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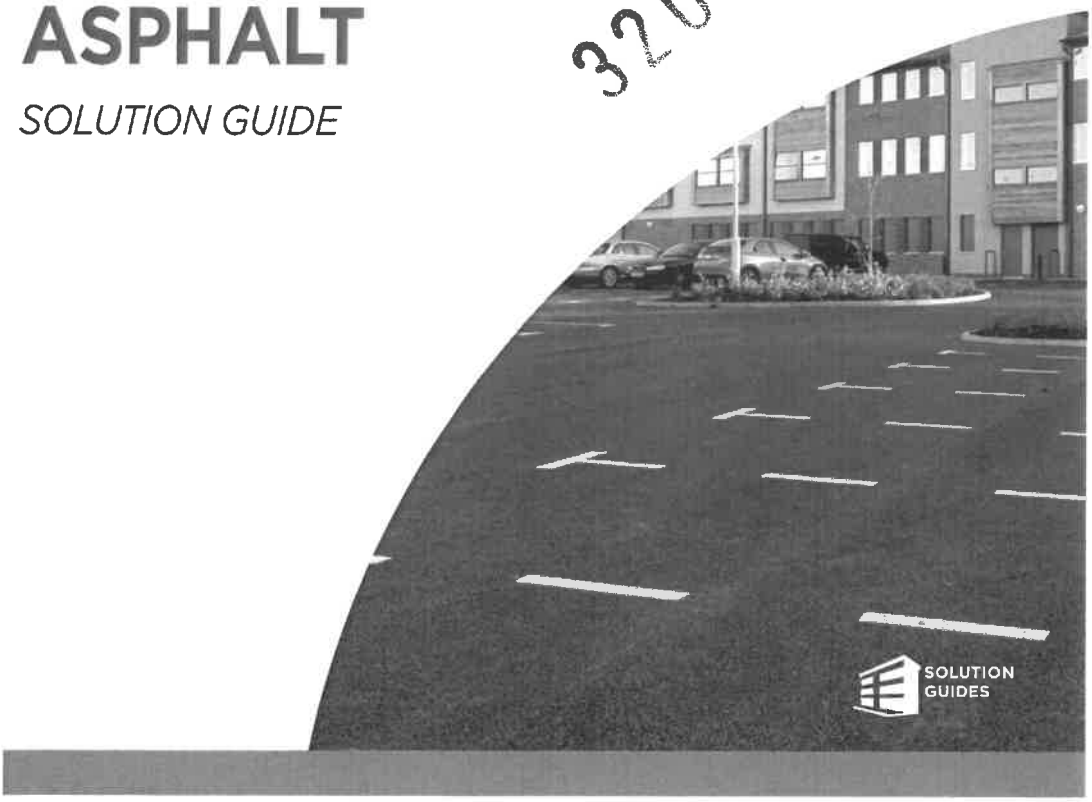
PERMEABLE ASPHALT

