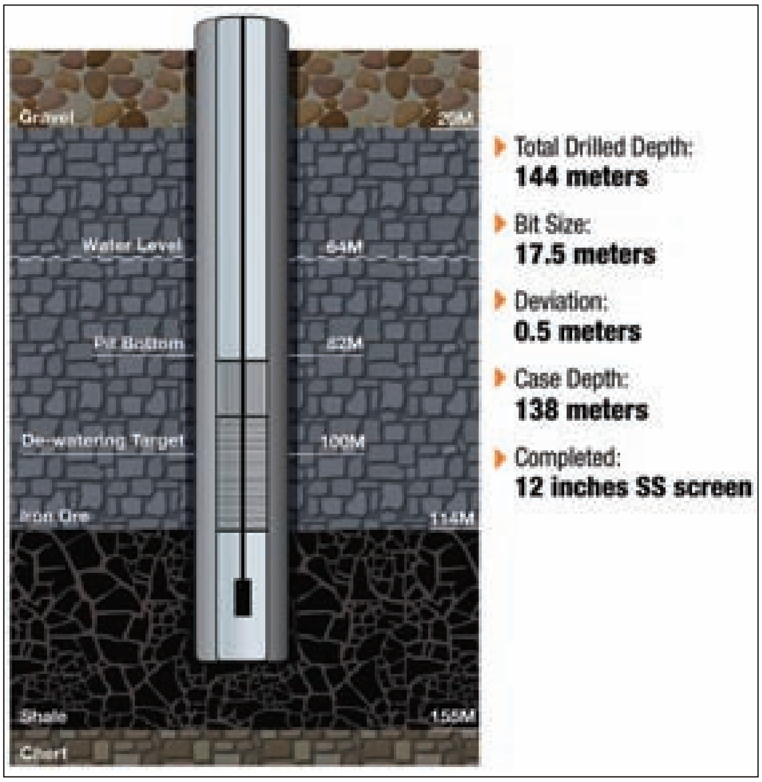
On the double

Boart Longyear offers an update and results of its dual-tube flooded reverse-circulation method used at mine sites in Western Australia for water-well development

Diagram of ex-pit dewatering bore



The Boart Longyear water-services division currently has multiyear contracts with the largest iron-ore mining operations in the Pilbara region of northern Western Australia to undertake water-well drilling at active and future mine sites.

The Boart Longyear dual-tube flooded reverse-circulation (DTFR) water-well drill rigs can accommodate casing diameters of up to 28in (71.1cm), can attain deep drill targets via a powerful 130,000lb (59,000kg) pullback and are mounted on a highly mobile platform.

The rigs use a closed-circulation mud system through specially designed mud tanks. By installing dewatering wells via DTFR, it is possible to control high-producing aquifers during drilling that are problematic for conventional mud or air drilling.

> **"For the development of one ex-pit dewatering well, the DTFR reached a depth of 144m with less than 1% of deviation during drilling"**

The DTFR method is distinguished from other drilling methods by the way the drill cuttings are returned to the surface through the drill string, whereas with conventional mud or air operations the cuttings are returned up the annulus. The advantages of the DTFR method of circulation are threefold:

- Cuttings are rapidly returned to the surface and do not comingle with the annulus. This reduces contamination and annular washouts or hole enlargement. Samples return via the drill string, meaning that mud loss will not stop drilling operations as long as the drill bit remains submerged. Therefore circulation is almost never lost, and drilling mud can be replaced during drilling without the need to stop.
- The mud system is a closed loop. Utilising a proprietary mud system and drill cutting exchange, DTFR reduces the drilling footprint compared with conventional mud drilling operations. Formation water is not an issue during drilling, with almost zero discharge during drilling operations – making water management a non-issue.
- DTFR mud circulates in the annulus under ambient pressure conditions, reducing development time. During development, the residual mud is easily removed from the annulus wall. In addition to faster and more complete mud removal, the reduction in development time reduces the amount of discharge water that needs to be managed at the surface.

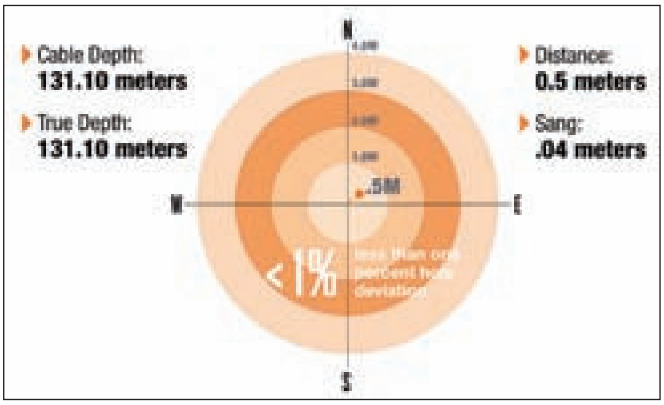
THE CHALLENGE

Reduce drilling and completion times, handle challenging ground conditions, reduce development time, manage discharge water in active mines and complete wells to target depths: this is the challenge.

