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THE PRODUCT GUIDE FOR DESIGNERS

THEMES:

- **Cladding and curtain walling**
- **Landscape**

SPECIFIER'S CHOICE:
Essex Goodman & Suggit's Indian Cultural Centre

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Theme: landscape

Following advances in roof-deck technology over the last decade, and the need to provide an answer to the ever-present problem of energy efficiency in buildings, we have seen the resurgence of the roof garden, not only in private residences but also in the public realm

BY PETER WILDER

Increasingly, as the value of land for development spirals upward, landscape exists as a thin membrane draped across the architectural fabric of our cities. Spaces that we frequently perceive as resting effortlessly on mother earth or nestling lazily between buildings are often the roofscapes of car parks, leisure centres, offices or stations. Whereas once the emphasis of roof gardens was to create a simple green carpet, today's roof gardens employ high technology to create spaces that work every bit as hard as the architecture around them to bring added value to urban schemes.

Historically, roof gardens have been flights of fancy, and an opportunity to enact fantasy amid the familiarity of the built environment. The roof garden built at Derry and Toms in 1931 included a series of interrelated gardens with exotic themes such as the Moorish and Elizabethan gardens. In the late 1950s, landscape architect Dan Kiley designed a roof garden over a department store in Oakland, California, which included olive trees set into flowing mounds. In 1976, Sylvia Crowe designed a roof promenade for recreational use by the employees of Scottish Widows. Roof gardens are expensive commodities, and are hard to justify when they provide a purely private or aesthetic function.

The re-emergence of roof-deck technology

MARTIN CHARLES

Above: the Award winning roof garden created for RMC Headquarters by Derek Lovejoy Partnership in 1991. Architect: Edward Cullinan

CANARY RIVERSIDE

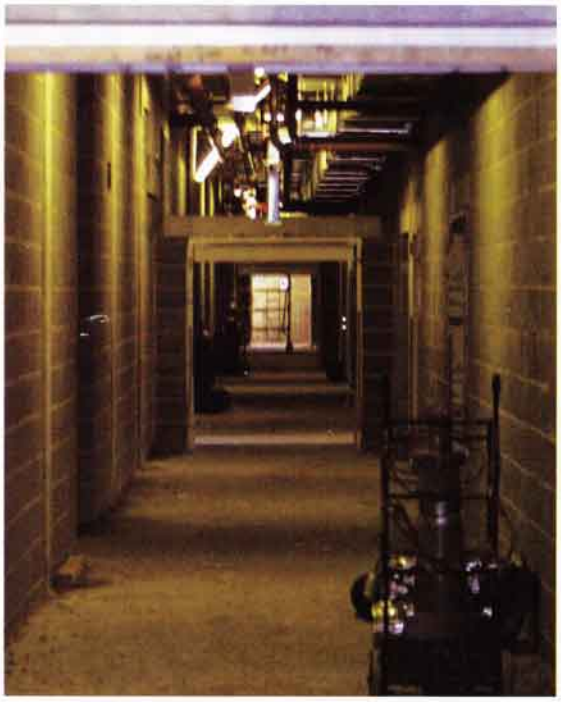
ERISCO BAUER

Above: the landscape created for Canary Riverside in 2000 sits predominantly on a roof deck, and creates the impression of sitting on the ground. Architect: Koeter Kim Associates. Right: green roof system by Erisco Bauder adorns the roof of the Landesbauparkasse in Mainz

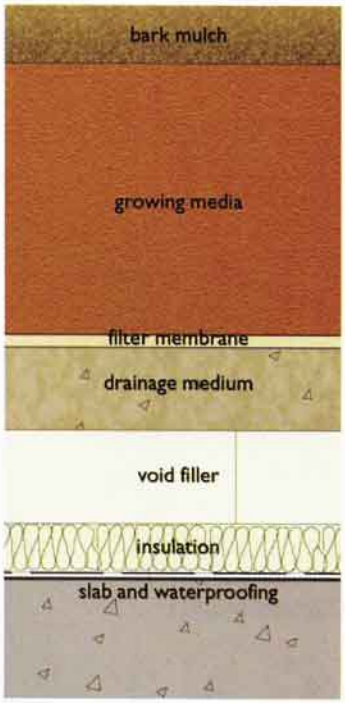
came about not as a response to a visual need or an aesthetic consideration, but as an answer to providing energy efficiency in buildings and as a way of reducing storm water runoff in urban environments. In Berlin, for example, stipulations that new buildings could only discharge 20 per cent of storm water into sewer systems meant that the remaining water had to be dealt with on site either by evapo-transpiration through extensive planting, by infiltration systems or through use in irrigation or WC flushing systems.