SOLUTION GUIDE



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GLOSSARY

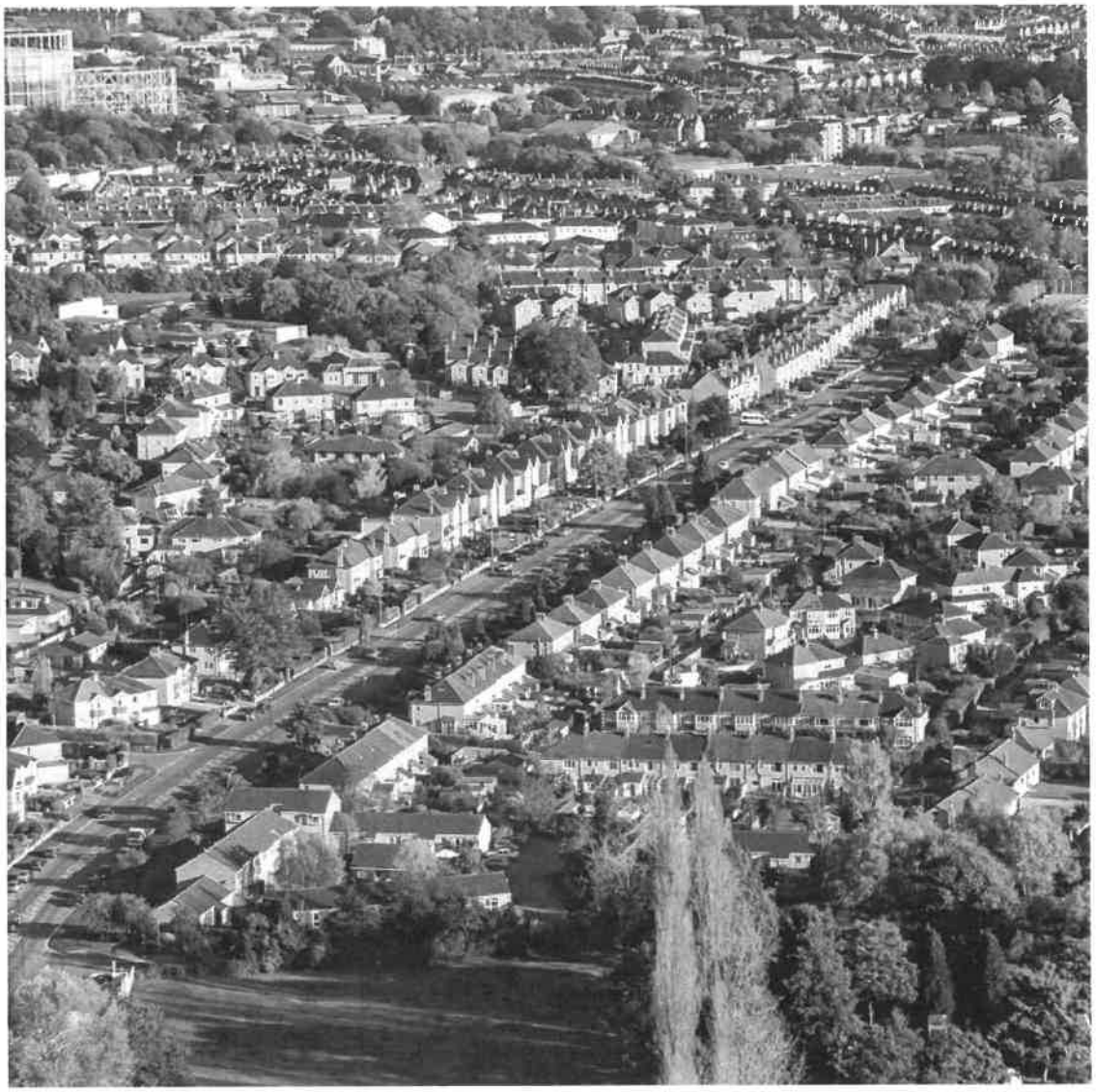
Heat Island Effect
Resulting from the urbanisation of areas due to the introduction of impermeable surfaces, which absorb solar radiation and emit heat energy more readily than those in undeveloped areas[1].

Sustainable Drainage System (SuDS)
SuDS are used to manage surface, mitigate flood risk and prevent water course pollution[2].

Biodiversity
Describes the variety of life on earth and the habitats they depend on.

Urbanisation
Defines an increase in the proportion of people living in urban areas compared to rural areas.

Californian Bearing Ratio (CBR)
A penetration test to establish the mechanical strength of sub-grades[3].



Our approach to construction encompasses innovative sustainable products, efficient building systems and practical solutions. We recognise the important role we have in promoting sustainable construction by optimising our products, their use and whole life performance. This document is one of a suite that identifies specific construction solutions that can help deliver a sustainable built environment. They explore the details of each system, its performance benefits, how it can be implemented in a project and then compares its environmental performance against alternative solutions.

This document introduces Permeable Asphalt which contributes to creating a built environment which is long lasting, robust and efficient.

Typical Applications

Car parks, low traffic access roads, driveways, pedestrian areas, multiuse games areas.

INTRODUCTION

Population growth, urbanisation and climate change have been identified as being responsible for the significant increase in the risk and severity of flood events.

