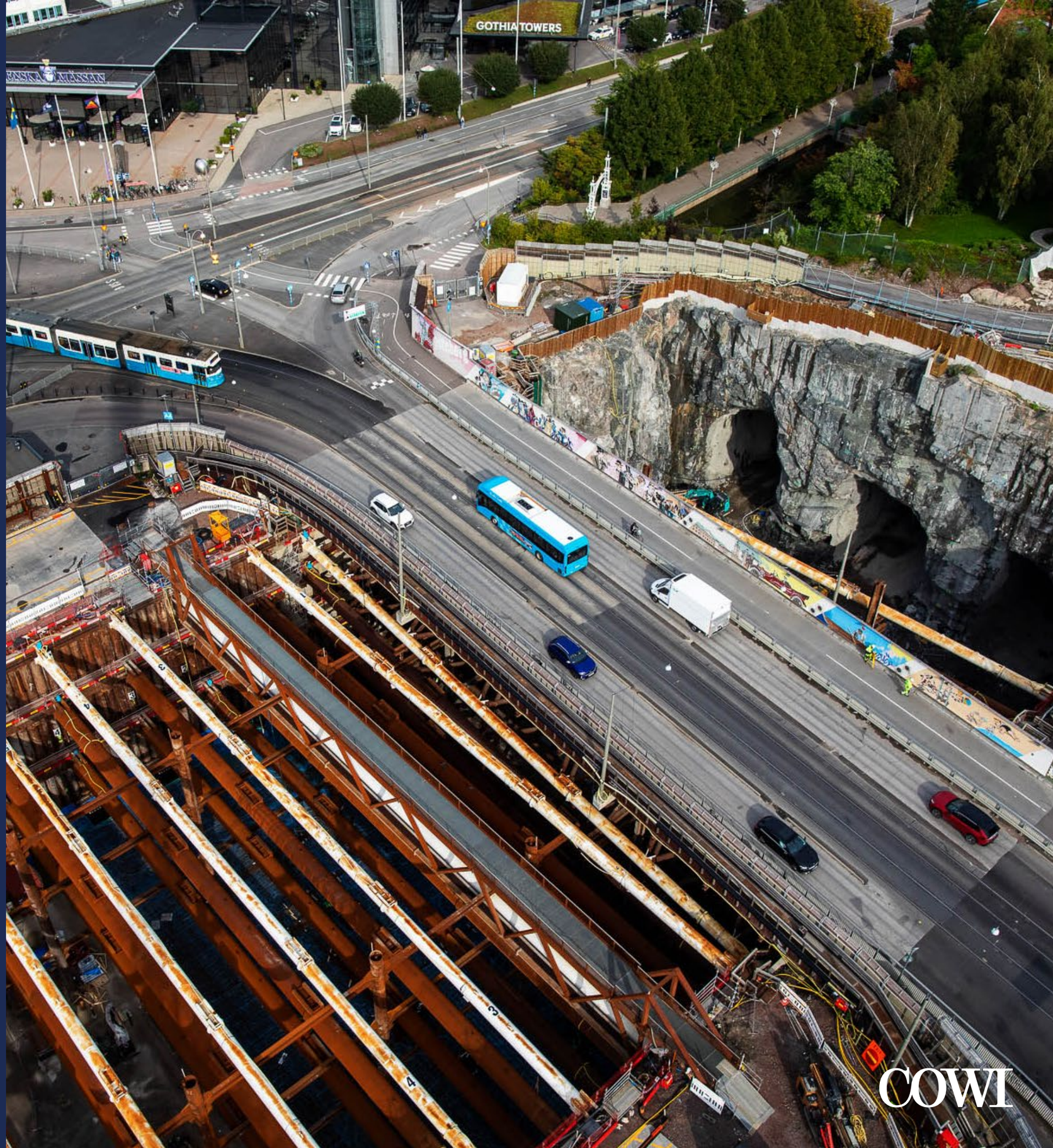
Tunnels



Content

Dig deeper

Urbanisation and the demands of modern society pose significant challenges for infrastructure in cities across the globe. While much of this development is being built at ground level, many features are taking place below ground to protect and support activities in spaces around us.

We can enhance commuters' quality of life and make transportation faster and more efficient by connecting underground spaces and driving innovation in congested environments. This way, people can spend their time on things that are valuable to them.

We work closely with our customers to design, construct and develop optimal tunnel and underground solutions for even the most complex projects. Whether it is a total engineering solution or professional advice on a specific problem, we support owners and contractors at every phase of a tunnel's life cycle, from early concepts to operations, rehabilitation or decommissioning.

We are more than 350 dedicated tunnel and underground engineers, scientists and other specialists who work together worldwide to deliver multidisciplinary and seamless solutions focused on safety, function and value. We are committed to the development and advancement of the tunnelling industry through our contributions to the International Tunnelling and Underground Space Association (ITA).

Together, we shape a sustainable and liveable world.

Your focus is our focus

Excavating and supporting soft soils or rock for a new rail line or a highway? Building a new metro line below centenary cities? Handling stormwater and wastewater safely or setting up a power plant? No matter the function, purpose or end use of the underground space, we have a solution for you.

Railways, light rail, tramways and metro:

- Alignment studies
- Integration with existing railway/ metro network
- Operation and safety concepts
- Stations and shafts
- Tunnels and portals crossover designs
- Approach ramps and earthworks.

Roads:

- Alignment studies
- Integration with existing network
- Operation and safety concepts
- Tunnel and portal designs
- Approach ramps and earthworks.

Fixed links and underwater crossings:

- Roads, railways or combined
- Crossings of rivers, inlets, straits and harbours
- Alternatives to embankments and/ or bridges
- Immersed tunnels
- Bored tunnels
- Drill and blast tunnels.

