Structure: No 29 | Sub-structure: Frontage (9)

Dist.	Coordinates			Displacements		Horizontal displacement along the Line	Horizontal displacement perpendicular to Line
	x	y	z	x	y		
	[m]	[m]	[m]	[mm]	[mm]	[mm]	[mm]
	0.0	2.00000	11.95000	84.00000	0.083175	-3.1607	3.1607
1.9667	2.00000	9.98333	84.00000	0.098820	-3.7552	3.7552	0.098820 d
3.9333	2.00000	8.01667	84.00000	0.11446	-4.3497	4.3497	0.11446 d
5.9000	2.00000	6.05000	84.00000	0.13011	-4.9442	4.9442	0.13011 d

d - Displacements include imported displacements.

Structure: Willoughby Road | Sub-structure: Roadway (10)

Dist.	Coordinates			Displacements		Horizontal displacement along the Line	Horizontal displacement perpendicular to Line
	x	y	z	x	y		
	[m]	[m]	[m]	[mm]	[mm]	[mm]	[mm]
	0.0	-2.00000	-6.00000	85.00000	1.0405	1.7391	1.7391
2.0000	-2.00000	-4.00000	85.00000	1.6249	1.6249	1.6249	-1.6249 d
4.0000	-2.00000	-2.00000	85.00000	2.5432	1.0650	1.0650	-2.5432 d
6.0000	-2.00000	0.00000	85.00000	3.7510	0.0	0.0	-3.7510 d
8.0000	-2.00000	2.00000	85.00000	3.7510	0.0	0.0	-3.7510 d
10.000	-2.00000	4.00000	85.00000	3.7510	0.0	0.0	-3.7510 d
12.000	-2.00000	6.00000	85.00000	3.7510	0.0	0.0	-3.7510 d
14.000	-2.00000	8.00000	85.00000	2.5535	-1.0828	-1.0828	-2.5535 d
16.000	-2.00000	10.00000	85.00000	1.6407	-1.6520	-1.6520	-1.6407 d
18.000	-2.00000	12.00000	85.00000	1.0574	-1.7681	-1.7681	-1.0574 d

d - Displacements include imported displacements.

Structure: Willow Cottages | Sub-structure: Retaining Wall (11)

Dist.	Coordinates			Displacements		Horizontal displacement along the Line	Horizontal displacement perpendicular to Line
	x	y	z	x	y		
	[m]	[m]	[m]	[mm]	[mm]	[mm]	[mm]
	0.0	0.00000	-10.00000	83.00000	0.23576	1.6403	0.94445
2.0264	1.81250	-9.09375	83.00000	0.028999	2.1806	1.0011	1.3617 d
4.0529	3.62500	-8.18750	83.00000	0.0	2.4843	1.1110	1.9374 d
6.0793	5.43750	-7.28125	83.00000	0.0	2.7584	1.2336	2.2220 d
8.1057	7.25000	-6.37500	83.00000	0.0	3.0326	1.3562	2.4672 d



31 Willoughby Road

Combined Movements & Damage Assessment

1st Stage - Short-term (with heave) - 5 mm limit on overall horizontal movements

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Dist.	Coordinates			Displacements		
	x	y	z	x	y	Horizontal displacement along the perpendicular
10.132	9.06250	-5.46875	83.00000	0.0	3.3067	1.4788
12.159	10.87500	-4.56250	83.00000	0.0	3.5808	1.6014
14.185	12.68750	-3.65625	83.00000	0.0	3.8550	1.7240
16.211	14.50000	-2.75000	83.00000	0.0	4.1291	1.8466
18.238	16.31250	-1.84375	83.00000	0.0	4.4033	1.9692
20.264	18.12500	-0.93750	83.00000	-0.58457	4.4979	1.4887
22.291	19.93750	-0.03125	83.00000	-2.5672	3.8508	-0.57404
24.317	21.75000	0.87500	83.00000	-2.5250	3.7875	-0.56461
26.344	23.56250	1.78125	83.00000	-4.0216	0.30159	-3.4622
28.370	25.37500	2.68750	83.00000	-3.6376	0.0	-3.2535
30.397	27.18750	3.59375	83.00000	-3.0893	0.0	-2.7631
32.423	29.00000	4.50000	83.00000	-2.5410	0.0	-2.2727
d - Displacements include imported displacements.						

Structure: Willow Cottages | Sub-structure: Rear Elevation

Dist.	Coordinates			Displacements		
	x	y	z	x	y	Horizontal displacement along the Line perpendicular to Line
[m]	[m]	[m]	[m]	[mm]	[mm]	[mm]
0.0	0.00000	-13.00000	83.00000	0.095453	0.88678	0.48196
2.0264	1.81250	-12.09375	83.00000	0.012852	1.2893	0.58811
4.0529	3.62500	-11.18750	83.00000	0.0	1.5768	0.70516
6.0793	5.43750	-10.28125	83.00000	0.0	1.8509	0.82776
8.1057	7.25000	-9.37500	83.00000	0.0	2.1251	0.95036
10.132	9.06250	-8.46875	83.00000	0.0	2.3992	1.0730
12.159	10.87500	-7.56250	83.00000	0.0	2.6733	1.1956
14.185	12.68750	-6.65625	83.00000	0.0	2.9475	1.3182
16.211	14.50000	-5.75000	83.00000	0.0	3.2216	1.4408
18.238	16.31250	-4.84375	83.00000	0.0	3.4958	1.5634
20.264	18.12500	-3.93750	83.00000	-0.11285	3.7351	1.5695
22.291	19.93750	-3.03125	83.00000	-2.0778	3.2436	-0.40784
24.317	21.75000	-2.12500	83.00000	-2.1061	3.1592	-0.47095
26.344	23.56250	-1.21875	83.00000	-2.2036	2.8268	-0.70675
28.370	25.37500	-0.31250	83.00000	-2.7009	1.4260	-1.7780
30.397	27.18750	0.59375	83.00000	-2.7336	0.57546	-2.1876
32.423	29.00000	1.50000	83.00000	-2.4645	0.13403	-2.1444
d - Displacements include imported displacements.						

Specific Building Damage Results - Vertical Displacements

Structure: No 33 | Sub-structure: Party Wall (1)

Dist.	Coordinates			Displacements
	x	y	z	z
[m]	[m]	[m]	[m]	[mm]

Vertical Offset 1				
0.0	2.05000	0.00000	84.00000	3.1854 d
1.9800	4.03000	0.00000	84.00000	3.8284 d
3.9600	6.01000	0.00000	84.00000	3.6210 d
5.9400	7.99000	0.00000	84.00000	3.5512 d
7.9200	9.97000	0.00000	84.00000	3.6162 d
9.9000	11.95000	0.00000	84.00000	4.4059 d
d - Displacements include imported displacements.				

Structure: No 33 | Sub-structure: Rear Elevation (2)

Dist.	Coordinates			Displacements
	x	y	z	z
[m]	[m]	[m]	[m]	[mm]

Vertical Offset 1				
0.0	12.00000	-0.05000	84.00000	2.8779 d
2.9000	12.00000	-2.95000	84.00000	0.44525 d
d - Displacements include imported displacements.				

Structure: No 33 | Sub-structure: Far Elevation (3)

Dist.	Coordinates			Displacements
	x	y	z	z
[m]	[m]	[m]	[m]	[mm]

Vertical Offset 1				
0.0	11.95000	-3.00000	84.00000	0.43678 d
2.2081	9.97500	-3.98750	84.00000	0.28736 d
4.4162	8.00000	-4.97500	84.00000	0.20909 d
6.6244	6.02500	-5.96250	84.00000	0.15849 d
8.8325	4.05000	-6.95000	84.00000	0.111799 d
d - Displacements include imported displacements.				

Structure: No 33 | Sub-structure: Far Eleavtion (4)

Dist.	Coordinates			Displacements
	x	y	z	z
[m]	[m]	[m]	[m]	[mm]

Vertical Offset 1				
0.0	3.95000	-7.00000	84.00000	0.11611 d
1.9000	2.05000	-7.00000	84.00000	0.10165 d
d - Displacements include imported displacements.				

Structure: No 33 | Sub-structure: Frontage (5)

Dist.	Coordinates			Displacements
	x	y	z	z
[m]	[m]	[m]	[m]	[mm]

Vertical Offset 1				
0.0	2.00000	-6.95000	84.00000	0.10227 d
2.3000	2.00000	-4.65000	84.00000	0.17167 d
4.6000	2.00000	-2.35000	84.00000	0.33645 d
6.9000	2.00000	-0.05000	84.00000	1.5869 d
d - Displacements include imported displacements.				

Structure: No 29 | Sub-structure: Party Wall (6)

Dist.	Coordinates			Displacements
	x	y	z	z
[m]	[m]	[m]	[m]	[mm]

Vertical Offset 1				
0.0	2.05000	6.00000	84.00000	2.8486 d
2.1134	4.16250	6.06250	84.00000	0.22729 d
4.2268	6.27500	6.12500	84.00000	-0.14824 d
6.3403	8.38750	6.18750	84.00000	-0.22904 d
8.4537	10.50000	6.25000	84.00000	-0.11368 d
10.567	12.61250	6.31250	84.00000	-1.6423 d



31 Willoughby Road

Combined Movements & Damage Assessment

1st Stage - Short-term (with heave) - 5 mm limit on overall horizontal movements

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Dist.	Coordinates			Displacements
	x	y	z	
[m]	[m]	[m]	[m]	[mm]
12.691	14.72500	6.37500	84.00000	2.5351 d
14.794	16.83750	6.43750	84.00000	3.3174 d
16.907	18.95000	6.50000	84.00000	4.4304 d
d - Displacements include imported displacements.				
Structure: No 29 Sub-structure: Rear Elevation (7)				
Dist.	Coordinates			Displacements
	x	y	z	
[m]	[m]	[m]	[m]	[mm]
Vertical Offset 1				
0.0	19.00000	6.55000	84.00000	3.3139 d
1.9667	19.00000	8.51667	84.00000	0.72411 d
3.9333	19.00000	10.48333	84.00000	0.35868 d
5.9000	19.00000	12.45000	84.00000	0.20594 d
d - Displacements include imported displacements.				
Structure: No 29 Sub-structure: Far Elevation (8)				
Dist.	Coordinates			Displacements
	x	y	z	
[m]	[m]	[m]	[m]	[mm]
Vertical Offset 1				
0.0	18.95000	12.50000	84.00000	0.20303 d
2.1134	16.83750	12.43750	84.00000	0.18266 d
4.2268	14.72500	12.37500	84.00000	0.14445 d
6.3403	12.61250	12.31250	84.00000	0.10093 d
8.4537	10.50000	12.25000	84.00000	0.063453 d
10.567	8.38750	12.18750	84.00000	0.040967 d
12.681	6.27500	12.12500	84.00000	0.035869 d
14.794	4.16250	12.06250	84.00000	0.042475 d
16.907	2.05000	12.00000	84.00000	0.049703 d
d - Displacements include imported displacements.				
Structure: No 29 Sub-structure: Frontage (9)				
Dist.	Coordinates			Displacements
	x	y	z	
[m]	[m]	[m]	[m]	[mm]
Vertical Offset 1				
0.0	2.00000	11.95000	84.00000	0.050404 d
1.9667	2.00000	9.98333	84.00000	0.088477 d
3.9333	2.00000	8.01667	84.00000	0.19708 d
5.9000	2.00000	6.05000	84.00000	1.2712 d
d - Displacements include imported displacements.				
Structure: Willoughby Road Sub-structure: Roadway (10)				
Dist.	Coordinates			Displacements
	x	y	z	
[m]	[m]	[m]	[m]	[mm]
Vertical Offset 1				
0.0	-2.00000	-6.00000	85.00000	0.076496 d
2.0000	-2.00000	-4.00000	85.00000	0.10876 d
4.0000	-2.00000	-2.00000	85.00000	0.15154 d
6.0000	-2.00000	0.00000	85.00000	0.19537 d
8.0000	-2.00000	2.00000	85.00000	0.21659 d
10.000	-2.00000	4.00000	85.00000	0.20208 d
12.000	-2.00000	6.00000	85.00000	0.15854 d
14.000	-2.00000	8.00000	85.00000	0.10684 d
16.000	-2.00000	10.00000	85.00000	0.066997 d
18.000	-2.00000	12.00000	85.00000	0.041626 d
d - Displacements include imported displacements.				
Structure: Willow Cottages Sub-structure: Retaining Wall (11)				
Dist.	Coordinates			Displacements
	x	y	z	
[m]	[m]	[m]	[m]	[mm]
Vertical Offset 1				
0.0	0.00000	-10.00000	83.00000	0.048608 d
2.0264	1.81250	-9.09375	83.00000	0.068243 d
4.0529	3.62500	-8.18750	83.00000	0.093086 d
6.0793	5.43750	-7.28125	83.00000	0.12334 d
8.1057	7.25000	-6.37500	83.00000	0.16024 d
10.132	9.06250	-5.46875	83.00000	0.20992 d
12.159	10.87500	-4.56250	83.00000	0.28820 d
14.185	12.68750	-3.65625	83.00000	0.42399 d
16.211	14.50000	-2.75000	83.00000	0.65407 d
18.238	16.31250	-1.84375	83.00000	1.0297 d
20.264	18.12500	-0.93750	83.00000	1.6517 d
22.291	19.93750	-0.03125	83.00000	1.6555 d
24.317	21.75000	0.87500	83.00000	1.2520 d
26.344	23.56250	1.78125	83.00000	0.70802 d
28.370	25.37500	2.68750	83.00000	0.42072 d
30.397	27.18750	3.59375	83.00000	0.26065 d
32.423	29.00000	4.50000	83.00000	0.16693 d
d - Displacements include imported displacements.				
Structure: Willow Cottages Sub-structure: Rear Elevation				
Dist.	Coordinates			Displacements
	x	y	z	
[m]	[m]	[m]	[m]	[mm]
Vertical Offset 1				
0.0	0.00000	-13.00000	83.00000	0.027625 d
2.0264	1.81250	-12.09375	83.00000	0.038829 d
4.0529	3.62500	-11.18750	83.00000	0.052764 d
6.0793	5.43750	-10.28125	83.00000	0.069823 d
8.1057	7.25000	-9.37500	83.00000	0.090729 d
10.132	9.06250	-8.46875	83.00000	0.11719 d
12.159	10.87500	-7.56250	83.00000	0.15259 d
14.185	12.68750	-6.65625	83.00000	0.20190 d
16.211	14.50000	-5.75000	83.00000	0.26939 d
18.238	16.31250	-4.84375	83.00000	0.35381 d
20.264	18.12500	-3.93750	83.00000	0.44118 d
22.291	19.93750	-3.03125	83.00000	0.49679 d
24.317	21.75000	-2.12500	83.00000	0.48670 d
26.344	23.56250	-1.21875	83.00000	0.41501 d
28.370	25.37500	-0.31250	83.00000	0.31662 d
30.397	27.18750	0.59375	83.00000	0.22761 d
32.423	29.00000	1.50000	83.00000	0.15977 d
d - Displacements include imported displacements.				
Specific Building Damage Results - All Segments				



31 Willoughby Road

Combined Movements & Damage Assessment

1st Stage - Short-term (with heave) - 5 mm limit on overall horizontal movements

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Dist.	Coordinates		Displacements								
	x [m]	y [m]	z [m]	z [mm]							
Structure: No 33 Sub-structure: Party Wall (1)											
Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category
[m] 0.0		[m]	[m]		[%]	[%]	[%]			[m]	
	1	0.0	4.5146	Sagging	0.010103	0.0	0.0093400	0.0	-324.76E-6	3572.4	0
	2	4.5146	5.3844	Hogging	0.0090980	0.0	0.0088413	0.0	-398.83E-6	4494.3	0
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.											(Negligible)
Structure: No 33 Sub-structure: Rear Elevation (2)											
Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category
[m] 0.0		[m]	[m]		[%]	[%]	[%]			[m]	
	1	0.0	2.9000	Hogging	0.0	0.030250	0.030250	-302.41E-6	838.60E-6	-	0
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.											(Negligible)
Structure: No 33 Sub-structure: Far Elevation (3)											
Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category
[m] 0.0		[m]	[m]		[%]	[%]	[%]			[m]	
	1	0.0	8.8320	Hogging	789.22E-6	0.0060500	0.0066717	-60.496E-6	67.666E-6	59443.	0
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.											(Negligible)
Structure: No 33 Sub-structure: Far Eleavtion (4)											
Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category
[m] 0.0		[m]	[m]		[%]	[%]	[%]			[m]	
	1	0.0	1.9000	None	0.0	0.0	0.0	0.0	7.6154E-6	-	0
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.											(Negligible)
Structure: No 33 Sub-structure: Frontage (5)											
Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category
[m] 0.0		[m]	[m]		[%]	[%]	[%]			[m]	
	1	0.0	0.70697	Sagging	0.0	0.030250	0.030250	-302.41E-6	-30.166E-6	34779.	0
	2	0.70697	6.1930	Hogging	0.011374	0.030250	0.036772	-302.41E-6	-543.49E-6	3970.3	0
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.											(Negligible)
Structure: No 29 Sub-structure: Party Wall (6)											
Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category
[m] 0.0		[m]	[m]		[%]	[%]	[%]			[m]	
	1	0.0	10.420	Hogging	0.023580	-155.26E-6	0.022431	7.6674E-6	0.0012403	1634.0	0
	2	10.420	3.2349	Sagging	0.0018484	0.0	0.0018147	0.0	-830.87E-6	23766.	0
	3	13.654	3.2525	Hogging	0.0035428	0.0	0.0035263	0.0	-526.61E-6	10131.	0
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.											(Negligible)
Structure: No 29 Sub-structure: Rear Elevation (7)											
Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category
[m] 0.0		[m]	[m]		[%]	[%]	[%]			[m]	
	1	0.0	5.3320	Hogging	0.027178	0.030229	0.044484	-302.20E-6	0.0013165	1419.0	0
	2	5.3320	0.56697	Sagging	0.0	0.030229	0.030229	-302.20E-6	77.643E-6	13343.	0
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.											(Negligible)
Structure: No 29 Sub-structure: Far Elevation (8)											
Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category
[m] 0.0		[m]	[m]		[%]	[%]	[%]			[m]	
	1	0.0	5.2991	Sagging	221.23E-6	0.0	210.82E-6	0.0	20.594E-6	212930.	0
	2	5.2991	1.0412	Sagging	0.0	0.0	0.0	0.0	20.594E-6	820570.	0
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.											(Negligible)
Structure: No 29 Sub-structure: Frontage (9)											
Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category
[m] 0.0		[m]	[m]		[%]	[%]	[%]			[m]	
	1	3.9333	1.9657	Hogging	0.0	0.030229	0.030229	-302.20E-6	-545.99E-6	3253.6	0
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.											(Negligible)



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Combined Movements & Damage Assessment

1st Stage - Short-term (with heave) - 5 mm limit on overall horizontal movements

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Vertical Offset from Line for Vertical Movement	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.											
Structure: Willoughby Road Sub-structure: Roadway (10)											
Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category
[m] 0.0		[m] 1 2.0000	[m] 1.5316	None	[%] 0.0	[%] -0.027994	[%] 0.0055988	280.02E-6	-21.396E-6	[m] 489820.	0
		2 3.5316	9.5232	Sagging	835.43E-6	-0.018557	0.0037114	541.68E-6	25.863E-6	130550.	(Negligible) 0
		3 13.055	0.94522	Sagging	0.0	-0.054139	0.010828	541.68E-6	25.863E-6	532540.	(Negligible) 0
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.											
Structure: Willow Cottages Sub-structure: Retaining Wall (11)											
Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category
[m] 0.0		[m] 1 6.0793	[m] 12.187	Hogging	[%] 0.0025208	[%] 0.0059809	[%] 0.0097271	237.19E-6	-307.04E-6	[m] 26179.	0
		2 18.266	6.9895	Sagging	0.0091494	-0.055354	0.011210	0.0014319	-307.04E-6	10427.	(Negligible) 0
		3 25.256	7.1663	Hogging	0.0030341	-0.0051141	0.0016101	0.0014319	268.83E-6	28397.	(Negligible) 0
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.											
Structure: Willow Cottages Sub-structure: Rear Elevation											
Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category
[m] 0.0		[m] 1 10.132	[m] 7.8238	Hogging	[%] 404.91E-6	[%] 0.0060500	[%] 0.0063370	-60.496E-6	-41.657E-6	[m] 244950.	0
		2 17.956	10.188	Sagging	0.0015764	-0.031456	0.0063240	976.71E-6	48.581E-6	73172.	(Negligible) 0
		3 28.144	4.2782	Hogging	271.67E-6	-0.011361	0.0022775	528.92E-6	48.581E-6	170170.	(Negligible) 0
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.											
Specific Building Damage Results - Critical Values for All Segments within Each Sub-Structure											
Structure: No 33 Sub-structure: Party Wall (1)											
Vertical Offset from Line for Vertical Movement Calculations	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category	
[m] 0.0	[%] 0.010103	[%] 0.0	-398.83E-6	[mm] 4.4055	[%] 0.0093400	0.0	-398.83E-6	[m] 4494.3	[m] 3572.4	0 (Negligible)	
Structure: No 33 Sub-structure: Rear Elevation (2)											
Vertical Offset from Line for Vertical Movement Calculations	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category	
[m] 0.0	[%] 0.0	[%] 0.030250	838.60E-6	[mm] 2.8779	[%] 0.030250	-302.41E-6	838.60E-6	[m] -	[m] -	0 (Negligible)	
Structure: No 33 Sub-structure: Far Elevation (3)											
Vertical Offset from Line for Vertical Movement Calculations	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category	
[m] 0.0	[%] 789.22E-6	[%] 0.0060500	67.666E-6	[mm] 0.43678	[%] 0.0066717	-60.496E-6	67.666E-6	[m] 59443.	[m] -	0 (Negligible)	
Structure: No 33 Sub-structure: Far Elevation (4)											
Vertical Offset from Line for Vertical Movement Calculations	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category	
[m] 0.0	[%] 0.0	[%] 0.0	7.6154E-6	[mm] 0.11611	[%] 0.0	0.0	7.6154E-6	[m] -	[m] -	0 (Negligible)	
Structure: No 33 Sub-structure: Frontage (5)											
Vertical Offset from Line for Vertical Movement Calculations	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category	
[m] 0.0	[%] 0.011374	[%] 0.030250	-543.49E-6	[mm] 1.5869	[%] 0.036772	-302.41E-6	-543.49E-6	[m] 3970.3	[m] 34779.	0 (Negligible)	
Structure: No 29 Sub-structure: Party Wall (6)											
Vertical Offset from Line for Vertical Movement Calculations	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category	



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Combined Movements & Damage Assessment

1st Stage - Short-term (with heave) - 5 mm limit on overall horizontal movements

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Made by MP	Date 24-Jan-2018	Checked

Structure Name	Parameter	Critical Sub-Structure	Critical Segment	Start	End	Curvature	Max Slope	Max Settlement	Max Tensile Strain	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category
(Sagging)												
Willow Cottages	Max Slope	Rear Elevation	2	17.956	28.144	Sagging	48.581E-6	0.49645	0.0063240	-	73172.0	0 (Negligible)
	Max Settlement	Rear Elevation	2	17.956	28.144	Sagging	48.581E-6	0.49645	0.0063240	-	73172.0	0 (Negligible)
	Max Tensile Strain	Rear Elevation	1	10.132	17.956	Hogging	41.657E-6	0.34206	0.0063370	244950.	-	0 (Negligible)
	Min Radius of Curvature (Hogging)	Rear Elevation	3	28.144	32.422	Hogging	48.581E-6	0.32760	0.0022775	170170.	-	0 (Negligible)
	Min Radius of Curvature (Sagging)	Rear Elevation	2	17.956	28.144	Sagging	48.581E-6	0.49645	0.0063240	-	73172.0	0 (Negligible)

Two-Stage Underpinning:
Stage 2 - Short Term Movement (Contour Plots)
& Tabular output of related damage assessment

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Analysis Options

Analysis: Boussinesq
Global Poisson's ratio: 0.50
Maximum allowable ratio between values of E: 1.5
Horizontal rigid boundary level: 35.00 [m OD]
Displacements at load centroids: Yes

Soil ProfilesSoil Profile 1

Layer	Level at top	Number of intermediate displacement levels	Youngs Modulus	Poissons ratio	Non-linear curve
	[mOD]		Top [kN/m ²]	Btm [kN/m ²]	
1	85.500	3	7500.0	7500.0	0.50000 None
2	82.500	1	15000.	15000.	0.50000 None
3	82.000	40	20000.	100000.	0.50000 None

Soil Zones

Zone	Name	X coordinates min max	Y coordinates min max	Profile
		[m] [m]	[m] [m]	
1	Soil Zone 1	-20.00000 40.00000	-20.00000 26.00000	Soil Profile 1

Load Data

Load ref.	Name	Shape	Orientation of Plane	Centre of load (Global)			Load position Angle of local x from	Width x or Radius	Length y	Polygon Coordinates	Rectangle tolerance	Number of rectangles	Normal (local z)	Load value		
				X	Y	Z (level)								Tangential (local x)	Tangential (local y)	
1	Basement Excavation	Polygonal	Horizontal	[m] N/A	[m] N/A	81.40000	[Degrees] N/A	[m] N/A	[m] N/A	[m] N/A (3,1) (18,1) (20,2.3) (20,5.5) (12,5.25) (12,4) (3,4)	{}	10.000	3	[kN/m²] -15.000	[kN/m²] N/A	[kN/m²] N/A
2	Existing Cellar	Polygonal	Horizontal	N/A	N/A	81.40000	N/A	N/A	N/A	N/A (3,4) (12,4) (12,5.25) (3,5)		10.000	1	-10.000	N/A	N/A
3	Underpinning	Polygonal	Horizontal	N/A	N/A	81.40000	N/A	N/A	N/A	N/A (2,6) (2,0) (12,0) (12,1) (3,1) (3,6)		10.000	2	60.000	N/A	N/A
4	Underpinning	Polygonal	Horizontal	N/A	N/A	81.40000	N/A	N/A	N/A	N/A (12,0) (18,0) (21,2) (21,6.5) (19,6.5) (19,5.5) (20,5.5) (20,2.3) (18,1) (12,1)		10.000	10	100.00	N/A	N/A
5	Underpinning	Polygonal	Horizontal	N/A	N/A	81.40000	N/A	N/A	N/A	N/A (19,6.5) (12,6.25) (12,5.25) (19,5.5)		10.000	1	60.000	N/A	N/A
6	Underpinning	Polygonal	Horizontal	N/A	N/A	81.40000	N/A	N/A	N/A	N/A (3,6) (12,6.25) (12,5.25) (3,5)		10.000	1	50.000	N/A	N/A

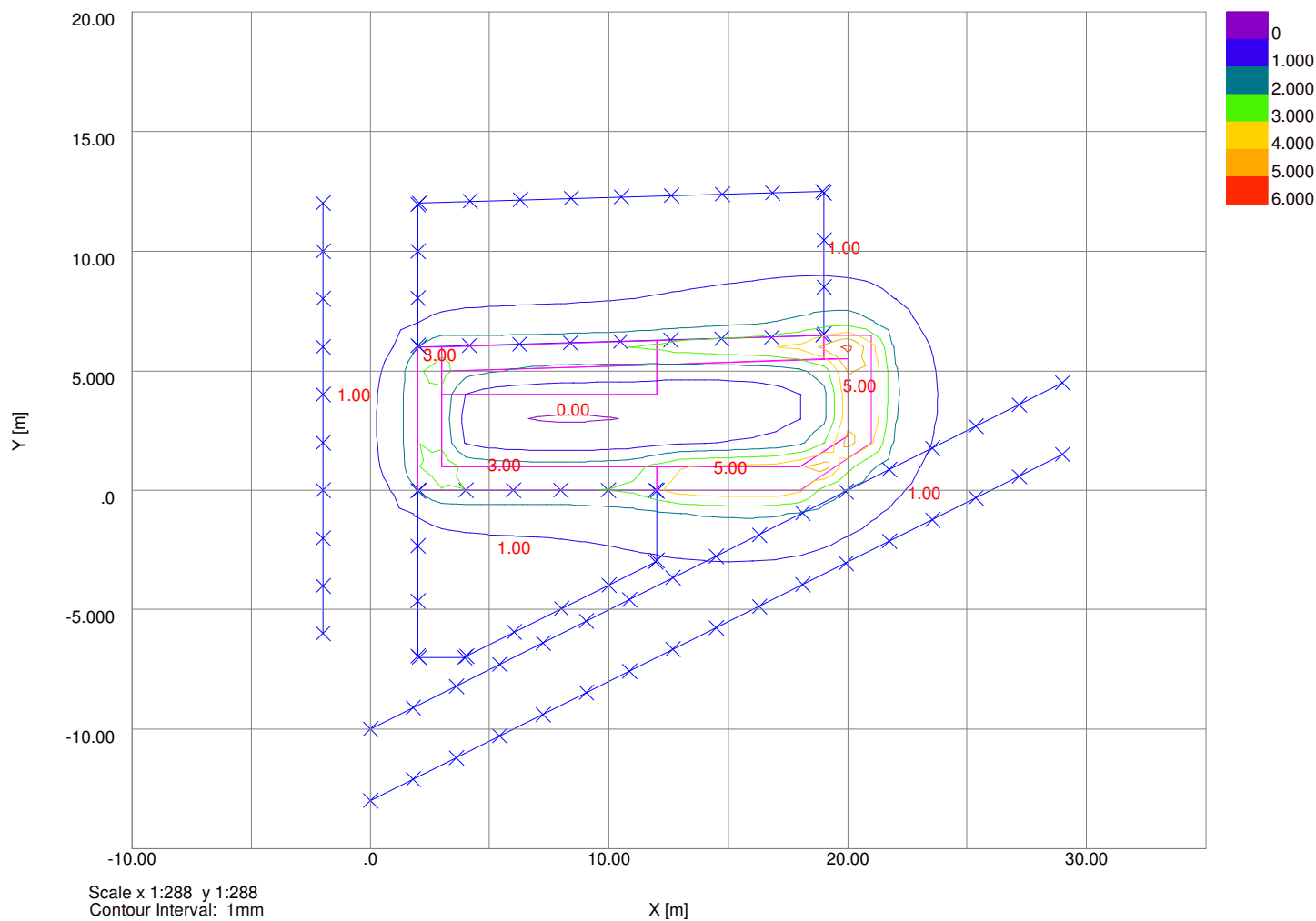
Polygonal Loads' Rectangles

No.	Centre of load X	Y	Angle of local x from global X [Degrees]	Width x [m]	Depth y [m]
Load 1 : Basement Excavation (Edge 1 optimal)					
1	7.50000	2.50000	0.0	9.0000	3.0000
2	15.00000	3.17188	0.0	6.0000	4.3438
3	19.00000	3.55938	0.0	2.0000	3.8187
Load 2 : Existing Cellar (Edge 1 optimal)					
1	7.50000	4.56250	0.0	9.0000	1.1250
Load 3 : Underpinning (Edge 1 optimal)					
1	2.50000	3.50000	-90.000	5.0000	1.0000
2	7.00000	0.50000	-90.000	1.0000	10.000
Load 4 : Underpinning (Edge 1 optimal)					
1	15.00000	0.50000	0.0	6.0000	1.0000
2	18.14286	0.59405	0.0	0.28571	0.99762
3	18.42857	0.78214	0.0	0.28571	0.99286
4	18.71429	0.97024	0.0	0.28571	0.98810
5	19.00000	1.15833	0.0	0.28571	0.98333
6	19.28571	1.34643	0.0	0.28571	0.97857
7	19.57143	1.53452	0.0	0.28571	0.97381
8	19.85714	1.72262	0.0	0.28571	0.96905
9	20.50000	4.08333	0.0	1.0000	4.8333
10	19.50000	6.00000	0.0	1.0000	1.0000
Load 5 : Underpinning (Edge 1 optimal)					
1	15.50000	5.87500	-177.95	6.9688	0.99936
Load 6 : Underpinning (Edge 2 optimal)					
1	7.50000	5.62500	1.5911	8.9757	0.99961

Displacement Data

Ref.	Type	Name	Direction of Extrusion	First point X [m]	Y [m]	Z (level) [m]	Line/Line for extrusion Second point X [m]	Y [m]	Z (level) [m]	No. of intrvl across extrusion/line	Extrusion Depth	No. of intrvl along extrusion	Calculate	Show Detailed results
1	Grid	Grid 1	Global X	-20.00000	-20.00000	85.50000	N/A	26.00000	85.50000	46	60.00000	60	Yes	No
2	Grid	Grid 2	Global X	-20.00000	-20.00000	84.00000	N/A	26.00000	84.00000	46	60.00000	60	Yes	No
3	Line	Line 1	N/A	2.05000	0.00000	84.00000	11.95000	0.00000	84.00000	5	N/A	N/A	Yes	No
4	Line	Line 2	N/A	12.00000	-0.05000	84.00000	12.00000	-2.95000	84.00000	1	N/A	N/A	Yes	No
5	Line	Line 3	N/A	11.95000	-3.00000	84.00000	4.05000	-6.95000	84.00000	4	N/A	N/A	Yes	No
6	Line	Line 4	N/A	3.95000	-7.00000	84.00000	2.05000	-7.00000	84.00000	1	N/A	N/A	Yes	No
7	Line	Line 5	N/A	2.00000	-6.95000	84.00000	2.00000	-0.05000	84.00000	3	N/A	N/A	Yes	No
8	Line	Line 6	N/A	2.05000	6.00000	84.00000	18.95000	6.50000	84.00000	8	N/A	N/A	Yes	No
9	Line	Line 7	N/A	19.00000	6.55000	84.00000	19.00000	12.45000	84.00000	3	N/A	N/A	Yes	No
10	Line	Line 8	N/A	18.95000	12.50000	84.00000	2.05000	12.00000	84.00000	8	N/A	N/A	Yes	No
11	Line	Line 9	N/A	2.00000	11.95000	84.00000	2.00000	6.05000	84.00000	3	N/A	N/A	Yes	No
12	Line	Line 10	N/A	-2.00000	-6.00000	85.00000	-2.00000	12.00000	85.00000	9	N/A	N/A	Yes	No
13	Line	Line 11	N/A	0.00000	-10.00000	83.00000	29.00000	4.50000	83.00000	16	N/A	N/A	Yes	No
14	Line	Line 12	N/A	0.00000	-13.00000	83.00000	29.00000	1.50000	83.00000	16	N/A	N/A	Yes	No

Settlement Contours : Grid 1 at 85.5000m



31 Willoughby Road
Combined Movements & Damage Assessment
2nd Stage - Short-term (no heave) - 5 mm limit on overall horizontal movements

Problem Type

Problem Type : Tunnelling and Embedded Wall Excavations

Displacement Data

Type	Name	Direction of extrusion	Point/Line/Line for extrusion						No. of intervals across extrusion/line	Extrusion depth	No. of intervals along extrusion	Calculate	Surface type for tunnels	
			First point			Second point								
			X	Y	Z (level)	X	Y	Z (level)						
			[m]	[m]		[m]								
Grid	Grid 1	Global X	-20.00000	-20.00000	85.50000	-	26.00000	85.50000	-	46	60.00000	60	Yes	Surface
Grid	Grid 2	Global X	-20.00000	-20.00000	84.00000	-	26.00000	84.00000	-	46	60.00000	60	Yes	Surface
Line	Line 1	-	2.05000	0.00000	84.00000	11.95000	0.00000	84.00000	-	5	-	-	Yes	Surface
Line	Line 2	-	12.00000	-0.05000	84.00000	12.00000	-2.95000	84.00000	-	1	-	-	Yes	Surface
Line	Line 3	-	11.95000	-3.00000	84.00000	4.05000	-6.95000	84.00000	-	4	-	-	Yes	Surface
Line	Line 4	-	3.95000	-7.00000	84.00000	2.05000	-7.00000	84.00000	-	1	-	-	Yes	Surface
Line	Line 5	-	2.00000	-6.95000	84.00000	2.00000	-0.05000	84.00000	-	3	-	-	Yes	Surface
Line	Line 6	-	2.05000	6.00000	84.00000	18.95000	6.50000	84.00000	-	8	-	-	Yes	Surface
Line	Line 7	-	19.00000	6.55000	84.00000	19.00000	12.45000	84.00000	-	3	-	-	Yes	Surface
Line	Line 8	-	18.95000	12.50000	84.00000	2.05000	12.00000	84.00000	-	8	-	-	Yes	Surface
Line	Line 9	-	2.00000	11.95000	84.00000	2.00000	6.05000	84.00000	-	3	-	-	Yes	Surface
Line	Line 10	-	2.00000	-6.00000	85.00000	-2.00000	85.00000	85.00000	-	3	-	-	Yes	Surface
Line	Line 11	-	0.00000	-10.00000	83.00000	29.00000	4.50000	83.00000	-	16	-	-	Yes	Surface
Line	Line 12	-	0.00000	-13.00000	83.00000	29.00000	1.50000	83.00000	-	16	-	-	Yes	Surface

Vertical Ground Movement Curves (Excavations)

Curve Name: No vertical ground movement

Coordinates: [Distance from wall / wall depth or max. excavation depth (x), Depth / wall depth or max. excavation depth (y), Settlement / wall depth or max. excavation depth (z) (%)
[0.000,0.000,0.000] [1.000,0.000,0.000] [0.000,1.000,0.000] [1.000,1.000,0.000]

Curve Fitting: Polynomial

Method:

x Order: 1

y Order: 0

Polynomial: $z = 0.00x + 0.0$

Coeff. of -2147483648.E+2147483647

Determination:

Horizontal Ground Movement Curves (Excavations)

```
Curve Name:      GEA Curve for 5 mm of horizontal deflection (after CIRIA 580 Fig. 2.11(a))
Coordinates:     [Distance from wall / wall depth or max. excavation depth (x), Depth / wall
                  depth or max. excavation depth (y), Horizontal movement / wall depth or max.
                  excavation depth (z) (%)
                  [0.000,0.000,0.121][4.000,0.000,0.000]
Curve Fitting    Polynomial
Method:
x Order:         1
y Order:         0
Polynomial: z =  -3.03E-2x + 1.21E-1
Coeff. of        1.00
Determination:
```

Polygonal Excavations

Excavation Name:	New Excavation
Surface level [m]:	85.500
Contribution:	Positive
Enabled:	Yes
Surface movement curves which are selected are applied between surface and [m]:	81.400

Corner	x	y	Base Level [m]	Stiffened	Previous Side			Next Side		
					d	pl	p2*	d	pl	p2*
	[m]	[m]	[m]		[d]	[pl]	[p2*]	[d]	[pl]	[p2*]
1	2.0000	0.0	81.400	No	-	-	-	-	-	-
2	18.000	0.0	81.400	No	-	-	-	-	-	-
3	21.000	2.0000	81.400	No	-	-	-	-	-	-
4	21.000	6.5000	81.400	No	-	-	-	-	-	-
5	2.0000	6.0000	81.400	No	-	-	-	-	-	-

Side	Corner 1		Corner 2		Vertical	Ground Movement Curve	
	x [m]	y [m]	x [m]	y [m]			Horizontal
1	2.0000	0.0	18.000	0.0	No vertical ground movement	GEA Curve for 5 mm of horizontal deflection (after CIRA 580 Fig. 2.11(a))	
2	18.000	0.0	21.000	2.0000	No vertical ground movement	GEA Curve for 5 mm of horizontal deflection (after CIRA 580 Fig. 2.11(a))	
3	21.000	2.0000	21.000	6.5000	No vertical ground movement	GEA Curve for 5 mm of horizontal deflection (after CIRA 580 Fig. 2.11(a))	
4	21.000	6.5000	2.0000	6.0000	No vertical ground movement	GEA Curve for 5 mm of horizontal deflection (after CIRA 580 Fig. 2.11(a))	
5	2.0000	6.0000	2.0000	0.0	No vertical ground movement	GEA Curve for 5 mm of horizontal deflection (after CIRA 580 Fig. 2.11(a))	

Damage Category Strains

Name	0 (Negligible) to 1 (Very Slight)	1 (Very Slight) to 2 (Slight)	2 (Slight) to 3 (Moderate)	3 (Moderate) to 4 (Severe)
Burland Strain Limits	0.0	500.00E-6	750.00E-6	0.0015000

Specific Structures - Geometry

Structure Name	Sub-Structure Name	Displacement Line	Start Distance Along Line	End Distance Along Line	Vertical Offsets from Line for Vertical Movement Calculations	Vertical Displacement Limit Sensitivity	Damage Category	Strains	Poisson's Ratio	E/G
No 33	Party Wall (1)	Line 1	[m] 0.00000	[m] 9.83900	[m] 0.0	[mm] 0.10000	Burland	Strain Limits	0.20000	2.6000
No 33	Rear Elevation (2)	Line 2	0.00000	2.90000	0.0	0.10000	Burland	Strain Limits	0.20000	2.6000
No 33	Far Elevation (3)	Line 3	0.00000	8.83200	0.0	0.10000	Burland	Strain Limits	0.20000	2.6000
No 33	Far Elevation	Line 4	0.00000	1.90000	0.0	0.10000	Burland	Strain Limits	0.20000	2.6000

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Structure Name	Sub-Structure Name	Displacement Line	Start Distance Along Line	End Distance Along Line	Vertical Offsets from Line for Vertical	Vertical Displacement Limit	Damage Category	Strains	Poisson's Ratio	E/G
No 33	Frontage (5)	Line 5	0.00000	6.90000	0.0	0.10000	Burland Strain Limits	0.20000	2.6000	
No 29	Party Wall (6)	Line 6	0.00000	16.90700	0.0	0.10000	Burland Strain Limits	0.20000	2.6000	
No 29	Rear Elevation (7)	Line 7	0.00000	5.89900	0.0	0.10000	Burland Strain Limits	0.20000	2.6000	
No 29	Far Elevation (8)	Line 8	0.00000	16.90700	0.0	0.10000	Burland Strain Limits	0.20000	2.6000	
No 29	Frontage (9)	Line 9	0.00000	5.89900	0.0	0.10000	Burland Strain Limits	0.20000	2.6000	
Willoughby Road	Roadway (10)	Line 10	0.00000	18.00000	0.0	0.10000	Burland Strain Limits	0.20000	2.6000	
Willow Cottages	Retaining Wall (11)	Line 11	0.00000	32.42200	0.0	0.10000	Burland Strain Limits	0.20000	2.6000	
Willow Cottages	Rear Elevation	Line 12	0.00000	32.42200	0.0	0.10000	Burland Strain Limits	0.20000	2.6000	

Specific Structures - Bending Parameters

Structure Name	Sub-Structure Name	Height	Default Properties	Hogging			Sagging		
				2nd Moment of Area (per unit width)	Distance of Bending Strain from N.A.	Distance of N.A. from Edge of Beam in Tension	2nd Moment of Area (per unit width)	Distance of Bending Strain from N.A.	Distance of N.A. from Edge of Beam in Tension
No 33	Party Wall (1)	[m]	8.0000 Yes	[m ⁴]	[m]	[m]	[m ⁴]	[m]	[m]
No 33	Rear Elevation (2)	8.0000	Yes	170.67	8.0000	8.0000	42.667	4.0000	4.0000
No 33	Far Elevation (3)	8.0000	Yes	170.67	8.0000	8.0000	42.667	4.0000	4.0000
No 33	Far Elevation (4)	8.0000	Yes	170.67	8.0000	8.0000	42.667	4.0000	4.0000
No 33	Frontage (5)	8.0000	Yes	170.67	8.0000	8.0000	42.667	4.0000	4.0000
No 29	Party Wall (6)	12.000	Yes	576.00	12.000	12.000	144.00	6.0000	6.0000
No 29	Rear Elevation (7)	12.000	Yes	576.00	12.000	12.000	144.00	6.0000	6.0000
No 29	Far Elevation (8)	12.000	Yes	576.00	12.000	12.000	144.00	6.0000	6.0000
No 29	Frontage (9)	12.000	Yes	576.00	12.000	12.000	144.00	6.0000	6.0000
Willoughby Road	Roadway (10)	0.50000	Yes	0.041667	0.50000	0.50000	0.010417	0.25000	0.25000
Willow Cottages	Retaining Wall (11)	2.5000	Yes	5.2083	2.5000	2.5000	1.3021	1.2500	1.2500
Willow Cottages	Rear Elevation	8.0000	Yes	170.67	8.0000	8.0000	42.667	4.0000	4.0000

Building Segment Combinations

Structure Name	Sub-Structure Name	Vertical Offset from Line for Vertical Movement Calculations	Segment Start	Length	Curvature	Combined Segment
No structures have segments combined.						

Utility Strain Calculation Options

Neglect beneficial contribution of axial strains : No

Warnings

- Sub-structure 6 crosses at least one excavation. Its building damage results in that area should be treated with caution.

Errors

None

Specific Building Damage Results - Horizontal Displacements

Structure: No 33 | Sub-structure: Party Wall (1)

Dist.	Coordinates			Displacements		
	x	y	z	x	y	
				Horizontal displacement along the Line	Horizontal displacement perpendicular to Line	
	[m]	[m]	[m]	[mm]	[mm]	
0.0	2.05000	0.00000	84.00000	0.0	4.9610	d
1.9800	4.03000	0.00000	84.00000	0.0	4.9610	d
3.9600	6.01000	0.00000	84.00000	0.0	4.9610	d
5.9400	7.99000	0.00000	84.00000	0.0	4.9610	d
7.9200	9.97000	0.00000	84.00000	0.0	4.9610	d
9.9000	11.95000	0.00000	84.00000	0.0	4.9610	d

d - Displacements include imported displacements.

Structure: No 33 | Sub-structure: Rear Elevation (2)

Dist.	Coordinates			Displacements		
	x	y	z	x	y	
				Horizontal displacement along the Line	Horizontal displacement perpendicular to Line	
	[m]	[m]	[m]	[mm]	[mm]	
0.0	12.00000	-0.05000	84.00000	0.0	4.9459	0.0 d
2.9000	12.00000	-2.95000	84.00000	0.0	4.0686	0.0 d

d - Displacements include imported displacements.

Structure: No 33 | Sub-structure: Far Elevation (3)

Dist.	Coordinates			Displacements		
	x	y	z	x	y	
				Horizontal displacement along the Line	Horizontal displacement perpendicular to Line	
	[m]	[m]	[m]	[mm]	[mm]	
0.0	11.95000	-3.00000	84.00000	0.0	4.0535	-3.6256 d
2.2081	9.97500	-3.98750	84.00000	0.0	3.7548	-3.3584 d
4.4162	8.00000	-4.97500	84.00000	0.0	3.4561	-3.0912 d
6.6244	6.02500	-5.96250	84.00000	0.0	3.1573	-2.8240 d
8.8325	4.05000	-6.95000	84.00000	0.0	2.8586	-2.5568 d

d - Displacements include imported displacements.

Structure: No 33 | Sub-structure: Far Elevation (4)

Dist.	Coordinates			Displacements		
	x	y	z	x	y	
				Horizontal displacement	Horizontal displacement	

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along the Line		perpendicular to Line	
[m]	[mm]	[m]	[mm]
0.0	3.95000	-7.00000	84.00000
1.9000	2.05000	-7.00000	84.00000

d - Displacements include imported displacements.

Structure: No 33 | Sub-structure: Frontage (5)

Dist.	Coordinates		Displacements	
x	y	z	Horizontal displacement along the Line	Horizontal displacement perpendicular to Line
[m]	[m]	[m]	[mm]	[mm]
0.0	2.00000	-6.95000	84.00000	0.0
2.3000	2.00000	-4.45000	84.00000	0.0
4.6000	2.00000	-2.35000	84.00000	0.0
6.9000	2.00000	-0.05000	84.00000	0.0

d - Displacements include imported displacements.

Structure: No 29 | Sub-structure: Party Wall (6)

Dist.	Coordinates		Displacements	
x	y	z	Horizontal displacement along the Line	Horizontal displacement perpendicular to Line
[m]	[m]	[m]	[mm]	[mm]
0.0	2.05000	6.00000	84.00000	0.0
2.1134	4.16250	6.06250	84.00000	0.13046
4.2268	6.27500	6.12500	84.00000	0.13041
6.3403	8.38750	6.18750	84.00000	0.13035
8.4537	10.50000	6.25000	84.00000	0.13030
10.567	12.61250	6.31250	84.00000	0.13024
12.681	14.72500	6.37500	84.00000	0.13019
14.794	16.83750	6.43750	84.00000	0.13013
16.907	18.95000	6.50000	84.00000	0.13008

d - Displacements include imported displacements.

Structure: No 29 | Sub-structure: Rear Elevation (7)

Dist.	Coordinates		Displacements	
x	y	z	Horizontal displacement along the Line	Horizontal displacement perpendicular to Line
[m]	[m]	[m]	[mm]	[mm]
0.0	19.00000	6.55000	84.00000	0.12969
1.9667	19.00000	8.51667	84.00000	0.11405
3.9333	19.00000	10.48333	84.00000	0.098401
5.9000	19.00000	12.45000	84.00000	0.082756

d - Displacements include imported displacements.

Structure: No 29 | Sub-structure: Far Elevation (8)

Dist.	Coordinates		Displacements	
x	y	z	Horizontal displacement along the Line	Horizontal displacement perpendicular to Line
[m]	[m]	[m]	[mm]	[mm]
0.0	18.95000	12.00000	84.00000	0.082248
2.1134	16.83750	12.43750	84.00000	0.082403
4.2268	14.72500	12.37500	84.00000	0.082458
6.3403	12.61250	12.31250	84.00000	0.082513
8.4537	10.50000	12.25000	84.00000	0.082568
10.567	8.38750	12.18750	84.00000	0.082623
12.681	6.27500	12.12500	84.00000	0.082678
14.794	4.16250	12.06250	84.00000	0.082733
16.907	2.05000	12.00000	84.00000	0.082788

d - Displacements include imported displacements.

Structure: No 29 | Sub-structure: Frontage (9)

Dist.	Coordinates		Displacements	
x	y	z	Horizontal displacement along the Line	Horizontal displacement perpendicular to Line
[m]	[m]	[m]	[mm]	[mm]
0.0	2.00000	11.95000	84.00000	0.083175
1.9667	2.00000	9.98333	84.00000	0.098820
3.9333	2.00000	8.01667	84.00000	0.11446
5.9000	2.00000	6.05000	84.00000	0.13011

d - Displacements include imported displacements.

Structure: Willoughby Road | Sub-structure: Roadway (10)

Dist.	Coordinates		Displacements	
x	y	z	Horizontal displacement along the Line	Horizontal displacement perpendicular to Line
[m]	[m]	[m]	[mm]	[mm]
0.0	-2.00000	-6.00000	85.00000	1.0405
2.0000	-2.00000	-4.00000	85.00000	1.6249
4.0000	-2.00000	-2.00000	85.00000	2.5432
6.0000	-2.00000	0.00000	85.00000	3.7510
8.0000	-2.00000	2.00000	85.00000	3.7510
10.000	-2.00000	4.00000	85.00000	3.7510
12.000	-2.00000	6.00000	85.00000	3.7510
14.000	-2.00000	8.00000	85.00000	2.5535
16.000	-2.00000	10.00000	85.00000	1.6520
18.000	-2.00000	12.00000	85.00000	1.0574

d - Displacements include imported displacements.

Structure: Willow Cottages | Sub-structure: Retaining Wall (11)

Dist.	Coordinates		Displacements	
x	y	z	Horizontal displacement along the Line	Horizontal displacement perpendicular to Line
[m]	[m]	[m]	[mm]	[mm]
0.0	0.00000	-10.00000	83.00000	0.23576
2.0264	1.81250	-9.09375	83.00000	0.028999
4.0529	3.62500	-8.18750	83.00000	0.0
6.0793	5.43750	-7.28125	83.00000	0.0
8.1057	7.25000	-6.37500	83.00000	0.0



31 Willoughby Road

Combined Movements & Damage Assessment

2nd Stage - Short-term (no heave) - 5 mm limit on overall horizontal movements

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Dist.	Coordinates			Displacements		
	x	y	z	x	y	Horizontal displacement along the Horizontal displacement perpendicular
10.132	9.06250	-5.46875	83.00000	0.0	3.3067	1.4788
12.159	10.87500	-4.56250	83.00000	0.0	3.5808	1.6014
14.185	12.68750	-3.65625	83.00000	0.0	3.8550	1.7240
16.211	14.50000	-2.75000	83.00000	0.0	4.1291	1.8466
18.238	16.31250	-1.84375	83.00000	0.0	4.4033	1.9692
20.264	18.12500	-0.93750	83.00000	-0.58457	4.4979	1.4887
22.291	19.93750	-0.03125	83.00000	-2.5672	3.8508	-0.57404
24.317	21.75000	0.87500	83.00000	-2.5250	3.7875	-0.56461
26.344	23.56250	1.78125	83.00000	-4.0216	0.30159	-3.4622
28.370	25.37500	2.68750	83.00000	-3.6376	0.0	-3.2535
30.397	27.18750	3.59375	83.00000	-3.0893	0.0	-2.7631
32.423	29.00000	4.50000	83.00000	-2.5410	0.0	-2.2727
d - Displacements include imported displacements.						

Structure: Willow Cottages | Sub-structure: Rear Elevation

Dist.	Coordinates			Displacements		
	x	y	z	x	y	Horizontal displacement along the Horizontal displacement perpendicular to Line
[m]	[m]	[m]	[m]	[mm]	[mm]	[mm]
0.0	0.00000	-13.00000	83.00000	0.095453	0.88678	0.48196
2.0264	1.81250	-12.09375	83.00000	0.012852	1.2893	0.58811
4.0529	3.62500	-11.18750	83.00000	0.0	1.5768	0.70516
6.0793	5.43750	-10.28125	83.00000	0.0	1.8509	0.82776
8.1057	7.25000	-9.37500	83.00000	0.0	2.1251	0.95036
10.132	9.06250	-8.46875	83.00000	0.0	2.3992	1.0730
12.159	10.87500	-7.56250	83.00000	0.0	2.6733	1.1956
14.185	12.68750	-6.65625	83.00000	0.0	2.9475	1.3182
16.211	14.50000	-5.75000	83.00000	0.0	3.2216	1.4408
18.238	16.31250	-4.84375	83.00000	0.0	3.4958	1.5634
20.264	18.12500	-3.93750	83.00000	-0.11285	3.7351	1.5695
22.291	19.93750	-3.03125	83.00000	-2.0778	3.2436	-0.40784
24.317	21.75000	-2.12500	83.00000	-2.1061	3.1592	-0.47095
26.344	23.56250	-1.21875	83.00000	-2.2036	2.8268	-0.70675
28.370	25.37500	-0.31250	83.00000	-2.7009	1.4260	-1.7780
30.397	27.18750	0.59375	83.00000	-2.7336	0.57546	-2.1876
32.423	29.00000	1.50000	83.00000	-2.4645	0.13403	-2.1444
d - Displacements include imported displacements.						

Specific Building Damage Results - Vertical Displacements

Structure: No 33 | Sub-structure: Party Wall (1)

Dist.	Coordinates			Displacements
	x	y	z	z
[m]	[m]	[m]	[m]	[mm]

Vertical Offset 1				
0.0	2.05000	0.00000	84.00000	2.1611 d
1.9800	4.03000	0.00000	84.00000	2.9874 d
3.9600	6.01000	0.00000	84.00000	2.9222 d
5.9400	7.99000	0.00000	84.00000	2.9260 d
7.9200	9.97000	0.00000	84.00000	3.0346 d
9.9000	11.95000	0.00000	84.00000	3.7737 d
d - Displacements include imported displacements.				

Structure: No 33 | Sub-structure: Rear Elevation (2)

Dist.	Coordinates			Displacements
	x	y	z	z
[m]	[m]	[m]	[m]	[mm]

Vertical Offset 1				
0.0	12.00000	-0.05000	84.00000	3.6508 d
2.9000	12.00000	-2.95000	84.00000	0.32695 d
d - Displacements include imported displacements.				

Structure: No 33 | Sub-structure: Far Elevation (3)

Dist.	Coordinates			Displacements
	x	y	z	z
[m]	[m]	[m]	[m]	[mm]

Vertical Offset 1				
0.0	11.95000	-3.00000	84.00000	0.91201 d
2.2081	9.97500	-3.98750	84.00000	0.65270 d
4.4162	8.00000	-4.97500	84.00000	0.48701 d
6.6244	6.02500	-5.96250	84.00000	0.36441 d
8.8325	4.05000	-6.95000	84.00000	0.26624 d
d - Displacements include imported displacements.				

Structure: No 33 | Sub-structure: Far Eleavtion (4)

Dist.	Coordinates			Displacements
	x	y	z	z
[m]	[m]	[m]	[m]	[mm]

Vertical Offset 1				
0.0	3.95000	-7.00000	84.00000	0.26183 d
1.9000	2.05000	-7.00000	84.00000	0.22462 d
d - Displacements include imported displacements.				

Structure: No 33 | Sub-structure: Frontage (5)

Dist.	Coordinates			Displacements
	x	y	z	z
[m]	[m]	[m]	[m]	[mm]

Vertical Offset 1				
0.0	2.00000	-6.95000	84.00000	0.22573 d
2.3000	2.00000	-4.65000	84.00000	0.36122 d
4.6000	2.00000	-2.35000	84.00000	0.64878 d
6.9000	2.00000	-0.05000	84.00000	1.9859 d
d - Displacements include imported displacements.				

Structure: No 29 | Sub-structure: Party Wall (6)

Dist.	Coordinates			Displacements
	x	y	z	z
[m]	[m]	[m]	[m]	[mm]

Vertical Offset 1				
0.0	2.05000	6.00000	84.00000	2.0934 d
2.1134	4.16250	6.06250	84.00000	2.5804 d
4.2268	6.27500	6.12500	84.00000	2.4500 d
6.3403	8.38750	6.18750	84.00000	2.4364 d
8.4537	10.50000	6.25000	84.00000	2.4762 d
10.567	12.61250	6.31250	84.00000	2.7524 d



31 Willoughby Road
Combined Movements & Damage Assessment
2nd Stage - Short-term (no heave) - 5 mm limit on overall horizontal movements

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Dist.	Coordinates			Displacements
	x	y	z	
[m]	[m]	[m]	[m]	[mm]
12.691	14.72500	6.37500	84.00000	2.9526 d
14.794	16.83750	6.43750	84.00000	3.1927 d
16.907	18.95000	6.50000	84.00000	4.0094 d
d - Displacements include imported displacements.				
Structure: No 29 Sub-structure: Rear Elevation (7)				
Dist.	Coordinates			Displacements
	x	y	z	
[m]	[m]	[m]	[m]	[mm]
Vertical Offset 1				
0.0	19.00000	6.55000	84.00000	3.8754 d
1.9667	19.00000	8.51667	84.00000	1.1848 d
3.9333	19.00000	10.48333	84.00000	0.63377 d
5.9000	19.00000	12.45000	84.00000	0.38964 d
d - Displacements include imported displacements.				
Structure: No 29 Sub-structure: Far Elevation (8)				
Dist.	Coordinates			Displacements
	x	y	z	
[m]	[m]	[m]	[m]	[mm]
Vertical Offset 1				
0.0	18.95000	12.50000	84.00000	0.39587 d
2.1134	16.83750	12.43750	84.00000	0.40392 d
4.2268	14.72500	12.37500	84.00000	0.40128 d
6.3403	12.61250	12.31250	84.00000	0.38810 d
8.4537	10.50000	12.25000	84.00000	0.37073 d
10.567	8.38750	12.18750	84.00000	0.35153 d
12.681	6.27500	12.12500	84.00000	0.32913 d
14.794	4.16250	12.06250	84.00000	0.29904 d
16.907	2.05000	12.00000	84.00000	0.25719 d
d - Displacements include imported displacements.				
Structure: No 29 Sub-structure: Frontage (9)				
Dist.	Coordinates			Displacements
	x	y	z	
[m]	[m]	[m]	[m]	[mm]
Vertical Offset 1				
0.0	2.00000	11.95000	84.00000	0.25859 d
1.9667	2.00000	9.98333	84.00000	0.39701 d
3.9333	2.00000	8.01667	84.00000	0.68253 d
5.9000	2.00000	6.05000	84.00000	1.9214 d
d - Displacements include imported displacements.				
Structure: Willoughby Road Sub-structure: Roadway (10)				
Dist.	Coordinates			Displacements
	x	y	z	
[m]	[m]	[m]	[m]	[mm]
Vertical Offset 1				
0.0	-2.00000	-6.00000	85.00000	0.16392 d
2.0000	-2.00000	-4.00000	85.00000	0.22537 d
4.0000	-2.00000	-2.00000	85.00000	0.30390 d
6.0000	-2.00000	0.00000	85.00000	0.38665 d
8.0000	-2.00000	2.00000	85.00000	0.43913 d
10.000	-2.00000	4.00000	85.00000	0.43603 d
12.000	-2.00000	6.00000	85.00000	0.37889 d
14.000	-2.00000	8.00000	85.00000	0.29461 d
16.000	-2.00000	10.00000	85.00000	0.21666 d
18.000	-2.00000	12.00000	85.00000	0.15652 d
d - Displacements include imported displacements.				
Structure: Willow Cottages Sub-structure: Retaining Wall (11)				
Dist.	Coordinates			Displacements
	x	y	z	
[m]	[m]	[m]	[m]	[mm]
Vertical Offset 1				
0.0	0.00000	-10.00000	83.00000	0.10594 d
2.0264	1.81250	-9.09375	83.00000	0.14875 d
4.0529	3.62500	-8.18750	83.00000	0.20355 d
6.0793	5.43750	-7.28125	83.00000	0.27156 d
8.1057	7.25000	-6.37500	83.00000	0.35425 d
10.132	9.06250	-5.46875	83.00000	0.45680 d
12.159	10.87500	-4.56250	83.00000	0.59313 d
14.185	12.68750	-3.65625	83.00000	0.78921 d
16.211	14.50000	-2.75000	83.00000	1.0746 d
18.238	16.31250	-1.84375	83.00000	1.4683 d
20.264	18.12500	-0.93750	83.00000	1.9373 d
22.291	19.93750	-0.03125	83.00000	1.9255 d
24.317	21.75000	0.87500	83.00000	1.5176 d
26.344	23.56250	1.78125	83.00000	0.93909 d
28.370	25.37500	2.68750	83.00000	0.57673 d
30.397	27.18750	3.59375	83.00000	0.36471 d
32.423	29.00000	4.50000	83.00000	0.23659 d
d - Displacements include imported displacements.				
Structure: Willow Cottages Sub-structure: Rear Elevation				
Dist.	Coordinates			Displacements
	x	y	z	
[m]	[m]	[m]	[m]	[mm]
Vertical Offset 1				
0.0	0.00000	-13.00000	83.00000	0.060561 d
2.0264	1.81250	-12.09375	83.00000	0.085497 d
4.0529	3.62500	-11.18750	83.00000	0.11648 d
6.0793	5.43750	-10.28125	83.00000	0.15419 d
8.1057	7.25000	-9.37500	83.00000	0.19932 d
10.132	9.06250	-8.46875	83.00000	0.25302 d
12.159	10.87500	-7.56250	83.00000	0.31756 d
14.185	12.68750	-6.65625	83.00000	0.39618 d
16.211	14.50000	-5.75000	83.00000	0.49078 d
18.238	16.31250	-4.84375	83.00000	0.59658 d
20.264	18.12500	-3.93750	83.00000	0.69423 d
22.291	19.93750	-3.03125	83.00000	0.74268 d
24.317	21.75000	-2.12500	83.00000	0.70518 d
26.344	23.56250	-1.21875	83.00000	0.59169 d
28.370	25.37500	-0.31250	83.00000	0.44987 d
30.397	27.18750	0.59375	83.00000	0.32415 d
32.423	29.00000	1.50000	83.00000	0.22799 d
d - Displacements include imported displacements.				
Specific Building Damage Results - All Segments				



31 Willoughby Road

Combined Movements & Damage Assessment

2nd Stage - Short-term (no heave) - 5 mm limit on overall horizontal movements

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Dist.	Coordinates		Displacements								
	x [m]	y [m]	z [m]	z [mm]							
Structure: No 33 Sub-structure: Party Wall (1)											
Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category
[m]		[m]	[m]		[%]	[%]	[%]			[m]	
0.0	1	0.0	4.7844	Sagging	0.010668	0.0	0.0097721	0.0	-417.33E-6	3464.3	0
	2	4.7844	5.1146	Hogging	0.0079526	0.0	0.0077495	0.0	-373.29E-6	5144.5	0
											(Negligible)
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.											
Structure: No 33 Sub-structure: Rear Elevation (2)											
Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category
[m]		[m]	[m]		[%]	[%]	[%]			[m]	
0.0	1	0.0	2.9000	None	0.0	0.030250	0.030250	-302.41E-6	938.98E-6	-	0
											(Negligible)
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.											
Structure: No 33 Sub-structure: Far Elevation (3)											
Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category
[m]		[m]	[m]		[%]	[%]	[%]			[m]	
0.0	1	0.0	8.8320	Hogging	0.0011551	0.0060500	0.0069598	-60.496E-6	117.43E-6	45886.	0
											(Negligible)
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.											
Structure: No 33 Sub-structure: Far Elevation (4)											
Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category
[m]		[m]	[m]		[%]	[%]	[%]			[m]	
0.0	1	0.0	1.9000	Sagging	0.0	0.0	0.0	0.0	19.584E-6	-	0
											(Negligible)
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.											
Structure: No 33 Sub-structure: Frontage (5)											
Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category
[m]		[m]	[m]		[%]	[%]	[%]			[m]	
0.0	1	0.0	0.37062	Sagging	0.0	0.030250	0.030250	-302.41E-6	-58.891E-6	73198.	0
	2	0.37062	6.5294	Hogging	0.011079	0.030250	0.036921	-302.41E-6	-581.20E-6	4154.8	0
											(Negligible)
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.											
Structure: No 29 Sub-structure: Party Wall (6)											
Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category
[m]		[m]	[m]		[%]	[%]	[%]			[m]	
0.0	1	0.0	5.1451	Sagging	0.0060449	-314.76E-6	0.0056499	7.6674E-6	-216.28E-6	6215.0	0
	2	5.1451	11.762	Hogging	0.0045476	0.0	0.0042838	0.0	-386.44E-6	6283.6	0
											(Negligible)
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.											
Structure: No 29 Sub-structure: Rear Elevation (7)											
Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category
[m]		[m]	[m]		[%]	[%]	[%]			[m]	
0.0	1	0.0	5.5750	Hogging	0.026426	0.030229	0.043847	-302.20E-6	0.0013677	1489.9	0
	2	5.5750	0.32403	None	0.0	0.030229	0.030229	-302.20E-6	124.10E-6	25629.	0
											(Negligible)
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.											
Structure: No 29 Sub-structure: Far Elevation (8)											
Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category
[m]		[m]	[m]		[%]	[%]	[%]			[m]	
0.0	1	0.0	16.907	Sagging	298.45E-6	0.0	429.05E-6	0.0	19.803E-6	192240.	0
											(Negligible)
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.											
Structure: No 29 Sub-structure: Frontage (9)											
Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category
[m]		[m]	[m]		[%]	[%]	[%]			[m]	
0.0	1	0.0	0.26592	None	0.0	0.030229	0.030229	-302.20E-6	-70.362E-6	70979.	0
	2	0.26592	5.6331	Hogging	0.011730	0.030229	0.034406	-302.20E-6	-629.76E-6	3350.2	0
											(Negligible)
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.											



31 Willoughby Road

Combined Movements & Damage Assessment

2nd Stage - Short-term (no heave) - 5 mm limit on overall horizontal movements

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Vertical Offset from Line for Vertical Movement	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category
Structure: Willoughby Road Sub-structure: Roadway (10)											
Vertical Offset from Line for Vertical Movement Calculations											
[m]		[m]	[m]		[%]	[%]	[%]			[m]	
0.0	1	0.0	3.8425	Hogging	211.24E-6	-0.016396	0.0032793	280.02E-6	-39.277E-6	196910.	0 (Negligible)
	2	3.8425	10.094	Sagging	0.0014027	-0.021374	0.0042749	541.68E-6	42.164E-6	81857.	0 (Negligible)
	3	13.937	4.0634	Hogging	224.02E-6	-0.017712	0.0035424	541.68E-6	42.164E-6	193300.	0 (Negligible)
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.											
Structure: Willow Cottages Sub-structure: Retaining Wall (11)											
Vertical Offset from Line for Vertical Movement Calculations											
[m]		[m]	[m]		[%]	[%]	[%]			[m]	
0.0	1	0.0	17.492	Hogging	0.0020506	0.0056004	0.0082675	-60.496E-6	-194.29E-6	43330.	0 (Negligible)
	2	17.492	7.9565	Sagging	0.0085408	-0.051608	0.010413	0.0014319	285.87E-6	11399.	0 (Negligible)
	3	25.448	6.9735	Hogging	0.0030896	-0.0013025	0.0031208	0.0014319	285.87E-6	27439.	0 (Negligible)
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.											
Structure: Willow Cottages Sub-structure: Rear Elevation											
Vertical Offset from Line for Vertical Movement Calculations											
[m]		[m]	[m]		[%]	[%]	[%]			[m]	
0.0	1	4.0529	12.884	Hogging	451.86E-6	0.0060500	0.0065300	-60.496E-6	-52.206E-6	287700.	0 (Negligible)
	2	16.937	10.981	Sagging	0.0021514	-0.027534	0.0055704	976.71E-6	70.022E-6	55489.	0 (Negligible)
	3	27.918	4.5040	Hogging	394.66E-6	-0.013442	0.0026978	528.92E-6	70.022E-6	124540.	0 (Negligible)
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.											
Specific Building Damage Results - Critical Values for All Segments within Each Sub-Structure											
Structure: No 33 Sub-structure: Party Wall (1)											
Vertical Offset from Line for Vertical Movement Calculations	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category	
[m]	[%]	[%]		[mm]	[%]			[m]	[m]		
0.0	0.010668		0.0	-417.33E-6	3.7734	0.0097721	0.0	-417.33E-6	5144.5	3464.3	0 (Negligible)
Structure: No 33 Sub-structure: Rear Elevation (2)											
Vertical Offset from Line for Vertical Movement Calculations	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category	
[m]	[%]	[%]		[mm]	[%]			[m]	[m]		
0.0	0.0	0.030250	938.98E-6	3.6508	0.030250	-302.41E-6	938.98E-6	-	-	0	(Negligible)
Structure: No 33 Sub-structure: Far Elevation (3)											
Vertical Offset from Line for Vertical Movement Calculations	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category	
[m]	[%]	[%]		[mm]	[%]			[m]	[m]		
0.0	0.0011551	0.0060500	117.43E-6	0.91201	0.0069598	-60.496E-6	117.43E-6	45886.	-	0	(Negligible)
Structure: No 33 Sub-structure: Far Elevation (4)											
Vertical Offset from Line for Vertical Movement Calculations	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category	
[m]	[%]	[%]		[mm]	[%]			[m]	[m]		
0.0	0.0	0.0	19.584E-6	0.26183	0.0	0.0	19.584E-6	-	-	0	(Negligible)
Structure: No 33 Sub-structure: Frontage (5)											
Vertical Offset from Line for Vertical Movement Calculations	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category	
[m]	[%]	[%]		[mm]	[%]			[m]	[m]		
0.0	0.011079	0.030250	-581.20E-6	1.9859	0.036921	-302.41E-6	-581.20E-6	4154.8	73198.	0	(Negligible)
Structure: No 29 Sub-structure: Party Wall (6)											
Vertical Offset from Line for Vertical Movement Calculations	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category	
[m]	[%]	[%]		[mm]	[%]			[m]	[m]		
0.0	0.0060449	-314.76E-6	-386.44E-6	4.0092	0.0056499	7.6674E-6	-386.44E-6	6283.6	6215.0	0	(Negligible)

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Offset from Line for Vertical	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement	Max Gradient of Vertical Displacement	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category		
Structure: No 29 Sub-structure: Rear Elevation (7)												
Vertical Offset from Line for Vertical Movement Calculations	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement	Max Gradient of Vertical Displacement	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category		
[m]	[%]	[%]		[mm]	[%]			[m]	[m]			
0.0	0.026426	0.030229	0.0013677	3.8754	0.043847	-302.20E-6	0.0013677	1489.9	- 0	(Negligible)		
Structure: No 29 Sub-structure: Far Elevation (8)												
Vertical Offset from Line for Vertical Movement Calculations	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement	Max Gradient of Vertical Displacement	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category		
[m]	[%]	[%]		[mm]	[%]			[m]	[m]			
0.0	298.45E-6	0.0	19.803E-6	0.40379	429.05E-6	0.0	19.803E-6	- 192240.0	0	(Negligible)		
Structure: No 29 Sub-structure: Frontage (9)												
Vertical Offset from Line for Vertical Movement Calculations	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement	Max Gradient of Vertical Displacement	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category		
[m]	[%]	[%]		[mm]	[%]			[m]	[m]			
0.0	0.011730	0.030229	-629.76E-6	1.9208	0.034406	-302.20E-6	-629.76E-6	3350.2	- 0	(Negligible)		
Structure: Willoughby Road Sub-structure: Roadway (10)												
Vertical Offset from Line for Vertical Movement Calculations	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement	Max Gradient of Vertical Displacement	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category		
[m]	[%]	[%]		[mm]	[%]			[m]	[m]			
0.0	0.0014027	-0.021374	42.164E-6	0.43909	0.0042749	541.68E-6	42.164E-6	193300.	81857.0	(Negligible)		
Structure: Willow Cottages Sub-structure: Retaining Wall (11)												
Vertical Offset from Line for Vertical Movement Calculations	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement	Max Gradient of Vertical Displacement	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category		
[m]	[%]	[%]		[mm]	[%]			[m]	[m]			
0.0	0.0085408	-0.051608	285.87E-6	1.9371	0.010413	0.0014319	285.87E-6	27439.	11399.0	(Negligible)		
Structure: Willow Cottages Sub-structure: Rear Elevation												
Vertical Offset from Line for Vertical Movement Calculations	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement	Max Gradient of Vertical Displacement	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category		
[m]	[%]	[%]		[mm]	[%]			[m]	[m]			
0.0	0.0021514	-0.027534	70.022E-6	0.74198	0.0065300	976.71E-6	70.022E-6	124540.	55489.0	(Negligible)		
Specific Building Damage Results - Critical Segments within Each Structure												
Structure Name	Parameter	Critical Sub-Structure	Critical Segment	Start	End	Curvature	Max Slope	Max Settlement	Max Tensile Strain	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category
No 33	Max Slope	Rear Elevation (2)	1	[m]	[m]			[mm]	[%]			
	Max Settlement	Party Wall (1)	2	4.7844	9.8990	Hogging	373.29E-6	3.7734	0.0077495	5144.5	- 0	(Negligible)
	Max Tensile Strain	Frontage (5)	2	0.37062	6.9000	Hogging	581.20E-6	1.9859	0.036921	4154.8	- 0	(Negligible)
	Min Radius of Curvature (Hogging)	Frontage (5)	2	0.37062	6.9000	Hogging	581.20E-6	1.9859	0.036921	4154.8	- 0	(Negligible)
	Min Radius of Curvature (Sagging)	Party Wall (1)	1	0.0	4.7844	Sagging	417.33E-6	2.9874	0.0097721	- 3464.3	0	(Negligible)
No 29	Max Slope	Rear Elevation (7)	1	0.0	5.5750	Hogging	0.0013677	3.8754	0.043847	1489.9	- 0	(Negligible)
	Max Settlement	Party Wall (6)	2	5.1451	16.907	Hogging	386.44E-6	4.0092	0.0042838	6283.6	- 0	(Negligible)
	Max Tensile Strain	Rear Elevation (7)	1	0.0	5.5750	Hogging	0.0013677	3.8754	0.043847	1489.9	- 0	(Negligible)
	Min Radius of Curvature (Hogging)	Rear Elevation (7)	1	0.0	5.5750	Hogging	0.0013677	3.8754	0.043847	1489.9	- 0	(Negligible)
	Min Radius of Curvature (Sagging)	Party Wall (6)	1	0.0	5.1451	Sagging	216.28E-6	2.5496	0.0056499	- 6215.0	0	(Negligible)
Willoughby Road	Max Slope	Roadway (10)	2	3.8425	13.937	Sagging	42.164E-6	0.43909	0.0042749	- 81857.0	0	(Negligible)
	Max Settlement	Roadway (10)	2	3.8425	13.937	Sagging	42.164E-6	0.43909	0.0042749	- 81857.0	0	(Negligible)
	Max Tensile Strain	Roadway (10)	2	3.8425	13.937	Sagging	42.164E-6	0.43909	0.0042749	- 81857.0	0	(Negligible)
	Min Radius of Curvature (Hogging)	Roadway (10)	3	13.937	18.000	Hogging	42.164E-6	0.29728	0.0035424	193300.	- 0	(Negligible)
	Min Radius of Curvature (Sagging)	Roadway (10)	2	3.8425	13.937	Sagging	42.164E-6	0.43909	0.0042749	- 81857.0	0	(Negligible)
Willow Cottages	Max Slope	Retaining Wall (11)	2	17.492	25.448	Sagging	285.87E-6	1.9371	0.010413	- 11399.0	0	(Negligible)
	Max Settlement	Retaining Wall (11)	2	17.492	25.448	Sagging	285.87E-6	1.9371	0.010413	- 11399.0	0	(Negligible)
	Max Tensile Strain	Retaining Wall (11)	2	17.492	25.448	Sagging	285.87E-6	1.9371	0.010413	- 11399.0	0	(Negligible)
	Min Radius of Curvature (Hogging)	Retaining Wall (11)	3	25.448	32.422	Hogging	285.87E-6	1.1946	0.0031208	27439.	- 0	(Negligible)
	Min Radius of Curvature (Sagging)	Retaining Wall (11)	2	17.492	25.448	Sagging	285.87E-6	1.9371	0.010413	- 11399.0	0	(Negligible)



31 Willoughby Road

Combined Movements & Damage Assessment

2nd Stage - Short-term (no heave) - 5 mm limit on overall horizontal movements

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Structure Name	Parameter	Critical Sub-Structure	Critical Segment	Start	End	Curvature	Max Slope	Max Settlement	Max Tensile Strain	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category
Willow Cottages	Max Slope	Rear Elevation	2	16.937	27.918	Sagging	70.022E-6	0.74198	0.0055704	-	55489.0	0 (Negligible)
	Max Settlement	Rear Elevation	2	16.937	27.918	Sagging	70.022E-6	0.74198	0.0055704	-	55489.0	0 (Negligible)
	Max Tensile Strain	Rear Elevation	1	4.0529	16.937	Hogging	52.206E-6	0.52864	0.0065300	287700.	-	0 (Negligible)
	Min Radius of Curvature (Hogging)	Rear Elevation	3	27.918	32.422	Hogging	70.022E-6	0.48151	0.0026978	124540.	-	0 (Negligible)
	Min Radius of Curvature (Sagging)	Rear Elevation	2	16.937	27.918	Sagging	70.022E-6	0.74198	0.0055704	-	55489.0	0 (Negligible)

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Problem Type

Problem Type : Tunnelling and Embedded Wall Excavations

Displacement Data

Type	Name	Direction of extrusion	Point/Line/Line for extrusion		No. of intervals across extrusion/line	Extrusion depth	No. of intervals along extrusion	Calculate	Surface type for tunnels
			First point	Second point					
			X [m]	Y [m]	Z (level) [m]	X [m]	Y [m]	Z (level) [m]	
Grid	Grid 1	Global X	-20.00000	-20.00000	85.50000	-	26.00000	85.50000	46 60.00000 60 Yes Surface
Grid	Grid 2	Global X	-20.00000	-20.00000	84.00000	-	26.00000	84.00000	46 60.00000 60 Yes Surface
Line	Line 1	-	2.05000	0.00000	84.00000	11.95000	0.00000	84.00000	5 - Yes Surface
Line	Line 2	-	12.00000	-0.05000	84.00000	12.00000	-2.95000	84.00000	1 - Yes Surface
Line	Line 3	-	11.95000	-3.00000	84.00000	4.05000	-6.95000	84.00000	4 - Yes Surface
Line	Line 4	-	3.95000	-7.00000	84.00000	2.05000	-7.00000	84.00000	1 - Yes Surface
Line	Line 5	-	2.00000	-6.95000	84.00000	2.00000	-0.05000	84.00000	3 - Yes Surface
Line	Line 6	-	2.05000	6.00000	84.00000	18.95000	6.50000	84.00000	8 - Yes Surface
Line	Line 7	-	19.00000	6.55000	84.00000	19.00000	12.45000	84.00000	3 - Yes Surface
Line	Line 8	-	18.95000	12.50000	84.00000	2.05000	12.00000	84.00000	8 - Yes Surface
Line	Line 9	-	2.00000	11.95000	84.00000	2.00000	6.05000	84.00000	3 - Yes Surface
Line	Line 10	-	-2.00000	-6.00000	85.00000	-2.00000	12.00000	85.00000	9 - Yes Surface
Line	Line 11	-	0.00000	-10.00000	83.00000	29.00000	4.50000	83.00000	16 - Yes Surface
Line	Line 12	-	0.00000	-13.00000	83.00000	29.00000	1.50000	83.00000	16 - Yes Surface

Vertical Ground Movement Curves (Excavations)

Curve Name: No vertical ground movement
Coordinates: [Distance from wall / wall depth or max. excavation depth (x), Depth / wall depth or max. excavation depth (y), Settlement / wall depth or max. excavation depth (z) (%)]
 [0.000,0.000,0.000] [1.000,0.000,0.000] [0.000,1.000,0.000] [1.000,1.000,0.000]
Curve Fitting Method: Polynomial
x Order: 1
y Order: 0
Polynomial: z = 0.0x + 0.0
Coeff. of Determination: -2147483648.E+2147483647

Horizontal Ground Movement Curves (Excavations)

Curve Name: GEA Curve for 10 mm of horizontal deflection (after CIRIA 580 Fig. 2.11(a))
Coordinates: [Distance from wall / wall depth or max. excavation depth (x), Depth / wall depth or max. excavation depth (y), Horizontal movement / wall depth or max. excavation depth (z) (%)]
 [0.000,0.000,0.242] [4.000,0.000,0.000]
Curve Fitting Method: Polynomial
x Order: 1
y Order: 0
Polynomial: z = -6.05E-2x + 2.42E-1
Coeff. of Determination: 1.00

Polygonal Excavations

Excavation Name: New Excavation
Surface level [m]: 85.500
Contribution: Positive
Enabled: Yes
Surface movement curves which are selected are applied between surface and [m]: 81.400

Corner	x	y	Base Level	Stiffened	Previous Side	Next Side
	[m]	[m]	[m]	d	p1 p2*	d p1 p2*
				[m]	[%]	[m]
1	2.0000	0.0	81.400	No	- -	- -
2	18.000	0.0	81.400	No	- -	- -
3	21.000	2.0000	81.400	No	- -	- -
4	21.000	6.5000	81.400	No	- -	- -
5	2.0000	6.0000	81.400	No	- -	- -

Side	Corner 1	Corner 2	Ground Movement Curve	
	x y	x y	Vertical	Horizontal
	[m] [m]	[m] [m]		
1	2.0000 0.0	18.000 0.0	No vertical ground movement	GEA Curve for 10 mm of horizontal deflection (after CIRIA 580 Fig. 2.11(a))
2	18.000 0.0	21.000 2.0000	No vertical ground movement	GEA Curve for 10 mm of horizontal deflection (after CIRIA 580 Fig. 2.11(a))
3	21.000 2.0000	21.000 6.5000	No vertical ground movement	GEA Curve for 10 mm of horizontal deflection (after CIRIA 580 Fig. 2.11(a))
4	21.000 6.5000	2.0000 6.0000	No vertical ground movement	GEA Curve for 10 mm of horizontal deflection (after CIRIA 580 Fig. 2.11(a))
5	2.0000 6.0000	2.0000 0.0	No vertical ground movement	GEA Curve for 10 mm of horizontal deflection (after CIRIA 580 Fig. 2.11(a))

Damage Category Strains

Name	0 (Negligible) to 1 (Very Slight)	1 (Very Slight) to 2 (Slight)	2 (Slight) to 3 (Moderate)	3 (Moderate) to 4 (Severe)
Burland Strain Limits	0.0	500.00E-6	750.00E-6	0.0015000

Specific Structures - Geometry

Structure Name	Sub-Structure Name	Displacement Line	Start Distance Along Line	End Distance Along Line	Vertical Offsets from Line for Vertical Movement Calculations	Vertical Displacement Limit	Damage Category Strains	Poisson's Ratio	E/G
			[m]	[m]	[m]	[mm]			
No 33	Party Wall (1)	Line 1	0.00000	9.89900	0.0	0.10000	Burland Strain Limits	0.20000	2.6000
No 33	Rear Elevation (2)	Line 2	0.00000	2.90000	0.0	0.10000	Burland Strain Limits	0.20000	2.6000
No 33	Far Elevation (3)	Line 3	0.00000	8.83200	0.0	0.10000	Burland Strain Limits	0.20000	2.6000
No 33	Far Elevation (4)	Line 4	0.00000	1.90000	0.0	0.10000	Burland Strain Limits	0.20000	2.6000

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Structure Name	Sub-Structure Name	Displacement Line	Start Distance Along Line	End Distance Along Line	Vertical Offsets from Line for Vertical	Vertical Displacement Limit Sensitivity	Damage Category	Strains	Poisson's Ratio	E/G
No 33	Frontage (5)	Line 5	0.00000	6.90000	0.0	0.10000	Burland Strain Limits	0.20000	2.6000	
No 29	Party Wall (6)	Line 6	0.00000	16.90700	0.0	0.10000	Burland Strain Limits	0.20000	2.6000	
No 29	Rear Elevation (7)	Line 7	0.00000	5.89900	0.0	0.10000	Burland Strain Limits	0.20000	2.6000	
No 29	Far Elevation (8)	Line 8	0.00000	16.90700	0.0	0.10000	Burland Strain Limits	0.20000	2.6000	
No 29	Frontage (9)	Line 9	0.00000	5.89900	0.0	0.10000	Burland Strain Limits	0.20000	2.6000	
Willoughby Road	Roadway (10)	Line 10	0.00000	18.00000	0.0	0.10000	Burland Strain Limits	0.20000	2.6000	
Willow Cottages	Retaining Wall (11)	Line 11	0.00000	32.42200	0.0	0.10000	Burland Strain Limits	0.20000	2.6000	
Willow Cottages	Rear Elevation	Line 12	0.00000	32.42200	0.0	0.10000	Burland Strain Limits	0.20000	2.6000	

Specific Structures - Bending Parameters

Structure Name	Sub-Structure Name	Height	Default Properties	Hogging			Sagging		
				2nd Moment of Area (per unit width)	Distance of Bending Strain from N.A.	Distance of N.A. from Edge of Beam in Tension	2nd Moment of Area (per unit width)	Distance of Bending Strain from N.A.	Distance of N.A. from Edge of Beam in Tension
No 33	Party Wall (1)	[m]	8.0000 Yes	[m ⁴]	[m]	[m]	[m ⁴]	[m]	[m]
No 33	Rear Elevation (2)	8.0000	Yes	170.67	8.0000	8.0000	42.667	4.0000	4.0000
No 33	Far Elevation (3)	8.0000	Yes	170.67	8.0000	8.0000	42.667	4.0000	4.0000
No 33	Far Elevation (4)	8.0000	Yes	170.67	8.0000	8.0000	42.667	4.0000	4.0000
No 33	Frontage (5)	8.0000	Yes	170.67	8.0000	8.0000	42.667	4.0000	4.0000
No 29	Party Wall (6)	12.000	Yes	576.00	12.000	12.000	144.00	6.0000	6.0000
No 29	Rear Elevation (7)	12.000	Yes	576.00	12.000	12.000	144.00	6.0000	6.0000
No 29	Far Elevation (8)	12.000	Yes	576.00	12.000	12.000	144.00	6.0000	6.0000
No 29	Frontage (9)	12.000	Yes	576.00	12.000	12.000	144.00	6.0000	6.0000
Willoughby Road	Roadway (10)	0.50000	Yes	0.041667	0.50000	0.50000	0.010417	0.25000	0.25000
Willow Cottages	Retaining Wall (11)	2.5000	Yes	5.2083	2.5000	2.5000	1.3021	1.2500	1.2500
Willow Cottages	Rear Elevation	8.0000	Yes	170.67	8.0000	8.0000	42.667	4.0000	4.0000

Building Segment Combinations

Structure Name	Sub-Structure Name	Vertical Offset from Line for Vertical Movement Calculations	Segment Start	Length	Curvature	Combined Segment
No structures have segments combined.						