The rise in impervious surfaces as a result of urbanisation and development prevents the natural dissipation of surface water. The removal of natural drainage routes increases demands on drainage infrastructure and where capacity is close to full, instantaneous runoff created during storm events has the capability to overwhelm existing infrastructure, leading to flash flooding.

A permeable asphalt system provides an effective solution to mitigate the increase in impermeable surfaces associated with new developments and urbanisation. Permeable asphalt can be integrated into drainage schemes or be utilised as a complete system to help create a Sustainable Drainage System (SuDS). It is the inherent infiltration, attenuation and pollutant retaining properties of the solution that enable it to contribute to SuDS and help mitigate the risk of flooding.

As the risk and severity of flooding increases a number of legislative and regulatory frameworks are now in place to minimise risk. The Government has identified through its National Planning Policy Framework[4] that SuDS are recommended on all new developments, this is also backed in supplementary guidance from the Environment Agency[5] and through Building Regulations[6].

ADVANTAGES OF SuDS

- Reduction of surface run off
- Reduction of heat island effect
- Maintenance of water quality
- Reduction in material quantities

As part of the community led design and build project to create the new Withywood Community Centre, there was a desire to implement a car park scheme which was as sustainable as possible, with minimum impact on the local environment.

WITHYWOOD COMMUNITY CENTRE CAR PARK, BRISTOL

Tarmac joined and integrated into the project team enabling close collaboration with all project stakeholders. This organisation enabled Tarmac to utilise their extensive knowledge and expertise to embed the sustainable credentials of permeable asphalt.

The solution enabled the attenuation of water to avoid the overloading of the surrounding existing drainage system. The car park now is an integral part of the storm water management system for what are and would have been impermeable surfaces.

During the design stage the paving system was tailored to the requirements of the project, based upon traffic loadings, existing ground conditions and volume of water to be attenuated by the system. The solution was designed to not only incorporate the surface runoff associated with the paved area of the car park but also as a direct store for the rainwater runoff from the 2,500m² community centre roof. It was the use of weirs, to increase storage capacity and responding to site constraints, which enabled the implementation of grey water harvesting and the management of outflow rates to existing drainage. Users of the centre are able to minimise their potable water demand through utilisation of their stored water for grey water applications.

Further sustainability benefits were achieved as vehicular movements and transport distances were minimised, as all materials were sourced and supplied from within four miles of the site.

Comment

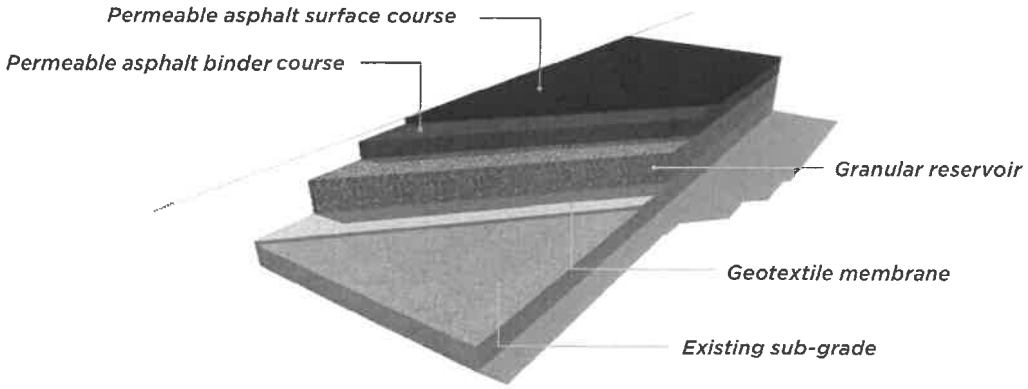
"It was a key part of our design brief to create a parking area that was not only environmentally friendly, but also capable of storing thousands of litres of rainwater as a sustainable solution for the new community centre. Working alongside Tarmac's National Contracting team, we were able to achieve this by using a permeable pavement. In addition to the environmental benefits it delivered for the local community, there were also cost saving benefits when compared to permanent traditional drainage systems. This innovative car park is working well and helping to protect the local community from the potential risk of localised flash-flooding."

