PD CAP 424

MOROCCO

WINTER SNOWPACK AUGMENTATION PROJECT

(608-0190)

BUREAU FOR NEAR EAST

UNITED STATES AGENCY FOR INTERNATIONAL DEVELOPMENT

FEBRUARY 1984

SUMMARY AND RECOMMENDATIONS

A. Project Title : MOROCCO - Winter Snowpack Augmentation Project

B. Project Number : 608-0190

C. Source of Funds : Morocco Mission Economic Support Fund

D. Total Project Amount : The Total Project Cost is estimated at $12.59 Million with an AID contribution of $6.0 Million or 47.9%. These costs broken out by source and percent of contribution are estimated below:

Estimated Life of Project Budget (in 1000's of U.S. Dollars)*

Source		Total
A. Government of United States		
1. AID	(47.9%)	$6000.0
2. NOAA**	(0.9%)	114.0
3. Peace Corps	(0.5%)	68.0
Subtotal	(49.3%)	$6182.0
B. Government of Morocco		
1. National Meteorological Organization	(18.9%)	$2370.0
2. Royal Moroccan Air Force	(31.5%)	4000.0
3. Royal Air Maroc	(0.3%)	40.0
Subtotal	(50.7%)	$6410.0
C. Total Project Cost		$12592.0

* All costs in Moroccan Dirhams have been converted at a rate of 8.0 dh to $1.00 U.S.

** NOAA: National Oceanographic and Atmospheric Administration, Department of Commerce.

E. Terms : Grant

F. Grantee : Funds will be made available to the National Meteorological Organziation, Ministry of Transportation, Government of Morocco. Use of AID funds will be restricted to support of civilian organizations in compliance with the provisions of the Foreign Assistance Act of 1961, as amended, Section 531 (c). In addition, no United States Government funds will be used for direct financing of cloud seeding equipment, materials or operation costs in compliance with current policy.

G. Coordinating Entities : USAID/Morocco and AID/W - NE/PD/ENV

H. Implementing Entities :

1. U.S. Government
   a. USAID/Morocco and AID/W - NE/PD/ENV (Project Design and Management);
   b. Bureau of Reclamation, U.S. Department of the Interior (Under a Participating Agency Service Agreement (PASA) provides scientific management and serves as a procurement agent for AID);
   c. National Oceanographic and Atmospheric Administration; Department of Commerce (Provides Scientific Equipment);
   d. Peace Corps (Provides a Volunteer to teach English).

2. Government of Morocco
   a. National Meteorological Organization, Ministry of Transportation (Provides scientific expertise and is responsible for design, planning, implementation, monitoring and evaluation of project);
   b. Royal Moroccan Air Force (Provides operational expertise and is responsible for cloud seeding operations);
   c. Royal Air Maroc (Provides international transportation for participant trainees);
   d. Other Government Organizations (Provide data and specialized support services).

I. Life of Project : Five Years

J. Project Goal : The goal of the project is to increase manageable water resources in Morocco through the implementation of a scientifically based weather modification project on a demonstration basis. It is anticipated that the project will increase precipitation in the project area by 10 percent on an annual basis. The project will also improve the availability of water to users by allowing for additional surface water to be stored in reservoirs and through increased groundwater storage.

K. Project Purpose : The purpose of the project is to develop within the Government of Morocco an ability to design, plan, implement, monitor and evaluate scientifically based weather modification programs. Weather modification programs will be developed as an integral part of overall management of water resources in Morocco. The project will support development of this capability through the transfer of technology, provision of technical assistance, execution of special analyses, provision of scientific equipment and training.

L. Environmental Soundness of Project : The project as designed is environmentally sound and is in compliance with the requirements of 22 CFR 216,"AID Environmental Procedures". The project design places emphasis on the development and implementation of suspension criteria which will serve as a mitigation measure to avoid potential

3

risks associated with flooding, creation of hail, etc. It is not anticipated that the project cause decreases in precipitation either within Morocco or in adjoining countries. The use of silver iodide (AgI) as a seeding agent will not result in negative environmental impacts. In addition, the project design requires the Environmental Coordinator, Bureau for Near East, AID/W to conduct an annual field monitoring visit of two weeks duration to assure environmental soundness during project implementation.

M. Special Policy Considerations : The project has been reviewed by AID, the Department of State, the White House Office of Science and Technology Policy and the National Security Council and has been granted a policy waiver from the National Security Council as required under the provisions of the United States Government and AID policy on "Weather Modification as Technical Assistance" (AIDTO CIRC 495, August 19, 1975).

N. Recommendation : USAID/Morocco recommends authorization of a grant in the amount of $6.0 million. This grant will be used to fund the U.S. dollar costs of scientific management services, administrative support, technical assistance, special analyses, scientific equipment and training.

LIST OF DESIGN TEAM AND REVIEW COMMITTEE MEMBERS

PROJECT DESIGN TEAM

NE/PD/ENV, Stephen F. Lintner, Environmental Coordinator, Team Leader
NE/TECH/HRST, James A. Bever, Energy Advisor/Science & Technology Advisor
Stanley A. Changnon, Jr., Illinois State Water Survey
Arnett S. Dennis, U.S. Bureau of Reclamation
Bernard A. Silverman, U.S. Bureau of Reclamation

EMBASSY AND MISSION PROJECT REVIEW COMMITTEE

Robert C. Chase, Mission Director
Harry J. Petrequin, Deputy Mission Director
Andres Acedo, Program Office
Gary C. Bricker, Office for Technical Projects
John Dorman, Mission Environmental Officer
Richard T. Ginman, Military Cooperation Office (MUSLO)
John Giusti, Program Office (Mission Project Officer)
Russell Graham, Economic Affairs Officer
Mark S. Matthews, Regional Controller
Stanley R. Nevin, Regional Contracting Officer
Malcolm Purvis, Office for Agriculture
W. Stacy Rhodes, Program Officer
James Smith, United States Information Service
Jay Smith, Mission Economist
Anne Williams, Regional Legal Advisor

AID/W PROJECT REVIEW COMMITTEE

NE/PD/ENV, Stephen F. Lintner, Project Chairperson
NE/PD, Ronald F. Venezia, Deputy Director
NE/PD/ENGR, Francis W. Montanari, Water Resources Advisor
NE/TECH/AD, Lee Voth, Agricultural Officer
NE/TECH/HRST, James A. Bever, Energy Advisor/Science & Technology Advisor
NE/TECH/HPN, Pamela R. Johnson, Social Science Advisor
NE/TECH/SARD, John Grayzel, Social Science Advisor
NE/DP, Robert Zimmerman, Evaluation Officer
NE/DP/PR, Lance Downing, Program Officer
NE/DP/PL, Leonard Rosenberg, Economist
NE/NENA, Thomas Reese, Director
GC/NE, Garber Davidson, Senior Legal Advisor
PPC/PB, Emily Leonard-Hughes, Near East Coordinator
PPC/PDPR, Albert C. Printz, Jr., Environmental Affairs Coordinator
S&T/FNR, Charles K. Paul, Physical Science Advisor
SER/CM/ROD, Katherine Cunningham, Contracts Officer
STATE/NEA/AFN, Lange Schermerhorn, Desk Officer
STATE/OES/ENR, Roger Soles, MAB Coordinator

TABLE OF CONTENTS

LIST OF TABLES AND FIGURES

I. INTRODUCTION

The Kingdom of Morocco has been subject to below normal rainfall conditions for the last ten years which has culminated in the last four years in an extremely serious drought. Due to the length of the drought, reservoirs already reduced in storage capacity from rapid siltation associated with poor land use practices and deforestation have been reduced to an average of 10 percent of their designed water storage capacity. The social and economic impact of the drought, considered to be the worst in modern history, have been compounded by greatly increased demand for additional water resources caused by extremely rapid population growth, urbanization, industrialization and expansion of irrigation. Economic impacts have become acute in the last three years when water rationing between hydro-electic power generation, irrigation, industrial and domestic demands has been required. This has resulted in electrical power load shedding, increased electric generation costs due to imported fossil fuel substitution, declines in foreign exchange earnings from agricultural and industrial sectors and social stress due to severe water shortages and rationing.