Utility Strain Calculation Options

Neglect beneficial contribution of axial strains : No

Warnings

- Sub-structure 6 crosses at least one excavation. Its building damage results in that area should be treated with caution.

Errors

None

Specific Building Damage Results - Horizontal Displacements

Structure: No 33 | Sub-structure: Party Wall (1)

Dist.	Coordinates			Displacements		
	x	y	z	x	y	
				Horizontal displacement along the Line	Horizontal displacement perpendicular to Line	
	[m]	[m]	[m]	[mm]	[mm]	
0.0	2.05000	0.00000	84.00000	0.0	9.9220	d
1.9800	4.03000	0.00000	84.00000	0.0	9.9220	d
3.9600	6.01000	0.00000	84.00000	0.0	9.9220	d
5.9400	7.99000	0.00000	84.00000	0.0	9.9220	d
7.9200	9.97000	0.00000	84.00000	0.0	9.9220	d
9.9000	11.95000	0.00000	84.00000	0.0	9.9220	d

d - Displacements include imported displacements.

Structure: No 33 | Sub-structure: Rear Elevation (2)

Dist.	Coordinates			Displacements		
	x	y	z	x	y	
				Horizontal displacement along the Line	Horizontal displacement perpendicular to Line	
	[m]	[m]	[m]	[mm]	[mm]	
0.0	12.00000	-0.05000	84.00000	0.0	9.8917	0.0 d
2.9000	12.00000	-2.95000	84.00000	0.0	8.1372	0.0 d

d - Displacements include imported displacements.

Structure: No 33 | Sub-structure: Far Elevation (3)

Dist.	Coordinates			Displacements		
	x	y	z	x	y	
				Horizontal displacement along the Line	Horizontal displacement perpendicular to Line	
	[m]	[m]	[m]	[mm]	[mm]	
0.0	11.95000	-3.00000	84.00000	0.0	8.1070	-7.2511 d
2.2081	9.97500	-3.98750	84.00000	0.0	7.5096	-6.7168 d
4.4162	8.00000	-4.97500	84.00000	0.0	6.9121	-6.1824 d
6.6244	6.02500	-5.96250	84.00000	0.0	6.3147	-5.6480 d
8.8325	4.05000	-6.95000	84.00000	0.0	5.7172	-5.1137 d

d - Displacements include imported displacements.

Structure: No 33 | Sub-structure: Far Elevation (4)

Dist.	Coordinates			Displacements		
	x	y	z	x	y	
				Horizontal displacement	Horizontal displacement	



31 Willoughby Road

Combined Movements & Damage Assessment

2nd Stage - Short-term (no heave) - 10 mm limit on overall horizontal movement

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along the Line						perpendicular to Line	
[m]	[m]	[m]	[m]	[mm]	[mm]	[mm]	[mm]
0.0	3.95000	-7.00000	84.00000	0.0	5.6870	0.0	-5.6870 d
1.9000	2.05000	-7.00000	84.00000	0.0	5.6870	0.0	-5.6870 d
d - Displacements include imported displacements.							

Structure: No 33 | Sub-structure: Frontage (5)

Dist.	Coordinates			Displacements		
	x	y	z	x	y	
				Horizontal displacement along the Line	Horizontal displacement perpendicular to Line	
[m]	[m]	[m]	[m]	[mm]	[mm]	
0.0	2.00000	-6.95000	84.00000	0.0	5.7172	5.7172 0.0 d
2.3000	2.00000	-6.45000	84.00000	0.0	7.1087	7.1087 0.0 d
4.6000	2.00000	-2.35000	84.00000	0.0	8.5002	8.5002 0.0 d
6.9000	2.00000	-0.05000	84.00000	0.0	9.8917	9.8917 0.0 d
d - Displacements include imported displacements.						

Structure: No 29 | Sub-structure: Party Wall (6)

Dist.	Coordinates			Displacements		
	x	y	z	x	y	
				Horizontal displacement along the Line	Horizontal displacement perpendicular to Line	
[m]	[m]	[m]	[m]	[mm]	[mm]	
0.0	2.05000	6.00000	84.00000	0.0	0.0	0.0 0.0 d
2.1134	4.16250	6.06250	84.00000	0.26093	-9.9152	-0.032409 -9.9186 d
4.2268	6.27500	6.12500	84.00000	0.26082	-9.9110	-0.032395 -9.9144 d
6.3403	8.38750	6.18750	84.00000	0.26071	-9.9068	-0.032381 -9.9102 d
8.4537	10.50000	6.25000	84.00000	0.26060	-9.9027	-0.032368 -9.9060 d
10.567	12.61250	6.31250	84.00000	0.26049	-9.8985	-0.032354 -9.9019 d
12.681	14.72500	6.37500	84.00000	0.26038	-9.8943	-0.032340 -9.8977 d
14.794	16.83750	6.43750	84.00000	0.26027	-9.8901	-0.032327 -9.8935 d
16.907	18.95000	6.50000	84.00000	0.26016	-9.8860	-0.032313 -9.8893 d
d - Displacements include imported displacements.						

Structure: No 29 | Sub-structure: Rear Elevation (7)

Dist.	Coordinates			Displacements		
	x	y	z	x	y	
				Horizontal displacement along the Line	Horizontal displacement perpendicular to Line	
[m]	[m]	[m]	[m]	[mm]	[mm]	
0.0	19.00000	6.55000	84.00000	0.25938	-9.8565	-9.8565 0.25938 d
1.9667	19.00000	8.51667	84.00000	0.22809	-8.6675	-8.6675 -0.22809 d
3.9333	19.00000	10.48333	84.00000	0.19680	-7.4785	-7.4785 -0.19680 d
5.9000	19.00000	12.45000	84.00000	0.16551	-6.2895	-6.2895 -0.16551 d
d - Displacements include imported displacements.						

Structure: No 29 | Sub-structure: Far Elevation (8)

Dist.	Coordinates			Displacements		
	x	y	z	x	y	
				Horizontal displacement along the Line	Horizontal displacement perpendicular to Line	
[m]	[m]	[m]	[m]	[mm]	[mm]	
0.0	18.95000	12.50000	84.00000	0.16470	-6.2585	0.020456 6.2606 d
2.1134	16.83750	12.43750	84.00000	0.16481	-6.2626	0.020470 6.2648 d
4.2268	14.72500	12.37500	84.00000	0.16492	-6.2668	0.020484 6.2690 d
6.3403	12.61250	12.31250	84.00000	0.16503	-6.2710	0.020497 6.2731 d
8.4537	10.50000	12.25000	84.00000	0.16514	-6.2752	0.020511 6.2773 d
10.567	8.38750	12.18750	84.00000	0.16525	-6.2793	0.020525 6.2815 d
12.681	6.27500	12.12500	84.00000	0.16536	-6.2835	0.020538 6.2857 d
14.794	4.16250	12.06250	84.00000	0.16547	-6.2877	0.020552 6.2898 d
16.907	2.05000	12.00000	84.00000	0.16558	-6.2919	0.020565 6.2940 d
d - Displacements include imported displacements.						

Structure: No 29 | Sub-structure: Frontage (9)

Dist.	Coordinates			Displacements		
	x	y	z	x	y	
				Horizontal displacement along the Line	Horizontal displacement perpendicular to Line	
[m]	[m]	[m]	[m]	[mm]	[mm]	
0.0	2.00000	11.95000	84.00000	0.16635	-6.3213	6.3213 0.16635 d
1.9667	2.00000	9.98333	84.00000	0.19764	-7.5103	7.5103 0.19764 d
3.9333	2.00000	8.01667	84.00000	0.22893	-8.6993	8.6993 0.22893 d
5.9000	2.00000	6.05000	84.00000	0.26022	-9.8883	9.8883 0.26022 d
d - Displacements include imported displacements.						

Structure: Willoughby Road | Sub-structure: Roadway (10)

Dist.	Coordinates			Displacements		
	x	y	z	x	y	
				Horizontal displacement along the Line	Horizontal displacement perpendicular to Line	
[m]	[m]	[m]	[m]	[mm]	[mm]	
0.0	-2.00000	-6.00000	85.00000	2.0810	3.4783	3.4783 -2.0810 d
2.0000	-2.00000	-4.00000	85.00000	3.2498	3.2498	3.2498 -3.2498 d
4.0000	-2.00000	-2.00000	85.00000	5.0863	2.1300	2.1300 -5.0863 d
6.0000	-2.00000	0.00000	85.00000	7.5020	0.0	0.0 -7.5020 d
8.0000	-2.00000	2.00000	85.00000	7.5020	0.0	0.0 -7.5020 d
10.000	-2.00000	4.00000	85.00000	7.5020	0.0	0.0 -7.5020 d
12.000	-2.00000	6.00000	85.00000	7.5020	0.0	0.0 -7.5020 d
14.000	-2.00000	8.00000	85.00000	5.1070	-2.1656	-2.1656 -5.1070 d
16.000	-2.00000	10.00000	85.00000	3.2814	-3.3040	-3.3040 -3.2814 d
18.000	-2.00000	12.00000	85.00000	2.1148	-3.5363	-3.5363 -2.1148 d
d - Displacements include imported displacements.						

Structure: Willow Cottages | Sub-structure: Retaining Wall (11)

Dist.	Coordinates			Displacements		
	x	y	z	x	y	
				Horizontal displacement along the Line	Horizontal displacement perpendicular to Line	
[m]	[m]	[m]	[m]	[mm]	[mm]	
0.0	0.00000	-10.00000	83.00000	0.47152	3.2807	1.8889 2.7234 d
2.0264	1.81250	-9.09375	83.00000	0.057998	4.3611	2.0022 3.8748 d
4.0529	3.62500	-8.18750	83.00000	0.0	4.9686	2.2220 4.4440 d
6.0793	5.43750	-7.28125	83.00000	0.0	5.5168	2.4672 4.9344 d
8.1057	7.25000	-6.37500	83.00000	0.0	6.0651	2.7124 5.4248 d



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Combined Movements & Damage Assessment

2nd Stage - Short-term (no heave) - 10 mm limit on overall horizontal movement

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Dist.	Coordinates			Displacements		
	x	y	z	x	y	Horizontal displacement along the perpendicular
10.132	9.06250	-5.46875	83.00000	0.0	6.6134	2.9576
12.159	10.87500	-4.56250	83.00000	0.0	7.1617	3.2028
14.185	12.68750	-3.65625	83.00000	0.0	7.7100	3.4480
16.211	14.50000	-2.75000	83.00000	0.0	8.2582	3.6932
18.238	16.31250	-1.84375	83.00000	0.0	8.8065	3.9384
20.264	18.12500	-0.93750	83.00000	-1.1691	8.9958	2.9773
22.291	19.93750	-0.03125	83.00000	-5.1343	7.7015	-1.1481
24.317	21.75000	0.87500	83.00000	-5.0500	7.5750	-1.1292
26.344	23.56250	1.78125	83.00000	-8.0432	6.6031	-6.9243
28.370	25.37500	2.68750	83.00000	-7.2751	0.0	-6.5071
30.397	27.18750	3.59375	83.00000	-6.1786	0.0	-5.5263
32.423	29.00000	4.50000	83.00000	-5.0820	0.0	-4.5455
d - Displacements include imported displacements.						

Structure: Willow Cottages | Sub-structure: Rear Elevation

Dist.	Coordinates			Displacements		
	x	y	z	x	y	Horizontal displacement along the Line perpendicular to Line
[m]	[m]	[m]	[m]	[mm]	[mm]	[mm]
0.0	0.00000	-13.00000	83.00000	0.19091	1.7736	0.96391
2.0264	1.81250	-12.09375	83.00000	0.025704	2.5787	1.1762
4.0529	3.62500	-11.18750	83.00000	0.0	3.1536	1.4103
6.0793	5.43750	-10.28125	83.00000	0.0	3.7019	1.6555
8.1057	7.25000	-9.37500	83.00000	0.0	4.2501	1.9007
10.132	9.06250	-8.46875	83.00000	0.0	4.7984	2.1459
12.159	10.87500	-7.56250	83.00000	0.0	5.3467	2.3911
14.185	12.68750	-6.65625	83.00000	0.0	5.8950	2.6363
16.211	14.50000	-5.75000	83.00000	0.0	6.4432	2.8815
18.238	16.31250	-4.84375	83.00000	0.0	6.9915	3.1267
20.264	18.12500	-3.93750	83.00000	-0.22569	7.4703	3.1389
22.291	19.93750	-3.03125	83.00000	-4.1556	6.4873	-0.81567
24.317	21.75000	-2.12500	83.00000	-4.2123	6.3184	-0.94190
26.344	23.56250	-1.21875	83.00000	-4.4072	5.6536	-1.4135
28.370	25.37500	-0.31250	83.00000	-5.4018	2.8520	-3.5560
30.397	27.18750	0.59375	83.00000	-5.4671	1.1509	-4.3753
32.423	29.00000	1.50000	83.00000	-4.9291	0.26806	-4.2888
d - Displacements include imported displacements.						

Specific Building Damage Results - Vertical Displacements

Structure: No 33 | Sub-structure: Party Wall (1)

Dist.	Coordinates			Displacements
	x	y	z	z
[m]	[m]	[m]	[m]	[mm]

Vertical Offset 1				
0.0	2.05000	0.00000	84.00000	2.1611 d
1.9800	4.03000	0.00000	84.00000	2.9874 d
3.9600	6.01000	0.00000	84.00000	2.9222 d
5.9400	7.99000	0.00000	84.00000	2.9260 d
7.9200	9.97000	0.00000	84.00000	3.0346 d
9.9000	11.95000	0.00000	84.00000	3.7737 d
d - Displacements include imported displacements.				

Structure: No 33 | Sub-structure: Rear Elevation (2)

Dist.	Coordinates			Displacements
	x	y	z	z
[m]	[m]	[m]	[m]	[mm]

Vertical Offset 1				
0.0	12.00000	-0.05000	84.00000	3.6508 d
2.9000	12.00000	-2.95000	84.00000	0.32695 d
d - Displacements include imported displacements.				

Structure: No 33 | Sub-structure: Far Elevation (3)

Dist.	Coordinates			Displacements
	x	y	z	z
[m]	[m]	[m]	[m]	[mm]

Vertical Offset 1				
0.0	11.95000	-3.00000	84.00000	0.91201 d
2.2081	9.97500	-3.98750	84.00000	0.65270 d
4.4162	8.00000	-4.97500	84.00000	0.48701 d
6.6244	6.02500	-5.96250	84.00000	0.36441 d
8.8325	4.05000	-6.95000	84.00000	0.26624 d
d - Displacements include imported displacements.				

Structure: No 33 | Sub-structure: Far Elevation (4)

Dist.	Coordinates			Displacements
	x	y	z	z
[m]	[m]	[m]	[m]	[mm]

Vertical Offset 1				
0.0	3.95000	-7.00000	84.00000	0.26183 d
1.9000	2.05000	-7.00000	84.00000	0.22462 d
d - Displacements include imported displacements.				

Structure: No 33 | Sub-structure: Frontage (5)

Dist.	Coordinates			Displacements
	x	y	z	z
[m]	[m]	[m]	[m]	[mm]

Vertical Offset 1				
0.0	2.00000	-6.95000	84.00000	0.22573 d
2.3000	2.00000	-4.65000	84.00000	0.36122 d
4.6000	2.00000	-2.35000	84.00000	0.64878 d
6.9000	2.00000	-0.05000	84.00000	1.9859 d
d - Displacements include imported displacements.				

Structure: No 29 | Sub-structure: Party Wall (6)

Dist.	Coordinates			Displacements
	x	y	z	z
[m]	[m]	[m]	[m]	[mm]

Vertical Offset 1				
0.0	2.05000	6.00000	84.00000	2.0934 d
2.1134	4.16250	6.06250	84.00000	2.5804 d
4.2268	6.27500	6.12500	84.00000	2.4500 d
6.3403	8.38750	6.18750	84.00000	2.4364 d
8.4537	10.50000	6.25000	84.00000	2.4762 d
10.567	12.61250	6.31250	84.00000	2.7524 d



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Combined Movements & Damage Assessment
2nd Stage - Short-term (no heave) - 10 mm limit on overall horizontal movement

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Dist.	Coordinates			Displacements
	x	y	z	z
[m]	[m]	[m]	[m]	[mm]
12.691	14.72500	6.37500	84.00000	2.9526 d
14.794	16.83750	6.43750	84.00000	3.1927 d
16.907	18.95000	6.50000	84.00000	4.0094 d
d - Displacements include imported displacements.				
Structure: No 29 Sub-structure: Rear Elevation (7)				
Dist.	Coordinates			Displacements
	x	y	z	z
[m]	[m]	[m]	[m]	[mm]
Vertical Offset 1				
0.0	19.00000	6.55000	84.00000	3.8754 d
1.9667	19.00000	8.51667	84.00000	1.1848 d
3.9333	19.00000	10.48333	84.00000	0.63377 d
5.9000	19.00000	12.45000	84.00000	0.38964 d
d - Displacements include imported displacements.				
Structure: No 29 Sub-structure: Far Elevation (8)				
Dist.	Coordinates			Displacements
	x	y	z	z
[m]	[m]	[m]	[m]	[mm]
Vertical Offset 1				
0.0	18.95000	12.50000	84.00000	0.39587 d
2.1134	16.83750	12.43750	84.00000	0.40392 d
4.2268	14.72500	12.37500	84.00000	0.40128 d
6.3403	12.61250	12.31250	84.00000	0.38810 d
8.4537	10.50000	12.25000	84.00000	0.37073 d
10.567	8.38750	12.18750	84.00000	0.35153 d
12.681	6.27500	12.12500	84.00000	0.32913 d
14.794	4.16250	12.06250	84.00000	0.29904 d
16.907	2.05000	12.00000	84.00000	0.25719 d
d - Displacements include imported displacements.				
Structure: No 29 Sub-structure: Frontage (9)				
Dist.	Coordinates			Displacements
	x	y	z	z
[m]	[m]	[m]	[m]	[mm]
Vertical Offset 1				
0.0	2.00000	11.95000	84.00000	0.25859 d
1.9667	2.00000	9.98333	84.00000	0.39701 d
3.9333	2.00000	8.01667	84.00000	0.68253 d
5.9000	2.00000	6.05000	84.00000	1.9214 d
d - Displacements include imported displacements.				
Structure: Willoughby Road Sub-structure: Roadway (10)				
Dist.	Coordinates			Displacements
	x	y	z	z
[m]	[m]	[m]	[m]	[mm]
Vertical Offset 1				
0.0	-2.00000	-6.00000	85.00000	0.16392 d
2.0000	-2.00000	-4.00000	85.00000	0.22537 d
4.0000	-2.00000	-2.00000	85.00000	0.30390 d
6.0000	-2.00000	0.00000	85.00000	0.38665 d
8.0000	-2.00000	2.00000	85.00000	0.43913 d
10.000	-2.00000	4.00000	85.00000	0.43603 d
12.000	-2.00000	6.00000	85.00000	0.37889 d
14.000	-2.00000	8.00000	85.00000	0.29461 d
16.000	-2.00000	10.00000	85.00000	0.21666 d
18.000	-2.00000	12.00000	85.00000	0.15652 d
d - Displacements include imported displacements.				
Structure: Willow Cottages Sub-structure: Retaining Wall (11)				
Dist.	Coordinates			Displacements
	x	y	z	z
[m]	[m]	[m]	[m]	[mm]
Vertical Offset 1				
0.0	0.00000	-10.00000	83.00000	0.10594 d
2.0264	1.81250	-9.09375	83.00000	0.14875 d
4.0529	3.62500	-8.18750	83.00000	0.20355 d
6.0793	5.43750	-7.28125	83.00000	0.27156 d
8.1057	7.25000	-6.37500	83.00000	0.35425 d
10.132	9.06250	-5.46875	83.00000	0.45680 d
12.159	10.87500	-4.56250	83.00000	0.59313 d
14.185	12.68750	-3.65625	83.00000	0.78921 d
16.211	14.50000	-2.75000	83.00000	1.0746 d
18.238	16.31250	-1.84375	83.00000	1.4683 d
20.264	18.12500	-0.93750	83.00000	1.9373 d
22.291	19.93750	-0.03125	83.00000	1.9255 d
24.317	21.75000	0.87500	83.00000	1.5176 d
26.344	23.56250	1.78125	83.00000	0.93909 d
28.370	25.37500	2.68750	83.00000	0.57673 d
30.397	27.18750	3.59375	83.00000	0.36471 d
32.423	29.00000	4.50000	83.00000	0.23659 d
d - Displacements include imported displacements.				
Structure: Willow Cottages Sub-structure: Rear Elevation				
Dist.	Coordinates			Displacements
	x	y	z	z
[m]	[m]	[m]	[m]	[mm]
Vertical Offset 1				
0.0	0.00000	-13.00000	83.00000	0.060561 d
2.0264	1.81250	-12.09375	83.00000	0.085497 d
4.0529	3.62500	-11.18750	83.00000	0.11648 d
6.0793	5.43750	-10.28125	83.00000	0.15419 d
8.1057	7.25000	-9.37500	83.00000	0.19932 d
10.132	9.06250	-8.46875	83.00000	0.25302 d
12.159	10.87500	-7.56250	83.00000	0.31756 d
14.185	12.68750	-6.65625	83.00000	0.39618 d
16.211	14.50000	-5.75000	83.00000	0.49078 d
18.238	16.31250	-4.84375	83.00000	0.59658 d
20.264	18.12500	-3.93750	83.00000	0.69423 d
22.291	19.93750	-3.03125	83.00000	0.74268 d
24.317	21.75000	-2.12500	83.00000	0.70518 d
26.344	23.56250	-1.21875	83.00000	0.59169 d
28.370	25.37500	-0.31250	83.00000	0.44987 d
30.397	27.18750	0.59375	83.00000	0.32415 d
32.423	29.00000	1.50000	83.00000	0.22799 d
d - Displacements include imported displacements.				
Specific Building Damage Results - All Segments				



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Combined Movements & Damage Assessment

2nd Stage - Short-term (no heave) - 10 mm limit on overall horizontal movement

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Dist.	Coordinates		Displacements								
	x [m]	y [m]	z [m]	z [mm]							
Structure: No 33 Sub-structure: Party Wall (1)											
Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category
[m]		[m]	[m]		[%]	[%]	[%]			[m]	
0.0	1	0.0	4.7844	Sagging	0.010668	0.0	0.0097721	0.0	-417.33E-6	3464.3	0
	2	4.7844	5.1146	Hogging	0.0079526	0.0	0.0077495	0.0	-373.29E-6	5144.5	0
											(Negligible)
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.											
Structure: No 33 Sub-structure: Rear Elevation (2)											
Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category
[m]		[m]	[m]		[%]	[%]	[%]			[m]	
0.0	1	0.0	2.9000	None	0.0	0.060500	0.060500	-604.63E-6	938.70E-6	-	1 (Very Slight)
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.											
Structure: No 33 Sub-structure: Far Elevation (3)											
Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category
[m]		[m]	[m]		[%]	[%]	[%]			[m]	
0.0	1	0.0	8.8320	Hogging	0.0011550	0.012100	0.013010	-120.99E-6	117.42E-6	45892.	0
											(Negligible)
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.											
Structure: No 33 Sub-structure: Far Elevation (4)											
Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category
[m]		[m]	[m]		[%]	[%]	[%]			[m]	
0.0	1	0.0	1.9000	Sagging	0.0	0.0	0.0	0.0	19.584E-6	-	0
											(Negligible)
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.											
Structure: No 33 Sub-structure: Frontage (5)											
Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category
[m]		[m]	[m]		[%]	[%]	[%]			[m]	
0.0	1	0.0	0.37062	Hogging	0.0	0.060500	0.060500	-604.63E-6	-58.873E-6	73242.	1 (Very Slight)
	2	0.37062	6.5294	Hogging	0.011076	0.060500	0.067169	-604.63E-6	-581.02E-6	4157.3	1 (Very Slight)
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.											
Structure: No 29 Sub-structure: Party Wall (6)											
Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category
[m]		[m]	[m]		[%]	[%]	[%]			[m]	
0.0	1	0.0	5.1451	Sagging	0.0060449	-629.51E-6	0.0055333	15.335E-6	-216.28E-6	6214.9	0
	2	5.1451	11.762	Hogging	0.0045476	0.0	0.0042840	0.0	-386.44E-6	6283.6	0
											(Negligible)
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.											
Structure: No 29 Sub-structure: Rear Elevation (7)											
Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category
[m]		[m]	[m]		[%]	[%]	[%]			[m]	
0.0	1	0.0	5.5750	Hogging	0.026418	0.060458	0.069770	-604.22E-6	0.0013673	1490.8	1 (Very Slight)
	2	5.5750	0.32403	Sagging	0.0	0.060458	0.060458	-604.22E-6	124.06E-6	25645.	1 (Very Slight)
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.											
Structure: No 29 Sub-structure: Far Elevation (8)											
Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category
[m]		[m]	[m]		[%]	[%]	[%]			[m]	
0.0	1	0.0	16.907	Sagging	298.45E-6	0.0	429.33E-6	0.0	19.803E-6	192240.	0
											(Negligible)
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.											
Structure: No 29 Sub-structure: Frontage (9)											
Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category
[m]		[m]	[m]		[%]	[%]	[%]			[m]	
0.0	1	0.0	0.26592	Sagging	0.0	0.060458	0.060458	-604.22E-6	-70.341E-6	71022.	1 (Very Slight)
	2	0.26592	5.6331	Hogging	0.011727	0.060458	0.064634	-604.22E-6	-629.57E-6	3352.2	1 (Very Slight)
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.											



31 Willoughby Road

Combined Movements & Damage Assessment

2nd Stage - Short-term (no heave) - 10 mm limit on overall horizontal movement

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Vertical Offset from Line for Vertical Movement	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category
Structure: Willoughby Road Sub-structure: Roadway (10)											
Vertical Offset from Line for Vertical Movement Calculations											
[m]		[m]	[m]		[%]	[%]	[%]			[m]	
0.0	1	0.0	3.8431	Hogging	211.46E-6	-0.032796	0.0065591	560.20E-6	-39.288E-6	196710.	0 (Negligible)
	2	3.8431	10.093	Sagging	0.0014029	-0.042746	0.0085493	0.0010840	42.187E-6	81835.	0 (Negligible)
	3	13.936	4.0637	Hogging	224.28E-6	-0.035428	0.0070856	0.0010840	42.187E-6	193100.	0 (Negligible)
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.											
Structure: Willow Cottages Sub-structure: Retaining Wall (11)											
Vertical Offset from Line for Vertical Movement Calculations											
[m]		[m]	[m]		[%]	[%]	[%]			[m]	
0.0	1	0.0	17.492	Hogging	0.0020504	0.011201	0.013868	-120.99E-6	-194.28E-6	43320.	0 (Negligible)
	2	17.492	7.9565	Sagging	0.0085448	-0.10320	0.020686	0.0028680	286.28E-6	11384.	0 (Negligible)
	3	25.448	6.9739	Hogging	0.0030916	-0.0026197	0.0018064	0.0028680	286.28E-6	27391.	0 (Negligible)
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.											
Structure: Willow Cottages Sub-structure: Rear Elevation											
Vertical Offset from Line for Vertical Movement Calculations											
[m]		[m]	[m]		[%]	[%]	[%]			[m]	
0.0	1	4.0529	12.884	Hogging	451.85E-6	0.012100	0.012580	-120.99E-6	-52.203E-6	287740.	0 (Negligible)
	2	16.937	10.981	Sagging	0.0021520	-0.055069	0.011046	0.0019553	70.059E-6	55459.	0 (Negligible)
	3	27.918	4.5044	Hogging	395.14E-6	-0.026891	0.0053829	0.0010584	70.059E-6	124450.	0 (Negligible)
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.											
Specific Building Damage Results - Critical Values for All Segments within Each Sub-Structure											
Structure: No 33 Sub-structure: Party Wall (1)											
Vertical Offset from Line for Vertical Movement Calculations	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category	
[m]	[%]	[%]		[mm]	[%]			[m]	[m]		
0.0	0.010668		0.0	-417.33E-6	3.7734	0.0097721	0.0	-417.33E-6	5144.5	3464.3	0 (Negligible)
Structure: No 33 Sub-structure: Rear Elevation (2)											
Vertical Offset from Line for Vertical Movement Calculations	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category	
[m]	[%]	[%]		[mm]	[%]			[m]	[m]		
0.0		0.0	0.060500	938.70E-6	3.6508	0.060500	-604.63E-6	938.70E-6	-	- 1	(Very Slight)
Structure: No 33 Sub-structure: Far Elevation (3)											
Vertical Offset from Line for Vertical Movement Calculations	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category	
[m]	[%]	[%]		[mm]	[%]			[m]	[m]		
0.0	0.0011550	0.012100	117.42E-6	0.91201	0.013010	-120.99E-6	117.42E-6	45892.		- 0	(Negligible)
Structure: No 33 Sub-structure: Far Elevation (4)											
Vertical Offset from Line for Vertical Movement Calculations	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category	
[m]	[%]	[%]		[mm]	[%]			[m]	[m]		
0.0		0.0	0.0	19.584E-6	0.26183	0.0	19.584E-6	-	-	- 0	(Negligible)
Structure: No 33 Sub-structure: Frontage (5)											
Vertical Offset from Line for Vertical Movement Calculations	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category	
[m]	[%]	[%]		[mm]	[%]			[m]	[m]		
0.0	0.011076	0.060500	-581.02E-6	1.9859	0.067169	-604.63E-6	-581.02E-6	4157.3		- 1	(Very Slight)
Structure: No 29 Sub-structure: Party Wall (6)											
Vertical Offset from Line for Vertical Movement Calculations	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category	
[m]	[%]	[%]		[mm]	[%]			[m]	[m]		
0.0	0.0060449	-629.51E-6	-386.44E-6	4.0092	0.0055333	15.335E-6	-386.44E-6	6283.6	6214.9	0	(Negligible)



31 Willoughby Road

Combined Movements & Damage Assessment

2nd Stage - Short-term (no heave) - 10 mm limit on overall horizontal movement

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Vertical Offset from Line for Vertical Movement	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category		
Structure: No 29 Sub-structure: Rear Elevation (7)												
Vertical Offset from Line for Vertical Movement Calculations	[m]	[%]	[%]	[mm]	[%]			[m]	[m]			
0.0	0.026418	0.060458	0.0013673	3.8754	0.069770	-604.22E-6	0.0013673	1490.8	25645.1	(Very Slight)		
Structure: No 29 Sub-structure: Far Elevation (8)												
Vertical Offset from Line for Vertical Movement Calculations	[m]	[%]	[%]	[mm]	[%]			[m]	[m]			
0.0	298.45E-6	0.0	19.803E-6	0.40379	429.33E-6	0.0	19.803E-6	-	192240.0	(Negligible)		
Structure: No 29 Sub-structure: Frontage (9)												
Vertical Offset from Line for Vertical Movement Calculations	[m]	[%]	[%]	[mm]	[%]			[m]	[m]			
0.0	0.011727	0.060458	-629.57E-6	1.9208	0.064634	-604.22E-6	-629.57E-6	3352.2	71022.1	(Very Slight)		
Structure: Willoughby Road Sub-structure: Roadway (10)												
Vertical Offset from Line for Vertical Movement Calculations	[m]	[%]	[%]	[mm]	[%]			[m]	[m]			
0.0	0.0014029	-0.042746	42.187E-6	0.43909	0.0085493	0.0010840	42.187E-6	193100.	81835.0	(Negligible)		
Structure: Willow Cottages Sub-structure: Retaining Wall (11)												
Vertical Offset from Line for Vertical Movement Calculations	[m]	[%]	[%]	[mm]	[%]			[m]	[m]			
0.0	0.0085448	-0.10320	286.28E-6	1.9371	0.020686	0.0028680	286.28E-6	27391.	11384.0	(Negligible)		
Structure: Willow Cottages Sub-structure: Rear Elevation												
Vertical Offset from Line for Vertical Movement Calculations	[m]	[%]	[%]	[mm]	[%]			[m]	[m]			
0.0	0.0021520	-0.055069	70.059E-6	0.74199	0.012580	0.0019553	70.059E-6	124450.	55459.0	(Negligible)		
Specific Building Damage Results - Critical Segments within Each Structure												
Structure Name	Parameter	Critical Sub-Structure	Critical Segment	Start	End	Curvature	Max Slope	Max Settlement	Max Tensile Strain	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category
No 33	Max Slope	Rear Elevation (2)	1	0.0	2.9000	Sagging	938.70E-6	3.6508	0.060500	-	-	1 (Very Slight)
	Max Settlement	Party Wall (1)	2	4.7844	9.8990	Hogging	373.29E-6	3.7734	0.0077495	5144.5	-	0 (Negligible)
	Max Tensile Strain	Frontage (5)	2	0.37062	6.9000	Hogging	581.02E-6	1.9859	0.067169	4157.3	-	1 (Very Slight)
	Min Radius of Curvature (Hogging)	Frontage (5)	2	0.37062	6.9000	Hogging	581.02E-6	1.9859	0.067169	4157.3	-	1 (Very Slight)
	Min Radius of Curvature (Sagging)	Party Wall (1)	1	0.0	4.7844	Sagging	417.33E-6	2.9874	0.0097721	-	3464.3	0 (Negligible)
No 29	Max Slope	Rear Elevation (7)	1	0.0	5.5750	Hogging	0.0013673	3.8754	0.069770	1490.8	-	1 (Very Slight)
	Max Settlement	Party Wall (6)	2	5.1451	16.907	Hogging	386.44E-6	4.0092	0.0042840	6283.6	-	0 (Negligible)
	Max Tensile Strain	Rear Elevation (7)	1	0.0	5.5750	Hogging	0.0013673	3.8754	0.069770	1490.8	-	1 (Very Slight)
	Min Radius of Curvature (Hogging)	Rear Elevation (7)	1	0.0	5.5750	Hogging	0.0013673	3.8754	0.069770	1490.8	-	1 (Very Slight)
	Min Radius of Curvature (Sagging)	Party Wall (6)	1	0.0	5.1451	Sagging	216.28E-6	2.5496	0.0055333	-	6214.9	0 (Negligible)
Willoughby Road	Max Slope	Roadway (10)	2	3.8431	13.936	Sagging	42.187E-6	0.43909	0.0085493	-	81835.0	(Negligible)
	Max Settlement	Roadway (10)	2	3.8431	13.936	Sagging	42.187E-6	0.43909	0.0085493	-	81835.0	(Negligible)
	Max Tensile Strain	Roadway (10)	2	3.8431	13.936	Sagging	42.187E-6	0.43909	0.0085493	-	81835.0	(Negligible)
	Min Radius of Curvature (Hogging)	Roadway (10)	3	13.936	18.000	Hogging	42.187E-6	0.29729	0.0070856	193100.	-	0 (Negligible)
	Min Radius of Curvature (Sagging)	Roadway (10)	2	3.8431	13.936	Sagging	42.187E-6	0.43909	0.0085493	-	81835.0	(Negligible)
Willow Cottages	Max Slope	Retaining Wall (11)	2	17.492	25.448	Sagging	286.28E-6	1.9371	0.020686	-	11384.0	(Negligible)
	Max Settlement	Retaining Wall (11)	2	17.492	25.448	Sagging	286.28E-6	1.9371	0.020686	-	11384.0	(Negligible)
	Max Tensile Strain	Retaining Wall (11)	2	17.492	25.448	Sagging	286.28E-6	1.9371	0.020686	-	11384.0	(Negligible)
	Min Radius of Curvature (Hogging)	Retaining Wall (11)	3	25.448	32.422	Hogging	286.28E-6	1.1947	0.0018064	27391.	-	0 (Negligible)
	Min Radius of Curvature (Sagging)	Retaining Wall (11)	2	17.492	25.448	Sagging	286.28E-6	1.9371	0.020686	-	11384.0	(Negligible)



31 Willoughby Road

Combined Movements & Damage Assessment

2nd Stage - Short-term (no heave) - 10 mm limit on overall horizontal movement

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Structure Name	Parameter	Critical Sub-Structure	Critical Segment	Start	End	Curvature	Max Slope	Max Settlement	Max Tensile Strain	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category
Willow Cottages	Max Slope	Rear Elevation	2	16.937	27.918	Sagging	70.059E-6	0.74199	0.011046	-	55459.0	0 (Negligible)
	Max Settlement	Rear Elevation	2	16.937	27.918	Sagging	70.059E-6	0.74199	0.011046	-	55459.0	0 (Negligible)
	Max Tensile Strain	Rear Elevation	1	4.0529	16.937	Hogging	52.203E-6	0.52866	0.012580	287740.	-	0 (Negligible)
	Min Radius of Curvature (Hogging)	Rear Elevation	3	27.918	32.422	Hogging	70.059E-6	0.48154	0.0053829	124450.	-	0 (Negligible)
	Min Radius of Curvature (Sagging)	Rear Elevation	2	16.937	27.918	Sagging	70.059E-6	0.74199	0.011046	-	55459.0	0 (Negligible)

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Analysis Options

Analysis: Boussinesq
Global Poisson's ratio: 0.50
Maximum allowable ratio between values of E: 1.5
Horizontal rigid boundary level: 35.00 [m OD]
Displacements at load centroids: Yes

Soil ProfilesSoil Profile 1

Layer	Level at top	Number of intermediate displacement levels	Youngs Modulus	Poissons ratio	Non-linear curve
			Top [kN/m ²]	Btm [kN/m ²]	
1	85.500	3	7500.0	7500.0	0.50000 None
2	82.500	1	15000.	15000.	0.50000 None
3	82.000	40	20000.	100000.	0.50000 None

Soil Zones

Zone	Name	X coordinates min max	Y coordinates min max	Profile
1	Soil	-20.00000 40.00000	-20.00000 26.00000	Soil Profile 1
	Zone 1			

Load Data

Load ref.	Name	Shape	Orientation of Plane	Centre of load (Global) X Y Z (level)	Load position Angle of local x from Radius	Width x or Radius	Length y	Polygon Coordinates	Rectangle of tolerance	Number of rectangles	Normal (local z)	Load value Tangential (local x) (local y)
1	Basement Excavation	Polygonal	Horizontal	N/A	N/A	N/A	N/A	(3,1) (18,1) (20,2.3) (20,5.5) (12,5.25) (12,4) (3,4)	10.000	3	-55.000	N/A N/A
2	Existing Cellar	Polygonal	Horizontal	N/A	N/A	N/A	N/A	(3,4) (12,4) (12,5.25) (3,5)	10.000	1	-30.000	N/A N/A
3	Underpinning	Polygonal	Horizontal	N/A	N/A	N/A	N/A	(2,6) (2,0) (12,0) (12,1)	10.000	2	60.000	N/A N/A
4	Underpinning	Polygonal	Horizontal	N/A	N/A	N/A	N/A	(12,0) (18,0) (21,2) (21,6.5) (19,6.5) (19,5.5) (20,5.5)	10.000	10	100.00	N/A N/A
5	Underpinning	Polygonal	Horizontal	N/A	N/A	N/A	N/A	(20,2.3) (18,1) (12,1) (19,6.5) (12,6.25) (12,5.25)	10.000	1	60.000	N/A N/A
6	Underpinning	Polygonal	Horizontal	N/A	N/A	N/A	N/A	(19,5.5) (3,6) (12,6.25) (12,5.25) (3,5)	10.000	1	50.000	N/A N/A

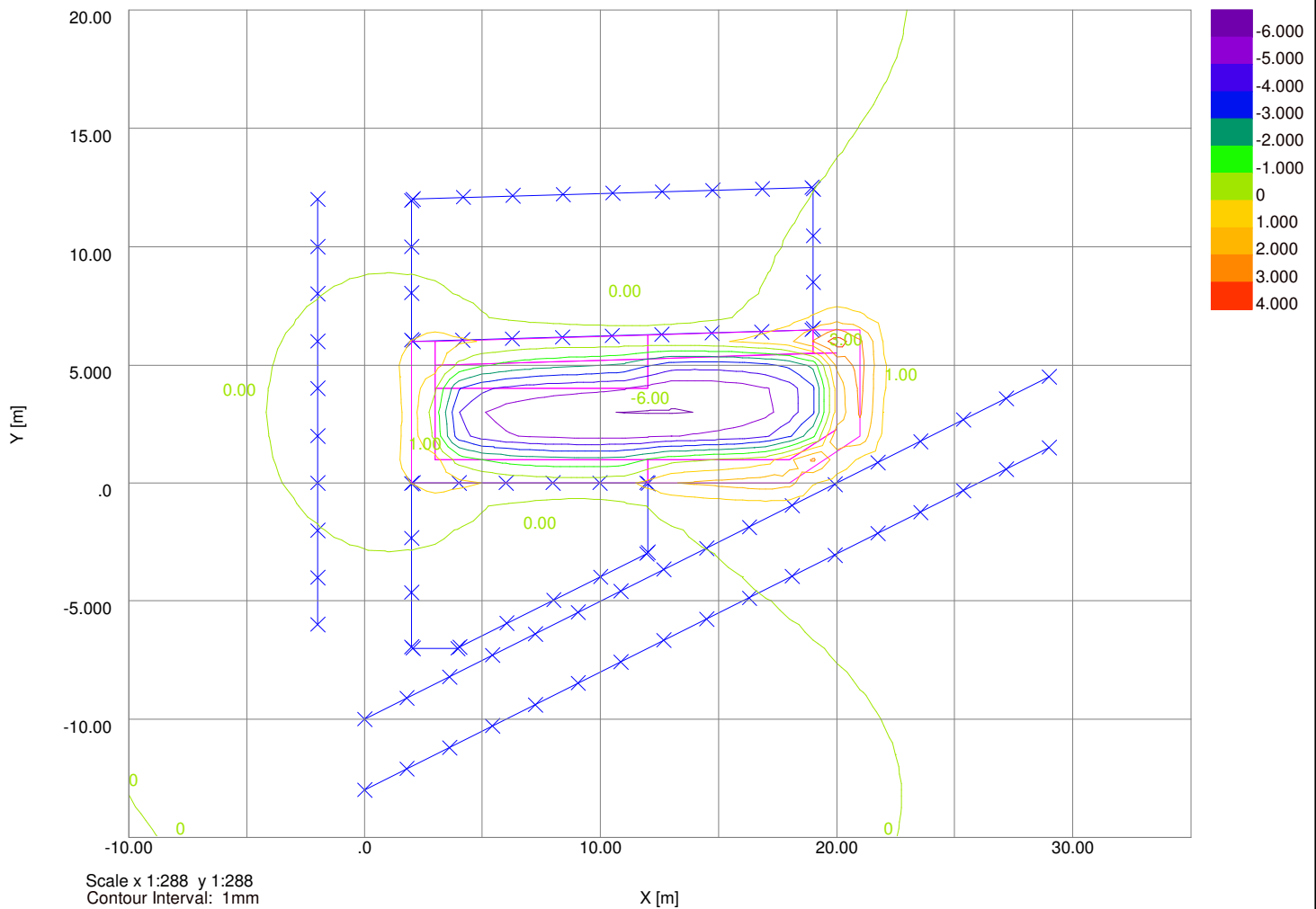
Polygonal Loads' Rectangles

No.	Centre of load X Y	Angle of local x from global X (Degrees)	Width x [m]	Depth y [m]
Load 1 : Basement Excavation (Edge 1 optimal)				
1	7.50000 2.50000	0.0	9.0000	3.0000
2	15.00000 3.17188	0.0	6.0000	4.3438
3	19.00000 3.55938	0.0	2.0000	3.8187
Load 2 : Existing Cellar (Edge 1 optimal)				
1	7.50000 4.56250	0.0	9.0000	1.1250
Load 3 : Underpinning (Edge 1 optimal)				
1	2.50000 3.50000	-90.000	5.0000	1.0000
2	7.00000 0.50000	-90.000	1.0000	10.000
Load 4 : Underpinning (Edge 1 optimal)				
1	15.00000 0.50000	0.0	6.0000	1.0000
2	18.14286 0.59405	0.0	0.28571	0.99762
3	18.42857 0.78214	0.0	0.28571	0.99286
4	18.71429 0.97024	0.0	0.28571	0.98810
5	19.00000 1.15833	0.0	0.28571	0.98333
6	19.28571 1.34643	0.0	0.28571	0.97857
7	19.57143 1.53452	0.0	0.28571	0.97381
8	19.85714 1.72262	0.0	0.28571	0.96905
9	20.50000 4.08333	0.0	1.0000	4.8333
10	19.50000 6.00000	0.0	1.0000	1.0000
Load 5 : Underpinning (Edge 1 optimal)				
1	15.50000 5.87500	-177.95	6.9688	0.99936
Load 6 : Underpinning (Edge 2 optimal)				
1	7.50000 5.62500	1.5911	8.9757	0.99961

Displacement Data

Ref.	Type	Name	Direction of Extrusion	First point X Y Z (level)	Line/Line for extrusion Second point X Y Z (level)	No. of intrvl's across extrusion/line	Extrusion Depth	No. of intrvl's along extrusion	Calculate	Show Detailed results
1	Grid	Grid 1	Global X	-20.00000 -20.00000 84.00000	N/A 26.00000 85.50000	46	60.00000	60	Yes	No
2	Grid	Grid 2	Global X	-20.00000 -20.00000 84.00000	N/A 26.00000 84.00000	46	60.00000	60	Yes	No
3	Line	Line 1	N/A	2.05000 0.00000 84.00000	11.95000 0.00000 84.00000	5	N/A	N/A	Yes	No
4	Line	Line 2	N/A	12.00000 -0.05000 84.00000	12.00000 -2.95000 84.00000	1	N/A	N/A	Yes	No
5	Line	Line 3	N/A	11.95000 -3.00000 84.00000	4.05000 -6.95000 84.00000	4	N/A	N/A	Yes	No
6	Line	Line 4	N/A	3.95000 -7.00000 84.00000	2.05000 -7.00000 84.00000	1	N/A	N/A	Yes	No
7	Line	Line 5	N/A	2.00000 -6.95000 84.00000	2.00000 -0.05000 84.00000	3	N/A	N/A	Yes	No
8	Line	Line 6	N/A	2.05000 6.00000 84.00000	18.95000 6.50000 84.00000	8	N/A	N/A	Yes	No
9	Line	Line 7	N/A	19.00000 6.55000 84.00000	19.00000 12.45000 84.00000	3	N/A	N/A	Yes	No
10	Line	Line 8	N/A	18.95000 12.50000 84.00000	2.05000 12.00000 84.00000	8	N/A	N/A	Yes	No
11	Line	Line 9	N/A	2.00000 11.95000 84.00000	2.00000 6.05000 84.00000	3	N/A	N/A	Yes	No
12	Line	Line 10	N/A	-2.00000 -6.00000 85.00000	-2.00000 12.00000 85.00000	9	N/A	N/A	Yes	No
13	Line	Line 11	N/A	0.00000 -10.00000 83.00000	29.00000 4.50000 83.00000	16	N/A	N/A	Yes	No
14	Line	Line 12	N/A	0.00000 -13.00000 83.00000	29.00000 1.50000 83.00000	16	N/A	N/A	Yes	No

Settlement Contours : Grid 1 at 85.5000m



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Problem Type

Problem Type : Tunnelling and Embedded Wall Excavations

Displacement Data

Type	Name	Direction of extrusion	Point/Line/Line for extrusion						No. of intervals across extrusion/line	Extrusion depth	No. of intervals along extrusion	Calculate	Surface type for tunnels
			First point			Second point							
			X	Y	Z (level)	X	Y	Z (level)					
			[m]	[m]	[m]	[m]	[m]	[m]		[m]			
Grid	Grid 1	Global X	-20.00000	-20.00000	85.50000	-	26.00000	85.50000	46	60.00000	60	Yes	Surface
Grid	Grid 2	Global X	-20.00000	-20.00000	84.00000	-	26.00000	84.00000	46	60.00000	60	Yes	Surface
Line	Line 1	-	2.05000	0.00000	84.00000	11.95000	0.00000	84.00000	5	-	-	Yes	Surface
Line	Line 2	-	12.00000	-0.05000	84.00000	12.00000	-2.95000	84.00000	1	-	-	Yes	Surface
Line	Line 3	-	11.95000	-3.00000	84.00000	4.05000	-6.95000	84.00000	4	-	-	Yes	Surface
Line	Line 4	-	3.95000	-7.00000	84.00000	2.05000	-7.00000	84.00000	1	-	-	Yes	Surface
Line	Line 5	-	2.00000	-6.95000	84.00000	2.00000	-0.05000	84.00000	3	-	-	Yes	Surface
Line	Line 6	-	2.05000	6.00000	84.00000	18.95000	6.50000	84.00000	8	-	-	Yes	Surface
Line	Line 7	-	19.00000	6.55000	84.00000	19.00000	12.45000	84.00000	3	-	-	Yes	Surface
Line	Line 8	-	18.95000	12.50000	84.00000	2.05000	12.00000	84.00000	8	-	-	Yes	Surface
Line	Line 9	-	2.00000	11.95000	84.00000	2.00000	6.05000	84.00000	3	-	-	Yes	Surface
Line	Line 10	-	-2.00000	-6.00000	85.00000	-2.00000	12.00000	85.00000	9	-	-	Yes	Surface
Line	Line 11	-	0.00000	-10.00000	83.00000	29.00000	4.50000	83.00000	16	-	-	Yes	Surface
Line	Line 12	-	0.00000	-13.00000	83.00000	29.00000	1.50000	83.00000	16	-	-	Yes	Surface

Vertical Ground Movement Curves (Excavations)

Curve Name: No vertical ground movement
Coordinates: [Distance from wall / wall depth or max. excavation depth (x), Depth / wall depth or max. excavation depth (y), Settlement / wall depth or max. excavation depth (z) (%)]
 [0.000,0.000,0.000] [1.000,0.000,0.000] [0.000,1.000,0.000] [1.000,1.000,0.000]
Curve Fitting Method: Polynomial
x Order: 1
y Order: 0
Polynomial: z = 0.0x + 0.0
Coeff. of Determination: -2147483648.E+2147483647

Horizontal Ground Movement Curves (Excavations)

Curve Name: GEA Curve for 5 mm of horizontal deflection (after CIRIA 580 Fig. 2.11(a))
Coordinates: [Distance from wall / wall depth or max. excavation depth (x), Depth / wall depth or max. excavation depth (y), Horizontal movement / wall depth or max. excavation depth (z) (%)]
 [0.000,0.000,0.121] [4.000,0.000,0.000]
Curve Fitting Method: Polynomial
x Order: 1
y Order: 0
Polynomial: z = -3.03E-2x + 1.21E-1
Coeff. of Determination: 1.00

Polygonal Excavations

Excavation Name: New Excavation
Surface level [m]: 85.500
Contribution: Positive
Enabled: Yes
Surface movement curves which are selected are applied between surface and [m]: 81.400

Corner	x	y	Base Level	Stiffened	Previous Side	Next Side
	[m]	[m]	[m]	d	p1 p2*	d p1 p2*
				[m]	[%]	[m]
1	2.0000	0.0	81.400	No	- -	- -
2	18.000	0.0	81.400	No	- -	- -
3	21.000	2.0000	81.400	No	- -	- -
4	21.000	6.5000	81.400	No	- -	- -
5	2.0000	6.0000	81.400	No	- -	- -

Side	Corner 1	Corner 2	Ground Movement Curve	
	x y	x y	Vertical	Horizontal
	[m] [m]	[m] [m]		
1	2.0000 0.0	18.000 0.0	No vertical ground movement	GEA Curve for 5 mm of horizontal deflection (after CIRIA 580 Fig. 2.11(a))
2	18.000 0.0	21.000 2.0000	No vertical ground movement	GEA Curve for 5 mm of horizontal deflection (after CIRIA 580 Fig. 2.11(a))
3	21.000 2.0000	21.000 6.5000	No vertical ground movement	GEA Curve for 5 mm of horizontal deflection (after CIRIA 580 Fig. 2.11(a))
4	21.000 6.5000	2.0000 6.0000	No vertical ground movement	GEA Curve for 5 mm of horizontal deflection (after CIRIA 580 Fig. 2.11(a))
5	2.0000 6.0000	2.0000 0.0	No vertical ground movement	GEA Curve for 5 mm of horizontal deflection (after CIRIA 580 Fig. 2.11(a))

Damage Category Strains

Name	0 (Negligible) to 1 (Very Slight)	1 (Very Slight) to 2 (Slight)	2 (Slight) to 3 (Moderate)	3 (Moderate) to 4 (Severe)
Burland Strain Limits	0.0	500.00E-6	750.00E-6	0.0015000

Specific Structures - Geometry

Structure Name	Sub-Structure Name	Displacement Line	Start Distance Along Line	End Distance Along Line	Vertical Offsets from Line for Vertical Movement Calculations	Vertical Displacement Limit	Damage Category Strains	Poisson's Ratio	E/G
			[m]	[m]	[m]	[mm]			
No 33	Party Wall (1)	Line 1	0.00000	9.89900	0.0	0.10000	Burland Strain Limits	0.20000	2.6000
No 33	Rear Elevation (2)	Line 2	0.00000	2.90000	0.0	0.10000	Burland Strain Limits	0.20000	2.6000
No 33	Far Elevation (3)	Line 3	0.00000	8.83200	0.0	0.10000	Burland Strain Limits	0.20000	2.6000
No 33	Far Elevation (4)	Line 4	0.00000	1.90000	0.0	0.10000	Burland Strain Limits	0.20000	2.6000

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Structure Name	Sub-Structure Name	Displacement Line	Start Distance Along Line	End Distance Along Line	Vertical Offsets from Line for Vertical	Vertical Displacement Limit Sensitivity	Damage Category Strains	Poisson's Ratio	E/G
No 33	Frontage (5)	Line 5	0.00000	6.90000	0.0	0.10000	Burland Strain Limits	0.20000	2.6000
No 29	Party Wall (6)	Line 6	0.00000	16.90700	0.0	0.10000	Burland Strain Limits	0.20000	2.6000
No 29	Rear Elevation (7)	Line 7	0.00000	5.89900	0.0	0.10000	Burland Strain Limits	0.20000	2.6000
No 29	Far Elevation (8)	Line 8	0.00000	16.90700	0.0	0.10000	Burland Strain Limits	0.20000	2.6000
No 29	Frontage (9)	Line 9	0.00000	5.89900	0.0	0.10000	Burland Strain Limits	0.20000	2.6000
Willoughby Road	Roadway (10)	Line 10	0.00000	18.00000	0.0	0.10000	Burland Strain Limits	0.20000	2.6000
Willow Cottages	Retaining Wall (11)	Line 11	0.00000	32.42200	0.0	0.10000	Burland Strain Limits	0.20000	2.6000
Willow Cottages	Rear Elevation	Line 12	0.00000	32.42200	0.0	0.10000	Burland Strain Limits	0.20000	2.6000

Specific Structures - Bending Parameters

Structure Name	Sub-Structure Name	Height	Default Properties	Hogging			Sagging		
				2nd Moment of Area (per unit width)	Distance of Bending Strain from N.A.	Distance of N.A. from Edge of Beam in Tension	2nd Moment of Area (per unit width)	Distance of Bending Strain from N.A.	Distance of N.A. from Edge of Beam in Tension
No 33	Party Wall (1)	[m]	8.0000 Yes	[m ⁴]	[m]	[m]	[m ⁴]	[m]	[m]
No 33	Rear Elevation (2)	8.0000	Yes	170.67	8.0000	8.0000	42.667	4.0000	4.0000
No 33	Far Elevation (3)	8.0000	Yes	170.67	8.0000	8.0000	42.667	4.0000	4.0000
No 33	Far Elevation (4)	8.0000	Yes	170.67	8.0000	8.0000	42.667	4.0000	4.0000
No 33	Frontage (5)	8.0000	Yes	170.67	8.0000	8.0000	42.667	4.0000	4.0000
No 29	Party Wall (6)	12.000	Yes	576.00	12.000	12.000	144.00	6.0000	6.0000
No 29	Rear Elevation (7)	12.000	Yes	576.00	12.000	12.000	144.00	6.0000	6.0000
No 29	Far Elevation (8)	12.000	Yes	576.00	12.000	12.000	144.00	6.0000	6.0000
No 29	Frontage (9)	12.000	Yes	576.00	12.000	12.000	144.00	6.0000	6.0000
Willoughby Road	Roadway (10)	0.50000	Yes	0.041667	0.50000	0.50000	0.010417	0.25000	0.25000
Willow Cottages	Retaining Wall (11)	2.5000	Yes	5.2083	2.5000	2.5000	1.3021	1.2500	1.2500
Willow Cottages	Rear Elevation	8.0000	Yes	170.67	8.0000	8.0000	42.667	4.0000	4.0000

Building Segment Combinations

Structure Name	Sub-Structure Name	Vertical Offset from Line for Vertical Movement Calculations	Segment Start	Length	Curvature	Combined Segment
No structures have segments combined.						

Utility Strain Calculation Options

Neglect beneficial contribution of axial strains : No

Warnings

- Sub-structure 6 crosses at least one excavation. Its building damage results in that area should be treated with caution.

Errors

None

Specific Building Damage Results - Horizontal Displacements

Structure: No 33 | Sub-structure: Party Wall (1)

Dist.	Coordinates			Displacements		
	x	y	z	x	y	
				Horizontal displacement along the Line	Horizontal displacement perpendicular to Line	
	[m]	[m]	[m]	[mm]	[mm]	
0.0	2.05000	0.00000	84.00000	0.0	4.9610	d
1.9800	4.03000	0.00000	84.00000	0.0	4.9610	d
3.9600	6.01000	0.00000	84.00000	0.0	4.9610	d
5.9400	7.99000	0.00000	84.00000	0.0	4.9610	d
7.9200	9.97000	0.00000	84.00000	0.0	4.9610	d
9.9000	11.95000	0.00000	84.00000	0.0	4.9610	d

d - Displacements include imported displacements.

Structure: No 33 | Sub-structure: Rear Elevation (2)

Dist.	Coordinates			Displacements		
	x	y	z	x	y	
				Horizontal displacement along the Line	Horizontal displacement perpendicular to Line	
	[m]	[m]	[m]	[mm]	[mm]	
0.0	12.00000	-0.05000	84.00000	0.0	4.9459	0.0 d
2.9000	12.00000	-2.95000	84.00000	0.0	4.0686	0.0 d

d - Displacements include imported displacements.

Structure: No 33 | Sub-structure: Far Elevation (3)

Dist.	Coordinates			Displacements		
	x	y	z	x	y	
				Horizontal displacement along the Line	Horizontal displacement perpendicular to Line	
	[m]	[m]	[m]	[mm]	[mm]	
0.0	11.95000	-3.00000	84.00000	0.0	4.0535	-3.6256 d
2.2081	9.97500	-3.98750	84.00000	0.0	3.7548	-3.3584 d
4.4162	8.00000	-4.97500	84.00000	0.0	3.4561	-3.0912 d
6.6244	6.02500	-5.96250	84.00000	0.0	3.1573	-2.8240 d
8.8325	4.05000	-6.95000	84.00000	0.0	2.8586	-2.5568 d

d - Displacements include imported displacements.

Structure: No 33 | Sub-structure: Far Elevation (4)

Dist.	Coordinates			Displacements		
	x	y	z	x	y	
				Horizontal displacement	Horizontal displacement	



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along the Line		perpendicular to Line	
[m]	[mm]	[m]	[mm]
0.0	3.95000	-7.00000	84.00000
1.9000	2.05000	-7.00000	84.00000
d - Displacements include imported displacements.			

Structure: No 33 | Sub-structure: Frontage (5)

Dist.	Coordinates			Displacements		
x	y	z	x	y	Horizontal displacement along the Line	Horizontal displacement perpendicular to Line
[m]	[m]	[m]	[mm]	[mm]	[mm]	[mm]
0.0	2.00000	-6.95000	84.00000	0.0	2.8586	2.8586
2.3000	2.00000	-4.45000	84.00000	0.0	3.5544	3.5544
4.6000	2.00000	-2.35000	84.00000	0.0	4.2501	4.2501
6.9000	2.00000	-0.05000	84.00000	0.0	4.9459	4.9459
d - Displacements include imported displacements.						

Structure: No 29 | Sub-structure: Party Wall (6)

Dist.	Coordinates			Displacements		
x	y	z	x	y	Horizontal displacement along the Line	Horizontal displacement perpendicular to Line
[m]	[m]	[m]	[mm]	[mm]	[mm]	[mm]
0.0	2.05000	6.00000	84.00000	0.0	0.0	0.0
2.1134	4.16250	6.06250	84.00000	0.13046	-4.9576	-0.016204
4.2268	6.27500	6.12500	84.00000	0.13041	-4.9555	-0.016197
6.3403	8.38750	6.18750	84.00000	0.13035	-4.9534	-0.016191
8.4537	10.50000	6.25000	84.00000	0.13030	-4.9513	-0.016184
10.567	12.61250	6.31250	84.00000	0.13024	-4.9492	-0.016177
12.681	14.72500	6.37500	84.00000	0.13019	-4.9472	-0.016170
14.794	16.83750	6.43750	84.00000	0.13013	-4.9451	-0.016163
16.907	18.95000	6.50000	84.00000	0.13008	-4.9430	-0.016157
d - Displacements include imported displacements.						

Structure: No 29 | Sub-structure: Rear Elevation (7)

Dist.	Coordinates			Displacements		
x	y	z	x	y	Horizontal displacement along the Line	Horizontal displacement perpendicular to Line
[m]	[m]	[m]	[mm]	[mm]	[mm]	[mm]
0.0	19.00000	6.55000	84.00000	0.12969	-4.9283	-0.12969
1.9667	19.00000	8.51667	84.00000	0.11405	-4.3338	-0.11405
3.9333	19.00000	10.48333	84.00000	0.098401	-3.7392	-0.098401
5.9000	19.00000	12.45000	84.00000	0.082756	-3.1447	-0.082756
d - Displacements include imported displacements.						

Structure: No 29 | Sub-structure: Far Elevation (8)

Dist.	Coordinates			Displacements		
x	y	z	x	y	Horizontal displacement along the Line	Horizontal displacement perpendicular to Line
[m]	[m]	[m]	[mm]	[mm]	[mm]	[mm]
0.0	18.95000	12.00000	84.00000	0.082348	-3.1292	0.010228
2.1134	16.83750	12.43750	84.00000	0.082403	-3.1313	0.010235
4.2268	14.72500	12.37500	84.00000	0.082458	-3.1334	0.010242
6.3403	12.61250	12.31250	84.00000	0.082513	-3.1355	0.010249
8.4537	10.50000	12.25000	84.00000	0.082568	-3.1376	0.010255
10.567	8.38750	12.18750	84.00000	0.082623	-3.1397	0.010262
12.681	6.27500	12.12500	84.00000	0.082678	-3.1418	0.010269
14.794	4.16250	12.06250	84.00000	0.082733	-3.1438	0.010276
16.907	2.05000	12.00000	84.00000	0.082788	-3.1459	0.010283
d - Displacements include imported displacements.						

Structure: No 29 | Sub-structure: Frontage (9)

Dist.	Coordinates			Displacements		
x	y	z	x	y	Horizontal displacement along the Line	Horizontal displacement perpendicular to Line
[m]	[m]	[m]	[mm]	[mm]	[mm]	[mm]
0.0	2.00000	11.95000	84.00000	0.083175	-3.1607	3.1607
1.9667	2.00000	9.98333	84.00000	0.098820	-3.7552	3.7552
3.9333	2.00000	8.01667	84.00000	0.11446	-4.3497	4.3497
5.9000	2.00000	6.05000	84.00000	0.13011	-4.9442	4.9442
d - Displacements include imported displacements.						

Structure: Willoughby Road | Sub-structure: Roadway (10)

Dist.	Coordinates			Displacements		
x	y	z	x	y	Horizontal displacement along the Line	Horizontal displacement perpendicular to Line
[m]	[m]	[m]	[mm]	[mm]	[mm]	[mm]
0.0	-2.00000	-6.00000	85.00000	1.0405	1.7391	1.7391
2.0000	-2.00000	-4.00000	85.00000	1.6249	1.6249	1.6249
4.0000	-2.00000	-2.00000	85.00000	2.5432	1.0650	1.0650
6.0000	-2.00000	0.00000	85.00000	3.7510	0.0	0.0
8.0000	-2.00000	2.00000	85.00000	3.7510	0.0	0.0
10.000	-2.00000	4.00000	85.00000	3.7510	0.0	0.0
12.000	-2.00000	6.00000	85.00000	3.7510	0.0	0.0
14.000	-2.00000	8.00000	85.00000	2.5535	-1.0828	-1.0828
16.000	-2.00000	10.00000	85.00000	1.6407	-1.6520	-1.6520
18.000	-2.00000	12.00000	85.00000	1.0574	-1.7681	-1.7681
d - Displacements include imported displacements.						

Structure: Willow Cottages | Sub-structure: Retaining Wall (11)

Dist.	Coordinates			Displacements		
x	y	z	x	y	Horizontal displacement along the Line	Horizontal displacement perpendicular to Line
[m]	[m]	[m]	[mm]	[mm]	[mm]	[mm]
0.0	0.00000	-10.00000	83.00000	0.23576	1.6403	0.94445
2.0264	1.81250	-9.09375	83.00000	0.028999	2.1806	1.0011
4.0529	3.62500	-8.18750	83.00000	0.0	2.4843	1.1110
6.0793	5.43750	-7.28125	83.00000	0.0	2.7584	1.2336
8.1057	7.25000	-6.37500	83.00000	0.0	3.0326	1.3562



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Dist.	Coordinates			Displacements		
x	y	z	x	y	Horizontal displacement along the	Horizontal displacement perpendicular
10.132	9.06250	-5.46875	83.00000	0.0	3.3067	1.4788
12.159	10.87500	-4.56250	83.00000	0.0	3.5808	1.6014
14.185	12.68750	-3.65625	83.00000	0.0	3.8550	1.7240
16.211	14.50000	-2.75000	83.00000	0.0	4.1291	1.8466
18.238	16.31250	-1.84375	83.00000	0.0	4.4033	1.9692
20.264	18.12500	-0.93750	83.00000	-0.58457	4.4979	1.4887
22.291	19.93750	-0.03125	83.00000	-2.5672	3.8508	-0.57404
24.317	21.75000	0.87500	83.00000	-2.5250	3.7875	-0.56461
26.344	23.56250	1.78125	83.00000	-4.0216	0.30159	-3.4622
28.370	25.37500	2.68750	83.00000	-3.6376	0.0	-3.2535
30.397	27.18750	3.59375	83.00000	-3.0893	0.0	-2.7631
32.423	29.00000	4.50000	83.00000	-2.5410	0.0	-2.2727
d - Displacements include imported displacements.						

Structure: Willow Cottages | Sub-structure: Rear Elevation

Dist.	Coordinates			Displacements		
x	y	z	x	y	Horizontal displacement along the Line	Horizontal displacement perpendicular to Line
[m]	[m]	[m]	[m]	[mm]	[mm]	[mm]
0.0	0.00000	-13.00000	83.00000	0.095453	0.88678	0.48196
2.0264	1.81250	-12.09375	83.00000	0.012852	1.2893	0.58811
4.0529	3.62500	-11.18750	83.00000	0.0	1.5768	0.70516
6.0793	5.43750	-10.28125	83.00000	0.0	1.8509	0.82776
8.1057	7.25000	-9.37500	83.00000	0.0	2.1251	0.95036
10.132	9.06250	-8.46875	83.00000	0.0	2.3992	1.0730
12.159	10.87500	-7.56250	83.00000	0.0	2.6733	1.1956
14.185	12.68750	-6.65625	83.00000	0.0	2.9475	1.3182
16.211	14.50000	-5.75000	83.00000	0.0	3.2216	1.4408
18.238	16.31250	-4.84375	83.00000	0.0	3.4958	1.5634
20.264	18.12500	-3.93750	83.00000	-0.11285	3.7351	1.5695
22.291	19.93750	-3.03125	83.00000	-2.0778	3.2436	-0.40784
24.317	21.75000	-2.12500	83.00000	-2.1061	3.1592	-0.47095
26.344	23.56250	-1.21875	83.00000	-2.2036	2.8268	-0.70675
28.370	25.37500	-0.31250	83.00000	-2.7009	1.4260	-1.7780
30.397	27.18750	0.59375	83.00000	-2.7336	0.57546	-2.1876
32.423	29.00000	1.50000	83.00000	-2.4645	0.13403	-2.1444
d - Displacements include imported displacements.						

Specific Building Damage Results - Vertical Displacements

Structure: No 33 | Sub-structure: Party Wall (1)

Dist.	Coordinates			Displacements
	x	y	z	z
[m]	[m]	[m]	[m]	[mm]

Vertical Offset 1			
0.0	2.05000	0.00000	84.00000
1.9800	4.03000	0.00000	84.00000
3.9600	6.01000	0.00000	84.00000
5.9400	7.99000	0.00000	84.00000
7.9200	9.97000	0.00000	84.00000
9.9000	11.95000	0.00000	84.00000
d - Displacements include imported displacements.			

Structure: No 33 | Sub-structure: Rear Elevation (2)

Dist.	Coordinates			Displacements
	x	y	z	z
[m]	[m]	[m]	[m]	[mm]

Vertical Offset 1			
0.0	12.00000	-0.05000	84.00000
2.9000	12.00000	-2.95000	84.00000
d - Displacements include imported displacements.			

Structure: No 33 | Sub-structure: Far Elevation (3)

Dist.	Coordinates			Displacements
	x	y	z	z
[m]	[m]	[m]	[m]	[mm]

Vertical Offset 1			
0.0	11.95000	-3.00000	84.00000
2.2081	9.97500	-3.98750	84.00000
4.4162	8.00000	-4.97500	84.00000
6.6244	6.02500	-5.96250	84.00000
8.8325	4.05000	-6.95000	84.00000
d - Displacements include imported displacements.			

Structure: No 33 | Sub-structure: Far Eleavtion (4)

Dist.	Coordinates			Displacements
	x	y	z	z
[m]	[m]	[m]	[m]	[mm]

Vertical Offset 1			
0.0	3.95000	-7.00000	84.00000
1.9000	2.05000	-7.00000	84.00000
d - Displacements include imported displacements.			

Structure: No 33 | Sub-structure: Frontage (5)

Dist.	Coordinates			Displacements
	x	y	z	z
[m]	[m]	[m]	[m]	[mm]

Vertical Offset 1			
0.0	2.00000	-6.95000	84.00000
2.3000	2.00000	-4.65000	84.00000
4.6000	2.00000	-2.35000	84.00000
6.9000	2.00000	-0.05000	84.00000
d - Displacements include imported displacements.			

Structure: No 29 | Sub-structure: Party Wall (6)

Dist.	Coordinates			Displacements
	x	y	z	z
[m]	[m]	[m]	[m]	[mm]

Vertical Offset 1			
0.0	2.05000	6.00000	84.00000
2.1134	4.16250	6.06250	84.00000
4.2268	6.27500	6.12500	84.00000
6.3403	8.38750	6.18750	84.00000
8.4537	10.50000	6.25000	84.00000
10.567	12.61250	6.31250	84.00000



31 Willoughby Road
Combined Movements & Damage Assessment
2nd Stage - Short-term (with heave) - 5 mm limit on overall horizontal movements

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Dist.	Coordinates			Displacements
	x	y	z	
[m]	[m]	[m]	[m]	[mm]
12.691	14.72500	6.37500	84.00000	0.56101 d
14.794	16.83750	6.43750	84.00000	1.0071 d
16.907	18.95000	6.50000	84.00000	2.2573 d
d - Displacements include imported displacements.				
Structure: No 29 Sub-structure: Rear Elevation (7)				
Dist.	Coordinates			Displacements
	x	y	z	
[m]	[m]	[m]	[m]	[mm]
Vertical Offset 1				
0.0	19.00000	6.55000	84.00000	2.1718 d
1.9667	19.00000	8.51667	84.00000	0.25827 d
3.9333	19.00000	10.48333	84.00000	0.048087 d
5.9000	19.00000	12.45000	84.00000	-0.0023866 d
d - Displacements include imported displacements.				
Structure: No 29 Sub-structure: Far Elevation (8)				
Dist.	Coordinates			Displacements
	x	y	z	
[m]	[m]	[m]	[m]	[mm]
Vertical Offset 1				
0.0	18.95000	12.50000	84.00000	-0.0039325 d
2.1134	16.83750	12.43750	84.00000	-0.050272 d
4.2268	14.72500	12.37500	84.00000	-0.096609 d
6.3403	12.61250	12.31250	84.00000	-0.12825 d
8.4537	10.50000	12.25000	84.00000	-0.13950 d
10.567	8.38750	12.18750	84.00000	-0.13108 d
12.681	6.27500	12.12500	84.00000	-0.10741 d
14.794	4.16250	12.06250	84.00000	-0.076516 d
16.907	2.05000	12.00000	84.00000	-0.048957 d
d - Displacements include imported displacements.				
Structure: No 29 Sub-structure: Frontage (9)				
Dist.	Coordinates			Displacements
	x	y	z	
[m]	[m]	[m]	[m]	[mm]
Vertical Offset 1				
0.0	2.00000	11.95000	84.00000	-0.048444 d
1.9667	2.00000	9.98333	84.00000	-0.036931 d
3.9333	2.00000	8.01667	84.00000	0.054493 d
5.9000	2.00000	6.05000	84.00000	0.97152 d
d - Displacements include imported displacements.				
Structure: Willoughby Road Sub-structure: Roadway (10)				
Dist.	Coordinates			Displacements
	x	y	z	
[m]	[m]	[m]	[m]	[mm]
Vertical Offset 1				
0.0	-2.00000	-6.00000	85.00000	-0.019727 d
2.0000	-2.00000	-4.00000	85.00000	-0.015393 d
4.0000	-2.00000	-2.00000	85.00000	-0.0023783 d
6.0000	-2.00000	0.00000	85.00000	0.016285 d
8.0000	-2.00000	2.00000	85.00000	0.027921 d
10.000	-2.00000	4.00000	85.00000	0.028727 d
12.000	-2.00000	6.00000	85.00000	0.017452 d
14.000	-2.00000	8.00000	85.00000	-0.0021792 d
16.000	-2.00000	10.00000	85.00000	-0.016232 d
18.000	-2.00000	12.00000	85.00000	-0.021250 d
d - Displacements include imported displacements.				
Structure: Willow Cottages Sub-structure: Retaining Wall (11)				
Dist.	Coordinates			Displacements
	x	y	z	
[m]	[m]	[m]	[m]	[mm]
Vertical Offset 1				
0.0	0.00000	-10.00000	83.00000	-0.021762 d
2.0264	1.81250	-9.09375	83.00000	-0.032251 d
4.0529	3.62500	-8.18750	83.00000	-0.047397 d
6.0793	5.43750	-7.28125	83.00000	-0.068979 d
8.1057	7.25000	-6.37500	83.00000	-0.096977 d
10.132	9.06250	-5.46875	83.00000	-0.12254 d
12.159	10.87500	-4.56250	83.00000	-0.13880 d
14.185	12.68750	-3.65625	83.00000	-0.10851 d
16.211	14.50000	-2.75000	83.00000	-698.08E-6 d
18.238	16.31250	-1.84375	83.00000	0.21940 d
20.264	18.12500	-0.93750	83.00000	0.57605 d
22.291	19.93750	-0.03125	83.00000	0.64006 d
24.317	21.75000	0.87500	83.00000	0.55078 d
26.344	23.56250	1.78125	83.00000	0.30372 d
28.370	25.37500	2.68750	83.00000	0.16323 d
30.397	27.18750	3.59375	83.00000	0.081827 d
32.423	29.00000	4.50000	83.00000	0.054799 d
d - Displacements include imported displacements.				
Structure: Willow Cottages Sub-structure: Rear Elevation				
Dist.	Coordinates			Displacements
	x	y	z	
[m]	[m]	[m]	[m]	[mm]
Vertical Offset 1				
0.0	0.00000	-13.00000	83.00000	-0.013721 d
2.0264	1.81250	-12.09375	83.00000	-0.020353 d
4.0529	3.62500	-11.18750	83.00000	-0.029066 d
6.0793	5.43750	-10.28125	83.00000	-0.040154 d
8.1057	7.25000	-9.37500	83.00000	-0.053255 d
10.132	9.06250	-8.46875	83.00000	-0.066494 d
12.159	10.87500	-7.56250	83.00000	-0.075651 d
14.185	12.68750	-6.65625	83.00000	-0.074142 d
16.211	14.50000	-5.75000	83.00000	-0.054746 d
18.238	16.31250	-4.84375	83.00000	-0.013291 d
20.264	18.12500	-3.93750	83.00000	0.045825 d
22.291	19.93750	-3.03125	83.00000	0.10179 d
24.317	21.75000	-2.12500	83.00000	0.13033 d
26.344	23.56250	-1.21875	83.00000	0.12566 d
28.370	25.37500	-0.31250	83.00000	0.098954 d
30.397	27.18750	0.59375	83.00000	0.070507 d
32.423	29.00000	1.50000	83.00000	0.048859 d
d - Displacements include imported displacements.				
Specific Building Damage Results - All Segments				



31 Willoughby Road

Combined Movements & Damage Assessment

2nd Stage - Short-term (with heave) - 5 mm limit on overall horizontal movements

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Dist.	Coordinates			Displacements							
	x [m]	y [m]	z [m]	z [mm]							
Structure: No 33 Sub-structure: Party Wall (1)											
Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category
[m] 0.0		[m] 1	[m] 0.0	[m] 3.8393	[%] Sagging	[%] 0.0081613	[%] 0.0	[%] 0.0077061	0.0	[m] 246.79E-6	4463.8 (Negligible) 0
		2	3.8393	6.0597	Hogging	0.0089807	0.0	0.0086621	0.0	-349.18E-6	4772.6 (Negligible) 0
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.											
Structure: No 33 Sub-structure: Rear Elevation (2)											
Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category
[m] 0.0		[m] 1	[m] 0.0	[m] 2.9000	[%] None	[%] 0.0	[%] 0.030250	[%] 0.030250	-302.41E-6	[m] 453.74E-6	- (Negligible) 0
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.											
Structure: No 33 Sub-structure: Far Elevation (3)											
Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category
[m] 0.0		[m] 1	[m] 0.0	[m] 4.4162	[%] Hogging	[%] 671.58E-6	[%] 0.0060500	[%] 0.0063297	-60.496E-6	[m] -19.397E-6	67344. (Negligible) 0
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.											
Structure: No 33 Sub-structure: Far Eleavtion (4)											
Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category
[m] 0.0		[m]	[m]		[%]	[%]	[%]			[m]	
All settlements are less than the Settlement Trough Limit Sensitivity.											
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.											
Structure: No 33 Sub-structure: Frontage (5)											
Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category
[m] 0.0		[m] 1	[m] 6.9000	[m] 0.0	[%] None	[%] 0.0	[%] 0.0	[%] -302.41E-6	[%] -407.56E-6	[m] 4941.8	0 (Negligible)
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.											
Structure: No 29 Sub-structure: Party Wall (6)											
Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category
[m] 0.0		[m] 1	[m] 0.0	[m] 3.6840	[%] Sagging	[%] 0.0038020	[%] -439.72E-6	[%] 0.0035458	7.6674E-6	[m] 204.99E-6	9409.6 (Negligible) 0
		2	3.6840	13.223	Hogging	0.0090404	0.0	0.0083877	0.0	-591.59E-6	4747.1 (Negligible) 0
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.											
Structure: No 29 Sub-structure: Rear Elevation (7)											
Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category
[m] 0.0		[m] 1	[m] 0.0	[m] 1.9667	[%] None	[%] 0.0	[%] 0.030229	[%] 0.030229	-302.20E-6	[m] 972.69E-6	1852.4 (Negligible) 0
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.											
Structure: No 29 Sub-structure: Far Elevation (8)											
Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category
[m] 0.0		[m] 1	[m] 6.3403	[m] 6.3403	[%] Hogging	[%] 286.99E-6	[%] 0.0	[%] 282.06E-6	0.0	[m] 14.971E-6	237760. (Negligible) 0
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.											
Structure: No 29 Sub-structure: Frontage (9)											
Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category
[m] 0.0		[m] 1	[m] 5.8990	[m] 0.0	[%] None	[%] 0.0	[%] 0.0	[%] 0.0	-302.20E-6	[m] -466.15E-6	3823.3 (Negligible) 0
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.											
Structure: Willoughby Road Sub-structure: Roadway (10)											
Vertical Offset from Line for Vertical Movement	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category



31 Willoughby Road

Combined Movements & Damage Assessment

2nd Stage - Short-term (with heave) - 5 mm limit on overall horizontal movements

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Calculations							Curve				
[m]	[m]	[m]		[%]	[%]	[%]				[m]	
0.0	All settlements are less than the Settlement Trough Limit Sensitivity.										
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.											
Structure: Willow Cottages Sub-structure: Retaining Wall (11)											
Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category
[m]		[m]	[m]		[%]	[%]	[%]			[m]	
0.0	1	10.132	8.3759	Hogging	0.0020634	0.0050901	0.0081826	237.19E-6	-176.04E-6	37619.0	(Negligible)
	2	18.508	7.3173	Sagging	0.0043923	-0.063223	0.012669	0.0014319	-176.04E-6	21699.0	(Negligible)
	3	25.825	2.5447	Hogging	849.16E-6	-0.020925	0.0042101	0.0014319	122.09E-6	58760.0	(Negligible)
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.											

