

# NAGA HAMMADI BARRAGE

Harnessing the forces of the Nile for the coming century



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# The players behind the project

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**The Clients:** The Naga Hammadi barrage was commissioned by the Arab Republic of Egypt's Ministry of Water Resources and Irrigation, and Ministry of Electricity and Energy, advised by a group of consultants comprising Lahmeyer International (Germany), Electrowatt (Switzerland) and Sogreah (France).

Funding was provided by the Egyptian government, with financing by the European Investment Bank and the German Entwicklungsbank, KfW.

**The Contractors:** VINCI Construction Grands Projets (leader), Bilfinger Berger and Orascom Construction Industries, acting in Joint-Venture, were awarded the civil works contract.

● **VINCI Construction Grands Projets** (France) designs and builds major civil engineering structures and buildings throughout the world. The company combines its engineering and project management expertise with the proactive creation of local partnerships when deploying solutions for its public and private-sector clients.

● **Bilfinger Berger** (Germany) is a leading international construction and service company. As a Multi Service Group, Bilfinger Berger delivers comprehensive solutions in the areas of real estate, infrastructure and industrial services. Its business activities range from consulting, development, design, financing and turnkey construction through to operation and maintenance.

● **Orascom Construction Industries** (Egypt) provides engineering, procurement and construction services on large-scale infrastructure, industrial and commercial projects principally across the Middle East, North Africa and Central Asia. OCI is a leader in the regional construction market.

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## A multi-purpose structure

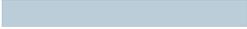
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**Irrigation:** the new dam (3.5 km downstream from the original dam) was designed to increase the existing irrigation system, a task for which rehabilitation of the previous 80-year-old structure was deemed insufficient. By raising the level of the Nile upstream by approximately one meter, the new barrage irrigates 60,000 additional hectares for agriculture land.

**Regulation of the Nile:** the new Naga Hammadi barrage will manage regular seasonal variations in the river's level, as well as cope with the maximum emergency output if the Aswan dam were to be opened upstream (7,000 m<sup>3</sup>/second).

**Electricity production:** four turbines with total output of 64 MW enough to power 200,000 Egyptian households with environmentally friendly, renewable energy.

**Increased shipping capacity:** two high capacity navigation locks accommodate even the largest Nile cruise ships, carrying visitors to Luxor and the other sites of Upper Egypt.



**7,000** m<sup>3</sup>/second  
maximum flow capacity



**200,000**  
households powered  
with clean hydroelectric energy



**60,000** ha  
of additional agricultural land

# A force for regional development



**The Nile river valley** is Egypt's breadbasket and home to 97% of the country's population, although the site chosen for construction of the new barrage is itself very isolated. Naga Hammadi lies in Upper Egypt, about mid-way between Aswan, upstream to the South, and Cairo, some 500 km distant to the Nile river delta.

The Naga Hammadi Barrage has major regional impact by increasing land available for cultivation, providing clean energy and improving floodwater regulation.

The Egyptian Clients also wanted the project itself to contribute to local added value and economic development.

- The Joint-Venture partners worked closely with local staff and labourers to ensure positive impact on the natural and economic environment of the region. An awareness campaign directed by the Ministry of Water Resources and Irrigation towards the local population provided information about the many benefits to be provided by the new dam.

- Workers from the local sugar cane farming operations were trained as the main source of manpower for the project, which employed close to 2,000 workers

during peak phases, most coming from the surrounding villages. A dedicated transport service by bus and boat brought workers to the construction site.

- Land which was temporarily reclaimed for construction of the diversion canal and other project elements was renaturalized before restoration to farmers.

- Certain specific activities have been sub-contracted to local companies such as **Arab Contractors** (dredging and riverbed protection), **Bauer Egypt** (diaphragm walls), **Bekheet and Awad** (earthworks), **Rowad** (steel reinforcement) and **Harb** (Electromechanical).

- Specific design and operating measures were implemented to protect groundwater quality and prevent Nile River from soil pollution.

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# Strong technical expertise and complex logistics

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**The Clients awarded contracts** in packages corresponding to the technical expertise required for the various facets of the dam's construction:

- Diversion canal and cofferdam,
- Civil engineering for the barrage structures,
- Hydromechanical and electrical equipment,
- Permanent housing and operation services building.

The civil works Joint-Venture comprising VINCI Construction Grands Projets / Bilfinger Berger / Orascom Construction Industries handled all these works except equipment.

The Joint-Venture delivered multiple structures on a tight deadline.

