

An isometric illustration of a city street scene, rendered in a monochromatic green color palette. The scene shows a street with a sidewalk, a road with a car, and a person walking. The street is lined with various green infrastructure elements, including trees, plants, and permeable paving. The illustration is composed of many small, repeating units of these elements, creating a dense, textured background. The title 'Dig Once, Green Twice' is prominently displayed in the upper left quadrant in a large, white, sans-serif font. Below the title, the subtitle 'A GLA guide to retrofitting green infrastructure in utility constrained streets' is written in a smaller, white, sans-serif font. In the bottom right corner, the version number 'V1.0 - MAY 2026' is displayed in a small, white, sans-serif font.

Dig Once, Green Twice

A GLA guide to retrofitting
green infrastructure in utility
constrained streets

V1.0 - MAY 2026

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EXECUTIVE SUMMARY

London is facing increasing climate pressures, including more frequent surface water flooding and rising temperatures. Many streets were not designed for these conditions, and the ageing combined sewer network in central London is already under significant strain. The Environment Agency's National Flood Risk Assessment identifies 4.6 million properties at risk nationally from surface water flooding, with 320,000 in London. Improving resilience will require a shift in how rainwater is managed and how streets are cooled, particularly within constrained urban environments.

Dig Once, Green Twice encourages better coordination between streetworks, tree planting and sustainable drainage (SuDS). Each year, approximately 196,000 utility repairs and upgrades require the excavation of urban surfaces in London. Digging up the city's streets can be used as an opportunity to add green infrastructure instead of reinstating impermeable materials. This approach aligns planting with planned streetworks while integrating designs that are compatible with existing underground services. The aim of this guidance is to provide the necessary tools to deliver greener, cooler and more flood-resilient streets, even in highly constrained locations.

The guidance sets out what successful integration looks like, defining the conditions required for green infrastructure to perform effectively and highlighting key constraints that must be addressed. It includes pre-works considerations to inform site selection, feasibility and early decision-making, followed by clear design advice using examples, solutions and practical workarounds to common issues. Standard details show how green infrastructure can be retrofitted near utilities across different street types, alongside options for managing typical conflicts. The document also emphasises the importance of maintenance and long-term care, with clear ownership and existing underground services essential to sustained performance. Case studies are included that demonstrate how all of these principles and solutions can be applied in practice.

This guidance was designed to support a number of London specific strategies, plans and projects namely, the SuDS through Streetworks Market (SSM) by removing barriers and providing clear, practical routes to consistent delivery. It also fulfils a key priority of the London Urban Forest Plan by supporting the delivery of trees through streetworks. The Mayor of London's Environment Strategy's 50% green cover target is also supported, as well as the Mayor of London's Clean and Healthy Waterways Plan and the London Green Infrastructure Framework, reinforcing SuDS and trees as central to a climate-resilient city.

ACKNOWLEDGEMENTS

This document was developed in collaboration with the intended user group which included of Local Authority representatives, utility providers and planting specialists. The author acknowledges their valuable contributions through workshops and feedback, all of which influenced the final document.

The Greater London Authority (GLA) has provided continued support and coordination to facilitate the publishing of this guidance.

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Turning the grey green®



Bradley-Hole Schoenaich Landscape

GLOSSARY

A glossary of defined key terms is provided here.

Amenity (SuDS benefit)	The contribution SuDS features make to the quality, usability and attractiveness of public spaces.
Asset owner	The statutory undertaker or organisation responsible for an asset (e.g., Thames Water, UKPN).
Biodiversity (SuDS benefit)	Enhancement of ecology through the creation of habitats that support plant, insect, and wildlife species.
Biochar	A soil amendment used to improve water retention and nutrient availability.
Catchment	The area from which rainfall drains into a SuDS feature.
Cellular Confinement System (CCS)	A geocell or grid structure used to provide load distribution and root protection beneath surfaces.
Conveyance (SuDS)	The movement of water from the catchment area through a SuDS system, often via channels, inlets, or sub-surface layers.
Exceedance flow route	A planned pathway for excess water during heavy rainfall that exceeds the design capacity of SuDS features.
Freeboard	The vertical height between the maximum designed water level within a SuDS feature and the top of the structure, providing a margin to prevent overflow onto adjacent surfaces.
Geotextile	A permeable fabric used to separate soils, prevent material migration, and allow air/ water movement.

Green infrastructure	In this document, the collective term for SuDS and/or trees retrofitted within the highway context.
Hard landscape	Constructed surfaces such as paving, asphalt, and kerbs.
Hit and miss kerbs	A kerb arrangement consisting of alternating openings and solid sections that allow lateral inflow of surface water into SuDS features such as rain gardens.
Impermeable membrane / geomembrane	A liner that prevents infiltration into the underlying soils, used in attenuation-based SuDS, specifically in London due to the presence of clay across the city.
Inlet (SuDS)	The entry point for water into a SuDS feature (e.g. flush kerb, hit and miss kerb, gully diversion).
Lane rental scheme	A fee system applied by TfL for occupying parts of the highway.
National Underground Asset Register (NUAR)	UK-wide digital map of underground utilities, intended to provide accurate asset data for planning and excavation.
New Roads and Street Works Act (NRSWA)	The legislation governing street works, utility access and protection of apparatus within the highway.
Offset distance (utility offset)	The minimum horizontal separation suggested between SuDS/tree features and underground utilities.
Outfall/Outlet	The final discharge point for water leaving a SuDS system.
Permeable paving	Surfacing that allows water to infiltrate through joints into a structural and drainage sub-base.
Rain garden	A vegetated SuDS feature comprising multiple engineered layers designed to capture, store, and treat surface water.
Root barrier / root director	Impenetrable products used to guide or restrict tree roots to protect infrastructure.

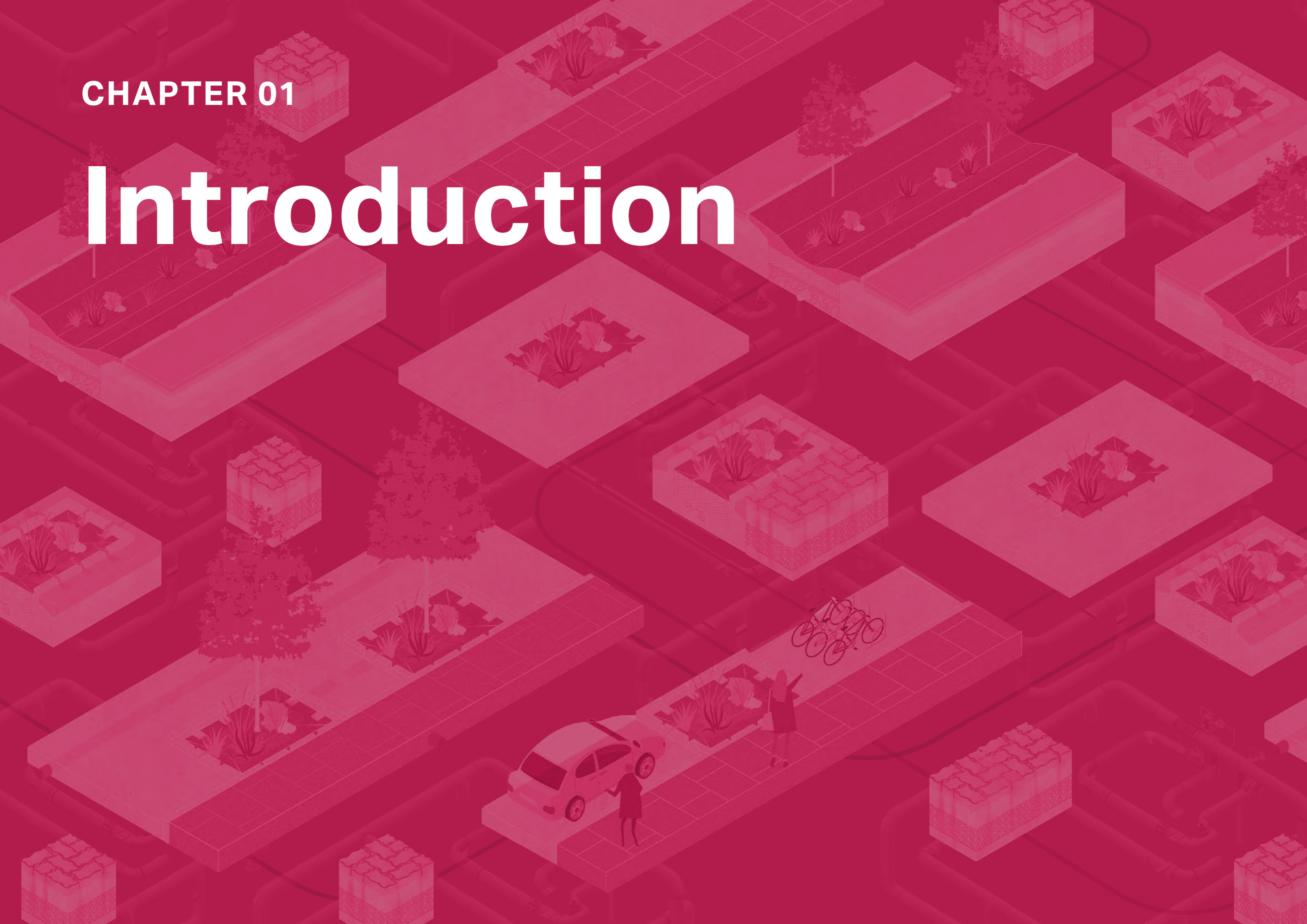
Root Protection Area (RPA)	Defined zone around a tree establishing minimum safeguards during works.
Shared utility corridor	A single corridor designed to host multiple utility types to reduce excavation and improve certainty of asset location.
Soil cells	Modular structural systems creating uncompacted soil volumes beneath hard surfaces for tree rooting.
Structural soil	A soil mix allowing both root growth and surface loading by pedestrians/vehicles.
SuDS (Sustainable Drainage Systems)	A set of water management features that slow, store, treat and convey stormwater at source.
SuDS through Streetworks Market (SSM)	A GLA and Thames Water co-led programme to deliver SuDS through streetworks using a market-based approach.
Swale	A shallow, vegetated channel that conveys and sometimes stores surface water.
Tree Pit	An engineered underground space providing soil volume and rooting conditions for new trees, sometimes integrated with SuDS.
Trial hole / trial pit	Small-scale excavation used to confirm the location and depth of utilities.
Underground guying	Below-ground anchoring technique used to stabilise newly planted trees without above-ground supports.
Utility provider / statutory undertaker	Organisations with statutory rights to install and maintain infrastructure (e.g. Cadent Gas, Thames Water).
Ventilation / aeration inlets	Surface openings enabling air movement into and out of tree pits or soil cells.
Water logging	Condition where soil becomes saturated for prolonged periods, affecting plant oxygen availability and growth.

ABBREVIATIONS LIST

BVOCs	Biogenic Volatile Organic Compounds (natural irritants emitted by certain tree species)
CCS	Cellular Confinement System
CDM	Construction (Design and Management) Regulations 2015
DNO	Distribution Network Operator (e.g., UKPN, SSEN)
EA	Environment Agency
GLA	Greater London Authority
HAUC UK	Highways Authorities and Utilities Committee (UK)
HSE	Health and Safety Executive
IDNO	Independent Distribution Network Operator
LLFA	Lead Local Flood Authority
LoPS	London Permit Scheme
NbS	Nature-based Solutions
NUAR	National Underground Asset Register
NRSWA	New Roads and Street Works Act (1991)
NJUG	National Joint Utilities Group
PAS 128	Publicly Available Specification 128 (standard for utility detection scanning)
PVC / uPVC	(Unplasticised) Polyvinyl Chloride
RPA	Root Protection Area
SED	Special Engineering Difficulty (NRSWA Schedule 4)
SGN	Southern Gas Networks
SSM	SuDS through Streetworks Market
SuDS	Sustainable Drainage Systems
TDAG	Trees and Design Action Group
TfL	Transport for London
TW	Thames Water
UKPN	UK Power Networks

CHAPTER 01

Introduction



INTRODUCTION

Objectives and audience

This guide is intended for anyone involved in retrofitting SuDS and/or trees into London's streetscape, specifically where green infrastructure is delivered in close proximity to buried utility services. It is aimed primarily at highways authorities, local authority officers, designers, utility undertakers, and their delivery partners.

Methodology

The need for this document was explored through a multi-step process:

- » A literature review was carried out to identify existing practices and guidance, with documents added iteratively as requirements evolved
- » A questionnaire was developed and shared with a group made up of local authority representatives, utility providers, tree specialists and other stakeholders, inviting written feedback
- » Workshops were held with the same group, providing an opportunity to discuss emerging needs in greater depth.

All feedback from these activities was systematically collated and analysed, forming the foundation of the Needs Assessment, that shaped the contents of this document.

Scope and limitations













The scope of this document is specific to the interface between SuDS, trees and underground utilities, and assumes a baseline level of understanding of SuDS principles. This document does not repeat general SuDS design guidance; instead, it directs readers to relevant external resources where needed.

As this document is focused on the retrofit scenario within the streets of Greater London, the guidance is unlikely to apply to new developments, although many principles may still apply.

Consultation was undertaken with utility providers between October 2025 and March 2026. The information available is therefore limited to the responses received during that period, particularly regarding minimum offset distances and guidance for alternative solutions in situations where these distances cannot be met.

Policy and Regulatory context

This guidance aligns with relevant London strategies and technical standards, and tools, including:

-  [Highways Greening Accelerator](#)
-  [Local Nature Recovery Strategy \(LNRS\)](#)
-  [London Drainage Engineers \(LoDEG\) Training Guide](#)
-  [London Environment Strategy](#)
-  [London Green Infrastructure Framework](#)
-  [London Heat Risk Delivery Plan](#)
-  [London Surface Water Strategy](#)
-  [London Urban Forest Plan \(Action Plan Update 2025\)](#)
-  [Mayor's Transport Strategy](#)
-  [SuDS Opportunity Map](#)
-  [SuDS Sector Guidance](#)
-  [SuDS through Streetworks Market \(SSM\)](#)

How to use this guide


This guide starts from the point where a decision has been made to retrofit green infrastructure. Each chapter begins with a title page and a call out box explaining its contents. All chapters include diagrams and images, with information presented in tables where possible to ensure brevity. Each chapter ends with a checklist summarising key considerations for that stage in the project life-cycle.

For suppliers operating in the SSM, this guidance should be used alongside the SSM design standards to support compliant delivery and ensure SuDS are installed to a high, reliable standard. Any references or information relating to the SSM will be in a call out box like this:





If you are participating in the SSM, you can select from five SuDS typologies ...

Other references and reading specific to the topic can be found in the bottom right corner in a call out box like this:

Key Reference

 **Implementation of Urban Nature-based Solutions, LAWPRO (2025)**

Icons used in the document are described below:

-  Online resources and web links
-  Books and guidance documents
-  Legislation and regulation
-  Drawings or technical information

CHAPTER 02

Understanding the challenge: Integrating trees and SuDS with underground utilities

Overview:

This chapter introduces SuDS and trees before outlining the key factors that support successful integration and the common pitfalls to avoid. It also provides an overview of utilities and the legislation that governs their placement and operation.

INTEGRATING TREES

Trees provide numerous indispensable services to people and wildlife in London, making them a critical component of urban infrastructure. Investing in both the early establishment and long-term health of a tree will ensure that continued benefits are provided as the tree grows.

Street trees face a number of constraints that limits their normal growth. As such, their lifespan is often considerably shorter than trees in parks or other green spaces. While a typical street tree may live for around thirty years, trees in open green spaces can live for several centuries.

Positioning

Trees can be established wherever space permits, provided key success factors are met. They require adequate above ground space for canopy development - helping to minimise future pruning - and sufficient below-ground rooting volume.

Careful consideration should be given to available space and the intended purpose of the tree, as these will influence species selection, layout and long-term performance.

Common Pitfalls:

- » Ground capping or soil sealing (resulting in reduced water infiltration and poor gaseous exchange)
- » Highly compacted and low quality soils
- » Soil contamination
- » Restricted root zones
- » Access to, and movement of, water
- » Damage during the construction and maintenance of infrastructure
- » Ground disturbance
- » Direct injury of the trunk or branches

Success Factors:

- » Good gas exchange and aeration of the rooting media
- » Access to water
- » Enough above ground canopy growing space
- » Sufficient volume of non-compacted rooting media

Limited yearly branch extension

Impermeable surfacing preventing water ingress

Compacted soil

Restricted root zone

Damage from utility maintenance

Weak tree anchoring and poor fibrous root extension

Large canopy cover

Mature, well-established tree

Good aeration

Uncompacted soil, enabling root development, infiltration and aeration

Greater root anchoring, thicker roots

Figure 1: Impact of common pitfalls versus success factors in tree integration

Further Guidance

British Standard Institute. (2026) **BS 5837 Trees in Relation to Design, Demolition and Construction** guidance for working around existing trees including methods for determining tree root protection areas, (RPAs), needed to safeguard the most vulnerable part of the tree during construction works.

British Standard Institute. (2026) **BS 8545 Trees: from nursery to independence in the landscape**. Guidance for specifying, planting and establishing new trees.

Hirons, A. D. and Martin K. W. E. (2025) **Future climate suitability of London's public realm trees**. Provides climate suitability scores for over 100 species based on anticipated conditions in 2090.

INTEGRATING SUSTAINABLE DRAINAGE FEATURES

RAIN GARDENS, SWALES AND PERMEABLE PAVING

Urban development has replaced permeable green landscapes with hard surfaces, reducing the ground's ability to absorb rainfall, and increasing the speed at which surface water enters piped drainage systems. As a result, the retrofitting of Sustainable Drainage Systems (SuDS) is more common to reduce the pressure on the sewer networks. Effective, high-quality and multifunctional SuDS design is underpinned by four key pillars, to provide the following benefits:

- » **Water quantity:** capturing and slowing water to reduce peak flows and prevent flooding
- » **Water quality:** improving treatment of pollutants through filtration, sedimentation and biological process
- » **Amenity:** creating places for people to dwell and enjoy
- » **Biodiversity:** integrating green spaces to enhance ecology.

Integrating Rain Gardens

Rain gardens are shallow landscaped depressions filled with a permeable sub-base that capture overland flows from the carriageway or footway. Beneath the surface, multiple engineered layers provide below-ground storage, with additional above-ground storage available during larger storm events.

Positioning

SuDS should be positioned at the low point to allow the surrounding catchment to drain as sheet flow from the surrounding area.

Common Pitfalls:

- » Inadequate storage
- » Erosion of soils
- » Poorly designed planting schemes
- » Waterlogging or excessive ponding (beyond what is designed)
- » Blocked inlets or outlets
- » Accumulation of silt or sediment
- » Maintenance not including the maintainer during design; or, not carried out during lifespan.

Success factors:

- » **Conveyance.** Inlet design may either be a point inlet, for example intercepting existing gully pots or lateral drains, or a lateral inflow, for example using flush kerbs or kerbs with intentional spacing (hit-and-miss kerbs). Inlet design should provide controlled entry to prevent the erosion of soil layers and reduce risks of sediment build-up. This can be achieved through products such as orifice plates or through hit-and-miss kerbs.
- » **Composition.** Build-up design for SuDS features should consider the structural integrity of the feature and the expected loading. The presence of free space above the surface of the feature is also important to create an area for water to accumulate in heavy rainfall
- » **Discharge location.** The eventual outfall of the system can dictate design factors like available attenuation volume, build-up depth requirements and, exceedance flow routes. SuDS should be hydraulically designed to provide attenuation for an appropriate return period (estimated average time between occurrences of an event such as a flood) and to ensure they drain down within a certain time period. This prevents the planted feature from being waterlogged and allows for concurrent storm events to be managed. This can be achieved through products such as orifice plates or through hit-and-miss kerbs.

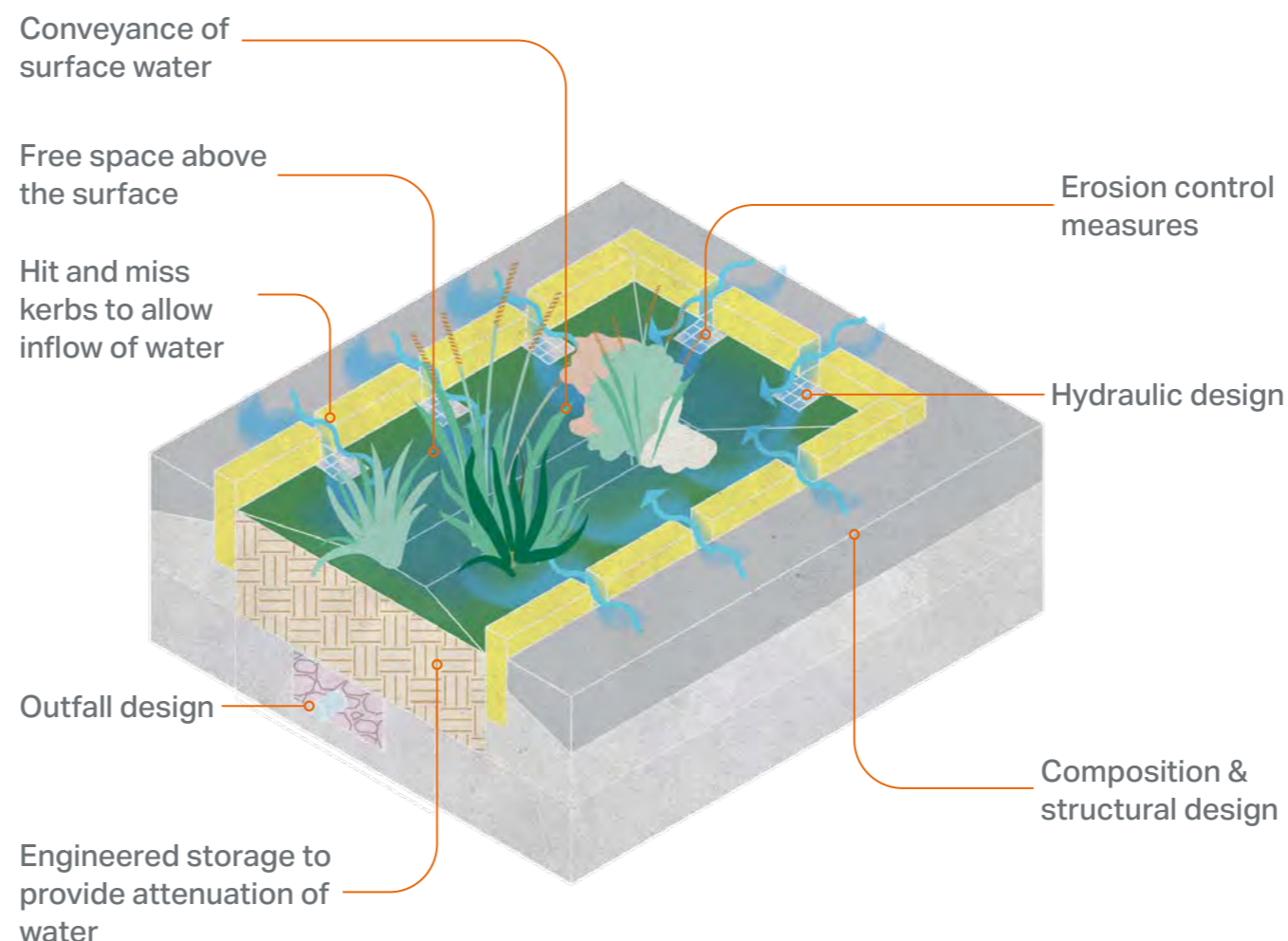


Figure 2: Key considerations for the integration of rain gardens

If you are participating in the SSM, you can select from five SuDS typologies: rain gardens, swales, filter drains, permeable paving and tree pits.

Integrating Conveyance Swales

Conveyance swales are shallow, vegetated channels that collect and move surface water from one area to another. They can be designed with enhanced below ground storage, or can be simple, with grass or turf on slopes and above ground storage.

In retrofit projects near utilities, narrow swales are generally more suitable than broad ones, which require larger areas of green space. Their linear form makes them effective for managing road run-off, but their side-slope requirements increase the overall footprint beyond the channel itself. As a result, they are typically located within soft-landscaped areas such as verges.

The opportunity to retrofit swales still exists where existing at-grade soft landscaping verges are present and retrofit should be explored in these contexts. Care should be taken to avoid utilities that may be sited in the verge when reprofiling as utility companies may favour burying services within the soft landscape due to easier excavation and reinstatement.

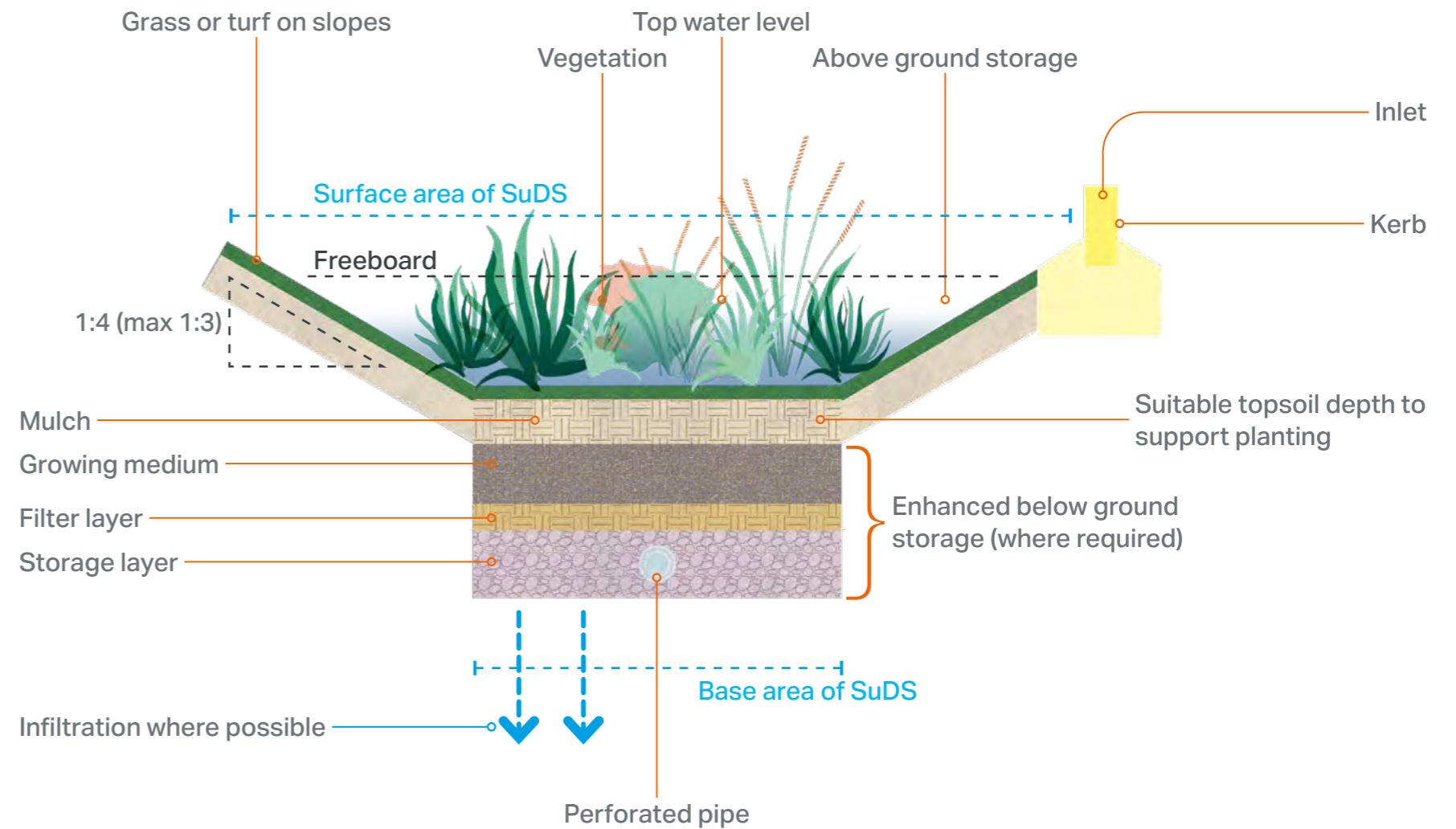


Figure 4: Cross section of conveyance swale [adapted from: 'SuDS Project Information Requirements for RSWV Accreditation', courtesy of Arup]

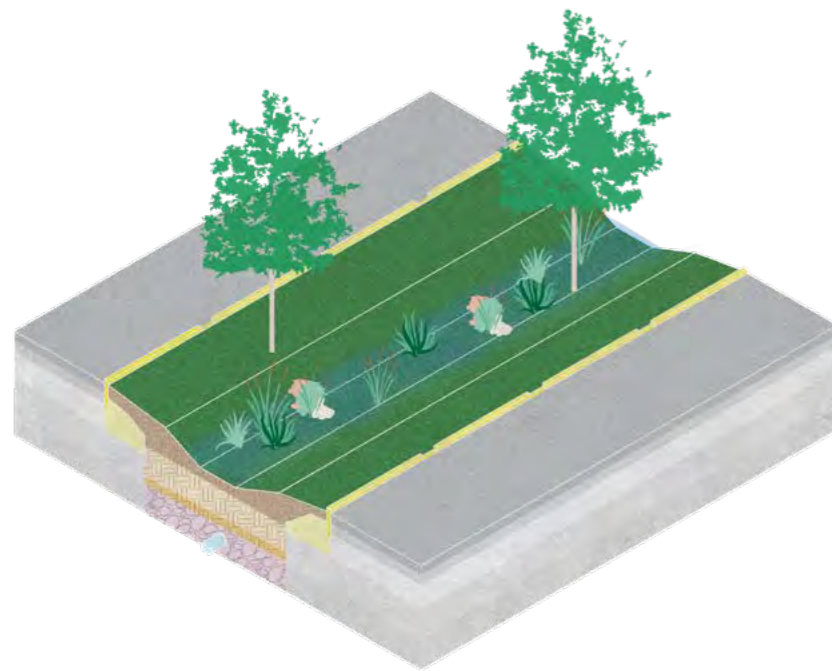


Figure 3: Conveyance swale



Figure 5: Swale retrofit at St Matthew's Estate, Lambeth



Figure 6: Swale retrofit at St Matthew's Estate, Lambeth

Integrating Permeable Paving

Permeable or porous paving is another viable SuDS feature for retrofitting in the context of highways, most commonly used in parking bays or areas with less frequent vehicular loading. Permeable paving is made up of paving units with joints that allow water to penetrate to the layers below. The layers below consist of a structural layer and a storage layer, made of coarse aggregate material, with a geotextile liner used in many London cases.

Permeable paving can be designed for both pedestrian and vehicular traffic and can be used on most sites if design criteria is met. Where possible, the construction of permeable paving should avoid shallow utilities that would intersect the permeable layer, however deeper services such as storm or foul sewers are often deep enough to run suitably beneath the permeable construction and avoid conflict.

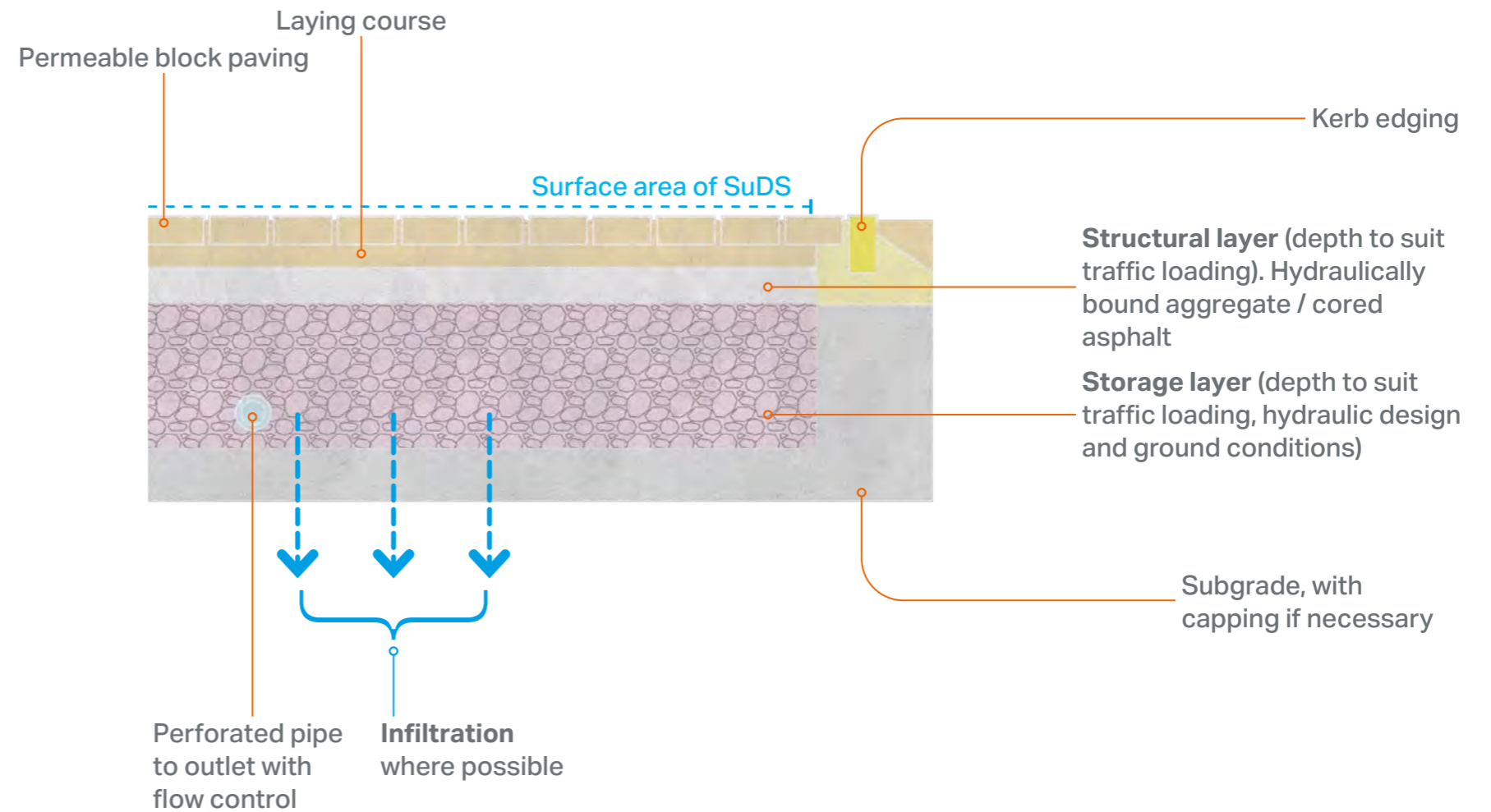


Figure 8: Cross section of permeable paving [adapted from: 'SuDS Project Information Requirements for RSWV Accreditation', courtesy of ARUP]



Figure 7: Permeable paving at St James Street [credit: Meristem Design]

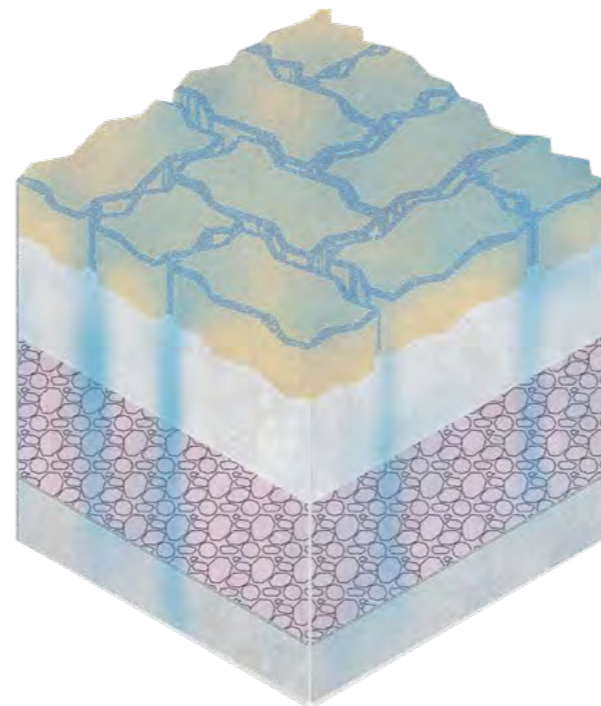






Figure 9: Permeable paving

Further Guidance

-  CIRIA. (2015) **C753 The SuDS Manual** for comprehensive background reading on SuDS principles and their benefits.
-  Greater London Authority. (2025) **Reimagining Rainwater in Highways** for further understanding of SuDS in urban streetscapes.
-  Greater Manchester Combined Authority (2024). **Greater Manchester's Sustainable Drainage Guide for designing and delivering SuDS**
-  Urban Design London. (2018) **Designing Rain Gardens: A Practical Guide** for design principles for including SuDS in and around highways.

