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Proposed Open Plan Garage Structure – Queens Road, Burnley BB10 1XX

Arboricultural Impact Assessment.

Introduction.

Proposals exist for the erection of an open plan type garage structure to the east of the front of the property to provide four parking spaces and a small storage area.

The garage will be formed on three columns with natural stone bases and capitals finished in render plus one steel column providing support to the front of the structure and the existing boundary wall forming support to the rear, all as illustrated on Lumitekton Dwg. No. LU092-P302C.

The requirement for the garage type structure is to provide shelter for the family cars which frequently have debris, aphid secretions etc. falling on them form adjacent trees.

Trees.

Various trees are present around the perimeter of the property and it is proposed to retain all items. A single stump is present T6 from which some sucker growth has developed and this remnant will be removed.

Due to the size and age of the trees plus potential restrictions caused by the adjacent highway, Electricity Sub-Station and formal boundary wall, it is probable that the root systems of all trees have become biased into the front of the property and as such, it is simply accepted that the structure will be within root protection areas and must be constructed in consideration of material present.

All canopies are at an acceptable height where no specific pruning is required to construct the structure.

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It is understood that all trees are protected by a Burnley B.C. Tree Preservation Order.

Construction Proposals.

To form the columns supporting the front of the structure piers will be required to be formed. These – depending on ground conditions, will be manually excavated to the required depth the holes lined with Visqueen or similar to provide a barrier to adjacent soils and back filled with blocks / concrete as specified by the Engineers.

Should any tree roots be encountered, in accordance with guidance within BS5837:2012 Trees in relation to design, demolition and construction - Recommendations, material less than 25mm in width can be simply cut back. Any material above 25mm should be retained where possible and if necessary, the position or form of the hole amended to avoid conflict.

The piers will be excavated through holes cut in the existing Tarmac surfacing.

Should ground conditions indicate that screw pile foundations are required, these will again be inserted through appropriate holes cut in the existing Tarmac. The first 600mm of soils will be manually excavated to ascertain any possible root presence and as per the pier construction, if roots are encountered they will be cut if below 25mm diameter or retained and the piles marginally relocated if above 25mm.

Any screw piles can be readily inserted utilising manually operated hydraulic drivers but should a mini rig be required, this can be readily operated on site from existing hard surfacing and thereby create no risks of soil compaction.

In respect of the steel pile in the proximity of T5, this can be readily inserted manually, the hole being excavated as for the piers and again lined with Visqueen to avoid contamination of the adjacent soils by concrete.

Any excavations will be low key but if concern is expressed as to potential foot traffic on open soils, Ground Mats or ply boarding can be readily laid across the area for the operatives to walk across.

In respect of the existing open soils, after removal of the stump of T6 (No Tree Preservation Order) by stump chipping by trained operatives, the soil will be cleared of all vegetation (weeds, herbaceous plants etc.) by skimming to a maximum of 50mm depth.

The cleared soils will then have an irrigation system laid across it utilising leaky pipes all of which will be fed in due course from the guttering and fall pipe system provided around the roof structure. This will readily provide suitable moisture availability to any root material that could be impacted upon by the potential umbrella effect of the roof structure.

The exposed soils will then be surfaced to continue the existing grade in accordance with Arboricultural Association Guidance Note 12, The Use of Cellular Confinement Systems Near Trees: A Guide to Good Practice utilising a 3D cellular confinement product with either an open gravel fill, resin bonded pea gravel or similar to maintain porosity for gaseous exchanges and avoid soil compaction.

Edge protection adjacent to T5 & T7 can be afforded by sleeper type edging rails or simply butted up to retained soils, there being no specific access or loadings at these points.

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All such actions are in full accordance with BS 5837 sections 7.4 & 7.5.

The construction of the roof can then be undertaken, guttering connected to the leaky pipe irrigation system and the garage completed.

It would not be expected that any spillages / pollution would be generated by the roof construction but if for whatever reason there was concern as to any pollution through the new porous surfacing, temporary cover could be provided utilising ply or OSB boards over a geotextile membrane.

Appropriate site guidance notes 9 & 10 as prepared by the Barrell Tree Consultancy are appended to indicate all necessary works and support the proposals.

Summary.

