

enka® solutions



LANDFILLS

SOLUTIONS OVERVIEW

INNOVATING TOGETHER

 **FREUDENBERG**
PERFORMANCE MATERIALS

We are proud our Enka®Solutions geosynthetics have a long history across the whole range of environmental projects and that the necessary cost, time and embodied carbon savings required for the sustainability of our infrastructure have been delivered time and again through effective geosynthetic application.

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INTRODUCTION

Of the civil infrastructure sectors, the environmental sector is the one which is growing the fastest as we seek to address the multiple issues posed by man-made pollution and population growth. We aim to reduce the environmental impact of our activities and preserve scarce resources by adopting sustainable development wherever possible.

In the second half of the 20th century, the global population doubled from 3 billion to 6 billion people and is expected to grow to 9 billion by 2050. Increasing consumerism and industrialization has dramatically increased the amount of waste we produce, with over 3.5 million metric tons per day produced now and with figures estimated to increase to a peak of 11 million metric tons per day by 2100 (World Bank figures). Going forward, there will be an increasing effort to ensure this waste is recycled as much as possible or disposed of as safe waste to, for instance, energy projects. However, it will never be possible to recycle all our waste. This means that the landfill industry will need to keep increasing both in terms of its capacity and its ability to safely dispose of the remaining waste and ensure that the existing landfills remain safe.

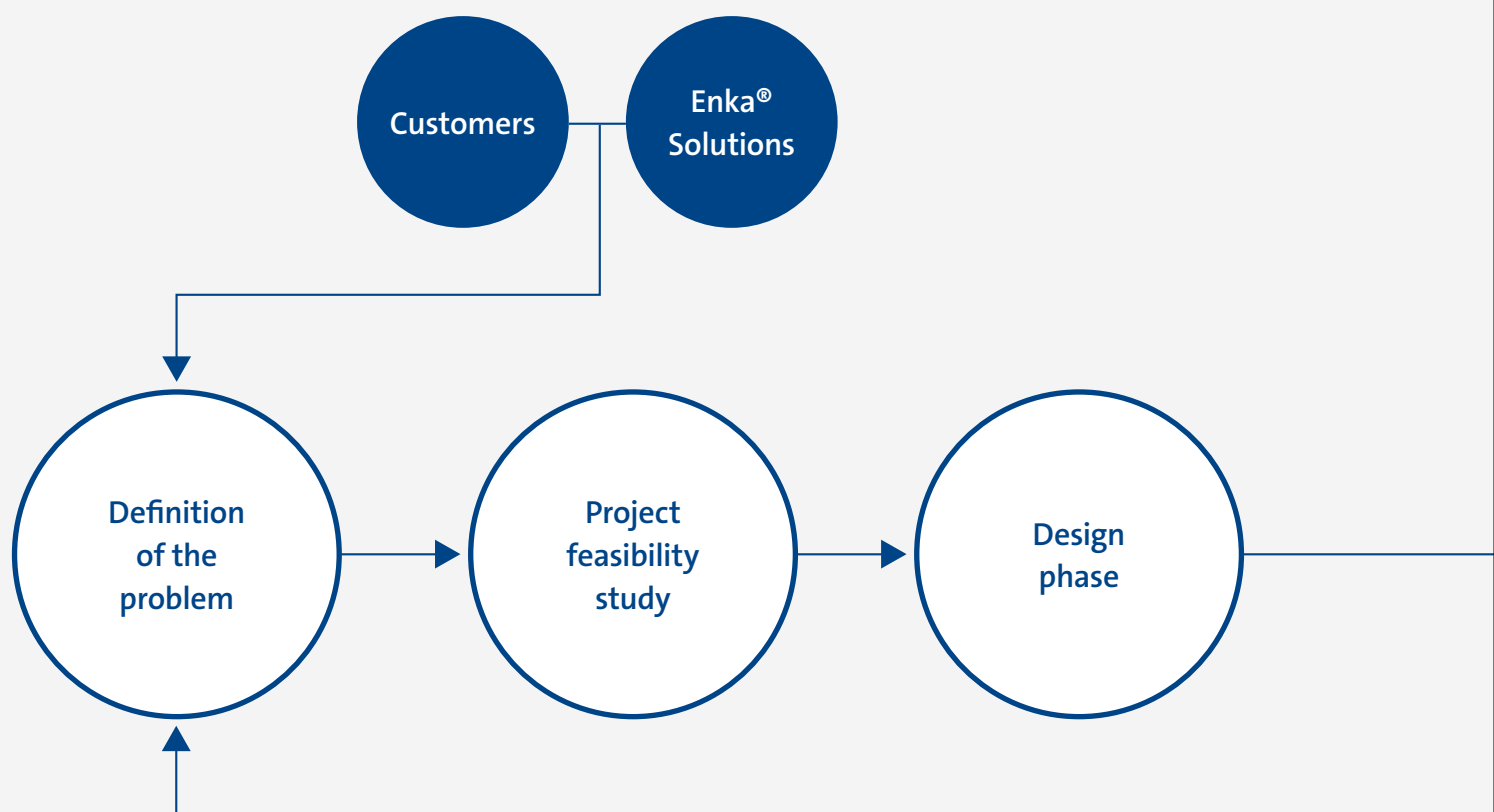
Changing patterns of consumerism and recycling are slowly reducing the volumes but nevertheless, the volume of waste per capita is one of the most significant problems in the developed world. The key task facing governments and landfill operators is one of maximizing the space available within landfills and safely containing the waste to ensure it will not contaminate groundwater or watercourses or pose threats in terms of instability or the buildup of potentially

explosive gases. Additionally, the developed world faces issues with many older closed landfills which would no longer meet current containment criteria and where the variability and dangers posed by the fill are poorly documented.

In the developing world, the amount of waste per capita is not as large but the growth of populations and increased urbanization has seen the growth of huge unregulated and uncontrolled dump sites around many of the world's largest and most densely populated cities. Corresponding problems of pollution, disease, and the ever-present risk of fire arise. In these countries, legislation and environmental controls are slowly being introduced and new landfills are needed to meet the safe containment requirements not only of new waste but of the large volumes of existing waste in dumps around these cities.

