

# Water Supply Secured for Major Oil and Gas Asset in Indian Desert

Groundwater resource developed as supply for 25-year water flood operation

## CHALLENGE

Locate and characterize a major water supply source in a desert environment and assess the feasibility of use without affecting community water supplies. Identify a cost-effective well-field layout and obtain regulatory approval for development.

## SOLUTION

Combine rigorous drilling and aquifer testing field programs with numerical modeling techniques to provide robust and defensible assessment of the development potential of deep, saline, and shallow fresh groundwater resources.

## RESULTS

Identified extensive and high-yielding saline aquifer capable of supporting long-term reservoir injection demands without affecting existing water users. Developed regulation-approved well-field design. Secured development future for major oil and gas asset.



## Sustainable, high-yield water supply required in desert environment

Since 2004, select oil fields in India have been established as a significant asset to the country, with gross hydrocarbons initially in place proved at 4.6 billion bbl of oil. The gross ultimate oil recovery measured more than 1 billion bbl in the first 10 years. Located in a desert, though, these fields see very little rainfall and possess no appreciable surface water resources. The only source of water for the region's large, primarily agricultural, population is a shallow freshwater aquifer above the deep, saline sandstone.

The client sought to locate and characterize a large-scale (25,000-m<sup>3</sup>/day) reservoir injection water supply source to support development of oilfield operations over a period of at least 25 years. A key objective was that abstraction should comprise saline water and must not impact existing water users, including public water supply well fields operated by the Public Health Engineering Department.

Licensing of the injection water supply source—and therefore development of the oil field itself—was critically dependent on obtaining acceptance from national and state regulators. Oil field operations had to be undertaken in a sustainable way without derogating existing domestic and public water supply sources.



*Test pumping site.*

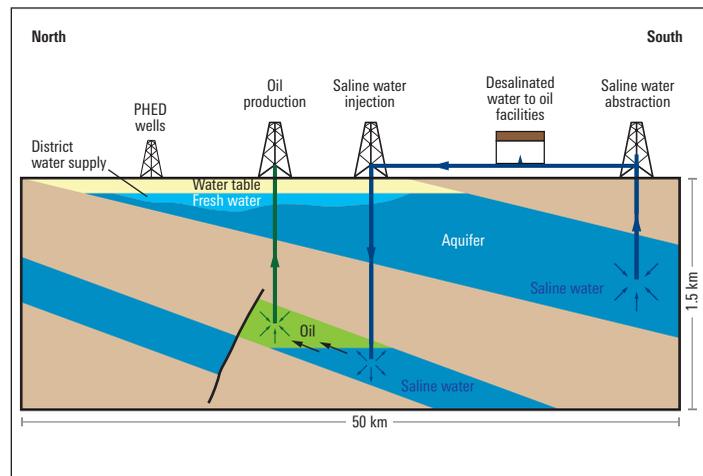
### Robust, defensible groundwater study conducted

Engagement with both government and nongovernment stakeholders was crucial to this work and the workflows were designed to facilitate collaboration between the client's technical specialists and decision makers within key regulatory organisations.

To locate and evaluate sources of water for oil field development, Schlumberger Water Services performed a comprehensive groundwater resources investigation. This highly technical groundwater study included

- collection, analysis, and reprocessing of large volumes of data from exploratory oilfield drilling
- development of baseline geological/hydrogeological databases and geographic information system (GIS) interfaces
- drilling and hydraulic testing of deep (400- to 500-m) aquifers within the oil fields.

Schlumberger used industry-standard codes to model the complex groundwater system and solute transport in detail. Many water supply options were considered and assessed, such as deep groundwater close to oil fields, surface canals, and seawater. Schlumberger water experts evaluated potential changes to the shallow freshwater lens in response to abstraction of saline water from depth and produced 3D visualizations to aid collaborative decision making by the client.



*Schematic cross section showing main elements of proposed aquifer abstraction and water injection.*

In parallel to the technical study, Schlumberger determined the risks to public water supplies associated with possible interaction between shallow and deep aquifers and developed a corporate social responsibility (CSR) study. The study necessitated thorough hydrocensus surveys to understand existing use of water for domestic and agricultural use. Together with the client advisors, Schlumberger hosted multiple workshops to keep interested parties abreast of progress and to foster stakeholder/developer relationships.

### Groundwater supply identified for world-class oil and gas asset

The technical study completed by Schlumberger revealed that for strategic, economic, and environmental reasons, the deep aquifer is the only source of water able to meet the demand required for pressure maintenance over the planned 25 years of reservoir development and operation.

Although the aquifer had already been the region's sole water source, testing demonstrated that much higher yields could be achieved than originally anticipated. The operational well field could be reduced from the 24 tube wells originally estimated to only three to five wells (including duty and standby wells), and wells could be spaced closer together. Fewer well locations would be required, less land would have to be acquired, pipeline layout would be simpler, and long-term operation of the production well field would be easier. Early estimates put capitalized running costs of using this deep groundwater resource at between 2 and 10 times less than other (less viable) sources.

Furthermore, field investigations and numerical modeling enabled regulatory approval for the aquifer exploitation because negligible interference was shown between shallow and deep groundwater sources.

The client also demonstrated its commitment to the long-term environmental sustainability of its projects with the CSR study, which proved that abstraction of large volumes of water from a deep, saline aquifer and subsequent injection of this water into a much deeper oil reservoir would not compromise the availability of the already scarce freshwater supplies on which local communities in the desert depend. The CSR work went even further in characterizing the existing status of fresh groundwater resources and providing high-level advice on management and conservation of the sensitive water resources.

The client could not continue its development of the full potential of its oil fields without a groundwater investigation — and Schlumberger delivered the crucial work to identify and acquire permissions for the necessary water supply. Now in production, the fields are considered a world-class oil and gas asset.

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