



Wanjiashai Yellow River Diversion Project

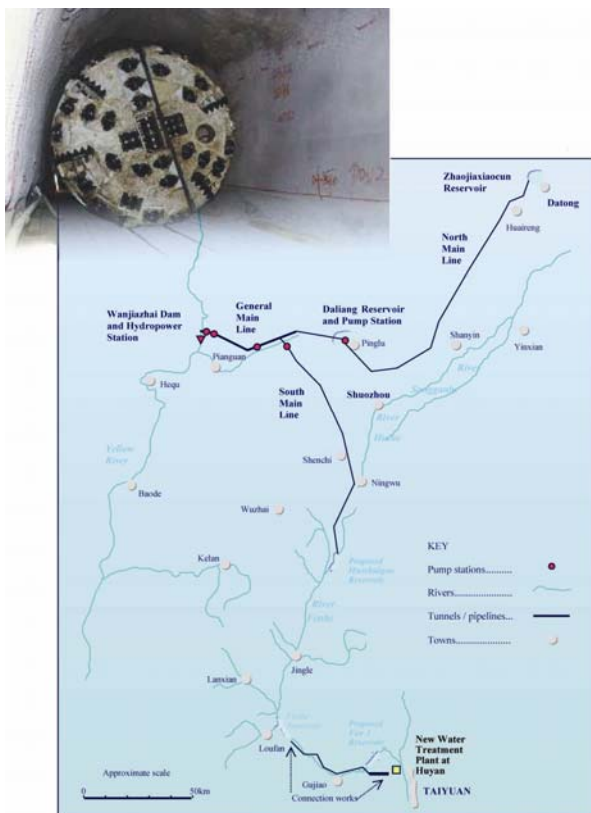
Pump Optimization

The Shanxi Wanjiashai Yellow River Diversion Project is an all-encompassing project to alleviate the water shortages in three of China's industrial areas - Taiyuan, Pingsuo and Datong. The country's rapid economic growth is fuelling water demand beyond the capacity of the existing infrastructure. The contracts were awarded in 2001. In November 2001 the first major step was inaugurated when water from the Yellow River ran to the Fenhe reservoir.



By the end of 2002, it should have been extended eastward 100km to the Taiyuan. The cost of the entire enterprise is estimated at \$1.5 billion, \$400 million of which will come from the World Bank.

7-Technologies performed the pump optimization project resulting in reduced electricity usage.



Major Waterways

The project is located in the north west region of Shanxi Province. The diversion project has three major waterways, the General Main, South Main and North Main. The General Main waterway is 44km in length. It is designed to take 48m³/s of water from the Wanjiashai reservoir to a diversion sluice located at Xiatuzhai village. The reservoir was created by the Yellow River Commission by the building of the Xiaolangdi dam. This was one of the largest World Bank-funded projects at \$1.6 billion. To speed the water on its way, there are three pumping stations on the General Main.

The South Main travels from the diversion sluice at Xiatuzhai for approximately 100km southward. It is intended to supply 640m³ x 106 of water per annum at a rate of 20.5m³/s.

The North Main travels from the diversion sluice at Xiatuzhai for approximately 167km in a northward direction. It has a flow rate of 22.2m³/s.

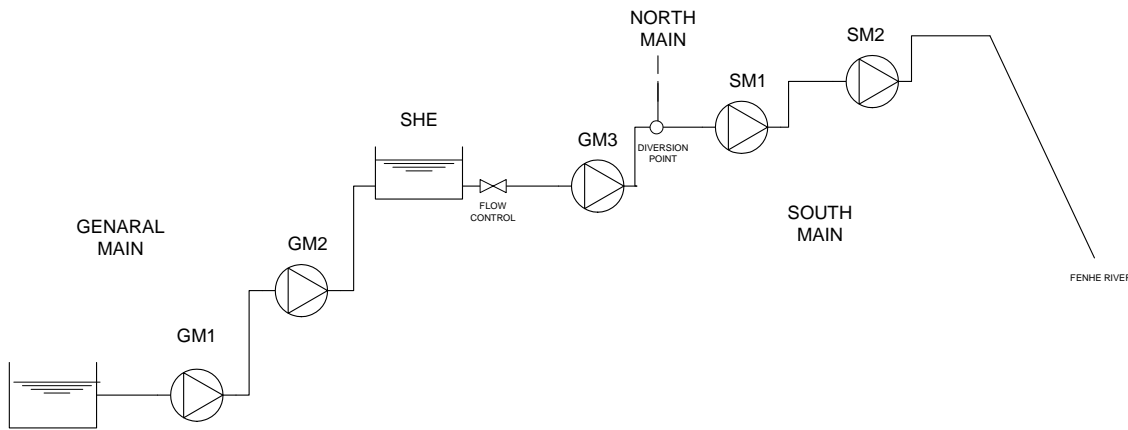
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System Description

The parts of the Wanjiashai Yellow River Diversion Project relevant for the pump optimization scheme are described in the following.