**Diversion canal:** full diversion of the Nile river is a procedure only used once before, during construction of the Aswan dam. 3.1 million m<sup>3</sup> of earth were removed through dry excavation and dredging of the right bank. The canal bed was reinforced with 300,000 m<sup>2</sup> of geotextile and a 200,000 m<sup>3</sup> stone layer, to withstand erosion even under strong current.

**Cofferdam:** a 1,650 m circular cofferdam reinforced with diaphragm walls of plastic concrete to a depth of up to 59 m was designed to withstand any tensions resulting from drainage, excavation and construction, without loss of waterproof properties.

**Barrage structures:** the 336 m length dam includes:

- the sluiceway with seven bays, each 17 m in width,
- dual 17 m x 160 m navigation locks,
- the hydroelectric plant housing four turbines and generators.

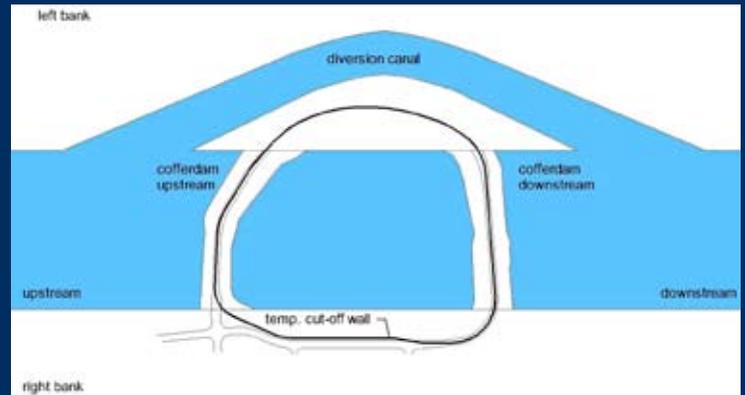
# Construction phases



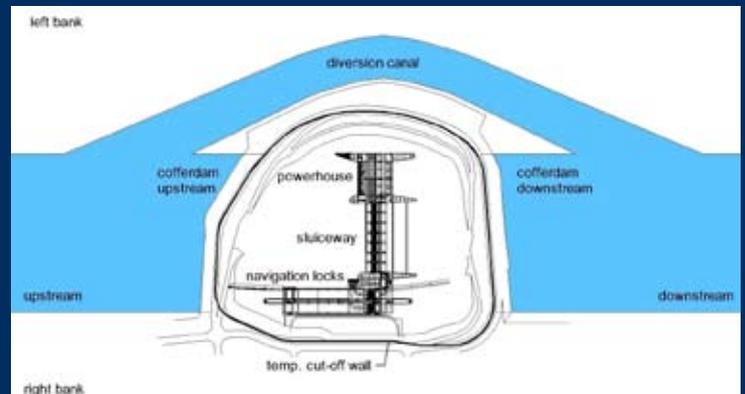
## 1. Diversion canal

(June 2002 – Dec. 2003)

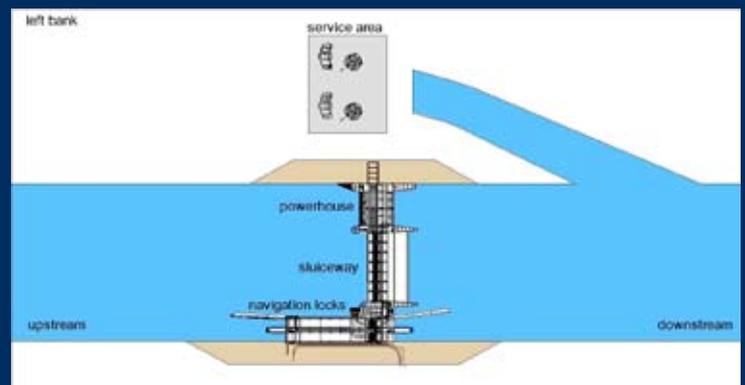
**Measuring 1.1 km in length**, 10 m deep with a minimum navigable width of 100 m, the canal served to divert the Nile in full for the duration of the project with no disruption in fluvial transport. Shipping was transferred to the canal in October 2003.



Situation with cofferdam and sealing element



After finishing structures within the pit



Final stage

6.6

million m<sup>3</sup> of earth removed



## 2. Cofferdam and construction pit

(Nov. 2003 – Nov. 2004)

**Cofferdam reinforced with excavation** of the plastic concrete cut-off walls created a construction pit on the bed of the Nile. Measuring 240,000 m<sup>2</sup> and 1,815 m in circumference, the pit was fully drained including lowering of ground water levels, to prepare the riverbed surface for the next phase.



