Innovative Practices for Greener Roads
Until relatively recently, concepts such as "sustainability", "green transport" and "greenhouse gas emissions" too often tended to be dismissed as the doomsday ravings of a few deluded fanatics preaching that the end of the world was nigh.

Today, confronted with unprecedented challenges to our global climate and economy, we are acutely aware that, without a rapid shift towards more forward thinking and sustainable lifestyles, we may indeed be on the verge of a major planetary reckoning.

Hard facts and mounting scientific evidence have replaced the extremist preaching.

Alongside other sectors, the transport industry must assume its share of responsibility. The seriousness of the situation calls for our sector to rise to the challenges and opportunities of the emerging green economy, so as to reduce the road industry’s impacts on the environment and enable it to contribute pro-actively to a more sustainable future.

Already, modern road transport systems increasingly reflect the commitment of road builders, scientists and city planners in these respects - as well as their growing ingenuity in efforts to ensure and safeguard a better living environment. Sustainability is becoming a major watchword, not only at the design phase but also in the construction and implementation stages of road schemes. The potential effects of a given road on the environment are assessed in terms of visual, landscape, biodiversity and other possible impacts. Factors such as recycling of materials as well as risks of water contamination, noise pollution and greenhouse gas emissions are also comprehensively taken into account, alongside detailed consideration of appropriate measures to avoid or remedy any issue that may arise.

Whilst there can be no room for complacency, everything seems to be moving in the right direction, and we are making encouraging progress on the path to sustainable roads. The legislative climate is changing, materials are being recycled, eco-driving awareness is being promoted and carbon trading and offsetting are gradually becoming standard practice. More research is being carried out and more efficient technologies are being made available to enhance the sustainability of road schemes. And this is only the beginning. The necessity of sustainable roads has been firmly established and universally acknowledged. It is now simply a matter of how many will follow … and how quickly.

This publication highlights a series of projects, products and practices from around the world that have demonstrated exemplary commitment to the environment and dedication to road sustainability. It is hoped that they will help set new standards throughout the road sector, as well as stimulate ongoing progress. The featured innovations range from advanced traffic signaling and pavement recycling right down to wildlife protection systems. They serve as a first reference compilation of model design considerations, technologies and research applications. Furthermore, they provide a comprehensive overview of the various aspects of environmental impact mitigation as they apply to the road industry, with the aim of setting practical examples and establishing a basis for the development of best practices.

It is our hope that innovations like these will guide and further inspire - not only our industry but also the full range of stakeholders, including the public sector and governments - regarding the clear economic, as well as environmental and social, benefits of sustainable road schemes and eco-friendly projects.

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3M™ Diamond Grade™ DG³
Reflective Sheeting

Next to the manufacturing advantages offered by microprismatic sheeting in general, this product offers additional benefits to road authorities in reducing investment and maintenance costs for certain traffic signs, as well as reduced operational energy cost. This is achieved without compromising road safety in any way. Traditional reflective sheeting processes are based on a multi-layer coating process. Lower molecular weight polymers are dissolved in various solvents, coated and dried, where the solvent needs recycling by condensation and cleaning, or is simply incinerated or released.

A microprismatic manufacturing process uses higher molecular weight polymers which are extruded on specially embossed cylinders. No solvents are required. The ability to use high molecular weight polymers during the manufacturing process provides a better UV and weather resistant retro-reflective film construction. This results in traffic signs than offer a longer effective life cycle. Warranties have increased from a maximum of seven years to ten years or more. In addition to the benefits attributed to standard microprismatic sheeting, Diamond Grade DG³ sheeting allows the replacement of illuminated signs with no negative impact on driver behaviour. Replacing illuminated signs by high performance retro-reflective signs enables authorities to reduce investment and maintenance costs, and energy consumption.

Environmental Benefits

Microprismatic retro-reflective sheeting manufacturing uses an innovative process that minimizes environmental impacts. It reduces VOC emissions by 97%, consumes 77% less energy, and generates 46% less solid waste compared to a traditional, beaded reflective sheeting manufacturing process.
The benefits for end users and for the environment can be illustrated by an Illinois Department of Transportation (IDOT) road agency case study. The agency have begun switching out all overhead signs on the state’s roadways to use high performance sign sheeting that will improve visibility. The new signs will also save the state money by allowing IDOT to remove lighting fixtures used on overhead signs. The new signs will be put up as old ones need to be replaced, so the change-over to the higher performance reflective sheeting is expected to take at least 10 years. The cost is USD 74,000 per year. Once the project is complete the state could save USD 1 million a year in maintenance and energy costs. In early spring of 2006, IDOT installed new sign sheeting on overhead guide signs along the Illinois Route 15 corridor in St. Clair County. The purpose was to test this high performance sheeting for safety, visibility and cost effectiveness. Due to the success of this pilot project, IDOT is using the new sign sheeting on replacement signs on the Upgrade 74 project in Peoria and Chicago’s Dan Ryan expressway reconstruction. The materials used on the new signs ensure them a better durability to all kind of weather conditions. In addition to durability and improved visibility, IDOT is also switching to an easier to read font on highway signs - Clearview - developed specifically to make highway signs easier to read for older drivers.
MIMAR is an AEC initiative to improve the knowledge of road users in the environmental aspects of roads. In Spain and other countries there is a growing concern about road accidents in which animals are killed. Such accidents are serious, not only for the species involved but also for the safety of drivers, passengers and others along the route. Wild boars and foxes are among the animals frequently involved in accidents. MIMAR is a map, providing road users with information on: road sections with a high risk of disturbing animals in their natural surroundings and, consequently, a high risk of accident involving animals; areas with a high environmental value, due to the diversity of animals or plants and protected areas. Using MIMAR, road users can increase their general awareness and adapt their driving accordingly.

Environmental Benefits

MIMAR is part of a wider AEC project developed as the “Programme for sustainable road maintenance” during 2006 and 2007, with the support of European Social Funds and Fundación Biodiversidad. The project promotes environmental training for road maintenance professionals, by developing training material and additional information in a specific website. The following environmental impacts of road maintenance operations were analysed: atmospheric emissions, noise, residues, water spills, water consumption, energy consumption, soil, wildlife, vegetation, visual.
For each of these impacts, a detailed set of guidelines were developed in order to avoid or minimize the consequences. For example, for pavement maintenance operations, the environmental effects relate to air pollution, contribution to climate change, negative impact for population, animals and vegetation and gas emissions. So the following management guidelines are suggested: avoid tipping materials from high places; use water to lay dust, especially under windy conditions; avoid high speeds; inform workers, so they know that burning of residues is forbidden; maintain vehicles to a high technical standard.
Greener Roads Through New Mixing and Compaction Technologies

Roads are the backbone of a flourishing economy. Thanks to new technologies, they can be built even more environment-friendly. A major step in this direction is reducing the asphalt temperatures, which has been achieved by new mixing technologies. As a consequence, asphalt laying asks for faster compaction technologies. Ammann provides proven solutions to the construction industry for both of these new challenges.

