BRIEF SUMMARY OF PROJECTS CARRIED OUT
BY
THE HYDRAULICS RESEARCH INSTITUTE

Irrigation system & hydraulic structures

1- Saryakos Barrage

Consultant : HRI

Period : 1987 - 1988

The discharge in Ismailia Canal is to be increased, Saryakos barrage is not capable of passing this amount of discharge, thus the structure should be removed. The study objective was to test the effect of this modification on the different intakes from Ismailia Canal. The studies comprised field investigations, data collection, bathymetric surveys and the construction of a 1-D mathematical model to study the flow parameters in the reach under consideration.

2- El-Salam Syphon under Suez Canal

Consultant : Sir William Halcrow & Partners - England.

Period : 1987 - 1993

The study objective was to test and modify (when necessary) the original design of the intake and outlet structure of the syphon. The water-hammer phenomena had to be studied and the required devices had to be suggested and the friction losses had to be minimized.

The study comprised field investigations, data collection and the construction of a physical scale model to investigate the parameters of the passing flow. A mathematical model was used to study the pressurized flow in the syphon body.

3- Hydraulic Study for El-Nasr Canal (second reach)

Consultant : HRI

Period : 1997 - 1998

The study objective was to study the optimal solution of the second reach storage capacity to satisfy the maximum discharge, 110 m^3/s.

The study was conducted by hydrographic survey for the whole reach (7.3 km). It showed that the maximum allowable discharge is 80 m^3/s due to roughness of lining bed which led to reducing manning roughness coefficient.

4- The Hydraulic Properties of Suez Channel

Consultant : HRI

Period : 1997 - 1998

The study objectives were to study the suitability of Suez Channel to pass the current and future

discharges and determination the hydraulic properties of the channel and giving the optimal solutions for improving and distribution of water according to the current and future water requirements.

The study was carried out using 1-D mathematical model and simulation of the model with prototype. The study recommended removing the wood and grass and cleaning it from all obstacles and the periodical monitoring.

5- Design of the Irrigation System for 400 000 fed. in Sinai (El-Salam Canal)

Consultant : North Sinai Development Organization

Period : 1995 - 1996

The study objective is to design the pipe network required to deliver the irrigation water from the canals to the cultivated land. The design of the pumping stations is to be carried out, water-hammer analysis is to be performed to protect the system from the surge waves. The interaction between the pipe network and the main, sub canals is to be regarded.

The study comprised field investigations, data collection, the construction of a mathematical model to study the pipe network and another 1-D model representing the open channel canals network and the interaction between them and the pipe network.

6- Channel Intake of El-Hasinia Pump Station

Consultant : HRI

Period : 1996

The study objective was to study the deposition problem that occurs along the intake channel and consequently deteriorates the efficiency of the pump station.
The study comprised field investigations, data collection, bathymetric surveys of 4 km length were carried out and desk study applying a 1-D mathematical model.

7- New Naga-Hammadi Barrage

Consultant : Lahmeyer Consulting Engineers

Period : 1997 - 1998

The study objectives were to optimize the arrangement of the structures in the general layout and the proposed river diversion during the construction stages. The study also was focusing on optimizing the flow conditions, check the safety of the rip-rap protection and evaluation of the structure impact on the river morphology.

The study comprised flume study in which one opening vent of the proposed design of the spillway is modeled with undistorted scale of 1:21.

8- Replacement of EL-Menofy and El-Tawfiky Head Regulators

Consultant : HRI

Period : 1996 - 1997

The study objective was to investigate the flow patterns at El-Menofy and El-Tawfiky canals with its new diversion canals.

The study comprised field investigations, data collection, bathymetric surveys of 4 km length were carried out and desk study using 2-D mathematical model.

9- The Hydraulic Design of Developed Irrigation System in North Sinai

Consultant : HRI

Period : 1997 - 1998

The study objective was to design the best irrigation system to irrigate 75000 feddan in Noth Sinai. The Institute offered the proper alternatives to develop the system. The agreement was to apply two alternatives, so the institute prepared the detailed hydraulic designs for pipelines, pump stations, the characteristic curves, and rotational speeds, valve diameters, and the preliminary cost and comparing the different alternatives.

10- Hydraulic Studies to Investigate Effect of Suez Canal Bridge Supports on Port-Said Canal

Consultant : HRI

Period : 1997 – 1998

The study objective was to study the hydraulic effects of Suez Canal Bridge supports on Port-Said Canal flowing at kilo 29 and 30.30.

The study comprised field measurements, hydrographic survey for problem area with 5 km long, water velocity distribution measurements, and analyzing of reach bed samples. From last survey and measurements, the proper solutions were recommended.

11- Feeding of Sheikh Zaid Canal reaches with water to keep lining

Consultant : HRI

Period : 1997 - 1998

The study objective was to study the optimal solution for pump station position taking into account water level fluctuation, topographic and hydrographic factors of the area and the horizontal motion of water surface.

The study comprised field measurements, hydrographic survey for problem area. The proper solutions were recommended according to field survey and measurements.

12- Study of Naga-Hammadi Weir

Consultant : HRI

Period : 1997 – 1998

The study objective was to investigate stability of Naga-Hammadi weir and reasons of collapsing some of its concrete blocks.

The study was carried out at maximum water head difference between upstream and downstream against all effective forces such as uplift, pressure, and sliding forces.

13- Construction of Harbor at Toshky

Consultant : HRI

Period : 1998 – 1999

The study objective was to specify the best water level to construct harbor next to the giant pump station and the effects of station operation on ships and vessels. The water level of Nasr- Lake from 1968 to 1998 were used to get the average level which is 7.725 m. By analyzing all data, it was deduced the best operation at lake different levels. Consequently, it was recommended the optimal location of harbor construction and also the pipeline taking into account the economic criteria.

14- Increasing Capacity of Toshky Spillway to Pass Flood Discharges

Consultant : HRI

Period : 1998 - 1999

The main objective of the study was to investigate how to increase Toshky spillway capacity to satisfy flood discharges. The study also aimed to increase the spillway capacity so as not to reach the maximum water level at Nasr-Lake and thus guarantee HAD safety. On the other hand, not passing more discharges downstream HAD guarantee the barrages and all hydraulic structures on the Nile to be safe. The study included hydrographic survey for 17.0 km around Gorge (Khoor) and 20.5 km of the spillway channel. 1-D mathematical model was applied to get the discharges in the spillway. The study recommended widening the water cross section for the spillway channel or deepening it, or lowering the spillway crest or dredging the Gorge (Khoor) bed.

15- Hydrographic Survey of Toshky Spillway and Toshky Khoor

Consultant : HRI

Period : 1998 - 1999

The main objective of the study was to improve the spillway and channel efficiency to allow discharges range from 300 to 500 million m^3/day.

The study comprised comprehensive hydrographic survey for the channel, topographic survey, analyzing water, bed, and suspended samples, calculating the channel water levels, plotting contour mapping to bed surface for more than 6000 point.

16- Calibration of Toshky Spillway

Consultant : HRI

Period : 1998 – 1999

The main objective of the study was to conclude discharge equation for spillway channel weir at km 20.5 according to inflow to Toshky depression.

The study comprised field survey, water level measurements upstream both High Aswan Dam (HAD) and Toshky Channel Intake and also upstream and downstream the constructed weir. The study also included measuring water velocity distribution and corresponding discharges and consequently the relation between water levels upstream HAD and Discharge of Toshky depression channel.

17- Design of Side Slope protections for El-Salam Canal

Consultant : HRI

Period : 1998 - 1999

The main study objective was to find the water velocity distribution at kilo 24.75 so that it can be used in designing the bed and side canal protection.

The study comprised 2-D mathematical model including rectangular network with varied dimension 2.0 m wide and 8.0 m long. The study also represented the bed levels and roughness and studying water discharge.

18- Study of Capacity Shortage of El-Nasr Canal

Consultant : HRI

Period : 1998 – 1999

The main study objectives were to study the capacity shortage of design discharge for El-Nasr Canal within the reach between pump station # 3 and # 4 and also the suitable alternative to widen the water section or increase the berm level to satisfy the maximum discharge.

The study was carried out using 1-D mathematical model (WENDY). The study recommended increasing the bed cross section by 6.0 m with 3.36 m long from the left bank and also increasing the left berm level to 34.07 m and completing two sides canal lining with the same previous slope (3:2).