In response to a request for technical assistance in weather modification made personally by His Majesty King Hassan II to the Ambassador of the United States a team of four American scientists was sent to Morocco to prepare a Weather Modification Assessment (Silverman, et. al., 1983). The assessment team found that:

> "...while weather modification will not end the present drought it can help reduce the economic and social impacts by increasing natural precipitation. A long-term precipitation enhancement program can help meet future water requirements and cushion the impact of future droughts.
>
> "To assure success of any long-term program it is essential to fully integrate efforts made in weather modification into the total water resources management and planning process (p. 2-3)."

The assessment team recommended a program of intervention which included the following elements:

1. Development and implementation of a scientifically based demonstration program of winter precipitation augmentation in the central High Atlas Mountains with the objective of providing additional water from runoff for hydro-electric power generation, irrigation, domestic and industrial use. The program would focus on the l'Oued Oum er Rbia Basin and is anticipated to increase streamflow and winter storage up to 10 percent over that produced by natural precipitation.

2. Testing on a controlled experimental basis the technical and economic feasibility of precipitation augmentation for rainfed agriculture in areas adjacent to the winter target area. The success of this activity is highly dependent on the ability to successfully increase rainfall during critical periods of the growing season.

3. Procurement of a variety of scientific equipment necessary for the conduct of the recommended weather modification program. This equipment includes radiosondes, radar, satellite receiver and use of aircraft equipped to collect cloud measurements. A critical component of the equipment is the provision of a significant supply of expendable materials required for data collection and analysis. Moroccan personnel must be trained to operate, interpret and maintain this equipment.

4. Training of Moroccan personnel in the design, planning, implementation, monitoring and evaluation of scientifically based programs of weather modification. Training should be provided to scientific, technical and managerial personnel using formal and informal techniques.

5. A scientific and economic evaluation of program results is critical to assure the technical soundness and cost effectiveness of the program. The evaluation will focus on the verification of changes in the water resources base and its subsequent economic implications. An element of the evaluation will be an examination of the clouds and precipitation to improve the scientific basis of the program. Emphasis will be placed in the evaluation on economic, social and environmental impacts, both positive and negative, to assure maximum benefit from program activities.

6. Development of suspension criteria to ensure avoidance of inadvertent outcomes such as floods or hailstorms and their effects on the safety of citizens, property and the stability of the environment. An important element of the program will be the execution of a study to develop meaningful suspension criteria consistent with responsible professional

practice and within risk levels acceptable to the Government of Morocco. Until the site specific suspension criteria are developed, interim suspension criteria based on data from similar environments should be followed in cloud seeding operations. (See Annex F, Interim Suspension Criteria.)

7. The Assessment Team noted that the successful implementation of the project will require a serious long-term commitment of personnel, equipment and financial resources to meet both capital and recurrent costs by the Government of Morocco. In addition, they noted that without a strong management system to coordinate the activities of cooperating government organizations the results of the project will be neither cost effective nor provide the maximum possible increase in precipitation. The success of any long-term program will require that weather modification be fully integrated into the total water resources managment and planning process for Morocco.

Following review of the findings of the assessment team the Government of Morocco, represented by His Majesty King Hassan II, has requested as its first priority for development assistance a weather modification program with emphasis on the winter snowpack augmentation in the High Atlas Mountains as recommended in the assessment (Annex C). The Ambassador of the United States to Morocco has determined that the provision of such assistance is in the political interests of the United States and that the proposed project represents an appropriate response to the request of His Majesty King Hassan II. The project has been reviewed by AID, the Department of State, the White House Office of Science and Technology Policy and the National Security Council and has been granted a policy waiver from the National Security Council as required under the provisions of United States Government and AID policy on "Weather Modification as Technical Assistance" (AIDTO CIRC 495, August 19, 1975; Annexes D, E).

The project, although representing a political response to an urgent need of the Government of Morocco, broadly conforms with the objectives of current AID priorities, the Bureau for Near East Strategy (1983) and the Morocco Country Development Strategy Statement (1984) in that it focuses on the provision of assistance in the area of water resources management and planning through the transfer of technology, institutional development, training and technical assistance. The project supports the Mission strategy for Morocco in that its successful implementation will result in increased availability of water for use in hydro-electric power generation and crop production thus resulting in reduced electrical power load shedding, reduced demand for energy imports and increased agricultural production. A major secondary benefit of the project will be significant improvements in the meteorological and climatological services provided by the National Meteorological Organization as the result of technology transfer, institution building and training.

The project has been designed to provide immediate assistance to the Government of Morocco in an area which they have determined is their highest development priority. However, it must be recognized that the current economic situation in Morocco could cause significant changes in anticipated project performance. The severe budget limitations of the Government of Morocco, with regard to both local currency and foreign exchange, could result in either delays in project implementation, revision of project design or termination of the project (see Section VIII). Successful implementation of the project will require the provision of extensive local and foreign currency support by the Government of Morocco for personnel, equipment and material for conduct of the cloud seeding operations by the Royal Moroccan Air Force. In addition, successful implementation of the project will require the timely importation and customs clearance of scientific equipment and materials.

The project design has provided, to the fullest extent possible, support for improved water resources planning and management. The first condition precedent is the formal creation of a National Steering Committee on Weather Modification which includes all the principal organizations involved in water data collection, allocation and utilization. The creation of this committee, is critical for successful project implementation and provides a major means for self-identification by the Government of Morocco of the serious need for

improved planning and management of water resources. The project and the National Committee will provide an opportunity for Moroccan personnel to interact across institutional lines which to date has been one of the principal constraints to effective use of water resources.

While it is unrealistic to expect that the project can resolve the basic problems in water resources planning and management in Morocco, it can be used to improve donor insights into the sector and lead to the identification of additional priority investments. The project has been structured and planned to provide Moroccan personnel with a significantly broader understanding of the water resources context of their work through technical assistance, long-term training and short-term training. The resources of the Bureau of Reclamation and other water resources organizations in the United States will be utilized to improve Moroccan institutional capacity. It must be recognized, however, that resolution of the water resources situation in Morocco will require long term commitments to institutional development and the training of personnel by a number of donors.

II. BACKGROUND

A. WEATHER MODIFICATION IN MOROCCO

In Morocco artificial seeding of summer convective clouds to produce precipitation for direct impact on rainfed agriculture and reservoir recharge has been conducted at periodic intervals since 1948. Seeding techniques have included the use of airplanes, ground generators and ground fired rockets and have been conducted by a variety of organizations under both the French Protectorate and the Kingdom of Morocco. In the past, cloud seeding projects have been conducted in nearly all inhabited areas of Morocco with concentrations of effort in the northeast near Oujda; the High Atlas Mountains to supply the Bin-El-Ouidane dam; and in rainfed areas near Kenitra, Meknes and Settat.

In response to the current drought, the Royal Moroccan Air Force initiated a series of briefings between the National Meteorological Organization and other government organizations to study the possibility of conducting weather modification programs for the enhancement of precipitation. After a technical review of the situation it was decided to proceed with a weather modification program which was named Project Al Ghait (classical Arabic for rain) by His Majesty King Hassan II.