Although such regulations led to a surge in roof-deck technology, the gardens created were a myopic solution, which resulted in flat carpets of succulent vegetation. These plants, although able to cope with the extremes of drought, temperature and desiccation experienced on exposed sites, offered little contribution to the landscape value of roof-deck spaces.

But advances in waterproofing and drainage technology, combined with the development of specialist growing media, meant that a normal soil profile could be compressed into a much shallower depth,



Service corridors at Paddington Central, underneath the roof deck



Typical make- up for a roof deck planting scheme

Laying of the waterproof membrane at Paddington Central by Rock Asphalte

and stay within the loading tolerances of modern building technology.

During the past decade we have begun to see roof gardens emerge as part of the public realm. They aspire to be places in their own right, rather than just the icing on the concrete cake. It is more appropriate to refer to these new spaces as perched landscapes, because they are more likely to be found connecting the fabric of urban platforms than sitting isolated on top of buildings.

The pressure on the designer has always been to create landscapes which look and feel natural on the surface so that the public is unaware that the trees that they see are suspended many metres above the ground level. The key to achieving this has been to recreate natural growing conditions for all types of plants in a completely artificial environment, and to hide all of the drainage and irrigation gubbins below the surface.

Construction techniques will vary according to the constraints of the site and the intensity of its usage. Important decisions have to be made early on in the design process about the end use of the roof garden, and its overall

functionality. In the design of the public realm for Paddington Central, the developer and the architect had considered from inception that the spaces should be fully integrated and mesh with the existing urban fabric. Although the brief for this site led to an intense development over an extensive area, many roofscapes are intended as purely visual pieces, to be viewed from spaces surrounding or above them. Good examples of this include the roof garden for the German Institute for Standardisation (DIN) in Berlin, or the roof gardens of Topher Delaney.

Whether planting is to be integrated in the slab construction to create the effect of being on ground level, or built into raised planters, the key elements of any roof garden profile will be the same, consisting of:

- waterproofing membrane;
- insulation and/or void-filling layer;
- drainage layer; and
- growing media.

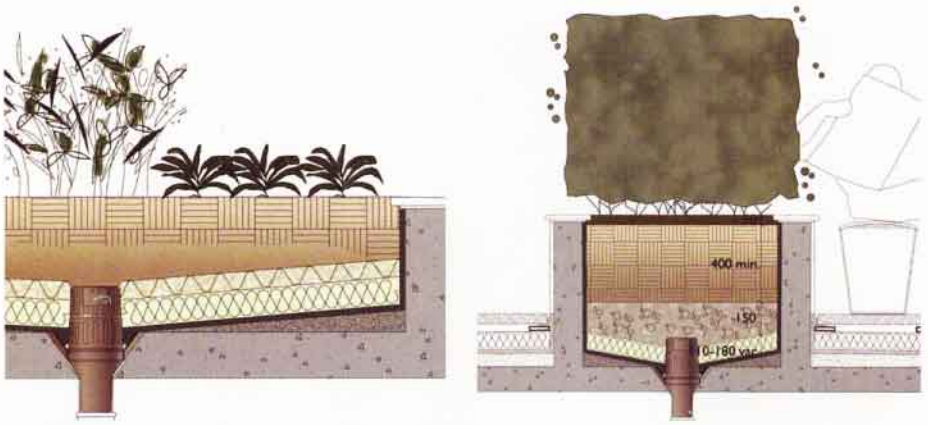
Waterproofing membrane

It is vital that the waterproofing membrane is procured from a reputable firm that can supply, install and guarantee the works for a minimum of 10 years. Companies such as Erisco Bauder supply complete systems including insulation layers and an extensive planting mat, which simplifies the process of procurement. However, where more elaborate construction is required, it is often better to separate the waterproofing works from the landscape construction due to the specialist nature of each operation.