There are two relevant sections of the Wanjiashai Yellow River Diversion Project in relation to pump optimization. The General Main (GM) is designed to take water from the upstream reservoir to a bifurcation point. The length is 44 km and includes 3 pump stations GM1, GM2 and GM3 and the Shentongzui Reservoir (SHE). The outlet from SHE is controlled by flow. The capacity of the GM is 4 m³/s. The South Main (SM) runs from the bifurcation point to the Fenhe River, a distance of 102 km. It has two pump stations (SM1 and SM2) and a capacity of 2.2 m³/s. The Wanjiashai Yellow River Diversion Project has a North Main (NM) as well. The NM flow is in the current scheme a prescribed outtake at the bifurcation point.

Principal sketch of relevant parts of the Wanjiashai Yellow River Diversion Project:



The pump stations from the upstream end to SHE are equipped with fixed speed pumps and SHE absorbs deviations from the (specified) outlet flow. The pump stations from SHE and downstream are equipped with both fixed speed pumps and variable speed pumps. The hydraulic storage capacities are very limited on this distance.

PUMP STATION EQUIPMENT		
Max. Fixed Speed Pumps Available	Max. Variable Speed Pumps Available	Pumps on standby
10	0	2
10	0	2
6	4	2
4	2	2
4	2	2

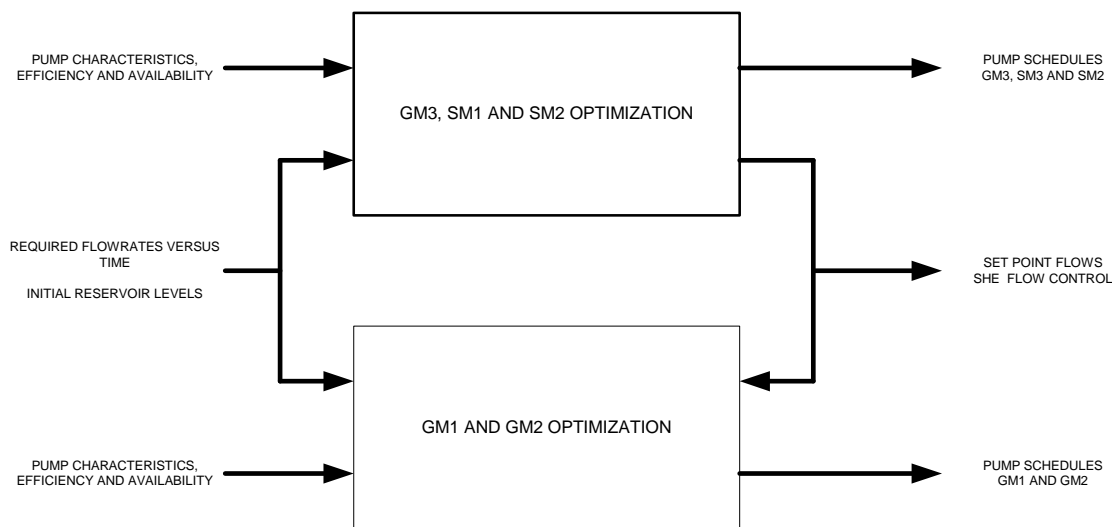
Overview

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The optimization will minimize the power consumption given a specified sequence of required flow rates over time.

The SHE reservoir makes it feasible to divide the pump optimization in two. First the GM3, SM1 and SM2 pumps are optimized then GM1 and GM2. The first optimization will also produce the set points for the SHE flow control, which are inputs to the second optimization.

The optimization principles are summarized below:



Optimization overview

Output of the optimization is the pump schedule for the individual pumps at all pump stations and the set points for the SHE outlet flow control.