To support this program, the Government of Morocco has informally created a high-level committee to supervise and coordinate weather modification policy and activities. The committee is chaired by Colonel Major Kabbaj, Inspector General of the Royal Moroccan Air Force, and includes senior representatives of the following organizations:

- Ministry of Agriculture (Water and Forest Service)
- Ministry of Equipment (Hydraulic and Water Supply Services)
- Ministry of Interior (including urban water and electricity distribution agencies)
- Ministry of Post and Telecommunications
- National Center for the Coordination and Planning of Scientific and Technical Research
- National Office of Electricity, Ministry of Energy and Mines
- National Meteorological Service, Ministry of Transportation
- National Police Service (Gendarmerie Nationale)
- National Radio and Television of Morocco

One of the principal actions of the committee has been to conduct a series of meetings to notify provincial governors, administrators, senior technical experts and selected public leaders about the present weather modification program and to solicit their assistance. Meetings followed a standardized format, including a 45 minute technical briefing followed by a 2 to 3 hour question and answer session. Participation included representatives of organized labor, official social movements (such as the National Women's Union) and religious leaders. Reports of these meetings indicate that the current program received strong support during these sessions and that

questions focused on the nature of the technology used in the program. It was noted repeatedly that people had been praying for rain both individually and collectively for the last three years.

The success of weather modification interventions in Morocco has been limited due to an inadequate understanding of the technology and important gaps in basic data concerning meteorological and climatological conditions in Morocco. The problem has been further compounded by limited access to proper seeding equipment and materials; in some cases clouds appear to be overseeded possibly resulting in a reduction in potential precipitation. Due to an absence of scientific control it is impossible to determine what the success of interventions has been in the production of useful precipitation. Interventions to date can be characterized as "best efforts" being made with inadequate understanding of the physical processes involved and with a lack of proper seeding materials and control.

B. PRECIPITATION ENHANCEMENT OPPORTUNITIES IN MOROCCO

The current drought situation in Morocco has been developing for many years and precipitation deficiency is very great. Cloud seeding by itself can not be expected to provide quick and immediate relief during the current drought or to provide for the incremental water needs of Morocco's growing population and economy. The Weather Modification Assessment Team found that scientifically based cloud seeding to enhance precipitation is a practical and promising means of augmenting the fresh water supplies of Morocco. The moderately small amount of added precipitation from cloud seeding will not make up for the deficiency but it will certainly help, especially if it occurs at crucial times in crop growth and in crucial locales for reservoir storage. A program of precipitation enhancement would have been more effective in easing this drought if it had been in place in past years when its application during more average precipitation years, and even wet years, could have served to build soil moisture, to improve cropland, and to increase water in storage facilities. A long-term program with these goals is the proper role of weather modification in the development and management of Morocco's water resources.

If successful, cloud seeding can be expected to augment natural water supplies in the project area by about 10 percent annually. While relatively small, the added amounts will be quite important as water demands by the growing population increase. Variations in natural water supply have large impacts on the economy, especially in agriculture, and weather modification can help even out these variations. Weather modification should be viewed as but one tool in water resources management, and implicit to its wise use is the presence of a well-developed water storage and distribution system. It should be recognized that other water management practices will also be needed to alleviate the present and future water problems of Morocco. Consideration must also be given to programs for improving soil conservation practices, water conservation practices, irrigation scheduling, and reservoir management including increasing the storage capacity of existing reservoirs by removing through dredging sedimentation that has developed over the years and by raising the crests of dams.

Precipitation enhancement may ease water shortages and stabilize natural water supplies by providing additional water in two ways. It can be used to increase the amount of water stored in reservoirs; surface or underground, man-made or natural. The water would be then available to draw on when and where needed for use by municipalities, irrigated agriculture, and the generation of hydroelectricity. The sophisticated water management system of Morocco, based on winter-spring runoff from the mountains, allows for weather modification use over most months when the appropriate weather conditions suitable for seeding exist. Timing is not critical because the added precipitation, whether from rain in November or snow in February, is caught and stored for use in reservoirs until needed.

Precipitation enhancement can also be used to serve the water needs of rainfed agriculture by direct application of precipitation on croplands and rangelands. However, the practicability of this approach depends on the availability of seedable clouds when and where the water is most beneficial. Timing of precipitation is critical because the water needs of crops are very time specific.

1. Cloud Types

Most of the precipitation enhancement opportunities in Morocco occur with cloud systems that are associated with the passage of troughs of low pressure in the upper atmosphere. These occur most frequently during the autumn and winter and less frequently during the spring. The northward shift of the Azores High Pressure system in the summer normally prevents such storm systems from reaching Morocco from June through September.

The storm systems in Morocco produce widely varying cloud and precipitation patterns depending on the depth of the storms and on how the streams of moisture-laden air interact with the complex topography, particularly the High Atlas, Middle Atlas and Rif Mountains. The intensity of storms ranges from very feeble depressions (lows) in which convective clouds, cloud lines and showers occur only over the mountains, to intense storm with cold temperatures aloft (polar outbreaks) which produce deep, massed cloud systems bringing general precipitation to all of the country except the arid region southeast of the Atlas Mountains. In all cases clouds are more abundant and more active on the windward slopes of the mountains and tend to dissipate on the leeward slopes in the descending air.

Nearly all of the precipitation falls from convective cloud elements that extend to altitudes with temperatures of -10 degrees C and colder. In weak and marginal situations, the individual convective cloud elements are separate and easily distinguished visually, especially from aircraft. Over the mountains, the convective towers are frequently embedded in a continuous cloud line. In the more organized and intense storm systems, the convective elements merge into convective bands which are recognizable on satellite photos. More than one convective band can be associated with the more organized systems. The highest precipitation rates occur when the convective bands interact with the mountain ranges giving cloud masses tens of kilometers across and 8 to 9 kilometers in depth rising from cloud bases considerably below the mountain tops.

During periods between passages of fronts, inversions are very common and cloud depths are limited. The cloudiness during these periods tends to occur in episodes of 3 to 5 days duration. The beginning of the episode is marked by shallow, warm convective clouds which become taller and more vigorous as the inversion destablizes in succeeding days. In the middle of the episode, the clouds attain their maximum depth with cloud tops reaching altitudes with temperatures of -10 degrees C and colder. During the final stages of the episode cloud depths diminish again and shallow, warm clouds reappear.

During the summer months Southern Morocco occasionally comes under the influence of southwesterly moist flow on the back side of the Saharan High Pressure system. In such cases thunderstorms develop over the southeastern slopes of the High Atlas. These storms can be quite large and vigorous. This situation appears to be most common in September.

As all important precipitation in Morocco is always associated with clouds whose tops are at temperatures well-below freezing, it is likely that the ice process is the dominant precipitation mechanism. Consequently seeding with an ice-phase seeding agent like silver iodide (AgI) is anticipated in project design. The additional ice crystals can grow into additional precipitation particles and, in addition, the heat released by the growing ice particles may intensify the air motions within the seeded clouds. Seeding of the clouds with warm tops is not indicated because these clouds tend to be too scattered and too shallow to produce useful quantities of precipitation.

2. Technical Feasibility

a. Precipitation Enhancement for Reservoir Storage

Isolated cumulonimbi and especially convective bands and cloud lines over the High Atlas Mountains appear to offer the best opportunity for significantly augmenting water supplies by cloud seeding. It is likely that only a fraction of the available water in these cloud systems falls as precipitation with much of it evaporating on the leeward mountain slopes. The additional precipitation produced by the seeding would fall on the mountains as snow or rain depending on the local temperature.

In the absence of specific data on the macro- and microphysical properties of Moroccan clouds, one can only estimate the probable results of seeding by extension from the results of precipitation enhancement programs in other areas where similar cloud systems were seeded. Previous seeding experiments in Morocco provide very limited experience for making these estimates since they were narrow in scope, short in duration and only crude evaluations were possible. The closest analogs to the proposed demonstration program, which have been evaluated over a long period, are several projects in the central and southern mountains of California and a project in the mountains of Tasmania. There too moist maritime airmasses are forced upward over mountain barriers as cold season storms pass by to the north (to the south in Tasmania).