1. Stump and sucker growth of T6 cut down and ground out by specialist equipment / operatives.
2. Soils / vegetation cleared and skimmed as necessary to a maximum depth of 50mm
3. Leaky pipe system laid.
4. Surfacing laid in accordance with Arboricultural Association Guidance Note 12, The Use of Cellular Confinement Systems Near Trees: A Guide to Good Practice – finished in gravel, resin bound pea gravel or similar.
5. Holes cut through Tarmac in position of 3 new columns.
6. Excavations to 600mm in locations of all four supports to establish root presence and adjust if necessary.
7. Either; Further manual excavations to required depths of piers, holes lined with Visqueen and backfill to engineering specifications.
8. Or; Screw piles inserted.
9. Structure formed and gutters / fall pipes connected to leaky pipe irrigation system.
10. Works completed.

Site Monitoring.

If required, the Project Arboriculturalist could be instructed to attend site at the implementation of specific operations to ensure works are correctly implemented.

However due to the small scale of the project and the clear level of works required, any such proposals may be considered unnecessary. The Project Arboriculturalist does however have a good working relationship with the Architects and if any problems do arise, advice would be readily sought.

If the LPA do have any concerns however all such issues could be addressed under a Condition attached to any approval.

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Conclusions.

The proposed open plan garage structure can be readily constructed utilising accepted techniques and methodologies as per guidance within BS5837:2012 Trees in relation to design, demolition and construction - Recommendations, Arboricultural Association Guidance Note 12, The Use of Cellular Confinement Systems Near Trees: A Guide to Good Practice *et al*.

The completed structure would have no significant impact upon retained trees but would assist in avoiding conflict between trees and parked vehicles thereby maximising the potential of the treescape.

This note is considered to have addressed all necessary issues and provides appropriate guidance for all parties. Should there be any queries however or if clarification of any points is necessary, please contact the writer.

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barrell TREE CONSULTANCY

Site Guidance Note 9: Installing/upgrading surfacing in root protection areas

SGN 9: Summary guidance for site operatives

Administration

1. Unauthorised damage to protected trees is a criminal offence and could lead to enforcement action.
2. Work under the normal site risk assessment procedures and comply with the wider site safety rules.
3. Brief operatives entering root protection areas (RPAs) by the supervising arboriculturist before work starts.

Other relevant SGNs

4. Monitor works in RPAs by the supervising arboriculturist (See SGN 1 Monitoring tree protection).
5. Design access to avoid soil compaction (See SGN 3 Ground protection).
6. Follow the guidance in SGN 4 Pollution control, if concrete is poured within or near RPAs.
7. Minimise excavation into original undisturbed soil (See SGN 7 Excavation in root protection areas).
8. Follow the guidance in SGN 8 Removing surfacing and structures in root protection areas, if existing surfacing is to be removed before installing new surfacing.
9. Follow the guidance in SGN 10 Installing structures in root protection areas, if the surfacing is to be installed on supports, i.e. piles, pads, or posts.

SGN 9: Summary guidance for site operatives

Important Reminders

10. For ground without existing surfacing, remove any loose material at the soil surface by hand and do not excavate into existing soil levels unless approved by the supervising arboriculturist.

11. For ground with a vegetation layer, excavations may be appropriate to remove the turf layer and surface vegetation, but this must be agreed by the supervising arboriculturist.

12. All new surfacing must be set back from trunks and buttress roots by at least 50 cm, unless otherwise agreed by the supervising arboriculturist.

13. Fill low points on undulating surfaces to an even level with any high points using an agreed granular material such as sand or stone.