Asphalt is an ideal material for the construction of high-quality roads, which consist of several layers of asphalt and gravel. The preparation of the asphalt is usually done in a central mixing plant, where minerals are dried, heated up and mixed with bitumen. The hot asphalt is delivered to the road construction side in lorries and a paving machine is laying the material on the prepared ground. Finally compactors effect consolidated layers and durability.

Environmental Benefits

Lowering the maximum temperature of the asphalt during production and mixing allows a reduction of fuel consumption at the mixing plants, since less energy is needed to heat the minerals and the bitumen. The second advantage of lower temperatures is the significant decrease of asphalt smoke that construction workers are exposed to.

The Ammann Compaction Expert (ACE) enables the operator of a roller to choose the optimal vibration mode on the road construction site. Very fast compaction is achieved and the current level of compaction is measured.
constantly. Excessive or over-compaction is prevented and in addition, the energy consumption of the machine itself is minimized. Ammann’s intelligent compaction with high-tech measurement and control equipment therefore is a key enabling technology for the wider application of low-temperature asphalt.

Mere optimisation of the compaction itself is often insufficient to achieve sufficiently fast compaction. Therefore, today’s compaction machines can be controlled using GPS positioning technology (e.g. ACEplus of Ammann). Real-time displays of machines’ current positions, compaction work done and positions were additional compaction is necessary, allow drivers and construction coordinators to plan the use of their machines. Staying within the narrower time slot for compaction is now possible. The combination of intelligent compaction modes, positioning technology and on-machine displays allow the new low-temperature asphalts to be applied on road construction sites. Energy savings thanks to lower process temperatures can now be realized.
Delivering Sustainable Outcomes

All highway schemes impact on the communities, environment and ecosystems they pass through. As road engineers, Arup is responsible for ensuring that solutions are carefully integrated into the surrounding environment, while ensuring the economic and social benefits are maximised.

Designing and constructing in this way requires a creative and innovative approach that is best illustrated by project examples.
Environmental Benefits

Running through Snowdonia National Park, Arup’s design of the A470 trunk road in Wales (previous page) provided a safe and reliable route for road users and preserved a landscape of lush pastures and diverse flora and fauna. The Shenzhen Western Corridor (previous page) demonstrates how the planning, design and construction of a major road can be completed in record time without compromising the water quality or cultural heritage of a region’s ecologically sensitive area.

The Bingley Relief Road shows how effective community engagement and sustainable innovative design can reduce traffic in urban areas and improve a community’s quality of life. Complex challenges included crossing a protected peat bog - where direct access for construction plant was denied - and ensuring minimal disturbance to its delicate hydrological and ecological balance. Sustainability was at the heart of the design for the M6 Toll Road. Three million tonnes of sand and gravel excavated from the site was re-used as special fills and aggregates for concrete and drainage, saving 400,000 lorry journeys to and from the site. Measures were taken to mitigate the effects of the route on the local environment including the translocation of heath land; the relocation of rare plants and wildlife and planting over one million new trees and shrubs.

At Arup we demonstrate how well considered infrastructure can be truly sustainable, improve people’s lives, enhance the environment and leave a legacy for the benefit of future generations.
Attica Tollway is the 65 km stretch of motorway which forms the Athens ring road, a pioneer project constructed on a concession basis. It is one of the largest co-financed road projects in Europe. Attica Tollway has two directionally separated carriageways, each including 3 lanes, plus an emergency lane. It is a unique piece of European road infrastructure, since it is essentially a closed toll motorway within a metropolitan capital where the problem of traffic congestion had been acute. Additionally, heavy traffic conditions were a main cause of reduced air quality in the surrounding environment.

**Environmental Benefits**

Attica Tollway has studied and implemented **significant noise protection measures**, depending on the configuration and the requirements of each area. More specifically, noise barriers have been installed, covering an area of several thousand square metres, as well as buffer zones, and specially planted slopes and embankments. In order to constantly monitor the levels of air and noise pollution, six noise measurement stations and eight air pollution measurement stations operate at key locations along the motorway. The presence of the motorway has achieved a **significant reduction in air pollution and traffic noise in the city of Athens** by reducing congestion. Studies by the local authorities suggest significant savings in fuel consumption - **as free flowing traffic moving along the motorway consumes on average 60% less fuel than that travelling on the local urban network**. Extensive sewage and flood protection works were created to collect superficial water run-off, since the rapid increase of human activity in the area allowed few remaining natural receptors. This resulted in **enhanced flood protection for Athens**, transferring...
rainwater to the transverse structures and leading it to sea receptors. The surrounding *landscape was extensively restored by rehabilitation and reforestation* of former quarries in the region. Attica Tollway used more than 15 million m³ of excavation by-products, to restore landscape damaged during the construction stage, to provide *new green spaces for recreation and to improve the area’s ecosystem.*

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Marketing Environmentally Sound Road Marking Products That Enhance Safety

Products typically are assessed according to their ecoprofile. That is, their environmental impact from extraction of raw materials, their production, packaging and transport, application to a road surface, use - and ultimate disposal. Current emphasis is given to Typhon paint, the PROSIGN G400 airless line marker and Ostrea Route and Ostrea Spray - the latter two made from pine resins, vegetable oils and ground oyster shells.

AXIMUM is the road equipment subsidiary of the Colas Group. A leader in this market, it boasts a complete array of products and skills. It has more than a dozen unique products and services well known by their trade names. It specialises in installation and maintenance of road safety equipment and signs, traffic monitoring, production and application of marking products and production of marking equipment. The Group employs 2000 people, throughout France and in other countries.

www.aximum.fr
Environmental Benefits

The ecoprofile approach requires the use of indicators to evaluate the environmental/health impacts of a product throughout its life cycle. Somaro typically look at greenhouse gas emissions (climate change), Volatile organic compound (VOC) emissions, eutrophication of the aquatic environment (asphyxia of aquatic fauna), energy consumed, potential toxicity and waste generation. The environmental/health balance sheet for the water-based road paint Typhon show impacts at least 30% lower than for a typical solvent-based paint. Atmospheric VOC emissions are an impressive 88% lower, especially during the application phase. The PROSIGN G400 airless line marker shows several clear advantages, compared to other machines/systems: superior operator ergonomics and safety; excellent application quality; centralised control station management of the main marking work; optimum reliability, safety and service life; lower noise levels. The two Ostrea products replace the use of quarry lime - eliminating the need for extraction and much of the raw material transport. They reduce the use of non-renewable petroleum resources and reduce greenhouse gas emissions by 20% on application and over the whole product life cycle and eliminate packaging waste.
The Caterpillar D7E Tractor

The Caterpillar D7E is a new track-type tractor (bulldozer) with electric drive that increases dozing efficiency by 25% (cubic meters/liter), and lowers operating costs by 10%. This revolutionary integrated powertrain reduces fuel consumption by 10 to 30% and uses fewer parts and fluids during its useful life. The D7E also helps the environment by reducing CO2 and gaseous emissions. The D7E is an innovative solution that will impact the customer’s bottom line and their environmental footprint.