Weather modification projects began in California in the 1950's and have continued ever since. For example, winter rainfall in Santa Clara County was

estimated to have been increased by about 10 percent over a 10-year period beginning in 1955. The Kings River Basin in the Sierra Nevada Mountains of California has been seeded every year but 2 years (operations suspended while building a power plant) since 1954 with recent data from that project indicating a net increase in runoff over a 25-year period of 3 to 4 percent of the expected runoff. A combination of experimental and operational projects in Santa Barbara Country over the past 30 years also indictes net rainfall increases. Evaluation of randomized seeding operations conducted from 1967 to 1974 indicated that the seeding of convective bands resulted in a 25 to 50 percent increase in total storm precipitation.

Aerial seeding over a 2600-square kilometer mountainous target area in Tasmania from 1964 to 1970 also resulted in increases in precipitation during the cold season with a 10 to 30 percent multiplicative increase in the autumn months and a 19 mm additive increase in the winter months mainly occurring in dry periods. The results of the proposed High Atlas Demonstration Program may be better or worse than these projects, depending on the characteristics of the clouds and the proportion of favorable clouds that are actually seeded in the correct manner.

b. Precipitation Enhancement for Rainfed Agriculture

Cloud systems similar to those proposed for the High Atlas Project also occur over the rainfed agricultural areas to the north and are potential candidates for seeding. There the frequency of occurrence of small to moderate isolated convective clouds is generally higher than that over the mountains and the frequency of cloud lines is less. Whenever more vigorous or more extensive cloud systems occur over the rainfed agricultural areas they also occur either concurrently or a short time later over the mountains.

There are no analogous experiments in other areas with sufficiently conclusive results to inspire great confidence in proceeding with large scale seeding of the cloud systems over the rainfed agricultural areas. The outcomes of these apparently similar experiments were mixed with some growing evidence of both precipitation increases and precipitation decreases. The lack of data on the physical properties of the Moroccan clouds is a major obstacle in proceeding to seed these clouds for water production on an operational basis.

There are other uncertainties associated with the seeding of these clouds to directly produce water that is beneficial to the growing crops. Suitable clouds must be present when the water will be of greatest value. The best times are during October and November to enrich soil moisture for planting, during January for tilling and during March and April for grain filling. Most of these periods do not coincide with the peak frequencies of rain-bearing cloud systems and it remains to be determined whether a sufficient number of seedable situations occur to make such an operation cost effective.

Given all of these uncertainties it is recommended that seeding of clouds over the rainfed agricultural areas be limited to a controlled experimental investigation of the technical and economic feasibility of seeding such systems. These investigations could be conducted in the context of seeding

trials to benefit from any rain that may result. The experiments should be conducted during the fall and spring months when water is of greatest value. However, these experiments should take a distant second priority to precipitation enhancement activities in the High Atlas where there is greater confidence that water can be produced and stored for future use.

C. POTENTIAL BENEFITS

a. Reservoir Storage

To assess the value of additional precipitation during winter in the mountains, the runoff for a 2945 km2 forested basin in the central High Atlas Mountains was crudely estimated from the mean monthly rainfall amounts at Azilal and the daily mean discharge rates at Oued Lakhdar Station Sidi Driss. This basin is in the proposed target area and although it has no reservoirs, it is physiographically and hydrologically representative of the entire project area.

The data indicate that most of the annual precipitation results in streamflow with some going to ground-water recharge through the fractured dolomite and some lost to evapotranspiration. This finding is supported by the rainfall and streamflow data from Bin el Ouidane which shows that they are linearly related with a correlation coefficient of 0.93. While there is value to the portion of additional precipitation from weather modification that goes to ground-water recharge, only that portion that results in additional streamflow is estimated here.

Assuming a 10 percent increase in average streamflow, a 5-month icrease of 21.8 million m3, or 7400 m3 per km2, would be produced. Extending this to the proposed target area of approximately 200 km by 80 km or 16,000 km2, the added streamflow from weather modification would be 118.4 million m3.

This added water was used to calculate the monetary benefits to hydro-electric power and to irrigation since the target area runoff totally goes to three reservoirs (Bin el Ouidane, Moulay Yousef and Al Massira). The value to power generation, as derived by fossil fuel (imported petroleum) substitution costs, is 0.4 dh per m3 (low head generation). Thus, the added water in the basin nas a value of 47.4 million dh for power generation. The unit value of this water to irrigation would range from 0.04 dh per m3 in a wet year to 0.8 dh per m3 in a dry year. Thus, the value of the added water based on its initial use for power generation and its subsequent use for irrigation, without any value estimated for ground-water recharge, would range from a low of 52.2 million dh in a wet year to a high of 142.2 million dh in a dry year. These values in U.S. dollars range from $6.52 million to 17.75 million ($1 U.S. for 8.0 dh).

b. Rainfed Agriculture

A 10 percent increase was postulated as an average increase obtainable in fall and spring precipitation. Since there are no crop yield-weather models available for Morocco, results were used from precipitation increases from the

Great Plains of the United States, a comparable dry land zone, to estimate yield increases from the assumed increase in Moroccan rainfall. Wheat, the primary crop on the central plains within 100 km of the radar was used to calculate potential benefits. The 10 percent increase, based on local average rainfall for the wheat season would produce a yield increase of 0.47 quintals per hectare. The area planted in wheat within radar range is 610,000 hectares. The total increase in wheat production would be 28,500 quintals or 2,850 metric tons. The current price for wheat is 150 dh per quintal. Thus, the postulated yield increase would have a value of 4.275 million dh or $534,000 ($1 US to 8.0 dh).

D. RELIABILITY OF INTERVENTIONS

Determination of whether operational precipitation enhancement programs are warranted should be based on scientifically sound feasibility and pilot studies in the area where these programs are to be conducted. In the absence of such studies, these determinations have of necessity been based on the results of programs in other areas where similar cloud systems have been seeded. However, it must be recognized that the implicit assumption that the cloud characteristics and water yields for economic evaluations are also similar may be incorrect. The results of the demonstration project will reveal whether the clouds and water projections are different, either better or worse. The urgency of the water crisis dictates that the baseline studies be conducted as part of a program aimed at producing water.

It should be recognized that not all clouds are suitable for seeding and those that are must be identified and seeded in an appropriate manner. Seeding clouds that are not suitable or improper seeding of suitable clouds could result in decreased precipitation. During the demonstration project seeding techniques used in analogous programs will be adopted to the Moroccan situation in order to safeguard against the possiblility of non-beneficial effects.

Although the proposed project area is generally uninhabited, especially during the winter months, care must be exercised to avoid the stimulation of hazardous weather. Seeding of some storms could result in making them more vigorous and thereby increase the likelihood of producing damaging hail, windstorms, and flash floods in the seeded areas. The development and implementation of suspension criteria are required to safeguard against such eventualities (see Section III, C, 4 and Section VII, C).

Since the cloud systems proposed for seeding over the High Atlas Mountains make little, if any, contribution to the precipitation in the areas downwind and beyond the mountains, the risk associated with negative downwind effects appears to be minimal (Section III, C, 3).

In general the risks associated with seeding of these clouds can best be minimized and the production of water be given the greatest chance of success through the implementation of a scientifically designed operational program that is executed by trained meteorologists and pilots working in a coordinated manner using appropriate monitoring and seeding equipment. Foreign technical

assistance, training and guidance will be provided to transfer current knowledge of the technology to the Moroccan personnel who will put it into practice.