INTEGRATING UTILITIES

Figure 10 summarises utilities in a pavement (adapted from Streetworks UK). It should be noted that distances are not always adhered to in practice and may vary for utilities that are found within a highway.

Although the most common feature encountered in utilities is the pipe or ductwork, there are associated infrastructure items that provide the access required to maintain and service these elements.

Access chambers and pits ensure infrastructure is accessible and allow for key asset maintenance [refer to Figure 11].

POWER

High Voltage (HV) Electricity or Low Voltage (LV) Electricity

What the asset is: Power supply cabling within ductwork coming from the National Grid network (HV) or local distribution centre (LV)

Purpose: HV: Transmits high-voltage electricity from power source to substations and distribution centres
LV: Supplies power to buildings, street lighting, traffic signals etc

Associated Infrastructure

- » Cabling can be laid in multiple individual ducts (often plastic)
- » Duct pits / joint bays
- » Substations
- » Distribution, link boxes, cabinets and feeder pillars

GAS

What the asset is: Pressurised gas network (low, medium and high pressure)

Purpose: Supplies natural gas to domestic and commercial uses

Associated Infrastructure:

- » Pipes (often plastic for low and medium pressure, with older pipes as ductile or cast iron, and steel for high pressure)
- » Valves and valve boxes / meters

FIBRE & TELECOMMUNICATIONS

What the asset is: Broadband, telephone, TV and fibre communications network

Purpose: Provides digital communication services to London

Associated Infrastructure:

- » Cables and ducts (often plastic, fibreglass or steel)
- » Cabinets

DRAINAGE

What the asset is: Foul, surface and combined sewer networks. Primarily gravity

Purpose: Drains building and highways, and conveys surface and foul wastewater to treatment or watercourse

Associated Infrastructure:

- » Sewers (often brick for trunk sewers; often concrete or plastic for separate circular sewers)
- » Manholes
- » Gullies
- » Vent pipes

WATER

What the asset is: Pressurised water distribution network

Purpose: Supplies potable water to London. Sutton and East Surrey Water (SES) also transfers raw water from source to treatment.

Associated Infrastructure:

- » Pipes - distribution or trunk (plastic, cast iron, copper, steel)
- » Valves and valve boxes / meters
- » Hydrant

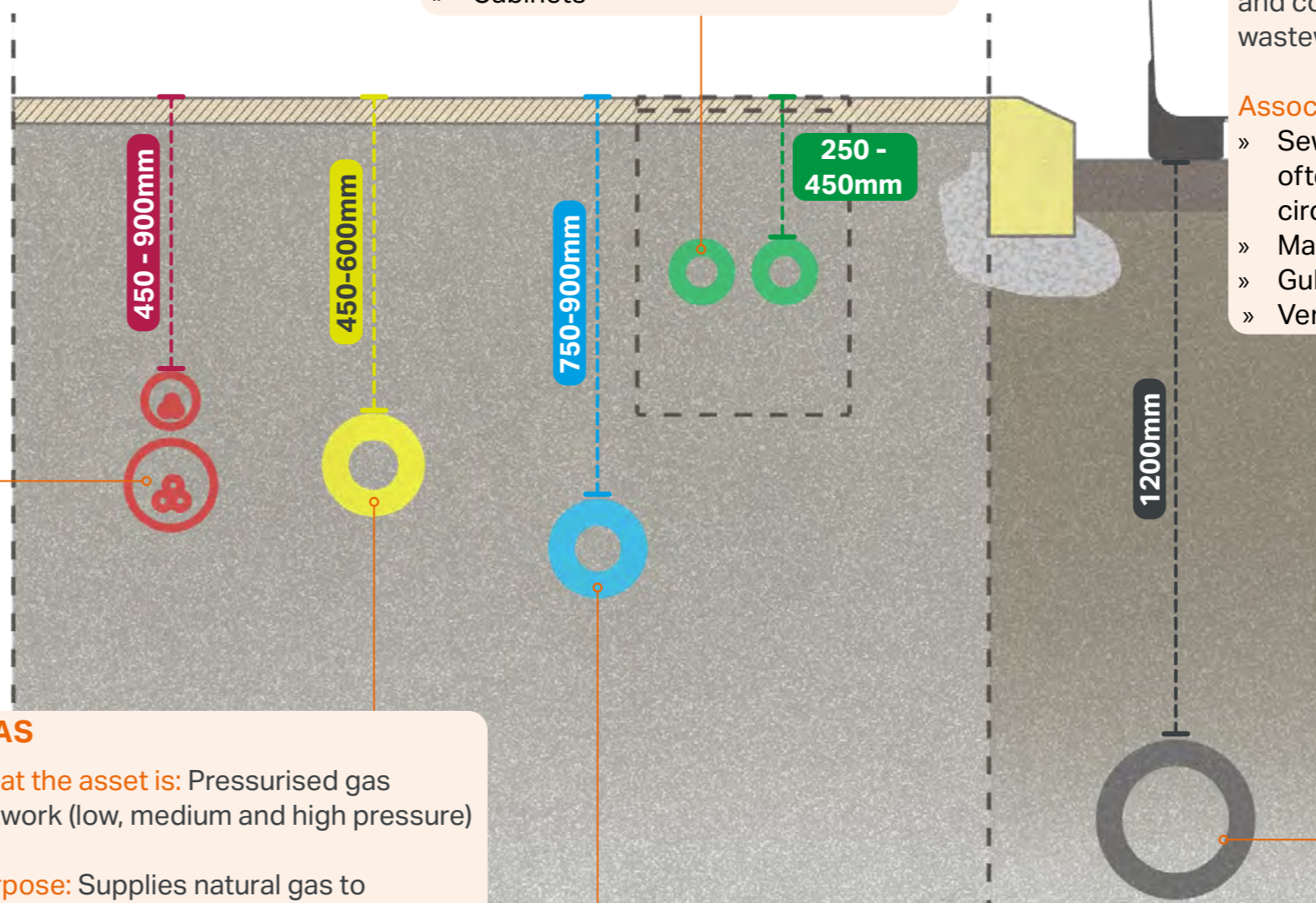


Figure 10: Cross section of utilities within a pavement, aligning with Streetworks UK requirements

Role of the Highway Authority

When SuDS are proposed above or near utility assets, the Highway Authority (HA) is required to consult the relevant asset owner to ensure any potential impacts on existing infrastructure are fully understood. Utility stakeholders often raise concerns where there may be perceived risks to their assets. The HA will work with utility partners to address these concerns, either through reasonable design adjustments or, where appropriate, by determining that the proposal can proceed. Mitigations such as impermeable linings may be incorporated to manage risks effectively.

Reinstatement (utility works affecting SuDS)

Reinstatement of SuDS features following utility works is undertaken in accordance with the New Roads and Street Works Act – Specification for the Reinstatement of Openings in Highways (SROH). Under this framework, the standard expectation is that utilities reinstate the affected SuDS feature on a like-for-like basis.

In practice, many utility contractors may not yet have the specialist skills or experience required to rebuild SuDS features to the necessary standard. As a result, it is common for utilities to fund the local authority to undertake the reinstatement using appropriately qualified contractors. This approach ensures quality but can involve higher costs than traditional reinstatement. It is recognised that utilities take on additional programme and financial risk where SuDS are located close to their assets, including potential future reinstatement responsibilities. Early collaboration can help to manage these risks and support more confident participation in SuDS delivery.

Post-construction

Completed SuDS assets are adopted by the Highway Authority under the formal adoption agreement. Assets must be entered into statutory flood asset registers and added to the Mayor of London’s SuDS retrofit map. SuDS assets should be designated as special engineering difficulties, requiring streetworks promoters to consult the HA before future works affecting the feature. Refer to chapter 5 for further information on SED.

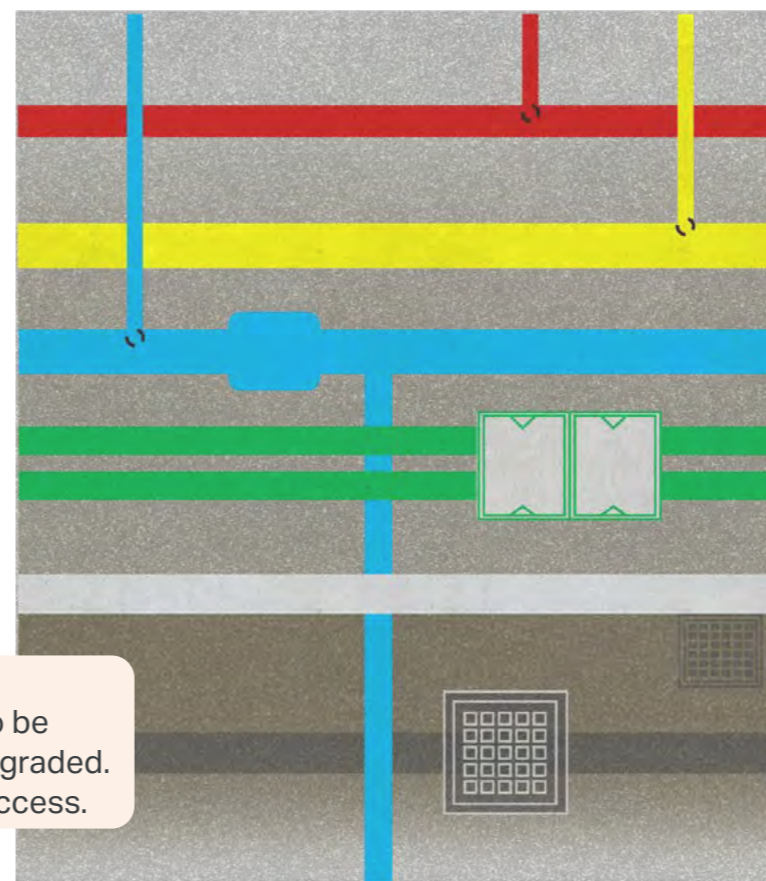


Figure 11: Plan view of streetscape showing utilities and network parts

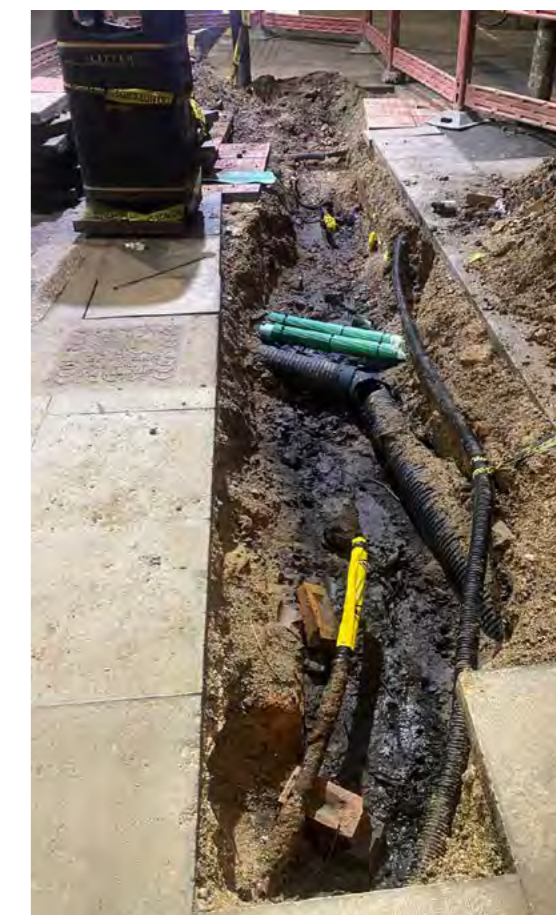


Figure 12: Underground utilities shown in situ

Utility Type	Greater London Provider(s) ⁱ	Comments
Electricity	National Grid, UK Power Networks, SSEN	High and low voltage underground distribution networks across London are generally managed by UK Power Networks (UKPN).
Gas	Cadent Gas, SGN	Network made of high, medium and low pressure networks
Water	Thames Water, Affinity Water, SES Water	Affinity Water serve outer areas of northwest London, SES Water serve areas of southwest London, and Thames Water serve the remaining areas
Sewerage	Thames Water	Comprised of the surface, foul and combined water sewer network
Fibre and telecommunications	Arelion, BT, City Fibre, Community Fibre, EXA Infrastructure, Gamma, G. Network, Neos, Virgin Media, Zayo	Providing services to telephone, internet, television and fibre

ⁱ Distribution and Independent Distribution Network Operators (DNOs and IDNOs) also operate certain networks however are not within the scope of this guidance. These should be contacted on site-specific requirements

Table A: Summary of utility types and providers in Greater London

Legislation that governs utilities

The legislation that utility street works is governed by is important to consider when looking at works adjacent to green infrastructure. There are legal and regulatory requirements to be considered when:

- » Placing apparatus, or
- » Inspecting, maintaining, adjusting, repairing, altering or renewing apparatus, changing the position of apparatus, or removing it

The New Roads and Streetworks Act 1991 (NRSWA) sets out the framework for these street works in public highways. Those involved in utility coordination on a SuDS or trees retrofit project should familiarise themselves with this legislation, as it sets out the requirements for the duties and liabilities for statutory undertakers including:

- » Rights to execute streetworks and place apparatus
- » Notice requirements before starting works
- » Duties to protect existing apparatus and requirements when works affect other utilities

Each utility type is governed by its respective industry act;


- » The Electricity Act (1989)
- » The Water Industry Act (1991)
- » The Communications Act (2003)
- » The Wireless Telegraphy Act (2006)
- » The Gas Act (1986)
- » The Gas Safety (Management) Regulations (1996)
- » The Pipelines Safety Regulations (1996)



A review of legislative context when considering the retrofit of SuDS and trees in highways is provided in Table B and their applicability and relevance should be considered on a case-by-case basis.

Scenario	Role / Responsibility	Relevant Legislation / Policy	Key Requirements / Constraints	Authority / Enforcing Body
Streetworks and/or highway occupation	To be authorised, as a utility provider, to construct SuDS or retrofit trees in line with streetworks legal requirements	Traffic Management Act 2004 (Part 3) NRSWA 1991 (s50) TfL Lane Rental Scheme (TMA 2004)	Street works permit (London Permit Scheme - LoPS) required under TMA. S50 Streetworks licence required if not a statutory undertaker. Lane rental charges*	Highway Authority (TfL or borough)
Construction	To ensure SuDS / tree installation complies with health, safety, and legal streetworks requirements.	CDM Regulations 2015 LoPS permit conditions	Requirement for appointment of Principal Designer /Principal Contractor roles Prepare Construction Phase Plan (CPP) Notify HSE (F10) Maintain permit records and inspection logs	Highway Authority Client
Adoption & maintenance	To confirm which authority will adopt and maintain SuDS and trees post-construction.	Highways Act 1980 (s41) Water Industry Act 1991 (s115, ss102–104) London Plan 2021* Approvals such as Section 104, 106, 38 and 278 Agreement	Responsibility of adopting body to maintain assets Highways Authority or Local Authority duty to maintain adopted SuDS and street trees	Highway Authority Thames Water LPA & TfL Asset Managers
Utility constraints	To allow SuDS and trees to be reinstated after utility works.	Gas Act 1986 (Schedule 4) Electricity Act 1989 (Schedule 4) Communications Act 2003 (Schedule 3A Part 8) Water Industry Act 1991 (s158)	Utility companies retain rights to access and maintain their assets within the adopted highway, even if located within SuDS or tree pits	Asset Owner
Tree retrofitting adjacent to utilities	To ensure tree planting does not compromise utility access or safety.	NRSWA 1991 Highways Act 1980 (s96, s141-142)	Protection of utility apparatus General provisions for installation and maintenance of trees within the highway	Highway Authority Utility Companies

Table B: Relevant legislation and policy for underground utilities [courtesy of Arup]

Further Guidance

-  Government Digital Service, Geospatial Commission and Department for Science, Innovation and Technology. (2026) **National Underground Asset Register**. A live map of public and private assets, available to parties responsible for underground infrastructure.
-  Street Works UK. (2023) **Volume 1: Street Works UK Guidelines on the Positioning and Colour Coding of Underground Utilities Apparatus**.
-  Street Works UK. (2026) **Volume 4: Guidelines for the planning, installation and maintenance of Utility apparatus in proximity to Trees**.

-  Department for Transport. (2020) **Specification for the Reinstatement of Openings in Highways** standard drawings and cross sections for highways and footways construction.
-  National Grid. (2023) **Third Party guidance for working near National Grid Electricity Transmission equipment**.
Highways Authority and Utilities Committee. (Multiple Dates) **General publications**, for support with planning, permitting, the safe execution of work and engagement with utility providers.

CHAPTER 03

Key design approaches and pre-works considerations

Overview:

This chapter sets out what good design looks like, highlighting the key design principles that help deliver successful, well-considered projects. It emphasises approaches that can be applied even in complex or highly constrained London streetscapes.

SITE SELECTION

The selection of a suitable green infrastructure retrofit site is influenced by both the available space (such as carriageway and footway widths, verge extents and any overrun lanes) and the timing and scope of the planned utility works.

The following steps can be used to support site selection, demonstrated with images from a case study project (Juniper Pocket Park, Walthamstow).

Site walkover

An initial site visit allows the opportunity to assess existing drainage such as gullies and channels, street furniture, lighting columns and signage. Specialist input from the LLFA and/or trees and SuDS colleagues should be sought at this stage to advise on optimal placement of the feature to enable establishment and success. Often, surface water is already directed towards existing drainage features through the ground profile.

The use of the highway should also be assessed on site, to understand how people use the space at different times of the day.

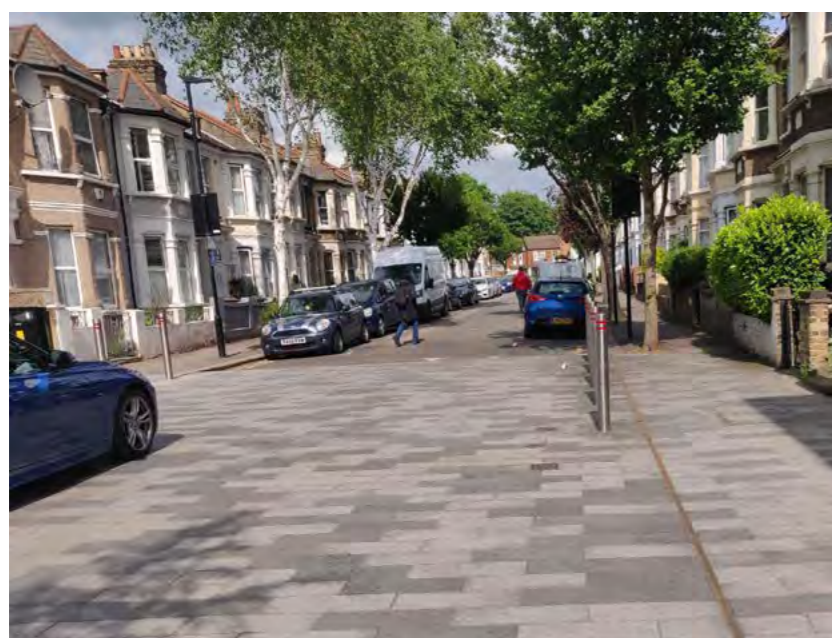


Figure 13: Site walkover at Juniper Pocket Park

Review of desktop information

Including but not limited to:

- » Topographical survey
- » Historical boreholes
- » Historic OS mapping (to determine former watercourses and land uses that may affect contamination risk)
- » Open source flood risk maps from the Environment Agency
- » SuDS opportunity map
- » Eligible area map (part of SSM)
- » London Green Infrastructure Framework for green infrastructure needs
- » Infrastructure Mapping Tool (part of the IMA toolbox)
- » Traffic Speed Data
- » Thames Water DWMP portal

Marking above ground constraints at this stage is recommended to help identify where the construction of SuDS and trees would be preferable within the context of the planned works.

Utilities Information

Consult the NUAR or asset maps and validate findings with on site detection (at least PAS 128 Type B scanning for tree pits).

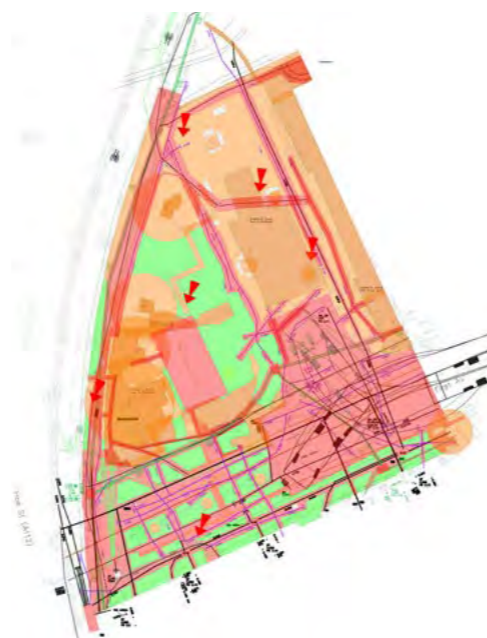


Figure 14: SuDS heat map showing preferable areas [courtesy of: Civic]



Figure 15: Trial holes

Highways and Safety Considerations

Selection should consider:

- » Retention of visibility splays
- » Presence of pedestrian crossing points, and - conflicts with pedestrian and vehicular traffic flow, which should be avoided

Ensure visibility splays, pedestrian crossings, and traffic flows are not obstructed. Engage with relevant highways authority to agree on proposed approach.

Exploring incentives

Incentives such as TfL lane rental waivers or collaboration incentives can be explored by checking the TfL website. TfL offer reduced or waived charges for projects that are part of diversionary works or that use innovative technologyⁱ.

On-site validation

Site investigation works such as soil sampling can also be undertaken to confirm existing levels of infiltration, compaction and aeration testing.

ⁱ Transport for London. (2021) Lane Rental Scheme: Delivering roadworks that optimise road network performance



Figure 16: Construction underway at Juniper Pocket Park

If you are a Supplier proposing SuDS within the SSM, the feature must be located within an eligible area as defined on the SSM Eligible Area Map.

OPTION SELECTION

Trees or SuDS or both?

Selecting the right feature for a retrofit site is important for good performance.

In some schemes, the primary objectives of the project will dictate from an early stage whether a tree or SuDS component is more suitable. For sites where flexibility exists, the decision can be guided by desired outcomes to ensure that the maximum benefits for the project are realised. The maximum benefits from green infrastructure would be delivered through a combined trees and SuDS solution. However, site constraints may prevent this. Some potential use cases for where each option may be most appropriate are explored here:



Figure 17: Before photos - Juniper Pocket Park



Figure 18: After photos - Juniper Pocket Park where both trees and SuDS were selected [credit: Meristem Design]



Trees in streetscapes

Trees may be the most appropriate solution where the site has:

- » Cooling needs
- » Space for crown/rooting
- » Heritage/townscape value
- » Below ground rooting volume
- » Flush surfacing requirements
- » A requirement to maximise space for pavement users.



SuDS in streetscapes

SuDS with shrub planting may be most appropriate where the site has:

- » Large contributing catchments
- » Shallow/critical utilities that preclude trees
- » Sightline/clearance constraints
- » Near-term deliverability requirements
- » Tight corridors with dense shallow ducts; with/or constrained maintenance access
- » Above ground constraints that do not allow canopy spread
- » Insufficient tree rooting volume available for lasting tree growth.



Trees in SuDS in streetscapes

SuDS with tree planting may be most appropriate where the site has:

- » Both cooling and surface water attenuation needs (common in London)
- » Sufficient rooting volume can be provided
- » Safe utility interfaces achievable.

Figure 19: Trees, SuDS or both?

Further Guidance



Local Authority Waters Programme. (2025) **Implementation of Urban Nature-based Solutions.**

If you are a Supplier proposing SuDS in the SSM you can choose from rain gardens, filter drains, swales, permeable paving or tree pits. Refer to the SSM detailed designs.

DESIGNING FOR TREES NEAR UTILITIES

Sizing and specifying the right rooting environment

Growth environments that differ substantially from the optimal conditions for a given species commonly result in a reduced mature size. This can contribute towards a loss in the intended ecosystem. Structural soils and good rooting environments are explored further in chapter 4.

Providing gaseous exchange and water ingress

Healthy soil requires good airflow: oxygen must reach the root zone, and root-generated gases (including CO₂) must be able to escape. In paved streetscapes, hard surfacing can restrict these natural exchanges.

Industry best practice is to use gas-permeable surface treatments around the base of the tree. Where this is not possible, or where permeability is limited, aeration inlets should be installed. Individual tree pits are typically expected to have at least two aeration inlets to support cross-ventilation and maintain healthy soil conditions. For shared tree pits, inlets should be spaced evenly around the pit to ensure adequate aeration throughout the underground rooting environment.

Advice from a tree specialist should be sought on designing pathways for water ingress and gaseous exchange, whether via aeration inlets or alternative irrigation approaches.

Surface treatment around the tree

The permeability of the surface material adjacent to a newly planted tree is an important design factor. More detailed technical guidance is provided under Further Guidance [refer to page 18 and chapter 7].

Selecting the right species

A full list of recommended species can be found in Appendix A. The defining characteristic of tree species recommended within SuDS is that they are at least moderately tolerant of both waterlogging and drought.

Working with seasonal constraints and commercial availability

Selection and availability of planting stock will vary depending on the time of year. The optimal planting period is between November and March, when trees are dormant. Techniques (such as coco-wrapping or spring-ringing) may be used to extend the planting season slightly; however, these should be regarded as mitigation measures rather than substitutes for planting during the optimal season.

Outside of the dormant period, planting is generally limited to container-grown stock, which comes in a narrower range of species and sizes. These are subject to increased risks, leading to a greater stress and chance of failure. In addition, containerised stock is usually more expensive.

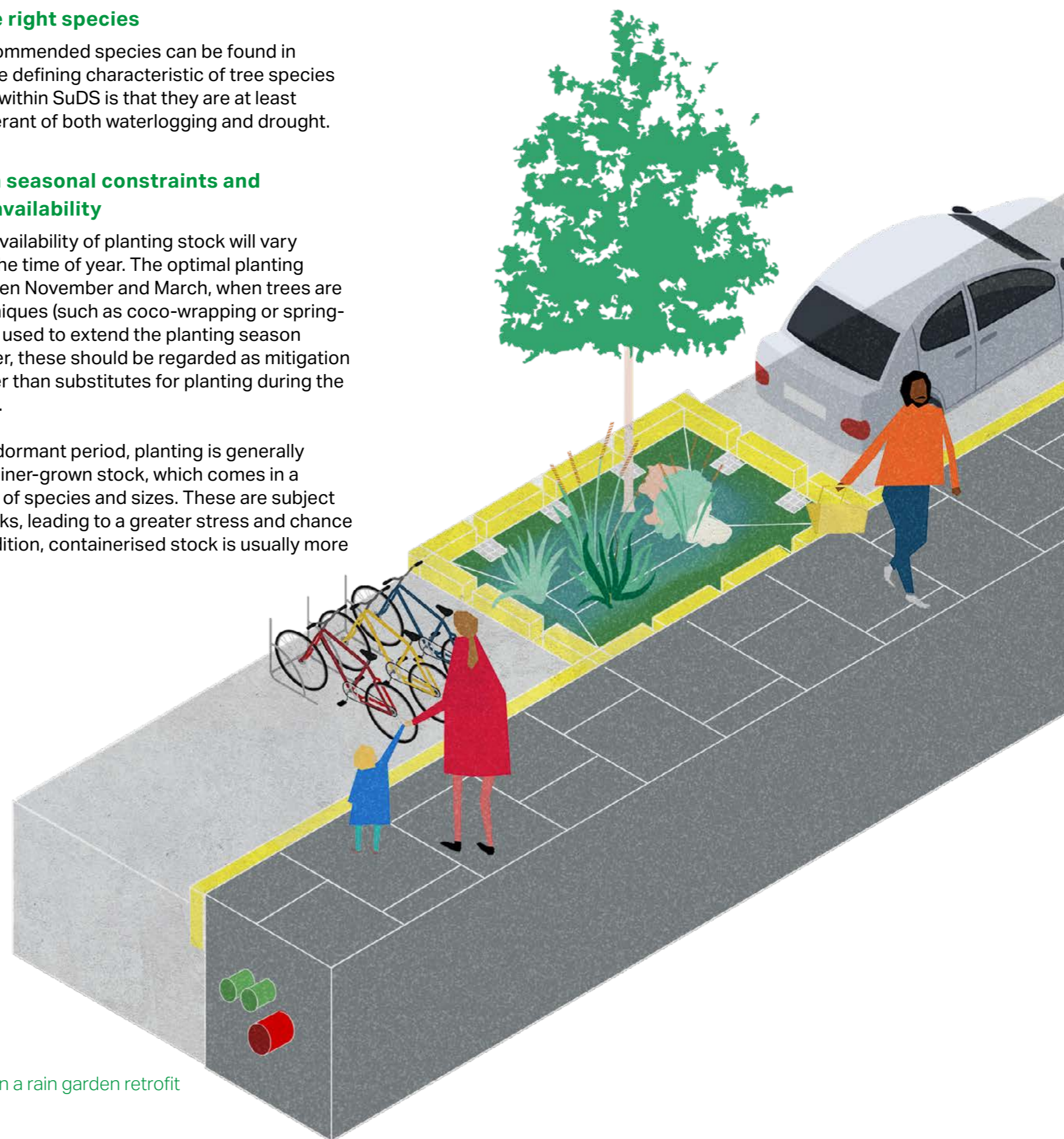


Figure 20: Tree in a rain garden retrofit in a streetscape

Working with Utility Companies and Assets

Utility companies typically specify minimum offset distances for tree planting from their assets. Through consultation with the utility provider, these headline restrictions may be reviewed and, where appropriate, reduced. Often the distance of GI features near utility assets can be reduced with the adoption of solutions, covered within chapter 4. In locations where tree planting is not feasible, shrubs and other low-growing planting may be used as suitable alternatives.

Poplars (*Populus sp.*) and willows (*Salix sp.*) are the most common species known to cause damage to sewers and drainage pipesⁱ and so it is advised that planting these species is avoided close to utility networks.



Figure 21: low-growing planting chosen for rain garden at Somers Town, Camden [credit: Meristem Design]

ⁱ Cutler, D. F. and Richardson I. B. K. (1989) Tree Roots and Buildings

Damage to Utility Networks by Trees

The problem of roots proliferating within sewer systems and ducting networks is well known and common throughout the world, but cases where pipes have broken as a result of root growth are reported to be rare. Tree roots will follow water gradients in the soil and so they will be found around cracked or leaking pipework. It is not uncommon for tree roots to completely block pipes and sewers.

Utilities found at deeper levels (more than approximately 600mm deep) are usually made of rigid materials including clay, concrete, or cast iron, with modern installations favouring UPVC. UPVC pipe is more resistant to root inclusion due to longer pipe runs and fewer joints, which are usually tight fitting and are less likely to leak as a result of settlement of the backfill around the pipe.

It is the joints between pipe sections that tend to be the point of entry for tree rootsⁱⁱ. Jointing techniques have changed over the years, and a typical pipeline may consist of many short sections of different pipe materials, each joined in different ways. Rigid joints are vulnerable to subsidence and soil movement. In more recent decades, rubber joints have become commonplace; these joints are usually tight but flexible, and pipes can flex somewhat without cracking.

Underground utility networks can face risk of damages due to their constrained environment. Whilst damage to utility networks can be significant, reported damage caused directly by trees is sporadic with a small evidence base.

ⁱⁱ Roberts J., Jackson N. and Smith M. (2006) Tree Roots in the Built Environment.

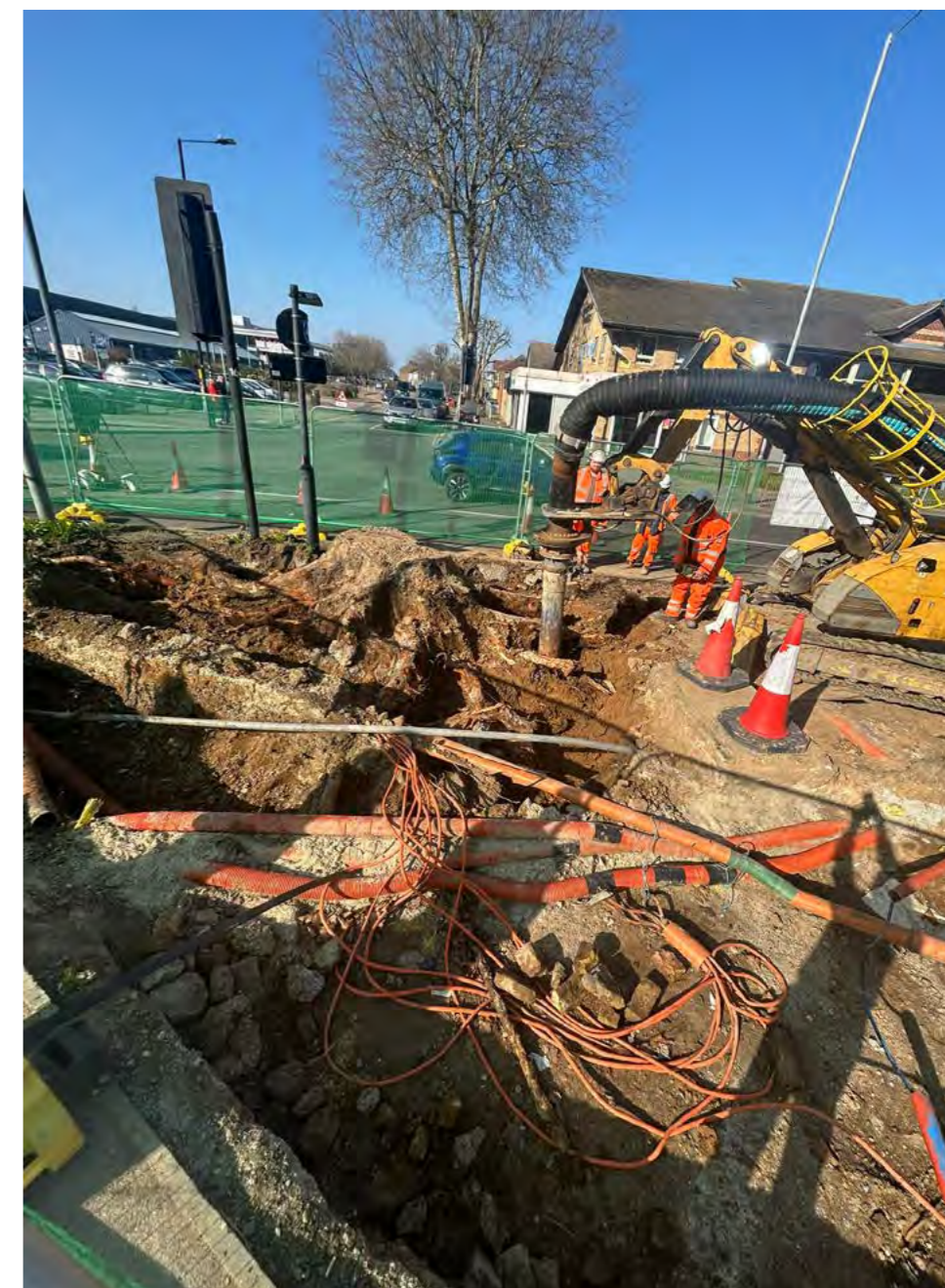


Figure 22: Vacuum excavation exposing tree roots and utilities

Further Guidance

-  Trees & Design Action Group. (2025) **Trees Species Selection for Green Infrastructure.**
-  London Tree Officers Association. (2017) **Surface Materials Around Trees In Hard Landscapes.**

DESIGNING FOR SuDS NEAR UTILITIES

Considering location

Rain gardens can be designed to fit into any streetscape and can be scaled up or down depending on the space available. The limiting factor will often be the space within the highway context. Traditionally rain gardens have been constructed through the widening of a footway, however, creative solutions can be sought such as the conversion of parking bays, integration with traffic calming measures or construction at wider junctions.