Environmental Benefits

The D7E is an innovative new track-type tractor designed to deliver powerful performance and precise maneuverability while consuming fewer resources. The most significant design feature is an AC electric drive train, which replaces the power shift transmission that is typically used in these size track-type tractors. Electric drive trains have been utilized in other types of construction equipment (such as off-highway trucks) and other types of transportation equipment (such as locomotives). The D7E electric drive train is the first of its kind, specifically designed to meet the demands of a variety of dozing applications, such as frequent changes in direction, working in harsh conditions and the need to have very powerful electrical components in a small amount of space (power density).

In addition to the electric drive train, the D7E features a beltless design. The accessory systems, like air conditioning and the water pump, are electrically powered so there is no need to repair, adjust or replace engine belts. Additional innovations such as a center post cab which is combined with a single lift cylinder...
Environmentally, the engine meets Tier 3 standards with a view to Tier 4, while the rest of the D7E is designed with more lifetime parts and fewer fluids required. All major components are engineered to be rebuilt/reused. The D7E will come to market in 2009 making a positive impact on the environment and a positive impact on a road builder’s bottom line.

The D7E improves operating efficiency and this is very important since finding qualified labor is a significant issue in the construction industry. New operators can be trained quickly and can be more efficient in a shorter amount of time. In addition, the D7E comes grade control ready from the factory and performs extremely well when a grade control system is utilized. The grade control system utilizes either laser or GPS signals to help the operator move the material in an efficient manner and achieve grade. This improvement in material movement was not factored into the reductions but typically results in an additional 30% improvement in the time to complete a job (due to moving the material efficiently).

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The Colas Group is a leader in the construction and maintenance of infrastructure for transport, urban development and recreational facilities (roads, highways, runways, ports, industrial platforms, logistics facilities, city streets, parking lots, reserved-lane public transport networks, athletic fields, automobile racing circuits, etc.). Backed by a tight international network of quarries, emulsion plants and asphalt plants, upstream activities include the production and recycling of construction materials. Colas also operates in other road-related activities: safety, road marking, traffic management; civil engineering; pipes and mains; waterproofing, siding and roofing; building (construction, deconstruction); railways (trains, tramways, subways) along with services and concessions.

With 73,600 employees throughout 1,400 profit centers in 40 countries on five continents, the Colas Group carries out 112,000 projects each year.

www.colas.com

Developing Silent, Natural, Low Temperature, Recycled Road Products and Techniques

NANOSOFT is Colas’ latest generation of noise-reducing surfacing. VEGECOL is a translucent colorable plant-based binder made of renewable plant products, as a substitute for bitumen. VEGERFLUX is a flux agent containing plant-based raw materials. 3E ASPHALT MIX (environmentally-friendly, energy-efficient asphalt mix) is manufactured at lower temperatures than conventional mixes. COLAS RECYCLING TECHNIQUES include cold and hot techniques, in situ or using asphalt plants, that use RAP or reclaimed asphalt pavement aggregates. ECOLOGICIEL is a Carbon Footprint® type software developed by Colas for the proposal of alternative solutions to clients.
Environmental Benefits
Reducing noise, cutting energy consumption, diminishing greenhouse gas emissions and saving materials.

**Nanoso**t ensures a 9 dB(A) decrease of traffic noise compared to conventional mixes, dividing noise power by 8. **Vegecol** can serve as a true carbon sink and allows for production of asphalt mixes at temperatures that are 40°C lower than conventional mixes. **Vegeflux** does not emit volatile organic compounds. **3E asphalt mix** saves between 10% to 20% energy and reduces greenhouse gas emissions from 15% to 25%. **Colas recycling techniques** save aggregates, transport, energy; 5 million m² of roads were recycled by Colas in 2008.

**EcologicieL** allowed for a 15,000-metric ton reduction in equivalent in CO2 emissions in 2008.

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Promoting the Widespread Use of VALORCOL

By 2010 Switzerland’s CO2 emissions have to be reduced to 90% of those of 1990 (Federal law on CO2 emissions reduction, 1999). Road construction companies will contribute to this objective. In line with this common aim, Colas Switzerland developed in 2006 a new asphalt concrete, which is both economic and ecologically sound. The new product is a cold asphalt concrete, based entirely on reclaimed asphalt aggregate - VALORCOL. The binder used is also a cold asphalt emulsion, so there is no need for heat during preparation and mixing. VALORCOL can be used for sub-base course, base course and, in some conditions, for surface courses. Asphalt aggregates result from the crushing and sorting of old road superstructures. Gravels, stones and bitumen parts of the aggregates are of high and proved quality. VALORCOL is manufactured in a dedicated and simple plant and laid in a traditional way, using normal equipment. The thicknesses of the layers are comparable to those of traditional hot asphalt and depend on the result desired.

Environmental Benefits

Resource saving. As it uses mainly reclaimed asphalt, VALORCOL saves natural resources of gravel and stones, which are becoming scarce. It is commonly said that the first source of granulates in future could be the old road itself! The use of fossil resources is limited to the bitumen in the emulsion, which is only some 2% of the final product. Traditional asphalt concrete uses between 4 and 6% of bitumen. The regeneration of old granulates lessens the need for waste disposal.

Limiting transportation: The sources of reclaimed asphalt are commonly closer to the road work than a quarry. So transportation of materials can be greatly reduced.

Colas Switzerland

COLAS was founded in 1927, in Geneva, to exploit the patent for COLd ASphalt - a totally new emulsification process. Colas Suisse Holding SA is now a group of some fifteen companies directly or indirectly active in public works. Today, the COLAS Switzerland group is established throughout the Suisse Romande and is active in road construction and engineering, civil engineering, the production of aggregates and bituminous products and laboratory research.

www.colas.ch
Energy consumption and GHG emission reduction. Through use of cold emulsion, simply prepared aggregates, and unheated mixing, energy consumption and emissions are both reduced. For the plant in Geneva, it has been calculated that the GHG emissions are reduced by 300 tons of CO2 each year, if a mere 10% of its asphalt concretes are replaced by VALORCOL.

A recent roadworks in the Jura used 12,000 square metres of base course and 3,000 tonnes of VALORCOL. Energy and CO2 savings of nearly 48% were obtained, compared to the traditional use of transported hot bitumen and extracted aggregates. The energy saving was equivalent to 530 Swiss families’ electricity consumption for lighting during one year. The CO2 saving was 84 tonnes, which is the equivalent CO2 output of a 30 tonne truck covering 87,000 kilometres.
Traffic noise has been identified as a key concern for the public. Noise emissions from highways adversely affect the quality of life of nearby residents, create communication difficulties and lower real estate values. In order to reduce noise, it is first necessary to understand where these emissions are occurring. Studies have shown that the majority of noise produced from a highway is due to the tyre/pavement interaction. The mechanisms by which noise is generated in the tyre/pavement interaction vary, and will be dependent on the match between tyre characteristics and pavement properties. However, certain effects are proven: smooth surfaces are quieter than rough surfaces; porous are quieter than non-porous; elastic are quieter than non-elastic. ECOPATH has sought to achieve smoothness, porosity and elasticity in paving surfaces in an eco-friendly way.

