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# Root Barrier Design

**Innovation File No.:** IFS-LBG-SUB-22-0100956
**Policyholder**: Mrs Janet Ivermee
**Address**: 51 Lund Avenue, Barnsley, S71 5NW

## Front Elevation

**Table of Contents**

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# 1.0 Introduction

**Why have we recommended an intervention technique**

Damage at the property has been investigated, and the affected parts of the building are believed to be suffering from clay shrinkage subsidence. The cause of the problem is considered to relate to several trees located to the rear of the risk address owned by a Third Party neighbour but subject to a tree preservation orders. Although the tree is not classified as ancient and veteran it is certainly a notable specimen and is mentioned in surveys/maps from the 1800's.

The location of the identified tree provides the opportunity to implement the intervention techniques detailed below, in order to mitigate against their influence and reduce the foundational movement in order to restore relative stability.

**How do Copper Root Barriers work?**

In the UK the shrinkage and swelling of clay soils, particularly when influenced by trees, is the single most common cause of foundation movements that damage domestic buildings.

Trees are known to cause clay soils to shrink by drawing water through their roots, predominantly during spring and summer. This shrinkage results in both vertical and horizontal ground movements that, when transmitted to a building's foundations, cause damage to the building structure.

The amount of shrinkage depends on the type of clay soil, the type and size of vegetation, and on climate. Trees growing under grass cover are forced to compete for their water and to extract water from greater depths than they might otherwise do, as is the case in this instance.

The water content of a shrinkable clay soil will vary with depth remote from and near to a large tree. Near the ground surface there can be relatively large changes in soil water content between summer and winter as a result of evaporation from the ground surface and transpiration by the grass. Such variations are normally confined to the top 1-1.5m of the ground, possibly less adjacent to buildings. Where mature trees grow at the same location, then the water-content profiles will vary and the seasonal fluctuations in soil water content are both larger and extend to a greater depth. Soil volume changes and hence ground movements will be greater.

A crack due to differential foundation movement occurring after a tree has reached maturity, there being no cracks up to that time, means it is probable that an exceptionally long dry spell has also had an influence. But cracks will recover when ground moisture contents recover and will not recur to any greater width in future. BRE Cracking in Buildings. The intention of the Bioroot shield is to mitigate against this periodically damaging effect. The solution adopted in this case seeks to decrease water uptake by the trees thereby lessening subsidence risk by conserving soil moisture and reducing clay subsoil shrinkage. This aim is to achieve an impairment to root growth by the focused introduction of a proprietary Bioroot-shield that offers all the benefits of being both flexible and permeable. In addition, it works as a biological repellent.

The Copper signal barrier details a cooper foil securely bonded between porous geotextile, releasing copper ions and forming copper carbonate (Verdigris) that signals an adverse reaction to roots deflecting them away from the barrier. The presence of copper does not constitute an eco-system burden or impact on groundwater

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This solution is multipurpose and ideally suited to the current application. Traditional impervious barriers divert rather stop roots and may block moisture movement. Also roots getting under such barriers can grow back to the surface. Therefore, the use of this permeable barrier stops roots either by engaging and constricting them or by chemically inhibiting them.

The benefits of such a shield are its dual protection both physical and biological. The multi layered sheets can be welded together whilst retaining its flexible qualities, i.e. can be cut and effectively resealed to fit round services and foundations, inert with a 50-year service life expectancy. Equally the solution inhibits root growth on the barrier face which is often problematic with conventional barriers where increased moisture levels can cause root growth to become more prolific on the face of a traditional barrier. Research has shown that the use of the recommended style of copper-based screening has greatly reduced the effects of root growth when compared to other traditional physical barrier installations

Following the installation of the shield the trench will be backfilled and compacted mechanically where the originally excavated soil is pre-used. Alternatively dependent upon site conditions backfill using lean mix concrete will be utilised on the structure side of the shield. On occasions some natural settlement is anticipated following completion. In all instances the project envisages a return visit to the property to affect any required maintenance of the surface of the reinstatement routinely programmed within 6 months following completion of the installation.