19- Hydraulic Efficiency of Toshky Pump Station Siphon

Consultant : HRI

Period : 1998 - 1999

The main study objective was to study the hydraulic efficiency of Toshky pump station siphon. The study was carried out by designing different alternatives of siphon exit shape at discharge tank to select the optimal design that has the least pipeline hydraulic losses and consequently the best operational efficiency. The study also searched preventing waterhammer in the system in case of power off. After selecting the optimal design of tunnel outlet, it was represented on physical model for investigating and offering the proper recommendations.

20- Pump Station Hydraulic Efficiency *of South Valley Project*

Consultant : HRI

Period : 1998 - 1999

The main study objective was to perform the hydraulic studies on the suggested design of suction sump of South Valley pump station.
The study was carried out using undistorted physical model with scale 1:30. The pump station contains 24 units, suction sump, and delivery channel were represented on the model. Water velocity, traverse velocity, swirling and vortices were measured and investigated on different

alternatives of suction shape and design to reach the optimal design. The study conducted that the suggested design is the most suitable but it was recommended putting upper vanes at pump station intake.

21- Pump Station Intake *of South Valley Project*

Consultant : HRI

Period : 1998 – 1999

The main study objective was to perform detailed studies of pump station intake of South Valley Project to avoid forming swirling and vortices. After studying the suction sump of pump station and deciding the optimal alternative, it was investigated in detail to avoid any vortices, which result in decreasing efficiency.

This was carried out by dividing the system into four groups where each group consists of three intakes at different operational cases. The study illustrated that the suggested design is the most suitable because there in no vortices and the velocity distribution is uniform which lead to increasing efficiency.

22- Detailed Study for Optimal Design for Bays and Stilling Basin *of Naga-Hammadi Barrage*

Consultant : HRI

Period : 1998 – 1999

The main study objectives were to study the optimal design of Naga-Hammadi Barrage openings and to determine the optimal dimensions for openings, stilling basin, and the required protection downstream the barrage.

The study was executed by constructing a physical model to represent one opening to achieve the performance in case of flood, minimum discharges, required water levels, optimum stilling basin to dissipate water energy at opening, and finally preventing higher velocities to prevent scour and then decrease pitching and cost.

23- Stilling Basin Design for Ghezlan Station Outlet *in Saudi Arabia*

Consultant : HRI

Period : 1998 - 1999

The main study objectives were to study the optimal design of outlet shape which achieve the best performance, also to specify the required dimensions for outlet protection (pitching) to avoid scouring problem downstream the station outlet. The study investigated different alternatives of outlet shape and design to reach the optimal design. The study conducted the most suitable design that achieved the least hydraulic losses and then best performance.

24- Hydrographic and Topographic Survey of Toshky Depression # 1

Consultant : HRI

Period : 1999 – 2000
2000 - 2001

The main objective of the study was to follow water level changes at Toshky depression because off entering water to it.

The study comprised comprehensive hydrographic survey for the depression for 116.3 km including 53 readings, plotting contour mapping to bed surface. Mathematical model was applied to calculate the surface area and storage capacity corresponding to level 160 m and making comparison between the measured and design readings. The results showed no significant differences, which assured high performance and confidence in drawn contour mapping that can be used in future studies. The study also resulted in a difference in storage capacity about 1.5%.

25- Study of Infiltration Problem at Right Bank for Ismailia Canal between km 75 & 77.5

Consultant : HRI

Period : 1999 –2000

The study main objective was to study effect of infiltration from Ismailia Canal on safety and stability of the right part of barrage.

The study was conducted by hydrographic survey for 2.5 km long between km 75 & 77.5, topographic survey to left and right banks, and comparison between current sections and design sections.

26- Possibility of Increasing Discharges of Max Pump Station Delivery *in Alexandria*

Consultant : HRI

Period : 1999 **-** 2000

The study main objective was to study possibility of increasing discharges of Max pump station to guarantee safety of high way, buildings, roads and bridges besides the pump station delivery canal.

The study comprised a hydrographic survey for the two delivery canals for 1.0 km long starting from the pump station to the Mediterranean Sea mouth, water velocity cross-sections distributions, analyzing bed samples, plotting contour mapping for the problem area, calculating the longitudinal slopes for two the delivery channels. The study also was conducted using 1-D mathematical model for calculating water levels corresponding to maximum discharges at different alternatives.

27- The Suction Basin with Side Slopes for Mubarak Pump Station

Consultant : HRI

Period : 1999 –2000

The study main objectives were to report data helping for evaluating the flow charactristics in the suction basin and the pump intake area for different configurations of the basin shape and pump operation.

The study comprised undistorted physical model of scale 1:30 representing the the suction basin and a part of conveyance canal. The area of the model was 23 m long and 8 m wide and the simulated length of the basin and a part of the conveyance canal were 261 and 239 m respectively.

28- Delivery basin with side slopes for Mubarak Pump Station

Consultant : HRI

Period : 1999 –2000

The study main objectives were to decrease hydraulic losses at delivery basin to get uniform flow to El-Sheikh Zaid canal.

The study involved undistorted physical model with scale 1:20 representing the twenty-four pumps delivery tanks and part of El-Sheikh Zaid canal along with the twenty-four delivery siphons. The applied design had an advantage of side slopes of 2:1 for delivery basin.

29- The Delivery Basin with Vertical Walls for Mubarak Pump Station

Consultant : HRI

Period : 1999 – 2000
2000 – 2001
2001 – 2002

The study main objectives were to decrease hydraulic losses at delivery basin to get uniform flow to El-Sheikh Zaid canal.
The study involved undistorted physical model with scale 1:20 representing the twenty-four pumps delivery tanks and part of El-Sheikh Zaid canal along with the twenty-four delivery siphons. The applied design had an advantage of vertical walls instead of side slopes for delivery basin that leads to decreasing the losses and in turn decreasing power consumption and thus increasing plant efficiency. The study of (2001 – 2002) recommended modifying the entering pier to Sheikh Zaid Canal from radius 0.5 m to 1.9 m to minimize hydraulic losses and then overcome vortices and swirling.

30- The Hydraulic Studies for Suction Basin of El-Wadi El-Gadeed Pump Station

Consultant : HRI

Period : 1999 **-** 2000

The study main objective was to investigate water flowing in suction basin of El-Wadi El-Gadeed pump station at different operational cases.

The study was executed using undistorted physical model with scale 1:30 where twenty-four units on two sides, the suction basin and part of channel connecting from lake to channel were represented on the model. The study also included measuring water velocity, swirling and vortices, traverse velocities at many different cases of operation to get the system optimal operation.

31- Hydraulic Model Investigations of the New Naga -Hammadi Barrage Sluiceway
Consultant : HRI
Period : 1997 - 1998

The main objective of the study is to investigate in detail one bay of the sluiceway radial gate in case of flood simulation (fully open gate), normal operation (partially open gate), and flap gate operation.

The study was conducted by using 2-D hydraulic model of the sluiceway bay (in a flume) is the best tool to check the flow patterns upstream and downstream of the proposed structure, and to provide input for further 3-D hydraulic scale model testing of the proposed barrage layout.

32- Management of Irrigation System at El-Salaam Canal

Consultant : HRI
Period : 1999 –2000

The study main objective was to get the optimal way to manage and operate El-Salaam Canal to avoid facing sudden problems due to any trouble, disorders, or power off at any unit and overcoming these problems.

The study was carried out using 1-D mathematical model (SOBEK) for the whole canal started at Dammietta Branch and ending at Saro and Kawareer accompanied with representing all side inlets, barrages, regulators and siphons installed on it.74- The Detailed Studies for Final Design of New Naga-Hammadi Barrage

33- The Optimal Design of Naga-Hammadi Navigation Lock

Consultant : HRI
Period : 1999 -2000

The study main objective was testing the design of filling and emptying system of the lock and

making the necessary modifications to reach the optimal usage.

The study comprised modifying the system to get the least time of filling and emptying and also the least force acting to vessels inside the lock. The study also aimed at getting out water from filling and emptying ducts without effecting on ships and vessels.

34- Sedimentation Problem Upstream Pumping Station *of Port-Said South Drain*

Consultant : HRI
Period : 1999 - 2000
2000 - 2001

The study main objective was studying sedimentation in pumping plant suction basins and increasing the drain bed level with about 2.0 m which of course leads to decreasing operation efficiency, vibration, and not safety of the system.

