

76 Fitzjohn's Avenue
London
NW3 5LS

Basement Impact Assessment

For
London Borough of Camden

Project Number: 12466-62
Revision: F2

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1.0 NON-TECHNICAL SUMMARY

- 1.1. CampbellReith was instructed by London Borough of Camden, (LBC) to carry out an audit on the Basement Impact Assessment submitted as part of the Planning Submission documentation for 76 Fitzjohn's Avenue (planning reference 2017/1047/P). The basement is considered to fall within Category B as defined by the Terms of Reference.
- 1.2. The Audit reviewed the Basement Impact Assessment for potential impact on land stability and local ground and surface water conditions arising from basement development in accordance with LBC's policies and technical procedures.
- 1.3. CampbellReith was able to access LBC's Planning Portal and gain access to the latest revision of submitted documentation and reviewed it against an agreed audit check list.
- 1.4. The Basement Impact Assessment (BIA) and supporting documents have been carried out by well-known firms holding the required qualifications.
- 1.5. 76 Fitzjohn's Avenue is not listed and nor are the neighbouring properties.
- 1.6. The proposal consists of constructing a single storey basement below the existing property with front and rear lightwells.
- 1.7. The geology was found to be made ground overlaying sandy clay with layers of sand. Water level monitoring has indicated that the proposed basement is above ground water level, and it is proposed this monitoring will be ongoing until construction. The BIA recommends trial excavations to demonstrate that the sand layers will remain stable during construction.
- 1.8. The basement is proposed to be constructed of reinforced concrete using established design principles and following a conventional construction method.
- 1.9. Aspects of how the basement walls have been designed requires further calculation and clarification. As the methodology is well established, this may be undertaken as part of detailed design.
- 1.10. A ground movement assessment has been produced that predicts Burland category 1 (very slight) damage to the neighbouring properties. Following the receipt of various clarifications, the ground movement assessment is accepted.
- 1.11. The impact on the surface water drainage system has been considered and the revised CMS contains details of proposed mitigation including SUDs.

- 1.12. It is proposed to remove one of the two trees in the front garden, with the larger higher quality tree retained. The front lightwell construction method has been amended so as to lessen the impact on the retained tree.
- 1.13. Movement monitoring strategies have been proposed, which should be further refined in due course to make the monitoring strategy bespoke to this specific project.
- 1.14. It is accepted that there are no slope stability concerns regarding the proposed development and it is not in an area prone to flooding.
- 1.15. The property is located close to a Network Rail asset, whose approval will be required prior to construction.
- 1.16. An outline works programme has been provided.
- 1.17. Following the receipt of revised documents (BIA and Construction Method Statement) and further clarification, it is confirmed that the basement proposals comply with the requirements of CPG: Basements. However, due to the recommendations for further work contained in those documents and this audit, it is recommended that a Basement Construction Plan is produced. This should cover, as a minimum:
 - The results of (and impact of) further groundwater monitoring.
 - The results of trial excavations.
 - Confirmation of changes to impermeable areas and design of mitigation.
 - Confirmation of omission of ramped access at front of property and impact to trees.
 - Further development of retaining wall design to confirm feasibility of reduced temporary propping and proposals for resisting shear.
 - A detailed monitoring strategy.

2.0 INTRODUCTION

- 2.1. CampbellReith was instructed by London Borough of Camden (LBC) on 16/03/17 to carry out a Category B Audit on the Basement Impact Assessment (BIA) submitted as part of the Planning Submission documentation for 76 Fitzjohn's Avenue NW3 5LS.
- 2.2. The Audit was carried out in accordance with the Terms of Reference set by LBC. It reviewed the Basement Impact Assessment for potential impact on land stability and local ground and surface water conditions arising from basement development.
- 2.3. A BIA is required for all planning applications with basements in Camden in general accordance with policies and technical procedures contained within
- Guidance for Subterranean Development (GSD). Issue 01. November 2010. Ove Arup & Partners.
 - Camden Planning Guidance (CPG): Basements.
 - Camden Development Policy (DP) 27: Basements and Lightwells.
 - Camden Development Policy (DP) 23: Water.
 - Local Plan Policy A5 Basements.
- 2.4. The BIA should demonstrate that schemes:
- a) maintain the structural stability of the building and neighbouring properties;
 - b) avoid adversely affecting drainage and run off or causing other damage to the water environment;
 - c) avoid cumulative impacts upon structural stability or the water environment in the local area, and;
- evaluate the impacts of the proposed basement considering the issues of hydrology, hydrogeology and land stability via the process described by the GSD and to make recommendations for the detailed design.
- 2.5. LBC's Audit Instruction described the planning proposal as *"Creation of a single storey basement with lightwell to front and rear, installation of 1 x AC unit within front garden, removal of 1 x palm tree from front garden, alterations to side elevation fenestration, alterations to rear ground floor patio doors and erection of a new fence in the front garden."*
- 2.6. CampbellReith accessed LBC's Planning Portal on 06/04/17 and gained access to the following relevant documents for audit purposes:

- Arboricultural Impact Assessment, 160820-PD-11a
 - Basement Impact Assessment, J16214
 - Construction Method Statement, MBP-7009-February 2017
 - Design & Access Statement, January 2016
 - Planning Application Drawings consisting of
 - Location Plan
 - Existing plans and elevations
 - Proposed plans and elevations
 - Planning Comments and Response
- 2.7. Further planning comments and objections were received subsequent to the above date, along with updated architectural plans indicating reductions in the depth of the basement and the length of the front lightwell.
- 2.8. Following the D1 issue of this report, the following additional information was submitted by the applicant in October 2017;
- Works programme – 76 Fitzjohns Avenue
 - CampbellReith Audit Query tracker – Applicant responses
 - Construction Method Statement - MBP-7009 – Ver 1.13, May 2017
- 2.9. Following the D3 issue of this report, the applicant submitted the following additional information in October 2017;
- PDISP short and long term tabular results.
 - Responses to CampbellReith 20.12.2017 – email and attachment presented in Appendix 3.
- 2.10. Following the F1 issue of this report, the applicant submitted the following additional information between May and September 2018;
- Site Investigation and Basement Impact Assessment Report 3232_J16214 - 76 Fitzjohns Ave Rep Iss 2 complete, dated July 2018
 - J16214 - PDISP - Overall Term - Tabular Results 171219 082108, dated December 2017
 - J16214 - PDISP - Short Term - Tabular Results 171219 082108, dated December 2017
 - MBP-7009-Construction Method Statement-V2.0, dated May 2018
 - Emails dated 20 August and 25 September 2018.
- The PDISP tabular results and emails are presented in Appendix 3.

3.0 BASEMENT IMPACT ASSESSMENT AUDIT CHECK LIST

Item	Yes/No/NA	Comment
Are BIA Author(s) credentials satisfactory?	Yes	Section 1.3.2 of the BIA confirms that individuals holding MICE and CGeol accreditation have been involved with the BIA's production.
Is data required by Cl.233 of the GSD presented?	Yes	
Does the description of the proposed development include all aspects of temporary and permanent works which might impact upon geology, hydrogeology and hydrology?	Yes	A detailed construction method statement, along with construction drawings have been provided.
Are suitable plan/maps included?	Yes	While maps from the GSD have not been provided, appropriate maps and plans have been provided to indicate the proposed development and the wider area.
Do the plans/maps show the whole of the relevant area of study and do they show it in sufficient detail?	Yes	
Land Stability Screening: Have appropriate data sources been consulted? Is justification provided for 'No' answers?	Yes	An explanation statement with referenced data sources has generally been provided for all 'no' answers.
Hydrogeology Screening: Have appropriate data sources been consulted? Is justification provided for 'No' answers?	Yes	An explanation statement with referenced data sources has generally been provided for all 'no' answers.
Hydrology Screening: Have appropriate data sources been consulted? Is justification provided for 'No' answers?	No	An explanation statement with referenced data sources has generally been provided for all 'no' answers. Supplementary information has confirmed mitigation measures to deal with increased impermeable area.
Is a conceptual model presented?	Yes	Section 7.0 of the BIA provides a conceptual ground model based

Item	Yes/No/NA	Comment
		on the ground investigation data.
Land Stability Scoping Provided? Is scoping consistent with screening outcome?	Yes	An appropriate scoping statement has been provided for each item carried forward from screening.
Hydrogeology Scoping Provided? Is scoping consistent with screening outcome?	Yes	An appropriate scoping statement has been provided for each item carried forward from screening.
Hydrology Scoping Provided? Is scoping consistent with screening outcome?	Yes	No items were carried forward from hydrology screening. However subsequent information considers need to mitigate increased impermeable areas.
Is factual ground investigation data provided?	Yes	Borehole logs and other SI data are appended to the BIA.
Is monitoring data presented?	Yes	Data is provided in section 5.3 of the GMA.
Is the ground investigation informed by a desk study?	Yes	A desk study is carried out in section 2 of the BIA.
Has a site walkover been undertaken?	Yes	A site walkover is referenced in section 2.1 of the BIA.
Is the presence/absence of adjacent or nearby basements confirmed?	No	The presence of neighbouring basements has not been confirmed. Conservative assumptions have been made in respect of potential impact.
Is a geotechnical interpretation presented?	Yes	Section 8 of the BIA provides an interpretation of soil properties and relates this to different potential forms of construction.
Does the geotechnical interpretation include information on retaining wall design?	Yes	Soil engineering properties relevant to the design of retaining walls are provided in section 8.1 of the BIA.
Are reports on other investigations required by screening and scoping presented?	Yes	A ground movement assessment has been provided which is accepted following the receipt of supplementary information.