# 2.0 History of the Claim and Results of Site Investigations

## Claim Details and History

| | |
|---|---|
| **Date of discovery:** | Circa June 2022 |
| **Location of offending vegetation:** | Immediately beyond rear boundary |
| **Obstacles to removal:** | TPO |
| **Any Additional Action required:** | Root Severance |
| **Damage Category (BRE 251):** | 3 |
| **Area of Damage:** | Single storey extension |
| **Crack Monitoring:** | No |
| **Level Monitoring:** | Yes - +/-13mm seasonal movement in weather event years |

## Vegetation

| Tree | Species | Current Height | Mature Height | Distance | Water Demand | Owner |
|---|---|---|---|---|---|---|
| H1 | Cypress | 6m | 20m | 5.6m | High | PH |
| T5 | Oak | 9m | 18m | 14m | High | TP |
| T6 | Magnolia | 4m | 9m | 5.8m | Low | PH |
| T7 | Oak | 9m | 18m | 12.6m | High | TP |
| T8 | Sycamore | 11m | 20m | 7.8m | Moderate | TP |

## Site Investigations

| | |
|---|---|
| **Soil Type:** | Clay |
| **Soil Condition:** | Dry |
| **Desiccation Depth:** | Swell potential to 1.2m depth |
| **Tree Roots Recovered:** | 1.8m Deep (from the rear) |
| **CCTV Completed:** | Yes – Repairs completed |
| **Previous stabilisation:** | No |
| **Details:** | N/A |
| **Conservation Area:** | No |
| **TPO:** | Yes |

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## Samples from BH1

| Lab Ref | Depth (m) | WC (%) | LL (%) | PL (%) | PI (%) | .425 mm(%) | mod. PI (%) | Av. Suc. (kPa) | Description |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.71 | 20.1 | 64 | 29 | 35 | 95 | 33 | | Very stiff brown/orange-brown/grey mottled silty CLAY |
| 2 | 1.2 | 19.4 | 64 | 29 | 35 | 95 | 33 | | Very stiff brown/orange-brown/grey mottled silty CLAY |
| 3 | 1.5 | 14.0 | 50 | 24 | 26 | 74 | 19 | | Very stiff brown/orange-brown/grey mottled gravelly CLAY/SILT . Gravel is fine, medium and coarse. |

## Samples from BH2

| Lab Ref | Depth (m) | WC (%) | LL (%) | PL (%) | PI (%) | .425 mm(%) | mod. PI (%) | Av. Suc. (kPa) | Description |
|---|---|---|---|---|---|---|---|---|---|
| 4 | 1.41 | 27.7 | 58 | 26 | 32 | 100 | 32 | | Firm brown/orange-brown/grey mottled silty CLAY |
| 5 | 1.8 | 18.2 | 58 | 26 | 32 | 100 | 32 | | Firm brown/orange-brown/grey mottled silty CLAY |

## Summary of Oedometer Testing for BH1

| Lab Ref | Depth (m) | Strain | Heave (mm) | Remarks |
|---|---|---|---|---|
| 1 | 0.71 | 0.0427 | 15.2 | |
| 2 | 1.2 | 0.029 | 7.1 | |
| 3 | 1.5 | | | |