The study comprised hydrographic survey for drain for a distance of 4.5 km long, measuring the water velocity distribution, water slope. Using previous data, a one-dimension mathematical model (SOBEK) was applied to get the optimal solution. To overcome the problem, it was recommended by dredging the drain according to the suggested design and installing submerged stone weir upstream the pump station at distance of 300 m and at height of 1.0 m above the suggested design level (- 5.42 m) with side slopes 3:2. Moreover, the study recommended protecting the drain side and bed between pump station and weir using stone has average diameter of 25 cm. The study also recommended constructing two submerged weirs, the first held in Port-Said Drain and the second on Sarhan Drain with height of 1.0 m from suggested design and at distance of 150.0 m from their mouth.

35- Sedimentation Problem Upstream Pumping Station *of South Port-Said Plain Drain*

Consultant : HRI
Period : 1999 –2000

The main objective was to study sedimentation at drain bed and pump station suction basin.
The study was executed by hydrographic survey for drain covering 2.5 m long starting from the pump station and water velocity distribution measurement. The collected data and measurements were represented on 1-D mathematical model and it was recommended by the same modifications mentioned in sedimentation problem upstream pumping station of Port-Said South Drain.

36- Field Studies of Bani-Hemeil Pump Station

Consultant : HRI
Period : 2000 -2001

The main objective was to study the effect of water level increasing on Bani-Hemeil pumping station in Western Naga-Hammadi Canal.

The study comprised field measurements, hydrographic survey covering 0.7 km from Kesra

Canal, measuring water velocity distributions, and analyzing bed samples. The study also included hydrographic survey for Belena Canal starting from its mouth for 2.0 km long downstream Bani-Hemeil pumping station. From previous collected data, undistorted physical with scale 1:20 was constructed to study effects of water level increasing. The study investigated the different alternatives for water controlling in pumping station suction basin, optimal representation for converting channel of the new pump station, the required protection at Belena Canal mouth covering the converting channel.

37- Study of Capacity Increasing of Toshky Spillway and Foundation Protection of Bridge km 3

Consultant : HRI
Period : 2000 -2001

The main study objective was to study increasing the capacity of Toshky canal to pass more discharges to avoid increasing water level in Nasr lake during flood periods.

The study was conducted applying 1-D mathematical model covering 17 km from Toshky khoor upstream the spillway and 20.5 km from the canal. After model calibration and investigation, the different alternatives and suggestions were searched to reach the optimal solution. Keeping width of existing canal at Aswan-Abu Simple road (km #3) and keeping width of existing weir on canal were taken into account. The study recommended putting protection layers at bridge area for a distance of 280 m including 30 m upstream the bridge and 250 m downstream the bridge.

38- Hydraulic Studies on Saryakos Regulator on Ismailia Canal

Consultant : HRI
Period : 2000 -2001

The study objective was constructing a new barrage including navigation lock and carrying out the necessary hydraulic studies for different discharges during the executing stages.

The study comprised hydrographic survey for canal reach for a distance of 2270 m at problem area, measuring the water velocity distribution at five cross-sections, analyzing the bed samples and measuring water surface currents. The study also included preparing and developing contour mapping and plotting forty-six cross-sections and nine longitudinal sections. From last collected data and measurements, a physical model would be constructed to study effects of new navigation sheet piles on hydraulic system and usage of the new navigation for water balancing and passing required discharges.

39- The Hydraulic Studies on Bahr-Youssif

Consultant : HRI

Period : 2000 -2001

The main objective was to study reasons of reach capacity shortage to pass the required discharges.

The study included hydrographic and topographic survey for the reach, measuring the water velocity distributions, and analyzing different bed samples. The study also comprised plotting contour mapping for bed and bank reach, and plotting the grain size distribution curve. One-dimension mathematical model was applied taking into account representing all intakes and mouths of drains connected to Bahr-Youssif so as to predict the maximum discharges. The study recommended plotting the contour maps for all Bahr-Youssif reach and representing all the reach on mathematical model and revising the constant values for barrage discharge calibration equation.

40- 3-D Mathematical Model for Kalapsho Drain Pumping Station

Consultant : HRI

Period **:** 2000 –2001

The main objectives were to design optimal delivery basin for the pumping station and to study the necessary stone protection so as not to affected by strong storm.
The study comprised measuring water velocity distribution, measuring discharges, analyzing bed samples, determining the water surface currents, and plotting contour map for bed. From collected data and measurements, 3-D mathematical model (DELFT – 3 D) was applied where an area with length of 3.1 km and 2. m wide and part of Klapsho Drain 250 m long were represented. The hydraulic tests for different operation cases were carried out. The study recommended by making protection consists of four layers with certain grain size and thickness. The study also resulted in:

1. Operating the existing pump station without dredging gives high velocities and non-uniform velocity distribution.
2. Extension of drain bed inside the sea to have level of 2.00 m improves velocity distribution and gives velocities till 1.4 m/sec.
3. The drain side slopes inside the sea should be kept at 2H:1V and with height equals to the sea height using the suggested stone protection.
4. Carrying out hydrographic survey for the pump station suction basin and also hydrographic survey upstream the two main feeding drains.

More studies were carried out in (2001-2002) using 1-D mathematical model (SOBEX) to study the water velocity inside drain in case of different operations to be used in designing sediment trap. The study of (2001-2002) recommended to construct sediment trap upstream the pump station suction basin and to protect the trap sides using gradual grain size stones.

41- Design the Out-fall of New Tabia Drain Pumping Station

Consultant : HRI

Period : 2000 –2001

The main objectives were to design the delivery basin out-fall to the Mediterranean Sea and to study connecting the delivery of old station with the new one.

The study comprised carrying out the field survey including hydrographic survey for the drain with length of 1.2 km starting from the pump station and ended at the sea, and water velocity measurements. Using collected data and field measurements; 1-D mathematical model was applied for both the old and new pump station. The study showed that:

The drain could satisfy discharges up to 40 m^3/sec and the delivery level could reach 1.1 m although the suggested design level was 0.9 m.

1. Length of the new drain is about 550 m if it is separated from the old one but it is about 600 m in case of connecting with the old one.

2. In case of connecting the new drain with the old one, water delivery level is higher than the Designed one with about 0.59 m.

4. It is preferred to separate the new drain from the old drain and protect the new drain with riprap provided with filter consisting of three layers of gradual size sand and stone.

42- The New Pump Station on El-Nasr Canal

Consultant : HRI

Period : 2000-2001

The study objectives were to search the optimal design of converting channel upstream and downstream the new pump station, getting the optimal design shape of delivery and suction basins, getting uniform velocity distribution at curving sites and upstream suction basin, then overcoming vortices upstream the plant.

The study included undistorted physical model with scale 1:20 where the existing and new suggested pump stations and converting channel were represented on the model.

43- The Hydrographic Survey Upstream and Downstream Ismailia Head Regulator

Consultant : HRI
Period : 2000-2001

The main objective was to study the high water velocities upstream the Delta Barrage Intakes. The study comprised a hydrographic survey for the Nile reach upstream Ismailia head regulator including 3.0 km downstream Delta Barrage, developing the bed contour mapping using DGPS. The study showed finding local scour downstream the old barrage at distance of 100 m with diameter and depth 1.0 m, sedimentation upstream the new barrage ranges from 0.25 m to 3.25 m, stability for the whole remaining area. The study recommended the periodical and permanent follow to find out any changes or any unstability.

44- Optimum Usage of Flood Water Flowing to Toshky Spillway

Consultant : HRI
Period : 2001 -2002

The main study objective was to study suggestions and alternatives for optimum usage of flood water flowing to Toshky Spillway for High Aswan Dam safety.

The study was carried out using 2-D mathematical model representing the four Toshky depressions (1-2-3-4). The water level was deduced using contour map, also the water discharge into depression was assumed. The study recommended the following:

1. Studying possibility of installing digital model for heights to study probability of exposing roads to water flood.
2. Studying possibility of constructing earthen dam at depression outlet (4)
3. Studying possibility of constructing earthen dam between depressions (1 & 2)
4. Increasing depth of canal connecting depressions (1 & 3)
5. Making hydrographic survey of canals connecting the four depressions.

45- Hydrographic Survey for Assiut Barrage Development

Consultant : HRI

Period : 2001 -2002

The main study objective was to study possibility of Assiut Barrage development and adding power plant.