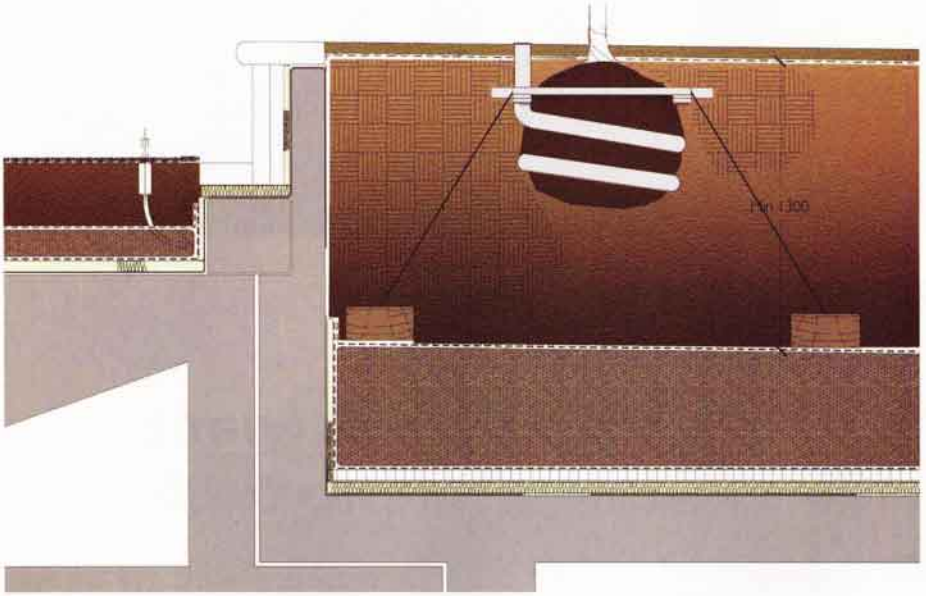
Most commonly the waterproofing membrane is a bitumen mastic layer, laid over the concrete slab with or without a screed layer to falls. Systems which do not use a screed to direct water to drainage outlets rely more heavily on a drainage layer to act as a buffer between the slab and the growing medium, and place a greater strain on the integrity of the waterproofing membrane. In areas to be planted, the waterproofing membrane will include a root-protection barrier, which helps to prevent root penetration of the waterproof membrane. The most common point for the failure of waterproofing membranes occurs where there are expansion joints in slabs, or roof-deck penetrations. Therefore, the design of services and levels changes should be considered carefully at an early stage.

Insulation or void-filling layer

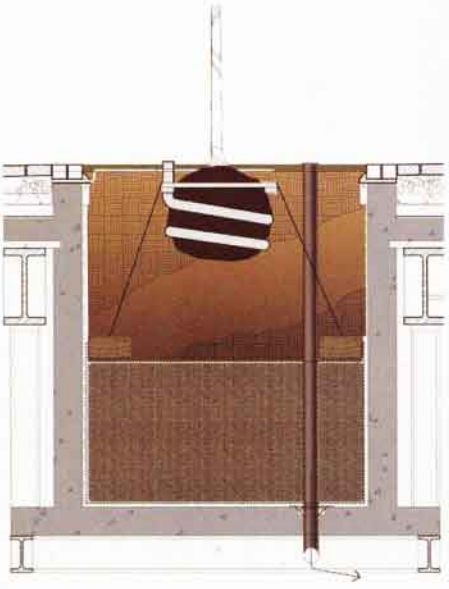
Most often the spaces beneath the slab will offer some kind of accommodation and will require insulation. Even car-parking areas will often require insulation to the roof-deck slab to prevent condensation and dripping



Construction details for Harrods Place, Knightsbridge, employ an 'inverted roof' system with a concrete screed to falls for increased drainage efficiency