# Construction phases



## 3. Concrete structures

(Dec. 2004 – Oct. 2006)

- **The main concrete structures** were completed on a tight deadline, 18 months from start to finish. Meeting this schedule required proactive team management and careful logistical planning, to achieve a high daily cadence of 1,000 m<sup>3</sup>.

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# 400,000

m<sup>3</sup> of concrete poured





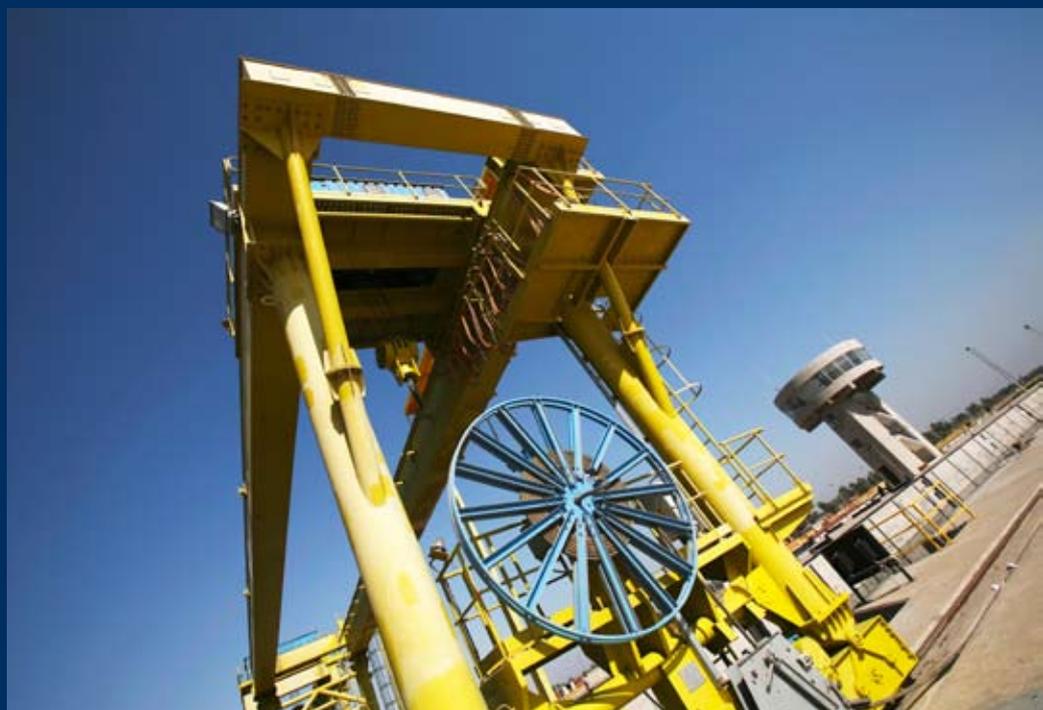
## 4. Impounding

(Oct. 2006)

- **The construction pit was refilled** following completion of the barrage, using pumps for a controlled impounding to avoid erosion of the cofferdam walls before their removal. Once the new locks were opened to navigation (February 2007), backfill of the diversion canal and construction of service buildings completed the project, on schedule in May 2008.

# Specific characteristics

- **The Joint-Venture** successfully negotiated the multiple strategic and technical challenges imposed by the nature of the project and the requirements of the Clients.
- **Extremely tight calendar:** 63 key dates over 2 years imposed by the Clients to ensure coordination of the project lots.
- **Rapid pace of concrete work:** 25,000 m<sup>3</sup> of concrete in average per month, during the 8 months peak period.
- Construction of the barrage in a single piece on the riverbed, **without disruption to Nile shipping.**
- **High density of reinforcement steel:** 48,000 tons required for a confined space necessitated expert engineering.
- **Curved geometry**, in particular of the powerhouse inflow and outflow structures, required complex and technically challenging formwork (265,000 m<sup>2</sup> of formwork in all).





# Specific characteristics

- Significant engineering **design modifications** introduced by the Consultant after start of construction, requiring the rapid implementation of additional equipment and manpower.
- **Environmental protection:** measures to maintain groundwater quality, renaturalization of farmland, etc.
- **Regional added value:** local manpower used for the bulk of the work, requiring specific, intensive training programmes. Small management teams from Cairo, local staff and labourers.
- **Logistics:** transport of materials to the site's remote location took several days.
- **Weather conditions:** temperatures more than 40°C during the summer months required the use of a special cooling system and ice flake to maintain the concrete at a temperature not exceeding 25°C.











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