Other transportation:

- Waterways
- Walkways and cycle paths
- Airport infrastructure
- Underground parking
- Underground materials transport.

Utilities:

- Underground product (liquid/gas/materials) transit
- Water and wastewater
- Power lines
- Attenuation and storage
- District heating.

Energy:

- Nuclear underground facilities
- Generating halls
- Cooling water intakes and outfalls
- Hydroelectric installations.

Industry:

- Marine and river intakes and outfalls
- Access and ventilation shafts
- Storage and attenuation space
- Conduits and tunnels
- Space optimisation
- Mine-related applications.

Development of cavernisation:

- Underground space for a unique purpose
- Growth technology across the globe
- Secure space and deep basements
- Warehousing, storage and distribution
- Accommodation of processes and utilities.

Tunnel disciplines:

- Operation and maintenance
- Fire and life safety
- Structures
- Geotechnical and hydrogeological
- Tunnels (bored and mined tunnels)
- Construction engineering, logistics and cost
- Mechanical and electrical installations
- Flood protection
- Hydraulics (for immersed tunnels)
- Refurbishment and decommission.

Tunnel-related disciplines:

- Roads
- Railways
- Railway systems
- Sewer systems
- Environmental services
- Sustainability
- Risk analysis
- Architecture
- Landscape architecture
- Traffic management
- Utility diversions
- Areas and rights.

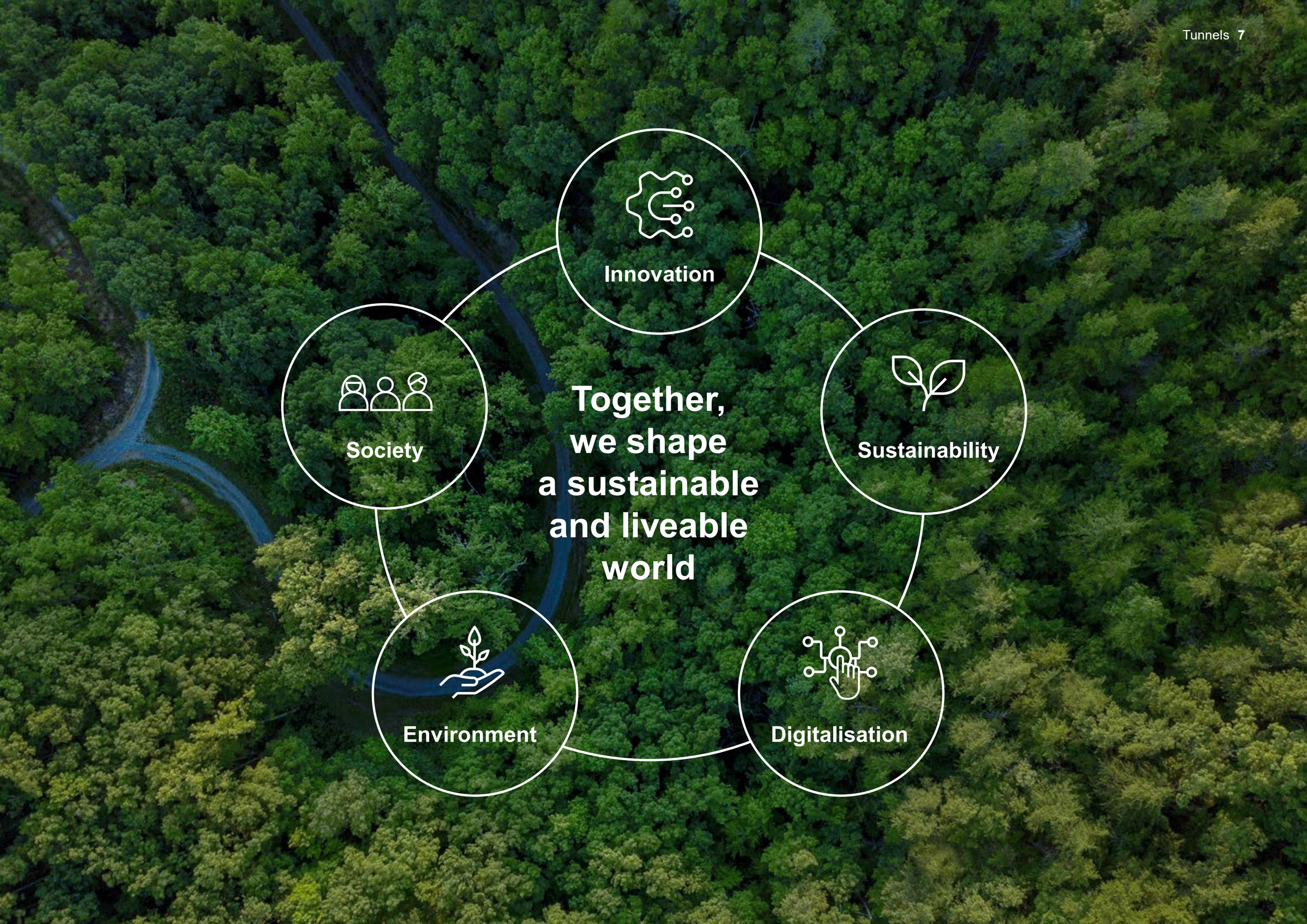
Where can COWI add value to your project?

Constructing tunnels is more than just connecting points. It is about shaping a sustainable and digital future. We prioritise the environment while maintaining high-quality deliverables. Our tunnel structures are designed for longevity, lasting up to 120 years or more, ensuring an investment that will last for generations. We also believe in the potential of existing tunnel structures, turning old tunnels into valuable assets through repurposing and lifetime extension, thereby reducing waste and climate impact from new constructions.