Sizing and specifying depth of SuDS

Rain gardens can be constructed in various shapes and sizes and can accommodate a utility asset running completely below the rain garden or through the rain garden, within the structural layer.

Standard details for different streetscape scenarios are provided in chapter 4.

Inlets, Outlets and Kerbing

Rain garden inlets and outlets should be positioned away from utility joints, valves and chambers. Consideration should especially be given to kerbing elements and not placing these directly on top of a utility due to the concrete haunching that is required to lay them. When new kerbing is installed along a bus route reinforcement should be considered.

Geotextiles and liners

A geotextile is a permeable fabric layer used to separate materials and prevent migration of layers, such as preventing the soil layer material of a feature from migrating into subbase layer. The geotextile will also prevent small root matter from growing down into the sub-base material, while still allowing air and water to pass through.

Rain gardens are often lined with an impermeable liner to attenuate water and discharge it to the sewer via a positive outfall. This is typically necessary because underlying ground conditions in London are often clay, which limits infiltration. Where infiltration is low, additional storage or a positive connection to existing drainage is required to accommodate larger storm events. Impermeable liners are also used to prevent infiltration near existing below-ground structures which could be undermined, such as foundations or an adjacent road sub-base.

Future visibility of utilities within rain gardens

When constructing a rain garden near a utility, thought should be given to the future visibility of the utility asset, especially if it sits within constructed within the layers of the rain garden. Warning markers such as tapes should be replaced if encountered during the construction phase. If excavation exposes the utility completely, support underneath may be required through a sand bedding, or by propping the utility with an approved Temporary Works design.

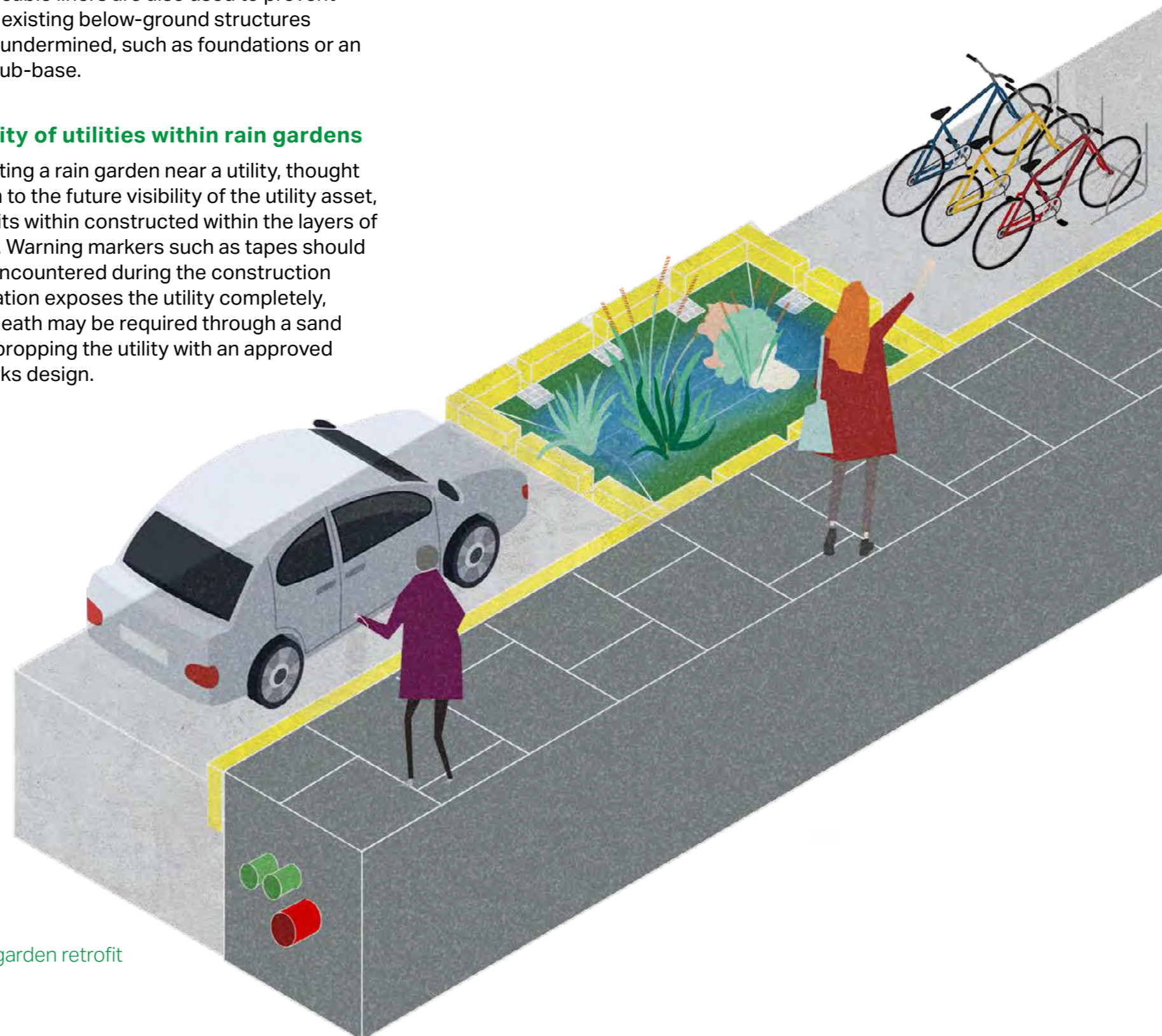


Figure 23: Rain garden retrofit in a streetscape

Shrubs

When integrating rain gardens with or near utilities, utility providers often have specific requirements to planting specification within these systems [refer to chapter 4].

Further guidance on shrub species selection is included within Appendix A. Shrub selection should be based on the following criteria:

- » Tolerant of shallow rooting environment
- » Slow-growing, can cope with simple, infrequent maintenance operations
- » Selection of smaller sizes that are more suited to typically constrained urban locations - height and width not exceeding 1.2 metres
- » Tolerant of temporary inundation and slightly drier conditions in summer
- » Suited to planting in large groups, such as for groundcover planting under trees
- » Selected to suit aspect, typically in urban settings, shade-tolerant planting should be considered due to overshadowing by trees and buildings.

Planting schemes should avoid excessive variety of species, which can look uneven. Where there is potential for an extensive SuDS scheme, this will require planting plans and schedules developed by a landscape professional.

Herbaceous planting and ornamental grasses

These planting groups are effective for providing groundcover under trees, as well as for rapid establishment of greening where constrained rooting conditions restrict the use of trees and larger shrubs. Grasses are effectively used in combination with herbaceous plants for providing evergreen cover during the dormant months. This group of plants requires high maintenance, through seasonal division, removal of spent growth and usually full replacement over a 3–5-year cycle.

Often maintenance is neglected and this results in poor appearance and ultimately removal. Therefore, green infrastructure schemes should carefully balance the maintenance objectives and commitment when considering herbaceous planting.

Final planting proposals should be reviewed in collaboration with landscape professionals and relevant authorities to ensure suitability for the site and compliance with current standards and guidance.


CHECKLIST FOR PRE-WORKS

- Have all utility assets been located?
- Has a tree and/or SuDS specialist been engaged on the project?
- Has coordination with utilities companies occurred?
- Have all constraints been identified above and below ground?
- Have the inlet, outlet and overflow levels been checked against site levels?
- Has the species selection been considered?
- Have all relevant utility providers been coordinated with?
- Has a design review been undertaken with different disciplines?
- Have materials been ordered to factor in longer lead in times for less typical components (such as structural soil and planting nurseries)?
- Are operatives undertaking the work trained to a competent level?
- Has an appropriate construction method been devised and RAMS produced?
- Have maintaining bodies been informed?
- Have maintenance arrangements been considered? Has liaison with maintainers been undertaken?



Figure 24: Shallow SuDS planting with ornamental grasses at Reedworth Street [credit: London Borough of Lambeth]

Further Guidance

 Urban Design Learning. (2024) **Planting Design Guide for Streets**

CHAPTER 04

Design scenarios, solutions and workarounds

Overview:

This chapter explains how to coordinate effectively with utility companies and provides standard details for installing green infrastructure in varied streetscape contexts. It outlines practical workarounds, protection measures and technical guidance to ensure safe integration alongside existing utilities.

(UTILITY OFFSETS)

WHAT DO UTILITY COMPANIES SUGGEST?

Utility providers operating within Greater London were contacted and asked to share the minimum horizontal distances they typically recommend between newly installed SuDS or trees and their assets. Their responses are summarised in Table C below, and in full in Appendix B. These distances should be used for strategic design guidance only - it is always recommended to consult directly with the utility supplier for site specific advice.

These offsets are not mandated or fixed requirements. They are provided for guidance and represent typical separations that each company has

confirmed they are comfortable with. With workarounds described later in this chapter, it is likely the distances can be reduced. It is important to remember that green infrastructure plays a crucial role in natural processes and supporting human life. Rather than an obstruction, roots should be seen as an additional, life sustaining utility.

Specified numerical distances vary for several reasons and are not supported by peer-reviewed evidence. Factors influencing the required offset may include:

- » Type of utility
- » Criticality of infrastructure
- » Cable diameter
- » Depth and condition of the asset
- » Hard capping of services
- » Maintenance requirements and access strategy.

Works sequencing and informing the public

Works sequencing is essential for the successful delivery of any construction scheme. A works sequence that has been considered, ensures that risks have been calculated and protection measures are put in place. Appendix E contains a table outlining the key stakeholders in a SuDS and trees retrofit project, with their responsibilities in both design and construction phases.

Effective communication with the public and road users is essential to ensure understanding, minimise disruption, and maintain confidence in the works. Information boards should be clearly displayed, identifying the organisation undertaking the works and providing emergency contact details. They can also briefly explain the purpose of the works, address any concerns and help the public better understand the benefits of installing green infrastructure. Other best practices include using letter drops, drop in sessions and door to doors with affected residents.

Recommended depth of cover	Utility Provider	Asset Type	Guidance for tree planting	Guidance for SuDS features
250 - 450mm	Arelion	Telecoms	Suggested 1500mm offset	Suggested 1500mm offset
	CityFibre	Telecoms	A distance of 500mm from the base of the root is recommended with root protection.	No guidance provided
	MUA Group	Telecoms	Trees should follow BS5837 to ensure tree root protection.	<ul style="list-style-type: none"> » At least 5m from buildings and infrastructure » 2.5m from site boundaries » 1m above the water table » 300mm from water and wastewater pipes
	Neos	Telecoms	Assets are in a 110mm conduit that should protect assets from tree roots. Preference for new tree planting would be 10m away	There are no specified offsets for SuDS. Preference for systems that do not require draining in the event of a repair or alteration
	Zayo	Telecoms	No defined offset distances. Suggested a root barrier system is employed in urban areas. In rural areas they request the easement in place is observed, and to consult them ahead of planting new woodlands or plantings	No specified minimum distances for SuDS features. The installation of a soakaway or permeable paving would be preferable over a pond or water retention basin above the network. Interested in having visibility and providing feedback for each potential design and believe that each design should be assessed on its own merits.
LV: 450mm HV: 450 - 950mm	UK Power Networks	Electric	<p>UKPN request sufficient clearance from their assets with tree planting to ensure that future excavation and cable replacements are not impeded by root growth. Where a tree is located within 5 m of their assets, they advise the use of root barriers.</p> <p>Generally, 10m clearance to buildings and 5m clearance to an open compound/substation boundary is advised. This depends on the size of the tree as UKPN's priorities are the stability of structures and keeping compounds secure from unauthorised access by people climbing trees.</p>	A 10m clearance from substations is advised due to unplanned events of oil contamination

600mm	SGN Gas	Gas	<p>SGN request written approval should be obtained from them before any tree planting is carried out.</p> <p>SGN have published a guidance document 'Dig safely: Measures to avoid injury and damage to gas pipelines' (March 2017) where tree species and corresponding recommended distances are given</p>	<p>Consultation for SuDS features should take place on an individual basis as the distance recommended from the pipe will vary due to size and material. SGN have stated that construction of a rain garden directly above or in close proximity to their assets is not permitted.</p>
	Cadent Gas	Gas	<p>Cadent Gas have published a guidance document titled 'Specification for Safe Working in the Vicinity of Cadent Assets' (2023) with planting guidelines:</p> <ul style="list-style-type: none"> » Recommended above the asset (for screening): Quickthorn, Blackthorn » Over 2m: Raspberries, Gooseberries and Blackcurrants » Over 3m: Dwarf Apple Stocks and Christmas trees (Picea Abies (Christmas trees clear-felled at intervals not exceeding 7 years) » Over 6m: Ash, Beech, Birch, most Conifers, Elm, Maple, Horse Chestnut, Oak, Sycamore, Apple, Lime and Pear » Over 10m: Poplar and Willow 	<p>Cadent Gas prefer SuDS features above plastic mains rather than metallic. Consultation is required for each design to be assessed individually, and trial holes to prove no diversions are necessary.</p> <p>For plastic pipes remaining within SuDS, no valves should be in the area, the minimum depth of cover (according to Streetworks UK) should remain and backfilling should be in line with their Guidance Document.</p>
750 - 1200mm	Affinity Water	Water	<p>Affinity Water have published a guidance document titled 'Developing And Working Near Our Pipes And Apparatus' (July 2024). With consultation and prior approval, Affinity Water may allow shallow rooted plants in proximity to their assets.</p> <ul style="list-style-type: none"> » Recommended above the asset (for screening): Blackthorn, Broom, Cotoneaster, Elder, Hazel, Laurel, Privet, Quick Thorn, Snowberry and most ornamental flowering shrubs. » Over 6m: Ash, Beech, Birch, Conifers, Elm, Horse Chestnut, Lime, Oak, Sycamore, Apple and Pear » Over 12m: Poplar and Willow 	<p>Preferred widths for structures are given, varying on the diameter of the Water Main. The measurements are taken from the outside barrel of the Water Main.</p> <ul style="list-style-type: none"> » 150mm or less (6"): 3m » Between 151mm and 600mm (6"-24"): 3.5m » Greater than 600mm: 4.5m <p>When minimum offsets cannot be achieved, consultation is required, suggested email: maps@affinitywater.co.uk</p>
	Thames Water	Water / Sewerage	<p>Thames Water have published a guidance document 'Tree Planting Guidelines' (March 2022) which includes a species list and a distance from the centre line of the asset.</p> <p>The document notes if tree planting designs propose a root protection barrier or other root management structures (such as root crates) Thames Water can agree a reduction on the horizontal clearance distance by 50%.</p>	<p>After a survey to confirm the condition of the asset, Thames Water will accept shallow planted rain gardens directly above, or near their feature if the following conditions are met:</p> <ul style="list-style-type: none"> » Good access to asset provided either side of the shallow planted rain garden » The shallow planted rain garden is lined » The sewer is not a trunk water main or a material which is at a higher risk of damage (eg. cast iron) » 500mm clearance is provided to valves or hydrants, with shallow planted rain garden not covering these assets » 500mm vertical clearance above sewer

Table C: Register of suggested offsets by utility companies

A full version of this table, including utilities which did not provide guidance information refer to Appendix B

STREET SCENARIO STANDARD DETAILS

The following pages include standard details that provide solutions and possible build ups where space allows for retrofit. The standard details cover trees, rain gardens, and trees in rain gardens for a range of scenarios.

As the utilities shown within the standard detail drawings are indicative, the placement of the green infrastructure will depend on site specific conditions. For the full, labelled technical drawings refer to Appendix D.

Retrofitting in wide pavements

Green infrastructure can be retrofit into wide pavements, and where pavement space is under-utilised. The retrofit of green infrastructure could occur during utilities maintenance work, during pavement widening work, public realm improvement works or for traffic calming measures.

Standard detail description: The wide pavement standard detail should be used when the green infrastructure feature has areas of footpath either side which are at the same level. The opportunity to retrofit comes from the space beyond the standard pavement width, where the wide pavement allows for sufficient spacing between utilities or where the pavement has previously been widened and utilities are sited within the original pavement extent. If the green infrastructure feature abuts the carriageway, see Build Out detail.

Expected utilities: Gas, LV, Fibre, Comms, Distribution/ Trunk Water Main.

Typical site: Oversized junctions or pavements, or open public realm areas.

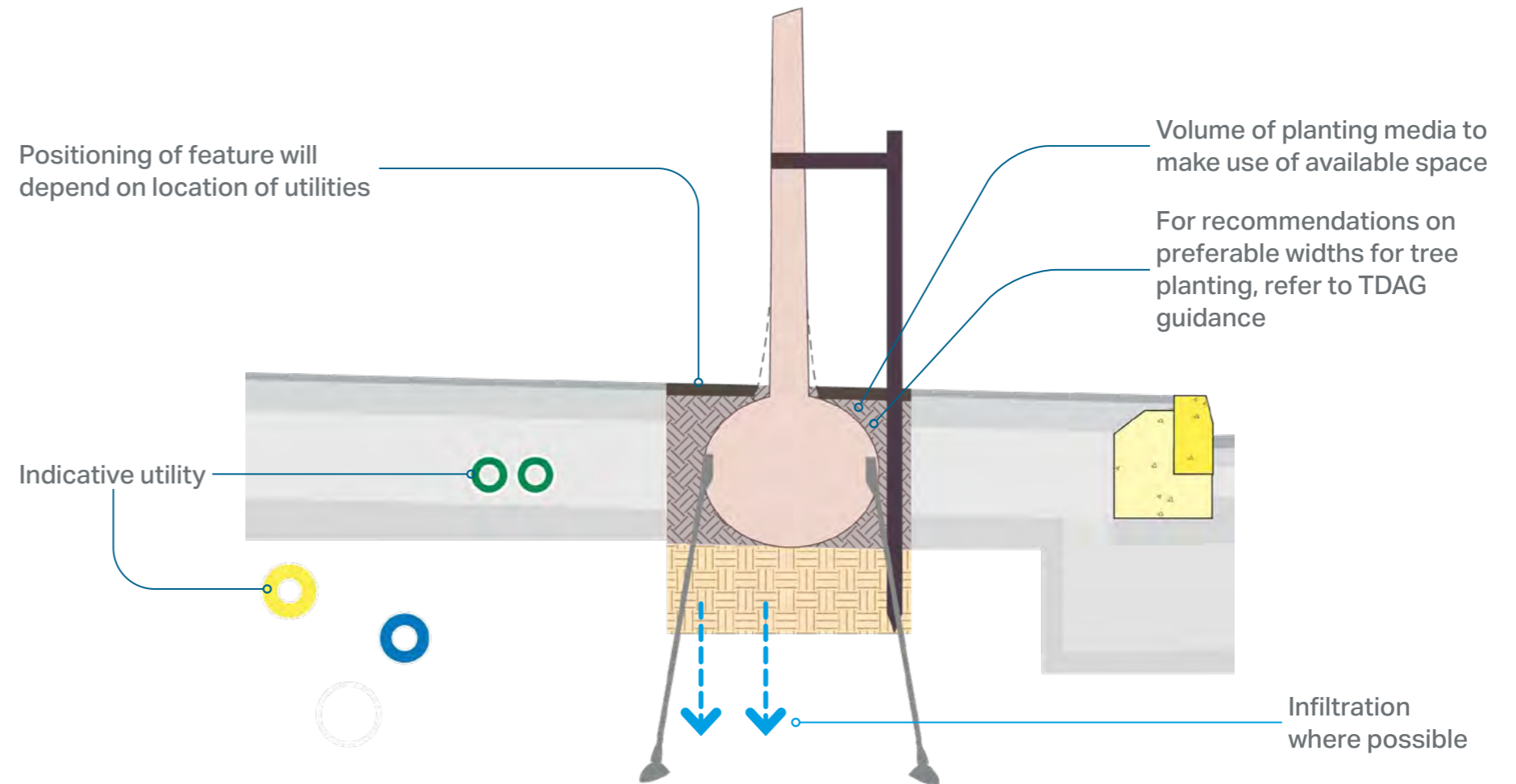


Figure 25: Tree retrofit into a wide pavement

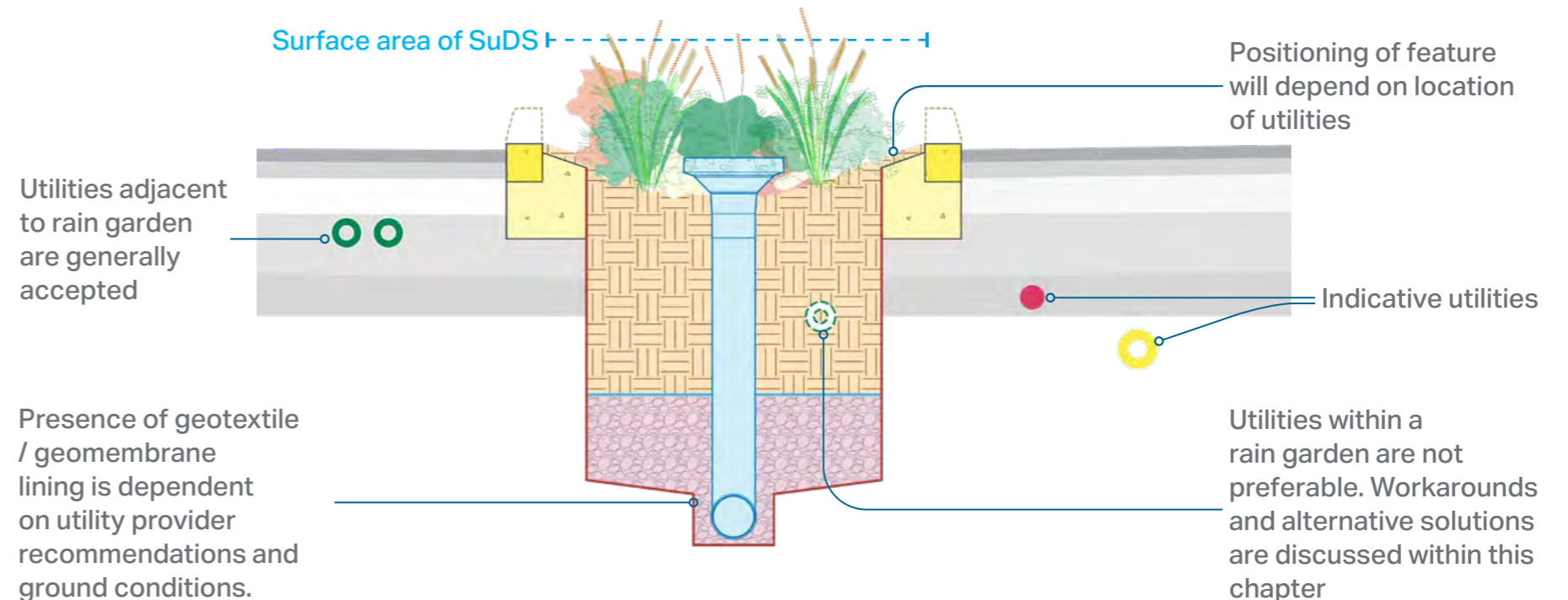


Figure 26: Rain garden retrofit in a wide pavement

Suppliers must adhere to the prescribed detailed design standards when delivering SuDS through the SSM.

RETROFITTING IN WIDE PAVEMENTS (CONTINUED)

Additional considerations

Street furniture may affect the final positioning of retrofit, although it can be moved as part of the scheme. Green infrastructure feature to be positioned away from valves, chambers and ancillary utility infrastructure.

Opportunity

If the position of the rain garden is close to council owned buildings, there may be feasibility to route downpipes into the SuDS feature.

These standard details have been produced for the cases where a rain garden and a tree in a rain garden are retrofit within a wide pavement. As the utilities shown within the standard detail drawings are indicative, the placement of the green infrastructure will depend on site specific conditions.

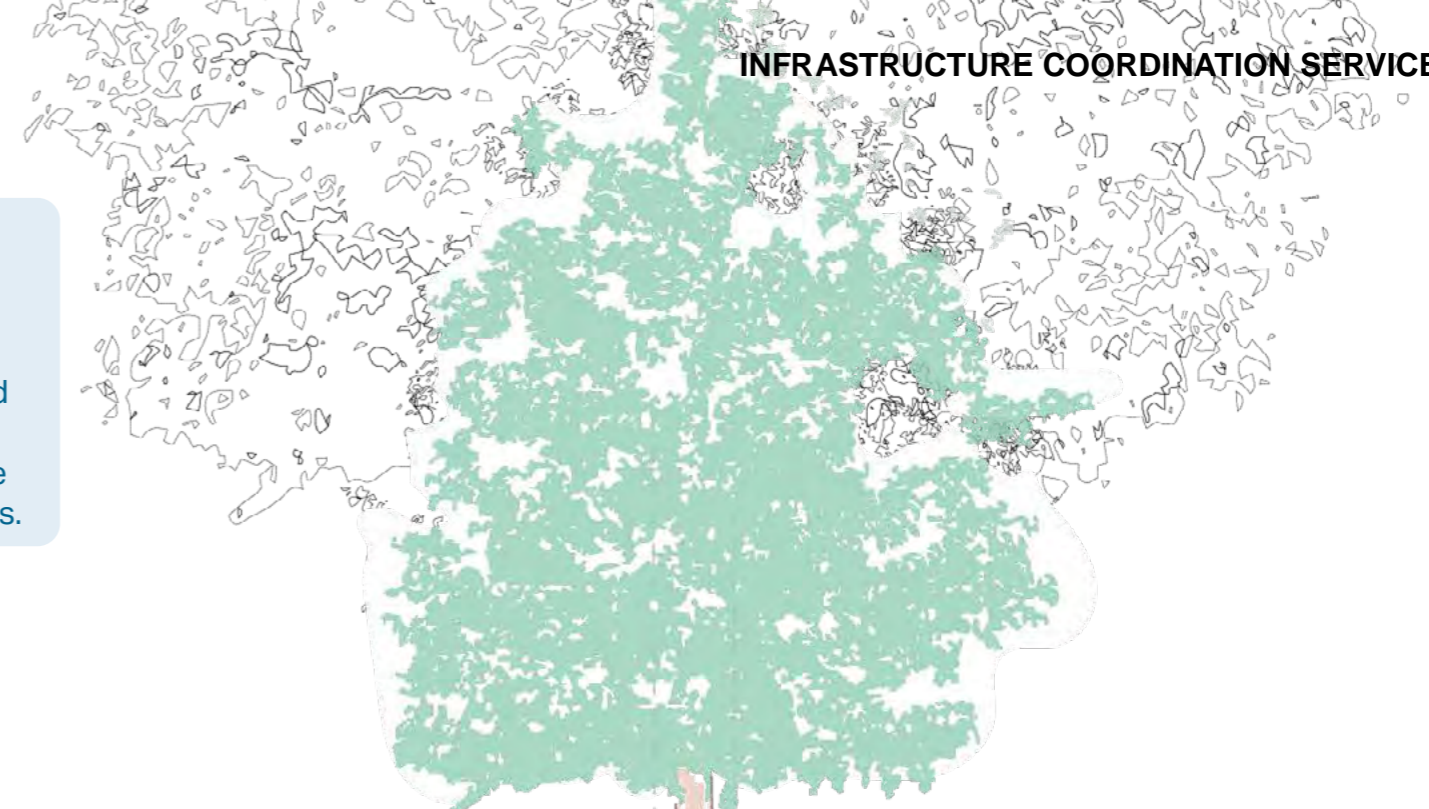


Figure 27: Tree retrofit into a wide pavement at Crouch End

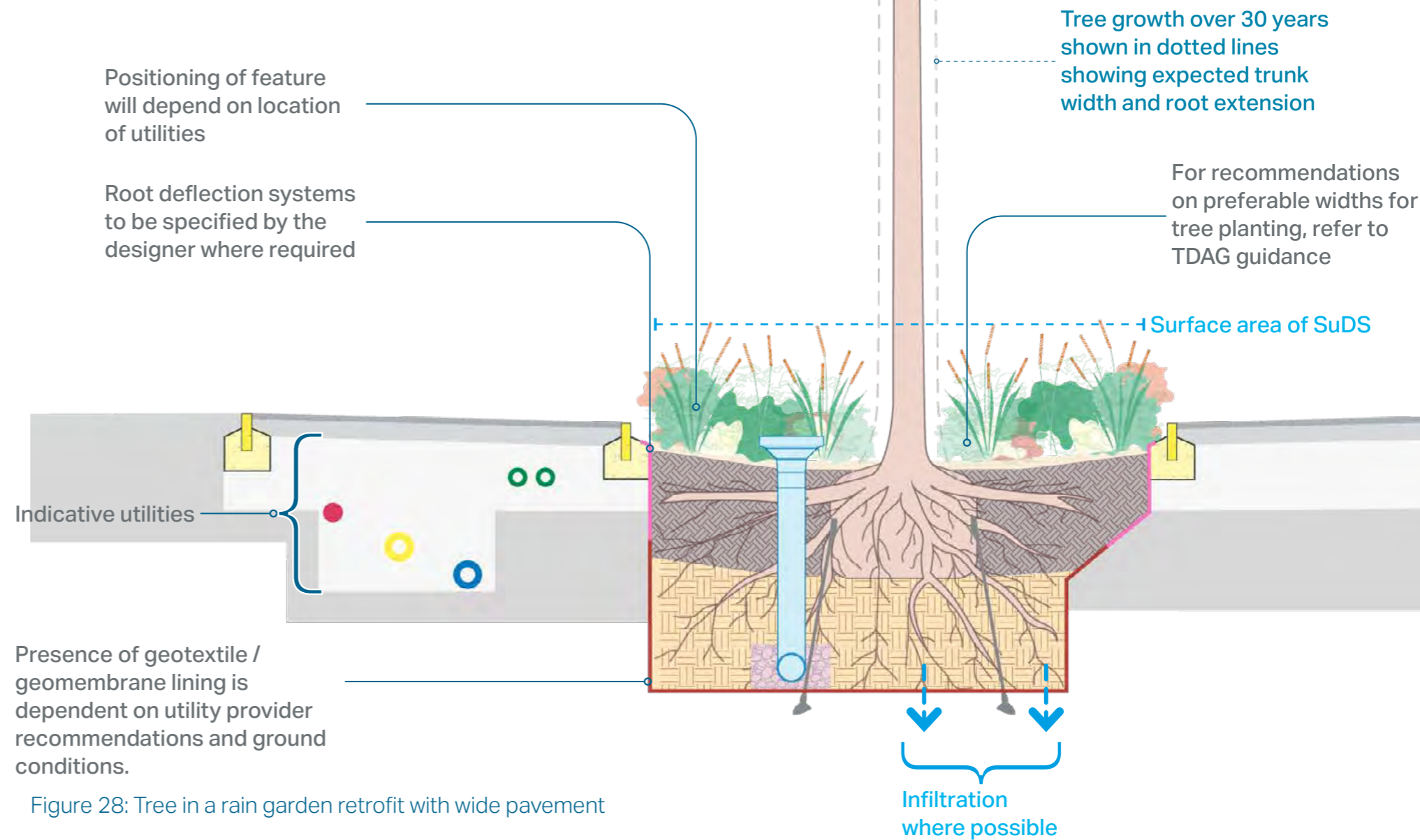


Figure 28: Tree in a rain garden retrofit with wide pavement

Retrofitting in a build-out

Green infrastructure can be retrofit into a newly constructed build out where there is additional road width. This could be through the conversion of surplus parking bays or in wide carriageways.

There may also be some instances that an existing build out could be converted into a green infrastructure, although it is preferable to prioritise 'greening' existing areas of asphalt over grassed areas. The retrofit of green infrastructure could occur during utilities maintenance work, public realm improvement works or for traffic calming measures.

Standard detail description: The build out standard detail should be used when the green infrastructure feature abuts the carriageway on one side, with the footpath on the other side. For the retrofit of green infrastructure in Greater London, it is expected this is the most common scenario.



Figure 29: Rain garden retrofit in a build out at Charlton Place, Islington

Expected utilities: Sewers, Gas, Distribution/Trunk Water Main, LV/HV.

Typical site: Wide carriageways or parking bays.

Additional considerations

It may be possible to route a wider catchment into the feature by diverting gullies serving other areas into this system. Green infrastructure should not be built on top of gullies unless the gully is raised and used as the overflow for a rain garden. Planting media specification should consider the expected hydrocarbons from the catchment.

