A STATE-OF-THE-ART SHORE CROSSING

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ABSTRACT

An insight is provided into the design and construction of the shore crossing of the export pipeline system for the Otway Gas Project in Western Victoria. The development of the Otway Gas Project, which is now underway, requires the installation of a 20-inch gas pipeline and a 4-inch glycol service line across the shoreline in the Port Campbell National Park along the Great Ocean Road, one of the major tourist attractions in Australia. An account is given of the reclamation site selection process, the collection of required site data, the identification of geo-hazards, the development of a unique construction method based on a combination of retractable micro-tunneling and horizontal directional drilling, and an outline of the construction challenges. These include the complex geotechnical conditions, the ever present high-energy Southern Ocean swell, and the environmental significance of the site. The design and construction work performed demonstrates that trenchless technology can successfully be applied for the installation of pipelines across shorelines provided detailed attention is paid to a number of design and construction aspects; bearing in mind that horizontal directional drilling design guidelines are generally limited with respect to these crossings.

KEYWORDS

Horizontal directional drilling, shoreline, geotechnical, pipeline, environment.

INTRODUCTION

The Geographe and Thylacine gas fields, both situated in the Otway Basin of the Southern Ocean, were discovered in May and June 2001 (Woodside, 2002). They are significant fields which have added to southeast Australia’s gas resources, discovered at a time just as traditional supply sources are beginning to decline. It is estimated that these fields contain sufficient natural gas to provide more than 10% of current annual demand in southeastern Australia for at least 10 years and have the potential to be operational for much longer. The Geographe and Thylacine gas fields are in exploration permits VIC/P43 and T/30P respectively, located about 55 and 70 km south of Port Campbell in water depths of 80–100 m (Fig. 1). The project proposes to extract natural gas, liquefied petroleum gas (LPG) and condensate from the gas fields and transfer it by subsea and underground pipeline to an onshore gas processing plant. The development will include installation and operation of new gas production wells, subsea manifolds and flowlines, and a platform, with a 20-inch diameter gas export pipeline to shore. Gas processing will be onshore, with a connection to the Victorian gas transmission pipeline network. The development also includes the installation of a 4-inch in diameter service line parallel with the gas pipeline. The project is targeting a 2006 gas delivery start-up. The exploration permits are held by a joint venture of Woodside Energy Ltd, Origin Energy Resources Limited, CalEnergy Gas (Australia) Limited, and Benaris International N.V.

The first construction activity on site, which started late in September 2004, has been in relation to the shore crossing preparation for the export pipeline system. Spudding of the first pilot hole was achieved mid January 2005. The installation of the 29-inch and 10 3/4-inch pipeline casings across the shoreline is due for completion in April 2005.

Shore crossing description

The shoreline represents a major obstacle for the pipeline system. The coastline in proximity of the gas fields is dominated by 30–60 m high limestone cliffs (Fig. 2). These cliffs actively erode with block slumping occurring regularly due to the under-cutting effect of wave action and rainwater runoff. Some natural arches, such as London Bridge, have collapsed due to this process (Wilmap). Vertical jointing controls the erosion process of the relatively weak sedimentary rock. Solution along the joints has produced numerous caves, sink holes and offshore stacks which include features of national tourist significance. Examples of these are Sentinel Rock, The Arch and The Twelve Apostles.

This part of Australia has constant high-energy wave conditions (Fig. 3). Mid-latitude cyclones move continuously across the Southern Ocean and generate most of the waves arriving at the western Victorian coast. In summer the waves will occur as long, moderate-to-high swell due to the cyclones being far to the south of Australia at this time of the year. In winter the cyclones are closer to the coast, producing higher seas and swells, and associated onshore winds. Waves arrive from the southwest predominantly with a spectral peak period of between 12 and 15 seconds for more than 60% of the time. The most common wave heights are between 2.0 and 3.5 m and in winter they are known to rise well above 7 m (Woodside, 2003). Conditions are more severe in winter, but all seasons show a relatively high level of wave energy. Statistically, the reasonably benign times of the year are November–December, but even during these months the periods during which significant wave heights drop below 1.5 m are limited and of short duration only.
The shoreline is also an area of major environmental importance. Much of the coastline is either National Park or Coastal Reserve with areas of unique flora species, and protected fauna onshore as well as offshore (Parks Victoria). The spectacular characteristics of the entire western Victorian coastline as previously described have turned it into a major national tourist attraction.