We prioritise resource efficiency and sustainability by using fewer natural resources, promoting recycling and minimising energy usage.
Further, we reduce the environmental impact by utilising excavated tunnel material while upholding the highest tunnel standards.
Our commitment to sustainability embraces the ‘build with nature’ concept to improve biodiversity during construction. Through careful planning, execution and the use of digitalisation by models and simulations, we create spaces that have a positive impact on the surrounding ecosystems and respect local identity and heritage.

Our approach to achieving our sustainability goals involves implementing evidence-based sustainability management supported by a data-driven digital approach, enabling optimal design development. Furthermore, we support value-adding decision-making processes to drive tangible improvements. Our main goal is to benefit society, enhancing transportation networks and fostering economic growth for positive change in communities.

Collaboration and innovation are essential.
We engage with all parts of the supply chain to promote a sustainable culture and push the boundaries for innovative solutions. At COWI, sustainability and digitalisation go hand in hand. We are excited about a future where tunnels are made to connect people and shape a sustainable and liveable world. Join us on this journey as we shape a brighter future together.


Innovation
Society
Sustainability
Together, we shape a sustainable and liveable world
Environment
Digitalisation

Working for owners and contractors

We are involved in tunnel projects from start to finish and beyond, offering comprehensive support to our customers. This includes assisting with early ideas, planning approvals, detailed design, technical support during construction, operation and maintenance, refurbishment, lifetime extension, repurposing and/or decommissioning.

With our extensive experience in road, railway, water, bridge and tunnel engineering, we are well-equipped to conduct thorough comparative studies of various solutions, considering at-grade, above-ground or below-ground options involving bridges or tunnels in the initial project stages.

We understand that successful infrastructure projects require a holistic approach that prioritises sustainability, safety, construction, operation and maintenance from the early stages.

Our collaboration with public owners and contractors is focused on maximising the value of tunnel projects by reducing costs or increasing project benefits.

When working with owners and planners, we leverage our knowledge and experience in construction methods, logistics, alignment studies, environmental impact assessments and cost estimation in project development.

In collaboration with contractors, we prioritise owner’s requirements, safety, constructability and risk reduction in our designs. We consider their expertise and preferences regarding construction methods to ensure a smooth and efficient process.

Our services for contractors are tailored to their specific needs, ranging from assistance during tendering and bidding to detailed designs and support during project delivery. We provide advice on various construction-related aspects such as immersed tunnel production, retaining walls, including support systems, bored tunnel segments and strategies for using tunnel boring machines (TBM).

By understanding the expectations of both owners and contractors, we create an environment that aligns project development with contractors’ preferences while incorporating the owners’ perspectives and goals. This connection between owners and contractors allows both sides to achieve their objectives and enhance the overall project outcomes. We are proud to be involved in record-breaking infrastructure projects for both owners and contractors, where technological innovation is the norm.

Large Infrastructure

Client
BC Ministry of Transportation and Infrastructure

Location
Canada

Period
2021 – ongoing

Large infrastructure, immersed tunnels, owners

Fraser River Tunnel project

The Fraser River Tunnel Project includes a new, eight-lane immersed tube tunnel that will replace the existing George Massey Tunnel on Highway 99. The new tunnel will have three vehicle lanes and a dedicated transit lane in each direction, with a separated active transportation corridor for cyclists and pedestrians.

Considering the foundation of liquefiable soils, the tunnel structure will be designed to remain operational after any significant seismic event. The tunnel flood protection system ensures that the road remains operational during extreme flood events and in the face of rising sea levels. As a key transportation link within BC and between Canada and the United States, the Fraser River Tunnel will facilitate greater economic growth and trade throughout the region and internationally.

In addition to the new Fraser River Tunnel, the project involves the replacement of the Deas Slough Bridge and the decommissioning of the old tunnel once the new immersed tunnel is operational.

COWI is part of the BC Ministry of Transportation and Infrastructure's owner's engineer team, acting as the immersed tube tunnel specialist.

Client
Femern Link Contractors (FLC)

Location
Denmark, Germany

Period
2013 – ongoing

Large infrastructure, fixed link, immersed tunnels, contractors

Fehmarnbelt Fixed Link

The 18-kilometre Fehmarnbelt Fixed Link connecting Denmark and Germany will be the world's longest combined road and rail-immersed tunnel. The immersed tunnel section will comprise a four-lane motorway, two electrified rail tracks and a bore for emergency, electrical and mechanical installations, consisting of 79 individual elements in total, each 217 metres long.

Once complete, the journey through the tunnel will take just ten minutes by car and seven minutes by train, saving about one hour of travel each way.

As one of hundreds of projects within the trans-European transport network (TEN-T), this transport corridor will help improve mobility, cohesion and interoperability within the European Union, resulting in an overall reduction in carbon emissions.

COWI acts as the primary consultant for FLC (the contractor to the owner and operator Sund & Bælt) on this major infrastructure project.

