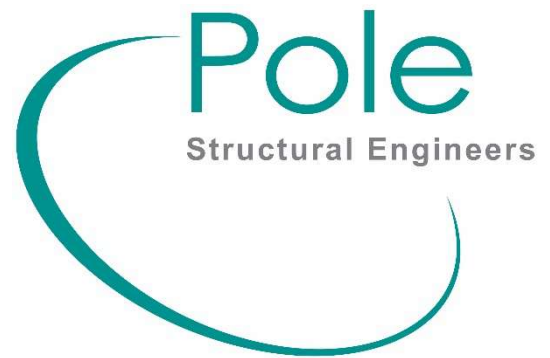


Kingswood Estate, Dashwood House SE21 8PA

24th August 2022

Liam Markey
Cignia Consulting Limited
Cannon Wharf,
Pell Street,
London
SE8 5EN



Dear Mr Markey

RE: Dashwood House, Kingswood Estate, London SE21 8PA

Structural Engineer's recommendations to mitigate the subsidence risk due to near trees

Summary

Dashwood House has suffered structural damage, caused by;

1. Change in moisture levels of the underlying subsoil, due to the close proximity of large trees and possibly some natural/seasonal variation. This is the primary cause of damage.
2. Inherent shortcomings in the original construction, most notably the lack of movement joints. This has caused more secondary damage as a consequence of the subsidence and some thermal cracking.

If the building is left as it is and simply repaired, it will foreseeably occur again, which is not a good use of funds. Some sort of "improvements" is required either by way of better (deeper) foundations or alternatively to eliminate or reduce the cause of the problem in the first place i.e., the existence of the large trees and their system of roots growing under the foundations.

In conjunction with the advises of the geotechnical company (Geosphere Environmental) and the arboricultural expert company (Usher's Tree Contractors & Consultants), to mitigate the risk of future subsidence issues, we recommend the following alternative measures, with varying degrees of success, cost, and disruption.

OPTION 1 (BEST SOLUTION)

Mass concrete underpinning or supplementary piling. This will solve the problem, eliminate the presence of the trees but will be very expensive and disruptive to occupants.

We have provided calculations to indicate how deep the underpinning would need to extend, to cater for the mature height of the various tree species.

OPTION 2 (COMPROMISE/PRAGMATIC SOLUTION)

Remove or reduce the size of the near trees in conjunction with the advice of the arboriculturist. Consideration to root barriers could also be considered. Apparently, removal of the trees is likely to cause heave damage and therefore they recommend a controlled approach of tree surgery and on-going tree maintenance. See their report.

We have summarised the recommended tree heights in the detail of the report, but reference should be made to the arborists report for detail and note that POLE STRUCTURAL ENGINEERS no longer provide (As of March 2022) "design, Specification or site inspection works".

Once the works to either or the trees and foundations have been carried out the superstructure can be broadly repaired in line with outline specification provided in previous reporting by Pole Structural Engineers in January 2022 but following the termination of "POLE STRUCTURAL ENGINEERS" design, specification and site supervision division in March 2022, this work would be "redesigned and supervised/ inspected" by Elite Designers Limited or others as agreed.

Brief

Following recommendations made in Pole Structural Engineers, Cignia Consulting has arranged for Usher's Tree Contractors & Consultants to undertake an Arboricultural Report to determine the trees' effect on the foundations at Dashwood House.

Pole Structural Engineers have been asked to provide concluding remarks and recommendations on remedial measures (if appropriate) to address the subsidence issues at Dashwood House. The recommendations are general only and will not include construction details or repair schedules, which will be by others, if appropriate, at a later date.

This letter must be read in conjunction with Pole Structural Engineer's General Movement Reports (GMR) for the same property, dated 8th March 2019 & 10th July 2021. The GMR's contains background information, a detailed brief and terms and conditions, which are not repeated here. It must be noticed that some recommendations/conclusions from these reports might have been updated due to further investigations and the recommendations of this "final" report supersedes previous reports.

This letter must be read in conjunction with Geosphere Environmental (GEO) report number 3830,GI/Ground/SG,GF/11-06-19/V1.

This letter must be read in conjunction with Usher's Tree Contractors & Consultants report number 040221.

Summary of Geotechnical Investigation Findings

GEO's ground investigation at Dashwood house revealed that;

- The foundations are relatively deep considering the age of the building at 1.5m BGL . They consist of brickwork extending to approximately 0.75m BGL, sitting onto a concrete foundation down to approximately 1.50mBGL. The concrete foundation extends approximately 0.25m from the face of the brick wall.
- The foundations are in “good condition, with no visible defects, damage or weaknesses”.
- The ground conditions consist of Made Ground (to an average depth of 0.5m BGL) overlying firm London Clay, becoming stiff at depth.
- The London Clay has ‘high volume change potential’, as defined by NHBC Chapter 4.2
- Groundwater was not encountered.
- Rare/occasional roots were noted in all trial pits, at depth of up to 1.0mBGL.
- A net allowable bearing pressure of 80kN/m² has been calculated, which is likely to be less than the applied load to the foundations.
- Although no ‘significant’ desiccation was noted to exist within any of the samples tested, the ‘heave potential calculations indicated potential soil shrinkage in the range of 10 – 17.5mm (WS5) and 29 – 39mm (WS6) during natural changes in soil moisture.



Figure 1 - Extract from GEO report, showing investigation locations at Dashwood House.

