



From Qurayyah to Khurais: Turning Water Into Oil

Posted by [JoulesBurn](#) on March 23, 2012 - 8:11am

Topic: [Supply/Production](#)

Tags: [aramco](#), [khurais](#), [qurayyah](#), [satellite](#), [saudi arabia](#) [[list all tags](#)]

This article was first published on [Satellite o'er the Desert](#)

Synopsis: A poignant little film about someone taking a lot of precious seawater, piping it miles into a parched desert, and forcing it into the ground. Oh, and then poking a bunch of holes in said ground and collecting the ooze that comes out. And separating said ooze into crude oil, bad smelling gas, and assorted other liquids with a whole lot of fancy plumbing. A bit slow occasionally, but this, plus a strange score choice ("Nomads of the Tibetan High Plateau"), forces the viewer to ponder the meaning of it all. In 3D animation.



Shorter synopsis: This video is an animated flyover of the Khurais Crude Increment Program in Saudi Arabia. Interesting stuff about oil production.

OK, so this is more of an educational film. But by watching, you will learn the following:

- How crude oil straight out of the ground is processed prior to being shipped around the world.
- How Saudi Aramco takes seawater from the coast, treats it, transports it, and injects it into the ground, thus helping to force the oil to the surface.
- A few interesting tidbits about the Khurais and Ghawar oil fields.
- How to correctly pronounce several Saudi Arabian oil place names.

The 23-minute video (in two parts) is an animated flyover of the Khurais Crude Increment Program, which was [completed](#) in 2009. I [reported](#) on Khurais prior to its completion. The fields of Khurais, Abu Jifan, and Mazalij together now have a reported capacity of 1.2 million barrels of oil production per day. This project required drilling new production wells plus peripheral water injection wells. Water for the injection is pumped via pipeline from the Arabian Gulf, specifically from the Qurayyah Seawater Treatment Plant, which is also used to provide water for injection into the Ghawar field. Some of the new capacity of Qurayyah was slated for Ghawar. The video covers upgrades made at Qurayyah and Ghawar as part of the Khurais project, as well as showing the workings of the Khurais Central Processing Facility.

Well, enough with the spoilers. Watch the video. There will be a quiz afterwards.

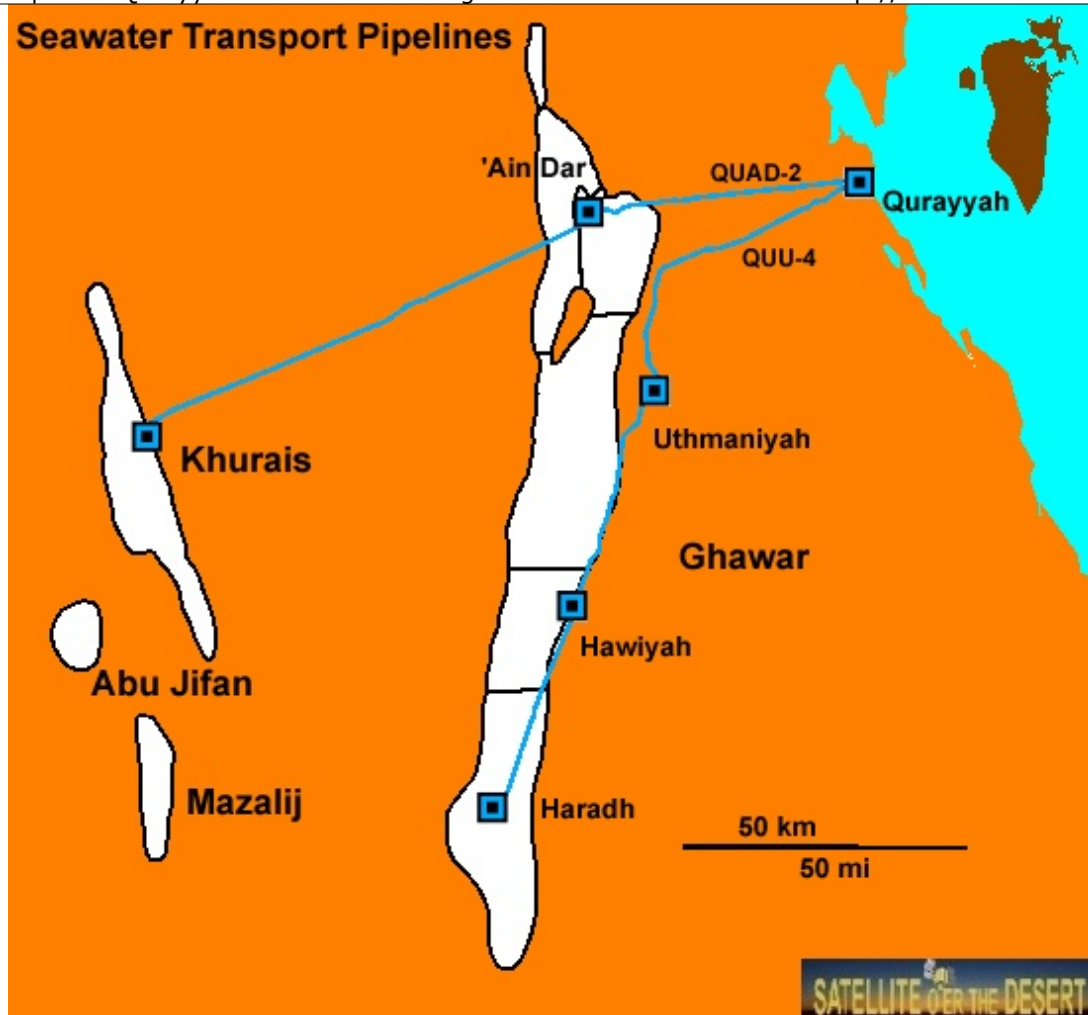
Part 1: The Khurais Central Processing Facility