The study comprised comprehensive hydrographic survey included cross-sections every 50.0 m covering 1.5 km upstream the barrage and 4.0 km downstream it and 1.0 km downstream Ibrahimia Regulator. The study also included measuring water velocity distribution, analyzing bed samples, measuring water surface velocity and current in the problem area in the Nile and Ibrahimia Canal.

46- Study of Water-hammer Phenomena in Senanea Pump Station *in Dammietta*

Consultant : HRI
Period : 2001 –2002

The study main objective was to design protection devise against water-hammer phenomena, which causes cavitation phenomena and high pressures in the system.

The study was executed using mathematical model (WANDA 3) where the pipeline in detail and all control devices were represented on the model. The pressures, velocities, and discharges were calculated. It was found that the measured pressures are higher than the allowable pressures, which resulted in collapsing the pipeline. Therefore, the suitable protection device was designed where it was tested and calibrated.

47- Increasing Capacity of Nasry-Rayah

Consultant : HRI

Period : 2001 –2002

The main objective was to study reasons of decreasing the maximum allowable discharge from 14 million cubic meter to 10.750 million cubic meter and getting the optimal solution.

One-dimension mathematical model (SOBEK) was applied on reach between the regulator and km 20. The study showed sedimentation and weeding at some places through the reach, which resulted in decreasing the designed bed width and increasing the bed roughness. Consequently, the reach capacity was reduced and unable passing the allowable discharge. The study recommended dredging some places to reach the design cross-section.

48- New Esna Barrage and Power Plant

Consultant : Cogefar, Italy.

Period : 1987 – 1993

The study objective was to test and modify the general layout before and during the construction stage of the Barrage. The navigation channel had to be checked from the morpho-dynamic point of view and also the stability of the rip-rap protection downstream the structure.

The study comprised field investigation, data collection, bathymetric surveys, and the construction of a hydraulic model. Different types of riprap protection were tested.

49- Sariaquse Barrage

Consultant :HRI

Period : 1987- 1988

The discharge in Ismailia Canal was to be increased. The Sariaquse barrage was not capable of passing the increased discharge, and the structure was to be removed. The study objective was to test the effect of this removal on the different intakes on Ismailia Canal.
The study comprised field investigation, data collection, bathmetric survey, and the construction of a 1-D mathematical model to study the flow parameters in the reach under consideration.

50- El-Salam Syphon Under Suez Canal

Consultant : Sir William Halcro & Partners – England.

Period : 1987 – 1993

The study objective was to test and modify the original design of the intake and outlet structure of the syphon. The waterhammer phenomena had to be studied and the required devices had to be suggested and the friction losses had to be minimized.

The study comprised field investigation, data collection, and the construction of a physical scale model to investigate the parameters of the passing flow. A mathematical model was used to study the pressurized flow in the syphon.

51- New Naga Hammady Barrage and Power Plant

Consultant : Lahmeyer Consulting Engineers.

Period : 1995 - 1996

The study objective was to test and modify the general layout of the proposed structure. The flow pattern has to be estimated for the final design stage.

The study comprised field investigation, data collection, bethymetric surveys, and the construction of a 2-D mathematical model to study the flow pattern and to predict whether erosion and /or sedimentation will occur.

52- Design of the Irrigation System for 300 000 Fed. In Sinai (El-Salam Canal)

Consultant : North Sinai Development Organization

Period : 1995 - 1996

The study objective was to design the pipe network required to deliver the irrigation water from the canals to the cultivated land. The design of the pumping station was to be carried out, and the waterhmmer analysis was to be performed to protect the system from the surge waves. The interaction between the pipe network and the main canal and secondary canals was to be considered. The study comprised field investigation, data collection, the construction of a mathematical model to study the pipe network, and another 1-D model representing the canal network and the interaction between the two networks.

53- Channel Intake of El-Hasinia Pump Station

Consultant :HRI

Period : 1996- 1997

The study objective was to study the deposition problem in the intake channel which effects the efficiency of the pump station.

The study comprised field investigation, data collection, bathymetric surveys, were carried

out together with a desk work applying a 1-D numerical model.

54- New Naga Hammadi Barrage

Consultant: Lahmeyer Consulting Engineers

Period : 1997- 1998

The study objectives were to optimize the arrangement of the structures in the general layout and the proposed river diversion during the construction stages. The study also focused on optimizing the flow conditions, the safety of the riprap protection and the evaluation of the structure impact on the river morphology.

The study comprised a flume study in which one opening vent of the proposed design of the spillway was modeled with an undistorted scale of 1 : 21.

55- New Valley Land Reclamation and Water Supply (Toushka Project)

Consultant :HRI

Period : 1997- 1998

The study objective was to select the suitable location for the intake structure of the Giant Pumping Station which will be constructed to deliver water from lake Nasser to the proposed canal. The canal will be extended through the Egyptian West Desert for about 300 km towards the North up to El-Wady El-Gedid City.

The study comprised field investigation, data collection, bathymetric surveys, and desk work for selecting the location of the intake.

56- Replacement of El-Menofy and El-Tawfiky Barrage

Consultant :HRI

Period : 1996- 1997

The study objective was to investigate the flow patterns at El-Menofy and El-Tawfiky Canals with their new diversion canals.

The study comprised field investigation, data colleciton, bathymetric survey of and desk work using 2-D mathematical model.

57- New Naga Hammady Barrage and Power Plant

Consultant : Lahmeyer Consulting Engineers.

Period : 1997- 1998

The study objective was to test and modify the general layout of the proposed structure. The flow pattern has to be estimated for the final design stage. The general morphological changes in the Nile River reach down stream the location of the new barrage, the operation of the barrage lock.

The study comprised field investigations, data collection, bathymetric surveys and the construction of a three physical models to study the flow pattern, to predict if erosion and / or sedimentation, and the time needed for filling and emptying the lock.

58- New Valley Irrigation Project Main Pump Station Water-hammer Analysis

Consultant : HRI

Period : 1997 - 1998

The study objective was to make a preliminary design of the intake in Lake Naser and the conduits and pump system which will feed the New Valley (El-Waddy Al-Gadied) Canal. This will be conducted by mathematical model computations (TRISULA and WANDA) and hydraulic model studies. This study described the results of the water hammer calculations of the original design of the intake structure, pump station, and piping system.

59- Safety of Damietta and Rossetta Branch Barrage

Consultant : Ministry of Irrigation and Water Resources

Period : 1999- 2000

The study objective was to study the safety of the Barrages on the Damietta and Rossetta Branches and whether they need rehabilitation or renovation. The study also included the scour downstream each barrage and the required protection.

60- Site Selection of a Pump Station Intake at EL- Minia New City

Consultant : Ministry of Construction

Period : 1999- 2000

The study objective was to study the validity of the proposed site for the station intake. The suitability of the intake, as and the prevention of its sedimentation was investigated.

61- Hydrographic Survey of Toshky Spillway and Part of Toshky Khour

Consultant :HRI

Period : 1999-2000

The study objective was to improve the spillway efficiency to allow the passing discharges up to 300-500 M m^3/day.

62- Calibration of Toshky Spillway Weir

Consultant : HRI

Period : 1999 - 2000

The study objective was to find a discharge equation for the spillway weir.

63- Design the Protection of the Side Slopes of El-Salam Canal in front of Balosa Pump Station

Consultant : HRI

Period : 1999-2000

The study objective was to study the water velocity in El-Salaam Canal at km 24.75 to determine the protection of its bed and side slopes.

64- Study of Gazlan Station Intake # 2 (Dammam – Saudi Arabia)

Consultant : HRI

Period : 1999-2000

The study objective was to investigate the performance of the proposed design of the stilling basins using a fixed bed and a movable bed models corresponding to minimum and maximum gulf water levels. Also to find the required modifications to improve the flow conditions, to prevent the bed scour in the stilling basins, and to prevent the sediment motion into the station intake.

65- Study of El-Nasr Canal to Allow Passing the Design Discharge at the Reach Between Stations (3) and (4)

Consultant : HRI

Period : 1999-2000

The study objective was to develop one-dimensional mathematical model to study a canal reach to pass the design discharge (101 m^3/s), and to investigate the procedures for passing the maximum discharge.

66- Study of the Hydraulic Efficiency of Toshky Pump Station Canal

Consultant : HRI

Period : 1999-2000

The study objective was to investigate the hydraulic efficiency of Toshky Pump Station Canal.

