1

Designing a Soil Strategy
Grounding the Olympic Park

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1. The Olympic Park set the stage for the London 2012 Olympic Games.

2, 3. The annual meadows at the Park.

As the Olympic Park soil design required a number of distinct soil types with very specific properties, it was quickly established that topsoil manufacture was going to be an essential part of the strategy.

The Importance of Soil

Even from an early stage of the Olympic Park project, it was recognised that soils would play a fundamental part in the regeneration of the land and the establishment of a new landscape, particularly given the "brownfield" status of the site.

Soil fulfils many functions that are central to social, economic, and environmental sustainability. In the built environment, it is generally present at the land's surface in the form of public open spaces and parks, gardens and allotments, derelict land, roadside verges, playing fields, and wetlands. In these environments it carries out, to a greater or smaller degree, a number of functions and services for society.

These are:

- Support of the landscape (e.g., plants growing in the soil).
- Support of ecological habitats and biodiversity (e.g., soil fungi, bacteria, large soil fauna, and birds and insects that rely on plant for food and protection).
- Environmental interaction, including: the exchange of gases with the atmosphere; sequestration of carbon; regulation of the through-flow of water; and degradation, storage, and transformation of soil organic matter and nutrients, wastes, and contaminants deposited by human activities.
- Providing water attenuation and filtration—soil acts as a natural reservoir for billions of cubic metres of water.
- Providing a platform for construction.
- Protection of cultural heritage—soils may cover the remains of buildings, burials, and other archaeological features and include a variety of artefacts and other materials resulting from human activity.
- Production of food (which, in the urban environment, is largely limited to vegetable growing in allotments and gardens), fibre, and biomass.

These functions were all taken into consideration when developing and implementing the Soil Strategy for the Olympic Park.

2

3

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Soil Design

The selection of soils to be used for the construction of the Olympic Park's landscape scheme was very much part of the whole landscape design process. This is emphasised by the number of factors and drivers that had to be taken into consideration, as follows.

Landscape and ecology design

The landscape design for the Park presented an extremely broad and ambitious range of planting environments that needed to be catered for from the soil's perspective: large, semi-mature, and specimen trees, groundcover shrubs, ferns, tall ruderal and herb planting, wet woodland, amenity grass spectator lawns, and species-rich annual and perennial grassland meadows. The 2012 Gardens incorporated plants from around the world, each group with its own demands on the soils and cultural growing conditions. There were specific requirements for soil pH values, lime content, fertility status (both *high* and *low*), organic matter content, drainage capacity, and moisture retention.

These factors alone ensured that more than one soil was required to support the landscape scheme. A total of nine soil types were eventually identified, each with its own specific composition to meet the needs of the plants and functions of the landscape.

Remediation strategy

The Park's "brownfield" status and history of varied industrial uses resulted in the implementation of an extensive remediation strategy to clean up the contaminated land. One of the main elements of the remediation design was the use of a "cover system" to isolate the contamination from site operatives, end-users, and the wider environment. This is used on the majority of brownfield site redevelopments and essentially involves the placement of clean soil materials over potentially contaminated grounds to form a "human health layer". The landscape soils were to be used to fulfil this requirement. As a consequence, the landscape soils needed to be consistently free from contamination and had to meet the standards set out in the remediation strategy.

Drainage strategy

The Park's drainage strategy integrated the principles of Sustainable Urban Drainage Systems to control water runoff from paved and landscape areas and to maximise water attenuation within the Park. It was decided that the reliance on artificial land drainage was to be minimised to deal with excess water and waterlogging issues. Instead, excess water was to be moved to a series of swales and wooded valleys by relying upon a combination of the site's newly created sloping topography (in most of the Park) and the natural drainage properties of the landscape soils. This meant that the soils, and in particular the subsoils, needed to possess properties that would promote drainage, but at the same time, attenuate water for plant uptake and aid flood prevention.

Programme constraints

The tight programme afforded to the whole development project included the construction and establishment of the landscape. In order to establish a landscape scheme by the summer of 2012, soiling, planting, and seeding operations had to be completed by the summer of 2011 to provide for at least one growing season for plant communities and grass swards to establish.

With this aim in mind, the programme did not allow for works to be suspended during the wetter, winter months, during which soil placement and cultivations are traditionally often restricted due to unworkable soil conditions. The physical characteristics of the soils, and in particular their particle size distribution, needed to offer as much flexibility as possible for working through periods of wet weather.

Furthermore, it was important that soil treatments (e.g., cultivation) and soil amelioration (e.g., fertiliser, compost, and lime) on site would be minimised to shorten the timescales between soil placement and planting, turfing, or seeding. It was therefore stressed that all soils used within the project should be "fit for purpose" upon arrival without the need for additional amelioration or improvement prior to planting or seeding.

