

PDCAP 170

FINAL REPORT

TECHNICAL ASSISTANCE TO THE  
AQABA WASTEWATER PROJECT (278-0206)  
GROUNDWATER MONITORING PROGRAM

HASHEMITE KINGDOM OF JORDAN

PHASE I - INITIAL EVALUATION

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MAY 1986

**FILE**

278-0206  
and  
278-0260

The opinions expressed in this report are the professional opinions of the author and do not represent the official position of the Government of the United States of America.

## EXECUTIVE SUMMARY

A consultant to the WASH project, USAID Washington, conducted a one week field review of the status of a groundwater monitoring program to evaluate impacts upon the groundwaters of the Aqaba region following startup of the AID funded Aqaba Wastewater Project (278-0206). This review was between May 19-23, 1986 and included a site visit along with numerous discussions with key personnel involved in initiating and continuing the program. In addition, groundwater samples were collected and carried back to the USA for testing in the Boston laboratory of Camp Dresser & McKee Inc.

### Findings

The principal findings are as follows:

1. WAJ has made a sincere and meaningful start on the program, which assuming expeditious implementation of the recommendations made in this report, will provide adequate baseline data as the initial step of an effective monitoring program.
2. WAJ, by installation of the monitoring wells, has now committed the greatest part of the total cost of the program.
3. The central laboratory facilities of WAJ appear to be fully capable of performing all required testing.
4. Evaluation of limited data obtained to date indicates complex mixing of two discrete aquifers of different hydraulic and chemical composition in the Aqaba area.
5. A limited program involving technical assistance and commodities will be necessary to aid WAJ in the execution of the monitoring program.

## Recommendations

The principal recommendations contained in this report are as follows:

1. Time is of the essence regarding obtaining meaningful baseline data of the aquifers in the area of the treatment plant. WAJ must be encouraged to continue its efforts to complete this critical part of the program. Final development of the monitoring wells followed immediately by sampling and testing under supervision of WAJ lab personnel, is essential and must be concluded prior to startup of the plant, which is imminent.
2. The configuration, both quantitatively and qualitatively, of the mixing zone of the Wadi Araba and Wadi Utam should be carefully established using modern tracing and modeling techniques. This most likely will involve data from areas beyond Aqaba.
3. Phase II of this technical assistance should carefully integrate training with other programs now underway or planned for the near future. Of particular importance is the contractor (Aqaba plant construction) furnished training. The groundwater monitoring should be carefully integrated into overall plant process monitoring.

## ACKNOWLEDGMENTS

The assistance of Mr. Abdullah Ahmed - USAID, Jordan, is most gratefully acknowledged. In addition, the cooperation of WAJ personnel, particularly Dr. Samir Hijzin, Abdel Hamid Khatib and James G. Cassanos is equally appreciated.

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## 1. INTRODUCTION

### 1.1 Overview

As the initial action of a program intended to assist the Water Authority of Jordan in its efforts to monitor groundwater conditions in the vicinity of the newly constructed Aqaba wastewater treatment facility, Mr. Robert J. Kachinsky, P.E. traveled to Jordan to review progress to date and assist WAJ wherever possible. This assistance was to be primarily to advise regarding:

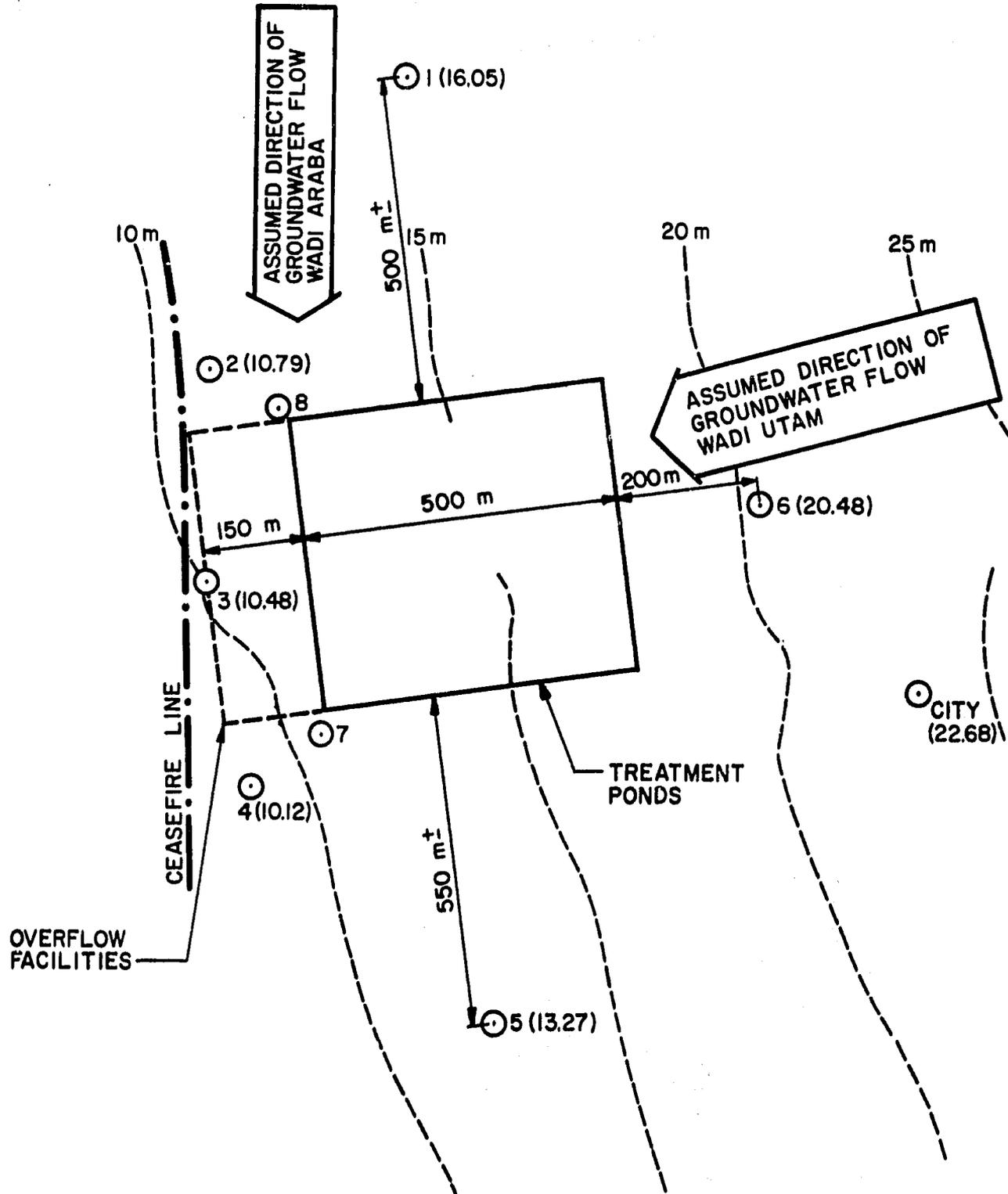
- o well location
- o well configuration
- o well development
- o sampling techniques
- o testing
- o organization of overall program

