

URBAN TREES, HIGHWAYS & UTILITIES

BY GREENBLUE URBAN

V1.1



02

Structural Applications



Northumberland Avenue

The Principles of Pavement Support

With any type of hard surface design, there are several vital pieces of information that are required to make sure that the build-up is calculated properly. These include the structural bearing ability of the sub-base, the classification of use, (what will pass over it) and the drainage requirements among many others.

Much of the design consideration revolves around long term stability of the finished surfacing; any sub-standard design issues below the surface can cause heave or subsidence within a short period of time, which will bring large potential liabilities for the authority responsible for the paving. Often high levels of construction compaction of mixed size aggregates are used to create stable sub-bases which will not move under normal use and should last for many decades.

However, this type of paving support – compacted aggregate – is not suitable for tree establishment. Tree roots are very sensitive to ground compaction and cannot penetrate heavily compacted soils. Often trees planted adjacent or into this kind of base root very superficially and cause hard surface failure through root breakout below the paving. In the 1860s, the Victorians used suspended paving systems to give the trees large volumes of uncompacted soil. In Northumberland Avenue, London, this system consisted of wrought iron girders supporting large tree grilles and the paving, leaving below it a soil vault continuing right along the road.

This system gives an uninterrupted uncompacted soil trench, adequately watered and with enough gaseous exchange, making these beautiful trees the envy of London.

In North America a similar system is used with pre-formed concrete sidewalk sections, often called cantilever sidewalk construction, but again providing good volumes of uncompacted soil.

During the mid-1990s, different methods were trialled using a rock-soil matrix. This method mixed aggregate together with organic material and could be compacted to provide suitable long-term structural stability, but trials in the UK have shown that the high percentage of aggregate and very low proportion of clay has meant that trees do not establish well in these systems.

The reduced volume of organic material leads to nutrient depletion, and the low clay levels mean that there is very little water holding capability, leading to premature tree mortality.

The use of soil cell systems has proved very effective, and where installed correctly has protected against any surface disruption. GreenBlue Urban pioneered the concept in 2001 with the RootCell, moving onto the StrataCell in 2006 and now manufacturing the RootSpace module capable of taking very high vehicle loadings without deflection, but keeping the precious soil in optimum root growing condition.

Manufactured from 100% recycled material, GreenBlue Urban are saving the planet as well as its inhabitants.

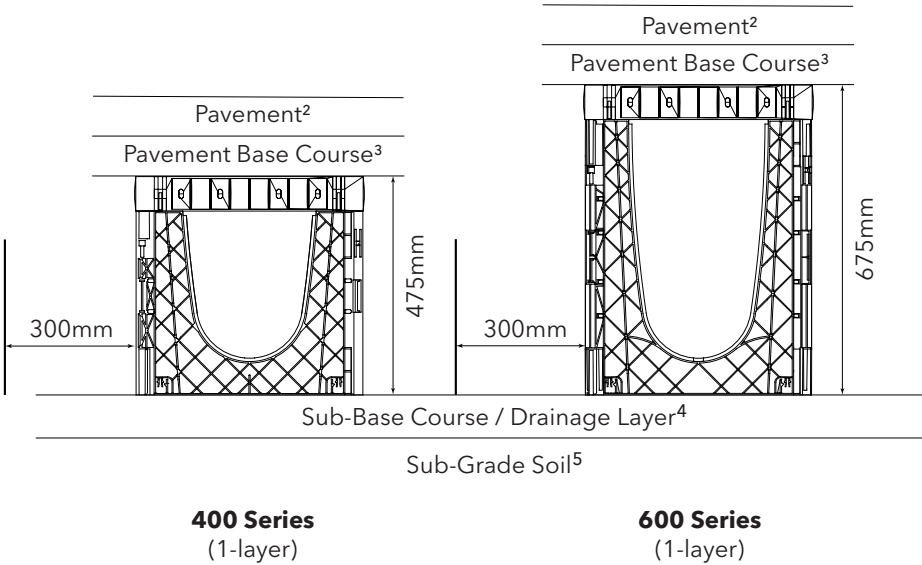
Different combinations and cellular systems are available to suit all design criteria – please visit our website or speak to one of our engineers for details about your project.