Geosynthetics form a key part nowadays of the toolbox that the landfill designer and operator has available. They enable fill to be safely contained and leachates and gases to be safely collected. Geosynthetics maximize the space available within the site. They also reduce the need for mineral exploitation by reducing the need for thick clay liners, granular collectors, and filter systems.

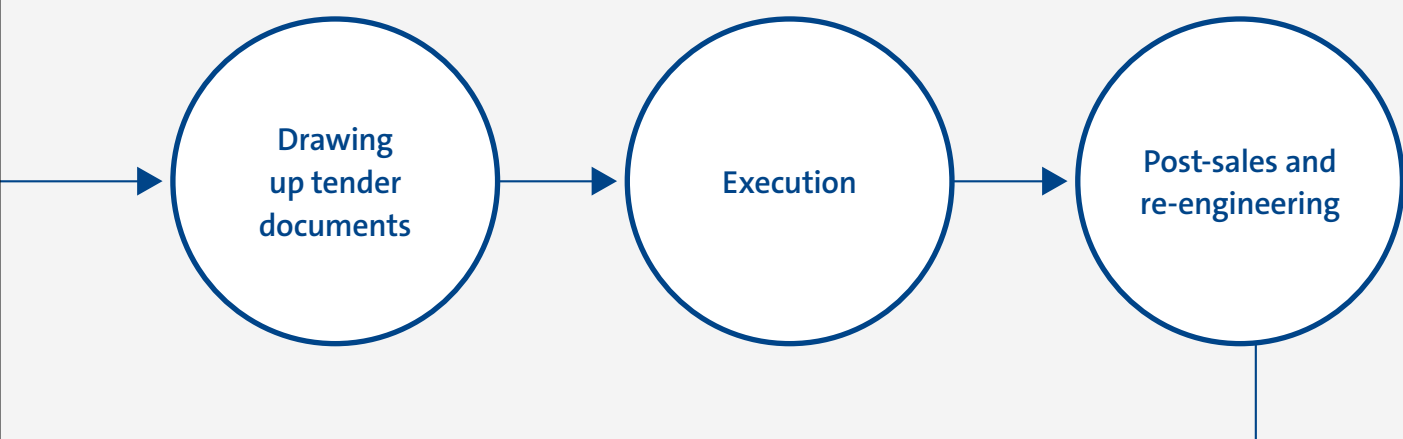
PROJECT APPROACH



From our many years of international experience, our specialists have accumulated the necessary expertise to provide all the support you need with regard to defining a problem and to gathering the necessary data that will lead to the creation of the appropriate framework.

We provide advice and contribute possible solutions for specific problems or applications. If desired, we can also provide training on specific topics associated with the use of geosynthetics in civil engineering.

In this phase we work out the best possible solution in conjunction with the customer. We provide tailored advice by means of calculations for the all-round solution and delivering drawings, sketches and models. An optimal mix of products is sought for the specific situation, including the relevant cost calculations.