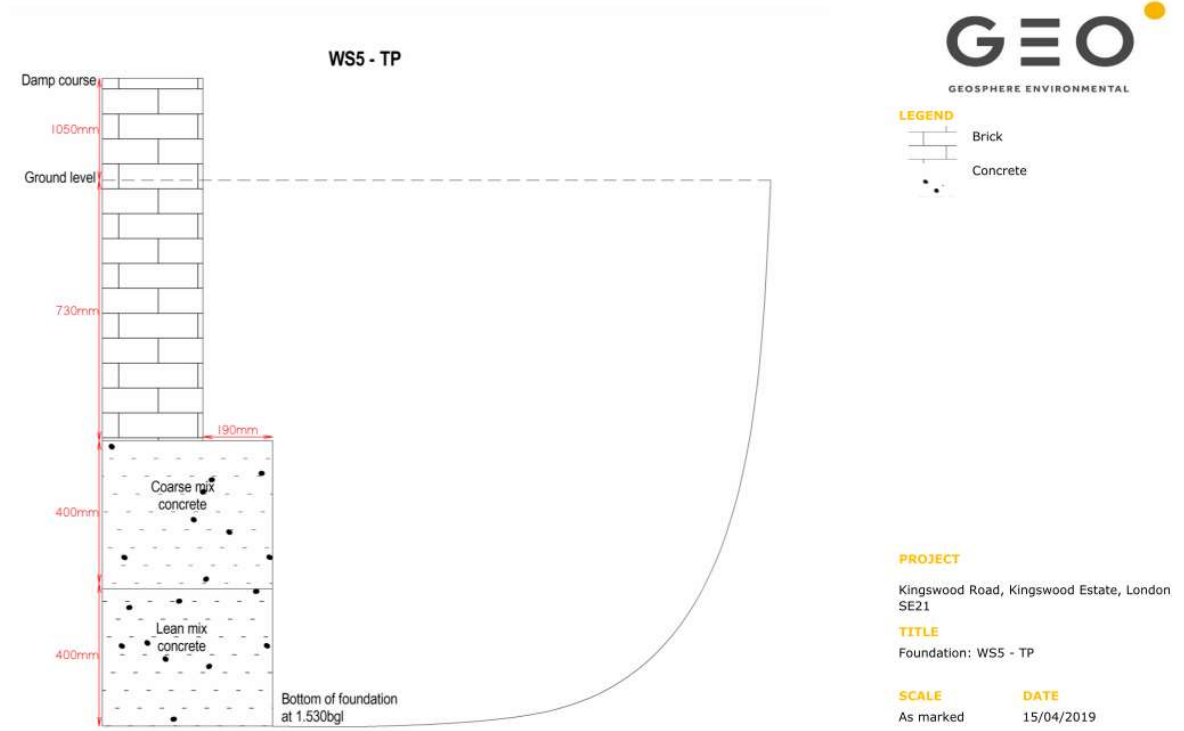


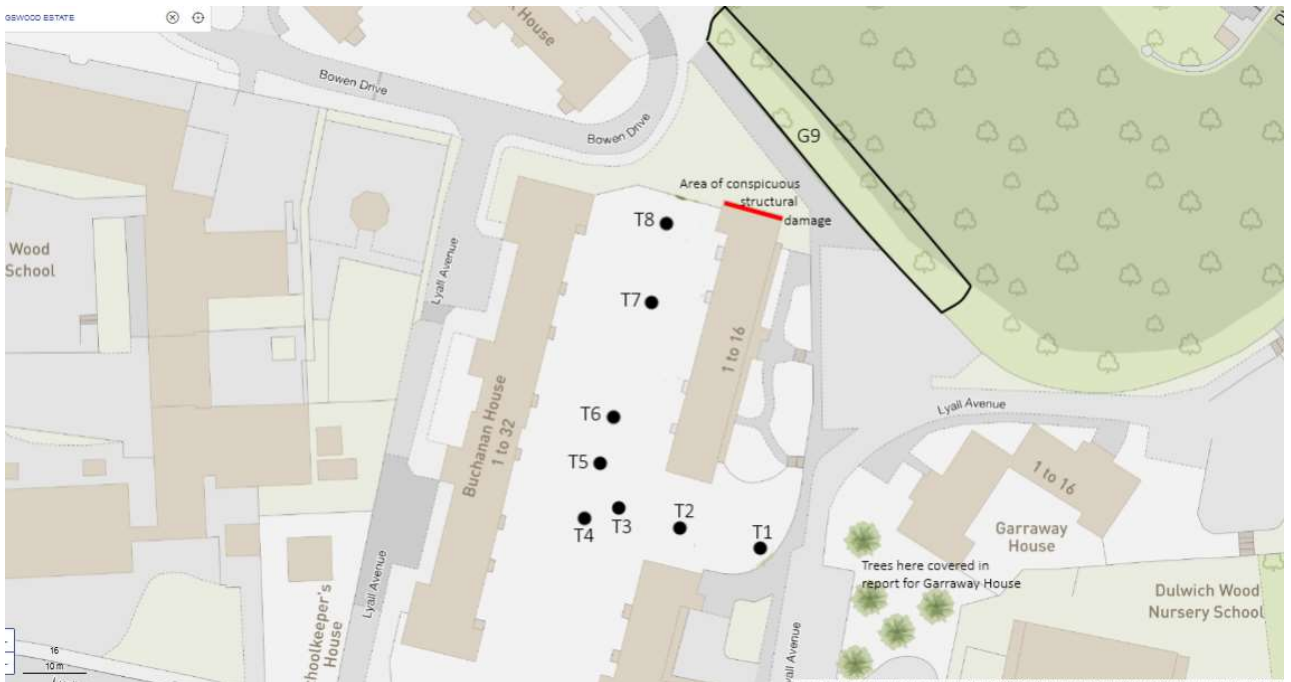
Figure 2 - Extract from GEO report, showing typical Trial Pit at Dashwood House.

Summary of Arboricultural Report Findings

Usher's Tree Contractors & Consultants was instructed by the client to inspect and report on the trees in the vicinity (within 30m) of the block and record:

- Tree location (plotted on a suitable site plan)
- Species of each tree
- State of health of each tree Potential for future growth
- Heave risk analysis in the event of tree removal

Below can be found the Key Plan with the trees at 30m of Dashwood House and a table with their findings.



Surveyor: James Forrest	Client: Elkins Construction	Weather: Cloudy
Date: 21st July 2022	Site: Dashwood House, Kingswood Estate, SE21	Reference: 040221

Tree No.	Species	Height (m)	Age class	Distance from structure (m)	Water demand	Zone of influence (m)	Vigour	Ownership	Condition		Damage risk		Notes
									Structural	Physiological	Subsidence	Heave	
T1	Pedunculate oak (<i>Quercus robur</i>)	20	EM	14.0	High	30.00	Medium	Kingswood Estate	<u>Good</u> . Buttressed	<u>Good</u>	Moderate	65% chance / Prolonged duration	Located on grass verge to the south of the block. No recent previous management noted
T2	Pedunculate oak (<i>Quercus robur</i>)	20	EM	7.5	High	30.00	Medium	Kingswood Estate	Buttressed. Basal cavity on northern side is not thought to be extensive	<u>Good</u>	High	75% chance / Prolonged duration	Located within lawn area inbetween Dashwood and Buchanan House. No recent previous management noted
T3	Pedunculate oak (<i>Quercus robur</i>)	16	SM	8.5	High	30.00	Medium	Kingswood Estate	<u>Fair</u>	<u>Fair</u>	High	75% chance / Prolonged duration	Located within lawn area inbetween Dashwood and Buchanan House. No recent previous management noted
T4	Pedunculate oak (<i>Quercus robur</i>)	16	SM	12.5	High	30.00	Medium	Kingswood Estate	<u>Fair</u>	<u>Fair</u>	Moderate / High	65% chance / Prolonged duration	Located within lawn area inbetween Dashwood and Buchanan House. No recent previous management noted
T5	Small-leaved lime (<i>Tilia cordata</i>)	17	SM	10.5	Moderate	20.00	High	Kingswood Estate	Large surface roots present as if ground level has been lowered in the past. Twin-leader (fork at 2m). The fork here is a tight, compression fork - potential point of failure	<u>Good</u>	Moderate	50% chance / Moderate duration	Located within lawn area inbetween Dashwood and Buchanan House. No recent previous management noted
T6	Whitebeam (<i>Sorbus aria</i>)	10	EM	11.0	Moderate	11.00	Medium	Kingswood Estate	<u>Fair</u>	<u>Fair</u>	Very Low	<10% chance / Short duration	Located within lawn area inbetween Dashwood and Buchanan House. No recent previous management noted
T7	Small-leaved lime (<i>Tilia cordata</i>)	18	SM	9.0	Moderate	20.00	High	Kingswood Estate	Large surface roots present as if ground level has been lowered in the past	<u>Good</u>	Moderate	50% chance / Moderate duration	Located within lawn area inbetween Dashwood and Buchanan House. No recent previous management noted

Tree No.	Species	Height (m)	Age class	Distance from structure (m)	Water demand	Zone of influence (m)	Vigour	Ownership	Condition		Damage risk		Notes
									Structural	Physiological	Subsidence	Heave	
T8	London plane tree (<i>Platanus x hispanica</i>)	20	SM	12.5	Moderate	15.00	Medium	Kingswood Estate	Buttressed. Trunk lean noted but crown growth has self-corrected	<u>Good</u>	Moderate	50% chance / Moderate duration	Located within lawn area inbetween Dashwood and Buchanan House. Tree been previously managed by crown reduction works
G9	Mixed species (predominantly oak)	0m-20m	Y-EM	11.0 (at nearest point)	High	30.00	Medium	3rd party	Formal inspection of trees the responsibility of the tree owner	Formal inspection of trees the responsibility of the tree owner	High	75% chance / Prolonged duration	Woodland area between railway lines and the estate. Dense group of vegetation that includes large trees (mainly oak). There will be an increase in water extraction given the cumulative effect of the group when compared to a single tree. This tree group is the nearest vegetation to the conspicuous damage highlighted on the site plan

Discussions and Conclusions

We believe that the recent movement of the foundations is due to subsidence of the underlying subsoil content. From GEO's report, it appears that this subsidence is largely due to natural changes in the soil moisture. However, due to the proximity of large trees (most notably the Oak), we believe that trees may also be a contributing factor (or at least a risk).

Using the information provided by the Arboricultural Report we have calculated how deep the foundations would need to be to not be affected by the various trees. The enclosed calculations (Appendix A) demonstrate that the existing foundations are not deep enough to cope with the height of the mature trees.

OPTION 1 UNDERPINNING (PREFERRED SOLUTION)

To eliminate the risk of future subsidence the foundations would need to be as deep as shown in the enclosed calculations. This is most commonly achieved by mass concrete underpinning or sometimes supplementary piling. As shown in the enclosed calculations, supplementary piling would be the only solution in some areas (foundations required at more than 2.5m below ground level).

The required remedial underpinning / piling would be relatively deep and very costly with significant H& S implications, and tenants' disturbance.

OPTION 2 TREE SURGERY (COMPROMISE/ PRAGMATIC SOLUTION)

If for commercial reasons the most conclusive method of underpinning/piling is not realistic (for commercial/ financial or other practical reasons not known to us), alternative more proportionate approaches might be considered providing the risk of further movement is fully understood.