The long-term impact of the project on the availability of water resources will depend on the commitment made by Morocco in its execution. This will require a substantial commitment of personnel to carry out the planning, implementation, and evaluation of the program. Personnel from various organizations in the Government of Morocco will have to work cooperatively to cover all aspects of the program effectively. The Government of Morocco will also have to commit the financial resources to establish the necessary operational facilities and provide for the recurring costs of operating and maintaining the equipment. Failure to make the appropriate level of commitment to the personnel, equipment, funding and management needs of the Moroccan weather modification program would seriously jeopardize its chances of success and the opportunity to obtain more water would be lost.

III. THE PROJECT

A. PROJECT GOAL

The goal of the project is to increase manageable water resources in Morocco through the implementation of a scientifically based weather modification project on a demonstration basis. It is anticipated that the project will increase precipitation in the project area by 10 percent on an annual basis. The project will also improve the availability of water to users by allowing for additional surface water to be stored in reservoirs and through increased groundwater storage.

The project is designed to provide limited relief of the economic and social impacts of the present drought by seeding promising clouds over a limited but critical portion of the country and place emphasis on the evaluation of results. This project itself represents a demonstration and test program to determine the feasibility from a scientific and economic standpoint of long-term weather modification as a water resources management technique.

B. PROJECT PURPOSE

The purpose of the project is to assist the development within the Government of Morocco of an ability to design, plan, implement, monitor and evaluate scientifically based weather modification programs. Weather modification programs will be developed as an integral part of overall management of water resources in Morocco. The project will support development of this capability through the transfer of technology, provision of technical assistance, execution of special analyses, provision of scientific equipment and training.

The project design, it should be noted, recognizes the need to include both short-term measures which might help alleviate the present drought and to develop a long-term program to enhance water supplies. The long-term program focuses on development of a completely Moroccan capability to direct and control weather modification operations; however, in the short-term, foreign technical assistance and equipment is required if the project is to have any impact on the drought situation in the target area.

C. PROJECT DESCRIPTION

1. PRECIPITATION ENHANCEMENT FOR RESERVOIR STORAGE

a. Operational Area

Taking into account frequency of cloud seeding opportunities, the probability of successful intervention, and the utility of any additional water produced, the project places first priority on a program of activities to increase reservoir storage by seeding part of the northeastern slopes of the High Atlas mountains, with the upper basin of the L'Oued Oum er Rbia (See Figure 1) as the target area. This basin features major existing investments in dams, irrigation projects and hydro-electric plants. It is the main source of

domestic and industrial water supply for Casablanca, El Jadida and Safi. A large potential for increased demand exists from anticipated population growth in these cities, increases in irrigated acreage in the basin and further interbasin water transfers to the Tensift basin which surrounds Marrakech.

The L'Oued Oum er Rbia basin approaches 30,000 km2 and the target area in the upper basin is about 16,000 km2. Peak elevations are up to 3000 to 4000 m at the crest of the High Atlas Mountains.

b. Operational Description

The seeding opportunities over the basin range from general storms to isolated convective clouds, with the general storms confined to the winter months. During the general storms the convective cloud elements are often massed together, especially over the High Atlas, to give a continuous cloud cover for several hours.

All important precipitation involves clouds that extend above the 0 degree C isotherm and form precipitation through ice processes, even though the resultant particles melt to rain after reaching the lower slopes. Therefore, the planned seeding approach for all situations is the release of silver iodide (AgI) crystals from airborne generators to serve as artifical ice nuclei. However, two distinct types of flight patterns are envisaged depending on cloud conditions.

General storms would be seeded by operating generators on aircraft flying back and forth about 20 minutes upwind of the highland area in which precipitation is expected to fall. The recommended seeding altitude is just below the 0 degree C level. The objective would be to have the AgI crystals carried upward through the 0 degree C level in the convective currents as the air stream ascended the windward slopes.

As the aircraft will often be operating in the clouds and below the tops of the High Atlas Mountains, precise navigation will be required. It is planned that the aircraft positions will be monitored by aircraft operations controllers using the IFF (Identification-Friend-Foe) system on weather radar. Pilots will communicate with the controller and each other frequently when airborne to check position, altitude and planned maneuvers as an added safety precaution. However, for timing missions and selection of seeding tracks, it will be essential to have a separate weather radar scope capable of picking out active precipitation cells within the general overcast. It will be most important to seed strong embedded convective bands and if they are present, the aircraft seeding tracks should be adjusted to follow individual bands across the target area.

When the convective cells are somewhat isolated, which would be the case nearly always in the summer and sometimes in the winter, the aircraft will fly over and between the cloud towers. The objective will be to drop pyrotechnic cartridges containing 20g of AgI each into rising cloud towers as the tops moved upward through the -15 degree C level. A typical cloud tower can be seeded by dropping one cartridge into the updraft region from the -15 degree C

level, but for large cloud towers two or more cartridges should be used. The cartridges should be dropped so that they would be at least 500 m apart.

A detailed winter operations plan will be prepared, throughly reviewed and operational procedures practiced before the start of the 1984-85 winter season snowpack augmentation program. Included in the plan will be the seedability criteria, all the operating procedures for seeding, the suspension and flight safety criteria, forecasting and communication procedures, and the utilization plan for project resources. This plan will be updated each year as required.

Although the winter seeding program now planned is based entirely on aircraft seeding, the option of ground-based seeding with supplemental aircraft seeding will be investigated. If the wind structure, atmospheric stability, geography, cloud types, and costs indicate a revision in the program is warranted, this option will be recommended in the Phase I report. The use of ground generators for rain enhancement over the agricultural area will not be considered since many scientific uncertainties are associated with this method.

c. Deployment of Personnel and Equipment

The project, although quite complex, builds on previous experience in weather modification operations conducted by the National Meteorological Organization and the Royal Moroccan Air Force during the implementation of Project Al Ghait. The project will require the close coordination among meteorologists, cloud seeding pilots and aircraft controllers operating from a number of different geographic locations. These locations include:

- The headquarters of the National Meteorological Organization in Casablanca at which project management will be based and scientific and evaluation activities conducted;
- The field operations center located at the Beni Mellal synoptic weather station from which cloud seeding operations will be supervised;
- A radar facility located near Oued Zem which will provide data through a telecommunications link to the operations center;
- An operations support base in the vicinity of Beni Mellal for the refueling and resupply of aircraft during operations; and
- A permanent base for aircraft where they will be maintained and stored.

The Operations Director, a meteorologist from the National Meterological Organization will be located at the Beni Mellal synoptic station which will also serve as the Operations Control Center. He will be responsible for laying out seeding tracks and should be present at the radar site during operations. Other vital information to be provided to the Operations Director includes conventional weather maps, radiosonde data and satellite cloud photos. The Operations Director would be responsible for organizing all the information, making scientific decisions to launch and terminate seeding missions, determining seeding tracks and altitudes, and conveying his decisions to the seeding pilots. Instructions to pilots will be given by aircraft operations controllers, Royal Air Force officers, who in most cases

will be at the Operations Control Center during seeding operations. In order to assure efficiency and safety, reliable radio communications will be essential.

After considering accessibility and the need for an unobstructed view of the target area, it has been determined that the radar site be somewhere in the vicinity of Oued Zem. The radar facility will be linked to the operations center by a dedicated telephone line and radio communication system.

Considerations of the area to be covered and the aircraft capabilities suggest a need for three seeding aircraft which may be operated simultaneously. This will require that three aircraft be fully fitted for seeding operations and that a fourth be in ready condition to serve as a back-up aircraft. In addition, it is estimated that 8 crews will be required for rotational assignments during operations given their potential duration.

