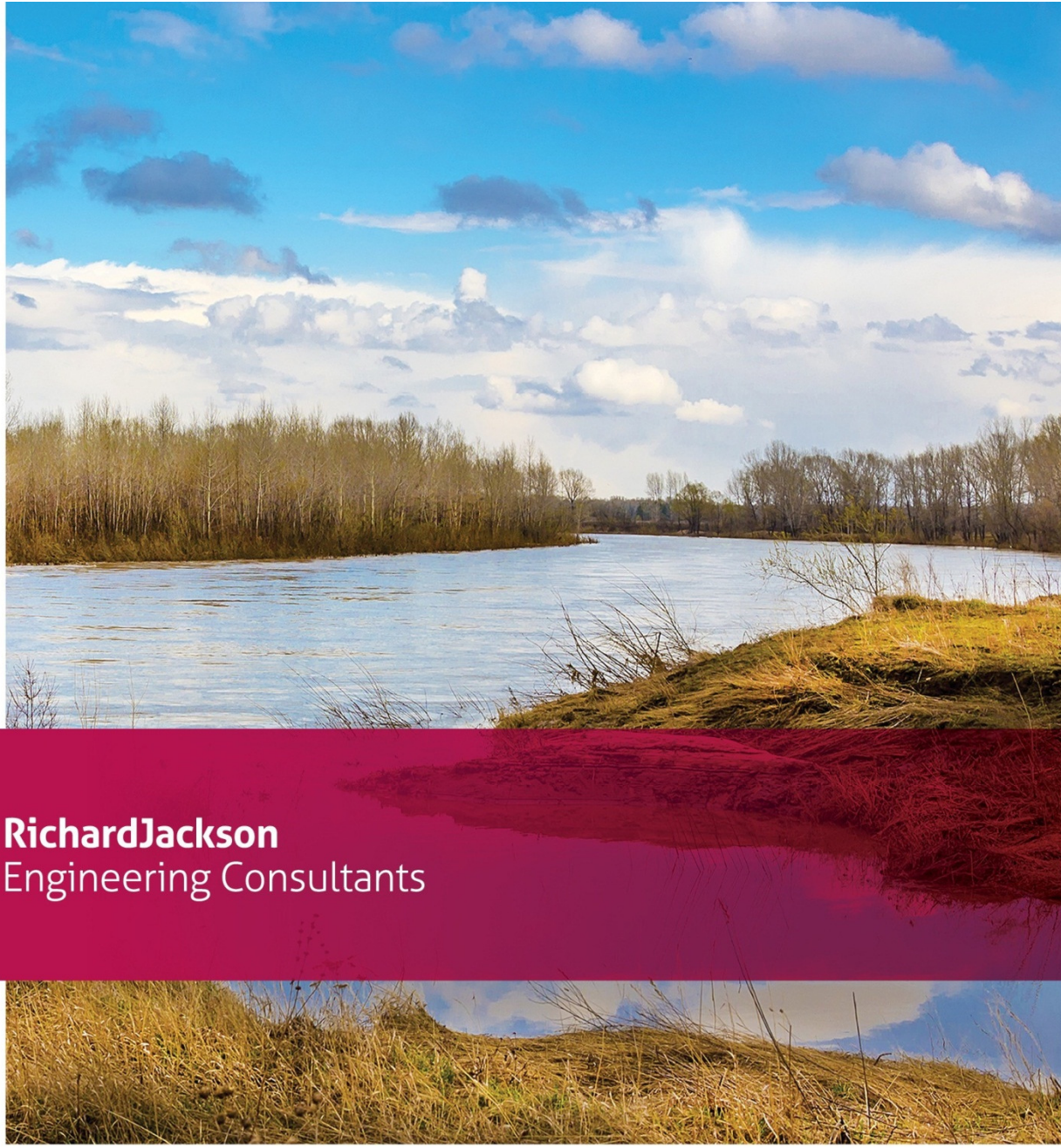


RichardJackson
Engineering Consultants

TECHNICAL NOTE – GROUND MOVEMENT ASSESSMENT

No. 4 KEATS GROVE, LONDON, NW3 2RT

MARCUS PIGGOT

MAY 2018

Project no: 51659

RichardJackson
Engineering Consultants

4 KEATS GROVE, LONDON, NW3 2RT **51659**

TECHNICAL NOTE **25 May 2018**

GROUND MOVEMENT ASSESMENT

INTRODUCTION

Richard Jackson Limited (RJL) has been commissioned by Marcus Piggot, to undertake a ground movement assessment for the proposed redevelopment of 4 Keats Grove, London, NW3 2RT. The proposed development comprises alterations to No. 4 (main dwelling) and the construction of a new basement swimming pool and plant room. The proposed swimming pool and plant room are located within the footprint of the existing studio building, located at the front of the property adjacent to Keats Grove.

RJL have previously prepared a Basement Impact Assessment (BIA), dated December 2017. The BIA provided discussion on the potential impacts associated with the basement. The potential impact of ground movements on the adjacent structures, arising from construction of the basement was highlight as part of the BIA.

The purpose of this assessment is to determine the effects of the proposed basement construction upon the adjacent structures.

SITE LOCATION & DESCRIPTION

The site is located to the front of no. 4 Keats Grove, Hampstead, London Borough of Camden, Greater London, NW3 2RT. The approximate Ordnance Survey grid reference for the centre of the site is TQ269856. The site is rectangular in shape with maximum approximate dimensions of 50m north to south by 18m east to west. The majority of the site was generally at an elevation of approximately 20.7m AOD.

A two-storey brickwork structure with a pitched roof (the studio, as described above) occupied the eastern part of the site, fronting onto Keats Grove. Access to the rear of the studio was at a lower ground level than the garden (approximately 18.8m AOD). It is understood that the existing floor level of The Studio is approximately 19.7m AOD.

GROUND CONDITIONS

RJL have previously prepared Ground Investigation Report (GIR), dated November 2016. Geotechnical investigations undertaken as part of this report have been used to develop parameters for use in the ground movement assessment.

The RJL GIR, indicated the prevailing ground conditions to comprise;

- Made ground from ground level to 2.25m below ground level (bgl), comprising slight silty and gravelly Clay.
- London Clay from 2.25m bgl to at least 6.00m bgl, comprising very stiff silty Clay.

From a review of the British Geological Survey (BGS) borehole information, the London Clay is expected to extend to at least 100m bgl.