Road / Pavement Build-up Design

Guidelines given in the DMRB HD24 HD26: Pavement Design and Construction, require the design of road surfacing and layer works to be based principally on a traffic assessment figures. These are expressed in terms of million standard (80kN) axle loads (msa) to be carried during the design life of the construction. This traffic loading together with the quality of the subgrade dictates the selection of the surfacing and depth of a road pavement required.

The dispersal of wheel loads carried by buried structures depends on the type and depth of road layer works selected. Subbase layers are normally made up of compacted gravel. Surfacing layers are typically bituminous macadam, reinforced concrete or block pavers.

Material	Angle of load spread
Reinforced concrete	1.5 horz. to 1 vertical
Bituminous macadam	1.0 horz. to 1 vertical
Unreinforced concrete	1.0 horz. to 1 vertical
Compacted DTp Type 1 Gravel	0.5 horz. to 1 vertical
Interlocking block paving	1.0 horz. to 1 vertical

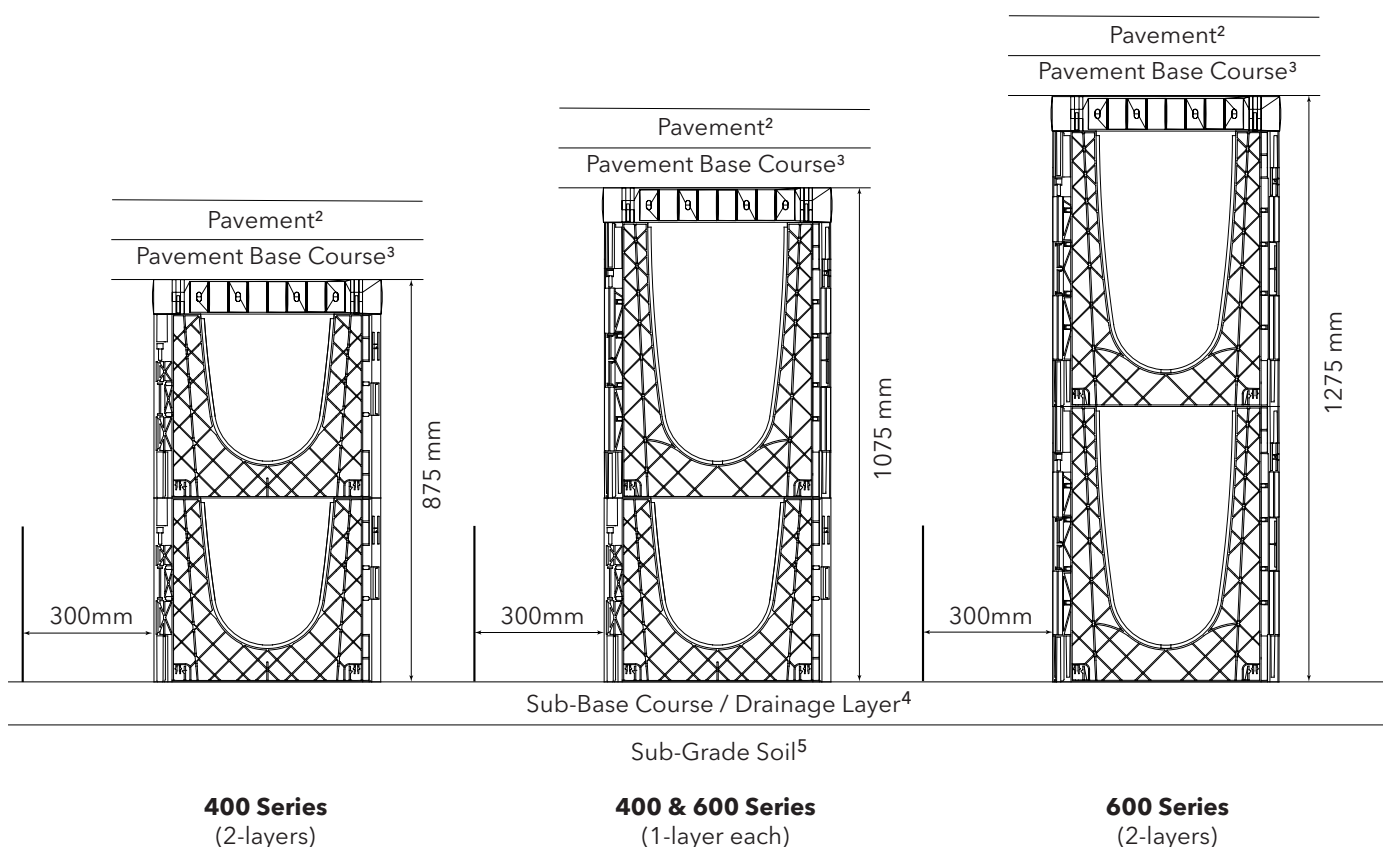


The wheel load “footprint” on the road surface may be assumed to disperse further through the materials as shown in:

The following table gives the minimum allowable paving construction depths required to disperse a 4.5 tonne wheel load (as an example) on different RootSpace configurations (this is based on a typical macadam type road construction and the standard tree pit detail of GBU specification:

RootSpace configuration	Height	Subbase DTp Type 1 depth	Macadam depth *	Total depth
400 single	475mm	150mm	150mm	300mm
600 single	675mm	300mm	150mm	450mm
400 + 400	875mm	300mm	150mm	450mm
400 + 600	1075mm	325mm	150mm	475mm
600 + 600	1275mm	325mm	150mm	475mm

* Total depth of bound bituminous layers (Minimum construction depths for a full range of wheel loads are available separately)



Load Bearing Requirements and Paving Depths

There are many British and European standards that apply to highway design & construction, but there is no formal standard yet for below ground Soil Cell Systems. To give clarity and compatibility, BS EN 124:2015 is used for comparison purposes.

The applicable British Standard in the UK for access covers and gully grates is BS EN 124:2015. This standard divides access covers and gully grates into a number of classes by static test load. It also categorises the various places where they may be installed from A15, the least demanding environment, through to F900, the most demanding environment. It provides guidance on the minimum class of covers and grates to be used in each environment classification.

While BS EN 124:2015 provides a useful classification of loading classes and is common knowledge with many people in the industry, the testing regime it specifies for manhole covers, etc., cannot be applied to soil cell type systems. These soil cell systems encounter a completely different scale and form of loading factors and comparison cannot therefore be drawn from BS EN 124:2015 on this aspect.



The **RootCell** structure underneath this pavement was subjected to 400 passes of an 8.2 tonne (9 ton) axle loading immediately adjacent to the structure and then a further 200 passes immediately above the **RootCell**. As expected, no adverse movement of the structure was detected

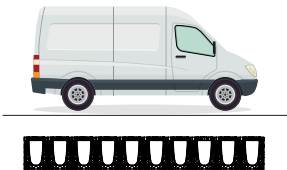
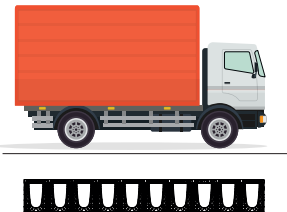
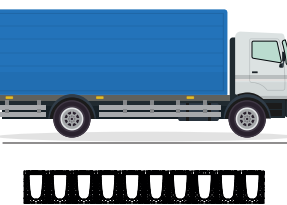
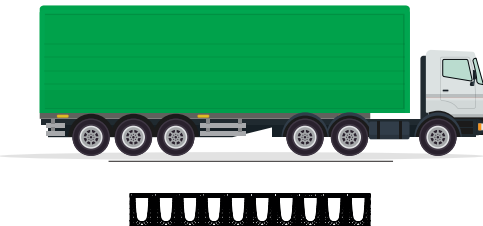
Loading Environment Categories

GBU Category	Maximum GVW	BS EN 124:2015 Class
Category 1	Pedestrian and cycles	A15
Category 2	1.5t Cars	B125
Category 3	3.5t LGV	B125
Category 4	7.5t HGV	B125
Category 5	18.0t HGV	D400
Category 6	44.0t HGV	D400

Layer Works Depth

Note, layer works depths described below assumes a minimum depth of 150mm bitumen bound aggregate is included in the total layer works depth.

Example: Category 3 loading, RootSpace G2 400 product, layerworks should include as a minimum 150mm granular aggregate and 150mm bitumen bound surfacing.