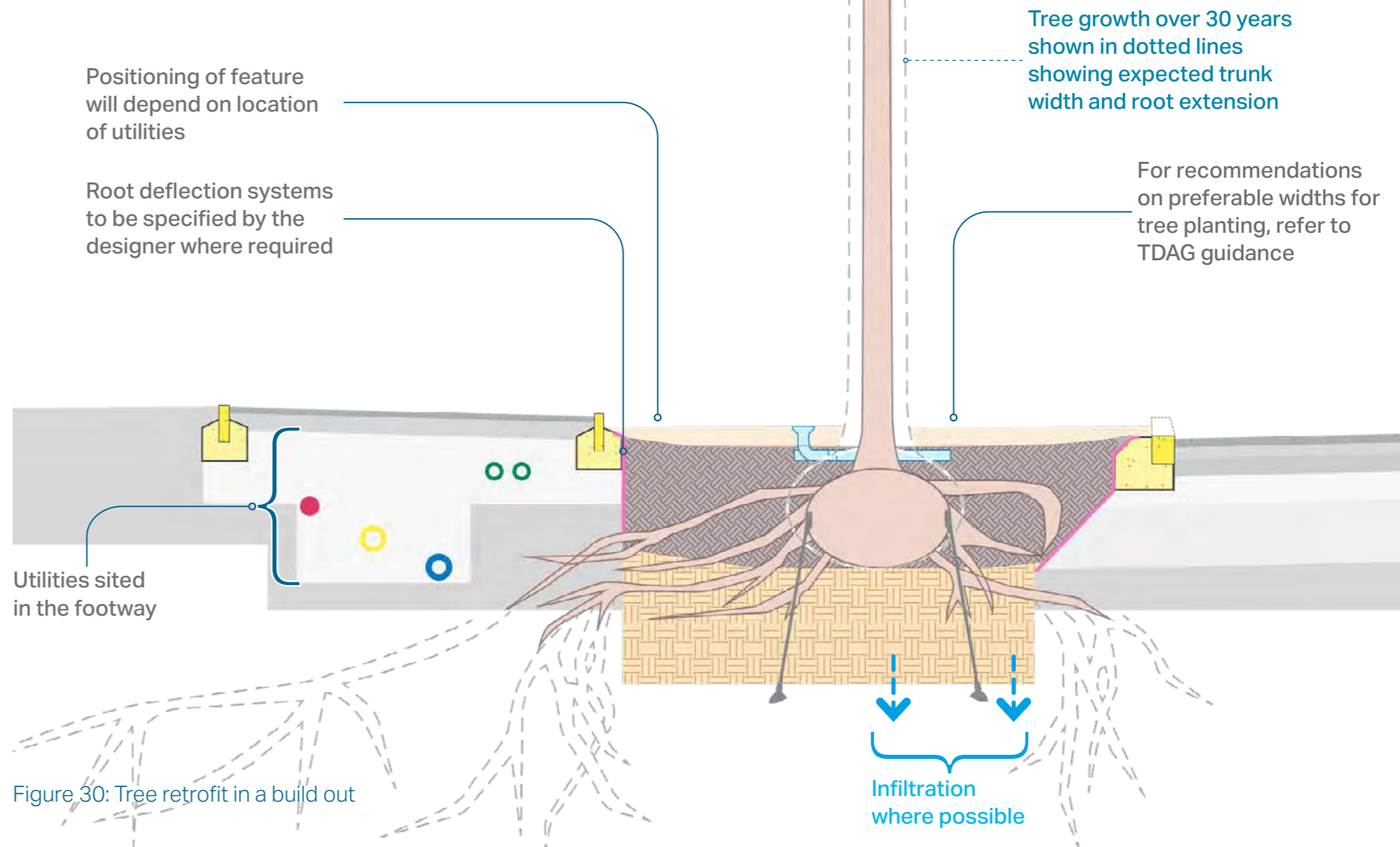
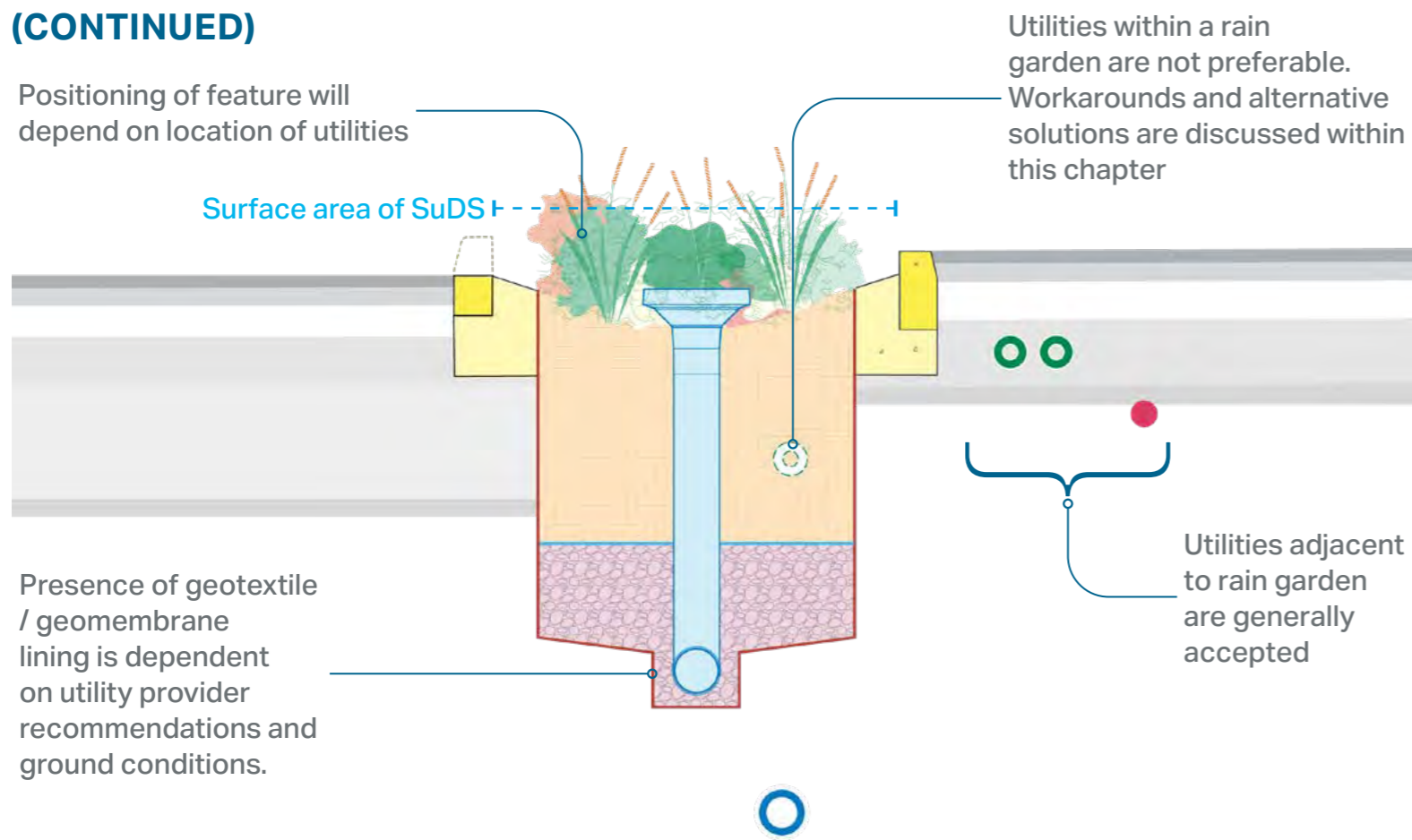


Figure 30: Tree retrofit in a build out

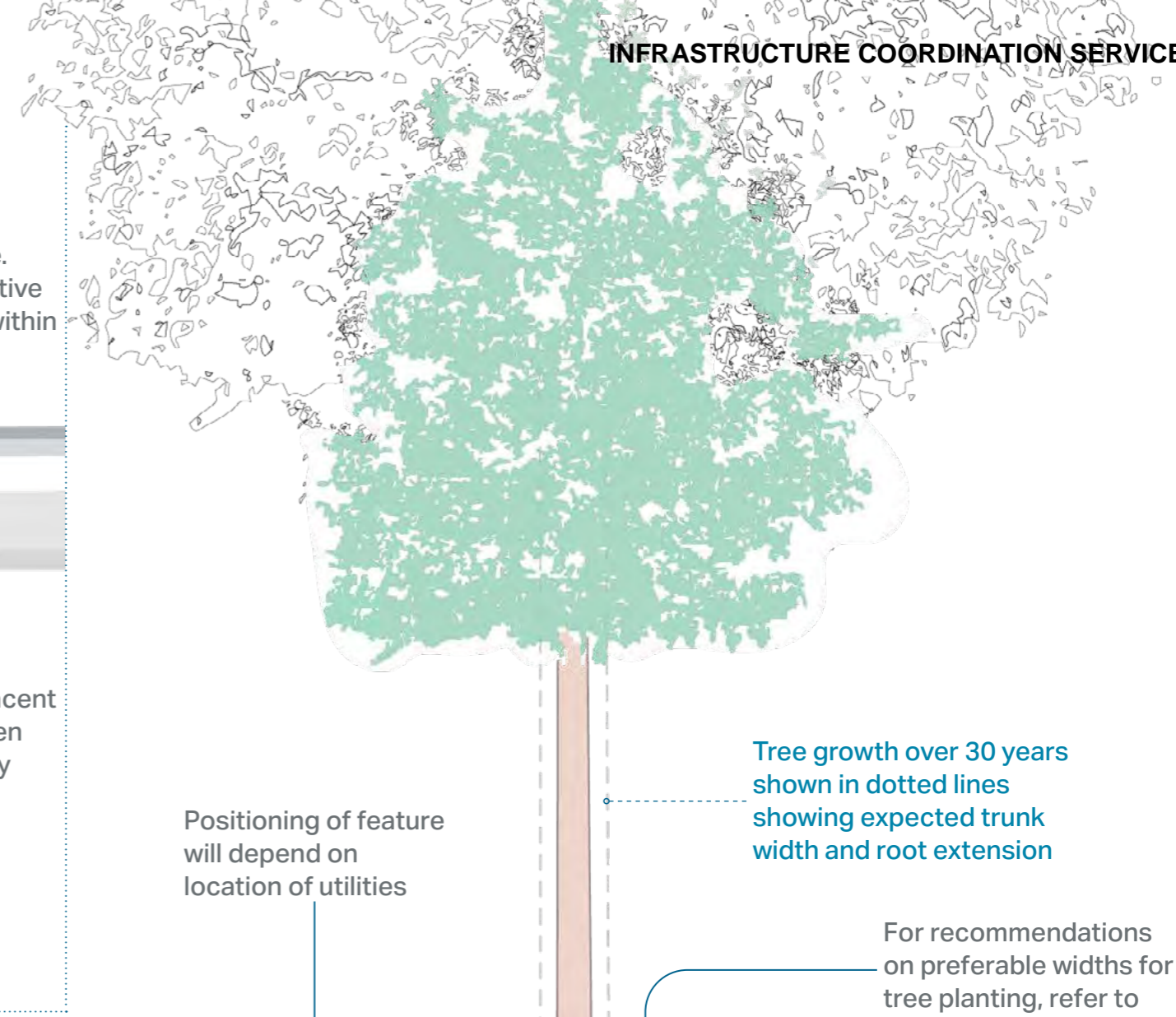
RETROFITTING IN A BUILD-OUT (CONTINUED)

Positioning of feature will depend on location of utilities



Presence of geotextile / geomembrane lining is dependent on utility provider recommendations and ground conditions.

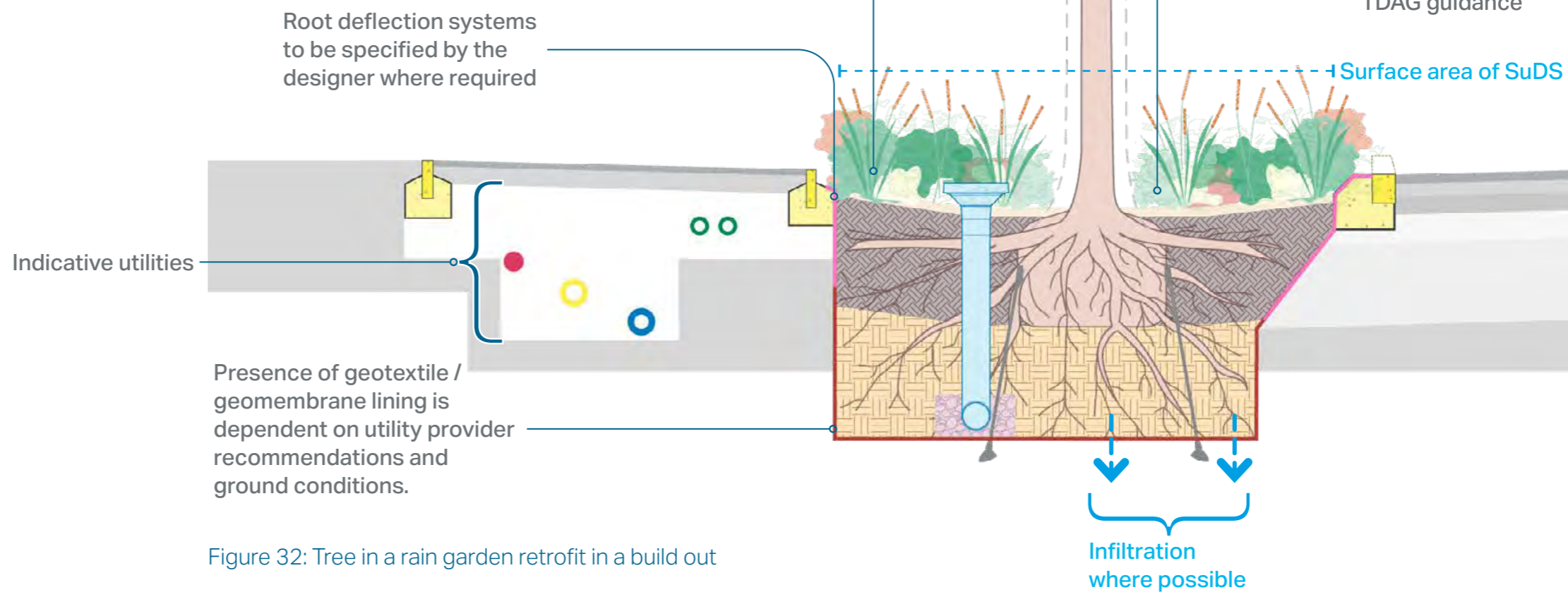
Figure 31: Rain garden retrofit in a build out



Tree growth over 30 years shown in dotted lines showing expected trunk width and root extension

Positioning of feature will depend on location of utilities

For recommendations on preferable widths for tree planting, refer to TDAG guidance



Root deflection systems to be specified by the designer where required

Indicative utilities

Presence of geotextile / geomembrane lining is dependent on utility provider recommendations and ground conditions.

Infiltration where possible

These standard details have been produced for the cases where a rain garden and a tree in a rain garden are retrofit within a build out. As the utilities shown within the standard detail drawings are indicative, the placement of the green infrastructure will depend on site specific conditions.

Figure 32: Tree in a rain garden retrofit in a build out

Retrofitting in a central reservation

Green infrastructure can be retrofit into a central reservation where the carriageway has width for both the green infrastructure feature and traffic volume, and where maintenance can be accommodated. The retrofit of green infrastructure could occur during utilities maintenance work or public realm improvement works where the central reservation is being changed.

Standard detail description: The central reservation standard detail should be used when the green infrastructure feature sits within the carriageway.

Expected utilities: Trunk Water, HV, Sewer, Gas.

Typical site: Wide carriageways, open public realm areas.

Additional considerations

Due to the crossfall of the carriageway sloping away from the central reservation, this is often a hydraulically unfavourable site for rain gardens and areas of general planting or trees may be the better solution. The watering needs of trees may also be increased. Due to the proximity to the carriageway additional protection items such as tree guards should be considered. It should be considered that the run-off from highly trafficked areas will contain more pollutants and as such may need additional water quality measures.

These standard details have been produced for the cases where a tree and a tree in a rain garden are retrofit within a central reservation. As the utilities shown within the standard detail drawings are indicative, the placement of the green infrastructure will depend on site specific conditions.

Thames Water's Tree Planting Guidance (2022) notes if tree planting designs propose a root protection barrier or other root management structures (such as root crates) Thames Water can agree to reduce the horizontal clearance distance by 50%.

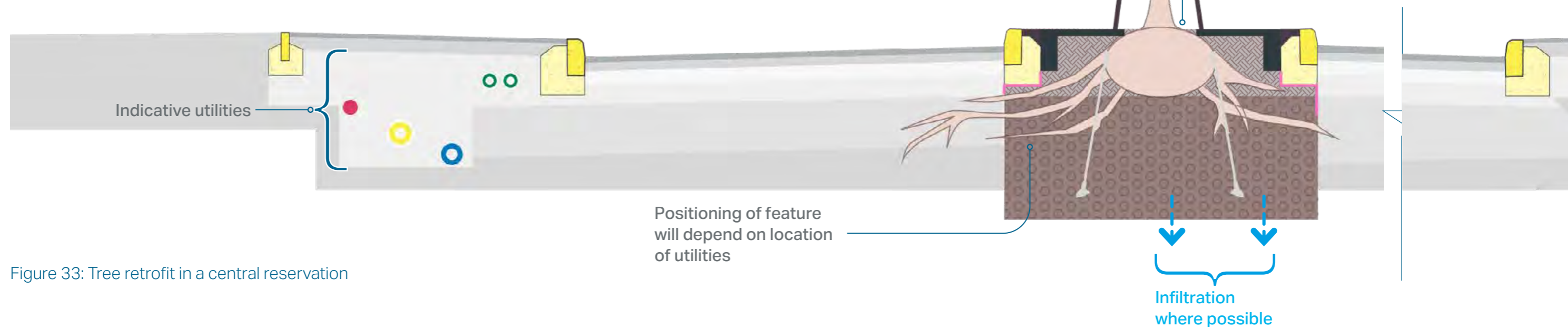


Figure 33: Tree retrofit in a central reservation

RETROFITTING IN A CENTRAL RESERVATION (CONTINUED)



Figure 34: Rain garden retrofit in a central reservation at St John Street, Islington

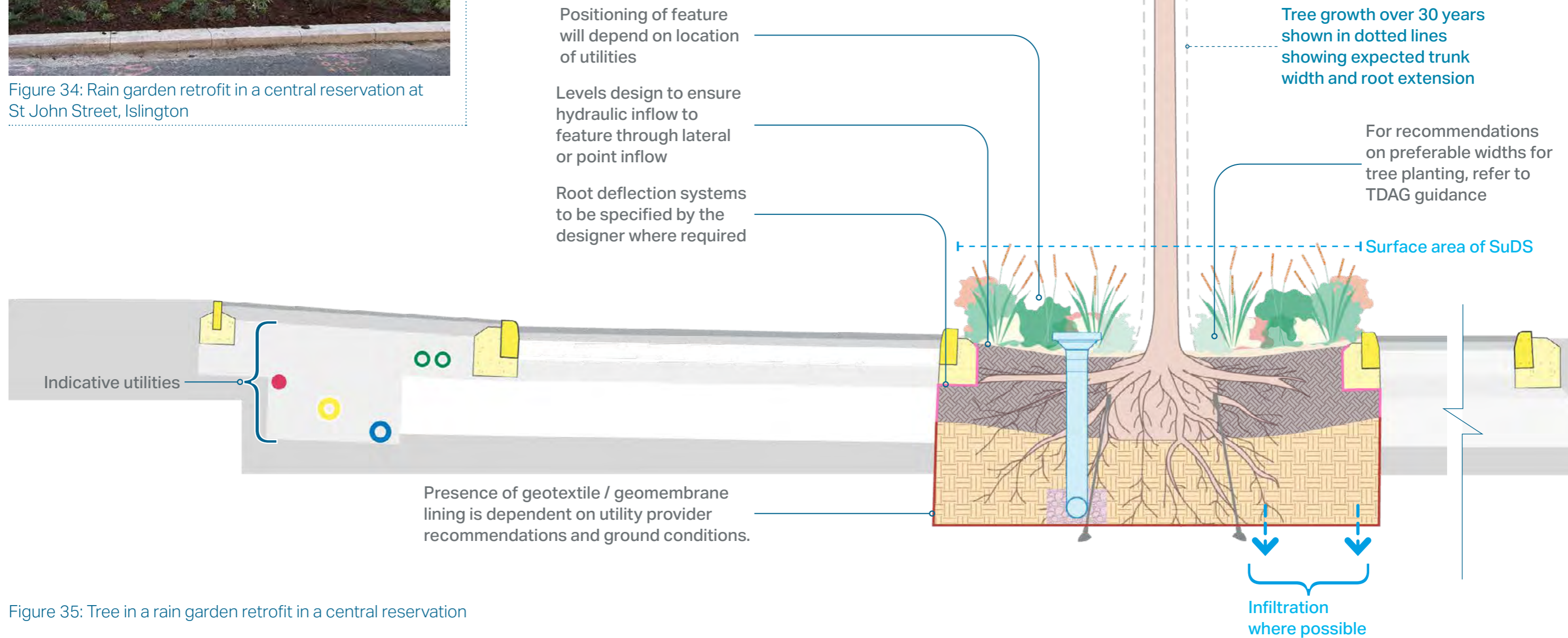


Figure 35: Tree in a rain garden retrofit in a central reservation

Retrofitting in existing highway green spaces

Green infrastructure can be retrofit into existing green space to help alleviate flooding issues. The retrofit of green infrastructure could occur during planned flood mitigation works, planned utilities work or planned public realm improvement works.

Standard detail description: The existing green space standard detail should be used where the green infrastructure feature is sited with existing grassed areas either side of it.

Expected utilities: Gas, LV, Fibre, Comms.

Typical site: Verges.

Additional considerations

This may be an appropriate location for a swale or depression basin solution, if flood mitigation is the primary aim.

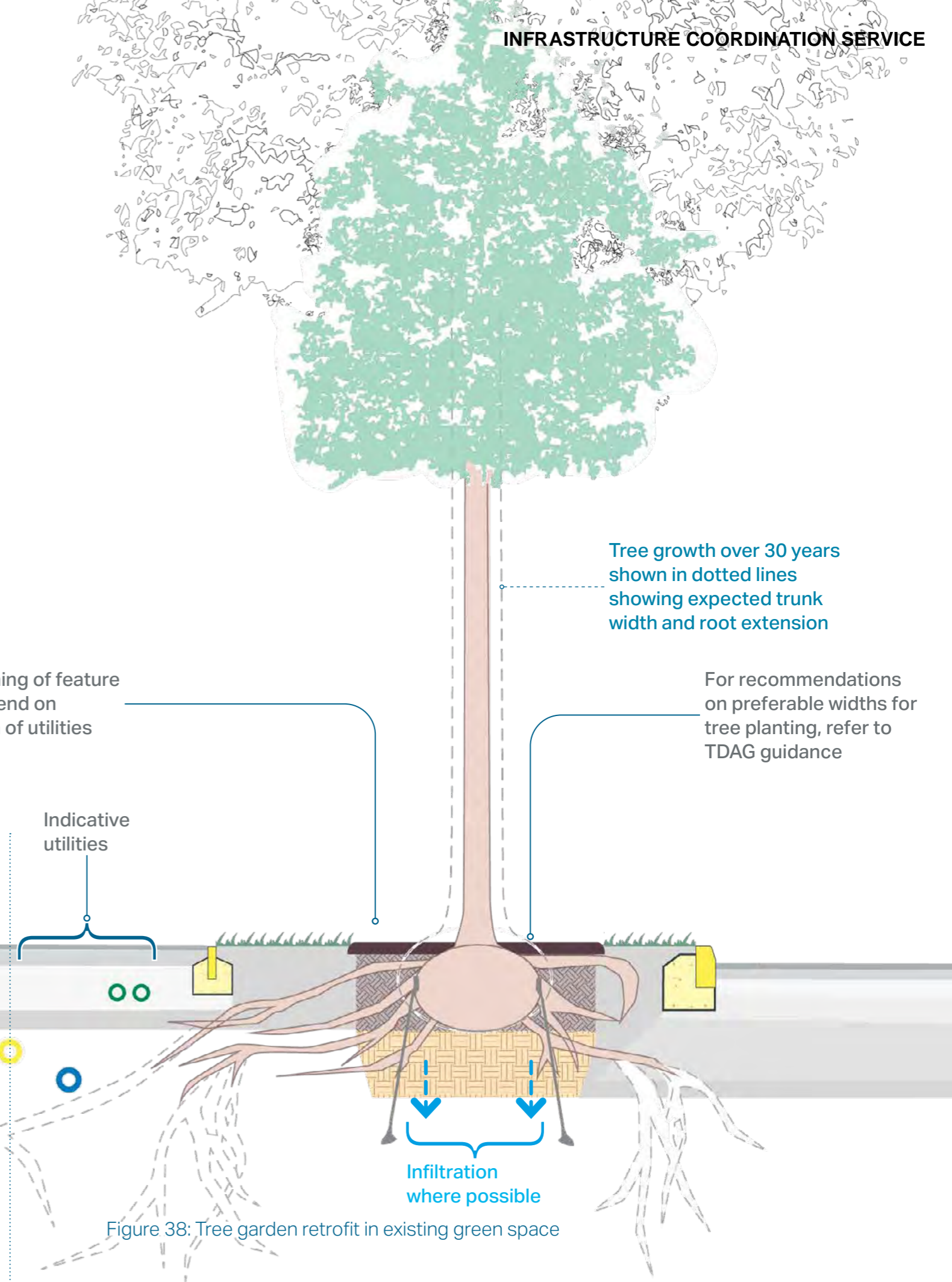


Figure 36: Before photo - George Crescent, Barnet



Figure 37: After photo, retrofitted with rain garden - George Crescent, Barnet [credit: Meristem Design]

RETROFITTING IN EXISTING HIGHWAY GREEN SPACES (CONTINUED)

Positioning of feature will depend on location of utilities

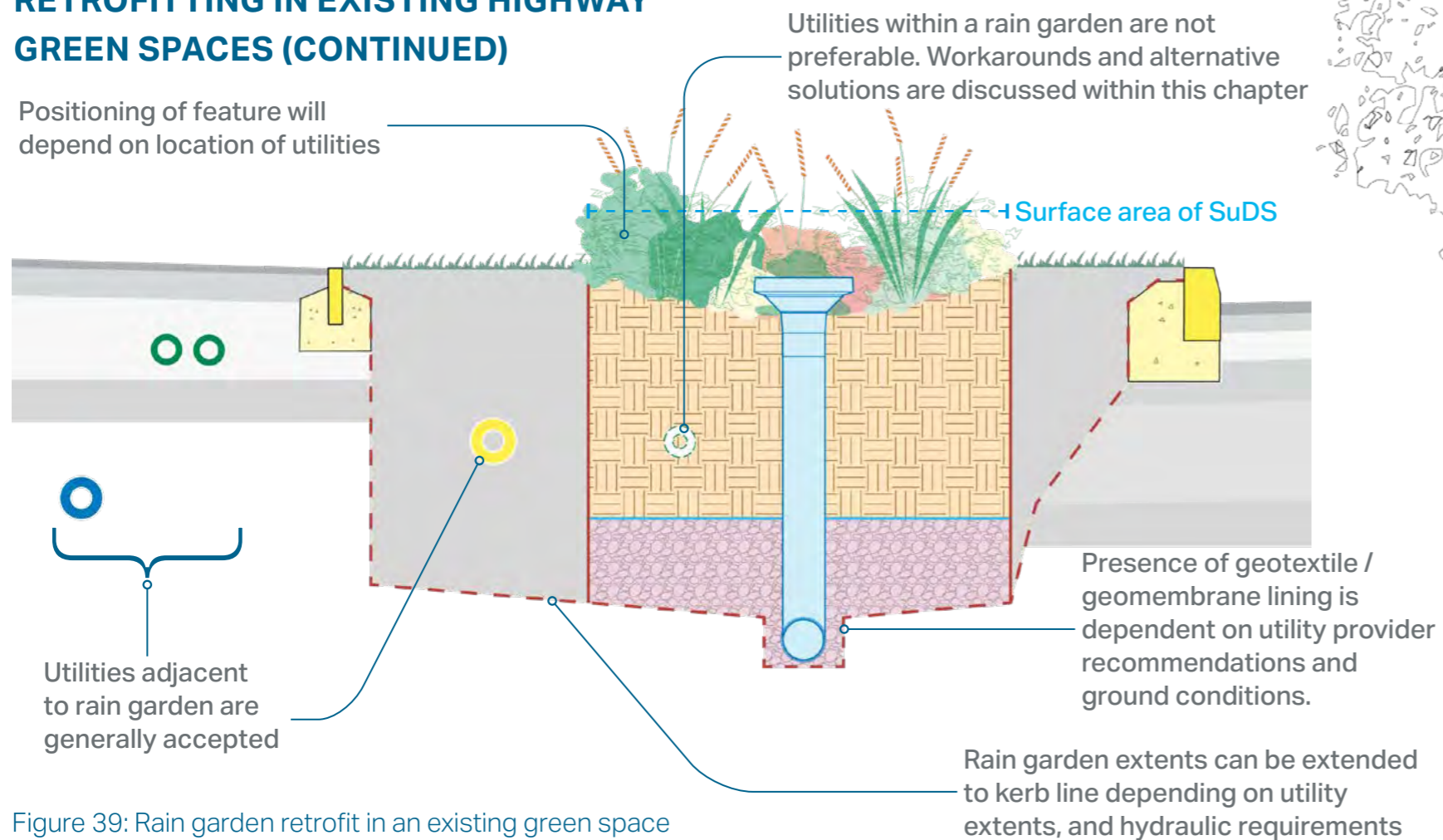


Figure 39: Rain garden retrofit in an existing green space

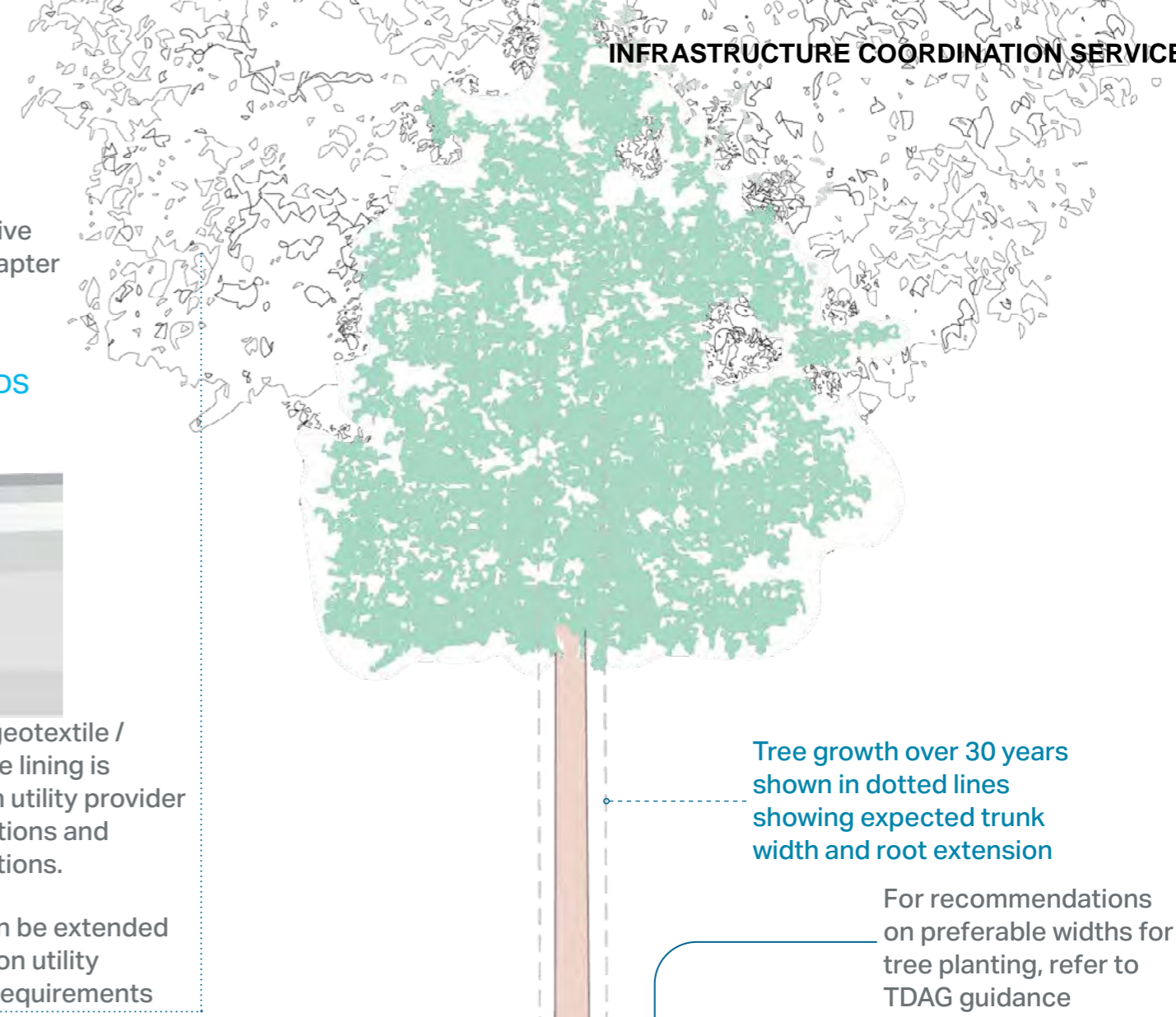
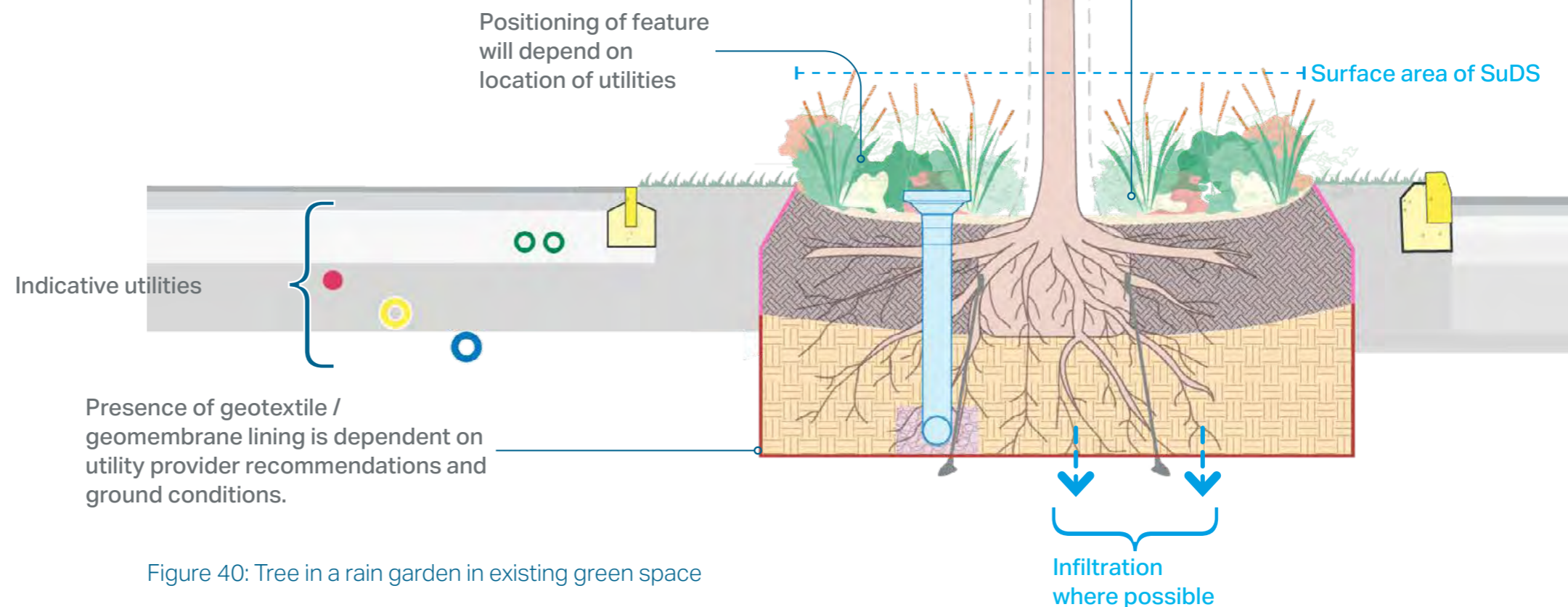


Figure 40: Tree in a rain garden in existing green space

These standard details have been produced for the cases where a rain garden and a tree in a rain garden are retrofit within existing green space. As the utilities shown within the standard detail drawings are indicative, the placement of the green infrastructure will depend on site specific conditions.



UTILITY SCENARIO STANDARD DETAILS

Shallow utilities

When utilities sit at shallow depths and directly interface with green infrastructure features that are being proposed for retrofit, several design options are possible. Rain gardens are one suitable approach, but other shallow-profile green infrastructure features may also be appropriate, depending on site conditions and utility constraints.

A rain garden, for example, can be designed in two ways:

- » A shallow, lined feature with the utility running beneath it
- » A deeper feature with the utility running directly through the engineered layers, with the utility wrapped with a liner.

In both cases, it is generally preferable for the green infrastructure feature to cross the utility at the shortest point, rather than run parallel along its length.

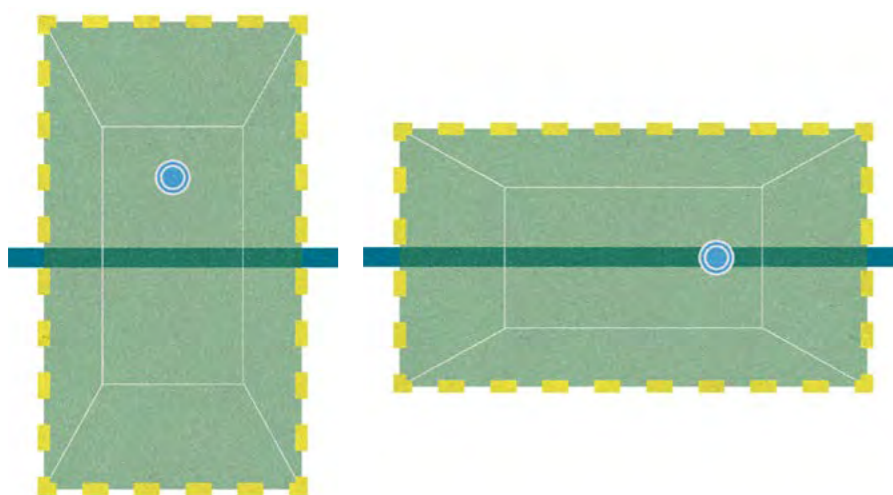


Figure 41: Green infrastructure features should span across the shortest distance of the utility

Shallow features

Where shallow features are selected, it can be beneficial to design green infrastructure in a way that allows flexibility in the positioning, to accommodate utilities encountered on site.

Key considerations:

- » Adjusting the footprint of the feature to meet design storm events
- » Species selection to consider those with a smaller root spread such as shrubs.

Utilities running through a feature

Alternatively, the utility may be routed through a green infrastructure feature. For example:

- » A rain garden may be constructed with the utility running through its structural layer
- » In tree retrofit situations, a utility line may run between soil cell units.

Key considerations:

- » Wrapping the utility with an impermeable membrane
- » Utility maintenance should be undertaken with an air spade
- » If ground conditions allow infiltration, this can support integration and reduce complications.

