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SOURCES FOR SANA'A WATER SUPPLY  
(SAWAS - II Project)

Progress Report 91 - 3  
No. 8

Reporting Period  
July - September 1991

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NATIONAL WATER AND SEWERAGE AUTHORITY  
SANA'A  
SANA'A WATER SUPPLY AND  
SANITATION (SAWAS)

National Water and Sewerage Authority (NWSA)  
P.O. Box 104  
Sana'a, Yemen Arab Republic

TNO Institute of Applied Geoscience  
P.O. Box 6012  
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823-YESA91-9175

Annex 1. SAWAS Personnel (September 30, 1991)

\* National Water and Sewerage Authority (NWSA) staff;

- Ali Al-Mohani	Project Co-ordinator
- Mohamed Ali Al-Halali	Hydrogeologist (Geographer)
- Mohamed Mayas	Hydrogeologist
- Mrs Lutfia Abdul Gafoor Siddiq	Hydrologist
- Mohamed Ahmed Abdulmalik Naji	Hydrologist (Hydrogeologist)
- Ali Al-Zuberi (temporarily)	Water supply engineer
- Abdul Baki Al-Mansoop	Assistant hydro(geo)logist
- Ahmed Nasser Al-Qaisi	Assistant hydrogeologist
- Arwa Ahmed Abdul Malik	Secretary
- Abdallah S. Ali	Public relation manager
- Ahmed Al-Mansur	Driver

\* Expatriate staff (TNO Institute of Applied Geoscience);

- Jan P. Heederik	Team leader (till 10 September 1991)
- Wim van Dalflen	Team leader (from 10 September 1991)
- Sander Bloemendaal *)	Hydrogeologist
- Ko (J.M.J.) van Kuyk *)	Geophysicist (shallow surveys)
- Wim van Dalflen *)	Geophysicist (deep seismics)
- Jac A.M. van der Gun *)	Project supervisor

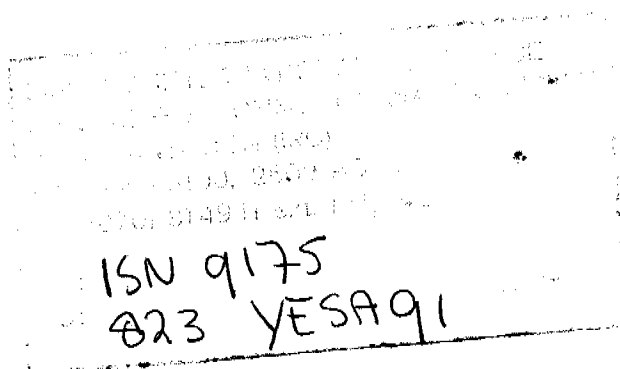
\*) non residents

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**Reporting period**  
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**By Ali Al-Mohani (Project co-ordinator)**  
**Jan P. Heederik (Team leader SAWAS-2)**  
**Wim van Dalzen (Project co-manager SAWAS-2/3)**



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## 1. GENERAL.

The eight quarterly report (91 - 8) of SAWAS - II covers the period July - September 1991. Officially the SAWAS-2 project ended on 30 August 1991. Because the formal approval for the third phase of the SAWAS programme (SAWAS-3) could not materialize prior to the termination of the SAWAS-2 project, a four month interim period became necessary: September - December 1991. Early September 1991 DGIS approved the proposed SAWAS-2/3 interim budget and officially commissioned the execution of the interim period to TNO Institute of Applied Geoscience. On the 8th of September 1991 the SAWAS-2/3 Project co-manager, Mr. W. van Dalzen arrived in Sana'a. However, a lot of the activities carried out during September were still related to SAWAS-2 and to a certain extent these activities were executed under the joint responsibility of the two Dutch Project co-managers. Therefore it was decided to include September into this last SAWAS-2 progress report.

During this period the project activities were focused on;

- drilling operation in the Tawilah Sandstone aquifer underlying Sana'a (South of Sana'a);
- selection of locations for wadi gauging stations in Wadi Kharid and Upper Wadi Surdud, and design of these stations;
- installation of rain gauges and meteorological equipment;
- monitoring meteorological and hydrological data at Wadi Kharid and upper Wadi Surdud;
- interim project management (1-10 September 1991);
- delegation of project responsibilities (SAWAS-2/3);

## 2. Activities.

2.1 Rehabilitation of metering system.  
No activities undertaken

2.2 Pump optimization.  
In order to enable the Sana'a Branch to use the Pump optimization spread sheet programme developed by SAWAS, an additional computer was purchased.

