



Y S I Environmental

## YSI Level Scouts® Monitor Groundwater Levels to Help Protect the Great Sphinx

Application Note



Massive and mysterious, the Sphinx has guarded Egypt's Great Pyramids for more than 4,500 years. At 241 feet long and 65 feet tall, it's history's oldest known monumental sculpture and still the largest monolith statue in the world. It's been nearly buried by the sand, suffered the indignity of having its nose carved off by a religious zealot in the 15th century, lost its beard, had its headdress frayed by blowing sand, and been shot at by centuries' worth of invading armies.

But the greatest threat to the Sphinx is silent, hidden and pernicious – rising groundwater that threatens the stability of the Sphinx. In addition, add to that vibration from road and air traffic.



*The Great Sphinx of Giza resides on the Giza Plateau on the west bank of the Nile, near modern-day Cairo, Egypt. It is the oldest known monumental sculpture and has endured for centuries and is now threatened by rising groundwater.*

### Rising Water

Groundwater threatens more than the great monument's stability. If water wicks up into the statue, it will leach salts from the limestone and deposit them on the surface of the stones. Eventually, the salts will accelerate the flaking erosion that has long afflicted the Sphinx.

The rising water table under Giza has many sources. The harnessing of the Nile with the Aswan High Dam and a network of irrigation canals creates constant seepage into the water table beneath the Nile Delta.

Another looming threat was the prospect of massive seepage contributions from urban sprawl. The village of Nazlet el-Samman has exploded into a bustling city of 200,000 people. The village is connected to the mass of development that is home to nearly 17 million people in the largest metropolitan area in Africa, and is now a suburb that extends the Cairo-Giza metropolis nearly to the foot of the pyramids. Until recently, Nazlet el-Samman and other nearby cities had little or no sewage containment, so water from the swelling population was going straight to the groundwater.

### Monitoring Wells

Led by Dr. Zahi Hawass, a world-renowned archeologist, Egypt's Supreme Council of Antiquities (SCA) embarked on a decade-long course of study and restoration beginning in January 1989.

By the mid-1990s, Nazlet el-Samman had a new sewer system including new plumbing and a centralized wastewater treatment plant. A canal was covered and changes made to the management of Canal Mansoria to reduce seepage. Meticulous studies of the Sphinx – from mapping its exterior to studying its materials – provided a foundation for future restoration efforts. Additionally, a climate monitoring station was installed on the statue's back to track conditions contributing to its decay.

Pools were forming in front of the Valley Temple of Khafre pyramids prompting quick action. In early 2008, the SCA teamed up with the Cairo University's Engineering Center for Archaeology and Environment to monitor groundwater under the Sphinx in real time. The team also enjoyed the leadership of Dr. Hafez Abdel Azem and Dr. Reda Eldamak, each of whom brought expertise to the very sensitive mission.



*A YSI Level Scout lowered into a well.*

Researchers drilled four boreholes four-inches in diameter and 20 meters (66 feet) deep into the bedrock beneath the Sphinx. They dropped cameras into the four-inch boreholes to look into the rocks supporting the statue.

(continued)

The groundwater table was 4.6 meters (15 feet) beneath the surface, reports Sameh Ali of Giga Systems in Cairo, YSI's distributor in Egypt.

After the camera work was completed, YSI Level Scout® pressure transducers were deployed in 4 monitoring stations at a depth of 15 meters (49 feet) from the ground surface to provide secure, long-term unattended monitoring of the water table, notes Mohamed Adel, Senior Engineer of Cairo University Engineering Center. Rugged, reliable and equipped with absolute gauge, each Level Scout records level data every eight hours, and is capable of recording up to 400,000 data points in its internal memory. The instruments can also be equipped to broadcast data via SDI-12, RS232 or RS485 for real-time data acquisition. Software included with Level Scouts facilitates data management on PCs or Pocket PCs.

The wealth of information generated by the Level Scouts has also sparked scientists to study the data in an effort to better understand the dynamics of wastewater in the region.

### Groundwater Pumping

In June 2008, SCA and its partners installed eight pump stations east of the Sphinx, drawing 640m<sup>3</sup>/hr from beneath the monument. Data from the Level Scouts allow SCA to monitor the project's success.

And it has indeed been successful. Just four months after pumping began, the groundwater table dropped to six meters beneath the soil surface, and it continues to fall. The reduction was clearly visible in front of the Valley Temple of Kharfe where the pools almost dried up.

SCA is also racing to shore up crumbling masonry with materials that will be sustainable in the long term, combating salt deposition and undoing the damage done in previous restoration efforts.

With dry paws and a reinforced coat, the newly protected Sphinx stands a strong chance to guard the ancient pyramids for millennia to come.



*Diagram showing the location of the four boreholes at the base of the Sphinx (Council of Antiquities, Project Sector and Cairo Engineering Center for Archaeology and Environment).*



For additional information on Dr. Hawass and his work, please visit: [www.drhawass.com](http://www.drhawass.com)



Watch The Drilling Online  
For an online peek at the drilling operation beneath the Sphinx – and commentary by Drs. Zahi Hawass and Mark Lehner – visit

<http://www.youtube.com/watch?v=3qGzfZHWbZE>

For additional information including specifications on YSI instruments, please visit: [www.ysi.com](http://www.ysi.com) or [www.ysi.com/groundwater](http://www.ysi.com/groundwater)

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