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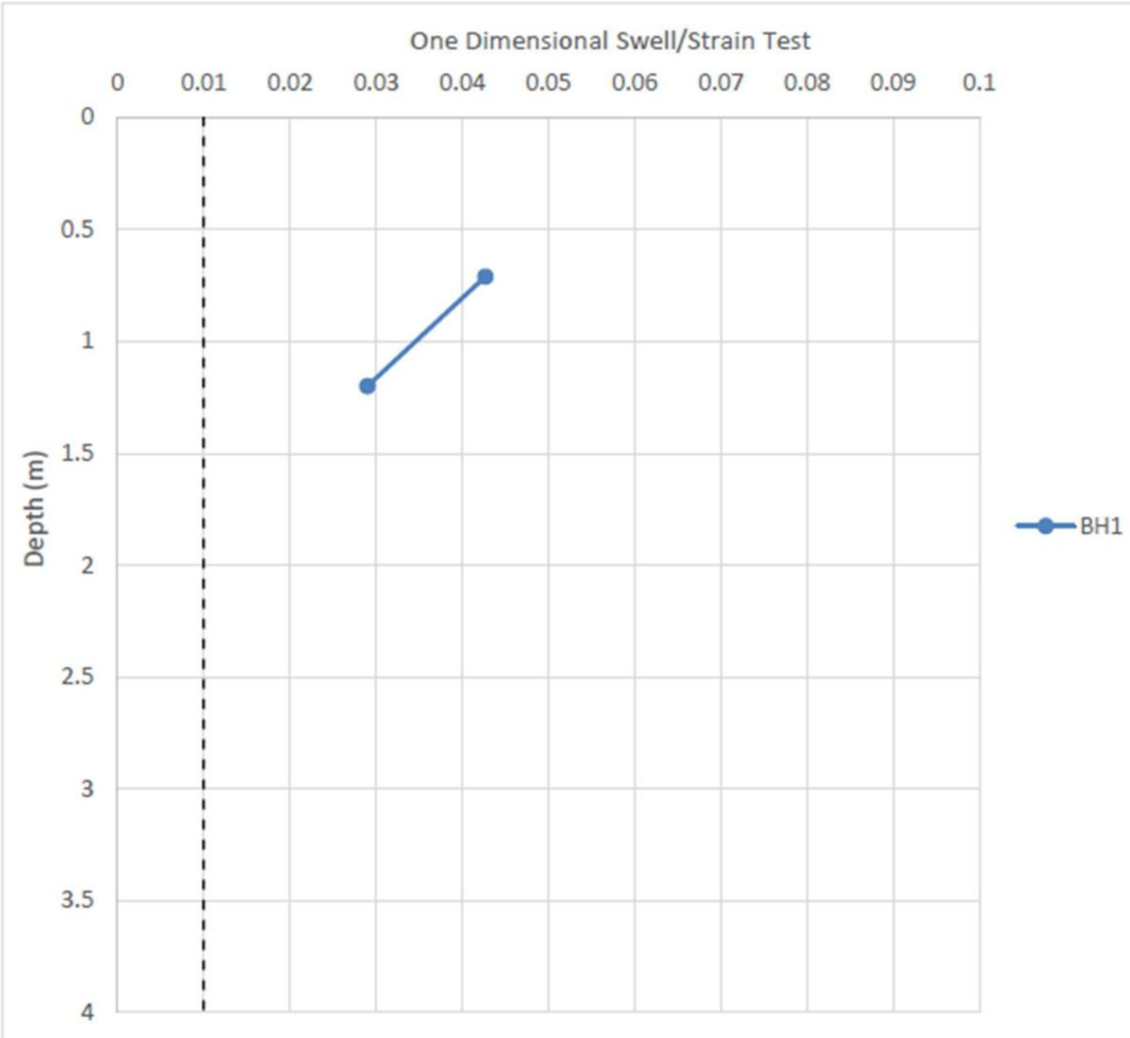
| | |
|---|---|
| BH 1 estimate of heave | 22mm |



