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THE FIRST WORD ON OILPATCH INNOVATION

ON THE Ball

Canadian companies advancing alternatives to plug-and-perf fracturing

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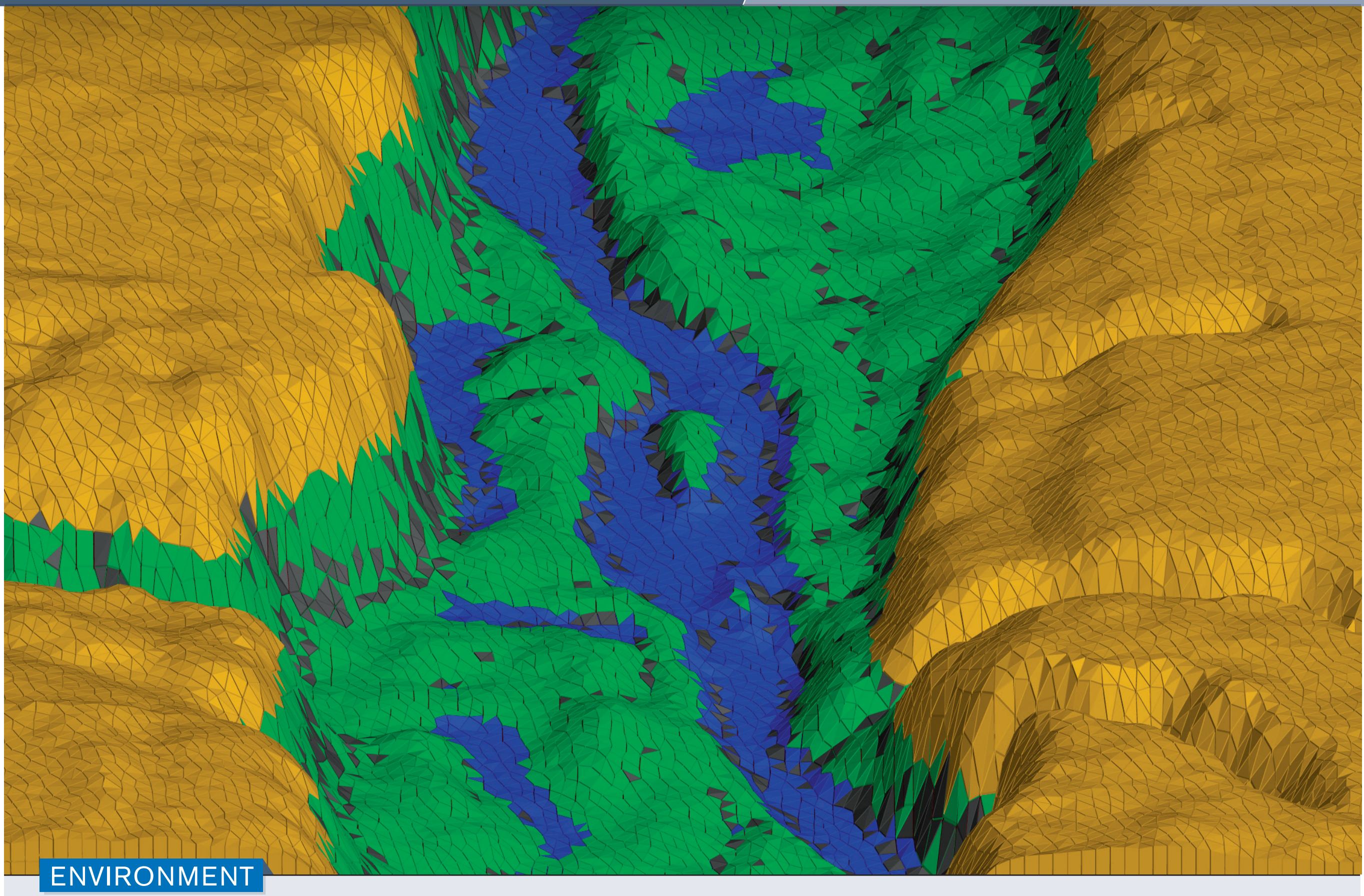


ENVIRONMENT

Making Waves

Computer program simulates movement of water through oilsands operations

WATERWORKS
Aquanty's finite element discretization of the Athabasca River north of Fort McMurray, looking north, illustrates the way real-world topography and geology are represented in computer simulations. Each triangular element's information on material properties is used to compute the movement of surface and subsurface water.