The pioneering work done by Charles McDonald in the 1960s showed that that the addition of finely ground scrap tires (crumb rubber) to asphalt yielded an excellent crack sealant. Since then, CRM binder has emerged as an efficient and "green" alternative to conventional polymer modified binders, due in part to a growing environmental sustainability movement, dwindling natural resources, increased environmental issues, and the quest for improved paving materials. Research has shown that crumb rubber modification of asphalt binder has many similar effects to conventional polymer modification. The major changes noted by researchers are seen with the increase in the high temperature stiffness, these are often seen to exceed levels normally achieved by conventional polymer modification. It is this property that is one of the keystones behind the success of implementing CRM binder in quiet pavements.
Environmental Benefits

One of the principal reasons behind the success of using CRM binder quiet pavements lies in its ability to maintain the “open” structure of the open graded mixes typically used in quiet pavements. While conventional asphalt binders are typically more prone to permanent deformation, \textit{CRM asphalt binders have been shown in numerous studies to withstand greater temperatures without deforming}. It is not uncommon for crumb rubber concentrations of 20\% to be used in CRM binder formulations; these high concentrations of crumb rubber explain, in part, the significant increase in elasticity typically seen in pavements using CRM binder.

The need for improved paving surfaces increases, as populations increase, budgets tighten, and environmental consciousness gains momentum. Therefore, cutting edge materials are necessary to fulfill these requirements; CRM asphalt binder is a “green” paving a material which exhibits excellent qualities with respect to these demands. Many US state agencies have achieved significant noise reductions through the use of appropriate pavement design and CRM asphalt binder. \textit{The success of CRM asphalt binders lies in their capacity to provide improved engineering properties, such as reduced noise, through an environmentally sustainable process.}
Egnatia Motorway Management

The Egnatia motorway is a priority project of the Trans-European transport network and is the communication link spanning northern Greece from its western to eastern border. Being a collector axis of the Pan-European north-south corridors, it is of great geostrategic importance for both the Balkans and south-eastern Europe. The Egnatia motorway is one of the first large-scale public works to apply a system of environmental management, that is, a method of organising and implementing environmental protection and mitigation measures in the design, construction, and operation stages of the project. This covers heritage protection, impacts on ecosystems, noise, waste, energy, cleaning/maintenance/restoration, pollutant gases, and water.

Environmental Benefits

The Egnatia motorway follows traces of the ancient Via Egnatia. Along its route and within a 1,000m wide zone, 270 sites of historical interest have been identified. Egnatia Odos S.A. protected all these, where feasible. The company works with environmental organisations and scientists to minimise the motorway impact on ecosystems and fauna. A monitoring programme for noise is set up in residential districts; where necessary, appropriate protection measures are applied. The concentration of pollutant gases is continually measured - even in most of the tunnels; air quality management is a priority - to protect quality of life and mitigate global warming. Skilled staff gather and dispose surface waste, based on existing environmental legislation. Action is taken to limit energy consumption, via: a programme of light measurements and energy management in tunnels; a regular maintenance programme; a time-schedule for lighting; limitation of electricity consumption based on timely

Egnatia Odos S.A.

Egnatia Odos S.A. is the company responsible for the design, construction, operation, maintenance and exploitation of Egnatia motorway. Egnatia Odos S.A. also manages the design and construction of additional projects and has extended its activities abroad, by participating in international tenders and undertaking contracts for the management and supervision of designs and construction works, mainly of large infrastructure projects.

www.egнатia.eu
Biodiversity is protected through maintenance of fencing and monitoring of fauna mortality caused by collisions with vehicles; regular cleaning and maintenance of box culverts and of wildlife underpasses; restoration of disturbed surfaces and control of the quantity of salt used for snow ploughing. Last, but not least, in order to protect the quality of surface and ground water, Egnatia Odos S.A. monitors and assesses motorway water run-off quality at the points of discharge to adjacent rivers and lakes. Necessary mitigation measures are taken.
In 2007-2008, a part of the motorway E34 near Antwerp was rehabilitated with a double-layered CRCP (continuously reinforced concrete pavement). The original road pavement of 1977 consisted of concrete slabs, laid on a base of lean concrete. Although the slabs were initially dowelled, serious step forming originated at the joints. The road became very uncomfortable, particularly on the right-hand lane carrying heavy traffic. In recent years there were also increasing numbers of cracked slabs that had to be repaired. Even if the number of cracked slabs remained within reason, general renovation became necessary because of poor driving comfort.

The Roads and Traffic Agency (AWV) of the Flemish Government had drawn up a list of potentially innovative applications for road-building. The use of recycled aggregates in road paving was one of them. For this E34 renovation, it was decided to apply two-lift concrete with recycled aggregates in the lower course. Continuously reinforced concrete pavement was chosen, thereby giving the best guarantees of a long and maintenance-free service life. The technique of double-layered concrete or two-lift paving consists of dividing the concrete pavement into a bottom lift of approx. 80% of the total design thickness, and a top lift of approx. 20% of the total thickness. The thinner upper course makes it economically justifiable to use fine, hard but also more expensive stones.

As a result, a high-quality upper course can be obtained with excellent safety and driving comfort properties. Because the lower course does not reach the surface the strict polishing resistance requirement no longer applies, and less noble and cheaper aggregates can be used. This permits the use of recycled aggregates.
Environmental Benefits

After construction, the surface characteristics were evaluated. The evenness, measured using a Longitudinal Profile Analyser, was excellent with the exception of some sections where, in the right-hand lane, the profile had to match the level of the adjacent old hard shoulder. For the coefficient of evenness CE 2,5 a maximum value of 35 is required, but 90% of the results were below 25 and 70% below 20. The skid resistance was checked with the SCRM. The transverse friction coefficient must be at least 0.48. The results varied between 0.60 and 0.87 with 84% of them above 0.70.

In terms of rolling noise, a reduction of more than 3 dBA was achieved with the two-lift paving technique compared to the traditional single-layer exposed aggregate concrete with a maximum aggregate size of 20 mm.
Operating primarily in Europe and North America, Eurovia - a subsidiary of the VINCI Group - is a world leader in the construction and maintenance of transport infrastructure. Heir to a century of roadwork tradition, making the most of specialised expertise whilst driving innovation, Eurovia is supported by its 39,000 employees working in nearly 1,000 industrial and commercial entities in 14 countries. Eurovia’s activity is centred on four complementary businesses: roadworks, materials production, quality of life developments and infrastructure-related services. Eurovia seeks to go beyond the traditional rôle of a roadworks company. It has developed new business approaches, providing more added value and technical content, meeting new needs voiced by customers and road users. Eurovia’s dual ambition is to be the expertise benchmark in its business lines and the special partner of its contracting authorities.

www.eurovia.com

Creating New Methods and Materials for 21st. Century Roads

Eurovia developed **GAIA** as an environmental decision-making tool for use by contracting authorities when evaluating the technical solutions proposed by companies bidding on roadworks projects. Gaia uses recognised, published European databases. The tool compares the environmental assessments of different solutions for a given road worksite and utilisation. The system then calculates the environmental impact of each solution. The impact categories used to evaluate the solutions are taken from the French NFP 01-010 standard for construction materials (resource depletion, GHG emissions, atmospheric acidification, etc.) and from an additional list of "customised" impacts (for example: local road transport (tonnes/km), excavated materials removed for recycling, etc.).