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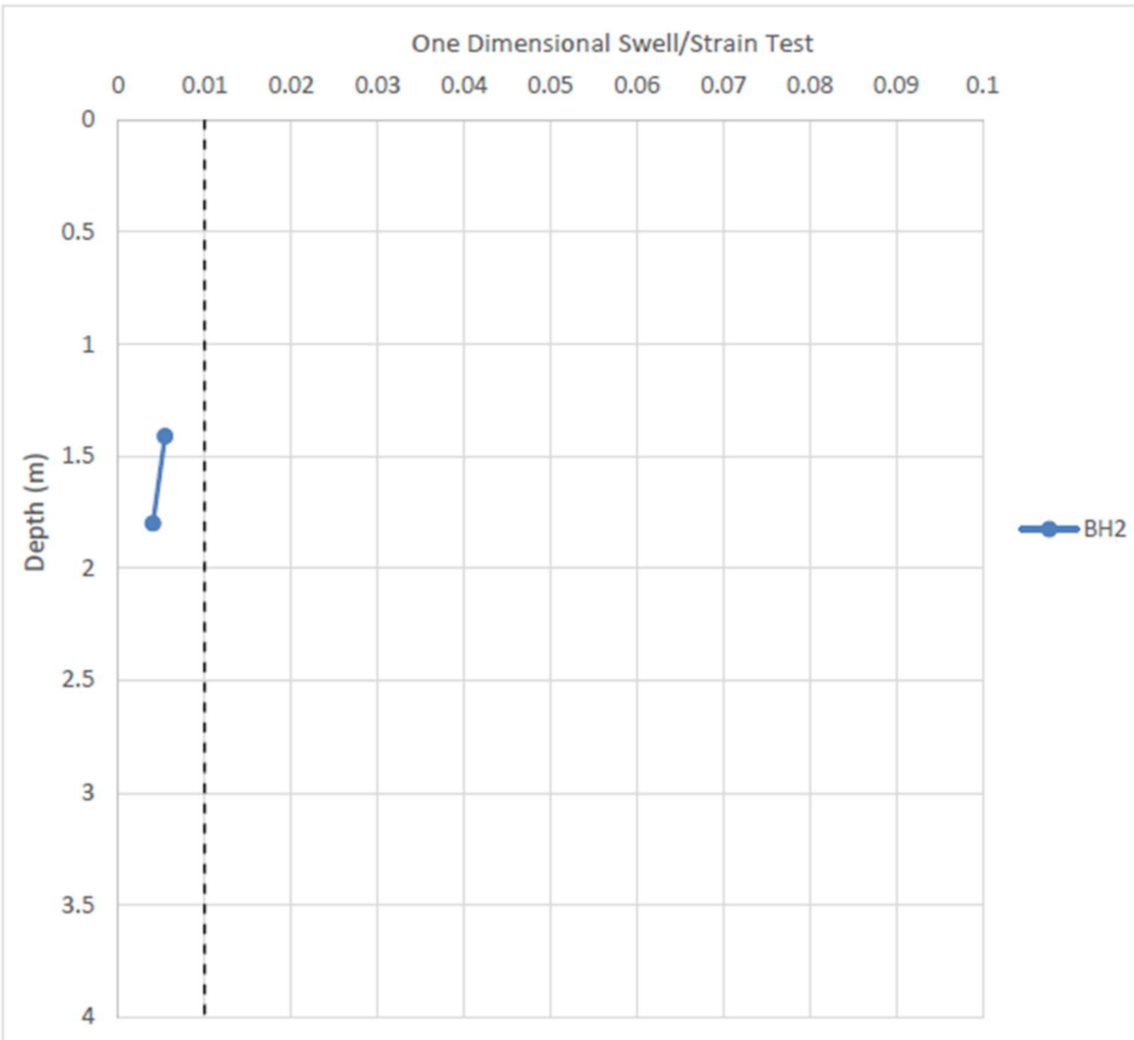
# Summary of Oedometer Testing for BH2

| Lab Ref | Depth (m) | Strain | Heave (mm) | Remarks |
|---|---|---|---|---|
| 4 | 1.41 | 0.0054 | 0 | |
| 5 | 1.8 | 0.004 | 0 | |

| | |
|---|---|
| BH 2 estimate of heave | 0mm |



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## 3.0 Feasibility

**Access**
Access is available via the front entrance, there is no gate, and the opening is wide enough to cater for a large machine.

**Location**
The barrier will need to be installed at the rear of the property between the vegetation and the main building. Care will need to be taken around the services entering the building including Gas, Electric, Mains Water and sewerage pipes.