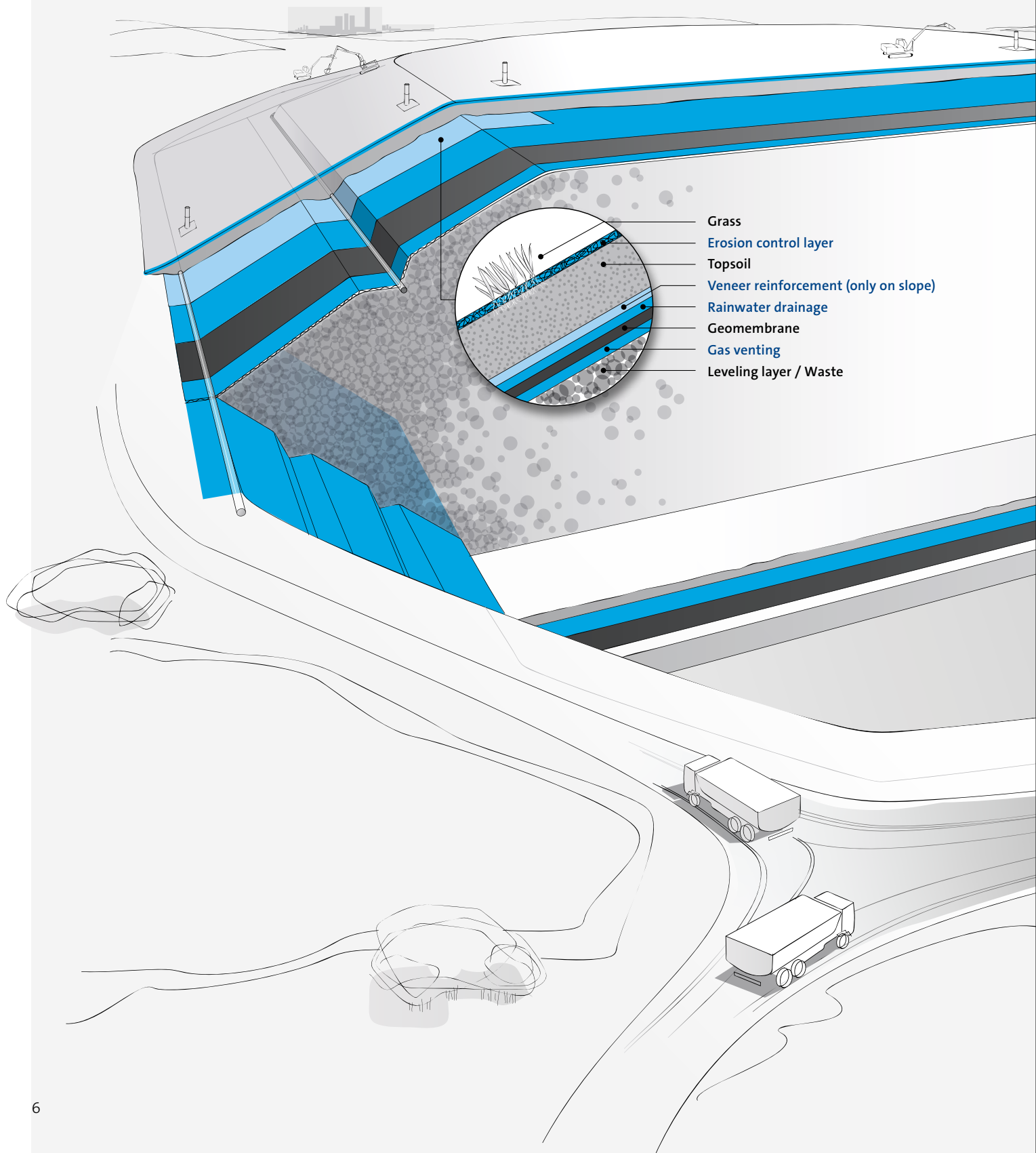


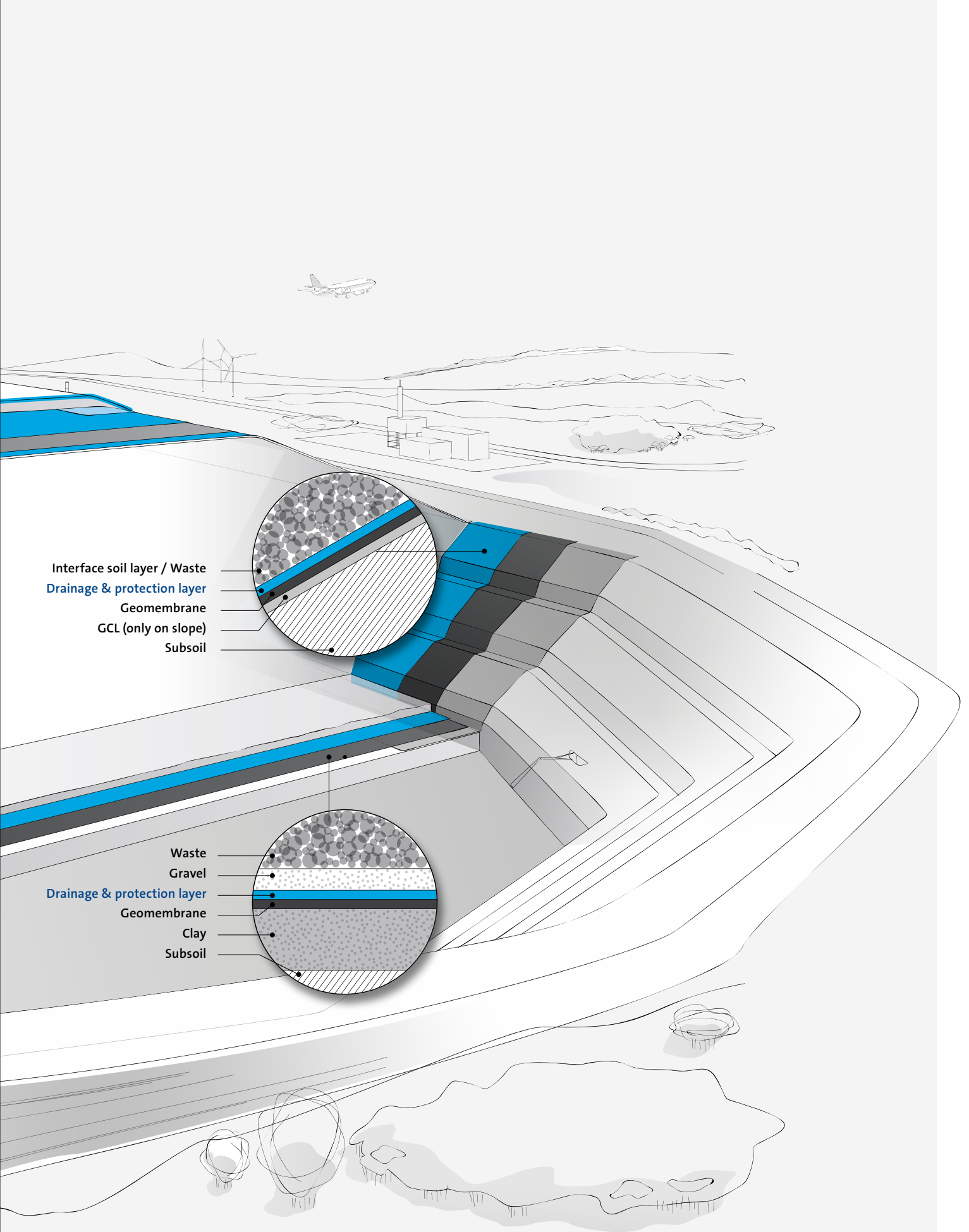
We can either deliver standardised specification documents and drawings, or draw up a set of project-specific installation instructions.

We prepare for the execution of the project by providing clear installation instructions. If desired, we can also organise project-specific installation training sessions. Our customers can also rely on on-site support.

Once the project has been completed, we will be happy to assist our customers with any future challenges. We make use of the expertise gained during the execution of specific projects to further streamline our solutions and develop new products.

OUR SOLUTIONS FOR YOUR LANDFILL INFRASTRUCTURE NEEDS





PROTECTION AND LEACHATE COLLECTION AT THE BASE OF A LANDFILL

The waste landfill is built on subsoil with favorable geological and hydrological properties, fulfilling water tightness criteria required by local authorities. On top of this mineral/geological safety barrier, a geomembrane is laid. It is crucial that these safety barriers not be damaged during the operation phase (the phase of landfill construction) because they must remain undamaged to prevent contamination in the long term.

At the bottom of the cell, the geomembrane is covered with a protection layer and a drainage layer. Traditionally, a thick protecting non-woven geotextile is placed over the geomembrane, on top of which a gravel layer of at least 50 cm in height is installed.

Alternatively, for a more efficient solution in terms of required materials and available waste volume, EnkaDrain can be applied as the geosynthetic drainage composite at the base of a landfill. EnkaDrain is then placed directly on top of the geomembrane where it fulfils both a protecting and draining role. With its capacities, EnkaDrain can replace approximately 20 cm of gravel, providing a huge gain in storage volume for fill. An additional advantage is that the geomembrane on the slopes of landfill cells can be protected and drained by EnkaDrain. The first feedback on the efficiency of EnkaDrain in this application dates back to 2002.