GEOTECHNICAL PARAMETERS

As the basement excavation will extend below the depth of made ground, geotechnical parameters have been developed for London Clay only. Geotechnical parameters have been developed as follows:

a) Bulk unit weights have been assumed and based on the advice provided in BS8002:2015, Figures 1 and 2, assuming an average between medium to high strength cohesive soil.

b) Undrained shear strength (c_u) has been assessed, based on the correlation between c_u and SPT N value developed by Stroud, as shown below:

$c_u = f_1 \times N$

where f_1 is a variable based on plasticity index (PI). Geotechnical laboratory testing, undertaken as part of the GIR indicated an average PI of 25%, therefore f_1 equates to 5.

c) Soll stiffness values (E, Young's Modulus) have been estimated based on the correlation between E' / E_u and c_u based on the work of Padfield & Sharrock and O'Brien & Sharp, as follows:

- $E' = 300 \times c_u$
- $E_u = 500 \times c_u$

As soil stiffness is dependent on confinement, E values have been assumed to increase with depth.

The geotechnical parameters adopted for geotechnical assessment are summarised in Table 1.

Table 1: Geotechnical Parameters for Adopted for Assessment

Geotechnical Parameter	London Clay
Bulk Unit Weight, γ_b (kN/m^3)	20
Undrained Shear Strength c_u (kN/m^2)	80
E' (kN/m^2)	24,000+ 2100z
E_u (kN/m^2)	70,000 + 3500z
Poisson's ratio v'	0.25
Poisson's ratio v_u	0.5

CONSTRUCTION METHODOLOGY

In advance of a full temporary works design being undertaken, the construction methodology is to generally comprise excavation for the swimming room and plant room basement and removal of spoil which will be accompanied by installation of temporary sheet piles to the boundary of the opening; embedded; to secure the bottom of the sheets and with propped wailing beams to support the upper part of the sheets in place. The temporary works design criteria will be set to limit potential movement of the soil behind the sheet piles, to limit the risk of undue movement and hence damage to adjacent properties.

Given that the plant room basement is single storey, it is expected that a single horizontal wailer beam will be required to support the sheet piles, near the existing ground level. The temporary sheets would thus be designed to support the applied ground, nominal groundwater loads and also those resulting from the spread of foundation load from the studio building. To inform this part of the design, the sequencing of the studio underpin would be carried out initially to limit the impact during the plant room basement construction. To minimise horizontal deflection of the wailer beam, it would be propped at regular centres; with the props taken down at an incline to temporary footings within the excavation or horizontally across the excavation.

In the permeant case, construction of the reinforced concrete base and wall and installation of the waterproof membrane behind it would be detailed around the temporary props, so that they could remain in place until the concrete works are sufficiently and safely completed. Except where the concrete wall is designed as a free-standing cantilever, such as to the plant room, this will be once a part of the ground slab is in place to prop that portion of the wall. The props and wailer beam can then be removed, and the penetrations made good.

Details of the proposed construction methodology are shown on RJL drawing no: 56159-S-01 (Rev E) in Appendix A.

GROUND MOVEMENT ASSESSMENT

An assessment of ground movements surrounding the excavation has been undertaken using the OASYS Xdisp and Pdisp computer software, developed by Arup. These programs are industry standard software for undertaking ground movement assessments of basement structures.

The Xdisp program (Version 19.4) has been used to estimate ground movements likely to arise from the excavation of the basement in front of the temporary sheet piled wall. As ground movements arising from sheet pile installation are generally considered negligible, this has not been modelled. For the Xdisp analysis, the CIRIA 760 ground movement curve have been used to estimate ground movements.

The analysis of potential ground movements due the reduction in overburden caused by basement excavation has been carried out using the Oasys Pdisp (Version 19.4) software package and is based on the assumption that the soils behave elastically, which provides a reasonable approximation to soil behaviour at the stress and strain levels in this analysis.

Sheet Pile Installation and Excavation Related Movements

The installation of temporary sheet piles has not been modelled as due to the minimal soil disturbance associated with sheet pile installation, negligible ground movements are expected.

The excavation in front of the sheet pile wall has been modelled using the CIRIA C760 ground movement curve for "excavation in front of a high stiffness wall in stiff clay". This is considered appropriate as the walls are to be continuously propped during the formation of the basement.

The estimated horizontal and vertical movements generated by the basement excavation in front of the temporary sheet pile wall are shown in Table 2 below.

Table 2: Calculated Vertical and Horizontal Ground Movement

Construction Phase	Vertical Settlement (mm)	Horizontal Settlement (mm)
Sheet pile instillation	Negligible	Negligible
Excavation to formation level of Basement	3	6

Outputs from Xdisp are presented in Figure 1.

Basement Heave and Reloading Considerations

To estimate the magnitude of heave, an analysis has been undertaken considering the heave immediately after excavation (overburden removal) and then in the longer term where pore water pressures dissipate. The stress relief in swimming pool and plant room areas has been calculated based on the soil unit weight and height of excavation and is shown in Table 2.

Table 3: Calculated Overburden Removal in Swimming Pool and Plant Room

Area	Excavation Height (m)	Overburden Removal (kN/m^2)
Swimming Pool	2.4	50
Plant Room	3.5	70

The heave that will occur immediately upon excavation (i.e. short term) due to the removal of overburden has been analysed and the maximum heave is estimated to be 5mm in the centre of the plant room and approximately 3mm at the perimeter of the swimming pool and plant room. At the perimeter wall of the of No. 4 (main dwelling) and at the footpath of Keats Grove, adjacent to the basement excavation, estimated heave is approximately 2mm.

The total heave, which is short term plus long term heave, is estimated to be about 17 mm and the total heave at the perimeter of the footprint is approximately 10 mm. At the perimeter wall of No. 4 (main dwelling) and at the footpath of Keats Grove, adjacent to the basement excavation, estimated heave is approximately 3mm.

Outputs from Pdisp are presented in Figure 2 and 3.

Building Damage Assessment

The effect of calculated ground movements has been assessed in relation to the surrounding structures to assess the potential for damage.

The adjacent structures, No. 4 (main building), and No. 2,3,5 and 6 Keats Grove have been considered. The structures have been modelled as elastic beams with strain levels calculated based on the estimated ground movements and compared to the Burland damage criteria, as recommended in CIRIA C760. The calculated damage categories are shown in Table 3 below.

Table 4: Structure Damage Categories

Structure	Burland Damage Category
No. 4 (Main Building)	0 (Negligible)
No. 2 Keats Grove	0 (Negligible)
No. 3 Keats Grove	0 (Negligible)
No. 5 Keats Grove	0 (Negligible)
No. 6 Keats Grove	0 (Negligible)

As shown in Table 3 and in accordance with the BIA the calculated damage categories are below Category 2.