Item	Yes/No/NA	Comment
Are the baseline conditions described, based on the GSD?	Partially	The geology and baseline conditions have been described, however the presence of neighbouring basements has not been confirmed.
Do the base line conditions consider adjacent or nearby basements?	No	The presence of neighbouring basements has not been confirmed, although a conservative assessment of potential impact has been made.
Is an Impact Assessment provided?	Yes	An impact assessment has been provided for all the items carried forward from the screening and scoping stages.
Are estimates of ground movement and structural impact presented?	Yes	A ground movement assessment has been provided.
Is the Impact Assessment appropriate to the matters identified by screen and scoping?	Yes	The impact assessment addresses each point raised by screening and scoping. Supplementary information considers surface water.
Has the need for mitigation been considered and are appropriate mitigation methods incorporated in the scheme?	Yes	Mitigation measures have discussed in section 9 of the BIA.
Has the need for monitoring during construction been considered?	Yes	A movement monitoring strategy has been proposed.
Have the residual (after mitigation) impacts been clearly identified?	Yes	Section 10 of the BIA.
Has the scheme demonstrated that the structural stability of the building and neighbouring properties and infrastructure will be maintained?	Yes	The ground movement assessment is accepted following the receipt of further information.
Has the scheme avoided adversely affecting drainage and run-off or causing other damage to the water environment?	Yes	The amount of impermeable area will be increased. The use of SUDs has been proposed.
Has the scheme avoided cumulative impacts upon structural stability or the water environment in the local area?	Yes	

Item	Yes/No/NA	Comment
Does report state that damage to surrounding buildings will be no worse than Burland Category 1?	Yes	
Are non-technical summaries provided?	Yes	A non-technical summary has been provided in section 9.2 of the BIA.

4.0 DISCUSSION

- 4.1. The Basement Impact Assessment (BIA) has been carried out by a well-known firm of engineering consultants, Geotechnical & Environmental Associates (GEA) and the individuals concerned in its production have suitable qualifications.
- 4.2. The Construction Method Statement has similarly been carried out by a well-known firm of engineering consultants, Michael Barclay Partnership; the author of which is a Chartered Structural Engineer.
- 4.3. The LBC Instruction to proceed with the audit identified that the basement proposal did not involve nor was adjacent to listed buildings. The Design & Access Statement identified that the property is within the Fitzjohn Netherhall conservation area.
- 4.4. The proposal consists of constructing a single storey basement below an existing two storey property, with the basement to extend to the entire footprint of the existing building, as well as beneath a two storey rear extension which has previously received planning permission. The basement will also extend outside of the building footprint at the front and the rear to allow for the formation of two lightwells.
- 4.5. The basement is proposed to be constructed by reinforced concrete underpins which are to be formed in a hit and miss sequence to the underside of the existing foundation. The ground floor structure is to be replaced with a reinforced concrete slab cast on metal decking, which is to bear into the existing masonry walls above the level of the underpinning. The basement slab is proposed to form a ground bearing raft foundation to distribute the load from the walls. Given that thick bands of sand are identified within the depth of the basement excavation care should be taken during the excavation work due to the potential instability of excavation faces in sand, and the suitability of such methods should be further considered, particularly if ground water is found to be present.
- 4.6. The underpinning has been designed as propped cantilevers, with high level propping proposed in the construction case and the new RC ground slab propping the walls in the permanent case. A dowelled connection is proposed between the top of the underpins and the underside of the existing foundation which would require the shear force to be transferred via the existing brickwork. Concrete columns have been indicated as spanning between the basement slab and the ground slab in a 3d diagram only, however these are not thought to form an effective shear connection between the wall and the slab in terms of lateral forces due to the slenderness of the columns that would have to be provided. In order to demonstrate the feasibility of a laterally propped cantilever wall, particularly if relying on the prop to reduce ground movements, this lateral shear connection should be substantiated for detailed design via calculation as either being transferred via the brickwork, via the columns, or other proposed method.

- 4.7. It is stated in the construction method statement that lateral propping will only be provided at 2-3m centres as continuity reinforcement is to be provided between underpins. While this may be an acceptable strategy, no design or details of the continuity reinforcement is provided. This should be considered in the detailed design stage further if it is proposed to reduce the amount of propping during the construction stage to less than every pin given the impact this may have on ground movements.
- 4.8. The construction method statement provides outline details for the formation of the basement and the temporary works required. Notwithstanding the points raised in paragraphs 4.5 and 4.7, the method is satisfactory with the underpinning propped against the opposite face of soil in temporary case.
- 4.9. It is stated in the BIA that further assessment of the basement raft is required to determine heave and settlement. The construction method statement separately concludes that heave after the basement raft has been formed will likely be negligible. Further discussion of the heave potential has been carried out in the construction method statement. This is not substantiated via calculation, however it is accepted that heave pressures are likely to be off set by the weight of the existing structure.
- 4.10. The BIA identified that the differential foundation levels will likely be increasing with the neighbouring properties and a ground movement assessment was carried out based on CIRIA C760. Although this is intended for use with piled retaining walls, it is accepted that it is likely to give conservative results, and the predicted results (c6-7mm vertical and horizontal movement at edge of excavation) are typical of what can be achieved with good control of workmanship. The GMA and CMS are consistent in predicting that damage to neighbouring properties should not exceed Burland Category 1.
- 4.11. The screening identified that the basement will extend to within 5m of the public highway and foot path and recommends the provision of a retention system to ensure the stability of the public highway and footpath. The proposed front lightwell has been reduced in length and the proximity of the basement to the public footpath and highway is now greater than 5m.
- 4.12. Appropriate site investigations have been undertaken with an 18m borehole, two window samplers, and three trial pits. The trial pits were taken to the front wall, original rear wall, and extended rear wall. Water levels were also recorded with standpipes installed in each exploratory hole.
- 4.13. The geology was found to be made ground overlaying the Claygate Member to a depth of 18mbgl. Ground water was measured in the standpipes at depths of 1.05mbgl and 4.51mbgl, with no water found in the third pipe to the full depth of 4.41mbgl. The BIA has concluded that

the first measurement is unreliable as the standpipe was located within a flower bed. This is discussed further in paragraph 4.16.

- 4.14. It has been identified that the Claygate Member is classed as a secondary aquifer, and is capable of containing perched water and local ground flows. Screening has identified that the excavation level will 'possibly' be located above the anticipated ground water level, which based on SI concludes is likely around 4.50mbgl, whereas the basement excavation extends to approximately 3.80mbgl. This is discussed further in paragraph 4.16.
- 4.15. Screening has identified that the historic River Tyburn is located close to the property, and the site is within 80m of a former spring line that feeds the Tyburn, although it is not clear how this distance was calculated. It is concluded that as the basement is not extending below the ground water level the spring line will not be impacted. While it is accepted that the water level in two of the exploratory holes at the time of monitoring was found to be below the proposed basement level, there is the potential for seasonal variation in ground water levels which may not have been picked up during a short period of monitoring, particularly if located within the vicinity of a spring line. It can be seen that 'Spring Path' is located immediately adjacent to the rear garden of the property potentially indicating this historic spring line may be located very close to the property.
- 4.16. Given that the geology has been identified as a secondary aquifer, along with potential historic nearby underground watercourses, and one high ground water reading, further ground water monitoring was carried out in August and September 2017 (see Appendix 3), with further readings to be taken prior to construction. These subsequent readings identified ground water levels of between 4.6mbgl and 4.72mbgl. It is accepted that the basement is likely to be above the ground water level, however it is recommended that readings continue to be taken until construction commences in order to further understand seasonal variations.
- 4.17. The BIA initially states that the surface water discharge into the sewer system will not be increased as the portion of hardstanding is not increasing. As the basement will contain front and rear lightwells this was queried. The updated Construction Method Statement has considered the impact on the drainage system. It is not clear by how much the impermeable area is increasing, however, elements of SUDs including an attenuation tank beneath the front drive, permeable paving and a valve to limit the discharge rate to 5 l/s to the combined sewage network are proposed.
- 4.18. An Arboricultural report has been produced by Tin Moya Associates which indicates that of the two trees in the front garden one will likely have to be removed, with the larger high quality tree (T1) requiring some controlled excavation within its root protection areas that will coincide with the front light well. It has been confirmed separately by the applicant that the front lightwell is no longer proposed to be constructed via battered back front garden.

- 4.19. Movement monitoring strategies are proposed both in the BIA and CMS, with generic trigger levels provided and appropriate actions to be taken when triggers are reached. Whilst the trigger levels are slightly different, they appear linked to the wall movements predicted by the ground movement assessment. A final monitoring strategy should be agreed as part of detailed design.
- 4.20. The proposed basement will be within the vicinity of a Network Rail asset with evidence of correspondence with Network Rail's safeguarding department presented, who have confirmed that a BAPA will be required. Network Rail approval is recommended to be secured via planning condition.
- 4.21. An outline works programme providing commencement dates and durations for main phases of work has been provided.
- 4.22. It is accepted that there are no slope stability concerns regarding the proposed development and it is not in an area prone to flooding.