If nothing is done to either the trees or the foundations, further damage is eminently foreseeable. It is not possible to control the natural changes in soil moisture (and volume).

To control the tree-induced changes in soil moisture, the trees are usually removed. However, this may cause 're-bounce' volume changes in the soil called "heave" which could also damage the property further.

We appreciate that the trees provide significant amenity value also.

Subject to the advice of the arboriculturist a pragmatical approach would be to reduce the size of the trees as far as possibly but where the risk of heave is unlikely. Periodical maintenance will be required to maintain to trees at any such height.

We understand that the option to reduce and control the tree's height will not increase the heave risk.

To perform this exercise, we have had to make assumptions regarding foundation depths as these are only known in some areas currently. We have assumed that the formation level of the foundations is at 1.5m below ground level (BGL). This is based on Trial Pits WS5-TP & WS6-TP carried out by GEO.

The table below shows the proposed measure for the trees near the building in order to mitigate the subsidence risk if underpinning is not adopted.

1	2	3	4	5	6
Tree	Description	Distance to the building (m)	Measured Height (m)	Recommend Height (m)	Measures
T1	Pedunculate oak (Quercus robur)	14.0	20.0	11.0	<ul style="list-style-type: none"> - Reduce the tree height to the recommended height (column 5). - Periodical maintenance to control that the tree's height does not exceed the recommended height.
T2	Pedunculate oak (Quercus robur)	7.5	20.0	7.0	<ul style="list-style-type: none"> - Reduce the tree height to the recommended height (column 5). - Periodical maintenance to control that the tree's height does not exceed the recommended height.
T3	Pedunculate oak (Quercus robur)	8.5	16.0	8.0	<ul style="list-style-type: none"> - Reduce the tree height to the recommended height (column 5). - Periodical maintenance to control that the tree's height does not exceed the recommended height.
T4	Pedunculate oak (Quercus robur)	12.5	16.0	11.0	<ul style="list-style-type: none"> - Reduce the tree height to the recommended height (column 5). - Periodical maintenance to control that the tree's height does not exceed the recommended height.
T5	Small-leaved lime (Tilia cordata)	10.5	17.0	-	<ul style="list-style-type: none"> - No action is required. But we suggest maintaining the current height to reduce the potential effects on adjacent buildings (outside the scope of this report).
T6	Whitebeam (Sorbus aria)	11.0	10.0	-	<ul style="list-style-type: none"> - No action is required. But we suggest maintaining the current height to reduce the potential effects on adjacent buildings (outside the scope of this report).
T7	Small-leaved lime (Tilia cordata)	9.0	18.0	10.0	<ul style="list-style-type: none"> - Reduce the tree height to the recommended height (column 5). - Periodical maintenance to control that the tree's height does not exceed the recommended height.
T8	London plane tree (Platanus x hispanica)	12.5	20.0	-	<ul style="list-style-type: none"> - No action is required. But we suggest maintaining the current height to reduce the potential effects on adjacent buildings (outside the scope of this report).

1	2	3	4	5	6
Tree	Description	Distance to the building (m)	Measured Height (m)	Recommend Height (m)	Measures
G9	Mixed species (predominantly oak)	11.0 (at nearest point)	0-20.0	11.0	<ul style="list-style-type: none"> - Reduce the tree height to the recommended height (column 5) of the trees that are at a maximum 25m distance to the building. - Periodical maintenance to control that the trees' height does not exceed the recommended height. - We suggest extending the recommendation above to the rest of the trees (beyond 25m distance) or at least controlling their growth to mitigate the subsidence risk in adjacent buildings (outside the scope of this report).

It is important to understand that many of the causes are due to inherent and intrinsic properties of the subsoil and the building itself. Therefore, there are no guarantees that movement cracking will not continue, and these recommendations should be considered mitigation measures only.

SUPERSTRUCTURE REPAIRS- AFTER EITHER UNDERPINNING OR TREE WORKS AND STABILISATION PERIOD.

Once the works to either or the trees and foundations have been carried out the superstructure can be broadly repaired in line with outline specification provided in previous reporting by Pole Structural Engineers in January 2022 (drawings 6505-SK21-A & 6505-SK22-A). Following the termination of "POLE STRUCTURAL ENGINEERS" design, specification and site supervision division in March 2022, this work would be "redesigned and supervised/ inspected" by Elite Designers Limited or others as agreed.

We trust the above is clear, but please contact the writer if you have any questions.

Yours sincerely,



Jorge Martinez Torregrosa – Structural Engineer MEng



Simon Pole BSc C Eng FStructE MICE MRICS

Appendix A - NHBC Calculations for building near trees
For information only

Project Kingswood Estate, SE21 8QJ				Job no. 6505	
Calcs for Dashwood House				Start page no./Revision 1	
Calcs by JMT	Calcs date 18/08/2022	Checked by SP	Checked date	Approved by	Approved date

FOUNDATIONS NEAR TREES

In accordance with Appendix B of NHBC Part 4: Foundations - Chapter 4.2

Tedds calculation version 2.0.02

Site Details

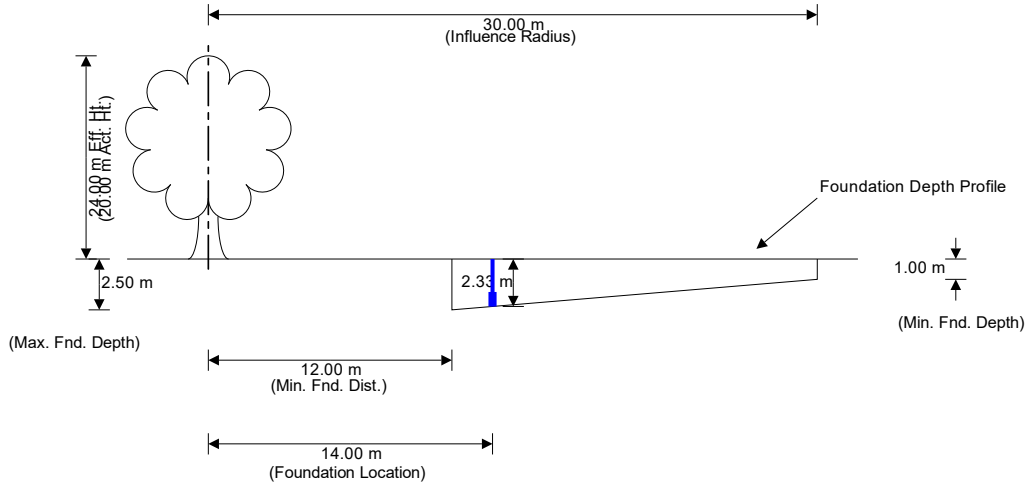
Site location London
Reduction depth due to climate variations - Fig. 13 $Z_c = 0.00$ m

Soil Details

Plasticity index from lab tests $I_p = 59$ %
Percentage of particles < 425 μm $p_{425} = 100$ %
Modified plasticity index - cl. D5(b) $I'_p = I_p \times p_{425} / 100$ % = **59** %
Volume change potential - Table 1 High

Details for Tree - 1 : T1 (Pedunculate Oak)

Species of tree Broad leaf - Red Oak
The tree is to remain at the site, with no further planting allowed.
Water demand of tree - Table 12 High
Mature height of tree - Table 12 $H_{m1} = 24.00$ m
Influence radius - Table 2 $r_{inf1} = 1.25 \times H_{m1} = 30.00$ m
Measured height of tree $H_{act1} = 20.00$ m
Distance from centre of tree to face of foundations $D_1 = 14.00$ m
Effective height of tree - Fig. 1 $H_{eff1} = 24.00$ m