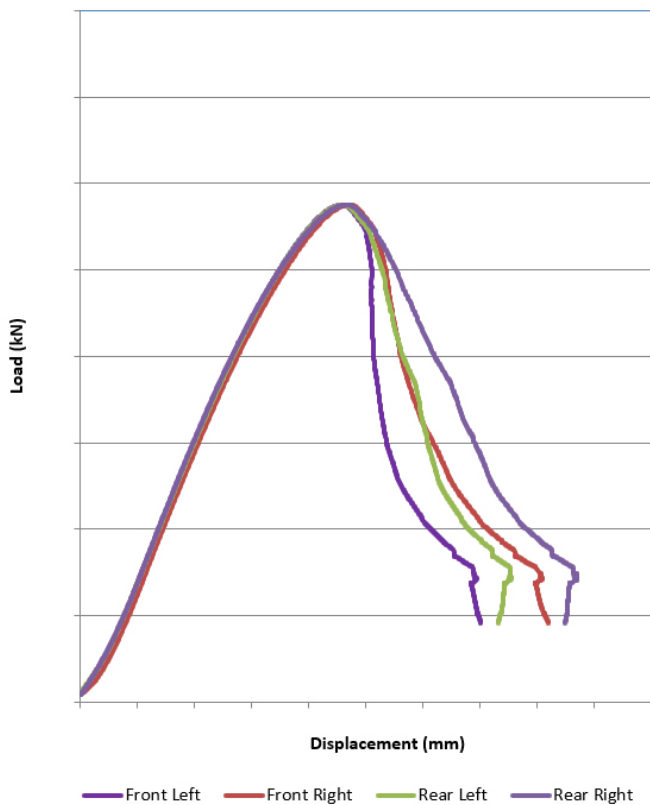
Category	GVW	Layer Works Depth RootSpace G2 400	Layer Works Depth RootSpace G2 600
Category 1	 Pedestrian	200mm	200mm
Category 2	 1.5t GVW	250mm	250mm
Category 3	 3.5t GVW	300mm	300mm
Category 4	 7.5t GVW	350mm	400mm
Category 5	 18.0t GVW	400mm	500mm
Category 6	 44.0t GVW	450mm	600mm

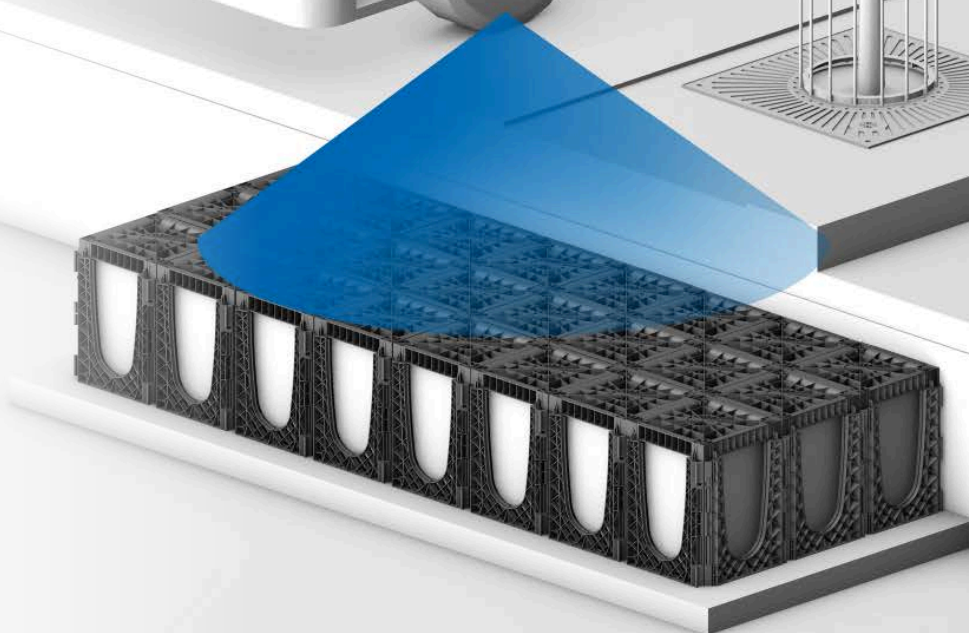
Note, these are indicative numbers only, layer works should be designed and approved by a qualified structural engineer in accordance with applicable standards and the annual design loadings intended for the location.

RootSpace Load Testing

Extensive compression testing of RootSpace units has been carried out at highly reputable independent testing laboratories. Test data is interpreted from several repetitions of the same test to provide reliability of data and ensure consistency and accuracy of structural performance.