Client
National Highway

Location
United Kingdom

Period
2016 – ongoing

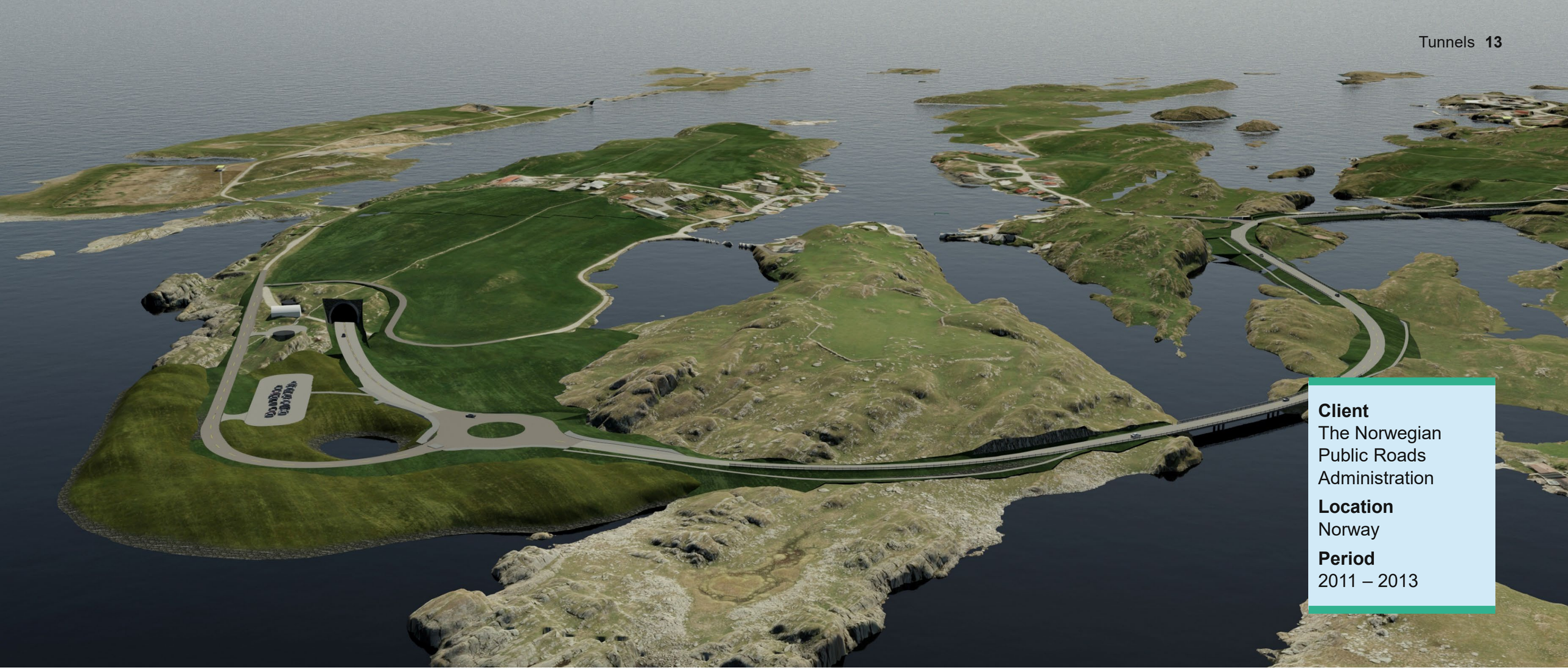
Large infrastructure, fixed link, subsea bored tunnels, owners

Lower Thames Crossing

The Lower Thames Crossing is going to be the longest road tunnel in the United Kingdom, running for four kilometres under the River Thames east of Gravesend and Tilbury. It will consist of two bored tunnels, each 16 metres in diameter, one for southbound traffic and one for northbound traffic. When complete, it will be the largest-diameter bored tunnel in Europe.

The new crossing will ease congestion on the existing Dartford Crossing, which handles around 55 million trips every year. It will also provide more than 70% additional road capacity across the river, unlock major investments and create new jobs while minimising construction impacts on the riverside marshes and riverbed.

COWI is the technical partner on the project in a joint venture with Arcadis and Jacobs. One of COWI's key responsibilities is the development of the preliminary design for the bored tunnel, delivering optimum solutions for tunnel safety, availability and customer experience.



Client
The Norwegian Public Roads Administration

Location
Norway

Period
2011 – 2013

Large infrastructure, fixed link, subsea rock tunnels, owners

Rogfast Tunnel

The 25.4-kilometre Rogfast tunnel in Norway will consist of two dual-lane tunnels under the Boknafjord, north of Stavanger. On completion, the tunnel will be the longest and deepest subsea road tunnel ever built.

The ambitious project will shave 35 minutes off the journey on one of Norway's busiest roads between Stavanger and Bergen, while facilitating an expansion in the housing and labour markets in the region.

The two tubes of the main tunnel will be connected by cross passages for emergency and cross tunnels for diversion of traffic when necessary. Additionally, four caverns are planned for each tube to break the monotony passengers may feel driving through a tunnel of this length.

COWI prepared the conceptual design as basis for municipal plans, had overall responsibility for the tunnel design and construction including geological assessment, tunnel installations, operational safety and roads in tunnels, visualisation and video presentation.

The tunnel is planned to open in 2033.

Client
Danish Road Directorate

Location
Denmark

Period
2022 – ongoing

Large infrastructure, urban road tunnels, owners

Tunnel under Marselis Boulevard

The 2.15-kilometre tunnel will link the E45 motorway and Denmark's largest container port, the Port of Aarhus. The tunnel is a two-celled cut-and-cover tunnel with two lanes in each direction, each end connecting to street level via ramps.

It is a very complex project because it requires constructing the tunnel while minimising the impact on existing traffic during construction. This results in restrictions to the project and challenges to the construction logistics.

Once in operation, the tunnel will host heavy truck traffic, including dangerous goods traffic, while the residents of Marselis Boulevard above it will be able to enjoy a less noisy environment. The project will also provide possibilities for other plans to utilise the area above ground.

COWI is responsible for delivering the conceptual design and environmental impact assessment of the project.

Client
Leighton China
State JV (LCSJV)

Location
Hong Kong

Period
2016 – 2018

Large infrastructure,
urban road tunnels, contractors

TKO – Lam Tin Tunnel

The Tseung Kwan O – Lam Tin (TKO-LT) Tunnel and Cross Bay Link project connects the town of Tseung Kwan O and East Kowloon. It comprises twin-bore drill-and-blast highway tunnels spanning approximately 2.6 kilometres in length. In addition, it involves the construction of a bifurcation tunnel, highway interchanges and site formations.