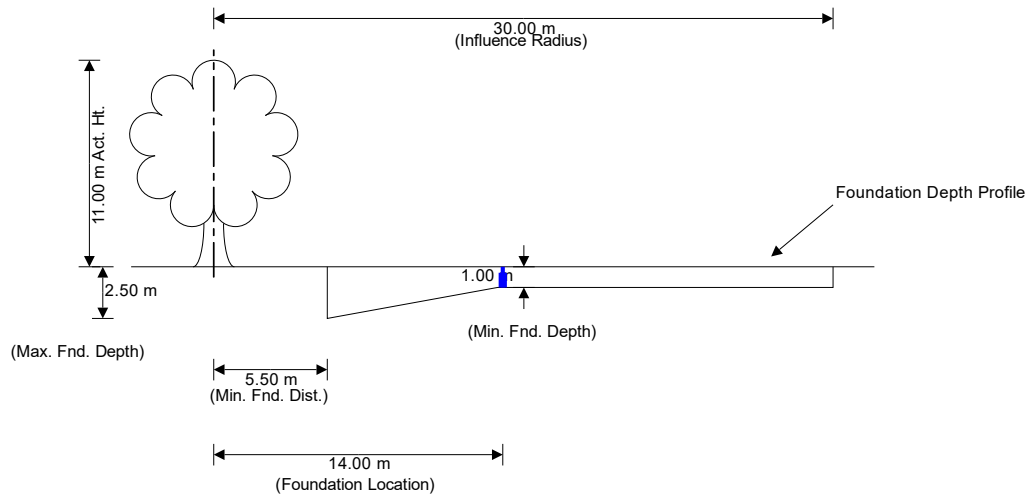


Minimum foundation depth - Table 5 $Z_{min} = 1.00$ m
Look up value for foundation depth - Chart 1 Soils with HIGH volume change potential
 $Z_{LookUp1} = 2.33$ m
Required foundation depth $Z_{req1} = Z_{LookUp1} - Z_c = 2.33$ m

Project Kingswood Estate, SE21 8QJ				Job no. 6505	
Calcs for Dashwood House				Start page no./Revision 2	
Calcs by JMT	Calcs date 18/08/2022	Checked by SP	Checked date	Approved by	Approved date

Details for Tree - 2 : T1 (Pedunculate Oak) - IF REDUCED

Species of tree Broad leaf - Red Oak
The tree is to be removed from the site, and H_{act} is less than 50% of H_m , with no further planting allowed.
 Water demand of tree - Table 12 High
 Mature height of tree - Table 12 $H_{m2} = 24.00$ m
 Influence radius - Table 2 $r_{inf2} = 1.25 \times H_{m2} = 30.00$ m
 Measured height of tree $H_{act2} = 11.00$ m
 Distance from centre of tree to face of foundations $D_2 = 14.00$ m
 Effective height of tree - Fig. 1 $H_{eff2} = 11.00$ m



Minimum foundation depth - Table 5 $Z_{min} = 1.00$ m
 Look up value for foundation depth - Chart 1 Soils with HIGH volume change potential
 $Z_{LookUp2} = 1.00$ m
 Required foundation depth $Z_{req2} = Z_{LookUp2} - Z_c = 1.00$ m

Project Kingswood Estate, SE21 8QJ				Job no. 6505	
Calcs for Dashwood House				Start page no./Revision 3	
Calcs by JMT	Calcs date 18/08/2022	Checked by SP	Checked date	Approved by	Approved date

Details for Tree - 3 : T2 (Pedunculate Oak)

Species of tree Broad leaf - Red Oak

The tree is to remain at the site, with no further planting allowed.

Water demand of tree - Table 12 High

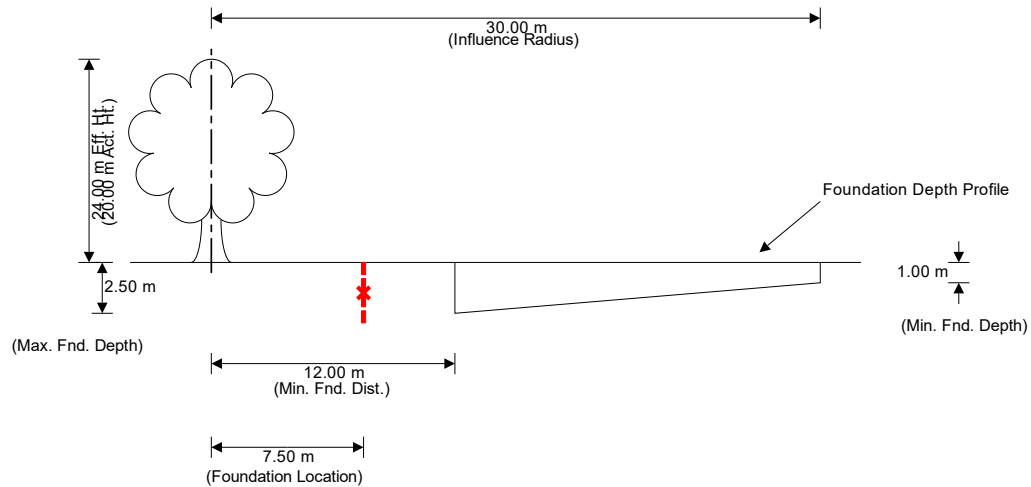
Mature height of tree - Table 12 $H_{m3} = 24.00$ m

Influence radius - Table 2 $r_{inf3} = 1.25 \times H_{m3} = 30.00$ m

Measured height of tree $H_{act3} = 20.00$ m

Distance from centre of tree to face of foundations $D_3 = 7.50$ m

Effective height of tree - Fig. 1 $H_{eff3} = 24.00$ m



Minimum foundation depth - Table 5 $Z_{min} = 1.00$ m

Look up value for foundation depth - Chart 1 Soils with HIGH volume change potential

$Z_{LookUp3} > 2.5$ m

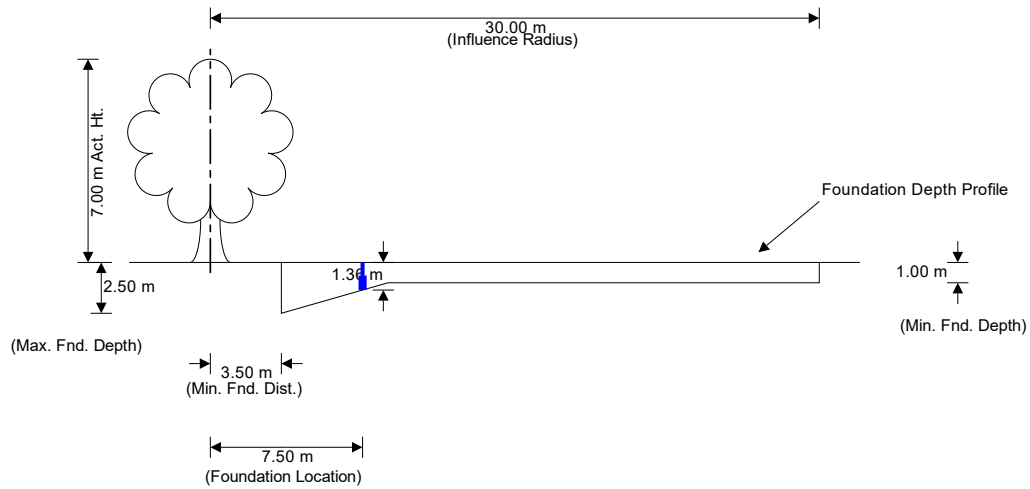
Required foundation depth

WARNING! - Foundation depth greater than 2.5m. To be Engineer designed.

Project Kingswood Estate, SE21 8QJ				Job no. 6505	
Calcs for Dashwood House				Start page no./Revision 4	
Calcs by JMT	Calcs date 18/08/2022	Checked by SP	Checked date	Approved by	Approved date

Details for Tree - 4 : T1 (Pedunculate Oak) - IF REDUCED

Species of tree Broad leaf - Red Oak
The tree is to be removed from the site, and H_{act} is less than 50% of H_m , with no further planting allowed.
 Water demand of tree - Table 12 High
 Mature height of tree - Table 12 $H_{m4} = 24.00$ m
 Influence radius - Table 2 $r_{inf4} = 1.25 \times H_{m4} = 30.00$ m
 Measured height of tree $H_{act4} = 7.00$ m
 Distance from centre of tree to face of foundations $D_4 = 7.50$ m
 Effective height of tree - Fig. 1 $H_{eff4} = 7.00$ m



Minimum foundation depth - Table 5 $Z_{min} = 1.00$ m
 Look up value for foundation depth - Chart 1 Soils with HIGH volume change potential
 $Z_{LookUp4} = 1.36$ m
 Required foundation depth $Z_{req4} = Z_{LookUp4} - Z_c = 1.36$ m

Project Kingswood Estate, SE21 8QJ				Job no. 6505	
Calcs for Dashwood House				Start page no./Revision 5	
Calcs by JMT	Calcs date 18/08/2022	Checked by SP	Checked date	Approved by	Approved date

Details for Tree - 5 : T3 (Pedunculate Oak)

Species of tree **Broad leaf - Red Oak**

The tree is to remain at the site, with no further planting allowed.