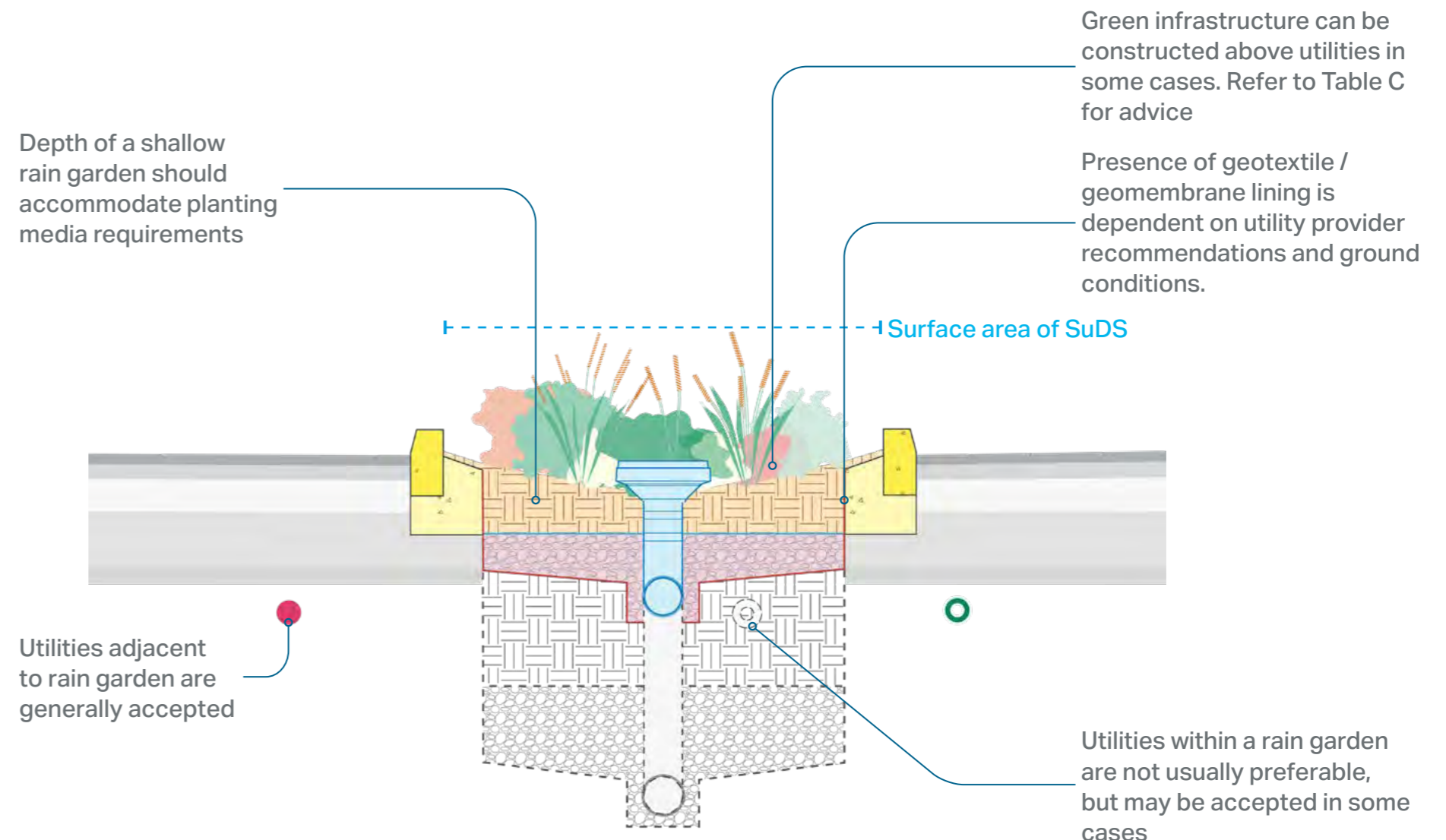


Figure 42: Utilities running through a feature and shallow rain garden

High risk utilities

Higher risk utilities include high voltage electricity cables, high pressure gas mains, trunk sewers and trunk water mains. These assets are designed to move energy, gas and water over long distances, at high capacity and serve the wider branches of these networks. The consequences of their failure can cause fatal or severe injury, as well as significant disruption to infrastructure including service outages and damage to the environmentⁱ.

It is important to allow for inspection, maintenance, and emergency repair. In urban environments, these utilities are most commonly located within the carriageway, and in rural areas, they are often routed through verges or fields.

Choice of planting species can be especially important near higher risk assets, especially ageing infrastructure, such as trunk sewers, that are facing structural or service issues. Appendix A contains a comprehensive species selection for varying use cases. The risk is equally associated with the personnel undertaking the installation in proximity to these assets.

ⁱ Health and Safety Executive. (2014) Avoiding danger from underground services

High voltage electricity

Risks: Impressed voltage is uncommon in routine street works but can be a risk with HV infrastructure. This occurs when conductive materials are installed near HV equipment which can raise the materials to an elevated voltage compared to the local earth, even without any direct contact.

Considerations: HV networks are often laid in parallel, so any investigatory works should ensure the extent of these assets is understood.

High pressure gas

Risk: Accidental strikes are the most common cause of damage and can cause major explosions and fires.

Trunk water main

Risk: A compromised trunk main will release large quantities of water rapidly and can cause flooding, ground erosion and collapse of nearby surfaces.

Trunk sewers

Risk: Damage to trunk sewers can cause flooding both in the streetscape and to connecting properties. Full collapse has potential to impact the carriageway above.

Considerations: Trunk sewers are generally brick, egg shaped sewers that have joints.

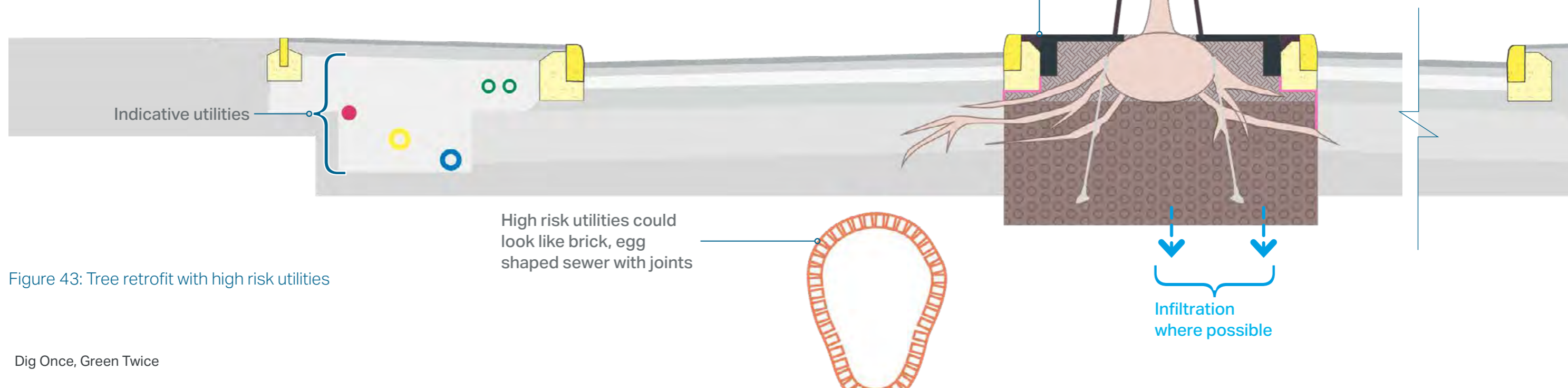


Figure 43: Tree retrofit with high risk utilities

WHAT ARE THE SOLUTIONS?

The following subsections describe a number of measures or 'solutions.' When these solutions are agreed with utility providers, the required distance between green infrastructure features and utilities can often be reduced.

Trees exposed to compacted or low-quality soils tend to develop shallow, laterally spreading roots, increasing the likelihood of surface conflicts. From a structural perspective, poorly drained SuDS and NbS can suffer from soil collapse, settlement and surface failure, particularly beneath paved areas. Ensuring positive drainage through well-designed soil structures is therefore essential not only to support healthy root systems, but also to prevent long-term maintenance issues.

To meet the competing needs for support of trafficked areas and access for root growth in a common soil volume, integrated design solutions have been developed in the use of "load bearing" soils and non-load-bearing (protected) soils within structural cells. The load-bearing soils include sand-based soils such as "Amsterdam tree soils" and stone-based "structural soils", such as those developed in the "Stockholm system" ⁱ.

Structural soils

A structural soil is a stone-based planting substrate that can withstand pedestrian and vehicle loadings. When correctly designed and installed, structural soils provide a stable medium that also maintains sufficient void space to allow for root penetration, aeration and the positive drainage of water, which can be used in many green infrastructure contexts. In particular, structural soils can be used to extend rain gardens beneath surrounding

ⁱ British Standard Institute. BS8640:2025 (2025) **Structural and supported soils for trees in hard landscapes Guide for soil volumes required for trees of different sizes.**

hard surfacing, so allowing larger-growing tree species to be accommodated within small rain gardens. A key benefit of using structural soils is that they can be easily excavated and reinstated.

At present, a widely used high-performing stone-based structural soil mix includes 32–63 mm clean angular stone with organic amendments such as enriched biochar and PAS100 compost, as recognised within BS 8640:2025 guidance. The 32-63mm clean stone should be screened to remove fines and can be a hard angular stone such as crushed granite, or basalt. Crushed limestone or recycled concrete can be used in the structural soil mix if these materials are used designers must ensure that only an alkaline tolerant species is planted because these aggregates will elevate the soil pH. When installing structural soils around existing services the structural soil should be treated as any other sub-base material, and so delicate pipework or infrastructure can be protected with pipe bed aggregate as it is under normal circumstances.

Structural soils are typically designed for sites where the ground has a gradient of $\leq 5\%$. Where the ground is steeper, water can flow through the structural soil and drainage layers too quickly, with the potential of removing the non-structural elements. In this situation, site-specific designs need to be produced by the project engineer.

Presence of geotextile / geomembrane lining is dependent on utility provider recommendations and ground conditions.

Structural soil

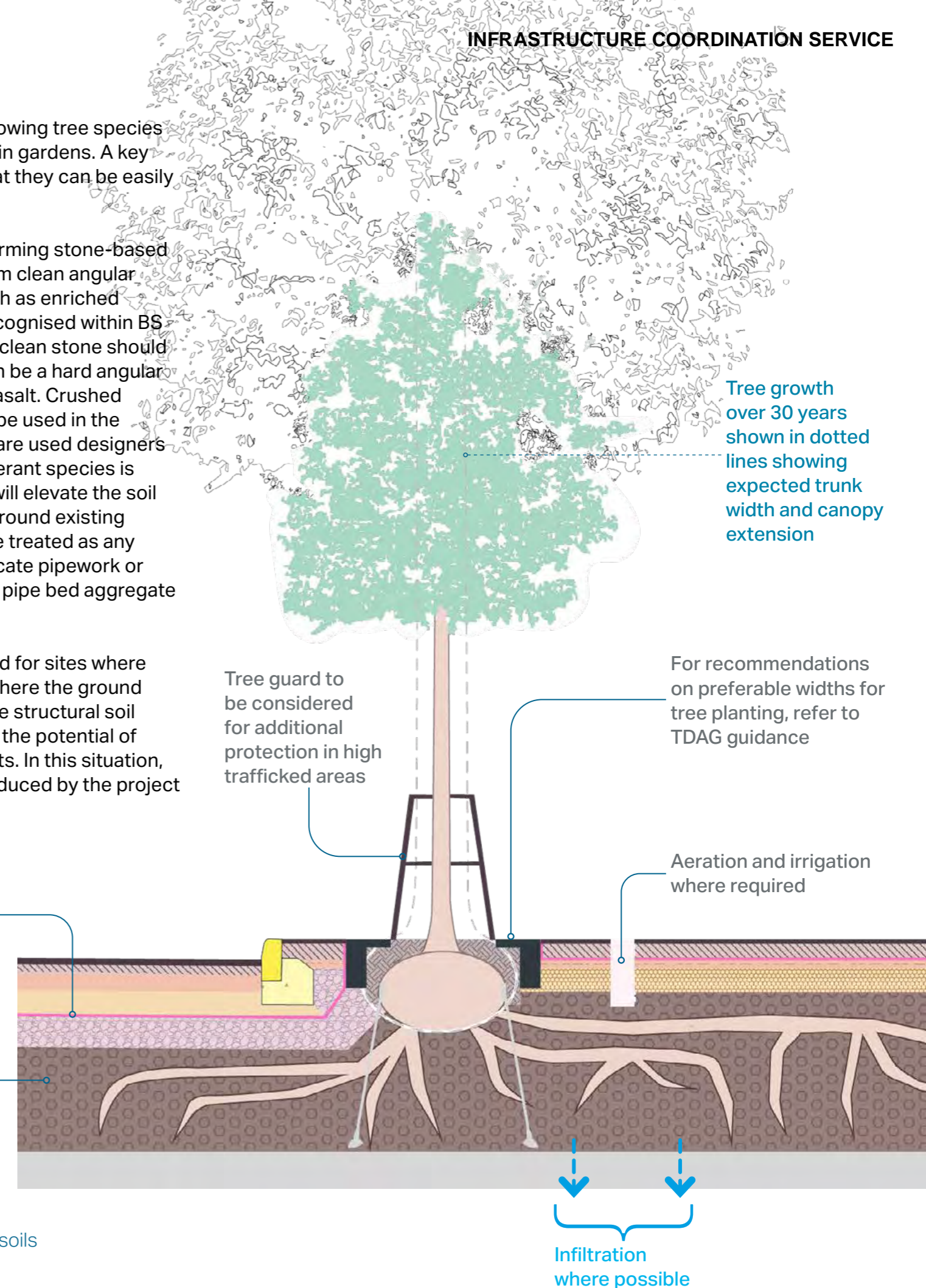


Figure 44: Tree retrofit with structural soils

Soil cells

Soil cells are prefabricated modular structural units, typically made from recycled plastics in the UK, although concrete options exist for larger-scale applications. They are designed with large horizontal voids to balance plant rooting with the distribution of loads. Installation of soil cells varies depending on the product, and so guidance should be sought from the manufacturer for installation.

Soil cells are normally installed over a compacted sub-base. Many systems use aggregate around the perimeter for structural stability, with the internal volume filled with a suitable soil mix; however, details vary by system and manufacturer. Suitable soils are typically engineered loam or bioretention mixes designed for structural cell systemsⁱ where soil profiles would normally include subsoil and topsoil layers. Aeration/ventilation pipes are recommended as part of soil cell designs as these will help support root growth and associated soil life.

Soil cells can be integrated with tree pits to be constructed near or on top of utility services, where systems bridge over the utility and distribute the load.

Soil cells function as an interlocking structural matrix. Removing or cutting modules can reduce strength so they must be engineered carefully. Nevertheless, it is possible to route cables through soil cells or construct soil cell structures around existing services. A successful trial with Green Blue Urban and Southern Water shows that a leaking water main was successfully repaired beneath their tree pit system using trenchless techniques (air spade)ⁱⁱ.

Cellular Confinement Systems

Cellular confinement systems (CCS) or are strips of hard-wearing plastic that are joined together at intervals, and expand to form a grid of cells: the cells are filled with soil or aggregate to provide stability and can protect tree roots by preventing erosion and distributing surface loads over a wider area. The installation of the system should always involve coordination with the manufacturer or project engineer, to ensure that the system is suitable for site conditions.

Cellular confinement systems (CCS) are designed for effective load bearing of pedestrian traffic or vehicular loads, depending on ground conditions and the product selected. CCS can be used as a temporary or permanent measure. However, because CCS functions as a continuous confinement layer, repairs or utility access beneath it may require partial removal and reinstatement of panels, which can be challenging on heavily loaded or trafficked sites.

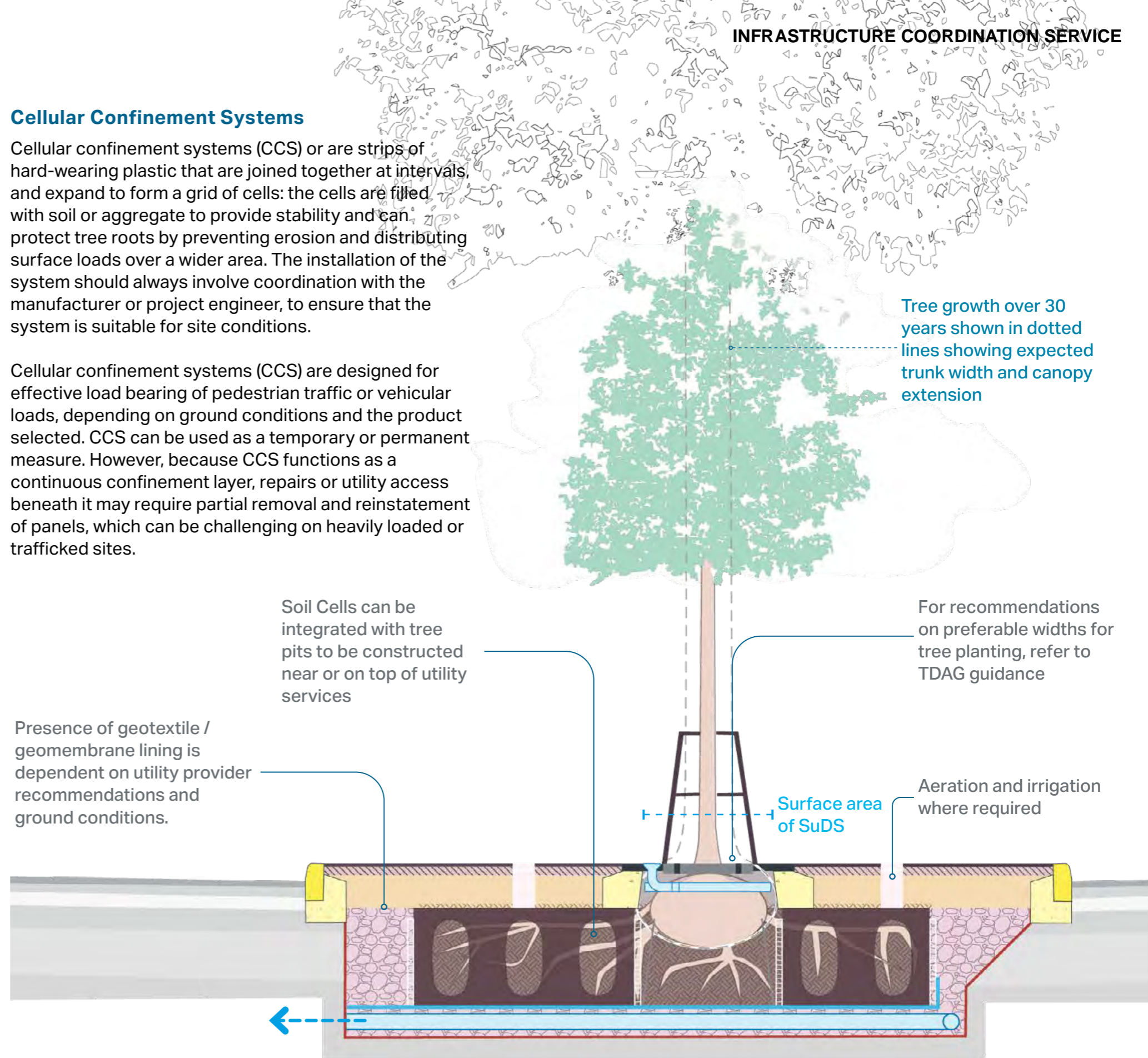


Figure 45: Tree retrofit with soil cells

i BS8640:2025
 ii AJS Flood Risk Consulting. (2023) Trees and Utilities Study

Root deflection systems

Root deflection systems are products made of an impenetrable (often plastic) layer to direct the growth of root systems in a longitudinal direction rather than laterally. The product is installed to surround the root ball of the tree to, in theory, guide early roots downwards into deeper aerated soil layers, reducing shallow lateral spread.

By guiding roots downwards, pavement lifting and distortion caused by lateral roots can be reduced. With correct installation, roots may emerge farther from the trunk. This can reduce the impact of root disturbance at the surface although long-term evidence remains limited. However, if an adequate rooting environment is not provided, roots will still seek out favourable conditions such as the sand layer beneath.

Pruning distant roots has less impact on the health of the tree as the critical anchoring roots remain intact. Root directors are often specified by designers when installing trees into hard landscapes, however their long-term impact on mature trees is not yet documented and their long-term effectiveness remains unprovenⁱ.



Figure 46: Structural Soils being implemented at Markhouse Corner, London Borough of Waltham Forest

Membrane root barriers

Membrane root barriers are impermeable sheets made of synthetic polymers which block root penetration. When selecting and installing protective measures, the priority should be protecting the asset or feature that is at risk of root intrusion. Consideration should be given to maintenance or reinstatement works where a membrane is wrapped around a utility due to complexities with reinstating the membrane root barrier.

Root barriers should only be specified where there is a specific need to restrict root growth and should not be used to line the tree pit. The product manufacturers should be able to advise on the lifespan and performance criteria of these products.

Utility access panels

A retrofit scheme can be designed with removable surfaces such as access panels to provide access to shallow, flexible services such as telecoms. Clear space should be provided around the cover for safe lifting and covers should be robust, raised and, watertight. For larger green infrastructure features with dense planting, including a small hardstanding area can also support maintenance access without damaging vegetation.

Cable protection

Utility sleeves or conduits can still be installed to retrofit existing cables during utility works. Products on the market such as split pipe or half pipe systems can be dismantled into two pieces and fit around the existing utility. The built-in locking mechanism can then be used, such as sliding the tongue and groove joint or using the external clamp once the two halves are attached, ensuring a quick and easy installation. Products exist on the market which are sand, water and gas proof, with the ability to withstand heavy loads such as those from roots.

Utility corridors

Utility corridors are linear channels which are designed to accommodate the utility or utilities. Streetworks UK recommends the sharing of trenches wherever possible, to reduce the number utilities causing uncertainty in the highwayⁱⁱ.

By using easy to reinstate materials in utility corridors such as gravel, cost savings can be found in construction methods and reinstatement liabilities for utility companies. By offsetting utilities in known utility corridors, certainty is gained around their location, and the risk of impairing the function of a green infrastructure feature is removed due to separate space designations.

For the context of retrofitting, a utility corridor may not be an appropriate or cost-effective measure, unless the site extends to cover a large portion of the highway. Design should ensure that that infiltration of water from green infrastructure features is not directed toward the utility trench.



Figure 47: Utility protection sleeves

ⁱ Morgenroth J. (2008) A Review of Root Barrier Research

ⁱⁱ Street Works UK. (2026) Volume 4: Guidelines for the planning, installation and maintenance of Utility apparatus in proximity to Trees)

Green infrastructure configuration

Strategically placed gaps or soft access zones can provide access to underground assets at certain locations, whilst still maintaining overall system function. These may include gravel bands, turf strips or removable surface treatments that can be temporarily lifted and reinstated following utility works.

Green infrastructure configuration could also make use of modular construction; a series of hydraulically linked rain garden features or tree pits that are strategically placed to provide sufficient access for utilities. This approach avoids the need for the full excavation of planted areas, whilst making use of catchments where gradients are less steep as water run-off is shared between features.

Shallower rain gardens

Semi-recessed planters may also offer a solution to managing surface water run-off where rain gardens are not able to be installed. A small amount of excavation is required for the lateral inflow from an inlet such as a channel drain to reach the base of the unit. The planters can sit above a layer of rock-wool based porous blocks or a stone base, where the surface water is absorbed by capillary action into the planting substrate.

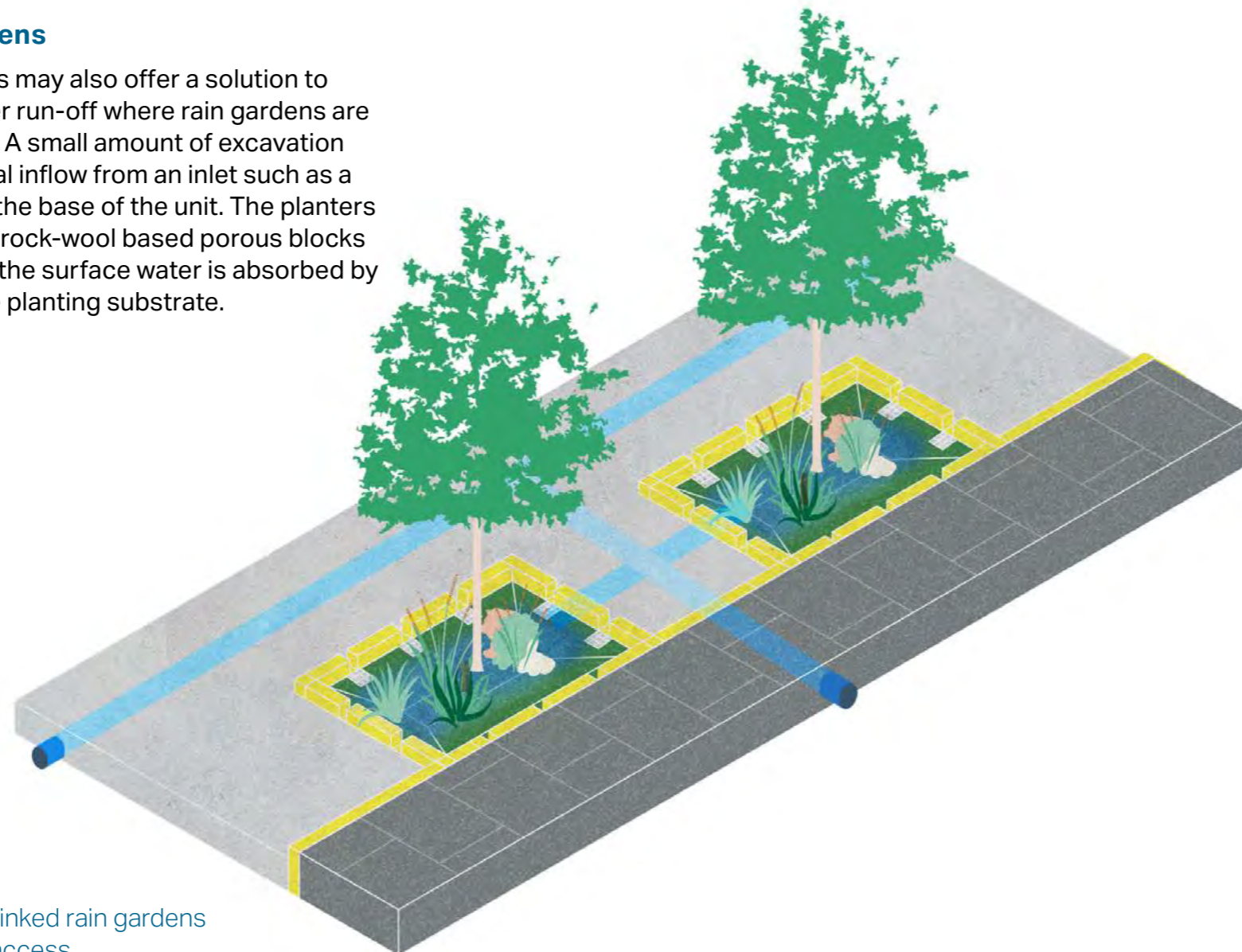


Figure 48: Hydraulically linked rain gardens to provide better utility access

Retrofitting during utility replacement works

The replacement of a utility asset, for example the upgrade from a cast iron to a uPVC main, may provide opportunity to retrofit green infrastructure rather than replacing with hard surfaces such as asphalt.

The replacement of a utility main likely requires the excavation of a large portion of the street, meaning the green infrastructure feature can be designed and placed in more locations, as opposed to a dig down maintenance activity which only requires excavation at a single location or intervals.

CHECKLIST FOR DURING WORKS

- Are there any root protection zones for existing trees?
- Are roots of new trees being protected from potential damage during installation?
- How will soil be stored on site?
- Have all utility assets been scanned on site and marked?
- Are areas of hand dig required?
- Have assets been inspected for damage prior to backfilling?
- Are inspections being carried out at hold points identified in RAMS?
- Are connections to inlets/outlets clear and free-flowing?
- Have inlets/outlets been checked against site levels?
- How are unexpected utilities or ground conditions being managed?
- Have works been completed as per the design?

CHAPTER 05

Maintenance and long-term management

Overview:

This chapter focuses on post-construction considerations. It highlights the importance of ongoing maintenance and outlines methods and practices that help ensure long-term performance and success of the installed scheme.

MAINTENANCE OF GREEN INFRASTRUCTURE

Maintenance considerations

Effective SuDS design should consider the maintenance strategy from the outset. Where schemes are being adopted, designers should coordinate with the adopting authority to understand existing asset management practices and align new schemes with established regimes. Maintenance requirements should fit the context of the area and rely on standard, cost-effective techniques. Reliance on specialist equipment can increase costs and subsequently decrease maintenance frequency, making routine upkeep impractical.

The public perception (as well as the function and ecosystem services) of a successful SuDS or tree scheme often comes down to how well the feature is maintained. Visible issues such as silt build-up, litter, or stressed vegetation can lead to the impression that a scheme is failing, even when it performs well hydraulically.

The cost of green infrastructure maintenance should be estimated and budgeted at a scheme design stage and not be addressed at the point of maintenance. This allows funds to be discussed and sufficiently allocated to cover the life cycle of the newly installed feature.

To allow maintenance teams to understand and effectively maintain a new SuDS or tree, as-built information should be thoroughly recorded and passed over to the adopting authority. It is often the case that teams undertaking maintenance do not have the same level of information as designers, so it is important to share information and to communicate residual risks. This information should be converted into activities from the standard activity schedules. The clear allocation of responsibilities is important as this may sit across multiple teams (for example the grounds maintenance, drainage or trees service.)

Typical maintenance activities

Cyclical maintenance activities may include removal of litter, grass cutting, weeding, tree pruning, inspection of inlets/ outlets and the sweeping of permeable surfaces. The frequency of these activities will vary due to type and size of features and can be determined during a site walkover, which should be recorded for future reference. Although the maintenance activities listed above do not require excavation, some activities can still damage utilities. Activities that have a higher risk of damaging utilities are trenching, stump grinding, desilting, and the use of heavy plant. Due to the cyclical nature of maintenance activities, it is easy to find a level of complacency with repeated activities. Hand digging or the use of an air spade is advised for excavations within proximity to a known utility service.

Maintenance activities may also involve establishment care and cyclical activities. Establishment care is required for at least 3 years for trees, and ensures the early root system can thrive. Typical establishment care activities may include consistent watering, removal of weeds and ensuring the integrity of any surface treatment surrounding the tree.



Figure 49: Typical maintenance activities [credit: Meristem Design]

Protecting roots during utility operations

Typical 'open trench' installation of underground services near trees is likely to sever roots; this will harm the tree's physiological condition, provide an opportunity for fungal infection, and could leave them prone to windthrow. To minimise potential damage to trees, high pressure air or water can be used for excavations, allowing major roots to remain intact. Directional drilling can also be used to install new pipework to minimise damage to established trees.



Figure 50: Typical maintenance activities [credit: Meristem Design]

ENSURING LONG TERM SUCCESS

Maintenance schedules

A maintenance plan should be prepared following the site walkover and retained for record-keeping. However, it should remain flexible and be updated in response to any newly observed landscape or drainage requirements. The maintenance plan may need to be standardised to meet the schedules already in place by the adopting authority.

Protecting green infrastructure features

Utilities companies have a right to access and maintain their assets within the adopted highway, even when those assets lie within or beneath a SuDS or tree featureⁱ. This can create challenges, as a utility owner may need to excavate a constructed feature for maintenance or repair.

To future-proof green infrastructure and ensure proper reinstatement after utility or highway maintenance, eligible features can be designated as a 'Special Engineering Difficulty' (SED) under Schedule 4 of the New Roads and Street Works Act 1991.

An SED is defined as engineering works of significant complexity or risk. Certain streets and areas can be designated as SED when they contain structures or special construction features meaning that works must be executed to avoid damage, or failure of, the associated feature.

In the context of retrofitting green infrastructure, rain gardens are the features most likely to meet the criteria for an SED. Other examples may include:

- » Large attenuation tanks
- » Trees with cellular systems
- » Complex pipe networks
- » Features adjacent to critical utilities or structures.

ⁱ UK Government. (1991) New Roads and Street Works Act

An SED designation is made by the local highway authority, either independently or at the request of the responsible party. The designation of an SED is not statutory, but recommended for protection. Supporting technical information may be required to demonstrate why the feature qualifies. Once satisfied, the authority should confirm in writing that the feature is registered as an SED under Schedule 4 of the NRSWA.

Designation does not prevent utilities or highway maintenance from taking place. Instead, it ensures that no works are undertaken until a plan and section of the works have been agreed between the undertaker and the relevant authority. This requirement helps secure competent reinstatement and protects the hydraulic and functional integrity of the feature - for example, preventing reinstatement with unsuitable materials such as asphalt.

Where more complex green infrastructure is constructed near existing utility apparatus, it may be beneficial to agree a protection and reinstatement detail with the utility provider. This will help ensure that drainage performance is not compromised during reinstatement works.



Figure 51: Rain garden retrofit in a central reservation at St John Street, Islington

CHECKLIST FOR POST-WORKS

- Does the feature need protection from erosion before planting is established?
- Have any as-built drawings been completed?
- Have the as-built drawings been issued to all relevant parties? Have they been issued in the correct formats to support integration into existing systems and maintenance schedules?
- Are any protection measures recorded?
- Is the SuDS/ tree feature functioning as designed?
- Has a plan been put in place for maintenance? Are the responsibilities clear? Has it been added to the necessary asset registers?
- Has a plan been put in place for maintenance and been handed over to the adopting authority?
- Have lessons learned been captured for future projects?
- Has the feature been registered and designated as a Special Engineering Difficulty?
- Has the project been recorded on the Mayor's SuDS Retrofit Map to enable comprehensive monitoring across London?

Participants in the SSM are required to follow the prescribed maintenance schedules

CHAPTER 06

Case studies

Overview:

This chapter presents a series of case studies showcasing how green infrastructure has been successfully retrofitted in close proximity to utility networks. Each example highlights the site conditions, design approach and how the scheme has performed over time. Additional examples of SuDS retrofit projects can be explored using the Mayor of London's SuDS Retrofit Map, which provides a broader range of schemes across London and can be filtered by SuDS type and sector.

LOWER GREEN WEST, LONDON BOROUGH OF MERTON

Project description

This project involved the design and construction of a rain garden and two planters. The 54.8m² rain garden has incorporated play features, a bug hotel and both educational and interactive signage. The project was delivered by FM Conway and Meristem Design for Merton Council in conjunction with SGN Gas and Thames Water. Delivered as a pilot scheme of the SuDS through Streetworks Market.

Coordination with utilities:

This rain garden was constructed after essential SGN gas network upgrades, where a portion of the road was being excavated and green infrastructure was retrofit in areas of existing hard landscape.

Performance over time:

The rain gardens were constructed in a wide pavement area that was utilised by vehicles for unauthorized parking. The construction of the rain garden has successfully changed the way the pavement is used. The planting is well established wooden posts offering protection and maintenance and care instructions have been installed. The reduction in surface water volume for this scheme is 0.9m³.



Figure 52: Photos showing utilities scanning and completed rain garden at Lower Green West [credit: Meristem Design]

ST ANDREWS ROAD, LONDON BOROUGH OF CROYDON

Project description

This project involved the design and installation of two rain gardens along St Andrew's Road, Croydon, which was delivered as a pilot scheme of the SuDS through Streetworks Market. The scheme was delivered by JDT Utilities for Croydon Borough Council, and took place in conjunction with gas main upgrades.

Coordination with utilities:

Utility records showed surface water, foul water and gas infrastructure within the carriageway. Rain garden layouts were positioned to avoid known service covers and major assets, with scope to adjust their locations during construction if unexpected clashes were identified on site following the gas main replacement. The scheme involved coordination and agreement from SGN to build a rain garden over their asset.

Performance over time:

The scheme has been constructed in accordance with the design, incorporating effective erosion control measures and levels to support water inflow via the inlets. The rain gardens have only recently been planted, so their performance and establishment are yet to be assessed. The reduction in surface water volume for both rain gardens is 5m³.