The TKO-LT tunnel, together with the trunk road T2 and the Central Kowloon route, will provide an east-west express link between Kowloon West and Tseung Kwan O, relieving traffic resulting from the future development of the district.

COWI was responsible for the assessment of ground conditions, including 3D and structural modelling, the detailed design of temporary support for main and branch tunnels, and construction impact assessment.

Client - Korsvägen
West Link Contractors (WLC) – Joint venture of NCC and Wayss & Freytag

Client - Central Station
NCC

Location
Sweden

Period
2012 – ongoing

Large infrastructure,
urban rail tunnels, contractors

Gothenburg West Link (Västlänken)

The West Link is set to be an eight-kilometre double-track railway with a six-kilometre railway tunnel and three new stations underneath the city of Gothenburg. The new railway not only makes local and regional public transportation more accessible and quicker but also contributes to West Sweden becoming a larger labour market region by improving connections between Gothenburg and other locations.

The project is full of complexities, from the need for large, deep shafts in the heart of the city centre to geological challenges such as the soft clay well-known to Gothenburg that can cause structures to settle by more than a metre if no preventive measures are taken.

COWI is involved in multiple parts of the project, including the detailed design of the Central Station and the design and construction works of the Korsvägen section, a 3.2-kilometre system of tunnels.

Client
Metroselskabet

Location
Denmark

Period
2023 – ongoing

Large infrastructure,
underground metros, owners

Copenhagen’s M5 metro line

The new M5 metro line in Copenhagen will serve existing urban areas as well as new districts. It will also help relieve congestion on the M1/M2 harbour crossing and contribute to sustainable urban development in the new districts of Kløverparken, Refshaleøen and Lynetteholm.

Metroselskabet aims to halve the carbon footprint of the M5 compared to previous lines while prioritising passenger experience, the metro’s contribution to the city, and health and safety during construction and operation.

COWI is the consultant on the environmental impact assessment, utility relocations, and civil works design in a joint venture with Ove Arup & Partners Denmark A/S. Furthermore, COWI will consult on area and rights.

Client
Nishimatsu Construction Co., Ltd.

Location
Singapore

Period
2022 – ongoing

Large infrastructure, underground metros, contractor

Cross Island Line

Expected to open in 2030, the Cross Island Line (CRL) is set to become Singapore's longest fully underground line, spanning over 50 kilometres and carrying over 600,000 commuters each day. CRL will ease travel across the eastern and western parts of Singapore and reduce traffic congestion on the existing East-West Line while providing an alternative option to commuters.

A large-diameter tunnel boring machine (TBM), measuring 12.6 metres in diameter, will be used to construct a single tunnel with two tracks as part of CR110 contract. This will be one of the largest tunnel boring machines ever to be deployed in Singapore.

COWI will deliver the detailed design of a 2.9-kilometre bored tunnel, 300-metre-long cut-and-cover tunnels and a two-storey facility building with five basement levels to provide electrical and mechanical services for the tunnel.

Water and Climate adaptation

Client
HOFOR
and Novafos
(infrastructure
asset owners)

Location
Denmark

Period
2016 – ongoing

Climate adaptation and water,
stormwater tunnels, owners

Svanemøllen stormwater tunnel

The Svanemøllen stormwater tunnel is part of the Copenhagen Cloudburst Programme, which targets climate adaptation in Greater Copenhagen.

The ten-kilometre underground stormwater tunnel consists of 14 shafts to collect the rainwater run-off, plus one outfall structure with diameters ranging between 8 and 17 metres and depths up to 33 metres. Between the shafts, bored tunnels with a diameter of between 2 and 4.9 metres will direct rainwater run-off from the surface and into the Oresund via the outlet shaft. Pipe jacking will be used to construct the tunnel with diameters from 1.6 to 3.2 metres, and segmental tunnel lining will be used for the 4.9 metres tunnel.

In the early phase of the project, COWI delivered conceptual and preliminary design as well as the environmental impact assessment and is currently developing the detailed designs of hydraulics, drainage and tunnel engineering components, environmental impact assessment updates and general regulatory processing. Furthermore, COWI will also provide input to the procurement documents.

Client
CBNA and Halmar construction JV

Location
United States

Period
2023 – ongoing

Climate adaptation and water, combined sewage and stormwater tunnels, contractors

Potomac River Tunnel

To improve water quality, the 8.8-kilometre Potomac River Tunnel will control combined sewer overflows (CSOs) to the Potomac River in Washington, D.C.

This undertaking is part of the Clean Rivers Project set to improve the water quality of the Anacostia and Potomac Rivers and Rock Creek by increasing the capacity of the sewer system.

Once operational, the tunnel is expected to reduce CSOs by 93% in an average year of rainfall. With its 5.5-metre diameter, the tunnel will run deep underground beneath the Georgetown waterfront, along the edge of the National Mall and East Potomac Park, past Hains Point and connect by gravity to the existing Anacostia River Tunnel. Construction will require two tunnel boring machines. Starting from West Potomac Park, one machine will mine south through mostly soft ground, and another will head north to bore through rock.

COWI is working with Hatch to deliver detailed design services to a joint venture of CBNA and Halmar.

