

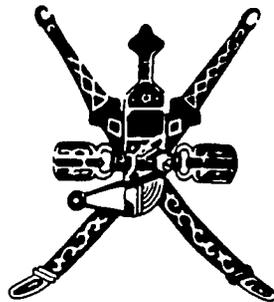
PD AAT-706

45737

**OMANI-AMERICAN JOINT COMMISSION
FOR ECONOMIC AND TECHNICAL CO-OPERATION**

**FEASIBILITY REPORT
SUMMARY**

**THE WADI AL KHAWD
AQUIFER RECHARGE PROJECT**



**SULTANATE OF OMAN
MINISTRY OF AGRICULTURE AND FISHERIES**

DECEMBER 1981



STANLEY CONSULTANTS

FEASIBILITY REPORT SUMMARY

1.1 General

This is a summary of the design and feasibility of recharging the aquifer underlying the Wadi Al Khawd with stormwater.

1.2 Project Chronology

Sir Alexander Gibb and Partners. 1974. "Water Supply to Muscat and Mutrah" recommended investigation of the possibility of impounding wadi flood flows in the coastal plain for increasing groundwater recharge.

The United States Army Corps of Engineers. 1978. "Report on Water Resources Study, Phase I and Technical Proposal for Construction of Water Recharge Projects" recommended development of conceptual designs and specific sitings for recharge projects.

The United States Corps of Engineers. 1979. "Report on Water Resources Study, Phase II and Technical Proposal for Construction of Water Recharge Projects" undertook more detailed study leading to the selection of Wadi Samail as the initial recharge development site.

The Public Authority for Water Resources. 1980. "Preliminary Engineering Design for Wadi Al Khawd Recharge Scheme" proposed two permeable retention structures acting in series over the alluvial fan. The dams would spread the water over wide leveled spreading basins by spillway overflow and seepage through the dams.

Tetra Tech International Inc. 1980. "Evaluation of Alternate Groundwater Development Schemes for the Wadi Samail Aquifer" evaluated the effects of long-term uniform recharge of the Public Authority for Water Resource's plan upon water levels in the aquifer. Additional study of the effectiveness of spreading basins was recommended.

The Public Authority for Water Resources. 1980. "Groundwater Recharge Alternatives for Wadi Al Khawd" compared proposed plans by the

U.S. Army Corps of Engineers and The Public Authority for Water Resources. They developed 5 objectives which would be most desirable for the project and, based on these objectives, recommended the Public Authority for Water Resources plan for further development.

Stanley Consultants, Inc. 1981. The Government of Oman and the U.S. Agency for International Development acting through the Joint Commission on Economic and Technical Cooperation authorized Stanley Consultants, Inc. to proceed with development of the recommended plan. A "Feasibility Report, The Wadi Al Khawd Aquifer Recharge Project", construction plans, bidding documents and "Feasibility Report Summary" were submitted in December 1981.

1.3 Project Summary

General

The Wadi Al Khawd is located approximately 50 kilometers northwest of Muscat near Seeb (See Figure 1). The project site is presently adjacent to two groundwater well fields which furnish part of the potable water supply for the capital area. Increased use of water under recent drought conditions is reported to have caused an increase in the concentration of salts in the well water used for irrigation in the gardens near Seeb.