Structure: Willow Cottages Sub-structure: Rear Elevation											
Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category
[m]		[m]	[m]		[%]	[%]	[%]			[m]	
0.0		1	22.291	4.0529	Sagging	405.50E-6	-0.0073753	0.0014914	976.71E-6	-27.643E-6	141950.0 (Negligible)
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.											

Specific Building Damage Results - Critical Values for All Segments within Each Sub-Structure

Structure: No 33 Sub-structure: Party Wall (1)										
Vertical Offset from Line for Vertical Movement Calculations	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category
[m]	[%]	[%]		[mm]	[%]			[m]	[m]	
0.0	0.0089807		0.0	-349.18E-6	1.2709	0.0086621	0.0	-349.18E-6	4772.6	4463.8 0 (Negligible)

Structure: No 33 Sub-structure: Rear Elevation (2)										
Vertical Offset from Line for Vertical Movement Calculations	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category
[m]	[%]	[%]		[mm]	[%]			[m]	[m]	
0.0	0.0	0.030250	453.74E-6	1.1763	0.030250	-302.41E-6	453.74E-6	-	-	0 (Negligible)

Structure: No 33 Sub-structure: Far Elevation (3)										
Vertical Offset from Line for Vertical Movement Calculations	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category
[m]	[%]	[%]		[mm]	[%]			[m]	[m]	
0.0	671.58E-6	0.0060500	-19.397E-6	0.16884	0.0063297	-60.496E-6	-19.397E-6	67344.		- 0 (Negligible)

Structure: No 33 Sub-structure: Far Elevation (4)										
Vertical Offset from Line for Vertical Movement Calculations	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category
[m]	[%]	[%]		[mm]	[%]			[m]	[m]	
0.0										

Structure: No 33 Sub-structure: Frontage (5)										
Vertical Offset from Line for Vertical Movement Calculations	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient Horizontal Displacement Curve	Max Gradient Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category
[m]	[%]	[%]		[mm]	[%]			[m]	[m]	
0.0	0.0	0.0	-407.56E-6	0.96369	0.0	-302.41E-6	-407.56E-6	-	-	0 (Negligible)

Structure: No 29 Sub-structure: Party Wall (6)										
Vertical Offset from Line for Vertical Movement Calculations	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient Horizontal Displacement Curve	Max Gradient Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category
[m]	[%]	[%]		[mm]	[%]			[m]	[m]	
0.0	0.0090404	-439.72E-6	-591.59E-6	2.2571	0.0083877	7.6674E-6	-591.59E-6	4747.1	9409.6	0 (Negligible)

Structure: No 29 Sub-structure: Rear Elevation (7)										
Vertical Offset from Line for Vertical Movement Calculations	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category
[m]	[%]	[%]		[mm]	[%]			[m]	[m]	
0.0	0.0	0.030229	972.69E-6	2.1718	0.030229	-302.20E-6	972.69E-6	-	-	0 (Negligible)

Structure: No 29 Sub-structure: Far Elevation (8)										
Vertical	Deflection	Average	Max Slope	Max	Max	Max Gradient	Max Gradient	Min	Min	Damage Category

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Offset from Line for Vertical Movement Calculations	Ratio	Horizontal Strain	Settlement	Tensile Strain	of Horizontal Displacement Curve	of Vertical Displacement Curve	Radius of Curvature (Hogging)	Radius of Curvature (Sagging)
[m] 0.0	[%] 286.99E-6	[%] 0.0	[mm] 14.971E-6	[%] 0.13950	282.06E-6	0.0	[m] 14.971E-6	[m] 237760. - 0 (Negligible)

Structure: No 29 | Sub-structure: Frontage (9)

Vertical Offset from Line for Vertical Movement Calculations	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category
[m] 0.0	[%] 0.0	[%] 0.0	-466.15E-6	[mm] 0.97106	[%] 0.0	-302.20E-6	-466.15E-6	[m] -	[m] -	- 0 (Negligible)

Structure: Willoughby Road | Sub-structure: Roadway (10)

Vertical Offset from Line for Vertical Movement Calculations	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category
[m] 0.0	[%] 0.0	[%] 0.0	-466.15E-6	[mm] 0.97106	[%] 0.0	-302.20E-6	-466.15E-6	[m] -	[m] -	- 0 (Negligible)

Structure: Willow Cottages | Sub-structure: Retaining Wall (11)

Vertical Offset from Line for Vertical Movement Calculations	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category
[m] 0.0	[%] 0.0043923	[%] -0.063223	-176.04E-6	[mm] 0.63964	[%] 0.012669	0.0014319	-176.04E-6	[m] 37619.	[m] 21699. 0	(Negligible)

Structure: Willow Cottages | Sub-structure: Rear Elevation

Vertical Offset from Line for Vertical Movement Calculations	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category
[m] 0.0	[%] 405.50E-6	[%] -0.0073753	-27.643E-6	[mm] 0.13028	[%] 0.0014914	976.71E-6	-27.643E-6	[m] -	[m] 141950. 0	(Negligible)

Specific Building Damage Results - Critical Segments within Each Structure

Structure Name	Parameter	Critical Sub-Structure	Critical Segment	Start	End	Curvature	Max Slope	Max Settlement	Max Tensile Strain	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category
No 33	Max Slope	Rear Elevation (2)	1	[m] 0.0	[m] 2.9000	Sagging	453.74E-6	[mm] 1.1763	[%] 0.030250	[m] -	[m] -	- 0 (Negligible)
	Max Settlement	Party Wall (1)	1	0.0	3.8393	Sagging	246.79E-6	1.2709	0.0077061	-	4463.8 0	(Negligible)
	Max Tensile Strain	Rear Elevation (2)	1	0.0	2.9000	Sagging	453.74E-6	1.1763	0.030250	-	- 0 (Negligible)	
	Min Radius of Curvature (Hogging)	Party Wall (1)	2	3.8393	9.8990	Hogging	349.18E-6	1.2523	0.0086621	4772.6	- 0 (Negligible)	
	Min Radius of Curvature (Sagging)	Party Wall (1)	1	0.0	3.8393	Sagging	246.79E-6	1.2709	0.0077061	-	4463.8 0	(Negligible)
No 29	Max Slope	Rear Elevation (7)	1	0.0	1.9667	Sagging	972.69E-6	2.1718	0.030229	-	1852.4 0	(Negligible)
	Max Settlement	Party Wall (6)	2	3.6840	16.907	Hogging	591.59E-6	2.2571	0.0083877	4747.1	- 0 (Negligible)	
	Max Tensile Strain	Rear Elevation (7)	1	0.0	1.9667	Sagging	972.69E-6	2.1718	0.030229	-	1852.4 0	(Negligible)
	Min Radius of Curvature (Hogging)	Party Wall (6)	2	3.6840	16.907	Hogging	591.59E-6	2.2571	0.0083877	4747.1	- 0 (Negligible)	
	Min Radius of Curvature (Sagging)	Party Wall (6)	1	0.0	3.6840	Sagging	204.99E-6	1.1200	0.0035458	-	9409.6 0	(Negligible)
Willoughby Road All settlements are less than the Settlement Trough Limit Sensitivity.												
All settlements are less than the Settlement Trough Limit Sensitivity.												
All settlements are less than the Settlement Trough Limit Sensitivity.												
All settlements are less than the Settlement Trough Limit Sensitivity.												
Willow Cottages	Max Slope	Retaining Wall (11)	1	10.132	18.508	Hogging	176.04E-6	0.26695	0.0081826	37619.	- 0 (Negligible)	
	Max Settlement	Retaining Wall (11)	2	18.508	25.825	Sagging	176.04E-6	0.63964	0.012669	-	21699. 0	(Negligible)
	Max Tensile Strain	Retaining Wall (11)	2	18.508	25.825	Sagging	176.04E-6	0.63964	0.012669	-	21699. 0	(Negligible)
	Min Radius of Curvature (Hogging)	Retaining Wall (11)	1	10.132	18.508	Hogging	176.04E-6	0.26695	0.0081826	37619.	- 0 (Negligible)	
	Min Radius of Curvature (Sagging)	Retaining Wall (11)	2	18.508	25.825	Sagging	176.04E-6	0.63964	0.012669	-	21699. 0	(Negligible)
Willow Cottages	Max Slope	Rear Elevation	1	22.291	26.344	Sagging	27.643E-6	0.13028	0.0014914	-	141950. 0	(Negligible)
	Max Settlement	Rear Elevation	1	22.291	26.344	Sagging	27.643E-6	0.13028	0.0014914	-	141950. 0	(Negligible)
	Max Tensile Strain	Rear Elevation	1	22.291	26.344	Sagging	27.643E-6	0.13028	0.0014914	-	141950. 0	(Negligible)
	Min Radius of Curvature (Hogging)		-	-	-	-	-	-	-	-	-	
	Min Radius of Curvature (Sagging)	Rear Elevation	1	22.291	26.344	Sagging	27.643E-6	0.13028	0.0014914	-	141950. 0	(Negligible)

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Problem Type

Problem Type : Tunnelling and Embedded Wall Excavations

Displacement Data

Type	Name	Direction of extrusion	Point/Line/Line for extrusion		No. of intervals across extrusion/line	Extrusion depth	No. of intervals along extrusion	Calculate	Surface type for tunnels
			First point	Second point					
			X [m]	Y [m]	Z (level) [m]	X [m]	Y [m]	Z (level) [m]	
Grid	Grid 1	Global X	-20.00000	-20.00000	85.50000	-	26.00000	85.50000	46 60.00000 60 Yes Surface
Grid	Grid 2	Global X	-20.00000	-20.00000	84.00000	-	26.00000	84.00000	46 60.00000 60 Yes Surface
Line	Line 1	-	2.05000	0.00000	84.00000	11.95000	0.00000	84.00000	5 - Yes Surface
Line	Line 2	-	12.00000	-0.05000	84.00000	12.00000	-2.95000	84.00000	1 - Yes Surface
Line	Line 3	-	11.95000	-3.00000	84.00000	4.05000	-6.95000	84.00000	4 - Yes Surface
Line	Line 4	-	3.95000	-7.00000	84.00000	2.05000	-7.00000	84.00000	1 - Yes Surface
Line	Line 5	-	2.00000	-6.95000	84.00000	2.00000	-0.05000	84.00000	3 - Yes Surface
Line	Line 6	-	2.05000	6.00000	84.00000	18.95000	6.50000	84.00000	8 - Yes Surface
Line	Line 7	-	19.00000	6.55000	84.00000	19.00000	12.45000	84.00000	3 - Yes Surface
Line	Line 8	-	18.95000	12.50000	84.00000	2.05000	12.00000	84.00000	8 - Yes Surface
Line	Line 9	-	2.00000	11.95000	84.00000	2.00000	6.05000	84.00000	3 - Yes Surface
Line	Line 10	-	-2.00000	-6.00000	85.00000	-2.00000	12.00000	85.00000	9 - Yes Surface
Line	Line 11	-	0.00000	-10.00000	83.00000	29.00000	4.50000	83.00000	16 - Yes Surface
Line	Line 12	-	0.00000	-13.00000	83.00000	29.00000	1.50000	83.00000	16 - Yes Surface

Vertical Ground Movement Curves (Excavations)

Curve Name: No vertical ground movement
Coordinates: [Distance from wall / wall depth or max. excavation depth (x), Depth / wall depth or max. excavation depth (y), Settlement / wall depth or max. excavation depth (z) (%)]
 [0.000,0.000,0.000] [1.000,0.000,0.000] [0.000,1.000,0.000] [1.000,1.000,0.000]
Curve Fitting Method: Polynomial
x Order: 1
y Order: 0
Polynomial: z = 0.0x + 0.0
Coeff. of Determination: -2147483648.E+2147483647

Horizontal Ground Movement Curves (Excavations)

Curve Name: GEA Curve for 10 mm of horizontal deflection (after CIRIA 580 Fig. 2.11(a))
Coordinates: [Distance from wall / wall depth or max. excavation depth (x), Depth / wall depth or max. excavation depth (y), Horizontal movement / wall depth or max. excavation depth (z) (%)]
 [0.000,0.000,0.242] [4.000,0.000,0.000]
Curve Fitting Method: Polynomial
x Order: 1
y Order: 0
Polynomial: z = -6.05E-2x + 2.42E-1
Coeff. of Determination: 1.00

Polygonal Excavations

Excavation Name: New Excavation
Surface level [m]: 85.500
Contribution: Positive
Enabled: Yes
Surface movement curves which are selected are applied between surface and [m]: 81.400

Corner	x	y	Base Level	Stiffened	Previous Side	Next Side
	[m]	[m]	[m]	d	p1 p2*	d p1 p2*
1	2.0000	0.0	81.400	No	- - -	- - -
2	18.000	0.0	81.400	No	- - -	- - -
3	21.000	2.0000	81.400	No	- - -	- - -
4	21.000	6.5000	81.400	No	- - -	- - -
5	2.0000	6.0000	81.400	No	- - -	- - -

Side	Corner 1	Corner 2	Ground Movement Curve	
	x y	x y	Vertical	Horizontal
	[m] [m]	[m] [m]		
1	2.0000 0.0	18.000 0.0	No vertical ground movement	GEA Curve for 10 mm of horizontal deflection (after CIRIA 580 Fig. 2.11(a))
2	18.000 0.0	21.000 2.0000	No vertical ground movement	GEA Curve for 10 mm of horizontal deflection (after CIRIA 580 Fig. 2.11(a))
3	21.000 2.0000	21.000 6.5000	No vertical ground movement	GEA Curve for 10 mm of horizontal deflection (after CIRIA 580 Fig. 2.11(a))
4	21.000 6.5000	2.0000 6.0000	No vertical ground movement	GEA Curve for 10 mm of horizontal deflection (after CIRIA 580 Fig. 2.11(a))
5	2.0000 6.0000	2.0000 0.0	No vertical ground movement	GEA Curve for 10 mm of horizontal deflection (after CIRIA 580 Fig. 2.11(a))

Damage Category Strains

Name	0 (Negligible) to 1 (Very Slight)	1 (Very Slight) to 2 (Slight)	2 (Slight) to 3 (Moderate)	3 (Moderate) to 4 (Severe)
Burland Strain Limits	0.0	500.00E-6	750.00E-6	0.0015000

Specific Structures - Geometry

Structure Name	Sub-Structure Name	Displacement Line	Start Distance Along Line	End Distance Along Line	Vertical Offsets from Line for Vertical Movement Calculations	Vertical Displacement Limit	Damage Category Strains	Poisson's Ratio	E/G
			[m]	[m]	[m]	[mm]			
No 33	Party Wall (1)	Line 1	0.00000	9.89900	0.0	0.10000	Burland Strain Limits	0.20000	2.6000
No 33	Rear Elevation (2)	Line 2	0.00000	2.90000	0.0	0.10000	Burland Strain Limits	0.20000	2.6000
No 33	Far Elevation (3)	Line 3	0.00000	8.83200	0.0	0.10000	Burland Strain Limits	0.20000	2.6000
No 33	Far Elevation (4)	Line 4	0.00000	1.90000	0.0	0.10000	Burland Strain Limits	0.20000	2.6000

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Structure Name	Sub-Structure Name	Displacement Line	Start Distance Along Line	End Distance Along Line	Vertical Offsets from Line for Vertical	Vertical Displacement Limit Sensitivity	Damage Category	Strains	Poisson's Ratio	E/G
No 33	Frontage (5)	Line 5	0.00000	6.90000	0.0	0.10000	Burland Strain Limits	0.20000	2.6000	
No 29	Party Wall (6)	Line 6	0.00000	16.90700	0.0	0.10000	Burland Strain Limits	0.20000	2.6000	
No 29	Rear Elevation (7)	Line 7	0.00000	5.89900	0.0	0.10000	Burland Strain Limits	0.20000	2.6000	
No 29	Far Elevation (8)	Line 8	0.00000	16.90700	0.0	0.10000	Burland Strain Limits	0.20000	2.6000	
No 29	Frontage (9)	Line 9	0.00000	5.89900	0.0	0.10000	Burland Strain Limits	0.20000	2.6000	
Willoughby Road	Roadway (10)	Line 10	0.00000	18.00000	0.0	0.10000	Burland Strain Limits	0.20000	2.6000	
Willow Cottages	Retaining Wall (11)	Line 11	0.00000	32.42200	0.0	0.10000	Burland Strain Limits	0.20000	2.6000	
Willow Cottages	Rear Elevation	Line 12	0.00000	32.42200	0.0	0.10000	Burland Strain Limits	0.20000	2.6000	

Specific Structures - Bending Parameters

Structure Name	Sub-Structure Name	Height	Default Properties	Hogging			Sagging		
				2nd Moment of Area (per unit width)	Distance of Bending Strain from N.A.	Distance of N.A. from Edge of Beam in Tension	2nd Moment of Area (per unit width)	Distance of Bending Strain from N.A.	Distance of N.A. from Edge of Beam in Tension
No 33	Party Wall (1)	[m]	8.0000 Yes	[m ⁴]	[m]	[m]	[m ⁴]	[m]	[m]
No 33	Rear Elevation (2)	8.0000	Yes	170.67	8.0000	8.0000	42.667	4.0000	4.0000
No 33	Far Elevation (3)	8.0000	Yes	170.67	8.0000	8.0000	42.667	4.0000	4.0000
No 33	Far Elevation (4)	8.0000	Yes	170.67	8.0000	8.0000	42.667	4.0000	4.0000
No 33	Frontage (5)	8.0000	Yes	170.67	8.0000	8.0000	42.667	4.0000	4.0000
No 29	Party Wall (6)	12.000	Yes	576.00	12.000	12.000	144.00	6.0000	6.0000
No 29	Rear Elevation (7)	12.000	Yes	576.00	12.000	12.000	144.00	6.0000	6.0000
No 29	Far Elevation (8)	12.000	Yes	576.00	12.000	12.000	144.00	6.0000	6.0000
No 29	Frontage (9)	12.000	Yes	576.00	12.000	12.000	144.00	6.0000	6.0000
Willoughby Road	Roadway (10)	0.50000	Yes	0.041667	0.50000	0.50000	0.010417	0.25000	0.25000
Willow Cottages	Retaining Wall (11)	2.5000	Yes	5.2083	2.5000	2.5000	1.3021	1.2500	1.2500
Willow Cottages	Rear Elevation	8.0000	Yes	170.67	8.0000	8.0000	42.667	4.0000	4.0000

Building Segment Combinations

Structure Name	Sub-Structure Name	Vertical Offset from Line for Vertical Movement Calculations	Segment Start	Length	Curvature	Combined Segment
No structures have segments combined.						

Utility Strain Calculation Options

Neglect beneficial contribution of axial strains : No

Warnings

- Sub-structure 6 crosses at least one excavation. Its building damage results in that area should be treated with caution.

Errors

None

Specific Building Damage Results - Horizontal Displacements

Structure: No 33 | Sub-structure: Party Wall (1)

Dist.	Coordinates			Displacements		
	x	y	z	x	y	
				Horizontal displacement along the Line	Horizontal displacement perpendicular to Line	
	[m]	[m]	[m]	[mm]	[mm]	
0.0	2.05000	0.00000	84.00000	0.0	9.9220	d
1.9800	4.03000	0.00000	84.00000	0.0	9.9220	d
3.9600	6.01000	0.00000	84.00000	0.0	9.9220	d
5.9400	7.99000	0.00000	84.00000	0.0	9.9220	d
7.9200	9.97000	0.00000	84.00000	0.0	9.9220	d
9.9000	11.95000	0.00000	84.00000	0.0	9.9220	d

d - Displacements include imported displacements.

Structure: No 33 | Sub-structure: Rear Elevation (2)

Dist.	Coordinates			Displacements		
	x	y	z	x	y	
				Horizontal displacement along the Line	Horizontal displacement perpendicular to Line	
	[m]	[m]	[m]	[mm]	[mm]	
0.0	12.00000	-0.05000	84.00000	0.0	9.8917	0.0 d
2.9000	12.00000	-2.95000	84.00000	0.0	8.1372	0.0 d

d - Displacements include imported displacements.

Structure: No 33 | Sub-structure: Far Elevation (3)

Dist.	Coordinates			Displacements		
	x	y	z	x	y	
				Horizontal displacement along the Line	Horizontal displacement perpendicular to Line	
	[m]	[m]	[m]	[mm]	[mm]	
0.0	11.95000	-3.00000	84.00000	0.0	8.1070	-7.2511 d
2.2081	9.97500	-3.98750	84.00000	0.0	7.5096	-6.7168 d
4.4162	8.00000	-4.97500	84.00000	0.0	6.9121	-6.1824 d
6.6244	6.02500	-5.96250	84.00000	0.0	6.3147	-5.6480 d
8.8325	4.05000	-6.95000	84.00000	0.0	5.7172	-5.1137 d

d - Displacements include imported displacements.

Structure: No 33 | Sub-structure: Far Elevation (4)

Dist.	Coordinates			Displacements		
	x	y	z	x	y	
				Horizontal displacement	Horizontal displacement	



31 Willoughby Road

Combined Movements & Damage Assessment

2nd Stage - Short-term (with heave) - 10 mm limit on overall horizontal movements

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along the Line						perpendicular to Line	
[m]	[m]	[m]	[m]	[mm]	[mm]	[mm]	[mm]
0.0	3.95000	-7.00000	84.00000	0.0	5.6870	0.0	-5.6870 d
1.9000	2.05000	-7.00000	84.00000	0.0	5.6870	0.0	-5.6870 d
d - Displacements include imported displacements.							

Structure: No 33 | Sub-structure: Frontage (5)

Dist.	Coordinates			Displacements		
x	y	z	x	y	Horizontal displacement along the Line	Horizontal displacement perpendicular to Line
[m]	[m]	[m]	[m]	[mm]	[mm]	[mm]
0.0	2.00000	-6.95000	84.00000	0.0	5.7172	5.7172 0.0 d
2.3000	2.00000	-6.45000	84.00000	0.0	7.1087	7.1087 0.0 d
4.6000	2.00000	-2.35000	84.00000	0.0	8.5002	8.5002 0.0 d
6.9000	2.00000	-0.05000	84.00000	0.0	9.8917	9.8917 0.0 d
d - Displacements include imported displacements.						

Structure: No 29 | Sub-structure: Party Wall (6)

Dist.	Coordinates			Displacements		
x	y	z	x	y	Horizontal displacement along the Line	Horizontal displacement perpendicular to Line
[m]	[m]	[m]	[m]	[mm]	[mm]	[mm]
0.0	2.05000	6.00000	84.00000	0.0	0.0	0.0 0.0 d
2.1134	4.16250	6.06250	84.00000	0.26093	-9.9152	-0.032409 -9.9186 d
4.2268	6.27500	6.12500	84.00000	0.26082	-9.9110	-0.032395 -9.9144 d
6.3403	8.38750	6.18750	84.00000	0.26071	-9.9068	-0.032381 -9.9102 d
8.4537	10.50000	6.25000	84.00000	0.26060	-9.9027	-0.032368 -9.9060 d
10.567	12.61250	6.31250	84.00000	0.26049	-9.8985	-0.032354 -9.9019 d
12.681	14.72500	6.37500	84.00000	0.26038	-9.8943	-0.032340 -9.8977 d
14.794	16.83750	6.43750	84.00000	0.26027	-9.8901	-0.032327 -9.8935 d
16.907	18.95000	6.50000	84.00000	0.26016	-9.8860	-0.032313 -9.8893 d
d - Displacements include imported displacements.						

Structure: No 29 | Sub-structure: Rear Elevation (7)

Dist.	Coordinates			Displacements		
x	y	z	x	y	Horizontal displacement along the Line	Horizontal displacement perpendicular to Line
[m]	[m]	[m]	[m]	[mm]	[mm]	[mm]
0.0	19.00000	6.55000	84.00000	0.25938	-9.8565	-9.8565 -0.25938 d
1.9667	19.00000	8.51667	84.00000	0.22809	-8.6675	-8.6675 -0.22809 d
3.9333	19.00000	10.48333	84.00000	0.19680	-7.4785	-7.4785 -0.19680 d
5.9000	19.00000	12.45000	84.00000	0.16551	-6.2895	-6.2895 -0.16551 d
d - Displacements include imported displacements.						

Structure: No 29 | Sub-structure: Far Elevation (8)

Dist.	Coordinates			Displacements		
x	y	z	x	y	Horizontal displacement along the Line	Horizontal displacement perpendicular to Line
[m]	[m]	[m]	[m]	[mm]	[mm]	[mm]
0.0	18.95000	12.50000	84.00000	0.16470	-6.2585	0.020456 6.2606 d
2.1134	16.83750	12.43750	84.00000	0.16481	-6.2626	0.020470 6.2648 d
4.2268	14.72500	12.37500	84.00000	0.16492	-6.2668	0.020484 6.2690 d
6.3403	12.61250	12.31250	84.00000	0.16503	-6.2710	0.020497 6.2731 d
8.4537	10.50000	12.25000	84.00000	0.16514	-6.2752	0.020511 6.2773 d
10.567	8.38750	12.18750	84.00000	0.16525	-6.2793	0.020525 6.2815 d
12.681	6.27500	12.12500	84.00000	0.16536	-6.2835	0.020538 6.2857 d
14.794	4.16250	12.06250	84.00000	0.16547	-6.2877	0.020552 6.2898 d
16.907	2.05000	12.00000	84.00000	0.16558	-6.2919	0.020565 6.2940 d
d - Displacements include imported displacements.						

Structure: No 29 | Sub-structure: Frontage (9)

Dist.	Coordinates			Displacements		
x	y	z	x	y	Horizontal displacement along the Line	Horizontal displacement perpendicular to Line
[m]	[m]	[m]	[m]	[mm]	[mm]	[mm]
0.0	2.00000	11.95000	84.00000	0.16635	-6.3213	6.3213 0.16635 d
1.9667	2.00000	9.98333	84.00000	0.19764	-7.5103	7.5103 0.19764 d
3.9333	2.00000	8.01667	84.00000	0.22893	-8.6993	8.6993 0.22893 d
5.9000	2.00000	6.05000	84.00000	0.26022	-9.8883	9.8883 0.26022 d
d - Displacements include imported displacements.						

Structure: Willoughby Road | Sub-structure: Roadway (10)

Dist.	Coordinates			Displacements		
x	y	z	x	y	Horizontal displacement along the Line	Horizontal displacement perpendicular to Line
[m]	[m]	[m]	[m]	[mm]	[mm]	[mm]
0.0	-2.00000	-6.00000	85.00000	2.0810	3.4783	3.4783 -2.0810 d
2.0000	-2.00000	-4.00000	85.00000	3.2498	3.2498	3.2498 -3.2498 d
4.0000	-2.00000	-2.00000	85.00000	5.0863	2.1300	2.1300 -5.0863 d
6.0000	-2.00000	0.00000	85.00000	7.5020	0.0	0.0 -7.5020 d
8.0000	-2.00000	2.00000	85.00000	7.5020	0.0	0.0 -7.5020 d
10.000	-2.00000	4.00000	85.00000	7.5020	0.0	0.0 -7.5020 d
12.000	-2.00000	6.00000	85.00000	7.5020	0.0	0.0 -7.5020 d
14.000	-2.00000	8.00000	85.00000	5.1070	-2.1656	-2.1656 -5.1070 d
16.000	-2.00000	10.00000	85.00000	3.2814	-3.3040	-3.3040 -3.2814 d
18.000	-2.00000	12.00000	85.00000	2.1148	-3.5363	-3.5363 -2.1148 d
d - Displacements include imported displacements.						

Structure: Willow Cottages | Sub-structure: Retaining Wall (11)

Dist.	Coordinates			Displacements		
x	y	z	x	y	Horizontal displacement along the Line	Horizontal displacement perpendicular to Line
[m]	[m]	[m]	[m]	[mm]	[mm]	[mm]
0.0	0.00000	-10.00000	83.00000	0.47152	3.2807	1.8889 2.7234 d
2.0264	1.81250	-9.09375	83.00000	0.057998	4.3611	2.0022 3.8748 d
4.0529	3.62500	-8.18750	83.00000	0.0	4.9686	2.2220 4.4440 d
6.0793	5.43750	-7.28125	83.00000	0.0	5.5168	2.4672 4.9344 d
8.1057	7.25000	-6.37500	83.00000	0.0	6.0651	2.7124 5.4248 d



31 Willoughby Road

Combined Movements & Damage Assessment

2nd Stage - Short-term (with heave) - 10 mm limit on overall horizontal movements

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Dist.	Coordinates			Displacements		
x	y	z	x	y	Horizontal displacement along the	Horizontal displacement perpendicular
10.132	9.06250	-5.46875	83.00000	0.0	6.6134	2.9576
12.159	10.87500	-4.56250	83.00000	0.0	7.1617	3.2028
14.185	12.68750	-3.65625	83.00000	0.0	7.7100	3.4480
16.211	14.50000	-2.75000	83.00000	0.0	8.2582	3.6932
18.238	16.31250	-1.84375	83.00000	0.0	8.8065	3.9384
20.264	18.12500	-0.93750	83.00000	-1.1691	8.9958	2.9773
22.291	19.93750	-0.03125	83.00000	-5.1343	7.7015	-1.1481
24.317	21.75000	0.87500	83.00000	-5.0500	7.5750	-1.1292
26.344	23.56250	1.78125	83.00000	-8.0432	6.0317	-6.9243
28.370	25.37500	2.68750	83.00000	-7.2751	0.0	-6.5071
30.397	27.18750	3.59375	83.00000	-6.1786	0.0	-5.5263
32.423	29.00000	4.50000	83.00000	-5.0820	0.0	-4.5455
d - Displacements include imported displacements.						

Structure: Willow Cottages | Sub-structure: Rear Elevation

Dist.	Coordinates			Displacements		
x	y	z	x	y	Horizontal displacement along the Line	Horizontal displacement perpendicular to Line
[m]	[m]	[m]	[mm]	[mm]	[mm]	[mm]
0.0	0.00000	-13.00000	83.00000	0.19091	1.7736	0.96391
2.0264	1.81250	-12.09375	83.00000	0.025704	2.5787	1.1762
4.0529	3.62500	-11.18750	83.00000	0.0	3.1536	1.4103
6.0793	5.43750	-10.28125	83.00000	0.0	3.7019	1.6555
8.1057	7.25000	-9.37500	83.00000	0.0	4.2501	1.9007
10.132	9.06250	-8.46875	83.00000	0.0	4.7984	2.1459
12.159	10.87500	-7.56250	83.00000	0.0	5.3467	2.3911
14.185	12.68750	-6.65625	83.00000	0.0	5.8950	2.6363
16.211	14.50000	-5.75000	83.00000	0.0	6.4432	2.8815
18.238	16.31250	-4.84375	83.00000	0.0	6.9915	3.1267
20.264	18.12500	-3.93750	83.00000	-0.22569	7.4703	3.1389
22.291	19.93750	-3.03125	83.00000	-4.1556	6.4873	-0.81567
24.317	21.75000	-2.12500	83.00000	-4.2123	6.3184	-0.94190
26.344	23.56250	-1.21875	83.00000	-4.4072	5.6536	-1.4135
28.370	25.37500	-0.31250	83.00000	-5.4018	2.8520	-3.5560
30.397	27.18750	0.59375	83.00000	-5.4671	1.1509	-4.3753
32.423	29.00000	1.50000	83.00000	-4.9291	0.26806	-4.2888
d - Displacements include imported displacements.						

Specific Building Damage Results - Vertical Displacements

Structure: No 33 | Sub-structure: Party Wall (1)

Dist.	Coordinates			Displacements
	x	y	z	z
[m]	[m]	[m]	[m]	[mm]

Vertical Offset 1			
0.0	2.05000	0.00000	84.00000
1.9800	4.03000	0.00000	84.00000
3.9600	6.01000	0.00000	84.00000
5.9400	7.99000	0.00000	84.00000
7.9200	9.97000	0.00000	84.00000
9.9000	11.95000	0.00000	84.00000
d - Displacements include imported displacements.			

Structure: No 33 | Sub-structure: Rear Elevation (2)

Dist.	Coordinates			Displacements
	x	y	z	z
[m]	[m]	[m]	[m]	[mm]

Vertical Offset 1			
0.0	12.00000	-0.05000	84.00000
2.9000	12.00000	-2.95000	84.00000
d - Displacements include imported displacements.			

Structure: No 33 | Sub-structure: Far Elevation (3)

Dist.	Coordinates			Displacements
	x	y	z	z
[m]	[m]	[m]	[m]	[mm]

Vertical Offset 1			
0.0	11.95000	-3.00000	84.00000
2.2081	9.97500	-3.98750	84.00000
4.4162	8.00000	-4.97500	84.00000
6.6244	6.02500	-5.96250	84.00000
8.8325	4.05000	-6.95000	84.00000
d - Displacements include imported displacements.			

Structure: No 33 | Sub-structure: Far Eleavtion (4)

Dist.	Coordinates			Displacements
	x	y	z	z
[m]	[m]	[m]	[m]	[mm]

Vertical Offset 1			
0.0	3.95000	-7.00000	84.00000
1.9000	2.05000	-7.00000	84.00000
d - Displacements include imported displacements.			

Structure: No 33 | Sub-structure: Frontage (5)

Dist.	Coordinates			Displacements
	x	y	z	z
[m]	[m]	[m]	[m]	[mm]

Vertical Offset 1			
0.0	2.00000	-6.95000	84.00000
2.3000	2.00000	-4.65000	84.00000
4.6000	2.00000	-2.35000	84.00000
6.9000	2.00000	-0.05000	84.00000
d - Displacements include imported displacements.			

Structure: No 29 | Sub-structure: Party Wall (6)

Dist.	Coordinates			Displacements
	x	y	z	z
[m]	[m]	[m]	[m]	[mm]

Vertical Offset 1			
0.0	2.05000	6.00000	84.00000
2.1134	4.16250	6.06250	84.00000
4.2268	6.27500	6.12500	84.00000
6.3403	8.38750	6.18750	84.00000
8.4537	10.50000	6.25000	84.00000
10.567	12.61250	6.31250	84.00000



31 Willoughby Road

Combined Movements & Damage Assessment

2nd Stage - Short-term (with heave) - 10 mm limit on overall horizontal movements

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Dist.	Coordinates			Displacements
	x	y	z	
[m]	[m]	[m]	[m]	[mm]

12.691 14.72500 6.37500 84.00000 0.56101 d
14.794 16.83750 6.43750 84.00000 1.0071 d
16.907 18.95000 6.50000 84.00000 2.2573 d
d - Displacements include imported displacements.

Structure: No 29 | Sub-structure: Rear Elevation (7)

Dist.	Coordinates			Displacements
	x	y	z	
[m]	[m]	[m]	[m]	[mm]

Vertical Offset 1
0.0 19.00000 6.55000 84.00000 2.1718 d
1.9667 19.00000 8.51667 84.00000 0.25827 d
3.9333 19.00000 10.48333 84.00000 0.048087 d
5.9000 19.00000 12.45000 84.00000 -0.0023866 d
d - Displacements include imported displacements.

Structure: No 29 | Sub-structure: Far Elevation (8)

Dist.	Coordinates			Displacements
	x	y	z	
[m]	[m]	[m]	[m]	[mm]

Vertical Offset 1
0.0 18.95000 12.50000 84.00000 -0.0039325 d
2.1134 16.83750 12.43750 84.00000 -0.050272 d
4.2268 14.72500 12.37500 84.00000 -0.096609 d
6.3403 12.61250 12.31250 84.00000 -0.12825 d
8.4537 10.50000 12.25000 84.00000 -0.13950 d
10.567 8.38750 12.18750 84.00000 -0.13108 d
12.681 6.27500 12.12500 84.00000 -0.10741 d
14.794 4.16250 12.06250 84.00000 -0.076516 d
16.907 2.05000 12.00000 84.00000 -0.048957 d
d - Displacements include imported displacements.

Structure: No 29 | Sub-structure: Frontage (9)

Dist.	Coordinates			Displacements
	x	y	z	
[m]	[m]	[m]	[m]	[mm]

Vertical Offset 1
0.0 2.00000 11.95000 84.00000 -0.048444 d
1.9667 2.00000 9.98333 84.00000 -0.036931 d
3.9333 2.00000 8.01667 84.00000 0.054493 d
5.9000 2.00000 6.05000 84.00000 0.97152 d
d - Displacements include imported displacements.

Structure: Willoughby Road | Sub-structure: Roadway (10)

Dist.	Coordinates			Displacements
	x	y	z	
[m]	[m]	[m]	[m]	[mm]

Vertical Offset 1
0.0 -2.00000 -6.00000 85.00000 -0.019727 d
2.0000 -2.00000 -4.00000 85.00000 -0.015393 d
4.0000 -2.00000 -2.00000 85.00000 -0.0023783 d
6.0000 -2.00000 0.00000 85.00000 0.016285 d
8.0000 -2.00000 2.00000 85.00000 0.027921 d
10.000 -2.00000 4.00000 85.00000 0.028727 d
12.000 -2.00000 6.00000 85.00000 0.017452 d
14.000 -2.00000 8.00000 85.00000 -0.0021792 d
16.000 -2.00000 10.00000 85.00000 -0.016232 d
18.000 -2.00000 12.00000 85.00000 -0.021250 d
d - Displacements include imported displacements.

Structure: Willow Cottages | Sub-structure: Retaining Wall (11)

Dist.	Coordinates			Displacements
	x	y	z	
[m]	[m]	[m]	[m]	[mm]

Vertical Offset 1
0.0 0.00000 -10.00000 83.00000 -0.021762 d
2.0264 1.81250 -9.09375 83.00000 -0.032251 d
4.0529 3.62500 -8.18750 83.00000 -0.047397 d
6.0793 5.43750 -7.28125 83.00000 -0.068979 d
8.1057 7.25000 -6.37500 83.00000 -0.096977 d
10.132 9.06250 -5.46875 83.00000 -0.12554 d
12.159 10.87500 -4.56250 83.00000 -0.13880 d
14.185 12.68750 -3.65625 83.00000 -0.10851 d
16.211 14.50000 -2.75000 83.00000 -698.08E-6 d
18.238 16.31250 -1.84375 83.00000 0.21940 d
20.264 18.12500 -0.93750 83.00000 0.57605 d
22.291 19.93750 -0.03125 83.00000 0.64006 d
24.317 21.75000 0.87500 83.00000 0.55078 d
26.344 23.56250 1.78125 83.00000 0.30372 d
28.370 25.37500 2.68750 83.00000 0.16323 d
30.397 27.18750 3.59375 83.00000 0.081827 d
32.423 29.00000 4.50000 83.00000 0.054799 d
d - Displacements include imported displacements.

Structure: Willow Cottages | Sub-structure: Rear Elevation

Dist.	Coordinates			Displacements
	x	y	z	
[m]	[m]	[m]	[m]	[mm]

Vertical Offset 1
0.0 0.00000 -13.00000 83.00000 -0.013721 d
2.0264 1.81250 -12.09375 83.00000 -0.020353 d
4.0529 3.62500 -11.18750 83.00000 -0.029066 d
6.0793 5.43750 -10.28125 83.00000 -0.040134 d
8.1057 7.25000 -9.37500 83.00000 -0.053255 d
10.132 9.06250 -8.46875 83.00000 -0.066494 d
12.159 10.87500 -7.56250 83.00000 -0.075651 d
14.185 12.68750 -6.65625 83.00000 -0.074142 d
16.211 14.50000 -5.75000 83.00000 -0.054746 d
18.238 16.31250 -4.84375 83.00000 -0.013291 d
20.264 18.12500 -3.93750 83.00000 0.045825 d
22.291 19.93750 -3.03125 83.00000 0.10179 d
24.317 21.75000 -2.12500 83.00000 0.13033 d
26.344 23.56250 -1.21875 83.00000 0.12566 d
28.370 25.37500 -0.31250 83.00000 0.098954 d
30.397 27.18750 0.59375 83.00000 0.070507 d
32.423 29.00000 1.50000 83.00000 0.048859 d
d - Displacements include imported displacements.

Specific Building Damage Results - All Segments



31 Willoughby Road

Combined Movements & Damage Assessment

2nd Stage - Short-term (with heave) - 10 mm limit on overall horizontal movements

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Dist.	Coordinates			Displacements							
[m]	x [m]	y [m]	z [m]	z [mm]							
Structure: No 33 Sub-structure: Party Wall (1)											
Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category
[m] 0.0		[m] 1	[m] 0.0	[m] 3.8393	[%] Sagging	[%] 0.0081613	[%] 0.0	[%] 0.0077061	0.0	246.79E-6	4463.8
											0
											(Negligible)
											0
											(Negligible)
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.											
Structure: No 33 Sub-structure: Rear Elevation (2)											
Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category
[m] 0.0		[m] 1	[m] 0.0	[m] 2.9000	[%] None	[%] 0.0	[%] 0.060500	[%] 0.060500	-604.63E-6	453.61E-6	-
											1 (Very Slight)
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.											
Structure: No 33 Sub-structure: Far Elevation (3)											
Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category
[m] 0.0		[m] 1	[m] 0.0	[m] 4.4162	[%] Hogging	[%] 671.53E-6	[%] 0.012100	[%] 0.012380	-120.99E-6	-19.39E-6	67352.
											0
											(Negligible)
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.											
Structure: No 33 Sub-structure: Far Elevation (4)											
Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category
[m] 0.0		[m]	[m]		[%]	[%]	[%]			[m]	
All settlements are less than the Settlement Trough Limit Sensitivity.											
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.											
Structure: No 33 Sub-structure: Frontage (5)											
Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category
[m] 0.0		[m] 1	[m] 6.9000	[m] 0.0	[%] None	[%] 0.0	[%] 0.0	[%] 0.0	-604.63E-6	-407.43E-6	4944.8
											0
											(Negligible)
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.											
Structure: No 29 Sub-structure: Party Wall (6)											
Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category
[m] 0.0		[m] 1	[m] 0.0	[m] 3.6840	[%] Sagging	[%] 0.0038020	[%] -879.43E-6	[%] 0.0033978	15.335E-6	204.99E-6	9409.6
											0
											(Negligible)
											0
											(Negligible)
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.											
Structure: No 29 Sub-structure: Rear Elevation (7)											
Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category
[m] 0.0		[m] 1	[m] 0.0	[m] 1.9667	[%] Hogging	[%] 0.0	[%] 0.060458	[%] 0.060458	-604.22E-6	972.39E-6	1853.5
											1 (Very Slight)
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.											
Structure: No 29 Sub-structure: Far Elevation (8)											
Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category
[m] 0.0		[m] 1	[m] 6.3403	[m] 6.3403	[%] Hogging	[%] 286.99E-6	[%] 0.0	[%] 282.20E-6	0.0	14.971E-6	237760.
											0
											(Negligible)
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.											
Structure: No 29 Sub-structure: Frontage (9)											
Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category
[m] 0.0		[m] 1	[m] 5.8990	[m] 0.0	[%] None	[%] 0.0	[%] 0.0	[%] 0.0	-604.22E-6	-466.01E-6	3825.6
											0
											(Negligible)
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.											
Structure: Willoughby Road Sub-structure: Roadway (10)											
Vertical Offset from Line for Vertical Movement	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category

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Calculations

[m] [m] [m] [%] [%] [%] Curve [m]

0.0 All settlements are less than the Settlement Trough Limit Sensitivity.
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.

Structure: Willow Cottages | Sub-structure: Retaining Wall (11)

Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category
[m] 0.0		[m] 1	[m] 10.132	[m] 8.3755	[m] Hogging	[m] 0.0020631	[m] 0.010183	[m] 0.013275	[m] 474.49E-6	[m] -176.08E-6	[m] 37608.0 (Negligible)
		2	18.508	7.3174	Sagging	0.0043951	-0.12644	0.025300	0.0028680	-176.08E-6	21670.0 (Negligible)
		3	25.825	2.5450	Hogging	852.29E-6	-0.041871	0.0083869	0.0028680	122.27E-6	58674.0 (Negligible)

Tensile horizontal strains are +ve, compressive horizontal strains are -ve.

Structure: Willow Cottages | Sub-structure: Rear Elevation

Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category
[m] 0.0		[m] 1	[m] 22.291	[m] 4.0529	[m] Sagging	[m] 405.54E-6	[m] -0.014751	[m] 0.0029583	[m] 0.0019553	[m] -27.670E-6	[m] 141830.0 (Negligible)

Tensile horizontal strains are +ve, compressive horizontal strains are -ve.

Specific Building Damage Results - Critical Values for All Segments within Each Sub-Structure

Structure: No 33 | Sub-structure: Party Wall (1)

Vertical Offset from Line for Vertical Movement Calculations	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category
[m] 0.0	[m] 0.0089807	[m] 0.0	[m] -349.18E-6	[mm] 1.2709	[m] 0.0086621	[m] 0.0	[m] -349.18E-6	[m] 4772.6	[m] 4463.8	0 (Negligible)

Structure: No 33 | Sub-structure: Rear Elevation (2)

Vertical Offset from Line for Vertical Movement Calculations	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category
[m] 0.0	[m] 0.0	[m] 0.060500	[m] 453.61E-6	[mm] 1.1763	[m] 0.060500	[m] -604.63E-6	[m] 453.61E-6	[m] -	[m] -	- 1 (Very Slight)

Structure: No 33 | Sub-structure: Far Elevation (3)

Vertical Offset from Line for Vertical Movement Calculations	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category
[m] 0.0	[m] 671.53E-6	[m] 0.012100	[m] -19.396E-6	[mm] 0.16884	[m] 0.012380	[m] -120.99E-6	[m] -19.396E-6	[m] 67352.0	[m] -	- 0 (Negligible)

Structure: No 33 | Sub-structure: Far Elevation (4)

Vertical Offset from Line for Vertical Movement Calculations	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category
[m] 0.0	[m] 0.0	[m] 0.0	[m] -407.43E-6	[mm] 0.96369	[m] 0.0	[m] -604.63E-6	[m] -407.43E-6	[m] -	[m] -	- 0 (Negligible)

Structure: No 29 | Sub-structure: Party Wall (6)

Vertical Offset from Line for Vertical Movement Calculations	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category
[m] 0.0	[m] 0.0090404	[m] -879.43E-6	[m] -591.59E-6	[mm] 2.2571	[m] 0.0083878	[m] 15.335E-6	[m] -591.59E-6	[m] 4747.1	[m] 9409.6	0 (Negligible)

Structure: No 29 | Sub-structure: Rear Elevation (7)

Vertical Offset from Line for Vertical Movement Calculations	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category
[m] 0.0	[m] 0.0	[m] 0.060458	[m] 972.39E-6	[mm] 2.1718	[m] 0.060458	[m] -604.22E-6	[m] 972.39E-6	[m] 1853.5	[m] -	- 1 (Very Slight)

Structure: No 29 | Sub-structure: Far Elevation (8)

Vertical Offset from Line for Vertical Movement Calculations	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category
[m] 0.0	[m] 0.0	[m] 0.060458	[m] 972.39E-6	[mm] 2.1718	[m] 0.060458	[m] -604.22E-6	[m] 972.39E-6	[m] 1853.5	[m] -	- 1 (Very Slight)



31 Willoughby Road

Combined Movements & Damage Assessment

2nd Stage - Short-term (with heave) - 10 mm limit on overall horizontal movements

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Offset from Line for Vertical Movement Calculations	Ratio	Horizontal Strain	Settlement	Tensile Strain	of Horizontal Displacement Curve	of Vertical Displacement Curve	Radius of Curvature (Hogging)	Radius of Curvature (Sagging)
[m] 0.0	[%] 286.99E-6	[%] 0.0	[mm] 14.971E-6	[%] 0.13950	282.20E-6	0.0	[m] 14.971E-6	[m] 237760. - 0 (Negligible)

Structure: No 29 | Sub-structure: Frontage (9)

Vertical Offset from Line for Vertical Movement Calculations	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category
[m] 0.0	[%] 0.0	[%] 0.0	-466.01E-6	[mm] 0.97106	[%] 0.0	-604.22E-6	-466.01E-6	[m] -	[m] -	- 0 (Negligible)

Structure: Willoughby Road | Sub-structure: Roadway (10)

Vertical Offset from Line for Vertical Movement Calculations	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category
[m] 0.0	[%] 0.0	[%] 0.0	-466.01E-6	[mm] 0.97106	[%] 0.0	-604.22E-6	-466.01E-6	[m] -	[m] -	- 0 (Negligible)

Structure: Willow Cottages | Sub-structure: Retaining Wall (11)

Vertical Offset from Line for Vertical Movement Calculations	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category
[m] 0.0	[%] 0.0043951	[%] -0.12644	-176.08E-6	[mm] 0.63963	[%] 0.025300	0.0028680	-176.08E-6	[m] 37608.	[m] 21670. 0	(Negligible)

Structure: Willow Cottages | Sub-structure: Rear Elevation

Vertical Offset from Line for Vertical Movement Calculations	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category
[m] 0.0	[%] 405.54E-6	[%] -0.014751	-27.670E-6	[mm] 0.13028	[%] 0.0029583	0.0019553	-27.670E-6	[m] -	[m] 141830. 0	(Negligible)

Specific Building Damage Results - Critical Segments within Each Structure

Structure Name	Parameter	Critical Sub-Structure	Critical Segment	Start	End	Curvature	Max Slope	Max Settlement	Max Tensile Strain	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category
No 33	Max Slope	Rear Elevation (2)	1	[m] 0.0	[m] 2.9000	Sagging	453.61E-6	[mm] 1.1763	[%] 0.060500	[m] -	[m] -	- 1 (Very Slight)
	Max Settlement	Party Wall (1)	1	0.0	3.8393	Sagging	246.79E-6	1.2709	0.0077061	-	4463.8	0 (Negligible)
	Max Tensile Strain	Rear Elevation (2)	1	0.0	2.9000	Sagging	453.61E-6	1.1763	0.060500	-	-	- 1 (Very Slight)
	Min Radius of Curvature (Hogging)	Party Wall (1)	2	3.8393	9.8990	Hogging	349.18E-6	1.2523	0.0086621	4772.6	-	- 0 (Negligible)
	Min Radius of Curvature (Sagging)	Party Wall (1)	1	0.0	3.8393	Sagging	246.79E-6	1.2709	0.0077061	-	4463.8	0 (Negligible)
No 29	Max Slope	Rear Elevation (7)	1	0.0	1.9667	Hogging	972.39E-6	2.1718	0.060458	1853.5	-	- 1 (Very Slight)
	Max Settlement	Party Wall (6)	2	3.6840	16.907	Hogging	591.59E-6	2.2571	0.0083878	4747.1	-	- 0 (Negligible)
	Max Tensile Strain	Rear Elevation (7)	1	0.0	1.9667	Hogging	972.39E-6	2.1718	0.060458	1853.5	-	- 1 (Very Slight)
	Min Radius of Curvature (Hogging)	Rear Elevation (7)	1	0.0	1.9667	Hogging	972.39E-6	2.1718	0.060458	1853.5	-	- 1 (Very Slight)
	Min Radius of Curvature (Sagging)	Party Wall (6)	1	0.0	3.6840	Sagging	204.99E-6	1.1200	0.0033978	-	9409.6	0 (Negligible)
Willoughby Road		All settlements are less than the Settlement Trough Limit Sensitivity.										
Willow Cottages		All settlements are less than the Settlement Trough Limit Sensitivity.										
Willow Cottages	Max Slope	Retaining Wall (11)	1	10.132	18.508	Hogging	176.08E-6	0.26688	0.013275	37608.	-	- 0 (Negligible)
	Max Settlement	Retaining Wall (11)	2	18.508	25.825	Sagging	176.08E-6	0.63963	0.025300	-	21670. 0	(Negligible)
	Max Tensile Strain	Retaining Wall (11)	2	18.508	25.825	Sagging	176.08E-6	0.63963	0.025300	-	21670. 0	(Negligible)
	Min Radius of Curvature (Hogging)	Retaining Wall (11)	1	10.132	18.508	Hogging	176.08E-6	0.26688	0.013275	37608.	-	- 0 (Negligible)
	Min Radius of Curvature (Sagging)	Retaining Wall (11)	2	18.508	25.825	Sagging	176.08E-6	0.63963	0.025300	-	21670. 0	(Negligible)
Willow Cottages	Max Slope	Rear Elevation	1	22.291	26.344	Sagging	27.670E-6	0.13028	0.0029583	-	141830. 0	(Negligible)
	Max Settlement	Rear Elevation	1	22.291	26.344	Sagging	27.670E-6	0.13028	0.0029583	-	141830. 0	(Negligible)
	Max Tensile Strain	Rear Elevation	1	22.291	26.344	Sagging	27.670E-6	0.13028	0.0029583	-	141830. 0	(Negligible)
	Min Radius of Curvature (Hogging)		-	-	-	-	-	-	-	-	-	-
	Min Radius of Curvature (Sagging)	Rear Elevation	1	22.291	26.344	Sagging	27.670E-6	0.13028	0.0029583	-	141830. 0	(Negligible)

Two-Stage Underpinning:
Stage 2 - Total Movement (Contour Plots)
& Tabular output of related damage assessment

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Analysis Options

Analysis: Boussinesq
Global Poisson's ratio: 0.20
Maximum allowable ratio between values of E: 1.5
Horizontal rigid boundary level: 35.00 [m OD]
Displacements at load centroids: Yes

Soil ProfilesSoil Profile 1

Layer	Level at top	Number of intermediate displacement levels	Youngs Modulus	Poissons ratio	Non-linear curve
	[mOD]		Top [kN/m ²]	Btm [kN/m ²]	
1	85.500	3	7500.0	7500.0	0.20000 None
2	82.500	1	9000.0	9000.0	0.20000 None
3	82.000	40	12000.	60000.	0.20000 None

Soil Zones

Zone	Name	X coordinates min max	Y coordinates min max	Profile
1	Soil	-20.00000 40.00000	-20.00000 26.00000	Soil Profile 1
	Zone 1			

Load Data

Load ref.	Name	Shape	Orientation of Plane	Centre of load (Global) X Y Z (level)	Load position Angle of local x from Radius	Width x or Radius	Length y	Polygon Coordinates	Rectangle of tolerance	Number of rectangles	Normal (local z)	Load value Tangential (local x) (local y)
1	Basement Excavation	Polygonal	Horizontal	N/A N/A 81.40000	N/A	N/A	N/A	(3,1) (18,1) (20,2.3) (20,5.5) (12,5.25) (12,4) (3,4)	10.000	3	-55.000	N/A N/A
2	Existing Cellar	Polygonal	Horizontal	N/A N/A 81.40000	N/A	N/A	N/A	(3,4) (12,4) (12,5.25) (3,5)	10.000	1	-30.000	N/A N/A
3	Underpinning	Polygonal	Horizontal	N/A N/A 81.40000	N/A	N/A	N/A	(2,6) (2,0) (12,0) (12,1)	10.000	2	50.000	N/A N/A
4	Underpinning	Polygonal	Horizontal	N/A N/A 81.40000	N/A	N/A	N/A	(12,0) (18,0) (21,2) (21,6.5) (19,6.5) (19,5.5) (20,5.5)	10.000	10	95.000	N/A N/A
5	Underpinning	Polygonal	Horizontal	N/A N/A 81.40000	N/A	N/A	N/A	(20,2.3) (18,1) (12,1) (19,6.5) (12,6.25) (12,5.25)	10.000	1	50.000	N/A N/A
6	Underpinning	Polygonal	Horizontal	N/A N/A 81.40000	N/A	N/A	N/A	(3,6) (12,6.25) (12,5.25) (3,5)	10.000	1	50.000	N/A N/A

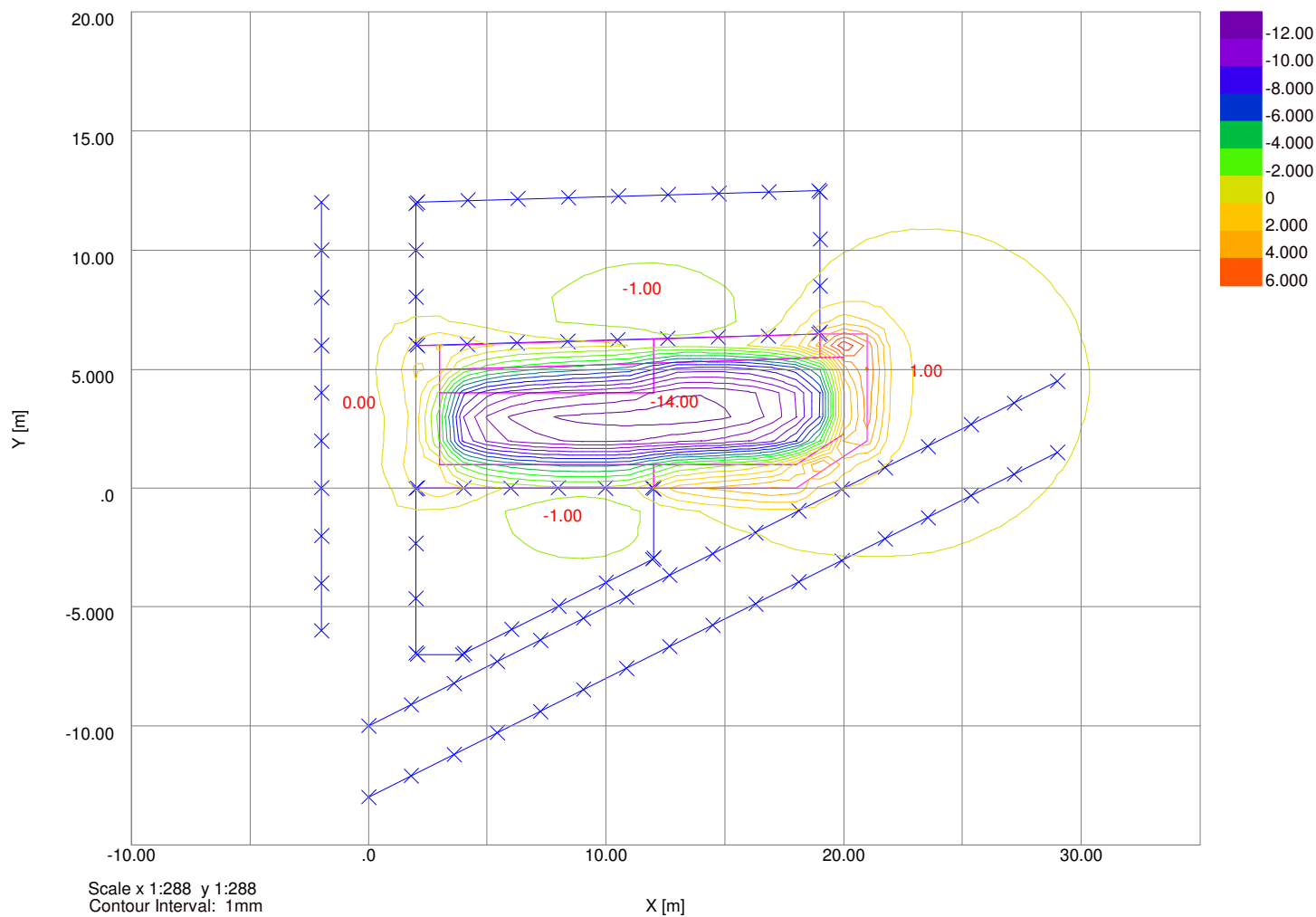
Polygonal Loads' Rectangles

No.	Centre of load X Y	Angle of local x from global X (Degrees)	Width x [m]	Depth y [m]
Load 1 : Basement Excavation (Edge 1 optimal)				
1	7.50000 2.50000	0.0	9.0000	3.0000
2	15.00000 3.17188	0.0	6.0000	4.3438
3	19.00000 3.55938	0.0	2.0000	3.8187
Load 2 : Existing Cellar (Edge 1 optimal)				
1	7.50000 4.56250	0.0	9.0000	1.1250
Load 3 : Underpinning (Edge 1 optimal)				
1	2.50000 3.50000	-90.000	5.0000	1.0000
2	7.00000 0.50000	-90.000	1.0000	10.000
Load 4 : Underpinning (Edge 1 optimal)				
1	15.00000 0.50000	0.0	6.0000	1.0000
2	18.14286 0.59405	0.0	0.28571	0.99762
3	18.42857 0.78214	0.0	0.28571	0.99286
4	18.71429 0.97024	0.0	0.28571	0.98810
5	19.00000 1.15833	0.0	0.28571	0.98333
6	19.28571 1.34643	0.0	0.28571	0.97857
7	19.57143 1.53452	0.0	0.28571	0.97381
8	19.85714 1.72262	0.0	0.28571	0.96905
9	20.50000 4.08333	0.0	1.0000	4.8333
10	19.50000 6.00000	0.0	1.0000	1.0000
Load 5 : Underpinning (Edge 1 optimal)				
1	15.50000 5.87500	-177.95	6.9688	0.99936
Load 6 : Underpinning (Edge 2 optimal)				
1	7.50000 5.62500	1.5911	8.9757	0.99961

Displacement Data

Ref.	Type	Name	Direction of Extrusion	First point X Y Z (level)	Line/Line for extrusion Second point X Y Z (level)	No. of intrvl across extrusion/line	Extrusion Depth	No. of intrvl along extrusion	Calculate	Show Detailed results
1	Grid	Grid 1	Global X	-20.00000 -20.00000 85.50000	N/A 26.00000 85.50000	46	60.00000	60	Yes	No
2	Grid	Grid 2	Global X	-20.00000 -20.00000 84.00000	N/A 26.00000 84.00000	46	60.00000	60	Yes	No
3	Line	Line 1	N/A	2.05000 0.00000 84.00000	11.95000 0.00000 84.00000	5	N/A	N/A	Yes	No
4	Line	Line 2	N/A	12.00000 -0.05000 84.00000	12.00000 -2.95000 84.00000	1	N/A	N/A	Yes	No
5	Line	Line 3	N/A	11.95000 -3.00000 84.00000	4.05000 -6.95000 84.00000	4	N/A	N/A	Yes	No
6	Line	Line 4	N/A	3.95000 -7.00000 84.00000	2.05000 -7.00000 84.00000	1	N/A	N/A	Yes	No
7	Line	Line 5	N/A	2.00000 -6.95000 84.00000	2.00000 -0.05000 84.00000	3	N/A	N/A	Yes	No
8	Line	Line 6	N/A	2.05000 6.00000 84.00000	18.95000 6.50000 84.00000	8	N/A	N/A	Yes	No
9	Line	Line 7	N/A	19.00000 6.55000 84.00000	19.00000 12.45000 84.00000	3	N/A	N/A	Yes	No
10	Line	Line 8	N/A	18.95000 12.50000 84.00000	2.05000 12.00000 84.00000	8	N/A	N/A	Yes	No
11	Line	Line 9	N/A	2.00000 11.95000 84.00000	6.05000 84.00000	3	N/A	N/A	Yes	No
12	Line	Line 10	N/A	-2.00000 -6.00000 85.00000	-2.00000 12.00000 85.00000	9	N/A	N/A	Yes	No
13	Line	Line 11	N/A	0.00000 -10.00000 83.00000	29.00000 4.50000 83.00000	16	N/A	N/A	Yes	No
14	Line	Line 12	N/A	0.00000 -13.00000 83.00000	29.00000 1.50000 83.00000	16	N/A	N/A	Yes	No

Settlement Contours : Grid 1 at 85.5000m



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Problem Type

Problem Type : Tunnelling and Embedded Wall Excavations

Displacement Data

Type	Name	Direction of extrusion	Point/Line/Line for extrusion						No. of intervals across extrusion/line	Extrusion depth	No. of intervals along extrusion	Calculate	Surface type for tunnels
			First point			Second point							
			X [m]	Y [m]	Z (level)	X [m]	Y [m]	Z (level)					
Grid	Grid 1	Global X	-20.00000	-20.00000	85.50000	-	26.00000	85.50000	46	60.00000	60	Yes	Surface
Grid	Grid 2	Global X	-20.00000	-20.00000	84.00000	-	26.00000	84.00000	46	60.00000	60	Yes	Surface
Line	Line 1	-	2.05000	0.00000	84.00000	11.95000	0.00000	84.00000	5	-	-	Yes	Surface
Line	Line 2	-	12.00000	-0.05000	84.00000	12.00000	-2.95000	84.00000	1	-	-	Yes	Surface
Line	Line 3	-	11.95000	-3.00000	84.00000	4.05000	-6.95000	84.00000	4	-	-	Yes	Surface
Line	Line 4	-	3.95000	-7.00000	84.00000	2.05000	-7.00000	84.00000	1	-	-	Yes	Surface
Line	Line 5	-	2.00000	-6.95000	84.00000	2.00000	-0.05000	84.00000	3	-	-	Yes	Surface
Line	Line 6	-	2.05000	6.00000	84.00000	18.95000	6.50000	84.00000	8	-	-	Yes	Surface
Line	Line 7	-	19.00000	6.55000	84.00000	19.00000	12.45000	84.00000	3	-	-	Yes	Surface
Line	Line 8	-	18.95000	12.50000	84.00000	2.05000	12.00000	84.00000	8	-	-	Yes	Surface
Line	Line 9	-	2.00000	11.95000	84.00000	2.00000	6.05000	84.00000	3	-	-	Yes	Surface
Line	Line 10	-	-2.00000	-6.00000	85.00000	-2.00000	12.00000	85.00000	9	-	-	Yes	Surface
Line	Line 11	-	0.00000	-10.00000	83.00000	29.00000	4.50000	83.00000	16	-	-	Yes	Surface
Line	Line 12	-	0.00000	-13.00000	83.00000	29.00000	1.50000	83.00000	16	-	-	Yes	Surface

Vertical Ground Movement Curves (Excavations)

Curve Name: No vertical ground movement
Coordinates: [Distance from wall / wall depth or max. excavation depth (x), Depth / wall depth or max. excavation depth (y), Settlement / wall depth or max. excavation depth (z) (%)]
 [0.000,0.000,0.000] [1.000,0.000,0.000] [0.000,1.000,0.000] [1.000,1.000,0.000]
Curve Fitting Method: Polynomial
x Order: 1
y Order: 0
Polynomial: z = 0.0x + 0.0
Coeff. of Determination: -2147483648.E+2147483647

Horizontal Ground Movement Curves (Excavations)

Curve Name: GEA Curve for 5 mm of horizontal deflection (after CIRIA 580 Fig. 2.11(a))
Coordinates: [Distance from wall / wall depth or max. excavation depth (x), Depth / wall depth or max. excavation depth (y), Horizontal movement / wall depth or max. excavation depth (z) (%)]
 [0.000,0.000,0.121] [4.000,0.000,0.000]
Curve Fitting Method: Polynomial
x Order: 1
y Order: 0
Polynomial: z = -3.03E-2x + 1.21E-1
Coeff. of Determination: 1.00

Polygonal Excavations

Excavation Name: New Excavation
Surface level [m]: 85.500
Contribution: Positive
Enabled: Yes
Surface movement curves which are selected are applied between surface and [m]: 81.400

Corner	x	y	Base Level	Stiffened	Previous Side	Next Side
	[m]	[m]	[m]	d	p1 p2*	d p1 p2*
1	2.0000	0.0	81.400	No	- - -	- - -
2	18.000	0.0	81.400	No	- - -	- - -
3	21.000	2.0000	81.400	No	- - -	- - -
4	21.000	6.5000	81.400	No	- - -	- - -
5	2.0000	6.0000	81.400	No	- - -	- - -

Side	Corner 1	Corner 2	Ground Movement Curve	
	x y	x y	Vertical	Horizontal
	[m] [m]	[m] [m]		
1	2.0000 0.0	18.000 0.0	No vertical ground movement	GEA Curve for 5 mm of horizontal deflection (after CIRIA 580 Fig. 2.11(a))
2	18.000 0.0	21.000 2.0000	No vertical ground movement	GEA Curve for 5 mm of horizontal deflection (after CIRIA 580 Fig. 2.11(a))
3	21.000 2.0000	21.000 6.5000	No vertical ground movement	GEA Curve for 5 mm of horizontal deflection (after CIRIA 580 Fig. 2.11(a))
4	21.000 6.5000	2.0000 6.0000	No vertical ground movement	GEA Curve for 5 mm of horizontal deflection (after CIRIA 580 Fig. 2.11(a))
5	2.0000 6.0000	2.0000 0.0	No vertical ground movement	GEA Curve for 5 mm of horizontal deflection (after CIRIA 580 Fig. 2.11(a))

Damage Category Strains

Name	0 (Negligible) to 1 (Very Slight)	1 (Very Slight) to 2 (Slight)	2 (Slight) to 3 (Moderate)	3 (Moderate) to 4 (Severe)
Burland Strain Limits	0.0	500.00E-6	750.00E-6	0.0015000

Specific Structures - Geometry

Structure Name	Sub-Structure Name	Displacement Line	Start Distance Along Line	End Distance Along Line	Vertical Offsets from Line for Vertical Movement Calculations	Vertical Displacement Limit	Damage Category Strains	Poisson's Ratio	E/G
			[m]	[m]	[m]	[mm]			
No 33	Party Wall (1)	Line 1	0.00000	9.89900	0.0	0.10000	Burland Strain Limits	0.20000	2.6000
No 33	Rear Elevation (2)	Line 2	0.00000	2.90000	0.0	0.10000	Burland Strain Limits	0.20000	2.6000
No 33	Far Elevation (3)	Line 3	0.00000	8.83200	0.0	0.10000	Burland Strain Limits	0.20000	2.6000
No 33	Far Elevation (4)	Line 4	0.00000	1.90000	0.0	0.10000	Burland Strain Limits	0.20000	2.6000

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Structure Name	Sub-Structure Name	Displacement Line	Start Distance Along Line	End Distance Along Line	Vertical Offsets from Line for Vertical	Vertical Displacement Limit Sensitivity	Damage Category Strains	Poisson's Ratio	E/G
No 33	Frontage (5)	Line 5	0.00000	6.90000	0.0	0.10000	Burland Strain Limits	0.20000	2.6000
No 29	Party Wall (6)	Line 6	0.00000	16.90700	0.0	0.10000	Burland Strain Limits	0.20000	2.6000
No 29	Rear Elevation (7)	Line 7	0.00000	5.89900	0.0	0.10000	Burland Strain Limits	0.20000	2.6000
No 29	Far Elevation (8)	Line 8	0.00000	16.90700	0.0	0.10000	Burland Strain Limits	0.20000	2.6000
No 29	Frontage (9)	Line 9	0.00000	5.89900	0.0	0.10000	Burland Strain Limits	0.20000	2.6000
Willoughby Road	Roadway (10)	Line 10	0.00000	18.00000	0.0	0.10000	Burland Strain Limits	0.20000	2.6000
Willow Cottages	Retaining Wall (11)	Line 11	0.00000	32.42200	0.0	0.10000	Burland Strain Limits	0.20000	2.6000
Willow Cottages	Rear Elevation	Line 12	0.00000	32.42200	0.0	0.10000	Burland Strain Limits	0.20000	2.6000

Specific Structures - Bending Parameters

Structure Name	Sub-Structure Name	Height	Default Properties	Hogging			Sagging		
				2nd Moment of Area (per unit width)	Distance of Bending Strain from N.A.	Distance of N.A. from Edge of Beam in Tension	2nd Moment of Area (per unit width)	Distance of Bending Strain from N.A.	Distance of N.A. from Edge of Beam in Tension
No 33	Party Wall (1)	[m]	8.0000 Yes	[m ⁴]	[m]	[m]	[m ⁴]	[m]	[m]
No 33	Rear Elevation (2)	8.0000	Yes	170.67	8.0000	8.0000	42.667	4.0000	4.0000
No 33	Far Elevation (3)	8.0000	Yes	170.67	8.0000	8.0000	42.667	4.0000	4.0000
No 33	Far Elevation (4)	8.0000	Yes	170.67	8.0000	8.0000	42.667	4.0000	4.0000
No 33	Frontage (5)	8.0000	Yes	170.67	8.0000	8.0000	42.667	4.0000	4.0000
No 29	Party Wall (6)	12.000	Yes	576.00	12.000	12.000	144.00	6.0000	6.0000
No 29	Rear Elevation (7)	12.000	Yes	576.00	12.000	12.000	144.00	6.0000	6.0000
No 29	Far Elevation (8)	12.000	Yes	576.00	12.000	12.000	144.00	6.0000	6.0000
No 29	Frontage (9)	12.000	Yes	576.00	12.000	12.000	144.00	6.0000	6.0000
Willoughby Road	Roadway (10)	0.50000	Yes	0.041667	0.50000	0.50000	0.010417	0.25000	0.25000
Willow Cottages	Retaining Wall (11)	2.5000	Yes	5.2083	2.5000	2.5000	1.3021	1.2500	1.2500
Willow Cottages	Rear Elevation	8.0000	Yes	170.67	8.0000	8.0000	42.667	4.0000	4.0000

Building Segment Combinations

Structure Name	Sub-Structure Name	Vertical Offset from Line for Vertical Movement Calculations	Segment Start	Length	Curvature	Combined Segment
No structures have segments combined.						

Utility Strain Calculation Options

Neglect beneficial contribution of axial strains : No

Warnings

- Sub-structure 6 crosses at least one excavation. Its building damage results in that area should be treated with caution.

Errors

None

Specific Building Damage Results - Horizontal Displacements

Structure: No 33 | Sub-structure: Party Wall (1)

Dist.	Coordinates			Displacements		
	x	y	z	x	y	
				Horizontal displacement along the Line	Horizontal displacement perpendicular to Line	
	[m]	[m]	[m]	[mm]	[mm]	
0.0	2.05000	0.00000	84.00000	0.0	4.9610	d
1.9800	4.03000	0.00000	84.00000	0.0	4.9610	d
3.9600	6.01000	0.00000	84.00000	0.0	4.9610	d
5.9400	7.99000	0.00000	84.00000	0.0	4.9610	d
7.9200	9.97000	0.00000	84.00000	0.0	4.9610	d
9.9000	11.95000	0.00000	84.00000	0.0	4.9610	d

d - Displacements include imported displacements.

Structure: No 33 | Sub-structure: Rear Elevation (2)

Dist.	Coordinates			Displacements		
	x	y	z	x	y	
				Horizontal displacement along the Line	Horizontal displacement perpendicular to Line	
	[m]	[m]	[m]	[mm]	[mm]	
0.0	12.00000	-0.05000	84.00000	0.0	4.9459	0.0 d
2.9000	12.00000	-2.95000	84.00000	0.0	4.0686	0.0 d

d - Displacements include imported displacements.

Structure: No 33 | Sub-structure: Far Elevation (3)

Dist.	Coordinates			Displacements		
	x	y	z	x	y	
				Horizontal displacement along the Line	Horizontal displacement perpendicular to Line	
	[m]	[m]	[m]	[mm]	[mm]	
0.0	11.95000	-3.00000	84.00000	0.0	4.0535	-3.6256 d
2.2081	9.97500	-3.98750	84.00000	0.0	3.7548	-3.3584 d
4.4162	8.00000	-4.97500	84.00000	0.0	3.4561	-3.0912 d
6.6244	6.02500	-5.96250	84.00000	0.0	3.1573	-2.8240 d
8.8325	4.05000	-6.95000	84.00000	0.0	2.8586	-2.5568 d

d - Displacements include imported displacements.

Structure: No 33 | Sub-structure: Far Elevation (4)

Dist.	Coordinates			Displacements		
	x	y	z	x	y	
				Horizontal displacement	Horizontal displacement	



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along the Line		perpendicular to Line	
[m]	[mm]	[m]	[mm]
0.0	3.95000	-7.00000	84.00000
1.9000	2.05000	-7.00000	84.00000
d - Displacements include imported displacements.			

Structure: No 33 | Sub-structure: Frontage (5)

Dist.	Coordinates			Displacements		
x	y	z	x	y	Horizontal displacement along the Line	Horizontal displacement perpendicular to Line
[m]	[m]	[m]	[mm]	[mm]	[mm]	[mm]
0.0	2.00000	-6.95000	84.00000	0.0	2.8586	2.8586
2.3000	2.00000	-4.45000	84.00000	0.0	3.5544	3.5544
4.6000	2.00000	-2.35000	84.00000	0.0	4.2501	4.2501
6.9000	2.00000	-0.05000	84.00000	0.0	4.9459	4.9459
d - Displacements include imported displacements.						

Structure: No 29 | Sub-structure: Party Wall (6)

Dist.	Coordinates			Displacements		
x	y	z	x	y	Horizontal displacement along the Line	Horizontal displacement perpendicular to Line
[m]	[m]	[m]	[mm]	[mm]	[mm]	[mm]
0.0	2.05000	6.00000	84.00000	0.0	0.0	0.0
2.1134	4.16250	6.06250	84.00000	0.13046	-4.9576	-0.016204
4.2268	6.27500	6.12500	84.00000	0.13041	-4.9555	-0.016197
6.3403	8.38750	6.18750	84.00000	0.13035	-4.9534	-0.016191
8.4537	10.50000	6.25000	84.00000	0.13030	-4.9513	-0.016184
10.567	12.61250	6.31250	84.00000	0.13024	-4.9492	-0.016177
12.681	14.72500	6.37500	84.00000	0.13019	-4.9472	-0.016170
14.794	16.83750	6.43750	84.00000	0.13013	-4.9451	-0.016163
16.907	18.95000	6.50000	84.00000	0.13008	-4.9430	-0.016157
d - Displacements include imported displacements.						

Structure: No 29 | Sub-structure: Rear Elevation (7)

Dist.	Coordinates			Displacements		
x	y	z	x	y	Horizontal displacement along the Line	Horizontal displacement perpendicular to Line
[m]	[m]	[m]	[mm]	[mm]	[mm]	[mm]
0.0	19.00000	6.55000	84.00000	0.12969	-4.9283	-0.012969
1.9667	19.00000	8.51667	84.00000	0.11405	-4.3338	-0.011405
3.9333	19.00000	10.48333	84.00000	0.098401	-3.7392	-0.0098401
5.9000	19.00000	12.45000	84.00000	0.082756	-3.1447	-0.0082756
d - Displacements include imported displacements.						

Structure: No 29 | Sub-structure: Far Elevation (8)

Dist.	Coordinates			Displacements		
x	y	z	x	y	Horizontal displacement along the Line	Horizontal displacement perpendicular to Line
[m]	[m]	[m]	[mm]	[mm]	[mm]	[mm]
0.0	18.95000	12.00000	84.00000	0.082248	-3.1292	0.010228
2.1134	16.83750	12.43750	84.00000	0.082403	-3.1313	0.010235
4.2268	14.72500	12.37500	84.00000	0.082458	-3.1334	0.010242
6.3403	12.61250	12.31250	84.00000	0.082513	-3.1355	0.010249
8.4537	10.50000	12.25000	84.00000	0.082568	-3.1376	0.010255
10.567	8.38750	12.18750	84.00000	0.082623	-3.1397	0.010262
12.681	6.27500	12.12500	84.00000	0.082678	-3.1418	0.010269
14.794	4.16250	12.06250	84.00000	0.082733	-3.1438	0.010276
16.907	2.05000	12.00000	84.00000	0.082788	-3.1459	0.010283
d - Displacements include imported displacements.						

Structure: No 29 | Sub-structure: Frontage (9)

Dist.	Coordinates			Displacements		
x	y	z	x	y	Horizontal displacement along the Line	Horizontal displacement perpendicular to Line
[m]	[m]	[m]	[mm]	[mm]	[mm]	[mm]
0.0	2.00000	11.95000	84.00000	0.083175	-3.1607	3.1607
1.9667	2.00000	9.98333	84.00000	0.098820	-3.7552	3.7552
3.9333	2.00000	8.01667	84.00000	0.11446	-4.3497	4.3497
5.9000	2.00000	6.05000	84.00000	0.13011	-4.9442	4.9442
d - Displacements include imported displacements.						