**Depth**
Taking into consideration the root depth at the property and guidance from NHBC Section 4.2 guide on building near trees the depth of the barrier needed is 2.3m but preferably to 3.0m depth to allow for root depth change variations & environmental considerations given recent drought conditions.

**Length**
We have considered the required length and indicate on the picture below where the estimated area of the tree's influence is 35m.

## 4.0 Specification

| | |
|---|---|
| **Barrier Material:** | Geocomposite root barrier system with copper sheet mechanically encapsulated between a woven polypropylene geotextile. Or similar approved. |
| **Backfill:** | 20mm rounded Gravel. (rounded so as not to rip or compromise the barrier) |
| **Length of Barrier:** | Approximately 35m, but in accordance with the principles set out in the schematic below, with the barrier in place the roots from the tree would have to travel 20m to reach the property along a convoluted route. |
| ** Consider the length of the barrier according to site constraints against the anticipated distance roots will grow from the tree. | |
| **Depth of Barrier** | 3.0m unless shown otherwise |
| **Min Distance between barrier and property :** | 2.0m |

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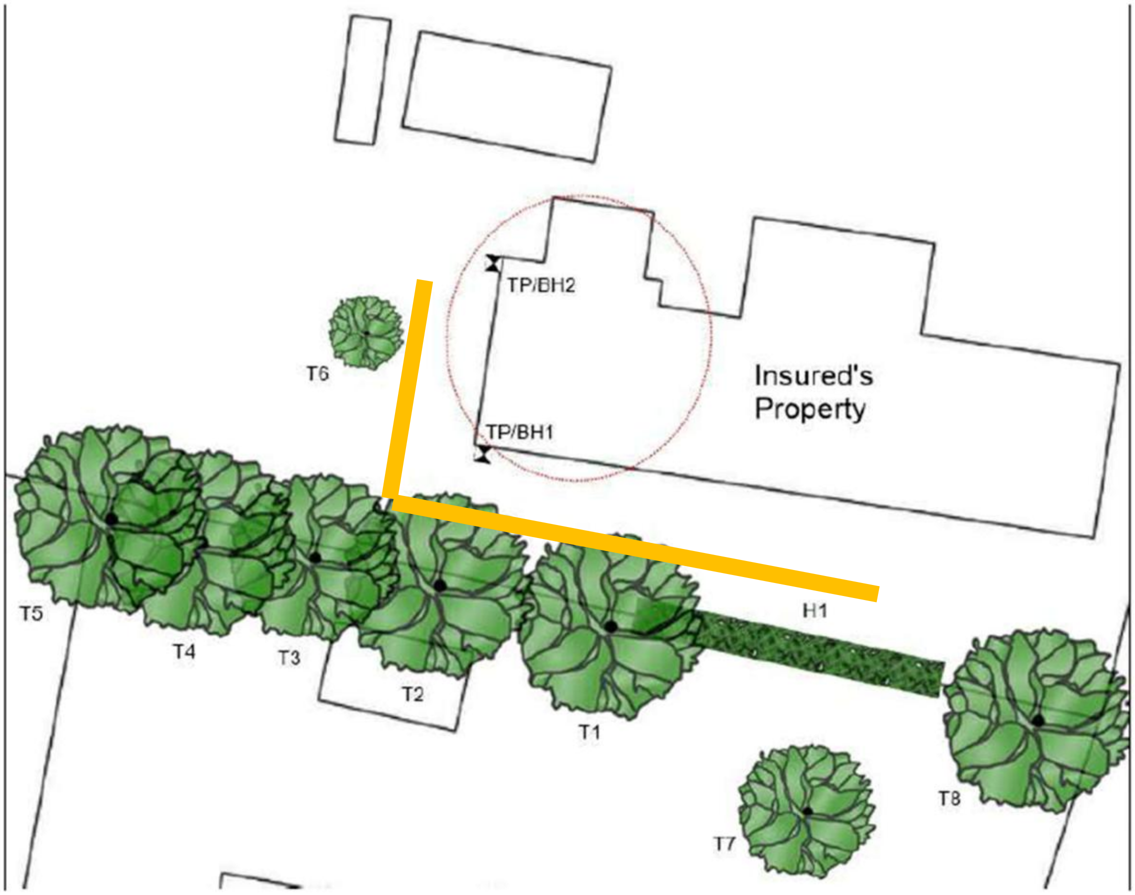
## 7. Site Plan