5.0 CONCLUSIONS

- 5.1. The Basement Impact Assessment (BIA) and supporting documents have been carried out by well-known firms holding the required qualifications.
- 5.2. 76 Fitzjohn's Avenue is not listed and nor are the neighbouring properties.
- 5.3. The proposal consists of constructing a single storey basement below the existing property with front and rear lightwells.
- 5.4. The basement is proposed to be constructed by reinforced concrete underpins with a reinforced concrete raft basement slab and foundation. A new ground floor structure is to be constructed as a reinforced concrete slab.
- 5.5. The underpinning has been designed to be propped at the head by the new ground floor slab, however there are some concerns regarding how the shear force generated by the propping will transfer via the existing masonry wall to the head of the wall. Calculations are to be provided for this connection or the underpinning is to be designed as unpropped.
- 5.6. It is proposed to reduce the amount of lateral propping to every 2-3m rather than every underpin, with continuity reinforcement between the underpins allowing the underpins to span laterally between lateral props. The design of which should be considered in the detailed design stage.
- 5.7. The construction method comprises underpins to be formed in a hit and miss sequence.
- 5.8. A ground movement assessment has been produced that predicts a worst case damage category of 1 (very slight). Following the receipt of clarifications, this is accepted.
- 5.9. Appropriate site investigations have been carried out with boreholes and trial pits have been carried out. Ongoing water monitoring has indicated that the ground water level is located beneath the proposed basement level, however it is recommended this continue in order to determine the seasonal high level. Trial excavations are also recommended in the BIA.
- 5.10. It has been identified that the property is located close to the underground river Tyburn and a spring line. The possible location of the spring line very close to the property adds further suggestion that water level monitoring should continue until construction commences.
- 5.11. The Construction Method Statement has been revised to accord with the ground movement assessment which predicts that the damage to neighbouring buildings will be no worse than Burland category 1.

- 5.12. The impact on surface water drainage to the existing sewer system has been considered and the requirement for SUDs recognised.
- 5.13. Excavation is required within the root protection area of a tree in the front garden. However, the proposal to form a battered soil slope in this area is no longer proposed limiting the excavation required within the RPA.
- 5.14. A movement monitoring strategy has been proposed, although the trigger values of which require co-ordination with the ground movement assessment results.
- 5.15. The property is located close to a Network Rail tunnel. Evidence of correspondence with Network Rail has been provided and Network Rail approval will be required prior to construction.
- 5.16. It is accepted that there are no slope stability concerns regarding the proposed development and it is not in an area prone to flooding.
- 5.17. An outline works programme has been provided.
- 5.18. Whilst the documentation presented confirms that the proposal can meet to the requirements of CPG: Basements, due to a number of minor discrepancies, and recommendations in the documentation for further work, a Basement Construction Plan is recommended.

Appendix 1: Residents' Consultation Comments

Residents' Consultation Comments

Surname	Address	Date	Issue raised	Response
The Heath and Hampstead Society	-	22/03/17	No assessment of damage to adjoining buildings is made	A ground movement assessment has been produced, which is accepted following receipt of further clarification (see Appendix 3).
Orwell	-	23/03/17	Information provided on water table is flawed	The applicant has carried out further ground water monitoring which to date has indicated a ground water level below the basement level. Ground water monitoring to continue until construction.
Earrey	86a Fitzjohn's Avenue	30/3/17	Basement may extend below the ground water level and disrupt the local water supply	The applicant has carried out further ground water monitoring which to date has indicated a ground water level below the basement level. Ground water monitoring to continue until construction.
Earrey	86a Fitzjohn's Avenue	30/3/17	Subsidence to the road and public footpath.	A ground movement assessment has been produced, which is accepted following receipt of further clarification (see Appendix 3).
Earrey	86a Fitzjohn's Avenue	30/3/17	Disturbance of lead could be poisonous	Not pertinent to BIA.
Williams	16A Maresfield Gardens	24/3/17	Presence of natural watercourse below property.	The applicant has carried out further ground water monitoring which to date has indicated a ground water level below the basement level. Ground water monitoring to continue until construction.
Zimmerman	26 Redington Road	28/3/17	Basement not fit for purpose due to sloping terrain.	The BIA has adequately screened for slope instability issues.
Eldred Geotechnics Ltd	-	22/04/17	The application provides no assessment of the risk of damage to neighbouring property.	A ground movement assessment has been produced, which is accepted following receipt of further clarification (see Appendix 3).
Eldred Geotechnics Ltd	-	22/04/17	Increase in impermeable area due to the front lightwell, adversely affecting drainage.	Whilst the change to impermeable areas is not clearly stated, mitigation measures to avoid adverse impact to drainage are presented in the updated CMS.

Eldred Geotechnics Ltd	-	22/04/17	Inadequate research of the ground water regime in the immediate region.	The applicant has carried out further ground water monitoring which to date has indicated a ground water level below the basement level. Ground water monitoring to continue until construction.
First Steps Ltd	-	-	Interception of water by the basement making it difficult for number 78 to carry out similar basement construction in the future.	CPG: Basements does not stipulate that the impact on unplanned basements needs to be considered.
Feiereisen	-	-	Erosion risk to neighbouring properties foundations	The presence of ground water would provide the greatest risk to erosion of soils beneath existing neighbouring foundations. The applicant has carried out further ground water monitoring which to date has indicated a ground water level below the basement level. Ground water monitoring to continue until construction.
Feiereisen	-	-	Impact of heave on neighbouring properties	Heave beyond the footprint of the property is considered in both the revised GMA and CMS and predicted to be negligible.
Feiereisen	-	-	Impact of the basement on trees outside of the boundary of number 76.	An Arboricultural report has been produced that confirms that all trees both on and off site were surveyed that may be of significance to the proposed development.
Feiereisen	-	-	Risk of lead contamination to the public, in particular local children.	Not pertinent to BIA.
Nataf-Pesonen	-	28/04/17	Movement monitoring trigger values of neighbouring properties exceeds that of the predicted damage category.	Updated monitoring strategies which reflect the GMA have been presented. A final strategy should be agreed as part of detailed design.
Pesonen	74 Fitzjohn's Avenue	28/04/17	Impact of ramp in front garden on Beech tree that is to be retained.	The applicant has confirmed a ramp will not be constructed (see Appendix 3).
Spinella	-	11/06/17	Possibility that the excavation extends below the water table, and insufficient period of monitoring.	The applicant has carried out further ground water monitoring which to date has indicated a ground water level below the basement level. Ground water monitoring to continue until

				construction.
Spinella	-	11/06/17	Site investigations within 750m of the site and not within site boundary	A site specific investigation was carried out, with some desk study information also taken from existing boreholes within 750m of the site.
Unknown	-	Unknown	Applicant not recording of ground water levels over the winter period	The applicant has carried out further ground water monitoring to indicate that the ground level is not likely to be significantly above the proposed basement level. It has been recommended that further monitoring be carried out however this is not deemed critical to obtaining compliance with CPG: Basements.
Eldred	-	14/11/17	The following issues where relevant to the stability, hydrogeology, hydrology have been taken from objection letter ref G1702/17L14/CNP1. Points listed below in an arbitrary order; 1) Ground movement assessment not justified 2) Closing out of query 4 relating to design of continuity reinforcement 3) Closing out of query 5 relating to inconsistencies relating to geological conditions 4) Closing out of query 6 relating to heave analysis. 5) Closing of query 8 relating the creation of a ramp at the front of the property.	1) Further clarification has been presented regarding the ground movement assessment which is now accepted. 2) Providing continuity reinforcement is an acceptable solution and, in light of a detailed temporary work proposals not being required for planning submission, it has been accepted that the detail may form part of detailed design. 3) It was concluded that the screening and scoping was carried out in consideration of the relevant geological data/interpretation therefore satisfying the requirements of CPG4. However it is accepted that the CMS remains inconsistent. 4) The revised GMA predicts heave beyond the perimeter of the site to be negligible. 5) Confirmation was received by the applicant that the proposal is no longer to form a slope at the front of the property within document "CampbellReith Audit query tracker – applicant responses 25 September 2017". See Appendix 3.

			6) Structural stability and movements of the basement walls during construction. 7) Inconsistent depth of wall between drawings and structural calculations 8) Buoyancy not considered in structural design. 9) CMS incorrectly states that the basement is founded on dense gravels 10) Inadequate temporary works proposals.	6) The applicant has provided appropriate temporary works details. 7) The inconsistency does not prevent the demonstration of the feasibility of the proposal with respect to construction or structural adequacy. 8) Additional groundwater monitoring has shown that buoyancy not critical. Outline calculations allow for 2m head of water pressure. 9) Agreed, however, the screening and scoping study has been carried out with consideration of the correct geology. 10) The applicant has demonstrated the feasibility of constructing the basement by providing outline temporary works details and construction methodology.
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Where similar queries have been raised on separate occasions, the query has only been listed once.