Chris Goodsall, Project Manager, Quattro Design

A permeable asphalt system is a development of traditional asphalt pavements. consisting of four distinct layers, a surface course, binder course, granular reservoir and a geotextile or geomembrane. The properties and dimensions of each layer is dependent on the systems structural and hydraulic performance requirements and the existing site conditions.

It is the binder course which provides the key structural performance characteristics of the solution, when combined with the other component layers UltiSuDS, Tarmac's permeable asphalt solution, can provide a stiffness of >1,100 MPa and 1,250 MPa in the surface and base course respectively.

Permeable asphalt surfacing solutions can be utilised in place of impervious surfaces, traditional drainage and other more common permeable solutions to deliver a SuDS solution.



With all asphalt pavements the surface course is designed to provide a smooth finish, with no trip hazards an appropriate level of slip and skid resistance. These characteristics in a permeable solution are maintained whilst being free draining (removing risks of standing water and ice) and acting as a pollutant filter, removing contaminants prior to discharge.

It is the granular layer, that Tarmac can supply, consisting of specifically graded unbound aggregates to create voids, which can act as a reservoir for the attenuation of surface run off, delaying the instantaneous surface run off associated with impermeable surfaces.

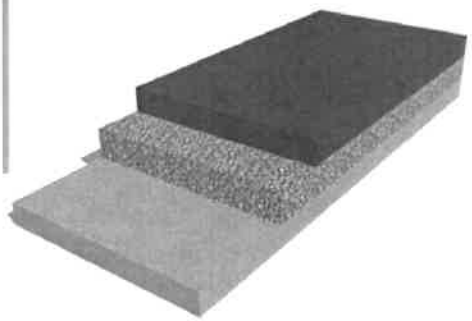
When a permeable solution is used to attenuate surface run off it can play a role in the reduction of the heat island effect through evaporation cooling. As periods of raised temperatures are experienced the trapped water evaporates creating a surface cooling cycle. Throughout the system each layer acts as a filter and pollutant screen, trapping silts, organic materials and heavy metals within its structure reducing their discharge into water courses.

PERMEABLE ASPHALT SYSTEMS

There are three core systems for the implementation of permeable paving systems, whose suitability is dependent on site conditions.

SYSTEM A
Full Infiltration

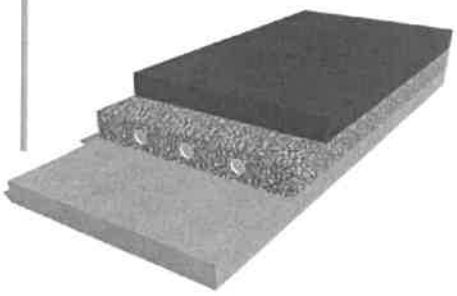
The preferable solution for drainage systems, as it enables the surface water to be dealt with on site. The system allows all water entering the pavement to infiltrate through the constructed layers into the existing underlying ground.



SYSTEM B

Partial Infiltration

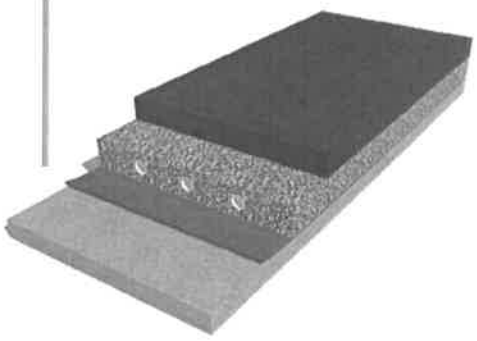
Where sites have low permeability properties a partial infiltration system allows the excess run off, which can not be absorbed by the underlying ground to be attenuated or discharged into a suitable drainage system.



SYSTEM C

Full Attenuation

On sites where no infiltration is possible an attenuation system is required, this is achieved through the installation of an impermeable membrane which does not allow any water penetration. The system acts as a temporary store prior to controlled discharge or reuse.