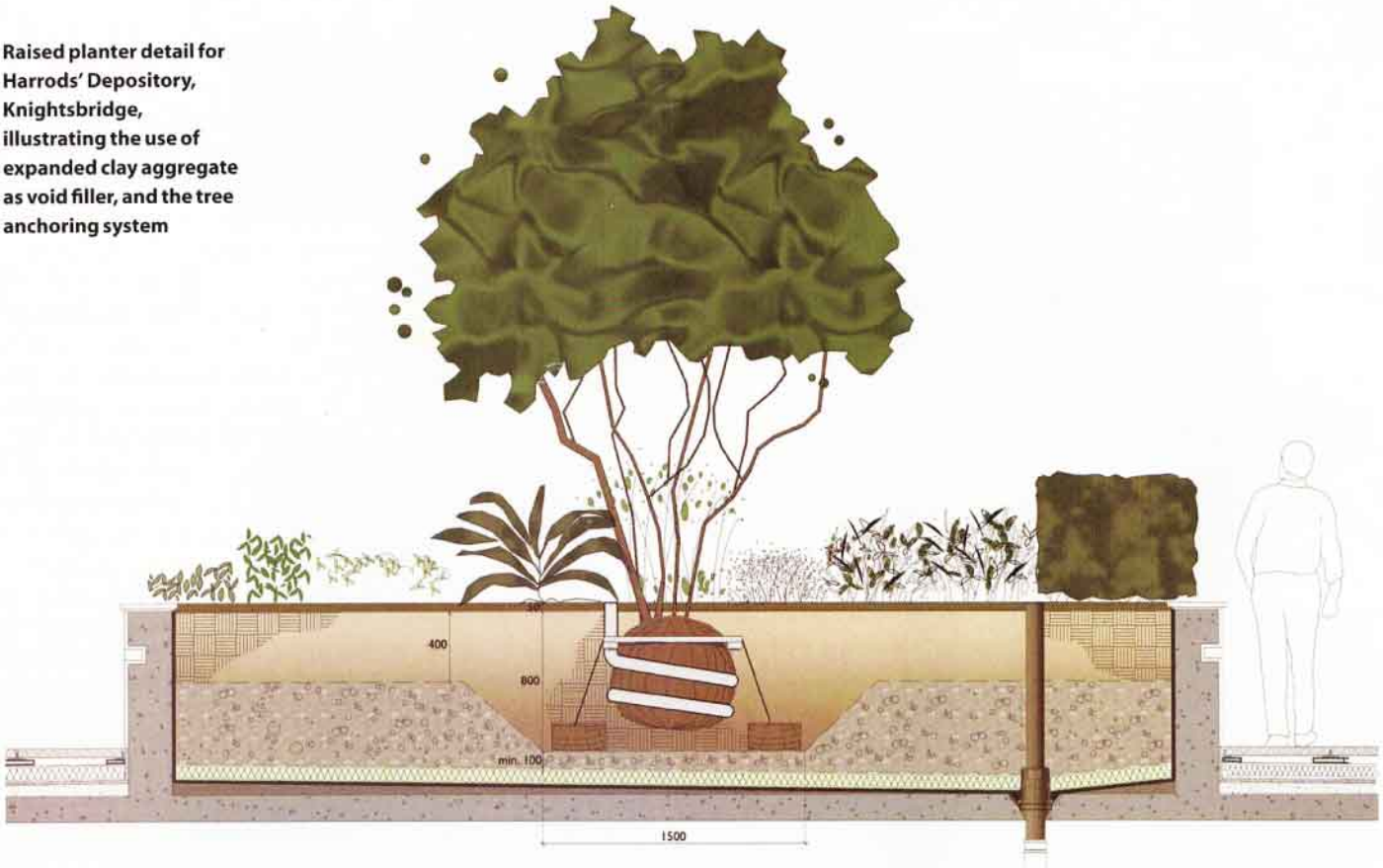


Tree pit and lawn terrace interface detail for Paddington Central, showing drainage sump detail and insulation layer



Tree pit detail and tree pit under construction at Paddington Central

Raised planter detail for Harrods' Depository, Knightsbridge, illustrating the use of expanded clay aggregate as void filler, and the tree anchoring system



on to vehicles below. In areas where differential soil depths are required, or where there is a transition from a planted to a paved surface finish, it is common for inert void-filling material to be used to make up levels and reduce the loadings associated with saturated growing media. Load-bearing void fillers, such as lightweight concrete aggregate, or high-density polystyrene materials, such as Filcor by Cordek, are often used where the finished surface will take pedestrian or vehicular traffic. Filcor can be specified with different densities to take various types of traffic, and the material can be cut to size or even sculpted to create flowing contours or profiles beneath the topsoil layers.

Where there is no requirement for profiling, or the soiling zone is well contained, loose void-filling material such as Hydroleca or Optiroc, a lightweight expanded clay aggregate, can be used. It is important that such materials are not used in areas that will receive vehicular traffic as they will tend to break down and subside, and it is important to wrap loose void-filling materials in a geotextile filter membrane to prevent loose fines entering the drainage system. In planted areas, leca provides a cheaper alternative to polystyrene or block void fillers, with the added advantage that it provides an expanded drainage buffer in the sub-soil profile.

Drainage layer

In many ways the drainage layer is the most critical element of any roof-garden system. The most common cause of plant failures on roof gardens is waterlogging due to failure of the drainage system. Therefore, it is not surprising that a multitude of drainage systems have evolved. Some specialist systems combine water-retention reservoirs, a drainage-layer filtration membrane and a root-protection membrane in one easily rolled-out mat. This may improve the speed of laying, and offer the benefit of easy handling on roof decks with difficult access, but care must be taken to avoid over-specifying where elements such as the root barrier have already been procured in the waterproofing package. Where soil depth is limited, drainage mats can reduce the space required for the drainage layer to as little as 20cm. Products such as Floradrain and Enkamat provide a drainage layer which is sandwiched between two geotextile filter membranes.