Please note that this plan is not to scale. OS Licence No. 100043218

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## 5.0 Methodology

- Clear site clear and ensure welfare set up
- Undertake any necessary enabling work such as the safe removal of any vegetation.
- All necessary surface protections to be put in place.
- Trench 450mm wide to be formed to full depth of proposed barrier. If the trench is wet or does not stay open, seek advice from Innovation Group Engineer.
- Check the condition of the barrier for any damage that could have been caused during transit to site.
- Check the installation location for sharp objects including stones and any object that is likely to puncture the barrier. It is essential that material placed close to a root barrier is free from any such object that could puncture it. Remove all such objects and/or provide additional protection.
- Additional protection: where there is concern over possible punctures then a suitable protective geo-membrane should be used for vertical applications to both sides of the barrier.
- Large root barrier sections must be secured, particularly if backfilling cannot be completed straight away. Do not pierce the root barrier; instead weight it down with objects that will not puncture the root barrier.
- Where jointing is required the barrier material can be tape jointed in a 150mm minimum prayer fold as the method concentrates the copper foil within the barrier at the joint location thus inhibiting root growth.
- When jointing around services we recommend that proprietary barrier socks are used.
- Granular backfill, as per specification, to be backfilled in layers of no greater than 300mm and fully compacted. Where additional support is required, the use of 'no-fines' concrete is advised.
- Top of barrier to be bent and laid flat toward the implicated vegetation. Flat region of barrier should be 250mm below ground level and extend a minimum of 250mm towards the implicated vegetation
- All existing surfaces to be re-instated and surface protections will be maintained throughout the course of the works.

Additional Items to consider (Bespoke for each installation)

- All surface treatments to be replaced as they were found
- Care to be taken when excavating close to the services which we know run along the path of the barrier

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# Appendix 01 – Supporting Calculations

The following calculations build up on the work by Allen, G. (2021) on the design and specification of Root Barriers. Rather than determine permissible depth of the barrier along a range of locations, as suggested by Allen, the following calculations assume that a preferred path for the barrier has initially been determined. This initial path is to be based on a qualitative assessment by a suitably qualified engineer, experienced in the specification of root barriers, that is informed by buildability of the barrier and takes account of the specific constraints and geometry of the site.

The required depth of the barrier, in the preferred location, is then calculated by considering a number of critical sections. The sections are drawn through the implicated vegetation and the closest point of the affected property.

The calculations then check the required depth of the barrier against two criteria:

1. What the depth of a traditional foundation would need to be, in the preferred location of the barrier, based on Chapter 4.2 of the National House Building Council (NHBC).

2. 500mm below the deepest roots recovered during the Geotechnical Site Investigations.

The calculations also check that the proposed barrier depth (h) will not undermine the foundations ($d_b$).