Sustainability

At the start of the design process it was recognised that the soils used within the Park should promote sustainable principles. This would include their actual selection, for example by choosing to use soils that contained recycled materials, such as green compost, and had favourable properties that reduced their reliance on irrigation water resources or reduced the need to use chemical fertilisers and pesticides.

Soil Type	Planting Environment
Multipurpose Topsoil	Woodland Planting Shrub and groundcover planting Annual meadows Olympic 2012 Gardens
Moisture Retentive Topsoil	Wooded Gullies
Low Nutrient Topsoil	Perennial species-rich grassland meadow
High Permeability Turf Soil	Spectator Lawns
Urban Tree Sand	Trees in paved areas
Landscape Subsoil	All soft landscape environments

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Soil Types and Their Planting Environments

Soil Types

From this design process, the following soil types were identified as necessary to support the landscape scheme as summarised in Table A.

Multipurpose topsoil

As its name suggests, this was the most widely used topsoil type. The soil properties and characteristics needed to be suitable for the majority of tree and shrub species within the landscape, whilst meeting the requirements of the other factors and drivers of the project. To achieve this, a broad pH range was acceptable, but the overall lime content was to be low for species with a low tolerance for calcareous soils.

A moderate drainage rate and porosity was required to provide a balance between good "available water-holding capacity" for plant uptake and sufficient drainage potential to remove surplus water and avoid stagnation and anaerobism.

The fertility status was moderate to high, with a large proportion of nutrients available in a slow-release form. Organic matter was recognised as a means to help achieve good water-holding properties and improved nutrient retention. It was also likely to be the main source of plant nutrients and trace elements in manufactured topsoils, and to supply essential soil microbes that are required for nutrient synthesis. There was also a need for this topsoil to be able to be modified locally to meet the demands of specific plant species selected for the 2012 Gardens.

Moisture retentive topsoil

High soil moisture retention was necessary to maintain damp soil conditions during the growing season. To achieve this, a topsoil with a slower drainage rate was required. However, it was also important for the topsoil to have sufficient gaseous exchange capacity for aeration. As such, a topsoil with the capacity to retain a strong, well-developed soil structure after importation and placement was required. Clay-based soils, which usually have strong structures, as well as the ability to self-repair after excessive handling, were therefore used.

Low nutrient topsoil

Low phosphorus levels are generally required to encourage species diversity and discourage the establishment of dominant species (such as nettle, dock, and rye grass) into a monoculture.

High-permeability turf soil

The spectator lawns receive high levels of "wear and tear" from foot-traffic, in a manner similar to sports pitches and golf greens. The soil therefore needed to be able to resist the compaction caused by such activities. It was also necessary to ensure that the lawns could even be used during and after heavy periods of rain without problems associated with standing water or waterlogged soils. High sand content and narrow particle size distribution were important properties to ensure that good infiltration, percolation, and porosity could be maintained.

Urban tree sand

The ability to provide hospitable growing conditions for tree roots whilst at the same time supporting overlying hard standing (paving, vehicular access) was also considered. This required the use of specialist rootzones with the necessary properties to provide water, air, nutrients, and soil microbes for healthy root function, whilst being compacted to a sufficient degree to offer structural stability and support and to function as a sub-base for hard surfacing.

Land subsoil

It was recognised that subsoil is a vital part of any soil profile and has several important functions, including water attenuation, drainage of surplus water, and anchorage for trees and larger shrubs. For this project, sandy subsoil with moderate drainage rates was required, which could play a crucial role to support the Park's drainage strategy. Sand-textured soils also had the ability to remain non-plastic and workable at high moisture contents.

Soil Profiles

Overall soil depths were mainly controlled by two factors: the need for a cover system as part of the site's remediation strategy, and the anticipated rooting depth of the plants to be established. Traditionally, landscape designs have placed topsoil to depths of up to one metre in tree pits and planting beds on the basis that "the more topsoil, the better". Yet it has been proven that this is not the case, and that in many instances, topsoil placed unnaturally deep is harmful to the soil and the plants that grow in it.

The design process acknowledged that topsoils do not normally perform well below depths of 300 to 400 millimetres from the surface, where there would be an increase in self-compaction and where the biochemical oxygen demand then often exceeds the rate of aeration. This often results in the development of anaerobic (or oxygen-depleted) conditions that are detrimental to plant root functions. Subsoil, by virtue of its low organic matter content and associated biochemical oxygen demand, should be used to create rooting depths in excess of 300 to 400 millimetres.