67- The Hydraulic Tests for the Suction Basin of the Main Lifting Station for the South Wadi-Project

Consultant : HRI

Period : 1999-2000

The study objective was to conduct the required hydraulic investigations of the proposed design for the intake basin of the main lifting station for the South–Wadi Project.

68- Models for the Intake of the Lifting Station at the South- Wadi Project

Consultant : HRI

Period : 1999-2000

The study objective was to investigate the intake of the lifting units for different operation conditions to avoid vortices.

69- Study of the Optimal Openings and the Stilling Basin for Naga-Hammadi Barrage

Consultant : HRI

Period : 1999-2000

The study objective was to investigate the optimal design of Naga-Hammadi gate openings and the selection of their sizes, and the dimensions of the stilling basin and the needed protection.

70- Design of the Stilling Basin for Gazlan Station Outlet (Saudi Arabia)

Consultant : HRI

Period : 1999-2000

The study objective was to determine the efficiency of the proposed design for the station outlet, and make all the required modifications on the outlet shape and extension to get the

best hydraulic condition and to dissipate the outlet energy in case of stopping the station. The study aimed also to get the required diameter of pitching the outlet and its extension to avoid scour.

71- The Morphological Study Downstream the New Naga-Hammadi Barrage

Consultant : HRI

Period : 1999-2000

The study objective was to investigate the different cases for the barrage operation on the Nile River.

72 – Increasing the Hydraulic Efficiency of Water Streams in West Delta

Consultant : HRI

Period : 2002 – 2003

The study objective was to examine the possibility of increasing the carrying capacity of the canals in the distance from Delta Barrage to El-Hammam Canal by 1.5-2 Million Cubic Meters (MCM) in order to efficiently supply water to El- Hammam Canal for the purpose of cultivating 100,000 feddans (42,000 ha) in the West Delta Development Project.

The study involved field investigations, data collection, and bathymetric survey. One-dimensional hydrodynamic mathematical model "SOBEK", which includes the hydraulic characteristics of all the canals of the study area, was applied. Different scenarios and alternatives were tested and compared to select the most appropriate solution to convey water to the project area.

The model results revealed that there is a deficiency of 3 MCM in the carrying capacity of both El-Nassery Canal and El-Nubaria Canal. It was recommended to construct a culvert between El-Behairy and El-Nassery Canals at km (38.000) upstream El-Khatatbba Barrage.

73 – Field Measurements for New Saryakos Barrage

Consultant : HRI

Period : 2002 – 2003

The study objective was to check the stability of new Saryakos Barrage.

The study comprised comprehensive hydrographic survey through a distance of 1000 m (500 m upstream the Barrage and 500 m downstream it) using high technology instruments, such as DGPS, Complete Total Station, and Range Finder. The study also included water velocity measurements and bed samples collection.
The hydrographic survey divulged that two scour holes were originated. The first scour hole

is located at a distance of 30 m upstream the navigational lock, while the second is positioned 60 m downstream the navigational lock beside the sheet piles. It was recommended to use the old constructed physical model to study the convenient methods for canal bed protection upstream and downstream the navigational lock.

74 – Hydraulic Design of the Control Barrage on Toshky Spillway Canal

Consultant : HRI

Period : 2002 – 2003

The study objective was to examine the hydraulic design of the control Barrage on Toshky Spillway Canal, which in turn will be used in the structural design of the Barrage.

The study comprised field investigations, data collection, and bathymetric survey. A two-dimensional hydrodynamic model was used to test the possible alternatives for designing the Barrage under different hydraulic and flow conditions, including the high flood period.

Three different designs for the Barrage were explored and the study revealed that a control barrage should be constructed at km (8.000) on the Spillway Canal with a total length of 400 m and 23 openings of 15 m width each.

75 – Investigating the Optimum Free water Path between El-Wady El-Gadeed and Toshky Depression No. 4

Consultant : HRI

Period : 2002 – 2003

The main objective was to explore the optimum water path for the proposed canal that to be constructed between El-Wady El-Gadeed and Toshky Depression No. 4 in order to make use of the flooding water in irrigating the Oasis Area. In addition, the study aimed at investigating the locations that need protection.

The water path was first determined through the Digital Elevation Model. The model revealed that the path has a length of 303 km. The path was then tested using the one dimensional hydrodynamic model "SOBEK". The model revealed that it takes water 345 days to reach Paris Oasis. It was recommended to update the hydrographic survey of Darb El-Arbeen Road, particularly in the parts that intersect the free path of the canal so as to determine the most appropriate method for the road protection.

76 – Field Measurements of Edco Drainage System

Consultant : HRI

Period : 2002 – 2003

In the last few years, the water levels in both Edko Lake and Edko Drain tended to rise during the period of maximum water demand. Consequently, the efficiency of drainage pump stations was decreased and the agricultural lands were exposed to inundation. The main objective of the study was to assess the performance of the drainage system in Edco. The study comprised a hydrographic survey for the Edco Drain from Km (14.000) to Km (48.000). Bed levels and water velocities were measured, whilst some water samples were collected to perform chemical and biological analyses.

The study revealed the need for raising the Edko Drain banks. In addition, it was recommended to prohibit any construction work in the Lake that may hinder the water from reaching the Sea.

77 – Improvement of Drainage Efficiency for Ganabea Bahr Hadous Drain

Consultant : HRI

Period : 2002 – 2003

The main objective of the study was to increase the drainage efficiency of Ganabea Bahr Hadous Drain so as to develop the agricultural services in the East Delta.

The study comprised field investigations, data collection, and bathymetric survey. The one-dimensional mathematical model "SOBEK" was applied to determine the most appropriate location and hydraulic design for the new proposed pump station.

The study revealed that a pump station with 6 units (1.3 m^3/s per unit), of which one unit is for emergency cases, is the most appropriate alternative. Furthermore, it was recommended to dredge the Drain bottom and increase the bed width in the distance from km (5.120) up to km (6.300), from km (6.300) up to km (8.360), and from km (86.360) up to km (11.980) with 8 m, 5 m, and 4 m respectively.

78 – Improving the Drainage Efficiency of El-Tard Belraha Drain

Consultant : HRI

Period : 2002 – 2003

The main objective of the study was to enhance the drainage efficiency of El-Tard Belraha Drain and prevent the seepage to the Qantara and Umm Reesh Canals.

The study comprised field investigations, data collection, and bathymetric survey. The one-dimensional mathematical model "SOBEK" was utilized to determine the most appropriate solution for the seepage problem.

The study revealed that there is no seepage to the Umm Reesh Canal, while the water seeps

from the Drain to the Qantara Canal at Km (10.500). It was recommended to fill 15 m of the water section width at the side of the Qantara Canal in the distance from km (10.500) to km (14.400).

79 – New Naga Hammadi Barrage Hydraulic Model Investigation

Consultant : HRI

Period : 2002 – 2003

In the context of New Naga Hammadi Barrage Project, a cofferdam design that takes into account the closure of the normal River path is to be examined. The hydraulic model study aimed at investigating the hydraulic conditions of the River during the different phases of the cofferdam construction to ensure its stability.

The model covered a reach of 800 m upstream the new Barrage and 1,200 m downstream it. The geometrical scale of the model was selected as 1:30 and with fixed bed, which was locally covered with riprap.

The study results revealed that a respective design, including stability calculations should be prepared to ensure the cofferdams material stability, particularly in phase 1 and phase 3, which characterized by high velocities. Also, the periods of executing these phases need to be limited, i.e. the diversion canal should be opened after a short period and the complete closure of the upstream cofferdam (phase 4) should be implemented as soon as possible after phase 3.

80 – Mitigation of Flooding and Drainage Problems in Edko Drain and Lake System

Consultant : HRI

Period : 2002 – 2003

The main objective of the study was to investigate the causes and solutions to the flooding problems at Edko Lake and Drain System.

A two-dimensional hydrodynamic numerical model was developed at HRI to examine the different alternatives for solving the flooding problems. The developed model succeeded in simulating the hydrodynamics of Edko Drain, Magror, Lake and Bougaz System.

The finite element mesh was able to capture the high irregular shape of the Lake and channel systems in two dimensions. The study revealed the necessity for implementing dredging works starting from Edko Magror at km (10.000) with a bed level of –4 m and going all the way in the upstream direction up to the siphon with bed slope of 10 cm/km. It was also recommended to improve the existing data for Lake Edko and Edko Drain.