Alberta's oilsands mines need to be dewatered for extraction to take place, requiring a great deal of water diversion during operations and construction, and it is important to know how much water is involved, where the water is going and how it's being managed.

And there has been concern about seepage.

"We need to know how much, when, where and what the quality of seepage might be," says Chris Powter, executive director of the Oil Sands Research and Information Network in the School of Energy and the Environment at the University of Alberta.

The Alberta government requires that oilsands mining companies submit closure plans that detail how they plan to integrate with their adjoining boundaries—not just between one mine and its neighbour, but between it and the environment.

That's because water flows downhill to the lowest point. "It's absolutely critical that we have a proper picture of how this water is going to move around," says Powter.

A new software tool, HydroGeoSphere (HGS), is designed to tackle these and other water-related issues.

HGS, jointly developed by scientists at the University of Waterloo and the Laval University and provided by Waterloo, Ont.–based Aquanty Inc., simulates the entire terrestrial portion of the hydrologic cycle.

It is a computer program that simulates the movement of water within the terrestrial portion of the hydrosphere.

In addition to water flow, HGS is capable of simulating the transport of solutes such as salts, hydrocarbons and metals in both the surface and subsurface.

The ability to accurately simulate the movement of water allows different scenarios to be posed to the model.

PHOTO: AQUANTY INC.

For example, at the watershed scale, the impacts of climate change on water resources can be assessed, or the selection of mine closure materials can be tested with the computer simulation prior to construction, resulting in optimal closure design.

"HGS is capable of simulating surface and subsurface flow and transport, which is of particular use for all aspects of mining involving movement of water in the environment, such as surface water flow—rivers, creeks, tailings ponds—groundwater flow, and surface-water-groundwater interactions like seepage and recharge," says Steve Berg, Aquanty's senior hydrogeologist.

The technology is about 15 years old but has been available commercially for only about two years and has been used by 10 companies on three oilsands mines, a pyrite mine in Australia and a gold mine in Africa, but also on a nuclear waste project in France.

"It's as close as possible to how physical processes actually work," says Ranjeet Nagare, who has modelled oilsands mine reclamations and wetlands re-establishment projects with HGS.