Eurovia also created **RECYCLOVIA®,** an in-situ pavement recycling process involving the use of a cold bituminous binder, emulsion or foamed bitumen. The technique can be used to refurbish flexible and semi-rigid pavement surfacings to a depth of approximately 150 mm.

**TEMPERA®** is a third current Eurovia product family with large potential. **TEMPERA®** is a range of warm mixes that are produced and laid at temperatures 30°C to 50°C below those of conventional mixes. The **TEMPERA®** range is suitable for use in virtually almost all applications - wearing courses and base courses - whatever the binder, modified and non-modified. Warm mixes are suitable for all types of traffic, from motorways to urban streets.
Environmental Benefits

The GAIA worksite environmental assessment tool now provides customers with a reliable environmental criterion that can be used to support decision-making. Beyond the tables of results generated by the system for a given call for tender, the GAIA tool enables both the roadworks company and the customer to ask the right questions in order to reduce worksite environmental impact. Specifically, the tool makes it possible to systematically take global warming issues on board and, for large projects, to make greenhouse gas emissions and resource conservation part and parcel of the road structure design process. The RECYCLOVIA® process offers substantial environmental benefits: the process requires no added aggregates; the technique offers energy savings of some 40%; a reduction of greenhouse gas emissions by 20 to 40%; the worksite generates no waste; the use of a cold technique inherently limits the emission of odours; there is limited disruption to the surrounding community. The TEMPERA® process is particularly suitable for urban worksites since disruption to the surrounding community - odours, fumes, delays in re-opening the road to traffic - during application are reduced. The absence of steam emissions also enhances safety for motorists driving near worksites. The process lends itself to night work and worksites with long transport times, since the workability of the product is maintained longer than that of a conventional mix. Over 700,000 tonnes have been laid since 2001. Performance values measured in-situ have proven equivalent to those of conventional solutions, ensuring the durability of structures using these products.
The ultimate goal of this tool is multifaceted:
- Performing a detailed environmental analysis of road projects;
- Setting the stage for a comparative analysis of various road-building techniques and materials;
- Optimising the road construction site supply scheme regarding raw materials providers, choice of suppliers, delivery locations and materials transport modes;
- Deriving a detailed estimation of GHG emissions specifically ascribable to the road construction industry.

The GHG is designed to be consistent, transparent, and credible in its coverage of emissions sources. It is fully compatible with International Panel on Climate Change (IPCC) guidelines and the emission standards used are regularly cross checked and validated. The basis module for road construction and maintenance will be completed with more specific modules, such as barriers, road signs, ITS and waste. The IRF GHG Calculator tool is available for purchase in electronic version and as a CD Rom. Updates will be regularly available.
Environmental Benefits

Sustainable roads can only be built by practitioners who are fully aware of the environmental impacts of their activities, as well as the possibilities for reducing this impact. The new IRF GHG Calculator will enable this.

The tool is based on an input/output modelling approach. The calculation model is composed of a simple set of equations and enables estimating the total GHG emissions (outputs) generated by each of the identified and quantified emission sources (inputs). The calculations undertaken refer to the full life-cycle of the road infrastructure and are repeated for different scenarios and different construction techniques. Three basic phases can be identified: preconstruction, road construction and road maintenance. Among the data collected, distinctions are drawn between

- The inventory of the emissions sources;
- Data and standards relative to the evaluation of these emissions sources;
- The database of emissions factors pertaining to the set of identified sources.

The calculator’s output provides an incentive for innovation and advancement of current construction practices, aiming at reducing emissions and generating corporate economies. In particular, it will help to identify intensive energy consumption practices that can be replaced by more energy-efficient techniques and technologies.

The IRF would like to thank its technical partners for their valued assistance in the development of the Greenhouse Gas calculator: 3M, Ammann Group, COLAS, EPFL, Scott Wilson, Volkmann & Rossbach.

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Greenhouse gas emissions, especially CO2 emissions, are the main cause of anthropogenic climate change. The transport sector is responsible for the highest increase in greenhouse gas emissions. Within the EU-15 greenhouse gas emissions rose by 26% between 1999 and 2004 (European Environment Agency, 2006). This development demands clear political decisions at both national and European levels.

In this context congestion and traffic effectiveness are significant keywords - because the European Commission foresees a growth of 55% in commercial traffic and 35% in passenger traffic on European roads in the years to 2015. The adverse environmental effects of the traffic must be diminished. In trying to do this, it has to be recognised that upgrading of road infrastructure can be ecologically limited in its effects and expensive. So traffic management comes into its own.

Today traffic management consists of traffic lights, key information for the driver about traffic conditions, and systems for influencing routes and road networks. The goal for traffic management today is to control driving behaviour and choice of vehicle, route and departure time. Road user charging can contribute to achieving that goal. The most appropriate concept uses differentiated fees according to the vehicles’ emission class. An integrated road user charging system based on GPS/GNSS and GSM/GPRS and DSRC technologies is the most advanced and suitable solution.
Environmental Benefits

The Institute of Transport Studies of the University of Natural Resources and Applied Life Sciences in Vienna published the results of a study of urban road-user charging on travel behavior, the environment and the economy - Impact Analysis of Urban Road-Use Pricing on Travel Behaviour, the Environment and the Economy. **Reductions in travel times and traffic volumes achieved by tolling lead to decreased congestion, fuel consumption, emissions, noise and traffic accidents.**

Another study published by the Austrian Institute of Economic Research investigated various measures that can be taken in the transport sector, such as substantial improvements in public transport, road pricing, increases in fuel tax, and promotion of bio fuels. **Road pricing turned out to be the most effective measure in reducing CO2 emissions.**
Michelin Fleet Solutions offers large truck fleets all-inclusive tyre management services, providing the customer with numerous advantages: instead of buying tyres, customers purchase travel mileage. Designed for large European and North American truck fleets, Michelin Fleet Solutions is a full service offer that includes tyre availability and supply, maintenance and monitoring to provide the customer with streamlined management, budget control and improved productivity. The “Fleet Solutions” system is based on the principle of the sale of a service replacing the sale of a product. It features a new economic model in which the invoicing unit is the mile or kilometre travelled. The market for this type of offer is strong since transportation companies strive to focus resources on their core business, particularly by outsourcing vehicle maintenance. Michelin Fleet Solutions is a business model well adapted to the current era of high energy costs. The virtuous circle of sustainable development is in place: top economic performance goes hand in hand with a lower environmental impact for the benefit of all.