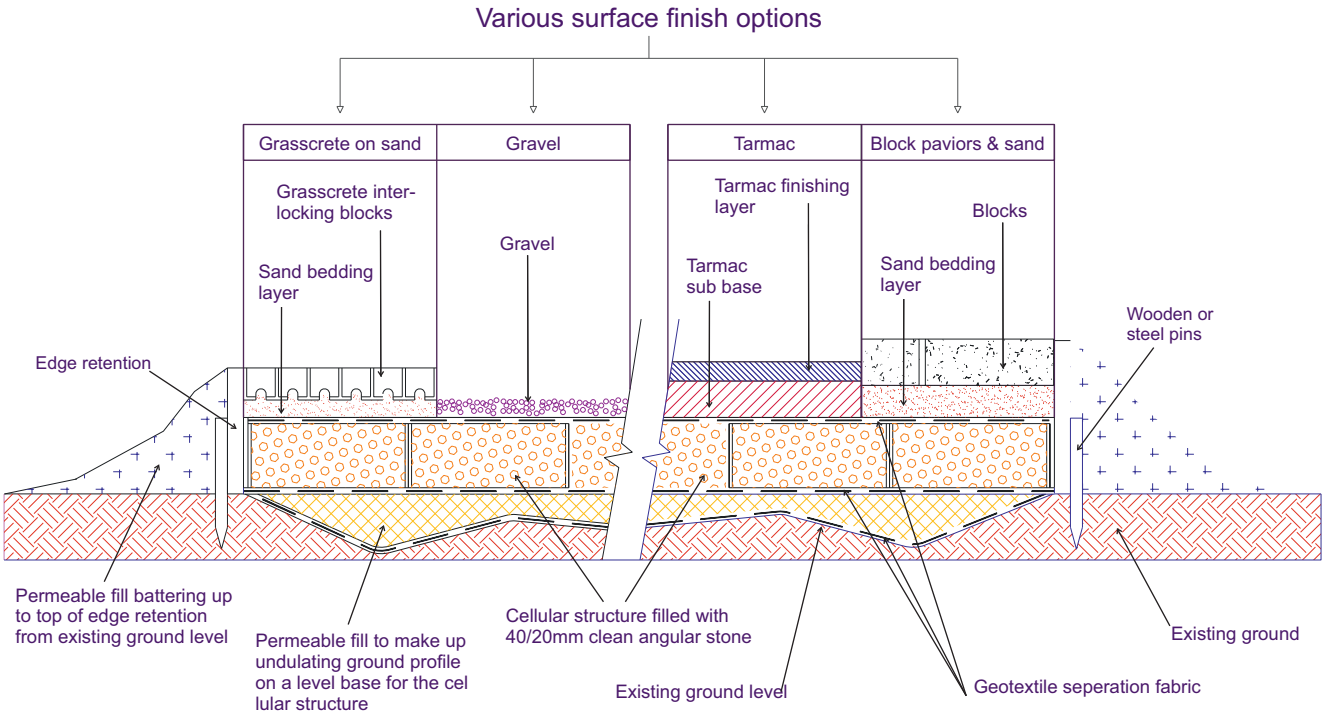
14. Do not mechanically compact new fill or existing soil.

15. If a three-dimensional cellular confinement system is used, install it according to the manufacturer's technical specification. Note: The cellular fill will be washed angular stone with no fines, as specified by the manufacturer.

SGN 9: Explanatory notes and examples

Purpose

SGN 9 describes the practical requirements for installing new surfacing and upgrading existing surfacing in RPAs, based on the recommendations in BS 5837 (7.4).



Illustrative specification for no-dig cellular confinement surfacing with examples of finishing options.
Note: The final design must be site specific and detailed by an appropriate specialist

BS 5837 recommends that three-dimensional cellular confinement systems are an appropriate sub-base for installing surfacing in RPAs. Most products are made from heavy-duty plastic that is pulled apart to open into cells. These are then filled with washed stone, after the product is spread over the ground and pinned in place. This forms a base layer that acts as a floating raft, spreading the load across the whole construction width. The base layer can be topped with a variety of finishes as illustrated in the cross-section.

Product suppliers: Protectaweb 3D cellular confinement product - https://wrekinproducts.com

SGN 9: Explanatory notes and examples

General principles and clarifications

Conventional surfacing installation based on excavating and compacting a supporting sub-base is unacceptable in RPAs because it can damage roots and the rooting environment. This harm is caused by killing roots, compacting soil structure, and impeding water/gaseous exchange through the soil. Adverse impact on trees will be reduced by minimising the extent of these changes in RPAs.

New surfacing solutions

Important elements of an effective design include protecting roots and the rooting environment during installation, a load spreading capability to prevent localised compaction, and providing adequate permeability for water and gasses to support living roots. The main approaches are:

- three-dimensional cellular confinement systems filled with washed stone laid directly onto the soil surface;
- concrete slabs cast directly onto the soil surface; and,
- surfacing supported above the soil surface on top of piles, pads, or posts.

The specific design of the chosen approach is an engineering issue that will take account of the bearing capacity of the soil, the intended loading, and the frequency of loading. The detail of product and specification are technical matters to be provided by an appropriate specialist.