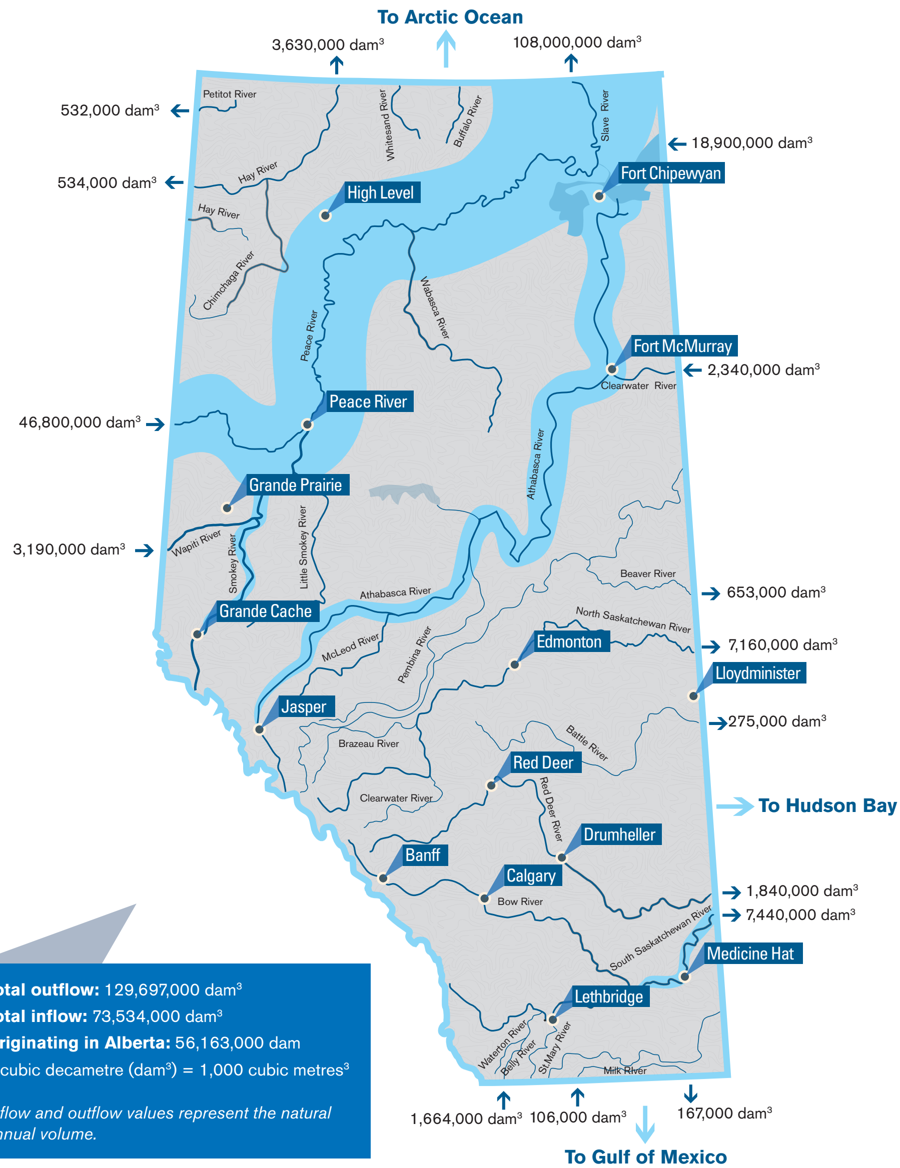
"Simulating natural processes using mathematics is a fairly difficult job, and these guys have done a very good job of it. It's a fantastic technology, actually. It's ahead of its time," says Nagare, a groundwater scientist with WorleyParsons Canada Services Ltd. in Edmonton. "It's very helpful in solving complex problems and will save a lot of money."

Jon Paul Jones has used the tool in his work as a research assistant professor in the department of earth and environmental sciences at the University of Waterloo and as a senior researcher in hydrogeology for Alberta Innovates – Technology Futures.

Jones says the big advantage of HGS is that it integrates what happens to the surface water and groundwater, whereas in the industry, pretty much all the surface water and groundwater questions are addressed with separate studies and assumptions are made.

For example, there is the danger that pumping too much water from the ground will affect surface water flows and result in the loss of fish habitat, he says. >

Mean Annual Natural River Charges



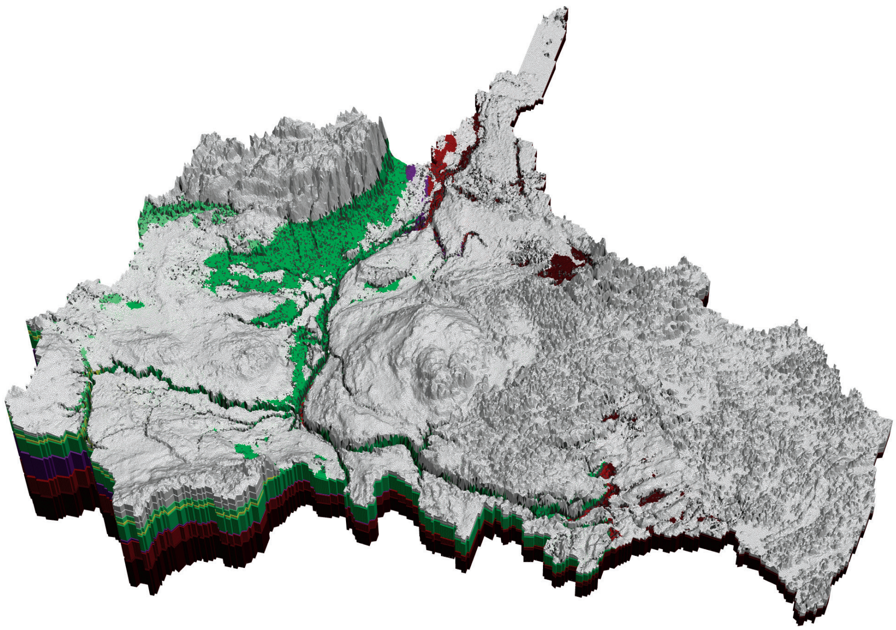
Total outflow: 129,697,000 dam³
Total inflow: 73,534,000 dam³
Originating in Alberta: 56,163,000 dam
1 cubic decametre (dam³) = 1,000 cubic metres³