In addition, samples were taken concurrently with WAJ from four wells. These samples will be tested simultaneously in the laboratory of Camp Dresser & McKee in Boston and the WAJ lab in Amman.

While in Amman, Mr. Kachinsky gave a lecture to selected WAJ staff in which current USA practices regarding monitoring of groundwater contamination from wastewater sources and other sources.

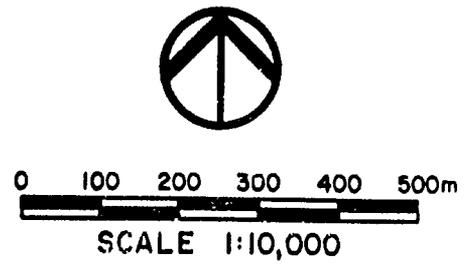
### 1.2 Overall Status of Groundwater Monitoring

Prior to 19 May 1986, WAJ had installed, with its own personnel, six monitoring wells with another underway. The plan calls for a total of eight wells. Figure 1.1 shows the approximate location of these wells. In addition WAJ had found an abandoned well installed by the City of Aqaba near the site. This well had been used for irrigation purposes.



**LEGEND**

- 10m TOPOGRAPHIC CONTOUR
- (20.48) GROUND ELEVATION
- PROPOSED OBSERVATION BOREHOLE



**FIG. I.1 LOCATION OF MONITORING WELLS**

A limited amount of sampling had been done and some lab results were available. Annex A provides these results. It should be noted that all sampling had been taken without any development/stabilization of the new wells.

### 1.3 Cooperation

Mr. Kachinsky accompanied by Mr. A. Ahmed of USAID, met with top management of WAJ and the key personnel involved in the monitoring program immediately following his arrival in Amman. The level of interest in the program and spirit of cooperation was quite high. Arrangements had already been made for travel to Aqaba the next day as well as for all necessary equipment and military clearance.

### 1.4 Status of Sewerage Facilities

At the time of this report preparation, the contractor had not yet obtained a certificate of substantial completion. He was in the process of repairing some erosion to the dikes as well as miscellaneous cleanup activities at the main pump station and plant operations buildings. There was also some speculation as to when electric power would be connected to the facilities.

The City of Aqaba had planted a large area south of the plant with date palms and had installed an irrigation system.

A major concern, shared by R. Kachinsky, is the lack of house connections to date. It is estimated that less than 2200 CMD of flow will be available at startup. This represents about 25% of plant design capacity. Given that startup will be in the hot season, it appears that it will be impossible to maintain pond depths with a good chance of foul odor resulting. WAJ operations staff are very concerned and are exploring alternatives to normal startup. One alternative is spreading of raw sewage at the newly established date palm area south of the plant.

## 2. MONITORING WELLS

### 2.1 Description of Wells

Wells installed are more than adequate for monitoring. In fact, they are production wells considerably larger than what is needed for monitoring. Other than the unnecessary expense, these wells are suitable for the program. WAJ personnel were reluctant to provide anything more than verbal information regarding detail of these wells and drilling records. A completion report is being prepared and will be available in a month. Figure 2.1 provides some information which was gleaned from discussions with WAJ and field observations. Annex B includes photos of the well heads at each well.

WAJ has expended a considerable sum to construct these wells. The locations of six wells is exactly as recommended by the USEPA<sup>( )</sup>. In addition, two extra wells are being drilled, one north and another south of the seepage beds. See Figure 1.1.