2.3 Wellfield investigations Sana'a South.

2.3.1. Wellfield investigations  
The draft Technical Report No.3 "Wellfield Investigations Sana'a South" was submitted for comments to: NWSA and the Advisory Committee for Water Project in (North) Yemen.

2.3.2. Drilling programme  
The SAWAS-2 drilling programme in the area South of Sana'a has been completed.

2.3.3. Monitoring  
On 5 august 1991 an Omnidata water level recorder (pressure transducer type) was installed at the borehole near Hyziat (A-1). Since then the recorder works satisfactory and has given good and interesting data. Additional monitoring equipment to be installed in the well near Dar Salm (A-2) has been ordered.

2.4 Wellfield investigations East of Shibam/Kawkaban

2.4.1. Wellfield investigations.  
The drilling programme is not yet completed, neither are the production and distribution cost of water from an eventual well field East of Shibam properly evaluated. Never the less, the draft Technical Report No.4 "Wellfield Investigations East of Shibam" was submitted for comments to: NWSA and the Advisory Committee for Water Projects in (North ) Yemen. During September the draft drilling report of the exploration well at Bayt Al-Dayl became ready.

#### 2.4.2. Drilling programme

Till now the anticipated target formation (Tawilah Sandstone) has not yet been encountered. On 3 July 1991 the drilling operation has been temporarily suspended, because the continuation of the drilling of this borehole requires a larger drilling rig (a T-5 instead of a T-4).

At the end of the reporting period, the drilling operations at the Berish location were not yet resumed.

#### 2.4.3. Monitoring

Suitable monitoring equipment for the Bayt Al-Dayl (B-1) has been ordered.

#### 2.5 Preliminary study deep sandstone aquifers.

##### 2.5.1. Tawilah Sandstone

###### Drilling programme

For various reasons the drilling operations at Al Sabaeen Municipal Park took considerably longer than anticipated: a) the top of the Tawilah Sandstone appeared to be deeper than estimated; b) because of the great depth unexpected technical problems occurred, such as: several breakdowns of the mud pump, drill string got stuck, etc., c) the well design was more complicated, requiring high quality 9 5/8 casing, d) the required casing was only available in Aden and the negotiations with the Russian to purchase the casing took more than one month, e) etc. etc.

On 3 July the top Tawilah was struck at a depth of 630 m below surface level (8 1/2" diameter borehole), the drilling continued till a depth of 753 m (11 July). On 11 July the drill string got stuck in a layer of swelling clay at a depth of 480 m. After the string got loose it appeared that the mud pump had broken down. This of course caused loss of circulation which could have been the case for getting stuck in the swelling layer. On the evening of 17 July the string became loose.

The negotiation between the drilling company and the (Russian) owner of the casing in Aden took more than one month (20 July-28 August).

Prior to the running of the 9 5/8" casing the borehole was reamed (12 1/2" diameter) and cleaned till a depth of 660 m (3 September). A 7 m deep 11" hole was drilled to accommodate the casing shoe (4 September).

Casing running started Saturday 7 September, on Thursday 12 September 667 m of casing was installed, subsequently the drilling with 8 1/2" diameter continued till a depth of 850 m (a record depth for water well drilling in Yemen and also a record depth for a local drilling company). This depth was reached on 16 September 1991.

The well was temporarily cleaned (back washing) and the well head (large concrete slab) completed. Because of the celebrations for Revolution Day 26 September 1991, the drilling company was summoned to demobilize completely before the 26th of September. For that reason the drilling company was unable to continue the cleaning and development of the well. After Revolution Day the drilling company was hampered by the negotiations with the Sana'a Branch of NWSA concerning the rental of a suitable pump for further development.

It is expected that the Al Sabaeen well might be a very promising well, however, at the end of the reporting period no definitive figures can be given because the well could not yet be properly tested. Alternative ways to clean and develop the well are still being studied.