Seeding operations over many hours during both day and night will be required. In the interest of both operational and cost effectiveness, provisions should be made to refuel and resupply with chemicals the seeding aircraft at an operations support base adjacent to the project. It is anticipated that all major maintenance, especially routine engine overhauls, will be conducted at a main facility where the aircraft are hangared.

d. Scientific and Economic Evaluation

Evaluation will be designed and conducted on many interrelated fronts (See Table 1). A research aircraft equipped with the basic cloud physics instrumentation will be obtained under contract to investigate the cloud characteristics and winds in the demonstration project area and other potential areas for future weather modification opeations. Effects of seeding on the microphysical properties of the clouds will also be measured. Radar data will be recorded and analyzed to determine the effects of sseding on the physical properties of the clouds. Satellite imagery will be analyzed to determine the effects of seeding on cloud height and distribution. However, the most critical evaluation data are the current and hitorical streamflow and precipitation data in Morocco. Continuation of the existing observations is mandatory.

The main evaluation will be based upon hydrographic data, and particularly upon comparisons of runoff from the target area with the runoff from neighboring upwind basins in the High Atlas. Previous studies by Moroccan hydrologists have shown the correlations among annual streamflows in different basins to be sufficently high to make such an evaluation feasible. Subbasins in the upper reaches of the l'Oued Oum er Rbia have experienced little land use change, so comparisons of historical streamflow hydrographs with those during the seeded period will also provide information useful in the evaluation. To provide for a full understanding of the range and variation in climatic events, especially flooding, hydrometeorological baseline studies of these phenomena will be conducted in the target and control area using a broad array of field techniques including oral history.

TABLE 1: ILLUSTRATIVE LIST OF SCIENTIFIC AND ECONOMIC DESIGN AND EVALUATION STUDIES

A. Scientific Studies	Estimated Cost
1. Statistical Hydrology Design Develop statistical relationships within and between historical hydrologic data for the target and control basins. Establish statistical procedures for estimating the amount and confidence level of expected streamflow increases due to seeding.	$ 75,000
2. Suspension Criteria Develop and implement site specific suspension criteria for the demonstration project area for snowpack and rainfall increase seeding operations by the 1985-1986 winter field season. Extend these suspension criteria to other areas of Morocco recommended for future weather modification operations.	$ 75,000
3. Landsat Snowcover-Runoff Studies Compare areal estimates of snowcover in drought and non-drought years. Monitor snowcover in Morocco on a current basis. Adapt an existing snowcover-runoff model to the Moroccan situation for use in evaluations and suspension criteria.	$ 80,000
4. Airborne Cloud Physics Data Analysis Evaluate seedability conditions and determine the frequency and duration of seedable situations as a function of storm type. Evaluate the effects of seeding on microphysical properties of clouds to confirm efficacy of seeding hypothesis.	$130,000
5. Mountain Airflow Analyses Evaluate airborne wind and radiosonde data to establish the airflow over and around the Atlas Mountains during seedable storm conditions. Establish the number and locations of groundbased seeding generators and the conditions under which their operation is effective.	$ 60,000

6. Radar and Precipitation Data Analysis $170,000

Evaluate the effect of seeding on the physical and dynamical properties of the clouds and their resultant production of precipitation. Develop relationship for estimating precipitation from radar data for convective cloud systems, especially in spring through fall months, and use it in the evaluation studies.

7. Operational Effectiveness Studies $ 75,000

Evaluate the efficiency and effectiveness of seeding operations including the adequacy of opportunity recognition and reaction procedures, seeding coverage and equipment and personnel performance. Develop improved operational procedures. Assess the impact of the weather modification project and its equipment and training on improving the meteorological and climatological services to Morocco.

Total $665,000

B. Economic Studies

1. River Simulation Modeling $200,000

Develop a computer model that simulates the operation of the demonstration project water basin including all water sources, water uses and water losses in accordance with current management practices and operational procedures. Estimate the value of the additional water from weather modification among its various uses -- hydropower generation, irrigation, domestic water supplies, groundwater recharge and water quality improvement. Examine alternative operational procedures to improve water resource management practices.

2. Agricultural Impact Studies $320,000

Develop computer models for key agricultural crops that simulate yields as a function of soil moisture, temperature, radiation, water (precipitation or irrigation) and farming practices. Evaluate the effect of timing, amount and frequency of water on crop yields to establish the most beneficial opportunities for augmenting natural precipitation by either weather modification or irrigation. Estimate increases in agricultural production and its economic impact resulting from timely augmentation of natural precipitation.

3. Water Resources Assessment and Analysis	$200,000

Survey Moroccan water resources, management practices, distribution and needs. Identify structural and non-structural water development options and improved management techniques. Evaluate the relative role of long-term weather modification operations within the total national water management program. Identify the most promising options or combination of options in addition to weather modification for further investigation and planning.

Total	$720,000

To aid the evaluation the areal extent of snowcover, as determined from Landsat photographs in seeded seasons, will be compared with unseeded prior years and unseeded control basins in the same years. Snow measurements will be made in the target and control basins to obtain snowfall depths and snowpack water content values. Historical estimates of Landsat snowcover estimates and high-altitude temperature and preciptation data will be used to adapt existing snowcover-runoff models to the demonstration project basins in interest. Predictions from such a model will be valuable in both the evaluations and the development and use of site specific flooding suspension criteria.

There is an excellent potential for evaluating the economic impacts derived from added water in the river-reservoir system of the project basin. These impacts will fall in three broad areas: hydroelectric power generation, agricultural water for irrigation and domestic and industrial water supplies. Additional benefits from groundwater recharge and water quality improvement are also possible. A river simulation model of the project basin will be developed and used to determine the distribution and use of the additional water estimated from the cloud seeding operations. The economic benefits will be calculated from the value of water used by each sector.

The evaluation studies will include an assessment of the effectiveness of the cloud seeding operation, including timeliness and coverage of the seeding, forecast accuracy and equipment and personnel performance. This critical assessment of the operational efficiency will provide the basis for improved operations.

An assessment survey of the Moroccan water resources, management system, needs and development options will be made. Through this study, the future role of weather modification within a total national water management plan can be evaluated. The most promising structural and/or nonstructural improvements will be identified for further investigation and planning.

The components of the scientific and economic design and evaluation studies are summarized below along with their main objectives and estimated costs. These studies will consider the activities in the demonstration project area and other regions of Morocco where weather modification operations are determined to be a practical part of a long-term water resources program. The estimated budget is for illustrative purposes and is subject to change as a result of contract negotiations and yearly findings.

2. RAINFALL ENHANCEMENT FOR RAINFED AGRICULTURE

a. Operational Area

Although top priority should be given to increasing runoff into reservoirs, seeding to the north of the basin within the range of the weather radar set will be undertaken as a second priority on a controlled experiment basis. The objective of such seeding will be to provide rain directly on crops. Such seeding will be restricted to the area within range of the weather radar set (approximately 100 km) to allow for scientific control and evaluation.

b. Operational Description

The cloud types encountered will range from isolated cumulus to massed convective clouds, often in bands, just as in the case of seeding for reservoir storage. However, because the seeding will be done over flatter and lower terrain, the massed clouds will be more rare and, even when they occur, their bases would be several hundred meters above the ground. The seeding tracks might be flown occasionally below cloud base. However, it would still be necessary to have the tracks laid out by a meteorologist at the radar site on the basis of data available to him, rather than by pilots on the basis of visual observations.

For seeding isolated clouds, one would turn again to seeding from above, near the -15 degree C level, with the final selection of target clouds made by the pilots themselves on the basis of their meteorological characteristics.