The leachate collection system needs to be designed for leachate levels to stay within the gravel layer at all times with a preferable maximum gravel height of 30 cm.

Leakage detection

EnkaDrain can also be applied as a leakage detection layer underneath the landfill base, installed between two liners, one being the previously mentioned geomembrane.

Piggy backing

Existing waste containment structures can be extended. The landfill is enlarged by creating a new cell on top of the existing one. However, this poses the risk of cracking and loss of water tightness at the base of the new upper structure, caused by settlement of the underlying landfill. Applying our high-strength woven PET geotextile will prevent this potential failure.

Solutions

[Drainage](#)
[Protection](#)
[Separation](#)
[Filtration](#)
[Reinforcement](#)

Relevant products

[EnkaDrain®](#)
[Woven PET geotextile](#)



Woven PET geotextile



EnkaDrain®

STEEP SIDE SLOPES INSIDE AND OUTSIDE LANDFILLS

Landfills typically have gently sloping sides which facilitate the easy placement of mineral and geosynthetic layers in accordance with the design requirements. Where landfills are to be built against steeper rock faces, however, usually in spent quarry and open cast mining sites, the necessity to maintain the integrity of the slope protection system may need to be balanced against the desire to maximize the space available within the landfill footprint for waste disposal.

Where there is a steep rock face, a liner needs to be installed on a smooth soil slope. A natural soil slope at 1:2 will cause a significant decrease in space available within the waste landfill. To overcome this loss of space, a steep reinforced slope can be constructed with the use of reinforcing EnkaGrid.

Once installed, the membrane would be protected with the same heavy duty non-woven and geocomposite layers as the conventional side slopes or landfill base to ensure that the membrane is not punctured by sharp objects within the waste.

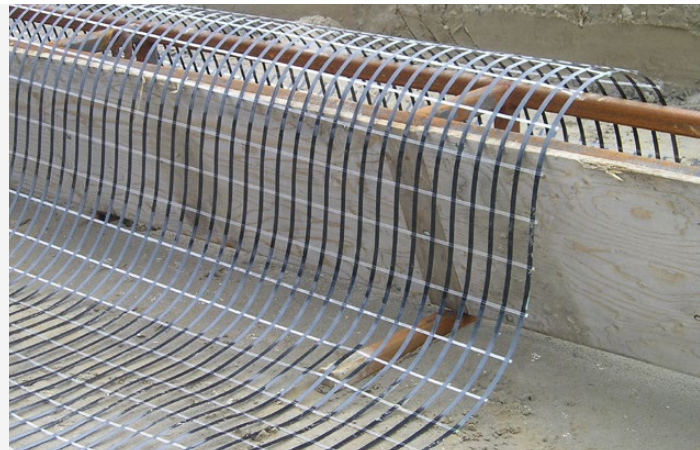
The reinforced slopes are typically built to a height of 2 to 3 m. They require only 1-1.5 m of geogrid reinforced backfill to maintain their internal stability prior to the placement of waste against the slope face. The facing of the slopes can be achieved with a simple EnkaGrid wraparound which provides a soft flexible face.

Similar steep slopes and double-sided sloping bunds have been successfully used to build steep levee containment faces around landfills above ground level or between cells in multiphase landfill operations.

Sometimes steep rocks or granular slide slopes are smooth enough to take a membrane or GCL (Geosynthetic Clay Liner) directly. Such natural slopes may, however, show uneven surfaces or small voids at spots that could cause an elongation of the membrane or liner. The use of a reinforcing EnkaGrid will prevent this elongation, thus avoiding failure or reduced performance.

Solutions
[Reinforcement](#)
[Protection](#)

Relevant products
[EnkaGrid® PRO](#)
[Woven PET geotextile](#)



EnkaGrid® PRO



Woven PET geotextile

GAS VENTING

Geosynthetic barrier layers are used in cappings. Because these barriers are impermeable, gas buildup may occur as gas cannot escape the landfill. Such buildup can lead to bulging of geomembranes and lifting of soil covers, thus creating so-called 'whales' filled with methane gas, which can result in serious sliding failure and dangers on the site.

Evacuation of gas is accomplished by collection systems. A gas collection system can consist of either a gas relieving sand blanket or a geocomposite layer such as EnkaDrain, plus highly conductive perforated pipes (called French drains) in gravel trenches and outlet points.

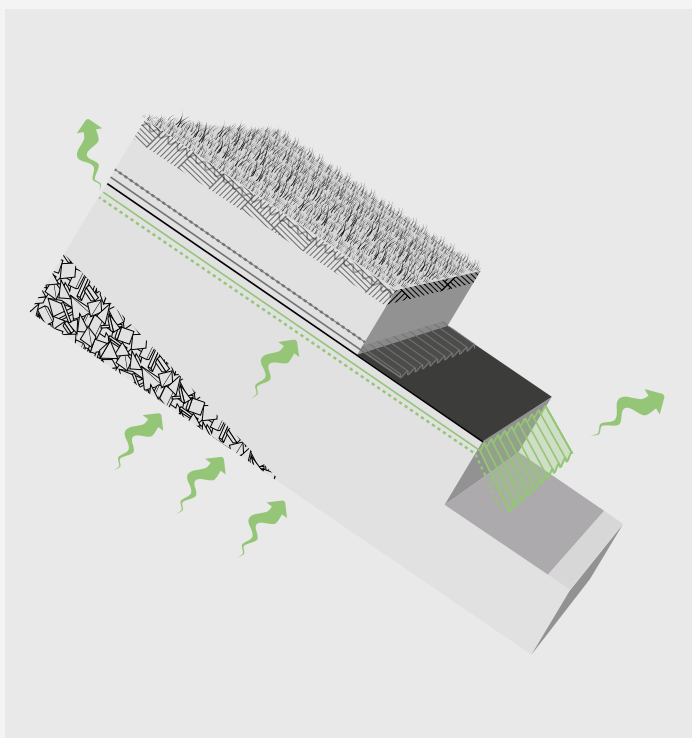
It is important to avoid moisture in the gas relief layer resulting from rain during installation, or from condensate generation underneath the geosynthetic barrier.