DESIGN

Recognising the difficulties of installing the required pipeline system across this unique shoreline, Woodside engaged specialist Perth-based engineering company Atteris Pty Ltd in August 2001 to perform a study covering the following scope:

- identification of suitable locations for a pipeline shore crossing for the gas fields development;
- development of pipeline shore crossing construction concepts;
- identification of key design issues;
- provision of construction cost estimates and expected construction periods; and
- identification of areas of risk in relation to the shore crossing.

Site data required to undertake this front-end work was initially limited to that available in the public domain, but was supplemented with data from another gas field development in the area and with a selection of aerial photographs which covered the coastline between Portland and Cape Otway.
Site selection

Site selection for the pipeline landfall location took into account the coastline section between Portland and Princetown (Fig. 4). The steps taken in this process are described here.

- A desk study of the coastline was performed taking into account: geology and geomorphology; shoreline topography and nearshore bathymetry; exposure to seastate; areas of environmental (flora and fauna), tourist, social, heritage and historical significance; and land access. This was done by studying marine charts, topographical maps, geological maps, aerial photography, information provided from other developments in the area, and the worldwide web.

- Based on outline construction concepts, a total of eight candidate sites were identified using the following key criteria:
  - distance from onshore to the ~20 m water mark not to exceed 1,200 m (the 20 m water mark is based on accessibility of a suitable pipelay vessel in Southern Ocean seastate);
  - shoreline section of relative inactive geomorphology, and limited geo-hazards; and
  - avoiding areas of environmental, tourist, social, heritage and/or historical significance; densely populated areas; and areas with extensive marine activity such as shipping traffic, fishing and the like;

- Screening and ranking of identified candidate sites against criteria set below:
  - offshore pipeline route selection—due to very limited seabed data a simplistic approach was taken on the basis of route length x cost per unit length;
  - liaison with the site selection process for onshore gas plant and onshore pipeline route (performed by others under a separate contract with Woodside Energy)—a process for the selection of the onshore gas treatment plant was put in pace in parallel with that for the pipeline landfall location, co-ordinated by Woodside;
  - estimated construction cost and risk;
  - the three key criteria listed above.

Figure 2. Western Victoria’s rugged coastline.
The eight identified candidate sites were studied in greater detail, subjected to walk-over surveys, and subsequently ranked. The Rifle Range site, 2 km west of the township of Port Campbell, was selected as the best site to bring the pipeline system ashore. This site is still actively used as a rifle range. It provides an area of disturbed land within the Port Campbell National Park which is suitable for pipeline construction purposes.

Major benefits of the Rifle Range site compared to the other candidates are:

- the stability of this section of the coastline;
- the estimated low probability of presence of caverns and/or Karst features in the limestone formations;
- deep water relatively close to shore; the 20 m water mark is about 800 m from the top of the shoreline cliff;
- nearshore seabed being flat and relatively featureless, and limited offshore pipeline route length; and
- compatibility with a suitable onshore gas plant location with minimum onshore pipeline route length.

The environmental significance of this site was immediately recognised and required a rigorous approach in minimising any detrimental impact on the unique flora species and protected fauna. The site also contains aboriginal heritage sites requiring careful management.

Geotechnical and geophysical surveys

Ground surface and sub-surface surveys were undertaken in two stages: the first stage was performed at selected sites with the aim of using the collected data for final site selection; a second stage involved further surveys at Port Campbell’s Rifle Range site with the objective of collecting data for detail design and construction purposes. An overview of all surveys performed at the Rifle Range site is provided:

- hydrographic surveys (multi-beam bathymetry, side scan sonar, shallow seismic reflection and refraction) between the gas fields and the landfall site along the proposed offshore pipeline routes;
- laser airborne depth sounding survey nearshore, to provide coarse bathymetry data in this zone;
laser airborne scanning survey, to provide aerial photography and topographic data onshore;
• onshore core sampling using a conventional onshore coring rig; a pair of vertical boreholes were drilled to 120 m depth, followed—later—by an inclined borehole at 60° to the vertical along a borehole depth of 180 m; full core samples were retrieved with selected samples subjected to laboratory testing; and
• nearshore coring using a diverless operated subsea coring rig was attempted, but aborted in view of the hostile seastate conditions typical for the Southern Ocean; a second attempt using a 70 m long drill ship succeeded in collecting core samples to 4.5 m depth in the nearshore area, however the drilling to 20 m depth was aborted due to the severe swell conditions.