A detailed summer operations plan will be prepared, thoroughly reviewed and operational procedures practiced prior to the start of the 1985 rainfall enhancement program. This plan will contain all the seedability criteria, the procedures for seeding the convective clouds, the forecasting and suspension criteria, and the utilization plan for project resources. This plan will be updated each year as required.

c. Scientific and Economic Evaluation

It will not be possible to evaluate the seeding over the rainfed farmlands with much precision during the 5 year life of the project. Visual observations from the aircraft and radar observations of seeded showers will be made, but these will, at best, indicate only trends. The characteristics of individual convective clouds vary so widely that it is unlikely that any post-seeding events can be ascribed unequivocally to seeding treatments. However, on those days when many convective elements are present, it is likely that some will go unseeded due to the inability of the seeding aircraft to seed all the cells. The possibility exists for use of a randomized approach to seeding of cells when their frequency exceeds a preset level. For example, if 10 or more cells of a given size exist in the rainfed target area, 5 would be chosen at random for seeding. Another approach is to use different seeding techniques selected in a randomized mannner. Then the echo characteristics (growth, volume and intensity) of the seeded sample and non-seeded sample would be compared.

The economic evaluation of the radar-determined rainfall changes will be difficult but must be pursued. First, crop-weather models based on 1959-1983 data must be developed for the major crops (wheat, barley and corn) in the central plains target area. These should allow for estimating effects of daily precipitation changes. The added daily precipitation, determined from comparisons of characteristics of seeded echoes with those of non-seeded echoes, will be expressed in area-depth values. These volumes can be inserted in the yield equations on a monthly basis to predict total effects on yield and area coverage. These production changes can be translated into monetary

values. No other economic evaluation is envisioned, although slight impacts could be expected in relation to long-term stabilization of income from reduced variability of yield between years.

3. DOWNWIND EFFECTS

In proposing any seeding project, it is necessary to consider the possibility of seeding having some effects downwind of the intended target area.

Although many researchers have examined downwind areas for possible seeding effects, it is generally agreed that no serious evidence exists for effects on precipitation more than 100 km downwind of the seeding location. There are some weak statistical indications that changes in precipitation (either increases or decreases) induced in a target area "spill over" some tens of kilometers downwind. The changes are always in the same sense as those observed in the target area; there is no evidence so far of a reduction in rainfall downwind of a target area showing rainfall increases.

In the case of seeding on the windward side of the High Atlas, the clouds will be dissipating rapidly as the air descends on the leeward side. In many cases the High Atlas completely blocks cloud systems from progressing further southeast. It is obvious that no downwind effects could be found in such cases. Rainfall in the downwind region is produced by entirely different cloud systems. Therefore, it is not anticipated that the proposed winter snowpack program will result in a reduction in precipitation to downwind areas in Morocco or neighboring countries.

The situation is different for seeding over the plains on low hills; in such cases the analysis will include a search for downwind effects even though the large rainfall variations will make such effects very hard to detect.

4. SUSPENSION CRITERIA

Criteria based on atmospheric conditions and known impacts of weather events on society and the environment must be established and used in weather modification programs. The potential for inadvertent outcomes, such as reducing natural levels of rain or snow; or production of severe hail storms, major windstorms or damaging floods, must be considered and built into the design of weather modification programs.

In scientifically based weather modification programs extreme emphasis is placed on avoiding the creation of hazardous conditions through the suspension of cloud seeding activities under certain conditions. The decision to suspend operations either on a temporary or indefinite basis is made through the use of suspension criteria. Suspension criteria are a set of guidelines which specify a number of parameters, such as thickness of snowpack within the water year, and establish thresholds at which activities are suspended.

Conditions vary sufficiently between areas such that no universal suspension criteria can now be applied. Interim suspension criteria (Annex F) adopted from similar environments in the United States assuming comparable

meterological and hydrological conditions will be used until site specific suspension criteria are developed. Therefore, a major objective of the program's weather modification evaluation studies will be to discern those atmospheric conditions when damaging weather events occur. Such studies will allow for the development of site specific suspension criteria that are consistent with responsible professional practice and are within the risk levels acceptable to the Government of Morocco.

As part of the evaluation investigations historical and field descriptive studies of flood events, hailstorms and other severe weather phenomena within the project area and their social, economic and environmental effects will be conducted to provide baseline data for comparison with their antecedent atmospheric conditions. In addition, an assessment will be made of discharge values from seeded events (rain or snow) when high streamflows occur. By the beginning of the second year of field operations, specific criteria for suspending cloud seeding operations in the demonstration program area that are developed from these evaluation studies will be implemented. At the end of the third year of the program, suspension criteria for other recommended areas of operation will be presented along with an operational plan for their implementation as an element of future program management. The schedule for suspension criteria development and implementation is given below. In order for the project to remain in compliance with the provisions of 22 CFR 216, "AID Environmental Regulations" (Section VII, C) and to avoid invoking conditions of termination (Section VIII) suspension criteria must be developed as indicated in the schedule and rigorously used in program management.

TABLE 2: SCHEDULE OF SUSPENSION CRITERIA DEVELOPMENT AND IMPLEMENTATION

March 1984:

Specification of interim suspension criteria.

June - September 1984:

Familiarize Moroccan program meteorologists and pilots with suspension criteria concepts and procedures, and implement the interim suspension criteria for the demonstration program.

October 1984 - September 1985:

Develop and implement site specific suspension criteria for the demonstration program.

October 1985 - September 1986:

Develop suspension criteria for other recommended areas of operation and prepare a plan for their implementation.

IV. TECHNICAL DESCRIPTION

A. IMPLEMENTING MECHANISM

Following authorization of the Project, USAID/Morocco will negotiate a project agreement with the National Meteorological Organization, Ministry of Transportation. The project agreement will designate the National Meteorological Organization as the Government of Morocco implementing agency and will specify how the National Steering Committee on Weather Modification and the Project Steering Committee will supervise project implementation (see Section VII, D and Section VIII, A).

AID will implement the project principally through a Participating Agency Services Agreement (PASA) with the Bureau of Reclamation, U.S. Department of Interior. The Bureau of Reclamation will provide overall scientific management and serve as a procurement agent for scientific commodities and services subcontracts for AID.

B. DETAILED DESCRIPTIONS

1. FACILITIES AND EQUIPMENT REQUIREMENTS

a. Project Planning and Management Center

The project will be planned and managed from the technical headquarters of the National Meteorological Organization at the old airport in Casablanca. Facilities will be provided there for all senior project personnel, project administration and scientific analysis. The main METEOSAT receiver will be housed at this facility and will be linked by telecommunications to the Operations Control Center. The center will require allocation of five furnished offices, classroom space and storage for equipment.

b. Operations Control Center

Experiences in conducting weather modification projects indicate the critical importance of having an operations control center to direct the cloud seeding activities. The operations control center will be located at the Beni Mellal Synoptic Weather Station and will be linked through a communications system with the radar trailer near Oued Zem. The operations center will require 2 furnished offices and storage space. A balloon inflation shelter for the radiosonde will be constructed at Beni Mellal.