The gas permeability of granular soils is often seriously reduced by partial saturation due to a high capillary moisture content. EnkaDrain drainage mats are non-absorbent with a large open void ratio which prevents capillary moisture and high concentrations of condensate.

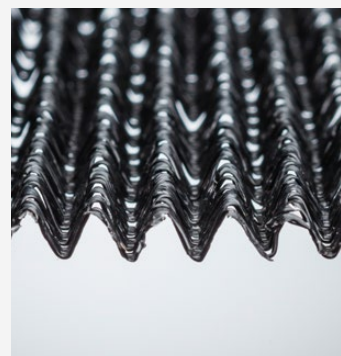
Proper gas venting performance is a major design element of a landfill and it includes the proper number and spacing of collection wells and trenches, adequate size and depth of well boreholes and proper packing and sealing around the well screens. Including EnkaDrain will contribute to the long term performance of the gas relief system by keeping it clear of excessive moisture.

Solutions
[Gas drainage](#)

Relevant products
[EnkaDrain®](#)



EnkaDrain® Wide



EnkaDrain®

Gas venting system with EnkaDrain Wide geocomposite removes gases from landfill capping sealing layers creating an artificial void laid under the geosynthetic barrier layers.

RAINWATER DRAINAGE

Two years at the latest after the end of the operation phase, a permanent capping has to be implemented to prevent uncontrolled penetration of water in waste as well as biogas emission into the atmosphere which would increase the carbon footprint of the landfill.

Rainwater distribution

The typical cross-section of a capping consists of a layer of topsoil e.g. 1 m thick with a drainage composite such as EnkaDrain on top of an impermeable barrier. EnkaDrain functions as a single rainwater drainage system. It eliminates the need for a filtration geotextile plus a thick gravel layer which are applied in more traditional drainage systems.

The goal of the rainwater drainage system is to avoid hydraulic pressure in the topsoil layers so as to ensure their mechanical stability: the water pressure would reduce the internal shear resistance of the soil and would increase the risk of direct sliding.

The design of a geocomposite drainage system, like EnkaDrain, is project specific. It requires knowledge of such things as the rainfall flow rate, usually defined for rainfall

durations of 0.5 hr to 1 hr, and the runoff ratio which depends on the slope angle and the type of topsoil layer. In case of original design/tender specifications requiring a granular drainage layer with a given permeability and thickness, equivalence between EnkaDrain and the required granular drainage layer can be justified as well. Thanks to the high water flow capacity of EnkaDrain, no water pressure on top of the drainage composite needs to be taken into account for hydraulic gradient calculation.

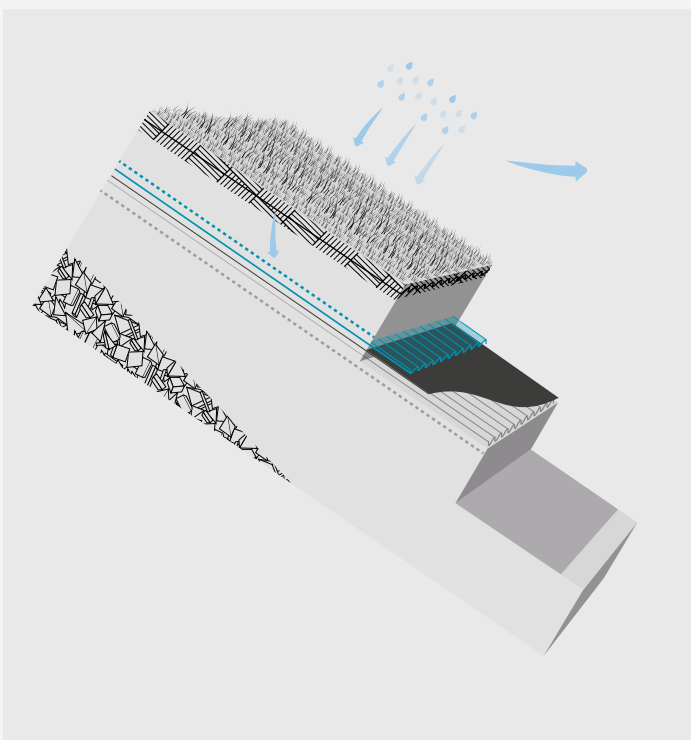
EnkaDrain's long-term efficiency has been confirmed by external laboratories who have checked the drainage and filtration properties of EnkaDrain after several years of service life.

Solutions

**Drainage
Protection
Filtration**

Relevant products

EnkaDrain®



EnkaDrain®

REINFORCEMENT AND GRIP LAYERS

Reduction of the waste storage footprint and optimization of the landfill's storage capacity often lead to increased angles of the side slopes. At the same time, successful integration of the landfill in the surrounding landscape requires the installation of cover soil on top of the construction. The stability of the soil veneer layers and the reinforcement performance of the multilayered geosynthetic system on top of the geomembrane needs to be safeguarded.

When designing the covered steep slopes of a landfill, the stability of soil cover can be steered with the use of EnkaGrip, which is a multilayered geocomposite consisting of a uniquely formed 3D monofilament structure with a 95% void ratio, combined with a reinforcement layer. Installed directly underneath the cover layer, it will increase the friction angle between the soil and the underlying surface so that it prevents direct sliding of the soil layer. EnkaGrip's 3D mat can be fixed to different types of reinforcement layers. The choice of the appropriate layer(s) depends on specific project situation.

Usually, the landfill capping system includes a geomembrane to ensure the water tightness of the side slopes. Due to the slope angle and the weight of the soil cover, this smooth geomembrane will inflict tensile forces in the upper geosynthetic layer. Failure of this geosynthetic layer can be prevented with the use of a reinforcement product. Depending on the project situation, reinforcement can be achieved by either installing EnkaGrid, or EnkaGrip with multiple functions.

A part of the rainwater goes through the covering layer of soil and creates water pressure in the soil which would reduce the stability of the soil and increase the risk of direct sliding. That's why a drainage layer is always recommended on top of the geomembrane. In some conditions, therefore, the upper part of the multilayered geosynthetic system located on top of the smooth geomembrane has to include a drainage layer and also a soil-gripping layer. The high flexibility of the stitching process used for EnkaDrain and EnkaGrip products allows production of geocomposites including up to four geosynthetic layers.

