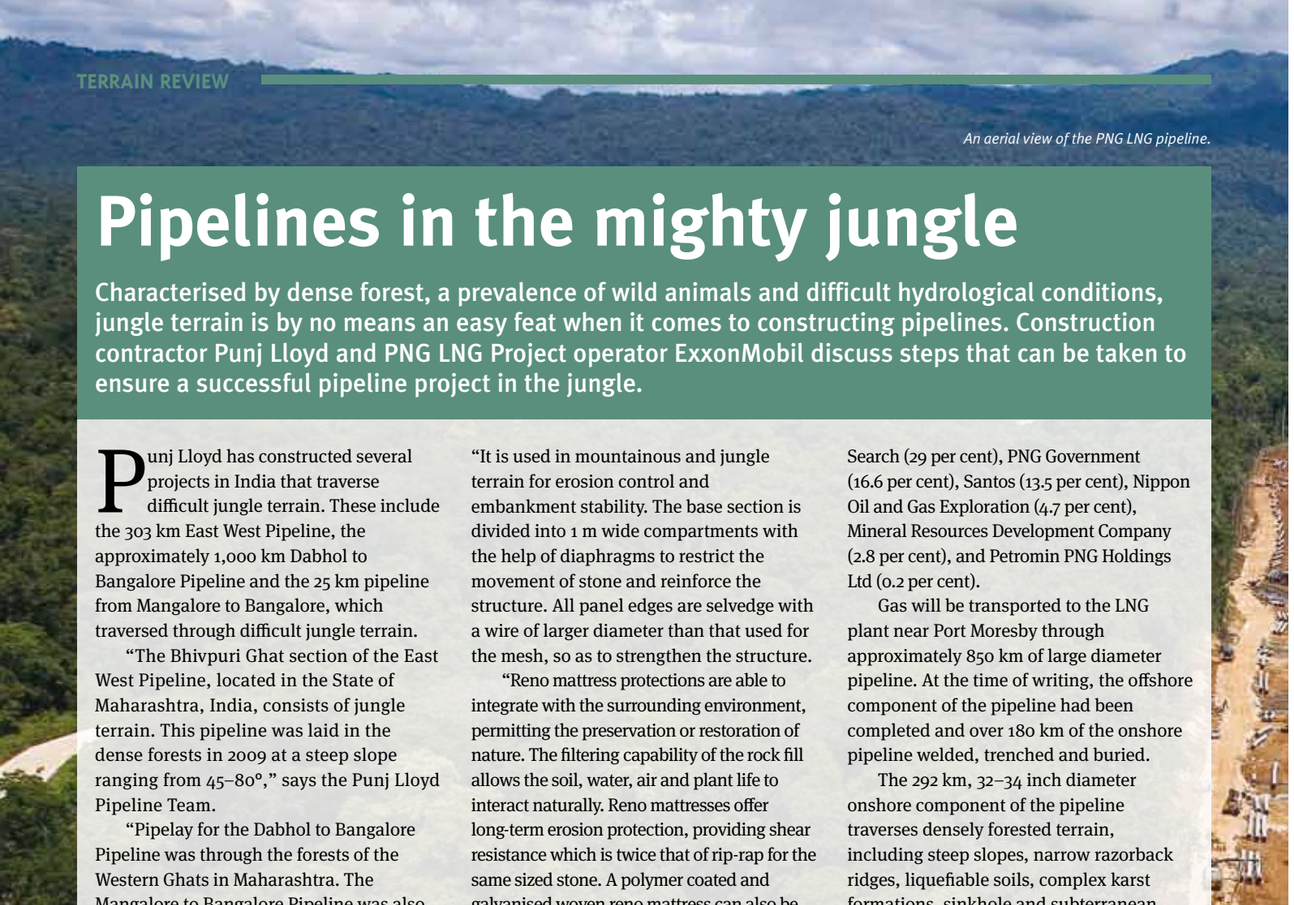

An aerial view of the PNG LNG pipeline.

Pipelines in the mighty jungle

Characterised by dense forest, a prevalence of wild animals and difficult hydrological conditions, jungle terrain is by no means an easy feat when it comes to constructing pipelines. Construction contractor Punj Lloyd and PNG LNG Project operator ExxonMobil discuss steps that can be taken to ensure a successful pipeline project in the jungle.

Punj Lloyd has constructed several projects in India that traverse difficult jungle terrain. These include the 303 km East West Pipeline, the approximately 1,000 km Dabhol to Bangalore Pipeline and the 25 km pipeline from Mangalore to Bangalore, which traversed through difficult jungle terrain.

"The Bhivpuri Ghat section of the East West Pipeline, located in the State of Maharashtra, India, consists of jungle terrain. This pipeline was laid in the dense forests in 2009 at a steep slope ranging from 45–80°," says the Punj Lloyd Pipeline Team.

"Pipelay for the Dabhol to Bangalore Pipeline was through the forests of the Western Ghats in Maharashtra. The Mangalore to Bangalore Pipeline was also laid in the dense forests of Karnataka, which contained vulnerable species."