**Test 39 - 1275mm Standard 2x2x2
- no side panels - 1000mm plate**



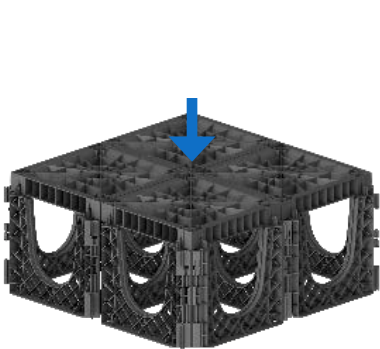


RootSpace Load Bearing Capacity

Load bearing capacity of structural soil cells is a complex science. It is common to interpret the actual breaking point of structural products as the ultimate allowable wheel load. Engineers employed by GreenBlue allow a factor of safety by basing calculations on loadings before undue displacement occurs.

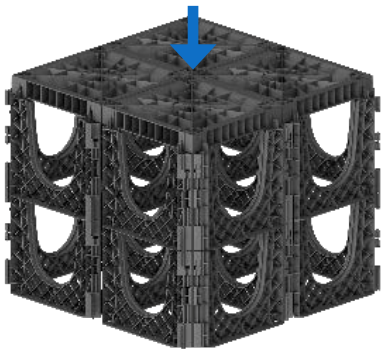
Vertical Load Bearing Capacity

Horizontal Load Capacity (With Side Panels)



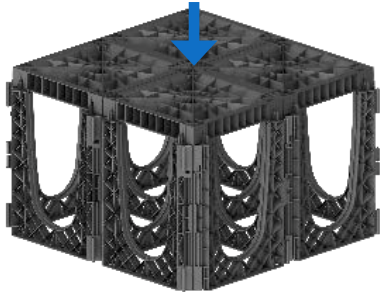
322.7 kN/m² 32.9 tonne/m²

G2 400: 475mm units (single height)



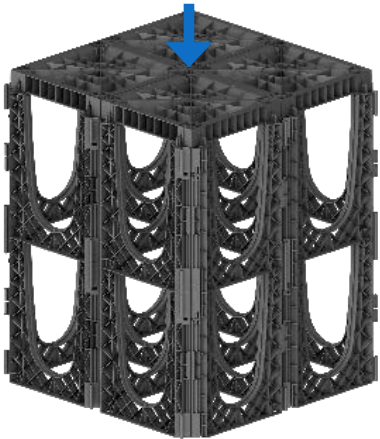
278.3 kN/m² 28.4 tonne/m²

G2 400: 875mm units (double height)



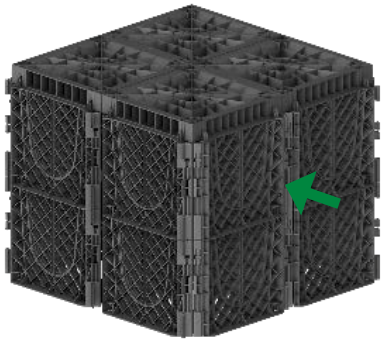
245.3 kN/m² 25.0 tonne/m²

G2 600: 675mm units (single height)



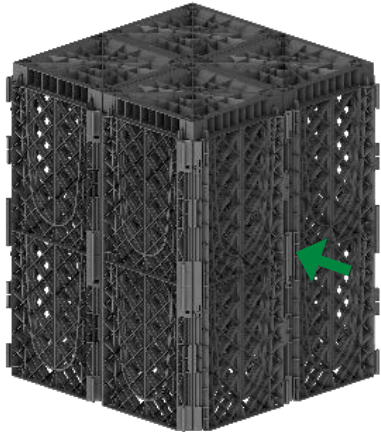
228.5 kN/m² 23.3 tonne/m²

G2 600: 1275mm units (double height)



82.3 kN/m² 8.4 tonne/m²

G2 400: 875mm units (double height)
Loaded on side - with side panels



56.5 kN/m² 5.8 tonne/m²

G2 600: 1275mm units (double height)
Loaded on side - with side panels



Soil Cells Under Pedestrian Areas

Caversham, just across the river Thames from the city of Reading, has been a seat of human habitation for over 1,000 years. Mentioned in the Domesday Book, the river was bridged here sometime during the early 13th Century, and a chapel dedicated to St Anne stood on the island part way across the bridge.

Just north of the bridge, King Charles 1st fought a desperate but unsuccessful battle to relieve the besieged city of Reading, bringing thousands of reinforcements from Caversham Hill to help.