81 – Hydraulic Design Investigation of the Branch 3 and 4 Siphon under Toshka

Spillway Canal

Consultant : HRI

Period : 2003 – 2004

The main objective of the study was to investigate the hydraulic conditions of the proposed siphon under Toshka Spillway Canal. Moreover, the study aimed at determining the expected sedimentation rate inside the siphon and the appropriate methods to alleviate this problem.

The study comprised field investigations, data collection, and bathymetric survey. A physical model of scale 1:27 that represented the siphon body and siphon inlet and outlet structures was constructed. The study also included measuring water velocity, swirling and vortices, and traverse velocities at many different cases of operation to get the system optimal operation.

The results revealed that the proposed design of the inlet structure is acceptable. Also, it was recommended to construct a sediment trap that should be monitored each 6 months to remove the accumulated sediment if necessary.

82 – Integrated Management Plan for El-Sheikh Zaied Canal

Consultant : HRI

Period : 2003 – 2004

The main objective of the study was to improve the system performance in order to efficiently deliver water to all the intakes and minimize the operational losses.

A hydrodynamic mathematical model "SOBEK-1D" was applied to investigate the different alternatives for operating and managing the canal system. The aptitude of the system to accurately convey the water during the periods of minimum and maximum supply, as well as in case of power failures of pump stations was also examined.

The study revealed that the performance of the canal system is adversely affected by the change in the roughness coefficient. However, it was recommended to collect more data on the proposed cropping patterns and pump stations for further detailed research study.

83– Hydraulic and Environmental Assessment of Edko Drain and Edko Lack

Consultant : HRI

Period : 2003 – 2004

The main objective of the study was to investigate the main causes of water level rise in the Edko Drain and Lake, which resulted in inundating the adjacent agricultural lands and produced partial bank failure of the Drain.

A mathematical model "SOBEK-1D" was employed to test the effect of installing a temporary pump station at km (6.500) of El-Boseely Drain. Different scenarios were examined, including the use of the emergency units with a capacity of 12 m^3/s and the installation of a temporary pump station with a capacity of 25 m^3/s.

The results revealed that the water level downstream El-Mahmoudiya Siphon drops down by 29 cm when using the temporary pump station. But, it declines with 90 cm when 50 percent of the sediments are removed. It was recommended to replace the emergency units whose water was discharged to El-Mahmoudiya Canal by other six units; two units on Lawia Drain, three on El-Atef Drain, and one unit on Halq Al-Gamel Drain.

84– Hydrographic Survey of the Edfo Main Drain Siphon

Consultant : HRI

Period : 2003 – 2004

The main objective of the study was to examine the possibility of protecting the Siphon or increasing its capacity.

The hydrographic survey encompassed 4 km of the main Drain. In addition, 5 water samples were collected.

The survey revealed that the average width of the Drain water section is about 15 m, 8 m more than the design water width and the water surface slope downstream the Siphon is 20c/km compared to a design value of 5cm/km. Moreover, the water velocities are too low.

85– Assessment of the Proposed Alternatives for Conveying the New El- Kassasen Pump Station Discharged Water to El-Mahssama Drain

Consultant : HRI

Period : 2003 – 2004

The main objective of the study was to explore on the optimum hydraulic and economic alternative for conveying the discharge water from the El-Kassasen New Pump Station to El-Mahssama Drain.

A mathematical model "SOBEK-1D" was used to test 2 alternatives. The first alternative was to convey the discharged water through a new canal that to be constructed with a width of 7.5 m and a bed slope of 10 cm/km. The second alternative was to convey the water via pipeline system with 1,100 m length and 1.7 m diameter.

The model results revealed that the first alternative is hydraulically and economically the optimum solution.

86– Improving the Conveyance Efficiency of El-Giza Canal

Consultant : HRI

Period : 2003 – 2004

The main objective of the study was to improve El-Giza Canal from its intake up to Km (59.000).

The study comprised field investigations, data collection, and bathymetric survey for the Canal in he abovementioned reach. A mathematical model "SOBEK-1D" was used to study the effect of the suggested pump station at Km (76.000) on the stability of the left bank of the River. Also, the different alternatives for discharging the water upstream the Lahoon Regulator were examined.

The model results revealed that the maximum carrying capacity of the Canal at its intake is 52 m^3/s. Furthermore, it was recommended to construct a weir at km (46.000) with a width of 10 m to ensure adequate water supply to all offtakes.

87– Investigating the Stability and the Carrying Capacity of the Mahmoudiya and Meet Yazid Canals: Field Survey and Data Collection

Consultant : HRI

Period : 2003 – 2004

The main objective of the study was to assess and evaluate the stability and the carrying capacity of both the Mahmoudiya and Meet Yazid Canals in order to fulfill the Integrated Irrigation Improvement and Management Project (IIIMP) requirements.

The study comprised field investigations, data collection, and bathymetric survey using high technology instruments, such as DGPS, Complete Total Station, and Range Finder.

The study revealed that the Mahmoudiya Canal has a limited capacity in the distance between its intake and km (16.000). On the other hand, it was realized that the left bank of the Meet Yazid Canal at km (1.000) is unstable. It was recommended to perform a detailed field survey for the two main canals as well as for the main branches.

88–Improving the Conveyance Efficiency of the Edfo Main Drain Siphon: Hydrodynamic Mathematical Model

Consultant : HRI

Period : 2003 – 2004

The main objective of the study was to assess the actual discharge of the Drain, including the agricultural drainage water and the wastewater. Moreover, the study aimed at determining the

conveyance efficiency of the main Drain Siphon.

The study comprised field investigations, data collection, and bathymetric survey. The one dimensional mathematical model "SOBEK" was used to examine the different alternatives for ameliorating the Siphon Conveyance efficiency. Seven alternatives were investigated, including the provisions for flash floods.

It was found that there is a need for constructing a bridge above the Main Drain for enhancing the Cairo-Aswan transport flow because of the Siphon low capacity.

89– New Nubaria Power Plant III: Hydrothermal Modeling of the Cooling System

Consultant : HRI

Period : 2003 – 2004

The study aimed at investigating the convenient location of constructing a cooling system of module III and the impact of its construction together with modules I and II on the canal environment and operation.

The Delft-3D hydrodynamic model was employed to simulate the Nile River reach at El-Nubaria Canal. The model was used to test the different scenarios of operating the cooling system.

The results revealed that there is recirculation of warm water from the outfall structure of module III to the intake structure of modules I and II. But, when the location of the intake structures was moved on El-Nassery Canal at a distance of 140 m downstream Abd El-Hady Barrage and the outfall was on El-Nubaria Canal (200 m downstream the outfall of modules I, II), there was no recirculation registered. A separate physical model with relatively large undistorted scale is required to study inflow characteristics, vortex preventing, and intake detailed design.

90– Improving the Performance of Wady El-Saaida Canal

Consultant : HRI

Period : 2004 – 2005

The main objective of the study was to assess the canal system of Wady El-Saaida in order to formulate the required measures for its development

The study comprised field investigations, data collection, and bathymetric survey. A mathematical model "SOBEK-1D" was applied for examining the different alternatives to improve the canal performance.

The model results revealed that the maximum discharge in case of implementing modern irrigation methods is about 17.52 m^3/s. This implies the operation of the fourth unit in each

pump station on the Canal four times. Also, the results showed that it is indispensable to shut down the pump station located upstream any other pump station that encountered a power failure within a period of 15 minutes.

91– Suez Canal Field Investigation

Consultant : HRI

Period : 2004 – 2005

The study main goal was to assess the actual carrying capacity of the Suez Canal and determine the most appropriate method for the protection of its banks.

The study comprised field investigations, data collection, and bathymetric survey that covered the whole length of the Canal.

The results recorded several failures along the left bank. In addition, it was realized that the Canal carrying capacity is negatively affected by the high percentage of weed growth.

92– Impact of Constructing a New Navigational Lock on Irrigation and Drainage Works in the Nubaria Canal Command Area

Consultant : HRI

Period : 2004 – 2005

The main objective of the study is to assess the impact of constructing a new navigational lock along the left bank of El-Nubaria Canal at km (100.000) on the irrigation and drainage works in the adjacent command area. In this context, the study aimed at investigating the different alternatives to discharge the excess water and examining the effect of the new lock construction method on the safety of West El-Nubaria Drain.

The study comprised field investigations, data collection, and bathymetric survey that covered a distance of 5 km, of which 2.5 km are located upstream the new lock and 2.5 km downstream it. A mathematical model "SOBEK-1D" was applied for testing the different alternatives to discharge the excess water.