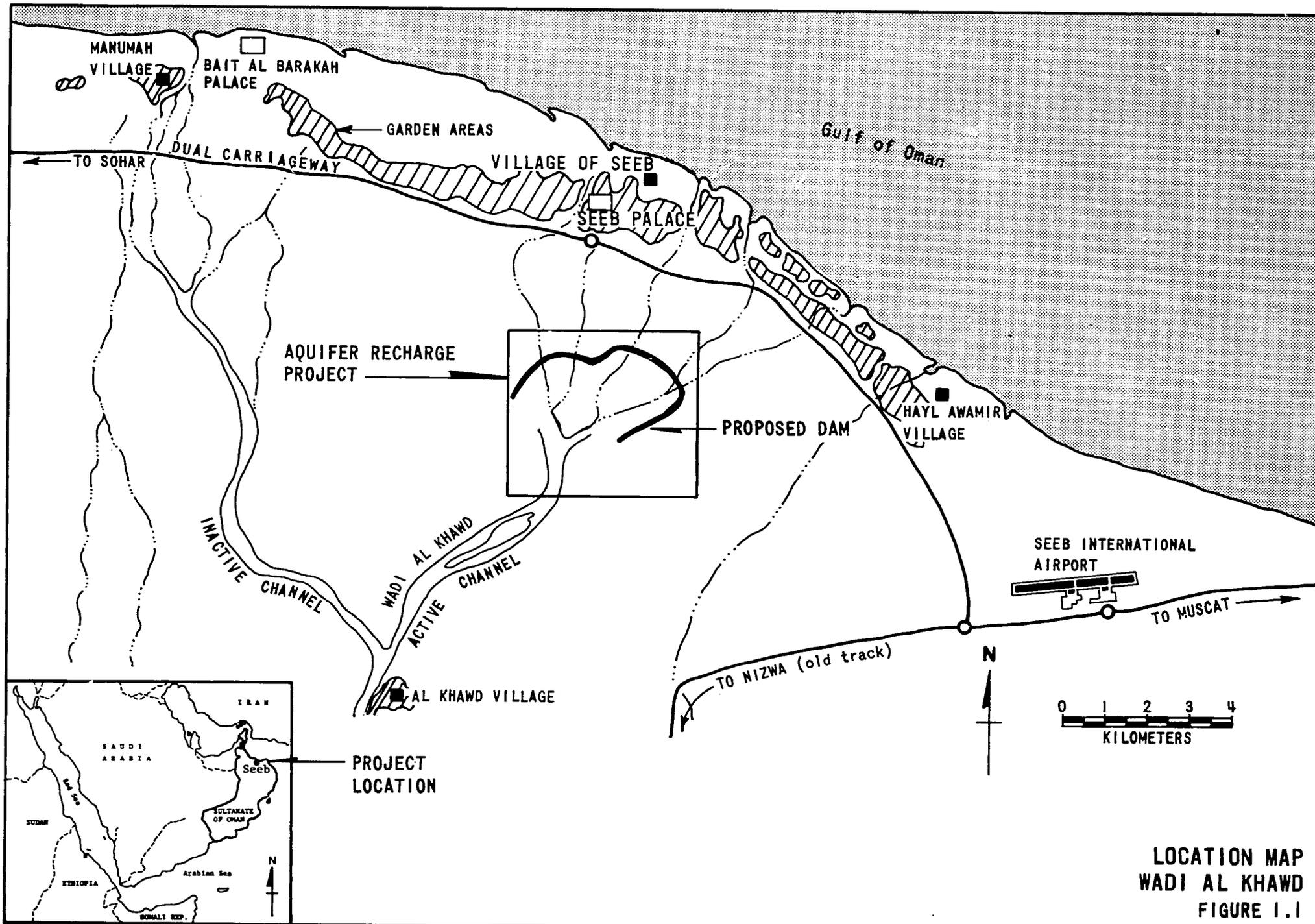
An expanding economy in Oman has led to a rapid pace of development in the capital area. Water is critical to sustain this rapid growth.

New sources of water are being developed to meet increasing demand. Capturing stormwater runoff and recharging aquifers by infiltration presents an attractive potential source.

Alternative Designs

Three alternatives were analyzed to retard stormwater runoff and recharge it to the aquifer. They are:

1. Construction of two pervious gravel and rock fill structures in series across the wadi to spread the water over leveled basins for infiltration.
2. Construction of two impervious gravel and rock fill structures in series across the wadi with culverts which release the water into existing wadi channels for infiltration.



LOCATION MAP
WADI AL KHAWD
FIGURE 1.1

3. Construction of a single impervious gravel and rock fill structure across the wadi with culverts which release the water into existing wadi channels for infiltration.