SUMMARY AND CONCLUSIONS

As part of the proposed development at No. 4 Keats Grove, it is proposed to construct a basement swimming pool and plant room within the footprint of the existing studio. The basement is to be formed using temporary sheet piles. The purpose of this ground movement assessment was to assess the effects of the proposed basement construction upon the adjacent structures.

A ground movement assessment has been undertaken in general accordance with CIRIA C760 and has indicated that the risk of the proposed basement construction affecting the adjacent structures is low as the calculated Burland damage criteria for adjacent structures is category 1 (negligible).

LIMITATIONS

All information provided by others is taken in good faith as being accurate, but Richard Jackson Ltd cannot and does not accept liability for the detailed accuracy, errors or omissions in such information.

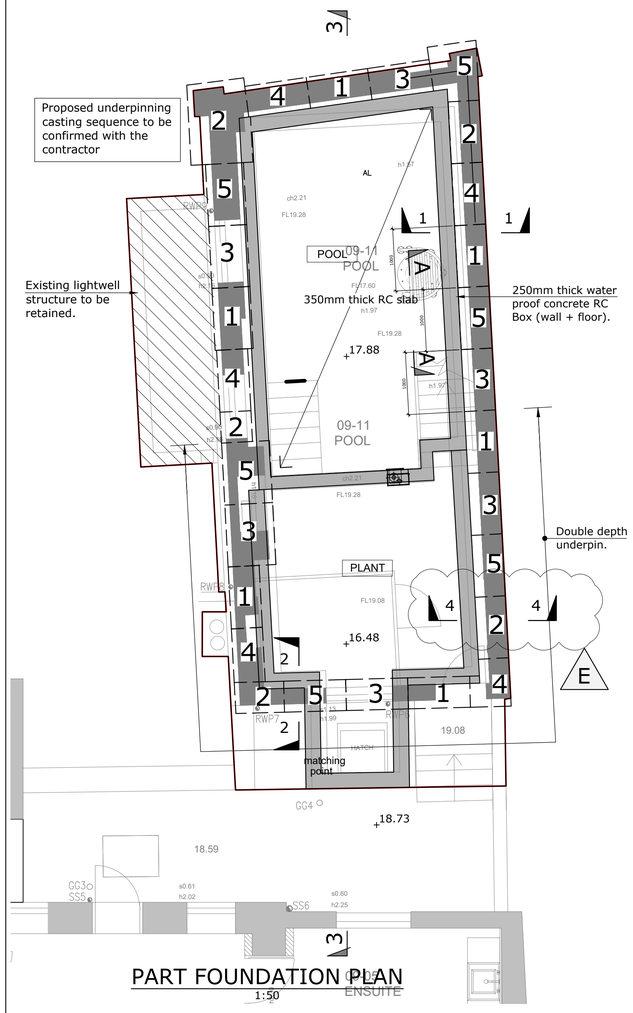
This TN has been prepared for the use of Marcus Piggot. If any unauthorised third party makes use of this report, they do so at their own risk and Richard Jackson Ltd owe them no duty of care or skill.

Document Review	
Prepared by	**Approved by**
Matthew Kemmy Geotechnical Engineer on behalf of Richard Jackson Limited	Rik Miall Chief Executive on behalf of Richard Jackson Limited

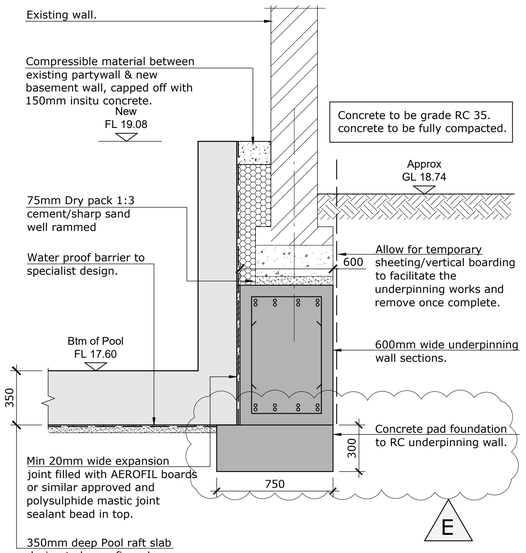
APPENDIX A

Figures & Drawings

DO NOT SCALE



PART FOUNDATION PLAN
1:50



SECTION 1-1
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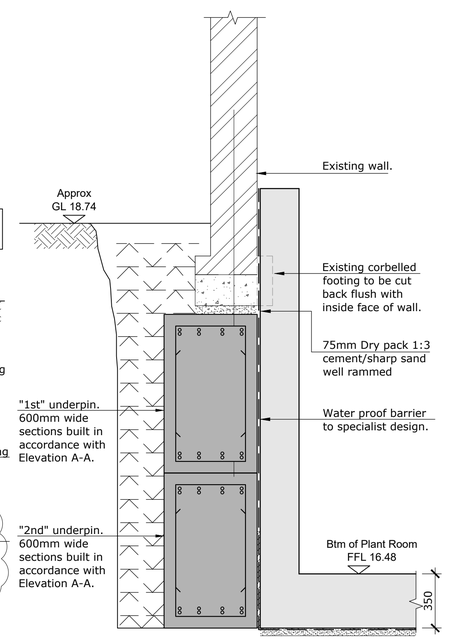
UNDERPIN TO BE CARRIED OUT FROM WITHIN No.4 KEATS GROVE



SECTION 2-2
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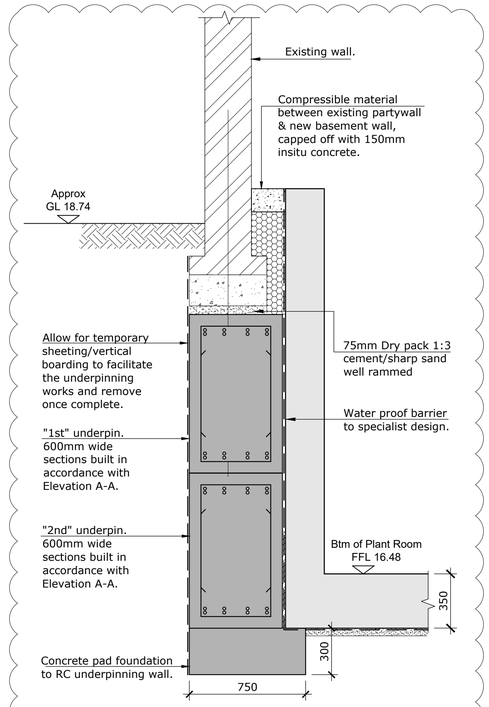

