

case study

People's Republic of China Shenhua Group

Shenhua Group is helping preserve precious water resources by pioneering underground reservoirs in Western China.

In China, mining coal and protecting water resources are inextricably linked.

There isn't enough fresh water in China to go around. The country's water resource per capita is 2200 cubic metres – a quarter of the global average – and the parts of China with the richest coal fields are arid even by this standard.

In 2013, 71 percent of the coal produced in China came from Western China, an area comprising Shanxi, Shaanxi, Inner Mongolia, Gansu and Ningxia. This area's per capita water resource is just 927 cubic metres.

Shenhua Group, China's largest producer of coal, owes 80 percent of its production to Western China. In 1995, when it began building fully mechanised modern mines in the area, the company realised its activities could make the water shortage worse.

For every tonne of coal they produce, Chinese mines accumulate two tonnes of water, which seeps in through the fissures formed during mining. This mine water is traditionally pumped to the surface to keep the miners safe. But Western China's capacity for surface water evaporation is six

times higher than its rainfall. Mine water discharged the usual way would evaporate and be lost, exacerbating the drought.

Shenhua's Research and Development (R&D) team, headed by Dr Gu Dazhao, began working on possible solutions.

At first, the team approached the problem from two directions:

1. Limit the amount of mine water generated. Backfilling and limiting the mining height are known ways of achieving this, but they drastically reduce the mine's efficiency.
2. Store and utilise mine water.

Previous experiments with above-ground mine water storage facilities had shown them to be a poor use of both money and land. But what about below ground? The team began investigating the possibility of storing water in the goaf: the underground space left by the extraction of coal.

“Water is a precious resource especially in arid regions. Shenhua has implemented an innovative solution to water scarcity at its coal mines by storing billions of litres of water in underground facilities. Water that would otherwise be lost to evaporation is instead available for local industry and agriculture. This is an excellent example of sustainable development in practice in the coal industry.”

Harry Kenyon-Slaney, Chairman, World Coal Association, Chief Executive, Rio Tinto Energy



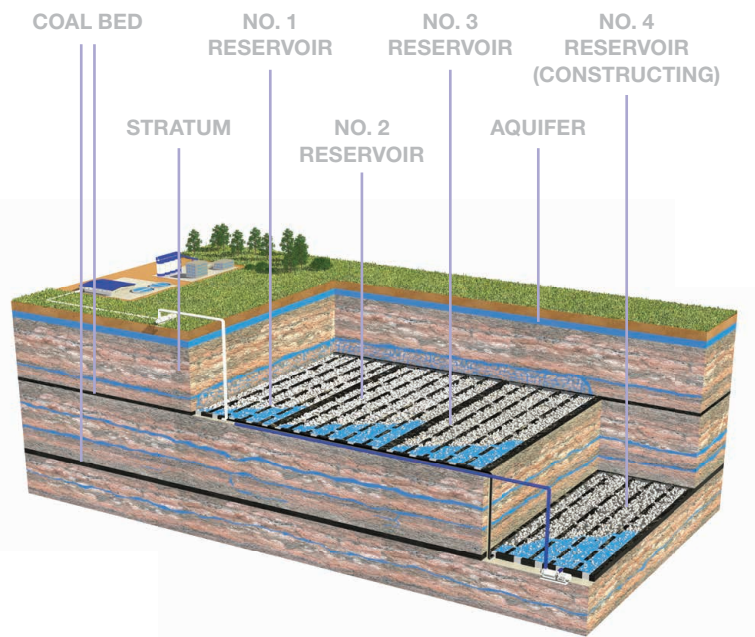
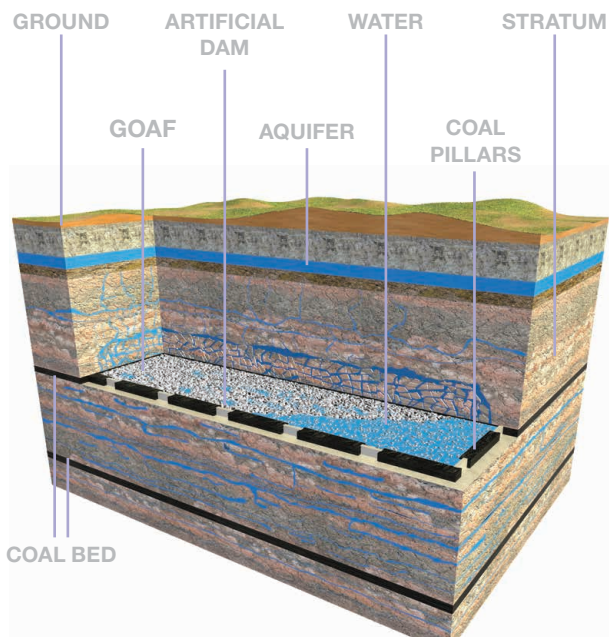
Overview of the Shendong coal mine area