This solution works quite well where the slab is quite even or is laid to drainage falls. In areas where the slab level is inconsistent or the depth allowance is more generous, a drainage layer of lightweight expanded-clay aggregate (Hydroleca or Optiroc) provides a drainage sump, which ensures that the growing medium does not become saturated. It is important to ensure that such drainage layers are wrapped in a geotextile filter membrane of not less than 100g/m^2, such as the Terram 1000 Pr used at Paddington Central, to ensure that fines are not washed through into the drainage outlets.

It is also important that individual planting cells have at least one inspection tube that allows access to the drainage outlet. This allows manual inspection to establish whether the drainage layer is functioning correctly, and may provide early warning signs of a blockage in the drainage outlet. The inspection tube also provides the possibility to flush through or suck out any blockages at the point of discharge from the planting pit.

Growing media

The specification of soils and growing media is in itself a subject worthy of much attention, and is currently under review by the Landscape Institute. In order to sustain plant life, a good topsoil must be free from pests, disease, noxious or invasive weeds and harmful quantities of toxic substances. It must have a tilth or structure, which allows sufficient drainage and air-filled porosity for the gaseous exchanges that occur around plant roots, and sufficient organic content for the retention of important trace elements and nutrients.

However, saturated topsoil is very heavy and, even at depths of 400mm, can impart a loading factor of 8-9kN/m^2. On roof decks where loadings are critical, this can be nearly halved by the importation of lightweight topsoil. Normal topsoil will contain up to 20 per cent dry weight of stones ranging from

2-5mm in diameter. Lightweight topsoil is manufactured by substituting the stone content, which is necessary for good drainage and air-filled porosity, with inert and lightweight particles of the same size such as perlite or vermiculite. This does not affect the performance of the soil, but significantly reduces the saturated weight of the soil.

Such a specification is currently being used to allow tree planting on a new roof garden for the old Harrods Depository in Knightsbridge, west London. The use of expanded clay aggregate as a void filler enables trees and shrubs to be planted side by side with a minimum of imported topsoil, sufficiently reducing the load factor to enable intensive planting in an area which would otherwise only be capable of supporting lawn or succulents. A firm that specialises in the supply of lightweight soils is Boughton Loams. Other specialist soils, such as tree sand, allow the growing media to be compacted without compromising the drainage or water-holding capacity of the soil. These manufactured soils enable trees to survive in situations where traffic and paving cause compaction of the root zone.

Various companies now manufacture tree sand in the UK under different trade

The author demonstrates where the tree sand should go, prior to soiling at Paddington Central

The tree pit soiled and compacted, with cables attached to tree anchors prior to planting.

Case study: Paddington Central, London

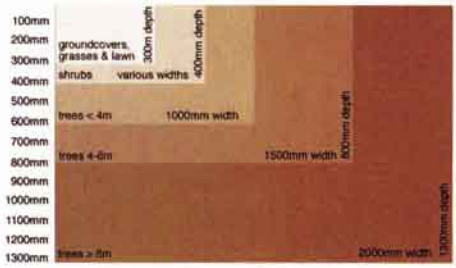
Artist's impression of the central arena, Paddington Central

One of the most difficult aspects of the Paddington Central site in London was access. Sandwiched between the Westway, Regents Canal and railway lines emanating from Paddington Station, the old goods yard was destined to have an introverted nature that focused on a high-quality public realm design. Through dialogue with the architect, Sidell Gibson Partnership, the central square evolved from a tranquil London square into a curved arena, an active social hub with retail and leisure facilities, and opportunities for organised events and impromptu street theatre.

Ron Sidell had worked at Brindleyplace and recognised the importance of making a major investment in the public realm at the outset. A feature avenue of mature lime trees, imported from Von Ehrens Nursery in Germany, was to become a major element of the scheme, with the intention that pedestrian access would not be hindered by raised planters or mounding to achieve soil depths. The landscape would flow between the buildings, as if on natural ground. The levels beneath the podium deck were to contain shops and restaurants, cafes and a leisure complex. Services, plant and storage facilities were slotted into the voids underneath and between the large tree pits.