Appendix 2: Audit Query Tracker

Audit Query Tracker

Query No	Subject	Query	Status	Date closed out
1	BIA	An outline works programme is required, that should as a minimum provide details of main phases of work with anticipated commencement dates and durations.	Closed	07/11/17
2	Stability	Connection between head of underpinning and ground floor slab to be proved by calculation to demonstrate adequacy for transmitting shear force between underpinning and prop. Or underpinning wall to be designed as an unpropped cantilever.	Closed	11/06/18 Basement Construction Plan recommended.
3	Stability	Design of continuity reinforcement required if propping not provided to each underpinning bay.	Closed	07/11/17 Basement Construction Plan recommended.
4	Stability	Details of ground movement assessment are required, such as parameters used in the calculation as discussed in paragraph 4.10.	Closed	25/09/18
5	Stability	Section 7 of the construction method statement requires amendment to be consistent with the rest of the submitted information, with regards to geological conditions and damage category.	Closed	07/11/17
6	Stability	Heave analysis or evidence to indicate that heave is negligible is required.	Closed	07/11/17
7	Stability	Viability of proposed permanent and temporary works methodologies to be confirmed once groundwater regime determined.	Closed	07/11/17
8	Stability	The Arboricultural report is to consider the impact of creating and use of a slope at the front of the property on retained tree T1, or this proposal is omitted with the construction method statement amended.	Closed	07/11/17

9	Stability	Movement monitoring values are to be linked to values calculated in the ground movement assessment to ensure the calculated Burland damage category is not exceeded.	Closed	23/08/18 Basement Construction Plan recommended.
10	Stability	Evidence of correspondence with Network Rail to indicate whether the property is within a Network Rail safeguarding zone is required.	N/A	Network Rail approval is required for the scheme
11	Hydrogeology	Further ground water monitoring is required due to the high ground water level being recorded on one of the three standpipes that were monitored and the potential impacts for construction and the water environment.	Closed	07/11/17 Basement Construction Plan recommended.
12	Hydrology	Evidence that the area of impermeable area is not increasing is required, given that the lightwells are impermeable. Details of SUDs are required should the impermeable area be increasing.	Closed	11/06/18 Basement Construction Plan recommended.

Appendix 3: Supplementary Supporting Documents



{In Archive} FW: 2017/1047/P; 76 Fitzjohn's Avenue
Hazelton, Laura to: camdenaudit@campbellreith.com
Cc: "RobertMorley@campbellreith.com"

20/12/2017 11:39

Archive: This message is being viewed in an archive.

Hi Robert,

Please see the applicant's response to your previous report below.

Kind regards,

Laura Hazelton
Senior Planning Officer

Telephone: 020 7974 1017



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- on new improved posters on lamp posts
- by signing up to [planning e-alerts](#)
- in the planning section of the [Camden Account](#)
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You can [sign up](#) to our new and improved planning e-alerts to let you know about new planning applications, decisions and appeals.

From: Thorpe, Emma [mailto:Emma.Thorpe@eu.jll.com]
Sent: 20 December 2017 11:30
To: Hazelton, Laura <Laura.Hazelton@camden.gov.uk>
Cc: Field, Jeff <Jeff.Field@eu.jll.com>
Subject: 2017/1047/P; 76 Fitzjohn's Avenue

Hello Laura,

Thank you for sending us Campbell Reith's updated comments. Most of the information they have requested has already been provided. I provide a summary of the applicant's response below...

Can you please advise when Campbell Reith will be reviewing this and issuing their sign-off?

Query number	Query	Applicant response
2	Connection between head of underpinning and ground floor slab to be proved by calculation to demonstrate adequacy for transmitting shear force between underpinning and prop. Or underpinning wall to be designed as an	This has already been provided on Drawings 110 & 111, both P2 which show the top of the RC Wall/Underpin at ground level.

	unpropped cantilever.	
4	Details of ground movement assessment are required, such as parameters used in the calculation as discussed in paragraph 4.8.	Please see attached reports.
9	Movement monitoring values are to be linked to values calculated in the ground movement assessment to ensure the calculated Burland damage category is not exceeded.	This has already been provided in Section 11 of the CMS (re attached for reference).
12	Evidence that the area of impermeable area is not increasing is required, given that the lightwells are impermeable. Details of SUDs are required should the impermeable area be increasing.	This has already been provided and considers the increase as a result of the lightwells. See section 6 of the CMS and Applicant's response of 25 September 2017 (both reattached for reference).

Thank you,
Emma

Emma Thorpe

Graduate Planning Consultant - Planning, Development & Heritage
JLL
30 Warwick Street, London W1B 5NH

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J16214 - PDISP - Overall Term - Tabular Results 171219 082108.pdf



J16214 - PDISP - Short Term - Tabular Results 171219 082108.pdf



MBP-7009-Construction Method Statement-V1.13.pdf



Campbell Reith Audit Query Tracker - Applicant responses 25 September 20....pdf

Campbell Reith Audit Query Number (As set out in Appendix 2 of revision D1)	Query	Applicant Response
1	An outline works programme is required, that should as a minimum provide details of main phases of work with anticipated commencement dates and durations.	Addressed in enclosed works programme.
2	Connection between head of underpinning and ground floor slab to be proved by calculation to demonstrate adequacy for transmitting shear force between underpinning and prop. Or underpinning wall to be designed as an unpropped cantilever.	Addressed in enclosed Construction Method Statement.
3	Design of continuity reinforcement required if propping not provided to each underpinning bay.	Addressed in enclosed Construction Method Statement.
4	Details of ground movement assessment are required, such as parameters used in the calculation as discussed in paragraph 4.8.	Addressed in enclosed Construction Method Statement.
5	Section 7 of the construction method statement requires amendment to be consistent with the rest of the submitted information, with regards to geological conditions and damage category.	Addressed in enclosed Construction Method Statement.
6	Heave analysis or evidence to indicate that heave is negligible is required.	Addressed in enclosed Construction Method Statement.
7	Viability of proposed permanent and temporary works methodologies to be confirmed once groundwater regime determined.	Groundwater monitoring underway as per point 11. We welcome this to be conditioned.
8	The Arboricultural report is to consider the impact of creating and use of a slope at the front of the property on retained tree T1, or this proposal is omitted with the construction method statement amended.	The applicant is no longer proposing a slope. Addressed in enclosed Construction Method Statement.

9	Movement monitoring values are to be linked to values calculated in the ground movement assessment to ensure the calculated Burland damage category is not exceeded.	Addressed in enclosed Construction Method Statement.
10	Evidence of correspondence with Network Rail to indicate whether the property is within a Network Rail safeguarding zone is required.	The applicant has already engaged with Network Rail's Asset Protection Anglia team, who has confirmed that the property is situated above the Hampstead Heath Tunnel. The applicant will enter into a Basic Asset Protection Agreement ('BAPA') at the appropriate time to ensure that Network Rail assets are protected. Email confirmation in Appendix 1.
11	Further ground water monitoring is required due to the high ground water level being recorded on one of the three standpipes that were monitored and the potential impacts for construction and the water environment.	Additional ground water monitoring has been taking place. Readings took place on 16 August 2017, 21 August 2017 and 4 September 2017. The results are shown in Appendix 2. Three further readings are due to take place on 02 October 2017, 06 November 2017 and 04 December 2017. The applicant will share these results with the Council, and will welcome an appropriate planning condition to secure this.
12	Evidence that the area of impermeable area is not increasing is required, given that the lightwells are impermeable. Details of SUDs are required should the impermeable area be increasing.	The amount of impermeable area is increasing by 1sqm. A drawing illustrating this is included in Appendix 3.

Appendix 1 – Email correspondence with Network Rail

From: Pelusi Dino [<mailto:Dino.Pelusi@networkrail.co.uk>]
Sent: 03 November 2016 16:15
To: naqi.zain@gmail.com
Cc: alex@gea-ltd.co.uk; Matthew McFerran <M.McFerran@bbpartnership.co.uk>
Subject: 152341/AR6188 76 Fitzjohn's Avenue, London, NW3 5LS

Good afternoon Mr Zain

Please accept our apologise for the delay in responding to your recent requests regarding the proposed development/redevelopment at no 75 Fitzjohn's Avenue, London.

There was some initial confusion as we had 2 (two) applications relating to the same property, however after speaking with one of your representatives at BB Partnerships, it has been decided that in order to avoid any future confusion that we will close down one of the applications, namely the one submitted by Madlins LLP under reference 152341/AR6168.

For ease going forward please use reference 152341/AR6188.

In order to start actively facilitate this scheme in terms of taking it forward, we will need to enter in to an agreement known as a Basic Asset Protection Agreement (BAPA), which is an approved mechanism we use with the majority of the external clients/customers who contact us for simple to reasonable complex schemes. This particular scheme I would proffer falls initially under the more complex schemes mainly because of the proximity of Hampstead Heath Rail Tunnel to you proposed works.

Obviously depending upon how your proposed method of works and design develop, the risk rating for your proposed scheme may well drop and in turn turning your scheme in to a less complex affair.

The BAPA document will deal with our working relationship, the level of information we will provide, how we go about reviewing your design submissions, work methodology, etc., along with the matter of the payment for our services.

In order to 'kick start' the process off my proposal is that I will issue out an initial BAPA to you for say £5,000.00, this will cover various upfront formalities and will allow us to better understand your requirements and in turn provide your design team with vital information they may require regarding our rail tunnel. Once we have a better understanding of your requirements, etc., we will then be in a better position to refine our BAPA and tailor it more to your actual needs and requirements.

As part of our discussion and advice and dependent upon your proposed method of works, the physical depth & types of piles proposed, any basement works, etc., it may be necessary to monitor the movement of the physical tunnel and or track to ensure that there is no excessive vibration as a result of your works. However all of these things can be discussed once the initial BAPA and associated documentation has been signed, returned and agreed.

Going forward, I may ask one of the other members of the team to be your day to day point of contact in order to ensure a more expedient response going forward, however I will still be on hand to offer guidance should the need arise.

I will endeavour to send out the necessary BAPA paperwork within the next couple of days.

In the meantime, if you have any queries, please feel free to drop me a line as noted below.