REDUCTION OF SURFACE RUNOFF

Instantaneous runoffs, due to increases in impervious surfaces can lead to and result in the overwhelming of existing drainage systems with the consequence of flooding. Managing surface run off through the use of permeable drainage systems can regulate the flow, delaying or attenuating surface water before allowing it to dissipate naturally or in a controlled manner through existing drainage systems.

Our permeable asphalt, UltiSuDS, is an advanced asphalt solution with typical insitu flow rates and void ratios of >8,000 mm/hr and 16% and 25,000 mm/hr and circa 25% for surface and base courses respectively.

REDUCTION OF HEAT ISLAND EFFECT

Materials such as asphalt and concrete contribute to the heat island effect[1] by absorbing solar energy, which is released as thermal energy resulting in local temperature gains.

However, the implementation of a pervious asphalt solution can help mitigate the urban heat island effect through localised cooling. As the surface is heated in warm periods, due to solar energy absorption, water held within the voids of the asphalt evaporates creating a cooling effect.

MAINTAINING WATER QUALITY

Permeable asphalt solutions can be extremely effective in the maintenance of water quality whilst minimising surface run off. The use of permeable surfaces can minimise the need for additional treatment solutions, such as petrol and oil interceptors, by acting as the primary treatment facility in accordance with best practice guidance (e.g. CIRIA C697 'The SuDS Manual'[7]).

Tarmac has undertaken a significant research project with Coventry University to explore the ability of UltiSuDS to maintain water quality[8]. UltiSuDS has been demonstrated to act as an intermediate interceptor, treating, filtering and trapping contaminants.

The research at Coventry University tested the solution against a number of pollutants, street dust, heavy metals, sediments and engine oil with positive results in all cases.

Heavy metal contents were below World Health Organisation (WHO)[9] drinking water specification limits, sediment concentrations were below background levels and all heavy metals, hydrocarbons, phosphorus and nitrogen were removed from runoff.

REDUCTION IN MATERIAL QUANTITIES

Utilising permeable solutions can facilitate a reduction in drainage products and systems such as drains, gulleys and catchment pits can be reduced or removed along with the activities needed to install them. Ancillary products such as interceptors and drainage pipe networks may also be able to be removed. These design changes facilitate material savings to be made throughout production, transportation and installation, while protecting material reserves.

ONSITE SOLUTION

According to the water management train the most sustainable method of dealing with surface and storm water runoff is via prevention[7] (i.e. stopping its generation). The use of permeable surfaces allows pre-development infiltration rates to be maintained along with natural drainage routes, reducing demands on additional site drainage systems. This can also reduce sewerage charges as no surface water is required to be discharged.

RAINWATER HARVESTING

Through intelligent design permeable solutions can not only enable pre-development infiltration levels to be maintained but also the opportunity for water harvesting.

The attenuation layer can be used to store runoff water which can be redirected for use on the development in a number of grey water applications, reducing potable water demands.

ONGOING MAINTENANCE

Flow rates in permeable asphalt can be reduced by the interception and trapping of contaminants and fine materials. As these are held in the uppermost surfaces of the pavement they can be readily removed by a suction road sweeper, without any need to disturb or reconstruct the pavement.

PLANNING LEGISLATION

The inability of existing drainage systems to deal with significant heavy rainfall events was identified as a contributing factor to the serious flooding incidents of 2007. As a result the Government legislated that any new hard standings over 5m² require prior planning permission if they are to be constructed from a non permeable material[10]. Permeable Asphalt is a solution which allows the construction of hard standings without the need for planning permission, however appropriate design consultation should be undertaken prior to the commencement of any works.

The design of a permeable asphalt solution is required to take into consideration site and location specific conditions, such as the strength of underlying ground and weather conditions it is expected to endure.

An indicative design has been created to provide a base for the development of specific designs once site conditions have been ascertained:

- 120mm layer of permeable asphalt
- 200mm (minimum) granular reservoir layer
- Geotextile or geomembrane dependent on application
- Subgrade with a minimum CBR of 5%

The design and implementation of permeable paving solutions are dictated by a number of key characteristics related to site conditions and post construction performance. A permeable paving solution is required to be tailored to each individual application having considered the points shown in the table opposite.