All data was collated and used to produce a geotechnical model of the shore crossing site, thereby providing a tool for performing detail design and development of the construction plans. The surveys confirmed the complex geological nature of the shoreline with associated risks.

Pipeline construction concept

Pipeline construction concepts were developed in parallel with, and to support, the landfall site selection process. Construction methods considered were based on the two main concepts that exist for installing pipelines across shorelines:
• open cut (traditional); and
• trenchless (horizontal directional drilling or tunneling).

The shoreline characteristics with its high cliffs, almost constant high-energy wave climate, in combination with the sensitivity from an environmental and tourist point of view precludes any open-cut method. A technical and commercial comparison between micro-tunnelling and horizontal directional drilling (HDD) resulted in the former being discounted. A pipeline construction method based on HDD was, therefore, selected.

Several HDD concepts were developed, studied and screened, including those methods recently applied in Bass Strait and Tasmania for smaller diameter pipelines where the pipeline is pulled by the HDD rig directly from the pipelay vessel, or pushed downhole in one operation from onshore. However, technical reasons and/or site conditions did not allow application of these methods.

Figure 4. Study area.
Atteris, therefore, developed a method based on installing a casing pipe large enough to contain the gas pipeline in advance of offshore pipelay, divorcing the HDD activities from the offshore pipelay activities, with adequate float in between, thereby significantly improving the cost and risk profile of the project (Fig. 5). To allow efficient installation Atteris proposed using threaded connectors welded onto the casing pipe joints. Particular attention was required during detail design regarding the choice of the connectors of this size, in relation to make-up time and acceptance of upsets either internally or externally, the latter in relation to the pulling-in of the product pipeline. At the end of preliminary design a casing size of 30-inch was considered. Due to unavailability in the world market of this size, a slightly smaller diameter of 29-inch was ultimately selected.

A similar construction concept was put forward for the 4-inch diameter service line, for which a 10.75-inch diameter standard casing is proposed to be installed by HDD, parallel to the 30-inch diameter casing pipe. Both HDDs measure 800 m in length, between the entry point on top of the cliff onshore to a point offshore in 20 m water depth.

Prior to starting the HDD operations for the 29-inch diameter casing pipe installation, it was required to install a 48-inch diameter support casing along about the first 200 m of the borehole, for the following reasons:

- to avoid drilling fluid surfacing at the toe of the fore-shore cliff due to expected hydraulic fracturing of the formation occurring;
- to provide physical borehole support along this borehole section given that it is not filled with drilling fluid upon punch-out of the pilot hole drilling assembly at the subsea extremity of the HDD; and
- to prevent the heavy downhole tools cutting a slot in the bottom of this section of the borehole, again given that it will not be filled with buoyancy providing drilling fluid upon pilot hole punch-out.

In view of the length and diameter of this support casing, a novel technique called retractable micro-tunnelling was planned to be adopted for installing this support casing. The method requires a specially designed tunnel boring machine which, upon completion of installation of the 200 m inclined support casing section will be retracted and subsequently pulled out back to the surface through the support casing pipe. The operation requires an inclined entry pit to initiate the tunnelling operation from the surface.

**Detail design aspects**

For this difficult crossing it was decided that detail design engineering would best be undertaken by the HDD contractor who was the successful bidder based on the developed concept, in an integrated team with Woodside specialists, managed and co-ordinated by Atteris. An extensive pre-qualification and tender process resulted in the contract being awarded to DrillTec Australia Pty Ltd, a subsidiary of DrillTec GmbH from Germany. The contract was split into two separable portions:

- Separable portion 1: Detail design phase (January–June 2004);
- Separable portion 2: Construction engineering and construction (July 2004–April 2005).