SECTION 4-4
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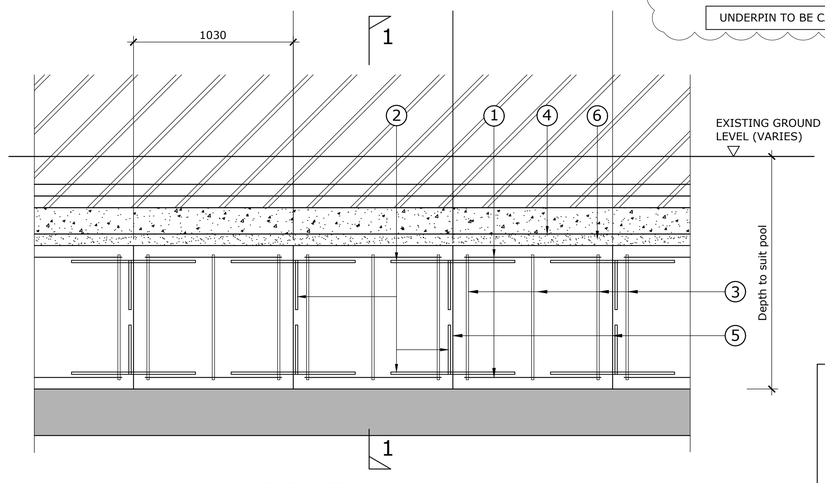
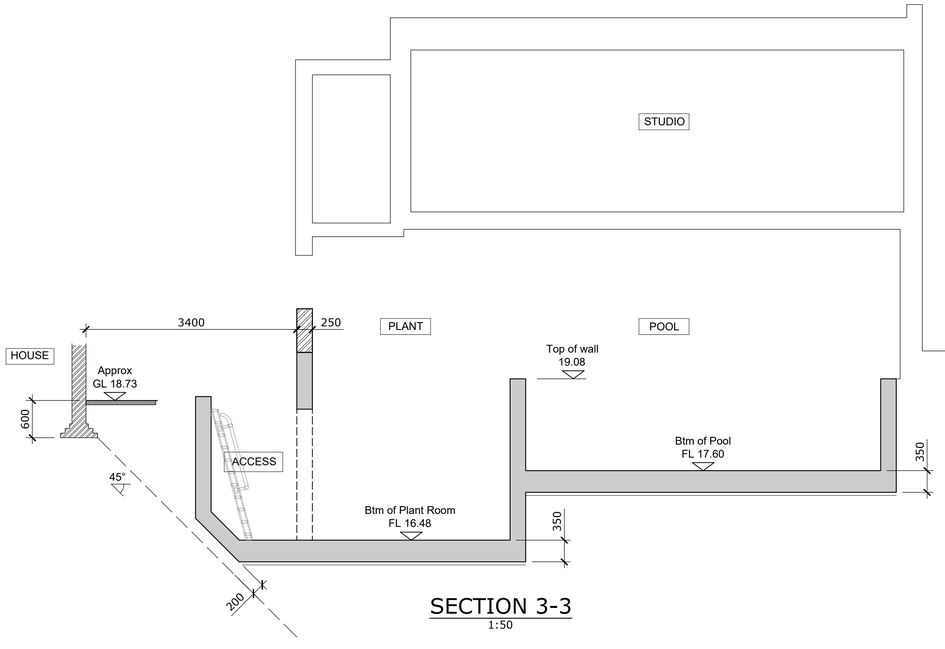
UNDERPIN TO BE CARRIED OUT FROM WITHIN No.4 KEATS GROVE



ELEVATION ON A-A
1:20



SECTION 3-3
1:50

KEY

1. 8H12 LONGITUDINAL BARS (4T,4B)
2. 8H12 DOWEL BARS BENT STRAIGHT ON SITE (500 / 500)
3. H10 OVERLAPPING 'U' BARS
4. UNDERSIDE OF EXISTING FOUNDATION TO BE THOROUGHLY CLEANED AND SCABBLED AND ANY LOOSE MATERIAL REMOVED PRIOR TO CASTING NEW CONCRETE.
5. JOINT BETWEEN BAYS TO CONSIST OF EXPAMET HYRIB PERMANENT SHUTTERING. PLACE 1200g POLYTHENE AGAINST EARTH FACE TO PROTECT HYRIB AND DOWELS. REMOVE POLYTHENE ON EXCAVATION OF ADJACENT BAY
6. 75mm (1:3 CEMENT/SHARP SAND) DRY PACK WELL RAMMED IN
7. SURFACE TO BE REINSTATED AS EXISTING
8. BACKFILL TO WORKING SPACE TO BE 300mm CONCRETE PLUG OR AS DETAIL WITH DPT TYPE 2 OR AS RAISED INERT SELECTED GRANULAR MATERIAL COMPACTED IN 150mm MAXIMUM LAYERS OVER
9. BASE PAD FOUNDATION TO BE CAST IN MASS CONCRETE UNDERPIN BAYS TO BE AGREED WITH THE STRUCTURAL ENGINEER.

* ENGINEER TO INSPECT AND DETERMINE EXTENT AND DEPTH OF FOUNDATION

GENERAL NOTES

1. The drawings, design and all information contained therein are the sole copyright of Richard Jackson Ltd and reproduction in any form is forbidden unless permission is obtained in writing.
2. All drawings shall be read in conjunction with all relevant Civil/Structural Engineering drawings, the project specification and drawings produced by the Architects, Services Engineers & Landscape Architects.
3. For all setting out information refer to the Architects drawings and details.
4. Any discrepancies between the information given by the Engineer, and that provided by others, must be referred to the Engineer before the affected works proceed.
5. Dimensions must not be scaled from the Engineers drawings.
6. All dimensions are in millimetres unless noted otherwise.
7. Dimensions marked * are subject to confirmation by site measurement before construction proceeds.
8. All dimensions are given to structural surfaces unless noted otherwise.
9. No holes, chases, cut-outs or the like may be formed in any beam, column, or load bearing wall unless written permission is obtained from the Engineer.
10. Holes smaller than 225 x 225mm through slabs are not necessarily shown on the Engineers drawings.
11. For size and location of all services refer to the Service Engineers and Architects drawings.
12. Inspections made by the Local Authority or other Statutory bodies, shall be arranged by the Contractor to suit his programme. Any costs arising out of failing to carry out the work to the satisfaction of the Checking Authority will be the sole responsibility of the Contractor.
13. Non-structural fixings are generally not shown on the Engineers drawings and if any such detail is indicated it must be confirmed by cross-reference to other specialists before construction.
14. All drawing specifications are given in accordance with NBS (National Building Specification) e.g. E10/130 which refers to NBS Section E10, Clause 130.
15. Abbreviations:
S.S.L.- Structural Slab Level.
U.N.O.- Unless Noted Otherwise
T.O.B.- Top Of Beam.