The study results revealed that the maximum discharge, which can be conveyed, if the gate is fully opened, is about 12.28 m^3/s. Also, it was recommended to discharge the irrigation excess water (up to 26.38 m^3/s) through the old lock after the completion of the new lock.

93 – Field Measurements for New Saryakos Barrage

Consultant : HRI

Period : 2004 – 2005

The study objective was to check the stability status of scour holes for new Saryakos Barrage compared to that of year 2003.

The study comprised comprehensive hydrographic survey through a distance of 2,750 m (1,250 m upstream the Barrage and 1,500 m downstream it) using high technology instruments, such as DGPS, Complete Total Station, and Range Finder. The study also included water velocity measurements and bed samples collection.

The hydrographic survey revealed that one scour hole was originated at the Saryakos Water Plant intake, where the bed level is 5.9 m + MSL. This implies a decline of 4.25 m in the bed level compared to year 2003. Hence, it was recommended to perform another field survey after 6 months to monitor the scour holes' status.

94 – Field Investigations for Naga Hammadi El-Gharbiya Canal

Consultant : HRI

Period : 2004 – 2005

The study objective was to execute a comprehensive data collection program in order to pinpoint the irrigation system elements that to be improved so that to enhance the Canal performance.

The study comprised comprehensive hydrographic survey through a distance of 174 km using high technology instruments, such as DGPS, Complete Total Station, and Range Finder. The study also engrossed water velocity measurements and bed samples collection.

The survey revealed that the current Canal command area is 460,000 feddans, while the Canal was designed to serve 425,000 feddans. Moreover, the actual measured discharge was 11.49 MCM/day compared to a design discharge of 15.38 MCM/day. Thus, it was recommended to simulate the Canal performance through the mathematical model "SOBEK-1D".

95 – Hydraulic and Electric Calibrations for Mubarak Pumping Station (Toshky)

Consultant : HRI

Period : 2004 – 2005

The study objective was to check the hydraulic and electric status of Mubarak Pumping Station.

The depth of the vertical profile was measured and then the velocities at each point of the current meters were also measured. This process was repeated three times followed by measuring the static head, discharge and the electric power in each case, with which the efficiency could be calculated . The method of "velocity area" was used in discharge

calculation with some programs that have been developed by HRI staff.

The average discharge for each pump station unit was coincident to the design discharge ($16.7 m^3/s$). However, it was recommended to recalibrate the discharge and pressure measurement instruments.

96– Suction Basin Design of the Proposed New Pump Station at the Intake of km (57.000) on El-Sheikh Zayed Canal

Consultant : HRI

Period : 2004 – 2005

The study objective was to investigate the design of the suction basin so that to prevent the cavitations.

A physical model with a scale of 1:15 was constructed to get better understanding of the functionality of the proposed pump station. The model covered a length of 240 m of branches 1 and 2 on El-Sheikh Zayed Canal.

The model results revealed that the Canal has a uniform velocity distribution pattern and the hydraulic losses inside the distribution basin were 0.166 m. Accordingly, the available water depth in the Canal has dropped to 4.81 m. This value should be taken into account in the design of the suction basin.

97 – Improving the Conveyance Efficiency of the Suez Canal

Consultant : HRI

Period : 2004 – 2005

The study objective was to determine the actual conveyance efficiency of the Canal and examine the stability of its banks.

The study comprised field investigations, data collection, and bathymetric survey. A mathematical model "SOBEK-1D" was applied for examining the different alternatives to improve the Canal performance. The model aimed at investigating the design of the water cross section needed for future irrigation, industrial, and municipal requirements.

The results revealed that the present water cross section could not accommodate the required future discharges to cultivate 165,204 feddans. Therefore, it was recommended to widen the Canal width by 7 m and construct a vertical wall in the distance between the intake and km (74.000). On the other hand, the Canal cross sections in the distance between km (74.000) and the downstream end should be dredged to the design values.

98 – Improving the Conveyance Efficiency of the Suez Canal (Final Report)

Consultant : HRI

Period : 2005 – 2006

The study objective was to determine the actual conveyance efficiency of the Canal and examine the stability of its banks.

The study comprised field investigations, data collection, and bathymetric survey. A mathematical model "SOBEK-1D" was applied for examining the different alternatives to improve the canal performance. The model aimed at investigating the design of the water cross section needed for future irrigation, industrial, and municipal requirements.

The results revealed that the present water cross section could not accommodate the required future discharges to cultivate 165,204 feddans. Therefore, it was recommended to widen the Canal width by 7 m and construct a vertical wall in the distance between the intake and km (74.000). On the other hand, the Canal cross sections in the distance between km (74.000) and the downstream end should be dredged to the design values. Also, it was recommended to lower the bed level by 1 m**.**

99 – Hydraulic Assessment of the Naga Hammadi El-Gharbia Canal

Consultant : HRI

Period : 2005-2006

The study objective was to determine the difficulties that hinder the efficient and reliable distribution of irrigation water in the Canal.

The study comprised field investigations, data collection, and bathymetric survey. A mathematical model "SOBEK-1D" was applied for examining the different alternatives to improve the Canal performance.

The study revealed that the weed growth affects the Canal conveyance efficiency. Thus, the canal should be cleaned up form weeds. However, if the weed growth continues, the bed level should be lowered by 50 cm to allow for the cultivation of new 35,000 feddans.

100– Improving the Operational Management System of El-Ismaillia Canal: Proposal for Hydrographic Survey and Mathematical Modeling

Consultant : HRI

Period : 2005-2006

This study is to be conducted in order to improve the canal efficiency by enhancing the operational management system. This will be achieved by investigating the:

- Location of the bottlenecks;
- Cross section suitable for the second stage;
- Cross section suitable for the third stage;
- Locations of seepage along the Canal;
- Quantities of current seepage;
- The effect of the different measurers to control the seepage in the canal capacity; and
- The best Canal operation system, which fulfils the water needs, keeps the required level to operate the intakes along the canal, and at the same time saves the water.

The bathymetric survey will cover:

- 128 km downstream the Canal intake;
- Average cross section spacing over the study area is 100 m;
- Maximum cross section ordinate spacing of 25 m; and
- Maximum bank profile ordinate spacing of 10 m.

At each of the cross sections the water surface levels should be measured at the left and right banks. All level data to be referenced to meters above sea level (MSL). A single local datum may be used for location coordinates. The location of the datum is to be clearly indicated on plans and referenced back to ISG coordinates.

101– New Assyut Barrage: Field Measurements and Barrage Model Construction (Proposal)

Consultant : HRI

Period : 2005-2006

The objective of the study was to conduct a comprehensive hydrographic survey and filed measurements to assess the hydraulic conditions at the location of the proposed new Barrage.

Discharge and velocity measurements were carried out, in addition to bed sampling.

102– Improving the Hydraulic Efficiency of El-Nubaria, El-Naser, and El-Bostan Canals, as Base of the Integrated Water Management of the Western Delta (Proposal)

Consultant : HRI

Period : 2005-2006

This study was performed in order to improve the canals' hydraulic efficiency by enhancing the operational management system. This can be achieved by investigating the:

- Location of the bottlenecks;
- Cross sections suitable for the designed discharges for all canals;
- The best canals operation system, which fulfils the water needs, keeps the required level to operate the intakes along the canals, and at the same time saves the water; and
- The water quality problem in the Rosetta Branch, and its effect in the water quality of El-Nubaria and El-Naser Canals.

These characteristics will be examined through both a hydrographic survey and a 1-D hydrodynamic Model "SOBEK". The model will include the following:

- 117 km from El-Nubaria Canal;
- El-Naser Canal with a total length of 75.5 km;
- El-Boastan Canal with a total length of 54 km;
- 82 km from El-Behairy Canal;
- In addition to El-Nassery Canal with total length of 84 km; and
- All regulators, bridges, pumping stations, culverts, siphons as well as any hydraulic structures will be simulated in the model.

103- Increasing the Carrying Capacity of Bahr Hasan Wasef Canal

Consultant : HRI

Period : 2005-2006

The study main objective was to investigate the possibility of increasing the carrying capacity of Bahr Hasan Wasef Canal in order to meet the future irrigation requirements.

The study comprised field investigations, data collection, and bathymetric survey. A mathematical model "SOBEK-1D" was applied for examining the different alternatives to improve the Canal performance.