Structure: Willoughby Road | Sub-structure: Roadway (10)

Dist.	Coordinates			Displacements		
x	y	z	x	y	Horizontal displacement along the Line	Horizontal displacement perpendicular to Line
[m]	[m]	[m]	[mm]	[mm]	[mm]	[mm]
0.0	-2.00000	-6.00000	85.00000	1.0405	1.7391	1.7391
2.0000	-2.00000	-4.00000	85.00000	1.6249	1.6249	1.6249
4.0000	-2.00000	-2.00000	85.00000	2.5432	1.0650	1.0650
6.0000	-2.00000	0.00000	85.00000	3.7510	0.0	0.0
8.0000	-2.00000	2.00000	85.00000	3.7510	0.0	0.0
10.000	-2.00000	4.00000	85.00000	3.7510	0.0	0.0
12.000	-2.00000	6.00000	85.00000	3.7510	0.0	0.0
14.000	-2.00000	8.00000	85.00000	2.5535	-1.0828	-1.0828
16.000	-2.00000	10.00000	85.00000	1.6407	-1.6520	-1.6520
18.000	-2.00000	12.00000	85.00000	1.0574	-1.7681	-1.7681
d - Displacements include imported displacements.						

Structure: Willow Cottages | Sub-structure: Retaining Wall (11)

Dist.	Coordinates			Displacements		
x	y	z	x	y	Horizontal displacement along the Line	Horizontal displacement perpendicular to Line
[m]	[m]	[m]	[mm]	[mm]	[mm]	[mm]
0.0	0.00000	-10.00000	83.00000	0.23576	1.6403	0.94445
2.0264	1.81250	-9.09375	83.00000	0.028999	2.1806	1.0011
4.0529	3.62500	-8.18750	83.00000	0.0	2.4843	1.1110
6.0793	5.43750	-7.28125	83.00000	0.0	2.7584	1.2336
8.1057	7.25000	-6.37500	83.00000	0.0	3.0326	1.3562



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Dist.	Coordinates			Displacements		
	x	y	z	x	y	Horizontal displacement along the line
10.132	9.06250	-5.46875	83.00000	0.0	3.3067	1.4788
12.159	10.87500	-4.56250	83.00000	0.0	3.5808	1.6014
14.185	12.68750	-3.65625	83.00000	0.0	3.8550	1.7240
16.211	14.50000	-2.75000	83.00000	0.0	4.1291	1.8466
18.238	16.31250	-1.84375	83.00000	0.0	4.4033	1.9692
20.264	18.12500	-0.93750	83.00000	-0.58457	4.4979	1.4887
22.291	19.93750	-0.03125	83.00000	-2.5672	3.8508	-0.57404
24.317	21.75000	0.87500	83.00000	-2.5250	3.7875	-0.56461
26.344	23.56250	1.78125	83.00000	-4.0216	0.30159	-3.4622
28.370	25.37500	2.68750	83.00000	-3.6376	0.0	-3.2535
30.397	27.18750	3.59375	83.00000	-3.0893	0.0	-2.7631
32.423	29.00000	4.50000	83.00000	-2.5410	0.0	-2.2727
d - Displacements include imported displacements.						

Structure: Willow Cottages | Sub-structure: Rear Elevation

Dist.	Coordinates			Displacements		
	x	y	z	x	y	Horizontal displacement along the line
[m]	[m]	[m]	[m]	[mm]	[mm]	[mm]
0.0	0.00000	-13.00000	83.00000	0.095453	0.88678	0.48196
2.0264	1.81250	-12.09375	83.00000	0.012852	1.2893	0.58811
4.0529	3.62500	-11.18750	83.00000	0.0	1.5768	0.70516
6.0793	5.43750	-10.28125	83.00000	0.0	1.8509	0.82776
8.1057	7.25000	-9.37500	83.00000	0.0	2.1251	0.95036
10.132	9.06250	-8.46875	83.00000	0.0	2.3992	1.0730
12.159	10.87500	-7.56250	83.00000	0.0	2.6733	1.1956
14.185	12.68750	-6.65625	83.00000	0.0	2.9475	1.3182
16.211	14.50000	-5.75000	83.00000	0.0	3.2216	1.4408
18.238	16.31250	-4.84375	83.00000	0.0	3.4958	1.5634
20.264	18.12500	-3.93750	83.00000	-0.11285	3.7351	1.5695
22.291	19.93750	-3.03125	83.00000	-2.0778	3.2436	-0.40784
24.317	21.75000	-2.12500	83.00000	-2.1061	3.1592	-0.47095
26.344	23.56250	-1.21875	83.00000	-2.2036	2.8268	-0.70675
28.370	25.37500	-0.31250	83.00000	-2.7009	1.4260	-1.7780
30.397	27.18750	0.59375	83.00000	-2.7336	0.57546	-2.1876
32.423	29.00000	1.50000	83.00000	-2.4645	0.13403	-2.1444
d - Displacements include imported displacements.						

Specific Building Damage Results - Vertical Displacements

Structure: No 33 | Sub-structure: Party Wall (1)

Dist.	Coordinates			Displacements
	x	y	z	
[m]	[m]	[m]	[m]	[mm]

Vertical Offset 1				
0.0	2.05000	0.00000	84.00000	1.2257 d
1.9800	4.03000	0.00000	84.00000	0.99422 d
3.9600	6.01000	0.00000	84.00000	-0.15701 d
5.9400	7.99000	0.00000	84.00000	-0.66222 d
7.9200	9.97000	0.00000	84.00000	-0.66132 d
9.9000	11.95000	0.00000	84.00000	0.95027 d
d - Displacements include imported displacements.				

Structure: No 33 | Sub-structure: Rear Elevation (2)

Dist.	Coordinates			Displacements
	x	y	z	
[m]	[m]	[m]	[m]	[mm]

Vertical Offset 1				
0.0	12.00000	-0.05000	84.00000	0.89278 d
2.9000	12.00000	-2.95000	84.00000	-0.79255 d
d - Displacements include imported displacements.				

Structure: No 33 | Sub-structure: Far Elevation (3)

Dist.	Coordinates			Displacements
	x	y	z	
[m]	[m]	[m]	[m]	[mm]

Vertical Offset 1				
0.0	11.95000	-3.00000	84.00000	-0.79347 d
2.2081	9.97500	-3.98750	84.00000	-0.79562 d
4.4162	8.00000	-4.97500	84.00000	-0.65702 d
6.6244	6.02500	-5.96250	84.00000	-0.49730 d
8.8325	4.05000	-6.95000	84.00000	-0.36581 d
d - Displacements include imported displacements.				

Structure: No 33 | Sub-structure: Far Eleavtion (4)

Dist.	Coordinates			Displacements
	x	y	z	
[m]	[m]	[m]	[m]	[mm]

Vertical Offset 1				
0.0	3.95000	-7.00000	84.00000	-0.36016 d
1.9000	2.05000	-7.00000	84.00000	-0.29973 d
d - Displacements include imported displacements.				

Structure: No 33 | Sub-structure: Frontage (5)

Dist.	Coordinates			Displacements
	x	y	z	
[m]	[m]	[m]	[m]	[mm]

Vertical Offset 1				
0.0	2.00000	-6.95000	84.00000	-0.29981 d
2.3000	2.00000	-4.65000	84.00000	-0.37247 d
4.6000	2.00000	-2.35000	84.00000	-0.36176 d
6.9000	2.00000	-0.05000	84.00000	1.0175 d
d - Displacements include imported displacements.				

Structure: No 29 | Sub-structure: Party Wall (6)

Dist.	Coordinates			Displacements
	x	y	z	
[m]	[m]	[m]	[m]	[mm]

Vertical Offset 1				
0.0	2.05000	6.00000	84.00000	1.4253 d
2.1134	4.16250	6.06250	84.00000	1.3373 d
4.2268	6.27500	6.12500	84.00000	0.41250 d
6.3403	8.38750	6.18750	84.00000	-0.029471 d
8.4537	10.50000	6.25000	84.00000	-0.32869 d
10.567	12.61250	6.31250	84.00000	-0.79441 d



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Dist.	Coordinates			Displacements
	x	y	z	
[m]	[m]	[m]	[m]	[mm]
12.691	14.72500	6.37500	84.00000	-0.54280 d
14.794	16.83750	6.43750	84.00000	0.48879 d
16.907	18.95000	6.50000	84.00000	3.4444 d
d - Displacements include imported displacements.				
Structure: No 29 Sub-structure: Rear Elevation (7)				
Dist.	Coordinates			Displacements
	x	y	z	
[m]	[m]	[m]	[m]	[mm]
Vertical Offset 1				
0.0	19.00000	6.55000	84.00000	3.3625 d
1.9667	19.00000	8.51667	84.00000	0.14865 d
3.9333	19.00000	10.48333	84.00000	-0.17655 d
5.9000	19.00000	12.45000	84.00000	-0.21653 d
d - Displacements include imported displacements.				
Structure: No 29 Sub-structure: Far Elevation (8)				
Dist.	Coordinates			Displacements
	x	y	z	
[m]	[m]	[m]	[m]	[mm]
Vertical Offset 1				
0.0	18.95000	12.50000	84.00000	-0.21937 d
2.1134	16.83750	12.43750	84.00000	-0.35509 d
4.2268	14.72500	12.37500	84.00000	-0.48003 d
6.3403	12.61250	12.31250	84.00000	-0.55813 d
8.4537	10.50000	12.25000	84.00000	-0.57860 d
10.567	8.38750	12.18750	84.00000	-0.54783 d
12.681	6.27500	12.12500	84.00000	-0.47905 d
14.794	4.16250	12.06250	84.00000	-0.39118 d
16.907	2.05000	12.00000	84.00000	-0.30740 d
d - Displacements include imported displacements.				
Structure: No 29 Sub-structure: Frontage (9)				
Dist.	Coordinates			Displacements
	x	y	z	
[m]	[m]	[m]	[m]	[mm]
Vertical Offset 1				
0.0	2.00000	11.95000	84.00000	-0.30674 d
1.9667	2.00000	9.98333	84.00000	-0.38435 d
3.9333	2.00000	8.01667	84.00000	-0.22834 d
5.9000	2.00000	6.05000	84.00000	1.2086 d
d - Displacements include imported displacements.				
Structure: Willoughby Road Sub-structure: Roadway (10)				
Dist.	Coordinates			Displacements
	x	y	z	
[m]	[m]	[m]	[m]	[mm]
Vertical Offset 1				
0.0	-2.00000	-6.00000	85.00000	-0.20888 d
2.0000	-2.00000	-4.00000	85.00000	-0.23159 d
4.0000	-2.00000	-2.00000	85.00000	-0.24045 d
6.0000	-2.00000	0.00000	85.00000	-0.23554 d
8.0000	-2.00000	2.00000	85.00000	-0.22928 d
10.000	-2.00000	4.00000	85.00000	-0.21887 d
12.000	-2.00000	6.00000	85.00000	-0.21195 d
14.000	-2.00000	8.00000	85.00000	-0.21595 d
16.000	-2.00000	10.00000	85.00000	-0.21234 d
18.000	-2.00000	12.00000	85.00000	-0.19579 d
d - Displacements include imported displacements.				
Structure: Willow Cottages Sub-structure: Retaining Wall (11)				
Dist.	Coordinates			Displacements
	x	y	z	
[m]	[m]	[m]	[m]	[mm]
Vertical Offset 1				
0.0	0.00000	-10.00000	83.00000	-0.18071 d
2.0264	1.81250	-9.09375	83.00000	-0.23176 d
4.0529	3.62500	-8.18750	83.00000	-0.29955 d
6.0793	5.43750	-7.28125	83.00000	-0.38804 d
8.1057	7.25000	-6.37500	83.00000	-0.49367 d
10.132	9.06250	-5.46875	83.00000	-0.60627 d
12.159	10.87500	-4.56250	83.00000	-0.67993 d
14.185	12.68750	-3.65625	83.00000	-0.64829 d
16.211	14.50000	-2.75000	83.00000	-0.43428 d
18.238	16.31250	-1.84375	83.00000	0.030477 d
20.264	18.12500	-0.93750	83.00000	0.79598 d
22.291	19.93750	-0.03125	83.00000	0.98234 d
24.317	21.75000	0.87500	83.00000	0.88472 d
26.344	23.56250	1.78125	83.00000	0.44098 d
28.370	25.37500	2.68750	83.00000	0.19355 d
30.397	27.18750	3.59375	83.00000	0.75023 d
32.423	29.00000	4.50000	83.00000	0.019492 d
d - Displacements include imported displacements.				
Structure: Willow Cottages Sub-structure: Rear Elevation				
Dist.	Coordinates			Displacements
	x	y	z	
[m]	[m]	[m]	[m]	[mm]
Vertical Offset 1				
0.0	0.00000	-13.00000	83.00000	-0.13209 d
2.0264	1.81250	-12.09375	83.00000	-0.16411 d
4.0529	3.62500	-11.18750	83.00000	-0.20367 d
6.0793	5.43750	-10.28125	83.00000	-0.25124 d
8.1057	7.25000	-9.37500	83.00000	-0.30526 d
10.132	9.06250	-8.46875	83.00000	-0.36003 d
12.159	10.87500	-7.56250	83.00000	-0.40396 d
14.185	12.68750	-6.65625	83.00000	-0.41977 d
16.211	14.50000	-5.75000	83.00000	-0.38909 d
18.238	16.31250	-4.84375	83.00000	-0.30139 d
20.264	18.12500	-3.93750	83.00000	-0.16555 d
22.291	19.93750	-3.03125	83.00000	-0.025485 d
24.317	21.75000	-2.12500	83.00000	0.066217 d
26.344	23.56250	-1.21875	83.00000	0.091785 d
28.370	25.37500	-0.31250	83.00000	0.067445 d
30.397	27.18750	0.59375	83.00000	0.033156 d
32.423	29.00000	1.50000	83.00000	0.0075034 d
d - Displacements include imported displacements.				
Specific Building Damage Results - All Segments				



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2nd Stage - Total - 5 mm limit on overall horizontal movements

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Dist.	Coordinates			Displacements								
	x [m]	y [m]	z [m]	z [mm]								
Structure: No 33 Sub-structure: Party Wall (1)												
Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category	
[m] 0.0		[m]	[m]		[%]	[%]	[%]			[m]		
	1	0.0	3.3786	Sagging	0.011265	0.0	0.010772	0.0	581.43E-6	2990.1	0	(Negligible)
	2	3.3786	6.5204	Hogging	0.021093	0.0	0.020232	0.0	-813.93E-6	2077.3	0	(Negligible)
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.												
Structure: No 33 Sub-structure: Rear Elevation (2)												
Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category	
[m] 0.0		[m]	[m]		[%]	[%]	[%]			[m]		
	1	0.0	2.9000	Sagging	0.0	0.030250	0.030250	-302.41E-6	580.97E-6	-	0	(Negligible)
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.												
Structure: No 33 Sub-structure: Far Elevation (3)												
Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category	
[m] 0.0		[m]	[m]		[%]	[%]	[%]			[m]		
	1	0.0	5.9813	Hogging	0.0015672	0.0060500	0.0069201	-60.496E-6	-72.327E-6	28572.	0	(Negligible)
	2	5.9813	2.8507	Sagging	221.33E-6	0.0060500	0.0061675	-60.496E-6	-72.327E-6	120220.	0	(Negligible)
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.												
Structure: No 33 Sub-structure: Far Elevation (4)												
Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category	
[m] 0.0		[m]	[m]		[%]	[%]	[%]			[m]		
	1	0.0	1.9000	None	0.0	0.0	0.0	0.0	-31.807E-6	-	0	(Negligible)
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.												
Structure: No 33 Sub-structure: Frontage (5)												
Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category	
[m] 0.0		[m]	[m]		[%]	[%]	[%]			[m]		
	1	0.0	0.85156	None	0.0	0.030250	0.030250	-302.41E-6	31.583E-6	22249.	0	(Negligible)
	2	0.85156	6.0484	Hogging	0.014270	0.030250	0.038256	-302.41E-6	-599.48E-6	3132.5	0	(Negligible)
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.												
Structure: No 29 Sub-structure: Party Wall (6)												
Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category	
[m] 0.0		[m]	[m]		[%]	[%]	[%]			[m]		
	1	0.0	3.9772	Sagging	0.0097754	-407.28E-6	0.0093478	7.6674E-6	437.56E-6	3828.6	0	(Negligible)
	2	3.9772	12.930	Hogging	0.023377	0.0	0.021758	0.0	-0.0013985	2020.9	0	(Negligible)
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.												
Structure: No 29 Sub-structure: Rear Elevation (7)												
Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category	
[m] 0.0		[m]	[m]		[%]	[%]	[%]			[m]		
	1	0.0	5.3471	Hogging	0.035254	0.030229	0.051344	-302.20E-6	0.0016336	1093.4	1 (Very Slight)	
	2	5.3471	0.55187	Sagging	0.0	0.030229	0.030229	-302.20E-6	20.319E-6	10593.	0	(Negligible)
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.												
Structure: No 29 Sub-structure: Far Elevation (8)												
Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category	
[m] 0.0		[m]	[m]		[%]	[%]	[%]			[m]		
	1	0.0	15.104	Hogging	0.0017991	0.0	0.0016334	0.0	64.217E-6	83937.	0	(Negligible)
	2	15.104	1.8028	Hogging	0.0	0.0	0.0	0.0	-39.640E-6	451760.	0	(Negligible)
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.												
Structure: No 29 Sub-structure: Frontage (9)												
Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category	
[m] 0.0		[m]	[m]		[%]	[%]	[%]			[m]		
	1	0.0	0.54451	Hogging	0.0	0.030229	0.030229	-302.20E-6	14.033E-6	23342.	0	(Negligible)



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Vertical Offset from Line for Vertical Movement	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category
	2	0.54451	5.3545	Hogging	0.016228	0.030229	0.036294	-302.20E-6	-730.44E-6	2373.4	0 (Negligible)
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.											
Structure: Willoughby Road Sub-structure: Roadway (10)											
Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category
[m] 0.0	1	[m] 0.0	[m] 8.6180	Hogging	[%] 273.59E-6	[%] -0.020180	[%] 0.0040361	532.79E-6	11.357E-6	[m] 288140.	0 (Negligible)
	2	8.6180	4.3951	Sagging	109.31E-6	-0.012479	0.0024958	541.68E-6	-5.2036E-6	904320.	0 (Negligible)
	3	13.013	4.9869	Hogging	185.05E-6	-0.024457	0.0048915	541.68E-6	-8.2752E-6	280370.	0 (Negligible)
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.											
Structure: Willow Cottages Sub-structure: Retaining Wall (11)											
Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category
[m] 0.0	1	[m] 0.0	[m] 7.7803	Sagging	[%] 463.17E-6	[%] 0.0050392	[%] 0.0056758	-60.496E-6	53.108E-6	[m] 212970.	0 (Negligible)
	2	7.7803	10.848	Hogging	0.0051184	0.0049776	0.012719	237.19E-6	-377.85E-6	16718.	0 (Negligible)
	3	18.629	7.3426	Sagging	0.0086023	-0.065459	0.013183	0.0014319	-377.85E-6	11021.	0 (Negligible)
	4	25.971	2.3987	Hogging	0.0012629	-0.013491	0.0027857	0.0014319	219.29E-6	31718.	0 (Negligible)
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.											
Structure: Willow Cottages Sub-structure: Rear Elevation											
Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category
[m] 0.0	1	[m] 0.0	[m] 7.8673	Sagging	[%] 182.39E-6	[%] 0.0057704	[%] 0.0059915	-60.496E-6	26.653E-6	[m] 536810.	0 (Negligible)
	2	7.8673	12.397	Hogging	0.0015206	0.0051104	0.0066812	976.71E-6	-69.185E-6	79159.	0 (Negligible)
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.											
Specific Building Damage Results - Critical Values for All Segments within Each Sub-Structure											
Structure: No 33 Sub-structure: Party Wall (1)											
Vertical Offset from Line for Vertical Movement Calculations	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category	
[m] 0.0	[%] 0.021093	[%] 0.0	[mm] -813.93E-6	[mm] 1.2257	[%] 0.020232	0.0	-813.93E-6	[m] 2077.3	[m] 2990.1	0 (Negligible)	
Structure: No 33 Sub-structure: Rear Elevation (2)											
Vertical Offset from Line for Vertical Movement Calculations	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category	
[m] 0.0	[%] 0.0	[%] 0.030250	[mm] 580.97E-6	[mm] 0.89278	[%] 0.030250	-302.41E-6	580.97E-6	[m] -	[m] -	0 (Negligible)	
Structure: No 33 Sub-structure: Far Elevation (3)											
Vertical Offset from Line for Vertical Movement Calculations	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category	
[m] 0.0	[%] 0.0015672	[%] 0.0060500	[mm] -72.327E-6	[mm] 0.79559	[%] 0.0069201	-60.496E-6	-72.327E-6	[m] 28572.	[m] 120220.	0 (Negligible)	
Structure: No 33 Sub-structure: Far Eleavtion (4)											
Vertical Offset from Line for Vertical Movement Calculations	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category	
[m] 0.0	[%] 0.0	[%] 0.0	[mm] -31.807E-6	[mm] 0.36016	[%] 0.0	0.0	-31.807E-6	[m] -	[m] -	0 (Negligible)	
Structure: No 33 Sub-structure: Frontage (5)											
Vertical Offset from Line for Vertical Movement Calculations	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category	
[m] 0.0	[%] 0.014270	[%] 0.030250	[mm] -599.48E-6	[mm] 1.0175	[%] 0.038256	-302.41E-6	-599.48E-6	[m] 3132.5	[m] -	0 (Negligible)	
Structure: No 29 Sub-structure: Party Wall (6)											
Vertical Offset from Line for Vertical Movement Calculations	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category	
[m] 0.0	[%] 0.014270	[%] 0.030250	[mm] -599.48E-6	[mm] 1.0175	[%] 0.038256	-302.41E-6	-599.48E-6	[m] 3132.5	[m] -	0 (Negligible)	



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2nd Stage - Total - 5 mm limit on overall horizontal movements

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Movement Calculations					Curve							
[m]	[%]	[mm]	[%]					[m]	[m]			
0.0	0.023377	-407.28E-6	-0.0013985	3.4439	0.021758	7.6674E-6	-0.0013985	2020.9	3828.6	0 (Negligible)		
Structure: No 29 Sub-structure: Rear Elevation (7)												
Vertical Offset from Line for Vertical Movement Calculations	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category		
[m]	[%]	[%]		[mm]	[%]			[m]	[m]			
0.0	0.035254	0.030229	0.0016336	3.3625	0.051344	-302.20E-6	0.0016336	1093.4	10593.1	(Very Slight)		
Structure: No 29 Sub-structure: Far Elevation (8)												
Vertical Offset from Line for Vertical Movement Calculations	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category		
[m]	[%]	[%]		[mm]	[%]			[m]	[m]			
0.0	0.0017991		0.0	64.217E-6	0.57800	0.0016334	0.0	64.217E-6	83937.0	- 0 (Negligible)		
Structure: No 29 Sub-structure: Frontage (9)												
Vertical Offset from Line for Vertical Movement Calculations	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category		
[m]	[%]	[%]		[mm]	[%]			[m]	[m]			
0.0	0.016228	0.030229	-730.44E-6	1.2079	0.036294	-302.20E-6	-730.44E-6	2373.4		- 0 (Negligible)		
Structure: Willoughby Road Sub-structure: Roadway (10)												
Vertical Offset from Line for Vertical Movement Calculations	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category		
[m]	[%]	[%]		[mm]	[%]			[m]	[m]			
0.0	273.59E-6	-0.024457	11.357E-6	0.24044	0.0048915	541.68E-6	11.357E-6	280370.0	904320.0	0 (Negligible)		
Structure: Willow Cottages Sub-structure: Retaining Wall (11)												
Vertical Offset from Line for Vertical Movement Calculations	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category		
[m]	[%]	[%]		[mm]	[%]			[m]	[m]			
0.0	0.0086023	-0.065459	-377.85E-6	0.98011	0.013183	0.0014319	-377.85E-6	16718.0	11021.0	0 (Negligible)		
Structure: Willow Cottages Sub-structure: Rear Elevation												
Vertical Offset from Line for Vertical Movement Calculations	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category		
[m]	[%]	[%]		[mm]	[%]			[m]	[m]			
0.0	0.0015206	0.0057704	-69.185E-6	0.41932	0.0066812	976.71E-6	-69.185E-6	79159.0	536810.0	0 (Negligible)		
Specific Building Damage Results - Critical Segments within Each Structure												
Structure Name	Parameter	Critical Sub-Structure	Critical Segment	Start	End	Curvature	Max Slope	Max Settlement	Max Tensile Strain	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category
				[m]	[m]			[mm]	[%]	[m]	[m]	
No 33	Max Slope	Party Wall (1)	2	3.3786	9.8990	Hogging	813.93E-6	0.94946	0.020232	2077.3	- 0 (Negligible)	
	Max Settlement	Party Wall (1)	1	0.0	3.3786	Sagging	581.43E-6	1.2257	0.010772	-	2990.1	0 (Negligible)
	Max Tensile Strain	Frontage (5)	2	0.85156	6.9000	Hogging	599.48E-6	1.0175	0.038256	3132.5	- 0 (Negligible)	
	Min Radius of Curvature (Hogging)	Party Wall (1)	2	3.3786	9.8990	Hogging	813.93E-6	0.94946	0.020232	2077.3	- 0 (Negligible)	
	Min Radius of Curvature (Sagging)	Party Wall (1)	1	0.0	3.3786	Sagging	581.43E-6	1.2257	0.010772	-	2990.1	0 (Negligible)
No 29	Max Slope	Rear Elevation (7)	1	0.0	5.3471	Hogging	0.0016336	3.3625	0.051344	1093.4	- 1 (Very Slight)	
	Max Settlement	Party Wall (6)	2	3.9772	16.907	Hogging	0.0013985	3.4439	0.021758	2020.9	- 0 (Negligible)	
	Max Tensile Strain	Rear Elevation (7)	1	0.0	5.3471	Hogging	0.0016336	3.3625	0.051344	1093.4	- 1 (Very Slight)	
	Min Radius of Curvature (Hogging)	Rear Elevation (7)	1	0.0	5.3471	Hogging	0.0016336	3.3625	0.051344	1093.4	- 1 (Very Slight)	
	Min Radius of Curvature (Sagging)	Party Wall (6)	1	0.0	3.9772	Sagging	437.56E-6	1.4253	0.0093478	-	3828.6	0 (Negligible)
Willoughby Road	Max Slope	Roadway (10)	1	0.0	8.6180	Hogging	11.357E-6	0.24044	0.0040361	288140.0	- 0 (Negligible)	
	Max Settlement	Roadway (10)	1	0.0	8.6180	Hogging	11.357E-6	0.24044	0.0040361	288140.0	- 0 (Negligible)	
	Max Tensile Strain	Roadway (10)	3	13.013	18.000	Hogging	8.2752E-6	0.21591	0.0048915	280370.0	- 0 (Negligible)	
	Min Radius of Curvature (Hogging)	Roadway (10)	3	13.013	18.000	Hogging	8.2752E-6	0.21591	0.0048915	280370.0	- 0 (Negligible)	
	Min Radius of Curvature (Sagging)	Roadway (10)	2	8.6180	13.013	Sagging	5.2036E-6	0.22606	0.0024958	-	904320.0	0 (Negligible)
Willow Cottages	Max Slope	Retaining Wall (11)	2	7.7803	18.629	Hogging	377.85E-6	0.67985	0.012719	16718.0	- 0 (Negligible)	
	Max Settlement	Retaining Wall (11)	3	18.629	25.971	Sagging	377.85E-6	0.98011	0.013183	-	11021.0	0 (Negligible)
	Max Tensile Strain	Retaining Wall (11)	3	18.629	25.971	Sagging	377.85E-6	0.98011	0.013183	-	11021.0	0 (Negligible)
	Min Radius of Curvature (Hogging)	Retaining Wall (11)	2	7.7803	18.629	Hogging	377.85E-6	0.67985	0.012719	16718.0	- 0 (Negligible)	



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Structure Name	Parameter	Critical Sub-Structure	Critical Segment	Start	End	Curvature	Max Slope	Max Settlement	Max Tensile Strain	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category
Willow Cottages	Min Radius of Curvature (Sagging)	Retaining Wall (11)	3	18.629	25.971	Sagging	377.85E-6	0.98011	0.013183	-	11021.0	0 (Negligible)
	Max Slope	Rear Elevation	2	7.8673	20.264	Hogging	69.185E-6	0.41932	0.0066812	79159.	-	0 (Negligible)
	Max Settlement	Rear Elevation	2	7.8673	20.264	Hogging	69.185E-6	0.41932	0.0066812	79159.	-	0 (Negligible)
	Max Tensile Strain	Rear Elevation	2	7.8673	20.264	Hogging	69.185E-6	0.41932	0.0066812	79159.	-	0 (Negligible)
	Min Radius of Curvature (Hogging)	Rear Elevation	2	7.8673	20.264	Hogging	69.185E-6	0.41932	0.0066812	79159.	-	0 (Negligible)
	Min Radius of Curvature (Sagging)	Rear Elevation	1	0.0	7.8673	Sagging	26.653E-6	0.29890	0.0059915	-	536810.0	0 (Negligible)

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Problem Type

Problem Type : Tunnelling and Embedded Wall Excavations

Displacement Data

Type	Name	Direction of extrusion	Point/Line/Line for extrusion						No. of intervals across extrusion/line	Extrusion depth	No. of intervals along extrusion	Calculate	Surface type for tunnels
			First point			Second point							
			X [m]	Y [m]	Z (level) [m]	X [m]	Y [m]	Z (level) [m]					
Grid	Grid 1	Global X	-20.00000	-20.00000	85.50000	-	26.00000	85.50000	46	60.00000	60	Yes	Surface
Grid	Grid 2	Global X	-20.00000	-20.00000	84.00000	-	26.00000	84.00000	46	60.00000	60	Yes	Surface
Line	Line 1	-	2.05000	0.00000	84.00000	11.95000	0.00000	84.00000	5	-	-	Yes	Surface
Line	Line 2	-	12.00000	-0.05000	84.00000	12.00000	-2.95000	84.00000	1	-	-	Yes	Surface
Line	Line 3	-	11.95000	-3.00000	84.00000	4.05000	-6.95000	84.00000	4	-	-	Yes	Surface
Line	Line 4	-	3.95000	-7.00000	84.00000	2.05000	-7.00000	84.00000	1	-	-	Yes	Surface
Line	Line 5	-	2.00000	-6.95000	84.00000	2.00000	-0.05000	84.00000	3	-	-	Yes	Surface
Line	Line 6	-	2.05000	6.00000	84.00000	18.95000	6.50000	84.00000	8	-	-	Yes	Surface
Line	Line 7	-	19.00000	6.55000	84.00000	19.00000	12.45000	84.00000	3	-	-	Yes	Surface
Line	Line 8	-	18.95000	12.50000	84.00000	2.05000	12.00000	84.00000	8	-	-	Yes	Surface
Line	Line 9	-	2.00000	11.95000	84.00000	2.00000	6.05000	84.00000	3	-	-	Yes	Surface
Line	Line 10	-	-2.00000	-6.00000	85.00000	-2.00000	12.00000	85.00000	9	-	-	Yes	Surface
Line	Line 11	-	0.00000	-10.00000	83.00000	29.00000	4.50000	83.00000	16	-	-	Yes	Surface
Line	Line 12	-	0.00000	-13.00000	83.00000	29.00000	1.50000	83.00000	16	-	-	Yes	Surface

Vertical Ground Movement Curves (Excavations)

Curve Name: No vertical ground movement
Coordinates: [Distance from wall / wall depth or max. excavation depth (x), Depth / wall depth or max. excavation depth (y), Settlement / wall depth or max. excavation depth (z) (%)]
 [0.000,0.000,0.000] [1.000,0.000,0.000] [0.000,1.000,0.000] [1.000,1.000,0.000]
Curve Fitting Method: Polynomial
x Order: 1
y Order: 0
Polynomial: z = 0.0x + 0.0
Coeff. of Determination: -2147483648.E+2147483647

Horizontal Ground Movement Curves (Excavations)

Curve Name: GEA Curve for 10 mm of horizontal deflection (after CIRIA 580 Fig. 2.11(a))
Coordinates: [Distance from wall / wall depth or max. excavation depth (x), Depth / wall depth or max. excavation depth (y), Horizontal movement / wall depth or max. excavation depth (z) (%)]
 [0.000,0.000,0.242] [4.000,0.000,0.000]
Curve Fitting Method: Polynomial
x Order: 1
y Order: 0
Polynomial: z = -6.05E-2x + 2.42E-1
Coeff. of Determination: 1.00

Polygonal Excavations

Excavation Name: New Excavation
Surface level [m]: 85.500
Contribution: Positive
Enabled: Yes
Surface movement curves which are selected are applied between surface and [m]: 81.400

Corner	x	y	Base Level	Stiffened	Previous Side	Next Side
	[m]	[m]	[m]	d	p1 p2*	d p1 p2*
1	2.0000	0.0	81.400	No	- - -	- - -
2	18.000	0.0	81.400	No	- - -	- - -
3	21.000	2.0000	81.400	No	- - -	- - -
4	21.000	6.5000	81.400	No	- - -	- - -
5	2.0000	6.0000	81.400	No	- - -	- - -

Side	Corner 1	Corner 2	Ground Movement Curve	
	x y	x y	Vertical	Horizontal
	[m] [m]	[m] [m]		
1	2.0000 0.0	18.000 0.0	No vertical ground movement	GEA Curve for 10 mm of horizontal deflection (after CIRIA 580 Fig. 2.11(a))
2	18.000 0.0	21.000 2.0000	No vertical ground movement	GEA Curve for 10 mm of horizontal deflection (after CIRIA 580 Fig. 2.11(a))
3	21.000 2.0000	21.000 6.5000	No vertical ground movement	GEA Curve for 10 mm of horizontal deflection (after CIRIA 580 Fig. 2.11(a))
4	21.000 6.5000	2.0000 6.0000	No vertical ground movement	GEA Curve for 10 mm of horizontal deflection (after CIRIA 580 Fig. 2.11(a))
5	2.0000 6.0000	2.0000 0.0	No vertical ground movement	GEA Curve for 10 mm of horizontal deflection (after CIRIA 580 Fig. 2.11(a))

Damage Category Strains

Name	0 (Negligible) to 1 (Very Slight)	1 (Very Slight) to 2 (Slight)	2 (Slight) to 3 (Moderate)	3 (Moderate) to 4 (Severe)
Burland Strain Limits	0.0	500.00E-6	750.00E-6	0.0015000

Specific Structures - Geometry

Structure Name	Sub-Structure Name	Displacement Line	Start Distance Along Line	End Distance Along Line	Vertical Offsets from Line for Vertical Movement Calculations	Vertical Displacement Limit	Damage Category Strains	Poisson's Ratio	E/G
No 33	Party Wall (1)	Line 1	0.00000	9.89900	0.0	0.10000	Burland Strain Limits	0.20000	2.6000
No 33	Rear Elevation (2)	Line 2	0.00000	2.90000	0.0	0.10000	Burland Strain Limits	0.20000	2.6000
No 33	Far Elevation (3)	Line 3	0.00000	8.83200	0.0	0.10000	Burland Strain Limits	0.20000	2.6000
No 33	Far Elevation (4)	Line 4	0.00000	1.90000	0.0	0.10000	Burland Strain Limits	0.20000	2.6000



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Structure Name	Sub-Structure Name	Displacement Line	Start Distance Along Line	End Distance Along Line	Vertical Offsets from Line for Vertical	Vertical Displacement Limit Sensitivity	Damage Category	Strains	Poisson's Ratio	E/G
No 33	Frontage (5)	Line 5	0.00000	6.90000	0.0	0.10000	Burland Strain Limits	0.20000	2.6000	
No 29	Party Wall (6)	Line 6	0.00000	16.90700	0.0	0.10000	Burland Strain Limits	0.20000	2.6000	
No 29	Rear Elevation (7)	Line 7	0.00000	5.89900	0.0	0.10000	Burland Strain Limits	0.20000	2.6000	
No 29	Far Elevation (8)	Line 8	0.00000	16.90700	0.0	0.10000	Burland Strain Limits	0.20000	2.6000	
No 29	Frontage (9)	Line 9	0.00000	5.89900	0.0	0.10000	Burland Strain Limits	0.20000	2.6000	
Willoughby Road	Roadway (10)	Line 10	0.00000	18.00000	0.0	0.10000	Burland Strain Limits	0.20000	2.6000	
Willow Cottages	Retaining Wall (11)	Line 11	0.00000	32.42200	0.0	0.10000	Burland Strain Limits	0.20000	2.6000	
Willow Cottages	Rear Elevation	Line 12	0.00000	32.42200	0.0	0.10000	Burland Strain Limits	0.20000	2.6000	

Specific Structures - Bending Parameters

Structure Name	Sub-Structure Name	Height	Default Properties	Hogging			Sagging		
				2nd Moment of Area (per unit width)	Distance of Bending Strain from N.A.	Distance of N.A. from Edge of Beam in Tension	2nd Moment of Area (per unit width)	Distance of Bending Strain from N.A.	Distance of N.A. from Edge of Beam in Tension
No 33	Party Wall (1)	[m]	8.0000 Yes	[m ⁴]	[m]	[m]	[m ⁴]	[m]	[m]
No 33	Rear Elevation (2)	8.0000	Yes	170.67	8.0000	8.0000	42.667	4.0000	4.0000
No 33	Far Elevation (3)	8.0000	Yes	170.67	8.0000	8.0000	42.667	4.0000	4.0000
No 33	Far Elevation (4)	8.0000	Yes	170.67	8.0000	8.0000	42.667	4.0000	4.0000
No 33	Frontage (5)	8.0000	Yes	170.67	8.0000	8.0000	42.667	4.0000	4.0000
No 29	Party Wall (6)	12.000	Yes	576.00	12.000	12.000	144.00	6.0000	6.0000
No 29	Rear Elevation (7)	12.000	Yes	576.00	12.000	12.000	144.00	6.0000	6.0000
No 29	Far Elevation (8)	12.000	Yes	576.00	12.000	12.000	144.00	6.0000	6.0000
No 29	Frontage (9)	12.000	Yes	576.00	12.000	12.000	144.00	6.0000	6.0000
Willoughby Road	Roadway (10)	0.50000	Yes	0.041667	0.50000	0.50000	0.010417	0.25000	0.25000
Willow Cottages	Retaining Wall (11)	2.5000	Yes	5.2083	2.5000	2.5000	1.3021	1.2500	1.2500
Willow Cottages	Rear Elevation	8.0000	Yes	170.67	8.0000	8.0000	42.667	4.0000	4.0000

Building Segment Combinations

Structure Name	Sub-Structure Name	Vertical Offset from Line for Vertical Movement Calculations [m]	Segment Start	Length	Curvature	Combined Segment
No structures have segments combined.						

Utility Strain Calculation Options

Neglect beneficial contribution of axial strains : No

Warnings

- 1 Sub-structure 6 crosses at least one excavation. Its building damage results in that area should be treated with caution.

Errors

None

Specific Building Damage Results - Horizontal Displacements

Structure: No 33 | Sub-structure: Party Wall (1)

Dist.	Coordinates			Displacements		
	x	y	z	x	y	
				Horizontal displacement along the Line	Horizontal displacement perpendicular to Line	
	[m]	[m]	[m]	[mm]	[mm]	
	0.0	2.05000	0.00000	84.00000	0.0	9.9220 d
1.9800	4.03000	0.00000	84.00000	0.0	9.9220	d
3.9600	6.01000	0.00000	84.00000	0.0	9.9220	d
5.9400	7.99000	0.00000	84.00000	0.0	9.9220	d
7.9200	9.97000	0.00000	84.00000	0.0	9.9220	d
9.9000	11.95000	0.00000	84.00000	0.0	9.9220	d

d - Displacements include imported displacements.

Structure: No 33 | Sub-structure: Rear Elevation (2)

Dist.	Coordinates			Displacements		
	x	y	z	x	y	
				Horizontal displacement along the Line	Horizontal displacement perpendicular to Line	
	[m]	[m]	[m]	[mm]	[mm]	
	0.0	12.00000	-0.05000	84.00000	0.0	9.8917
2.9000	12.00000	-2.95000	84.00000	0.0	8.1372	0.0 d

d - Displacements include imported displacements.

Structure: No 33 | Sub-structure: Far Elevation (3)

Dist.	Coordinates			Displacements		
	x	y	z	x	y	
				Horizontal displacement along the Line	Horizontal displacement perpendicular to Line	
	[m]	[m]	[m]	[mm]	[mm]	
	0.0	11.95000	-3.00000	84.00000	0.0	8.1070
2.2081	9.97500	-3.98750	84.00000	0.0	7.5096	-3.6256
4.4162	8.00000	-4.97500	84.00000	0.0	6.9121	-3.3584
6.6244	6.02500	-5.96250	84.00000	0.0	6.3147	-3.0912
8.8325	4.05000	-6.95000	84.00000	0.0	5.7172	-2.8240
						-2.5568

d - Displacements include imported displacements.

Structure: No 33 | Sub-structure: Far Elevation (4)

Dist.	Coordinates			Displacements		
	x	y	z	x	y	
				Horizontal displacement	Horizontal displacement	



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along the Line						perpendicular to Line	
[m]	[m]	[m]	[m]	[mm]	[mm]	[mm]	[mm]
0.0	3.95000	-7.00000	84.00000	0.0	5.6870	0.0	-5.6870 d
1.9000	2.05000	-7.00000	84.00000	0.0	5.6870	0.0	-5.6870 d
d - Displacements include imported displacements.							

Structure: No 33 | Sub-structure: Frontage (5)

Dist.	Coordinates			Displacements		
	x	y	z	x	y	
				Horizontal displacement along the Line	Horizontal displacement perpendicular to Line	
[m]	[m]	[m]	[m]	[mm]	[mm]	
0.0	2.00000	-6.95000	84.00000	0.0	5.7172	5.7172 0.0 d
2.3000	2.00000	-6.45000	84.00000	0.0	7.1087	7.1087 0.0 d
4.6000	2.00000	-2.35000	84.00000	0.0	8.5002	8.5002 0.0 d
6.9000	2.00000	-0.05000	84.00000	0.0	9.8917	9.8917 0.0 d
d - Displacements include imported displacements.						

Structure: No 29 | Sub-structure: Party Wall (6)

Dist.	Coordinates			Displacements		
	x	y	z	x	y	
				Horizontal displacement along the Line	Horizontal displacement perpendicular to Line	
[m]	[m]	[m]	[m]	[mm]	[mm]	
0.0	2.05000	6.00000	84.00000	0.0	0.0	0.0 0.0 d
2.1134	4.16250	6.06250	84.00000	0.26093	-9.9152	-0.032409 -9.9186 d
4.2268	6.27500	6.12500	84.00000	0.26082	-9.9110	-0.032395 -9.9144 d
6.3403	8.38750	6.18750	84.00000	0.26071	-9.9068	-0.032381 -9.9102 d
8.4537	10.50000	6.25000	84.00000	0.26060	-9.9027	-0.032368 -9.9060 d
10.567	12.61250	6.31250	84.00000	0.26049	-9.8985	-0.032354 -9.9019 d
12.681	14.72500	6.37500	84.00000	0.26038	-9.8943	-0.032340 -9.8977 d
14.794	16.83750	6.43750	84.00000	0.26027	-9.8901	-0.032327 -9.8935 d
16.907	18.95000	6.50000	84.00000	0.26016	-9.8860	-0.032313 -9.8893 d
d - Displacements include imported displacements.						

Structure: No 29 | Sub-structure: Rear Elevation (7)

Dist.	Coordinates			Displacements		
	x	y	z	x	y	
				Horizontal displacement along the Line	Horizontal displacement perpendicular to Line	
[m]	[m]	[m]	[m]	[mm]	[mm]	
0.0	19.00000	6.55000	84.00000	0.25938	-9.8565	-0.020456 -9.8593 d
1.9667	19.00000	8.51667	84.00000	0.22809	-8.6675	-0.022809 d
3.9333	19.00000	10.48333	84.00000	0.19680	-7.4785	-0.019680 d
5.9000	19.00000	12.45000	84.00000	0.16551	-6.2895	-0.016551 d
d - Displacements include imported displacements.						

Structure: No 29 | Sub-structure: Far Elevation (8)

Dist.	Coordinates			Displacements		
	x	y	z	x	y	
				Horizontal displacement along the Line	Horizontal displacement perpendicular to Line	
[m]	[m]	[m]	[m]	[mm]	[mm]	
0.0	18.95000	12.50000	84.00000	0.16470	-6.2585	0.020456 6.2606 d
2.1134	16.83750	12.43750	84.00000	0.16481	-6.2626	0.020470 6.2648 d
4.2268	14.72500	12.37500	84.00000	0.16492	-6.2668	0.020484 6.2690 d
6.3403	12.61250	12.31250	84.00000	0.16503	-6.2710	0.020497 6.2731 d
8.4537	10.50000	12.25000	84.00000	0.16514	-6.2752	0.020511 6.2773 d
10.567	8.38750	12.18750	84.00000	0.16525	-6.2793	0.020525 6.2815 d
12.681	6.27500	12.12500	84.00000	0.16536	-6.2835	0.020538 6.2857 d
14.794	4.16250	12.06250	84.00000	0.16547	-6.2877	0.020552 6.2898 d
16.907	2.05000	12.00000	84.00000	0.16558	-6.2919	0.020565 6.2940 d
d - Displacements include imported displacements.						

Structure: No 29 | Sub-structure: Frontage (9)

Dist.	Coordinates			Displacements		
	x	y	z	x	y	
				Horizontal displacement along the Line	Horizontal displacement perpendicular to Line	
[m]	[m]	[m]	[m]	[mm]	[mm]	
0.0	2.00000	11.95000	84.00000	0.16635	-6.3213	6.3213 0.16635 d
1.9667	2.00000	9.98333	84.00000	0.19764	-7.5103	7.5103 0.19764 d
3.9333	2.00000	8.01667	84.00000	0.22893	-8.6993	8.6993 0.22893 d
5.9000	2.00000	6.05000	84.00000	0.26022	-9.8883	9.8883 0.26022 d
d - Displacements include imported displacements.						

Structure: Willoughby Road | Sub-structure: Roadway (10)

Dist.	Coordinates			Displacements		
	x	y	z	x	y	
				Horizontal displacement along the Line	Horizontal displacement perpendicular to Line	
[m]	[m]	[m]	[m]	[mm]	[mm]	
0.0	-2.00000	-6.00000	85.00000	2.0810	3.4783	3.4783 -2.0810 d
2.0000	-2.00000	-4.00000	85.00000	3.2498	3.2498	3.2498 -3.2498 d
4.0000	-2.00000	-2.00000	85.00000	5.0863	2.1300	2.1300 -5.0863 d
6.0000	-2.00000	0.00000	85.00000	7.5020	0.0	0.0 -7.5020 d
8.0000	-2.00000	2.00000	85.00000	7.5020	0.0	0.0 -7.5020 d
10.000	-2.00000	4.00000	85.00000	7.5020	0.0	0.0 -7.5020 d
12.000	-2.00000	6.00000	85.00000	7.5020	0.0	0.0 -7.5020 d
14.000	-2.00000	8.00000	85.00000	5.1070	-2.1656	-2.1656 -5.1070 d
16.000	-2.00000	10.00000	85.00000	3.2814	-3.3040	-3.3040 -3.2814 d
18.000	-2.00000	12.00000	85.00000	2.1148	-3.5363	-3.5363 -2.1148 d
d - Displacements include imported displacements.						

Structure: Willow Cottages | Sub-structure: Retaining Wall (11)

Dist.	Coordinates			Displacements		
	x	y	z	x	y	
				Horizontal displacement along the Line	Horizontal displacement perpendicular to Line	
[m]	[m]	[m]	[m]	[mm]	[mm]	
0.0	0.00000	-10.00000	83.00000	0.47152	3.2807	1.8889 2.7234 d
2.0264	1.81250	-9.09375	83.00000	0.057998	4.3611	2.0022 3.8748 d
4.0529	3.62500	-8.18750	83.00000	0.0	4.9686	2.2220 4.4440 d
6.0793	5.43750	-7.28125	83.00000	0.0	5.5168	2.4672 4.9344 d
8.1057	7.25000	-6.37500	83.00000	0.0	6.0651	2.7124 5.4248 d



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Dist.	Coordinates			Displacements		
x	y	z	x	y	Horizontal displacement along the	Horizontal displacement perpendicular
10.132	9.06250	-5.46875	83.00000	0.0	6.6134	2.9576
12.159	10.87500	-4.56250	83.00000	0.0	7.1617	3.2028
14.185	12.68750	-3.65625	83.00000	0.0	7.7100	3.4480
16.211	14.50000	-2.75000	83.00000	0.0	8.2582	3.6932
18.238	16.31250	-1.84375	83.00000	0.0	8.8065	3.9384
20.264	18.12500	-0.93750	83.00000	-1.1691	8.9958	2.9773
22.291	19.93750	-0.03125	83.00000	-5.1343	7.7015	-1.1481
24.317	21.75000	0.87500	83.00000	-5.0500	7.5750	-1.1292
26.344	23.56250	1.78125	83.00000	-8.0432	6.0317	-6.9243
28.370	25.37500	2.68750	83.00000	-7.2751	0.0	-6.5071
30.397	27.18750	3.59375	83.00000	-6.1786	0.0	-5.5263
32.423	29.00000	4.50000	83.00000	-5.0820	0.0	-4.5455
d - Displacements include imported displacements.						

Structure: Willow Cottages | Sub-structure: Rear Elevation

Dist.	Coordinates			Displacements		
x	y	z	x	y	Horizontal displacement along the Line	Horizontal displacement perpendicular to Line
[m]	[m]	[m]	[mm]	[mm]	[mm]	[mm]
0.0	0.00000	-13.00000	83.00000	0.19091	1.7736	0.96391
2.0264	1.81250	-12.09375	83.00000	0.025704	2.5787	1.1762
4.0529	3.62500	-11.18750	83.00000	0.0	3.1536	1.4103
6.0793	5.43750	-10.28125	83.00000	0.0	3.7019	1.6555
8.1057	7.25000	-9.37500	83.00000	0.0	4.2501	1.9007
10.132	9.06250	-8.46875	83.00000	0.0	4.7984	2.1459
12.159	10.87500	-7.56250	83.00000	0.0	5.3467	2.3911
14.185	12.68750	-6.65625	83.00000	0.0	5.8950	2.6363
16.211	14.50000	-5.75000	83.00000	0.0	6.4432	2.8815
18.238	16.31250	-4.84375	83.00000	0.0	6.9915	3.1267
20.264	18.12500	-3.93750	83.00000	-0.22569	7.4703	3.1389
22.291	19.93750	-3.03125	83.00000	-4.1556	6.4873	-0.81567
24.317	21.75000	-2.12500	83.00000	-4.2123	6.3184	-0.94190
26.344	23.56250	-1.21875	83.00000	-4.4072	5.6536	-1.4135
28.370	25.37500	-0.31250	83.00000	-5.4018	2.8520	-3.5560
30.397	27.18750	0.59375	83.00000	-5.4671	1.1509	-4.3753
32.423	29.00000	1.50000	83.00000	-4.9291	0.26806	-4.2888
d - Displacements include imported displacements.						

Specific Building Damage Results - Vertical Displacements

Structure: No 33 | Sub-structure: Party Wall (1)

Dist.	Coordinates			Displacements
	x	y	z	z
[m]	[m]	[m]	[m]	[mm]

Vertical Offset 1			
0.0	2.05000	0.00000	84.00000
1.9800	4.03000	0.00000	84.00000
3.9600	6.01000	0.00000	84.00000
5.9400	7.99000	0.00000	84.00000
7.9200	9.97000	0.00000	84.00000
9.9000	11.95000	0.00000	84.00000
d - Displacements include imported displacements.			

Structure: No 33 | Sub-structure: Rear Elevation (2)

Dist.	Coordinates			Displacements
	x	y	z	z
[m]	[m]	[m]	[m]	[mm]

Vertical Offset 1			
0.0	12.00000	-0.05000	84.00000
2.9000	12.00000	-2.95000	84.00000
d - Displacements include imported displacements.			

Structure: No 33 | Sub-structure: Far Elevation (3)

Dist.	Coordinates			Displacements
	x	y	z	z
[m]	[m]	[m]	[m]	[mm]

Vertical Offset 1			
0.0	11.95000	-3.00000	84.00000
2.2081	9.97500	-3.98750	84.00000
4.4162	8.00000	-4.97500	84.00000
6.6244	6.02500	-5.96250	84.00000
8.8325	4.05000	-6.95000	84.00000
d - Displacements include imported displacements.			

Structure: No 33 | Sub-structure: Far Eleavtion (4)

Dist.	Coordinates			Displacements
	x	y	z	z
[m]	[m]	[m]	[m]	[mm]

Vertical Offset 1			
0.0	3.95000	-7.00000	84.00000
1.9000	2.05000	-7.00000	84.00000
d - Displacements include imported displacements.			

Structure: No 33 | Sub-structure: Frontage (5)

Dist.	Coordinates			Displacements
	x	y	z	z
[m]	[m]	[m]	[m]	[mm]

Vertical Offset 1			
0.0	2.00000	-6.95000	84.00000
2.3000	2.00000	-4.65000	84.00000
4.6000	2.00000	-2.35000	84.00000
6.9000	2.00000	-0.05000	84.00000
d - Displacements include imported displacements.			

Structure: No 29 | Sub-structure: Party Wall (6)

Dist.	Coordinates			Displacements
	x	y	z	z
[m]	[m]	[m]	[m]	[mm]

Vertical Offset 1			
0.0	2.05000	6.00000	84.00000
2.1134	4.16250	6.06250	84.00000
4.2268	6.27500	6.12500	84.00000
6.3403	8.38750	6.18750	84.00000
8.4537	10.50000	6.25000	84.00000
10.567	12.61250	6.31250	84.00000



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Dist.	Coordinates			Displacements
	x	y	z	
[m]	[m]	[m]	[m]	[mm]
12.691	14.72500	6.37500	84.00000	-0.54280 d
14.794	16.83750	6.43750	84.00000	0.48879 d
16.907	18.95000	6.50000	84.00000	3.4444 d
d - Displacements include imported displacements.				
Structure: No 29 Sub-structure: Rear Elevation (7)				
Dist.	Coordinates			Displacements
	x	y	z	
[m]	[m]	[m]	[m]	[mm]
Vertical Offset 1				
0.0	19.00000	6.55000	84.00000	3.3625 d
1.9667	19.00000	8.51667	84.00000	0.14865 d
3.9333	19.00000	10.48333	84.00000	-0.17655 d
5.9000	19.00000	12.45000	84.00000	-0.21653 d
d - Displacements include imported displacements.				
Structure: No 29 Sub-structure: Far Elevation (8)				
Dist.	Coordinates			Displacements
	x	y	z	
[m]	[m]	[m]	[m]	[mm]
Vertical Offset 1				
0.0	18.95000	12.50000	84.00000	-0.21937 d
2.1134	16.83750	12.43750	84.00000	-0.35509 d
4.2268	14.72500	12.37500	84.00000	-0.48003 d
6.3403	12.61250	12.31250	84.00000	-0.55813 d
8.4537	10.50000	12.25000	84.00000	-0.57860 d
10.567	8.38750	12.18750	84.00000	-0.54783 d
12.681	6.27500	12.12500	84.00000	-0.47905 d
14.794	4.16250	12.06250	84.00000	-0.39118 d
16.907	2.05000	12.00000	84.00000	-0.30740 d
d - Displacements include imported displacements.				
Structure: No 29 Sub-structure: Frontage (9)				
Dist.	Coordinates			Displacements
	x	y	z	
[m]	[m]	[m]	[m]	[mm]
Vertical Offset 1				
0.0	2.00000	11.95000	84.00000	-0.30674 d
1.9667	2.00000	9.98333	84.00000	-0.38435 d
3.9333	2.00000	8.01667	84.00000	-0.22834 d
5.9000	2.00000	6.05000	84.00000	1.2086 d
d - Displacements include imported displacements.				
Structure: Willoughby Road Sub-structure: Roadway (10)				
Dist.	Coordinates			Displacements
	x	y	z	
[m]	[m]	[m]	[m]	[mm]
Vertical Offset 1				
0.0	-2.00000	-6.00000	85.00000	-0.20888 d
2.0000	-2.00000	-4.00000	85.00000	-0.23159 d
4.0000	-2.00000	-2.00000	85.00000	-0.24045 d
6.0000	-2.00000	0.00000	85.00000	-0.23554 d
8.0000	-2.00000	2.00000	85.00000	-0.22928 d
10.000	-2.00000	4.00000	85.00000	-0.21887 d
12.000	-2.00000	6.00000	85.00000	-0.21195 d
14.000	-2.00000	8.00000	85.00000	-0.21595 d
16.000	-2.00000	10.00000	85.00000	-0.21234 d
18.000	-2.00000	12.00000	85.00000	-0.19579 d
d - Displacements include imported displacements.				
Structure: Willow Cottages Sub-structure: Retaining Wall (11)				
Dist.	Coordinates			Displacements
	x	y	z	
[m]	[m]	[m]	[m]	[mm]
Vertical Offset 1				
0.0	0.00000	-10.00000	83.00000	-0.18071 d
2.0264	1.81250	-9.09375	83.00000	-0.23176 d
4.0529	3.62500	-8.18750	83.00000	-0.29955 d
6.0793	5.43750	-7.28125	83.00000	-0.38804 d
8.1057	7.25000	-6.37500	83.00000	-0.49367 d
10.132	9.06250	-5.46875	83.00000	-0.60627 d
12.159	10.87500	-4.56250	83.00000	-0.67993 d
14.185	12.68750	-3.65625	83.00000	-0.64829 d
16.211	14.50000	-2.75000	83.00000	-0.43428 d
18.238	16.31250	-1.84375	83.00000	0.030477 d
20.264	18.12500	-0.93750	83.00000	0.79598 d
22.291	19.93750	-0.03125	83.00000	0.98234 d
24.317	21.75000	0.87500	83.00000	0.88472 d
26.344	23.56250	1.78125	83.00000	0.44098 d
28.370	25.37500	2.68750	83.00000	0.19355 d
30.397	27.18750	3.59375	83.00000	0.75023 d
32.423	29.00000	4.50000	83.00000	0.019492 d
d - Displacements include imported displacements.				
Structure: Willow Cottages Sub-structure: Rear Elevation				
Dist.	Coordinates			Displacements
	x	y	z	
[m]	[m]	[m]	[m]	[mm]
Vertical Offset 1				
0.0	0.00000	-13.00000	83.00000	-0.13209 d
2.0264	1.81250	-12.09375	83.00000	-0.16411 d
4.0529	3.62500	-11.18750	83.00000	-0.20367 d
6.0793	5.43750	-10.28125	83.00000	-0.25124 d
8.1057	7.25000	-9.37500	83.00000	-0.30526 d
10.132	9.06250	-8.46875	83.00000	-0.36003 d
12.159	10.87500	-7.56250	83.00000	-0.40396 d
14.185	12.68750	-6.65625	83.00000	-0.41977 d
16.211	14.50000	-5.75000	83.00000	-0.38909 d
18.238	16.31250	-4.84375	83.00000	-0.30139 d
20.264	18.12500	-3.93750	83.00000	-0.16555 d
22.291	19.93750	-3.03125	83.00000	-0.025485 d
24.317	21.75000	-2.12500	83.00000	0.066217 d
26.344	23.56250	-1.21875	83.00000	0.091785 d
28.370	25.37500	-0.31250	83.00000	0.067445 d
30.397	27.18750	0.59375	83.00000	0.033156 d
32.423	29.00000	1.50000	83.00000	0.0075034 d
d - Displacements include imported displacements.				
Specific Building Damage Results - All Segments				



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Dist.	Coordinates		Displacements										
[m]	x [m]	y [m]	z [m]	z [mm]									
Structure: No 33 Sub-structure: Party Wall (1)													
Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category		
[m] 0.0		[m] 1	[m] 0.0	[m] 3.3786	[%] Sagging	[%] 0.011265	[%] 0.0	0.010772	0.0	581.43E-6	[m] 2990.1	0 (Negligible)	
		2	3.3786	6.5204	Hogging	0.021093	0.0	0.020232	0.0	-813.93E-6	2077.3	0 (Negligible)	
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.													
Structure: No 33 Sub-structure: Rear Elevation (2)													
Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category		
[m] 0.0		[m] 1	[m] 0.0	[m] 2.9000	[%] Sagging	0.0	0.060500	0.060500	-604.63E-6	580.80E-6	-	[m] 1	(Very Slight)
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.													
Structure: No 33 Sub-structure: Far Elevation (3)													
Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category		
[m] 0.0		[m] 1	[m] 0.0	[m] 5.9813	[%] Hogging	0.0015671	0.012100	0.012970	-120.99E-6	-72.323E-6	[m] 28576.	0 (Negligible)	
		2	5.9813	2.8507	Sagging	221.32E-6	0.012100	0.012218	-120.99E-6	-72.323E-6	120240.	0 (Negligible)	
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.													
Structure: No 33 Sub-structure: Far Eleavtion (4)													
Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category		
[m] 0.0		[m] 1	[m] 0.0	[m] 1.9000	[%] None	0.0	0.0	0.0	0.0	-31.807E-6	-	[m] 0	(Negligible)
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.													
Structure: No 33 Sub-structure: Frontage (5)													
Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category		
[m] 0.0		[m] 1	[m] 0.0	[m] 0.85156	[%] None	0.0	0.060500	0.060500	-604.63E-6	31.573E-6	[m] 22262.	1 (Very Slight)	
		2	0.85156	6.0484	Hogging	0.014266	0.060500	0.068503	-604.63E-6	-599.30E-6	3134.3	1 (Very Slight)	
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.													
Structure: No 29 Sub-structure: Party Wall (6)													
Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category		
[m] 0.0		[m] 1	[m] 0.0	[m] 3.9772	[%] Sagging	0.0097753	-814.55E-6	0.0091942	15.335E-6	437.56E-6	[m] 3828.6	0 (Negligible)	
		2	3.9772	12.930	Hogging	0.023377	0.0	0.021758	0.0	-0.0013985	2020.9	0 (Negligible)	
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.													
Structure: No 29 Sub-structure: Rear Elevation (7)													
Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category		
[m] 0.0		[m] 1	[m] 0.0	[m] 5.3471	[%] Hogging	0.035244	0.060458	0.074452	-604.22E-6	0.0016332	[m] 1094.1	1 (Very Slight)	
		2	5.3471	0.55187	Hogging	0.0	0.060458	0.060458	-604.22E-6	20.313E-6	10599.	1 (Very Slight)	
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.													
Structure: No 29 Sub-structure: Far Elevation (8)													
Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category		
[m] 0.0		[m] 1	[m] 0.0	[m] 15.104	[%] Hogging	0.0017991	0.0	0.0016335	0.0	64.217E-6	[m] 83937.	0 (Negligible)	
		2	15.104	1.8028	None	0.0	0.0	0.0	0.0	-39.640E-6	451760.	0 (Negligible)	
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.													
Structure: No 29 Sub-structure: Frontage (9)													
Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category		
[m] 0.0		[m] 1	[m] 0.0	[m] 0.54451	[%] Hogging	0.0	0.060458	0.060458	-604.22E-6	14.029E-6	[m] 23356.	1 (Very Slight)	



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Vertical Offset from Line for Vertical Movement	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category
	2	0.54451	5.3545	Hogging	0.016224	0.060458	0.065956	-604.22E-6	-730.22E-6	2374.8	1 (Very Slight)

Tensile horizontal strains are +ve, compressive horizontal strains are -ve.

Structure: Willoughby Road | Sub-structure: Roadway (10)

Vertical Offset from Line for Vertical Movement	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category
Calculations											
[m]		[m]	[m]		[%]	[%]	[%]			[m]	
0.0	1	0.0	8.6176	Hogging	273.66E-6	-0.040362	0.0080724	0.0010662	11.358E-6	288160.	0 (Negligible)
	2	8.6176	4.3953	Sagging	109.27E-6	-0.024953	0.0049906	0.0010840	-5.2036E-6	904330.	0 (Negligible)
	3	13.013	4.9871	Hogging	185.08E-6	-0.048917	0.0097834	0.0010840	-8.2757E-6	280350.	0 (Negligible)

Tensile horizontal strains are +ve, compressive horizontal strains are -ve.

Structure: Willow Cottages | Sub-structure: Retaining Wall (11)

Vertical Offset from Line for Vertical Movement	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category
Calculations											
[m]		[m]	[m]		[%]	[%]	[%]			[m]	
0.0	1	0.0	7.7803	Sagging	463.12E-6	0.010078	0.010715	-120.99E-6	53.105E-6	213000.	0 (Negligible)
	2	7.7803	10.848	Hogging	0.0051177	0.0099569	0.017697	474.49E-6	-377.94E-6	16714.	0 (Negligible)
	3	18.628	7.3428	Sagging	0.0086080	-0.13091	0.026228	0.0028680	-377.94E-6	11006.	0 (Negligible)
	4	25.971	2.3988	Hogging	0.0012660	-0.027002	0.0054443	0.0028680	219.60E-6	31673.	0 (Negligible)

Tensile horizontal strains are +ve, compressive horizontal strains are -ve.

Structure: Willow Cottages | Sub-structure: Rear Elevation

Vertical Offset from Line for Vertical Movement	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category
Calculations											
[m]		[m]	[m]		[%]	[%]	[%]			[m]	
0.0	1	0.0	7.8673	Sagging	182.38E-6	0.011541	0.011762	-120.99E-6	26.651E-6	536880.	0 (Negligible)
	2	7.8673	12.397	Hogging	0.0015206	0.010221	0.011792	0.0019553	-69.252E-6	79163.	0 (Negligible)

Tensile horizontal strains are +ve, compressive horizontal strains are -ve.

Specific Building Damage Results - Critical Values for All Segments within Each Sub-Structure

Structure: No 33 | Sub-structure: Party Wall (1)

Vertical Offset from Line for Vertical Movement	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category
Calculations										
[m]	[%]	[%]		[mm]	[%]			[m]	[m]	
0.0	0.021093		0.0	-813.93E-6	1.2257	0.020232	0.0	-813.93E-6	2077.3	2990.1 0 (Negligible)

Structure: No 33 | Sub-structure: Rear Elevation (2)

Vertical Offset from Line for Vertical Movement	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category
Calculations										
[m]	[%]	[%]		[mm]	[%]			[m]	[m]	
0.0	0.0	0.060500	580.80E-6	0.89278	0.060500	-604.63E-6	580.80E-6		-	1 (Very Slight)

Structure: No 33 | Sub-structure: Far Elevation (3)

Vertical Offset from Line for Vertical Movement	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category
Calculations										
[m]	[%]	[%]		[mm]	[%]			[m]	[m]	
0.0	0.0015671	0.012100	-72.323E-6	0.79559	0.012970	-120.99E-6	-72.323E-6	28576.	120240. 0 (Negligible)	

Structure: No 33 | Sub-structure: Far Eleavtion (4)

Vertical Offset from Line for Vertical Movement	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category
Calculations										
[m]	[%]	[%]		[mm]	[%]			[m]	[m]	
0.0	0.0	0.0	-31.807E-6	0.36016	0.0	0.0	-31.807E-6		-	0 (Negligible)

Structure: No 33 | Sub-structure: Frontage (5)

Vertical Offset from Line for Vertical Movement	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category
Calculations										
[m]	[%]	[%]		[mm]	[%]			[m]	[m]	
0.0	0.014266	0.060500	-599.30E-6	1.0175	0.068503	-604.63E-6	-599.30E-6	3134.3		1 (Very Slight)

Structure: No 29 | Sub-structure: Party Wall (6)

Vertical Offset from Line for Vertical Movement	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category



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Movement Calculations										
Curve										
Offset from Line for Vertical Movement Calculations	[m]	[%]	[%]	[mm]	[%]			[m]	[m]	
0.0	0.023377	-814.55E-6	-0.0013985	3.4439	0.021758	15.335E-6	-0.0013985	2020.9	3828.6	0 (Negligible)
Structure: No 29 Sub-structure: Rear Elevation (7)										
Vertical Offset from Line for Vertical Movement Calculations	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category
[m]	[%]	[%]		[mm]	[%]			[m]	[m]	
0.0	0.035244	0.060458	0.0016332	3.3625	0.074452	-604.22E-6	0.0016332	1094.1		- 1 (Very Slight)
Structure: No 29 Sub-structure: Far Elevation (8)										
Vertical Offset from Line for Vertical Movement Calculations	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category
[m]	[%]	[%]		[mm]	[%]			[m]	[m]	
0.0	0.0017991		0.0	64.217E-6	0.57800	0.0016335	0.0	64.217E-6	83937.	- 0 (Negligible)
Structure: No 29 Sub-structure: Frontage (9)										
Vertical Offset from Line for Vertical Movement Calculations	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category
[m]	[%]	[%]		[mm]	[%]			[m]	[m]	
0.0	0.016224	0.060458	-730.22E-6	1.2079	0.065956	-604.22E-6	-730.22E-6	2374.8		- 1 (Very Slight)
Structure: Willoughby Road Sub-structure: Roadway (10)										
Vertical Offset from Line for Vertical Movement Calculations	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category
[m]	[%]	[%]		[mm]	[%]			[m]	[m]	
0.0	273.66E-6	-0.048917	11.358E-6	0.24044	0.0097834	0.0010840	11.358E-6	280350.	904330.	0 (Negligible)
Structure: Willow Cottages Sub-structure: Retaining Wall (11)										
Vertical Offset from Line for Vertical Movement Calculations	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category
[m]	[%]	[%]		[mm]	[%]			[m]	[m]	
0.0	0.0086080	-0.13091	-377.94E-6	0.98012	0.026228	0.0028680	-377.94E-6	16714.	11006.	0 (Negligible)
Structure: Willow Cottages Sub-structure: Rear Elevation										
Vertical Offset from Line for Vertical Movement Calculations	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category
[m]	[%]	[%]		[mm]	[%]			[m]	[m]	
0.0	0.0015206	0.011541	-69.252E-6	0.41932	0.011792	0.0019553	-69.252E-6	79163.	536880.	0 (Negligible)

Specific Building Damage Results - Critical Segments within Each Structure

Structure Name	Parameter	Critical Sub-Structure	Critical Segment	Start	End	Curvature	Max Slope	Max Settlement	Max Tensile Strain	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category
No 33	Max Slope	Party Wall (1)		[m]	[m]			[mm]	[%]			
	Max Settlement	Party Wall (1)		2	3.3786	9.8990	Hogging	813.93E-6	0.94946	0.020232	2077.3	- 0 (Negligible)
	Max Tensile Strain	Frontage (5)		1	0.0	3.3786	Sagging	581.43E-6	1.2257	0.010772	- 2990.1	0 (Negligible)
				2	0.85156	6.9000	Hogging	599.30E-6	1.0175	0.068503	3134.3	- 1 (Very Slight)
	Min Radius of Curvature (Hogging)	Party Wall (1)		2	3.3786	9.8990	Hogging	813.93E-6	0.94946	0.020232	2077.3	- 0 (Negligible)
No 29	Min Radius of Curvature (Sagging)	Party Wall (1)		1	0.0	3.3786	Sagging	581.43E-6	1.2257	0.010772	- 2990.1	0 (Negligible)
	Max Slope	Rear Elevation (7)		1	0.0	5.3471	Hogging	0.0016332	3.3625	0.074452	1094.1	- 1 (Very Slight)
	Max Settlement	Party Wall (6)		2	3.9772	16.907	Hogging	0.0013985	3.4439	0.021758	2020.9	- 0 (Negligible)
	Max Tensile Strain	Rear Elevation (7)		1	0.0	5.3471	Hogging	0.0016332	3.3625	0.074452	1094.1	- 1 (Very Slight)
	Min Radius of Curvature (Hogging)	Rear Elevation (7)		1	0.0	5.3471	Hogging	0.0016332	3.3625	0.074452	1094.1	- 1 (Very Slight)
Willoughby Road	Min Radius of Curvature (Sagging)	Party Wall (6)		1	0.0	3.9772	Sagging	437.56E-6	1.4253	0.0091942	- 3828.6	0 (Negligible)
	Max Slope	Roadway (10)		1	0.0	8.6176	Hogging	11.358E-6	0.24044	0.0080724	288160.	- 0 (Negligible)
	Max Settlement	Roadway (10)		1	0.0	8.6176	Hogging	11.358E-6	0.24044	0.0080724	288160.	- 0 (Negligible)
	Max Tensile Strain	Roadway (10)		3	13.013	18.000	Hogging	8.2757E-6	0.21591	0.0097834	280350.	- 0 (Negligible)
	Min Radius of Curvature (Hogging)	Roadway (10)		3	13.013	18.000	Hogging	8.2757E-6	0.21591	0.0097834	280350.	- 0 (Negligible)
Willow Cottages	Min Radius of Curvature (Sagging)	Roadway (10)		2	8.6176	13.013	Sagging	5.2036E-6	0.22606	0.0049906	- 904330.	0 (Negligible)
	Max Slope	Retaining Wall (11)		2	7.7803	18.628	Hogging	377.94E-6	0.67986	0.017697	16714.	- 0 (Negligible)
	Max Settlement	Retaining Wall (11)		3	18.628	25.971	Sagging	377.94E-6	0.98012	0.026228	- 11006.	0 (Negligible)
	Max Tensile Strain	Retaining Wall (11)		3	18.628	25.971	Sagging	377.94E-6	0.98012	0.026228	- 11006.	0 (Negligible)
	Min Radius of Curvature (Hogging)	Retaining Wall (11)		2	7.7803	18.628	Hogging	377.94E-6	0.67986	0.017697	16714.	- 0 (Negligible)



31 Willoughby Road

Combined Movements & Damage Assessment

2nd Stage - Total - 10 mm limit on overall horizontal movements

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Drg. Ref.