Client
Leighton Asia

Location
Singapore

Period
2018 – ongoing

Climate adaptation and water, sewage tunnels, contractors

Deep Tunnel Sewerage System – Phase 2

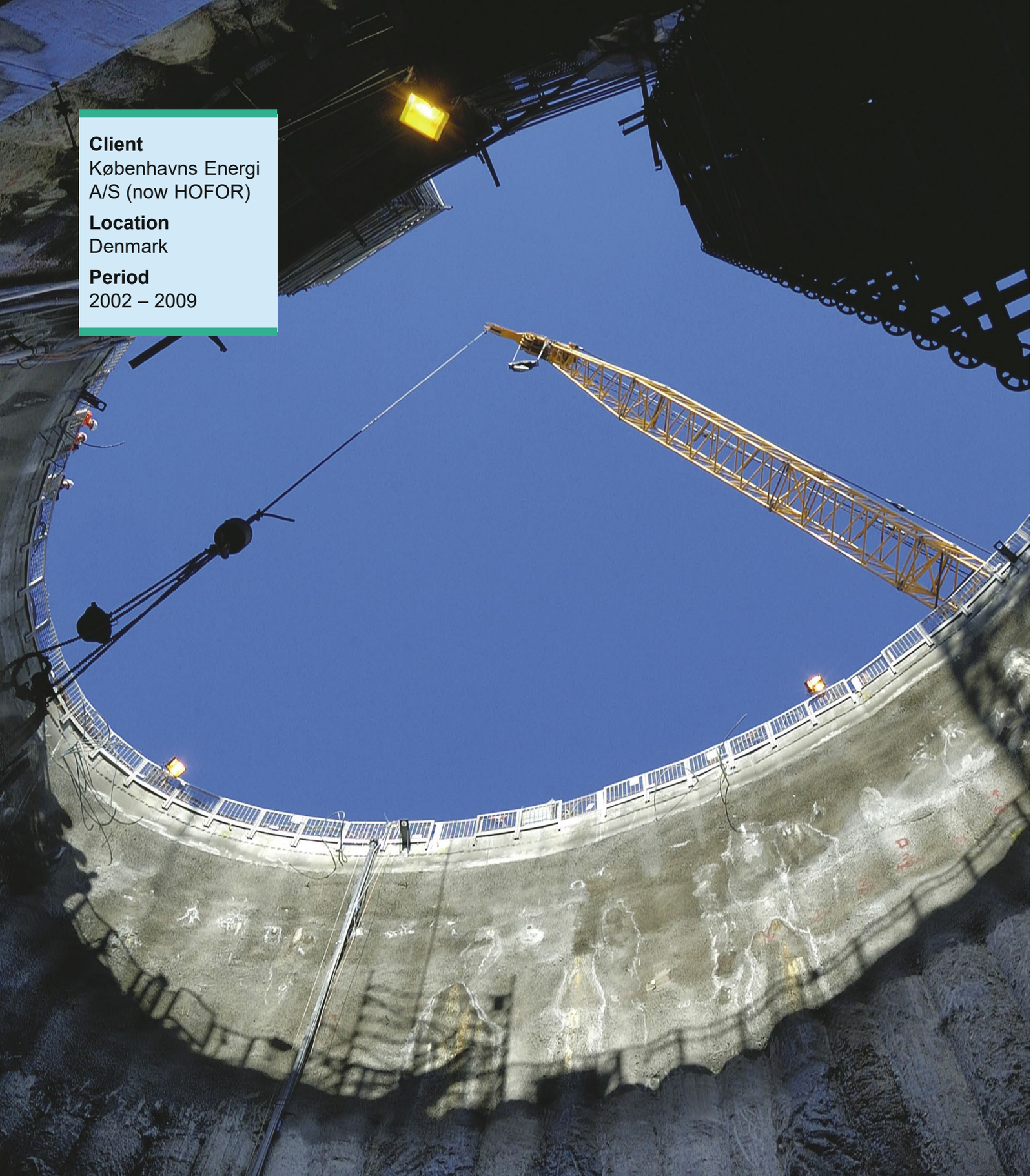
Singapore is building the Deep Tunnel Sewerage System (DTSS) to meet its long-term need for sustainable wastewater collection, treatment, reclamation and disposal.

The scheme uses deep tunnel sewers to convey used water by gravity to water reclamation plants, where it is purified into ultra-clean, high-grade reclaimed water or discharged to the sea through outfalls. The deep tunnels in Phase 2 will connect to the existing deep tunnels in Phase 1, serving the eastern part of Singapore and the public sewer network to create one seamless, integrated system.

Singapore's densely populated urban environment makes DTSS a highly complex project with major design challenges since the work site is highly constrained, with deep shafts required in challenging geology adjacent to major civil infrastructure.

Under this design contract, COWI, together with CPG Corporation, devised solutions to these challenges, including investigating options to combine temporary work shafts to minimise land take and designing ground improvement measures to reduce any impact on adjacent structures.

Sustainable Energy



Client
København Energi A/S (now HOFOR)

Location
Denmark

Period
2002 – 2009

Sustainable energy, owners and contractors

District heating tunnel in Copenhagen

This four-kilometre district heating tunnel was constructed 30 metres below central Copenhagen to carry a major system of district heating pipes under Copenhagen Harbour, providing the residents with cost-effective and environmentally friendly district heating.

The heating pipes in the tunnel convey either hot water or steam. These conditions impose high demands on the structural design. The solutions must be able to resist the expansions and detrimental processes resulting from the elevated temperatures.

We solved these by applying steel fibre-reinforced concrete for the tunnel lining – one of the first of its kind in the world – and by adopting the latest methodologies in durability design to achieve the required 100-year lifetime.

COWI was responsible for tender design and tender document preparation, detailed design and construction supervision.

Client
SSE Renewables

Location
United Kingdom

Period
2021 – ongoing

Sustainable energy, hydropower tunnels, owner

Coire Glas

With the capacity to power three million homes non-stop for 24 hours, Coire Glas will be the first large-scale pumped storage scheme in the United Kingdom for four decades. With its 30 GWh of storage capacity, it will also be the UK's largest-ever electricity storage project, more than doubling the country's current storage capacity.