Environmental Benefits

Environmental benefits accrue directly and via advantages for both the customer and the company. Fewer materials and energy are consumed for more activity. Tyre performance is optimized, thereby cutting fuel consumption. Fewer end-of-life tyres need to be recovered, thus reducing energy use and other disposal costs. Customers know their tyre budget up front and no longer fund their tyre stock. Former fixed costs become variable costs and the rate of unscheduled downtime time is reduced.
Preventive servicing makes it possible to reduce repair costs, thereby reducing the cost price of the service. Servicing time is reduced - thanks to the preventive work carried out during maintenance, thereby improving vehicle productivity and helping customers to focus on their core business. For Michelin, fewer tyres are manufactured for an equivalent or superior activity, with more customers and a good loyalty rate. At the end of the day, the environmental impact of transportation is reduced. Michelin Fleet Solutions key figures: more than €280 M in sales; more than 500 contracts covering more than 300,000 vehicles; 850 Michelin employees dedicated to the activity, in 22 countries.
Assessing Storm Water Run Off into Sensitive Receiving Areas

This project is but one example among many, of the work conducted by the Agency. It is chosen because water assessment and management has not been accorded its rightful place in the environmental pantheon until relatively recently. Water management is now a leading concern of the World Business Council for Sustainable Development, of the World Meteorological Organisation, of national transport authorities and of academic research. With climate change, unusual storm events are becoming increasingly frequent. Good design has to cope with this, in addition to ameliorating the effects of normal run-off into sensitive receiving areas; both surface and ground water, through better collection, conveyance and treatment systems. But the starting point for any action has to be evidence-based decision making.

The starting point for a recent assessment under the Stormwater Management Programme of the Agency was that road water run-off was considered to account for 40-50% of urban metal contamination to aquatic ecosystems. A comprehensive study of vehicle kilometres travelled (VTK), VTK per catchment area, VKT discharge to surface water, VKT discharge to groundwater and the regional distribution of waterbody crossings by VTK was modelled for the national state highway network. Analysis of this data led to identification of estuarine hot spots in receipt of highway discharge from the Auckland road network. Based on NZ data, the relative amount of vehicle contamination can be differentiated from other sources by using a fingerprinting technique developed from Grafton gully storm water tank which exclusively collects highway discharge. Analysis of two dependent variables - vehicle-derived (zinc and copper) and road-derived (polynuclear aromatic hydrocarbons, or PAH). PAH sources include coal tar, exhaust and pyrogenic origins. Hopane, a steroid found
Estimated (based on hopane:PAH ratios) contribution of modern road run off particulates to the concentration of PAH in catchment sediments.

Environmental Benefits

The study showed that PAH concentrations from predominantly road surfaces is significantly lower than non-road derived PAH. Based on 50 samples from five locations the contribution of zinc, copper and PAHs to estuarine contamination may be much less than that which was previously expected, when compared to other urban sources.

Of themselves, such findings are not of immediate environmental benefit. The benefit derives from the fact that the relative amounts of contamination may be better identified, as to source. Such identification is the building-block upon which public policy, in terms of any necessary amelioration, may be built. The study will be expanded to a wider range of road conditions and receiving environment to further develop the hypothesis.

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Asphalt pavements have gained acceptance in recent years as an interesting new renewable energy source. As asphalt pavements can heat up to 70 degrees Celsius during solar irradiation, a comparison with solar hot water systems seems obvious. Given the enormous area of asphalt pavement that is available, the thermal energy potential therefore appears infinite. This heat can be utilized in different ways. Generally the energy will have to be stored over seasons, for example in an aquifer. Several designs have been developed to extract heat from an asphalt pavement. Most available solutions apply a heat exchanger design by incorporating tubes in the asphalt pavement. This type of asphalt pavement in the Netherlands is known as ‘asphalt collector’. Demand comes from buildings, supply from the asphalt pavement. Through the use of an aquifer, the difference in timing between seasonal supply and demand is covered to a large extent.

Environmental Benefits

In addition to its energy potential, the advantage in using an asphalt collector is the maintenance of the pavement. In summer time the maximum temperature of the asphalt pavement can be reduced so that the chance of permanent deformation is mitigated. In winter time, it is possible to avoid slippery roads by increasing the minimum pavement temperature. Snow-free pavement is the result, requiring no salt or other environmentally hazardous contaminants. Though these additional advantages of the use of an asphalt collector may be obvious, interest in such a collector is mainly focused on the energy potential and...
the application of this energy in the built-up environment. In terms of cost-effectiveness, this aspect is most important. Thus, environmental gains with RES® include less use of fossil fuel, reduced CO2 emissions and elimination of use of salt on icy pavements, thus reducing the environmental impact of salt or other similar contaminants. These are among the reasons that, since its introduction ten years ago, RES® has been successfully applied in several road and airport projects in the Netherlands, Belgium and Scotland - and there is a growing interest and demand for the technology in the US and China.

Collector in a larger system in summer and winter condition

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PB’s Highway Sustainability Checklist was selected by the American Association of State Highway and Transportation Officials (AASHTO) as the winning US entry in the Sustainable Development category for the 2007 World Road Association’s (PIARC) International Competition. The checklist was developed in response to growing interest in an objective, non-prescriptive, broad-based tool that would support the integration of environmental stewardship practices and CSS into day-to-day highway-related practices. The checklist is a compendium of possible measures associated with various phases of highway projects—from planning to design, through construction, operations and maintenance. It is meant to facilitate decisions about the extent to which highway improvements might incorporate measures that go beyond satisfying minimum functional requirements by addressing contextual factors which contribute to sustainability of the natural, built, and human environments.

Environmental Benefits

Sustainability is as much a frame of mind as it is a body of technical knowledge. The checklist is intended to be used not as a "mechanical" approach to determining what would make a highway project more sustainable but rather to instill a frame of mind by triggering questions that may otherwise be overlooked and debate that might otherwise not occur. The idea is to plan, design, manage, implement, operate and maintain highways in a way that does not simply avoid or minimize harm (this is considered necessary but not sufficient) but creates net benefits that transcend transportation functionality - benefits in terms of the natural, built and social environments. The fact that so much highway work involves improving existing facilities that were not necessarily held to the higher...
environmental and societal standards that prevail today provides a unique opportunity to achieve "better than before" outcomes in terms of sustainability as well as transportation functionality.

The checklist is flexible and may be adapted to individual agencies or specific project applications. A more structured approach can be used with the relative significance of each factor assessed, or the checklist can be used as an agenda for a project team meeting. Checklist items can be modified, deleted or new ones added as desired. The checklist is included in AASHTO’s Center for Environmental Excellence website and may be accessed at: http://environment.transportation.org/pdf/context_sens_sol/PBChecklistV7.zip

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The concept of ‘green’ roadways and buildings is sweeping the nation. The US Green Building Council (USGBC) and its initiative for including green elements in its construction projects is growing in importance for communities. In an effort to become more environmentally friendly, every owner, engineering firm, and construction supplier is looking for ways to use new ‘green’ concepts. Resource International is at the forefront of this.

Environmental Benefits

The City of Colorado Springs, Colorado is experimenting with a new pavement method, Terminal Blend Tire Rubber Asphalt (TBTRA), on select roadways. The goal was to not only create quieter and safer driving conditions, but also provide the most durable surface while creating a more environmentally-friendly atmosphere. After extensive research, the City learned that using “wet” and “dry” tire rubber asphalt manufacturing processes led to excessive smoke and aroma being released into the atmosphere at asphalt plants. However, opting for the terminally blended manufacturing process proved to be the most environmentally-friendly option. TBTRA is produced in a closed-system plant, preventing smoke and particulates from entering the atmosphere.