With the trees costing about £1,000 each, it was important that adequate preparation went into the design and construction of tree pits. The tree pits themselves were cast into the roof deck slab, each pair of trees sharing a single pit running perpendicular to the avenue. Due to the size of the imported trees (60-70cm girth, with root balls measuring up to 1m across), the tree pits were constructed 2.0m wide and 2.0m deep. This size accommodated a drainage layer of expanded clay aggregate (Optiroc), which was enclosed in a geotextile filter wrap. The surface finish of the avenue was to be laid to Cedec gravel, a self-binding path gravel which forms a cohesive surface when compacted and rolled. This is normally laid on a load-bearing surface such as MOT Type 1. In order to lay the Cedec gravel bed beneath the tree avenue, the tree pits were backfilled with Metro-Sand. This material is laid and compacted in 150mm layers in order to achieve an even consolidation throughout the tree-pit depth. In doing so, considerable care had to be exercised so as not to damage the waterproofing membrane on the tree-pit walls.

In order to provide optimal growing conditions for the amenity turf laid in the amphitheatre and on the terraces, turf soil developed by the United States Golfing Association (USGA) was manufactured and laid to a minimum depth of 300mm for all turf areas. Poor drainage in turf areas rapidly leads to fungal diseases and a deterioration in the lawn quality, and the high sand content of the



Minimum recommended soil depths and tree pit widths for an irrigated roof garden system

names such as Urban Tree Soil, Metro-Sand, and Heicom Tree Sand. Tree sand is a proprietary product and as such should come with a performance guarantee. Metro-Sand provides a guideline on the volume of tree soil required for each tree, which is:

$$\frac{(\text{Desired Crown Diameter})^2}{4} = \text{Volume of Metro-Sand } (m^3)$$

Soil depths required by plants vary according to climate, the type of plant and the extent to which they will receive artificial irrigation. That said, the growth of a plant can be severely stunted or adversely affected unless certain minimum depths are maintained. The diagram provides a recommendation for minimum soil depths (and tree pit widths) for various plant types, assuming that an automatic irrigation system is present.

Derek Lovejoy Partnership has been involved in the design and implementation of roof gardens for more than 40 years. During that time there has been a steady movement of roof gardens from private or corporate ownership into the public realm. Increasingly they have an important role to play in the creation of memorable urban spaces that engage the community and bind our multi-layered cities together. As development of roof-garden technology leaps forward, becomes cheaper, and fuses with outstanding product design, there will be a great difficulty in telling those landscapes which are on the ground from those which have been built on the deck; and the sky will no longer be the limit.

Peter Wilder is an associate with Derek Lovejoy Partnership

READER ENQUIRIES

Boughton Loams **1500**
Cedec **1501**
Cordek **1502**
Enkamat **1503**
Erisco Bauder **1504**
Filcor **1505**
Floradrain **1506**
Heicom Tree Sand **1507**
Heron Irrigation Consultants **1508**
Hydroleca **1509**
leca **1510**
Metro-Sand **1511**
Optiroc **1512**
Rainbird **1513**
Terram **1514**
United States Golfing Association **1515**
Urban Tree Soil **1516**
Von Ehrens Nursery **1517**

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Above: the central arena under construction, summer 2002. Below left: lawn terraces under construction with waterproof layer laid and awaiting installation of the insulation blocks. Below right: the completed lawn terraces in November 2002

USGA mix ensures an optimal drainage regime, which encourages deep rooting. The use of high-performance turf soils requires a high level of irrigation to ensure year-round performance of the turf, and specialist advice was sought from Heron Irrigation Consultants.

A multi-region irrigation system was implemented at Paddington Central with fittings by Rainbird that provided drip irrigation to trees and shrubs as well as pop-up sprinkler heads for the lawn arena and terraces. Solenoid valve boxes were hidden from view beneath the Cedec gravel where they can be accessed easily by brushing away the surface and lifting the lid for inspection. An automatic rain sensor was located on the roof of the cafe, where it is neither obtrusive, rain-shadowed nor vandal-prone.

One particular problem of providing irrigation in areas of hard water is limescale build up. Apart from affecting the performance of drip emitters, limescale can render geotextiles impermeable, resulting in the complete failure of drainage layers. Historically, acid dosing was the only viable method of neutralising the effect of limescale, but the associated health and safety risk of delivering, handling and storing concentrated nitric acid on commercial schemes has seen a gradual decline in their implementation. Alternative systems for water softening, such as the base exchange unit supplied by Ocas and installed at Paddington Central, use natural salts to neutralise the effects of limescale in the header tank prior to being pumped through the system.