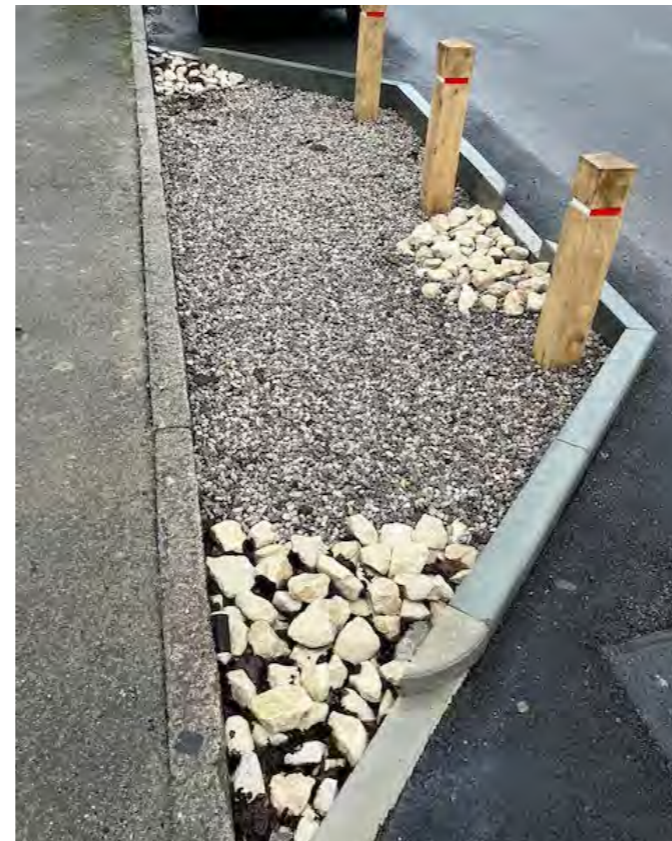


Figure 53: Photos showing completed rain garden at St Andrews Road [credit: SGN]

ST JOHN STREET, LONDON BOROUGH OF ISLINGTON

Project description

At the southern junction of St John's Lane and St John Street, the existing carriageway is wide with a hard landscaped central reservation. In 2018, 3 trees were installed in this reservation in soil cell systems to create tree rooting space while maintaining clear utility corridors. The current project builds on this by greening the street further - adding new trees within the pavement and converting the central reservation into rain gardens, with all soil cell systems and trees retained and integrated into the revised design.

Coordination with utilities

The utility coordination of the 2018 phase required coordination around feeder pillars, water main, low voltage network and multiple comms ducts within the central reservation. Soil cells were used to preserving access and clearances around these existing assets. The current proposals have involved coordination with a number of those same asset owners, including Thames Water for the water main, where the project managed to add value by introducing a water fountain due to encountering the asset on site. Rain garden locations avoid existing high voltage cables.

Performance over time

After nearly eight years in place, the soil cell systems have performed well. Some settlement has occurred within the soil, but the modular structure has prevented any surface issues. Islington's Green Space Officer has shared his long term observations with the soil cell manufacturer to report findings after nearly 8 years to inform developments on that system. The performance of new planting and rain gardens cannot yet be assessed, as works are still being installed, however users of this guide can follow the projectⁱ.

ⁱ [/www.letstalk.islington.gov.uk/st-john-street](http://www.letstalk.islington.gov.uk/st-john-street)

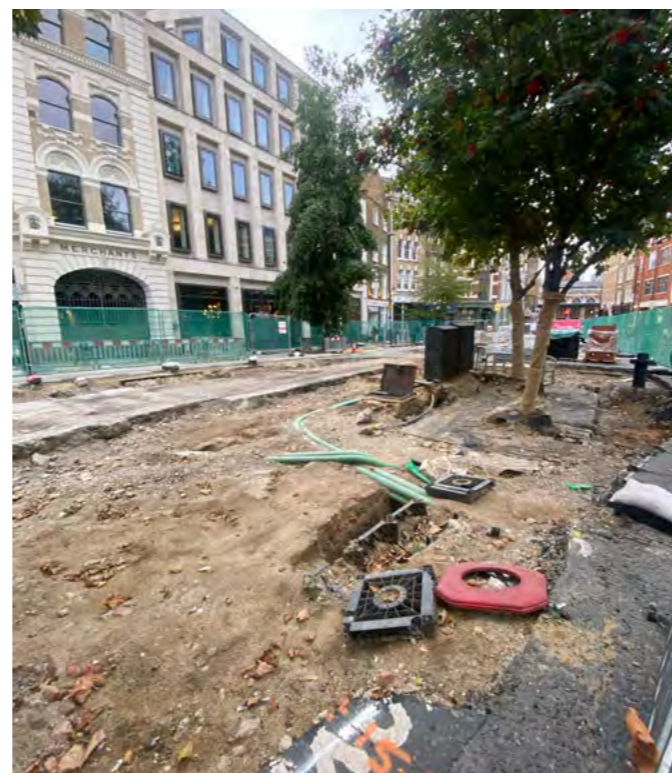


Figure 54: Construction progress at St John Street showing retention of existing trees



Figure 55: Completed scheme at St John Street [credit: Meristem Design]

MARKHOUSE CORNER, LONDON BOROUGH OF WALTHAM FOREST

Project description

This project involved the design and installation of green infrastructure at Markhouse Corner, Walthamstow. The scheme included over 200m² of rain garden and installation of 3 new trees, with improvements at Barker House, Potters House Corner and around the existing clock tower area.

The project was delivered by Rineys in conjunction with Matter Architecture, Churchman Thornhill Finch, Light Follows Behaviour and Meristem for the London Borough of Waltham Forest. This project is part of Waltham Forest's wider Lea Bridge Area Framework.

The project used existing materials and planting wherever possible to minimise wastage with a series of public consultation events undertaken to inform the local residents and stakeholders.

Coordination with utilities:

The interface between utilities and tree roots were managed using the Stockholm system. During construction works, an experienced tree consultant was present to support the term contractors with installation methods and to provide design advice.

Performance over time:

Feedback suggests the trees and planting have been thriving. The scheme included upgrades to lighting columns and proposed public art interventions and shopfront improvements to enhance the public realm.



Figure 56: Finished scheme at Markhouse Corner, London Borough of Waltham Forest [credit: Meristem Design]



Figure 57: Construction works at Markhouse Corner, London Borough of Waltham Forest [credit: London Borough of Waltham Forest]

CHAPTER 07

References and further reading















REFERENCES & FURTHER READING

All references and reading from footnotes and Further Guidance call out boxes is included here.















Chapter 01

Introduction

-  Highways Greening Accelerator
-  Local Nature Recovery Strategy (LNRS)
-  London Drainage Engineers (LoDEG) Training Guide
-  London Environment Strategy
-  London Green Infrastructure Framework
-  London Heat Risk Delivery Plan
-  London Surface Water Strategy
-  London Urban Forest Plan (Action Plan Update 2025)
-  Mayor's Transport Strategy
-  SuDS Opportunity Map
-  SuDS Sector Guidance
-  SuDS through Streetworks Market (SSM)








Chapter 02

Understanding the challenge: integrating trees and SuDS with underground utilities

-  British Standard Institute. (2026) **BS 5837 Trees in Relation to Design, Demolition and Construction**
-  British Standard Institute. (2026) **BS 8545 Trees: from nursery to independence in the landscape**
-  CIRIA. (2015) **C753 The SuDS Manual**
-  Department for Transport. (2020) **Specification for the Reinstatement of Openings in Highways**
-  Hirons, A. D. and Martin K. W. E. (2025) **Future climate suitability of London's public realm trees**
-  Highways Authority and Utilities Committee. (Multiple Dates) **General publications**
-  Laille P., Courtant C. and Meyer-Grandbastien A. (2025) **Racines & réseaux**
-  National Grid. (2023) **Third Party guidance for working near National Grid Electricity Transmission equipment**
-  Government Digital Service, Geospatial Commission and Department for Science, Innovation and Technology. (2026) **National Underground Asset Register**
-  Greater London Authority. (2025) **Reimagining Rainwater in Highways**
-  Greater Manchester Combined Authority (2024). **Greater Manchester's Sustainable Drainage Guide for designing and delivering SuDS**
-  Urban Design London. (2018) **Designing Rain Gardens: A Practical Guide**
-  Street Works UK. (2023) **Volume 1: Street Works UK Guidelines on the Positioning and Colour Coding of Underground Utilities Apparatus**
-  Street Works UK. (2026) **Volume 4: Guidelines for the planning, installation and maintenance of Utility apparatus in proximity to Trees**

Chapter 03

Key design approaches and pre-works considerations

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-  Local Authority Waters Programme. (2025) **Implementation of Urban Nature-based Solutions**
-  London Tree Officers Association. (2017) **Surface Materials Around Trees In Hard Landscapes**
-  Roberts J., Jackson N. and Smith M. (2006) **Tree Roots in the Built Environment**
-  Transport for London. (2021) **Lane Rental Scheme: Delivering roadworks that optimise road network performance**
-  Trees & Design Action Group. (2025) **Trees Species Selection for Green Infrastructure**
-  Urban Design Learning. (2024) **Planting Design Guide for Streets**


Chapter 04

Design scenarios, solutions and workarounds

-  AJS Flood Risk Consulting. (2023) **Trees and Utilities Study**
-  British Standard Institute. (2025) **Structural and supported soils for trees in hard landscapes**
-  Health and Safety Executive. (2014) **Avoiding danger from underground services**
-  Morgenroth J. (2008) **A Review of Root Barrier Research**

Chapter 05

Maintenance and long-term management

-  UK Government. (1991) **New Roads and Street Works Act**

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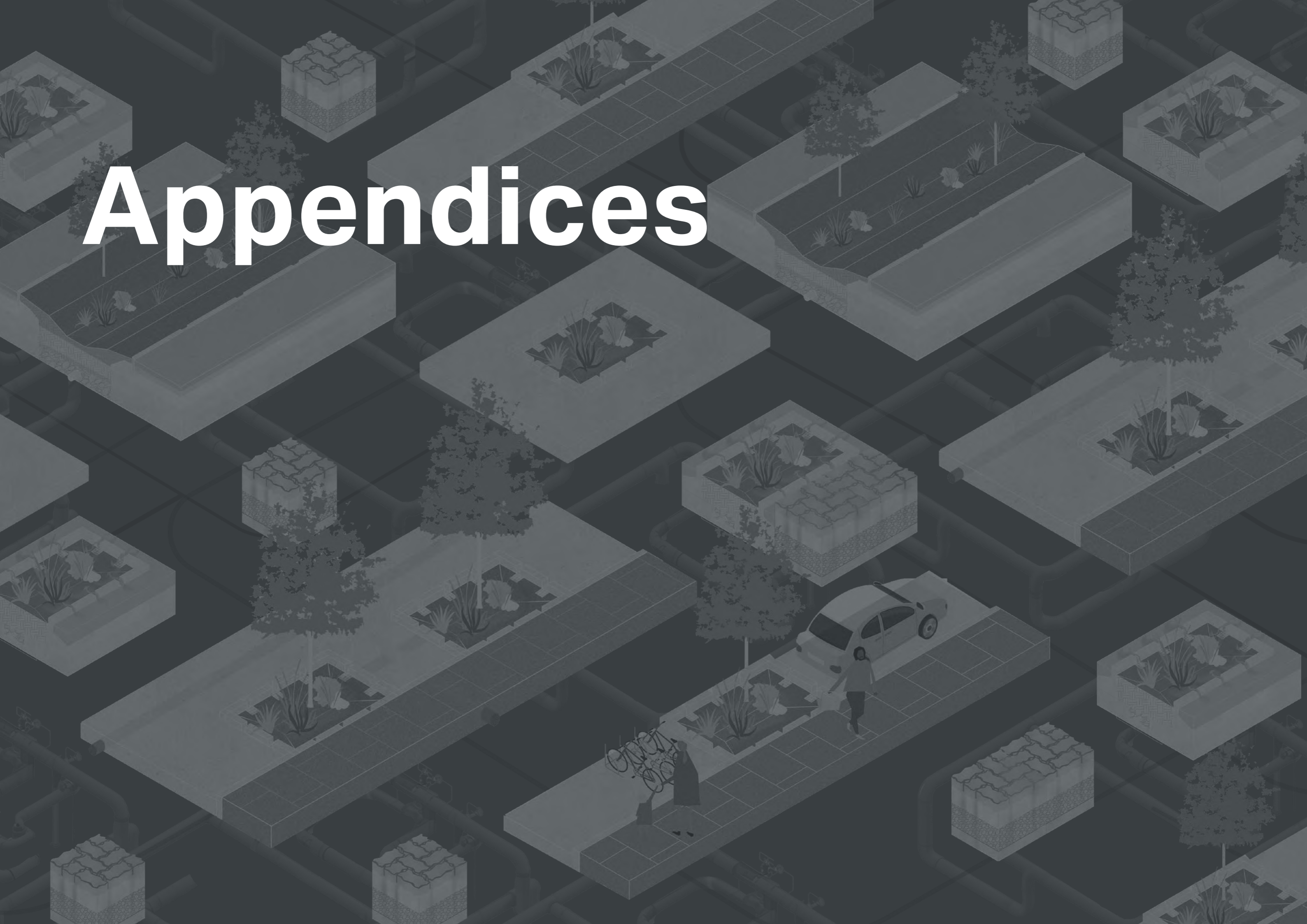
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Appendices



APPENDIX A SPECIES PLANTING GUIDANCE

TDAG's Tree Species Selection for Green Infrastructure tool provides a framework for selecting trees within the urban environment. TDAG provides filters for species selection for SuDS-specific applications, which are signposted in Table D.

Planting guides often give advice in relation to plant tolerance of waterlogging. Waterlogging is often the cause of plant failure, and most plants will not tolerate soils that are not adequately drained. However, an important distinction with SuDS schemes is that whilst soils will be periodically inundated, with the correct drainage, this is short-lived and most plants will tolerate this. The guidance is therefore expanded to list other tree species which are potentially suited to SuDS schemes.

These additions remain consistent with TDAG's principles, while offering a broader species palette to support design flexibility, biodiversity, and resilience for tree planting in rain gardens.

Note: *Betula Nigra*, may be possible to use in SuDS schemes but is likely to shed leaves during dry periods.

SPECIES PLANTING GUIDANCE IN ADHERENCE WITH TDAG

Genus	Species	Good for...	Bad for...
<i>Acer</i>	<i>x freemanii</i>	Medium tree, fast-growing, pH tolerant, adaptable to urban conditions, favoured for strong autumn colour	Brittle wood, asymmetrical / uneven canopy
<i>Acer</i>	<i>negundo</i>	Medium tree, fast-growing adaptable to variable soil conditions, including drought flooding and compaction	
<i>Acer</i>	<i>rubrum</i>	Medium tree, excellent autumn colour	Requires low pH, otherwise rarely performs well on UK soils
<i>Acer</i>	<i>saccharinum</i>	Fast-growing, medium tree tolerates air pollution and wet soils	Branches brittle and prone to breaking, avoid in restricted areas
<i>Acer</i>	<i>x zoeschense</i>	Medium tree	Difficult to obtain commercially
<i>Alnus</i>	<i>cordata</i>	Medium tree, thrives on all ground, conical habit useful for narrow spaces	Avoid planting adjacent to hard surfaces, causes lifting, better in soft verge
<i>Alnus</i>	<i>incana</i>	Medium tree, copes with exposed situations and wet soils	Root suckers common
<i>Alnus</i>	<i>x spaethii</i>	Medium tree, fast-growing, tolerant of dry soils once established, vivid catkins	
<i>Gleditsia</i>	<i>triacanthos</i>	Medium tree, suited to heavily polluted environments, performs well in hard surfaces	Thorny, alternative thornless varieties available, e.g. Draves Street Keeper (narrow form)
<i>Liquidambar</i>	<i>styraciflua</i>	Medium tree, fast-growing, versatile tree for green infrastructure.	Ubiquitous, some councils resistant to use, dislikes chalk soils (not prevalent in London)
<i>Platanus</i>	<i>x hispanica</i>	Large tree and very commonly used throughout urban street plantings	Produces air-borne irritant (BVOCs)
<i>Platanus</i>	<i>orientalis</i>	Large tree and very commonly used throughout urban street plantings	Produces air-borne irritant (BVOCs)
<i>Quercus</i>	<i>bicolor</i>	Large broad tree, typically <20m in British Isles, tolerant of soil compaction	Regal Prince a good alternative for smaller spaces. Restriction on movement outside buffer zones for Oak Processionary Moth
<i>Quercus</i>	<i>palustris</i>	Medium tree, pyramidal varieties available for smaller spaces, tolerant of some waterlogging, excellent autumn colour	Crown lifting often required, Restriction on movement outside buffer zones for Oak Processionary Moth
<i>Quercus</i>	<i>phellos</i>	Medium to large tree, willow-like leaves, can tolerate wetter soils	Restriction on movement outside buffer zones for Oak Processionary Moth

Table D: Species planting guidance in adherence with TDAG

Outlined below are alternative possible SuDS options, based on site specific experience.

Selection of multiple planting species together can increase complexity of maintenance requirements. Planting schemes could look to avoid excessive variety of species to avoid this.

FURTHER SPECIES PLANTING GUIDANCE

Genus	Species	Good for...	Bad for...
<i>Betula</i>	<i>nigra</i> <i>pendula subsp utilis subsp</i>	Large trees pendula subsp is native	Shallow rooting and irritant pollen
<i>Corylus</i>	<i>colurna</i>	Medium large tree	Slow growing and slow to establish so requires good aftercare for 3-5 years post planting
<i>Crataegus</i>	<i>monogyna laevigata</i>	Small native tree	Thorned
<i>Ginkgo</i>	<i>biloba</i>	Large robust tree	High emitter of (BVOCs)
<i>Hamamelis</i>	<i>x intermedia</i>	Small tree – shrub like	Sensitive to warm dry conditions
<i>Ilex</i>	<i>altaclerensis</i> <i>aquifolium</i> <i>koehneana</i> <i>nellie r</i>	Small – medium trees aquifolium is native	High emitter of (BVOCs)
<i>Taxodium</i>	<i>distichum</i>	Very large tree tolerance to salt	Produces adaptive knee roots
<i>Parrotia</i>	<i>persica</i>	Large shrubby tree	Slow growing, produces root suckers
<i>Pinus</i>	<i>wallichiana</i>	Very large and tolerant to air pollution	Intolerant to shade
<i>Tilia</i>	<i>tomentosa</i> <i>cordata</i>	Very large tree, cordata excellent for bees and pollinating insects	Requires a lot of space
<i>Ulmus</i>	<i>resistant</i> <i>cultivars</i>	Medium large tree fast growing	High pollen
<i>Magnolia</i>	<i>grandiflora</i>	Large tree	High emitter of (BVOCs)
<i>Zelkova</i>	<i>serrata</i>	Very large tree tolerance to salt and air pollution	Produces root suckers
<i>Metasequoia</i>	<i>glyptostroboides</i>	Large tree fast growing and easy to establish	Can be sensitive to drought during establishment
<i>Prunus</i>	<i>Padus</i>	Medium large tree, good pollinating tree	Fruit litter

Table E: Further species planting guidance [provided by Bradley-Hole Schoenaich Landscape]

APPENDIX B UTILITY OFFSET REGISTER

Recommended depth of cover	Utility Provider	Asset Type	Guidance for tree planting	Guidance for SuDS features
250 - 450mm	Arelion	Telecoms	Suggested 1500mm offset	Suggested 1500mm offset
	BT Openreach	Telecoms	No guidance provided	No guidance provided
	CityFibre	Telecoms	A distance of 500mm from the base of the root is recommended with root protection.	No guidance provided
	euNetworks FiberUK	Telecoms	No guidance provided	No guidance provided
	EXA Infrastructure	Telecoms	No guidance provided	No guidance provided
	G. Network	Telecoms	No guidance provided	No guidance provided
	Gamma	Telecoms	No guidance provided	No guidance provided
	MUA Group	Telecoms	Trees should follow BS5837 to ensure tree root protection.	<ul style="list-style-type: none"> » At least 5m from buildings and infrastructure » 2.5m from site boundaries » 1m above the water table » 300mm from water and wastewater pipes
	Neos	Telecoms	Assets are in a 110mm conduit that should protect assets from tree roots. Preference for new tree planting would be 10m away	There are no specified offsets for SuDS. Preference for systems that do not require draining in the event of a repair or alteration
	Virgin Media	Telecoms	No guidance provided	No guidance provided
LV: 450mm HV: 450 - 950mm	Zayo	Telecoms	No defined offset distances. Suggested a root barrier system is employed in urban areas. In rural areas they request the easement in place is observed, and to consult them ahead of planting new woodlands or plantings	No specified minimum distances for SuDS features. The installation of a soakaway or permeable paving would be preferable over a pond or water retention basin above the network. Interested in having visibility and providing feedback for each potential design and believe that each design should be assessed on its own merits.
	SSEN	Electric	No guidance provided	No guidance provided
	UK Power Networks	Electric	<p>UKPN request sufficient clearance from their assets with tree planting to ensure that future excavation and cable replacements are not impeded by root growth. Where a tree is located within 5 m of their assets, they advise the use of root barriers.</p> <p>Generally, 10m clearance to buildings and 5m clearance to an open compound/substation boundary is advised. This depends on the size of the tree as UKPN's priorities are the stability of structures and keeping compounds secure from unauthorised access by people climbing trees.</p>	A 10m clearance from substations is advised due to unplanned events of oil contamination
	National Grid	Electric	No guidance provided	No guidance provided

600mm	SGN Gas	Gas	<p>SGN request written approval should be obtained from them before any tree planting is carried out.</p> <p>SGN have published a guidance document 'Dig safely: Measures to avoid injury and damage to gas pipelines' (March 2017) where tree species and corresponding recommended distances are given</p>	<p>Consultation for SuDS features should take place on an individual basis as the distance recommended from the pipe will vary due to size and material. SGN have stated that construction of a rain garden directly above or in close proximity to their assets is not permitted.</p>
	Cadent Gas	Gas	<p>Cadent Gas have published a guidance document titled 'Specification for Safe Working in the Vicinity of Cadent Assets' (2023) with planting guidelines:</p> <ul style="list-style-type: none"> » Recommended above the asset (for screening): Quickthorn, Blackthorn » Over 2m: Raspberries, Gooseberries and Blackcurrants » Over 3m: Dwarf Apple Stocks and Christmas trees (Picea Abies (Christmas trees clear-felled at intervals not exceeding 7 years) » Over 6m: Ash, Beech, Birch, most Conifers, Elm, Maple, Horse Chestnut, Oak, Sycamore, Apple, Lime and Pear » Over 10m: Poplar and Willow 	<p>Cadent Gas prefer SuDS features above plastic mains rather than metallic. Consultation is required for each design to be assessed individually, and trial holes to prove no diversions are necessary.</p> <p>For plastic pipes remaining within SuDS, no valves should be in the area, the minimum depth of cover (according to Streetworks UK) should remain and backfilling should be in line with their Guidance Document</p> <p>For plastic pipes remaining within SuDS, no valves should be in the area, the minimum depth of cover should be observed, and backfilling should be in line with their Guidance Document</p>
750 - 1200mm	Affinity Water	Water	<p>Affinity Water have published a guidance document titled 'Developing And Working Near Our Pipes And Apparatus' (July 2024). With consultation and prior approval, Affinity Water may allow shallow rooted plants in proximity to their assets.</p> <ul style="list-style-type: none"> » Recommended above the asset (for screening): Blackthorn, Broom, Cotoneaster, Elder, Hazel, Laurel, Privet, Quick Thorn, Snowberry and most ornamental flowering shrubs. » Over 6m: Ash, Beech, Birch, Conifers, Elm, Horse Chestnut, Lime, Oak, Sycamore, Apple and Pear » Over 12m: Poplar and Willow 	<p>Preferred widths for structures are given, varying on the diameter of the Water Main. The measurements are taken from the outside barrel of the Water Main.</p> <ul style="list-style-type: none"> » 150mm or less (6"): 3m » Between 151mm and 600mm (6"-24"): 3.5m » Greater than 600mm: 4.5m <p>When minimum offsets cannot be achieved, consultation is required, suggested email: maps@affinitywater.co.uk</p>
	SES Water	Water	No guidance provided	No guidance provided
	Thames Water	Water / Sewerage	<p>Thames Water have published a guidance document 'Tree Planting Guidelines' (March 2022) which includes a species list and a distance from the centre line of the asset.</p> <p>The document notes if tree planting designs propose a root protection barrier or other root management structures (such as root crates) Thames Water can agree a reduction on the horizontal clearance distance by 50%.</p>	<p>After a survey to confirm the condition of the asset, Thames Water will accept shallow planted rain gardens directly above, or near their feature if the following conditions are met:</p> <ul style="list-style-type: none"> » Good access to asset provided either side of the shallow planted rain garden » The shallow planted rain garden is lined » The sewer is not a trunk water main or a material which is at a higher risk of damage (eg. cast iron) » 500mm clearance is provided to valves or hydrants, with shallow planted rain garden not covering these assets » 500mm vertical clearance above sewer

Table F: Register of suggested offsets by utility companies

A concise version of this table is provided in chapter 4: Design scenarios, solutions and workarounds.

APPENDIX C

EXAMPLE TOOLBOX TALK

What is the purpose of this talk?

The purpose of this toolbox talk is to understand the key materials in SuDS rain garden construction and the importance of installing them correctly.

What are rain gardens?

Rain gardens are engineered planting features which can be retrofit into the carriageway or footway. They capture, store and treat rain water run off before slowly releasing it back to the drainage system, taking the pressure off existing surface water or combined sewers in heavy rainfall events.

What are the key materials in construction?

- » Impermeable liner made of flexible plastics
- » Perforated pipe
- » Layer of granular material
- » Geotextile to stop the migration of finer particles into the granular layer. This can be a hessian material
- » Layer of filter material made of clean fine aggregate
- » Layer of growing medium
- » Mulch layer and planting
- » Overflow gully
- » Inlet with erosion protection.

Why is the construction important?

- » A liner should be installed if utilities are present beneath the rain garden or if the ground is unsuitable for infiltration
- » The layers of granular and filter material should be clean and separate
- » The geotextile should be fully wrapped and bonded to the liner to prevent fines migration
- » Levels are important to ensure the entry of surface water into the feature
- » The layers should not be over compacted to allow for the water to drain.

What are the key safety risks?

- » Working near live utilities
- » Deep excavations
- » Working in a carriageway.

Highways and Safety Considerations

Remember to use a permit to dig and follow safe digging practices

APPENDIX D

TECHNICAL DRAWINGS

The following pages provide a collation of scaled technical drawings relating to green infrastructure and utilities:

Wide pavements:

Tree in a wide pavement

Tree and rain garden in a wide pavement

Rain garden in a wide pavement

Build outs:

Tree in a build out

Tree and rain garden in a build out

Rain garden in a build out

Central reservation:

Tree in a central reservation

Tree and rain garden in a central reservation

Existing green space:

Tree in existing green space

Tree and rain garden in existing green space

Rain garden in existing green space

Other:

High risk utilities

Shallow utilities

Tree in structural soil

Tree in soil cell

CROSS SECTION OF TYPICAL TREE IN A WIDE PAVEMENT (PROXIMITY TO UTILITIES)

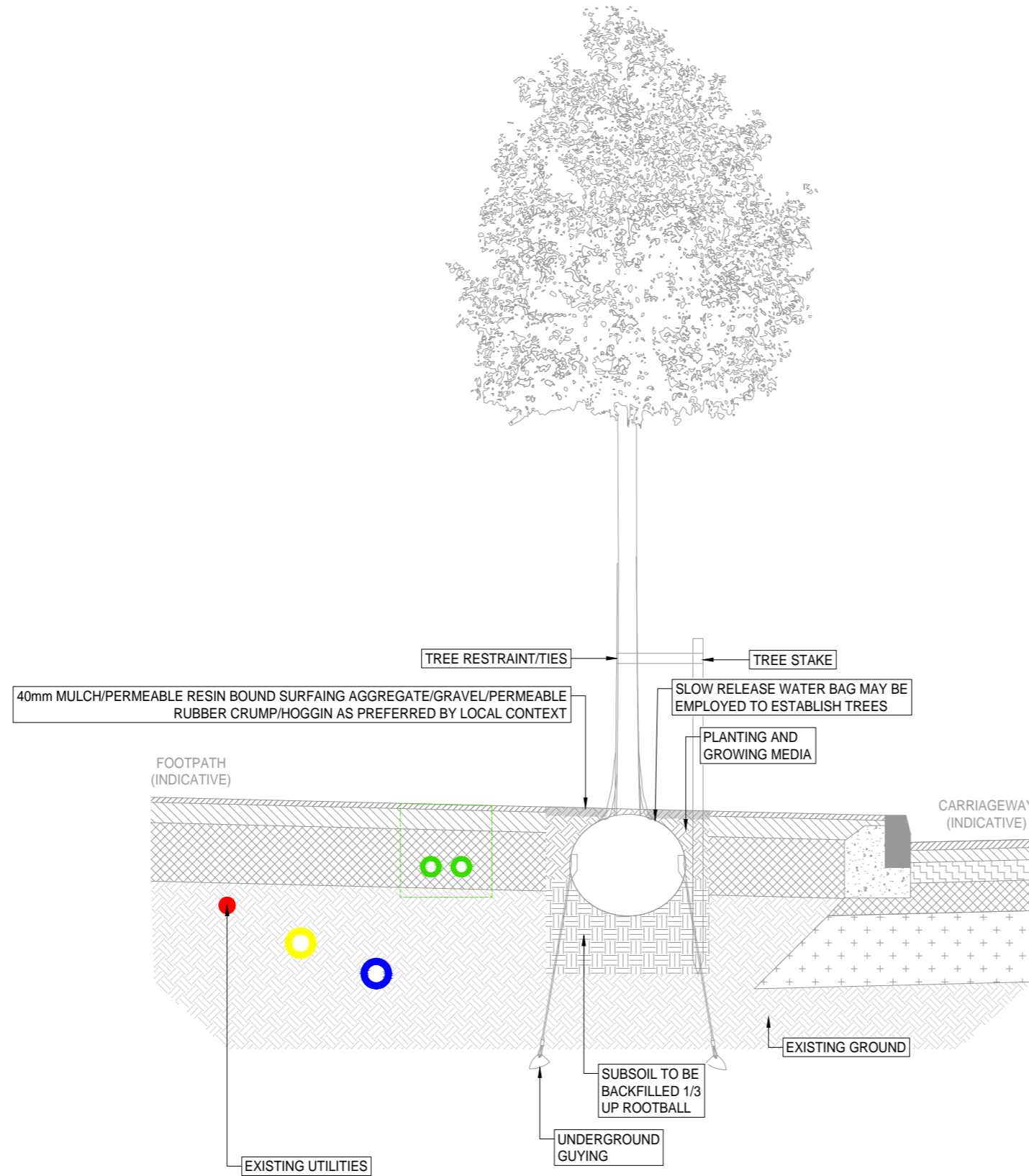
KEY	
	EXISTING GROUND
	SURFACE COURSE
	BINDER COURSE
	BASE COURSE
	SUB-BASE
	CAPPING LAYER
	PLANTING AND GROWING MEDIA
	SUBSOIL

- STANDARD NOTES
- THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL RELEVANT ARCHITECTS AND ENGINEER'S DRAWINGS AND THE SPECIFICATIONS.
 - THIS DRAWING SHOULD NOT BE SCALED.
 - ALL DIMENSIONS ARE TO BE VERIFIED BY THE CONTRACTOR ON SITE.
 - ALL DISCREPANCIES SHOULD BE REPORTED TO C.A./E.A. PRIOR TO THE COMMENCEMENT OF WORKS.

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- NOTES:
- THESE DRAWINGS DO NOT PROVIDE BLUEPRINTS FOR ALL GREEN INFRASTRUCTURE RETROFITTING, BUT OUTLINE SOME KEY PRINCIPLES FOR SOME TYPICAL LOCATIONS. THEY DO NOT REPLACE APPROPRIATE PROFESSIONAL ADVICE.
 - THE DRAWING SHOULD BE READ IN CONJUNCTION WITH THE RELEVANT SECTIONS OF THE FULL DOCUMENT.
 - FOR LIVE PROJECTS DECISIONS MUST BE MADE ON A SITE BY SITE BASIS.
 - ALL DIMENSIONS ARE IN mm UNLESS OTHERWISE STATED.
 - POSITIONING OF GREEN INFRASTRUCTURE FEATURES SHOULD CONSIDER HYDRAULIC INFLOW, WHERE LATERAL INFLOW CANNOT BE ACHIEVED, OR WHERE ADDITIONAL INFLOWS CAN BE ACCOMMODATED WITHIN THE GREEN INFRASTRUCTURE STORAGE CAPACITY. POINT INFLOW VIA A PIPED CONNECTION CAN BE EXPLORED AND SHOULD BE REVIEWED WITH THE PROJECT ENGINEER.
 - FOR TREE-LINED STREETS DISTANCES BETWEEN TREES WILL DEPEND ON SPECIES, ANTICIPATED SIZE AT MATURITY.
 - UNDERGROUND GUYING / ANCHOR SYSTEMS: TREES UP TO 14-16cm GIRTH ARE USUALLY STAKED RATHER THAN SUPPORTED BY UNDERGROUND GUYING.
 - TREE STAKES, GUARDS, TREE BASE SURROUNDS WILL VARY WITH LOCATION, TREE SIZE AND AESTHETIC PREFERENCES. FOR THIS REASON, WHEN SHOWN ON THE DRAWING THEY ARE INDICATIVE (SEE PRECEDING PAGE FOR DRAWING SPECIFIC NOTES).
 - LOCATION OF SERVICES ARE SHOWN INDICATIVELY ONLY. SPACED AS PER STREET WORKS UK GUIDANCE ON THE POSITIONING AND COLOUR CODING OF UNDERGROUND UTILITIES APPARATUS VOLUME 1
 - POTENTIAL GROWTH OF TREE ROOTS, TREE TRUNK/STEM AND TREE CANOPY IS SHOWN TO INDICATE THAT THE TREES WILL GROWN IN THESE DIMENSIONS OVER TIME, BUT CANNOT SHOW SPECIFIC DIMENSIONS AS THESE WILL VARY SPECIES BY SPECIES.
 - FOR FURTHER INFORMATION REGARDING TREE PLANTING REFER TO TDAG GUIDANCE - STREET TREES: A GUIDE TO PLANTING ESTABLISHMENT AND AFTERCARE.
 - FOR THE ESTABLISHMENT OF NEW TREES REFER TO BS 8545 - TREES: FROM NURSERY TO INDEPENDENCE IN THE LANDSCAPE.
 - USE OF LINERS, AND PERMEABILITY OF LINING, SHOULD REFLECT THE SITE CONDITIONS AND HYDRAULIC DESIGN OF THE SYSTEM

THIS DRAWING WAS PREPARED BY CIVIC ENGINEERS.