In addition to being smoother, quieter, and safer-particularly during rainstorms, the TBTRA has proven to have a significantly lower concentration of roadway pollutants running into the roadside ditches compared to contaminated stormwater runoff of other asphalt pavement.
With its new commitment to ‘going green,’ the City of Columbus, Ohio is also experimenting with various solutions to help create ‘Cool Communities.’ For its Pearl Street and Sidewalks Improvement Project, the City will be using pervious concrete pavement for its sidewalks, curbs and gutters to reduce stormwater runoff. Pervious concrete pavement with detention, in addition to stormwater control, also can gain LEED® (Leadership in Energy and Environmental Design) credits with USGBC.
Five projects illustrate Scott Wilson’s efforts to deliver sustainable road solutions. They are: the A30 Bodmin to Indian Queens trunk road in Cornwall, UK; post-consumer tyre rubber in rights of way and road surfacings; and two instances of the use of hydraulically bound mixtures.

Environmental Benefits

The A30 trunk road was a single carriageway with flows of 25,000 vpd, well in excess of capacity. It also severed the Goss Moor National Nature Reserve, a Special Area of Conservation protected under European Law. The objective was to produce a solution which reduced congestion and improved road safety whilst minimising the impact on environmental areas, all within the delivery target of 5 years from award of the Early Contractor Involvement contract to completion. The scheme has been commended as an example of cooperation for the successful delivery of highways projects in sensitive environmental areas. Continuous dialogue with stakeholders has driven the delivery of a solution which enhanced and improved the environment.

Scott Wilson led two projects which explored the use of post-consumer tyre rubber in rights of way and road surfacings. The first, a demonstration project, involved the development and testing of a number of potential surfacings for impact-absorbing rights of way. A bridleway in Nottinghamshire (UK) was reconstructed using recycled rubber, recycled aggregate and quarry by-products. The trial proved that the use of rubber provides a cost-effective and durable alternative surfacing which is equally acceptable to cyclists, walkers, and horse-riders, and can be applied in route maintenance or in full

Scott Wilson Group plc has more than 6,000 staff worldwide. It provides sustainable, integrated solutions to meet the planning, engineering, management and environmental needs of clients across the transportation, property, environment and natural resources market sectors. The Group has doubled in size over the past few years and, from its UK headquarters, currently controls a worldwide network of 80 offices, of which 40 are in the UK. Main international centres are in China, Hong Kong, India, SE Asia, the Middle East, Eastern Europe and Southern Africa.

www.scottwilson.com
route reconstruction. This beneficial approach to using tyre waste has been adopted by the the rights of way management sector and is being taken forward. The second project involved a desk study and a suite of laboratory testing on Rubberised Asphalt (RA) to UK standards, using a range of UK materials. Consultation with industry experts for the purposes of the study led to identification of information on the practical issues associated with RA for road surfacing applications.

Recycled aggregates from construction and demolition materials (including highway arisings), and quarry by-products, often perceived as waste material, can be used to manufacture Hydraulically Bound Mixtures (HBMs) for a range of applications, up to and including base layers within major trunk roads and motorways. WRAP (Waste & Resources Action Programme) commissioned Scott Wilson to examine the performance of HBMs in road construction and trench reinstatement. HBMs can be mixed and placed using conventional paving equipment. They have the potential to increase materials resource efficiency; they reduce demand for traditional primary materials; and they provide cost savings over traditional primary aggregates. The use of HBMs for trench reinstatement is also the subject of a technical report prepared by Scott Wilson. Following on from this work, Scott Wilson have undertaken in-situ compaction trials and produced a guidance document on the use of recycled materials.
Many factors can contribute to traffic congestion. The most basic explanation is that the number of drivers trying to use the same road is so high that it goes beyond the road’s capacity to handle cars. Unfortunately, the underlying reasons for too many cars in one place at one time are complicated. University departments and civil engineers dedicate hundreds of hours to understand how traffic congestion forms and what can be done about it. The important thing is to do what needs to be done - quickly. Very often, what needs to be done is to change the number and availability of traffic lanes.

The QMB innovative system prevents tail-backs at motorway exits, allowing for rapid movement of the safety barrier delimiting motorway deviations and lanes. In the USA, the QMB System is used for both construction sites and fixed plant, where the flow of commuter traffic is in different directions in the morning and evening. The system involves a machine that shifts the barrier sideways at a rate of 9 and 15 km/h. The barrier is made from shaped concrete elements very similar, for example, to the New Jersey guard-rail. The top section is T shaped, making it possible for the machine to lift barrier elements by a few centimetres, thanks to a system of rollers that passes under the two side wings.
Environmental Benefits

Reconfiguring the roadway to expand the work zone without permanently closing lanes accelerates construction and relieves congestion. Using the movable barriers system during construction can: reduce congestion by adjusting traffic flow, reduce accidents due to positive separation, increase work-zone size during off peak periods to increase contractor productivity, significantly reduce overall construction time which leads to lower costs, reduce fuel consumption and, therefore, air pollution and carbon dioxide emissions, avoid stress and frustration to motorists and avoid congestion on secondary roads.
As a result of a “cradle-to-grave” life cycle analysis (using ISO 14040 methodology) of former traffic light and VMS generations, SWARCO FUTURIT designed and developed a new traffic signal named FUTURA and a new generation of VMS. The assessment considered raw material extraction, processing into semi-finished product, production of finished product, use phase (incl. energy consumption) and the end-of-life management. For the variable message sign with a 4x3m freely programmable full-colour display, a use phase of 10 years, a switch-on rate of 20% and an average brightness of 50% were assumed in order to calculate energy requirements. For end-of-life management, the recycling of metals and a thermal treatment of plastics - in accordance with most European waste regulations - were specified. Since the LED module of the FUTURA traffic light remained unchanged, efforts concentrated on simplifying the housing design of the new signal head, with a significant reduction in material inputs while not compromising the signal’s stability. Material extraction and emissions during the production and recycling phases were reduced, too. For the VMS, major changes have been made to the sign housing, energy supply, heating and cooling systems and the LED modules; surface mounted technology (SMT) based printed circuit boards and components are used for the new generation.