NOTE

SUBSTRUCTURE FOUNDATION WORKS TO COMPLY WITH ARBORICULTURAL SURVEY REPORT AND 13.6m RADIUS TREE PROTECTION ZONE (TPZ)

NOTES

1. The Contractor shall verify all dimensions before starting work.
2. It is essential to read this drawing in conjunction with the specification.
3. The design assumes natural clay with allowable bearing pressure of 100kN/sq.m at the underpinning formation.
4. Unexpected conditions must be reported to the Engineer immediately so that the design can be reviewed and altered if necessary.
5. This drawing is to be read in conjunction with Ground Investigation Report by Richard Jackson Ltd dated November 2016, ref: 51659.

HEALTH AND SAFETY

1. The contractor is responsible for identifying hazards and for carrying out risk assessments and for taking all necessary precautions to eliminate or reducer risks so far as reasonably practicable. The building may not be considered stable in its temporary state and the contractor is to provide all necessary temporary support until all structural works are complete.
2. The following hazards are known:

Collapse of excavations. All excavations to be shored.

i) Instability of building being underpinned: Maximum single length of building to be left unsupported = 1200mm. No more than 4No. legs to be left unsupported. Maximum percentage of excavation on any elevation not to exceed 25%. Minimum distance between unsupported legs = 3600mm. Working space may not be excavated outside the unsupported legs. "Unsupported" applies to the period between start of excavation for working space and 12 hours after hard packing. Provide sacrificial props/stools if necessary at centres to suit the site conditions to archive stability of wall over.

ii) Underground services. Services may be present. Contractor to check and locate.

iii) Adjacent building to remain occupied: Contractor to agree with residents areas of control and access.

iv) Silica dust from breaking out: dampen down to avoid dusting. PPE essential.

v) Exposure to noise: ears defenders essential.

vi) Expose to exhaust fumes: vent to external air.

ISSUED FOR INFORMATION

REV	DATE	DESCRIPTION	DRAWN	CHKD
E	15.12.17	UNDERPINNING (SECTION 1-1) REVISED SECTION 4-4 ADDED	CYF	JM
D	30.11.17	POSITION OF UNDERPINNING ADJUSTED ALONG PARTYWALL (SECTION 1-1)	RFL	JM
C	17.10.17	UPDATED TO SHOW PLANT ROOM WALLS	RFL	JM
B	12.06.17	ISSUED FOR INFORMATION	RFL	JM
A	15.05.17	ISSUED FOR INFORMATION	RFL	JM

REVISIONS

This drawing is to be read in conjunction with all other Engineer's drawings and all other project information. Any discrepancy between the Engineer's drawings and other project information is to be reported to the Engineer immediately.

Project

4 KEATS GROVE
HAMPSTEAD, NW7

Title

INDICATIVE
SWIMMING POOL
PROPOSED FOUNDATIONS

Client

Mr MARCUS PIGGOTT

Scale	Drawn	Date
1:50; 1:20 @ A1	RFL	01.09.16
Job Manager	Checked	Approved
JM	JM	

RichardJackson Engineering Consultants
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The Wheelhouse, Bonds Mill, Stonehouse, Gloucestershire GL10 3RF Tel: 01172 020070 ☐
Email Address: mail@rj.uk.com Website: http://www.rj.uk.com