All wells were constructed by WAJ crews and equipment. Equipment was of the cable tool type.

All aquifers were reported to be sand except for one well (not defined) which was gravel.

Details of the city well are unknown. Figure 2.2 shows the approximate relationship of ground surface to groundwater table across the ponds.

| WELL # | ELEVATIONS     |             |              |
|--------|----------------|-------------|--------------|
|        | GROUND SURFACE | BOTTOM WELL | GROUND WATER |
| 1      | 16.052         | -14.0       | 7.13         |
| 2      | 10.788         | -13.2       | 6.64         |
| 3      | 10.483         | -13.5       | 6.87         |
| 4      | 10.117         | -22.8       | 6.34         |
| 5      | 13.267         | -19.7       | 6.85         |
| 6      | 20.485         | -12.5       | 7.51         |
| CITY   | 22.682         | —           | 7.81         |
| 7      | —              | —           | —            |
| 8      | —              | —           | —            |

NOTE: WELLS 7 & 8 STILL BEING INSTALLED. PLANNED DEPTH IS 24m.

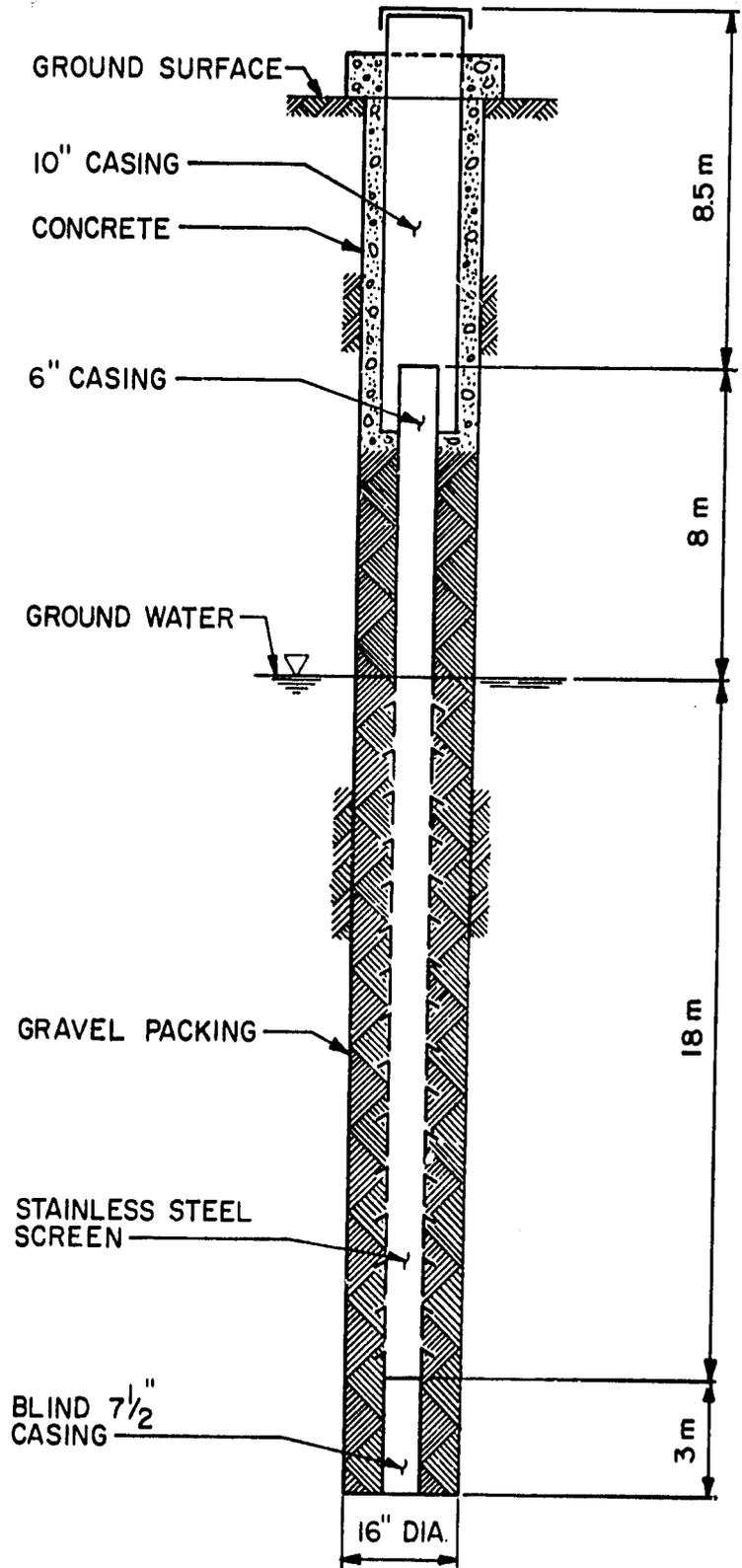


FIG. 2.1 "ROUGH" DATA ON WELL CONFIGURATION

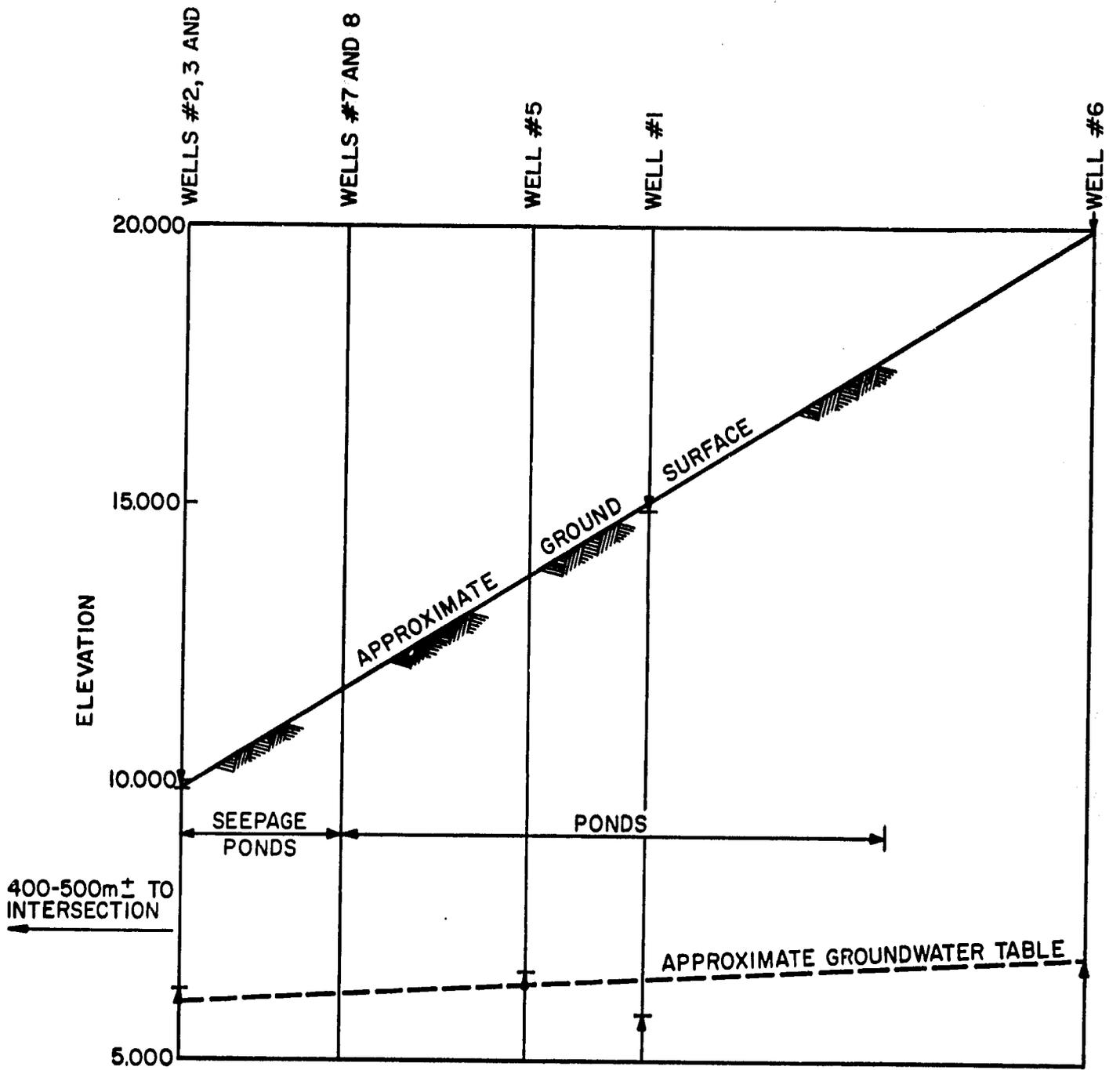


FIG. 2.2 APPROXIMATE LOCATION OF GROUNDWATER

## 2.2 Needs and Recommendations

None of the wells have been developed and stabilized. WAJ personnel are aware of the need and have indicated that proper development will be undertaken very soon. Sampling from wells 6, 3 and 2 on 20 and 21 May 1986 was done after an average of 1-1/2 hours of air jetting. Wells 6 and 2 were fairly free of sand but well 3 continued to discharge significant