Inflow and outflow values represent the natural annual volume.

SOURCE: ALBERTA ENVIRONMENTAL PROTECTION

WATER IMBALANCE

Oilsands development occurs in the northern half of Alberta, where water is abundant and use is relatively low. The north accounts for about 86 per cent of Alberta's water supply (and the Athabasca River about 17 per cent), compared to just 13 per cent contained in the North and South Saskatchewan River basins, which support 88 per cent of water allocation demand, according to the Canadian Association of Petroleum Producers.



FLOW SIMULATION
Three-dimensional view of a finite element model of the oilsands region built from publically available topography and subsurface geology. Such models can be used to simultaneously simulate the movement of water and solutes, like salt and napthenic acids, in the surface and subsurface.

PHOTO: AQUANTY INC.

"[Most applications] treat groundwater and surface water in isolation, but really they're just one big system," says Jones.

HGS is useful to the oilsands mining industry in particular because it can predict what will happen to a changing landscape—which an oilsands mine certainly creates—as water moves through it, he adds.

HGS can also be applied to assess how a closure design will perform under different conditions.

"When it comes to mine closure, the use of numerical simulations is very powerful as it allows the closure design engineers to test out their designs prior to actual construction," says Berg. "When we work on mine closure problems, the process is usually iterative. Initially, we are provided with a closure design or a set of designs.

"We simulate the designs under various climate scenarios—wet, dry and average conditions—and based on the results, the closure design engineers update their design to improve its performance. We then repeat the simulations with the updated design. This process is repeated until the design performance criteria are met. It is not uncommon for this to result in dozens of design permutations to be simulated. This process helps the design engineers to understand how their design will perform and what design elements are most critical to that performance."

Given the detailed engineering design of where the liners are, how thick they are, what the material is and what the flow rates are, HGS can create a model to look at what the seepage is out of the base of a tailings pond, says Berg.

"That's actually kind of similar to looking at a closure design as well. We can incorporate on the closure side the detailed engineering design of where the tailing sand is going to be deposited, where the cap material is and look at how those designs will perform over the long term under different climate scenarios—look at what their seepage to nearby streams or water bodies might be, how those plumes could evolve with time."

The Cumulative Environmental Management Association, a multistakeholder group that makes recommendations about the cumulative impacts of oilsands development to provincial and federal regulators, cited HGS in its groundwater-monitoring guidelines report as a future option. University of Waterloo researchers have used HGS to model a proposed fen reclamation project for an oilsands mine, and it was used by University of Alberta researchers to look at water flow relative to aspen growth for oilsands reclamation.

It can also be used for water-management issues associated with in situ operations such as steam assisted gravity drainage, say its developers. This may range from migration of subsurface contamination to the impact of water withdrawal from surface water.

But so far, in the oilsands, HGS has primarily been used for projects focusing on operations and mine closure, as well as a basin-wide assessment of the impacts of climate change, says Dieter Hensler, Aquanty's president and chief executive officer.

■ ***Lynda Harrison***

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