###### Well logging

The preparations for a long term Service Agreement with Schlumberger for the logging of exploratory water continued. The well logging of the Al Sabaeen well should be carried out under the umbrella of the long term service agreement. At the end of the reporting period some point of the contract still had to be solved.

## Monitoring

For future monitoring suitable monitoring equipment has been ordered.

2.5.2. Kohlan - and Wajid Sandstone  
No specific activities undertaken

2.6 Monitoring Wadi Kharid and Wadi Surdud.

2.6.1 General.

During the reporting period Mr W. Boiten (Hydrometrist of Delft Hydraulic Laboratory) visited the project to assist with the design and implementation of river gauging stations in Wadi Kharid and Upper wadi Surdud. Unfortunately the implementation of the wadi gauging stations required more preparations than anticipated. It was decided that the construction of these gauging stations will be directed by the SAWAS team. The concerning team members were thoroughly instructed by the hydrometrist.

The hydrometrist worked closely together with the recently appointed hydrologist Mr. Mohamed Naji. Mr Mohamed Naji's group is in charge of the hydrological and hydrogeological fieldwork, installation of monitoring equipment and monitoring of the field work.

2.6.2 Wadi Kharid.

During July three rain gauges were installed and in August one rain gauge station and one meteo station were installed. The functioning of the stations was regularly checked and no mal-functioning has been observed so far. Discharge measurements were taken at two locations.

Several field trips have been made with the hydrometrist to study the location for future gauging structures. Two different measuring techniques have been recommended; "slope-area" method for peak flows and a sharp crested weir for measuring the base flows. The selected locations for the gauging station have been mapped by levelling.

2.6.3 Wadi Surdud.

The functioning of the hydrological network (rain gauges and meteorological stations) was regularly checked. The location of some rain gauges were improved. Rainfall data were collected according to schedule. Discharge measurements were taken at the confluence of the Wadi Surdud with the Wadi Dayan.

Two field trips were made with the hydrometrist to study the locations for a future gauging station. Contrary to the proposal for Wadi Kharid only one gauging station has been recommended.

2.7 Adjustment of "water sources planning model".

The calculations of the production and distribution cost for the different options, which form the basis of the "water sources planning model" as presented in Technical report No. 1 Water Resources Inventory (Reprint Mission report SAWAS-1), were up dated. The updated planning model will be presented in the administrative report "Final Review of the SAWAS-2 Project".

2.8 Training.

The hydrometrist, Mr. Boiten has given intensive on-the-job training to the Hydrology Group concerning: discharge measurements, flow monitoring, design and implementation of gauging stations and levelling techniques. It is planned that Mr. Boiten will return under SAWAS-3 to give more extensive training in the above mentioned subjects. No further training activities were undertaken.

2.9 Reporting

The drilling operations at Berish (East of Shibam) and at Al-Sabaeen Municipal Park (Tawilah Sandstone), consequently writing and/or completion of Technical Reports No. 4 and 5 are delayed as well.

Meanwhile the reporting continued on;

- Van Dalfsen, W.

- Mission report June 14th - July 3rd 1991
- Bloemendaal, S., J.P. Heederik and K.M.J. van Kuijk (January 1991)  
Wellfield Investigations Sana'a South  
Technical Report No. 3  
Awaiting the comments form NWSA and the Advisory Committee Water Project (North) Yemen.
- Bloemendaal, S., J.P. Heederik and K.M.J. van Kuijk (July 1991)  
Wellfield Investigations East of Shibam  
Technical Report No. 4  
Awaiting the comments form NWSA and the Advisory Committee.
- Van Dalfsen, W.  
Wellfield Investigations Tawilah Sandstone  
Technical Report No.5
- Van Dalfsen, W.  
Pre-feasibility Study Deep Aquifers  
Technical Report No. 6
- Boiten, W. (September 1991)  
Wadi Gauging Stations in the Wadi Kharid and the Upper Wadi Surdud  
Technical note
- Al- Halali, Mohamed and Mohamed Mayas  
Exploration well drilling East of Shibam, exploration well B-2
- Al-Halali, Mohamed and Mohamed Mayas  
Exploration well drilling Tawilah Sandstone (Al-Sabaeen Borehole)

Various internal technical notes (4) have been issued concerning the hydrological fieldwork by Mohamed Naji, one technical note on the horological and hydrogeological database (Lutfia Siddiq) and one drilling report (draft) concerning the exploration well at Bayt Al-Dayl.