Dealing with undulating surfaces and establishing a tolerable level of excavation

The precise location and depth of roots within the soil is unpredictable and will often only be known when careful digging starts on site. Ideally, all new surfacing in RPAs will be no-dig, i.e. requiring no excavation, but this can sometimes be difficult on undulating surfaces. New surfacing normally requires an evenly graded sub-base layer, which can be made up to any high points with granular, permeable fills such as crushed stone or sharp sand. This sub-base will not be compacted as would happen in conventional surface installation. Some limited excavation can be necessary to achieve this and need not be damaging if carried out carefully and large roots are not cut. Tree roots and grass roots rarely occupy the same soil volume at the top of the soil profile, so the removal of an established turf layer up to 5cm from the surface is unlikely to be damaging to trees. However, this may not be possible where there is no grass because tree roots may grow right up to the soil surface. In some situations, it may be possible to dig to a greater depth,

SGN 9: Explanatory notes and examples

depending on local conditions, but this will be assessed by the supervising arboriculturist if excavation deeper than 5cm is anticipated.

On undulating surfaces, finished gradients and levels will be planned with sufficient flexibility to allow on-site adjustment if excavation of any high points reveals large unexpected roots near the surface. If the roots are less than 2.5cm in diameter, they can be cut and the base for the surfacing formed with the preferred minimal excavation of up to 5cm. However, if roots over 2.5cm in diameter are exposed, cutting them may be too damaging and further excavation may not be possible. If that is the case, the surrounding levels will be adjusted to take account of these high points by filling with suitable material. If this is not practical, the situation will be discussed with the supervising arboriculturist before a final decision is made.

Edge retention

Conventional kerb edge retention set in concrete-filled excavated trenches can cause damage to roots and will be avoided. Edge retention in RPAs will be designed to avoid any significant excavation into existing soil levels, with several approaches that are fit for this purpose. For block paviours, the use of pre-formed edging secured by metal pins is effective and can be reinforced by concrete supports if there is no excavation into the soil. Railway sleepers pinned in place or wooden boards offer alternative options, depending on the expected loading of the surfacing. If the edge retention needs to be battered down to lower surrounding ground levels, a permeable soil fill will be used, as agreed with the supervising arboriculturist.

Footpaths and surfacing without a load-spreading base layer

In some situations, limited-width floating concrete rafts constructed directly onto the soil surface may be acceptable for both pedestrian and vehicular access, but the design will not include any strip-dug supports. If concrete is poured directly, precautions must be taken to ensure that no toxic fluids can contaminate the adjacent soil, e.g. confining the concrete in an impermeable liner. Alternatively, elevated paths supported on low impact frames or post supports allow a decking surface to cross sensitive areas. Where paths are installed very close to trunks, provision will be made for distortion from future root growth through using flexible components for the supporting frame and surfacing.

Specific considerations for upgrading existing surfacing

When upgrading existing surfacing, the preferred option will be to leave it in place and install the new surfacing on top of it. If the retained surfacing is impermeable, it may improve conditions for tree roots if it

SGN 9: Explanatory notes and examples

is punctured before the new surfacing is laid, but this is detail to be agreed with the supervising arboriculturist. If the existing surfacing is to be removed, it will be excavated down to the soil level beneath following the guidance set out in SGN 8 (Removing surfacing and structures in root protection areas). The new surfacing will then be installed on this surface, as described above.

New surfacing near trunks

All new surfacing should be set back from trunks and buttress roots by at least 50cm to allow space for future growth and minimise the risk of distortion.

The flat-packed three-dimensional cells are pulled apart, spread across the area to be surfaced, and pinned in place ready for the washed angular stone fill (with no fines).

SGN 9-01

The stone-filled cells spread the load of traffic to prevent localised compaction. The permeable geotextile membrane on the ground allows the movement of water and gasses, but prevents the migration of stone into the soil profile.

SGN 9-02

SGN 9: Explanatory notes and examples

SGN 9-03

Although BS 5837 recommends a minimum distance of 50cm between new surfacing and buttress roots, there may be scope for flexibility in this separation for mature trees with little potential for future growth, if agreed by the supervising arboriculturist.

SGN 9-04

A conventional concrete haunching can be used to retain new surfacing if it is not dug into a trench - here it is placed on top of the three-dimensional cellular confinement layer.