Yours sincerely

Dino P Pelusi

Scheme Project Manager
Anglia Route Asset Management
Network Rail 11th Floor
One Stratford Place
Montfichet Road
Stratford
London
E20 1EJ



Int: 085 68511



Ext: 020 3356 2511



Group Fax: 012 1345 4282



Mobile: 07443 469 343



dino.pelusi@networkrail.co.uk

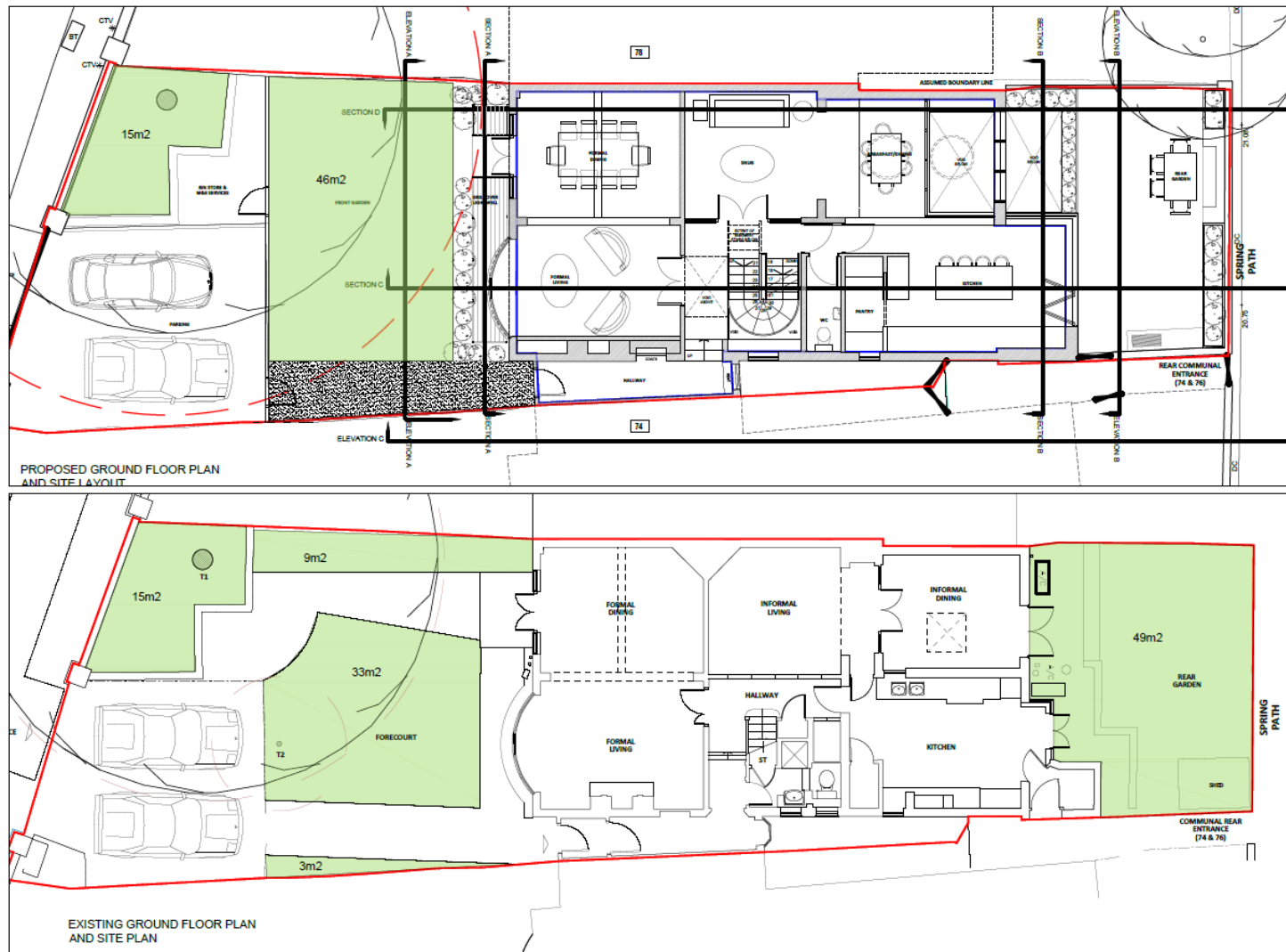


Appendix 2 – Additional Ground Water Monitoring Results

(supplied by Malcolm Brady Partnerships)

MBP-7009: 76 Fitzroy Avenue Groundwater Monitoring Record						
Date		16/08/17	21/08/17	04/09/17	02/10/17	06/11/17 04/12/17
Depth (m)	BH1A	4.70	4.60	4.72		

Appendix 3 – Drawing to illustrate impermeable area.



76 Fitzjohns Avenue

Application ref: 2017/1047/P



To: Liz Brown/CRH@Campbellreith,
Cc:
Bcc:
Subject: Re: FW: MBP-7009:- 76 Fitzjohns Ave Rep Iss 3 complete" with you.
From: Robert Morley/CRH - Thursday 23/08/2018 17:00

History: This message has been replied to.

"Field, Jeff"	Laura - responses below. Jeff	23/08/2018 16:54:00
---------------	-------------------------------	---------------------

From: "Field, Jeff" <Jeff.Field@eu.jll.com>
To: "Hazelton, Laura" <Laura.Hazelton@camden.gov.uk>
Cc: "RobertMorley@campbellreith.com" <RobertMorley@campbellreith.com>
Date: 23/08/2018 16:54
Subject: FW: MBP-7009:- 76 Fitzjohns Ave Rep Iss 3 complete" with you.

Laura – responses below.

Jeff

- section 9.3.1 second paragraph - Can the applicant confirm whether they have incorporated immediate or long term heave. As the full long term heave will not be recognised for a number of years and may not be the most onerous case. **Both have been considered**
- section 9.3.2 trigger level table - We have assumed that 12mm for horizontal green movement is an error for line 19 and should read 2mm? **Correct, that should read 2mm**
- section 9.3.1 last paragraph - Top down construction is not consistent with the temporary works and sequence as detailed in the construction method statement. Can the applicant confirm that top down construction is indeed the proposed construction methodology and that the assumptions made in the GMA are therefore valid. **Construction will either be top-down or top-propped, i.e. the basement walls will not, at any point in the process, cantilever**

Jeff Field

Chairman - Planning, Development & Heritage
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To: Camden Audit/CRH@campbellreith,
Cc:
Bcc:
Subject: Fw: MBP-7009:- 76 Fitzjohns Ave Rep Iss 3 complete" with you.
From: Robert Morley/CRH - Tuesday 25/09/2018 12:13
Sent by: Jacqui Parker/CRH

----- Forwarded by Jacqui Parker/CRH on 25/09/2018 12:14 -----

From: "Field, Jeff" <Jeff.Field@eu.jll.com>
To: "Hazelton, Laura" <Laura.Hazelton@camden.gov.uk>, "RobertMorley@campbellreith.com" <RobertMorley@campbellreith.com>
Cc: "Malcolm Brady" <malcolm.brady@mbp-uk.com>
Date: 25/09/2018 08:39
Subject: RE: MBP-7009:- 76 Fitzjohns Ave Rep Iss 3 complete" with you.

Laura – the response back from GEA is as follows. I am reliably told that CR will know what this means.

Can we get this one moving again?

Thanks

Jeff

So, we've reviewed the query and the analysis and the conclusion of the building damage assessment: that assessment used both the short-term and overall term movements and the results of the overall term assessment proved to be the most conservative as the predicted damage was at its highest level. This is because the loads are such that the resulting settlement in the overall term will be larger than the heave movement caused by the unloading as a result of the basement excavation. The building damage will, therefore, be controlled by the overall settlements and it is those results that have been included in GEA's report and have therefore been suitably conservative in approach.

Jeff Field

Chairman - Planning, Development & Heritage
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M +44 (0)7912 120453
Jeff.Field@eu.jll.com
jll.co.uk

From: Field, Jeff
Sent: 10 September 2018 14:18
To: 'Hazelton, Laura' <Laura.Hazelton@camden.gov.uk>
Subject: RE: [EXTERNAL] RE: MBP-7009:- 76 Fitzjohns Ave Rep Iss 3 complete" with you.

Laura – I had thought I had put in measures to stop you going into spam but it keeps happening..

I have asked our engineer the latest question.

Jeff

From: Hazelton, Laura [<mailto:Laura.Hazelton@camden.gov.uk>]
Sent: 10 September 2018 10:35
To: Field, Jeff <Jeff.Field@eu.jll.com>
Subject: [EXTERNAL] RE: MBP-7009:- 76 Fitzjohns Ave Rep Iss 3 complete" with you.

Hi Jeff,

Just checking you received the email I forwarded on Friday?

Kind regards,

Laura Hazelton
Senior Planning Officer

Telephone: 020 7974 1017

From: Field, Jeff <Jeff.Field@eu.jll.com>
Sent: 07 September 2018 10:21
To: Hazelton, Laura <Laura.Hazelton@camden.gov.uk>
Cc: RobertMorley@campbellreith.com
Subject: RE: MBP-7009:- 76 Fitzjohns Ave Rep Iss 3 complete" with you.

Laura – is there any news on this one?