amounts of sand after more than two hours of pumping. Conductivity readings were taken prior to pumping and prior to sampling as well as several times during pumping. Some stabilization was noted, however it must be questionable due to the limited time of pumping. Table 2.1 displays E.C. readings taken at these wells.

Table 2.1  
Electro-Conductivity Micro MHOS/CM

| <u>Well</u> | <u>Prepumping</u> | <u>At Start</u> | <u>At End</u> |
|-------------|-------------------|-----------------|---------------|
| 2           | 21,000            | 12,000          | 15,000        |
| 3           | 4,550             | 3,900           | 3,900         |
| 6           | 4,500             | 3,700           | 3,650         |

Equipment employed during the above sampling was a compressor rated at 175 cfm at 100 psi. During air jetting pressure at the compressor was 62 psi. This resulted in "slug" discharge as opposed to a steady discharge. It is recommended that either a larger capacity compressor or a submersible pump arrangement be used for development/stabilization of these wells. It is further recommended that development begin immediately and be supervised by appropriate WAJ staff.

### 3. GROUNDWATER SAMPLING

#### 3.1 Prior to 19 May 1986

Grab samples were taken immediately following well completion at wells 1, 4, and 6. In addition, grab sampling was done at the city well. Tests were run at the WAJ lab in Amman and the results were recorded. It was reported that another set of grab samples was taken at wells 1, 2, 3, 4, 5, 6 and the city well and sent to WAJ. The WAJ lab did not acknowledge receiving these samples.