The following aspects of particular interest were addressed during the detail design phase:

- refinement of the geotechnical model;
- further development of the construction concept;
- borehole stability and hydraulic fracturing assessments;
- support casing design and application of the inclined retractable micro-tunnelling technique;
- preliminary construction engineering; calculation of installation loads and developing means of minimising these through buoyancy control;
- casing pipe mechanical design, including installation stresses;
- casing pipe selection and final choice of casing joint connectors;
- corrosion protection of the pipeline section through the casing pipes is a critical design aspect, the requirement or not of attaching sacrificial anodes to the product pipelines inside the casing pipe section being the key issue;
- pipeline overbend support at the HDD exit location subsea, and pipeline stabilisation design during construction (installation period stability) and during its operation (lifetime stability);
- drilling fluid design including ensuring continuous fresh water availability at the required flow rates for the drilling and borehole reaming operations;
- focus on eliminating/limiting the scope for marine works in hostile seastate conditions if practicable; and
- environmental and social impact management (flora, fauna, noise control, heritage management).

The design phase resulted in the following key decisions being made:

- Casing pipe for hole #1: 29-inch OD with 1-inch wall thickness. The selection of this odd size casing was a result of limited availability worldwide of steel pipe in the range 28–30-inch. The 1-inch wall thickness was required to ensure near-neutral buoyancy of the casing inside the borehole filled with 1.2–1.3 tonnes per cum density drilling fluid, to limit the installation loads;
- Connectors for 29-inch casing: threaded oil tool connectors. The key in the selection of the casing connectors was the robustness of the threads and limited number of turns to make up each connector;
- Casing pipe for hole #2: 10.75-inch; threaded standard connectors. Standard casing was used for this purpose; and
- Adopt the construction concept as described previously.
Figure 5. Sequence of construction activities.
RISK MANAGEMENT

HDD can be an environmentally friendly and economic method for crossing obstacles such as a shoreline, but it has a reputation of sometimes providing disappointing results. Many reputable oil and gas operators have been faced with either delayed installation or complete failure of installing the shore crossing section of their pipeline by HDD, with consequential significant negative impact on cost and schedule of field development.

For this drilled shore crossing the following key design approaches have been applied from the initial stages of the design:
- collection of an adequate level of geological and geo-technical data, onshore as well as nearshore;
- selection of a HDD contractor with relevant experience gained on other drilled shore crossing projects of similar nature; and
- in view of the pipeline diameter (20-inch) and exceptional site conditions the drilling length should be retained to less than 1,200 m for this crossing, this allowing a more controlled risk management of the HDD operations.

Geotechnical hazards

Geological studies performed in support of the site selection process and later in support of concept design revealed the following geotechnical hazards:
- cliff stability, a risk mitigated by selecting a stable shoreline section;
- potential presence of caverns (Karsts) in the limestone formations, a risk minimised through site selection, targeting an area where this risk was minimal;
- hard bands in the generally weak limestone formation; these hard bands, typically up to 0.5 m in thickness with USC values of up to 40 MPa have been identified whereas the USC strengths of the main limestone formations range between 1 and 1.5 MPa, which could have caused problems during pilot hole drilling if not properly identified and logged; therefore this risk is significantly minimised through this knowledge;
- risk of hydraulic fracturing of weak zones; this risk is mitigated by the use of an additional support casing along the critical area, and drilling profile design;
- much weaker rock underlying a stronger caprock in the nearshore area having the potential of creating difficulty through all phases of the HDD operation; this risk is planned to be managed by applying suitable work methods and appropriate contingency procedures; and
- high clay content of the formations and its impact on drilling fluid and downhole tools behaviour; this risk is planned to be managed by applying suitable work methods and appropriate contingency procedures.

Seastate

The hostile seastate conditions of the Southern Ocean represented one of the key challenges for marine support operations required at the HDD exit point. This risk was initially managed by limiting the marine works scope as much as practically possible, and ultimately by the choice of marine contractor and vessel, and operational procedures.

Health and safety, and environment

A robust and effective HSE management plan for the site construction activities greatly assisted in performing the construction activities in a controlled manner, and has contributed significantly in enhancing the reputation of the trenchless industry in these applications.

It was a requirement for DrillTec to prepare detailed enviromental management and health and safety management plans. These were prepared in close co-operation with Woodside and the regulators.

The value and sensitivity of the site, surrounded by the pristine Port Campbell National Park, the Southern Ocean, sensitivity with regard to the community and heritage issues, imposed significant challenges to the construction team. However, the robust systems put in place and the positive attitudes displayed by all stakeholders proved fruitful in this regard.

CONSTRUCTION

Site survey activities started onsite toward the end of August. Upon agreement on the final sound boundaries with all stakeholders on the site, preparation activities started onsite on 27 September 2004.