Thanks

Jeff

Jeff Field

Chairman - Planning, Development & Heritage
JLL
30 Warwick Street, London W1B 5NH

T +44 (0)207 852 4742
M +44 (0)7912 120453
Jeff.Field@eu.jll.com
jll.co.uk

From: Field, Jeff
Sent: 23 August 2018 16:57
To: Hazelton, Laura <Laura.Hazelton@camden.gov.uk>
Cc: RobertMorley@campbellreith.com
Subject: FW: [EXTERNAL] MBP-7009:- 76 Fitzjohns Ave Rep Iss 3 complete" with you.

Laura – responses below.

Jeff

- section 9.3.1 second paragraph - Can the applicant confirm whether they have incorporated immediate or long term heave. As the full long term heave will not be recognised for a number of years and may not be the most onerous case. **Both have been considered**
- section 9.3.2 trigger level table - We have assumed that 12mm for horizontal green movement is an error for line 19 and should read 2mm? **Correct, that should read 2mm**
- section 9.3.1 last paragraph - Top down construction is not consistent with the temporary works and sequence as detailed in the construction method statement. Can the applicant confirm that top down construction is indeed the proposed construction methodology and that the assumptions made in the GMA are therefore valid. **Construction will either be top-down or top-propped, i.e. the basement walls will not, at any point in the process, cantilever**

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76 Fitzjohns Avenue, London, NW3 5LS
Wall Installation & Excavation (Overall Term)
Tabular Output

Job No.	Sheet No.	Rev.
J16214		
Drg. Ref.		
Made by AT	Date	Checked

Analysis Options

Analysis: Boussinesq
Global Poisson's ratio: 0.20
Maximum allowable ratio between values of E: 1.5
Horizontal rigid boundary level: -45.00 [m OD]
Stiffness for horizontal displacement calculations: Weighted average
Using legacy heave correction factor: No
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	0.0	1	5000.0 5000.0	0.20000	None
2	-1.0000	4	32000. 32000.	0.20000	None
3	-5.0000	40	19500. 39000.	0.20000	None

Soil Zones

Zone	Name	X coordinates min [m]	X coordinates max [m]	Y coordinates min [m]	Y coordinates max [m]	Profile
1	Soil Zone 1	0.00000	60.00000	0.00000	50.00000	Soil Profile 1

Load Data

Load ref.	Name	Shape	Orientation of Plane	Centre of load (Global)			Load position			Length y	Polygon Coordinates	Rectangle tolerance	Number of rectangles	Load value		
				X	Y	Z (level)	Angle of local x from	Width x or Radius	Normal (local z)					(local x)	Tangential (local y)	
1	Front Retaining Wall	Rectangular	Horizontal	[m] 21.00000	[m] 24.00000	[m] -4.00000	[Degrees] 0.0	[m] 2.0000	[m] 8.0000	N/A	[m]	[%]	1	[kN/m²] 91.000	[kN/m²] 0.0	[kN/m²] 0.0
2	Rear Retaining Wall	Rectangular	Horizontal	37.00000	24.00000	-4.00000	0.0	2.0000	8.0000	N/A			1	91.000	0.0	0.0
3	Southern Retaining Wall	Rectangular	Horizontal	29.00000	21.00000	-4.00000	0.0	13.900	2.0000	N/A			1	91.000	0.0	0.0
4	Northern Retaining Wall	Rectangular	Horizontal	29.00000	27.00000	-4.00000	0.0	13.900	2.0000	N/A			1	91.000	0.0	0.0
5	Basement Excavation	Rectangular	Horizontal	29.00000	24.00000	-4.00000	0.0	13.900	3.9000	N/A			1	-74.000	0.0	0.0

Displacement Data

Ref.	Type	Name	Direction of Extrusion	First point X Y Z [m] [m] [level]	Line/Line for extrusion Second point X Y Z [m] [m] [level]	No. of intrvl across extrusion/line	Extrusion Depth	No. of intrvl along extrusion	Calculate	Show Detailed results
1	Grid	Grid 1	Global X	0.00000 0.00000 0.00000	N/A 50.00000 0.00000	50	60.00000	60	Yes	Yes
2	Line	Line 1	N/A	38.10000 28.00000 -0.50000	42.50000 28.00000 -0.50000	5	N/A	N/A	Yes	Yes
3	Line	Line 2	N/A	42.60000 28.00000 -0.50000	42.60000 20.00000 -0.50000	8	N/A	N/A	Yes	Yes
4	Line	Line 3	N/A	38.10000 20.00000 -0.50000	42.50000 20.00000 -0.50000	5	N/A	N/A	Yes	Yes
5	Line	Line 4	N/A	19.90000 28.00000 -0.50000	11.00000 28.00000 -0.50000	9	N/A	N/A	Yes	Yes
6	Line	Line 5	N/A	10.90000 28.00000 -0.50000	6.90000 18.00000 -0.50000	10	N/A	N/A	Yes	Yes
7	Line	Line 6	N/A	7.00000 19.00000 -0.50000	34.00000 19.00000 -0.50000	14	N/A	N/A	Yes	Yes
8	Line	Line 7	N/A	33.90000 19.00000 -0.50000	33.90000 19.00000 -0.50000	10	N/A	N/A	Yes	Yes
9	Line	Line 8	N/A	42.60000 38.00000 -0.50000	42.60000 28.10000 -0.50000	10	N/A	N/A	Yes	Yes
10	Line	Line 9	N/A	15.10000 38.00000 -0.50000	42.50000 38.00000 -0.50000	14	N/A	N/A	Yes	Yes
11	Line	Line 10	N/A	10.90000 28.10000 -0.50000	14.50000 38.00000 -0.50000	8	N/A	N/A	Yes	Yes
12	Line	Line 11	N/A	6.90000 17.90000 -0.50000	36.60000 19.00000 -1.00000	9	N/A	N/A	Yes	Yes
13	Line	Line 13	N/A	4.10000 9.00000 -0.50000	23.90000 10.00000 -0.50000	10	N/A	N/A	Yes	Yes
14	Line	Line 14	N/A	37.10000 11.00000 -0.50000	42.50000 11.00000 -0.50000	5	N/A	N/A	Yes	Yes
15	Line	Line 15	N/A	42.60000 20.00000 -0.50000	42.60000 11.00000 -0.50000	8	N/A	N/A	Yes	Yes
16	Line	Line 16	N/A	24.00000 10.00000 -1.00000	23.00000 18.00000 -1.00000	8	N/A	N/A	Yes	Yes
17	Line	Line 17	N/A	23.10000 18.00000 -1.00000	38.60000 19.00000 -1.00000	9	N/A	N/A	Yes	Yes
18	Line	Line 18	N/A	36.50000 16.00000 -1.00000	37.00000 11.00000 -1.00000	8	N/A	N/A	Yes	Yes
19	Line	Line 19	N/A	36.90000 11.00000 -1.00000	24.10000 10.00000 -1.00000	7	N/A	N/A	Yes	Yes
20	Line	Line 20	N/A	23.00000 28.10000 -1.00000	23.00000 36.00000 -1.00000	8	N/A	N/A	Yes	Yes
21	Line	Line 21	N/A	23.10000 36.00000 -1.00000	36.00000 36.00000 -1.00000	7	N/A	N/A	Yes	Yes
22	Line	Line 22	N/A	36.10000 35.00000 -1.00000	36.10000 16.50000 -1.00000	8	N/A	N/A	Yes	Yes
23	Line	Line 23	N/A	33.00000 35.90000 -1.00000	33.00000 28.10000 -1.00000	8	N/A	N/A	Yes	Yes
24	Line	Line 24	N/A	29.00000 28.10000 -1.00000	29.00000 31.90000 -1.00000	3	N/A	N/A	Yes	Yes
25	Line	Line 25	N/A	28.00000 32.10000 -1.00000	28.00000 35.90000 -1.00000	4	N/A	N/A	Yes	Yes
26	Line	Line 26	N/A	29.00000 32.00000 -1.00000	23.10000 32.00000 -1.00000	6	N/A	N/A	Yes	Yes
27	Line	Line 27	N/A	36.50000 16.10000 -1.00000	39.00000 16.50000 -1.00000	8	N/A	N/A	Yes	Yes
28	Line	Line 28	N/A	39.00000 16.60000 -1.00000	38.70000 19.00000 -1.00000	3	N/A	N/A	Yes	Yes
29	Line	Line 29	N/A	24.00000 9.90000 -1.00000	25.00000 0.00000 -1.00000	10	N/A	N/A	Yes	Yes
30	Line	Line11	N/A	42.60000 10.90000 -0.50000	42.60000 0.00000 -0.50000	10	N/A	N/A	Yes	Yes
31	Line	Line 30	N/A	37.00000 10.90000 -1.00000	37.50000 7.00000 -1.00000	4	N/A	N/A	Yes	Yes
32	Line	Line 31	N/A	37.60000 7.00000 -1.00000	39.60000 7.40000 -1.00000	8	N/A	N/A	Yes	Yes
33	Line	Line 32	N/A	39.60000 7.30000 -1.00000	40.10000 3.00000 -1.00000	4	N/A	N/A	Yes	Yes
34	Line	Line 33	N/A	4.00000 8.90000 -0.50000	1.00000 0.00000 -0.50000	9	N/A	N/A	Yes	Yes
35	Line	Line 34	N/A	42.60000 38.10000 -0.50000	42.60000 48.00000 -0.50000	10	N/A	N/A	Yes	Yes
36	Line	Line 35	N/A	38.50000 38.10000 -1.00000	38.50000 48.00000 -1.00000	10	N/A	N/A	Yes	Yes
37	Line	Line 36	N/A	24.50000 39.10000 -1.00000	24.50000 48.00000 -1.00000	10	N/A	N/A	Yes	Yes
38	Line	Line 37	N/A	14.50000 38.10000 -0.50000	18.00000 48.00000 -0.50000	5	N/A	N/A	Yes	Yes
39	Line	Line 38	N/A	44.50000 48.00000 -0.50000	44.50000 0.00000 -0.50000	24	N/A	N/A	Yes	Yes
40	Line	Line 39	N/A	44.60000 26.00000 -0.50000	60.00000 28.00000 -0.50000	8	N/A	N/A	Yes	Yes
41	Line	Line 40	N/A	44.60000 38.50000 -0.50000	60.00000 40.50000 -0.50000	8	N/A	N/A	Yes	Yes
42	Line	Network	N/A	0.00000 36.00000 -32.00000	60.00000 38.00000 -32.00000	60	N/A	N/A	Yes	Yes

Warnings

(1)The displacement location of Line 34 at (1.000, -0.000, -0.500)m lies wide of all soil zones. The first soil profile will be used. There are more displacement locations for which this warning applies. Only one is detailed here.