Water demand of tree - Table 12 **High**

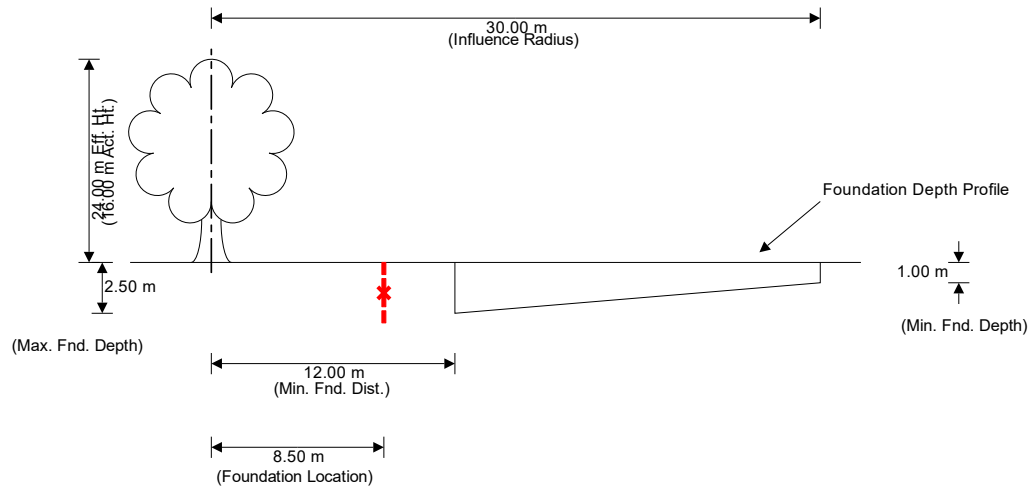
Mature height of tree - Table 12 **H_{m5} = 24.00 m**

Influence radius - Table 2 **r_{inf5} = 1.25 × H_{m5} = 30.00 m**

Measured height of tree **H_{act5} = 16.00 m**

Distance from centre of tree to face of foundations **D₅ = 8.50 m**

Effective height of tree - Fig. 1 **H_{eff5} = 24.00 m**



Minimum foundation depth - Table 5 **Z_{min} = 1.00 m**

Look up value for foundation depth - Chart 1 Soils with HIGH volume change potential

Z_{LookUp5} > 2.5 m

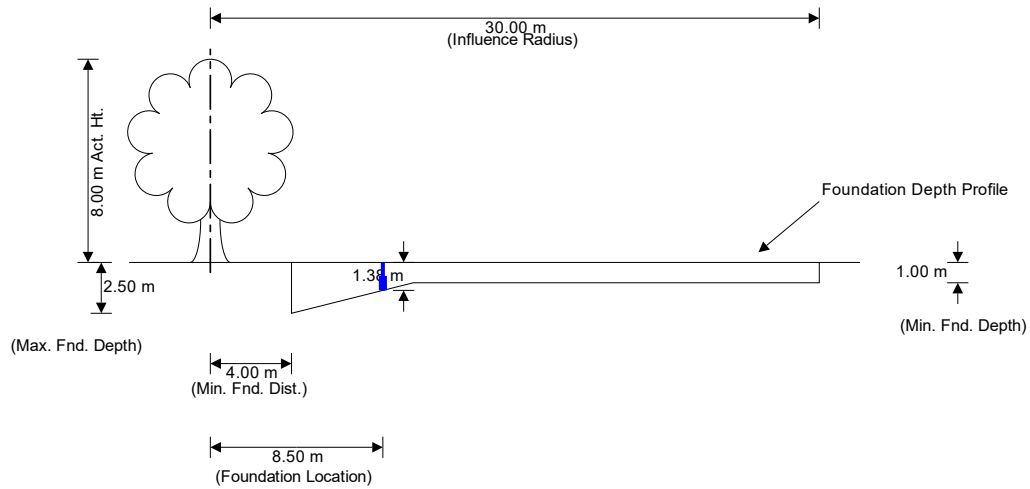
Required foundation depth

WARNING! - Foundation depth greater than 2.5m. To be Engineer designed.

Project Kingswood Estate, SE21 8QJ				Job no. 6505	
Calcs for Dashwood House				Start page no./Revision 6	
Calcs by JMT	Calcs date 18/08/2022	Checked by SP	Checked date	Approved by	Approved date

Details for Tree - 6 : T3 (Pedunculate Oak) - IF REDUCED

Species of tree Broad leaf - Red Oak
The tree is to be removed from the site, and H_{act} is less than 50% of H_m , with no further planting allowed.
 Water demand of tree - Table 12 High
 Mature height of tree - Table 12 $H_{m6} = 24.00$ m
 Influence radius - Table 2 $r_{inf6} = 1.25 \times H_{m6} = 30.00$ m
 Measured height of tree $H_{act6} = 8.00$ m
 Distance from centre of tree to face of foundations $D_6 = 8.50$ m
 Effective height of tree - Fig. 1 $H_{eff6} = 8.00$ m



Minimum foundation depth - Table 5 $Z_{min} = 1.00$ m
 Look up value for foundation depth - Chart 1 Soils with HIGH volume change potential
 $Z_{LookUp6} = 1.38$ m
 Required foundation depth $Z_{req6} = Z_{LookUp6} - Z_c = 1.38$ m

Project				Job no.	
Kingswood Estate, SE21 8QJ				6505	
Calcs for				Start page no./Revision	
Dashwood House				7	
Calcs by	Calcs date	Checked by	Checked date	Approved by	Approved date
JMT	18/08/2022	SP			

Details for Tree - 7 : T4 (Pedunculate Oak)

Species of tree Broad leaf - Red Oak

The tree is to remain at the site, with no further planting allowed.

Water demand of tree - Table 12 High

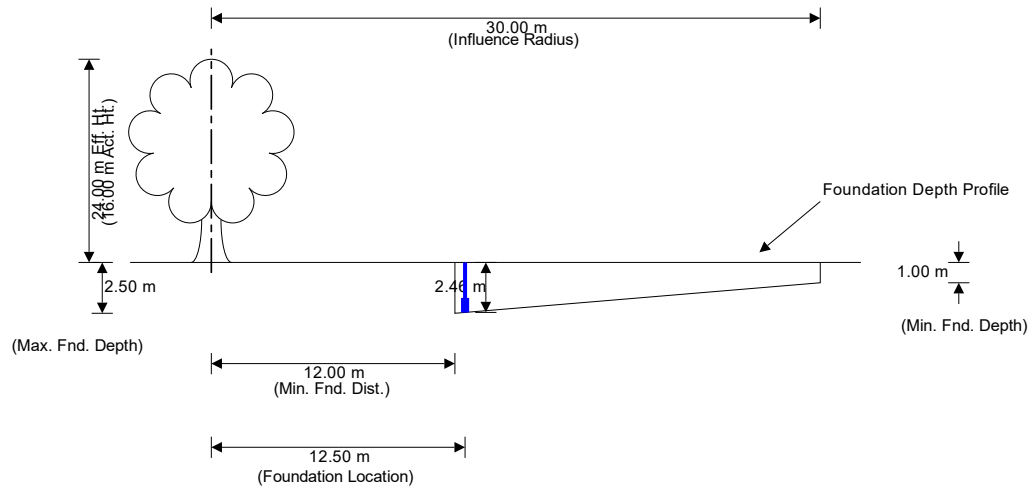
Mature height of tree - Table 12 $H_{m7} = 24.00$ m

Influence radius - Table 2 $r_{inf7} = 1.25 \times H_{m7} = 30.00$ m

Measured height of tree $H_{act7} = 16.00$ m

Distance from centre of tree to face of foundations $D_7 = 12.50$ m

Effective height of tree - Fig. 1 $H_{eff7} = 24.00$ m



Minimum foundation depth - Table 5 $Z_{min} = 1.00$ m

Look up value for foundation depth - Chart 1 Soils with HIGH volume change potential