The up to 1.5 GW scheme will use surplus renewable energy to pump water to the upper reservoir and, consequently, help manage costs and promptly provide electricity to the grid when needed for long periods of time. Pumped storage is the most efficient proven large scale electricity storage technology that can help to mitigate variable generation output from other renewable energy sources such as onshore and offshore wind.

Coire Glas would be able to start generating from standby operation in under 10 seconds and reach full generating capacity in under 60 seconds, rapidly supporting grid stability.

COWI has delivered the reference design for multiple underground structures and provides a range of ongoing engineering, ground investigation and client-side services to SSE. We collaborate with SSE's long-standing consultant Stantec as part of an owner's engineer joint venture on the delivery of this major infrastructure project.

Client
Landsvirkjun

Location
Iceland

Period
2002 – 2007

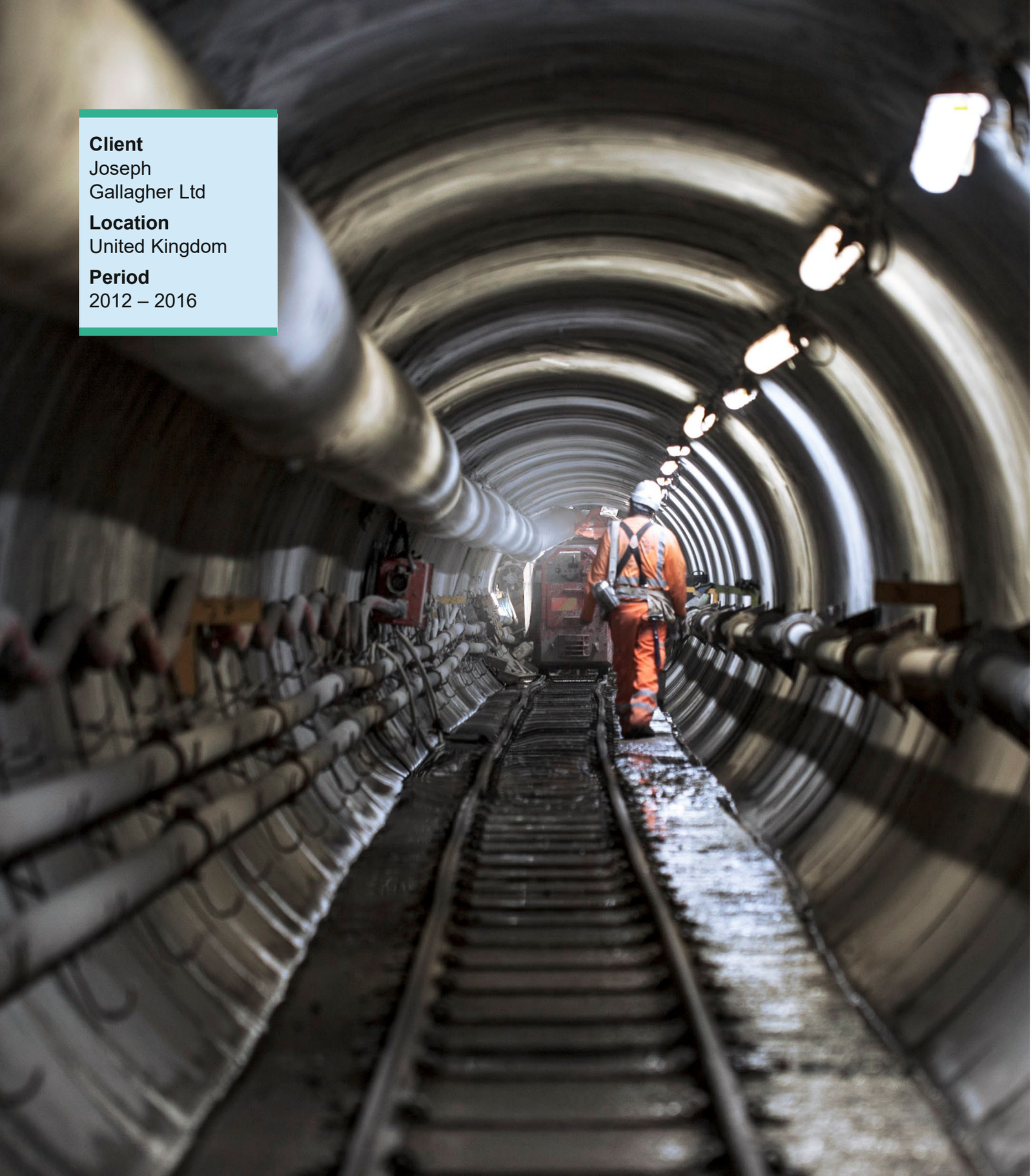
Sustainable energy,
hydropower tunnels, energy developer

Kárahnjúkar Hydroelectric Power Station

Iceland’s largest power plant, Kárahnjúkar Hydroelectric Power Station, produces electricity for Alcoa’s aluminium smelter in Reyðarfjörður. The 690 MW capacity plant harnesses two glacial rivers, and the complex comprises a 200-metre high concrete-faced rock-fill dam (CFRD) as well as several smaller rock-fill dams, 72 kilometres of tunnels and an underground power station.

The Kárahnjúkar Dam is the tallest concrete-faced rock-fill dam in Europe and among the largest of its kind in the world. In the powerhouse, the water drives six Francis turbines and then flows through a tailrace tunnel and canal into the River Jökulsá in Fljótsdalur.

COWI delivered design works for the project, including the civil, structural and mechanical design for diversions, including dams and tunnels and prepared the environmental impact assessment and the tender documents for diversions. Furthermore, we performed site supervision of the power station construction, including tunnels and the underground powerhouse.