Part 2: From Qurayyah to Ghawar and Khurais

Supplemental Information and Observations

Location of Facilities

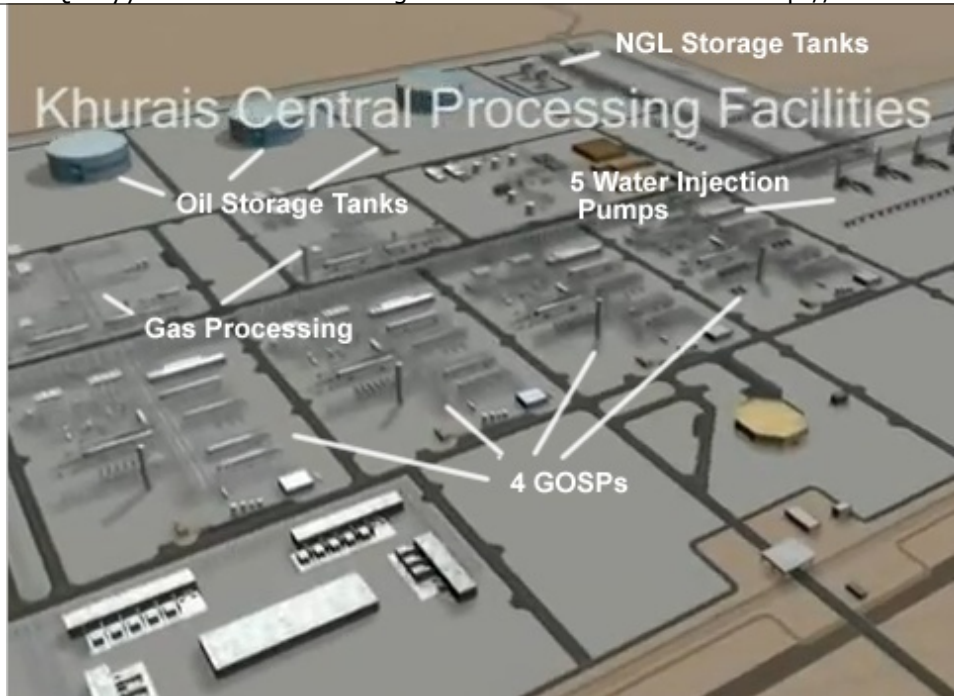
Shown below are the locations of the various facilities and pipelines discussed in the video. The 'Ain Dar Water Injection Plant actually appears to be located in the Shedgum area of Ghawar. The Haradh WIP is located adjacent to Haradh GOSP-2. The new pipelines were generally laid next to existing pipelines, and the new pipeline from 'Ain Dar to Khurais follows the [E-W Crude Pipeline](#) that runs between Abqaiq and Yanbu on the Red Sea.



Khurais and Ghawar seawater injection feeder pipelines from Qurayyah Seawater Treatment Plant on the Arabian Gulf coast.

Khurais Central Processing Facility

The Khurais project is novel for Saudi Arabia in that nearly all of the processing happens in a central location. Instead of having gas-oil separation plants scattered around the field, they are located next to each other and connected in parallel. This arrangement is enabled by the fact that all of the Khurais producing wells employ downhole submersible pumps, helping to push the oil from each well to the Khurais Central Processing Facility located up to 100 kilometers away.



Various components within the Khurais Central Processing Facility identified.