Made by
MP

Date
23-Jan-2018

Checked

Structure Name	Parameter	Critical Sub-Structure	Critical Segment	Start	End	Curvature	Max Slope	Max Settlement	Max Tensile Strain	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category
	Min Radius of Curvature (Sagging)	Retaining Wall (11)	3	18.628	25.971	Sagging	377.94E-6	0.98012	0.026228	-	11006.0	0 (Negligible)
Willow Cottages	Max Slope	Rear Elevation	2	7.8673	20.264	Hogging	69.252E-6	0.41932	0.011792	79163.	-	0 (Negligible)
	Max Settlement	Rear Elevation	2	7.8673	20.264	Hogging	69.252E-6	0.41932	0.011792	79163.	-	0 (Negligible)
	Max Tensile Strain	Rear Elevation	2	7.8673	20.264	Hogging	69.252E-6	0.41932	0.011792	79163.	-	0 (Negligible)
	Min Radius of Curvature (Hogging)	Rear Elevation	2	7.8673	20.264	Hogging	69.252E-6	0.41932	0.011792	79163.	-	0 (Negligible)
	Min Radius of Curvature (Sagging)	Rear Elevation	1	0.0	7.8673	Sagging	26.651E-6	0.29890	0.011762	-	536880.0	0 (Negligible)

Single Stage Underpinning:
Short Term Movement (Contour Plots)
& Tabular output of related damage assessment

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Analysis Options

Analysis: Boussinesq
Global Poisson's ratio: 0.50
Maximum allowable ratio between values of E: 1.5
Horizontal rigid boundary level: 35.00 [m OD]
Displacements at load centroids: Yes

Soil ProfilesSoil Profile 1

Layer	Level at top	Number of intermediate displacement levels	Youngs Modulus	Poissons ratio	Non-linear curve
	[mOD]		Top [kN/m ²]	Btm [kN/m ²]	
1	85.500	3	7500.0	7500.0	0.50000 None
2	82.500	1	15000.	15000.	0.50000 None
3	82.000	40	20000.	100000.	0.50000 None

Soil Zones

Zone	Name	X coordinates min max	Y coordinates min max	Profile
		[m] [m]	[m] [m]	
1	Soil Zone 1	-20.00000 40.00000	-20.00000 26.00000	Soil Profile 1

Load Data

Load ref.	Name	Shape	Orientation of Plane	Centre of load (Global)	Load position Angle of local x from Radius	Width x or Radius	Length y	Polygon Coordinates	Rectangle of tolerance	Number of rectangles	Normal (local z)	Load value Tangential (local x) (local y)
				X [m]	Y [m]	Z (level) [m]					[kN/m ²]	[kN/m ²] [kN/m ²]
1	Basement Excavation - Main House	Polygonal	Horizontal	N/A	N/A	81.40000	N/A	N/A	N/A	(3,1) (18,1) (20,2.3) (20,5.5) (12,5.25) (12,4) (3,4)	10.000	3 0.0 N/A N/A
2	Basement Excavation - Existing Cellar	Polygonal	Horizontal	N/A	N/A	81.40000	N/A	N/A	N/A	(3,4) (12,4) (12,5.25) (3,5)	10.000	1 0.0 N/A N/A
3	Underpinning	Polygonal	Horizontal	N/A	N/A	81.40000	N/A	N/A	N/A	(2,6) (2,0) (12,0) (12,1) (3,1) (3,6)	10.000	2 60.000 N/A N/A
4	Underpinning	Polygonal	Horizontal	N/A	N/A	81.40000	N/A	N/A	N/A	(12,0) (18,0) (21,2) (21,6.5) (19,6.5) (19,5.5) (20,5.5) (20,2.3) (18,1) (12,1)	10.000	10 95.000 N/A N/A
5	Underpinning	Polygonal	Horizontal	N/A	N/A	81.40000	N/A	N/A	N/A	(19,6.5) (12,6.25) (12,5.25) (19,5.5)	10.000	1 60.000 N/A N/A
6	Underpinning	Polygonal	Horizontal	N/A	N/A	81.40000	N/A	N/A	N/A	(3,6) (12,6.25) (12,5.25) (3,5)	10.000	1 50.000 N/A N/A

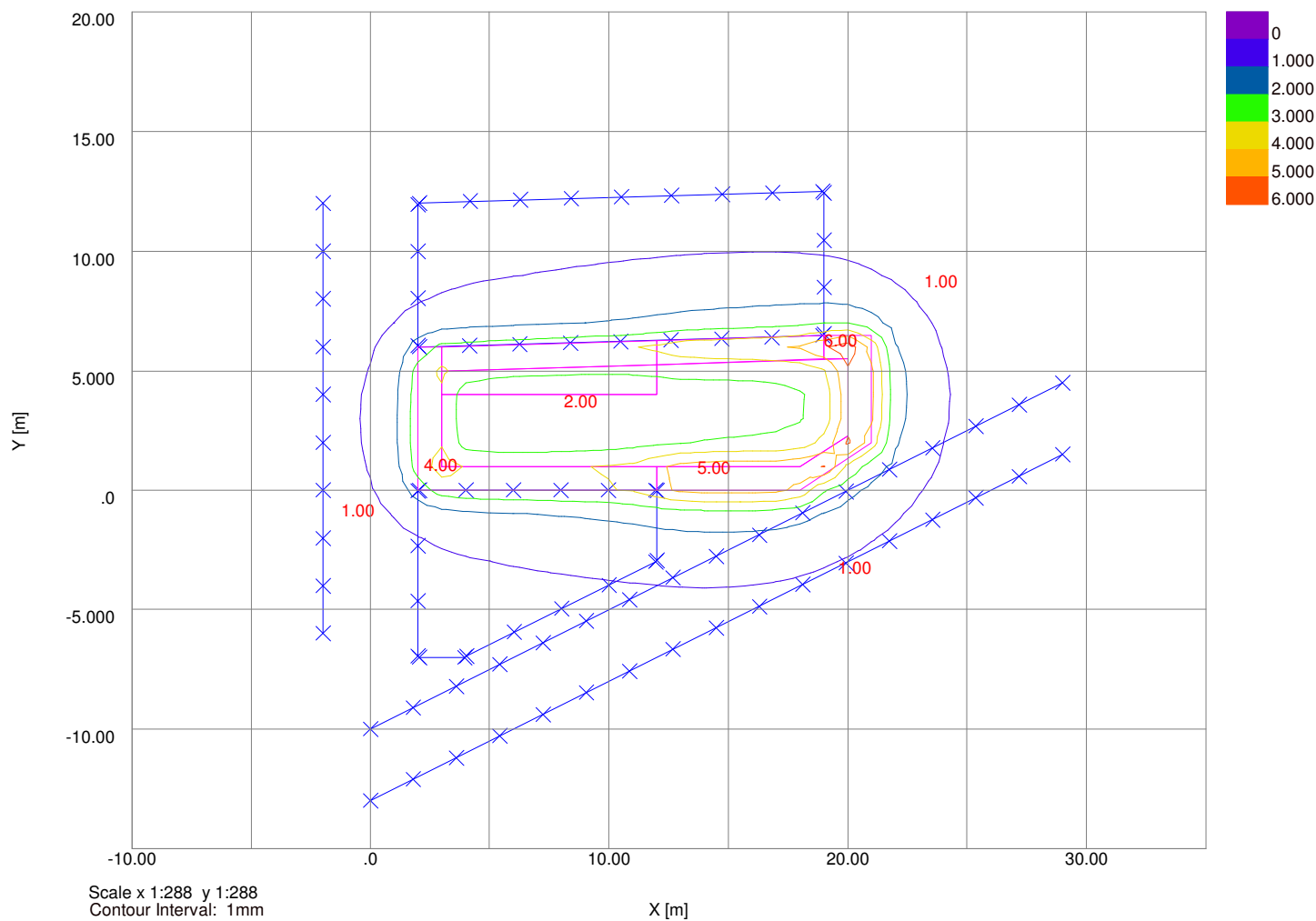
Polygonal Loads' Rectangles

No.	Centre of load X	Y	Angle of local x from global X [Degrees]	Width x [m]	Depth y [m]
Load 1 : Basement Excavation - Main House					
(Edge 1 optimal)	1	7.50000	2.50000	0.0	9.0000 3.0000
	2	15.00000	3.17188	0.0	6.0000 4.3438
	3	19.00000	3.55938	0.0	2.0000 3.8187
Load 2 : Basement Excavation - Existing Cellar					
(Edge 1 optimal)	1	7.50000	4.56250	0.0	9.0000 1.1250
Load 3 : Underpinning					
(Edge 1 optimal)	1	2.50000	3.50000	-90.000	5.0000 1.0000
	2	7.00000	0.50000	-90.000	1.0000 10.000
Load 4 : Underpinning					
(Edge 1 optimal)	1	15.00000	0.50000	0.0	6.0000 1.0000
	2	18.14286	0.59405	0.0	0.28571 0.99762
	3	18.42857	0.78214	0.0	0.28571 0.99286
	4	18.71429	0.97024	0.0	0.28571 0.98810
	5	19.00000	1.15833	0.0	0.28571 0.98333
	6	19.28571	1.34643	0.0	0.28571 0.97857
	7	19.57143	1.53452	0.0	0.28571 0.97381
	8	19.85714	1.72262	0.0	0.28571 0.96905
	9	20.50000	4.08333	0.0	1.0000 4.8333
	10	19.50000	6.00000	0.0	1.0000 1.0000
Load 5 : Underpinning					
(Edge 1 optimal)	1	15.50000	5.87500	-177.95	6.9688 0.99936
Load 6 : Underpinning					
(Edge 2 optimal)	1	7.50000	5.62500	1.5911	8.9757 0.99961

Displacement Data

Ref.	Type	Name	Direction of Extrusion	Line/Line for extrusion	No. of intrvl across	Extrusion Depth	No. of intrvl along	Show Calculate Detailed results
				First point X Y Z(level) [m] [m] [m]	Second point X Y Z(level) [m] [m] [m]			
1	Grid	Grid 1	Global X	-20.00000 -20.00000 85.50000	N/A 26.00000 85.50000	46	60.00000	Yes No
2	Grid	Grid 2	Global X	-20.00000 -20.00000 84.00000	N/A 26.00000 84.00000	46	60.00000	Yes No
3	Line	Line 1	N/A	2.05000 0.00000 84.00000	11.95000 0.00000 84.00000	5	N/A	Yes No
4	Line	Line 2	N/A	12.00000 -0.05000 84.00000	12.00000 -2.95000 84.00000	1	N/A	Yes No
5	Line	Line 3	N/A	11.95000 -3.00000 84.00000	4.05000 -6.95000 84.00000	4	N/A	Yes No
6	Line	Line 4	N/A	3.95000 -7.00000 84.00000	2.05000 -7.00000 84.00000	1	N/A	Yes No
7	Line	Line 5	N/A	2.00000 -6.95000 84.00000	2.00000 -0.05000 84.00000	3	N/A	Yes No
8	Line	Line 6	N/A	2.05000 6.00000 84.00000	18.95000 6.50000 84.00000	8	N/A	Yes No
9	Line	Line 7	N/A	19.00000 6.55000 84.00000	19.00000 12.45000 84.00000	3	N/A	Yes No
10	Line	Line 8	N/A	18.95000 12.50000 84.00000	2.05000 12.00000 84.00000	8	N/A	Yes No
11	Line	Line 9	N/A	2.00000 11.95000 84.00000	2.00000 6.05000 84.00000	3	N/A	Yes No
12	Line	Line 10	N/A	-2.00000 -6.00000 85.00000	-2.00000 12.00000 85.00000	9	N/A	Yes No
13	Line	Line 11	N/A	0.00000 -10.00000 83.00000	29.00000 4.50000 83.00000	16	N/A	Yes No
14	Line	Line 12	N/A	0.00000 -13.00000 83.00000	29.00000 1.50000 83.00000	16	N/A	Yes No

Settlement Contours : Grid 1 at 85.5000m



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Problem Type

Problem Type : Tunnelling and Embedded Wall Excavations

Displacement Data

Type	Name	Direction of extrusion	Point/Line/Line for extrusion						No. of intervals across extrusion/line	Extrusion depth	No. of intervals along extrusion	Calculate	Surface type for tunnels
			First point			Second point							
			X [m]	Y [m]	Z (level) [m]	X [m]	Y [m]	Z (level) [m]					
Grid	Grid 1	Global X	-20.00000	-20.00000	85.50000	-	26.00000	85.50000	46	60.00000	60	Yes	Surface
Grid	Grid 2	Global X	-20.00000	-20.00000	84.00000	-	26.00000	84.00000	46	60.00000	60	Yes	Surface
Line	Line 1	-	2.05000	0.00000	84.00000	11.95000	0.00000	84.00000	5	-	-	Yes	Surface
Line	Line 2	-	12.00000	-0.05000	84.00000	12.00000	-2.95000	84.00000	1	-	-	Yes	Surface
Line	Line 3	-	11.95000	-3.00000	84.00000	4.05000	-6.95000	84.00000	4	-	-	Yes	Surface
Line	Line 4	-	3.95000	-7.00000	84.00000	2.05000	-7.00000	84.00000	1	-	-	Yes	Surface
Line	Line 5	-	2.00000	-6.95000	84.00000	2.00000	-0.05000	84.00000	3	-	-	Yes	Surface
Line	Line 6	-	2.05000	6.00000	84.00000	18.95000	6.50000	84.00000	8	-	-	Yes	Surface
Line	Line 7	-	19.00000	6.55000	84.00000	19.00000	12.45000	84.00000	3	-	-	Yes	Surface
Line	Line 8	-	18.95000	12.50000	84.00000	2.05000	12.00000	84.00000	8	-	-	Yes	Surface
Line	Line 9	-	2.00000	11.95000	84.00000	2.00000	6.05000	84.00000	3	-	-	Yes	Surface
Line	Line 10	-	-2.00000	-6.00000	85.00000	-2.00000	12.00000	85.00000	9	-	-	Yes	Surface
Line	Line 11	-	0.00000	-10.00000	83.00000	29.00000	4.50000	83.00000	16	-	-	Yes	Surface
Line	Line 12	-	0.00000	-13.00000	83.00000	29.00000	1.50000	83.00000	16	-	-	Yes	Surface

Vertical Ground Movement Curves (Excavations)

Curve Name: No vertical ground movement
Coordinates: [Distance from wall / wall depth or max. excavation depth (x), Depth / wall depth or max. excavation depth (y), Settlement / wall depth or max. excavation depth (z) (%)]
 [0.000,0.000,0.000] [1.000,0.000,0.000] [0.000,1.000,0.000] [1.000,1.000,0.000]
Curve Fitting Method: Polynomial
x Order: 1
y Order: 0
 Polynomial: z = 0.0x + 0.0
 Coeff. of -2147483648.E+2147483647
Determination:

Horizontal Ground Movement Curves (Excavations)

Curve Name: No horizontal ground movement
Coordinates: [Distance from wall / wall depth or max. excavation depth (x), Depth / wall depth or max. excavation depth (y), Horizontal movement / wall depth or max. excavation depth (z) (%)]
 [0.000,0.000,0.000] [1.000,0.000,0.000] [0.000,1.000,0.000] [1.000,1.000,0.000]
Curve Fitting Method: Polynomial
x Order: 0
y Order: 0
 Polynomial: z = 0.0
 Coeff. of -2147483648.E+2147483647
Determination:

Polygonal Excavations

Excavation Name: New Excavation
Surface level [m]: 85.500
Contribution: Positive
Enabled: Yes
 Surface movement curves which are selected are applied between surface and [m]: 81.400

Corner	x	y	Base Level	Stiffened	Previous Side	Next Side
	[m]	[m]	[m]	d	p1 p2*	d p1 p2*
				[m]	[%]	[m]
1	2.0000	0.0	81.400	No	- -	- -
2	18.000	0.0	81.400	No	- -	- -
3	21.000	2.0000	81.400	No	- -	- -
4	21.000	6.5000	81.400	No	- -	- -
5	2.0000	6.0000	81.400	No	- -	- -

Side	Corner 1	Corner 2	Ground Movement Curve	
	x y	x y	Vertical	Horizontal
	[m] [m]	[m] [m]		
1	2.0000 0.0	18.000 2.0000	0.0 No vertical ground movement	No horizontal ground movement
2	18.000 0.0	21.000 2.0000	No vertical ground movement	No horizontal ground movement
3	21.000 2.0000	21.000 6.5000	No vertical ground movement	No horizontal ground movement
4	21.000 6.5000	2.0000 6.0000	No vertical ground movement	No horizontal ground movement
5	2.0000 6.0000	2.0000 0.0	No vertical ground movement	No horizontal ground movement

Damage Category Strains

Name	0 (Negligible)	1 (Very Slight)	2 (Slight)	3 (Moderate)
	to	to	to	to
Burland Strain Limits	1 (Very Slight)	2 (Slight)	3 (Moderate)	4 (Severe)
	0.0	500.00E-6	750.00E-6	0.0015000

Specific Structures - Geometry

Structure Name	Sub-Structure Name	Displacement Line	Start Distance Along Line	End Distance Along Line	Vertical Offsets from Line for Vertical Movement Calculations	Vertical Displacement Limit Sensitivity	Damage Category Strains	Poisson's Ratio	E/G
			[m]	[m]	[m]	[mm]			
No 33	Party Wall (1)	Line 1	0.00000	9.89900	0.0	0.10000	Burland Strain Limits	0.20000	2.6000
No 33	Rear Elevation (2)	Line 2	0.00000	2.90000	0.0	0.10000	Burland Strain Limits	0.20000	2.6000
No 33	Far Elevation (3)	Line 3	0.00000	8.83200	0.0	0.10000	Burland Strain Limits	0.20000	2.6000
No 33	Far Elevation (4)	Line 4	0.00000	1.90000	0.0	0.10000	Burland Strain Limits	0.20000	2.6000
No 33	Frontage (5)	Line 5	0.00000	6.90000	0.0	0.10000	Burland Strain Limits	0.20000	2.6000
No 29	Party Wall (6)	Line 6	0.00000	16.90700	0.0	0.10000	Burland Strain Limits	0.20000	2.6000
No 29	Rear Elevation (7)	Line 7	0.00000	5.89900	0.0	0.10000	Burland Strain Limits	0.20000	2.6000
No 29	Far Elevation (8)	Line 8	0.00000	16.90700	0.0	0.10000	Burland Strain Limits	0.20000	2.6000
No 29	Frontage (9)	Line 9	0.00000	5.89900	0.0	0.10000	Burland Strain Limits	0.20000	2.6000
Willoughby Road	Roadway (10)	Line 10	0.00000	18.00000	0.0	0.10000	Burland Strain Limits	0.20000	2.6000
Willow Cottages	Retaining Wall (11)	Line 11	0.00000	32.42200	0.0	0.10000	Burland Strain Limits	0.20000	2.6000

Structure Name	Sub-Structure Name	Displacement Line	Start Distance Along Line	End Distance Along Line	Vertical Offsets from Line for Vertical	Vertical Displacement Limit Sensitivity	Damage Category	Strains	Poisson's Ratio	E/G
Willow Cottages	Rear Elevation	Line 12	0.00000	32.42200	0.0	0.10000	Burland	Strain Limits	0.20000	2.6000

Specific Structures - Bending Parameters

Structure Name	Sub-Structure Name	Height	Default Properties	Hogging			Sagging		
				2nd Moment of Area (per unit width)	Distance of Bending Strain from N.A.	Distance of N.A. from Edge of Beam in Tension	2nd Moment of Area (per unit width)	Distance of Bending Strain from N.A.	Distance of N.A. from Edge of Beam in Tension
No 33	Party Wall (1)	[m]	8.0000 Yes	[m ³]	[m]	[m]	[m ³]	[m]	[m]
No 33	Rear Elevation (2)	8.0000	Yes	170.67	8.0000	8.0000	42.667	4.0000	4.0000
No 33	Far Elevation (3)	8.0000	Yes	170.67	8.0000	8.0000	42.667	4.0000	4.0000
No 33	Far Elevation (4)	8.0000	Yes	170.67	8.0000	8.0000	42.667	4.0000	4.0000
No 33	Frontage (5)	8.0000	Yes	170.67	8.0000	8.0000	42.667	4.0000	4.0000
No 29	Party Wall (6)	12.000	Yes	576.00	12.000	12.000	144.00	6.0000	6.0000
No 29	Rear Elevation (7)	12.000	Yes	576.00	12.000	12.000	144.00	6.0000	6.0000
No 29	Far Elevation (8)	12.000	Yes	576.00	12.000	12.000	144.00	6.0000	6.0000
No 29	Frontage (9)	12.000	Yes	576.00	12.000	12.000	144.00	6.0000	6.0000
Willoughby Road	Roadway (10)	0.50000	Yes	0.041667	0.50000	0.50000	0.010417	0.25000	0.25000
Willow Cottages	Retaining Wall (11)	2.5000	Yes	5.2083	2.5000	2.5000	1.3021	1.2500	1.2500
Willow Cottages	Rear Elevation	8.0000	Yes	170.67	8.0000	8.0000	42.667	4.0000	4.0000

Building Segment Combinations

Structure Name	Sub-Structure Name	Vertical Offset from Line for Vertical Movement Calculations	Segment Start	Length	Curvature	Combined Segment
No structures have segments combined.						

Utility Strain Calculation Options

Neglect beneficial contribution of axial strains : No

Warnings

- Sub-structure 6 crosses at least one excavation. Its building damage results in that area should be treated with caution.

Errors

None

Specific Building Damage Results - Horizontal Displacements

Structure: No 33 | Sub-structure: Party Wall (1)

Dist.	Coordinates			Displacements		
	x	y	z	Horizontal displacement along the Line	Horizontal displacement perpendicular to Line	
	[m]	[m]	[m]	[mm]	[mm]	
	0.0	2.05000	0.00000	84.00000	0.0	0.0 d
1.9800	4.03000	0.00000	84.00000	0.0	0.0	0.0 d
3.9600	6.01000	0.00000	84.00000	0.0	0.0	0.0 d
5.9400	7.99000	0.00000	84.00000	0.0	0.0	0.0 d
7.9200	9.97000	0.00000	84.00000	0.0	0.0	0.0 d
9.9000	11.95000	0.00000	84.00000	0.0	0.0	0.0 d

d - Displacements include imported displacements.

Structure: No 33 | Sub-structure: Rear Elevation (2)

Dist.	Coordinates			Displacements		
	x	y	z	Horizontal displacement along the Line	Horizontal displacement perpendicular to Line	
	[m]	[m]	[m]	[mm]	[mm]	
	0.0	12.00000	-0.05000	84.00000	0.0	0.0 d
2.9000	12.00000	-2.95000	84.00000	0.0	0.0	0.0 d

d - Displacements include imported displacements.

Structure: No 33 | Sub-structure: Far Elevation (3)

Dist.	Coordinates			Displacements		
	x	y	z	Horizontal displacement along the Line	Horizontal displacement perpendicular to Line	
	[m]	[m]	[m]	[mm]	[mm]	
	0.0	11.95000	-3.00000	84.00000	0.0	0.0 d
2.2081	9.97500	-3.98750	84.00000	0.0	0.0	0.0 d
4.4162	8.00000	-4.97500	84.00000	0.0	0.0	0.0 d
6.6244	6.02500	-5.96250	84.00000	0.0	0.0	0.0 d
8.8325	4.05000	-6.95000	84.00000	0.0	0.0	0.0 d

d - Displacements include imported displacements.

Structure: No 33 | Sub-structure: Far Elevation (4)

Dist.	Coordinates			Displacements		
	x	y	z	Horizontal displacement along the Line	Horizontal displacement perpendicular to Line	
	[m]	[m]	[m]	[mm]	[mm]	
	0.0	3.95000	-7.00000	84.00000	0.0	0.0 d
1.9000	2.05000	-7.00000	84.00000	0.0	0.0	0.0 d

d - Displacements include imported displacements.

Structure: No 33 | Sub-structure: Frontage (5)



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Dist.	Coordinates			Displacements	
	x	y	z	x	y
				Horizontal displacement along the Line	Horizontal displacement perpendicular to Line
	[m]	[m]	[m]	[mm]	[mm]
0.0	2.00000	-6.95000	84.00000	0.0	0.0
2.3000	2.00000	-4.85000	84.00000	0.0	0.0
4.6000	2.00000	-2.35000	84.00000	0.0	0.0
6.9000	2.00000	-0.05000	84.00000	0.0	0.0

d - Displacements include imported displacements.

Structure: No 29 | Sub-structure: Party Wall (6)

Dist.	Coordinates			Displacements	
	x	y	z	x	y
				Horizontal displacement along the Line	Horizontal displacement perpendicular to Line
	[m]	[m]	[m]	[mm]	[mm]
0.0	2.05000	6.00000	84.00000	0.0	0.0
2.1134	4.16250	6.06250	84.00000	0.0	0.0
4.2268	6.27500	6.12500	84.00000	0.0	0.0
6.3403	8.38750	6.18750	84.00000	0.0	0.0
8.4537	10.50000	6.25000	84.00000	0.0	0.0
10.567	12.61250	6.31250	84.00000	0.0	0.0
12.681	14.72500	6.37500	84.00000	0.0	0.0
14.794	16.83750	6.43750	84.00000	0.0	0.0
16.907	18.95000	6.50000	84.00000	0.0	0.0

d - Displacements include imported displacements.

Structure: No 29 | Sub-structure: Rear Elevation (7)

Dist.	Coordinates			Displacements	
	x	y	z	x	y
				Horizontal displacement along the Line	Horizontal displacement perpendicular to Line
	[m]	[m]	[m]	[mm]	[mm]
0.0	19.00000	6.55000	84.00000	0.0	0.0
1.9667	19.00000	8.51667	84.00000	0.0	0.0
3.9333	19.00000	10.48333	84.00000	0.0	0.0
5.9000	19.00000	12.45000	84.00000	0.0	0.0

d - Displacements include imported displacements.

Structure: No 29 | Sub-structure: Far Elevation (8)

Dist.	Coordinates			Displacements	
	x	y	z	x	y
				Horizontal displacement along the Line	Horizontal displacement perpendicular to Line
	[m]	[m]	[m]	[mm]	[mm]
0.0	19.95000	12.50000	84.00000	0.0	0.0
2.1134	16.83750	12.43750	84.00000	0.0	0.0
4.2268	14.72500	12.37500	84.00000	0.0	0.0
6.3403	12.61250	12.31250	84.00000	0.0	0.0
8.4537	10.50000	12.25000	84.00000	0.0	0.0
10.567	8.38750	12.18750	84.00000	0.0	0.0
12.681	6.27500	12.12500	84.00000	0.0	0.0
14.794	4.16250	12.06250	84.00000	0.0	0.0
16.907	2.05000	12.00000	84.00000	0.0	0.0

d - Displacements include imported displacements.

Structure: No 29 | Sub-structure: Frontage (9)

Dist.	Coordinates			Displacements	
	x	y	z	x	y
				Horizontal displacement along the Line	Horizontal displacement perpendicular to Line
	[m]	[m]	[m]	[mm]	[mm]
0.0	2.00000	11.95000	84.00000	0.0	0.0
1.9667	2.00000	9.98333	84.00000	0.0	0.0
3.9333	2.00000	8.01667	84.00000	0.0	0.0
5.9000	2.00000	6.05000	84.00000	0.0	0.0

d - Displacements include imported displacements.

Structure: Willoughby Road | Sub-structure: Roadway (10)

Dist.	Coordinates			Displacements	
	x	y	z	x	y
				Horizontal displacement along the Line	Horizontal displacement perpendicular to Line
	[m]	[m]	[m]	[mm]	[mm]
0.0	-2.00000	-6.00000	85.00000	0.0	0.0
2.0000	-2.00000	-4.00000	85.00000	0.0	0.0
4.0000	-2.00000	-2.00000	85.00000	0.0	0.0
6.0000	-2.00000	0.00000	85.00000	0.0	0.0
8.0000	-2.00000	2.00000	85.00000	0.0	0.0
10.000	-2.00000	4.00000	85.00000	0.0	0.0
12.000	-2.00000	6.00000	85.00000	0.0	0.0
14.000	-2.00000	8.00000	85.00000	0.0	0.0
16.000	-2.00000	10.00000	85.00000	0.0	0.0
18.000	-2.00000	12.00000	85.00000	0.0	0.0

d - Displacements include imported displacements.

Structure: Willow Cottages | Sub-structure: Retaining Wall (11)

Dist.	Coordinates			Displacements	
	x	y	z	x	y
				Horizontal displacement along the Line	Horizontal displacement perpendicular to Line
	[m]	[m]	[m]	[mm]	[mm]
0.0	0.00000	-10.00000	83.00000	0.0	0.0
2.0264	1.81250	-9.09375	83.00000	0.0	0.0
4.0529	3.62500	-8.18750	83.00000	0.0	0.0
6.0793	5.43750	-7.28125	83.00000	0.0	0.0
8.1057	7.25000	-6.37500	83.00000	0.0	0.0
10.132	9.06250	-5.46875	83.00000	0.0	0.0
12.159	10.87500	-4.56250	83.00000	0.0	0.0
14.185	12.68750	-3.65625	83.00000	0.0	0.0
16.211	14.50000	-2.75000	83.00000	0.0	0.0
18.238	16.31250	-1.84375	83.00000	0.0	0.0
20.264	18.12500	-0.93750	83.00000	0.0	0.0
22.291	19.93750	-0.03125	83.00000	0.0	0.0
24.317	21.75000	0.87500	83.00000	0.0	0.0
26.344	23.56250	1.78125	83.00000	0.0	0.0
28.370	25.37500	2.68750	83.00000	0.0	0.0
30.397	27.18750	3.59375	83.00000	0.0	0.0



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Dist.	Coordinates			Displacements		
	x	y	z	x	y	z
32.423 29.00000	4.50000	83.00000	0.0	0.0	0.0	0.0
d - Displacements include imported displacements.						
Structure: Willow Cottages Sub-structure: Rear Elevation						
Dist.	Coordinates			Displacements		
	x	y	z	x	y	z
					Horizontal displacement along the line	Horizontal displacement perpendicular to line
[m]	[m]	[m]	[m]	[mm]	[mm]	[mm]
0.0	0.00000	-13.00000	83.00000	0.0	0.0	0.0
2.0264	1.81250	-12.09375	83.00000	0.0	0.0	0.0
4.0529	3.62500	-11.18750	83.00000	0.0	0.0	0.0
6.0793	5.43750	-10.28125	83.00000	0.0	0.0	0.0
8.1057	7.25000	-9.37500	83.00000	0.0	0.0	0.0
10.132	9.06250	-8.46875	83.00000	0.0	0.0	0.0
12.159	10.87500	-7.56250	83.00000	0.0	0.0	0.0
14.185	12.68750	-6.65625	83.00000	0.0	0.0	0.0
16.211	14.50000	-5.75000	83.00000	0.0	0.0	0.0
18.238	16.31250	-4.84375	83.00000	0.0	0.0	0.0
20.264	18.12500	-3.93750	83.00000	0.0	0.0	0.0
22.291	19.93750	-3.03125	83.00000	0.0	0.0	0.0
24.317	21.75000	-2.12500	83.00000	0.0	0.0	0.0
26.344	23.56250	-1.21875	83.00000	0.0	0.0	0.0
28.370	25.37500	-0.31250	83.00000	0.0	0.0	0.0
30.397	27.18750	0.59375	83.00000	0.0	0.0	0.0
32.423 29.00000	4.50000	83.00000	0.0	0.0	0.0	0.0
d - Displacements include imported displacements.						
Specific Building Damage Results - Vertical Displacements						
Structure: No 33 Sub-structure: Party Wall (1)						
Dist.	Coordinates			Displacements		
	x	y	z	x	y	z
[m]	[m]	[m]	[m]	[mm]		
Vertical Offset 1						
0.0	2.05000	0.00000	84.00000	2.5611	d	
1.9800	4.03000	0.00000	84.00000	3.6389	d	
3.9600	6.01000	0.00000	84.00000	3.7309	d	
5.9400	7.99000	0.00000	84.00000	3.8094	d	
7.9200	9.97000	0.00000	84.00000	3.9426	d	
9.9000	11.95000	0.00000	84.00000	4.6017	d	
d - Displacements include imported displacements.						
Structure: No 33 Sub-structure: Rear Elevation (2)						
Dist.	Coordinates			Displacements		
	x	y	z	x	y	z
[m]	[m]	[m]	[m]	[mm]		
Vertical Offset 1						
0.0	12.00000	-0.05000	84.00000	4.4599	d	
2.9000	12.00000	-2.95000	84.00000	1.2985	d	
d - Displacements include imported displacements.						
Structure: No 33 Sub-structure: Far Elevation (3)						
Dist.	Coordinates			Displacements		
	x	y	z	x	y	z
[m]	[m]	[m]	[m]	[mm]		
Vertical Offset 1						
0.0	11.95000	-3.00000	84.00000	1.2795	d	
2.2081	9.97500	-3.98750	84.00000	0.94807	d	
4.4162	8.00000	-4.97500	84.00000	0.71475	d	
6.6244	6.02500	-5.96250	84.00000	0.53330	d	
8.8325	4.05000	-6.95000	84.00000	0.38743	d	
d - Displacements include imported displacements.						
Structure: No 33 Sub-structure: Far Elevation (4)						
Dist.	Coordinates			Displacements		
	x	y	z	x	y	z
[m]	[m]	[m]	[m]	[mm]		
Vertical Offset 1						
0.0	3.95000	-7.00000	84.00000	0.38090	d	
1.9000	2.05000	-7.00000	84.00000	0.32440	d	
d - Displacements include imported displacements.						
Structure: No 33 Sub-structure: Frontage (5)						
Dist.	Coordinates			Displacements		
	x	y	z	x	y	z
[m]	[m]	[m]	[m]	[mm]		
Vertical Offset 1						
0.0	2.00000	-6.95000	84.00000	0.32588	d	
2.3000	2.00000	-4.65000	84.00000	0.51269	d	
4.6000	2.00000	-2.35000	84.00000	0.84466	d	
6.9000	2.00000	-0.05000	84.00000	2.3756	d	
d - Displacements include imported displacements.						
Structure: No 29 Sub-structure: Party Wall (6)						
Dist.	Coordinates			Displacements		
	x	y	z	x	y	z
[m]	[m]	[m]	[m]	[mm]		
Vertical Offset 1						
0.0	2.05000	6.00000	84.00000	2.4795	d	
2.1134	4.16250	6.06250	84.00000	3.1688	d	
4.2268	6.27500	6.12500	84.00000	3.1983	d	
6.3403	8.38750	6.18750	84.00000	3.2435	d	
8.4537	10.50000	6.25000	84.00000	3.3182	d	
10.567	12.61250	6.31250	84.00000	3.6438	d	
12.681	14.72500	6.37500	84.00000	3.8251	d	
14.794	16.83750	6.43750	84.00000	3.9651	d	
16.907	18.95000	6.50000	84.00000	4.5241	d	
d - Displacements include imported displacements.						
Structure: No 29 Sub-structure: Rear Elevation (7)						
Dist.	Coordinates			Displacements		
	x	y	z	x	y	z
[m]	[m]	[m]	[m]	[mm]		



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Vertical Offset 1
0.0 19.00000 6.55000 84.00000 4.3718 d
1.9667 19.00000 8.51667 84.00000 1.4895 d
3.9333 19.00000 10.48333 84.00000 0.83199 d
5.9000 19.00000 12.45000 84.00000 0.52431 d
d - Displacements include imported displacements.

Structure: No 29 | Sub-structure: Far Elevation (8)

Dist.	Coordinates		Displacements
	x	y	z
	[m]	[m]	[mm]

Vertical Offset 1
0.0 18.95000 12.50000 84.00000 0.51989 d
2.1134 16.83750 12.43750 84.00000 0.56402 d
4.2268 14.72500 12.37500 84.00000 0.58080 d
6.3403 12.61250 12.31250 84.00000 0.57796 d
8.4537 10.50000 12.25000 84.00000 0.56150 d
10.567 8.38750 12.18750 84.00000 0.53447 d
12.681 6.27500 12.12500 84.00000 0.49632 d
14.794 4.16250 12.06250 84.00000 0.44390 d
16.907 2.05000 12.00000 84.00000 0.37575 d
d - Displacements include imported displacements.

Structure: No 29 | Sub-structure: Frontage (9)

Dist.	Coordinates		Displacements
	x	y	z
	[m]	[m]	[mm]

Vertical Offset 1
0.0 2.00000 11.95000 84.00000 0.37752 d
1.9667 2.00000 9.98333 84.00000 0.56610 d
3.9333 2.00000 8.01667 84.00000 0.92917 d
5.9000 2.00000 6.05000 84.00000 2.2980 d
d - Displacements include imported displacements.

Structure: Willoughby Road | Sub-structure: Roadway (10)

Dist.	Coordinates		Displacements
	x	y	z
	[m]	[m]	[mm]

Vertical Offset 1
0.0 -2.00000 -6.00000 85.00000 0.23348 d
2.0000 -2.00000 -4.00000 85.00000 0.31689 d
4.0000 -2.00000 -2.00000 85.00000 0.42080 d
6.0000 -2.00000 0.00000 85.00000 0.52866 d
8.0000 -2.00000 2.00000 85.00000 0.59764 d
10.000 -2.00000 4.00000 85.00000 0.59389 d
12.000 -2.00000 6.00000 85.00000 0.51950 d
14.000 -2.00000 8.00000 85.00000 0.41020 d
16.000 -2.00000 10.00000 85.00000 0.30732 d
18.000 -2.00000 12.00000 85.00000 0.22565 d
d - Displacements include imported displacements.

Structure: Willow Cottages | Sub-structure: Retaining Wall (11)

Dist.	Coordinates		Displacements
	x	y	z
	[m]	[m]	[mm]

Vertical Offset 1
0.0 0.00000 -10.00000 83.00000 0.15374 d
2.0264 1.81250 -9.09375 83.00000 0.21617 d
4.0529 3.62500 -8.18750 83.00000 0.29658 d
6.0793 5.43750 -7.28125 83.00000 0.39708 d
8.1057 7.25000 -6.37500 83.00000 0.51929 d
10.132 9.06250 -5.46875 83.00000 0.66738 d
12.159 10.87500 -4.56250 83.00000 0.85307 d
14.185 12.68750 -3.65625 83.00000 1.0991 d
16.211 14.50000 -2.75000 83.00000 1.4315 d
18.238 16.31250 -1.84375 83.00000 1.8640 d
20.264 18.12500 -0.93750 83.00000 2.3463 d
22.291 19.93750 -0.03125 83.00000 2.3048 d
24.317 21.75000 0.87500 83.00000 1.8002 d
26.344 23.56250 1.78125 83.00000 1.1292 d
28.370 25.37500 2.68750 83.00000 0.70293 d
30.397 27.18750 3.59375 83.00000 0.44909 d
32.423 29.00000 4.50000 83.00000 0.29318 d
d - Displacements include imported displacements.

Structure: Willow Cottages | Sub-structure: Rear Elevation

Dist.	Coordinates		Displacements
	x	y	z
	[m]	[m]	[mm]

Vertical Offset 1
0.0 0.00000 -13.00000 83.00000 0.088307 d
2.0264 1.81250 -12.09375 83.00000 0.12476 d
4.0529 3.62500 -11.18750 83.00000 0.17012 d
6.0793 5.43750 -10.28125 83.00000 0.22534 d
8.1057 7.25000 -9.37500 83.00000 0.29106 d
10.132 9.06250 -8.46875 83.00000 0.36791 d
12.159 10.87500 -7.56250 83.00000 0.45706 d
14.185 12.68750 -6.65625 83.00000 0.56010 d
16.211 14.50000 -5.75000 83.00000 0.67669 d
18.238 16.31250 -4.84375 83.00000 0.79920 d
20.264 18.12500 -3.93750 83.00000 0.90422 d
22.291 19.93750 -3.03125 83.00000 0.94582 d
24.317 21.75000 -2.12500 83.00000 0.88479 d
26.344 23.56250 -1.21875 83.00000 0.73629 d
28.370 25.37500 -0.31250 83.00000 0.55872 d
30.397 27.18750 0.59375 83.00000 0.40300 d
32.423 29.00000 1.50000 83.00000 0.28375 d
d - Displacements include imported displacements.

Specific Building Damage Results - All Segments

Structure: No 33 | Sub-structure: Party Wall (1)

Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category	
[m]		[m]	[m]		[%]	[%]	[%]			[m]		
0.0		1	0.0	5.1607	Sagging	0.011831	0.0	0.010690	0.0	-544.34E-6	3190.4	0



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Vertical Offset from Line for Vertical Movement	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category	
		2	5.1607	4.7383	Hogging	0.0065946	0.0	0.0064496	0.0	-332.91E-6	6088.3	(Negligible)
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.												
												0
												(Negligible)

Structure: No 33 | Sub-structure: Rear Elevation (2)

Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category
[m] 0.0		[m] 1	[m] 0.0	[m] 2.9000	None	[%] 0.0	[%] 0.0	[%] 0.0	0.0	0.0010901	- 0 (Negligible)
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.											

Structure: No 33 | Sub-structure: Far Elevation (3)

Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category	
[m] 0.0		[m] 1	[m] 0.0	[m] 8.8320	Hogging	[%] 0.0013417	[%] 0.0	[%] 0.0012445	0.0	150.10E-6	[m] 44454. (Negligible)	0
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.												

Structure: No 33 | Sub-structure: Far Elevation (4)

Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category
[m] 0.0		[m] 1	[m] 0.0	[m] 1.9000	None	[%] 0.0	[%] 0.0	[%] 0.0	0.0	29.739E-6	- [m] 0 (Negligible)
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.											

Structure: No 33 | Sub-structure: Frontage (5)

Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category
[m] 0.0		[m] 1	[m] 0.0	[m] 0.23802	None	[%] 0.0	[%] 0.0	[%] 0.0	0.0	-81.225E-6	[m] 109480.
		2	0.23802	6.6620	Hogging	0.011796	0.0	0.011294	0.0	-648.25E-6	3911.4
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.											

Structure: No 29 | Sub-structure: Party Wall (6)

Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category	
[m] 0.0		1	[m] 0.0	[m] 5.5958	Sagging	[%] 0.0071961	[%] 0.0	[%] 0.0068160	0.0	-326.17E-6	[m] 5389.7	(Negligible)
		2	5.5958	4.6130	Hogging	0.0028701	0.0	0.0028432	0.0	-154.08E-6	46212.	
		3	10.209	0.97415	Sagging	0.0015734	0.0	0.0015707	0.0	-154.08E-6	228260.	
		4	11.183	5.7240	Hogging	0.0043916	0.0	0.0043285	0.0	-264.48E-6	8364.9	
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.												

Structure: No 29 | Sub-structure: Rear Elevation (7)

Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category	
[m] 0.0		[m] 1	[m] 0.0	5.6502	Hogging	[%] 0.027365	[%] 0.0	0.026982	0.0	0.0014656	[m] 1436.0	0 (Negligible)
		2	5.6502	0.24885	None	0.0	0.0	0.0	0.0	156.45E-6	32600.	0 (Negligible)
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.												

Structure: No 29 | Sub-structure: Far Elevation (8)

Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category	
[m] 0.0		[m] 1	[m] 0.0	16.907	Sagging	671.98E-6	0.0	965.27E-6	0.0	32.242E-6	[m] 152640.	0 (Negligible)
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.												

Structure: No 29 | Sub-structure: Frontage (9)

Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category	
[m] 0.0		[m] 1	[m] 0.0	0.15788	Sagging	[%] 0.0	[%] 0.0	[%] 0.0	0.0	-95.886E-6	[m] 115890.	0 (Negligible)
		2	0.15788	5.7411	Hogging	0.012456	0.0	0.012276	0.0	-696.01E-6	3186.5	0 (Negligible)
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.												

Structure: Willoughby Road | Sub-structure: Roadway (10)

Vertical Offset from Line for Vertical	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement	Max Gradient of Vertical Displacement	Min Radius of Curvature	Damage Category
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Movement Calculations						Displacement Curve	Curve		
[m]		[m]	[m]	[%]	[%]	[%]		[m]	
0.0	1	0.0	3.7240	Hogging	254.01E-6	0.0	319.40E-6	0.0	-51.954E-6
									162370.
	2	3.7240	10.300	Sagging	0.0018441	0.0	532.26E-6	0.0	54.652E-6
									62819.
	3	14.024	3.9760	Hogging	264.16E-6	0.0	319.76E-6	0.0	51.441E-6
									160510.

Tensile horizontal strains are +ve, compressive horizontal strains are -ve.

Structure: Willow Cottages | Sub-structure: Retaining Wall (11)

Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category
[m]		[m]	[m]		[%]	[%]	[%]			[m]	
0.0	1	0.0	17.243	Hogging	0.0021236	0.0	0.0027823	0.0	-213.46E-6	48839.	0
											(Negligible)
	2	17.243	8.1411	Sagging	0.0095802	0.0	0.012905	0.0	331.14E-6	10178.	0
											(Negligible)
	3	25.384	7.0375	Hogging	0.0036163	0.0	0.0051929	0.0	331.14E-6	23889.	0
											(Negligible)

Tensile horizontal strains are +ve, compressive horizontal strains are -ve.

Structure: Willow Cottages | Sub-structure: Rear Elevation

Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category
[m]		[m]	[m]		[%]	[%]	[%]			[m]	
0.0	1	2.0264	14.345	Hogging	516.85E-6	0.0	591.05E-6	0.0	-60.454E-6	306530.	0
											(Negligible)
	2	16.371	11.407	Sagging	0.0026089	0.0	0.0037619	0.0	87.625E-6	46348.	0
											(Negligible)
	3	27.778	4.6442	Hogging	500.53E-6	0.0	489.91E-6	0.0	87.625E-6	102300.	0
											(Negligible)

Tensile horizontal strains are +ve, compressive horizontal strains are -ve.

Specific Building Damage Results - Critical Values for All Segments within Each Sub-Structure

Structure: No 33 | Sub-structure: Party Wall (1)

Vertical Offset from Line for Vertical Movement Calculations	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category
[m]		[%]		[mm]	[%]			[m]	[m]	
0.0	0.011831	0.0	-544.34E-6	4.6014	0.010690	0.0	-544.34E-6	6088.3	3190.4	0 (Negligible)

Structure: No 33 | Sub-structure: Rear Elevation (2)

Vertical Offset from Line for Vertical Movement Calculations	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category
[m]		[%]		[mm]	[%]			[m]	[m]	
0.0	0.0	0.0	0.0010901	4.4599	0.0	0.0	0.0010901	-	-	0 (Negligible)

Structure: No 33 | Sub-structure: Far Elevation (3)

Vertical Offset from Line for Vertical Movement Calculations	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category
[m]		[%]		[mm]	[%]			[m]	[m]	
0.0	0.0013417	0.0	150.10E-6	1.2795	0.0012445	0.0	150.10E-6	44454.	-	0 (Negligible)

Structure: No 33 | Sub-structure: Far Elevation (4)

Vertical Offset from Line for Vertical Movement Calculations	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category
[m]		[%]		[mm]	[%]			[m]	[m]	
0.0	0.0	0.0	29.739E-6	0.38090	0.0	0.0	29.739E-6	-	-	0 (Negligible)

Structure: No 33 | Sub-structure: Frontage (5)

Vertical Offset from Line for Vertical Movement Calculations	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category
[m]		[%]		[mm]	[%]			[m]	[m]	
0.0	0.011796	0.0	-648.25E-6	2.3756	0.011294	0.0	-648.25E-6	3911.4	-	0 (Negligible)

Structure: No 29 | Sub-structure: Party Wall (6)

Vertical Offset from Line for Vertical Movement Calculations	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category
[m]		[%]		[mm]	[%]			[m]	[m]	
0.0	0.0071961	0.0	-326.17E-6	4.5240	0.0068160	0.0	-326.17E-6	8364.9	5389.7	0 (Negligible)

Structure: No 29 | Sub-structure: Rear Elevation (7)

Vertical Offset from	Deflection Ratio	Average Horizontal	Max Slope	Max Settlement	Max Tensile	Max Gradient of	Max Gradient of Vertical	Min Radius of	Min Radius of	Damage Category

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Line for Vertical Movement Calculations	Strain		Strain		Horizontal Displacement Curve		Displacement Curve		Curvature Curvature (Sagging)			
[m] 0.0	[%] 0.027365	[%] 0.0	0.0014656	[mm] 4.3718	[%] 0.026982	0.0	0.0014656	[m] 1436.0	[m] - 0	(Negligible)		
Structure: No 29 Sub-structure: Far Elevation (8)												
Vertical Offset from Line for Vertical Movement Calculations	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category		
[m] 0.0	[%] 671.98E-6	[%] 0.0	32.242E-6	[mm] 0.58075	[%] 965.27E-6	0.0	32.242E-6	[m] -	[m] 152640.0	(Negligible)		
Structure: No 29 Sub-structure: Frontage (9)												
Vertical Offset from Line for Vertical Movement Calculations	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category		
[m] 0.0	[%] 0.012456	[%] 0.0	-696.01E-6	[mm] 2.2973	[%] 0.012276	0.0	-696.01E-6	[m] 3186.5	[m] 115890.0	(Negligible)		
Structure: Willoughby Road Sub-structure: Roadway (10)												
Vertical Offset from Line for Vertical Movement Calculations	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category		
[m] 0.0	[%] 0.0018441	[%] 0.0	54.652E-6	[mm] 0.59746	[%] 532.26E-6	0.0	54.652E-6	[m] 160510.	[m] 62819.0	(Negligible)		
Structure: Willow Cottages Sub-structure: Retaining Wall (11)												
Vertical Offset from Line for Vertical Movement Calculations	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category		
[m] 0.0	[%] 0.0095802	[%] 0.0	331.14E-6	[mm] 2.3458	[%] 0.012905	0.0	331.14E-6	[m] 23889.	[m] 10178.0	(Negligible)		
Structure: Willow Cottages Sub-structure: Rear Elevation												
Vertical Offset from Line for Vertical Movement Calculations	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category		
[m] 0.0	[%] 0.0026089	[%] 0.0	87.625E-6	[mm] 0.94492	[%] 0.0037619	0.0	87.625E-6	[m] 102300.	[m] 46348.0	(Negligible)		
Specific Building Damage Results - Critical Segments within Each Structure												
Structure Name	Parameter	Critical Sub-Structure	Critical Segment	Start	End	Curvature	Max Slope	Max Settlement	Max Tensile Strain	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category
No 33	Max Slope	Rear Elevation (2)	1	[m] 0.0	[m] 2.9000	Sagging	0.0010901	[mm] 4.4599	[%] 0.0	[m] -	[m] -	- 0 (Negligible)
	Max Settlement	Party Wall (1)	2	5.1607	9.8990	Hogging	332.91E-6	4.6014	0.0064496	6088.3	- 0 (Negligible)	- 0 (Negligible)
	Max Tensile Strain	Frontage (5)	2	0.23802	6.9000	Hogging	648.25E-6	2.3756	0.011294	3911.4	- 0 (Negligible)	- 0 (Negligible)
	Min Radius of Curvature (Hogging)	Frontage (5)	2	0.23802	6.9000	Hogging	648.25E-6	2.3756	0.011294	3911.4	- 0 (Negligible)	- 0 (Negligible)
	Min Radius of Curvature (Sagging)	Party Wall (1)	1	0.0	5.1607	Sagging	544.34E-6	3.7785	0.010690	-	3190.4	0 (Negligible)
No 29	Max Slope	Rear Elevation (7)	1	0.0	5.6502	Hogging	0.0014656	4.3718	0.026982	1436.0	- 0 (Negligible)	- 0 (Negligible)
	Max Settlement	Party Wall (6)	4	11.183	16.907	Hogging	264.48E-6	4.5240	0.0043285	8364.9	- 0 (Negligible)	- 0 (Negligible)
	Max Tensile Strain	Rear Elevation (7)	1	0.0	5.6502	Hogging	0.0014656	4.3718	0.026982	1436.0	- 0 (Negligible)	- 0 (Negligible)
	Min Radius of Curvature (Hogging)	Rear Elevation (7)	1	0.0	5.6502	Hogging	0.0014656	4.3718	0.026982	1436.0	- 0 (Negligible)	- 0 (Negligible)
	Min Radius of Curvature (Sagging)	Party Wall (6)	1	0.0	5.5958	Sagging	326.17E-6	3.2276	0.0068160	-	5389.7	0 (Negligible)
Willoughby Road	Max Slope	Roadway (10)	2	3.7240	14.024	Sagging	54.652E-6	0.59746	532.26E-6	-	62819.0	0 (Negligible)
	Max Settlement	Roadway (10)	2	3.7240	14.024	Sagging	54.652E-6	0.59746	532.26E-6	-	62819.0	0 (Negligible)
	Max Tensile Strain	Roadway (10)	2	3.7240	14.024	Sagging	54.652E-6	0.59746	532.26E-6	-	62819.0	0 (Negligible)
	Min Radius of Curvature (Hogging)	Roadway (10)	3	14.024	18.000	Hogging	51.441E-6	0.40896	319.76E-6	160510.	- 0 (Negligible)	- 0 (Negligible)
	Min Radius of Curvature (Sagging)	Roadway (10)	2	3.7240	14.024	Sagging	54.652E-6	0.59746	532.26E-6	-	62819.0	0 (Negligible)
Willow Cottages	Max Slope	Retaining Wall (11)	2	17.243	25.384	Sagging	331.14E-6	2.3458	0.012905	-	10178.0	0 (Negligible)
	Max Settlement	Retaining Wall (11)	2	17.243	25.384	Sagging	331.14E-6	2.3458	0.012905	-	10178.0	0 (Negligible)
	Max Tensile Strain	Retaining Wall (11)	2	17.243	25.384	Sagging	331.14E-6	2.3458	0.012905	-	10178.0	0 (Negligible)
	Min Radius of Curvature (Hogging)	Retaining Wall (11)	3	25.384	32.422	Hogging	331.14E-6	1.4468	0.0051929	23889.	- 0 (Negligible)	- 0 (Negligible)
	Min Radius of Curvature (Sagging)	Retaining Wall (11)	2	17.243	25.384	Sagging	331.14E-6	2.3458	0.012905	-	10178.0	0 (Negligible)
Willow Cottages	Max Slope	Rear Elevation	2	16.371	27.778	Sagging	87.625E-6	0.94492	0.0037619	-	46348.0	0 (Negligible)
	Max Settlement	Rear Elevation	2	16.371	27.778	Sagging	87.625E-6	0.94492	0.0037619	-	46348.0	0 (Negligible)
	Max Tensile Strain	Rear Elevation	2	16.371	27.778	Sagging	87.625E-6	0.94492	0.0037619	-	46348.0	0 (Negligible)
	Min Radius of Curvature	Rear Elevation	3	27.778	32.422	Hogging	87.625E-6	0.61062	489.91E-6	102300.	- 0 (Negligible)	- 0 (Negligible)



31 Willoughby Road
Combined Movements & Damage Assessment
Single Stage - Short-term (no heave) - No horizontal movements

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Structure Name	Parameter	Critical Sub-Structure	Critical Segment	Start	End	Curvature	Max Slope	Max Settlement	Max Tensile Strain	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category
	(Hogging)											
	Min Radius of Curvature (Sagging)	Rear Elevation	2	16.371	27.778	Sagging	87.625E-6	0.94492	0.0037619	-	46348.0	0 (Negligible)

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Problem Type

Problem Type : Tunnelling and Embedded Wall Excavations

Displacement Data

Type	Name	Direction of extrusion	Point/Line/Line for extrusion						No. of intervals across extrusion/line	Extrusion depth	No. of intervals along extrusion	Calculate	Surface type for tunnels
			First point			Second point							
			X [m]	Y [m]	Z (level) [m]	X [m]	Y [m]	Z (level) [m]					
Grid	Grid 1	Global X	-20.00000	-20.00000	85.50000	-	26.00000	85.50000	46	60.00000	60	Yes	Surface
Grid	Grid 2	Global X	-20.00000	-20.00000	84.00000	-	26.00000	84.00000	46	60.00000	60	Yes	Surface
Line	Line 1	-	2.05000	0.00000	84.00000	11.95000	0.00000	84.00000	5	-	-	Yes	Surface
Line	Line 2	-	12.00000	-0.05000	84.00000	12.00000	-2.95000	84.00000	1	-	-	Yes	Surface
Line	Line 3	-	11.95000	-3.00000	84.00000	4.05000	-6.95000	84.00000	4	-	-	Yes	Surface
Line	Line 4	-	3.95000	-7.00000	84.00000	2.05000	-7.00000	84.00000	1	-	-	Yes	Surface
Line	Line 5	-	2.00000	-6.95000	84.00000	2.00000	-0.05000	84.00000	3	-	-	Yes	Surface
Line	Line 6	-	2.05000	6.00000	84.00000	18.95000	6.50000	84.00000	8	-	-	Yes	Surface
Line	Line 7	-	19.00000	6.55000	84.00000	19.00000	12.45000	84.00000	3	-	-	Yes	Surface
Line	Line 8	-	18.95000	12.50000	84.00000	2.05000	12.00000	84.00000	8	-	-	Yes	Surface
Line	Line 9	-	2.00000	11.95000	84.00000	2.00000	6.05000	84.00000	3	-	-	Yes	Surface
Line	Line 10	-	-2.00000	-6.00000	85.00000	-2.00000	12.00000	85.00000	9	-	-	Yes	Surface
Line	Line 11	-	0.00000	-10.00000	83.00000	29.00000	4.50000	83.00000	16	-	-	Yes	Surface
Line	Line 12	-	0.00000	-13.00000	83.00000	29.00000	1.50000	83.00000	16	-	-	Yes	Surface

Vertical Ground Movement Curves (Excavations)

Curve Name: No vertical ground movement
Coordinates: [Distance from wall / wall depth or max. excavation depth (x), Depth / wall depth or max. excavation depth (y), Settlement / wall depth or max. excavation depth (z) (%)]
 [0.000,0.000,0.000] [1.000,0.000,0.000] [0.000,1.000,0.000] [1.000,1.000,0.000]
Curve Fitting Method: Polynomial
x Order: 1
y Order: 0
Polynomial: z = 0.0x + 0.0
Coeff. of Determination: -2147483648.E+2147483647

Horizontal Ground Movement Curves (Excavations)

Curve Name: GEA Curve for 5 mm of horizontal deflection (after CIRIA 580 Fig. 2.11(a))
Coordinates: [Distance from wall / wall depth or max. excavation depth (x), Depth / wall depth or max. excavation depth (y), Horizontal movement / wall depth or max. excavation depth (z) (%)]
 [0.000,0.000,0.121] [4.000,0.000,0.000]
Curve Fitting Method: Polynomial
x Order: 1
y Order: 0
Polynomial: z = -3.03E-2x + 1.21E-1
Coeff. of Determination: 1.00

Polygonal Excavations

Excavation Name: New Excavation
Surface level [m]: 85.500
Contribution: Positive
Enabled: Yes
Surface movement curves which are selected are applied between surface and [m]: 81.400

Corner	x	y	Base Level	Stiffened	Previous Side	Next Side
	[m]	[m]	[m]	d	p1 p2*	d p1 p2*
1	2.0000	0.0	81.400	No	- - -	- - -
2	18.000	0.0	81.400	No	- - -	- - -
3	21.000	2.0000	81.400	No	- - -	- - -
4	21.000	6.5000	81.400	No	- - -	- - -
5	2.0000	6.0000	81.400	No	- - -	- - -

Side	Corner 1	Corner 2	Ground Movement Curve	
	x y	x y	Vertical	Horizontal
	[m] [m]	[m] [m]		
1	2.0000 0.0	18.000 0.0	No vertical ground movement	GEA Curve for 5 mm of horizontal deflection (after CIRIA 580 Fig. 2.11(a))
2	18.000 0.0	21.000 2.0000	No vertical ground movement	GEA Curve for 5 mm of horizontal deflection (after CIRIA 580 Fig. 2.11(a))
3	21.000 2.0000	21.000 6.5000	No vertical ground movement	GEA Curve for 5 mm of horizontal deflection (after CIRIA 580 Fig. 2.11(a))
4	21.000 6.5000	2.0000 6.0000	No vertical ground movement	GEA Curve for 5 mm of horizontal deflection (after CIRIA 580 Fig. 2.11(a))
5	2.0000 6.0000	2.0000 0.0	No vertical ground movement	GEA Curve for 5 mm of horizontal deflection (after CIRIA 580 Fig. 2.11(a))

Damage Category Strains

Name	0 (Negligible) to 1 (Very Slight)	1 (Very Slight) to 2 (Slight)	2 (Slight) to 3 (Moderate)	3 (Moderate) to 4 (Severe)
Burland Strain Limits	0.0	500.00E-6	750.00E-6	0.0015000

Specific Structures - Geometry

Structure Name	Sub-Structure Name	Displacement Line	Start Distance Along Line	End Distance Along Line	Vertical Offsets from Line for Vertical Movement Calculations	Vertical Displacement Limit	Damage Category Strains	Poisson's Ratio	E/G
			[m]	[m]	[m]	[mm]			
No 33	Party Wall (1)	Line 1	0.00000	9.89900	0.0	0.10000	Burland Strain Limits	0.20000	2.6000
No 33	Rear Elevation (2)	Line 2	0.00000	2.90000	0.0	0.10000	Burland Strain Limits	0.20000	2.6000
No 33	Far Elevation (3)	Line 3	0.00000	8.83200	0.0	0.10000	Burland Strain Limits	0.20000	2.6000
No 33	Far Elevation (4)	Line 4	0.00000	1.90000	0.0	0.10000	Burland Strain Limits	0.20000	2.6000

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Structure Name	Sub-Structure Name	Displacement Line	Start Distance Along Line	End Distance Along Line	Vertical Offsets from Line for Vertical	Vertical Displacement Limit Sensitivity	Damage Category	Strains	Poisson's Ratio	E/G
No 33	Frontage (5)	Line 5	0.00000	6.90000	0.0	0.10000	Burland Strain Limits	0.20000	2.6000	
No 29	Party Wall (6)	Line 6	0.00000	16.90700	0.0	0.10000	Burland Strain Limits	0.20000	2.6000	
No 29	Rear Elevation (7)	Line 7	0.00000	5.89900	0.0	0.10000	Burland Strain Limits	0.20000	2.6000	
No 29	Far Elevation (8)	Line 8	0.00000	16.90700	0.0	0.10000	Burland Strain Limits	0.20000	2.6000	
No 29	Frontage (9)	Line 9	0.00000	5.89900	0.0	0.10000	Burland Strain Limits	0.20000	2.6000	
Willoughby Road	Roadway (10)	Line 10	0.00000	18.00000	0.0	0.10000	Burland Strain Limits	0.20000	2.6000	
Willow Cottages	Retaining Wall (11)	Line 11	0.00000	32.42200	0.0	0.10000	Burland Strain Limits	0.20000	2.6000	
Willow Cottages	Rear Elevation	Line 12	0.00000	32.42200	0.0	0.10000	Burland Strain Limits	0.20000	2.6000	

Specific Structures - Bending Parameters

Structure Name	Sub-Structure Name	Height	Default Properties	Hogging			Sagging		
				2nd Moment of Area (per unit width)	Distance of Bending Strain from N.A.	Distance of N.A. from Edge of Beam in Tension	2nd Moment of Area (per unit width)	Distance of Bending Strain from N.A.	Distance of N.A. from Edge of Beam in Tension
No 33	Party Wall (1)	[m]	8.0000 Yes	[m ⁴]	[m]	[m]	[m ⁴]	[m]	[m]
No 33	Rear Elevation (2)	8.0000	Yes	170.67	8.0000	8.0000	42.667	4.0000	4.0000
No 33	Far Elevation (3)	8.0000	Yes	170.67	8.0000	8.0000	42.667	4.0000	4.0000
No 33	Far Elevation (4)	8.0000	Yes	170.67	8.0000	8.0000	42.667	4.0000	4.0000
No 33	Frontage (5)	8.0000	Yes	170.67	8.0000	8.0000	42.667	4.0000	4.0000
No 29	Party Wall (6)	12.000	Yes	576.00	12.000	12.000	144.00	6.0000	6.0000
No 29	Rear Elevation (7)	12.000	Yes	576.00	12.000	12.000	144.00	6.0000	6.0000
No 29	Far Elevation (8)	12.000	Yes	576.00	12.000	12.000	144.00	6.0000	6.0000
No 29	Frontage (9)	12.000	Yes	576.00	12.000	12.000	144.00	6.0000	6.0000
Willoughby Road	Roadway (10)	0.50000	Yes	0.041667	0.50000	0.50000	0.010417	0.25000	0.25000
Willow Cottages	Retaining Wall (11)	2.5000	Yes	5.2083	2.5000	2.5000	1.3021	1.2500	1.2500
Willow Cottages	Rear Elevation	8.0000	Yes	170.67	8.0000	8.0000	42.667	4.0000	4.0000

Building Segment Combinations

Structure Name	Sub-Structure Name	Vertical Offset from Line for Vertical Movement Calculations	Segment Start	Length	Curvature	Combined Segment
No structures have segments combined.						

Utility Strain Calculation Options

Neglect beneficial contribution of axial strains : No

Warnings

- Sub-structure 6 crosses at least one excavation. Its building damage results in that area should be treated with caution.

Errors

None

Specific Building Damage Results - Horizontal Displacements

Structure: No 33 | Sub-structure: Party Wall (1)

Dist.	Coordinates			Displacements		
	x	y	z	x	y	
				Horizontal displacement along the Line	Horizontal displacement perpendicular to Line	
	[m]	[m]	[m]	[mm]	[mm]	
0.0	2.05000	0.00000	84.00000	0.0	4.9610	d
1.9800	4.03000	0.00000	84.00000	0.0	4.9610	d
3.9600	6.01000	0.00000	84.00000	0.0	4.9610	d
5.9400	7.99000	0.00000	84.00000	0.0	4.9610	d
7.9200	9.97000	0.00000	84.00000	0.0	4.9610	d
9.9000	11.95000	0.00000	84.00000	0.0	4.9610	d

d - Displacements include imported displacements.

Structure: No 33 | Sub-structure: Rear Elevation (2)

Dist.	Coordinates			Displacements		
	x	y	z	x	y	
				Horizontal displacement along the Line	Horizontal displacement perpendicular to Line	
	[m]	[m]	[m]	[mm]	[mm]	
0.0	12.00000	-0.05000	84.00000	0.0	4.9459	0.0 d
2.9000	12.00000	-2.95000	84.00000	0.0	4.0686	0.0 d

d - Displacements include imported displacements.

Structure: No 33 | Sub-structure: Far Elevation (3)

Dist.	Coordinates			Displacements		
	x	y	z	x	y	
				Horizontal displacement along the Line	Horizontal displacement perpendicular to Line	
	[m]	[m]	[m]	[mm]	[mm]	
0.0	11.95000	-3.00000	84.00000	0.0	4.0535	-3.6256 d
2.2081	9.97500	-3.98750	84.00000	0.0	3.7548	-3.3584 d
4.4162	8.00000	-4.97500	84.00000	0.0	3.4561	-3.0912 d
6.6244	6.02500	-5.96250	84.00000	0.0	3.1573	-2.8240 d
8.8325	4.05000	-6.95000	84.00000	0.0	2.8586	-2.5568 d

d - Displacements include imported displacements.

Structure: No 33 | Sub-structure: Far Elevation (4)

Dist.	Coordinates			Displacements		
	x	y	z	x	y	
				Horizontal displacement	Horizontal displacement	

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		along the Line		perpendicular to Line	
[m]	[m]	[m]	[mm]	[mm]	[mm]
0.0	3.95000	-7.00000	84.00000	0.0	2.8435
1.9000	2.05000	-7.00000	84.00000	0.0	2.8435
d - Displacements include imported displacements.					

Structure: No 33 | Sub-structure: Frontage (5)

Dist.	Coordinates			Displacements		
	x	y	z	x	y	
				Horizontal displacement along the Line	Horizontal displacement perpendicular to Line	
[m]	[m]	[m]	[m]	[mm]	[mm]	[mm]
0.0	2.00000	-6.95000	84.00000	0.0	2.8586	2.8586
2.3000	2.00000	-4.45000	84.00000	0.0	3.5544	3.5544
4.6000	2.00000	-2.35000	84.00000	0.0	4.2501	4.2501
6.9000	2.00000	-0.05000	84.00000	0.0	4.9459	4.9459
d - Displacements include imported displacements.						

Structure: No 29 | Sub-structure: Party Wall (6)

Dist.	Coordinates			Displacements		
	x	y	z	x	y	
				Horizontal displacement along the Line	Horizontal displacement perpendicular to Line	
[m]	[m]	[m]	[m]	[mm]	[mm]	[mm]
0.0	2.05000	6.00000	84.00000	0.0	0.0	0.0
2.1134	4.16250	6.06250	84.00000	0.13046	-4.9576	-0.016204
4.2268	6.27500	6.12500	84.00000	0.13041	-4.9555	-0.016197
6.3403	8.38750	6.18750	84.00000	0.13035	-4.9534	-0.016191
8.4537	10.50000	6.25000	84.00000	0.13030	-4.9513	-0.016184
10.567	12.61250	6.31250	84.00000	0.13024	-4.9492	-0.016177
12.681	14.72500	6.37500	84.00000	0.13019	-4.9472	-0.016170
14.794	16.83750	6.43750	84.00000	0.13013	-4.9451	-0.016163
16.907	18.95000	6.50000	84.00000	0.13008	-4.9430	-0.016157
d - Displacements include imported displacements.						

Structure: No 29 | Sub-structure: Rear Elevation (7)

Dist.	Coordinates			Displacements		
	x	y	z	x	y	
				Horizontal displacement along the Line	Horizontal displacement perpendicular to Line	
[m]	[m]	[m]	[m]	[mm]	[mm]	[mm]
0.0	19.00000	6.55000	84.00000	0.12969	-4.9283	-0.012969
1.9667	19.00000	8.51667	84.00000	0.11405	-4.3338	-0.011405
3.9333	19.00000	10.48333	84.00000	0.098401	-3.7392	-0.0098401
5.9000	19.00000	12.45000	84.00000	0.082756	-3.1447	-0.0082756
d - Displacements include imported displacements.						

Structure: No 29 | Sub-structure: Far Elevation (8)

Dist.	Coordinates			Displacements		
	x	y	z	x	y	
				Horizontal displacement along the Line	Horizontal displacement perpendicular to Line	
[m]	[m]	[m]	[m]	[mm]	[mm]	[mm]
0.0	18.95000	12.00000	84.00000	0.082248	-3.1292	0.010228
2.1134	16.83750	12.43750	84.00000	0.082403	-3.1313	0.010235
4.2268	14.72500	12.37500	84.00000	0.082458	-3.1334	0.010242
6.3403	12.61250	12.31250	84.00000	0.082513	-3.1355	0.010249
8.4537	10.50000	12.25000	84.00000	0.082568	-3.1376	0.010255
10.567	8.38750	12.18750	84.00000	0.082623	-3.1397	0.010262
12.681	6.27500	12.12500	84.00000	0.082678	-3.1418	0.010269
14.794	4.16250	12.06250	84.00000	0.082733	-3.1438	0.010276
16.907	2.05000	12.00000	84.00000	0.082788	-3.1459	0.010283
d - Displacements include imported displacements.						

Structure: No 29 | Sub-structure: Frontage (9)

Dist.	Coordinates			Displacements		
	x	y	z	x	y	
				Horizontal displacement along the Line	Horizontal displacement perpendicular to Line	
[m]	[m]	[m]	[m]	[mm]	[mm]	[mm]
0.0	2.00000	11.95000	84.00000	0.083175	-3.1607	3.1607
1.9667	2.00000	9.98333	84.00000	0.098820	-3.7552	3.7552
3.9333	2.00000	8.01667	84.00000	0.11446	-4.3497	4.3497
5.9000	2.00000	6.05000	84.00000	0.13011	-4.9442	4.9442
d - Displacements include imported displacements.						

Structure: Willoughby Road | Sub-structure: Roadway (10)

Dist.	Coordinates			Displacements		
	x	y	z	x	y	
				Horizontal displacement along the Line	Horizontal displacement perpendicular to Line	
[m]	[m]	[m]	[m]	[mm]	[mm]	[mm]
0.0	-2.00000	-6.00000	85.00000	1.0405	1.7391	1.7391
2.0000	-2.00000	-4.00000	85.00000	1.6249	1.6249	1.6249
4.0000	-2.00000	-2.00000	85.00000	2.5432	1.0650	1.0650
6.0000	-2.00000	0.00000	85.00000	3.7510	0.0	0.0
8.0000	-2.00000	2.00000	85.00000	3.7510	0.0	0.0
10.000	-2.00000	4.00000	85.00000	3.7510	0.0	0.0
12.000	-2.00000	6.00000	85.00000	3.7510	0.0	0.0
14.000	-2.00000	8.00000	85.00000	2.5535	-1.0828	-1.0828
16.000	-2.00000	10.00000	85.00000	1.6407	-1.6520	-1.6520
18.000	-2.00000	12.00000	85.00000	1.0574	-1.7681	-1.7681
d - Displacements include imported displacements.						

Structure: Willow Cottages | Sub-structure: Retaining Wall (11)

Dist.	Coordinates			Displacements		
	x	y	z	x	y	
				Horizontal displacement along the Line	Horizontal displacement perpendicular to Line	
[m]	[m]	[m]	[m]	[mm]	[mm]	[mm]
0.0	0.00000	-10.00000	83.00000	0.23576	1.6403	0.94445
2.0264	1.81250	-9.09375	83.00000	0.028999	2.1806	1.0011
4.0529	3.62500	-8.18750	83.00000	0.0	2.4843	1.1110
6.0793	5.43750	-7.28125	83.00000	0.0	2.7584	1.2336
8.1057	7.25000	-6.37500	83.00000	0.0	3.0326	1.3562



31 Willoughby Road

Combined Movements & Damage Assessment

Single Stage - Short-term (no heave) - 5 mm limit on overall horizontal movements

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Dist.	Coordinates			Displacements		
x	y	z	x	y	Horizontal displacement along the	Horizontal displacement perpendicular
10.132	9.06250	-5.46875	83.00000	0.0	3.3067	1.4788
12.159	10.87500	-4.56250	83.00000	0.0	3.5808	1.6014
14.185	12.68750	-3.65625	83.00000	0.0	3.8550	1.7240
16.211	14.50000	-2.75000	83.00000	0.0	4.1291	1.8466
18.238	16.31250	-1.84375	83.00000	0.0	4.4033	1.9692
20.264	18.12500	-0.93750	83.00000	-0.58457	4.4979	1.4887
22.291	19.93750	-0.03125	83.00000	-2.5672	3.8508	-0.57404
24.317	21.75000	0.87500	83.00000	-2.5250	3.7875	-0.56461
26.344	23.56250	1.78125	83.00000	-4.0216	0.30159	-3.4622
28.370	25.37500	2.68750	83.00000	-3.6376	0.0	-3.2535
30.397	27.18750	3.59375	83.00000	-3.0893	0.0	-2.7631
32.423	29.00000	4.50000	83.00000	-2.5410	0.0	-2.2727
d - Displacements include imported displacements.						

Structure: Willow Cottages | Sub-structure: Rear Elevation

Dist.	Coordinates			Displacements		
x	y	z	x	y	Horizontal displacement along the Line	Horizontal displacement perpendicular to Line
[m]	[m]	[m]	[m]	[mm]	[mm]	[mm]
0.0	0.00000	-13.00000	83.00000	0.095453	0.88678	0.48196
2.0264	1.81250	-12.09375	83.00000	0.012852	1.2893	0.58811
4.0529	3.62500	-11.18750	83.00000	0.0	1.5768	0.70516
6.0793	5.43750	-10.28125	83.00000	0.0	1.8509	0.82776
8.1057	7.25000	-9.37500	83.00000	0.0	2.1251	0.95036
10.132	9.06250	-8.46875	83.00000	0.0	2.3992	1.0730
12.159	10.87500	-7.56250	83.00000	0.0	2.6733	1.1956
14.185	12.68750	-6.65625	83.00000	0.0	2.9475	1.3182
16.211	14.50000	-5.75000	83.00000	0.0	3.2216	1.4408
18.238	16.31250	-4.84375	83.00000	0.0	3.4958	1.5634
20.264	18.12500	-3.93750	83.00000	-0.11285	3.7351	1.5695
22.291	19.93750	-3.03125	83.00000	-2.0778	3.2436	-0.40784
24.317	21.75000	-2.12500	83.00000	-2.1061	3.1592	-0.47095
26.344	23.56250	-1.21875	83.00000	-2.2036	2.8268	-0.70675
28.370	25.37500	-0.31250	83.00000	-2.7009	1.4260	-1.7780
30.397	27.18750	0.59375	83.00000	-2.7336	0.57546	-2.1876
32.423	29.00000	1.50000	83.00000	-2.4645	0.13403	-2.1444
d - Displacements include imported displacements.						

Specific Building Damage Results - Vertical Displacements

Structure: No 33 | Sub-structure: Party Wall (1)

Dist.	Coordinates			Displacements
	x	y	z	z
[m]	[m]	[m]	[m]	[mm]

Vertical Offset 1			
0.0	2.05000	0.00000	84.00000
1.9800	4.03000	0.00000	84.00000
3.9600	6.01000	0.00000	84.00000
5.9400	7.99000	0.00000	84.00000
7.9200	9.97000	0.00000	84.00000
9.9000	11.95000	0.00000	84.00000
d - Displacements include imported displacements.			

Structure: No 33 | Sub-structure: Rear Elevation (2)

Dist.	Coordinates			Displacements
	x	y	z	z
[m]	[m]	[m]	[m]	[mm]

Vertical Offset 1			
0.0	12.00000	-0.05000	84.00000
2.9000	12.00000	-2.95000	84.00000
d - Displacements include imported displacements.			

Structure: No 33 | Sub-structure: Far Elevation (3)

Dist.	Coordinates			Displacements
	x	y	z	z
[m]	[m]	[m]	[m]	[mm]

Vertical Offset 1			
0.0	11.95000	-3.00000	84.00000
2.2081	9.97500	-3.98750	84.00000
4.4162	8.00000	-4.97500	84.00000
6.6244	6.02500	-5.96250	84.00000
8.8325	4.05000	-6.95000	84.00000
d - Displacements include imported displacements.			

Structure: No 33 | Sub-structure: Far Eleavtion (4)

Dist.	Coordinates			Displacements
	x	y	z	z
[m]	[m]	[m]	[m]	[mm]

Vertical Offset 1			
0.0	3.95000	-7.00000	84.00000
1.9000	2.05000	-7.00000	84.00000
d - Displacements include imported displacements.			

Structure: No 33 | Sub-structure: Frontage (5)

Dist.	Coordinates			Displacements
	x	y	z	z
[m]	[m]	[m]	[m]	[mm]

Vertical Offset 1			
0.0	2.00000	-6.95000	84.00000
2.3000	2.00000	-4.65000	84.00000
4.6000	2.00000	-2.35000	84.00000
6.9000	2.00000	-0.05000	84.00000
d - Displacements include imported displacements.			

Structure: No 29 | Sub-structure: Party Wall (6)

Dist.	Coordinates			Displacements
	x	y	z	z
[m]	[m]	[m]	[m]	[mm]

Vertical Offset 1			
0.0	2.05000	6.00000	84.00000
2.1134	4.16250	6.06250	84.00000
4.2268	6.27500	6.12500	84.00000
6.3403	8.38750	6.18750	84.00000
8.4537	10.50000	6.25000	84.00000
10.567	12.61250	6.31250	84.00000



31 Willoughby Road

Combined Movements & Damage Assessment

Single Stage - Short-term (no heave) - 5 mm limit on overall horizontal movements

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Dist.	Coordinates			Displacements
	x	y	z	z
[m]	[m]	[m]	[m]	[mm]
12.691	14.72500	6.37500	84.00000	3.8251 d
14.794	16.83750	6.43750	84.00000	3.9651 d
16.907	18.95000	6.50000	84.00000	4.5241 d
d - Displacements include imported displacements.				
Structure: No 29 Sub-structure: Rear Elevation (7)				
Dist.	Coordinates			Displacements
	x	y	z	z
[m]	[m]	[m]	[m]	[mm]
Vertical Offset 1				
0.0	19.00000	6.55000	84.00000	4.3718 d
1.9667	19.00000	8.51667	84.00000	1.4895 d
3.9333	19.00000	10.48333	84.00000	0.83199 d
5.9000	19.00000	12.45000	84.00000	0.52431 d
d - Displacements include imported displacements.				
Structure: No 29 Sub-structure: Far Elevation (8)				
Dist.	Coordinates			Displacements
	x	y	z	z
[m]	[m]	[m]	[m]	[mm]
Vertical Offset 1				
0.0	18.95000	12.50000	84.00000	0.51989 d
2.1134	16.83750	12.43750	84.00000	0.56402 d
4.2268	14.72500	12.37500	84.00000	0.58080 d
6.3403	12.61250	12.31250	84.00000	0.57796 d
8.4537	10.50000	12.25000	84.00000	0.56150 d
10.567	8.38750	12.18750	84.00000	0.53447 d
12.681	6.27500	12.12500	84.00000	0.49632 d
14.794	4.16250	12.06250	84.00000	0.44390 d
16.907	2.05000	12.00000	84.00000	0.37575 d
d - Displacements include imported displacements.				
Structure: No 29 Sub-structure: Frontage (9)				
Dist.	Coordinates			Displacements
	x	y	z	z
[m]	[m]	[m]	[m]	[mm]
Vertical Offset 1				
0.0	2.00000	11.95000	84.00000	0.37752 d
1.9667	2.00000	9.98333	84.00000	0.56610 d
3.9333	2.00000	8.01667	84.00000	0.92917 d
5.9000	2.00000	6.05000	84.00000	2.2980 d
d - Displacements include imported displacements.				
Structure: Willoughby Road Sub-structure: Roadway (10)				
Dist.	Coordinates			Displacements
	x	y	z	z
[m]	[m]	[m]	[m]	[mm]
Vertical Offset 1				
0.0	-2.00000	-6.00000	85.00000	0.23348 d
2.0000	-2.00000	-4.00000	85.00000	0.31689 d
4.0000	-2.00000	-2.00000	85.00000	0.42080 d
6.0000	-2.00000	0.00000	85.00000	0.52866 d
8.0000	-2.00000	2.00000	85.00000	0.59764 d
10.000	-2.00000	4.00000	85.00000	0.59389 d
12.000	-2.00000	6.00000	85.00000	0.51950 d
14.000	-2.00000	8.00000	85.00000	0.41020 d
16.000	-2.00000	10.00000	85.00000	0.30732 d
18.000	-2.00000	12.00000	85.00000	0.22565 d
d - Displacements include imported displacements.				
Structure: Willow Cottages Sub-structure: Retaining Wall (11)				
Dist.	Coordinates			Displacements
	x	y	z	z
[m]	[m]	[m]	[m]	[mm]
Vertical Offset 1				
0.0	0.00000	-10.00000	83.00000	0.15374 d
2.0264	1.81250	-9.09375	83.00000	0.21617 d
4.0529	3.62500	-8.18750	83.00000	0.29658 d
6.0793	5.43750	-7.28125	83.00000	0.39708 d
8.1057	7.25000	-6.37500	83.00000	0.51929 d
10.132	9.06250	-5.46875	83.00000	0.66738 d
12.159	10.87500	-4.56250	83.00000	0.85307 d
14.185	12.68750	-3.65625	83.00000	1.0991 d
16.211	14.50000	-2.75000	83.00000	1.4315 d
18.238	16.31250	-1.84375	83.00000	1.8640 d
20.264	18.12500	-0.93750	83.00000	2.3463 d
22.291	19.93750	-0.03125	83.00000	2.3048 d
24.317	21.75000	0.87500	83.00000	1.8002 d
26.344	23.56250	1.78125	83.00000	1.1292 d
28.370	25.37500	2.68750	83.00000	0.70293 d
30.397	27.18750	3.59375	83.00000	0.44909 d
32.423	29.00000	4.50000	83.00000	0.29318 d
d - Displacements include imported displacements.				
Structure: Willow Cottages Sub-structure: Rear Elevation				
Dist.	Coordinates			Displacements
	x	y	z	z
[m]	[m]	[m]	[m]	[mm]
Vertical Offset 1				
0.0	0.00000	-13.00000	83.00000	0.088307 d
2.0264	1.81250	-12.09375	83.00000	0.12476 d
4.0529	3.62500	-11.18750	83.00000	0.17012 d
6.0793	5.43750	-10.28125	83.00000	0.22534 d
8.1057	7.25000	-9.37500	83.00000	0.29106 d
10.132	9.06250	-8.46875	83.00000	0.36791 d
12.159	10.87500	-7.56250	83.00000	0.45706 d
14.185	12.68750	-6.65625	83.00000	0.56010 d
16.211	14.50000	-5.75000	83.00000	0.67669 d
18.238	16.31250	-4.84375	83.00000	0.79920 d
20.264	18.12500	-3.93750	83.00000	0.90422 d
22.291	19.93750	-3.03125	83.00000	0.94582 d
24.317	21.75000	-2.12500	83.00000	0.88479 d
26.344	23.56250	-1.21875	83.00000	0.73629 d
28.370	25.37500	-0.31250	83.00000	0.55872 d
30.397	27.18750	0.59375	83.00000	0.40300 d
32.423	29.00000	1.50000	83.00000	0.28375 d
d - Displacements include imported displacements.				
Specific Building Damage Results - All Segments				



31 Willoughby Road

Combined Movements & Damage Assessment

Single Stage - Short-term (no heave) - 5 mm limit on overall horizontal movements

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Dist.	Coordinates			Displacements							
[m]	x [m]	y [m]	z [m]	z [mm]							
Structure: No 33 Sub-structure: Party Wall (1)											
Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category
[m] 0.0		[m]	[m]		[%]	[%]	[%]			[m]	
	1	0.0	5.1607	Sagging	0.011831	0.0	0.010690	0.0	-544.34E-6	3190.4	0 (Negligible)
	2	5.1607	4.7383	Hogging	0.0065946	0.0	0.0064496	0.0	-332.91E-6	6088.3	0 (Negligible)
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.											
Structure: No 33 Sub-structure: Rear Elevation (2)											
Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category
[m] 0.0		[m]	[m]		[%]	[%]	[%]			[m]	
	1	0.0	2.9000	None	0.0	0.030250	0.030250	-302.41E-6	0.0010898	-	0 (Negligible)
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.											
Structure: No 33 Sub-structure: Far Elevation (3)											
Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category
[m] 0.0		[m]	[m]		[%]	[%]	[%]			[m]	
	1	0.0	8.8320	Hogging	0.0013417	0.0060500	0.0071068	-60.496E-6	150.09E-6	44459.	0 (Negligible)
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.											
Structure: No 33 Sub-structure: Far Eleavtion (4)											
Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category
[m] 0.0		[m]	[m]		[%]	[%]	[%]			[m]	
	1	0.0	1.9000	None	0.0	0.0	0.0	0.0	29.739E-6	-	0 (Negligible)
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.											
Structure: No 33 Sub-structure: Frontage (5)											
Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category
[m] 0.0		[m]	[m]		[%]	[%]	[%]			[m]	
	1	0.0	0.23802	None	0.0	0.030250	0.030250	-302.41E-6	-81.201E-6	109540.	0 (Negligible)
	2	0.23802	6.6620	Hogging	0.011792	0.030250	0.037482	-302.41E-6	-648.05E-6	3913.7	0 (Negligible)
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.											
Structure: No 29 Sub-structure: Party Wall (6)											
Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category
[m] 0.0		[m]	[m]		[%]	[%]	[%]			[m]	
	1	0.0	5.5958	Sagging	0.0071961	-289.38E-6	0.0067025	7.6674E-6	-326.17E-6	5389.6	0 (Negligible)
	2	5.5958	4.6130	Hogging	0.0028701	0.0	0.0028433	0.0	-154.08E-6	46212.	0 (Negligible)
	3	10.209	0.97415	Sagging	0.0015734	0.0	0.0015708	0.0	-154.08E-6	228260.	0 (Negligible)
	4	11.183	5.7240	Hogging	0.0043916	0.0	0.0043285	0.0	-264.48E-6	8364.9	0 (Negligible)
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.											
Structure: No 29 Sub-structure: Rear Elevation (7)											
Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category
[m] 0.0		[m]	[m]		[%]	[%]	[%]			[m]	
	1	0.0	5.6502	Hogging	0.027357	0.030229	0.044596	-302.20E-6	0.0014651	1436.9	0 (Negligible)
	2	5.6502	0.24885	Hogging	0.0	0.030229	0.030229	-302.20E-6	156.40E-6	32620.	0 (Negligible)
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.											
Structure: No 29 Sub-structure: Far Elevation (8)											
Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category
[m] 0.0		[m]	[m]		[%]	[%]	[%]			[m]	
	1	0.0	16.907	Sagging	671.98E-6	0.0	965.56E-6	0.0	32.242E-6	152640.	0 (Negligible)
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.											
Structure: No 29 Sub-structure: Frontage (9)											
Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category
[m] 0.0		[m]	[m]		[%]	[%]	[%]			[m]	
	1	0.0	0.15788	None	0.0	0.030229	0.030229	-302.20E-6	-95.857E-6	115960.	0 (Negligible)



31 Willoughby Road

Combined Movements & Damage Assessment

Single Stage - Short-term (no heave) - 5 mm limit on overall horizontal movements

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Vertical Offset from Line for Vertical Movement	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category
	2	0.15788	5.7411	Hogging	0.012452	0.030229	0.034746	-302.20E-6	-695.80E-6	3188.4	0 (Negligible)
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.											

Structure: Willoughby Road | Sub-structure: Roadway (10)

Vertical Offset from Line for Vertical Movement	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category
Calculations		[m]	[m]		[%]	[%]	[%]			[m]	
0.0	1	0.0	3.7247	Hogging	254.34E-6	-0.016029	0.0032060	280.02E-6	-51.969E-6	162190.	0 (Negligible)
	2	3.7247	10.299	Sagging	0.0018444	-0.021668	0.0043336	541.68E-6	54.682E-6	62803.	0 (Negligible)
	3	14.023	3.9765	Hogging	264.46E-6	-0.017067	0.0034135	284.69E-6	51.455E-6	160340.	0 (Negligible)
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.											

Structure: Willow Cottages | Sub-structure: Retaining Wall (11)

Vertical Offset from Line for Vertical Movement	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category
Calculations		[m]	[m]		[%]	[%]	[%]			[m]	
0.0	1	0.0	17.243	Hogging	0.0021234	0.0055939	0.0083759	-60.496E-6	-213.44E-6	48823.	0 (Negligible)
	2	17.243	8.1410	Sagging	0.0095845	-0.049123	0.0099370	0.0014319	331.62E-6	10164.	0 (Negligible)
	3	25.384	7.0379	Hogging	0.0036188	-0.0025985	0.0025981	0.0014319	331.62E-6	23854.	0 (Negligible)
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.											

Structure: Willow Cottages | Sub-structure: Rear Elevation

Vertical Offset from Line for Vertical Movement	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category
Calculations		[m]	[m]		[%]	[%]	[%]			[m]	
0.0	1	2.0264	14.345	Hogging	516.82E-6	0.0060113	0.0066023	-60.496E-6	-60.450E-6	306570.	0 (Negligible)
	2	16.371	11.406	Sagging	0.0026096	-0.025557	0.0052071	976.71E-6	87.672E-6	46324.	0 (Negligible)
	3	27.777	4.6445	Hogging	501.09E-6	-0.014635	0.0029407	528.92E-6	87.672E-6	102230.	0 (Negligible)
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.											