A general observation is that sampling was a bit shaky and procedures need to be tightened. Chain of custody and transferral procedures definitely need to be tightened up.

#### 3.2 Comments on WAJ Laboratory Facilities

A tour of the WAJ laboratory facilities in Amman was made under direction of Abdel Hamid Khatib, Director Laboratories and Environmental Control, WAJ. The facilities are well equipped and have ample staff to run all tests which WAJ will require for its operations. A. Khatib has been associated with this lab since 1968 when it was part of several other organizations prior to the formation of WAJ. The newest component is the addition of a bacteriological unit which was transferred from the Amman Sewerage Authority when WAJ took over their activities.

WAJ is currently planning to establish three district labs primarily for bacteriological testing. One will be located in Maan.

The WAJ has cooperative relations with the Royal Scientific Society (RSS) lab. In summary, there does not appear to be any problem with the WAJ lab performing all tests relative to the Aqaba groundwater monitoring program.

### 3.3 Sampling 20 and 21 May 1986

Immediately following pumping, samples were taken from wells 2 and 6. Samples were taken from well 3 approximately 12 hours following pumping and from the city well without pumping. Two - 2 liter samples were taken from each location for shipment to CDM's Boston lab. In each set one liter was fixed with 5 ml of concentrated nitric acid. All samples were packed in ice in an insulated container. WAJ took sets comprised of 2 - 1 liter samples at the same time and fixed one liter of each set with 2.5 ml of the same acid. These samples were not packed in ice or insulated containers.

The samples for metals were taken with a bailer from a constant depth while the samples for the other tests were taken from the airlift discharge just prior to shutdown. Samples from well 2 and the city well were taken by bailer since no pumping was done during sampling.

Readings for electro-conductivity, total dissolved solids, pH and temperature were recorded by R.J. Kachinsky at the time of sampling. WAJ similarly recorded electro-conductivity and pH. Table 3.1 displays these measurements.

### 3.4 Results

Annex A contains the full report prepared by CDM's lab.

In general this data does not contain any anomalies. All heavy metals tested for are lower than the limits of testing. The relatively high concentrations of chlorides and sulphates in wells 2 and 3 confirms that the highly brackish waters of Wadi Araba dominates these wells. The lower (but still high) readings at the other two wells confirms that Wadi Utam controls these wells. None of the other data indicates anything abnormal.

Since the primary purpose of this sampling was to check the WAJ laboratory data on concurrent samples, nothing further can be concluded at this point until that data is made available and compared under Phase II.

### 3.5 Needs and Recommendations

There is a clear need to establish procedures for consistency in sampling, transportation of samples and recording of data. Such would be part of a training program for overall monitoring of the Aqaba wastewater treatment facilities. All tests can and should be routinely done at the plant laboratory when it has been equipped and is operational. Occasional checking of results should be done by personnel from the WAJ central or district lab. This checking should include sampling, transportation and testing.

Considering that such training and equipment is not yet at the plant site the following course of action is recommended:

- o After all monitoring wells have been suitably developed, sample each well and run tests at the WAJ-Amman lab.
- o All sampling, transportation, and testing should be under direct supervision of WAJ lab personnel.
- o To the extent possible, those designated for laboratory control at the Aqaba plant should observe and assist in the above sampling and testing. This includes the contractor furnished lab trainer.
- o These results should be compared, where appropriate, with the results obtained by the sampling and testing by CDM.
- o If any unexplainable significant differences are noted, appropriate samples should be taken by WAJ lab personnel and retested. The RSS labs can be used as well.

The above actions will provide a meaningful data regarding pre-operational groundwater conditions at the Aqaba wastewater treatment plant site.

Given that the plant is now overdue for startup, this program must be commenced immediately. In the event that startup does occur before the above monitoring can be concluded, it is unlikely that the aquifers will be impacted for several months or longer. However this should not be a justification for delay of the above actions.

## 4. CONCLUSIONS

### 4.1 Overall

WAI has made a meaningful and sincere start on the program, which assuming expeditious implementation of the recommendations made in this report, will gather adequate baseline data and establish an effective ongoing monitoring program. It is highly recommended that USAID continue to provide technical assistance to WAI regarding groundwater monitoring at Aqaba but in concert with the overall facility process monitoring and control. Virtually all testing will be amenable to being done in Aqaba. This will minimize problems caused by transportation and chain-of-custody.

### 4.2 Aqaba Region Aquifers

Limited sampling and testing to date has fairly conclusively shown that the Aqaba wastewater plant is located above a mixing zone of two very different (qualitatively and quantitatively) aquifers. The first aquifer is the Wadi Araba, which appears to influence the westerly edge of the facilities. The Wadi Araba Aquifer is very brackish (readings more than 15,000 micro mhos/cm were recorded at the north west corner of the plant). The second aquifer is Wadi Utam which mixes with the Wadi Araba over the greater portion of the plant site. It is reported that Wadi Utam conveys significantly more water than the Wadi Araba aquifer.