In its experience with jungle terrain, the Punj Lloyd Pipeline Team faces a great challenge in preserving as many trees as possible, which can result in a severely restricted right-of-way (RoW) and a difficult construction spread. Other challenges include climatic challenges, such as heavy rains, the presence of wild animals in forested areas, and the general protection of rare flora and fauna.

"Another issue associated with jungle terrain is steep slopes, which can be tackled through use of specialised equipment," says the team.

"Only experienced and trained staff get selected to construct pipelines in jungle terrain," says the Punj Lloyd Pipeline Team. "Specialised operators and manpower have to be deployed on steep slopes, and special protection techniques are required to avoid any damage to the environment in these areas."

One of these special techniques includes use of an erosion control blanket, which is known as a reno mattress.

"The reno mattress is a special type of gabion with a large plan area to thickness ratio with double twist-woven mesh," explains the Punj Lloyd Pipeline Team.

"It is used in mountainous and jungle terrain for erosion control and embankment stability. The base section is divided into 1 m wide compartments with the help of diaphragms to restrict the movement of stone and reinforce the structure. All panel edges are selvedge with a wire of larger diameter than that used for the mesh, so as to strengthen the structure.

"Reno mattress protections are able to integrate with the surrounding environment, permitting the preservation or restoration of nature. The filtering capability of the rock fill allows the soil, water, air and plant life to interact naturally. Reno mattresses offer long-term erosion protection, providing shear resistance which is twice that of rip-rap for the same sized stone. A polymer coated and galvanised woven reno mattress can also be used in aggressive environments."

Another innovation that has been developed to tackle the challenge of steep slopes is the cable crane system.

"When pipelaying in jungle terrain, where obstacles come one after the other, the RoW is often blocked. The cable crane system is used for further movement of heavy equipment and material including pipes, to achieve direct routes traversing through the difficult terrains. Since it is an environmentally friendly system it does not harm the surroundings in which it operates.

"Punj Lloyd used the cable crane system for the first time in India on the Bhivpuri Ghat section of the East West Gas Pipeline for transporting equipment, and laying pipe in steep slopes ranging from 45–80°," the team said.

Case study: the PNG LNG Project

The PNG LNG Project, which is currently under construction in Papua New Guinea (PNG), involves a two-train, 6.6 MMt/a LNG processing facility, envisaging the integrated development of the Hides, Angore and Juha gas fields, as well as associated gas from the Kutubu, Agogo, Gobe and Moran oil fields.

Joint venture participants include Esso Highlands as operator (33.2 per cent), Oil Search (29 per cent), PNG Government (16.6 per cent), Santos (13.5 per cent), Nippon Oil and Gas Exploration (4.7 per cent), Mineral Resources Development Company (2.8 per cent), and Petromin PNG Holdings Ltd (0.2 per cent).

Gas will be transported to the LNG plant near Port Moresby through approximately 850 km of large diameter pipeline. At the time of writing, the offshore component of the pipeline had been completed and over 180 km of the onshore pipeline welded, trenched and buried.

The 292 km, 32–34 inch diameter onshore component of the pipeline traverses densely forested terrain, including steep slopes, narrow razorback ridges, liquefiable soils, complex karst formations, sinkhole and subterranean streams, wetlands and swamps. Additionally, difficult hydrological conditions including heavy rainfall and localised flooding, as well as the presence of geohazards such as seismic faults, pose challenges to pipeline construction.

"The PNG LNG onshore pipeline crosses seismic faults that have the potential of displacing several metres during the lifetime of the project," says Esso Highlands Ltd Onshore Pipeline Manager Suresh Batra.

"To overcome this challenge, we conducted a significant research and testing programme that looked at both the demand side of the equation (how the PNG soils apply load to the pipe during fault movement) as well as the capacity side (how the pipeline material reacts to the soil load). On the demand side, we conducted pipe-soil interaction tests to measure how much pressure various types of soil apply to the pipe as the soil moves around it during fault movement.

"On the capacity side, we first teamed with highly qualified line pipe mills to fabricate the pipe to the unique specifications. Then, full-scale strain tests – under operating conditions – were conducted on samples of the pipe to verify the strain capacity of the pipeline during a seismic event. Furthermore, we worked with the pipeline installation contractor to ensure that the tight construction specifications were transferred from the lab to the work site in PNG.

"Developing monitoring and mitigation plans for the long-term operation of the project was key to overcoming the construction challenges in PNG," adds Mr Batra.

Constructions challenges were overcome through:

- Establishing strict route selection criteria;
- Engineering processes – pipeline surveys (aerial and ground), mapping tools and field work;
- Evaluating geohazards and implementing appropriate risk mitigation measures; and,
- People – leveraging ExxonMobil's experience, industry experts and multiple organisations and disciplines.

The pipeline routeing was the single and largest environmental impact of the project. The physical, construction, as well as environmental and social factors also had to be considered in routing and construction of the pipeline.

Welded pipe for the PNG LNG Pipeline ready to be lowered in.

The pipeline route was optimally chosen in areas of reduced ecological value or risk such as brownfield sites (cleared areas), previously logged forest, secondary regrowth forests adjacent to existing infrastructure, minimised waterway crossings and terrain with stable soils.

ExxonMobil says it is actively managing these challenges and remains on track to deliver first gas in 2014.

Anchoring a reno mattress along the RoW, with a cable crane in the background.