Although the detailed design had been completed some months before work had started onsite, additional construction procedures were required for each activity before they could begin.

Site preparation

Site preparation comprised:
- some minor slashing of native vegetation to widen an existing access track;
- erection of fencing along the agreed site boundaries;
- placement of hardstand on geo-textile fabric over the total site area;
- establishment of temporary site facilities; and
- hook-up of associated services.

The hardstand material selected was a 0–200 mm grading Scoria. Testing of the source pit was required beforehand to ensure the material was free of weeds and diseases to protect the surrounding Port Campbell National Park. Scoria was selected due to its porous nature, which was preferred due to the possibility of heavy and consistent rainfall. Additionally, the material contained very few fines, which was beneficial in view of dust control and limited run...
off during periods of heavy rainfall. The robust design of the site has contributed significantly in the success of the drilling operations, allowing work to continue unhindered by the severe rainfall which occurred regularly.

To supply the drilling operations with the expected large quantities of fresh water required to prepare a reliable and environmentally friendly drilling fluid, a 15 million litre holding capacity water dam had been constructed beforehand, in a natural catchment area about 1.5 km from the shore crossing location. This dam was constructed in May–June 2004 and was completed just in time when winter rains in July–August filled it within a period of five weeks. The dam will have a permanent character in the western Victorian diary countryside providing both scenic views and functional services in the dry summer periods. As part of the site preparation phase, DrillTec constructed an 8-inch water pipeline between this dam and the shore crossing site.

Conductor casings

Conductor casings were required for each of the horizontal boreholes, a 24 m long and 20-inch in diameter conductor casing was installed at the entrance of the smaller hole which ultimately contained the 10-3/4-inch pipeline casing whilst a 210 m long and 48-inch in diameter conductor casing was installed for the larger hole, which ultimately contained the 29-inch pipeline casing.

The installation of the 20-inch conductor was a relatively straightforward operation. A small laser-guided boring machine was used to pre-bore a hole to a depth of 570 mm diameter. Once this had been completed, the boring head and drill rods were removed from the hole and the pre-fabricated conductor was welded in by a controlled sliding operation.

The installation of the 48-inch conductor was undertaken using the retractable micro-tunnelling technique, a first in Australia. This method involved the construction of a sheet-piled launch pit with back anchor followed by the launch of a tunnel boring machine (TBM) and the simultaneously jacking of casing pipe sections.

Standard steel sheet piles were installed in the stiff clay overburden which covered the first 8 m of the site. The thrust wall comprised of 11 No. 310 UC’s driven to a depth of 9.5 m installed to form a continuous wall i.e. thrust wall for microtunnelling operation. The design load for the thrust wall was 580 tonnes. The design was performed such that the thrust wall could also be used as the main anchor for the HDD operations.

Herrenknecht’s TBM AVN 800 specially adapted for retractability was used for this operation. Tunnelling commenced on 14 December 2004 and was completed on 30 December. Retraction of the TBM from the tunnel end was completed on 3 January 2005.

Drilling equipment

The drilling equipment was mobilised to site from Germany. Some modifications to the equipment were necessary including increasing the opening on the vices to handle the couplings on the 10-3/4-inch casing (11.72-inch OD) and noise mitigation modifications. Noise mitigation included additional mufflers on diesel engines, air intake/outlet silencers and acoustic screening around mud cleaning unit.

DrillTec also sent out one of its revolutionary ‘long’ version 300 tonne drill rigs constructed specifically for running 12 m long joints of casing.

Other key items of the drill spread included:
- Halliburton HT 400 mud pump;
- oil tools mud cleaning and mixing system;
- additional mud mixing tank complete with its own hopper;
- drill pipe storage rack complete with HIAB crane;
- workshop and stores containers;
- drill rig control cabin; and
- downhole tools.

Most of the specially designed tools were made in Europe and shipped over to Australia for use. The pilot system BHA was standard comprising 9-7/8-inch mill tooth drill bit, 6-1/4-inch mud motor and 6-1/2-inch non-magnetic drill collars. The drill string used for the entire project duration was 6-5/8-inch S-135 grade. The steering and tracking system used was ParaTrack 2.

Hole openers were purpose-built for the application and expected geotechnical conditions. The requirement for forward reaming meant that all hole openers needed to have sufficient front centralisation to reduce any possibility of reamers side tracking out of the hole. Buoyancy considerations were a part of the design to reduce the downhole weight of the tools. Therefore, the end result was a industry standard ‘split bit’ hole opener with a long front centraliser complete with buoyancy design.