Soil Specification

The mechanism for delivering the soil design was a series of *Soil Specifications*. A separate specification was produced for each soil type. Each document contained information on the nature and properties that the soil should possess, including:

- Visual characteristics (e.g., soil structure, consistency, foreign matter, visible contaminants, and roots, rhizomes or stolons of weeds)
- Physical properties (e.g., sand, silt, clay, stones, permeability, and porosity)
- Chemical parameters (e.g., pH, salinity, exchangeable sodium percentage, calcium carbonate, plant nutrients, organic matter, carbon:nitrogen ratio, and phytotoxic metals)
- Potential contaminants, in accordance with the remediation strategy

Manufactured Topsoil

Topsoil manufacture is the widely used term for the blending of mineral and organic materials to create topsoil substitutes. As the Olympic Park soil design required a number of distinct soil types with very specific properties, it was quickly established that topsoil manufacture was going to be an essential part of the strategy. Topsoil manufacture offered several benefits over the use of natural soils.

These included:

- Consistent composition and tighter quality control
- Year-round availability
- Reduction in weeds
- Absence of potential contaminants
- Option to modify soil composition by altering mixing ratios of the various components and/or adding particular materials to the mixture
- Use of recycled and sustainable materials
- Cost savings
- Reuse of surplus, often unusable, soils

Soil Handling and Management

The careful management of soils is an essential element of any landscape project. The establishment of the new landscape on what was essentially a construction site required a completely new soil profile to be constructed using new topsoils and subsoils. The manner in which this was carried out had a significant bearing on the soil's function, and particularly its ability to drain, aerate, and support the new trees, shrubs, and grass.

It is essential to provide a structured, uncompacted, and well-aerated soil profile for the successful establishment and subsequent growth of plants. However, where heavy machinery and large volumes of soil are involved, soil structure can easily be destroyed by over-compaction. This leads to problems of waterlogging, anaerobism, and restricted root development. The consequence of over-compacted soils is not only poor establishment or failure of plantings but also increased surface water runoff and surface ponding that can contribute to localised flooding. Minimising soil compaction is therefore an essential component of any Sustainable Urban Drainage System.

Almost all soils are physically degraded to a greater or smaller extent during soil handling and placement. The potential quality and the ultimate suitability of the soil depend on how well its physical condition is restored during and after soil placement. This problem was highlighted as a major risk to the success of the landscape scheme, both at its initial establishment and for its long-term sustained development. Soil management practice clauses were therefore incorporated within the Soil Specifications.

These included:

- Minimising double-handling of soils.
- Use of the correct machinery to move and spread the soils. For example, machines with low-ground-pressure tyres and tracks were used where possible.
- Implementation of soil handling restrictions during wet weather.
- Decompaction of each soil layer and integration of soil layers to reduce the risk of a perched watertable developing.

4. The newly constructed Spectator Lawn next to Birch-Stem Woodland.

5. The 2012 Gardens at the Park.

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6. Subsoil placement in the North Park.

7. Trees in paved areas grown using urban tree soil.

8. An example of a tree pit rootball.

9. The process of topsoil manufacture involves the blending of mineral and organic materials to create topsoil substitutes.

9

Implementation

Specialist equipment was introduced for the decompaction, including a single rigid tine attachment to excavators for subsoil decompaction and a landscape rake attachment for topsoil cultivations.

The sandy, non-plastic nature of the landscape subsoil made it an ideal material as a temporary working platform during the wet winter months. The soil's sandy texture meant that it remained non-plastic and resistant to compaction, even at relatively high moisture contents. This also allowed vehicles to grade and rip the subsoil prior to topsoil placement without the creation of ruts or smearing of the soil.

The philosophy that was applied to all soiling works was to get it right the first time. The programme would not allow for soils to be repaired or improved at a later stage, or for failed trees to be replaced as a result of inferior soils or inadequate drainage. It was therefore essential that all parties worked together to ensure that the installation of the landscape scheme was correct. As part of this approach, the selection of landscape soils, their importation to the site, and their handling and management during placement and planting were closely monitored. This enabled any "non-compliances" or unexpected problems to be identified and dealt with in sufficient time and whilst the correct equipment and manpower were still on site.

Each source of soil being considered for the Park was initially reviewed to confirm the suppliers' details, source location, quantity available, and whether it was manufactured soil or natural soil. Soil test data was checked against the relevant soil specification. Each source was then visited to allow examination of the soil(s). This mainly involved checking stockpiles of manufactured topsoil or excavated subsoil. The soils were sheeted at several locations for their physical conditions, including colour, texture, structure, moisture status, consistency, aeration/anaerobism, stoniness, foreign matter, and for weeds. The site's overall quality control procedures, soil management methods, soil handling equipment, storage methods, ground surfacing, and site drainage were also assessed to help determine the ability of the supplier to maintain the necessary quality and quantity of soil for the duration of the project.

Ongoing soil testing was carried out in accordance with the Soil Specifications' sampling and testing protocols, and the results were audited and approved before the soils left their source. Soil test data was supplied by the contractor for each batch of soil at no less than monthly intervals. When necessary, further visits to the source were undertaken to assess soil manufacture and management operations.