Specific Building Damage Results - Critical Values for All Segments within Each Sub-Structure

Structure: No 33 | Sub-structure: Party Wall (1)

Vertical Offset from Line for Vertical Movement	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category
Calculations	[%]	[%]		[mm]	[%]			[m]	[m]	
0.0	0.011831	0.0	-544.34E-6	4.6014	0.010690	0.0	-544.34E-6	6088.3	3190.4	0 (Negligible)

Structure: No 33 | Sub-structure: Rear Elevation (2)

Vertical Offset from Line for Vertical Movement	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category
Calculations	[%]	[%]		[mm]	[%]			[m]	[m]	
0.0	0.0	0.030250	0.0010898	4.4599	0.030250	-302.41E-6	0.0010898	[m]	-	0 (Negligible)

Structure: No 33 | Sub-structure: Far Elevation (3)

Vertical Offset from Line for Vertical Movement	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category
Calculations	[%]	[%]		[mm]	[%]			[m]	[m]	
0.0	0.0013417	0.0060500	150.09E-6	1.2795	0.0071068	-60.496E-6	150.09E-6	44459.	[m]	- 0 (Negligible)

Structure: No 33 | Sub-structure: Far Eleavtion (4)

Vertical Offset from Line for Vertical Movement	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category
Calculations	[%]	[%]		[mm]	[%]			[m]	[m]	
0.0	0.0	0.0	29.739E-6	0.38090	0.0	0.0	29.739E-6	[m]	-	0 (Negligible)

Structure: No 33 | Sub-structure: Frontage (5)

Vertical Offset from Line for Vertical Movement	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category
Calculations	[%]	[%]		[mm]	[%]			[m]	[m]	
0.0	0.011792	0.030250	-648.05E-6	2.3756	0.037482	-302.41E-6	-648.05E-6	3913.7	[m]	- 0 (Negligible)

Structure: No 29 | Sub-structure: Party Wall (6)

Vertical Offset from Line for Vertical Movement	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category

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Movement Calculations	Curve									
[m] 0.0	[%] 0.0071961	[%] -289.38E-6	[%] -326.17E-6	[mm] 4.5240	[%] 0.0067025	7.6674E-6	-326.17E-6	[m] 8364.9	[m] 5389.6	0 (Negligible)

Structure: No 29 | Sub-structure: Rear Elevation (7)

Vertical Offset from Line for Vertical Movement Calculations	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category
[m] 0.0	[%] 0.027357	[%] 0.030229	0.0014651	[mm] 4.3718	[%] 0.044596	-302.20E-6	0.0014651	[m] 1436.9	[m] -	0 (Negligible)

Structure: No 29 | Sub-structure: Far Elevation (8)

Vertical Offset from Line for Vertical Movement Calculations	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category
[m] 0.0	[%] 671.98E-6	[%] 0.0	32.242E-6	[mm] 0.58075	[%] 965.56E-6	0.0	32.242E-6	[m] -	[m] 152640.0	0 (Negligible)

Structure: No 29 | Sub-structure: Frontage (9)

Vertical Offset from Line for Vertical Movement Calculations	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category
[m] 0.0	[%] 0.012452	[%] 0.030229	-695.80E-6	[mm] 2.2973	[%] 0.034746	-302.20E-6	-695.80E-6	[m] 3188.4	[m] -	0 (Negligible)

Structure: Willoughby Road | Sub-structure: Roadway (10)

Vertical Offset from Line for Vertical Movement Calculations	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category
[m] 0.0	[%] 0.0018444	[%] -0.021668	54.682E-6	[mm] 0.59746	[%] 0.0043336	541.68E-6	54.682E-6	[m] 160340.0	[m] 62803.0	0 (Negligible)

Structure: Willow Cottages | Sub-structure: Retaining Wall (11)

Vertical Offset from Line for Vertical Movement Calculations	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category
[m] 0.0	[%] 0.0095845	[%] -0.049123	331.62E-6	[mm] 2.3458	[%] 0.0099370	0.0014319	331.62E-6	[m] 23854.0	[m] 10164.0	0 (Negligible)

Structure: Willow Cottages | Sub-structure: Rear Elevation

Vertical Offset from Line for Vertical Movement Calculations	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category
[m] 0.0	[%] 0.0026096	[%] -0.025557	87.672E-6	[mm] 0.94493	[%] 0.0066023	976.71E-6	87.672E-6	[m] 102230.0	[m] 46324.0	0 (Negligible)

Specific Building Damage Results - Critical Segments within Each Structure

Structure Name	Parameter	Critical Sub-Structure	Critical Segment	Start	End	Curvature	Max Slope	Max Settlement	Max Tensile Strain	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category
No 33	Max Slope	Rear Elevation (2)	1	[m] 0.0	[m] 2.9000	Sagging	0.0010898	[mm] 4.4599	[%] 0.030250	-	-	0 (Negligible)
	Max Settlement	Party Wall (1)	2	5.1607	9.8990	Hogging	332.91E-6	4.6014	0.0064496	6088.3	-	0 (Negligible)
	Max Tensile Strain	Frontage (5)	2	0.23802	6.9000	Hogging	648.05E-6	2.3756	0.037482	3913.7	-	0 (Negligible)
	Min Radius of Curvature (Hogging)	Frontage (5)	2	0.23802	6.9000	Hogging	648.05E-6	2.3756	0.037482	3913.7	-	0 (Negligible)
	Min Radius of Curvature (Sagging)	Party Wall (1)	1	0.0	5.1607	Sagging	544.34E-6	3.7785	0.010690	-	3190.4	0 (Negligible)
No 29	Max Slope	Rear Elevation (7)	1	0.0	5.6502	Hogging	0.0014651	4.3718	0.044596	1436.9	-	0 (Negligible)
	Max Settlement	Party Wall (6)	4	11.183	16.907	Hogging	264.48E-6	4.5240	0.0043285	8364.9	-	0 (Negligible)
	Max Tensile Strain	Rear Elevation (7)	1	0.0	5.6502	Hogging	0.0014651	4.3718	0.044596	1436.9	-	0 (Negligible)
	Min Radius of Curvature (Hogging)	Rear Elevation (7)	1	0.0	5.6502	Hogging	0.0014651	4.3718	0.044596	1436.9	-	0 (Negligible)
	Min Radius of Curvature (Sagging)	Party Wall (6)	1	0.0	5.5958	Sagging	326.17E-6	3.2276	0.0067025	-	5389.6	0 (Negligible)
Willoughby Road	Max Slope	Roadway (10)	2	3.7247	14.023	Sagging	54.682E-6	0.59746	0.0043336	-	62803.0	0 (Negligible)
	Max Settlement	Roadway (10)	2	3.7247	14.023	Sagging	54.682E-6	0.59746	0.0043336	-	62803.0	0 (Negligible)
	Max Tensile Strain	Roadway (10)	2	3.7247	14.023	Sagging	54.682E-6	0.59746	0.0043336	-	62803.0	0 (Negligible)
	Min Radius of Curvature (Hogging)	Roadway (10)	3	14.023	18.000	Hogging	51.455E-6	0.40899	0.0034135	160340.0	-	0 (Negligible)
	Min Radius of Curvature (Sagging)	Roadway (10)	2	3.7247	14.023	Sagging	54.682E-6	0.59746	0.0043336	-	62803.0	0 (Negligible)
Willow Cottages	Max Slope	Retaining Wall (11)	2	17.243	25.384	Sagging	331.62E-6	2.3458	0.0099370	-	10164.0	0 (Negligible)
	Max Settlement	Retaining Wall (11)	2	17.243	25.384	Sagging	331.62E-6	2.3458	0.0099370	-	10164.0	0 (Negligible)
	Max Tensile Strain	Retaining Wall (11)	2	17.243	25.384	Sagging	331.62E-6	2.3458	0.0099370	-	10164.0	0 (Negligible)
	Min Radius of Curvature	Retaining Wall (11)	3	25.384	32.422	Hogging	331.62E-6	1.4470	0.0025981	23854.0	-	0 (Negligible)

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Structure Name	Parameter	Critical Sub-Structure	Critical Segment	Start	End	Curvature	Max Slope	Max Settlement	Max Tensile Strain	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category
	(Hogging)											
	Min Radius of Curvature (Sagging)	Retaining Wall (11)	2	17.243	25.384	Sagging	331.62E-6	2.3458	0.0099370	-	10164.0	0 (Negligible)
Willow Cottages	Max Slope	Rear Elevation	2	16.371	27.777	Sagging	87.672E-6	0.94493	0.0052071	-	46324.0	0 (Negligible)
	Max Settlement	Rear Elevation	2	16.371	27.777	Sagging	87.672E-6	0.94493	0.0052071	-	46324.0	0 (Negligible)
	Max Tensile Strain	Rear Elevation	1	2.0264	16.371	Hogging	60.450E-6	0.68634	0.0066023	306570.	-	0 (Negligible)
	Min Radius of Curvature (Hogging)	Rear Elevation	3	27.777	32.422	Hogging	87.672E-6	0.61065	0.0029407	102230.	-	0 (Negligible)
	Min Radius of Curvature (Sagging)	Rear Elevation	2	16.371	27.777	Sagging	87.672E-6	0.94493	0.0052071	-	46324.0	0 (Negligible)

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Analysis Options

Analysis: Boussinesq
Global Poisson's ratio: 0.50
Maximum allowable ratio between values of E: 1.5
Horizontal rigid boundary level: 35.00 [m OD]
Displacements at load centroids: Yes

Soil ProfilesSoil Profile 1

Layer	Level at top	Number of intermediate displacement levels	Youngs Modulus		Poissons ratio	Non-linear curve
	[mOD]		Top [kN/m ²]	Btm [kN/m ²]		
1	85.500	3	7500.0	7500.0	0.50000	None
2	82.500	1	15000.	15000.	0.50000	None
3	82.000	40	20000.	100000.	0.50000	None

Soil Zones

Zone	Name	X coordinates min max	Y coordinates min max	Profile
1	Soil Zone 1	-20.00000 40.00000	-20.00000 26.00000	Soil Profile 1

Load Data

Load ref.	Name	Shape	Orientation of Plane	Centre of load (Global)			Load position Angle of local x from	Width x or Radius	Length y	Polygon Coordinates	Rectangle of tolerance	Number of rectangles	Normal (local z)	Load value		
				X	Y	Z (level)								(local x)	(local y)	
1	Basement Excavation - Main House	Polygonal	Horizontal	[m] N/A	[m] N/A	[m] 81.40000	[Degrees] N/A	[m] N/A	[m] N/A	[m] (3,1) (18,1) (20,2.3) (20,5.5) (12,5.25) (12,4) (3,4)	{8} 10.000	3	[kN/m²] -70.000	[kN/m²] N/A	[kN/m²] N/A	
2	Basement Excavation - Existing Cellar	Polygonal	Horizontal	N/A	N/A	81.40000	N/A	N/A	N/A	(3,4) (12,4) (12,5.25) (3,5)	10.000	1	-40.000	N/A	N/A	
3	Underpinning	Polygonal	Horizontal	N/A	N/A	81.40000	N/A	N/A	N/A	(2,6) (2,0) (12,0) (12,1) (3,1) (3,6)	10.000	2	60.000	N/A	N/A	
4	Underpinning	Polygonal	Horizontal	N/A	N/A	81.40000	N/A	N/A	N/A	(12,0) (18,0) (21,2) (21,6.5) (19,6.5) (19,5.5) (20,5.5) (20,2.3) (18,1) (12,1)	10.000	10	100.00	N/A	N/A	
5	Underpinning	Polygonal	Horizontal	N/A	N/A	81.40000	N/A	N/A	N/A	(19,6.5) (12,6.25) (12,5.25) (19,5.5)	10.000	1	60.000	N/A	N/A	
6	Underpinning	Polygonal	Horizontal	N/A	N/A	81.40000	N/A	N/A	N/A	(3,6) (12,6.25) (12,5.25) (3,5)	10.000	1	50.000	N/A	N/A	

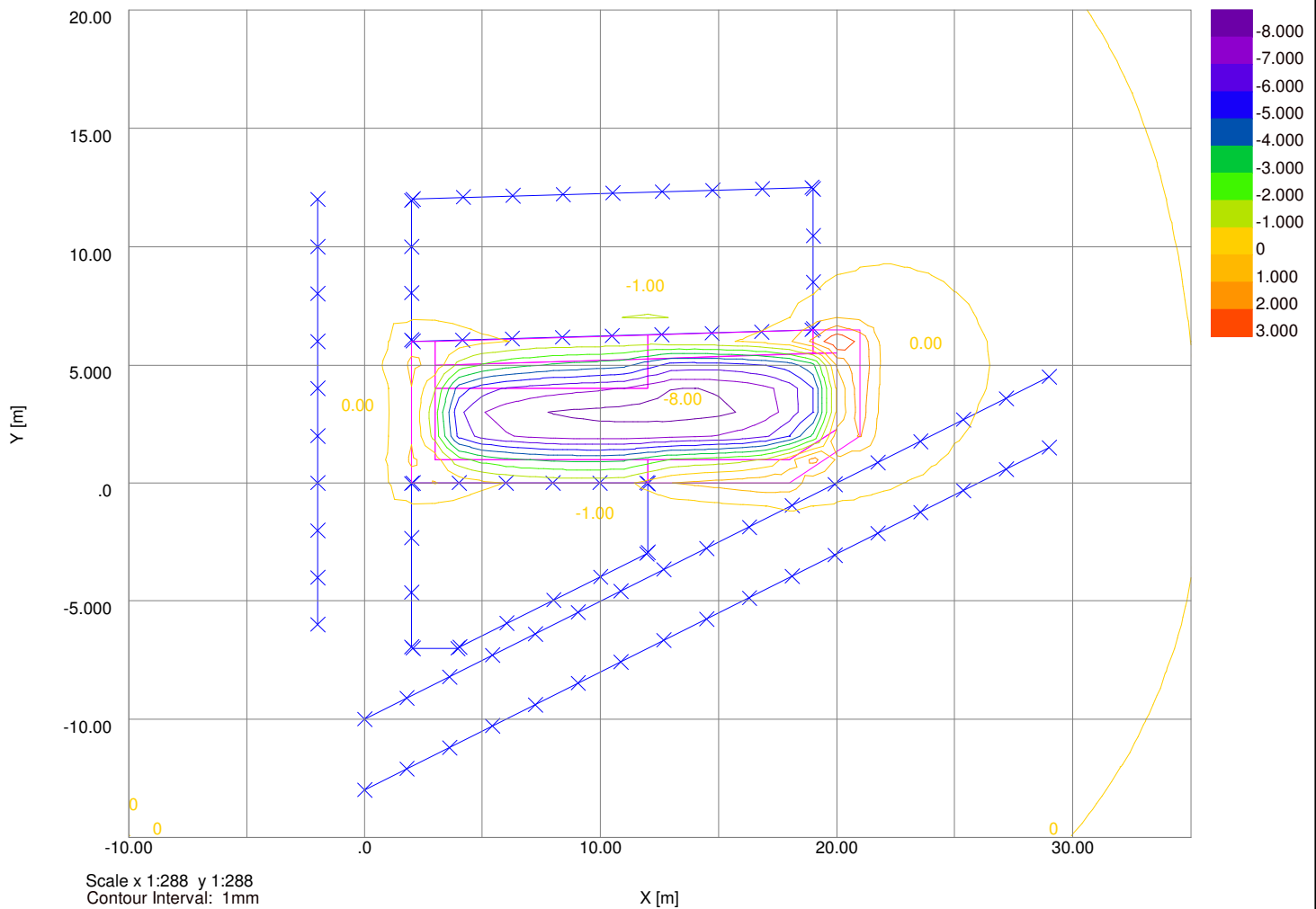
Polygonal Loads' Rectangles

No.	Centre of load X Y	Angle of local x from global X [Degrees]	Width x [m]	Depth y [m]
Load 1 : Basement Excavation - Main House				
(Edge 1 optimal)				
1	7.50000 2.50000	0.0	9.0000	3.0000
2	15.00000 3.17188	0.0	6.0000	4.3438
3	19.00000 3.55938	0.0	2.0000	3.8187
Load 2 : Basement Excavation - Existing Cellar				
(Edge 1 optimal)				
1	7.50000 4.56250	0.0	9.0000	1.1250
Load 3 : Underpinning				
(Edge 1 optimal)				
1	2.50000 3.50000	-90.000	5.0000	1.0000
2	7.00000 0.50000	-90.000	1.0000	10.000
Load 4 : Underpinning				
(Edge 1 optimal)				
1	15.00000 0.50000	0.0	6.0000	1.0000
2	18.14286 0.59405	0.0	0.28571	0.99762
3	18.42857 0.78214	0.0	0.28571	0.99286
4	18.71429 0.97024	0.0	0.28571	0.98810
5	19.00000 1.15833	0.0	0.28571	0.98333
6	19.28571 1.34643	0.0	0.28571	0.97857
7	19.57143 1.53452	0.0	0.28571	0.97381
8	19.85714 1.72262	0.0	0.28571	0.96905
9	20.50000 4.08333	0.0	1.0000	4.8333
10	19.50000 6.00000	0.0	1.0000	1.0000
Load 5 : Underpinning				
(Edge 1 optimal)				
1	15.50000 5.87500	-177.95	6.9688	0.99936
Load 6 : Underpinning				
(Edge 2 optimal)				
1	7.50000 5.62500	1.5911	8.9757	0.99961

Displacement Data

Ref.	Type	Name	Direction of Extrusion	Line/Line for extrusion First point X Y Z (level)	Second point X Y Z (level)	No. of intrvls across extrusion/line	Extrusion Depth	No. of intrvls along extrusion	Show Calculate Detailed results
1	Grid	Grid 1	Global X	-20.00000 -20.00000 85.50000	N/A 26.00000 85.50000	46	60.00000	60	Yes No
2	Grid	Grid 2	Global X	-20.00000 -20.00000 84.00000	N/A 26.00000 84.00000	46	60.00000	60	Yes No
3	Line	Line 1	N/A	2.05000 0.00000 84.00000	11.95000 0.00000 84.00000	5	N/A	N/A	Yes No
4	Line	Line 2	N/A	12.00000 -0.05000 84.00000	12.00000 -2.95000 84.00000	1	N/A	N/A	Yes No
5	Line	Line 3	N/A	11.95000 -3.00000 84.00000	4.05000 -6.95000 84.00000	4	N/A	N/A	Yes No
6	Line	Line 4	N/A	3.95000 -7.00000 84.00000	2.05000 -7.00000 84.00000	1	N/A	N/A	Yes No
7	Line	Line 5	N/A	2.00000 -6.95000 84.00000	2.00000 -0.05000 84.00000	3	N/A	N/A	Yes No
8	Line	Line 6	N/A	2.05000 6.00000 84.00000	18.95000 6.50000 84.00000	8	N/A	N/A	Yes No
9	Line	Line 7	N/A	19.00000 6.55000 84.00000	19.00000 12.45000 84.00000	3	N/A	N/A	Yes No
10	Line	Line 8	N/A	18.95000 12.50000 84.00000	2.05000 12.00000 84.00000	8	N/A	N/A	Yes No
11	Line	Line 9	N/A	2.00000 11.95000 84.00000	2.00000 6.05000 84.00000	3	N/A	N/A	Yes No
12	Line	Line 10	N/A	-2.00000 -6.00000 85.00000	-2.00000 12.00000 85.00000	9	N/A	N/A	Yes No
13	Line	Line 11	N/A	0.00000 -10.00000 83.00000	29.00000 4.50000 83.00000	16	N/A	N/A	Yes No
14	Line	Line 12	N/A	0.00000 -13.00000 83.00000	29.00000 1.50000 83.00000	16	N/A	N/A	Yes No

Settlement Contours : Grid 1 at 85.5000m



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Problem Type

Problem Type : Tunnelling and Embedded Wall Excavations

Displacement Data

Type	Name	Direction of extrusion	Point/Line/Line for extrusion		No. of intervals across extrusion/line	Extrusion depth	No. of intervals along extrusion	Calculate	Surface type for tunnels
			First point	Second point					
			X [m]	Y [m]	Z (level) [m]	X [m]	Y [m]	Z (level) [m]	
Grid	Grid 1	Global X	-20.00000	-20.00000	85.50000	-	26.00000	85.50000	46 60.00000 60 Yes Surface
Grid	Grid 2	Global X	-20.00000	-20.00000	84.00000	-	26.00000	84.00000	46 60.00000 60 Yes Surface
Line	Line 1	-	2.05000	0.00000	84.00000	11.95000	0.00000	84.00000	5 - - Yes Surface
Line	Line 2	-	12.00000	-0.05000	84.00000	12.00000	-2.95000	84.00000	1 - - Yes Surface
Line	Line 3	-	11.95000	-3.00000	84.00000	4.05000	-6.95000	84.00000	4 - - Yes Surface
Line	Line 4	-	3.95000	-7.00000	84.00000	2.05000	-7.00000	84.00000	1 - - Yes Surface
Line	Line 5	-	2.00000	-6.95000	84.00000	2.00000	-0.05000	84.00000	3 - - Yes Surface
Line	Line 6	-	2.05000	6.00000	84.00000	18.95000	6.50000	84.00000	8 - - Yes Surface
Line	Line 7	-	19.00000	6.55000	84.00000	19.00000	12.45000	84.00000	3 - - Yes Surface
Line	Line 8	-	18.95000	12.50000	84.00000	2.05000	12.00000	84.00000	8 - - Yes Surface
Line	Line 9	-	2.00000	11.95000	84.00000	2.00000	6.05000	84.00000	3 - - Yes Surface
Line	Line 10	-	-2.00000	-6.00000	85.00000	-2.00000	12.00000	85.00000	9 - - Yes Surface
Line	Line 11	-	0.00000	-10.00000	83.00000	29.00000	4.50000	83.00000	16 - - Yes Surface
Line	Line 12	-	0.00000	-13.00000	83.00000	29.00000	1.50000	83.00000	16 - - Yes Surface

Vertical Ground Movement Curves (Excavations)

Curve Name: No vertical ground movement
Coordinates: [Distance from wall / wall depth or max. excavation depth (x), Depth / wall depth or max. excavation depth (y), Settlement / wall depth or max. excavation depth (z) (%)]
 [0.000,0.000,0.000] [1.000,0.000,0.000] [0.000,1.000,0.000] [1.000,1.000,0.000]
Curve Fitting Method: Polynomial
x Order: 1
y Order: 0
Polynomial: z = 0.0x + 0.0
Coeff. of Determination: -2147483648.E+2147483647

Horizontal Ground Movement Curves (Excavations)

Curve Name: GEA Curve for 5 mm of horizontal deflection (after CIRIA 580 Fig. 2.11(a))
Coordinates: [Distance from wall / wall depth or max. excavation depth (x), Depth / wall depth or max. excavation depth (y), Horizontal movement / wall depth or max. excavation depth (z) (%)]
 [0.000,0.000,0.121] [4.000,0.000,0.000]
Curve Fitting Method: Polynomial
x Order: 1
y Order: 0
Polynomial: z = -3.03E-2x + 1.21E-1
Coeff. of Determination: 1.00

Polygonal Excavations

Excavation Name: New Excavation
Surface level [m]: 85.500
Contribution: Positive
Enabled: Yes
Surface movement curves which are selected are applied between surface and [m]: 81.400

Corner	x	y	Base Level	Stiffened	Previous Side	Next Side
	[m]	[m]	[m]	d	p1 p2*	d p1 p2*
				[m]	[%] [%]	[m] [%] [%]
1	2.0000	0.0	81.400	No	- -	- -
2	18.000	0.0	81.400	No	- -	- -
3	21.000	2.0000	81.400	No	- -	- -
4	21.000	6.5000	81.400	No	- -	- -
5	2.0000	6.0000	81.400	No	- -	- -

Side	Corner 1	Corner 2	Ground Movement Curve	
	x y	x y	Vertical	Horizontal
	[m] [m]	[m] [m]		
1	2.0000 0.0	18.000 0.0	No vertical ground movement	GEA Curve for 5 mm of horizontal deflection (after CIRIA 580 Fig. 2.11(a))
2	18.000 0.0	21.000 2.0000	No vertical ground movement	GEA Curve for 5 mm of horizontal deflection (after CIRIA 580 Fig. 2.11(a))
3	21.000 2.0000	21.000 6.5000	No vertical ground movement	GEA Curve for 5 mm of horizontal deflection (after CIRIA 580 Fig. 2.11(a))
4	21.000 6.5000	2.0000 6.0000	No vertical ground movement	GEA Curve for 5 mm of horizontal deflection (after CIRIA 580 Fig. 2.11(a))
5	2.0000 6.0000	2.0000 0.0	No vertical ground movement	GEA Curve for 5 mm of horizontal deflection (after CIRIA 580 Fig. 2.11(a))

Damage Category Strains

Name	0 (Negligible) to 1 (Very Slight)	1 (Very Slight) to 2 (Slight)	2 (Slight) to 3 (Moderate)	3 (Moderate) to 4 (Severe)
Burland Strain Limits	0.0	500.00E-6	750.00E-6	0.0015000

Specific Structures - Geometry

Structure Name	Sub-Structure Name	Displacement Line	Start Distance Along Line	End Distance Along Line	Vertical Offsets from Line for Vertical Movement Calculations	Vertical Displacement Limit	Damage Category Strains	Poisson's Ratio	E/G
			[m]	[m]	[m]	[mm]			
No 33	Party Wall (1)	Line 1	0.00000	9.89900	0.0	0.10000	Burland Strain Limits	0.20000	2.6000
No 33	Rear Elevation (2)	Line 2	0.00000	2.90000	0.0	0.10000	Burland Strain Limits	0.20000	2.6000
No 33	Far Elevation (3)	Line 3	0.00000	8.83200	0.0	0.10000	Burland Strain Limits	0.20000	2.6000
No 33	Far Elevation (4)	Line 4	0.00000	1.90000	0.0	0.10000	Burland Strain Limits	0.20000	2.6000



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Single Stage - Short-term (with heave) - 5 mm limit on overall horizontal movement

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Structure Name	Sub-Structure Name	Displacement Line	Start Distance Along Line	End Distance Along Line	Vertical Offsets from Line for Vertical	Vertical Displacement Limit	Damage Category	Strains	Poisson's Ratio	E/G
No 33	Frontage (5)	Line 5	0.00000	6.90000	0.0	0.10000	Burland Strain Limits	0.20000	2.6000	
No 29	Party Wall (6)	Line 6	0.00000	16.90700	0.0	0.10000	Burland Strain Limits	0.20000	2.6000	
No 29	Rear Elevation (7)	Line 7	0.00000	5.89900	0.0	0.10000	Burland Strain Limits	0.20000	2.6000	
No 29	Far Elevation (8)	Line 8	0.00000	16.90700	0.0	0.10000	Burland Strain Limits	0.20000	2.6000	
No 29	Frontage (9)	Line 9	0.00000	5.89900	0.0	0.10000	Burland Strain Limits	0.20000	2.6000	
Willoughby Road	Roadway (10)	Line 10	0.00000	18.00000	0.0	0.10000	Burland Strain Limits	0.20000	2.6000	
Willow Cottages	Retaining Wall (11)	Line 11	0.00000	32.42200	0.0	0.10000	Burland Strain Limits	0.20000	2.6000	
Willow Cottages	Rear Elevation	Line 12	0.00000	32.42200	0.0	0.10000	Burland Strain Limits	0.20000	2.6000	

Specific Structures - Bending Parameters

Structure Name	Sub-Structure Name	Height	Default Properties	Hogging			Sagging		
				2nd Moment of Area (per unit width)	Distance of Bending Strain from N.A.	Distance of N.A. from Edge of Beam in Tension	2nd Moment of Area (per unit width)	Distance of Bending Strain from N.A.	Distance of N.A. from Edge of Beam in Tension
No 33	Party Wall (1)	[m]	8.0000 Yes	[m ⁴]	[m]	[m]	[m ⁴]	[m]	[m]
No 33	Rear Elevation (2)	8.0000	Yes	170.67	8.0000	8.0000	42.667	4.0000	4.0000
No 33	Far Elevation (3)	8.0000	Yes	170.67	8.0000	8.0000	42.667	4.0000	4.0000
No 33	Far Elevation (4)	8.0000	Yes	170.67	8.0000	8.0000	42.667	4.0000	4.0000
No 33	Frontage (5)	8.0000	Yes	170.67	8.0000	8.0000	42.667	4.0000	4.0000
No 29	Party Wall (6)	12.000	Yes	576.00	12.000	12.000	144.00	6.0000	6.0000
No 29	Rear Elevation (7)	12.000	Yes	576.00	12.000	12.000	144.00	6.0000	6.0000
No 29	Far Elevation (8)	12.000	Yes	576.00	12.000	12.000	144.00	6.0000	6.0000
No 29	Frontage (9)	12.000	Yes	576.00	12.000	12.000	144.00	6.0000	6.0000
Willoughby Road	Roadway (10)	0.50000	Yes	0.041667	0.50000	0.50000	0.010417	0.25000	0.25000
Willow Cottages	Retaining Wall (11)	2.5000	Yes	5.2083	2.5000	2.5000	1.3021	1.2500	1.2500
Willow Cottages	Rear Elevation	8.0000	Yes	170.67	8.0000	8.0000	42.667	4.0000	4.0000

Building Segment Combinations

Structure Name	Sub-Structure Name	Vertical Offset from Line for Vertical Movement Calculations	Segment Start	Length	Curvature	Combined Segment
No structures have segments combined.						

Utility Strain Calculation Options

Neglect beneficial contribution of axial strains : No

Warnings

- 1 Sub-structure 6 crosses at least one excavation. Its building damage results in that area should be treated with caution.

Errors

None

Specific Building Damage Results - Horizontal Displacements

Structure: No 33 | Sub-structure: Party Wall (1)

Dist.	Coordinates			Displacements		
	x	y	z	x	y	
				Horizontal displacement along the Line	Horizontal displacement perpendicular to Line	
	[m]	[m]	[m]	[mm]	[mm]	
	0.0	2.05000	0.00000	84.00000	0.0	4.9610 d
1.9800	4.03000	0.00000	84.00000	0.0	4.9610	d
3.9600	6.01000	0.00000	84.00000	0.0	4.9610	d
5.9400	7.99000	0.00000	84.00000	0.0	4.9610	d
7.9200	9.97000	0.00000	84.00000	0.0	4.9610	d
9.9000	11.95000	0.00000	84.00000	0.0	4.9610	d

d - Displacements include imported displacements.

Structure: No 33 | Sub-structure: Rear Elevation (2)

Dist.	Coordinates			Displacements		
	x	y	z	x	y	
				Horizontal displacement along the Line	Horizontal displacement perpendicular to Line	
	[m]	[m]	[m]	[mm]	[mm]	
	0.0	12.00000	-0.05000	84.00000	0.0	4.9459
2.9000	12.00000	-2.95000	84.00000	0.0	4.0686	0.0 d

d - Displacements include imported displacements.

Structure: No 33 | Sub-structure: Far Elevation (3)

Dist.	Coordinates			Displacements		
	x	y	z	x	y	
				Horizontal displacement along the Line	Horizontal displacement perpendicular to Line	
	[m]	[m]	[m]	[mm]	[mm]	
	0.0	11.95000	-3.00000	84.00000	0.0	4.0535
2.2081	9.97500	-3.98750	84.00000	0.0	3.7548	-1.8128
4.4162	8.00000	-4.97500	84.00000	0.0	3.4561	-1.6792
6.6244	6.02500	-5.96250	84.00000	0.0	3.1573	-1.5456
8.8325	4.05000	-6.95000	84.00000	0.0	2.8586	-1.4120
						-1.2784

d - Displacements include imported displacements.

Structure: No 33 | Sub-structure: Far Elevation (4)

Dist.	Coordinates			Displacements		
	x	y	z	x	y	
				Horizontal displacement	Horizontal displacement	



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along the Line		perpendicular to Line	
[m]	[mm]	[m]	[mm]
0.0	3.95000	-7.00000	84.00000
1.9000	2.05000	-7.00000	84.00000

d - Displacements include imported displacements.

Structure: No 33 | Sub-structure: Frontage (5)

Dist.	Coordinates			Displacements		
x	y	z	x	y	Horizontal displacement along the Line	Horizontal displacement perpendicular to Line
[m]	[m]	[m]	[mm]	[mm]	[mm]	[mm]
0.0	2.00000	-6.95000	84.00000	0.0	2.8586	2.8586
2.3000	2.00000	-6.95000	84.00000	0.0	3.5544	3.5544
4.6000	2.00000	-2.35000	84.00000	0.0	4.2501	4.2501
6.9000	2.00000	-0.05000	84.00000	0.0	4.9459	4.9459

d - Displacements include imported displacements.

Structure: No 29 | Sub-structure: Party Wall (6)

Dist.	Coordinates			Displacements		
x	y	z	x	y	Horizontal displacement along the Line	Horizontal displacement perpendicular to Line
[m]	[m]	[m]	[mm]	[mm]	[mm]	[mm]
0.0	2.05000	6.00000	84.00000	0.0	0.0	0.0
2.1134	4.16250	6.06250	84.00000	0.13041	-4.9576	-0.016204
4.2268	6.27500	6.12500	84.00000	0.13041	-4.9555	-0.016197
6.3403	8.38750	6.18750	84.00000	0.13035	-4.9534	-0.016191
8.4537	10.50000	6.25000	84.00000	0.13030	-4.9513	-0.016184
10.567	12.61250	6.31250	84.00000	0.13024	-4.9492	-0.016177
12.681	14.72500	6.37500	84.00000	0.13019	-4.9472	-0.016170
14.794	16.83750	6.43750	84.00000	0.13013	-4.9451	-0.016163
16.907	18.95000	6.50000	84.00000	0.13008	-4.9430	-0.016157

d - Displacements include imported displacements.

Structure: No 29 | Sub-structure: Rear Elevation (7)

Dist.	Coordinates			Displacements		
x	y	z	x	y	Horizontal displacement along the Line	Horizontal displacement perpendicular to Line
[m]	[m]	[m]	[mm]	[mm]	[mm]	[mm]
0.0	19.00000	6.55000	84.00000	0.12969	-4.9283	-0.012969
1.9667	19.00000	8.51667	84.00000	0.11405	-4.3338	-0.011405
3.9333	19.00000	10.48333	84.00000	0.098401	-3.7392	-0.0098401
5.9000	19.00000	12.45000	84.00000	0.082756	-3.1447	-0.0082756

d - Displacements include imported displacements.

Structure: No 29 | Sub-structure: Far Elevation (8)

Dist.	Coordinates			Displacements		
x	y	z	x	y	Horizontal displacement along the Line	Horizontal displacement perpendicular to Line
[m]	[m]	[m]	[mm]	[mm]	[mm]	[mm]
0.0	18.95000	12.00000	84.00000	0.082248	-3.1292	0.010228
2.1134	16.83750	12.43750	84.00000	0.082403	-3.1313	0.010235
4.2268	14.72500	12.37500	84.00000	0.082458	-3.1334	0.010242
6.3403	12.61250	12.31250	84.00000	0.082513	-3.1355	0.010249
8.4537	10.50000	12.25000	84.00000	0.082568	-3.1376	0.010255
10.567	8.38750	12.18750	84.00000	0.082623	-3.1397	0.010262
12.681	6.27500	12.12500	84.00000	0.082678	-3.1418	0.010269
14.794	4.16250	12.06250	84.00000	0.082733	-3.1438	0.010276
16.907	2.05000	12.00000	84.00000	0.082788	-3.1459	0.010283

d - Displacements include imported displacements.

Structure: No 29 | Sub-structure: Frontage (9)

Dist.	Coordinates			Displacements		
x	y	z	x	y	Horizontal displacement along the Line	Horizontal displacement perpendicular to Line
[m]	[m]	[m]	[mm]	[mm]	[mm]	[mm]
0.0	2.00000	11.95000	84.00000	0.083175	-3.1607	3.1607
1.9667	2.00000	9.98333	84.00000	0.098820	-3.7552	3.7552
3.9333	2.00000	8.01667	84.00000	0.11446	-4.3497	4.3497
5.9000	2.00000	6.05000	84.00000	0.13011	-4.9442	4.9442

d - Displacements include imported displacements.

Structure: Willoughby Road | Sub-structure: Roadway (10)

Dist.	Coordinates			Displacements		
x	y	z	x	y	Horizontal displacement along the Line	Horizontal displacement perpendicular to Line
[m]	[m]	[m]	[mm]	[mm]	[mm]	[mm]
0.0	-2.00000	-6.00000	85.00000	1.0405	1.7391	1.7391
2.0000	-2.00000	-4.00000	85.00000	1.6249	1.6249	1.6249
4.0000	-2.00000	-2.00000	85.00000	2.5432	1.0650	1.0650
6.0000	-2.00000	0.00000	85.00000	3.7510	0.0	0.0
8.0000	-2.00000	2.00000	85.00000	3.7510	0.0	0.0
10.000	-2.00000	4.00000	85.00000	3.7510	0.0	0.0
12.000	-2.00000	6.00000	85.00000	3.7510	0.0	0.0
14.000	-2.00000	8.00000	85.00000	2.5535	-1.0828	-1.0828
16.000	-2.00000	10.00000	85.00000	1.6407	-1.6520	-1.6520
18.000	-2.00000	12.00000	85.00000	1.0574	-1.7681	-1.7681

d - Displacements include imported displacements.

Structure: Willow Cottages | Sub-structure: Retaining Wall (11)

Dist.	Coordinates			Displacements		
x	y	z	x	y	Horizontal displacement along the Line	Horizontal displacement perpendicular to Line
[m]	[m]	[m]	[mm]	[mm]	[mm]	[mm]
0.0	0.00000	-10.00000	83.00000	0.23576	1.6403	0.94445
2.0264	1.81250	-9.09375	83.00000	0.028999	2.1806	1.0011
4.0529	3.62500	-8.18750	83.00000	0.0	2.4843	1.1110
6.0793	5.43750	-7.28125	83.00000	0.0	2.7584	1.2336
8.1057	7.25000	-6.37500	83.00000	0.0	3.0326	1.3562



31 Willoughby Road

Combined Movements & Damage Assessment

Single Stage - Short-term (with heave) - 5 mm limit on overall horizontal movement

Job No.	Sheet No.	Rev.
J15315		
Drg. Ref.		
Made by MP	Date 23-Jan-2018	Checked

Dist.	Coordinates			Displacements		
	x	y	z	x	y	Horizontal displacement along the line Horizontal displacement perpendicular
10.132	9.06250	-5.46875	83.00000	0.0	3.3067	1.4788 2.9576 d
12.159	10.87500	-4.56250	83.00000	0.0	3.5808	1.6014 3.2028 d
14.185	12.68750	-3.65625	83.00000	0.0	3.8550	1.7240 3.4480 d
16.211	14.50000	-2.75000	83.00000	0.0	4.1291	1.8466 3.6932 d
18.238	16.31250	-1.84375	83.00000	0.0	4.4033	1.9692 3.9384 d
20.264	18.12500	-0.93750	83.00000	-0.58457	4.4979	1.4887 4.2845 d
22.291	19.93750	-0.03125	83.00000	-2.5672	3.8508	-0.57404 4.5923 d
24.317	21.75000	0.87500	83.00000	-2.5250	3.7875	-0.56461 4.5168 d
26.344	23.56250	1.78125	83.00000	-4.0216	0.30159	-3.4622 2.0683 d
28.370	25.37500	2.68750	83.00000	-3.6376	0.0	-3.2535 1.6268 d
30.397	27.18750	3.59375	83.00000	-3.0893	0.0	-2.7631 1.3816 d
32.423	29.00000	4.50000	83.00000	-2.5410	0.0	-2.2727 1.1364 d
d - Displacements include imported displacements.						

Structure: Willow Cottages | Sub-structure: Rear Elevation

Dist.	Coordinates			Displacements		
	x	y	z	x	y	Horizontal displacement along the line Horizontal displacement perpendicular to Line
[m]	[m]	[m]	[m]	[mm]	[mm]	[mm]
0.0	0.00000	-13.00000	83.00000	0.095453	0.88678	0.48196 0.75047 d
2.0264	1.81250	-12.09375	83.00000	0.012852	1.2893	0.58811 1.1475 d
4.0529	3.62500	-11.18750	83.00000	0.0	1.5768	0.70516 1.4103 d
6.0793	5.43750	-10.28125	83.00000	0.0	1.8509	0.82776 1.6555 d
8.1057	7.25000	-9.37500	83.00000	0.0	2.1251	0.95036 1.9007 d
10.132	9.06250	-8.46875	83.00000	0.0	2.3992	1.0730 2.1459 d
12.159	10.87500	-7.56250	83.00000	0.0	2.6733	1.1956 2.3911 d
14.185	12.68750	-6.65625	83.00000	0.0	2.9475	1.3182 2.6363 d
16.211	14.50000	-5.75000	83.00000	0.0	3.2216	1.4408 2.8815 d
18.238	16.31250	-4.84375	83.00000	0.0	3.4958	1.5634 3.1267 d
20.264	18.12500	-3.93750	83.00000	-0.11285	3.7351	1.5695 3.3913 d
22.291	19.93750	-3.03125	83.00000	-2.0778	3.2436	-0.40784 3.8304 d
24.317	21.75000	-2.12500	83.00000	-2.1061	3.1592	-0.47095 3.7676 d
26.344	23.56250	-1.21875	83.00000	-2.2036	2.8268	-0.70675 3.5139 d
28.370	25.37500	-0.31250	83.00000	-2.7009	1.4260	-1.7780 2.4833 d
30.397	27.18750	0.59375	83.00000	-2.7336	0.57546	-2.1876 1.7372 d
32.423	29.00000	1.50000	83.00000	-2.4645	0.13403	-2.1444 1.2221 d
d - Displacements include imported displacements.						

Specific Building Damage Results - Vertical Displacements

Structure: No 33 | Sub-structure: Party Wall (1)

Dist.	Coordinates			Displacements
	x	y	z	
[m]	[m]	[m]	[m]	[mm]
Vertical Offset 1				
0.0	2.05000	0.00000	84.00000	0.70718 d
1.9800	4.03000	0.00000	84.00000	0.61224 d
3.9600	6.01000	0.00000	84.00000	-0.037798 d
5.9400	7.99000	0.00000	84.00000	-0.33424 d
7.9200	9.97000	0.00000	84.00000	-0.38307 d
9.9000	11.95000	0.00000	84.00000	0.29376 d
d - Displacements include imported displacements.				

Structure: No 33 | Sub-structure: Rear Elevation (2)

Dist.	Coordinates			Displacements
	x	y	z	
[m]	[m]	[m]	[m]	[mm]
Vertical Offset 1				
0.0	12.00000	-0.05000	84.00000	0.23522 d
2.9000	12.00000	-2.95000	84.00000	-0.54674 d
d - Displacements include imported displacements.				

Structure: No 33 | Sub-structure: Far Elevation (3)

Dist.	Coordinates			Displacements
	x	y	z	
[m]	[m]	[m]	[m]	[mm]
Vertical Offset 1				
0.0	11.95000	-3.00000	84.00000	-0.54397 d
2.2081	9.97500	-3.98750	84.00000	-0.48348 d
4.4162	8.00000	-4.97500	84.00000	-0.37526 d
6.6244	6.02500	-5.96250	84.00000	-0.26933 d
8.8325	4.05000	-6.95000	84.00000	-0.16582 d
d - Displacements include imported displacements.				

Structure: No 33 | Sub-structure: Far Eleavtion (4)

Dist.	Coordinates			Displacements
	x	y	z	
[m]	[m]	[m]	[m]	[mm]
Vertical Offset 1				
0.0	3.95000	-7.00000	84.00000	-0.18227 d
1.9000	2.05000	-7.00000	84.00000	-0.14517 d
d - Displacements include imported displacements.				

Structure: No 33 | Sub-structure: Frontage (5)

Dist.	Coordinates			Displacements
	x	y	z	
[m]	[m]	[m]	[m]	[mm]
Vertical Offset 1				
0.0	2.00000	-6.95000	84.00000	-0.14529 d
2.3000	2.00000	-4.65000	84.00000	-0.19671 d
4.6000	2.00000	-2.35000	84.00000	-0.21434 d
6.9000	2.00000	-0.05000	84.00000	0.56914 d
d - Displacements include imported displacements.				

Structure: No 29 | Sub-structure: Party Wall (6)

Dist.	Coordinates			Displacements
	x	y	z	
[m]	[m]	[m]	[m]	[mm]
Vertical Offset 1				
0.0	2.05000	6.00000	84.00000	0.72960 d
2.1134	4.16250	6.06250	84.00000	0.39224 d
4.2268	6.27500	6.12500	84.00000	-0.17393 d
6.3403	8.38750	6.18750	84.00000	-0.42226 d
8.4537	10.50000	6.25000	84.00000	-0.55757 d
10.567	12.61250	6.31250	84.00000	-0.54589 d



31 Willoughby Road

Combined Movements & Damage Assessment

Single Stage - Short-term (with heave) - 5 mm limit on overall horizontal movement

Job No.	Sheet No.	Rev.
J15315		
Drg. Ref.		
Made by MP	Date 23-Jan-2018	Checked

Dist.	Coordinates		Displacements
	x	y	z
[m]	[m]	[m]	[mm]

12.691 14.72500 6.37500 84.00000 -0.34847 d
14.794 16.83750 6.43750 84.00000 0.18044 d
16.907 18.95000 6.50000 84.00000 1.5961 d
d - Displacements include imported displacements.

Structure: No 29 | Sub-structure: Rear Elevation (7)

Dist.	Coordinates		Displacements
	x	y	z
[m]	[m]	[m]	[mm]

Vertical Offset 1
0.0 19.00000 6.55000 84.00000 1.5287 d
1.9667 19.00000 8.51667 84.00000 -0.092890 d
3.9333 19.00000 10.48333 84.00000 -0.17461 d
5.9000 19.00000 12.45000 84.00000 -0.15183 d
d - Displacements include imported displacements.

Structure: No 29 | Sub-structure: Far Elevation (8)

Dist.	Coordinates		Displacements
	x	y	z
[m]	[m]	[m]	[mm]

Vertical Offset 1
0.0 18.95000 12.50000 84.00000 -0.15255 d
2.1134 16.83750 12.43750 84.00000 -0.22401 d
4.2268 14.72500 12.37500 84.00000 -0.28795 d
6.3403 12.61250 12.31250 84.00000 -0.32790 d
8.4537 10.50000 12.25000 84.00000 -0.33812 d
10.567 8.38750 12.18750 84.00000 -0.32013 d
12.681 6.27500 12.12500 84.00000 -0.27923 d
14.794 4.16250 12.06250 84.00000 -0.22477 d
16.907 2.05000 12.00000 84.00000 -0.16994 d
d - Displacements include imported displacements.

Structure: No 29 | Sub-structure: Frontage (9)

Dist.	Coordinates		Displacements
	x	y	z
[m]	[m]	[m]	[mm]

Vertical Offset 1
0.0 2.00000 11.95000 84.00000 -0.16979 d
1.9667 2.00000 9.98333 84.00000 -0.20902 d
3.9333 2.00000 8.01667 84.00000 -0.19574 d
5.9000 2.00000 6.05000 84.00000 0.59081 d
d - Displacements include imported displacements.

Structure: Willoughby Road | Sub-structure: Roadway (10)

Dist.	Coordinates		Displacements
	x	y	z
[m]	[m]	[m]	[mm]

Vertical Offset 1
0.0 -2.00000 -6.00000 85.00000 -0.090807 d
2.0000 -2.00000 -4.00000 85.00000 -0.10869 d
4.0000 -2.00000 -2.00000 85.00000 -0.12125 d
6.0000 -2.00000 0.00000 85.00000 -0.12781 d
8.0000 -2.00000 2.00000 85.00000 -0.13269 d
10.000 -2.00000 4.00000 85.00000 -0.13115 d
12.000 -2.00000 6.00000 85.00000 -0.12501 d
14.000 -2.00000 8.00000 85.00000 -0.11938 d
16.000 -2.00000 10.00000 85.00000 -0.10824 d
18.000 -2.00000 12.00000 85.00000 -0.091468 d
d - Displacements include imported displacements.

Structure: Willow Cottages | Sub-structure: Retaining Wall (11)

Dist.	Coordinates		Displacements
	x	y	z
[m]	[m]	[m]	[mm]

Vertical Offset 1
0.0 0.00000 -10.00000 83.00000 -0.071030 d
2.0264 1.81250 -9.09375 83.00000 -0.10200 d
4.0529 3.62500 -8.18750 83.00000 -0.14398 d
6.0793 5.43750 -7.28125 83.00000 -0.19986 d
8.1057 7.25000 -6.37500 83.00000 -0.27012 d
10.132 9.06250 -5.46875 83.00000 -0.34858 d
12.159 10.87500 -4.56250 83.00000 -0.41848 d
14.185 12.68750 -3.65625 83.00000 -0.45059 d
16.211 14.50000 -2.75000 83.00000 -0.40915 d
18.238 16.31250 -1.84375 83.00000 -0.25355 d
20.264 18.12500 -0.93750 83.00000 0.061808 d
22.291 19.93750 -0.03125 83.00000 0.15508 d
24.317 21.75000 0.87500 83.00000 0.18605 d
26.344 23.56250 1.78125 83.00000 0.063869 d
28.370 25.37500 2.68750 83.00000 0.0070372 d
30.397 27.18750 3.59375 83.00000 0.011285 d
32.423 29.00000 4.50000 83.00000 -0.013887 d
d - Displacements include imported displacements.

Structure: Willow Cottages | Sub-structure: Rear Elevation

Dist.	Coordinates		Displacements
	x	y	z
[m]	[m]	[m]	[mm]

Vertical Offset 1
0.0 0.00000 -13.00000 83.00000 -0.042356 d
2.0264 1.81250 -12.09375 83.00000 -0.061108 d
4.0529 3.62500 -11.18750 83.00000 -0.085037 d
6.0793 5.43750 -10.28125 83.00000 -0.11480 d
8.1057 7.25000 -9.37500 83.00000 -0.15013 d
10.132 9.06250 -8.46875 83.00000 -0.18885 d
12.159 10.87500 -7.56250 83.00000 -0.22596 d
14.185 12.68750 -6.65625 83.00000 -0.25356 d
16.211 14.50000 -5.75000 83.00000 -0.26238 d
18.238 16.31250 -4.84375 83.00000 -0.24489 d
20.264 18.12500 -3.93750 83.00000 -0.19990 d
22.291 19.93750 -3.03125 83.00000 -0.14071 d
24.317 21.75000 -2.12500 83.00000 -0.086983 d
26.344 23.56250 -1.21875 83.00000 -0.050437 d
28.370 25.37500 -0.31250 83.00000 -0.033637 d
30.397 27.18750 0.59375 83.00000 -0.025320 d
32.423 29.00000 1.50000 83.00000 -0.018800 d
d - Displacements include imported displacements.

Specific Building Damage Results - All Segments



31 Willoughby Road

Combined Movements & Damage Assessment

Single Stage - Short-term (with heave) - 5 mm limit on overall horizontal movement

Job No.	Sheet No.	Rev.
J15315		
Drg. Ref.		
Made by MP	Date 23-Jan-2018	Checked

Dist.	Coordinates			Displacements							
	x [m]	y [m]	z [m]	z [mm]							
Structure: No 33 Sub-structure: Party Wall (1)											
Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category
[m] 0.0		[m] 1	[m] 0.0	[m] 3.4976	[%] Sagging	[%] 0.0068807	[%] 0.0	[%] 0.0065592	0.0	[m] 328.30E-6	5011.7
		2	3.4976	6.4014	Hogging	0.0096805	0.0	0.0092989	0.0	-341.84E-6	4637.4
											(Negligible)
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.											
Structure: No 33 Sub-structure: Rear Elevation (2)											
Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category
[m] 0.0		[m] 1	[m] 0.0	[m] 2.9000	[%] Sagging	[%] 0.0	[%] 0.030250	[%] 0.030250	-302.41E-6	[m] 269.56E-6	-
		1	0.0	2.9000	Sagging	0.0	0.030250	0.030250	-302.41E-6	269.56E-6	-
											(Negligible)
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.											
Structure: No 33 Sub-structure: Far Elevation (3)											
Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category
[m] 0.0		[m] 1	[m] 0.0	[m] 4.9231	[%] Hogging	[%] 524.89E-6	[%] 0.0060500	[%] 0.0062926	-60.496E-6	[m] 80985.	0
		2	4.9231	3.9089	Sagging	249.16E-6	0.0060500	0.0062265	-60.496E-6	80985.	0
											(Negligible)
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.											
Structure: No 33 Sub-structure: Far Eleavtion (4)											
Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category
[m] 0.0		[m] 1	[m] 0.0	[m] 1.9000	[%] None	[%] 0.0	[%] 0.0	[%] 0.0	0.0	[m] -19.529E-6	-
		1	0.0	1.9000	None	0.0	0.0	0.0	0.0	-19.529E-6	-
											(Negligible)
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.											
Structure: No 33 Sub-structure: Frontage (5)											
Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category
[m] 0.0		[m] 1	[m] 0.0	[m] 0.94740	[%] None	[%] 0.0	[%] 0.030250	[%] 0.030250	-302.41E-6	[m] 22.350E-6	33494.
		2	0.94740	5.9526	Hogging	0.0083293	0.030250	0.034854	-302.41E-6	33494.	0
		2	0.94740	5.9526	Hogging	0.0083293	0.030250	0.034854	-302.41E-6	33494.	0
											(Negligible)
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.											
Structure: No 29 Sub-structure: Party Wall (6)											
Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category
[m] 0.0		[m] 1	[m] 0.0	[m] 2.9901	[%] Sagging	[%] 0.0022414	[%] -541.83E-6	[%] 0.0020134	7.6674E-6	[m] 267.89E-6	12222.
		2	2.9901	13.917	Hogging	0.010822	0.0	0.0099634	0.0	267.89E-6	12222.
		2	2.9901	13.917	Hogging	0.010822	0.0	0.0099634	0.0	267.89E-6	12222.
											(Negligible)
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.											
Structure: No 29 Sub-structure: Rear Elevation (7)											
Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category
[m] 0.0		[m] 1	[m] 0.0	[m] 5.2025	[%] Hogging	[%] 0.018730	[%] 0.030229	[%] 0.038004	-302.20E-6	[m] 824.31E-6	2038.2
		2	5.2025	0.69646	Hogging	0.0	0.030229	0.030229	-302.20E-6	824.31E-6	2038.2
		2	5.2025	0.69646	Hogging	0.0	0.030229	0.030229	-302.20E-6	824.31E-6	2038.2
											(Negligible)
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.											
Structure: No 29 Sub-structure: Far Elevation (8)											
Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category
[m] 0.0		[m] 1	[m] 0.0	[m] 15.968	[%] Hogging	[%] 0.0010227	[%] 0.0	[%] 940.53E-6	0.0	[m] 33.811E-6	160210.
		2	15.968	0.93851	Hogging	0.0	0.0	0.0	0.0	33.811E-6	160210.
		2	15.968	0.93851	Hogging	0.0	0.0	0.0	0.0	33.811E-6	160210.
											(Negligible)
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.											
Structure: No 29 Sub-structure: Frontage (9)											
Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category
[m] 0.0		[m] 1	[m] 0.0	[m] 0.69691	[%] Hogging	[%] 0.0	[%] 0.030229	[%] 0.030229	-302.20E-6	[m] 19.941E-6	30296.
		1	0.0	0.69691	Hogging	0.0	0.030229	0.030229	-302.20E-6	19.941E-6	30296.
											(Negligible)



31 Willoughby Road

Combined Movements & Damage Assessment

Single Stage - Short-term (with heave) - 5 mm limit on overall horizontal movement

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Vertical Offset from Line for Vertical Movement	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category
	2	0.69691	5.2021	Hogging	0.0094017	0.030229	0.033327	-302.20E-6	-399.82E-6	4058.1	0 (Negligible)
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.											
Structure: Willoughby Road Sub-structure: Roadway (10)											
Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category
[m] 0.0		[m] 1	[m] 2.0000	10.246 Hogging	[%] 172.47E-6	[%] -0.023406	[%] 0.0046813	541.68E-6	8.9402E-6	[m] 713730.	0 (Negligible)
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.											
Structure: Willow Cottages Sub-structure: Retaining Wall (11)											
Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category
[m] 0.0		[m] 1	[m] 2.0264	6.7326 Sagging	[%] 275.15E-6	[%] 0.0058613	[%] 0.0062599	-60.496E-6	38.714E-6	[m] 308910.	0 (Negligible)
	2	8.7590	10.246	Hogging	0.0023453	0.0038205	0.0073808	237.19E-6	-155.66E-6	35582.	0 (Negligible)
	3	19.005	5.3118	Sagging	0.0022528	-0.044275	0.0088756	0.0014319	-155.66E-6	32874.	0 (Negligible)
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.											
Structure: Willow Cottages Sub-structure: Rear Elevation											
Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category
[m] 0.0		[m] 1	[m] 6.0793	3.1099 Sagging	[%] 37.698E-6	[%] 0.0060500	[%] 0.0060717	-60.496E-6	19.108E-6	[m] 806610.	0 (Negligible)
	2	9.1892	12.663	Hogging	798.18E-6	-0.0078657	0.0016230	976.71E-6	-29.237E-6	166130.	0 (Negligible)
	3	21.852	0.43832	Hogging	0.0	-0.097576	0.019515	976.71E-6	-29.237E-6	1.1787E+6	0 (Negligible)
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.											
Specific Building Damage Results - Critical Values for All Segments within Each Sub-Structure											
Structure: No 33 Sub-structure: Party Wall (1)											
Vertical Offset from Line for Vertical Movement Calculations	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category	
[m] 0.0	[%] 0.0096805	[%] 0.0	-341.84E-6	[mm] 0.70718	[%] 0.0092989	0.0	-341.84E-6	[m] 4637.4	[m] 5011.7	0 (Negligible)	
Structure: No 33 Sub-structure: Rear Elevation (2)											
Vertical Offset from Line for Vertical Movement Calculations	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category	
[m] 0.0	[%] 0.0	[%] 0.030250	269.56E-6	[mm] 0.54674	[%] 0.030250	-302.41E-6	269.56E-6	[m] -	[m] -	0 (Negligible)	
Structure: No 33 Sub-structure: Far Elevation (3)											
Vertical Offset from Line for Vertical Movement Calculations	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category	
[m] 0.0	[%] 524.89E-6	[%] 0.0060500	-49.004E-6	[mm] 0.54397	[%] 0.0062926	-60.496E-6	-49.004E-6	[m] 80985.	[m] 177510.	0 (Negligible)	
Structure: No 33 Sub-structure: Far Elevation (4)											
Vertical Offset from Line for Vertical Movement Calculations	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category	
[m] 0.0	[%] 0.0	[%] 0.0	-19.529E-6	[mm] 0.18227	[%] 0.0	0.0	-19.529E-6	[m] -	[m] -	0 (Negligible)	
Structure: No 33 Sub-structure: Frontage (5)											
Vertical Offset from Line for Vertical Movement Calculations	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category	
[m] 0.0	[%] 0.0083293	[%] 0.030250	-340.54E-6	[mm] 0.56914	[%] 0.034854	-302.41E-6	-340.54E-6	[m] 5330.9	[m] -	0 (Negligible)	
Structure: No 29 Sub-structure: Party Wall (6)											
Vertical Offset from Line for Vertical Movement Calculations	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category	
[m] 0.0	[%] 0.010822	[%] -541.83E-6	-669.82E-6	[mm] 1.5958	[%] 0.0099634	7.6674E-6	-669.82E-6	[m] 4355.0	[m] 12222.	0 (Negligible)	



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Vertical Offset from Line for Vertical Movement Calculations	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category		
Structure: No 29 Sub-structure: Rear Elevation (7)												
[m] 0.0	[%] 0.018730	[%] 0.030229	824.31E-6	[mm] 1.5287	[%] 0.038004	-302.20E-6	824.31E-6	[m] 2038.2	[m]	- 0 (Negligible)		
Structure: No 29 Sub-structure: Far Elevation (8)												
[m] 0.0	[%] 0.0010227	[%] 0.0	33.811E-6	[mm] 0.33780	[%] 940.53E-6	0.0	33.811E-6	[m] 160210.	[m]	- 0 (Negligible)		
Structure: No 29 Sub-structure: Frontage (9)												
[m] 0.0	[%] 0.0094017	[%] 0.030229	-399.82E-6	[mm] 0.59041	[%] 0.033327	-302.20E-6	-399.82E-6	[m] 4058.1	[m]	- 0 (Negligible)		
Structure: Willoughby Road Sub-structure: Roadway (10)												
[m] 0.0	[%] 172.47E-6	[%] -0.023406	8.9402E-6	[mm] 0.13263	[%] 0.0046813	541.68E-6	8.9402E-6	[m] 713730.	[m]	- 0 (Negligible)		
Structure: Willow Cottages Sub-structure: Retaining Wall (11)												
[m] 0.0	[%] 0.0023453	[%] -0.044275	-155.66E-6	[mm] 0.44989	[%] 0.0088756	0.0014319	-155.66E-6	[m] 35582.	[m] 32874.0	0 (Negligible)		
Structure: Willow Cottages Sub-structure: Rear Elevation												
[m] 0.0	[%] 798.18E-6	[%] -0.097576	-29.237E-6	[mm] 0.26228	[%] 0.019515	976.71E-6	-29.237E-6	[m] 166130.	[m] 806610.0	0 (Negligible)		
Specific Building Damage Results - Critical Segments within Each Structure												
Structure Name	Parameter	Critical Sub-Structure	Critical Segment	Start	End	Curvature	Max Slope	Max Settlement	Max Tensile Strain	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category
No 33	Max Slope	Party Wall (1)		[m] 2	[m] 3.4976	Hogging	341.84E-6	[mm] 0.38244	[%] 0.0092989	[m] 4637.4		- 0 (Negligible)
	Max Settlement	Party Wall (1)		1	0.0	3.4976 Sagging	328.30E-6	0.70718	0.0065592	-	5011.7	0 (Negligible)
	Max Tensile Strain	Frontage (5)		2	0.94740	6.9000 Hogging	340.54E-6	0.56914	0.034854	5330.9	-	0 (Negligible)
	Min Radius of Curvature (Hogging)	Party Wall (1)		2	3.4976	9.8990 Hogging	341.84E-6	0.38244	0.0092989	4637.4	-	0 (Negligible)
	Min Radius of Curvature (Sagging)	Party Wall (1)		1	0.0	3.4976 Sagging	328.30E-6	0.70718	0.0065592	-	5011.7	0 (Negligible)
No 29	Max Slope	Rear Elevation (7)		1	0.0	5.2025 Hogging	824.31E-6	1.5287	0.038004	2038.2	-	0 (Negligible)
	Max Settlement	Party Wall (6)		2	2.9901	16.907 Hogging	669.82E-6	1.5958	0.0099634	4355.0	-	0 (Negligible)
	Max Tensile Strain	Rear Elevation (7)		1	0.0	5.2025 Hogging	824.31E-6	1.5287	0.038004	2038.2	-	0 (Negligible)
	Min Radius of Curvature (Hogging)	Rear Elevation (7)		1	0.0	5.2025 Hogging	824.31E-6	1.5287	0.038004	2038.2	-	0 (Negligible)
	Min Radius of Curvature (Sagging)	Party Wall (6)		1	0.0	2.9901 Sagging	267.89E-6	0.72960	0.0020134	-	12222.0	0 (Negligible)
Willoughby Road	Max Slope	Roadway (10)		1	2.0000	16.000 Hogging	8.9402E-6	0.13263	0.0046813	713730.	-	0 (Negligible)
	Max Settlement	Roadway (10)		1	2.0000	16.000 Hogging	8.9402E-6	0.13263	0.0046813	713730.	-	0 (Negligible)
	Max Tensile Strain	Roadway (10)		1	2.0000	16.000 Hogging	8.9402E-6	0.13263	0.0046813	713730.	-	0 (Negligible)
	Min Radius of Curvature (Hogging)	Roadway (10)		1	2.0000	16.000 Hogging	8.9402E-6	0.13263	0.0046813	713730.	-	0 (Negligible)
	Min Radius of Curvature (Sagging)			-	-	-	-	-	-	-	-	-
Willow Cottages	Max Slope	Retaining Wall (11)		2	8.7590	19.005 Hogging	155.66E-6	0.44989	0.0073808	35582.	-	0 (Negligible)
	Max Settlement	Retaining Wall (11)		2	8.7590	19.005 Hogging	155.66E-6	0.44989	0.0073808	35582.	-	0 (Negligible)
	Max Tensile Strain	Retaining Wall (11)		3	19.005	24.317 Sagging	155.66E-6	0.18605	0.0088756	-	32874.0	0 (Negligible)
	Min Radius of Curvature (Hogging)	Retaining Wall (11)		2	8.7590	19.005 Hogging	155.66E-6	0.44989	0.0073808	35582.	-	0 (Negligible)
	Min Radius of Curvature (Sagging)	Retaining Wall (11)		3	19.005	24.317 Sagging	155.66E-6	0.18605	0.0088756	-	32874.0	0 (Negligible)
Willow Cottages	Max Slope	Rear Elevation		2	9.1892	21.852 Hogging	29.237E-6	0.26228	0.0016230	166130.	-	0 (Negligible)



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Structure Name	Parameter	Critical Sub-Structure	Critical Segment	Start	End	Curvature	Max Slope	Max Settlement	Max Tensile Strain	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category
	Max Settlement	Rear Elevation	2	9.1892	21.852	Hogging	29.237E-6	0.26228	0.0016230	166130.	- 0	(Negligible)
	Max Tensile Strain	Rear Elevation	3	21.852	22.291	Hogging	29.237E-6	0.15352	0.019515	1.1787E+6	- 0	(Negligible)
	Min Radius of Curvature (Hogging)	Rear Elevation	2	9.1892	21.852	Hogging	29.237E-6	0.26228	0.0016230	166130.	- 0	(Negligible)
	Min Radius of Curvature (Sagging)	Rear Elevation	1	6.0793	9.1892	Sagging	19.108E-6	0.17084	0.0060717	- 806610.	0	(Negligible)

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Problem Type

Problem Type : Tunnelling and Embedded Wall Excavations

Displacement Data

Type	Name	Direction of extrusion	Point/Line/Line for extrusion		No. of intervals across extrusion/line	Extrusion depth	No. of intervals along extrusion	Calculate	Surface type for tunnels
			First point	Second point					
			X [m]	Y [m]	Z (level) [m]	X [m]	Y [m]	Z (level) [m]	
Grid	Grid 1	Global X	-20.00000	-20.00000	85.50000	-	26.00000	85.50000	46 60.00000 60 Yes Surface
Grid	Grid 2	Global X	-20.00000	-20.00000	84.00000	-	26.00000	84.00000	46 60.00000 60 Yes Surface
Line	Line 1	-	2.05000	0.00000	84.00000	11.95000	0.00000	84.00000	5 - Yes Surface
Line	Line 2	-	12.00000	-0.05000	84.00000	12.00000	-2.95000	84.00000	1 - Yes Surface
Line	Line 3	-	11.95000	-3.00000	84.00000	4.05000	-6.95000	84.00000	4 - Yes Surface
Line	Line 4	-	3.95000	-7.00000	84.00000	2.05000	-7.00000	84.00000	1 - Yes Surface
Line	Line 5	-	2.00000	-6.95000	84.00000	2.00000	-0.05000	84.00000	3 - Yes Surface
Line	Line 6	-	2.05000	6.00000	84.00000	18.95000	6.50000	84.00000	8 - Yes Surface
Line	Line 7	-	19.00000	6.55000	84.00000	19.00000	12.45000	84.00000	3 - Yes Surface
Line	Line 8	-	18.95000	12.50000	84.00000	2.05000	12.00000	84.00000	8 - Yes Surface
Line	Line 9	-	2.00000	11.95000	84.00000	2.00000	6.05000	84.00000	3 - Yes Surface
Line	Line 10	-	-2.00000	-6.00000	85.00000	-2.00000	12.00000	85.00000	9 - Yes Surface
Line	Line 11	-	0.00000	-10.00000	83.00000	29.00000	4.50000	83.00000	16 - Yes Surface
Line	Line 12	-	0.00000	-13.00000	83.00000	29.00000	1.50000	83.00000	16 - Yes Surface

Vertical Ground Movement Curves (Excavations)

Curve Name: No vertical ground movement
Coordinates: [Distance from wall / wall depth or max. excavation depth (x), Depth / wall depth or max. excavation depth (y), Settlement / wall depth or max. excavation depth (z) (%)]
 [0.000,0.000,0.000] [1.000,0.000,0.000] [0.000,1.000,0.000] [1.000,1.000,0.000]
Curve Fitting Method: Polynomial
x Order: 1
y Order: 0
Polynomial: z = 0.0x + 0.0
Coeff. of Determination: -2147483648.E+2147483647

Horizontal Ground Movement Curves (Excavations)

Curve Name: GEA Curve for 10 mm of horizontal deflection (after CIRIA 580 Fig. 2.11(a))
Coordinates: [Distance from wall / wall depth or max. excavation depth (x), Depth / wall depth or max. excavation depth (y), Horizontal movement / wall depth or max. excavation depth (z) (%)]
 [0.000,0.000,0.242] [4.000,0.000,0.000]
Curve Fitting Method: Polynomial
x Order: 1
y Order: 0
Polynomial: z = -6.05E-2x + 2.42E-1
Coeff. of Determination: 1.00

Polygonal Excavations

Excavation Name: New Excavation
Surface level [m]: 85.500
Contribution: Positive
Enabled: Yes
Surface movement curves which are selected are applied between surface and [m]: 81.400

Corner	x	y	Base Level	Stiffened	Previous Side	Next Side
	[m]	[m]	[m]	d	p1 p2*	d p1 p2*
1	2.0000	0.0	81.400	No	- - -	- - -
2	18.000	0.0	81.400	No	- - -	- - -
3	21.000	2.0000	81.400	No	- - -	- - -
4	21.000	6.5000	81.400	No	- - -	- - -
5	2.0000	6.0000	81.400	No	- - -	- - -

Side	Corner 1	Corner 2	Ground Movement Curve	
	x y	x y	Vertical	Horizontal
	[m] [m]	[m] [m]		
1	2.0000 0.0	18.000 0.0	No vertical ground movement	GEA Curve for 10 mm of horizontal deflection (after CIRIA 580 Fig. 2.11(a))
2	18.000 0.0	21.000 2.0000	No vertical ground movement	GEA Curve for 10 mm of horizontal deflection (after CIRIA 580 Fig. 2.11(a))
3	21.000 2.0000	21.000 6.5000	No vertical ground movement	GEA Curve for 10 mm of horizontal deflection (after CIRIA 580 Fig. 2.11(a))
4	21.000 6.5000	2.0000 6.0000	No vertical ground movement	GEA Curve for 10 mm of horizontal deflection (after CIRIA 580 Fig. 2.11(a))
5	2.0000 6.0000	2.0000 0.0	No vertical ground movement	GEA Curve for 10 mm of horizontal deflection (after CIRIA 580 Fig. 2.11(a))

Damage Category Strains

Name	0 (Negligible) to 1 (Very Slight)	1 (Very Slight) to 2 (Slight)	2 (Slight) to 3 (Moderate)	3 (Moderate) to 4 (Severe)
Burland Strain Limits	0.0	500.00E-6	750.00E-6	0.0015000

Specific Structures - Geometry

Structure Name	Sub-Structure Name	Displacement Line	Start Distance Along Line	End Distance Along Line	Vertical Offsets from Line for Vertical Movement Calculations	Vertical Displacement Limit	Damage Category Strains	Poisson's Ratio	E/G
			[m]	[m]	[m]	[mm]			
No 33	Party Wall (1)	Line 1	0.00000	9.89900	0.0	0.10000	Burland Strain Limits	0.20000	2.6000
No 33	Rear Elevation (2)	Line 2	0.00000	2.90000	0.0	0.10000	Burland Strain Limits	0.20000	2.6000
No 33	Far Elevation (3)	Line 3	0.00000	8.83200	0.0	0.10000	Burland Strain Limits	0.20000	2.6000
No 33	Far Elevation (4)	Line 4	0.00000	1.90000	0.0	0.10000	Burland Strain Limits	0.20000	2.6000

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Structure Name	Sub-Structure Name	Displacement Line	Start Distance Along Line	End Distance Along Line	Vertical Offsets from Line for Vertical	Vertical Displacement Limit Sensitivity	Damage Category	Strains	Poisson's Ratio	E/G
No 33	Frontage (5)	Line 5	0.00000	6.90000	0.0	0.10000	Burland Strain Limits	0.20000	2.6000	
No 29	Party Wall (6)	Line 6	0.00000	16.90700	0.0	0.10000	Burland Strain Limits	0.20000	2.6000	
No 29	Rear Elevation (7)	Line 7	0.00000	5.89900	0.0	0.10000	Burland Strain Limits	0.20000	2.6000	
No 29	Far Elevation (8)	Line 8	0.00000	16.90700	0.0	0.10000	Burland Strain Limits	0.20000	2.6000	
No 29	Frontage (9)	Line 9	0.00000	5.89900	0.0	0.10000	Burland Strain Limits	0.20000	2.6000	
Willoughby Road	Roadway (10)	Line 10	0.00000	18.00000	0.0	0.10000	Burland Strain Limits	0.20000	2.6000	
Willow Cottages	Retaining Wall (11)	Line 11	0.00000	32.42200	0.0	0.10000	Burland Strain Limits	0.20000	2.6000	
Willow Cottages	Rear Elevation	Line 12	0.00000	32.42200	0.0	0.10000	Burland Strain Limits	0.20000	2.6000	

Specific Structures - Bending Parameters

Structure Name	Sub-Structure Name	Height	Default Properties	Hogging			Sagging		
				2nd Moment of Area (per unit width)	Distance of Bending Strain from N.A.	Distance of N.A. from Edge of Beam in Tension	2nd Moment of Area (per unit width)	Distance of Bending Strain from N.A.	Distance of N.A. from Edge of Beam in Tension
No 33	Party Wall (1)	[m]	8.0000 Yes	[m ⁴]	[m]	[m]	[m ⁴]	[m]	[m]
No 33	Rear Elevation (2)	8.0000	Yes	170.67	8.0000	8.0000	42.667	4.0000	4.0000
No 33	Far Elevation (3)	8.0000	Yes	170.67	8.0000	8.0000	42.667	4.0000	4.0000
No 33	Far Elevation (4)	8.0000	Yes	170.67	8.0000	8.0000	42.667	4.0000	4.0000
No 33	Frontage (5)	8.0000	Yes	170.67	8.0000	8.0000	42.667	4.0000	4.0000
No 29	Party Wall (6)	12.000	Yes	576.00	12.000	12.000	144.00	6.0000	6.0000
No 29	Rear Elevation (7)	12.000	Yes	576.00	12.000	12.000	144.00	6.0000	6.0000
No 29	Far Elevation (8)	12.000	Yes	576.00	12.000	12.000	144.00	6.0000	6.0000
No 29	Frontage (9)	12.000	Yes	576.00	12.000	12.000	144.00	6.0000	6.0000
Willoughby Road	Roadway (10)	0.50000	Yes	0.041667	0.50000	0.50000	0.010417	0.25000	0.25000
Willow Cottages	Retaining Wall (11)	2.5000	Yes	5.2083	2.5000	2.5000	1.3021	1.2500	1.2500
Willow Cottages	Rear Elevation	8.0000	Yes	170.67	8.0000	8.0000	42.667	4.0000	4.0000

Building Segment Combinations

Structure Name	Sub-Structure Name	Vertical Offset from Line for Vertical Movement Calculations	Segment Start	Length	Curvature	Combined Segment
No structures have segments combined.						

Utility Strain Calculation Options

Neglect beneficial contribution of axial strains : No

Warnings

- Sub-structure 6 crosses at least one excavation. Its building damage results in that area should be treated with caution.

Errors

None

Specific Building Damage Results - Horizontal Displacements

Structure: No 33 | Sub-structure: Party Wall (1)

Dist.	Coordinates			Displacements		
	x	y	z	x	y	
				Horizontal displacement along the Line	Horizontal displacement perpendicular to Line	
	[m]	[m]	[m]	[mm]	[mm]	
0.0	2.05000	0.00000	84.00000	0.0	9.9220	d
1.9800	4.03000	0.00000	84.00000	0.0	9.9220	d
3.9600	6.01000	0.00000	84.00000	0.0	9.9220	d
5.9400	7.99000	0.00000	84.00000	0.0	9.9220	d
7.9200	9.97000	0.00000	84.00000	0.0	9.9220	d
9.9000	11.95000	0.00000	84.00000	0.0	9.9220	d

d - Displacements include imported displacements.

Structure: No 33 | Sub-structure: Rear Elevation (2)

Dist.	Coordinates			Displacements		
	x	y	z	x	y	
				Horizontal displacement along the Line	Horizontal displacement perpendicular to Line	
	[m]	[m]	[m]	[mm]	[mm]	
0.0	12.00000	-0.05000	84.00000	0.0	9.8917	0.0 d
2.9000	12.00000	-2.95000	84.00000	0.0	8.1372	0.0 d

d - Displacements include imported displacements.

Structure: No 33 | Sub-structure: Far Elevation (3)

Dist.	Coordinates			Displacements		
	x	y	z	x	y	
				Horizontal displacement along the Line	Horizontal displacement perpendicular to Line	
	[m]	[m]	[m]	[mm]	[mm]	
0.0	11.95000	-3.00000	84.00000	0.0	8.1070	-7.2511 d
2.2081	9.97500	-3.98750	84.00000	0.0	7.5096	-6.7168 d
4.4162	8.00000	-4.97500	84.00000	0.0	6.9121	-6.1824 d
6.6244	6.02500	-5.96250	84.00000	0.0	6.3147	-5.6480 d
8.8325	4.05000	-6.95000	84.00000	0.0	5.7172	-5.1137 d

d - Displacements include imported displacements.

Structure: No 33 | Sub-structure: Far Elevation (4)

Dist.	Coordinates			Displacements		
	x	y	z	x	y	
				Horizontal displacement	Horizontal displacement	



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Combined Movements & Damage Assessment

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along the Line						perpendicular to Line	
[m]	[m]	[m]	[m]	[mm]	[mm]	[mm]	[mm]
0.0	3.95000	-7.00000	84.00000	0.0	5.6870	0.0	-5.6870 d
1.9000	2.05000	-7.00000	84.00000	0.0	5.6870	0.0	-5.6870 d
d - Displacements include imported displacements.							

Structure: No 33 | Sub-structure: Frontage (5)

Dist.	Coordinates			Displacements		
x	y	z	x	y	Horizontal displacement along the Line	Horizontal displacement perpendicular to Line
[m]	[m]	[m]	[m]	[mm]	[mm]	[mm]
0.0	2.00000	-6.95000	84.00000	0.0	5.7172	5.7172 0.0 d
2.3000	2.00000	-6.45000	84.00000	0.0	7.1087	7.1087 0.0 d
4.6000	2.00000	-2.35000	84.00000	0.0	8.5002	8.5002 0.0 d
6.9000	2.00000	-0.05000	84.00000	0.0	9.8917	9.8917 0.0 d
d - Displacements include imported displacements.						

Structure: No 29 | Sub-structure: Party Wall (6)

Dist.	Coordinates			Displacements		
x	y	z	x	y	Horizontal displacement along the Line	Horizontal displacement perpendicular to Line
[m]	[m]	[m]	[m]	[mm]	[mm]	[mm]
0.0	2.05000	6.00000	84.00000	0.0	0.0	0.0 0.0 d
2.1134	4.16250	6.06250	84.00000	0.26093	-9.9152	-0.032409 -9.9186 d
4.2268	6.27500	6.12500	84.00000	0.26082	-9.9110	-0.032395 -9.9144 d
6.3403	8.38750	6.18750	84.00000	0.26071	-9.9068	-0.032381 -9.9102 d
8.4537	10.50000	6.25000	84.00000	0.26060	-9.9027	-0.032368 -9.9060 d
10.567	12.61250	6.31250	84.00000	0.26049	-9.8985	-0.032354 -9.9019 d
12.681	14.72500	6.37500	84.00000	0.26038	-9.8943	-0.032340 -9.8977 d
14.794	16.83750	6.43750	84.00000	0.26027	-9.8901	-0.032327 -9.8935 d
16.907	18.95000	6.50000	84.00000	0.26016	-9.8860	-0.032313 -9.8893 d
d - Displacements include imported displacements.						

Structure: No 29 | Sub-structure: Rear Elevation (7)

Dist.	Coordinates			Displacements		
x	y	z	x	y	Horizontal displacement along the Line	Horizontal displacement perpendicular to Line
[m]	[m]	[m]	[m]	[mm]	[mm]	[mm]
0.0	19.00000	6.55000	84.00000	0.25938	-9.8565	-0.020456 -0.25938 d
1.9667	19.00000	8.51667	84.00000	0.22809	-8.6675	-0.022809 d
3.9333	19.00000	10.48333	84.00000	0.19680	-7.4785	-0.019680 d
5.9000	19.00000	12.45000	84.00000	0.16551	-6.2895	-0.016551 d
d - Displacements include imported displacements.						

Structure: No 29 | Sub-structure: Far Elevation (8)

Dist.	Coordinates			Displacements		
x	y	z	x	y	Horizontal displacement along the Line	Horizontal displacement perpendicular to Line
[m]	[m]	[m]	[m]	[mm]	[mm]	[mm]
0.0	18.95000	12.50000	84.00000	0.16470	-6.2585	0.020456 6.2606 d
2.1134	16.83750	12.43750	84.00000	0.16481	-6.2626	0.020470 6.2648 d
4.2268	14.72500	12.37500	84.00000	0.16492	-6.2668	0.020484 6.2690 d
6.3403	12.61250	12.31250	84.00000	0.16503	-6.2710	0.020497 6.2731 d
8.4537	10.50000	12.25000	84.00000	0.16514	-6.2752	0.020511 6.2773 d
10.567	8.38750	12.18750	84.00000	0.16525	-6.2793	0.020525 6.2815 d
12.681	6.27500	12.12500	84.00000	0.16536	-6.2835	0.020538 6.2857 d
14.794	4.16250	12.06250	84.00000	0.16547	-6.2877	0.020552 6.2898 d
16.907	2.05000	12.00000	84.00000	0.16558	-6.2919	0.020565 6.2940 d
d - Displacements include imported displacements.						

Structure: No 29 | Sub-structure: Frontage (9)

Dist.	Coordinates			Displacements		
x	y	z	x	y	Horizontal displacement along the Line	Horizontal displacement perpendicular to Line
[m]	[m]	[m]	[m]	[mm]	[mm]	[mm]
0.0	2.00000	11.95000	84.00000	0.16635	-6.3213	6.3213 0.16635 d
1.9667	2.00000	9.98333	84.00000	0.19764	-7.5103	7.5103 0.19764 d
3.9333	2.00000	8.01667	84.00000	0.22893	-8.6993	8.6993 0.22893 d
5.9000	2.00000	6.05000	84.00000	0.26022	-9.8883	9.8883 0.26022 d
d - Displacements include imported displacements.						

Structure: Willoughby Road | Sub-structure: Roadway (10)

Dist.	Coordinates			Displacements		
x	y	z	x	y	Horizontal displacement along the Line	Horizontal displacement perpendicular to Line
[m]	[m]	[m]	[m]	[mm]	[mm]	[mm]
0.0	-2.00000	-6.00000	85.00000	2.0810	3.4783	3.4783 -2.0810 d
2.0000	-2.00000	-4.00000	85.00000	3.2498	3.2498	3.2498 -3.2498 d
4.0000	-2.00000	-2.00000	85.00000	5.0863	2.1300	2.1300 -5.0863 d
6.0000	-2.00000	0.00000	85.00000	7.5020	0.0	0.0 -7.5020 d
8.0000	-2.00000	2.00000	85.00000	7.5020	0.0	0.0 -7.5020 d
10.000	-2.00000	4.00000	85.00000	7.5020	0.0	0.0 -7.5020 d
12.000	-2.00000	6.00000	85.00000	7.5020	0.0	0.0 -7.5020 d
14.000	-2.00000	8.00000	85.00000	5.1070	-2.1656	-2.1656 -5.1070 d
16.000	-2.00000	10.00000	85.00000	3.2814	-3.3040	-3.3040 -3.2814 d
18.000	-2.00000	12.00000	85.00000	2.1148	-3.5363	-3.5363 -2.1148 d
d - Displacements include imported displacements.						