Qurayyah Seawater Treatment Plant

Below is a Google Earth view of the Qurayyah plant in 2010. The upgrades are in the south (toward screen bottom) end, and the two added pipelines (QUAD-2 and QUU-4) supplement the four existing prior to the Khurais project. Before 1974, the Qurayyah site was a sandy, remote beach. By 1978, it was supplying Ghawar with 4.2 million barrels of seawater for injection. Check it out on [Google Maps](#) and note the security around the perimeter.



Satellite view of the Qurayyah Seawater Treatment Plant. The two new pipelines are QUU-4 and QUAD-2.

Peripheral Water Injection Explained

Below is an animation (repeated from [here](#)) showing how peripheral water injection is used to help get the oil out of a reservoir.

Visual model of peripheral water injection into an oil reservoir. Note that Khurais producers are (reportedly) all horizontal wells.

Production and Water Cut in Ghawar and Khurais

The amount of water being injected into Ghawar has been of interest on this blog for many years. The video threw a lot of numbers out there regarding how much water the upgraded system can deliver, but it is not always clear when the upgrades alone or the total system are being referred to. But it seems we have the following:

1. 2.36 MMBD (million barrels per day) of new water supply is arriving at the Uthmaniyah facility via the new QUU-4 pipeline, adding to that supplied by the three existing lines (QUU-1, QUU-2, and QUU-3)
2. A total of 2.52 MMBD of water is being (or can be) injected into the Hawiyah area of Ghawar at 2820 psi. The oil production capacity of this area has not been specified, but it has been assumed to be about 1 MMBD.
3. A total of 1.99 MMBD of water is being (or can be) injected into the Haradh area of Ghawar in 135 injectors, also at 2820 psi. The oil production capacity of this area has been stated to be 0.9 MMBD. The figure of 135 water injectors, if true, would mean about 25 more injectors have been added over the last few years, based on previous counts in satellite images that I have done.
4. At about 17:00 into the video, it is stated that the water is injected into Haradh at 2500 psi and that the yield is 1.6 barrels oil for every barrel water. That pressure figure (at least)

seems to be a mistake, as it is inconsistent with the above values (which are in turn consistent with the Ghawar field operational pressure for many years). The 1.6 ratio is certainly not consistent with the assumed production capacities and the amount of water. The same figures are repeated later after discussing injection into Khurais, and it becomes clear that these apply to Khurais and not to Ghawar, as 2500 psi is sufficient to pressurize Khurais. Perhaps the video has not been edited for final release to theaters.

5. The QUAD-2 pipeline is delivering 2.14 MMBD to the 'Ain Dar Water Injection Plant and on to Khuais.

Certainly an unknown quantity is the amount of produced water (from the oil wells) being fed back into the system for reinjection in Ghawar. At 9:26 in the video, a figure of 636 thousand barrels per day of water is given for Khurais. This might be the current capacity for this, but Saudi Aramco recently [said](#):

KHURAIS, the single largest addition to oil capacity in Saudi Aramco's history, is now producing around 1 million barrels per day (mbpd), field production manager Yousef Al Furaidan says. ... On the other hand, Al Furaidan says it can pump far above nominal capacity. "We can produce up to 1.4 mbpd because this field is considered a virgin field, still at the beginning of its production life," he said. The facilities can handle the higher production levels as they are designed to deal with a 30 per cent water cut, while the water cut now is virtually zero, he says.

30 percent of 1.2 million is only 360k, so there is an inconsistency somewhere. That report also said this:

Decisions about managing spare capacity at Aramco fields are in the hands of reservoir engineers, but at Khurais, the state oil giant always tries to maximise output from the main field, Al Furaidan says. The two satellite fields, Abu Jifan and Mazalij, together produce 160,000 bpd. They have higher production costs than Khurais, and will be kept idle if not required, industry sources say.

And regarding gas and NGL production, there was:

According to data from the central processing centre, Khurais was exporting 31,900 bpd of natural gas liquids. It was also producing 290 million cubic feet per day (mmcf) of gas, although Al Furaidan says it can reach 330 mmcf at full stretch.

Raw gas production is proportionally lower, but NGL production is rather low (80k expected for 1.2 MMBPD oil) Where are those liquids going? It is possible that (much) more NGL comes from Abu Jifan and Mazalij such that when they are shut in, overall NGL production declines substantially.

Bottom Line

It gets a bit old watching fluids flow through pipelines, but there were some nice touches, such as the worker at Qurayyah turning pages and the sea critters in the Gulf. One thing missing from the story was what goes on in Khurais in between the water injection and the wet crude processing. Saudi Aramco has yet to reveal how the field is laid out. So I will -- in a future post.

Oh yeah, the quiz! Question: how many seahorses were in the video?



This work is licensed under a [Creative Commons Attribution-Share Alike 3.0 United States License](http://creativecommons.org/licenses/by-sa/3.0/).