DESIGN CONSIDERATIONS	
Traffic loading	In order for an accurate and cost effective design to be created it is necessary to determine the loadings which the pavement will be subjected to. Inaccurate specification of loadings may result in incorrect design which in turn can result in poor system performance or premature failure. Traffic loading is typically based upon the category of loading, such as domestic parking or commercial from which a standard axle loading can be determined for detailed design. UltiSuDS has been designed to withstand the loads associated cars and light commercial vehicles and therefore should not be employed in applications subject to higher traffic loads.
Maintenance	The UltiSuDS system is designed to incorporate a high redundancy factor, with regards to flow rates based on the assumption that the surface layer will become clogged over time, reducing flows. When 95% clogged the system has been shown to be able to cope with a 1 in 100 year storm event. Flow rates can be renewed through regular and ongoing maintenance, which can be simply completed with a suction road sweeper
Local governance	Planning and development processes are dictated by national Government and local authority policies. When any new or renovated paving systems are to be installed it is necessary to explore if there are any specific local authority requirements such as discharge consents, which may impact how the water is discharged from a site. Local authority requirements are typically enforced and determined by pavement use and the likelihood of contaminants being present.
Sub-grade suitability	The underlying permeability of sub-grades and water table levels play an important role in dictating the viability of a permeable solution. The level of infiltration dictates the system that can be employed (see pages 13 and 14) with water table levels storage capacity of attenuation layers. Permeability testing should be carried out on site at paving formation levels and water table level established in order to enable a suitable design to be selected.
Water storage capacity	The capacity of the drainage system needs to be designed in tandem with the structural requirements of the paving solution, with care taken that the greatest substructure design is utilised to ensure water storage capacity and structural performance is achieved. Storage capacity is required to be designed in line with rainfall return periods, which defines a period of time in which the depth of rainfall is only equalled or exceeded once.
Sloping sites	It is possible to install permeable paving solutions on both flat and sloping sites. However there is a limit to the maximum slope that can be accounted for. In the circumstances where sloping sites are encountered additional consideration is required during the design process, primarily concerning the attenuation layer. Within the attenuation layer, baffles or check dams are required to be installed to prevent run off water from flowing instantly to the lowest point which could significantly reduce the storage capacity of the system.

SUSTAINABILITY

The specification and installation of permeable paving solutions in place of traditional impermeable paving enables further environmental improvements to be delivered.

RESOURCE DEPLETION

Asphalt is an inherently flexible material with regards to its on site placement and also its constituents. It is possible to adapt mix designs to incorporate recycled and secondary aggregates to reduce its impact on virgin and finite materials. Further to this a permeable solution can reduce and remove the need for ancillary on site drainage systems, minimising the consumption of resources.

EMBODIED ENERGY

Asphalt traditionally requires high temperatures in production in order to enable complete mixing to take place and to ensure sufficient residual temperature remains to maintain flexibility for installation. In selected applications embodied energy associated with high temperature production can be reduced through the tailoring of of asphalt solutions for low temperature production.

RECYCLING

Asphalt is one of the UK's most versatile construction materials with an industry that strongly supports its application in a sustainable manner.

Asphalt roads are one of the most successful examples of the re-use of finite natural resources[11]. Asphalt is 100% recyclable and can be used in the manufacture of new asphalt and can utilise the waste from other industries[12].

BES 6001*

Tarmac has achieved a 'Very Good' rating for all its production sites and products. The independent third-party scheme assesses responsible sourcing polices and practices throughout the supply chain[13].

ISO 14001

Tarmac is fully accredited with ISO 14001, having implemented Environmental Management Systems throughout our business, maintaining our commitment to reducing our environmental impact[14].

SUSTAINABILITY ASSESSMENT SCHEMES

Asphalt can play an extended role in delivering sustainable infrastructure and can contribute in a number of assessment schemes and help achieve a range of credits[1].