Structure: Willow Cottages | Sub-structure: Retaining Wall (11)

Dist.	Coordinates			Displacements		
x	y	z	x	y	Horizontal displacement along the Line	Horizontal displacement perpendicular to Line
[m]	[m]	[m]	[m]	[mm]	[mm]	[mm]
0.0	0.00000	-10.00000	83.00000	0.47152	3.2807	1.8889 2.7234 d
2.0264	1.81250	-9.09375	83.00000	0.057998	4.3611	2.0022 3.8748 d
4.0529	3.62500	-8.18750	83.00000	0.0	4.9686	2.2220 4.4440 d
6.0793	5.43750	-7.28125	83.00000	0.0	5.5168	2.4672 4.9344 d
8.1057	7.25000	-6.37500	83.00000	0.0	6.0651	2.7124 5.4248 d



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Combined Movements & Damage Assessment

Single Stage - Short-term (with heave) - 10 mm limit on overall horizontal movement

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Dist.	Coordinates			Displacements		
x	y	z	x	y	Horizontal displacement along the	Horizontal displacement perpendicular
10.132	9.06250	-5.46875	83.00000	0.0	6.6134	2.9576
12.159	10.87500	-4.56250	83.00000	0.0	7.1617	3.2028
14.185	12.68750	-3.65625	83.00000	0.0	7.7100	3.4480
16.211	14.50000	-2.75000	83.00000	0.0	8.2582	3.6932
18.238	16.31250	-1.84375	83.00000	0.0	8.8065	3.9384
20.264	18.12500	-0.93750	83.00000	-1.1691	8.9958	2.9773
22.291	19.93750	-0.03125	83.00000	-5.1343	7.7015	-1.1481
24.317	21.75000	0.87500	83.00000	-5.0500	7.5750	-1.1292
26.344	23.56250	1.78125	83.00000	-8.0432	6.0317	-6.9243
28.370	25.37500	2.68750	83.00000	-7.2751	0.0	-6.5071
30.397	27.18750	3.59375	83.00000	-6.1786	0.0	-5.5263
32.423	29.00000	4.50000	83.00000	-5.0820	0.0	-4.5455
d - Displacements include imported displacements.						

Structure: Willow Cottages | Sub-structure: Rear Elevation

Dist.	Coordinates			Displacements		
x	y	z	x	y	Horizontal displacement along the Line	Horizontal displacement perpendicular to Line
[m]	[m]	[m]	[mm]	[mm]	[mm]	[mm]
0.0	0.00000	-13.00000	83.00000	0.19091	1.7736	0.96391
2.0264	1.81250	-12.09375	83.00000	0.025704	2.5787	1.1762
4.0529	3.62500	-11.18750	83.00000	0.0	3.1536	1.4103
6.0793	5.43750	-10.28125	83.00000	0.0	3.7019	1.6555
8.1057	7.25000	-9.37500	83.00000	0.0	4.2501	1.9007
10.132	9.06250	-8.46875	83.00000	0.0	4.7984	2.1459
12.159	10.87500	-7.56250	83.00000	0.0	5.3467	2.3911
14.185	12.68750	-6.65625	83.00000	0.0	5.8950	2.6363
16.211	14.50000	-5.75000	83.00000	0.0	6.4432	2.8815
18.238	16.31250	-4.84375	83.00000	0.0	6.9915	3.1267
20.264	18.12500	-3.93750	83.00000	-0.22569	7.4703	3.1389
22.291	19.93750	-3.03125	83.00000	-4.1556	6.4873	-0.81567
24.317	21.75000	-2.12500	83.00000	-4.2123	6.3184	-0.94190
26.344	23.56250	-1.21875	83.00000	-4.4072	5.6536	-1.4135
28.370	25.37500	-0.31250	83.00000	-5.4018	2.8520	-3.5560
30.397	27.18750	0.59375	83.00000	-5.4671	1.1509	-4.3753
32.423	29.00000	1.50000	83.00000	-4.9291	0.26806	-4.2888
d - Displacements include imported displacements.						

Specific Building Damage Results - Vertical Displacements

Structure: No 33 | Sub-structure: Party Wall (1)

Dist.	Coordinates			Displacements
	x	y	z	z
[m]	[m]	[m]	[m]	[mm]
Vertical Offset 1				
0.0	2.05000	0.00000	84.00000	0.70718 d
1.9800	4.03000	0.00000	84.00000	0.61224 d
3.9600	6.01000	0.00000	84.00000	-0.037798 d
5.9400	7.99000	0.00000	84.00000	-0.33424 d
7.9200	9.97000	0.00000	84.00000	-0.38307 d
9.9000	11.95000	0.00000	84.00000	0.29376 d
d - Displacements include imported displacements.				

Structure: No 33 | Sub-structure: Rear Elevation (2)

Dist.	Coordinates			Displacements
	x	y	z	z
[m]	[m]	[m]	[m]	[mm]
Vertical Offset 1				
0.0	12.00000	-0.05000	84.00000	0.23522 d
2.900	12.00000	-2.95000	84.00000	-0.54674 d
d - Displacements include imported displacements.				

Structure: No 33 | Sub-structure: Far Elevation (3)

Dist.	Coordinates			Displacements
	x	y	z	z
[m]	[m]	[m]	[m]	[mm]
Vertical Offset 1				
0.0	11.95000	-3.00000	84.00000	-0.54397 d
2.2081	9.97500	-3.98750	84.00000	-0.48168 d
4.4162	8.00000	-4.97500	84.00000	-0.37526 d
6.6244	6.02500	-5.96250	84.00000	-0.26933 d
8.8325	4.05000	-6.95000	84.00000	-0.18582 d
d - Displacements include imported displacements.				

Structure: No 33 | Sub-structure: Far Eleavtion (4)

Dist.	Coordinates			Displacements
	x	y	z	z
[m]	[m]	[m]	[m]	[mm]
Vertical Offset 1				
0.0	3.95000	-7.00000	84.00000	-0.18227 d
1.9000	2.05000	-7.00000	84.00000	-0.14517 d
d - Displacements include imported displacements.				

Structure: No 33 | Sub-structure: Frontage (5)

Dist.	Coordinates			Displacements
	x	y	z	
[m]	[m]	[m]	[m]	[mm]
Vertical Offset 1				
0.0	2.00000	-6.95000	84.00000	-0.14529 d
2.3000	2.00000	-4.65000	84.00000	-0.19671 d
4.6000	2.00000	-2.35000	84.00000	-0.21434 d
6.9000	2.00000	-0.05000	84.00000	0.56914 d
d - Displacements include imported displacements.				

Structure: No 29 | Sub-structure: Party Wall (6)

Dist.	Coordinates			Displacements
	x	y	z	z
[m]	[m]	[m]	[m]	[mm]
Vertical Offset 1				
0.0	2.05000	6.00000	84.00000	0.72960 d
2.1134	4.16250	6.06250	84.00000	0.39224 d
4.2268	6.27500	6.12500	84.00000	-0.173 d
6.3403	8.38750	6.18750	84.00000	-0.42226 d
8.4537	10.50000	6.25000	84.00000	-0.55757 d
10.567	12.61250	6.31250	84.00000	-0.54589 d



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Combined Movements & Damage Assessment

Single Stage - Short-term (with heave) - 10 mm limit on overall horizontal movement

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Dist.	Coordinates			Displacements
	x	y	z	
[m]	[m]	[m]	[m]	[mm]

12.691 14.72500 6.37500 84.00000 -0.34847 d
14.794 16.83750 6.43750 84.00000 0.18044 d
16.907 18.95000 6.50000 84.00000 1.5961 d
d - Displacements include imported displacements.

Structure: No 29 | Sub-structure: Rear Elevation (7)

Dist.	Coordinates			Displacements
	x	y	z	
[m]	[m]	[m]	[m]	[mm]

Vertical Offset 1
0.0 19.00000 6.55000 84.00000 1.5287 d
1.9667 19.00000 8.51667 84.00000 -0.092890 d
3.9333 19.00000 10.48333 84.00000 -0.17461 d
5.9000 19.00000 12.45000 84.00000 -0.15183 d
d - Displacements include imported displacements.

Structure: No 29 | Sub-structure: Far Elevation (8)

Dist.	Coordinates			Displacements
	x	y	z	
[m]	[m]	[m]	[m]	[mm]

Vertical Offset 1
0.0 18.95000 12.50000 84.00000 -0.15255 d
2.1134 16.83750 12.43750 84.00000 -0.22401 d
4.2268 14.72500 12.37500 84.00000 -0.28795 d
6.3403 12.61250 12.31250 84.00000 -0.32790 d
8.4537 10.50000 12.25000 84.00000 -0.33812 d
10.567 8.38750 12.18750 84.00000 -0.32013 d
12.681 6.27500 12.12500 84.00000 -0.27923 d
14.794 4.16250 12.06250 84.00000 -0.22477 d
16.907 2.05000 12.00000 84.00000 -0.16994 d
d - Displacements include imported displacements.

Structure: No 29 | Sub-structure: Frontage (9)

Dist.	Coordinates			Displacements
	x	y	z	
[m]	[m]	[m]	[m]	[mm]

Vertical Offset 1
0.0 2.00000 11.95000 84.00000 -0.16979 d
1.9667 2.00000 9.98333 84.00000 -0.20902 d
3.9333 2.00000 8.01667 84.00000 -0.19574 d
5.9000 2.00000 6.05000 84.00000 0.59081 d
d - Displacements include imported displacements.

Structure: Willoughby Road | Sub-structure: Roadway (10)

Dist.	Coordinates			Displacements
	x	y	z	
[m]	[m]	[m]	[m]	[mm]

Vertical Offset 1
0.0 -2.00000 -6.00000 85.00000 -0.090807 d
2.0000 -2.00000 -4.00000 85.00000 -0.10869 d
4.0000 -2.00000 -2.00000 85.00000 -0.12125 d
6.0000 -2.00000 0.00000 85.00000 -0.12781 d
8.0000 -2.00000 2.00000 85.00000 -0.13269 d
10.000 -2.00000 4.00000 85.00000 -0.13115 d
12.000 -2.00000 6.00000 85.00000 -0.12501 d
14.000 -2.00000 8.00000 85.00000 -0.11938 d
16.000 -2.00000 10.00000 85.00000 -0.10824 d
18.000 -2.00000 12.00000 85.00000 -0.091468 d
d - Displacements include imported displacements.

Structure: Willow Cottages | Sub-structure: Retaining Wall (11)

Dist.	Coordinates			Displacements
	x	y	z	
[m]	[m]	[m]	[m]	[mm]

Vertical Offset 1
0.0 0.00000 -10.00000 83.00000 -0.071030 d
2.0264 1.81250 -9.09375 83.00000 -0.10200 d
4.0529 3.62500 -8.18750 83.00000 -0.14398 d
6.0793 5.43750 -7.28125 83.00000 -0.19986 d
8.1057 7.25000 -6.37500 83.00000 -0.27012 d
10.132 9.06250 -5.46875 83.00000 -0.34858 d
12.159 10.87500 -4.56250 83.00000 -0.41848 d
14.185 12.68750 -3.65625 83.00000 -0.45059 d
16.211 14.50000 -2.75000 83.00000 -0.40915 d
18.238 16.31250 -1.84375 83.00000 -0.25355 d
20.264 18.12500 -0.93750 83.00000 0.061808 d
22.291 19.93750 -0.03125 83.00000 0.15508 d
24.317 21.75000 0.87500 83.00000 0.18605 d
26.344 23.56250 1.78125 83.00000 0.063869 d
28.370 25.37500 2.68750 83.00000 0.0070372 d
30.397 27.18750 3.59375 83.00000 0.011285 d
32.423 29.00000 4.50000 83.00000 -0.013887 d
d - Displacements include imported displacements.

Structure: Willow Cottages | Sub-structure: Rear Elevation

Dist.	Coordinates			Displacements
	x	y	z	
[m]	[m]	[m]	[m]	[mm]

Vertical Offset 1
0.0 0.00000 -13.00000 83.00000 -0.042356 d
2.0264 1.81250 -12.09375 83.00000 -0.061108 d
4.0529 3.62500 -11.18750 83.00000 -0.085037 d
6.0793 5.43750 -10.28125 83.00000 -0.11480 d
8.1057 7.25000 -9.37500 83.00000 -0.15013 d
10.132 9.06250 -8.46875 83.00000 -0.18885 d
12.159 10.87500 -7.56250 83.00000 -0.22596 d
14.185 12.68750 -6.65625 83.00000 -0.25356 d
16.211 14.50000 -5.75000 83.00000 -0.26238 d
18.238 16.31250 -4.84375 83.00000 -0.24489 d
20.264 18.12500 -3.93750 83.00000 -0.19990 d
22.291 19.93750 -3.03125 83.00000 -0.14071 d
24.317 21.75000 -2.12500 83.00000 -0.086983 d
26.344 23.56250 -1.21875 83.00000 -0.050437 d
28.370 25.37500 -0.31250 83.00000 -0.033637 d
30.397 27.18750 0.59375 83.00000 -0.025320 d
32.423 29.00000 1.50000 83.00000 -0.018800 d
d - Displacements include imported displacements.

Specific Building Damage Results - All Segments



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Combined Movements & Damage Assessment

Single Stage - Short-term (with heave) - 10 mm limit on overall horizontal movement

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Dist.	Coordinates		Displacements								
	x [m]	y [m]	z [m]	z [mm]							
Structure: No 33 Sub-structure: Party Wall (1)											
Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category
[m] 0.0		1	[m] 0.0	[m] 3.4976	Sagging	[%] 0.0068807	[%] 0.0	[%] 0.0065592	0.0	328.30E-6	[m] 5011.7
		2	3.4976	6.4014	Hogging	0.0096805	0.0	0.0092989	0.0	-341.84E-6	4637.4
											(Negligible)
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.											
Structure: No 33 Sub-structure: Rear Elevation (2)											
Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category
[m] 0.0		1	[m] 0.0	[m] 2.9000	None	[%] 0.0	[%] 0.060500	[%] 0.060500	-604.63E-6	269.48E-6	-
		1	0.0	2.9000	None	0.0	0.060500	0.060500	-604.63E-6	269.48E-6	1 (Very Slight)
											(Negligible)
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.											
Structure: No 33 Sub-structure: Far Elevation (3)											
Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category
[m] 0.0		1	[m] 0.0	[m] 4.9231	Hogging	[%] 524.85E-6	[%] 0.012100	[%] 0.012343	-120.99E-6	-49.001E-6	[m] 80995.
		2	4.9231	3.9089	Sagging	249.15E-6	0.012100	0.012276	-120.99E-6	-47.969E-6	177530.
											(Negligible)
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.											
Structure: No 33 Sub-structure: Far Elevation (4)											
Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category
[m] 0.0		1	[m] 0.0	[m] 1.9000	None	[%] 0.0	[%] 0.0	[%] 0.0	0.0	-19.529E-6	-
		1	0.0	1.9000	None	0.0	0.0	0.0	0.0	-19.529E-6	0
											(Negligible)
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.											
Structure: No 33 Sub-structure: Frontage (5)											
Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category
[m] 0.0		1	[m] 0.0	[m] 0.94740	Hogging	[%] 0.0	[%] 0.060500	[%] 0.060500	-604.63E-6	22.344E-6	[m] 33515.
		2	0.94740	5.9526	Hogging	0.0083267	0.060500	0.065103	-604.63E-6	-340.44E-6	5334.1
											1 (Very Slight)
											1 (Very Slight)
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.											
Structure: No 29 Sub-structure: Party Wall (6)											
Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category
[m] 0.0		1	[m] 0.0	[m] 2.9901	Sagging	[%] 0.0022414	[%] -0.0010837	[%] 0.0018666	15.335E-6	267.89E-6	[m] 12222.
		2	2.9901	13.917	Hogging	0.010822	0.0	0.0099635	0.0	-669.82E-6	4355.0
											(Negligible)
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.											
Structure: No 29 Sub-structure: Rear Elevation (7)											
Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category
[m] 0.0		1	[m] 0.0	[m] 5.2025	Hogging	[%] 0.018724	[%] 0.060458	[%] 0.066628	-604.22E-6	824.06E-6	[m] 2039.5
		2	5.2025	0.69646	None	0.0	0.060458	0.060458	-604.22E-6	-11.576E-6	15233.
											1 (Very Slight)
											1 (Very Slight)
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.											
Structure: No 29 Sub-structure: Far Elevation (8)											
Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category
[m] 0.0		1	[m] 0.0	[m] 15.968	Hogging	[%] 0.0010227	[%] 0.0	[%] 940.81E-6	0.0	33.811E-6	[m] 160210.
		2	15.968	0.93851	Hogging	0.0	0.0	0.0	0.0	-25.944E-6	1.5247E+6
											(Negligible)
											(Negligible)
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.											
Structure: No 29 Sub-structure: Frontage (9)											
Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category
[m] 0.0		1	[m] 0.0	[m] 0.69691	None	[%] 0.0	[%] 0.060458	[%] 0.060458	-604.22E-6	19.935E-6	[m] 30315.
		1	0.0	0.69691	None	0.0	0.060458	0.060458	-604.22E-6	19.935E-6	1 (Very Slight)



31 Willoughby Road

Combined Movements & Damage Assessment

Single Stage - Short-term (with heave) - 10 mm limit on overall horizontal movement

Job No.	Sheet No.	Rev.
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Vertical Offset from Line for Vertical Movement	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category
	2	0.69691	5.2021	Hogging	0.0093988	0.060458	0.063555	-604.22E-6	-399.70E-6	4060.6	1 (Very Slight)
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.											
Structure: Willoughby Road Sub-structure: Roadway (10)											
Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category
[m] 0.0	1	[m] 2.0000	[m] 14.000	Hogging	[%] 172.51E-6	[%] -0.046813	[%] 0.0093626	0.0010840	8.9407E-6	[m] 713780.	0 (Negligible)
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.											
Structure: Willow Cottages Sub-structure: Retaining Wall (11)											
Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category
[m] 0.0	1	[m] 2.0264	[m] 6.7326	Sagging	[%] 275.13E-6	[%] 0.011723	[%] 0.012121	-120.99E-6	38.712E-6	[m] 308950.	0 (Negligible)
	2	8.7590	10.246	Hogging	0.0023450	0.0076434	0.011203	474.49E-6	-155.69E-6	35580.	0 (Negligible)
	3	19.005	5.3122	Sagging	0.0022541	-0.008547	0.017720	0.0028680	-155.69E-6	32825.	0 (Negligible)
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.											
Structure: Willow Cottages Sub-structure: Rear Elevation											
Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category
[m] 0.0	1	[m] 6.0793	[m] 3.1099	Sagging	[%] 37.696E-6	[%] 0.012100	[%] 0.012122	-120.99E-6	19.107E-6	[m] 806710.	0 (Negligible)
	2	9.1892	12.663	Hogging	798.30E-6	-0.015724	0.0031698	0.0019553	-29.265E-6	166140.	0 (Negligible)
	3	21.852	0.43885	None	0.0	-0.19515	0.039030	0.0019553	-29.265E-6	1.1756E+6	0 (Negligible)
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.											
Specific Building Damage Results - Critical Values for All Segments within Each Sub-Structure											
Structure: No 33 Sub-structure: Party Wall (1)											
Vertical Offset from Line for Vertical Movement Calculations	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category	
[m] 0.0	[%] 0.0096805	[%] 0.0	-341.84E-6	[mm] 0.70718	[%] 0.0092989	0.0	-341.84E-6	[m] 4637.4	[m] 5011.7	0 (Negligible)	
Structure: No 33 Sub-structure: Rear Elevation (2)											
Vertical Offset from Line for Vertical Movement Calculations	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category	
[m] 0.0	[%] 0.0	[%] 0.060500	269.48E-6	[mm] 0.54674	[%] 0.060500	-604.63E-6	269.48E-6	[m] -	[m] -	- 1 (Very Slight)	
Structure: No 33 Sub-structure: Far Elevation (3)											
Vertical Offset from Line for Vertical Movement Calculations	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category	
[m] 0.0	[%] 524.85E-6	[%] 0.012100	-49.001E-6	[mm] 0.54397	[%] 0.012343	-120.99E-6	-49.001E-6	[m] 80995.	[m] 177530.	0 (Negligible)	
Structure: No 33 Sub-structure: Far Elevation (4)											
Vertical Offset from Line for Vertical Movement Calculations	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category	
[m] 0.0	[%] 0.0	[%] 0.0	-19.529E-6	[mm] 0.18227	[%] 0.0	0.0	-19.529E-6	[m] -	[m] -	- 0 (Negligible)	
Structure: No 33 Sub-structure: Frontage (5)											
Vertical Offset from Line for Vertical Movement Calculations	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category	
[m] 0.0	[%] 0.0083267	[%] 0.060500	-340.44E-6	[mm] 0.56914	[%] 0.065103	-604.63E-6	-340.44E-6	[m] 5334.1	[m] -	- 1 (Very Slight)	
Structure: No 29 Sub-structure: Party Wall (6)											
Vertical Offset from Line for Vertical Movement Calculations	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category	
[m] 0.0	[%] 0.010822	[%] -0.0010837	-669.82E-6	[mm] 1.5958	[%] 0.0099635	15.335E-6	-669.82E-6	[m] 4355.0	[m] 12222.	0 (Negligible)	

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Vertical Offset from Line for Vertical	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement	Max Gradient of Vertical Displacement	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category		
Structure: No 29 Sub-structure: Rear Elevation (7)												
Vertical Offset from Line for Vertical Movement Calculations	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category		
[m] 0.0	[%] 0.018724	[%] 0.060458	824.06E-6	[mm] 1.5287	[%] 0.066628	-604.22E-6	824.06E-6	[m] 2039.5	[m]	- 1 (Very Slight)		
Structure: No 29 Sub-structure: Far Elevation (8)												
Vertical Offset from Line for Vertical Movement Calculations	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category		
[m] 0.0	[%] 0.0010227	[%] 0.0	33.811E-6	[mm] 0.33780	[%] 940.81E-6	0.0	33.811E-6	[m] 160210.	[m]	- 0 (Negligible)		
Structure: No 29 Sub-structure: Frontage (9)												
Vertical Offset from Line for Vertical Movement Calculations	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category		
[m] 0.0	[%] 0.0093988	[%] 0.060458	-399.70E-6	[mm] 0.59041	[%] 0.063555	-604.22E-6	-399.70E-6	[m] 4060.6	[m]	- 1 (Very Slight)		
Structure: Willoughby Road Sub-structure: Roadway (10)												
Vertical Offset from Line for Vertical Movement Calculations	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category		
[m] 0.0	[%] 172.51E-6	[%] -0.046813	8.9407E-6	[mm] 0.13263	[%] 0.0093626	0.0010840	8.9407E-6	[m] 713780.	[m]	- 0 (Negligible)		
Structure: Willow Cottages Sub-structure: Retaining Wall (11)												
Vertical Offset from Line for Vertical Movement Calculations	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category		
[m] 0.0	[%] 0.0023450	[%] -0.088547	-155.69E-6	[mm] 0.44988	[%] 0.017720	0.0028680	-155.69E-6	[m] 35580.	[m] 32825.0	0 (Negligible)		
Structure: Willow Cottages Sub-structure: Rear Elevation												
Vertical Offset from Line for Vertical Movement Calculations	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category		
[m] 0.0	[%] 798.30E-6	[%] -0.19515	-29.265E-6	[mm] 0.26229	[%] 0.039030	0.0019553	-29.265E-6	[m] 166140.	[m] 806710.0	0 (Negligible)		
Specific Building Damage Results - Critical Segments within Each Structure												
Structure Name	Parameter	Critical Sub-Structure	Critical Segment	Start	End	Curvature	Max Slope	Max Settlement	Max Tensile Strain	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category
No 33	Max Slope	Party Wall (1)		[m]	[m]			[mm]	[%]	[m]	[m]	
	Max Settlement	Party Wall (1)		2	3.4976	9.8990 Hogging	341.84E-6	0.38244	0.0092989	4637.4	-	0 (Negligible)
	Max Tensile Strain	Frontage (5)		1	0.0	3.4976 Sagging	328.30E-6	0.70718	0.0065592	-	5011.7	0 (Negligible)
	Min Radius of Curvature (Hogging)	Party Wall (1)		2	0.94740	6.9000 Hogging	340.44E-6	0.56914	0.065103	5334.1	-	1 (Very Slight)
	Min Radius of Curvature (Sagging)	Party Wall (1)		2	3.4976	9.8990 Hogging	341.84E-6	0.38244	0.0092989	4637.4	-	0 (Negligible)
	Max Settlement	Party Wall (1)		1	0.0	3.4976 Sagging	328.30E-6	0.70718	0.0065592	-	5011.7	0 (Negligible)
No 29	Max Slope	Rear Elevation (7)		1	0.0	5.2025 Hogging	824.06E-6	1.5287	0.066628	2039.5	-	1 (Very Slight)
	Max Settlement	Party Wall (6)		2	2.9901	16.907 Hogging	669.82E-6	1.5958	0.0099635	4355.0	-	0 (Negligible)
	Max Tensile Strain	Rear Elevation (7)		1	0.0	5.2025 Hogging	824.06E-6	1.5287	0.066628	2039.5	-	1 (Very Slight)
	Min Radius of Curvature (Hogging)	Rear Elevation (7)		1	0.0	5.2025 Hogging	824.06E-6	1.5287	0.066628	2039.5	-	1 (Very Slight)
	Min Radius of Curvature (Sagging)	Party Wall (6)		1	0.0	2.9901 Sagging	267.89E-6	0.72960	0.0018666	-	12222.0	0 (Negligible)
Willoughby Road	Max Slope	Roadway (10)		1	2.0000	16.000 Hogging	8.9407E-6	0.13263	0.0093626	713780.	-	0 (Negligible)
	Max Settlement	Roadway (10)		1	2.0000	16.000 Hogging	8.9407E-6	0.13263	0.0093626	713780.	-	0 (Negligible)
	Max Tensile Strain	Roadway (10)		1	2.0000	16.000 Hogging	8.9407E-6	0.13263	0.0093626	713780.	-	0 (Negligible)
	Min Radius of Curvature (Hogging)	Roadway (10)		1	2.0000	16.000 Hogging	8.9407E-6	0.13263	0.0093626	713780.	-	0 (Negligible)
	Min Radius of Curvature (Sagging)			-	-	-	-	-	-	-	-	-
Willow Cottages	Max Slope	Retaining Wall (11)		2	8.7590	19.005 Hogging	155.69E-6	0.44988	0.011203	35580.	-	0 (Negligible)
	Max Settlement	Retaining Wall (11)		2	8.7590	19.005 Hogging	155.69E-6	0.44988	0.011203	35580.	-	0 (Negligible)
	Max Tensile Strain	Retaining Wall (11)		3	19.005	24.317 Sagging	155.69E-6	0.18605	0.017720	-	32825.0	0 (Negligible)
	Min Radius of Curvature (Hogging)	Retaining Wall (11)		2	8.7590	19.005 Hogging	155.69E-6	0.44988	0.011203	35580.	-	0 (Negligible)
	Min Radius of Curvature (Sagging)	Retaining Wall (11)		3	19.005	24.317 Sagging	155.69E-6	0.18605	0.017720	-	32825.0	0 (Negligible)
Willow Cottages	Max Slope	Rear Elevation		2	9.1892	21.852 Hogging	29.265E-6	0.26229	0.0031698	166140.	-	0 (Negligible)



31 Willoughby Road

Combined Movements & Damage Assessment

Single Stage - Short-term (with heave) - 10 mm limit on overall horizontal movement

Job No.	Sheet No.	Rev.
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Structure Name	Parameter	Critical Sub-Structure	Critical Segment	Start	End	Curvature	Max Slope	Max Settlement	Max Tensile Strain	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category
	Max Settlement	Rear Elevation	2	9.1892	21.852	Hogging	29.265E-6	0.26229	0.0031698	166140.	- 0	(Negligible)
	Max Tensile Strain	Rear Elevation	3	21.852	22.291	Sagging	29.265E-6	0.15353	0.039030	- 1.1756E+6	0	(Negligible)
	Min Radius of Curvature (Hogging)	Rear Elevation	2	9.1892	21.852	Hogging	29.265E-6	0.26229	0.0031698	166140.	- 0	(Negligible)
	Min Radius of Curvature (Sagging)	Rear Elevation	1	6.0793	9.1892	Sagging	19.107E-6	0.17084	0.012122	- 806710.	0	(Negligible)

Single Stage Underpinning:
Total Movement (Contour Plots)
& Tabular output of related damage assessment

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Analysis Options

Analysis: Boussinesq
Global Poisson's ratio: 0.20
Maximum allowable ratio between values of E: 1.5
Horizontal rigid boundary level: 35.00 [m OD]
Displacements at load centroids: Yes

Soil ProfilesSoil Profile 1

Layer	Level at top	Number of intermediate displacement levels	Youngs Modulus	Poissons ratio	Non-linear curve
	[mOD]		Top [kN/m ²]	Btm [kN/m ²]	
1	85.500	3	7500.0	7500.0	0.20000 None
2	82.500	1	9000.0	9000.0	0.20000 None
3	82.000	40	12000.	60000.	0.20000 None

Soil Zones

Zone	Name	X coordinates min max	Y coordinates min max	Profile
		[m] [m]	[m] [m]	
1	Soil Zone 1	-20.00000 40.00000	-20.00000 26.00000	Soil Profile 1

Load Data

Load ref.	Name	Shape	Orientation of Plane	Centre of load (Global) X Y Z (level)	Load position Angle of local x from Radius	Width x or Radius	Length y	Polygon Coordinates	Rectangle of tolerance	Number of rectangles	Normal (local z)	Load value Tangential (local x) (local y)
				[m] [m] [m]	[Degrees]	[m]	[m]	[m]	[m] [m] [m]	[%]	[kN/m ²]	[kN/m ²] [kN/m ²]
1	Basement Excavation - Main House	Polygonal	Horizontal	N/A N/A 81.40000	N/A	N/A	N/A	(3,1) (18,1) (20,2.3) (20,5.5) (12,5.25) (12,4) (3,4)	10.000	3	-70.000	N/A N/A
2	Basement Excavation - Existing Cellar	Polygonal	Horizontal	N/A N/A 81.40000	N/A	N/A	N/A	(3,4) (12,4) (12,5.25) (3,5)	10.000	1	-40.000	N/A N/A
3	Underpinning	Polygonal	Horizontal	N/A N/A 81.40000	N/A	N/A	N/A	(2,6) (2,0) (12,0) (12,1) (3,1) (3,6)	10.000	2	60.000	N/A N/A
4	Underpinning	Polygonal	Horizontal	N/A N/A 81.40000	N/A	N/A	N/A	(12,0) (18,0) (21,2) (21,6.5) (19,6.5) (19,5.5) (20,5.5) (20,2.3) (18,1) (12,1)	10.000	10	100.00	N/A N/A
5	Underpinning	Polygonal	Horizontal	N/A N/A 81.40000	N/A	N/A	N/A	(19,6.5) (12,6.25) (12,5.25) (19,5.5)	10.000	1	60.000	N/A N/A
6	Underpinning	Polygonal	Horizontal	N/A N/A 81.40000	N/A	N/A	N/A	(3,6) (12,6.25) (12,5.25) (3,5)	10.000	1	50.000	N/A N/A

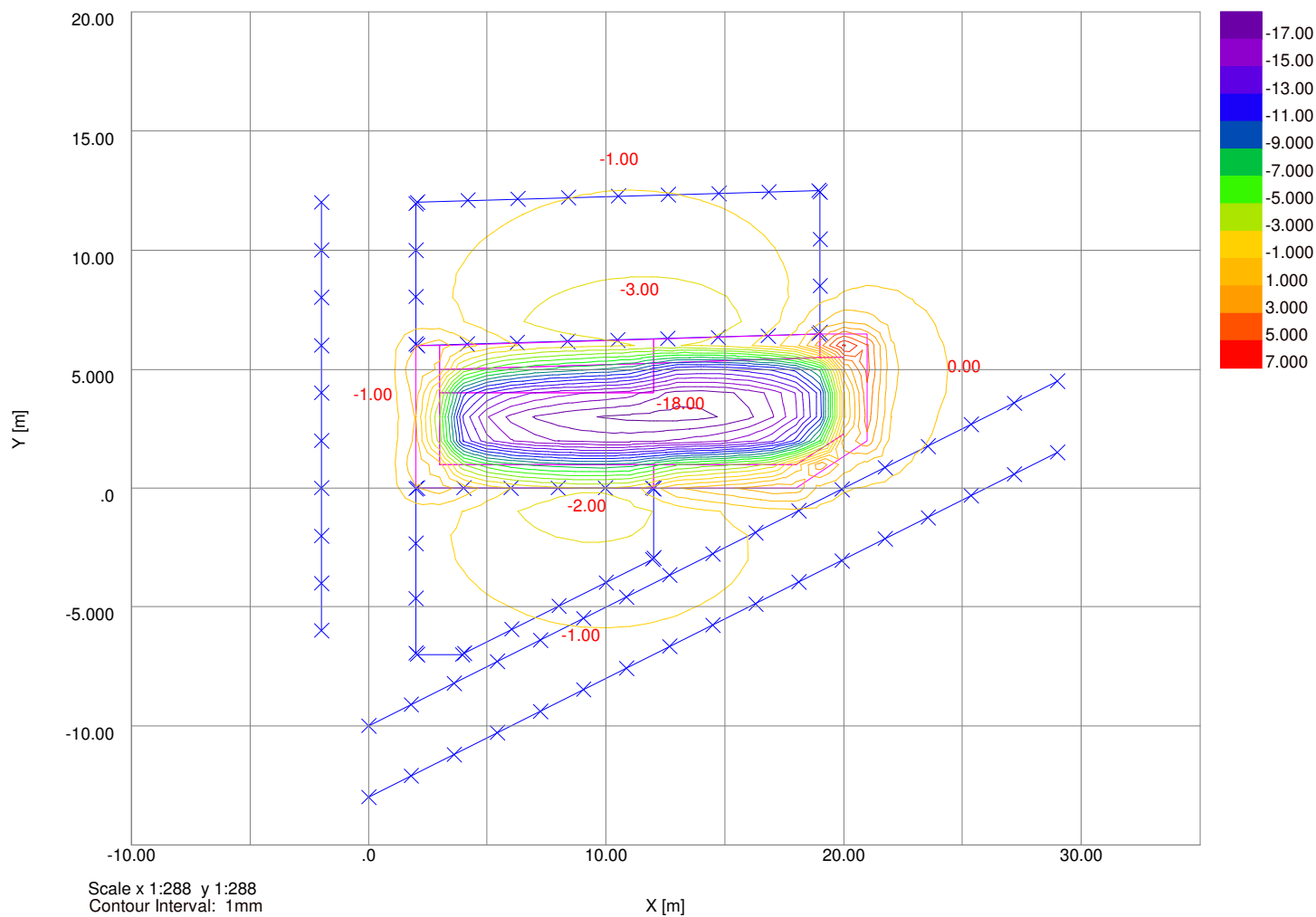
Polygonal Loads' Rectangles

No.	Centre of load X Y	Angle of local x from global X [Degrees]	Width x [m]	Depth y [m]
Load 1 : Basement Excavation - Main House (Edge 1 optimal)				
1	7.50000 2.50000	0.0	9.0000	3.0000
2	15.00000 3.17188	0.0	6.0000	4.3438
3	19.00000 3.55938	0.0	2.0000	3.8187
Load 2 : Basement Excavation - Existing Cellar (Edge 1 optimal)				
1	7.50000 4.56250	0.0	9.0000	1.1250
Load 3 : Underpinning (Edge 1 optimal)				
1	2.50000 3.50000	-90.000	5.0000	1.0000
2	7.00000 0.50000	-90.000	1.0000	10.000
Load 4 : Underpinning (Edge 1 optimal)				
1	15.00000 0.50000	0.0	6.0000	1.0000
2	18.14286 0.59405	0.0	0.28571	0.99762
3	18.42857 0.78214	0.0	0.28571	0.99286
4	18.71429 0.97024	0.0	0.28571	0.98810
5	19.00000 1.15833	0.0	0.28571	0.98333
6	19.28571 1.34643	0.0	0.28571	0.97857
7	19.57143 1.53452	0.0	0.28571	0.97381
8	19.85714 1.72262	0.0	0.28571	0.96905
9	20.50000 4.08333	0.0	1.0000	4.8333
10	19.50000 6.00000	0.0	1.0000	1.0000
Load 5 : Underpinning (Edge 1 optimal)				
1	15.50000 5.87500	-177.95	6.9688	0.99936
Load 6 : Underpinning (Edge 2 optimal)				
1	7.50000 5.62500	1.5911	8.9757	0.99961

Displacement Data

Ref.	Type	Name	Direction of Extrusion	Line/Line for extrusion			No. of intrvls across extrusion/line	Extrusion Depth	No. of intrvls along extrusion	Calculate	Show Detailed results			
				First point	Second point									
			X [m]	Y [m]	Z (level)	X [m]	Y [m]	Z (level)						
1	Grid	Grid 1	Global X	-20.00000	-20.00000	85.50000	N/A	26.00000	85.50000	46	60.00000	60	Yes	No
2	Grid	Grid 2	Global X	-20.00000	-20.00000	84.00000	N/A	26.00000	84.00000	46	60.00000	60	Yes	No
3	Line	Line 1	N/A	2.05000	0.00000	84.00000	11.95000	0.00000	84.00000	5	N/A	N/A	Yes	No
4	Line	Line 2	N/A	12.00000	-0.05000	84.00000	12.00000	-2.95000	84.00000	1	N/A	N/A	Yes	No
5	Line	Line 3	N/A	11.95000	-3.00000	84.00000	4.05000	-6.95000	84.00000	4	N/A	N/A	Yes	No
6	Line	Line 4	N/A	3.95000	-7.00000	84.00000	2.05000	-7.00000	84.00000	1	N/A	N/A	Yes	No
7	Line	Line 5	N/A	2.00000	-6.95000	84.00000	2.00000	-0.05000	84.00000	3	N/A	N/A	Yes	No
8	Line	Line 6	N/A	2.05000	6.00000	84.00000	18.95000	6.50000	84.00000	8	N/A	N/A	Yes	No
9	Line	Line 7	N/A	19.00000	6.55000	84.00000	19.00000	12.45000	84.00000	3	N/A	N/A	Yes	No
10	Line	Line 8	N/A	18.95000	12.50000	84.00000	2.05000	12.00000	84.00000	8	N/A	N/A	Yes	No
11	Line	Line 9	N/A	2.00000	11.95000	84.00000	2.00000	6.05000	84.00000	3	N/A	N/A	Yes	No
12	Line	Line 10	N/A	-2.00000	-6.00000	85.00000	-2.00000	12.00000	85.00000	9	N/A	N/A	Yes	No
13	Line	Line 11	N/A	0.00000	-10.00000	83.00000	29.00000	4.50000	83.00000	16	N/A	N/A	Yes	No
14	Line	Line 12	N/A	0.00000	-13.00000	83.00000	29.00000	1.50000	83.00000	16	N/A	N/A	Yes	No

Settlement Contours : Grid 1 at 85.5000m



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Problem Type

Problem Type : Tunnelling and Embedded Wall Excavations

Displacement Data

Type	Name	Direction of extrusion	Point/Line/Line for extrusion			No. of intervals across extrusion/line	Extrusion depth	No. of intervals along extrusion	Calculate	Surface type for tunnels	
			First point		Second point						
			X [m]	Y [m]	Z (level) [m]	X [m]	Y [m]	Z (level) [m]			
Grid	Grid 1	Global X	-20.00000	-20.00000	85.50000	-	26.00000	85.50000	46	60.00000	60 Yes Surface
Grid	Grid 2	Global X	-20.00000	-20.00000	84.00000	-	26.00000	84.00000	46	60.00000	60 Yes Surface
Line	Line 1	-	2.05000	0.00000	84.00000	11.95000	0.00000	84.00000	5	-	Yes Surface
Line	Line 2	-	12.00000	-0.05000	84.00000	12.00000	-2.95000	84.00000	1	-	Yes Surface
Line	Line 3	-	11.95000	-3.00000	84.00000	4.05000	-6.95000	84.00000	4	-	Yes Surface
Line	Line 4	-	3.95000	-7.00000	84.00000	2.05000	-7.00000	84.00000	1	-	Yes Surface
Line	Line 5	-	2.00000	-6.95000	84.00000	2.00000	-0.05000	84.00000	3	-	Yes Surface
Line	Line 6	-	2.05000	6.00000	84.00000	18.95000	6.50000	84.00000	8	-	Yes Surface
Line	Line 7	-	19.00000	6.55000	84.00000	19.00000	12.45000	84.00000	3	-	Yes Surface
Line	Line 8	-	18.95000	12.50000	84.00000	2.05000	12.00000	84.00000	8	-	Yes Surface
Line	Line 9	-	2.00000	11.95000	84.00000	2.00000	6.05000	84.00000	3	-	Yes Surface
Line	Line 10	-	-2.00000	-6.00000	85.00000	-2.00000	12.00000	85.00000	9	-	Yes Surface
Line	Line 11	-	0.00000	-10.00000	83.00000	29.00000	4.50000	83.00000	16	-	Yes Surface
Line	Line 12	-	0.00000	-13.00000	83.00000	29.00000	1.50000	83.00000	16	-	Yes Surface

Vertical Ground Movement Curves (Excavations)

Curve Name: No vertical ground movement
Coordinates: [Distance from wall / wall depth or max. excavation depth (x), Depth / wall depth or max. excavation depth (y), Settlement / wall depth or max. excavation depth (z) (%)]
 [0.000,0.000,0.000] [1.000,0.000,0.000] [0.000,1.000,0.000] [1.000,1.000,0.000]
Curve Fitting Method: Polynomial
x Order: 1
y Order: 0
Polynomial: z = 0.0x + 0.0
Coeff. of Determination: -2147483648.E+2147483647

Horizontal Ground Movement Curves (Excavations)

Curve Name: GEA Curve for 5 mm of horizontal deflection (after CIRIA 580 Fig. 2.11(a))
Coordinates: [Distance from wall / wall depth or max. excavation depth (x), Depth / wall depth or max. excavation depth (y), Horizontal movement / wall depth or max. excavation depth (z) (%)]
 [0.000,0.000,0.121] [4.000,0.000,0.000]
Curve Fitting Method: Polynomial
x Order: 1
y Order: 0
Polynomial: z = -3.03E-2x + 1.21E-1
Coeff. of Determination: 1.00

Polygonal Excavations

Excavation Name: New Excavation
Surface level [m]: 85.500
Contribution: Positive
Enabled: Yes
Surface movement curves which are selected are applied between surface and [m]: 81.400

Corner	x	y	Base Level	Stiffened	Previous Side	Next Side
	[m]	[m]	[m]	d	p1 p2*	d p1 p2*
1	2.0000	0.0	81.400	No	- - -	- - -
2	18.000	0.0	81.400	No	- - -	- - -
3	21.000	2.0000	81.400	No	- - -	- - -
4	21.000	6.5000	81.400	No	- - -	- - -
5	2.0000	6.0000	81.400	No	- - -	- - -

Side	Corner 1	Corner 2	Ground Movement Curve	
	x y	x y	Vertical	Horizontal
	[m] [m]	[m] [m]		
1	2.0000 0.0	18.000 0.0	No vertical ground movement	GEA Curve for 5 mm of horizontal deflection (after CIRIA 580 Fig. 2.11(a))
2	18.000 0.0	21.000 2.0000	No vertical ground movement	GEA Curve for 5 mm of horizontal deflection (after CIRIA 580 Fig. 2.11(a))
3	21.000 2.0000	21.000 6.5000	No vertical ground movement	GEA Curve for 5 mm of horizontal deflection (after CIRIA 580 Fig. 2.11(a))
4	21.000 6.5000	2.0000 6.0000	No vertical ground movement	GEA Curve for 5 mm of horizontal deflection (after CIRIA 580 Fig. 2.11(a))
5	2.0000 6.0000	2.0000 0.0	No vertical ground movement	GEA Curve for 5 mm of horizontal deflection (after CIRIA 580 Fig. 2.11(a))

Damage Category Strains

Name	0 (Negligible) to 1 (Very Slight)	1 (Very Slight) to 2 (Slight)	2 (Slight) to 3 (Moderate)	3 (Moderate) to 4 (Severe)
Burland Strain Limits	0.0	500.00E-6	750.00E-6	0.0015000

Specific Structures - Geometry

Structure Name	Sub-Structure Name	Displacement Line	Start Distance Along Line	End Distance Along Line	Vertical Offsets from Line for Vertical Movement Calculations	Vertical Displacement Limit	Damage Category Strains	Poisson's Ratio	E/G
			[m]	[m]	[m]	[mm]			
No 33	Party Wall (1)	Line 1	0.00000	9.89900	0.0	0.10000	Burland Strain Limits	0.20000	2.6000
No 33	Rear Elevation (2)	Line 2	0.00000	2.90000	0.0	0.10000	Burland Strain Limits	0.20000	2.6000
No 33	Far Elevation (3)	Line 3	0.00000	8.83200	0.0	0.10000	Burland Strain Limits	0.20000	2.6000
No 33	Far Elevation (4)	Line 4	0.00000	1.90000	0.0	0.10000	Burland Strain Limits	0.20000	2.6000



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Structure Name	Sub-Structure Name	Displacement Line	Start Distance Along Line	End Distance Along Line	Vertical Offsets from Line for Vertical	Vertical Displacement Limit	Damage Category	Strains	Poisson's Ratio	E/G
No 33	Frontage (5)	Line 5	0.00000	6.90000	0.0	0.10000	Burland Strain Limits		0.20000	2.6000
No 29	Party Wall (6)	Line 6	0.00000	16.90700	0.0	0.10000	Burland Strain Limits		0.20000	2.6000
No 29	Rear Elevation (7)	Line 7	0.00000	5.89900	0.0	0.10000	Burland Strain Limits		0.20000	2.6000
No 29	Far Elevation (8)	Line 8	0.00000	16.90700	0.0	0.10000	Burland Strain Limits		0.20000	2.6000
No 29	Frontage (9)	Line 9	0.00000	5.89900	0.0	0.10000	Burland Strain Limits		0.20000	2.6000
Willoughby Road	Roadway (10)	Line 10	0.00000	18.00000	0.0	0.10000	Burland Strain Limits		0.20000	2.6000
Willow Cottages	Retaining Wall (11)	Line 11	0.00000	32.42200	0.0	0.10000	Burland Strain Limits		0.20000	2.6000
Willow Cottages	Rear Elevation	Line 12	0.00000	32.42200	0.0	0.10000	Burland Strain Limits		0.20000	2.6000

Specific Structures - Bending Parameters

Structure Name	Sub-Structure Name	Height	Default Properties	Hogging			Sagging		
				2nd Moment of Area (per unit width)	Distance of Bending Strain from N.A.	Distance of N.A. from Edge of Beam in Tension	2nd Moment of Area (per unit width)	Distance of Bending Strain from N.A.	Distance of N.A. from Edge of Beam in Tension
No 33	Party Wall (1)	[m]	8.0000 Yes	[m ⁴]	[m]	[m]	[m ⁴]	[m]	[m]
No 33	Rear Elevation (2)	8.0000	Yes	170.67	8.0000	8.0000	42.667	4.0000	4.0000
No 33	Far Elevation (3)	8.0000	Yes	170.67	8.0000	8.0000	42.667	4.0000	4.0000
No 33	Far Elevation (4)	8.0000	Yes	170.67	8.0000	8.0000	42.667	4.0000	4.0000
No 33	Frontage (5)	8.0000	Yes	170.67	8.0000	8.0000	42.667	4.0000	4.0000
No 29	Party Wall (6)	12.000	Yes	576.00	12.000	12.000	144.00	6.0000	6.0000
No 29	Rear Elevation (7)	12.000	Yes	576.00	12.000	12.000	144.00	6.0000	6.0000
No 29	Far Elevation (8)	12.000	Yes	576.00	12.000	12.000	144.00	6.0000	6.0000
No 29	Frontage (9)	12.000	Yes	576.00	12.000	12.000	144.00	6.0000	6.0000
Willoughby Road	Roadway (10)	0.50000	Yes	0.041667	0.50000	0.50000	0.010417	0.25000	0.25000
Willow Cottages	Retaining Wall (11)	2.5000	Yes	5.2083	2.5000	2.5000	1.3021	1.2500	1.2500
Willow Cottages	Rear Elevation	8.0000	Yes	170.67	8.0000	8.0000	42.667	4.0000	4.0000

Building Segment Combinations

Structure Name	Sub-Structure Name	Vertical Offset from Line for Vertical Movement Calculations	Segment Start	Length	Curvature	Combined Segment
No structures have segments combined.						

Utility Strain Calculation Options

Neglect beneficial contribution of axial strains : No

Warnings

- 1 Sub-structure 6 crosses at least one excavation. Its building damage results in that area should be treated with caution.

Errors

None

Specific Building Damage Results - Horizontal Displacements

Structure: No 33 | Sub-structure: Party Wall (1)

Dist.	Coordinates			Displacements		
x	y	z	x	y	Horizontal displacement along the Line	Horizontal displacement perpendicular to Line
[m]	[m]	[m]	[mm]	[mm]	[mm]	[mm]
0.0	2.05000	0.00000	84.00000	0.0	4.9610	4.9610 d
1.9800	4.03000	0.00000	84.00000	0.0	4.9610	4.9610 d
3.9600	6.01000	0.00000	84.00000	0.0	4.9610	4.9610 d
5.9400	7.99000	0.00000	84.00000	0.0	4.9610	4.9610 d
7.9200	9.97000	0.00000	84.00000	0.0	4.9610	4.9610 d
9.9000	11.95000	0.00000	84.00000	0.0	4.9610	4.9610 d
d - Displacements include imported displacements.						

Structure: No 33 | Sub-structure: Rear Elevation (2)

Dist.	Coordinates			Displacements		
x	y	z	x	y	Horizontal displacement along the Line	Horizontal displacement perpendicular to Line
[m]	[m]	[m]	[mm]	[mm]	[mm]	[mm]
0.0	12.00000	-0.05000	84.00000	0.0	4.9459	0.0 d
2.9000	12.00000	-2.95000	84.00000	0.0	4.0686	0.0 d
d - Displacements include imported displacements.						

Structure: No 33 | Sub-structure: Far Elevation (3)

Dist.	Coordinates			Displacements		
x	y	z	x	y	Horizontal displacement along the Line	Horizontal displacement perpendicular to Line
[m]	[m]	[m]	[mm]	[mm]	[mm]	[mm]
0.0	11.95000	-3.00000	84.00000	0.0	4.0535	-3.6256 d
2.2081	9.97500	-3.98750	84.00000	0.0	3.7548	-3.3584 d
4.4162	8.00000	-4.97500	84.00000	0.0	3.4561	-3.0912 d
6.6244	6.02500	-5.96250	84.00000	0.0	3.1573	-2.8240 d
8.8325	4.05000	-6.95000	84.00000	0.0	2.8586	-2.5568 d
d - Displacements include imported displacements.						

Structure: No 33 | Sub-structure: Far Elevation (4)

Dist.	Coordinates			Displacements		
x	y	z	x	y	Horizontal displacement	Horizontal displacement



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along the Line		perpendicular to Line	
[m]	[mm]	[m]	[mm]
0.0	3.95000	-7.00000	84.00000
1.9000	2.05000	-7.00000	84.00000
d - Displacements include imported displacements.			

Structure: No 33 | Sub-structure: Frontage (5)

Dist.	Coordinates			Displacements		
x	y	z	x	y	Horizontal displacement along the Line	Horizontal displacement perpendicular to Line
[m]	[m]	[m]	[mm]	[mm]	[mm]	[mm]
0.0	2.00000	-6.95000	84.00000	0.0	2.8586	2.8586
2.3000	2.00000	-4.45000	84.00000	0.0	3.5544	3.5544
4.6000	2.00000	-2.35000	84.00000	0.0	4.2501	4.2501
6.9000	2.00000	-0.05000	84.00000	0.0	4.9459	4.9459
d - Displacements include imported displacements.						

Structure: No 29 | Sub-structure: Party Wall (6)

Dist.	Coordinates			Displacements		
x	y	z	x	y	Horizontal displacement along the Line	Horizontal displacement perpendicular to Line
[m]	[m]	[m]	[mm]	[mm]	[mm]	[mm]
0.0	2.05000	6.00000	84.00000	0.0	0.0	0.0
2.1134	4.16250	6.06250	84.00000	0.13041	-4.9576	-0.016204
4.2268	6.27500	6.12500	84.00000	0.13041	-4.9555	-0.016197
6.3403	8.38750	6.18750	84.00000	0.13035	-4.9534	-0.016191
8.4537	10.50000	6.25000	84.00000	0.13030	-4.9513	-0.016184
10.567	12.61250	6.31250	84.00000	0.13024	-4.9492	-0.016177
12.681	14.72500	6.37500	84.00000	0.13019	-4.9472	-0.016170
14.794	16.83750	6.43750	84.00000	0.13013	-4.9451	-0.016163
16.907	18.95000	6.50000	84.00000	0.13008	-4.9430	-0.016157
d - Displacements include imported displacements.						

Structure: No 29 | Sub-structure: Rear Elevation (7)

Dist.	Coordinates			Displacements		
x	y	z	x	y	Horizontal displacement along the Line	Horizontal displacement perpendicular to Line
[m]	[m]	[m]	[mm]	[mm]	[mm]	[mm]
0.0	19.00000	6.55000	84.00000	0.12969	-4.9283	-0.012969
1.9667	19.00000	8.51667	84.00000	0.11405	-4.3338	-0.011405
3.9333	19.00000	10.48333	84.00000	0.098401	-3.7392	-0.0098401
5.9000	19.00000	12.45000	84.00000	0.082756	-3.1447	-0.0082756
d - Displacements include imported displacements.						

Structure: No 29 | Sub-structure: Far Elevation (8)

Dist.	Coordinates			Displacements		
x	y	z	x	y	Horizontal displacement along the Line	Horizontal displacement perpendicular to Line
[m]	[m]	[m]	[mm]	[mm]	[mm]	[mm]
0.0	18.95000	12.00000	84.00000	0.082248	-3.1292	0.010228
2.1134	16.83750	12.43750	84.00000	0.082403	-3.1313	0.010235
4.2268	14.72500	12.37500	84.00000	0.082458	-3.1334	0.010242
6.3403	12.61250	12.31250	84.00000	0.082513	-3.1355	0.010249
8.4537	10.50000	12.25000	84.00000	0.082568	-3.1376	0.010255
10.567	8.38750	12.18750	84.00000	0.082623	-3.1397	0.010262
12.681	6.27500	12.12500	84.00000	0.082678	-3.1418	0.010269
14.794	4.16250	12.06250	84.00000	0.082733	-3.1438	0.010276
16.907	2.05000	12.00000	84.00000	0.082788	-3.1459	0.010283
d - Displacements include imported displacements.						

Structure: No 29 | Sub-structure: Frontage (9)

Dist.	Coordinates			Displacements		
x	y	z	x	y	Horizontal displacement along the Line	Horizontal displacement perpendicular to Line
[m]	[m]	[m]	[mm]	[mm]	[mm]	[mm]
0.0	2.00000	11.95000	84.00000	0.083175	-3.1607	3.1607
1.9667	2.00000	9.98333	84.00000	0.098820	-3.7552	3.7552
3.9333	2.00000	8.01667	84.00000	0.11446	-4.3497	4.3497
5.9000	2.00000	6.05000	84.00000	0.13011	-4.9442	4.9442
d - Displacements include imported displacements.						

Structure: Willoughby Road | Sub-structure: Roadway (10)

Dist.	Coordinates			Displacements		
x	y	z	x	y	Horizontal displacement along the Line	Horizontal displacement perpendicular to Line
[m]	[m]	[m]	[mm]	[mm]	[mm]	[mm]
0.0	-2.00000	-6.00000	85.00000	1.0405	1.7391	1.7391
2.0000	-2.00000	-4.00000	85.00000	1.6249	1.6249	1.6249
4.0000	-2.00000	-2.00000	85.00000	2.5432	1.0650	1.0650
6.0000	-2.00000	0.00000	85.00000	3.7510	0.0	0.0
8.0000	-2.00000	2.00000	85.00000	3.7510	0.0	0.0
10.000	-2.00000	4.00000	85.00000	3.7510	0.0	0.0
12.000	-2.00000	6.00000	85.00000	3.7510	0.0	0.0
14.000	-2.00000	8.00000	85.00000	2.5535	-1.0828	-1.0828
16.000	-2.00000	10.00000	85.00000	1.6407	-1.6520	-1.6520
18.000	-2.00000	12.00000	85.00000	1.0574	-1.7681	-1.7681
d - Displacements include imported displacements.						

Structure: Willow Cottages | Sub-structure: Retaining Wall (11)

Dist.	Coordinates			Displacements		
x	y	z	x	y	Horizontal displacement along the Line	Horizontal displacement perpendicular to Line
[m]	[m]	[m]	[mm]	[mm]	[mm]	[mm]
0.0	0.00000	-10.00000	83.00000	0.23576	1.6403	0.94445
2.0264	1.81250	-9.09375	83.00000	0.028999	2.1806	1.0011
4.0529	3.62500	-8.18750	83.00000	0.0	2.4843	1.1110
6.0793	5.43750	-7.28125	83.00000	0.0	2.7584	1.2336
8.1057	7.25000	-6.37500	83.00000	0.0	3.0326	1.3562



31 Willoughby Road

Combined Movements & Damage Assessment

Single Stage - Total - 5 mm limit on overall horizontal movements

Job No. Sheet No. Rev.

J15315

Drg. Ref.

Made by
MP

Date
23-Jan-2018

Checked

Dist.	Coordinates			Displacements		
	x	y	z	x	y	Horizontal displacement along the Horizontal displacement perpendicular
10.132	9.06250	-5.46875	83.00000	0.0	3.3067	1.4788
12.159	10.87500	-4.56250	83.00000	0.0	3.5808	1.6014
14.185	12.68750	-3.65625	83.00000	0.0	3.8550	1.7240
16.211	14.50000	-2.75000	83.00000	0.0	4.1291	1.8466
18.238	16.31250	-1.84375	83.00000	0.0	4.4033	1.9692
20.264	18.12500	-0.93750	83.00000	-0.58457	4.4979	1.4887
22.291	19.93750	-0.03125	83.00000	-2.5672	3.8508	-0.57404
24.317	21.75000	0.87500	83.00000	-2.5250	3.7875	-0.56461
26.344	23.56250	1.78125	83.00000	-4.0216	0.30159	-3.4622
28.370	25.37500	2.68750	83.00000	-3.6376	0.0	-3.2535
30.397	27.18750	3.59375	83.00000	-3.0893	0.0	-2.7631
32.423	29.00000	4.50000	83.00000	-2.5410	0.0	-2.2727
d - Displacements include imported displacements.						

Structure: Willow Cottages | Sub-structure: Rear Elevation

Dist.	Coordinates			Displacements		
	x	y	z	x	y	Horizontal displacement along the Horizontal displacement perpendicular to Line
[m]	[m]	[m]	[m]	[mm]	[mm]	[mm]
0.0	0.00000	-13.00000	83.00000	0.095453	0.88678	0.48196
2.0264	1.81250	-12.09375	83.00000	0.012852	1.2893	0.58811
4.0529	3.62500	-11.18750	83.00000	0.0	1.5768	0.70516
6.0793	5.43750	-10.28125	83.00000	0.0	1.8509	0.82776
8.1057	7.25000	-9.37500	83.00000	0.0	2.1251	0.95036
10.132	9.06250	-8.46875	83.00000	0.0	2.3992	1.0730
12.159	10.87500	-7.56250	83.00000	0.0	2.6733	1.1956
14.185	12.68750	-6.65625	83.00000	0.0	2.9475	1.3182
16.211	14.50000	-5.75000	83.00000	0.0	3.2216	1.4408
18.238	16.31250	-4.84375	83.00000	0.0	3.4958	1.5634
20.264	18.12500	-3.93750	83.00000	-0.11285	3.7351	1.5695
22.291	19.93750	-3.03125	83.00000	-2.0778	3.2436	-0.40784
24.317	21.75000	-2.12500	83.00000	-2.1061	3.1592	-0.47095
26.344	23.56250	-1.21875	83.00000	-2.2036	2.8268	-0.70675
28.370	25.37500	-0.31250	83.00000	-2.7009	1.4260	-1.7780
30.397	27.18750	0.59375	83.00000	-2.7336	0.57546	-2.1876
32.423	29.00000	1.50000	83.00000	-2.4645	0.13403	-2.1444
d - Displacements include imported displacements.						

Specific Building Damage Results - Vertical Displacements

Structure: No 33 | Sub-structure: Party Wall (1)

Dist.	Coordinates			Displacements
	x	y	z	
[m]	[m]	[m]	[m]	[mm]
Vertical Offset 1				
0.0	2.05000	0.00000	84.00000	1.0151 d
1.9800	4.03000	0.00000	84.00000	0.53161 d
3.9600	6.01000	0.00000	84.00000	-1.0012 d
5.9400	7.99000	0.00000	84.00000	-1.7176 d
7.9200	9.97000	0.00000	84.00000	-1.8480 d
9.9000	11.95000	0.00000	84.00000	-0.45568 d
d - Displacements include imported displacements.				

Structure: No 33 | Sub-structure: Rear Elevation (2)

Dist.	Coordinates			Displacements
	x	y	z	
[m]	[m]	[m]	[m]	[mm]
Vertical Offset 1				
0.0	12.00000	-0.05000	84.00000	-0.51925 d
2.9000	12.00000	-2.95000	84.00000	-1.5881 d
d - Displacements include imported displacements.				

Structure: No 33 | Sub-structure: Far Elevation (3)

Dist.	Coordinates			Displacements
	x	y	z	
[m]	[m]	[m]	[m]	[mm]
Vertical Offset 1				
0.0	11.95000	-3.00000	84.00000	-1.5804 d
2.2081	9.97500	-3.98750	84.00000	-1.4161 d
4.4162	8.00000	-4.97500	84.00000	-1.1369 d
6.6244	6.02500	-5.96250	84.00000	-0.86171 d
8.8325	4.05000	-6.95000	84.00000	-0.64037 d
d - Displacements include imported displacements.				

Structure: No 33 | Sub-structure: Far Eleavtion (4)

Dist.	Coordinates			Displacements
	x	y	z	
[m]	[m]	[m]	[m]	[mm]
Vertical Offset 1				
0.0	3.95000	-7.00000	84.00000	-0.63081 d
1.9000	2.05000	-7.00000	84.00000	-0.53054 d
d - Displacements include imported displacements.				

Structure: No 33 | Sub-structure: Frontage (5)

Dist.	Coordinates			Displacements
	x	y	z	
[m]	[m]	[m]	[m]	[mm]
Vertical Offset 1				
0.0	2.00000	-6.95000	84.00000	-0.53093 d
2.3000	2.00000	-4.65000	84.00000	-0.67414 d
4.6000	2.00000	-2.35000	84.00000	-0.74450 d
6.9000	2.00000	-0.05000	84.00000	0.77379 d
d - Displacements include imported displacements.				

Structure: No 29 | Sub-structure: Party Wall (6)

Dist.	Coordinates			Displacements
	x	y	z	
[m]	[m]	[m]	[m]	[mm]
Vertical Offset 1				
0.0	2.05000	6.00000	84.00000	1.0670 d
2.1134	4.16250	6.06250	84.00000	0.14641 d
4.2268	6.27500	6.12500	84.00000	-1.1961 d
6.3403	8.38750	6.18750	84.00000	-1.8010 d
8.4537	10.50000	6.25000	84.00000	-2.1250 d
10.567	12.61250	6.31250	84.00000	-2.1585 d



31 Willoughby Road
Combined Movements & Damage Assessment
Single Stage - Total - 5 mm limit on overall horizontal movements

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Dist.	Coordinates			Displacements
	x	y	z	
[m]	[m]	[m]	[m]	[mm]
12.691	14.72500	6.37500	84.00000	-1.7003 d
14.794	16.83750	6.43750	84.00000	-0.45772 d
16.907	18.95000	6.50000	84.00000	2.6887 d
d - Displacements include imported displacements.				
Structure: No 29 Sub-structure: Rear Elevation (7)				
Dist.	Coordinates			Displacements
	x	y	z	
[m]	[m]	[m]	[m]	[mm]
Vertical Offset 1				
0.0	19.00000	6.55000	84.00000	2.6019 d
1.9667	19.00000	8.51667	84.00000	-0.47675 d
3.9333	19.00000	10.48333	84.00000	-0.63034 d
5.9000	19.00000	12.45000	84.00000	-0.55446 d
d - Displacements include imported displacements.				
Structure: No 29 Sub-structure: Far Elevation (8)				
Dist.	Coordinates			Displacements
	x	y	z	
[m]	[m]	[m]	[m]	[mm]
Vertical Offset 1				
0.0	18.95000	12.50000	84.00000	-0.55610 d
2.1134	16.83750	12.43750	84.00000	-0.74301 d
4.2268	14.72500	12.37500	84.00000	-0.90915 d
6.3403	12.61250	12.31250	84.00000	-1.0134 d
8.4537	10.50000	12.25000	84.00000	-1.0408 d
10.567	8.38750	12.18750	84.00000	-0.99487 d
12.681	6.27500	12.12500	84.00000	-0.88879 d
14.794	4.16250	12.06250	84.00000	-0.74628 d
16.907	2.05000	12.00000	84.00000	-0.60042 d
d - Displacements include imported displacements.				
Structure: No 29 Sub-structure: Frontage (9)				
Dist.	Coordinates			Displacements
	x	y	z	
[m]	[m]	[m]	[m]	[mm]
Vertical Offset 1				
0.0	2.00000	11.95000	84.00000	-0.60011 d
1.9667	2.00000	9.98333	84.00000	-0.71210 d
3.9333	2.00000	8.01667	84.00000	-0.70802 d
5.9000	2.00000	6.05000	84.00000	0.82387 d
d - Displacements include imported displacements.				
Structure: Willoughby Road Sub-structure: Roadway (10)				
Dist.	Coordinates			Displacements
	x	y	z	
[m]	[m]	[m]	[m]	[mm]
Vertical Offset 1				
0.0	-2.00000	-6.00000	85.00000	-0.37969 d
2.0000	-2.00000	-4.00000	85.00000	-0.43287 d
4.0000	-2.00000	-2.00000	85.00000	-0.47282 d
6.0000	-2.00000	0.00000	85.00000	-0.49692 d
8.0000	-2.00000	2.00000	85.00000	-0.51338 d
10.000	-2.00000	4.00000	85.00000	-0.50989 d
12.000	-2.00000	6.00000	85.00000	-0.49070 d
14.000	-2.00000	8.00000	85.00000	-0.46913 d
16.000	-2.00000	10.00000	85.00000	-0.43283 d
18.000	-2.00000	12.00000	85.00000	-0.38254 d
d - Displacements include imported displacements.				
Structure: Willow Cottages Sub-structure: Retaining Wall (11)				
Dist.	Coordinates			Displacements
	x	y	z	
[m]	[m]	[m]	[m]	[mm]
Vertical Offset 1				
0.0	0.00000	-10.00000	83.00000	-0.32091 d
2.0264	1.81250	-9.09375	83.00000	-0.40975 d
4.0529	3.62500	-8.18750	83.00000	-0.52646 d
6.0793	5.43750	-7.28125	83.00000	-0.67770 d
8.1057	7.25000	-6.37500	83.00000	-0.86386 d
10.132	9.06250	-5.46875	83.00000	-1.0689 d
12.159	10.87500	-4.56250	83.00000	-1.2517 d
14.185	12.68750	-3.65625	83.00000	-1.3420 d
16.211	14.50000	-2.75000	83.00000	-1.2563 d
18.238	16.31250	-1.84375	83.00000	-0.90252 d
20.264	18.12500	-0.93750	83.00000	-0.18092 d
22.291	19.93750	-0.03125	83.00000	0.067871 d
24.317	21.75000	0.87500	83.00000	0.18737 d
26.344	23.56250	1.78125	83.00000	-0.048056 d
28.370	25.37500	2.68750	83.00000	-0.15200 d
30.397	27.18750	3.59375	83.00000	-0.17602 d
32.423	29.00000	4.50000	83.00000	-0.16770 d
d - Displacements include imported displacements.				
Structure: Willow Cottages Sub-structure: Rear Elevation				
Dist.	Coordinates			Displacements
	x	y	z	
[m]	[m]	[m]	[m]	[mm]
Vertical Offset 1				
0.0	0.00000	-13.00000	83.00000	-0.23508 d
2.0264	1.81250	-12.09375	83.00000	-0.29152 d
4.0529	3.62500	-11.18750	83.00000	-0.36120 d
6.0793	5.43750	-10.28125	83.00000	-0.44548 d
8.1057	7.25000	-9.37500	83.00000	-0.54330 d
10.132	9.06250	-8.46875	83.00000	-0.64873 d
12.159	10.87500	-7.56250	83.00000	-0.74882 d
14.185	12.68750	-6.65625	83.00000	-0.82363 d
16.211	14.50000	-5.75000	83.00000	-0.85008 d
18.238	16.31250	-4.84375	83.00000	-0.80956 d
20.264	18.12500	-3.93750	83.00000	-0.69882 d
22.291	19.93750	-3.03125	83.00000	-0.54863 d
24.317	21.75000	-2.12500	83.00000	-0.40579 d
26.344	23.56250	-1.21875	83.00000	-0.30091 d
28.370	25.37500	-0.31250	83.00000	-0.24324 d
30.397	27.18750	0.59375	83.00000	-0.20807 d
32.423	29.00000	1.50000	83.00000	-0.17951 d
d - Displacements include imported displacements.				
Specific Building Damage Results - All Segments				



31 Willoughby Road
Combined Movements & Damage Assessment
Single Stage - Total - 5 mm limit on overall horizontal movements

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Dist.	Coordinates			Displacements									
	x [m]	y [m]	z [m]	z [mm]									
Structure: No 33 Sub-structure: Party Wall (1)													
Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category		
[m] 0.0		[m] 1	[m] 0.0	3.2986	Sagging	[%] 0.012626	[%] 0.0	0.012098	0.0	774.15E-6	[m] 2586.4	0	
		2	3.2986	6.6004	Hogging	0.020912	0.0	0.020038	0.0	774.15E-6	2230.8	0	
												(Negligible)	
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.													
Structure: No 33 Sub-structure: Rear Elevation (2)													
Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category		
[m] 0.0		[m] 1	[m] 0.0	2.9000	Sagging	[%] 0.0	0.030250	0.030250	-302.41E-6	368.46E-6	-	0	
												(Negligible)	
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.													
Structure: No 33 Sub-structure: Far Elevation (3)													
Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category		
[m] 0.0		[m] 1	[m] 0.0	4.9521	Hogging	[%] 0.0012730	0.0060500	0.0066416	-60.496E-6	-126.44E-6	33710.	0	
		2	4.9521	3.8799	Sagging	594.70E-6	0.0060500	0.0064685	-60.496E-6	-124.63E-6	73504.	0	
												(Negligible)	
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.													
Structure: No 33 Sub-structure: Far Elevation (4)													
Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category		
[m] 0.0		[m] 1	[m] 0.0	1.9000	Hogging	[%] 0.0	0.0	0.0	0.0	-52.773E-6	-	0	
												(Negligible)	
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.													
Structure: No 33 Sub-structure: Frontage (5)													
Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category		
[m] 0.0		[m] 1	[m] 0.0	0.92896	Hogging	[%] 0.0	0.030250	0.030250	-302.41E-6	62.244E-6	17292.	0	
		2	0.92896	5.9710	Hogging	0.016574	0.030250	0.039438	-302.41E-6	-659.93E-6	2690.2	0	
												(Negligible)	
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.													
Structure: No 29 Sub-structure: Party Wall (6)													
Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category		
[m] 0.0		[m] 1	[m] 0.0	2.7127	Sagging	[%] 0.0034296	-597.28E-6	0.0031653	7.6674E-6	635.21E-6	6275.9	0	
		2	2.7127	14.194	Hogging	0.024946	0.0	0.022893	0.0	-0.0014888	2045.2	0	
												(Negligible)	
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.													
Structure: No 29 Sub-structure: Rear Elevation (7)													
Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category		
[m] 0.0		[m] 1	[m] 0.0	5.2510	Hogging	[%] 0.035851	0.030229	0.051882	-302.20E-6	0.0015649	1075.4	1 (Very Slight)	
		2	5.2510	0.64799	None	0.0	0.030229	0.030229	-302.20E-6	-38.569E-6	8712.9	0	
												(Negligible)	
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.													
Structure: No 29 Sub-structure: Far Elevation (8)													
Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category		
[m] 0.0		[m] 1	[m] 0.0	16.276	Hogging	[%] 0.0026944	0.0	0.0025149	0.0	88.442E-6	61888.	0	
		2	16.276	0.63105	None	0.0	0.0	0.0	0.0	-69.012E-6	903500.	0	
												(Negligible)	
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.													
Structure: No 29 Sub-structure: Frontage (9)													
Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category		
[m] 0.0		[m] 1	[m] 0.0	0.66002	None	[%] 0.0	0.030229	0.030229	-302.20E-6	56.930E-6	16333.	0	
												(Negligible)	



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Vertical Offset from Line for Vertical Movement	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category
	2	0.66002	5.2390	Hogging	0.018685	0.030229	0.037971	-302.20E-6	-778.69E-6	2057.3	0 (Negligible)

Tensile horizontal strains are +ve, compressive horizontal strains are -ve.

Structure: Willoughby Road | Sub-structure: Roadway (10)

Vertical Offset from Line for Vertical Movement	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category
Calculations											
[m]			[m]		[%]	[%]	[%]			[m]	
0.0	1	0.0	18.000	Hogging	735.84E-6	-0.019485	0.0038970	541.68E-6	26.590E-6	252930.	0 (Negligible)

Tensile horizontal strains are +ve, compressive horizontal strains are -ve.

Structure: Willow Cottages | Sub-structure: Retaining Wall (11)

Vertical Offset from Line for Vertical Movement	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category
Calculations											
[m]			[m]		[%]	[%]	[%]			[m]	
0.0	1	0.0	8.7118	Sagging	866.72E-6	0.0051473	0.0062768	-60.496E-6	101.20E-6	124630.	0 (Negligible)
	2	8.7118	10.395	Hogging	0.0056822	0.0035630	0.012183	237.19E-6	-356.18E-6	15322.	0 (Negligible)
	3	19.107	7.3102	Sagging	0.0058154	-0.071379	0.014314	0.0014319	-356.18E-6	15123.	0 (Negligible)
	4	26.417	6.0053	Hogging	0.0010346	0.019677	0.021073	-241.94E-6	51.289E-6	51003.	0 (Negligible)

Tensile horizontal strains are +ve, compressive horizontal strains are -ve.

Structure: Willow Cottages | Sub-structure: Rear Elevation

Vertical Offset from Line for Vertical Movement	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category
Calculations											
[m]			[m]		[%]	[%]	[%]			[m]	
0.0	1	0.0	9.0225	Sagging	372.95E-6	0.0058062	0.0062941	-60.496E-6	52.024E-6	293650.	0 (Negligible)
	2	9.0225	13.095	Hogging	0.0020969	-0.0095025	0.0021748	976.71E-6	-74.189E-6	65113.	0 (Negligible)
	3	22.117	10.305	Sagging	0.0010051	-0.018496	0.0037215	976.71E-6	-74.189E-6	106570.	0 (Negligible)

Tensile horizontal strains are +ve, compressive horizontal strains are -ve.

Specific Building Damage Results - Critical Values for All Segments within Each Sub-Structure

Structure: No 33 | Sub-structure: Party Wall (1)

Vertical Offset from Line for Vertical Movement	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category
Calculations										
[m]	[%]	[%]		[mm]	[%]			[m]	[m]	
0.0	0.020912	0.0	774.15E-6	1.8466	0.020038	0.0	774.15E-6	2230.8	2586.4	0 (Negligible)

Structure: No 33 | Sub-structure: Rear Elevation (2)

Vertical Offset from Line for Vertical Movement	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category
Calculations										
[m]	[%]	[%]		[mm]	[%]			[m]	[m]	
0.0	0.0	0.030250	368.46E-6	1.5881	0.030250	-302.41E-6	368.46E-6	-	-	0 (Negligible)

Structure: No 33 | Sub-structure: Far Elevation (3)

Vertical Offset from Line for Vertical Movement	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category
Calculations										
[m]	[%]	[%]		[mm]	[%]			[m]	[m]	
0.0	0.0012730	0.0060500	-126.44E-6	1.5804	0.0066416	-60.496E-6	-126.44E-6	33710.	73504.	0 (Negligible)

Structure: No 33 | Sub-structure: Far Elevation (4)

Vertical Offset from Line for Vertical Movement	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category
Calculations										
[m]	[%]	[%]		[mm]	[%]			[m]	[m]	
0.0	0.0	0.0	-52.773E-6	0.63081	0.0	0.0	-52.773E-6	-	-	0 (Negligible)

Structure: No 33 | Sub-structure: Frontage (5)

Vertical Offset from Line for Vertical Movement	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category
Calculations										
[m]	[%]	[%]		[mm]	[%]			[m]	[m]	
0.0	0.016574	0.030250	-659.93E-6	0.77379	0.039438	-302.41E-6	-659.93E-6	2690.2	-	0 (Negligible)

Structure: No 29 | Sub-structure: Party Wall (6)

Vertical Offset from Line for Vertical Movement	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category
Calculations										

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Single Stage - Total - 5 mm limit on overall horizontal movements

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Structure Name	Parameter	Critical Sub-Structure	Critical Segment	Start	End	Curvature	Max Slope	Max Settlement	Max Tensile Strain	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category
Willow Cottages	Max Slope	Rear Elevation	2	9.0225	22.117	Hogging	74.189E-6	0.84946	0.0021748	65113.	-	0 (Negligible)
	Max Settlement	Rear Elevation	2	9.0225	22.117	Hogging	74.189E-6	0.84946	0.0021748	65113.	-	0 (Negligible)
	Max Tensile Strain	Rear Elevation	1	0.0	9.0225	Sagging	52.024E-6	0.59099	0.0062941	-	293650.	0 (Negligible)
	Min Radius of Curvature (Hogging)	Rear Elevation	2	9.0225	22.117	Hogging	74.189E-6	0.84946	0.0021748	65113.	-	0 (Negligible)
	Min Radius of Curvature (Sagging)	Rear Elevation	3	22.117	32.422	Sagging	74.189E-6	0.56149	0.0037215	-	106570.	0 (Negligible)

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Problem Type

Problem Type : Tunnelling and Embedded Wall Excavations

Displacement Data

Type	Name	Direction of extrusion	Point/Line/Line for extrusion		No. of intervals across extrusion/line	Extrusion depth	No. of intervals along extrusion	Calculate	Surface type for tunnels
			First point	Second point					
			X [m]	Y [m]	Z (level) [m]	X [m]	Y [m]	Z (level) [m]	
Grid	Grid 1	Global X	-20.00000	-20.00000	85.50000	-	26.00000	85.50000	46 60.00000 60 Yes Surface
Grid	Grid 2	Global X	-20.00000	-20.00000	84.00000	-	26.00000	84.00000	46 60.00000 60 Yes Surface
Line	Line 1	-	2.05000	0.00000	84.00000	11.95000	0.00000	84.00000	5 - Yes Surface
Line	Line 2	-	12.00000	-0.05000	84.00000	12.00000	-2.95000	84.00000	1 - Yes Surface
Line	Line 3	-	11.95000	-3.00000	84.00000	4.05000	-6.95000	84.00000	4 - Yes Surface
Line	Line 4	-	3.95000	-7.00000	84.00000	2.05000	-7.00000	84.00000	1 - Yes Surface
Line	Line 5	-	2.00000	-6.95000	84.00000	2.00000	-0.05000	84.00000	3 - Yes Surface
Line	Line 6	-	2.05000	6.00000	84.00000	18.95000	6.50000	84.00000	8 - Yes Surface
Line	Line 7	-	19.00000	6.55000	84.00000	19.00000	12.45000	84.00000	3 - Yes Surface
Line	Line 8	-	18.95000	12.50000	84.00000	2.05000	12.00000	84.00000	8 - Yes Surface
Line	Line 9	-	2.00000	11.95000	84.00000	2.00000	6.05000	84.00000	3 - Yes Surface
Line	Line 10	-	-2.00000	-6.00000	85.00000	-2.00000	12.00000	85.00000	9 - Yes Surface
Line	Line 11	-	0.00000	-10.00000	83.00000	29.00000	4.50000	83.00000	16 - Yes Surface
Line	Line 12	-	0.00000	-13.00000	83.00000	29.00000	1.50000	83.00000	16 - Yes Surface

Vertical Ground Movement Curves (Excavations)

Curve Name: No vertical ground movement
Coordinates: [Distance from wall / wall depth or max. excavation depth (x), Depth / wall depth or max. excavation depth (y), Settlement / wall depth or max. excavation depth (z) (%)]
 [0.000,0.000,0.000] [1.000,0.000,0.000] [0.000,1.000,0.000] [1.000,1.000,0.000]
Curve Fitting Method: Polynomial
x Order: 1
y Order: 0
Polynomial: z = 0.0x + 0.0
Coeff. of Determination: -2147483648.E+2147483647

Horizontal Ground Movement Curves (Excavations)

Curve Name: GEA Curve for 10 mm of horizontal deflection (after CIRIA 580 Fig. 2.11(a))
Coordinates: [Distance from wall / wall depth or max. excavation depth (x), Depth / wall depth or max. excavation depth (y), Horizontal movement / wall depth or max. excavation depth (z) (%)]
 [0.000,0.000,0.242] [4.000,0.000,0.000]
Curve Fitting Method: Polynomial
x Order: 1
y Order: 0
Polynomial: z = -6.05E-2x + 2.42E-1
Coeff. of Determination: 1.00

Polygonal Excavations

Excavation Name: New Excavation
Surface level [m]: 85.500
Contribution: Positive
Enabled: Yes
Surface movement curves which are selected are applied between surface and [m]: 81.400

Corner	x	y	Base Level	Stiffened	Previous Side	Next Side
	[m]	[m]	[m]	d	p1 p2*	d p1 p2*
				[m]	[%] [%]	[m] [%] [%]
1	2.0000	0.0	81.400	No	- -	- -
2	18.000	0.0	81.400	No	- -	- -
3	21.000	2.0000	81.400	No	- -	- -
4	21.000	6.5000	81.400	No	- -	- -
5	2.0000	6.0000	81.400	No	- -	- -

Side	Corner 1	Corner 2	Ground Movement Curve	
	x y	x y	Vertical	Horizontal
	[m] [m]	[m] [m]		
1	2.0000 0.0	18.000 0.0	No vertical ground movement	GEA Curve for 10 mm of horizontal deflection (after CIRIA 580 Fig. 2.11(a))
2	18.000 0.0	21.000 2.0000	No vertical ground movement	GEA Curve for 10 mm of horizontal deflection (after CIRIA 580 Fig. 2.11(a))
3	21.000 2.0000	21.000 6.5000	No vertical ground movement	GEA Curve for 10 mm of horizontal deflection (after CIRIA 580 Fig. 2.11(a))
4	21.000 6.5000	2.0000 6.0000	No vertical ground movement	GEA Curve for 10 mm of horizontal deflection (after CIRIA 580 Fig. 2.11(a))
5	2.0000 6.0000	2.0000 0.0	No vertical ground movement	GEA Curve for 10 mm of horizontal deflection (after CIRIA 580 Fig. 2.11(a))

Damage Category Strains

Name	0 (Negligible) to 1 (Very Slight)	1 (Very Slight) to 2 (Slight)	2 (Slight) to 3 (Moderate)	3 (Moderate) to 4 (Severe)
Burland Strain Limits	0.0	500.00E-6	750.00E-6	0.0015000

Specific Structures - Geometry

Structure Name	Sub-Structure Name	Displacement Line	Start Distance Along Line	End Distance Along Line	Vertical Offsets from Line for Vertical Movement Calculations	Vertical Displacement Limit	Damage Category Strains	Poisson's Ratio	E/G
			[m]	[m]	[m]	[mm]			
No 33	Party Wall (1)	Line 1	0.00000	9.89900	0.0	0.10000	Burland Strain Limits	0.20000	2.6000
No 33	Rear Elevation (2)	Line 2	0.00000	2.90000	0.0	0.10000	Burland Strain Limits	0.20000	2.6000
No 33	Far Elevation (3)	Line 3	0.00000	8.83200	0.0	0.10000	Burland Strain Limits	0.20000	2.6000
No 33	Far Elevation (4)	Line 4	0.00000	1.90000	0.0	0.10000	Burland Strain Limits	0.20000	2.6000



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Structure Name	Sub-Structure Name	Displacement Line	Start Distance Along Line	End Distance Along Line	Vertical Offsets from Line for Vertical	Vertical Displacement Limit Sensitivity	Damage Category	Strains	Poisson's Ratio	E/G
No 33	Frontage (5)	Line 5	0.00000	6.90000	0.0	0.10000	Burland Strain Limits	0.20000	2.6000	
No 29	Party Wall (6)	Line 6	0.00000	16.90700	0.0	0.10000	Burland Strain Limits	0.20000	2.6000	
No 29	Rear Elevation (7)	Line 7	0.00000	5.89900	0.0	0.10000	Burland Strain Limits	0.20000	2.6000	
No 29	Far Elevation (8)	Line 8	0.00000	16.90700	0.0	0.10000	Burland Strain Limits	0.20000	2.6000	
No 29	Frontage (9)	Line 9	0.00000	5.89900	0.0	0.10000	Burland Strain Limits	0.20000	2.6000	
Willoughby Road	Roadway (10)	Line 10	0.00000	18.00000	0.0	0.10000	Burland Strain Limits	0.20000	2.6000	
Willow Cottages	Retaining Wall (11)	Line 11	0.00000	32.42200	0.0	0.10000	Burland Strain Limits	0.20000	2.6000	
Willow Cottages	Rear Elevation	Line 12	0.00000	32.42200	0.0	0.10000	Burland Strain Limits	0.20000	2.6000	

Specific Structures - Bending Parameters

Structure Name	Sub-Structure Name	Height	Default Properties	Hogging			Sagging		
				2nd Moment of Area (per unit width)	Distance of Bending Strain from N.A.	Distance of N.A. from Edge of Beam in Tension	2nd Moment of Area (per unit width)	Distance of Bending Strain from N.A.	Distance of N.A. from Edge of Beam in Tension
No 33	Party Wall (1)	[m]	8.0000 Yes	[m ⁴]	[m]	[m]	[m ⁴]	[m]	[m]
No 33	Rear Elevation (2)	8.0000	Yes	170.67	8.0000	8.0000	42.667	4.0000	4.0000
No 33	Far Elevation (3)	8.0000	Yes	170.67	8.0000	8.0000	42.667	4.0000	4.0000
No 33	Far Elevation (4)	8.0000	Yes	170.67	8.0000	8.0000	42.667	4.0000	4.0000
No 33	Frontage (5)	8.0000	Yes	170.67	8.0000	8.0000	42.667	4.0000	4.0000
No 29	Party Wall (6)	12.000	Yes	576.00	12.000	12.000	144.00	6.0000	6.0000
No 29	Rear Elevation (7)	12.000	Yes	576.00	12.000	12.000	144.00	6.0000	6.0000
No 29	Far Elevation (8)	12.000	Yes	576.00	12.000	12.000	144.00	6.0000	6.0000
No 29	Frontage (9)	12.000	Yes	576.00	12.000	12.000	144.00	6.0000	6.0000
Willoughby Road	Roadway (10)	0.50000	Yes	0.041667	0.50000	0.50000	0.010417	0.25000	0.25000
Willow Cottages	Retaining Wall (11)	2.5000	Yes	5.2083	2.5000	2.5000	1.3021	1.2500	1.2500
Willow Cottages	Rear Elevation	8.0000	Yes	170.67	8.0000	8.0000	42.667	4.0000	4.0000

Building Segment Combinations

Structure Name	Sub-Structure Name	Vertical Offset from Line for Vertical Movement Calculations [m]	Segment Start [m]	Length [m]	Curvature	Combined Segment
No structures have segments combined.						