$Z_{LookUp7} = 2.46$ m

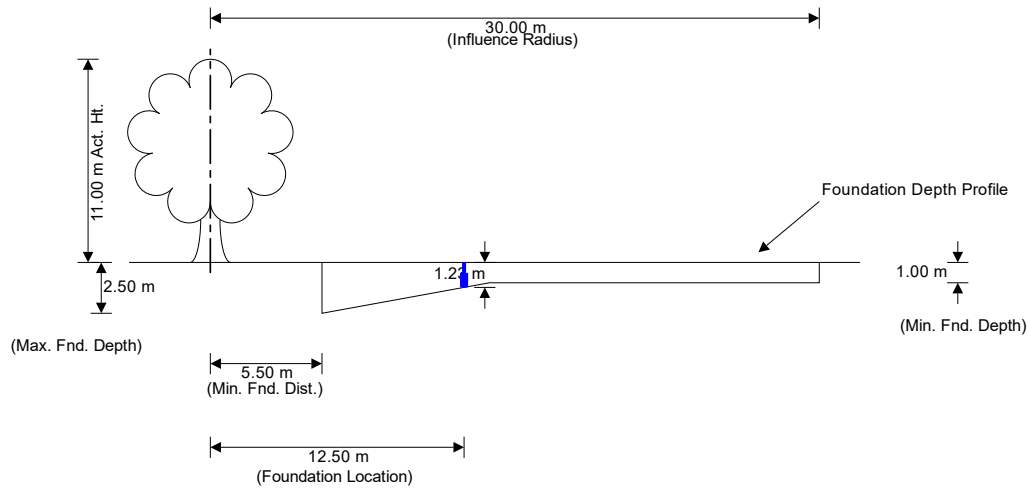
Required foundation depth

$Z_{req7} = Z_{LookUp7} - Z_c = 2.46$ m

Project Kingswood Estate, SE21 8QJ				Job no. 6505	
Calcs for Dashwood House				Start page no./Revision 8	
Calcs by JMT	Calcs date 18/08/2022	Checked by SP	Checked date	Approved by	Approved date

Details for Tree - 8 : T4 (Pedunculate Oak) - IF REDUCED

Species of tree Broad leaf - Red Oak
The tree is to be removed from the site, and H_{act} is less than 50% of H_m , with no further planting allowed.
 Water demand of tree - Table 12 High
 Mature height of tree - Table 12 $H_{m8} = 24.00$ m
 Influence radius - Table 2 $r_{inf8} = 1.25 \times H_{m8} = 30.00$ m
 Measured height of tree $H_{act8} = 11.00$ m
 Distance from centre of tree to face of foundations $D_8 = 12.50$ m
 Effective height of tree - Fig. 1 $H_{eff8} = 11.00$ m

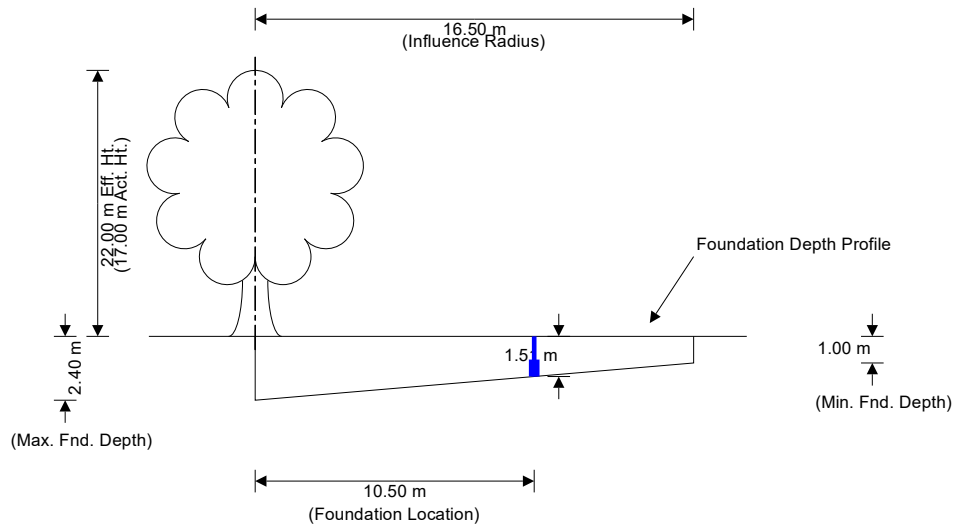


Minimum foundation depth - Table 5 $Z_{min} = 1.00$ m
 Look up value for foundation depth - Chart 1 Soils with HIGH volume change potential
 $Z_{LookUp8} = 1.23$ m
 Required foundation depth $Z_{req8} = Z_{LookUp8} - Z_c = 1.23$ m

Project Kingswood Estate, SE21 8QJ				Job no. 6505	
Calcs for Dashwood House				Start page no./Revision 9	
Calcs by JMT	Calcs date 18/08/2022	Checked by SP	Checked date	Approved by	Approved date

Details for Tree - 9 : T5 (Small-leaved lime)

Species of tree Broad leaf - Lime
The tree is to remain at the site, with no further planting allowed.
 Water demand of tree - Table 12 Moderate
 Mature height of tree - Table 12 $H_{m9} = 22.00$ m
 Influence radius - Table 2 $r_{inf9} = 0.75 \times H_{m9} = 16.50$ m
 Measured height of tree $H_{act9} = 17.00$ m
 Distance from centre of tree to face of foundations $D_9 = 10.50$ m
 Effective height of tree - Fig. 1 $H_{eff9} = 22.00$ m

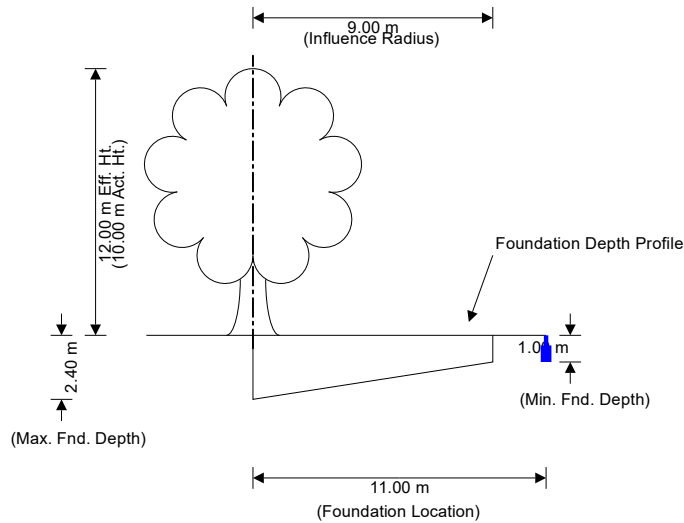


Minimum foundation depth - Table 5 $Z_{min} = 1.00$ m
 Look up value for foundation depth - Chart 1 Soils with HIGH volume change potential
 $Z_{LookUp9} = 1.51$ m
 Required foundation depth $Z_{req9} = Z_{LookUp9} - Z_c = 1.51$ m

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Details for Tree - 10 : T6 (Whitebeam)

Species of tree Broad leaf - Whitebeam
The tree is to remain at the site, with no further planting allowed.
 Water demand of tree - Table 12 Moderate
 Mature height of tree - Table 12 $H_{m10} = 12.00$ m
 Influence radius - Table 2 $r_{inf10} = 0.75 \times H_{m10} = 9.00$ m
 Measured height of tree $H_{act10} = 10.00$ m
 Distance from centre of tree to face of foundations $D_{10} = 11.00$ m
 Effective height of tree - Fig. 1 $H_{eff10} = 12.00$ m

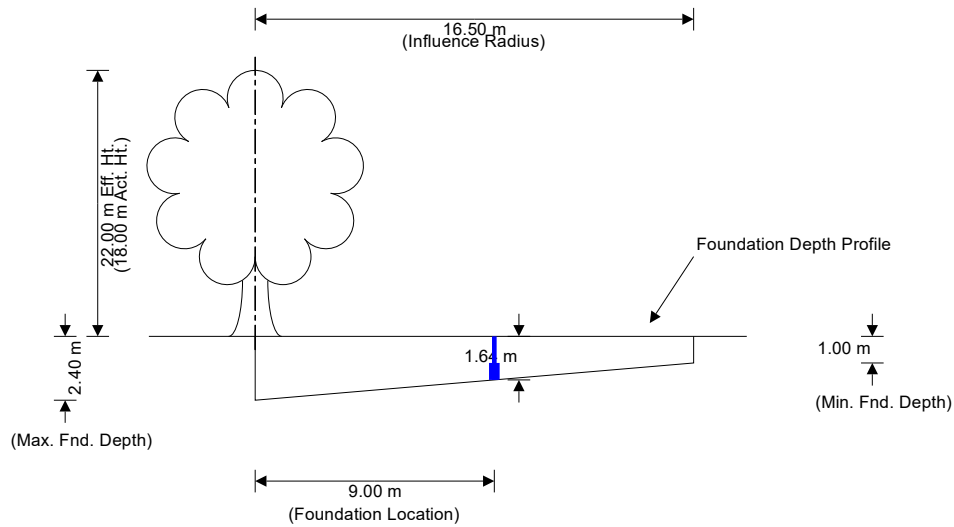


Minimum foundation depth - Table 5 $Z_{min} = 1.00$ m
 Look up value for foundation depth - Chart 1 Soils with HIGH volume change potential
 $Z_{LookUp10} = 1.00$ m
 Required foundation depth $Z_{req10} = Z_{LookUp10} - Z_c = 1.00$ m