Drilling operations

After the necessary rig-up operations the drilling spudded mid January 2005. The first hole, which would contain the 10-3/4-inch pipeline casing, was drilled and opened to 17-1/2-inch, however the 10-3/4-inch casing was not installed until later to eliminate magnetic interference of it on drilling the pilot hole for the second HDD which was spaced very close to the first hole.

Hole opening was performed in stages after completion of the pilot hole drilling; 17-1/2-inch, 26-inch, 34-inch and finally 39-inch. To limit the natural overbend of the gas pipeline immediately offshore of the HDD exit point a procedure was implemented comprising reaming of the boreholes so that a relatively steeper pilot hole punch-out could be lowered to the lowest practical angle with the seabed.

Casing pipe installation

Installing the 29-inch diameter x 1-inch wt casing pipe, (in total just under 400 tonnes of steel) by forward thrust, required detailed preparation work. Each 5.5-tonne pipe section had to be lifted onto the rig, positioned at the
17° incline of the entry point, and connected up to the previously installed joint. The installation loads were low due to the fact that the pipe was near neutrally buoyant in the drilling fluid. Similarly, the 10-3/4-inch casing pipe was installed by forward thrust with minimal installation loads.

**Marine works**

Upon completion of installation of the pipeline casings, bellmouths needed to be fixed at the offshore extremity of the casings. This was performed using air divers operating from a small diving support vessel.

**PIPELINE INSTALLATION**

Installation of the 20-inch gas pipeline and 4-inch service line inside the 29-inch and 10-3/4-inch casings is planned to be undertaken as part of the offshore pipeline installation contract by another contractor. Atteris is involved with the design and construction preparation of this operation.

**CONCLUSIONS**

Shore crossing projects such as these are unique on a global scale. Capturing the work performed in a paper is beneficial for future reference given that similar projects may eventuate. HDD is becoming the standard construction method for most pipeline shore crossings. In recent years Australia has seen several drilled shore crossings installed, some of which have experienced difficulties.

Consequently, although the offshore oil and gas industry regards HDD to be an elegant method to install pipelines across shorelines, the HDD industry (engineers as well as contractors) have to clearly demonstrate the ability to deliver a service which gives a much higher level of comfort to their clients.

Each shore crossing project has its own typical problem areas. Identifying them early and managing them in a professional manner is required.

Oil and gas operators have a healthy reputation of challenging the elements time and time again by exploring the more hostile parts of the world, consequently passing on the challenge to pipeline engineers to build the required infrastructure in such hostile environments. The Otway Gas Project is a typical example.
Eric Jas graduated as a Civil Engineer at Dordrecht’s University of Technology in The Netherlands in 1984. Upon graduation he joined Visser & Smit Hanab, one of Europe’s leading pipeline engineering and construction contractors specialising in landfalls, outfalls and trenchless technology, where he gained valuable design and construction experience in these particular fields. In 1996 he moved to Perth, Western Australia, working on several major pipeline engineering contracts. Since 1999 Eric has owned and operated Perth-based engineering company Atteris Pty Ltd, which provides engineering and construction management services to the pipeline industry. Recent and current major projects where Eric has had a leading role with design and/or construction management are Trunkline System Expansion Project (Woodside Energy), Tangguh Gas Project (BP), Otway Gas Project (Woodside Energy) and Gorgon Field Development (Chevron Texaco).

Aaron McPhee graduated from university in 1998 with a Bachelor of Applied Science (construction management and economics). After a year’s post graduate work experience he completed his Post Graduate Diploma in petroleum engineering. His next assignment took him to central Australia (Moomba) where he worked as a project engineer for a pipeline contractor whom had the annual contract to construct gas flowlines from newly completed wells to larger distribution trunklines. Following this, in 2001, he moved to another pipeline contractor where he first had experience with horizontal directional drilling (HDD). He worked on numerous river crossing projects in Australia and Hong Kong before joining DrillTec GUT GmbH in late 2001. His first projects with DrillTec were the Duke Energy TNGP and Bream A Project (both shore approaches), where he was the project manager. He is the project manager for DrillTec on the Otway Gas Project—HDD shore crossing. Member: APIA.