The model results revealed that the maximum carrying capacity of the Canal upstream the Weir is 41.5 m^3/s. Furthermore, it was recommended to lower the weir bottom level by 15 cm to increase the capacity by 7.8 m^3/s.

104- Hydrographic Survey of the Maryoot Pump Station

Consultant : HRI

Period : 2005-2006

The study aimed at investigating the main constraints that hinder the operation of the Maryoot Pump Station No.2. The survey covered a distance of 1,700 m of El-Nubaria Canal in front of the Maryoot Canal Intake, of which 950 m are located upstream the the intake.

The survey results revealed that the weed growth is propagating in the canal. Also, the deposition and the weed growth in El-Nubaria Canal hamper the possibility of increasing the flow to compensate the losses of the Maryoot Canal.

Based on the survey results, it was recommended to remove the weeds immediately. In addition, a further detailed study using a hydrodynamic mathematical model is suggested.

105- Riprap and Filter Protection of New Naga Hammadi Barrage

Consultant : HRI

Period : 2005-2006

The main aim of this study was to review and check the proposed filter design by the contractor and the consultant underneath the rip rap protection layer upstream and downstream New Naga Hammadi Barrage (NNHB). The study focused only on the riprap type 3, type 4 and type 5.

Based on the results that obtained for the proposed transition layer by the contractor and the consultant, it was found that both solutions didn't meet the criteria I, II, and III. It was concluded that both of the proposed transition layers by the contractor and consultant need more adjusting to fit all the design criteria of transition layer in order to secure the base material.

106- Alignment of Al-Ismailia Canal Upstream and Downstream New Saryakos Barrage

Consultant : HRI

Period : 2005-2006

The study objective was to examine the possible operational modes of the Barrage gates in regards to the realignment of Al-Ismailia Canal upstream and downstream the Barrage.

The hydrographic survey covered 3 km at the site of the Barrage, of which 2 km are located in the downstream side. A physical model of scale 1:40 was constructed to achieve the aforementioned goals.

The model results revealed that there is no difference between the construction of vertical walls and the restoration of the Canal banks with a side slope of 2H:1V. Hence, it was recommended to select the solution with the less costs.

107- Improving the Carrying Capacity of Bahr Wahba Canal

Consultant : HRI

Period : 2006-2007

The study main objective was to investigate the present hydraulic conditions of the Canal and envisage the possibility of increasing the carrying capacity of the Canal to accommodate the future irrigation requirements.

In order to achieve the abovementioned goal, the hydrodynamic model "SOBEK 1-D" was employed to test the different operating scenarios of the Canal. The model covered the distance between the Canal intake and km (56.550).

The results showed that the existing bed levels exceed the design water levels by 25 cm. Also, the results revealed that there is a decrease of 0.22 m to 2.3 m in the water levels. To accommodate the future discharges, it was recommended to replace the existing barrage with a new one that has 3 gates with 2.5 m width each.

108– Improving the Hydraulic Characteristics of El-Giza Canal

Consultant : HRI

Period : 2006-2007

The main objective of the study was to improve El-Giza Canal from its intake up to Km (59.000) in order to accommodate the irrigation water required to cultivate the new 43,000 feddans.

The study comprised field investigations, data collection, and bathymetric survey for the Canal in he abovementioned reach. A mathematical model "SOBEK-1D" was used to study the effect of the suggested pump station at Km (76.000) on the stability of the left bank of the River. Also, the different alternatives for discharging the water upstream the Lahoon Regulator were examined.

The model results revealed that the maximum carrying capacity of the Canal at its intake is 52 m^3/s. Based on the model results, it was recommended to calculate the construction costs of the pump stations on El-Athar, Momtaz, Tarkhan, and El-Meaqrab Canals. These costs should be compared with the costs of constructing a weir and 2 pump stations on Tarkhan and El-Meaqrab Canals. Consequently, the alternative with the least costs should be chosen.

109- New Assyut Barrage: Hydraulic Models Design, Construction and Calibration

Consultant : HRI

Period : 2006-2007

With the aim of confirming the main design features and optimising flow conditions in the vicinity of the main structures, physical model investigations were performed. The first aspect of the model studies involved confirmation of the general arrangement of the layout of the components and assessment of navigation conditions in the approach to the navigation lock. The second aspect of the model studies was the optimization of flow conditions in the immediate vicinity of the structures including, upstream, the shape of piers, guide walls, intakes, abutments etc., the shape of the apron of the sluiceway and the River bed protection. The second aspect also entailed proof of the stability of River bed and bank protection upstream and downstream of the structures.

To study the different aspects identified above four different models were constructed:

1. Sluiceway Detail Model (1) to assess the discharge rating curve for the radial gates and to optimize the design of the new Barrage sluiceway and upstream and downstream erosion protection measures. The scale of the model was 1:21.
2. Sluiceway Detail Model (2) to assess the discharge rating curve for the existing Assyut Barrage (during construction) and El-Ibrahimia Head Regulator (post-rehabilitation) and to optimize upstream and downstream erosion protection measures. The scale of the model was 1:20.
3. Barrage Model to study all local effects directly associated with the Barrage structure and the bed and bank protection systems. The scale of the model was 1:45.
4. Navigation Lock Model (provisional) to study the flow conditions in and around the lock during filling and emptying of the chamber. The selected scale of the model was 1:25.

The results of model calibration with the high River flow showed a good agreement between the prototype and the model. Also, the results of model calibration with the dominant and low River flow showed some acceptable deviation because the bed of the model was kept as it is according to the bathymetric survey of August, 2006.

The model calibration at cross section No. 6, in front of El-Walideya Power Plant, doesn't match with the prototype condition because of the ongoing dredging works in the River bed in this area. Hence, it was recommended to carry out special measurement set for the branch in front of El-Walideya Power Plant.

110- Hydraulic Design of El-Abbasi Main Canal Head Regulator

Consultant : HRI

Period : 2006-2007

The study objective was to examine the possibility of passing 28 MCM/day from the Head Regulator (under construction) of El-Abbasi Main Canal.

The study involved field investigations, data collection, and bathymetric surveys, and one-dimensional hydrodynamic mathematical model "SOBEK", which includes the hydraulic characteristics of the canal.

The model results showed that the design discharge can not pass through the Head Regulator. The actual discharge represents 91% from the design discharge the intake. It was recommended to dredge the reach in the distance between km (0.500) and km (1.500) in order to accommodate the 28 MCM/day. On the other hand, the canal may accommodate the 28 MCM/day when the Head Regulator is constructed through 8 gates with a 5 m width each.

111- Investigating the Required Infrastructure to Improve the Irrigation Process in the West Delta Project

Consultant : HRI

Period : 2006-2007

The study aimed at examining the different alternatives to convey sufficient irrigation water to the West Delta Project in order to improve the irrigation in 1.2 millions feddans in the Nubaria area.

The study involved field investigations, data collection, bathymetric survey, and one-dimensional hydrodynamic mathematical model "(SOBEK"), which includes the hydraulic characteristics of all the canals in the area.

According to the model results, it was recommended to construct a new culvert between El-Nassery Canal and El-Behairy Canal at km (38.000). The culvert consists of 4 pipes with 2.5 m diameter each. This will bring the discharge of both the old and new culverts to 6.4 MCM/day. Also, it was recommended to construct a pump station on Rosetta Branch at km (66.000). Moreover, an open channel with a length of 1.3 km was proposed to accommodate the 10.4 MCM/day that comes out from the pump station and convey it to El-Behairy Canal.

112- Controlling Bed Erosion in El-Ibrahimia Canal

Consultant : HRI

Period : 2006-2007

The study objective was to determine the possible measures to control the bed erosion in El-Ibrahimia Canal in the distance between the canal intake and Dayroot Barrage. Emphasis was placed on exploring the scour around the bridge at km (23.000).

The study involved field investigations, data collection, bathymetric survey, and one-dimensional hydrodynamic mathematical model "SOBEK", which includes the hydraulic characteristics of the Canal in the area, in addition to the existing hydraulic structures.

The model results revealed that the velocity beneath the bridge is 1.05 m/s before protection and can reach 1.2 m/s after protection. Also, the maximum discharge that the Canal can accommodate is 490 m^3/s. Based on these results, it was recommended to elevate the bed level by 1.75 m for a 30 m distance, of which 15 m are located upstream the bridge. This will help in protecting the bridge piles.