The Boart Longyear DTFR drilling method has been used to work in mine sites in the Pilbara region – where there is a high volume of water discharged during drilling – without hindering active mining operations.

Historically, conventional air drilling or dual rotary drilling was used to set large-diameter water supply, dewatering and injection wells. While these methods have the potential to drill quickly, maintaining circulation and hole integrity can be a challenge in fractured and friable ground conditions. As a result of circulation loss or collapsing, boreholes are often completed at shallower depths.

Drilling a large-diameter hole



Deviation survey for dewatering well

with either conventional air or dual-rotary air can also produce a tremendous amount of discharge water. This is an issue because many drill locations cannot release water to the environment due to water-quality issues. So the water is contained in giant sumps dug parallel to the drill rig.

Often these pits fill quickly during drilling, and operations must be stopped to allow for draining. With DTFR the need for large sumps is eliminated because water is not discharged during drilling. This is a tremendous advantage working in-pit where water-management issues can interrupt mining operations.

"Before the use of the DTFR in the Pilbara region, there was speculation that a tri-cone drill bit would not be able to handle the hard rocks associated with iron-ore deposits"

THE SOLUTION

A unique situation requires a unique drilling method. Over the period of a year, Boart Longyear drilled 2,300m for a large mine operator in the Pilbara region with hole diameters of 17.5 and 20in. The completed wells reached depths of 250m and were cased with 10 to 12in production strings.

Specifications

Service: Drilling of in-pit and ex-pit dewatering and water supply wells
Location: Pilbara region of Western Australia
Application: Dual-tube flooded reverse (DTFR) circulation

- Less than 1% hole deviation
- Single drill pass to reach target depth
- In 2013, 2,300 total metres were drilled in the Pilbara region
- Completed wells to depths of 250m and cased with 10in to 12in production strings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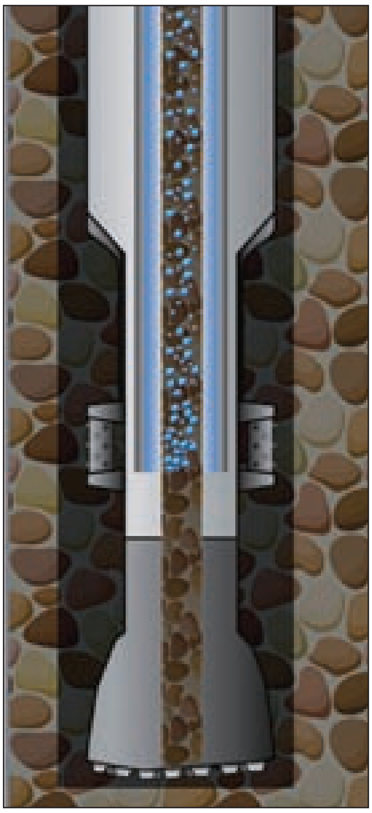
For the development of one ex-pit dewatering well in particular, the DTFR reached a depth of 144m with less than 1% of deviation during drilling.

Geology encountered included banded iron, thick sequences of friable mineralised ore, and shale inter-bedded with hard chert bands. These changing ground conditions were easily handled by the DTFR and drilling did not stop at any point due to loss of circulation.

Before the use of the DTFR in the Pilbara region, there was speculation that a tri-cone drill bit, which is typically used on all types of mud drilling, would not be able to handle the hard rocks associated with iron-ore deposits.

These concerns were alleviated with DTFR, which helped persuade other large iron-ore producers to sign multiyear contracts with Boart Longyear.



Flooded-reverse drilling in action. The method offers the following advantages: large potential diameter; single pass; designed mud programme; hole stability; and aquifer integrity

A driller welding casing on the Seattle project

Special challenges of urban drilling

Lack of subsurface information, limited working footprint, numerous underground utilities and soil contamination all present challenges to drilling in a modern American city

GeoDrilling International's September 2014 issue featured a number of articles concerning rough-terrain drilling. Often drilling in an urban environment is not much easier. Indeed, urban environments present their own set of unique challenges.

Robinson Noble, a hydrogeologic consulting firm based in Tacoma, Washington, was asked to develop a 1,000L-per-minute or greater groundwater source for a Seattle-based industry to replace water purchased from the city of Seattle. The site is situated in the heart of the city's downtown district within a stone's throw of the sea wall protecting the shore of Elliott Bay.

In addition to its proximity to the salt water, the site is in an area with significant construction activity, adjacent to an elevated highway and busy streets, where little to no prior information on groundwater resources was available.

SURFACE AND SUBSURFACE

The initial challenge to the project was determining whether the project was feasible and developing a scope for the drilling. The underlying problem is that little deep subsurface information, especially as it relates to potable groundwater, has been generated in downtown Seattle.

Seattle's municipal water system was founded in 1889, some 37 years after the city was founded. Shortly thereafter, the city built a pipeline to bring surface water from the Cedar River in the nearby Cascade Mountains into the city, and water-well drilling within the city limits virtually ceased.

"Reductions in the use of surface water are viewed as ecologically favourable in western Washington state because of the use of rivers by endangered species"

Drill spoils and water contaminated with old bunker oil