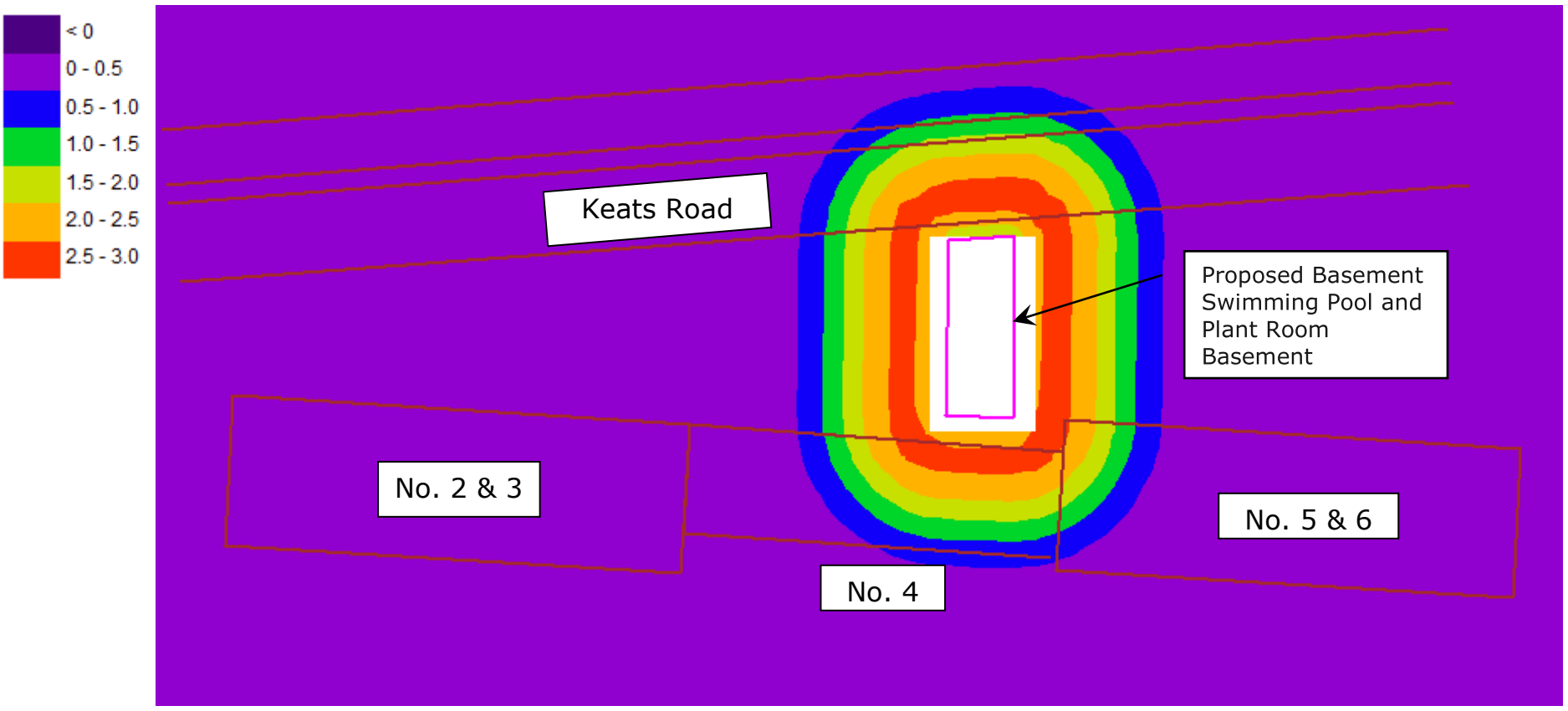
Drawing No.	Revision
51659/S/01	E

Drawing Status

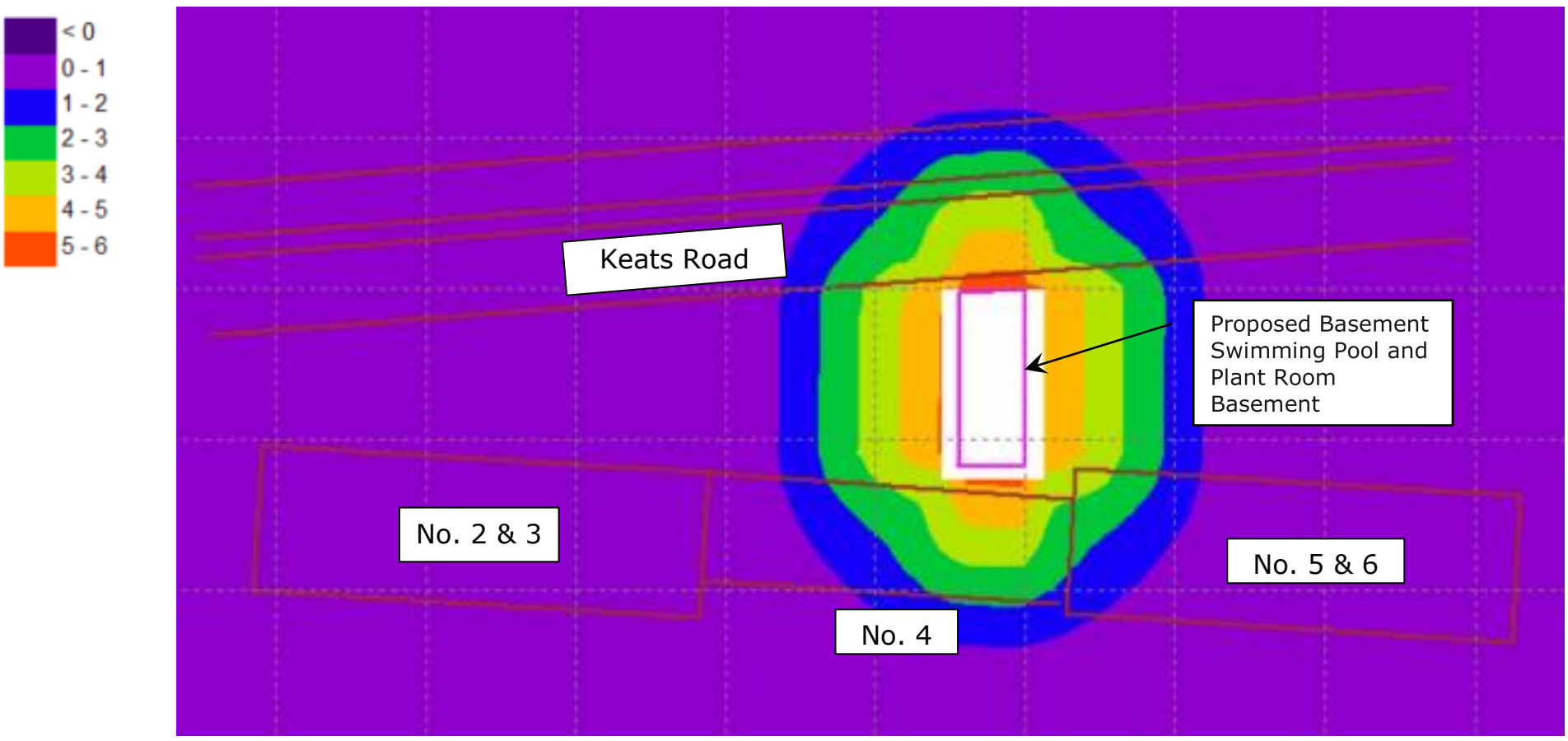
☒ INFORMATION ☐ APPROVAL ☐ COSTING
☐ TENDER ☐ CONSTRUCTION ☐ AS CONSTRUCTED

A1

Vertical Settlement Contours: Grid 1 (level 100.000m) (Interval 0.5mm)



Horizontal Displacement Contours: Grid 1 (level 100.000m) Interval 1mm



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4 Keats Grove, London NW3 2RT