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Details for Tree - 11 : T7 (Small leave lime)

Species of tree Broad leaf - Lime
The tree is to remain at the site, with no further planting allowed.
 Water demand of tree - Table 12 Moderate
 Mature height of tree - Table 12 $H_{m11} = 22.00$ m
 Influence radius - Table 2 $r_{inf11} = 0.75 \times H_{m11} = 16.50$ m
 Measured height of tree $H_{act11} = 18.00$ m
 Distance from centre of tree to face of foundations $D_{11} = 9.00$ m
 Effective height of tree - Fig. 1 $H_{eff11} = 22.00$ m

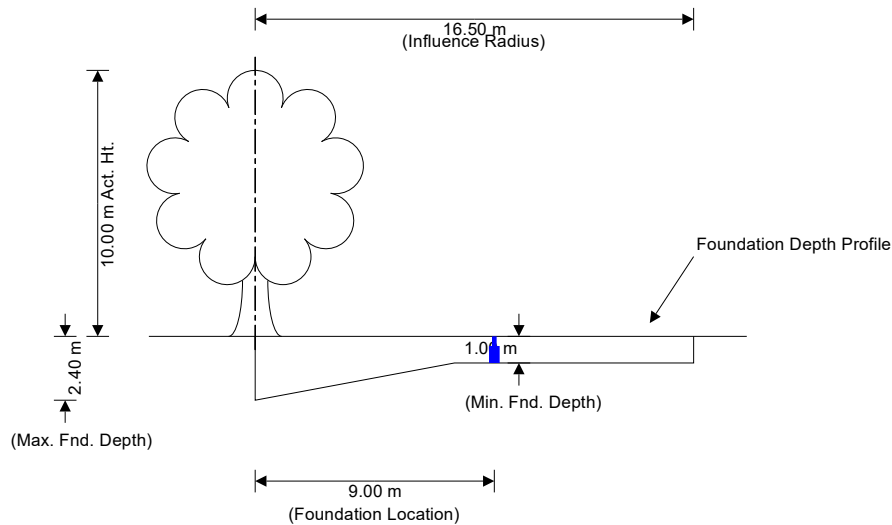


Minimum foundation depth - Table 5 $Z_{min} = 1.00$ m
 Look up value for foundation depth - Chart 1 Soils with HIGH volume change potential
 $Z_{LookUp11} = 1.64$ m
 Required foundation depth $Z_{req11} = Z_{LookUp11} - Z_c = 1.64$ m

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Details for Tree - 12 : T7 (Small leave lime) - IF REDUCED

Species of tree Broad leaf - Lime
The tree is to be removed from the site, and H_{act} is less than 50% of H_m , with no further planting allowed.
 Water demand of tree - Table 12 Moderate
 Mature height of tree - Table 12 $H_{m12} = 22.00$ m
 Influence radius - Table 2 $r_{inf12} = 0.75 \times H_{m12} = 16.50$ m
 Measured height of tree $H_{act12} = 10.00$ m
 Distance from centre of tree to face of foundations $D_{12} = 9.00$ m
 Effective height of tree - Fig. 1 $H_{eff12} = 10.00$ m



Minimum foundation depth - Table 5 $Z_{min} = 1.00$ m
 Look up value for foundation depth - Chart 1 Soils with HIGH volume change potential
 $Z_{LookUp12} = 1.00$ m
 Required foundation depth $Z_{req12} = Z_{LookUp12} - Z_c = 1.00$ m

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Details for Tree - 13 : T8 (London Plane)

Species of tree **Broad leaf - Plane**

The tree is to remain at the site, with no further planting allowed.

Water demand of tree - Table 12 **Moderate**

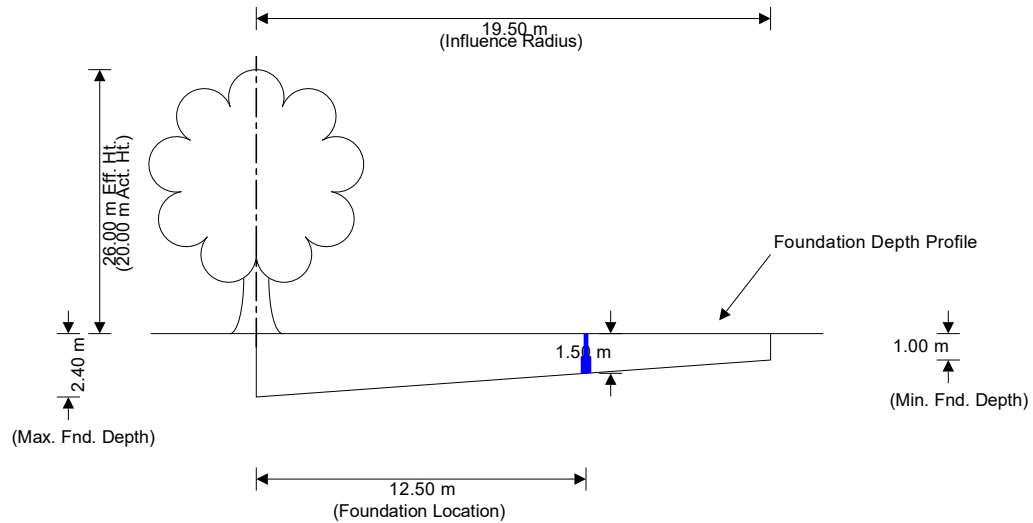
Mature height of tree - Table 12 **$H_{m13} = 26.00$ m**

Influence radius - Table 2 **$r_{inf13} = 0.75 \times H_{m13} = 19.50$ m**

Measured height of tree **$H_{act13} = 20.00$ m**

Distance from centre of tree to face of foundations **$D_{13} = 12.50$ m**

Effective height of tree - Fig. 1 **$H_{eff13} = 26.00$ m**



Minimum foundation depth - Table 5 **$Z_{min} = 1.00$ m**

Look up value for foundation depth - Chart 1 Soils with HIGH volume change potential

$Z_{LookUp13} = 1.50$ m

Required foundation depth **$Z_{req13} = Z_{LookUp13} - Z_c = 1.50$ m**

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Details for Tree - 14 : G9 (Mixed species) - at 11m

Species of tree Broad leaf - Red Oak

The tree is to remain at the site, with no further planting allowed.