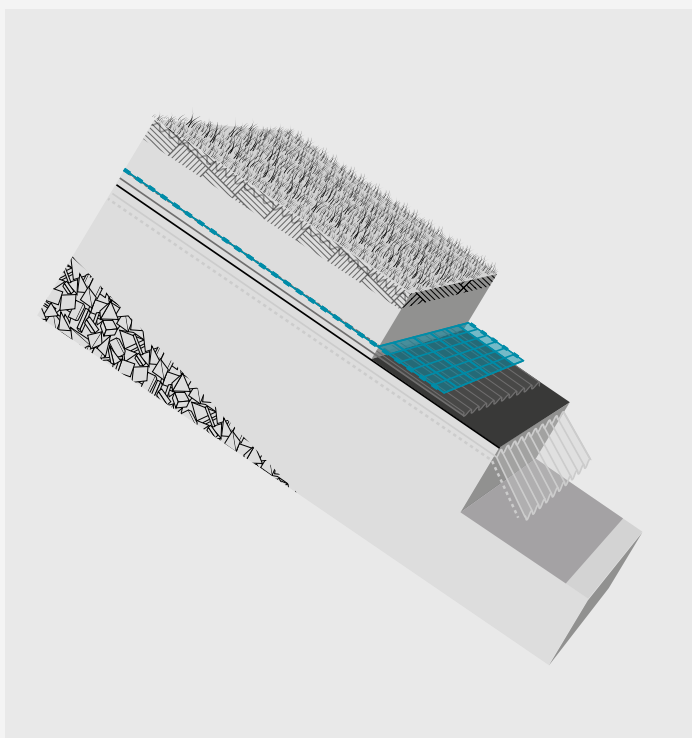
This EnkaGrip&Drain composite incorporates drainage, reinforcement, protection, and soil gripping in one product, and has been in use now for more than 15 years. EnkaSolutions therefore provides a complete, efficient and safe solution for your specific project in a single product 5 m in width, with one installation phase only, saving time and costs. We provide technical assistance at any stage of the project to check the slope and anchorage dimensions so as to help you define the right product or combination of products you should be using.

Solutions

[Veneer reinforcement](#)
[Soil gripping](#)
[Protection](#)
[Drainage](#)

Relevant products

[EnkaGrid®](#)
[EnkaDrain®](#)
[Enka®Grip](#)
[Enka®Grip&Drain](#)



EnkaGrid®



EnkaGrip®

When the internal friction in a landfill capping sealing system is too low, EnkaGrip can provide the necessary reinforcement and soil-gripping functions. EnkaGrip's upper homogeneous 3D monofilament structure increases the topsoil interface friction angle.

EROSION CONTROL

As gradients increase, the risk of soil erosion and rapid surface runoff increases. This may also lead to problems of increased suspended solids in drainage waters. Erosion control methods and practices should be adopted on sites where soil erosion may occur. This is particularly the case on the slopes of waste landfills and their collection ditches.

A reasonable estimate of soil loss can be made by careful determinations of climate (rainfall intensity and duration), soil (inherent erodability), topography (slope length and slope gradient) and vegetation (type and extent of coverage).

On sloping landfill covers, soil loss from rainfall is especially problematic and requires continuous maintenance until the erosion process is halted and long-term vegetative growth is established. Structural control materials and systems include vegetative and 3D polymeric stabilization of exposed surfaces, sediment traps, improved sediment basins, silt fences, filter fabrics, etc.

Vegetation systems

Nature itself provides an excellent product to protect soil against erosion in the form of

vegetation. Sometimes, however, nature needs a helping hand, for instance if the erosive forces are too strong or when vegetation needs to grow under difficult conditions. Biodegradable materials such as jute, coir, flax, wood wool, and straw mats will typically retain their structural integrity for only one or two years in a moist soil environment. They are intended to provide temporary protection until the vegetation can take over.

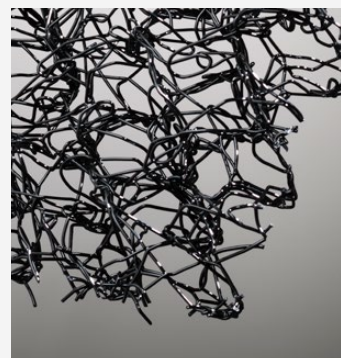
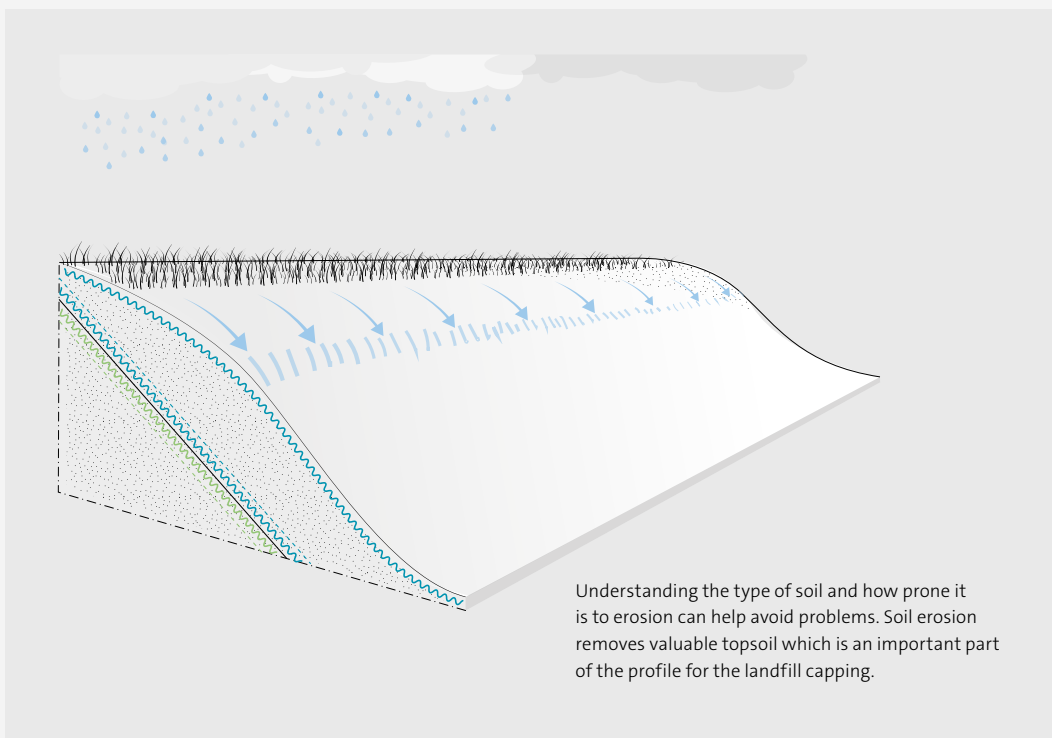
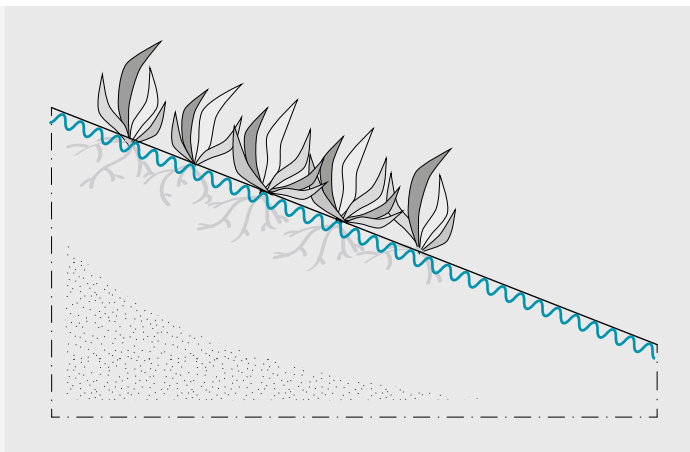
As an open three-dimensional synthetic mat, EnkaMat provides this temporary protection for the bare soil in order to encourage the development of vegetation. Additionally, EnkaMat will permanently reinforce the topsoil in the root zone should vegetation fail, resulting in the most secure erosion prevention system.