Between the hill and the bridge, the town centre is now a bustling shopping area, and at its heart, St Martins Precinct provides an outdoor retail zone. Built during the 1960s, this open square had mature trees established, which by 2015 were causing significant problems with the paving, and the buildings needed renovation.

The owners of the centre showed vision in insisting that new tree planting should be carried out to a high standard, making sure that the canopy cover should be replaced as soon as possible. GreenBlue Urban working with Barton Willmore, carefully designed a rooting system, utilising the RootSpace soil cell system which could take high loading capacity to allow for maintenance vehicle overrun, but allow full long term tree growth.

Completed during autumn 2017, this large interconnected tree pit containing high quality uncompacted topsoil was constructed, and the paving, trees and tree grilles installed.

Now this pedestrianised area gives the residents an attractive area to shop and eat, greatly enhanced by mature trees, providing shade, water attenuation, air pollution reduction and the many many other benefits that healthy trees bring to our urban environments.





Soil Cells Under Vehicular Parking Zones

Wokingham was late to be settled in comparison with other nearby towns, as it was always a heavily forested area. It appears it was first settled by Saxons travelling west from Woking, but there is no early record of it, until the church was built during the 1100s.

The real town building began in about 1220, when the Bishop set out numerous building plots on parallel roads, terminating in a triangular market place, where the Town Hall now stands. The right to hold markets in this space was granted, and this town became the centre for the Windsor Forest people during medieval times. During the Tudor reigns, the market place became associated with bull-baiting, where a local butcher donated a bull to be taunted and attacked by dogs on 21st December, then slaughtered and the meat distributed to the poor of the town; mercifully this cruel sport was outlawed in 1835.

Much of the town centre is Victorian, but there are several exceptional older properties, many of them dating back to more prosperous times. Wokingham was known for its silk, its bell foundries and more latterly, brick making, and these trades brought immigrants, and money to the town. The first Guildhall was built on the Market Place in 1612, but this was demolished in 1858, and replaced by the fine building currently in use in 1860.

As with many towns, road traffic began to cause major congestion in the town centre. Early one-way systems became a problem, and in 2010 the local authority decided that a total revamp of the market place and road network was essential.

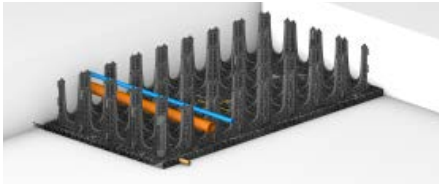
There have always been trees in Wokingham town centre – the town motto is E Glande Quercus (“from the acorn, the oak”) and the existing trees were causing pavement breakup and structural hazards. It was therefore obvious to include GreenBlue Urban when the new tree positions were planned, to ensure that the new trees planted had the opportunity to attain species potential and provide large canopies in the future.

Working with the contractors, GreenBlue Urban assisted in the installation of these full-sized tree pits, working around below ground utilities and constraints. The results are spectacular – the backdrop of green canopy cover giving this historic market place a calm peaceful air, and an attractive setting for those who work, live or pass through the town centre.



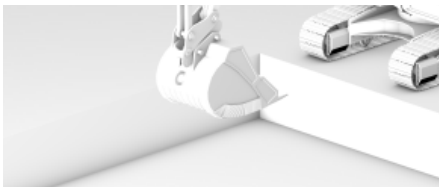
How to Install RootSpace

1



Survey potential tree pit for below ground constraints.

2



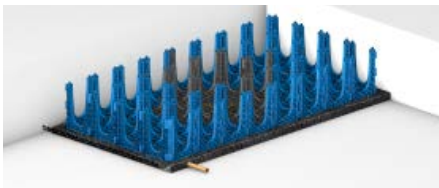
Excavate tree pit allowing 10% additional dig for installation ease.

3



Lay drainage stone level and GRN20 mesh to base and sides.

4



Install RootSpace system and underground guying.

5



Backfill sides of tree pit with Type 1.

6



Fill cells with soil, install lids, RootDirector, aeration, irrigation and twin wall geonet.

7



Complete sub-base buildup over RootSpace system, concrete haunch + tree grille frame.

8



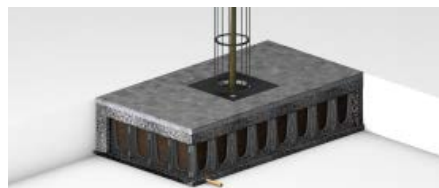
Plant tree.

9



Install grille & complete paving.