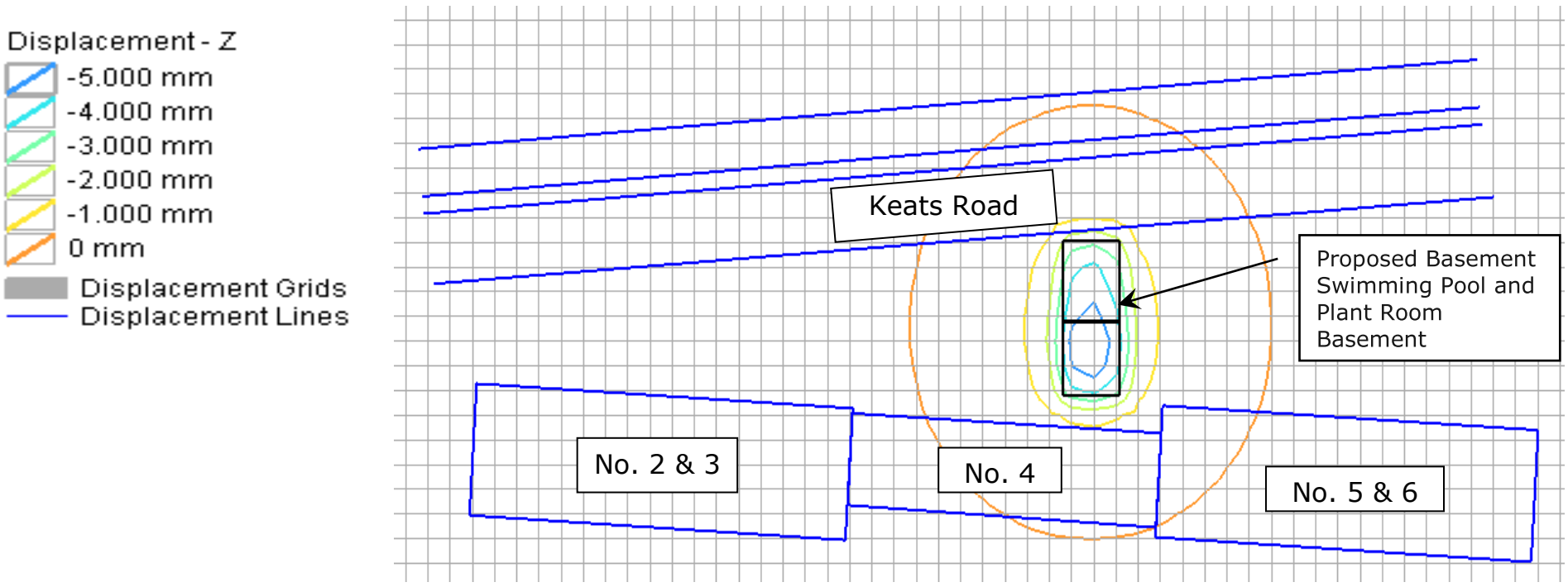
FIGURE 1

VERTICAL AND HORIZONTAL GROUND MOVEMENT DUE TO PROPOSED BASEMENT EXCAVATION

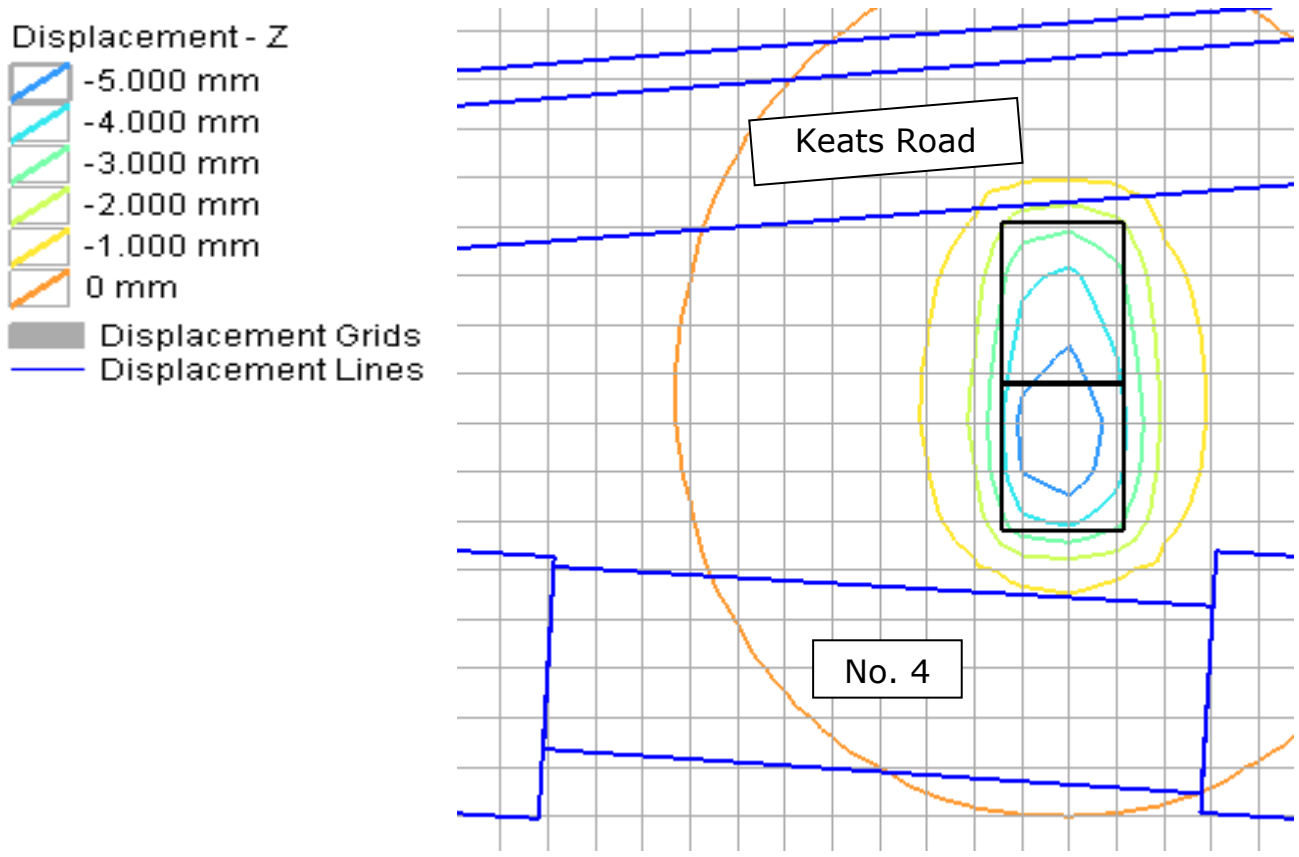
SCALE: N.T.S.