Solutions

Erosion control

Relevant products

EnkaMat®



EnkaMat®

WASTE STORAGE FACILITY, VILLEPARISIS, FRANCE

The Villeparisis waste storage facility is one of the five hazardous waste storage facilities of SITA FD, a subsidiary of the SUEZ Environment group. The site is authorized to receive 250,000 tons of industrial hazardous waste per year and requires regular refurbishment work.

Challenge

The works consisted of the refurbishment of 54-meter long 20° slopes capping some 15,000 m² of industrial waste storage area. In accordance with the local regulations, a waterproofing system and a drainage layer against rainfall have to be installed. Geosynthetics have been chosen as the solution to work with as they can provide easy-to-use, technically reliable, proven solutions. The main task here was to ensure stability of the 30-cm covering soil above the waterproofing geosynthetic capping system above the membrane.

Solution

In such conditions, EnkaGrip&Drain offers a unique solution, providing effective drainage with strong reinforcement and soil gripping which represents significant cost and time savings. EnkaGrip&Drain is made of a polypropylene geospacer combined with a polyester woven geotextile and a polyamide geomat. All components are seamed together to form a

multifunctional geocomposite. Drainage, reinforcement, and soil gripping are all implemented in a single operation, allowing cost and time savings.

Benefits of the solution

The technical proposal ensures a safe and secure solution to meet the technical and regulatory objectives for drainage and soil gripping. In addition, the use of EnkaGrip&Drain allowed the installer to reduce installation time and minimize traffic over the geosynthetic layer. As a result, the risks of potential damage during installation are reduced, lengthening the lifetime of the geosynthetics in addition to reducing costs.

Installation benefits

Taking into account the length of the slopes, a specific implementation methodology has been developed. The topsoil was installed using a long-reach Caterpillar 325 BL able to work at over 20 m from the bottom to the top of the slope to minimize trafficking on the geosynthetics during installation phases.

The excavator operated smoothly on a minimum thickness of 1 m of fill material to avoid dynamic loading and accidental damage to the geosynthetics. The rate of coverage was approximately 2,000 m² per day.

Result

The design was done according to the French standard NF G 38-067, including Eurocode 7 safety factors on dead loads (soil) and live loads (snow...), ensuring stability on each interface of the capping system.

By using EnkaGrip&Drain, regulatory and technical requirements have been met at the same time as providing time and cost savings during installation, thus ensuring that the project's budgetary and time constraints were met.



Project owner

Sita FD

Product

Enka®Grip&Drain
7010/200.50 PET/5006H

Functions

Drainage, reinforcement
and soil-gripping

Contractor

Fli France

Volume

15,000 m²

LANDFILL DRAINAGE AVRI THE NETHERLANDS

AVRI Geldermalsen is a closed landfill. After closure, the landfill has to be covered with a double barrier in order to have a safe 100% watertight solution with a minimum lifetime expectancy of 100 years. For drainage and to prevent cover soil from sliding off the liner, EnkaDrain was installed.

Challenge

After reaching the maximum capacity of the landfill, waste has to be isolated to prevent environmental pollution. After isolation, the aim is to give the landfill a 'natural' look and to have it fit in with the landscape by covering the capping with 1 meter of topsoil and seeding it with grass. Capping a landfill is an expensive job. Knowing that capping has to be redone after the lifetime of the capping system, authorities start saving a yearly amount of money so as to be able to finance future recapping.

When the life expectancy of the capping system is lengthened, less money per year needs to be saved for future recapping.

Solution

Installation of a high-quality capping system, all components having a lifetime expectancy of 100 years minimum!

Components are:

- Double barrier layer: polymer modified sand/bentonite layer, secure welded structured 2 mm HDPE liner
- Drainage layer: EnkaDrain ZB 350

Benefits of the solution

The knowledge of and standards for landfill design in Germany are amongst the highest in the world. EnkaDrain ZB 350 is produced and audited according to the German BAM (Bundesanstalt für Materialforschung und -prüfung) regulations, in order to produce a drainage composite with not only a 100-year lifetime expectancy for the product itself but also for its functionality. AVRI Geldermalsen chose a safe, 100-year lifetime expectancy solution. Savings for potential future recapping can be spread over a period of 100 years.