Utility Strain Calculation Options

Neglect beneficial contribution of axial strains : No

Warnings

- 1 Sub-structure 6 crosses at least one excavation. Its building damage results in that area should be treated with caution.

Errors

None

Specific Building Damage Results - Horizontal Displacements

Structure: No 33 | Sub-structure: Party Wall (1)

Dist.	Coordinates			Displacements		
	x	y	z	x	y	
				Horizontal displacement along the Line	Horizontal displacement perpendicular to Line	
	[m]	[m]	[m]	[mm]	[mm]	
	0.0	2.05000	0.00000	84.00000	0.0	9.9220 d
1.9800	4.03000	0.00000	84.00000	0.0	9.9220	d
3.9600	6.01000	0.00000	84.00000	0.0	9.9220	d
5.9400	7.99000	0.00000	84.00000	0.0	9.9220	d
7.9200	9.97000	0.00000	84.00000	0.0	9.9220	d
9.9000	11.95000	0.00000	84.00000	0.0	9.9220	d

d - Displacements include imported displacements.

Structure: No 33 | Sub-structure: Rear Elevation (2)

Dist.	Coordinates			Displacements		
	x	y	z	x	y	
				Horizontal displacement along the Line	Horizontal displacement perpendicular to Line	
	[m]	[m]	[m]	[mm]	[mm]	
	0.0	12.00000	-0.05000	84.00000	0.0	9.8917
2.9000	12.00000	-2.95000	84.00000	0.0	8.1372	0.0 d

d - Displacements include imported displacements.

Structure: No 33 | Sub-structure: Far Elevation (3)

Dist.	Coordinates			Displacements		
	x	y	z	x	y	
				Horizontal displacement along the Line	Horizontal displacement perpendicular to Line	
	[m]	[m]	[m]	[mm]	[mm]	
	0.0	11.95000	-3.00000	84.00000	0.0	8.1070
2.2081	9.97500	-3.98750	84.00000	0.0	7.5096	-3.6256
4.4162	8.00000	-4.97500	84.00000	0.0	6.9121	-3.3584
6.6244	6.02500	-5.96250	84.00000	0.0	6.3147	-3.0912
8.8325	4.05000	-6.95000	84.00000	0.0	5.7172	-2.8240

d - Displacements include imported displacements.

Structure: No 33 | Sub-structure: Far Elevation (4)

Dist.	Coordinates			Displacements		
	x	y	z	x	y	
				Horizontal displacement	Horizontal displacement	



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		along the Line		perpendicular to Line	
[m]	[m]	[m]	[mm]	[mm]	[mm]
0.0	3.95000	-7.00000	84.00000	0.0	5.6870
1.9000	2.05000	-7.00000	84.00000	0.0	5.6870
d - Displacements include imported displacements.					

Structure: No 33 | Sub-structure: Frontage (5)

Dist.	Coordinates			Displacements		
	x	y	z	x	y	
				Horizontal displacement along the Line	Horizontal displacement perpendicular to Line	
[m]	[m]	[m]	[m]	[mm]	[mm]	[mm]
0.0	2.00000	-6.95000	84.00000	0.0	5.7172	5.7172
2.3000	2.00000	-6.95000	84.00000	0.0	7.1087	7.1087
4.6000	2.00000	-2.35000	84.00000	0.0	8.5002	8.5002
6.9000	2.00000	-0.05000	84.00000	0.0	9.8917	9.8917
d - Displacements include imported displacements.						

Structure: No 29 | Sub-structure: Party Wall (6)

Dist.	Coordinates			Displacements		
	x	y	z	x	y	
				Horizontal displacement along the Line	Horizontal displacement perpendicular to Line	
[m]	[m]	[m]	[m]	[mm]	[mm]	[mm]
0.0	2.05000	6.00000	84.00000	0.0	0.0	0.0
2.1134	4.16250	6.06250	84.00000	0.26093	-9.9152	-9.9152
4.2268	6.27500	6.12500	84.00000	0.26082	-9.9110	-9.9110
6.3403	8.38750	6.18750	84.00000	0.26071	-9.9068	-9.9068
8.4537	10.50000	6.25000	84.00000	0.26060	-9.9027	-9.9027
10.567	12.61250	6.31250	84.00000	0.26049	-9.8985	-9.8985
12.681	14.72500	6.37500	84.00000	0.26038	-9.8943	-9.8943
14.794	16.83750	6.43750	84.00000	0.26027	-9.8901	-9.8901
16.907	18.95000	6.50000	84.00000	0.26016	-9.8860	-9.8860
d - Displacements include imported displacements.						

Structure: No 29 | Sub-structure: Rear Elevation (7)

Dist.	Coordinates			Displacements		
	x	y	z	x	y	
				Horizontal displacement along the Line	Horizontal displacement perpendicular to Line	
[m]	[m]	[m]	[m]	[mm]	[mm]	[mm]
0.0	19.00000	6.55000	84.00000	0.25938	-9.8565	-9.8565
1.9667	19.00000	8.51667	84.00000	0.22809	-8.6675	-8.6675
3.9333	19.00000	10.48333	84.00000	0.19680	-7.4785	-7.4785
5.9000	19.00000	12.45000	84.00000	0.16551	-6.2895	-6.2895
d - Displacements include imported displacements.						

Structure: No 29 | Sub-structure: Far Elevation (8)

Dist.	Coordinates			Displacements		
	x	y	z	x	y	
				Horizontal displacement along the Line	Horizontal displacement perpendicular to Line	
[m]	[m]	[m]	[m]	[mm]	[mm]	[mm]
0.0	18.95000	12.50000	84.00000	0.16470	-6.2585	-6.2585
2.1134	16.83750	12.43750	84.00000	0.16481	-6.2626	-6.2626
4.2268	14.72500	12.37500	84.00000	0.16492	-6.2668	-6.2668
6.3403	12.61250	12.31250	84.00000	0.16503	-6.2710	-6.2710
8.4537	10.50000	12.25000	84.00000	0.16514	-6.2752	-6.2752
10.567	8.38750	12.18750	84.00000	0.16525	-6.2793	-6.2793
12.681	6.27500	12.12500	84.00000	0.16536	-6.2835	-6.2835
14.794	4.16250	12.06250	84.00000	0.16547	-6.2877	-6.2877
16.907	2.05000	12.00000	84.00000	0.16558	-6.2919	-6.2919
d - Displacements include imported displacements.						

Structure: No 29 | Sub-structure: Frontage (9)

Dist.	Coordinates			Displacements		
	x	y	z	x	y	
				Horizontal displacement along the Line	Horizontal displacement perpendicular to Line	
[m]	[m]	[m]	[m]	[mm]	[mm]	[mm]
0.0	2.00000	11.95000	84.00000	0.16635	-6.3213	-6.3213
1.9667	2.00000	9.98333	84.00000	0.19764	-7.5103	-7.5103
3.9333	2.00000	8.01667	84.00000	0.22893	-8.6993	-8.6993
5.9000	2.00000	6.05000	84.00000	0.26022	-9.8883	-9.8883
d - Displacements include imported displacements.						

Structure: Willoughby Road | Sub-structure: Roadway (10)

Dist.	Coordinates			Displacements		
	x	y	z	x	y	
				Horizontal displacement along the Line	Horizontal displacement perpendicular to Line	
[m]	[m]	[m]	[m]	[mm]	[mm]	[mm]
0.0	-2.00000	-6.00000	85.00000	2.0810	3.4783	3.4783
2.0000	-2.00000	-4.00000	85.00000	3.2498	3.2498	3.2498
4.0000	-2.00000	-2.00000	85.00000	5.0863	2.1300	2.1300
6.0000	-2.00000	0.00000	85.00000	7.5020	0.0	0.0
8.0000	-2.00000	2.00000	85.00000	7.5020	0.0	0.0
10.000	-2.00000	4.00000	85.00000	7.5020	0.0	0.0
12.000	-2.00000	6.00000	85.00000	7.5020	0.0	0.0
14.000	-2.00000	8.00000	85.00000	5.1070	-2.1656	-2.1656
16.000	-2.00000	10.00000	85.00000	3.2814	-3.3040	-3.3040
18.000	-2.00000	12.00000	85.00000	2.1148	-3.5363	-3.5363
d - Displacements include imported displacements.						

Structure: Willow Cottages | Sub-structure: Retaining Wall (11)

Dist.	Coordinates			Displacements		
	x	y	z	x	y	
				Horizontal displacement along the Line	Horizontal displacement perpendicular to Line	
[m]	[m]	[m]	[m]	[mm]	[mm]	[mm]
0.0	0.00000	-10.00000	83.00000	0.47152	3.2807	1.8889
2.0264	1.81250	-9.09375	83.00000	0.057998	4.3611	2.0022
4.0529	3.62500	-8.18750	83.00000	0.0	4.9686	2.2220
6.0793	5.43750	-7.28125	83.00000	0.0	5.5168	2.4672
8.1057	7.25000	-6.37500	83.00000	0.0	6.0651	2.7124



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Dist.	Coordinates			Displacements		
x	y	z	x	y	Horizontal displacement along the	Horizontal displacement perpendicular
10.132	9.06250	-5.46875	83.00000	0.0	6.6134	2.9576
12.159	10.87500	-4.56250	83.00000	0.0	7.1617	3.2028
14.185	12.68750	-3.65625	83.00000	0.0	7.7100	3.4480
16.211	14.50000	-2.75000	83.00000	0.0	8.2582	3.6932
18.238	16.31250	-1.84375	83.00000	0.0	8.8065	3.9384
20.264	18.12500	-0.93750	83.00000	-1.1691	8.9958	2.9773
22.291	19.93750	-0.03125	83.00000	-5.1343	7.7015	-1.1481
24.317	21.75000	0.87500	83.00000	-5.0500	7.5750	-1.1292
26.344	23.56250	1.78125	83.00000	-8.0432	6.0317	-6.9243
28.370	25.37500	2.68750	83.00000	-7.2751	0.0	-6.5071
30.397	27.18750	3.59375	83.00000	-6.1786	0.0	-5.5263
32.423	29.00000	4.50000	83.00000	-5.0820	0.0	-4.5455
d - Displacements include imported displacements.						

Structure: Willow Cottages | Sub-structure: Rear Elevation

Dist.	Coordinates			Displacements		
x	y	z	x	y	Horizontal displacement along the Line	Horizontal displacement perpendicular to Line
[m]	[m]	[m]	[mm]	[mm]	[mm]	[mm]
0.0	0.00000	-13.00000	83.00000	0.19091	1.7736	0.96391
2.0264	1.81250	-12.09375	83.00000	0.025704	2.5787	1.1762
4.0529	3.62500	-11.18750	83.00000	0.0	3.1536	1.4103
6.0793	5.43750	-10.28125	83.00000	0.0	3.7019	1.6555
8.1057	7.25000	-9.37500	83.00000	0.0	4.2501	1.9007
10.132	9.06250	-8.46875	83.00000	0.0	4.7984	2.1459
12.159	10.87500	-7.56250	83.00000	0.0	5.3467	2.3911
14.185	12.68750	-6.65625	83.00000	0.0	5.8950	2.6363
16.211	14.50000	-5.75000	83.00000	0.0	6.4432	2.8815
18.238	16.31250	-4.84375	83.00000	0.0	6.9915	3.1267
20.264	18.12500	-3.93750	83.00000	-0.22569	7.4703	3.1389
22.291	19.93750	-3.03125	83.00000	-4.1556	6.4873	-0.81567
24.317	21.75000	-2.12500	83.00000	-4.2123	6.3184	-0.94190
26.344	23.56250	-1.21875	83.00000	-4.4072	5.6536	-1.4135
28.370	25.37500	-0.31250	83.00000	-5.4018	2.8520	-3.5560
30.397	27.18750	0.59375	83.00000	-5.4671	1.1509	-4.3753
32.423	29.00000	1.50000	83.00000	-4.9291	0.26806	-4.2888
d - Displacements include imported displacements.						

Specific Building Damage Results - Vertical Displacements

Structure: No 33 | Sub-structure: Party Wall (1)

Dist.	Coordinates			Displacements
	x	y	z	z
[m]	[m]	[m]	[m]	[mm]

Vertical Offset 1			
0.0	2.05000	0.00000	84.00000
1.9800	4.03000	0.00000	84.00000
3.9600	6.01000	0.00000	84.00000
5.9400	7.99000	0.00000	84.00000
7.9200	9.97000	0.00000	84.00000
9.9000	11.95000	0.00000	84.00000
d - Displacements include imported displacements.			

Structure: No 33 | Sub-structure: Rear Elevation (2)

Dist.	Coordinates			Displacements
	x	y	z	z
[m]	[m]	[m]	[m]	[mm]

Vertical Offset 1			
0.0	12.00000	-0.05000	84.00000
2.9000	12.00000	-2.95000	84.00000
d - Displacements include imported displacements.			

Structure: No 33 | Sub-structure: Far Elevation (3)

Dist.	Coordinates			Displacements
	x	y	z	z
[m]	[m]	[m]	[m]	[mm]

Vertical Offset 1			
0.0	11.95000	-3.00000	84.00000
2.2081	9.97500	-3.98750	84.00000
4.4162	8.00000	-4.97500	84.00000
6.6244	6.02500	-5.96250	84.00000
8.8325	4.05000	-6.95000	84.00000
d - Displacements include imported displacements.			

Structure: No 33 | Sub-structure: Far Eleavtion (4)

Dist.	Coordinates			Displacements
	x	y	z	z
[m]	[m]	[m]	[m]	[mm]

Vertical Offset 1			
0.0	3.95000	-7.00000	84.00000
1.9000	2.05000	-7.00000	84.00000
d - Displacements include imported displacements.			

Structure: No 33 | Sub-structure: Frontage (5)

Dist.	Coordinates			Displacements
	x	y	z	z
[m]	[m]	[m]	[m]	[mm]

Vertical Offset 1			
0.0	2.00000	-6.95000	84.00000
2.3000	2.00000	-4.65000	84.00000
4.6000	2.00000	-2.35000	84.00000
6.9000	2.00000	-0.05000	84.00000
d - Displacements include imported displacements.			

Structure: No 29 | Sub-structure: Party Wall (6)

Dist.	Coordinates			Displacements
	x	y	z	z
[m]	[m]	[m]	[m]	[mm]

Vertical Offset 1			
0.0	2.05000	6.00000	84.00000
2.1134	4.16250	6.06250	84.00000
4.2268	6.27500	6.12500	84.00000
6.3403	8.38750	6.18750	84.00000
8.4537	10.50000	6.25000	84.00000
10.567	12.61250	6.31250	84.00000



31 Willoughby Road
Combined Movements & Damage Assessment
Single Stage - Total - 10 mm limit on overall horizontal movements

Job No.	Sheet No.	Rev.
J15315		
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Dist.	Coordinates			Displacements
	x	y	z	
[m]	[m]	[m]	[m]	[mm]
12.691	14.72500	6.37500	84.00000	-1.7003 d
14.794	16.83750	6.43750	84.00000	-0.45772 d
16.907	18.95000	6.50000	84.00000	2.6887 d
d - Displacements include imported displacements.				
Structure: No 29 Sub-structure: Rear Elevation (7)				
Dist.	Coordinates			Displacements
	x	y	z	
[m]	[m]	[m]	[m]	[mm]
Vertical Offset 1				
0.0	19.00000	6.55000	84.00000	2.6019 d
1.9667	19.00000	8.51667	84.00000	-0.47675 d
3.9333	19.00000	10.48333	84.00000	-0.63034 d
5.9000	19.00000	12.45000	84.00000	-0.55446 d
d - Displacements include imported displacements.				
Structure: No 29 Sub-structure: Far Elevation (8)				
Dist.	Coordinates			Displacements
	x	y	z	
[m]	[m]	[m]	[m]	[mm]
Vertical Offset 1				
0.0	18.95000	12.50000	84.00000	-0.55610 d
2.1134	16.83750	12.43750	84.00000	-0.74301 d
4.2268	14.72500	12.37500	84.00000	-0.90915 d
6.3403	12.61250	12.31250	84.00000	-1.0134 d
8.4537	10.50000	12.25000	84.00000	-1.0408 d
10.567	8.38750	12.18750	84.00000	-0.99487 d
12.681	6.27500	12.12500	84.00000	-0.88879 d
14.794	4.16250	12.06250	84.00000	-0.74628 d
16.907	2.05000	12.00000	84.00000	-0.60042 d
d - Displacements include imported displacements.				
Structure: No 29 Sub-structure: Frontage (9)				
Dist.	Coordinates			Displacements
	x	y	z	
[m]	[m]	[m]	[m]	[mm]
Vertical Offset 1				
0.0	2.00000	11.95000	84.00000	-0.60011 d
1.9667	2.00000	9.98333	84.00000	-0.71210 d
3.9333	2.00000	8.01667	84.00000	-0.70802 d
5.9000	2.00000	6.05000	84.00000	0.82387 d
d - Displacements include imported displacements.				
Structure: Willoughby Road Sub-structure: Roadway (10)				
Dist.	Coordinates			Displacements
	x	y	z	
[m]	[m]	[m]	[m]	[mm]
Vertical Offset 1				
0.0	-2.00000	-6.00000	85.00000	-0.37969 d
2.0000	-2.00000	-4.00000	85.00000	-0.43287 d
4.0000	-2.00000	-2.00000	85.00000	-0.47282 d
6.0000	-2.00000	0.00000	85.00000	-0.49692 d
8.0000	-2.00000	2.00000	85.00000	-0.51338 d
10.000	-2.00000	4.00000	85.00000	-0.50989 d
12.000	-2.00000	6.00000	85.00000	-0.49070 d
14.000	-2.00000	8.00000	85.00000	-0.46913 d
16.000	-2.00000	10.00000	85.00000	-0.43283 d
18.000	-2.00000	12.00000	85.00000	-0.38254 d
d - Displacements include imported displacements.				
Structure: Willow Cottages Sub-structure: Retaining Wall (11)				
Dist.	Coordinates			Displacements
	x	y	z	
[m]	[m]	[m]	[m]	[mm]
Vertical Offset 1				
0.0	0.00000	-10.00000	83.00000	-0.32091 d
2.0264	1.81250	-9.09375	83.00000	-0.40975 d
4.0529	3.62500	-8.18750	83.00000	-0.52646 d
6.0793	5.43750	-7.28125	83.00000	-0.67770 d
8.1057	7.25000	-6.37500	83.00000	-0.86386 d
10.132	9.06250	-5.46875	83.00000	-1.0689 d
12.159	10.87500	-4.56250	83.00000	-1.2517 d
14.185	12.68750	-3.65625	83.00000	-1.3420 d
16.211	14.50000	-2.75000	83.00000	-1.2563 d
18.238	16.31250	-1.84375	83.00000	-0.90252 d
20.264	18.12500	-0.93750	83.00000	-0.18092 d
22.291	19.93750	-0.03125	83.00000	0.067871 d
24.317	21.75000	0.87500	83.00000	0.18737 d
26.344	23.56250	1.78125	83.00000	-0.048056 d
28.370	25.37500	2.68750	83.00000	-0.15200 d
30.397	27.18750	3.59375	83.00000	-0.17602 d
32.423	29.00000	4.50000	83.00000	-0.16770 d
d - Displacements include imported displacements.				
Structure: Willow Cottages Sub-structure: Rear Elevation				
Dist.	Coordinates			Displacements
	x	y	z	
[m]	[m]	[m]	[m]	[mm]
Vertical Offset 1				
0.0	0.00000	-13.00000	83.00000	-0.23508 d
2.0264	1.81250	-12.09375	83.00000	-0.29152 d
4.0529	3.62500	-11.18750	83.00000	-0.36120 d
6.0793	5.43750	-10.28125	83.00000	-0.44548 d
8.1057	7.25000	-9.37500	83.00000	-0.54330 d
10.132	9.06250	-8.46875	83.00000	-0.64873 d
12.159	10.87500	-7.56250	83.00000	-0.74882 d
14.185	12.68750	-6.65625	83.00000	-0.82363 d
16.211	14.50000	-5.75000	83.00000	-0.85008 d
18.238	16.31250	-4.84375	83.00000	-0.80956 d
20.264	18.12500	-3.93750	83.00000	-0.69882 d
22.291	19.93750	-3.03125	83.00000	-0.54863 d
24.317	21.75000	-2.12500	83.00000	-0.40579 d
26.344	23.56250	-1.21875	83.00000	-0.30091 d
28.370	25.37500	-0.31250	83.00000	-0.24324 d
30.397	27.18750	0.59375	83.00000	-0.20807 d
32.423	29.00000	1.50000	83.00000	-0.17951 d
d - Displacements include imported displacements.				
Specific Building Damage Results - All Segments				



31 Willoughby Road
Combined Movements & Damage Assessment
Single Stage - Total - 10 mm limit on overall horizontal movements

Job No.	Sheet No.	Rev.
J15315		
Drg. Ref.		
Made by MP	Date 23-Jan-2018	Checked

Dist.	Coordinates		Displacements									
[m]	x [m]	y [m]	z [m]	z [mm]								
Structure: No 33 Sub-structure: Party Wall (1)												
Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category	
[m] 0.0		[m] 1	[m] 0.0	[m] 3.2986	[%] Sagging	[%] 0.012626	[%] 0.0	[%] 0.012098	0.0	[m] 774.15E-6	2586.4	0
		2	3.2986	6.6004	Hogging	0.020912	0.0	0.020038	0.0	774.15E-6	2230.8	0
(Negligible)												
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.												
Structure: No 33 Sub-structure: Rear Elevation (2)												
Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category	
[m] 0.0		[m] 1	[m] 0.0	[m] 2.9000	[%] None	[%] 0.0	[%] 0.060500	[%] 0.060500	-604.63E-6	[m] 368.35E-6	-	1 (Very Slight)
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.												
Structure: No 33 Sub-structure: Far Elevation (3)												
Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category	
[m] 0.0		[m] 1	[m] 0.0	[m] 4.9521	[%] Hogging	[%] 0.0012729	[%] 0.012100	[%] 0.012692	-120.99E-6	[m] -126.43E-6	33714.	0
		2	4.9521	3.8799	Sagging	594.67E-6	0.012100	0.012518	-120.99E-6	-124.62E-6	73513.	0
(Negligible)												
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.												
Structure: No 33 Sub-structure: Far Eleavtion (4)												
Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category	
[m] 0.0		[m] 1	[m] 0.0	[m] 1.9000	[%] Hogging	[%] 0.0	[%] 0.0	[%] 0.0	0.0	[m] -52.773E-6	-	0
(Negligible)												
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.												
Structure: No 33 Sub-structure: Frontage (5)												
Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category	
[m] 0.0		[m] 1	[m] 0.0	[m] 0.92896	[%] Hogging	[%] 0.0	[%] 0.060500	[%] 0.060500	-604.63E-6	[m] 62.225E-6	17302.	1 (Very Slight)
		2	0.92896	5.9710	Hogging	0.016569	0.060500	0.069685	-604.63E-6	-659.73E-6	2691.8	1 (Very Slight)
(Negligible)												
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.												
Structure: No 29 Sub-structure: Party Wall (6)												
Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category	
[m] 0.0		[m] 1	[m] 0.0	[m] 2.7127	[%] Sagging	[%] 0.0034295	[%] -0.0011946	[%] 0.0029824	15.335E-6	[m] 635.21E-6	6276.0	0
		2	2.7127	14.194	Hogging	0.024946	0.0	0.022893	0.0	-0.0014888	2045.2	0
(Negligible)												
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.												
Structure: No 29 Sub-structure: Rear Elevation (7)												
Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category	
[m] 0.0		[m] 1	[m] 0.0	[m] 5.2510	[%] Hogging	[%] 0.035840	[%] 0.060458	[%] 0.074873	-604.22E-6	[m] 0.0015645	1076.0	1 (Very Slight)
		2	5.2510	0.64799	Hogging	0.0	0.060458	0.060458	-604.22E-6	-38.557E-6	8718.2	1 (Very Slight)
(Negligible)												
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.												
Structure: No 29 Sub-structure: Far Elevation (8)												
Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category	
[m] 0.0		[m] 1	[m] 0.0	[m] 16.276	[%] Hogging	[%] 0.0026944	[%] 0.0	[%] 0.0025152	0.0	[m] 88.442E-6	61888.	0
		2	16.276	0.63105	Sagging	0.0	0.0	0.0	0.0	-69.012E-6	903500.	0
(Negligible)												
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.												
Structure: No 29 Sub-structure: Frontage (9)												
Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category	
[m] 0.0		[m] 1	[m] 0.0	[m] 0.66002	[%] None	[%] 0.0	[%] 0.060458	[%] 0.060458	-604.22E-6	[m] 56.912E-6	16343.	1 (Very Slight)

31 Willoughby Road Combined Movements & Damage Assessment Single Stage - Total - 10 mm limit on overall horizontal movements

Job No.	Sheet No.	Rev.
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Drg. Ref.		
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Vertical Offset from Line for Vertical Movement	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category
	2	0.66002	5.2390	Hogging	0.018679	0.060458	0.066656	-604.22E-6	-778.46E-6	2058.6	1 (Very Slight)
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.											
Structure: Willoughby Road Sub-structure: Roadway (10)											
Vertical Offset from Line for Vertical Movement	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category
Calculations											
[m] 0.0	1	[m] 0.0	[m] 18.000	Hogging	[%] 735.98E-6	[%] -0.038970	[%] 0.0077940	0.0010840	26.592E-6	[m] 252880.	0 (Negligible)
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.											
Structure: Willow Cottages Sub-structure: Retaining Wall (11)											
Vertical Offset from Line for Vertical Movement	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category
Calculations											
[m] 0.0	1	[m] 0.0	[m] 8.7118	Sagging	[%] 866.65E-6	[%] 0.010295	[%] 0.011424	-120.99E-6	101.19E-6	[m] 124650.	0 (Negligible)
	2	8.7118	10.394	Hogging	0.0056816	0.0071281	0.015748	474.49E-6	-356.26E-6	15322.	0 (Negligible)
	3	19.106	7.3109	Sagging	0.0058202	-0.14274	0.028568	0.0028680	-356.26E-6	15103.	0 (Negligible)
	4	26.417	6.0050	Hogging	0.0010343	0.039355	0.040751	-483.77E-6	51.284E-6	50931.	0 (Negligible)
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.											
Structure: Willow Cottages Sub-structure: Rear Elevation											
Vertical Offset from Line for Vertical Movement	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category
Calculations											
[m] 0.0	1	[m] 0.0	[m] 9.0225	Sagging	[%] 372.92E-6	[%] 0.011612	[%] 0.012100	-120.99E-6	52.021E-6	[m] 293690.	0 (Negligible)
	2	9.0225	13.094	Hogging	0.0020968	-0.018994	0.0039384	0.0019553	-74.261E-6	65116.	0 (Negligible)
	3	22.116	10.306	Sagging	0.0010054	-0.037004	0.0074120	0.0019553	-74.261E-6	106560.	0 (Negligible)
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.											
Specific Building Damage Results - Critical Values for All Segments within Each Sub-Structure											
Structure: No 33 Sub-structure: Party Wall (1)											
Vertical Offset from Line for Vertical Movement	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category	
Calculations											
[m] 0.0	[%] 0.020912	[%] 0.0	774.15E-6	[mm] 1.8466	[%] 0.020038	0.0	774.15E-6	[m] 2230.8	[m] 2586.4	0	(Negligible)
Structure: No 33 Sub-structure: Rear Elevation (2)											
Vertical Offset from Line for Vertical Movement	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category	
Calculations											
[m] 0.0	[%] 0.0	[%] 0.060500	368.35E-6	[mm] 1.5881	[%] 0.060500	-604.63E-6	368.35E-6	[m] -	[m] -	1	(Very Slight)
Structure: No 33 Sub-structure: Far Elevation (3)											
Vertical Offset from Line for Vertical Movement	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category	
Calculations											
[m] 0.0	[%] 0.0012729	[%] 0.012100	-126.43E-6	[mm] 1.5804	[%] 0.012692	-120.99E-6	-126.43E-6	[m] 33714.	[m] 73513.	0	(Negligible)
Structure: No 33 Sub-structure: Far Elevation (4)											
Vertical Offset from Line for Vertical Movement	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category	
Calculations											
[m] 0.0	[%] 0.0	[%] 0.0	-52.773E-6	[mm] 0.63081	[%] 0.0	0.0	-52.773E-6	[m] -	[m] -	0	(Negligible)
Structure: No 33 Sub-structure: Frontage (5)											
Vertical Offset from Line for Vertical Movement	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category	
Calculations											
[m] 0.0	[%] 0.016569	[%] 0.060500	-659.73E-6	[mm] 0.77379	[%] 0.069685	-604.63E-6	-659.73E-6	[m] 2691.8	[m] -	1	(Very Slight)
Structure: No 29 Sub-structure: Party Wall (6)											
Vertical Offset from Line for Vertical Movement	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category	
Calculations											

[m]	[°]	[°]	[mm]	[°]	[m]	[m]			
0.0	0.024946	-0.0011946	-0.0014888	2.6881	0.022893	15.335E-6	-0.0014888	2045.2	6276.0 0 (Negligible)

Structure: No 29 | Sub-structure: Rear Elevation (7)

Vertical Offset from Line for Vertical Movement Calculations	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category
[m]	[%]	[%]		[mm]	[%]			[m]	[m]	
0.0	0.035840	0.060458	0.0015645	2.6019	0.074873	-604.22E-6	0.0015645	1076.0	- 1	(Very Slight)

Structure: No 29 | Sub-structure: Far Elevation (8)

Vertical Offset from Line for Vertical Movement Calculations	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Rogging)	Min Radius of Curvature (Sagging)	Damage Category
[m]	[%]	[%]		[mm]	[%]			[m]	[m]	
0.0	0.0026944	0.0	88.442E-6	1.0399	0.0025152	0.0	88.442E-6	61888.	903500.0	0 (Negligible)

Structure: No 29 | Sub-structure: Frontage (9)

Vertical Offset from Line for Vertical Movement Calculations	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category
	[m]	[%]		[mm]	[%]				[m]	
0.0	0.018679	0.060458	-778.46E-6	0.82309	0.066656	-604.22E-6	-778.46E-6	2058.6	-1	(Very Slight)

Structure: Willoughby Road | Sub-structure: Roadway (10)

Vertical Offset from Line for Vertical Movement Calculations	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category
[m] 0.0	[%] 735.98E-6	[%] -0.038970	26.592E-6	[mm] 0.51338	[%] 0.0077940	0.0010840	26.592E-6	252880.	[m] - 0	(Negligible)

Structure: Willow Cottages | Sub-structure: Retaining Wall (11)

Vertical Offset from Line for Vertical Movement Calculations	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max of Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category
[m]	[%]	[%]		[mm]	[%]				[m]	
0.0	0.0058202	-0.14274	-356.26E-6	1.3414	0.040751	0.0028680	-356.26E-6	15322.	15103.0	0 (Negligible)

Structure: Willow Cottages | Sub-structure: Rear Elevation

Vertical Offset from Line for Vertical Movement Calculations	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (hogging)	Min Radius of Curvature (sagging)	Damage Category
[m]	[%]	[%]		[mm]	[%]			[m]	[m]	
0.0	0.0020968	-0.037004	-74.261E-6	0.84944	0.012100	0.0019553	-74.261E-6	65116.	106560.0	0 (Negligible)

Specific Building Damage Results - Critical Segments within Each Structure

Structure Name	Parameter	Critical Sub-Structure	Critical Segment	Start	End	Curvature	Max Slope	Max Settlement	Max Tensile Strain	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category
No 33	Max Slope	Party Wall (1)	1	0.0	3.2986	Sagging	774.15E-6	1.0151	0.012098	-	2586.4	0 (Negligible)
	Max Settlement	Party Wall (1)	2	3.2986	9.8990	Hogging	774.15E-6	1.8466	0.020038	2230.8	-	0 (Negligible)
	Max Tensile Strain	Frontage (5)	2	0.92896	6.9000	Hogging	659.77E-6	0.77379	0.069685	2691.8	-	1 (Very Slight)
	Min Radius of Curvature (Hogging)	Party Wall (1)	2	3.2986	9.8990	Hogging	774.15E-6	1.8466	0.020038	2230.8	-	0 (Negligible)
	Min Radius of Curvature (Sagging)	Party Wall (1)	1	0.0	3.2986	Sagging	774.15E-6	1.0151	0.012098	-	2586.4	0 (Negligible)
No 29	Max Slope	Rear Elevation (7)	1	0.0	5.2510	Hogging	0.0015645	2.6019	0.074873	1076.0	-	1 (Very Slight)
	Max Settlement	Party Wall (6)	2	2.7127	16.907	Hogging	0.0014888	2.6881	0.022893	2045.2	-	0 (Negligible)
	Max Tensile Strain	Rear Elevation (7)	1	0.0	5.2510	Hogging	0.0015645	2.6019	0.074873	1076.0	-	1 (Very Slight)
	Min Radius of Curvature (Hogging)	Rear Elevation (7)	1	0.0	5.2510	Hogging	0.0015645	2.6019	0.074873	1076.0	-	1 (Very Slight)
	Min Radius of Curvature (Sagging)	Party Wall (6)	1	0.0	2.7127	Sagging	635.21E-6	1.0670	0.0029824	-	6276.0	0 (Negligible)
Willoughby Road	Max Slope	Roadway (10)	1	0.0	18.000	Hogging	26.592E-6	0.51338	0.0077940	252880.	-	0 (Negligible)
	Max Settlement	Roadway (10)	1	0.0	18.000	Hogging	26.592E-6	0.51338	0.0077940	252880.	-	0 (Negligible)
	Max Tensile Strain	Roadway (10)	1	0.0	18.000	Hogging	26.592E-6	0.51338	0.0077940	252880.	-	0 (Negligible)
	Min Radius of Curvature (Hogging)	Roadway (10)	1	0.0	18.000	Hogging	26.592E-6	0.51338	0.0077940	252880.	-	0 (Negligible)
	Min Radius of Curvature (Sagging)		-	-	-	-	-	-	-	-	-	-
Willow Cottages	Max Slope	Retaining Wall (11)	2	8.7118	19.106	Hogging	356.26E-6	1.3414	0.015748	15322.	-	0 (Negligible)
	Max Settlement	Retaining Wall (11)	2	8.7118	19.106	Hogging	356.26E-6	1.3414	0.015748	15322.	-	0 (Negligible)
	Max Tensile Strain	Retaining Wall (11)	4	26.417	32.422	Hogging	51.284E-6	0.17592	0.040751	50931.	-	0 (Negligible)
	Min Radius of Curvature (Hogging)	Retaining Wall (11)	2	8.7118	19.106	Hogging	356.26E-6	1.3414	0.015748	15322.	-	0 (Negligible)
	Min Radius of Curvature (Sagging)	Retaining Wall (11)	3	19.106	26.417	Sagging	356.26E-6	0.59337	0.028568	-	15103.	0 (Negligible)



31 Willoughby Road

Combined Movements & Damage Assessment

Single Stage - Total - 10 mm limit on overall horizontal movements

Job No.	Sheet No.	Rev.
J15315		
Drg. Ref.		
Made by MP	Date 23-Jan-2018	Checked

Structure Name	Parameter	Critical Sub-Structure	Critical Segment	Start	End	Curvature	Max Slope	Max Settlement	Max Tensile Strain	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category
Willow Cottages	Max Slope	Rear Elevation	2	9.0225	22.116	Hogging	74.261E-6	0.84944	0.0039384	65116.	-	0 (Negligible)
	Max Settlement	Rear Elevation	2	9.0225	22.116	Hogging	74.261E-6	0.84944	0.0039384	65116.	-	0 (Negligible)
	Max Tensile Strain	Rear Elevation	1	0.0	9.0225	Sagging	52.021E-6	0.59099	0.012100	-	293690.	0 (Negligible)
	Min Radius of Curvature (Hogging)	Rear Elevation	2	9.0225	22.116	Hogging	74.261E-6	0.84944	0.0039384	65116.	-	0 (Negligible)
	Min Radius of Curvature (Sagging)	Rear Elevation	3	22.116	32.422	Sagging	74.261E-6	0.56155	0.0074120	-	106560.	0 (Negligible)

Hydrogeological Assessment (ref 1109/LJE120118, dated January 2018)

Matt Penfold
Geotechnical & Environmental Associates
Widbury Barn
Widbury Hill
Ware
SG12 7QE

Your Ref:

Our Ref: 1109/LJE120118

Direct phone: 07595 023149

For the attention of: Matt Penfold

12th January 2018

31 Willoughby Road – BIA Audit Groundwater Issues

Dear Matt,

I have addressed the groundwater related comments raised within the Basement Impact Assessment (BIA) audit undertaken by Campbell Reith in December 2017. I have also addressed the concerns raised by local residents in response to planning application 2016/7146/P.

Chord Environmental specialise in the provision of hydrogeological services with extensive experience in the UK supporting both private and public sector clients. I am a geologist and hydrogeologist and have a BSc. in geology from the University of Bristol, a MSc. in hydrogeology from the University of East Anglia and am also a Chartered Geologist and fellow of the Geological Society. I am Managing Director at Chord Environmental and was previously a Technical Director with Paulex Environmental Consulting and managed Hyder Consulting (UK) Ltd's groundwater team.

I have been a hydrogeologist for 20 years. During that time I have advised on over 150 basement developments. Much of my career has been spent assessing the impact of development on the quality and quantity of groundwater resources. I have worked for both promoters and regulators of schemes and have acted as an expert witness for the Highways Agency and on BIA schemes.

Campbell Reith Audit

An audit of the Basement Impact Report prepared by Geotechnical and Environmental Associates (GEA) submitted with the planning application (Ref J15315 issue 1) was undertaken by Campbell Reith in March 2017. A revised version of the GEA BIA report was issued in August 2017 (Ref J15315 issue 1) which addressed the issues raised by the Campbell Reith audit. Subsequently Campbell Reith undertook an additional audit on the revised BIA which was issued in December 2017.

In summary, with regards to outstanding groundwater issues, the audit concluded that although the revised BIA provided further hydrogeological assessment, it had not demonstrated that the proposed basement will not cause groundwater to impact local structures e.g. Willow Cottages. Specifically;

- Groundwater flow rate and direction should be ascertained and considered with reference to the proposed structure and the potential impacts on neighbouring structures. Seasonal groundwater levels should be considered and further monitoring undertaken, as required.
- Campbell Reith have interpreted the presented groundwater level monitoring data to show a consistent level of 82.50m Ordnance Datum (OD) across the site.
- Campbell Reith consider 82.5m OD to correspond with a level close to, or just below, the lower ground floor level in Willow Cottages, the residents of which report anecdotally existing groundwater ingress issues. There is (anecdotally) a groundwater level within a well at 38 Willow Cottages of 83.60m OD, which is 1.10m above their lower ground floor level.

Residents Concerns

I have reviewed the groundwater based concerns to the proposed basement development which have been raised by the local residents. These are detailed within Appendix 1 of the Campbell Reith audit and summarised below:

- The local residents have an understanding that there are underground flows/tributaries/streams/watercourses present beneath the site.
- The proposed basement will realign/re-route existing underground water flows or streams resulting in 1) destabilisation of listed retaining wall, 2) loss of fines causing undermining of Willow Cottages and 3) weakening of load bearing brickwork.
- The proposed basement will have a damming effect on groundwater flows and cause flooding.
- The perceived high water level causes saturated lawns.
- The 1866 Ordnance Survey map identifies four wells following the downward slope of Willow Road suggesting an underground watercourse running close to or along the boundary of Willow Cottages and numbers 31 and 33 Willoughby Road.
- Water seepages into existing underground structures will be increased by the proposed basement construction.

Review of Published Geological and Hydrogeological Site Setting

The Site is mapped by the British Geological Survey (Sheet 256 – North London) as lying on the boundary between the Eocene Claygate Formation, which forms the top of the London Clay Formation, and Unit D of the London Clay Formation as shown on Figure 1 below. The sands of the Bagshot Formation overlie the Claygate Formation and outcrop c.320m up gradient of the site at an elevation of c. 110m OD, with the boundary running along the line of Streatley Place. The Bagshot Formation sands cap the top of hill on which Hampstead and the adjacent heath lie.

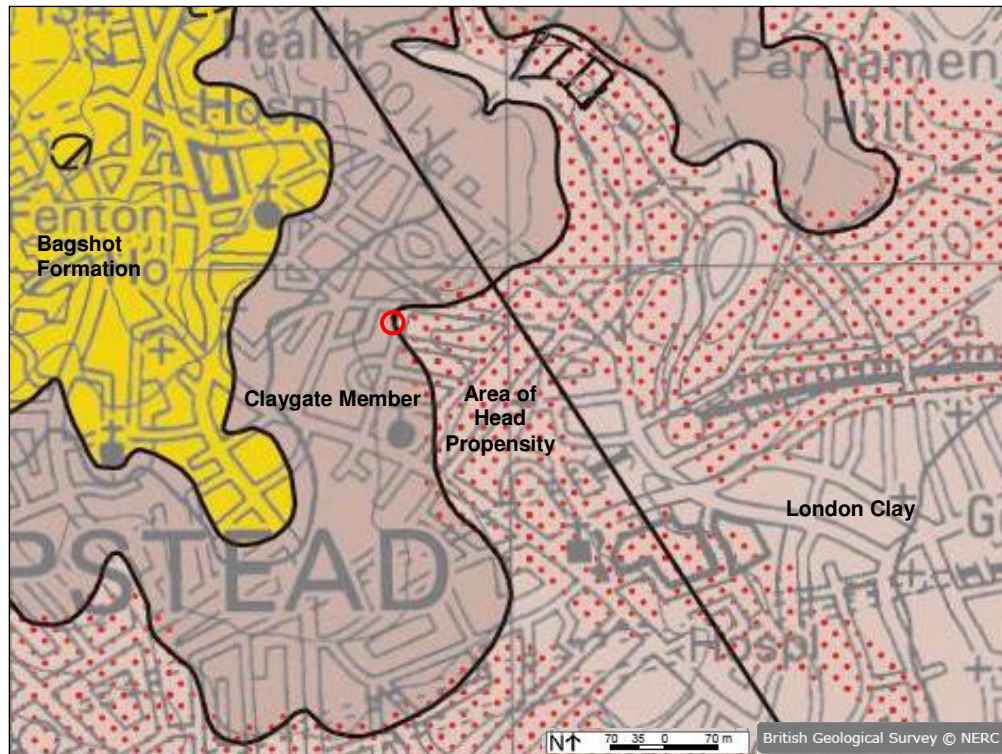


Figure 1 – Site Geology

The Claygate Member comprises dark grey clays with sand laminae, passing up into thin alternations of clays, silts and fine-grained sand, with beds of bioturbated silt. The top of the London Clay Formation is taken as the top of the Claygate Member, which is distinguished from the overlying Bagshot Formation by containing finer sand without cross-bedding and in the relative abundance of clay and silt in the Claygate Member¹.

Groundwater stored within the relatively permeable Bagshot Formation sands discharges at the boundary with the Claygate Formation and formed the headwaters of several historic streams such as the Westbourne, Fleet and Tyburn. A map showing the paths of these former streams based on historical records² is shown on Figure 2 below. Figure 11 of the Arup report does not show the site to be located within 250 m of any previous springs or watercourses. However, historical records indicate that a tributary of the River Fleet rose on the edge of Hampstead Heath to the northwest of the site and flowed in a south-easterly direction in the area between Christchurch Hill and East Heath Road, approximately 150 m to the north of the site, before joining with the main branch of the river, just to the south of Hampstead Ponds. This tributary, like many of London's lost rivers, was culverted or covered and incorporated into the existing sewer network in the late 19th Century.

The course of the former tributary is also coincident with the spring line shown on the late 19th Century maps, approximately 150 m to the north of the site on Well Walk, which subsequently become known as

¹ <http://www.bgs.ac.uk/Lexicon/lexicon.cfm?pub=LC>

² Nicholas Barton & Stephen Myers (2016). The Lost Rivers of London. Historical Publications Ltd

Chalybeate Spring or Well. Anecdotal evidence indicates that water has never flown freely from the well, due to development of the area and redirection of groundwater flows into the sewer network.

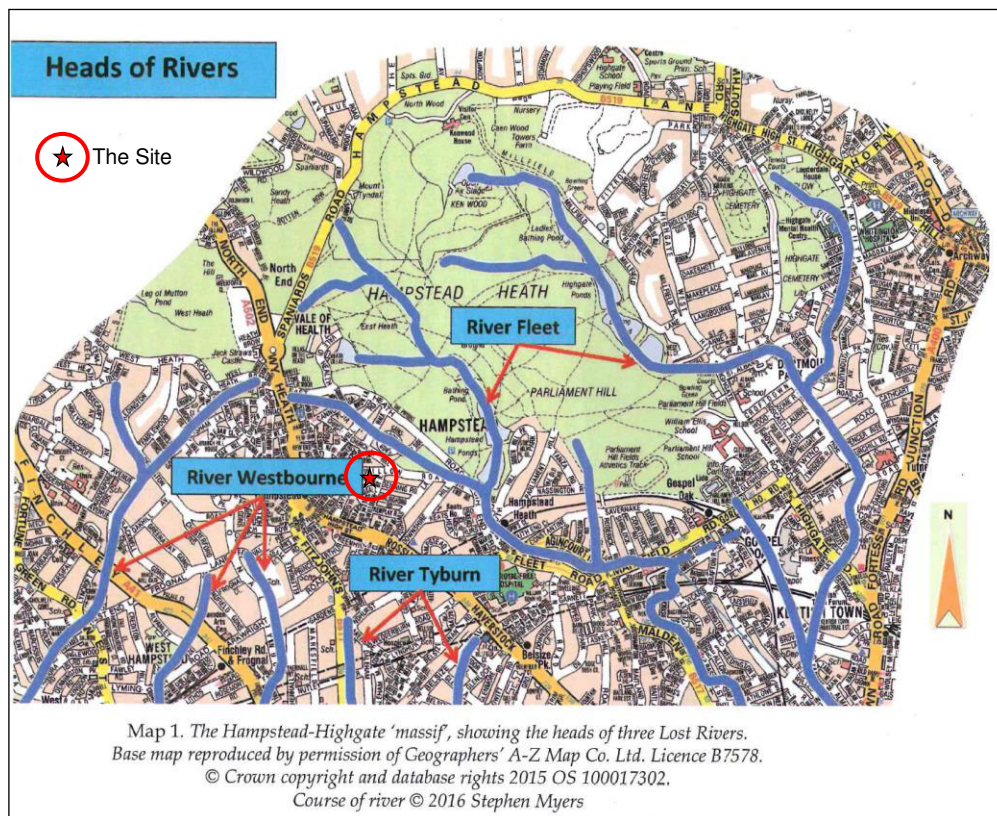


Figure 2 – Map of London's Lost Rivers

The flow from these headwater springs was an important supply of water to the City of London before the nineteenth century and offtakes from the springs were conveyed by wooden conduits along the original paths of the streams³. A valley feature is mentioned in Hampstead Wells which was backfilled and now lies c.10m below the present Gayton Road, within which a conduit was constructed to supply water to the residents of Hampstead. It is considered likely that flows from this conduit emanated at Flask Walk flowing over the Claygate Member clays within the valley feature along what is now Willow Road to South End Green and Kentish Town Fields.

Ponds were excavated below Flask Walk within the clays of the Claygate Member and London Clay which were filled by flow from the Bagshot Formation springs. As development of the area progressed, this spring and conduit was incorporated into the local surface water sewerage system as with the other tributary flows.

³ Hampstead Wells. George Potter. 1904.

Summary of Site Investigation Information

Three boreholes have been drilled in the rear garden to depths of 4.0 m (81.6 m OD) and 5.45 m (80.05 m OD) and two in the front garden of the property to depths of 4.5 m (80.9 m OD) and 10.0 m (75.4 m OD). The borehole locations are shown on the site investigation plan appended to this document. Made Ground mainly comprising silty sandy clay with brick fragments was established to be present in all boreholes, to depths between 2.4m (83.0m OD) and 3.2m (82.3m OD). Superficial Deposits comprising firm silty clay with gravel was found below the made ground to depths of between 3.50 m (81.90 m OD) and 3.75 m (81.65 m OD) in some boreholes. All boreholes terminated within stiff grey London Clay.

Standpipes were installed in each of the four boreholes to depths between 3.0 m (82.4 m OD) and 5.0 m (80.4 m OD). Groundwater levels have been monitored on six occasions and the results are summarised within the table below.

Borehole No	Standpipe depth (m bgl) [m OD]	Depth to groundwater (m bgl) [m OD]					
		02/02/2016	23/02/2016	14/12/2016	05/07/2017	11/07/2017*	19/12/2017
1	3.1 [82.45]	2.55 [83.00]	2.34 [83.21]	Not monitored	2.46 [83.09]	3.00 [82.55]	2.29 [83.26]
2	4.00 [81.50]	3.00 [82.50]	3.04 [82.46]	Not monitored	3.17 [82.33]	3.20 [82.30]	3.04 [82.46]
3	3.00 [82.40]	2.75 [82.65]	2.70 [82.70]	2.75 [82.65]	2.85 [82.55]	2.80 [82.60]	2.66 [82.74]
4	5.00 [80.40]	2.75 [82.65]	2.76 [82.64]	2.75 [82.65]	2.88 [82.52]	2.89 [82.51]	2.83 [82.57]

*Water levels within BH1 not fully recovered from rising head test undertaken on 5th July 2017.

Permeability Testing

Falling and rising head permeability testing were undertaken within the groundwater monitoring standpipes to establish the hydraulic properties of the saturated strata beneath the site. The analysis of the permeability test results is provided at the end of this document and summarised in the table below.

Borehole No	Rising Head Test (m/s)	Falling Head Test (m/s)
1	9.13×10^{-10}	2.03×10^{-9}
2	4.41×10^{-8}	1.66×10^{-9}
3		1.05×10^{-9}
4	3.71×10^{-9}	9.75×10^{-10}

Rising head tests remove water from the standpipe and monitor the recovery of the water level to pre-test levels whereas falling head tests fill the standpipe with water and monitor the water level fall to pre-test levels. As there may be saturated sandy partings or lenses within the clay strata, rising head test

generally provide higher permeability results than falling head tests. Falling head tests surcharge these sandy partings and lenses with water but as they are not continuous and lie within a clay matrix, the rate at which the water falls is determined by the lower permeability of the clay matrix. It is the lower permeabilities which best reflects the bulk permeability of the clay strata beneath the site.

The falling head test permeabilities are similar or less than those required for the lining of landfills (1×10^{-9} m/s) which are designed to hold and store leachate against a vertical hydraulic gradient. The hydraulic gradients that can be measured at this site are far shallower and therefore any movement of groundwater would be proportionately less. Boreholes BH3 and BH4 are located less than 0.5 m apart however the water level within BH3 was unaffected by the emptying of BH4 to a depth of 4.8m during the rising head test. This is a clear example of the inability of the clay strata beneath the site to conduct any significant groundwater flow.

The average linear groundwater flow velocity beneath the site can be estimated using the following equation⁴:

$$V = \frac{k i}{n_e}$$

Where :
V = average linear velocity
i = hydraulic gradient
n_e = effective porosity
k = permeability

Assuming conservative hydraulic gradient similar to the local topographic gradient (c.0.11) and a porosity for clay estimated to be 0.42 based on published data⁵, the rate of groundwater flow through the clay strata beneath the site is estimated to be less than 0.0001 m/d. However, the rate of groundwater flow through the clay soils will be far less than this due to the extremely small size of the intergranular pore throats and the property of water to adhere to the surface of the clay minerals (i.e. why clay behaves as a cohesive material).

Consideration of Campbell Reith Audit Groundwater Outstanding Issues

The Campbell Reith audit determines that the proposed structure has the potential to affect groundwater flows and impact on neighbouring structures and that the groundwater flow rate and direction should be ascertained with further groundwater monitoring to determine seasonal groundwater fluctuations. The falling head tests have established that the cohesive clay strata beneath the Site has a very low permeability and that the rate of groundwater flow within it is negligible.

Campbell Reith have interpreted the presented groundwater level monitoring data to show a consistent level of 82.50m Ordnance Datum (OD) across the site. However the greatest difference in monitored groundwater level (0.75m to 0.80m) consistently exists between the standpipes BH1 and BH2 which are only separated by a few metres at the rear of the Site.

Campbell Reith consider 82.5m OD to correspond with a level close to, or just below, the lower ground floor level in Willow Cottages, the residents of which report anecdotally existing groundwater ingress

⁴ Fetter, C.W. Contaminant Hydrogeology. 1993. Prentice Hall.

⁵ Todd, D.K. Groundwater Hydrology, 2nd Edition. 1980. John Wiley & Sons, Inc.

issues. There is (anecdotally) a well in the garden to the north of 38 Willow Cottages which has a groundwater level of 83.60m OD, which is 1.10m above their lower ground floor level. Given that Willow Cottages have been constructed within a trench excavated within very low permeability clay it is not surprising that there is water ingress, however this is not groundwater related but surface water drainage related.

Consideration of Resident's Concerns

Existence of underground flows/tributaries/streams/watercourses

The springs emanating from Hampstead Heath historically supplied the city of London with water. The springs issued from the base of the Bagshot Formation sands and were conveyed within wooden conduits. The alignment of these conduits were most likely to have followed the paths of the headwater tributaries of London's "lost rivers", the closest to the Site being the River Fleet which is likely to have followed topographic contours within the valley feature along which Willow Road has been built. The Fleet would have been perched on the clays of Claygate Member and London Clay and would not have received any significant flow from these strata.

Valley features were generally filled in to allow building and these conduits often became buried. Off-takes from the conduits would have fed "wells" or dipping points for pot-water. It is no coincidence that the "wells" marked on the 1866 map (below) follow the topographic gradient along the valley feature where people could have easy access to a water supply. A well is a structure excavated into the ground to capture intercepted groundwater. These wells were not fed by groundwater but are surface water off-takes. As these conduits fell into disuse and the area was developed, the headwaters and watercourses became incorporated into the surface water sewerage system. A famous example of a "well" in Hampstead is the Chalybeate Well in Well Walk which is a monument with a piped outlet and not an excavated well intercepting groundwater. The Chalybeate Well is well documented to have been fed by the Chalybeate Springs on Well Walk.

As the site investigation findings have demonstrated, the site is underlain by low permeability clay strata which cannot support groundwater flow and any underground flows now relate to the surface water sewer system.

Any excavation into the clay would fill with water during wet weather as it would hold the water and not drain away. It is the same clay strata which holds the water within the Hampstead Heath ponds (which does not drain out through the bottom). Underground structures constructed within the clay strata in the area are likely to be naturally affected by dampness and water ingress, especially after periods of wet weather. Gardens directly underlain by the clay are also prone to getting easily waterlogged during wet weather.

These issues are consistent with problems associated with local surface water drainage and are not consistent with being groundwater related. The site area is currently 100% impermeable and there will be no change under the proposed development. The site has been assessed as very low risk of surface water flooding and this has been accepted within Campbell Reith's BIA audit.



DIAGRAM_02 Extract 1866 OS showing Water Wells relative to Willow Cottages

KEY	
1	WATER WELLS SHOWN ON 1866 OS MAP SPECIFIC TO WILLOW ROAD & WILLOW COTTAGES
2	WATER WELL IN FRONT GARDEN OF 38 WILLOW COTTAGES
3	WILLOW COTTAGES 33-41 WITH TRENCH OUTLINED IN RED
4	SURROUNDING HIGHER GROUND LEVEL SLOPING TOWARDS WILLOW ROAD AND BEYOND
5	SLOPING COPSE
6	LINE OF BOUNDARY LOWER REAR RETAINING WALL OF WILLOW COTTAGES
ARROW	ARROWS INDICATE SCHEMATIC DIRECTION OF UNDERGROUND WATER FLOWS

Conclusions

The permeability testing has established that the clay strata underlying the Site has a very low permeability consistent with the clays of the Claygate Member and London Clay and which cannot support any significant groundwater flow. As such the proposed basement construction would not cause an impact on the existing groundwater regime or cause a change in groundwater levels which could affect existing neighbouring properties.

Yours sincerely,

John Evans BSc MSc CGeol.

Director



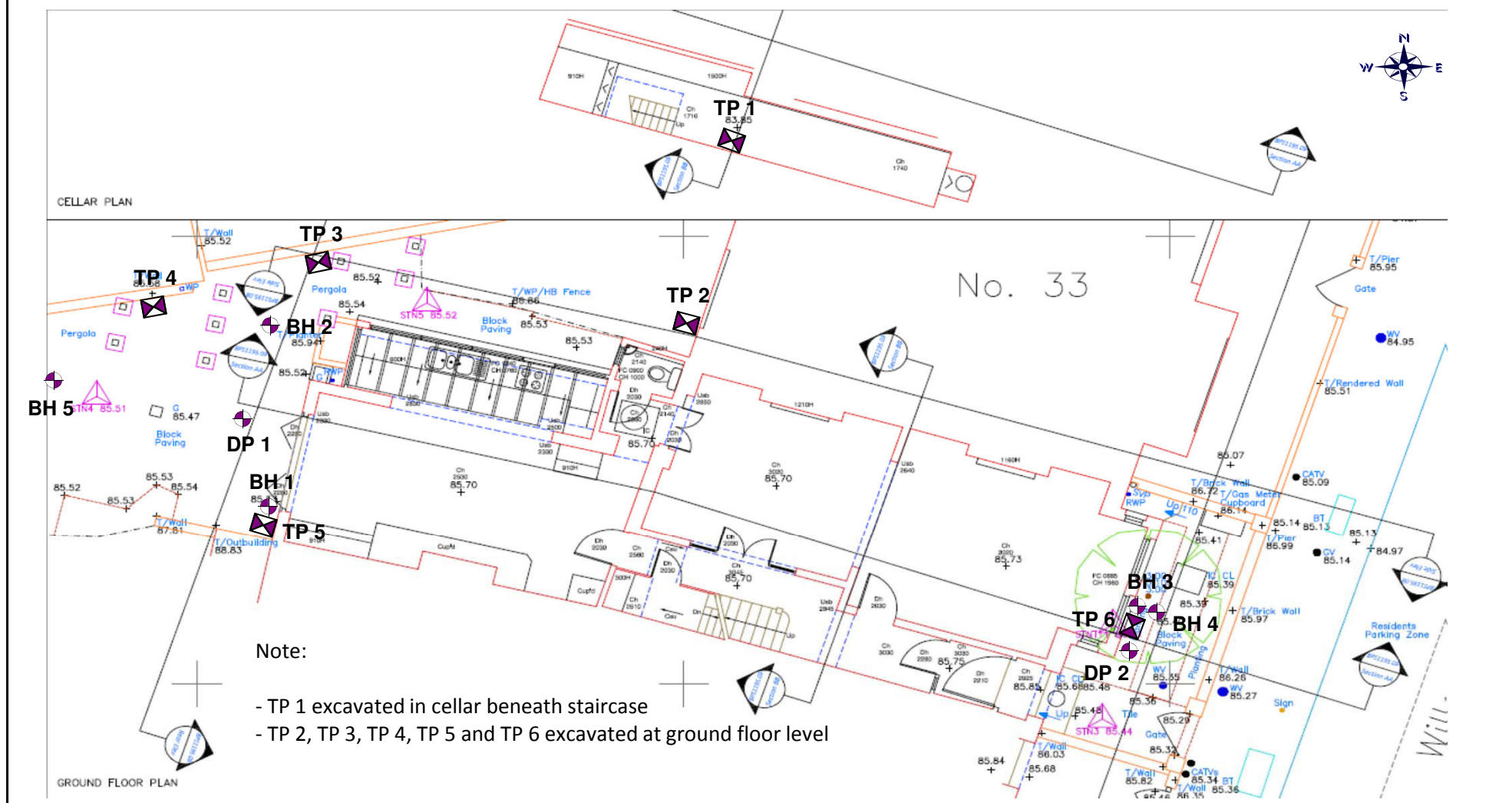
Site	31 Willoughby Road, London, NW3 1RT
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Client Manuela Eleuteri

Engineer Richard Tant Associates

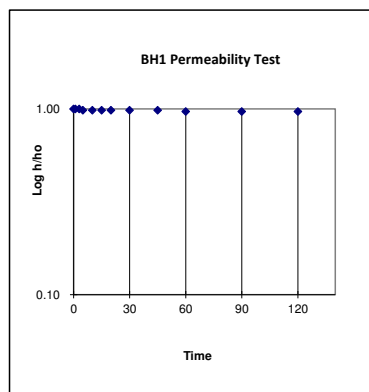
Job Number	J15315
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Sheet 1 / 1



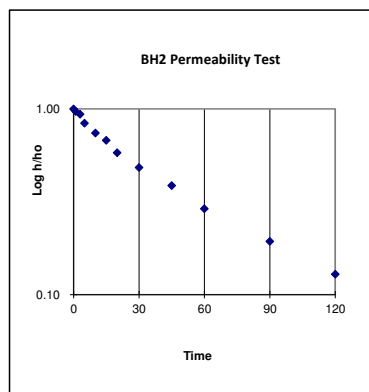
Chord Environmental			
Rising Head Data - Calculations using Horslev Test (1951)			
Client:	Geotechnical and Environmental Associates		
Project:	31 Willoughby Road		
Project No.:	1109		
Borehole No.	BH1		
Abbreviations			
L	Length of test section		
D	Borehole diameter		
d	Stand Pipe diameter		
m	Permeability transformation ratio		
h0 = excess head at time t0 (m) h = excess head at time t (m) t1 = time at t1 (minutes) h1 = excess head at time t1 (m) t2 = time at t2 (minutes) h2 = excess head at time t2 (m) K = hydraulic conductivity (m/d)			
All depths in metres below datum (borehole cover).			
Calculations			
FORMULA APPLIED = $k = d^2 \cdot \ln(2mL/D) \cdot \ln(h_1/h_2) / 8 \cdot L(t_2 - t_1)$			
NB Only applicable when $mL/D > 4$ See Horslev 1951, pg 44 equation G.			
Analysis			
BH1	Section Tested	1.00 - 3.28	mBD
	Borehole Depth	2.38	mBD
	Length of test section (L)	2.28	m
	Borehole diameter (D)	0.06	m
	Standpipe diameter (d)	0.03	m
	Transformation ratio (m)	1	
	Depth to rest water level	2.46	mBD
	Water level at test start (mbd)	3.12	mBD
Selected Values			
t1=	0.00	minutes	
h1=	0.66	m	
t2=	120.00	minutes	
h2=	0.64	m	
PERMEABILITY OF BOREHOLE SECTION:			
		0.000079	m/day
		9.13E-10	m/sec
Prepared by:	John Evans	Date	5-May-17
Reference:	Horslev 1951 Time Lag and Soil Permeability in Groundwater Observations Bulletin No. 36, Waterways Experiment Station, Mississippi.		

Time	TIME	h	h/h0
(seconds)	(minutes)	(metres)	
0	0.00	0.66	1.00
60	1.00	0.66	1.00
180	3.00	0.66	1.00
300	5.00	0.65	0.98
600	10.00	0.65	0.98
900	15.00	0.65	0.98
1200	20.00	0.65	0.98
1800	30.00	0.65	0.98
2700	45.00	0.65	0.98
3600	60.00	0.64	0.97
5400	90.00	0.64	0.97
7200	120.00	0.64	0.97



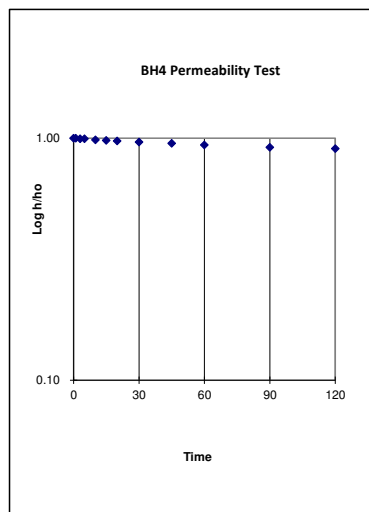
Chord Environmental			
Rising Head Data - Calculations using Horslev Test (1951)			
Client:	Geotechnical and Environmental Associates		
Project:	31 Willoughby Road		
Project No.:	1109		
Borehole No.	BH2		
Abbreviations			
L	Length of test section		
D	Borehole diameter		
d	Stand Pipe diameter		
m	Permeability transformation ratio		
h0 = excess head at time t0 (m) h = excess head at time t (m) t1 = time at t1 (minutes) h1 = excess head at time t1 (m) t2 = time at t2 (minutes) h2 = excess head at time t2 (m) K = hydraulic conductivity (m/d) All depths in metres below datum (borehole cover).			
Calculations			
FORMULA APPLIED = $k = d^2 \cdot \ln(2mL/D) \cdot \ln(h_1/h_2) / 8 \cdot L(t_2 - t_1)$			
NB Only applicable when mL/D > 4 See Horslev 1951, pg 44 equation G.			
Analysis			
BH2	Section Tested	1.00 - 3.83	mBD
	Borehole Depth	3.83	mBD
	Length of test section (L)	2.83	m
	Borehole diameter (D)	0.06	m
	Standpipe diameter (d)	0.03	m
	Transformation ratio (m)	1	
	Depth to rest water level	3.17	mBD
	Water level at test start (mbd)	3.48	mBD
Selected Values			
t1=	45.00	minutes	
h1=	0.12	m	
t2=	120.00	minutes	
h2=	0.04	m	
PERMEABILITY OF BOREHOLE SECTION:			
		0.003813	m/day
		4.41E-08	m/sec
Prepared by:	John Evans	Date	5-May-17
Reference:	Horslev 1951 Time Lag and Soil Permeability in Groundwater Observations Bulletin No. 36, Waterways Experiment Station, Mississippi.		

Time	TIME	h	h/h0
(seconds)	(minutes)	(metres)	
0	0.00	0.31	1.00
60	1.00	0.30	0.97
180	3.00	0.29	0.94
300	5.00	0.26	0.84
600	10.00	0.23	0.74
900	15.00	0.21	0.68
1200	20.00	0.18	0.58
1800	30.00	0.15	0.48
2700	45.00	0.12	0.39
3600	60.00	0.09	0.29
5400	90.00	0.06	0.19
7200	120.00	0.04	0.13



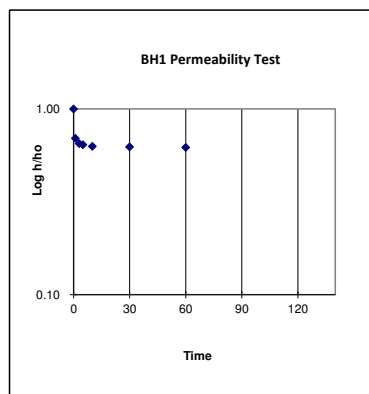
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Client:	Geotechnical and Environmental Associates																																		
Project:	31 Willoughby Road																																		
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Borehole No.	BH4																																		
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Calculations FORMULA APPLIED = $k = d^2 \cdot 2 \cdot \ln(2mL/D) \cdot \ln(h_1/h_2) / 8 \cdot L \cdot (t_2 - t_1)$ NB Only applicable when $mL/D > 4$ See Horslev 1951, pg 44 equation G.																																			
Analysis <table border="0"> <tr> <td>BH4</td> <td>Section Tested</td> <td>1.31-6.00</td> <td>mBD</td> </tr> <tr> <td></td> <td>Borehole Depth</td> <td>4.8</td> <td>mBD</td> </tr> <tr> <td></td> <td>Length of test section (L)</td> <td>1</td> <td>m</td> </tr> <tr> <td></td> <td>Borehole diameter (D)</td> <td>0.06</td> <td>m</td> </tr> <tr> <td></td> <td>Standpipe diameter (d)</td> <td>0.03</td> <td>m</td> </tr> <tr> <td></td> <td>Transformation ratio (m)</td> <td>1</td> <td></td> </tr> <tr> <td></td> <td>Depth to rest water level</td> <td>2.88</td> <td>mBD</td> </tr> <tr> <td></td> <td>Water level at test start (mbd)</td> <td>4.8</td> <td>mBD</td> </tr> </table>				BH4	Section Tested	1.31-6.00	mBD		Borehole Depth	4.8	mBD		Length of test section (L)	1	m		Borehole diameter (D)	0.06	m		Standpipe diameter (d)	0.03	m		Transformation ratio (m)	1			Depth to rest water level	2.88	mBD		Water level at test start (mbd)	4.8	mBD
BH4	Section Tested	1.31-6.00	mBD																																
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h2=	1.74	m																																	
PERMEABILITY OF BOREHOLE SECTION: 0.000321 m/day 3.71E-09 m/sec																																			
Prepared by:	John Evans	Date	5-May-17																																
Reference:	Horslev 1951 Time Lag and Soil Permeability in Groundwater Observations Bulletin No. 36, Waterways Experiment Station, Mississippi.																																		

Time	TIME	h	h/h0
(seconds)	(minutes)	(metres)	
0	0.00	1.92	1.00
60	1.00	1.92	1.00
180	3.00	1.91	0.99
300	5.00	1.91	0.99
600	10.00	1.89	0.98
900	15.00	1.88	0.98
1200	20.00	1.87	0.97
1800	30.00	1.85	0.96
2700	45.00	1.83	0.95
3600	60.00	1.80	0.94
5400	90.00	1.76	0.92
7200	120.00	1.74	0.91



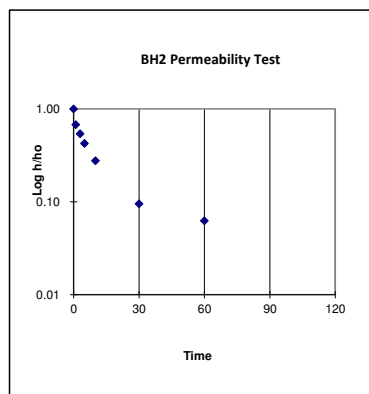
Chord Environmental																																			
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Project:	31 Willoughby Road																																		
Project No.:	1109																																		
Borehole No.	BH1																																		
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Analysis <table border="0"> <tr> <td>BH1</td> <td>Section Tested</td> <td>1.00 - 3.25</td> <td>mBD</td> </tr> <tr> <td></td> <td>Borehole Depth</td> <td>3.25</td> <td>mBD</td> </tr> <tr> <td></td> <td>Length of test section (L)</td> <td>2.25</td> <td>m</td> </tr> <tr> <td></td> <td>Borehole diameter (D)</td> <td>0.06</td> <td>m</td> </tr> <tr> <td></td> <td>Standpipe diameter (d)</td> <td>0.03</td> <td>m</td> </tr> <tr> <td></td> <td>Transformation ratio (m)</td> <td>1</td> <td></td> </tr> <tr> <td></td> <td>Depth to rest water level</td> <td>2.29</td> <td>mBD</td> </tr> <tr> <td></td> <td>Water level at test start (mbd)</td> <td>0</td> <td>mBD</td> </tr> </table>				BH1	Section Tested	1.00 - 3.25	mBD		Borehole Depth	3.25	mBD		Length of test section (L)	2.25	m		Borehole diameter (D)	0.06	m		Standpipe diameter (d)	0.03	m		Transformation ratio (m)	1			Depth to rest water level	2.29	mBD		Water level at test start (mbd)	0	mBD
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PERMEABILITY OF BOREHOLE SECTION: 0.000175 m/day 2.03E-09 m/sec																																			
Prepared by: John Evans Date 19-Dec-17 Reference: Horslev 1951 Time Lag and Soil Permeability in Groundwater Observations Bulletin No. 36, Waterways Experiment Station, Mississippi.																																			

Time	TIME	h	h/h0
(seconds)	(minutes)	(metres)	
0	0.00	2.29	1.00
60	1.00	1.59	0.69
180	3.00	1.49	0.65
300	5.00	1.47	0.64
600	10.00	1.44	0.63
1800	30.00	1.43	0.62
3600	60.00	1.42	0.62
172800	2880.00	0.29	0.13



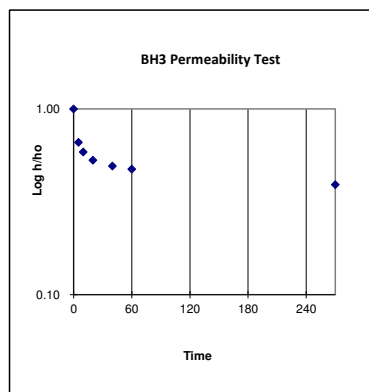
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Project:	31 Willoughby Road																																		
Project No.:	1109																																		
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Analysis <table border="0"> <tr> <td>BH2</td> <td>Section Tested</td> <td>1.00 - 3.83</td> <td>mBD</td> </tr> <tr> <td></td> <td>Borehole Depth</td> <td>3.83</td> <td>mBD</td> </tr> <tr> <td></td> <td>Length of test section (L)</td> <td>2.83</td> <td>m</td> </tr> <tr> <td></td> <td>Borehole diameter (D)</td> <td>0.06</td> <td>m</td> </tr> <tr> <td></td> <td>Standpipe diameter (d)</td> <td>0.03</td> <td>m</td> </tr> <tr> <td></td> <td>Transformation ratio (m)</td> <td>1</td> <td></td> </tr> <tr> <td></td> <td>Depth to rest water level</td> <td>3.04</td> <td>mBD</td> </tr> <tr> <td></td> <td>Water level at test start (mbd)</td> <td>0</td> <td>mBD</td> </tr> </table>				BH2	Section Tested	1.00 - 3.83	mBD		Borehole Depth	3.83	mBD		Length of test section (L)	2.83	m		Borehole diameter (D)	0.06	m		Standpipe diameter (d)	0.03	m		Transformation ratio (m)	1			Depth to rest water level	3.04	mBD		Water level at test start (mbd)	0	mBD
BH2	Section Tested	1.00 - 3.83	mBD																																
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Selected Values <table border="1"> <tr> <td>t1=</td> <td>60.00</td> <td>minutes</td> </tr> <tr> <td>h1=</td> <td>0.19</td> <td>m</td> </tr> <tr> <td>t2=</td> <td>2880.00</td> <td>minutes</td> </tr> <tr> <td>h2=</td> <td>0.04</td> <td>m</td> </tr> </table>				t1=	60.00	minutes	h1=	0.19	m	t2=	2880.00	minutes	h2=	0.04	m																				
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PERMEABILITY OF BOREHOLE SECTION: 0.000144 m/day 1.66E-09 m/sec																																			
Prepared by: <u>John Evans</u> Date 19-Dec-17 Reference: Horslev 1951 Time Lag and Soil Permeability in Groundwater Observations Bulletin No. 36, Waterways Experiment Station, Mississippi.																																			

Time	TIME	h	h/h0
(seconds)	(minutes)	(metres)	
0	0.00	3.04	1.00
60	1.00	2.06	0.68
180	3.00	1.64	0.54
300	5.00	1.29	0.42
600	10.00	0.84	0.28
1800	30.00	0.29	0.10
3600	60.00	0.19	0.06
172800	2880.00	0.04	0.01



Chord Environmental			
Falling Head Data - Calculations using Horslev Test (1951)			
Client:	Geotechnical and Environmental Associates		
Project:	31 Willoughby Road		
Project No.:	1109		
Borehole No.	BH3		
Abbreviations			
L	Length of test section		
D	Borehole diameter		
d	Stand Pipe diameter		
m	Permeability transformation ratio		
h0 =	excess head at time t0 (m)		
h =	excess head at time t (m)		
t1 =	time at t1 (minutes)		
h1 =	excess head at time t1 (m)		
t2 =	time at t2 (minutes)		
h2 =	excess head at time t2 (m)		
K =	hydraulic conductivity (m/d)		
All depths in metres below datum (borehole cover).			
Calculations			
FORMULA APPLIED = $k = d^2 \cdot 2 \cdot \ln(2mL/D) \cdot \ln(h_1/h_2) / 8 \cdot L(t_2 - t_1)$			
NB Only applicable when $mL/D > 4$ See Horslev 1951, pg 44 equation G.			
Analysis			
BH3	Section Tested	1.00 - 3.05	mBD
	Borehole Depth	3.05	mBD
	Length of test section (L)	2.05	m
	Borehole diameter (D)	0.06	m
	Standpipe diameter (d)	0.03	m
	Transformation ratio (m)	1	
	Depth to rest water level	2.66	mBD
	Water level at test start (mbd)	0	mBD
Selected Values			
t1=	270.00	minutes	
h1=	1.04	m	
t2=	2880.00	minutes	
h2=	0.51	m	
PERMEABILITY OF BOREHOLE SECTION:			
	0.000091	m/day	
	1.05E-09	m/sec	
Prepared by:	John Evans	Date	19-Dec-17
Reference:	Horslev 1951 Time Lag and Soil Permeability in Groundwater Observations Bulletin No. 36, Waterways Experiment Station, Mississippi.		

Time	TIME	h	h/h0
(seconds)	(minutes)	(metres)	
0	0.00	2.66	1.00
300	5.00	1.76	0.66
600	10.00	1.56	0.59
1200	20.00	1.41	0.53
2400	40.00	1.31	0.49
3600	60.00	1.26	0.47
16200	270.00	1.04	0.39
172800	2880.00	0.51	0.19



Chord Environmental Falling Head Data - Calculations using Horslev Test (1951)																																			
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Analysis <table border="0"> <tr> <td>BH4</td> <td>Section Tested</td> <td>1.00-4.80</td> <td>mBD</td> </tr> <tr> <td></td> <td>Borehole Depth</td> <td>4.8</td> <td>mBD</td> </tr> <tr> <td></td> <td>Length of test section (L)</td> <td>3.8</td> <td>m</td> </tr> <tr> <td></td> <td>Borehole diameter (D)</td> <td>0.06</td> <td>m</td> </tr> <tr> <td></td> <td>Standpipe diameter (d)</td> <td>0.03</td> <td>m</td> </tr> <tr> <td></td> <td>Transformation ratio (m)</td> <td>1</td> <td></td> </tr> <tr> <td></td> <td>Depth to rest water level</td> <td>2.88</td> <td>mBD</td> </tr> <tr> <td></td> <td>Water level at test start (mbd)</td> <td>0</td> <td>mBD</td> </tr> </table>				BH4	Section Tested	1.00-4.80	mBD		Borehole Depth	4.8	mBD		Length of test section (L)	3.8	m		Borehole diameter (D)	0.06	m		Standpipe diameter (d)	0.03	m		Transformation ratio (m)	1			Depth to rest water level	2.88	mBD		Water level at test start (mbd)	0	mBD
BH4	Section Tested	1.00-4.80	mBD																																
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h2=	0.10	m																																	
PERMEABILITY OF BOREHOLE SECTION: 0.000084 m/day 9.75E-10 m/sec																																			
Prepared by: John Evans Date 19-Dec-17 Reference: Horslev 1951 Time Lag and Soil Permeability in Groundwater Observations Bulletin No. 36, Waterways Experiment Station, Mississippi.																																			

Time (seconds)	TIME (minutes)	h (metres)	h/h0
0	0.00	2.83	1.00
300	5.00	2.23	0.79
600	10.00	1.83	0.65
1200	20.00	1.63	0.58
2400	40.00	1.45	0.51
3600	60.00	1.23	0.43
16200	270.00	0.29	0.10
172800	2880.00	0.10	0.04