#### 2.10 Coordination with other project

During this period the SAWAS project contacted/cooperated with the following projects and/or institutions;

- \* General Department for Water Resources Studies (GDWRS/WRAY-4 project
- \* Technical Secretariat of the High Water Council (TS/HWC)
- \* Integrated Rural Development project Al Mahwit Province
- \* Ministry of Municipalities and Housing
- \* Ministry of Agriculture and Water Resources (MOA)

### 3. Managerial aspects.

#### 3.1 General.

During the reporting period considerable time had to be spent on the drilling operations at Al-Sabaeen Municipal Park. The coordination of the hydrological field work and the mission of Mr. Boiten were important activities.

On the 8th of September 1991 the SAWAS-2/3 project co-manager Mr. Wim van Dalfsen arrived in Sana'a and toke over the overall responsibility from Mr . Jan P. Heederik.

#### 3.2 Personnel

Since the last progress report no changes in the NWSA project staffing have taken place. The present project staff (30 September 1991) is given in Annex 1.

#### 3.3 Logistics.

No logistic problems have been encountered.

#### 3.4 Equipment.

Before the end of SAWAS-2 still some equipment specifically related to the remaining SAWAS-2 activities have been ordered.

A complete list of the equipment ordered and delivered under SAWAS-2 will be presented in the Final Review of the SAWAS-2 Project.

#### 3.5 Finance.

Total disbursement (SAWAS-2) from The Netherlands budget till the end of September 1991 amounted to approximately Dfl. 3.080.000 ,-, the disbursement



over the first three quarter 1991 amounted to Dfl. 1.250.000 ,-. There are no exact figures available on the disbursement from the Yemini budget.

### 3.6 Back stopping.

During the reporting period the project received the following "short mission" support:

- Mr. W. van Dalfsen (the SAWAS Geophysicist - deep seismics) ended this third short mission regarding the deep sandstone aquifers on 3 July 1991;
- Mr. J.P. Heederik bridged the period between the end of SAWAS-2 (1 September 1991) and the arrival of Mr. W. van Dalfsen (7 September 1991). He extended his stay till 21 September 1991 as back stopper. The concerning mission report has been submitted;

## 4. Evaluation and required actions.

### 4.1 Project planning .

The following activities are behind schedule;

- drilling programme East of Shibam. Consequently the reporting on well field investigations East of Shibam, Technical Report No. 4 will be delayed (Never the less a preliminary draft report has been submitted);
- drilling programme Deep Sandstone aquifers - Tawilah Sandstone, underlying Sana'a. Consequently the reporting on well field investigations deep sandstone aquifers - Tawilah Sandstone, Technical Report No. 5 will be delayed;
- reporting on pre-feasibility study Kohlan- and Wajid Sandstone, Technical Report No. 6.
- installation of wadi gauging equipment in Wadi Kharid and Wadi Surdud. Because of the limited data records the preliminary reporting on the surface water potential of both wadi's will be postponed till a relevant number of data has become available Technical Report No. 7 (?);

### 4.2 Limiting circumstances.

The limiting circumstances from the past have been mentioned in previous progress report:

- relatively unexperienced counterparts;
- delayed ordering and delivery of essential (monitoring) equipment ;
- considerable time which had to spent on the drilling operations;

### 4.3 Required actions.

Per 1 September 1991 SAWAS-2 is officially ended. The remaining activities, as far as they are not included in the Plan of Operation of SAWAS-3, should be continued and as far as possible completed during the interim phase SAWAS-2/3. The activities are;

- completion of the Al-Sabaeen exploration well: cleaning, development logging and well testing;
- if the remaining SAWAS-2 budget allows, continue the drilling operation at Berish (East of Shibam) till the Tawilah Sandstone has been reached;
- installation of wadi flow gauging stations in Wadi Kharid and Upper Wadi Surdud

### 4.4 Conclusions.

As this is the final progress report dealing with SAWAS-2, the parting SAWAS team leader wants to thank NWSA and the SAWAS team member for the cooperation during the last two year. Although for various reasons appropriate staffing of the project in the beginning toke some time , at present the SAWAS team is well motivated and has gained relevant experience to continue the work according to the SAWAS-3 Plan of Operations.