Based upon the above limited data, it may be possible that, in the event of contamination of the groundwater by the Aqaba plant, the impact upon the Wadi Araba aquifer would be negligible. However, it will be essential that more detailed groundwater flow mapping and modeling be done to verify that assumption. Furthermore, it will most likely require data from the aquifer beyond Aqaba. An excellent source of data should be available from the wells now pumping from the Wadi Araba aquifer south west of the Aqaba wastewater plant.

#### 4.3 Phase II

This report concludes activities under Phase I. Phase II should take advantage of the fact that a chemist is being provided as part of the construction contract for three months at startup. Training envisioned as part of Phase II should be coordinated with that other training. Annex B provides a program outline and budget for Phase II

**ANNEX A**

**Laboratory Results**

# CDM

environmental engineers, scientists,  
planners, & management consultants

CAMP DRESSER & McKEE INC.

One Center Plaza  
Boston, Massachusetts 02108  
617 742-5151

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TASK NO: 86052702  
FILE NO: 9956-182  
LAB NOS: 18814-18

5 JUNE 1986

CERTIFICATE OF LABORATORY ANALYSIS

PROJECT: AQABA

REPORT TO: ROBERT J. KACHINSKY  
CDM/BOSTON  
RE: 3029-241-ALT-USA

DATE SAMPLES RECEIVED: 27 MAY 1986

DATE SAMPLES COLLECTED: 20 MAY 1986 BY R.KACHINSKY/CDM

ANALYTICAL METHODS: STANDARD METHODS FOR THE EXAMINATION OF WATER AND WASTEWATER, 16TH ED., 1985, AND/OR BY THE US EPA MANUAL OF METHODS FOR CHEMICAL ANALYSIS OF WATER AND WASTES, MARCH 1983.

ANALYTICAL RESULTS: AS ON ATTACHED TABLES.

*Peter T. Maynard* 5 June 1986  
PETER T. MAYNARD DATE  
SENIOR INORGANICS CHEMIST

*James F. Occhialini* 6/5/86  
JAMES F. OCCHIALINI DATE  
LABORATORY SUPERVISOR

PTM, JFO/EK

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ANALYTICAL RESULTS

| SAMPLE DESCRIPTION:                          | CITY WELL | WELL #3 | WELL #2 | WELL #6 | BLANK  |
|--|-----------|---------|---------|---------|--------|
| CDM LAB NO:                                  | 18814     | 18815   | 18816   | 18817   | 18818  |
| COLOR-TRUE, COLOR UNITS                      | 0.5       | 0.5     | 0.5     | 0.5     | X      |
| HARDNESS-TOTAL, MG/L AS<br>CaCO <sub>3</sub> | 379.      | 1330.   | 6280.   | 998.    | X      |
| TURBIDITY, NTU                               | 46.       | 50.     | 310.    | 90.     | X      |
| TOTAL ORGANIC CARBON,<br>MG/L                | 11.       | 11.     | 9.      | 13.     | X      |
| TOTAL SODIUM, MG/L                           | 390.      | 440.    | 2600.   | 370.    | <0.5   |
| TOTAL IRON, MG/L                             | 4.7       | 2.2     | 1.9     | 24.     | <0.05  |
| TOTAL MANGANESE, MG/L                        | 0.16      | 0.25    | 0.11    | 0.90    | <0.02  |
| TOTAL ARSENIC, MG/L                          | 0.005     | 0.024   | 0.121   | 0.018   | <0.005 |
| TOTAL BARIUM, MG/L                           | <1.0      | <1.0    | <1.0    | <1.0    | <1.0   |
| TOTAL CADMIUM, MG/L                          | <0.010    | <0.010  | <0.010  | <0.010  | <0.010 |
| TOTAL CHROMIUM, MG/L                         | <0.05     | <0.05   | <0.05   | <0.05   | <0.05  |
| TOTAL LEAD, MG/L                             | <0.010    | <0.010  | <0.010  | <0.010  | <0.010 |
| TOTAL MERCURY, MG/L                          | <0.002    | <0.002  | <0.002  | <0.002  | <0.002 |
| TOTAL SELENIUM, MG/L                         | 0.017     | 0.010   | <0.010  | <0.010  | <0.010 |
| TOTAL SILVER, MG/L                           | <0.05     | <0.05   | <0.05   | <0.05   | <0.05  |

NOTE: WELLS WERE NOT WELL DEVELOPED AND CONTAINED HIGH AMOUNTS OF SOLIDS.  
 SAMPLES WERE HOMOGENIZED AND ALLOWED TO SETTLE FOR A FEW MINUTES (APPROX. 5)  
 AND ANALYSES CONDUCTED ON THE SUPERNATANT.