Our analysis concludes the following:

- a) Alternative number two and alternative number three are more effective schemes to accomplish recharge than alternative number one.
- b) Alternative number three is as effective as alternate number two and is the least expensive. It saves an estimated 645,000 Rials Omani and shortens the construction period by four months.

We recommend alternative number three.

Infiltration to the aquifer underlying the Wadi Al Khawd is accomplished by capturing a major portion of the stormwater runoff and releasing it at a rate within the natural infiltration capacity of the existing wadi channels. The structure captures all the runoff from storms of less than a 10-year frequency. Culverts then release the water at a rate which permits infiltration before it reaches the dual carriageway. For storms greater than a 10-year frequency, some water flows over the spillway. It is estimated that 70 percent of spillway overflow is captured by infiltration while the remaining 30 percent is lost to the sea.

Recommended Project

The single structure (alternative number three) is a low impervious gravel and rock fill dam made of compacted material from the Wadi Al Khawd. It is approximately 7.5 meters high, 5 meters wide at the top, and has 3:1 slide slopes. It has riprap on the sides for erosion protection and a gabion mattress spillway. The 3000 meters long spillway is designed to pass five times the probable maximum flood of 1900 cubic meters per second without failure of the structure.

The recharged water stored in the aquifer can be used in different ways. It can be pumped out and used for potable water supply in the capital area, or for irrigating crops.

The average additional groundwater recharge produced by this project will range between three and five million cubic meters of water per year. Because of weather patterns, some years will produce more, others less. A groundwater recharge of four million cubic meters per year was used for economic analysis.

The cost of construction is estimated to be 4,027,000 Rials Omani. The project will take approximately 16 months to construct.

The economic analysis compared estimated project benefits to estimated project costs for agriculture and for urban water supply. The estimated internal rate of return for agriculture is 5.9 percent and for urban water supply 18.2 percent. Additional benefits derived but not accounted for in the rate of return computations include:

1. Experimental value of the project for recharging aquifers.
Data collected from this project can be very useful regarding design, operation, and management of future recharge projects elsewhere in Oman.
2. Reduction in flood flows and related reduction in flood damages.
3. Possible sale of sediment removed in the dam maintenance program.

Although there is a reduction in flood flows, this project is not intended for flood control. The downstream area should be set aside as a flood hazard area and development limited.

Complete utilization of the additional groundwater in the garden area for agricultural purposes will be made more difficult because intermittent recharge events are not coordinated with the seasonal nature of crop water requirements. Some of the additional water may therefore be lost as groundwater discharge to the ocean. The monitoring program mentioned below is necessary to manage this resource wisely.

The construction of this project will not change the general character and wildlife habitat of the Wadi Al Khawd, nor will there be significant reduction in flora. No endangered species are affected by this project. Therefore, the effect on the physical environment is not significant.

There are no religious, social, or cultural barriers to the construction of the dam, or use of the recharge water in connection with this project. However, proper communication strategies will be required to prevent misunderstandings of project purposes and potentials.

A three part groundwater monitoring and development planning system has been outlined to allow effective management of the new water resource. Each part has a specific function and can be implemented separately.

Parts of the system are:

*Part 1 - Determining recharge volumes by measuring basin inflows and outflows. This requires four water level monitoring stations and miscellaneous equipment at a cost of approximately 5,100 Rials Omani.

*Part 2 - Estimating the impact of recharge on water supplies and water quality. This requires twelve observation wells (50m depth) to monitor groundwater levels and quality in the area downstream of the recharge basin. The approximate cost for the wells, related engineering, and contingencies is 36,000 Rials Omani.

*Part 3 - Conducting a well pumping test to obtain reliable aquifer characteristics to design future wells in the recharge area. This requires approximately 21,000 Rials Omani for a well, three day pump test, related engineering, and contingencies.

The cost of the monitoring programs are presented for informational purposes only and are not part of the construction of this project.

Conclusions

The need for water in Oman is substantial. Aquifer recharge can be an important source of water supply. This project is not only economically, sociologically, and environmentally feasible, it is an important demonstration project for possible application elsewhere in Oman.

We recommend its construction and development.