RESULTS FOR GRIDS

Analysis: Boussinesq
Global Poisson's ratio: 0.20
Horizontal rigid boundary level: -45.00 [m OD]

The maximum displacement difference between the Boussinesq method (13.750mm) and the Mindlin method (7.8636mm) occurs at point X = 21.00000m, Y = 22.00000m, level = 0.0mOD, and is 5.8862mm.

Name	X [m]	Location Y [m]	Z[Level] [mOD]	Displacement Z [mm]	Calc Level [mOD]	Vert Stress [kN/m ²]	Sum Princ [kN/m ²]	Vert Strain [-]
Front Retaining Wall	21.00000	24.00000	-4.00000	13.428	-4.2500	90.268	178.22	0.0022712
Rear Retaining	37.00000	24.00000	-4.00000	13.428	-4.2500	90.268	178.22	0.0022712



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Wall Installation & Excavation (Overall Term)
Tabular Output

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Name	X [m]	Location Y [m]	Z[Level] [mOD]	Displacement Z [mm]	Calc Level [mOD]	Stresses		Vert Strain
						Vert Stress [kN/m ²]	Sum Princ [kN/m ²]	[-]
24.00000	36.80000	-32.00000	0.37592	-32.113	1.2663	1.2922	38.545E-6	
25.00000	36.83333	-32.00000	0.38035	-32.113	1.2831	1.3039	39.092E-6	
26.00000	36.86667	-32.00000	0.38370	-32.113	1.2958	1.3127	39.502E-6	
27.00000	36.90000	-32.00000	0.38592	-32.113	1.3042	1.3185	39.773E-6	
28.00000	36.93333	-32.00000	0.38701	-32.113	1.3082	1.3214	39.963E-6	
29.00000	36.96667	-32.00000	0.38696	-32.113	1.3078	1.3214	39.890E-6	
30.00000	37.00000	-32.00000	0.38577	-32.113	1.3031	1.3183	39.735E-6	
31.00000	37.03333	-32.00000	0.38344	-32.113	1.2940	1.3122	39.440E-6	
32.00000	37.06667	-32.00000	0.38000	-32.113	1.2807	1.3033	39.007E-6	
33.00000	37.10000	-32.00000	0.37549	-32.113	1.2633	1.2915	38.440E-6	
34.00000	37.13333	-32.00000	0.36993	-32.113	1.2419	1.2770	37.744E-6	
35.00000	37.16667	-32.00000	0.36339	-32.113	1.2167	1.2598	36.926E-6	
36.00000	37.20000	-32.00000	0.35591	-32.113	1.1880	1.2401	35.993E-6	
37.00000	37.23333	-32.00000	0.34756	-32.113	1.1560	1.2181	34.955E-6	
38.00000	37.26667	-32.00000	0.33842	-32.113	1.1211	1.1940	33.820E-6	
39.00000	37.30000	-32.00000	0.32857	-32.113	1.0835	1.1579	32.602E-6	
40.00000	37.33333	-32.00000	0.31809	-32.113	1.0437	1.1400	31.312E-6	
41.00000	37.36667	-32.00000	0.30708	-32.113	1.0020	1.1106	29.964E-6	
42.00000	37.40000	-32.00000	0.29563	-32.113	0.95893	1.0799	28.570E-6	
43.00000	37.43333	-32.00000	0.28384	-32.113	0.91478	1.0481	27.145E-6	
44.00000	37.46667	-32.00000	0.27179	-32.113	0.87000	1.0154	25.702E-6	
45.00000	37.50000	-32.00000	0.25959	-32.113	0.82499	0.98210	24.255E-6	
46.00000	37.53333	-32.00000	0.24733	-32.113	0.78011	0.94838	22.815E-6	
47.00000	37.56667	-32.00000	0.23508	-32.113	0.73572	0.91446	21.394E-6	
48.00000	37.60000	-32.00000	0.22292	-32.113	0.69212	0.88052	20.002E-6	
49.00000	37.63333	-32.00000	0.21093	-32.113	0.64957	0.84675	18.649E-6	
50.00000	37.66667	-32.00000	0.19917	-32.113	0.60832	0.81331	17.340E-6	
51.00000	37.70000	-32.00000	0.18769	-32.113	0.56855	0.78033	16.083E-6	
52.00000	37.73333	-32.00000	0.17654	-32.113	0.53041	0.74796	14.882E-6	
53.00000	37.76667	-32.00000	0.16577	-32.113	0.49400	0.71630	13.740E-6	
54.00000	37.80000	-32.00000	0.15539	-32.113	0.45941	0.68544	12.660E-6	
55.00000	37.83333	-32.00000	0.14544	-32.113	0.42668	0.65545	11.643E-6	
56.00000	37.86667	-32.00000	0.13593	-32.113	0.39582	0.62640	10.689E-6	
57.00000	37.90000	-32.00000	0.12687	-32.113	0.36683	0.59833	9.7967E-6	
58.00000	37.93333	-32.00000	0.11826	-32.113	0.33966	0.57128	8.9658E-6	
59.00000	37.96667	-32.00000	0.11012	-32.113	0.31429	0.54525	8.1941E-6	
60.00000	38.00000	-32.00000	0.10242	-32.113	0.29063	0.52026	7.4794E-6	!

! Point lies outside soil zones. Results calculated for this point assume a soil zone with properties of the first soil profile.

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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: -45.00 [m OD]
Stiffness for horizontal displacement calculations: Weighted average
Using legacy heave correction factor: No
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	0.0	1	5000.0 5000.0	0.50000	None
2	-1.0000	4	32000. 32000.	0.50000	None
3	-5.0000	40	32500. 65000.	0.50000	None

Soil Zones

Zone	Name	X coordinates min [m] max [m]	Y coordinates min [m] max [m]	Profile
1	Soil Zone 1	0.00000 60.00000	0.00000 50.00000	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 [Degrees]	Width x or Radius [m]	Length y [m]	Polygon Coordinates [m]	Rectangle tolerance [%]	Number of rectangles	Normal (local z) [kN/m ²]	Load value Tangential (local x) (local y) [kN/m ²] [kN/m ²]
1	Front Retaining Wall	Rectangular	Horizontal	20.25000 24.00000 -4.00000	0.0	0.50000	8.0000	N/A	N/A	1	256.00	0.0 0.0
2	Rear Retaining Wall	Rectangular	Horizontal	37.75000 24.00000 -4.00000	0.0	0.50000	8.0000	N/A	N/A	1	256.00	0.0 0.0
3	Southern Retaining Wall	Rectangular	Horizontal	29.00000 20.25000 -4.00000	0.0	16.900	0.50000	N/A	N/A	1	256.00	0.0 0.0
4	Northern Retaining Wall	Rectangular	Horizontal	29.00000 27.75000 -4.00000	0.0	16.900	0.50000	N/A	N/A	1	256.00	0.0 0.0
5	Basement Excavation	Rectangular	Horizontal	29.00000 24.00000 -4.00000	0.0	16.900	6.9000	N/A	N/A	1	-74.000	0.0 0.0