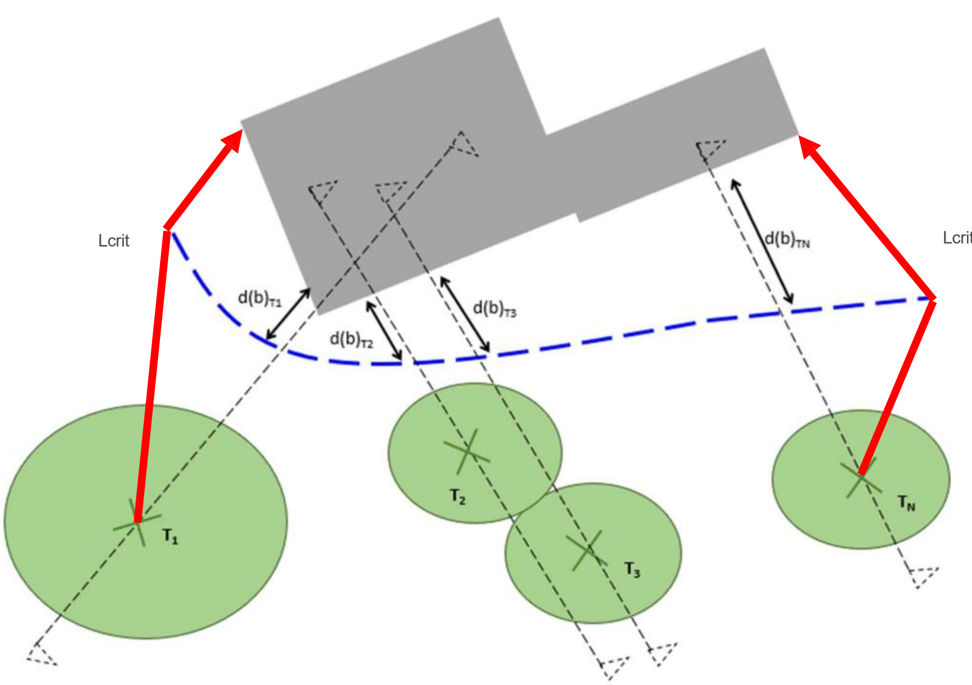

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**Figure A1: Plan Drawing Illustrating the General Case for the Root Barrier Calculations**

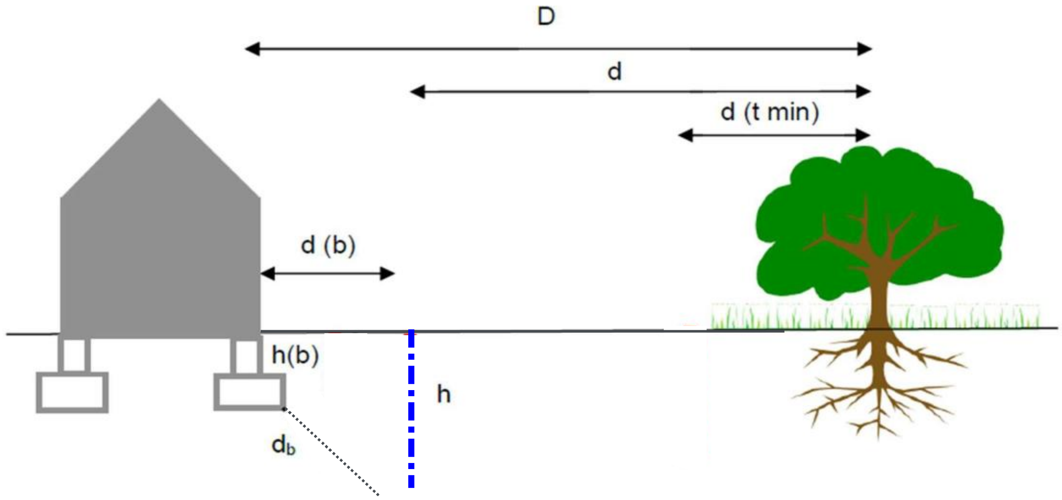


**Figure A2: Typical Section Considering shortest distance between implicated Vegetation and Affected Property**

**Soil Shrinkability:** Low

| Location | Tree Species | Type & Water Demand | Mature Height H (m) | D (m) | D/H | d(b) (m) | h(b) (m) | Root Depth from SI (m) | $d_b$ (m) | Depth due to Roots from SI | NHBC Foundation Depth Required (m) | h (m) | Check $h<d_b$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| T1 | English Oak | Broad Leaf High | 20 | 17.5 | 0.875 | 3.0 | 0.4 | 1.2 | 3.4 | 1.7 | 1.28 | 1.70 | PASS |
| - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| - | - | - | - | - | - | - | - | - | - | - | - | - | - |

**Figure A3: Calculations to Support the Barrier Layout illustrated in Section 4.0 of this report**