SGN 9-05

This preparation for a new residential access drive shows the base formation above the original ground level, with the permeable geotextile layer covering the ground. The wooden boards are pinned in place, creating an informal and rustic surface edging.

SGN 9: Explanatory notes and examples

The three-dimensional cells have been installed and filled with washed stone, ready for the finished surface to be laid above. The ground beyond the drive edges has been profiled with backfilled topsoil.

SGN 9-06

An alternative to the flexible three dimensional cells is rigid interlocking plastic cells, again filled with washed stone and retained by pinned wooden edges.

SGN 9-07

Another option for wooden edges at corner points that allows for vehicles to accidentally track over the edge of the formal surfacing.

SGN 9-08

SGN 9: Explanatory notes and examples

This temporary access for heavy construction traffic on the outer edge of a RPA is a concrete slab cast above ground level and will be removed when the project is completed. This approach is particularly suitable for slopes where a three-dimensional approach may be more prone to distortion when carrying heavy loads.

In some situations, it may be appropriate to cast a free-floating concrete surface directly onto the soil surface provided provision is made to prevent soil contamination while the concrete is being poured.

The RPA of this oak extended about 12m from its trunk and was previously covered in tarmac as parking. This original surfacing was removed and replaced with a new patio set above the ground level, with provision for water and air input into the covered RPA.

SGN 9: Explanatory notes and examples

Where new surfacing is to be installed over existing, sometimes it may assist the movement of gasses and water if the existing surfacing is punctured. In this situation, exploratory digging showed important roots directly beneath the existing tarmac, which would have been damaged if the tarmac was removed.

SGN 9-12

An option for installing surfacing close to mature trees is to use a light metal frame with rubberised surfacing to allow the path to distort without failing as the roots grow.

SGN 9-13

Board walks supported on posts or a light frame are another way of providing pedestrian access across sensitive RPAs (photo courtesy of Philip van Wassenaer).

SGN 9-14

SGN 9: Explanatory notes and examples


SGN 9-15

New surfacing such as decking can be supported above the ground on posts leaving the soil surface beneath undisturbed.


SGN 9-16

Although this is only a temporary surface, railway sleepers pinned into the ground can be used to retain the edges of new surfacing.


SGN 9-17

Where space is restricted it is possible to use metal edging.

SGN 9: Explanatory notes and examples

Technical reference

Due to copyright restrictions, the relevant British Standard clauses are summarised, not quoted, as follows:

1. ***BS 5837 (2012) Trees in relation to design, demolition and construction – Recommendations:***
   Clause 7.4 (Permanent hard surfacing within the RPA) recommends:
   - *7.4.2.1 New surface design should not require excavation other than the removal of the turf layer and surface vegetation. The design should be able to bear any anticipated loading, especially if it must carry construction traffic.*
   - *7.4.2.2 The design should evenly distribute the loading to avoid localised compaction.*
   - *7.4.2.7 The design should be resistant to or tolerant of deformation by tree roots, and should be set back from the stem and any root buttresses by a minimum of 50cm to allow for growth and movement. Levels can be made up using appropriate inert granular material.*
     ***NOTE** Piles, pads, elevated beams, and three-dimensional cellular confinement systems, can be used to support surfaces. If excavation is required, the location of roots greater than 2.5cm in diameter should be determined by exploratory investigations and retained if possible.*
   - *7.4.3 The conventional installation of kerbs, edgings, and haunchings, can damage tree roots and should be avoided either by using alternative methods of edge support or by not using supports at all.*
     ***NOTE** Examples of suitable edge supports include above-ground peg and board edging, sleepers, gabions, and other non-invasive ground-contact structures.*
   - *7.4.4.3 Ground levels should not be reduced to establish the new hard surface at the former ground level. Loose debris and turf should be removed carefully and the new surface should sit on top of the original soil.*
   - *7.4.4.4 Fill to raise levels should be a granular material which remains gas- and water-permeable throughout its design life.*
   - *7.4.4.5 Wet concrete should not be poured in the RPA unless an impermeable liner has been installed to prevent soil contamination from the toxic leachate.*

Site Guidance Note 10: Installing structures in root protection areas

SGN 10: Summary guidance for site operatives

Administration

1. Unauthorised damage to protected trees is a criminal offence and could lead to enforcement action.
2. Work under the normal site risk assessment procedures and comply with the wider site safety rules.
3. Brief operatives entering root protection areas (RPAs) by the supervising arboriculturist before work starts.