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 [m]	No. of intrvl along extrusion	Calculate	Show Detailed results
1	Grid	Grid 1	Global X	0.00000 0.00000 0.00000	N/A 50.00000 0.00000	50	60.00000	60	Yes	Yes
2	Line	Line 1	N/A	38.10000 28.00000 -0.50000	42.50000 28.00000 -0.50000	5	N/A	N/A	Yes	Yes
3	Line	Line 2	N/A	42.60000 28.00000 -0.50000	42.60000 20.00000 -0.50000	8	N/A	N/A	Yes	Yes
4	Line	Line 3	N/A	38.10000 20.00000 -0.50000	42.50000 20.00000 -0.50000	5	N/A	N/A	Yes	Yes
5	Line	Line 4	N/A	19.90000 28.00000 -0.50000	11.00000 28.00000 -0.50000	9	N/A	N/A	Yes	Yes
6	Line	Line 5	N/A	10.90000 28.00000 -0.50000	6.90000 18.00000 -0.50000	10	N/A	N/A	Yes	Yes
7	Line	Line 6	N/A	7.00000 19.00000 -0.50000	34.00000 19.00000 -0.50000	14	N/A	N/A	Yes	Yes
8	Line	Line 7	N/A	33.90000 19.00000 -0.50000	33.90000 19.00000 -0.50000	1	N/A	N/A	Yes	Yes
9	Line	Line 8	N/A	42.60000 38.00000 -0.50000	42.60000 28.10000 -0.50000	10	N/A	N/A	Yes	Yes
10	Line	Line 9	N/A	15.10000 38.00000 -0.50000	42.50000 38.00000 -0.50000	14	N/A	N/A	Yes	Yes
11	Line	Line 10	N/A	10.90000 28.10000 -0.50000	14.50000 38.00000 -0.50000	8	N/A	N/A	Yes	Yes
12	Line	Line 11	N/A	6.90000 17.90000 -0.50000	4.00000 9.00000 -0.50000	9	N/A	N/A	Yes	Yes
13	Line	Line 12	N/A	4.10000 9.00000 -0.50000	23.90000 10.00000 -0.50000	10	N/A	N/A	Yes	Yes
14	Line	Line 13	N/A	37.10000 11.00000 -0.50000	42.50000 11.00000 -0.50000	5	N/A	N/A	Yes	Yes
15	Line	Line 14	N/A	42.60000 20.00000 -0.50000	42.60000 11.00000 -0.50000	8	N/A	N/A	Yes	Yes
16	Line	Line 15	N/A	24.00000 10.00000 -1.00000	23.00000 18.00000 -1.00000	8	N/A	N/A	Yes	Yes
17	Line	Line 16	N/A	23.10000 18.00000 -1.00000	38.60000 19.00000 -1.00000	9	N/A	N/A	Yes	Yes
18	Line	Line 17	N/A	36.50000 16.00000 -1.00000	37.00000 11.00000 -1.00000	8	N/A	N/A	Yes	Yes
19	Line	Line 18	N/A	36.90000 11.00000 -1.00000	24.10000 10.00000 -1.00000	7	N/A	N/A	Yes	Yes
20	Line	Line 19	N/A	23.00000 28.10000 -1.00000	23.00000 36.00000 -1.00000	7	N/A	N/A	Yes	Yes
21	Line	Line 20	N/A	23.10000 36.00000 -1.00000	36.00000 36.00000 -1.00000	8	N/A	N/A	Yes	Yes
22	Line	Line 21	N/A	36.10000 35.00000 -1.00000	36.10000 28.10000 -1.00000	6	N/A	N/A	Yes	Yes
23	Line	Line 22	N/A	33.00000 35.00000 -1.00000	33.00000 28.10000 -1.00000	8	N/A	N/A	Yes	Yes
24	Line	Line 23	N/A	29.00000 28.10000 -1.00000	29.00000 31.00000 -1.00000	3	N/A	N/A	Yes	Yes
25	Line	Line 24	N/A	28.00000 32.10000 -1.00000	28.00000 35.00000 -1.00000	4	N/A	N/A	Yes	Yes
26	Line	Line 25	N/A	29.00000 38.10000 -1.00000	23.10000 32.00000 -1.00000	6	N/A	N/A	Yes	Yes
27	Line	Line 26	N/A	36.50000 16.10000 -1.00000	39.00000 16.50000 -1.00000	3	N/A	N/A	Yes	Yes
28	Line	Line 27	N/A	39.00000 16.00000 -1.00000	38.70000 19.00000 -1.00000	3	N/A	N/A	Yes	Yes
29	Line	Line 28	N/A	24.00000 9.90000 -1.00000	25.00000 0.00000 -1.00000	10	N/A	N/A	Yes	Yes
30	Line	Line 29	N/A	42.60000 10.90000 -0.50000	42.60000 0.00000 -0.50000	10	N/A	N/A	Yes	Yes
31	Line	Line 30	N/A	37.00000 10.90000 -1.00000	37.50000 7.00000 -1.00000	4	N/A	N/A	Yes	Yes
32	Line	Line 31	N/A	37.60000 7.00000 -1.00000	39.60000 7.40000 -1.00000	2	N/A	N/A	Yes	Yes
33	Line	Line 32	N/A	39.60000 7.30000 -1.00000	40.10000 3.00000 -1.00000	4	N/A	N/A	Yes	Yes
34	Line	Line 33	N/A	4.00000 8.90000 -0.50000	1.00000 0.00000 -0.50000	9	N/A	N/A	Yes	Yes
35	Line	Line 34	N/A	42.60000 38.10000 -0.50000	42.60000 48.00000 -0.50000	10	N/A	N/A	Yes	Yes
36	Line	Line 35	N/A	38.50000 38.10000 -1.00000	38.50000 48.00000 -1.00000	10	N/A	N/A	Yes	Yes
37	Line	Line 36	N/A	24.50000 38.10000 -1.00000	24.50000 48.00000 -1.00000	10	N/A	N/A	Yes	Yes
38	Line	Line 37	N/A	14.50000 38.10000 -0.50000	18.00000 48.00000 -0.50000	5	N/A	N/A	Yes	Yes
39	Line	Line 38	N/A	44.50000 48.00000 -0.50000	44.50000 0.00000 -0.50000	24	N/A	N/A	Yes	Yes
40	Line	Line 39	N/A	44.60000 26.00000 -0.50000	60.00000 28.00000 -0.50000	8	N/A	N/A	Yes	Yes
41	Line	Line 40	N/A	44.60000 38.50000 -0.50000	60.00000 40.50000 -0.50000	8	N/A	N/A	Yes	Yes
42	Line	Line 41	N/A	0.00000 36.00000 -32.00000	60.00000 38.00000 -32.00000	60	N/A	N/A	Yes	Yes

Warnings

(1)The displacement location of Line 34 at (1.000, -0.000, -0.500)m lies wide of all soil zones. The first soil profile will be used. There are more displacement locations for which this warning applies. Only one is detailed here.

RESULTS FOR GRIDS

Analysis: Boussinesq
Global Poisson's ratio: 0.50
Horizontal rigid boundary level: -45.00 [m OD]

The maximum displacement difference between the Boussinesq method (0.016493mm) and the Mindlin method (14.798mm) occurs at point X = 9.00000m, Y = 50.00000m, level = 0.0mOD, and is 14.781mm.

Name	X [m]	Location Y [m]	Z[Level] [mOD]	Displacement Z [mm]	Calc Level [mOD]	Vert Stress [kN/m ²]	Sum Princ [kN/m ²]	Vert Strain [-]
Front Retaining Wall	20.25000	24.00000	-4.00000	3.4793	-4.2500	204.72	340.92	0.0042692
Rear Retaining	37.75000	24.00000	-4.00000	3.4793	-4.2500	204.72	340.92	0.0042692



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Wall Installation & Excavation (Short Term)
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Name	X [m]	Location Y [m]	Z[Level] [mOD]	Displacement Z [mm]	Calc Level [mOD]	Stresses		
						Vert Stress [kN/m ²]	Sum Princ [kN/m ²]	Vert Strain [-]
39.00000	37.30000	-32.00000	-0.10605	-32.113	-0.65426	-0.88762	-9.8585E-6	
40.00000	37.33333	-32.00000	-0.10046	-32.113	-0.61897	-0.85903	-9.1498E-6	
41.00000	37.36667	-32.00000	-0.094757	-32.113	-0.58337	-0.82952	-8.4412E-6	
42.00000	37.40000	-32.00000	-0.089014	-32.113	-0.54792	-0.79942	-7.7419E-6	
43.00000	37.43333	-32.00000	-0.083289	-32.113	-0.51298	-0.76898	-7.0601E-6	
44.00000	37.46667	-32.00000	-0.077635	-32.113	-0.47890	-0.73845	-6.4024E-6	
45.00000	37.50000	-32.00000	-0.072098	-32.113	-0.44593	-0.70807	-5.7741E-6	
46.00000	37.53333	-32.00000	-0.066719	-32.113	-0.41429	-0.67803	-5.1701E-6	
47.00000	37.56667	-32.00000	-0.061529	-32.113	-0.38412	-0.64850	-4.6202E-6	
48.00000	37.60000	-32.00000	-0.056553	-32.113	-0.35554	-0.61961	-4.0989E-6	
49.00000	37.63333	-32.00000	-0.051811	-32.113	-0.32861	-0.59148	-3.6160E-6	
50.00000	37.66667	-32.00000	-0.047314	-32.113	-0.30335	-0.56420	-3.1713E-6	
51.00000	37.70000	-32.00000	-0.043070	-32.113	-0.27976	-0.53784	-2.7640E-6	
52.00000	37.73333	-32.00000	-0.039083	-32.113	-0.25700	-0.51244	-2.3928E-6	
53.00000	37.76667	-32.00000	-0.035352	-32.113	-0.23742	-0.48805	-2.0560E-6	
54.00000	37.80000	-32.00000	-0.031873	-32.113	-0.21857	-0.46467	-1.7516E-6	
55.00000	37.83333	-32.00000	-0.028640	-32.113	-0.20115	-0.44231	-1.4777E-6	
56.00000	37.86667	-32.00000	-0.025645	-32.113	-0.18511	-0.42097	-1.2319E-6	
57.00000	37.90000	-32.00000	-0.022877	-32.113	-0.17034	-0.40062	-1.0122E-6	
58.00000	37.93333	-32.00000	-0.020326	-32.113	-0.15676	-0.38126	0.0	
59.00000	37.96667	-32.00000	-0.017981	-32.113	-0.14430	-0.36284	0.0	
60.00000	38.00000	-32.00000	-0.015829	-32.113	-0.13286	-0.34535	0.0 !	

! Point lies outside soil zones. Results calculated for this point assume a soil zone with properties of the first soil profile.

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