X - ANALYSIS NOT REQUESTED

## EPA METHOD 300

- ALL CONCENTRATIONS IN MG/L -

| SAMPLE DESCRIPTION:<br>CDM LAB No: | CITY WELL<br>18814 | WELL #3<br>18815 | WELL #2<br>18816 | WELL #6<br>18817 |
|------------------------------------|--------------------|------------------|------------------|------------------|
| <u>ANION:</u>                      |                    |                  |                  |                  |
| FLUORIDE                           | <5                 | <5               | <5               | <5               |
| CHLORIDE                           | 610.               | 650.             | 5500.            | 880.             |
| NITRITE-N                          | <10                | <10              | <10              | <10              |
| ORTHO-P                            | <5                 | <5               | <5               | <5               |
| BROMIDE                            | <10                | <10              | <10              | <10              |
| NITRATE-N                          | <5                 | <5               | <5               | <5               |
| SULPHATE                           | 200.               | 1200.            | 1200.            | 280.             |

ANALYTICAL NOTES: ELEVATED DETECTION LIMITS DUE TO HIGH CHLORIDE AND SULFATE CONCENTRATIONS PRESENT

## CHROMATOGRAPHIC CONDITIONS:

UNIT: DIONEX 2000i  
 ANION COLUMN: DIONEX HPIC-AS4A  
 GUARD COLUMN: DIONEX HPIC-AG4A  
 DETECTOR: CONDUCTIVITY  
 ELUENT: 0.75 MM NAHCO<sub>3</sub>/2.2 MM NA<sub>2</sub>CO<sub>3</sub>  
 RANGE: 100 US  
 PUMP VOLUME: 2 ML/MIN  
 SAMPLE LOOP: 100 µL (APPROX.)

## ANNEX B

### Phase II Program

#### 1. PROGRAM

1.1 Purpose and Scope: The Phase II program provides technical assistance in the training of WAJ staff to perform routine sampling and testing necessary to ensure adequate control of the treatment process not only at startup, but under all future operating conditions. This will include both chemical and bacteriological sampling and testing.

Emphasis will be put on interpretation of data so as to understand what is happening at the time and to anticipate changes in the process in time to make adjustments necessary to avoid plant upsets or malfunctions.

Another very important part of the training will include sampling and testing associated with the groundwater monitoring program started under Phase I.

Particular stress will be put on the need for careful and consistent record keeping both for plant process control and groundwater monitoring activities.

Overall lab management requirements will be addressed as part of the training.

It is expected that most of the training will be for plant technicians assigned to the Aqaba facilities. Limited training will be provided to personnel assigned to the central laboratory in Amman as relevant to the Aqaba plant.

The program will also identify procedures for cross-checking of remote lab work using the WAJ central lab. In addition other labs either in Jordan (e.g. the Royal Scientific Society) or foreign will be considered for similar cross-checking.

An appropriate reference and standard procedures library will be developed and put in place towards the end of the training. This library will have procedures regarding upgrades in operation and will be closely articulated with the central lab and any remote labs currently being planned by WAJ.

## 1.2 Work Plan:

The following tasks constitute the initial part of the program:

- o Evaluation of the Aqaba laboratory equipment, reference materials and staff
- o To the extent possible, coordinate with training furnished under the plant construction contract
- o Assist in the final establishment of the operating relationships between the Aqaba and central labs
- o Evaluate comparative test results on samples taken from the monitoring wells under Phase I and if serious differences are present attempt to identify the causes
- o Evaluate the final report on monitoring well installation prepared by WAJ since Phase I
- o Establish parameters and frequencies of testing for both plant operational control and groundwater monitoring
- o Establish chain-of-custody procedures for all sampling
- o Establish record keeping procedures including interlaboratory testing (Aqaba and central)

This part of the program will involve discussions with both central lab and Aqaba plant staff. All tasks will be completed in the first five days with some fine-tuning at the end of the program.

Prior to start on the above tasks it is essential that the following conditions have been met:

- o The plant is ready for operation, and is either receiving wastewater, or will be within a day or so
- o The plant lab is fully equipped and ready for use
- o Aqaba based plant staff are all assigned and in place
- o Results of the Phase I testing are available for review
- o The monitoring well installation report (discussed during Phase I) is completed and available for review
- o The monitoring wells have all been fully developed, as discussed in the Phase I report
- o WAJ has established operational responsibilities between Aqaba and Amman.

After the above initial tasks have been completed the program will focus on intensive training of both Aqaba, and to a limited degree, central lab staff under actual plant operating conditions. Towards the end of this training period (approximately 5 days), specific operational procedures, calibrations, record-keeping, communications and on-going training programs will be developed.

The third and final week of the program will include the final tasks:

- o Sampling and testing of samples from the groundwater monitoring wells with comparison with data obtained during Phase I
- o In addition to the above testing, a full set of bacteriological tests will be run and recorded

- o Establishment of a program which identifies all parameters and frequency of testing for both plant operation control and the groundwater monitoring
- o A full day lecture in Amman for WAJ staff on the Aqaba for WAJ staff on the Aqaba program and similar applications
- o Preparation of a report which describes actual program implementation and includes recommendations for ongoing cooperation and, if necessary, assistance.
- o Issuance of certificates of completion and qualification to all staff trained under this program (OPTIONAL).