Other relevant SGNs

4. Monitor works in RPAs by the supervising arboriculturist (See SGN 1 Monitoring tree protection).
5. Design access to avoid soil compaction (See SGN 3 Ground protection).
6. Reduce the risk of chemical contamination from poured wet concrete (See SGN 4 Pollution control).
7. Minimise excavation into original undisturbed soil (See SGN 7 Excavation in root protection areas).
8. Install any surfacing acting as support for light structures directly onto the soil surface with minimal excavation (See SGN 9 Installing/upgrading surfacing in root protection areas).

SGN 10: Summary guidance for site operatives

Important Reminders

9. Hand-dig pile, pad, or post locations down to a depth of 60cm and, if necessary, adjust location to avoid cutting roots greater than 2.5cm diameter.

10. No excavation into existing soil levels except where authorised for supports. Note: This specifically applies to ground beams sitting above supports.

11. Make provision for ventilation and watering beneath substantial structures.

12. Where feasible, keep in place existing below ground structures where they can be reused to support new structures, e.g. new walls built on existing wall footings.

SGN 10: Explanatory notes and examples

Purpose

SGN 10 describes the practical requirements for installing new structures in RPAs, based on the recommendations in BS 5837 (7.5 & 7.6).

General principles and clarifications

Conventional installation of new structures using strip foundations is unacceptable in RPAs because the excavations can damage roots and adversely disturb the soil. Additionally, the covering created by the new structure over the soil can impede water and gaseous exchange. Adverse impact on trees will be reduced by minimising the extent of these changes in RPAs.

The installation of pile, pad, or post supports

Substantial structures such as heavy walls, garages, and larger buildings, will sit above ground level, supported by piles, pads, or posts, with provision for water and gaseous input into the covered area. The risk of harm through soil compaction during the construction activity will be reduced using ground protection as described in SGN 3 (Ground protection).

SGN 10: Explanatory notes and examples

The risk of chemical contamination will be reduced by following the guidance in SGN 4 (Pollution control). The risk of direct root damage from excavation will be reduced by following the guidance in SGN 7 (Excavation in root protection areas). If feasible, careful consideration should be given to retaining existing footings, especially relating to walls. This will allow the installation of new structures without the disturbance required to excavate and install new footings, as explained in SGN 8 (Removing surfacing and structures in root protection areas).

All support locations will be hand-dug to a depth of 60cm to identify if any roots over 2.5cm diameter are in the way. Sufficient flexibility will be built into the design to allow support locations to be moved to avoid roots over 2.5cm diameter.

Additionally, the diameter and the distribution of the supports will be minimised to reduce the risks of disturbance during the installation. The bases of such structures will allow for air and water input beneath through ventilation and irrigation provision.

The installation of no-dig surfacing supports

An alternative for lighter structures such as small sheds, carports, and bin stores, is to support them on custom designed no-dig surfacing, installed directly onto the soil surface, as described in SGN 9 (Installing/upgrading surfacing in root protection areas).

Basements

It is also feasible to install subterranean structures (basements) beneath RPAs if the volume of soil forming the RPA can be retained without significant disturbance. The detailed design and specification of all these solutions is an engineering issue, to be informed and guided by tree expertise.

Support locations should be hand-dug to a depth of 60cm to see if there are any significant roots in the way, with provision to move the location if roots are found (note the pile in this example was finally installed to avoid the root).

SGN 10-01

SGN 10: Explanatory notes and examples

Ground protection should be used to spread the load of the piling rig once excavation has confirmed that no substantial roots are in the preferred pile location.

Piles can also be used to support bridges across sensitive RPAs, but the temporary ground protection must be removed before the main structure is either imported in or cast on site.

The RPA for the trees behind the fencing extends across the whole view. The soil surface is protected by heavy duty ground protection to prevent compaction during the work and the poured concrete piles were sleeved to prevent RPA contamination.

SGN 10: Explanatory notes and examples

This RPA was protected from compaction from the piling rig by a three-dimensional cellular covering. The cellular covering was cut away from the pile locations, which were then hand-dug down to 60cm to make sure that no roots over 2.5cm were damaged. The piles were a screw type to avoid soil contamination from poured concrete.