DATE	REV	DESCRIPTION	DRAWN	CHKD

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PROJECT
DIG ONE GREEN TWICE
GREATER LONDON AUTHORITY

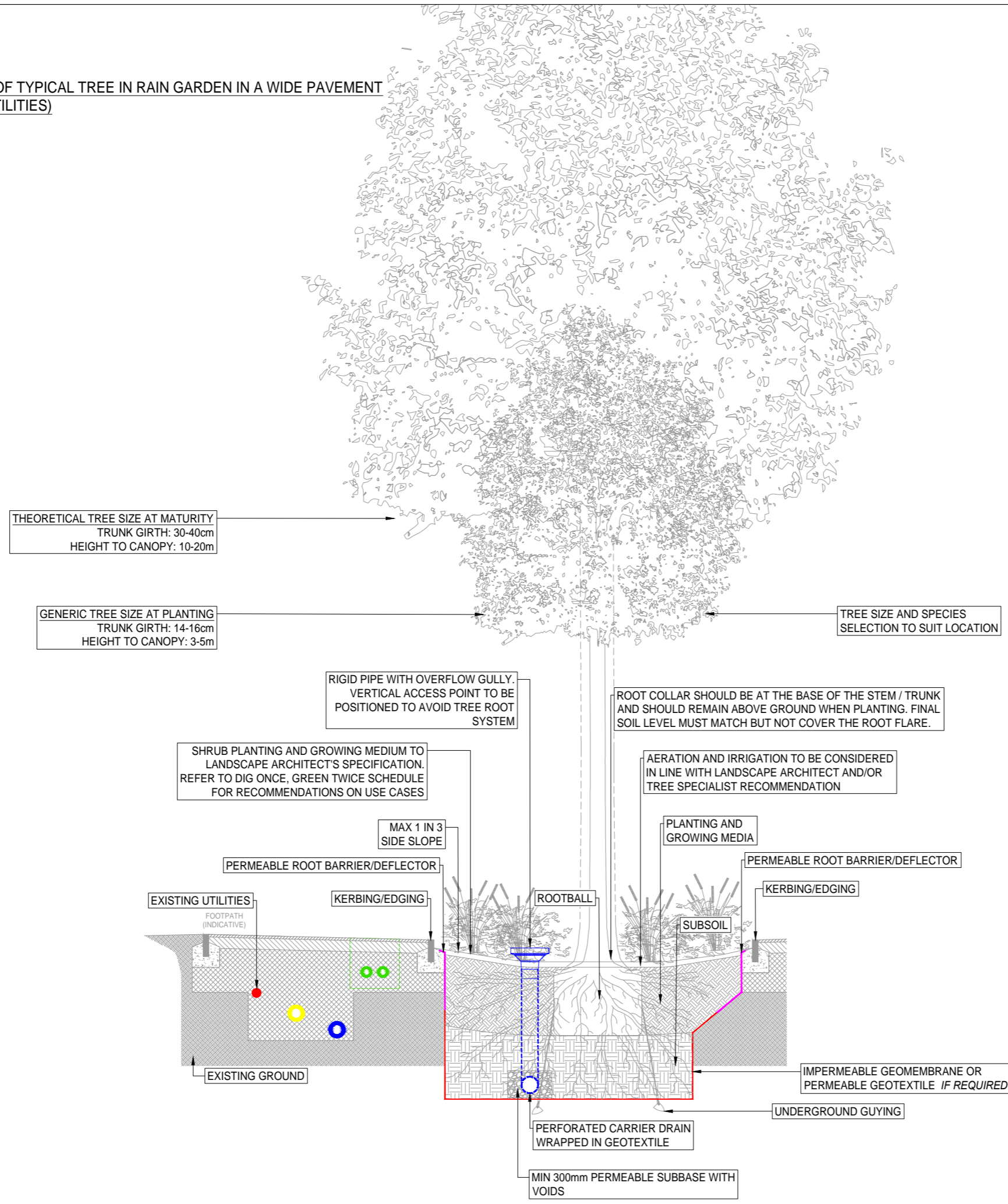
TITLE
TECHNICAL DRAWINGS
WIDE PAVEMENTS

DRAWING STATUS	STATUS CODE
-	-

CE PROJECT No.	SCALE @ A1	DATE CREATED	DRAWN	CHECKED
4142	1:15	-	MF	KW

DRAWING No.	REV
01	P01

CROSS SECTION OF TYPICAL TREE IN RAIN GARDEN IN A WIDE PAVEMENT
(PROXIMITY TO UTILITIES)



KEY	
[Pattern]	EXISTING GROUND
[Pattern]	SURFACE COURSE
[Pattern]	BINDER COURSE
[Pattern]	BASE COURSE
[Pattern]	SUB-BASE
[Pattern]	CAPPING LAYER
[Pattern]	PLANTING AND GROWING MEDIA
[Pattern]	SUBSOIL
[Pattern]	PERMEABLE SUBBASE
[Pattern]	STRUCTURAL SOIL
[Line]	GEOTEXTILE / GEOMEMBRANE
[Line]	ROOT BARRIER

STANDARD NOTES

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DATE	REV	DESCRIPTION	DRAWN	CHKD
<p>CIVIC INFRASTRUCTURE COORDINATION SERVICE</p>				
team-civic.com				
PROJECT				
DIG ONE GREEN TWICE GREATER LONDON AUTHORITY				
TITLE				
TECHNICAL DRAWINGS WIDE PAVEMENTS				
DRAWING STATUS				STATUS CODE
-				-
CE PROJECT No.	SCALE @ A1	DATE CREATED	DRAWN	CHECKED
4142	1:20	-	MF	KW
DRAWING No.				REV
02				P01

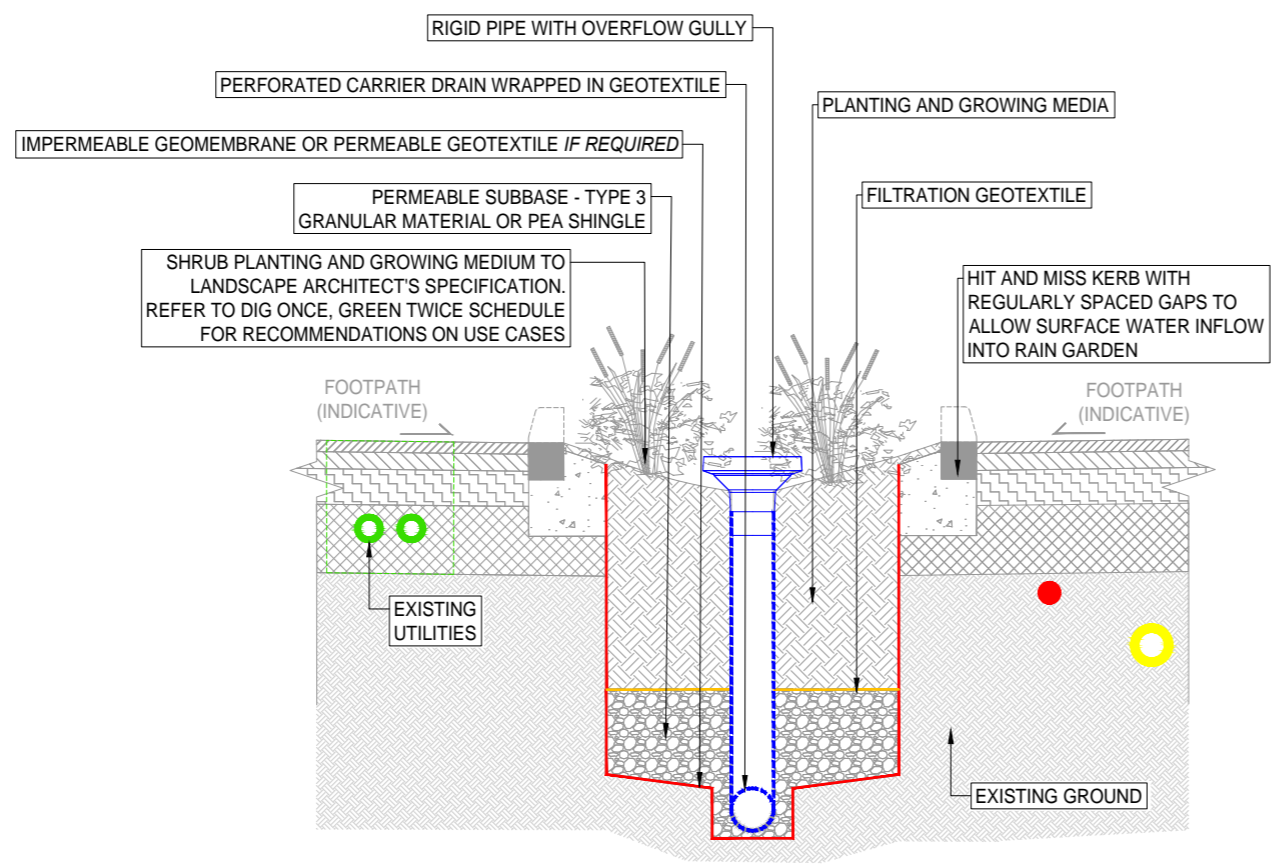
CROSS SECTION OF TYPICAL RAIN GARDEN IN A WIDE PAVEMENT (PROXIMITY TO UTILITIES)

KEY	
	EXISTING GROUND
	SURFACE COURSE
	BINDER COURSE
	BASE COURSE
	SUB-BASE
	CAPPING LAYER
	PLANTING AND GROWING MEDIA
	SUBSOIL
	PERMEABLE SUBBASE
	GEOTEXTILE / GEOMEMBRANE
	GEOTEXTILE

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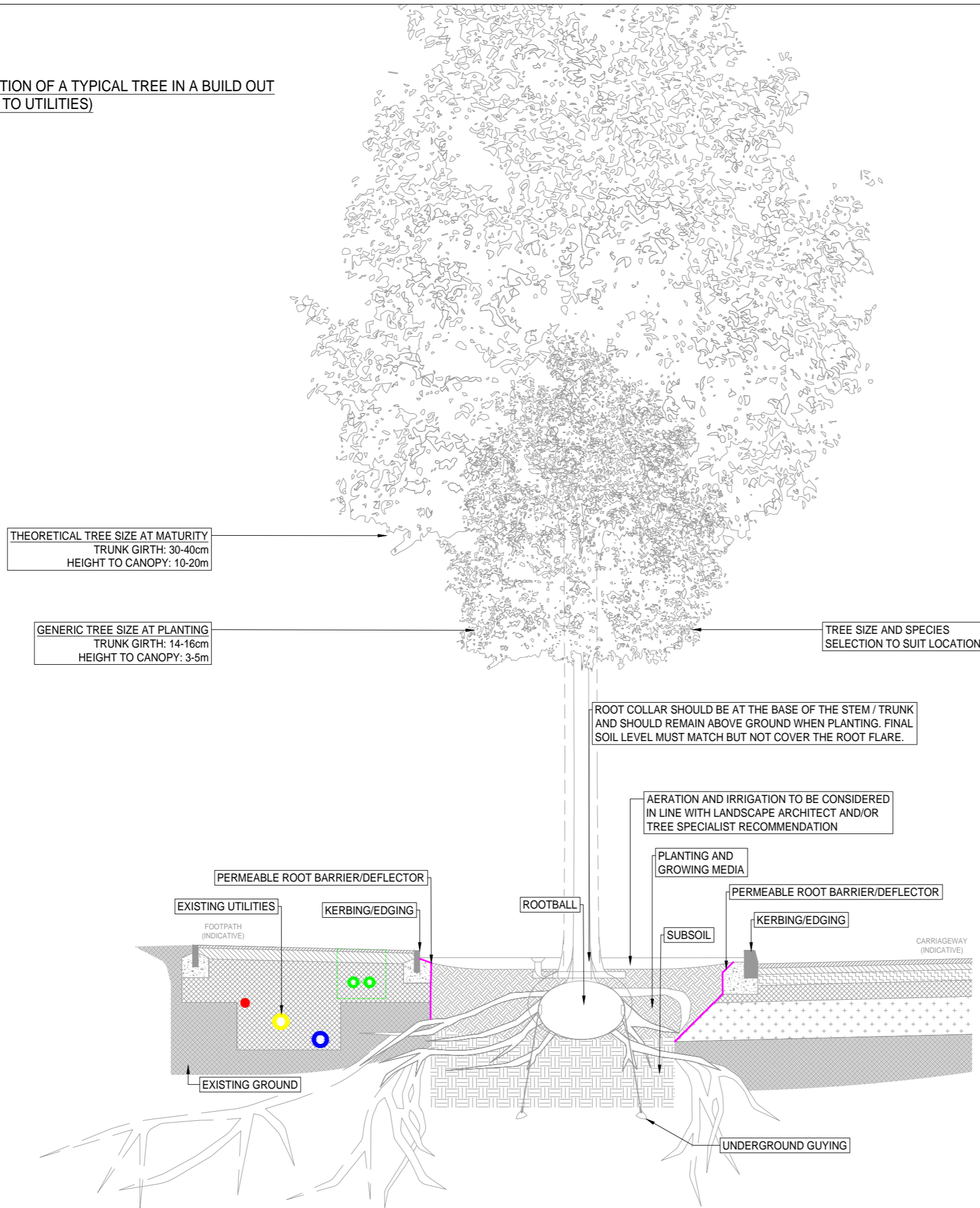
TITLE
TECHNICAL DRAWINGS
WIDE PAVEMENTS

DRAWING STATUS		STATUS CODE	
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4142	1:15	-	MF	KW

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03	P01

CROSS SECTION OF A TYPICAL TREE IN A BUILD OUT
(PROXIMITY TO UTILITIES)



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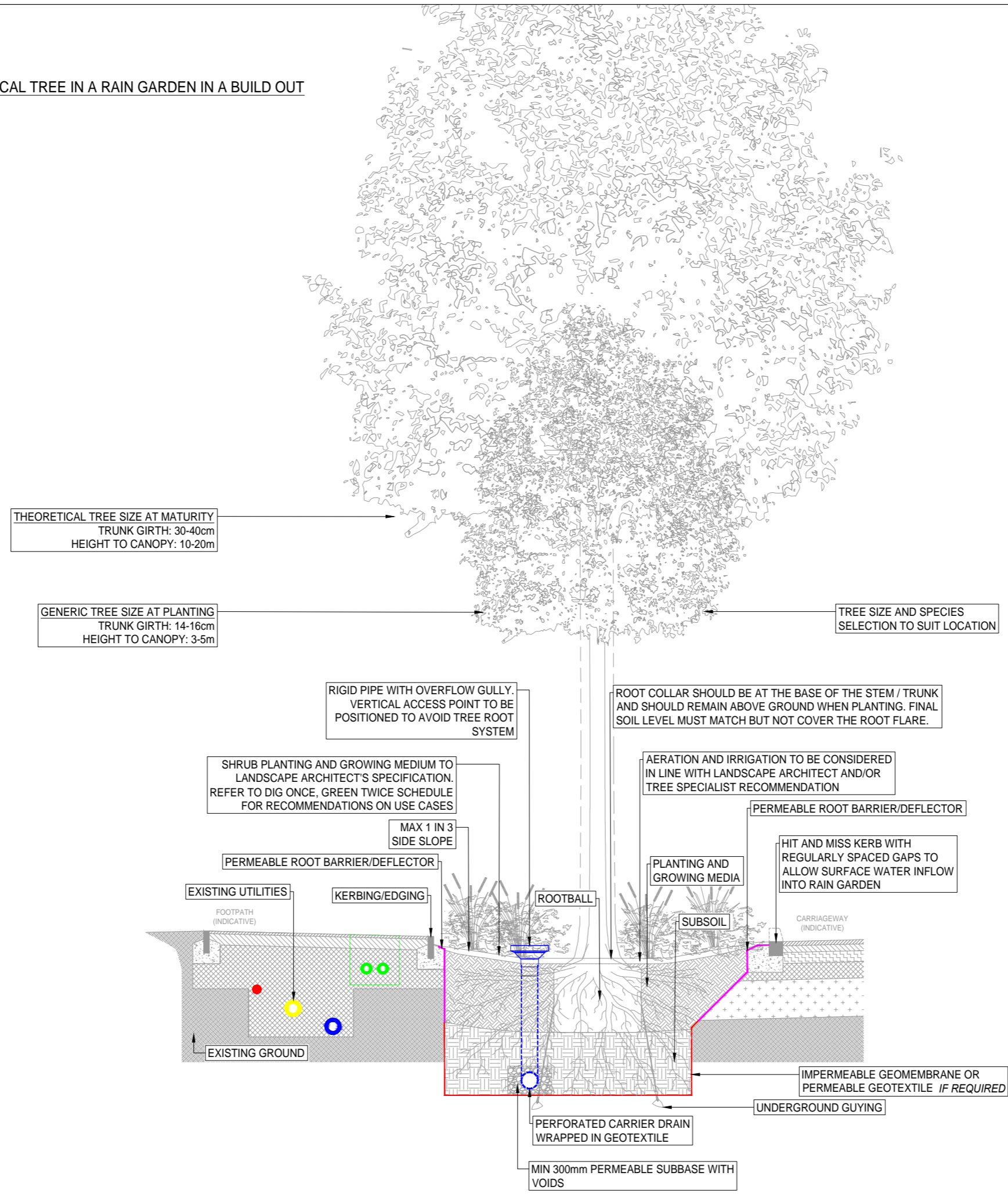
TITLE
TECHNICAL DRAWINGS
BUILD OUT

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CROSS SECTION OF A TYPICAL TREE IN A RAIN GARDEN IN A BUILD OUT (PROXIMITY TO UTILITIES)



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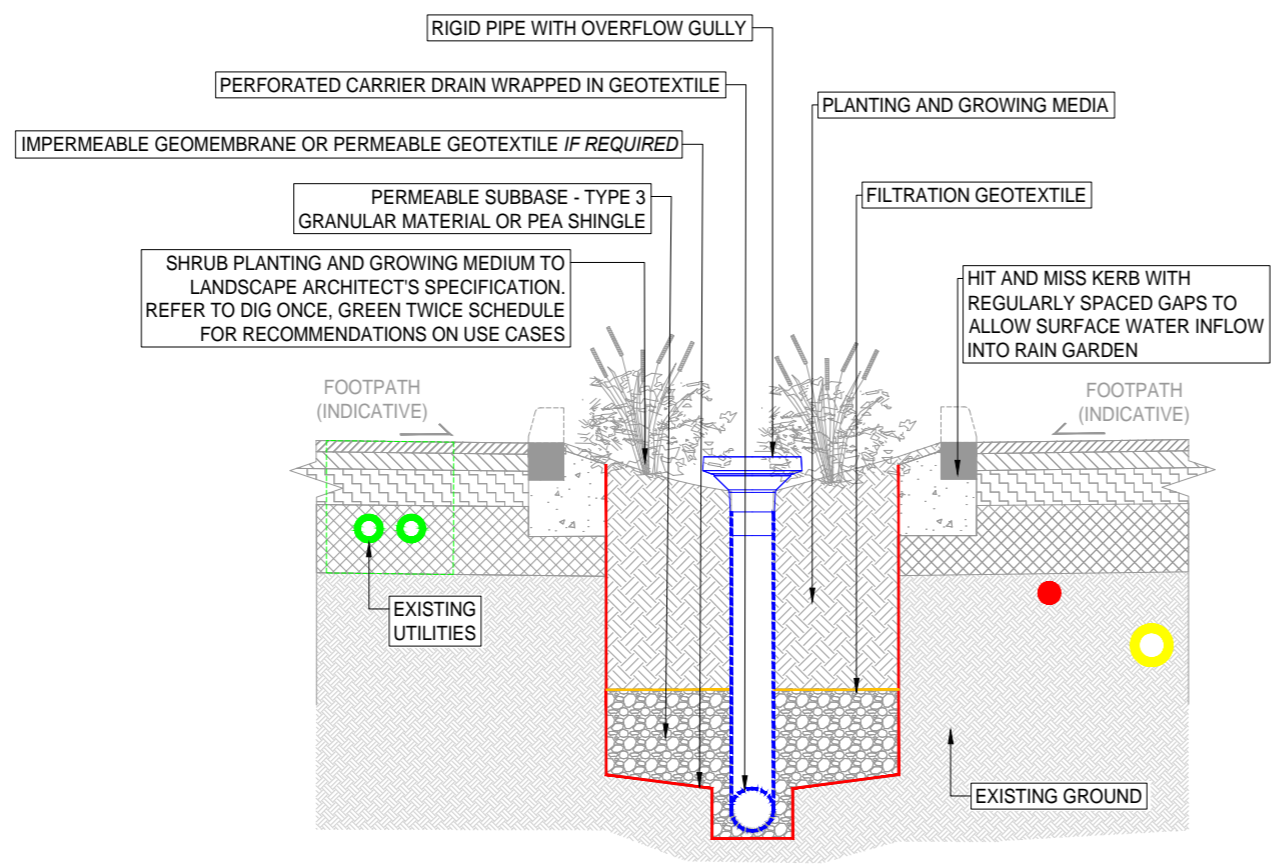
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PROJECT
DIG ONE GREEN TWICE
GREATER LONDON AUTHORITY

TITLE
TECHNICAL DRAWINGS
BUILD OUT

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06		P01

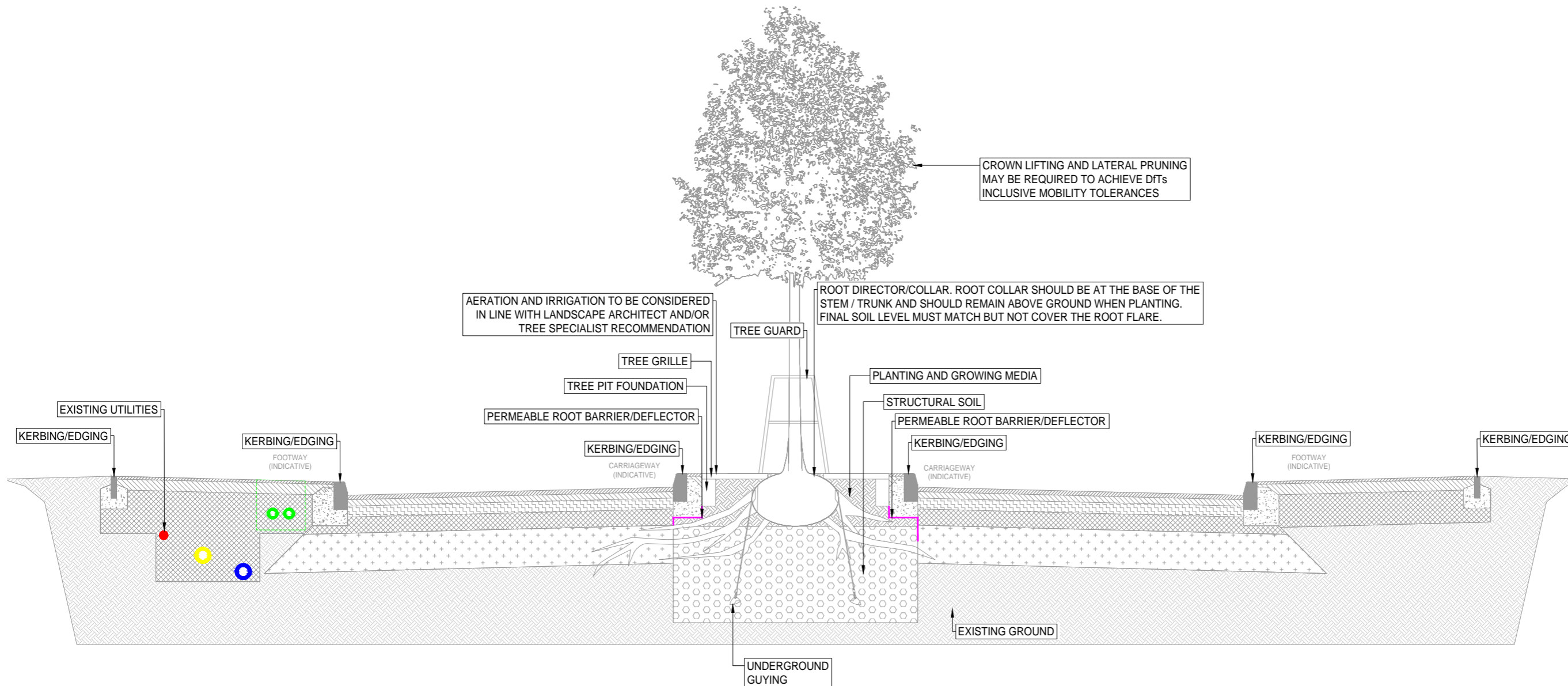
CROSS SECTION OF A TYPICAL TREE IN A CENTRAL RESERVATION (PROXIMITY TO UTILITIES)

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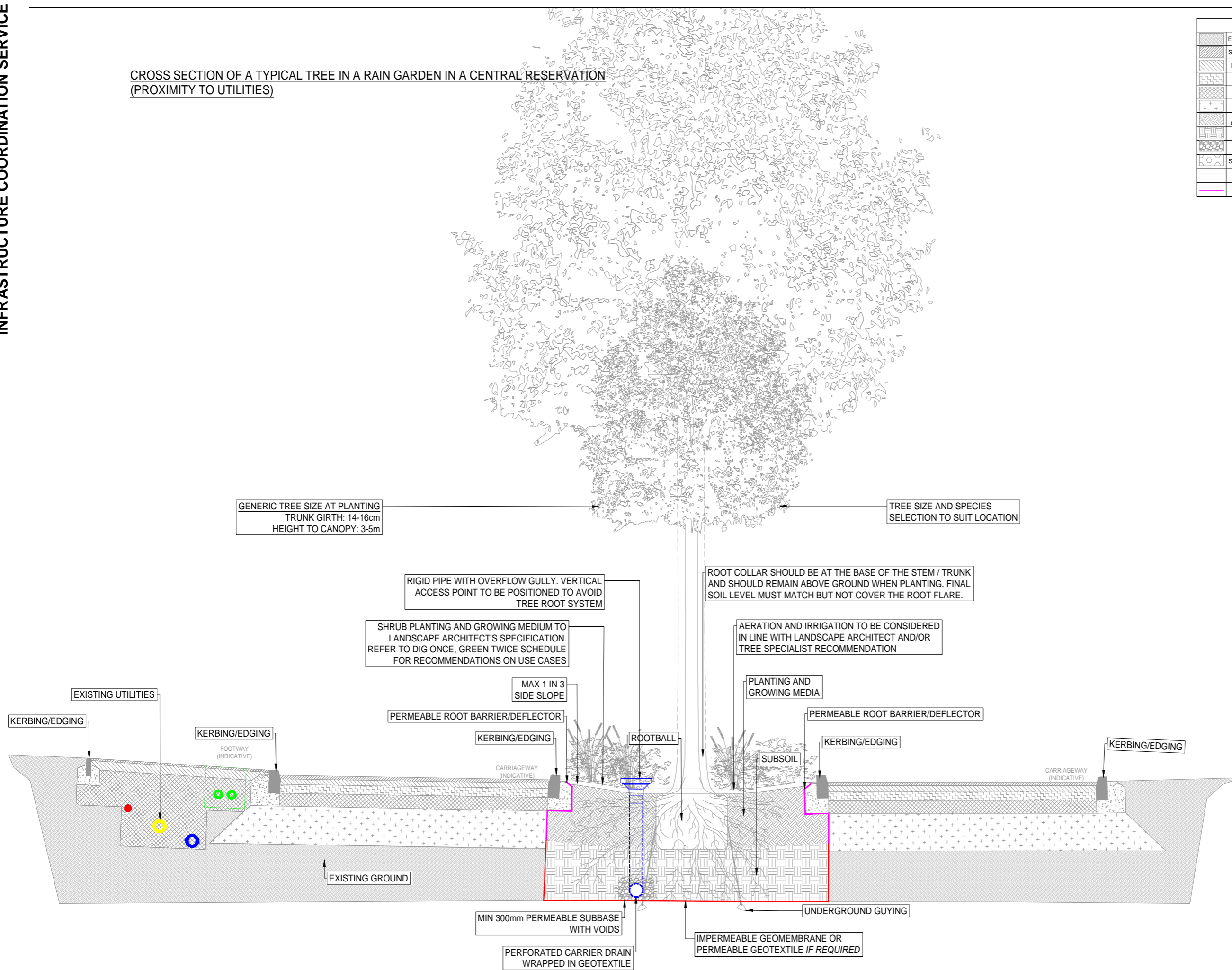
TITLE
TECHNICAL DRAWINGS
CENTRAL RESERVATION

DRAWING STATUS	STATUS CODE
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4142	1:20	-	MF	KW

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07	P01

CROSS SECTION OF A TYPICAL TREE IN A RAIN GARDEN IN A CENTRAL RESERVATION
(PROXIMITY TO UTILITIES)



GENERIC TREE SIZE AT PLANTING
TRUNK GIRTH: 14-16cm
HEIGHT TO CANOPY: 3-5m

TREE SIZE AND SPECIES
SELECTION TO SUIT LOCATION

RIGID PIPE WITH OVERFLOW GULLY. VERTICAL
ACCESS POINT TO BE POSITIONED TO AVOID
TREE ROOT SYSTEM

ROOT COLLAR SHOULD BE AT THE BASE OF THE STEM / TRUNK
AND SHOULD REMAIN ABOVE GROUND WHEN PLANTING. FINAL
SOIL LEVEL MUST MATCH BUT NOT COVER THE ROOT FLARE.

SHRUB PLANTING AND GROWING MEDIUM TO
LANDSCAPE ARCHITECT'S SPECIFICATION.
REFER TO DIG ONCE, GREEN TWICE SCHEDULE
FOR RECOMMENDATIONS ON USE CASES

AERATION AND IRRIGATION TO BE CONSIDERED
IN LINE WITH LANDSCAPE ARCHITECT AND/OR
TREE SPECIALIST RECOMMENDATION

MAX 1 IN 3
SIDE SLOPE

PLANTING AND
GROWING MEDIA

EXISTING UTILITIES

KERBING/EDGING

KERBING/EDGING

FOOTWAY
(INDICATIVE)

PERMEABLE ROOT BARRIER/DEFLECTOR

KERBING/EDGING

ROOTBALL

PERMEABLE ROOT BARRIER/DEFLECTOR

KERBING/EDGING

KERBING/EDGING

EXISTING GROUND

MIN 300mm PERMEABLE SUBBASE
WITH VOIDS

IMPERMEABLE GEOMEMBRANE OR
PERMEABLE GEOTEXTILE IF REQUIRED

UNDERGROUND GUYING

PERFORATED CARRIER DRAIN
WRAPPED IN GEOTEXTILE

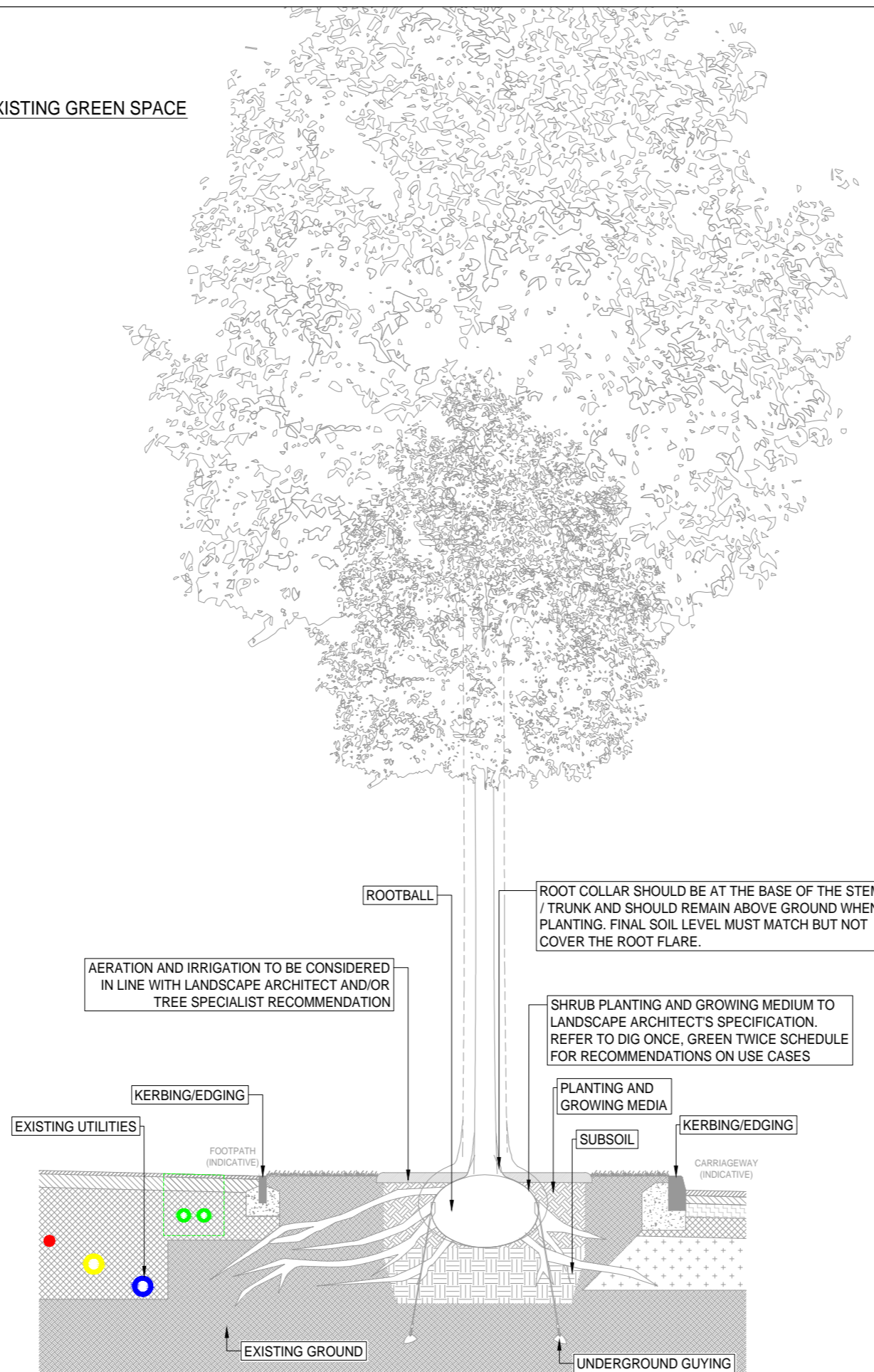
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- THIS DRAWING WAS PREPARED BY CIVIC ENGINEERS.

