



Hydroconsult



AWARD OF MERIT

Category: International

## GasAtacama Pipeline, Argentina

Calgary consulting engineers helped design and monitor a gas pipeline that travels along the treacherous river beds of the Andes mountain range in South America.

HYDROCONSULT

The 940-kilometre long GasAtacama pipeline from northern Argentina to the Pacific coast of Chile supplies fuel for power plants in northern Chile. It starts 100 metres above sea level in the humid tropical fruit and tobacco farming regions of northern Argentina where temperatures can be in excess of 40 C. The 24" diameter pipeline then climbs through steep and narrow river valleys up to the Andes mountains, where it reaches a record 5,032 metres elevation. It runs through the oxygen-starved regions of the Puna and Atacama desert, and finally drops down to the Chilean coast.



Excavating a ditch for the pipeline in Rio Purmamarca. The riverbed was restored and steps were taken to protect the small irrigation systems of local farmers.

The selected route for the pipeline follows the Rio Grande, Rio Purmamarca and Rio Sepultura river systems. The in-stream route minimizes the project's impact on limited flat land along river valleys that is intensively cultivated by poor farmers, and it avoids the city of San Salvador de Jujuy on the Rio Grande. However, the route posed challenges to the designers because it involves steep, meandering, mobile high bedload streams that are subject to flash floods.

The project manager, Fluor Daniel Williams Brothers

of Tulsa, Oklahoma, asked Hydroconsult of Calgary to provide specialist input for the design and construction of the river crossings and instream alignments for the difficult section that runs along the Rio Grande and Purmamarca river sections in the Andes. Staff from the two companies had worked together previously on reconstructing part of the Trans Alaska oil pipeline in 1991 in a similar instream alignment project.

Hydroconsult's scope of work was to review the instream and river crossing alignments, and then provide detailed design recommendations. In

total, the company fast-tracked the design for 20 major river crossings and 65 kilometres of instream alignment, with detailed contract drawings prepared by Fluor Daniel Williams Brothers. Hydroconsult also provided daily inspections and field engineering during construction from 1998 to 1999. Since then, Hydroconsult has continued to provide consulting services in monitoring the line. The company also specified and installed satellite-operated flow monitoring stations to provide real time information on the river to GasAtacama and the provincial water resources authority.

For the first 150 kilometres of its alignment, the gas pipeline roughly parallels existing and older pipelines. Many river training structures and exposed pipelines showed that numerous rivers crossed by the existing line were subject to bank erosion and scour. Consequently, Hydroconsult recommended directionally drilled crossings at the largest crossings, which, at little extra cost, allowed the line to be buried at significant depth and setback into the banks well in excess of any potential scour and river movement. The method was justified during the following flood season when bank erosion at the older lines led to them having to be replaced.

The design challenge in the Rio Grande instream section was to determine the behaviour of this variable and often violently flowing channel. In its steeper reaches, boulders up to one metre in size are transported — the ground literally shakes as the massive sediment load scours, fills and scours channels in rapid succession. An irrigation dam upstream of the City of Jujuy at various times stores and releases sediment, resulting in degradation and aggradation downstream. North of Jujuy a massive alluvial fan blocks the main highway to Bolivia and Chile several times during each flood season, and in 1947 blocked the Rio Grande to a depth of 20 metres.

Working with local geologists and river engineers, and garnering knowledge from long-term residents, Hydroconsult developed a "belt and suspender" type approach for the instream alignments and the crossings of the alluvial fans. For 23 kilometres the design consisted of burying the pipeline at 2-3 metres depth, and building a gabion — a 9-metre wide rock-filled wire enclosed mat to overlay the pipeline. In addition to providing added scour protection to the line, the mat enhances public safety around the line and helps to protect it from local gravel miners who often work uncontrolled along the rivers.

The local subsistence farmers were concerned about the impact of the project on their irrigation system, which is a series of intricate small channels that criss-cross the Rio. In conjunction with the environmental firm, local hydrogeologists, and with input from the local residents, Hydroconsult developed pumping systems and ditch plugs to maintain the irrigation flows at critical points.

To date the river crossings and the instream river sections are behaving as designed. During construction the instream design was viewed with extensive criticism by both the regulators and the public as numerous engineered structures on the Rio Grande have failed. Constructing the gabions involved 1,000 person months of employment in a relatively high unemployment area of Argentina, and Hydroconsult's role and performance on this project has resulted in the firm receiving consulting assignments in South America and elsewhere in the world.

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Top: the pipeline passes through narrow and steep rights-of-way through the mountains. Above: local labourers help place a 57-metre, one-metre thick gabion mat over the pipeline as protection.



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**Project name:** GasAtacama Pipeline, Argentina

**Owner:** GasAtacama

**Award-winning firm:** Hydroconsult, Calgary.

**Project team leaders:** Wim Veldman, P.Eng.,

Monica Caine, P.Eng.

**Design and construction management:** Fluor Daniel Williams Brothers, Tulsa, Oklahoma

**Other key players:** Vector Argentina (environmental), Contreras Ue (contractor)