SGN 10-05

Small diameter piles (less than 15cm) are an effective means of supporting structures in RPAs with minimal disturbance. The wooden formwork provides the receptacle for the steel reinforcement and the poured concrete that will form the building slab.

SGN 10-06

Where the slabs for larger structures are cast on site, a biodegradable void-former can be used to temporarily support the weight of the liquid concrete until it sets. The void-former can then be wetted and washed away to leave a void, or left to degrade naturally, both of which allow movement of air beneath the slab.

SGN 10-07

SGN 10: Explanatory notes and examples

SGN 10-08

This garage was supported on piles with a concrete ground slab poured on site using a biodegradable void-former. Note the drainage downpipe feeding into a perforated watering pipe laid below the slab to provide water input into the RPA.

SGN 10-09

It is possible to support very large structures on piles within sensitive RPAs.

SGN 10-10

This building is supported on piles, with ground beams above onto which the floor is laid. The beams are above ground level and the pipes are perforated with a shingle surround to provide water input into the RPA once the structure is completed.

SGN 10: Explanatory notes and examples

These carports are formed by wooden posts above a three-dimensional cellular no-dig and load-spreading surface of permeable crushed stone.

SGN 10-11

The workman is standing within the outline of a free standing concrete slab that is to be installed above the existing ground level within an RPA that was previously covered in tarmac as parking.

SGN10-12

This raised deck extension is supported on wooden posts, hand dug to avoid significant roots.

SGN 10-13

SGN 10: Explanatory notes and examples


SGN 10-14

The original church wall was displaced towards the pavement and had to be removed for safety reasons. The replacement structure was built on a new concrete reinforced footing installed without cutting any significant roots.


SGN 10-15

This covered bin store was constructed within RPAs by placing block paving on a levelled sand base directly onto the existing ground level, with the posts in hand dug holes to support the roof.


SGN 10-16

This church extension was built on a concrete beam and block floor slab supported on piles located in hand dug holes. Ground protection around the margins protected the RPA of the adjacent tree during construction.

SGN 10: Explanatory notes and examples

Where significant roots cannot be cut, a bridging lintel of concrete or steel can be used to support the wall slightly above the roots to be retained.


SGN 10-17

Hand excavation of soil and shrub roots allows preformed steel or concrete lintels to be installed as a solid base for the curved wall construction, raised slightly above ground level, sitting on small diameter piles.


SGN10-18

The voids beneath the wall and between the piles can be filled with soil/permeable fill leaving no indication that the finished wall is supported above the ground, allowing important tree roots to be retained intact.

SGN 10-19

SGN 10: Explanatory notes and examples

Technical reference

Due to copyright restrictions, the relevant British Standard clauses are summarised, not quoted, as follows:

1. ***BS 5837 (2012) Trees in relation to design, demolition and construction – Recommendations:*** *Clauses 7.5 (Special engineering for foundations within the RPA) and 7.6 (Subterranean construction within the RPA) recommend:*
   - *7.5.1 Traditional strip footings can result in extensive root loss and should be avoided, but specially engineered structures may be justified if this allows good quality trees to be retained. Foundation designs should consider existing levels, proposed finished levels, and cross-sectional details. Site-specific and specialist advice regarding foundation design should be sought from the project arboriculturist and an engineer.*
   - *7.5.2 Root damage can be minimised by using piles supporting beams, laid at or above ground level, with site investigation down to a minimum depth of 60cm to determine their optimal location. Alternatively, structures can be cantilevered to avoid roots identified by site investigation.*
   - *7.5.3 Slabs for minor structure should bear on existing ground level, and should not exceed an area greater than 20% of the existing unsurfaced ground.*
   - *7.5.4 Slabs for larger structures should be designed with an irrigation system and a ventilated air space between the underside of the slab and the existing soil surface. The design should take account of any effect on the load-bearing properties of underlying soil from the redirected roof run-off and prior approval should be sought from the building control authority.*
   - *7.5.5 The smallest practical pile diameter should be used to reduce the possibility of striking major tree roots. Small piles also reduce the size of the rig required and can reduce the need for access facilitation pruning. The pile type should be selected to protect RPAs from the potentially toxic effects of uncured concrete, e.g. sleeved bored pile or screw pile.*
   - *7.6.1 Where subterranean basement are proposed within RPAs, it is essential to avoid excavating down through rootable soil. It might be technically possible to form the excavation by undermining the soil beneath the RPA.*