10



Install guard.



Working Around Utilities

Our streets have been routes for our utilities for centuries. Early drainage consisted of open sewers in the centre of the streets, which were gradually enclosed by the mid 1800's. Piped water, then gas, electricity and now myriad communications make the below ground strata a veritable web of various services – some live, some redundant and some unidentified.

Urban tree planting has always had to compete with these important services to our properties. With the increase in technology particularly and the subsequent requirements for better and better communication networks, the available space for tree planting is severely constrained in most of our towns and cities.

The clue to successful tree planting in and around these utility lines is collaboration and understanding the risks to the utility provider. Trees are not inherently damaging, but they are exploitive of rooting volume, and tend to find the easiest route to nutrient, water and air. When the initial planting zone has become insufficient for the tree health, the tree roots will explore further areas in search of these items, and in doing so can find small fissures or holes in service ducts and drains. The fine fibrous roots will enter these apertures, grow and finally block or break the utility.

GreenBlue Urban always recommends a dual approach, both advocating root management and root baiting: discouraging tree rooting in areas where there would be a potential

conflict and attracting roots to a safe area where adequate uncompacted soil volume can be provided. The RootSpace soil cell system can be threaded around utilities, both providing for the tree and actually encasing the utility, protecting it from accidental damage. Many utilities are root resistant, and most are of no interest for tree roots as they do not provide any elements that the tree requires: e.g., electricity, gas and telecommunications.

Many utility companies have strict tree limitation guidance and working with them in a collaborative way usually overcomes these issues. Mainly these guides relate to future liability, or to the bad publicity caused by the removal of green infrastructure due to utility maintenance requirements. Intelligent planting and root management can largely overcome these issues and ensure that our cities remain healthy green places for all to enjoy.



Archway Gyratory, Islington

Urban Constraints



Utilities & RootSpace Guide

bit.ly/RootSpace-Utilities

Accessing Utilities After Tree Installation

The juxtaposition of below ground services and tree rooting environments will always require compromise to enable sustainable long-term satisfactory outcomes for all stakeholders. Many utility providers have become reluctant to allow tree planting because of future potential liability claims, leading to denuded streets.

With the GreenBlue Urban RootSpace system, the utilities are actually protected by the high capacity soil cells from accidental service strikes by encasing them within the cell structure.

If utilities need to be accessed in the case of an emergency, the contractor simply must excavate to the top of the cell system, remove the RootSpace lids (this does not require any tools) then hand dig or vacuum excavate through the rooting zone to access the service.

Because the rooting environment is optimum for the tree, the rooting system will have a higher proportion of fibrous roots, and less structural roots. This means that if roots have to be pruned to allow access to a utility, the tree will not be so severely affected and will recover quicker.

In compacted soils, tree roots often follow services through the ground, as these provide a route to fresh rooting zones. If sufficient high-quality uncompacted soil is initially supplied and kept healthy, there is evidence that the tree does not seek additional nutrient or water from elsewhere. This root baiting design, coupled with effective root management is proven to greatly reduce the problem of utility and root conflict.



Vacuum excavation. Image: MTA Capital Construction



Tree pit excavation using air spading to prevent root damage.

RootSpace Installation & Maintenance Manual

8.4 Service & Maintenance of Utilities below the ArborSystem®

- 1**  Locate utilities.
- 2**  Saw cut and remove pavement surface / pavers in affected area.
- 3**  Remove aggregate subbase to expose geocomposite.
- 4**  Cut and remove geocomposite.
- 5**  Remove RootSpace Lid(s) by pulling up or by excavating.
- 6**  Remove RootSpace Upright Panel(s) by pulling each Upright Panel up or by excavating.

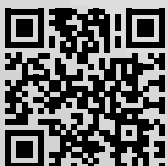
For further help telephone our technical helpline on

01580 830 800 or 1 866 282 2743

- 7**  Excavate soil below RootSpace to access and repair utility.
- 8**  Backfill and compact to surrounding sub-base to original elevations including geotextiles.
- 9**  Reassemble RootSpace Upright Panels.
- 10**  Replace AirFlow Lids and planting soil.
- 11**  Install geocomposite.
- 12**  Install pavement sub-base and pavement.

For further help telephone our technical helpline on 01580 830 800 or 1 866 282 2743

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ArborSystem Installation & Maintenance Manual

bit.ly/ArborSystem-Manual