JOB NO: 51659

Short Term Heave



Adjacent Properties

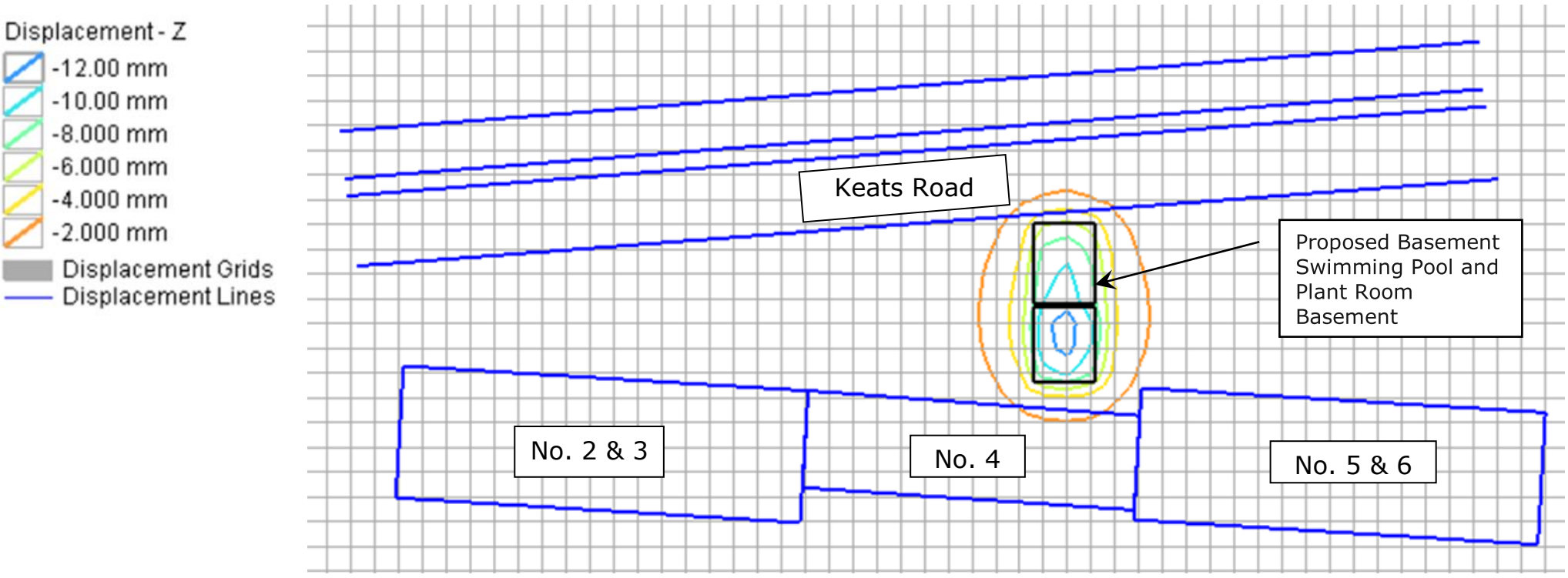


No. 4 Keats Road

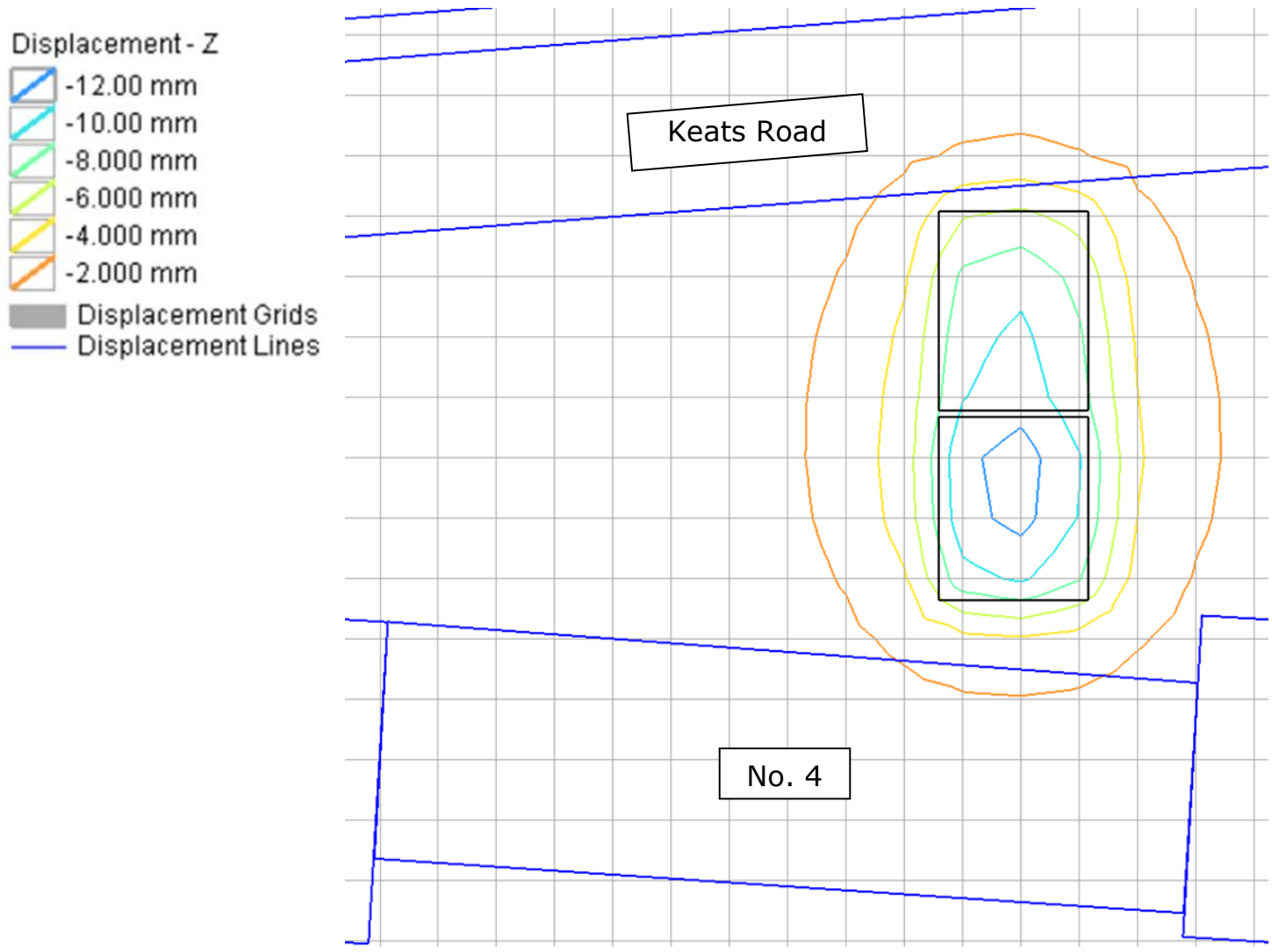
RichardJackson Engineering Consultants
consulting civil & structural engineers
847 The Crescent, Colchester, CO4 9YQ
Tel: 01206 228800

4 Keats Grove, London NW3 2RT	FIGURE 2
ESTIMATED SHORT TERM HEAVE	SCALE: N.T.S.
	JOB NO: 51659

Long Term Heave



Adjacent Properties



No. 4 Keats Road

RichardJackson Engineering Consultants **consulting civil & structural engineers** 847 The Crescent, Colchester, CO4 9YQ Tel: 01206 228800	**4 Keats Grove, London NW3 2RT**	FIGURE 3
	ESTIMATED LONG TERM HEAVE	SCALE: N.T.S. JOB NO: 51659

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