1.3 Budget: The following budget covers all activities under this program (Phases I and II):

Phase I

Labor \$ 8,800

ODCS

|                  |           |
|------------------|-----------|
| per diems        | \$ 834    |
| excess baggage   | 350       |
| airfares         | 1,900     |
| CDM lab          | 1,755     |
| ground trans.    | 225       |
| telex, telephone | 100       |
| miscellaneous    | <u>50</u> |

\$ 5,214

Phase I total \$14,014

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Phase II

Labor \$ 7,964

ODCS

|                  |               |
|------------------|---------------|
| per diems        | \$3,260       |
| excess baggage   | 200           |
| airfares         | 3,900         |
| ground trans.    | 2,500         |
| secretarial      | 800           |
| services         |               |
| telex, telephone | 700           |
| CDM lab          | 500           |
| commodities      | <u>5,000*</u> |

\$16,860

Phase II total \$24,824

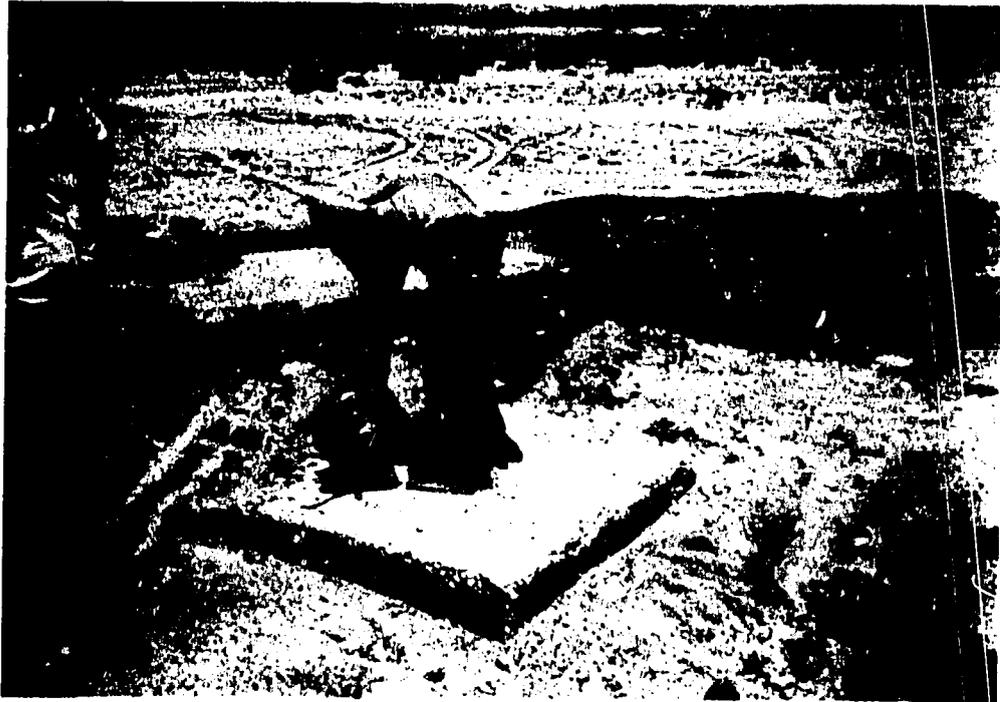
\*primarily lab equipment, field supplies and books

GRAND TOTAL BOTH PHASES \$38,838

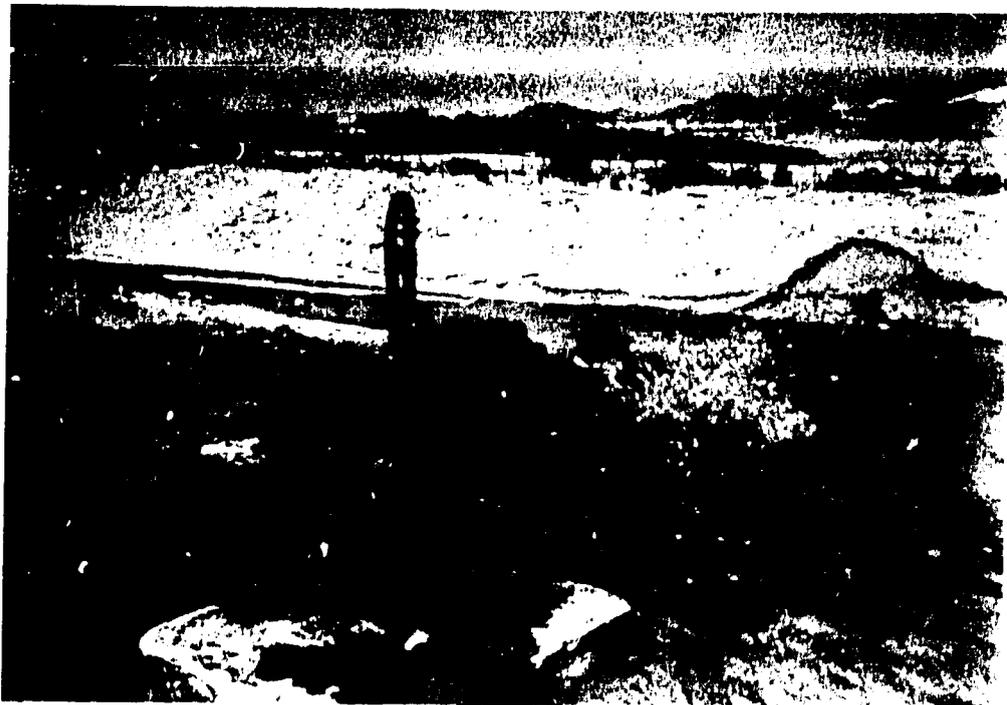
ANNEX C

PHOTOS OF OBSERVATION WELLS

JUNE 1986



OBSERVATION WELL NO. 1



OBSERVATION WELL NO. 2



OBSERVATION WELL NO. 6



OBSERVATION WELL NO. 4



OBSERVATION WELL NO. 5

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OBSERVATION WELL NO. 3



OBSERVATION WELL NO. 3