Client
Joseph
Gallagher Ltd

Location
United Kingdom

Period
2012 – 2016

Sustainable energy,
cable tunnels

Battersea Cable Tunnel

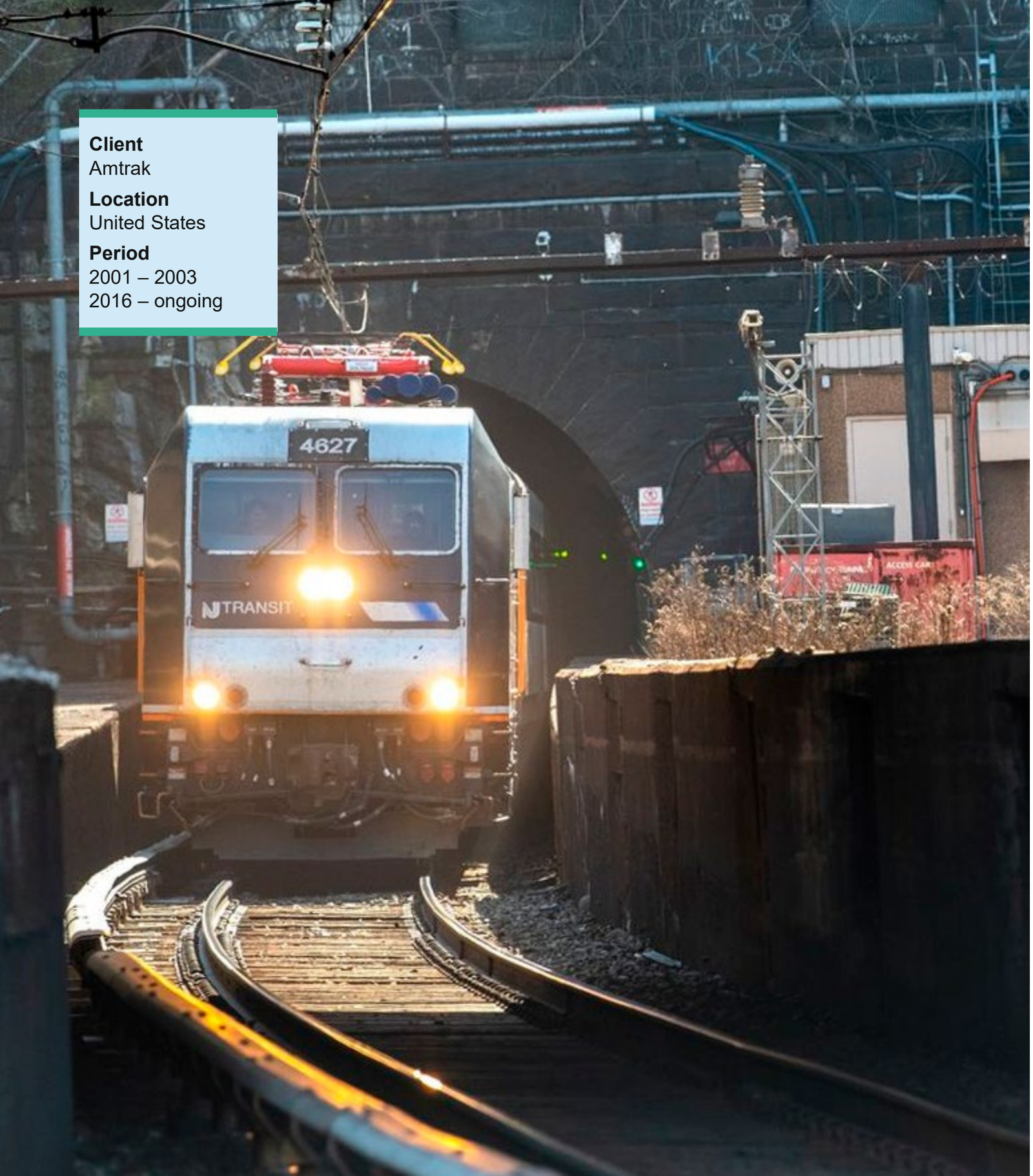
The new Battersea electricity substation is built to help distribute power to homes and businesses across the new neighbourhood. The Battersea Cable Tunnel connects the substation to the existing Battersea Power Station's electricity network, which stopped generating electricity in 1983.

The site was set up within an existing warehouse to reduce noise and disturbance during the tunnelling works. Inside the warehouse, a 30-metre deep, 7.5-metre diameter access shaft and a sprayed concrete lining (SCL) launch tunnel were constructed on the substation site in Battersea so that a tunnel boring machine (TBM) could be used to construct the new 300-metre long cable tunnel.

COWI was the contractor's permanent and temporary shaft works designer for the project, delivering the hybrid precast concrete/SCL shaft lining, the curved SCL launch chamber and temporary works' design and participating in community engagement.

In 2018, the tunnel project was named Best Infrastructure Project at the ICE London Awards.

Rehabilitation and service life time extension of tunnels



Client
Amtrak

Location
United States

Period
2001 – 2003
2016 – ongoing

Rehabilitation and service lifetime extension of tunnels

Amtrak Hudson and East River tunnels

The two projects consisted of inspection and rehabilitation design for six Amtrak tunnels and structures under Manhattan and the Hudson and East Rivers. These critical tunnels were constructed over 100 years ago and provide a vital rail service transportation link into New York and Northeast.

The North River (Hudson) Tunnel consists of two, single-track tubes which serve as the only passenger rail connection between Manhattan and New Jersey. The East River Tunnels are four single-track railroad passenger tunnels in Manhattan and cross the East River to Long Island City in Queens.

COWI's task included the inspection, evaluation, and design of repair/rehabilitation methods for the 24-kilometre-long tunnels and structures, including four ventilation shafts, portals, sub stations, manholes, bench walls, cross passages, and mid-river sumps.

Meet the team – Tunnel and underground

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