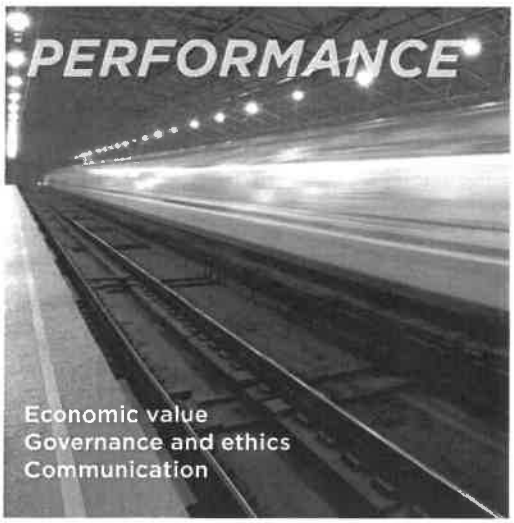
CREDIT/TARGET	BREEAM	LEED
	Man 03: Responsible Construction Practices Tarmac's Carbon Calculator has the capability to determine and provide data relating to the CO_2 arising from the production and delivery of materials. Through our contracting business department we can also provide a footprint including installation	**MR Credit 2: Construction waste** Construction and demolition waste is encouraged to be diverted away from landfill or incineration, asphalt is an inherently reusable material that is 100% recyclable
	Mat 03: Responsible sourcing of materials Asphalt primarily utilises materials which are local to the production plant, all of Tarmacs solutions and products are BES 6001 accredited, to a 'Very Good' level.	**MR Credit 4: Recycled content** Asphalt is a versatile material whose design can be readily adapted to enable the use of recycled, secondary or replacement materials
	Wst 02: Recycled Aggregates Asphalt is a versatile material which can readily accept recycled, secondary or replacement materials. Replacement and remedial works can utilise the removed material within the new asphalt layers	**SS Credit 6.1: Storm water Design - Quantity Control** Permeable asphalt can limit the disruption of natural hydrological cycles. It can be used to maintain or improve on site infiltration rates.
	Pol 03: Surface water run off Permeable asphalt can mitigate increases in surface run off by attenuating run off, maintaining natural infiltration rates or allowing improvements when replacing impervious surfaces. Additional contributions can be achieved with respect to reducing water course pollution	**SS Credit 6.2: Storm water Design – Quality Control** Permeable asphalt has the ability to reduce and filter polluting materials that can be present in vehicular paved areas

[1] Tarmac concrete products offer the ability to conform with a wide-ranging number of assessment criteria in both BREEAM and LEED. For more information contact Tarmac sustainability team.

* Our BES 6001 certificate number for our readymix concrete products is BES 559207.


PEOPLE
Safety and health
Our people
Community involvement


PLANET
Climate change
Environmental stewardship
Resource efficiency


PERFORMANCE
Economic value
Governance and ethics
Communication


SOLUTIONS
Sustainable supply chain
Innovation and quality
Sustainable construction

OUR SUSTAINABILITY STRATEGY

Sustainability is about securing long-term success for our business, customers and communities by improving the environmental, social and economic performance of our products and solutions through their life-cycle. This means considering not only the goods we purchase, our operations and logistics but also the performance of our products in use and their reuse and recycling at the end of their life. By doing this, we can understand and take action to minimise any negative aspects, while maximising the many positive sustainability benefits our business and products bring.

Using this 'whole life' thinking we have engaged with our stakeholders to develop our sustainability strategy. The strategy defines the main sustainability themes and our key priorities, those issues which are most important to our business and our stakeholders. It sets out our commitments to transform our business under four main themes: **People, Planet, Performance and Solutions**.

Building on progress already made, we have set ambitious 2020 milestone targets for each of our key priorities. These ambitious targets have been set to take us beyond incremental improvement programmes to business transforming solutions.

FOUR THEMES

Twelve key priorities

Twelve commitments

Twelve 2020 milestones

Forty four other performance targets

Our 2020 milestones are supported by a range of other performance targets. This hierarchy helps make it easier to build understanding, drive improvement and enables us to report progress in a meaningful and measurable way.

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