Environmental Benefits

Expressed in terms of global warming potential (GWP) the overall reduction achieved by both new product generations compared to the previous ones is around 60%. The environmental impacts arising from material consumption and
production are dominated by the production of the housings. The optimisation of the housing and related reduction in material demand for aluminium (VMS) and polycarbonate (FUTURA) have significantly improved the result for both phases. The improvements will benefit SWARCO customers, particularly through reduced energy needs during the life of FUTURA and the new VMS. But the principal beneficiary of SWARCO FUTURIT’s eco-design initiative is the environment. The redesign of the variable message sign will lead to a reduction of 25.5 tons of CO2 emissions over the VMS 10-year life cycle. To put this in perspective - a modern passenger car emitting 160g of CO2 per kilometre will have produced 5.5 tons of CO2 having travelled almost 160,000 km, equivalent to 4 journeys around the globe.
Long Island Sound is an estuary where saltwater from the Atlantic mixes with fresh water from New York and Connecticut rivers. The Sound is 110 miles long and up to 21 miles wide, and located in one of the most densely populated regions of the US, with 10 percent of the nation’s population living within 50 miles of its shores. Increasing development in the region has resulted in extensive habitat degradation. Funded by a USD 35,000 grant from the National Fish and Wildlife Foundation, 45 Transpo’s EnviroSafe™ Modular Catch Basin Filtration Systems were fitted into storm drains at Veterans Memorial Park in Norwalk CT. EnviroSafe™ can be retrofitted to fit flat-grated, combination curb-grated catch basins as well as curb only inlets. Comprised of a basin housing a filter cartridge, the unit is mounted at the grate (the point of entry). The large basin traps debris, while inside the cartridge, the modular construction includes open cell foam that is treated with an antimicrobial shield. In addition to filtering sediment this foam is highly effective against microorganisms like bacteria, fungus, and mold. The subsequent layers incorporate coagulant-based and ion-exchange processes for filtering hydrocarbons, oils, grease and heavy metals like cadmium, lead, copper and zinc.
Keeping Run-Off Pollutants Out of Long Island Sound

Environmental Benefits

When the filters were cleaned after six months of operation, each filter had an average of 54 pounds of trash, or 15,000 pounds total. Norwalk has been testing influent and effluent for E. coli and oil and gas to determine the efficiency of the filters and is happy with the quality of sediment removal. If the city can keep sediment from reaching the marina, it will increase the amount of time between dredging of the harbour. Since the last dredging cost the city approximately USD 250,000, any extension of time between dredging operations is a money saver. The catch basin insert filters are the most cost-effective solution because maintenance of the filters is a simple task. The time required to clean each filter is 10 to 15 minutes, which is considered quite acceptable. The filters have killed 80-90% of the bacteria that would have entered Long Island Sound - obviating the need to close beaches and avoiding local shellfish. The various filters have captured the equivalent of a major marine oil spill. The company has entered a partnership with local municipalities on a coastal education centre, to teach the next generation the importance of the Long Island Sound ecosystem.

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Amphibians - frogs, toads, salamanders and newts - are regarded by many scientists as early indicators of ecosystem health. Their sensitivity to environmental change make them one of the first organisms in an ecosystem to show signs of damage to the broader environment. Amphibians also play a vital ecological role by moving nutrients - in the form of their own bodies - from rich aquatic habitats to relatively nutrient-poor adjacent areas. They also serve as a crucial link in the food chain by eating insects and through being eaten, in turn, by hawks and foxes, for example. Amphibians make periodic mass migrations, particularly during their breeding seasons. At such times, local populations can suffer 50-100% mortality rates from passing vehicles when they attempt to cross even lightly travelled roads. The road industry has in recent years become aware of the fact that it can safeguard amphibian populations through special fencing and the provision of channelled road crossing points.

**Environmental Benefits**

VR amphibian rescue fences and channels provide safety for amphibians by active protection with environment and landscape-friendly profiles. They have an optimal price-performance ratio through use of patented construction kits assembled by qualified personnel, adapting the products to any topography. Typically, the animals are held back before they reach the road and then channelled into tunnels connecting the different parts of their habitat. VR thus helps to sustain natural species diversity and contributes to the environmental sustainability of roads, even in natural and unspoiled areas.
The fence system

The Amphibian-Guard® guiding device consists of 400 cm long elements. The steel plates are hot dipped galvanized and so have an average durability of over 20 years. The elements’ height of 40 cm and the overhanging edge of 7 cm makes the system invincible for toads, frogs and also small mammals. The large bottom area forms a vegetation-free running surface that channels the animals into safe crossing areas. The elements are fitted gap-free so that animals do not get trapped or try to climb. An additional underground barrier makes it impossible to tunnel under the system. The system can be adjusted to the topography both vertical and horizontal. The elements can be connected in any angle and so guarantee continuous assembling even under difficult circumstances.

Additionally, Amphibian Guard® can be combined with a robust wire mesh fence that is invincible for larger animals like wild deer or boars. This space saving solution protects animals of all kinds and sizes from accident with cars on open roads that lead through their habitats.

Thus, VR Amphibian Guard® offers an easy, long-lasting and very efficient way to make roads friendlier to the environment.
Combining Human Factors with Intelligent Transport Systems

One of the key causes of pollution and traffic congestion are unplanned incidents including accidents. Reducing accidents and making our roads safer and facilitating traffic flow are key elements in promoting efficiency and improving environmental performance. Transport and travel by sustainable modes is almost a cultural pre-requisite now, but one of the main challenges for transportation is of balancing individual benefits with those of society as a whole. For instance when considering Eco driving (increasing vehicle efficiency compared to fuel usage), the most fuel efficient route (distance) might appear to be through a town centre (particularly for vehicles fitted with automatic stop and go systems) but the town bypass may be a road with fewer junctions and a speed-flow profile that is much more fuel efficient. There is a risk that urban traffic systems, or a traffic control room or even in-car systems, can adversely affect the road users if traffic solutions do not factor in the human element. Often users experience visual and cognitive distractions, mental overload and a reduction in awareness of their surroundings. This of course can have negative connotations for safety.

At WSP Group our global transport planning experts combine with our specialists in civil engineering, intelligent transport systems, and human factors to ensure that we develop and implement sustainable transport and information services and systems for our clients and their customers. Our Group approach to sustainable business operations is mirrored in the advice we provide to our clients to make best use of their, and the world’s, global resources. Internally we have pioneered the development of car sharing software, innovative ‘smart working’ initiatives, and working closely with community leaders to promote sustainable living in our local environments.

At WSP our combined approach includes the selective application of Intelligent Transport Systems (ITS) and Human Factors as a way to change behaviour by providing management and information to enable better decision making. The current generation of technology can be evaluated not just with a view to modify if need be but to promote new design ideas. This in turn facilitates next generations of technology that further enhance the safety of ‘end’ users. It is by understanding all aspects of transport and user behaviour that we are able to develop successful systems and services.

www.wspgroup.com
Research should always consider all the road users and the growing demands upon their attention.

Using computer simulation to understand driver behaviour.

Environmental Benefits

ITS is helping to address many of today’s transport issues by harnessing technology to make our transportation safer, more efficient, easier to use and more environmentally acceptable. ITS provide greater returns when end users have confidence in the information. There research and evaluating the human interaction with road technology or policy will improve usage, acceptance and compliance with such systems.

Ultimately this will contribute to for more efficient and greener transportation based on knowledge and understanding.
When our efforts flourish

Attica Tollway Operation Authority

won 1st Prize Award for environmental mitigation

on Attica Tollway

The prestigious award of the IRF (International Road Federation), a reputable non-profit association, with more than 500 members and participants from the public and private sector globally, acknowledges our efforts in the operation of Attica Tollway (Attiki Odos) in preserving the environment. Thanks to the realisation of substantial environmental management works since the beginning of construction and with the application of advanced and effective operational methods, Attica Tollway demonstrates that a modern motorway can go through the heart of a populous city and operate in harmony with the environment.
International Road Federation
Innovative Practices for Greener Roads

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