DATE	REV	DESCRIPTION	DRAWN	CHKD
CIVIC				
INFRASTRUCTURE COORDINATION SERVICE				
team-civic.com				
PROJECT				
DIG ONE GREEN TWICE GREATER LONDON AUTHORITY				
TITLE				
TECHNICAL DRAWINGS CENTRAL RESERVATION				
DRAWING STATUS			STATUS CODE	
-			-	
CE PROJECT No.	SCALE @ A1	DATE CREATED	DRAWN	CHECKED
4142	1:20	-	MF	KW
DRAWING No.				REV
08				P01

CROSS SECTION OF A TYPICAL TREE IN EXISTING GREEN SPACE
(PROXIMITY TO UTILITIES)



KEY	
[Pattern]	EXISTING GROUND
[Pattern]	SURFACE COURSE
[Pattern]	BINDER COURSE
[Pattern]	BASE COURSE
[Pattern]	SUB-BASE
[Pattern]	CAPPING LAYER
[Pattern]	PLANTING AND GROWING MEDIA
[Pattern]	SUBSOIL
[Pattern]	PERMEABLE SUBBASE

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 4. ALL DISCREPANCIES SHOULD BE REPORTED TO C.A./E.A. PRIOR TO THE COMMENCEMENT OF WORKS.
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INFRASTRUCTURE COORDINATION SERVICE

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PROJECT
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GREATER LONDON AUTHORITY

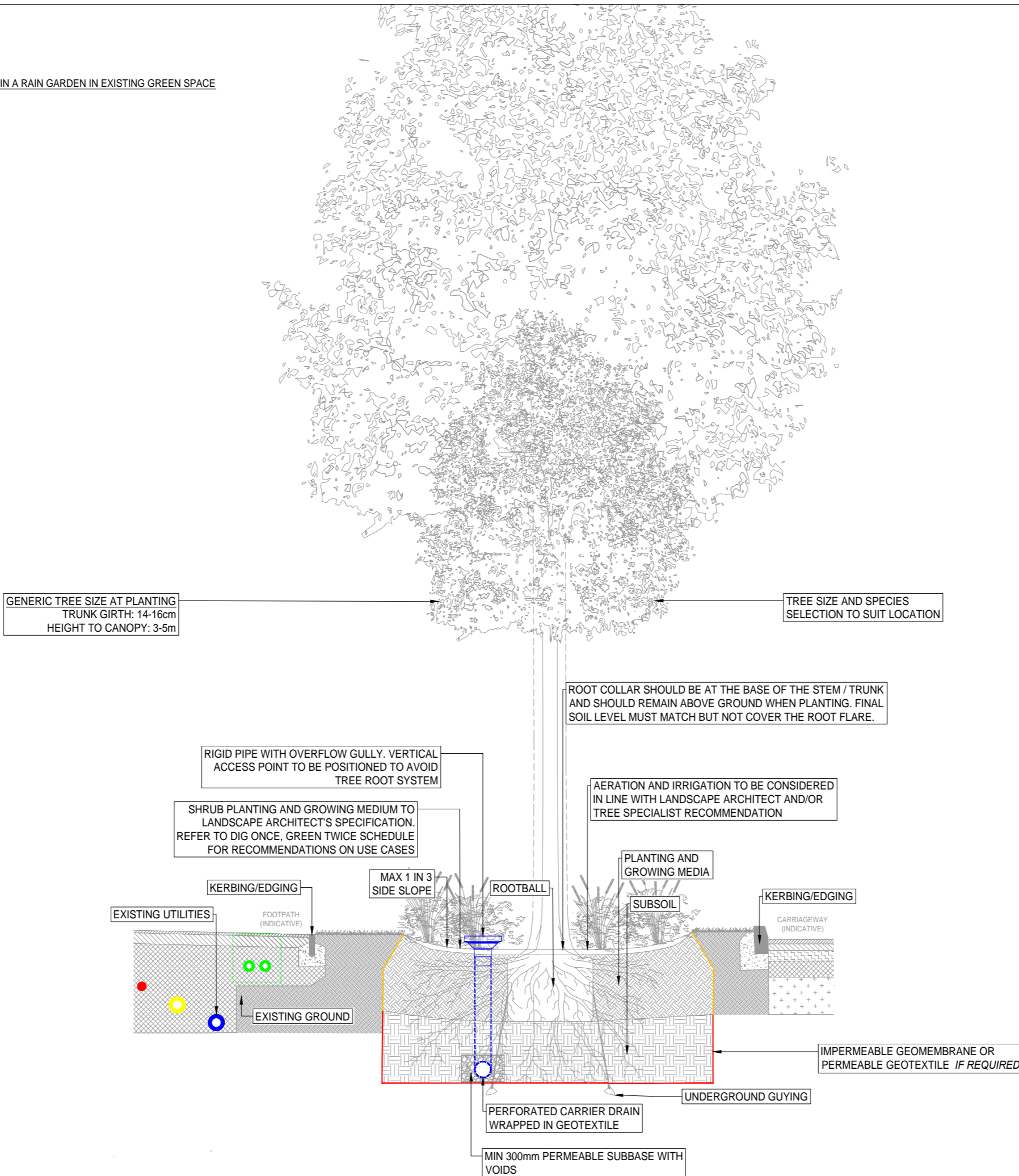
TITLE
TECHNICAL DRAWINGS
EXISTING GREEN SPACE

DRAWING STATUS	STATUS CODE
-	-

CE PROJECT No.	SCALE @ A1	DATE CREATED	DRAWN	CHECKED
4142	1:20	-	MF	KW

DRAWING No.	REV
09	P01

CROSS SECTION OF TYPICAL TREE IN A RAIN GARDEN IN EXISTING GREEN SPACE
(PROXIMITY TO UTILITIES)



GENERIC TREE SIZE AT PLANTING
TRUNK GIRTH: 14-16cm
HEIGHT TO CANOPY: 3-5m

TREE SIZE AND SPECIES
SELECTION TO SUIT LOCATION

ROOT COLLAR SHOULD BE AT THE BASE OF THE STEM / TRUNK
AND SHOULD REMAIN ABOVE GROUND WHEN PLANTING. FINAL
SOIL LEVEL MUST MATCH BUT NOT COVER THE ROOT FLARE.

RIGID PIPE WITH OVERFLOW GULLY. VERTICAL
ACCESS POINT TO BE POSITIONED TO AVOID
TREE ROOT SYSTEM

SHRUB PLANTING AND GROWING MEDIUM TO
LANDSCAPE ARCHITECT'S SPECIFICATION.
REFER TO DIG ONCE, GREEN TWICE SCHEDULE
FOR RECOMMENDATIONS ON USE CASES

AERATION AND IRRIGATION TO BE CONSIDERED
IN LINE WITH LANDSCAPE ARCHITECT AND/OR
TREE SPECIALIST RECOMMENDATION

IMPERMEABLE GEOMEMBRANE OR
PERMEABLE GEOTEXTILE IF REQUIRED

KEY	
[Pattern]	EXISTING GROUND
[Pattern]	SURFACE COURSE
[Pattern]	BINDER COURSE
[Pattern]	BASE COURSE
[Pattern]	SUB-BASE
[Pattern]	CAPPING LAYER
[Pattern]	PLANTING AND GROWING MEDIA
[Pattern]	SUBSOIL
[Pattern]	PERMEABLE SUBBASE
[Pattern]	STRUCTURAL SOIL
[Line]	GEOTEXTILE / GEOMEMBRANE
[Line]	GEOTEXTILE

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PROJECT				
DIG ONE GREEN TWICE GREATER LONDON AUTHORITY				
TITLE				
TECHNICAL DRAWINGS EXISTING GREEN SPACE				
DRAWING STATUS				STATUS CODE
-				-
CE PROJECT No.	SCALE @ A1	DATE CREATED	DRAWN	CHECKED
4142	1:20	-	MF	KW
DRAWING No.				REV
10				P01

CROSS SECTION OF A TYPICAL RAIN GARDEN IN EXISTING GREEN SPACE (PROXIMITY TO UTILITIES)

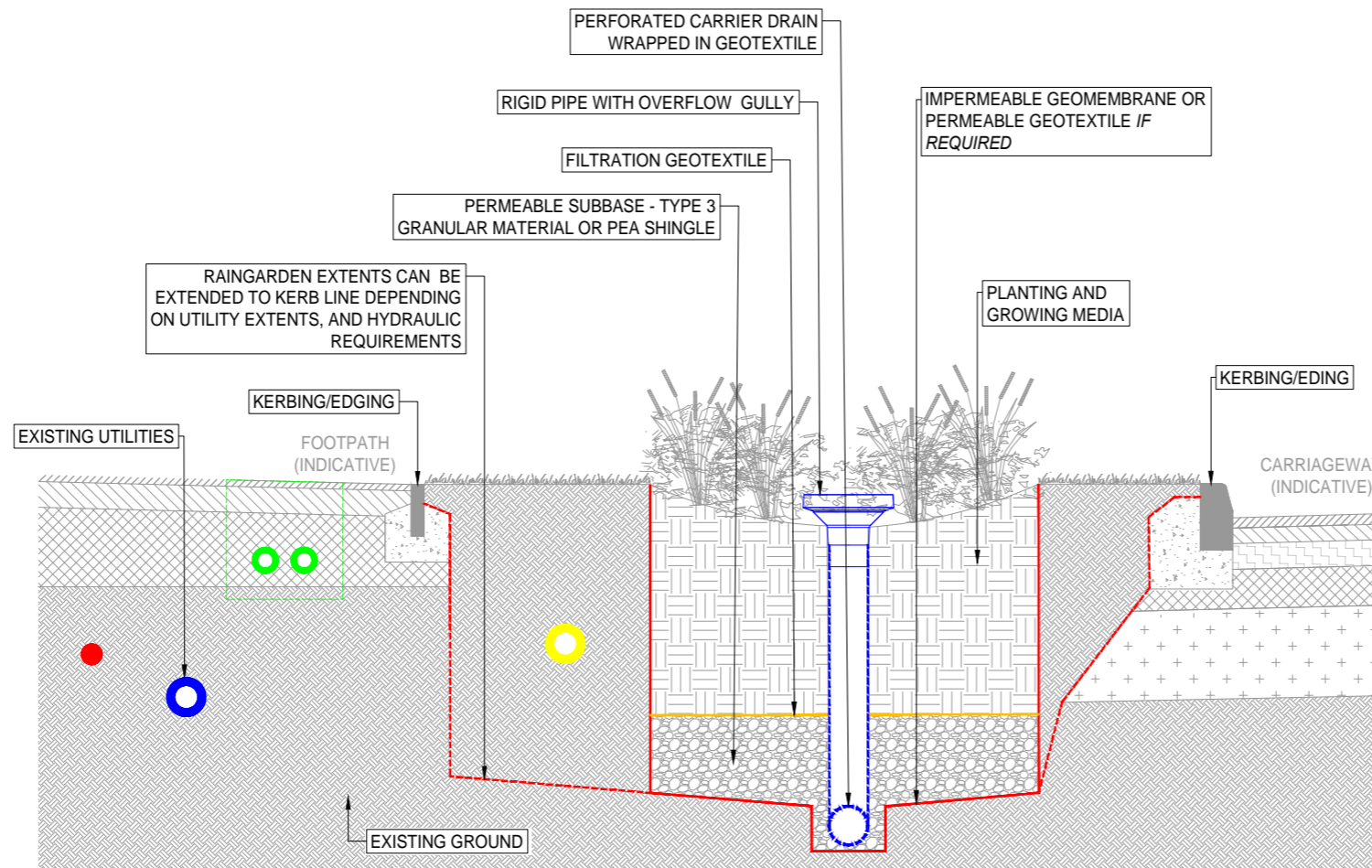
KEY	
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	BINDER COURSE
	BASE COURSE
	SUB-BASE
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PROJECT
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GREATER LONDON AUTHORITY

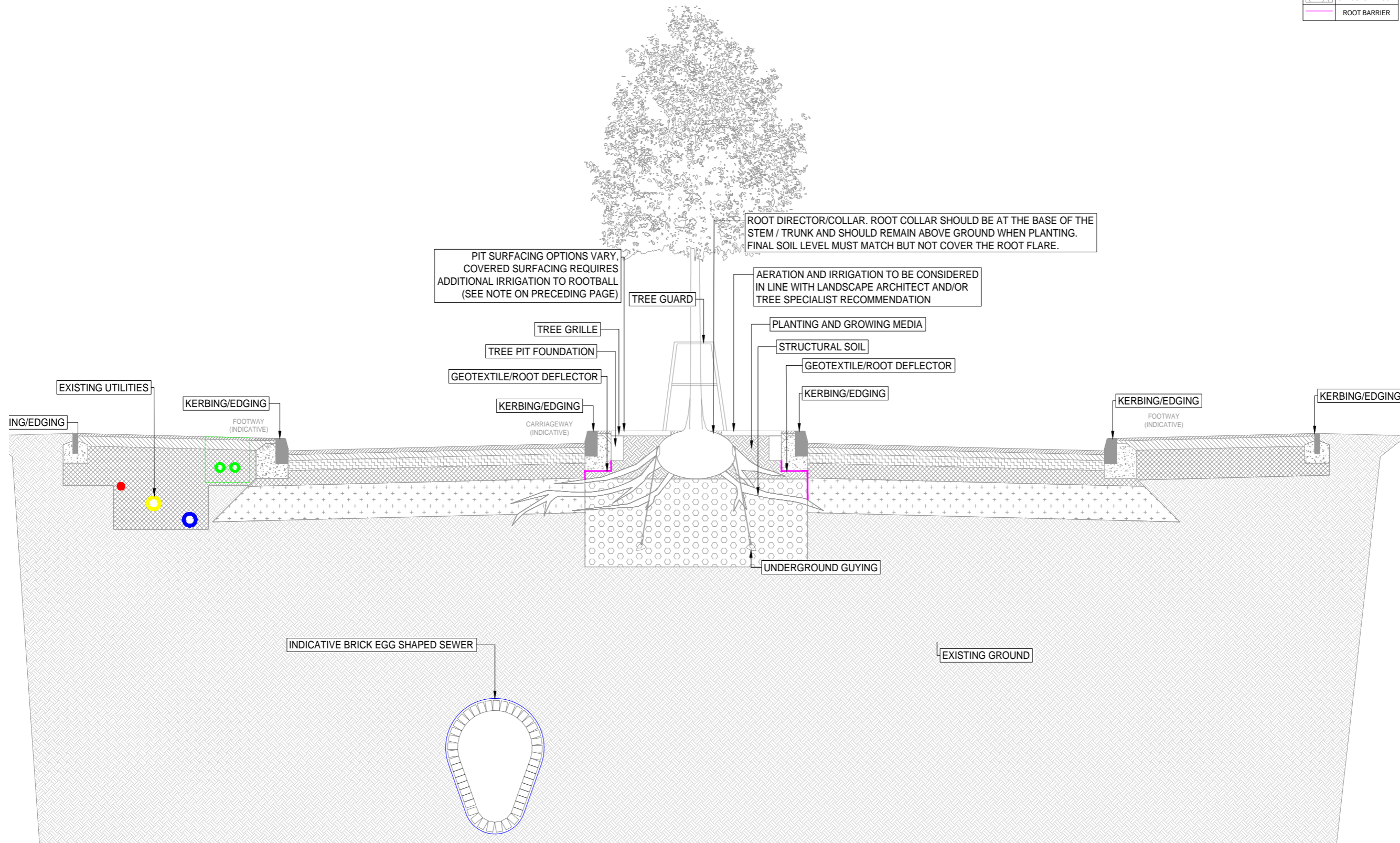
TITLE
TECHNICAL DRAWINGS
EXISTING GREEN SPACE

DRAWING STATUS	STATUS CODE
-	-

CE PROJECT No.	SCALE @ A1	DATE CREATED	DRAWN	CHECKED
4142	1:15	-	MF	KW

DRAWING No.	REV
11	P01

CROSS SECTION OF A TYPICAL TREE IN PROXIMITY TO HIGH RISK UTILITIES



KEY	
[Pattern]	EXISTING GROUND
[Pattern]	SURFACE COURSE
[Pattern]	BINDER COURSE
[Pattern]	BASE COURSE
[Pattern]	SUB-BASE
[Pattern]	CAPPING LAYER
[Pattern]	PLANTING AND GROWING MEDIA
[Pattern]	SUBSOIL
[Pattern]	PERMEABLE SUBBASE
[Pattern]	STRUCTURAL SOIL
[Line]	ROOT BARRIER

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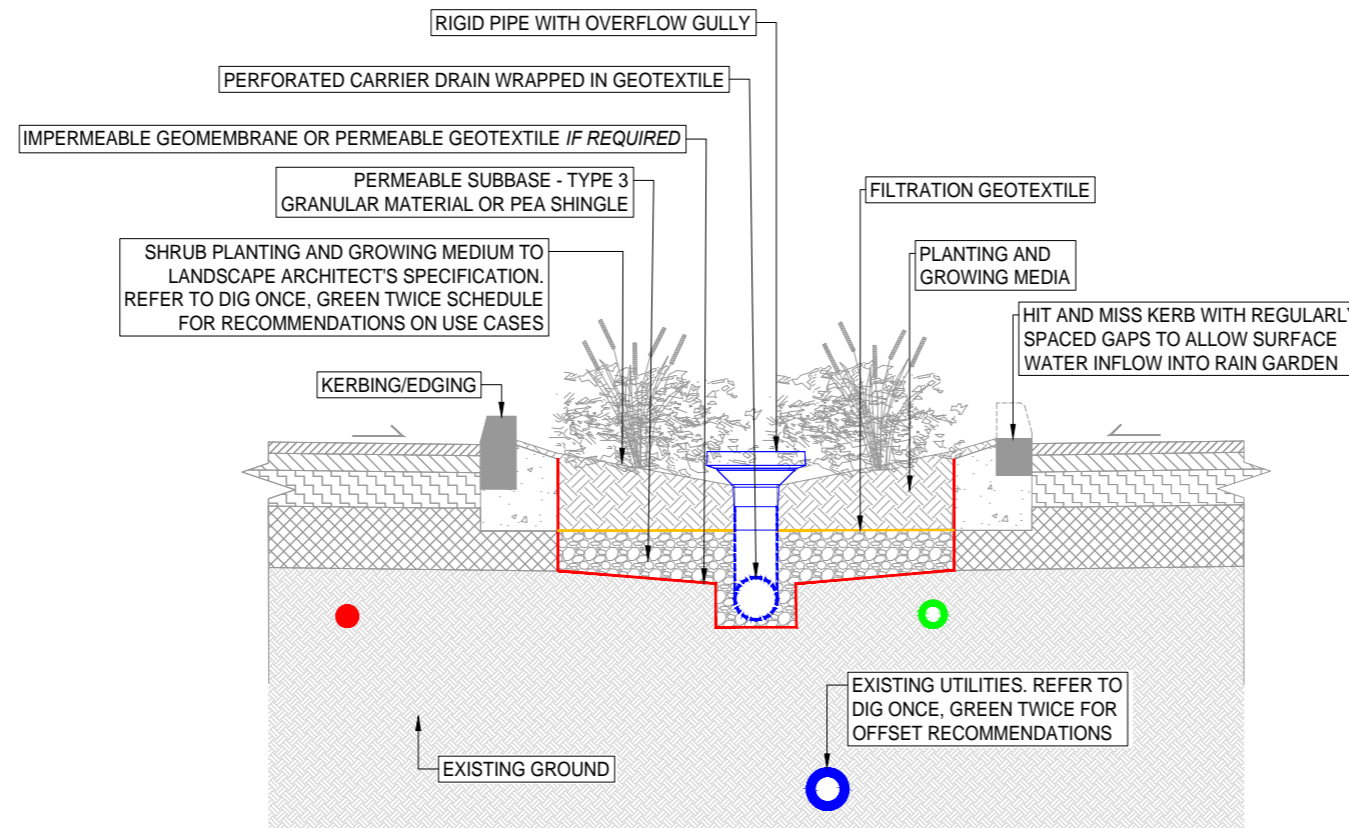
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PROJECT				
DIG ONE GREEN TWICE GREATER LONDON AUTHORITY				
TITLE				
TECHNICAL DRAWINGS HIGH RISK UTILITIES				
DRAWING STATUS				STATUS CODE
-				-
CE PROJECT No.	SCALE @ A1	DATE CREATED	DRAWN	CHECKED
4142	1:20	-	MF	KW
DRAWING No.				REV
12				P01

CROSS SECTION OF TYPICAL SHALLOW RAIN GARDEN (PROXIMITY TO UTILITIES)



KEY	
[Pattern]	EXISTING GROUND
[Pattern]	SURFACE COURSE
[Pattern]	BINDER COURSE
[Pattern]	BASE COURSE
[Pattern]	SUB-BASE
[Pattern]	CAPPING LAYER
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PROJECT
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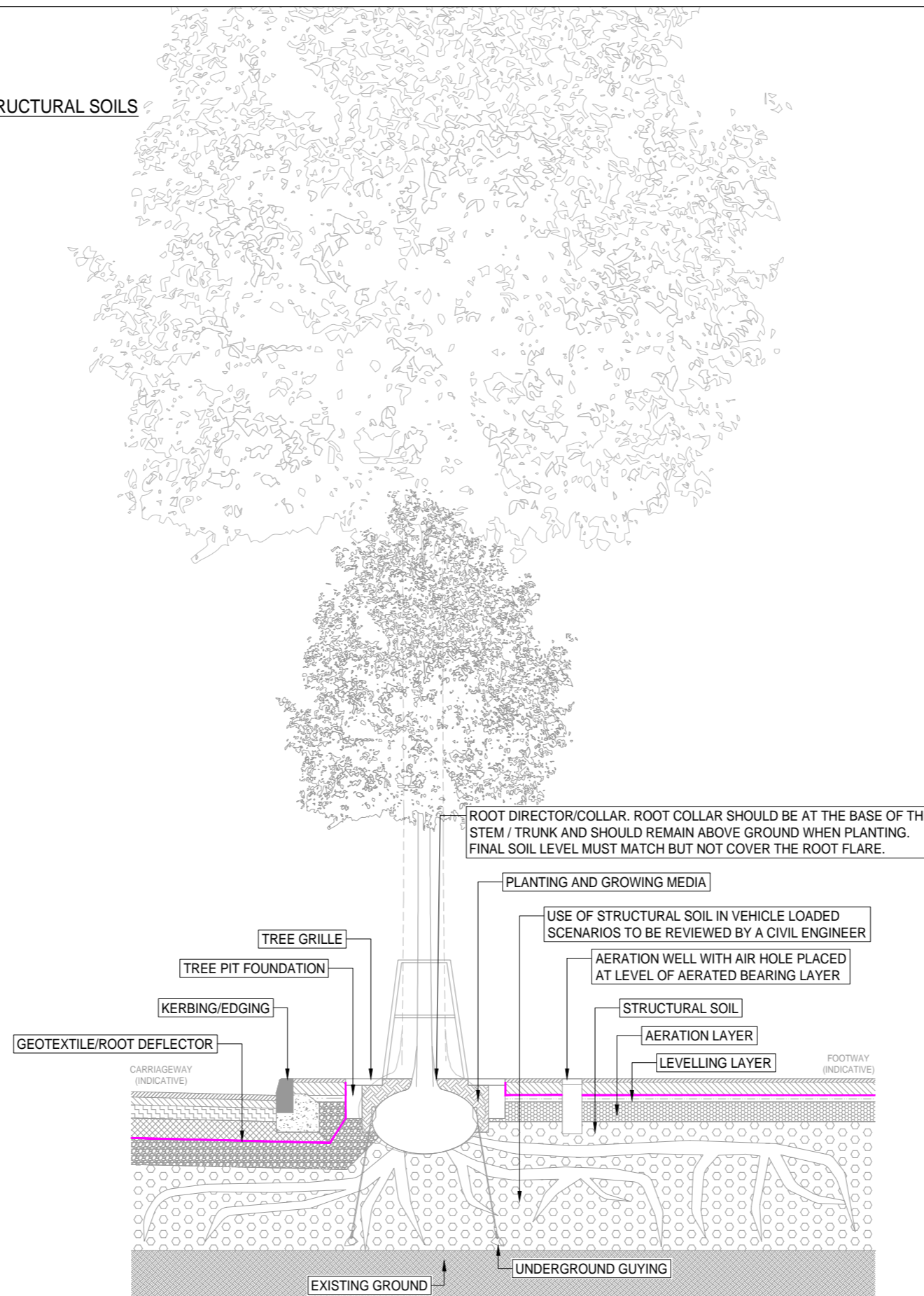
TITLE
TECHNICAL DRAWINGS
SHALLOW RAIN GARDEN

DRAWING STATUS		STATUS CODE	

CE PROJECT No.	SCALE @ A1	DATE CREATED	DRAWN	CHECKED
4142	1:15	-	MF	KW

DRAWING No.	REV
13	P01

CROSS SECTION OF A TYPICAL TREE IN STRUCTURAL SOILS



KEY	
[Pattern]	EXISTING GROUND
[Pattern]	SURFACE COURSE
[Pattern]	BINDER COURSE
[Pattern]	BASE COURSE
[Pattern]	SUB-BASE
[Pattern]	CAPPING LAYER
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[Pattern]	COARSE-GRADED AGGREGATE
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[Pattern]	AERATION LAYER
[Pattern]	LEVELLING LAYER
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 10. POTENTIAL GROWTH OF TREE ROOTS, TREE TRUNK/STEM AND TREE CANOPY IS SHOWN TO INDICATE THAT THE TREES WILL GROWN IN THESE DIMENSIONS OVER TIME, BUT CANNOT SHOW SPECIFIC DIMENSIONS AS THESE WILL VARY SPECIES BY SPECIES.
 11. FOR FURTHER INFORMATION REGARDING TREE PLANTING REFER TO TDAG GUIDANCE - STREET TREES: A GUIDE TO PLANTING ESTABLISHMENT AND AFTERCARE.
 12. FOR THE ESTABLISHMENT OF NEW TREES REFER TO BS 8545 - TREES: FROM NURSERY TO INDEPENDENCE IN THE LANDSCAPE.
 13. USE OF LINERS, AND PERMEABILITY OF LINING, SHOULD REFLECT THE SITE CONDITIONS AND HYDRAULIC DESIGN OF THE SYSTEM.

THIS DRAWING WAS PREPARED BY CIVIC ENGINEERS.

DATE	REV	DESCRIPTION	DRAWN	CHKD

CIVIC
INFRASTRUCTURE COORDINATION SERVICE

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PROJECT
DIG ONE GREEN TWICE
GREATER LONDON AUTHORITY

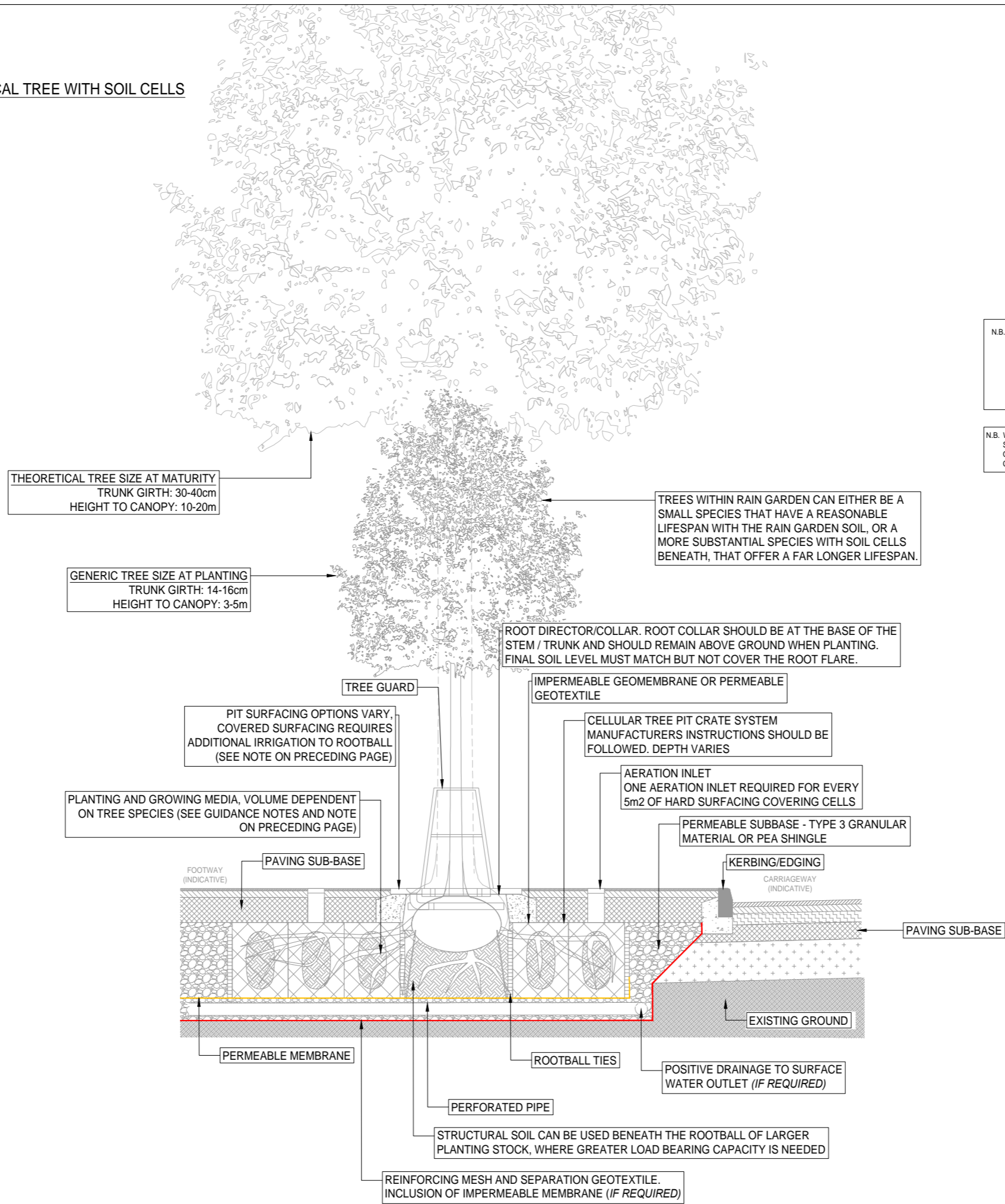
TITLE
TECHNICAL DRAWINGS
STRUCTURAL SOILS

DRAWING STATUS	STATUS CODE
-	-

CE PROJECT No.	SCALE @ A1	DATE CREATED	DRAWN	CHECKED
4142	1:20	-	MF	KW

DRAWING No.	REV
14	P01

CROSS SECTION OF A TYPICAL TREE WITH SOIL CELLS



KEY	
[Pattern]	EXISTING GROUND
[Pattern]	SURFACE COURSE
[Pattern]	BINDER COURSE
[Pattern]	BASE COURSE
[Pattern]	SUB-BASE
[Pattern]	CAPPING LAYER
[Pattern]	PLANTING AND GROWING MEDIA
[Pattern]	SUBSOIL
[Pattern]	COARSE-GRADED AGGREGATE
[Pattern]	STRUCTURAL SOIL
[Line]	GEOTEXTILE / GEOMEMBRANE
[Line]	GEOTEXTILE

N.B. THERE ARE MANY MODULAR SUSPENDED PAVEMENT SYSTEMS / SOIL CELLS ON THE MARKET FOR BOTH TREE PLANTING AND SUSTAINABLE DRAINAGE SYSTEMS WITH VARIOUS FORMS OF SURFACING OPTIONS. DESIGN TEAM TO CHOOSE THE MOST APPROPRIATE FOR THE SITE. INSTALLATION SHOULD BE IN ACCORDANCE WITH THE MANUFACTURER'S INSTRUCTION AND PREFERABLY MANUFACTURER'S SUPERVISION.

N.B. WHEN DETERMINING PROPOSALS PROFESSIONAL ADVICE SHOULD BE SOUGHT TO AGREE WHICH OF THESE OPTIONS IS MOST SUITABLE FOR THE SITE LOCATION AND CONTEXT

- STANDARD NOTES
- THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL RELEVANT ARCHITECT'S AND ENGINEER'S DRAWINGS AND THE SPECIFICATIONS.
 - THIS DRAWING SHOULD NOT BE SCALED.
 - ALL DIMENSIONS ARE TO BE VERIFIED BY THE CONTRACTOR ON SITE.
 - ALL DISCREPANCIES SHOULD BE REPORTED TO C.A./E.A. PRIOR TO THE COMMENCEMENT OF WORKS.
- © CIVIC LIMITED
- NOTES:
- THESE DRAWINGS DO NOT PROVIDE BLUEPRINTS FOR ALL GREEN INFRASTRUCTURE RETROFITTING, BUT OUTLINE SOME KEY PRINCIPLES FOR SOME TYPICAL LOCATIONS. THEY DO NOT REPLACE APPROPRIATE PROFESSIONAL ADVICE.
 - THE DRAWING SHOULD BE READ IN CONJUNCTION WITH THE RELEVANT SECTIONS OF THE FULL DOCUMENT.
 - FOR LIVE PROJECTS DECISIONS MUST BE MADE ON A SITE BY SITE BASIS
 - ALL DIMENSIONS ARE IN mm UNLESS OTHERWISE STATED.
 - POSITIONING OF GREEN INFRASTRUCTURE FEATURES SHOULD CONSIDER HYDRAULIC INFLOW, WHERE LATERAL INFLOW CANNOT BE ACHIEVED, OR WHERE ADDITIONAL INFLOWS CAN BE ACCOMMODATED WITHIN THE GREEN INFRASTRUCTURE STORAGE CAPACITY, POINT INFLOW VIA A PIPED CONNECTION CAN BE EXPLORED AND SHOULD BE REVIEWED WITH THE PROJECT ENGINEER.
 - FOR TREE-LINED STREETS DISTANCES BETWEEN TREES WILL DEPEND ON SPECIES, ANTICIPATED SIZE AT MATURITY.
 - UNDERGROUND GUYING / ANCHOR SYSTEMS: TREES UP TO 14-16cm GIRTH ARE USUALLY STAKED RATHER THAN SUPPORTED BY UNDERGROUND GUYING.
 - TREE STAKES, GUARDS, TREE BASE SURROUNDS WILL VARY WITH LOCATION, TREE SIZE AND AESTHETIC PREFERENCES. FOR THIS REASON, WHEN SHOWN ON THE DRAWING THEY ARE INDICATIVE (SEE PRECEDING PAGE FOR DRAWING SPECIFIC NOTES).
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DATE	REV	DESCRIPTION	DRAWN	CHKD
<p>CIVIC INFRASTRUCTURE COORDINATION SERVICE</p>				
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PROJECT				
DIG ONE GREEN TWICE GREATER LONDON AUTHORITY				
TITLE				
TECHNICAL DRAWINGS SOIL CELLS				
DRAWING STATUS				STATUS CODE
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CE PROJECT No.	SCALE @ A1	DATE CREATED	DRAWN	CHECKED
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DRAWING No.				REV
15				P01

APPENDIX E STAKEHOLDERS & APPROVALS

The below table presents the key responsibilities various stakeholders have during the design and construction phases

DESIGN PHASE:

Stakeholder	Responsibilities
Governance bodies (e.g. GLA, TfL etc)	<ul style="list-style-type: none"> » To set strategic objectives » Ensure alignment with regional transport and planning policies » Respond to enquiries
Combined and local authority	<ul style="list-style-type: none"> » Provide local planning guidance and design standards » Grant permits for works affecting their assets (e.g. Road space permit) » Provide input on proposed scheme » Respond to enquiries » Community Engagement
Public bodies	<ul style="list-style-type: none"> » Advise on regulatory compliance » Grant permits for works affecting their assets (e.g. EA watercourse permit) » Respond to enquiries
Design and drainage engineers	<ul style="list-style-type: none"> » Develop detailed design » Ensure compliance with design regulations » To design out all feasible risks » Coordination with other disciplines to avoid clashes » Develop detailed design
Landscape architects or planting specialists, including arboriculturist	<ul style="list-style-type: none"> » Advise on species selection to align with soil and drainage requirements » Provide design on proposed scheme
Statutory undertakers	<ul style="list-style-type: none"> » Provide accurate asset location data » Advise on required offsets and protection measures for utilities » Review design proposals if required
Construction team	<ul style="list-style-type: none"> » Identify construction risks » Offer buildability input during design phase
Local community	<ul style="list-style-type: none"> » Participate in consultations and engagement sessions

CONSTRUCTION PHASE:

Stakeholder	Responsibilities
Governance bodies	<ul style="list-style-type: none"> » To set strategic objectives » Ensure alignment with regional transport and planning policies
Combined and local authority	<ul style="list-style-type: none"> » Authority to designate and approve features as a Special Engineering Difficulty » Ability to adopt the SuDS post construction » Responsibility of maintenance if feature is adopted » Respond to enquiries
Public bodies	<ul style="list-style-type: none"> » Enforce permits and conditions » Provide guidance on construction issues
Design and drainage engineers	<ul style="list-style-type: none"> » Approve design adjustments » Respond to site queries » Conduct site visits to verify construction aligns with design intent
Landscape architects et al	<ul style="list-style-type: none"> » Provide guidance on construction issues » Respond to site queries
Statutory undertakers	<ul style="list-style-type: none"> » Approve and monitor works near their assets » Complete diversions if required
Construction team	<ul style="list-style-type: none"> » Execute works safely and in accordance with drawings » Coordination with other disciplines » Implement site safety protocol
Local community	<ul style="list-style-type: none"> » Comply with site safety arrangements

STAKEHOLDERS & APPROVALS
[CONTINUED]

MAINTENANCE PHASE:

Stakeholder	Responsibilities
Governance bodies	<ul style="list-style-type: none"> » Monitor performance against strategic objectives » Ensure ongoing alignment with regional policies
Combined and local authority	<ul style="list-style-type: none"> » Adopt and manage asset where applicable » Oversee maintenance regimes and funding allocation » Monitor performance and operational effectiveness » Respond to public and stakeholder enquiries » Ensure compliance if feature is designated as SED
Public bodies	<ul style="list-style-type: none"> » Provide guidance operational or maintenance issues » Undertake inspections where required
Design and drainage engineers	<ul style="list-style-type: none"> » Provide technical input for remedial works » Review performance of design in operation
Landscape architects et al	<ul style="list-style-type: none"> » Monitor establishment of planting » Provide maintenance guidance for planting and landscape elements
Statutory undertakers	<ul style="list-style-type: none"> » Carry out utility maintenance works if required » Ensure SED process is followed if a feature is designated
Maintenance team	<ul style="list-style-type: none"> » Undertake establishment care, routine and reactive maintenance activities » Inspect and clean assets » Manage vegetation » Record and report asset conditions and defects
Construction team	<ul style="list-style-type: none"> » Address defects during liability period » Provide handover information
Local community	<ul style="list-style-type: none"> » Comply with site safety arrangements

Table G: Stakeholders & approval responsibilities covering design and construction phases



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