Water demand of tree - Table 2 High

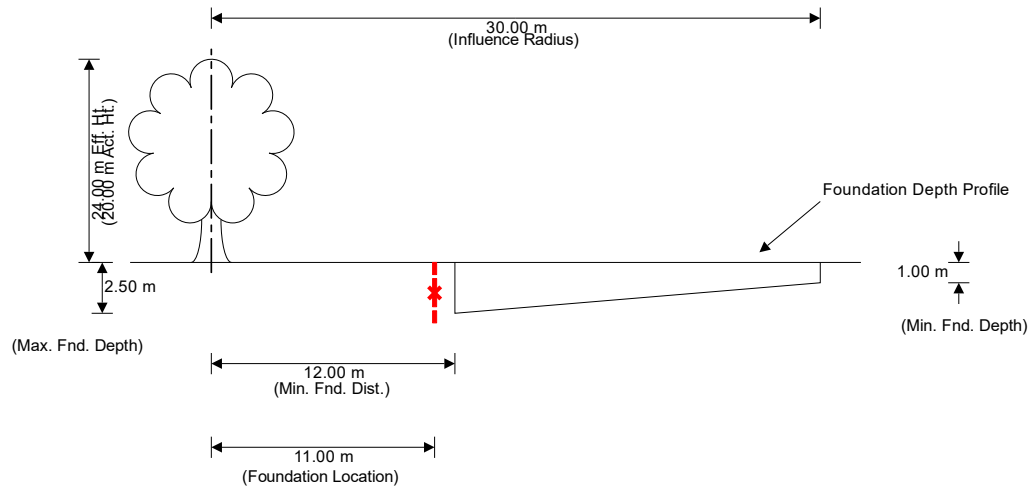
Mature height of tree - Table 12 $H_{m14} = 24.00$ m

Influence radius - Table 2 $r_{inf14} = 1.25 \times H_{m14} = 30.00$ m

Measured height of tree $H_{act14} = 20.00$ m

Distance from centre of tree to face of foundations $D_{14} = 11.00$ m

Effective height of tree - Fig. 1 $H_{eff14} = 24.00$ m



Minimum foundation depth - Table 5 $Z_{min} = 1.00$ m

Look up value for foundation depth - Chart 1 Soils with HIGH volume change potential

$Z_{LookUp14} > 2.5$ m

Required foundation depth

WARNING! - Foundation depth greater than 2.5m. To be Engineer designed.

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Details for Tree - 15 : G9 (Mixed species) - at 25m

Species of tree Broad leaf - Red Oak

The tree is to remain at the site, with no further planting allowed.

Water demand of tree - Table 2 High

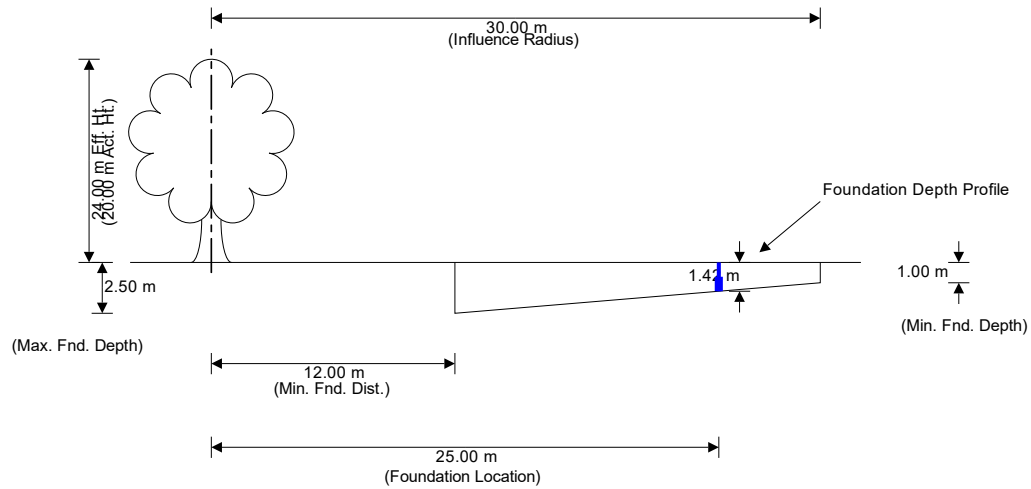
Mature height of tree - Table 12 $H_{m15} = 24.00$ m

Influence radius - Table 2 $r_{inf15} = 1.25 \times H_{m15} = 30.00$ m

Measured height of tree $H_{act15} = 20.00$ m

Distance from centre of tree to face of foundations $D_{15} = 25.00$ m

Effective height of tree - Fig. 1 $H_{eff15} = 24.00$ m



Minimum foundation depth - Table 5 $Z_{min} = 1.00$ m

Look up value for foundation depth - Chart 1 Soils with HIGH volume change potential

$Z_{LookUp15} = 1.42$ m

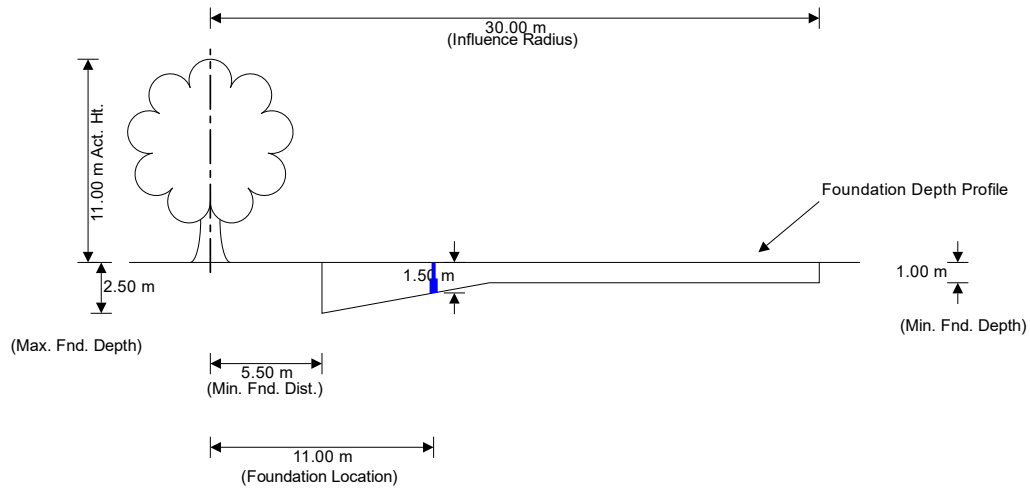
Required foundation depth

$Z_{req15} = Z_{LookUp15} - Z_c = 1.42$ m

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Details for Tree - 16 : G9 (Mixed species) - at 11m IF REDUCED

Species of tree Broad leaf - Red Oak
The tree is to be removed from the site, and H_{act} is less than 50% of H_m , with no further planting allowed.
 Water demand of tree - Table 12 High
 Mature height of tree - Table 12 $H_{m16} = 24.00$ m
 Influence radius - Table 2 $r_{inf16} = 1.25 \times H_{m16} = 30.00$ m
 Measured height of tree $H_{act16} = 11.00$ m
 Distance from centre of tree to face of foundations $D_{16} = 11.00$ m
 Effective height of tree - Fig. 1 $H_{eff16} = 11.00$ m



Minimum foundation depth - Table 5 $Z_{min} = 1.00$ m
 Look up value for foundation depth - Chart 1 Soils with HIGH volume change potential $Z_{LookUp16} = 1.50$ m
 Required foundation depth $Z_{req16} = Z_{LookUp16} - Z_c = 1.50$ m

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Summary Table

Tree	Description	Name	Distance (m)	Measured Height (m)	Effective Height (m)	Tree to be removed	Required Foundation Depth (m)
1	T1 (Pedunculate Oak)	Red Oak	14.0	20.0	24.0	No	2.33
2	T1 (Pedunculate Oak) - IF REDUCED	Red Oak	14.0	11.0	11.0	Yes	1.00
3	T2 (Pedunculate Oak)	Red Oak	7.5	20.0	24.0	No	*
4	T1 (Pedunculate Oak) - IF REDUCED	Red Oak	7.5	7.0	7.0	Yes	1.36
5	T3 (Pedunculate Oak)	Red Oak	8.5	16.0	24.0	No	*
6	T3 (Pedunculate Oak) - IF REDUCED	Red Oak	8.5	8.0	8.0	Yes	1.38
7	T4 (Pedunculate Oak)	Red Oak	12.5	16.0	24.0	No	2.46
8	T4 (Pedunculate Oak) - IF REDUCED	Red Oak	12.5	11.0	11.0	Yes	1.23
9	T5 (Small-leaved lime)	Lime	10.5	17.0	22.0	No	1.51
10	T6 (Whitebeam)	Whitebeam	11.0	10.0	12.0	No	1.00
11	T7 (Small leave lime)	Lime	9.0	18.0	22.0	No	1.64
12	T7 (Small leave lime) - IF REDUCED	Lime	9.0	10.0	10.0	Yes	1.00
13	T8 (London Plane)	Plane	12.5	20.0	26.0	No	1.50
14	G9 (Mixed species) - at 11m	Red Oak	11.0	20.0	24.0	No	*
15	G9 (Mixed species) - at 25m	Red Oak	25.0	20.0	24.0	No	1.42
16	G9 (Mixed species) - at 11m IF REDUCED	Red Oak	11.0	11.0	11.0	Yes	1.50

* Depth greater than 2.5m - foundations to be Engineer designed!