Installation benefits

The standard slope angle of a landfill in The Netherlands is 1:3 (18.5°). All

capping components used should have an angle of friction (internal and between each other) larger than 18.5° because parts of the slope would slide down if the angle of friction were to be lower. EnkaDrain ZB 350 fulfils the requirements; no extra measures need to be taken (e.g. installing a layer of geogrid on top of the drainage mat).

EnkaDrain ZB 350 has high-quality, heavy nonwovens on either side of the core, which makes it easy to weld the overlaps together. By welding the overlaps, the drainage mat is secured against sand getting into the core.

Result

By using EnkaDrain ZB 350, soil is prevented from sliding off the liner. A reliable capping with a lifetime expectancy of minimum 100 years has been achieved, with EnkaDrain ZB 350 securing its drainage component.



Project owner
AVRI

Functions
Water drainage

Volume
120,000 m²

Product
EnkaDrain® ZB 350

Contractor
Vink Barneveld

ENKASOLUTIONS

AREAS OF EXPERTISE AND PRODUCT OVERVIEW

Our solutions offering provides answers for many different geotechnical challenges. They can be applied to what we consider our 'areas of expertise'.

Transportation infrastructure

Our geosynthetic solutions support rails and roads throughout the world.

Waterway infrastructure

Geosynthetics are effective in protecting water embankments against the influence of hydraulic loadings.

Environmental infrastructure

Our geosynthetic solutions help to create parks, playgrounds, ponds and canals to improve our residential, commercial or industrial areas.

Landfills

Landfills are a common way of managing our disposal of regular waste. To ensure landfills will not cause any environmental harm, leachate and methane gas will not reach our environment.

Groundwork construction

When designing and constructing industrial, commercial or public buildings, special attention is required for foundation and drainage issues.

Tunneling and Mining

EnkaSolutions' offer for railway support, rock wall covering, soil stabilization, tunnel wall drainage and protection and vibration control are amongst the best in the world.

Product Portfolio

EnkaMat®

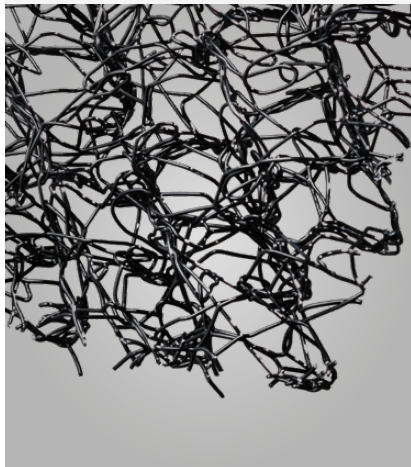
EnkaMat is a flexible three-dimensional mat for immediate, permanent erosion protection on many different slope types. Its unique structure creates an artificial root structure that prevents soil erosion from steep slopes, river banks, landfill containments and other vulnerable areas. EnkaMat has excellent soil retention, providing the perfect conditions for vegetative root systems to develop. Embedded with soil, it forms an integrated and fully vegetated system to control erosion.

EnkaDrain®

Consistent and excellent long-term performance is a key feature of the EnkaDrain drainage mat. Each variant has a drainage core bonded to a synthetic nonwoven geotextile layer or is sandwiched between two such layers. EnkaDrain provides solutions for groundwater issues for civil engineering and building projects, both during construction and in service. With an extensive portfolio of product types, EnkaDrain is suitable for many different applications.

EnkaGrid®

The EnkaGrid product range comprises a large portfolio of rigid geogrids, their common values being the optimum soil-grid interaction delivered for each application in any soil type and their outstanding mechanical long-term durability. EnkaGrid types are uni-axial or bi-axial and manufactured from laser welded strips. A high strength grid composite of aramid mesh and a thermally bonded nonwoven is available for the most demanding projects.



EnkaMat®



EnkaDrain®



EnkaGrid®



Colbondrain®



High strength PET woven

Colbondrain®

When the sub-grade of a construction site is too weak to bear normal construction activity, Colbondrain will speed up consolidation considerably. Colbondrain is a tough and durable prefabricated vertical drain (PVD), designed to extract pore water from soils to achieve 90% consolidation within six months. Thanks to its high performance Colbondrain is often the chosen PVD for major, technically demanding projects.

High strength PET Woven

The high modulus multifilament yarns used in the production of the woven fabrics offer excellent creep characteristics, making them the perfect choice for use in soil reinforcement applications. The range has been specifically designed to exhibit high strength at low elongation. Typical areas of application include reinforced soil walls, embankments on weak soil and load transfer platforms.



EnkaSolutions originated in the late 60s when we invented the unique 3D-structured polymeric mat which is typical of so many Enka products even today. Ever since its invention we've been pushing forward its possibilities in terms of varieties of product and applications, constantly expanding the EnkaSolutions portfolio through proprietary technologies.

The scope of markets supported by EnkaSolutions is wide-ranging – from Civil Engineering and Waste Management to Building and Sports as well as General Industries. It includes solutions in such specializations as water and gas drainage, prevention of erosion, soil stabilization, soil consolidation, vibration control, shock absorption and ventilation.

The EnkaSolutions portfolio includes market-leading and certified products such as EnkaMat®, EnkaDrain®, EnkaGrid®,

EnkaVent®, EnkaSonic®, Enka®Flex, Enka®Spacer, Enka®Fusion, and Colbondrain®, each with proven track records around the world.

For global supply, we maintain production facilities and/or sales offices in Europe, North America and China. (Customer-specific) product developments and tests are conducted by our in-house R&D centers in Europe and North America and by independent external institutions. Our quality management system has been approved by Lloyd's Register Quality Assurance to the ISO 9001:2015 standard.

Provision of the best solutions demands a thorough understanding of the need, and much of our success is down to our close collaboration with our valued customers.

Would you like to discover what EnkaSolutions can do for you?

Simply contact the local team with your requirements and together we will find the best solution to your challenge.

EnkaSolutions locations

China	T +86 519 6858 5555	Hungary	+36 23 610 870
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USA	T +1 828 665 5095	USA	+1 828 665 5095

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