To determine the feasibility of the idea, the team used 3D models, simulations and long-term observation programmes at working mines. They wanted to assess the migration patterns of groundwater, the engineering and construction challenges involved, the potential capacity of an underground reservoir and how one might operate – particularly in terms of mine safety.

They successfully developed equations to predict the rate at which mine water accumulates, rules for selecting appropriate reservoir sites and models for calculating the capacity of a selected site. They proposed a design based on connecting and reinforcing the natural coal pillar dams in the goaf with artificial dams, whose required dimensions and strength they also calculated. And they drew up a triple-layered safety mechanism to keep mine hazards to a minimum during both the construction and operation of the reservoir.

The research showed the advantages of underground mine water reservoirs more than made up for the challenges. Not only

Coal mine distributed underground reservoir



would they prevent water being lost through evaporation, they could act as a municipal water source: by connecting the reservoirs to the surface, Shenhua could improve local utilities' access to much-needed water.

Mine water is usually polluted. When allowed to evaporate from the surface, it can leave pollutants behind in the ground. But mine water stored in underground reservoirs

is naturally filtered and purified as it seeps through the gangues, the bed of non-valuable material left behind in the goaf after the coal is extracted.

This process can reduce the water's turbidity (which indicates pollution by solid impurities) by as much as 95 percent; its chemical oxygen demand (which indicates pollution by organic impurities) by as much as 86 percent; and its hardness by as much as 40 percent – all before any active human intervention.

By further treating the naturally filtered water, Shenhua Group could make it pure enough for industrial, agricultural and even domestic use.

Shenhua Group put its research into practice in 1998, establishing the world's first goaf water storage facility, which could hold 50,000 cubic metres of water. The first true coal mine underground reservoir, established in 2006, occupied four square kilometres and could hold 600,000 cubic metres of water.

In 2010, the world's first distributed underground reservoir was built in Daliuta Coal Mine in the Shendong mining area. Daliuta's four interconnected reservoirs can hold 7.1 million cubic metres of water. Before these were introduced, Daliuta was accumulating 450 cubic metres of mine water an hour and could only recycle 180

cubic metres an hour; the rest went to waste. Now, the amount of water Daliuta discharges is near zero.

Daliuta was followed by Bulianta, Shangwan, Wulanmulun and other mines in the Shendong mining area. Shenhua Group now operates 32 underground reservoirs there, with a total capacity of 32 million cubic metres. Between 2011 and 2013, these reservoirs saved 85 million cubic metres of water.

Far from making local water shortages worse as they first feared, Shenhua Group's mine water reservoirs now supply the Shendong mining area's power plants, industrial sites and homes with 95 percent of the water they need.

The company is now applying its underground reservoir technology in other mining areas, including Baotou and Xinjie – and considers it well worth commercialising to help coal miners in other arid areas of the world.



Introducing the coal mine underground reservoir technology to visitors

Find out more

To read more about Shenhua visit www.shenhua.cc

To find out more about the World Coal Association and our work, visit www.worldcoal.org or email info@worldcoal.org