The core equipment required at the center to enable the operations director to make the necessary decisions in initiating, monitoring, and controlling cloud seeding missions are listed below. It is important to note that stable power sources with backup power supply generators for all equipment are necessary.

i. A weather radar capable of processing and displaying contoured plan position and range-height reflectivity images and equipped with an IFF (identification-friend-foe) system to show locations of project aircraft using

coded transponders. Color displays of the radar images and aircraft positions will be transmitted to Beni Mellal and radar and flight track data will be recorded for evaluation analyses.

ii. Two radiosonde units, one for routine operations and one as an immediately available backup, will provide the upper air temperature, moisture and wind data over and upwind of the target area. This information is critical to recognizing the seeding opportunities, the suspension criteria, and direction of operational missions.

iii. A printer at the field operations center to provide high quality near real-time satellite cloud photos from the receiver located at Casablanca.

iv. A capability to receive standard available synoptic weather data and weather maps.

v. An independent radio communications system (or dedicated frequencies) to facilitate communication between the operations director and the seeding aircraft, and adequate telephone or radio communications linking the control center to the aircraft launch base, to the meteorological data sources and to other project personnel.

c. Seeding Aircraft

The aircraft to be used for cloud seeding need to be equipped with the following special equipment:

i. Silver iodide generators and ejectable flare racks;

ii. Dedicated radio communication frequencies to the operations control center and special coded transponders (or dedicated codes) for project radar tracking in addition to standard radio communication capabilities;

iii. Capability to record seeding events and times;

iv. Outside air temperature sensor with cockpit indicator;

v. An adequate navigational system to permit accurate navigation under IFR (Instrument Flight Rules) conditions within storms and at night; and

vi. An IFR equipped aircraft, including de-icing capability, for installation and operations with the airborne meteorological instrument package.

d. Aircraft Support Requirements

Home Base

Routine equipment for the operation and maintenance of aircraft, including the maintenance of engines. Adequate storage space for spare parts, fuel and seeding materials.

Operations Support Base

Ground control building, landing lights, storage for fuel and seeding materials and mobile maintenance unit.

e. Scientific and Economic Evaluation

Equipment required for the analysis and evaluation studies include:

i. A computer processing capability for the radar, including software printer for reproducing contoured images aircraft flight tracks, and radiosonde plots;

ii. Lease of a Cloud Physics Aircraft to collect basic data on the physical characteristics of clouds and stormfronts in the Moroccan weather system;

iii. Elementary cloud physics sensors and recording system for at least one of the seeding aircraft that will be equipped with IFR and de-icing.

iv. A weather station and several snow measurement courses in the target and control mountain snowpack area.

v. Data processing and analysis facilities.

The evaluation program presumes continuation of all existing streamflow gauges and weather stations. Collection of additional data concerning crop yields and hydro-electricity generation is needed for the evaluations; however, this will not require special additional equipment.

2. PERSONNEL REQUIREMENTS

The requirement for around-the-clock operations, though not for more than several consecutive days, and a comprehensive technical and economic evaluation are the main factors in developing the program staff needs. Through a variety of training programs, existing staff in Morocco can be qualified to perform the required scientific, technical, and management functions of the weather modification program. In some cases, accomplishment of the required functions will be a full-time duty. In other cases, the functions will be in addition to existing duties.

There will be significant requirements made upon the Royal Moroccan Air Force for the routine maintenance and operation of aircraft. This will require a major allocation of staff and budget resources. It is anticipated that given the large number of flight hours required for the operation major efforts in maintenance and logistics will be required on a full time basis. The need for a large number of qualified flight crews may require holding an intensive aircraft specific training program at the beginning of the project which can be conducted by training pilots from the Royal Moroccan Air Force.

The following list is intended to be illustrative of Government of Morocco personnel requirements. It does not include non-specialized staff required for meteorological and data support activities which will be expected to continue their routine activities in support of the project.

a. National Meteorological Organization Headquarters (Casablanca)

The following personnel will be required for administration and management of the overall program and coordination of the activities of the cooperating governmental organizations:

1 Program Director (Full Time)

1 Assistant Program Director (Full Time)

The following personnel will be required for directing and conducting the technical and economic evaluations, and the associated data processing and archiving for the program:

1 Physical Meteorologist (Full Time)

1 Hydrometeorologist (Full Time)

1 Agrometeorologist (Full Time)

b. Operations Control Center (Beni Mellal National Meteorological Organization)

The following personnel will be required for managing and directing field operations, and launching and controlling cloud seeding missions:

1 Operations Director (Full Time)

1 Assistant Operations Director (Full Time)

2 Aircraft Operations Controllers, Royal Moroccan Air Force (Full Time)

The following personnel will be required for providing meteorological data, and operating and maintaining the equipment that is used to collect it:

1 Chief Radar Operator (Full Time)

2 Assistant Radar Operators (Full Time)

1 Radar Electronics Technician (Full Time)

1 Weather Forecaster (Full Time)

1 Assistant Weather Forecaster (Full Time)

2 Radiosonde Launch Teams (Full Time)

1 Electronic Technician (For meteorological and communications equipment) (Full Time)

c. Seeding Aircraft Home Base (Royal Moroccan Air Force)

The following personnel will be required for coordinating operations, flying and maintaining the seeding aircraft:

1 Program Coordinator (Full Time)

2 Crews per seeding aircraft and backup crews
8 Pilots (Part Time)
8 Systems Operators (Part Time)

The following ground support crews will be required for maintaining and servicing aircraft, specialized meteorological and cloud seeding equipment, and preparing and loading seeding materials:

Maintenance Support

1 Director (Full Time)

1 Assistant Director (Full Time)

2 Electronics Specialists (Full Time)

20 Enlisted Men in Operation and Support Functions (Part Time)

Logistical Support

1 Director (Full Time)

1 Assistant Director (Full Time)

10 Enlisted Men in Logistical Support Functions (Part Time)

d. Seeding Aircraft Operations Support Base (Royal Moroccan Air Force)

The following personnel will be required to provide support for local landing, refueling and maintenance during operations:

1 Director (Part Time)

1 Assistant Director (Part Time)

2 Ground Controllers (Part Time)

5 Ground Control Staff (Part Time)

15 Enlisted Men in Ground Support Crew (Part Time)

Mobile Maintenance Team from Home Base of Aircraft (Part Time)

e. High Altitude Weather Station

The following personnel will be required for operating and maintaining the weather station, collecting and transmitting the data, and making the snow course measurements:

2 Meteorological Observers (Part Time)

1 Meteorological Technician (Part Time)

3. TRAINING REQUIREMENTS

The primary purpose of the project is to develop within Morocco the scientific, technical and management capability to conduct a long-term, scientifically sound weather modification program as part of its water resources management program. This will require training in all facets of weather modification operations, management and evaluation to transfer relevant technology existing worldwide to the Moroccan situation as appropriate.

Training activities in Morocco based on the learning-while-doing concept with both primary and follow-up instruction will be emphasized; however, in some cases training at centers of expertise in the United States will be required. Two electronic technicians will take part in the fabrication of the radar system in the U.S. at the contractor's location during July and August 1984. All contracts for scientific and technical equipment provided through the project will have training components to assure proper operation and maintenance.

Video tape of training procedures for equipment maintenance and repair, scientific methodology and theoretical aspects of applied analysis, forecasting, cloud physics and weather modification will be provided in English and French. Scientific exchanges of information between the Bureau's projects in California and Colorado and meteorologist and pilots in Morocco will be achieved by video tape with French dubbing. This will be accomplished through video tapes of the scientific meetings, workshops, field equipment, radar, satellite observations and operational procedures.

In Morocco video recordings will be used to document the progress of the program, and the radar, satellite and aircraft observations. Routine recordings of radar, satellite and aircraft operations will be used to debrief pilots and meteorologists after daily operations and will assist in training of seeding and operational procedures. Video tapes of satellite and radar data will also provide a continuous record of cloud and echo characteristics for use in the evaluation of the project.

a. Immediate Familiarization

Ongoing winter cloud seeding programs in the United States offer an immediate opportunity for Moroccan personnel to become familiar with the conduct of the proposed cloud seeding demonstration program. The first priority in training will be given to a study tour for the two principal meteorologists and two senior pilots who have been assigned to the weather modification program. The program should be field orientd and last approximately 3 weeks. During the tour, participants will be able to observe how cloud seeding operations are conducted, to learn why and how suspension criteria are used, and to become familiar with the equipment, data collection, and data processing techniques that are used. Information and techniques obtained during the familiarization visits should be put into practice immediately on their return to Morocco to enhance current weather modification operations.

These activities and experiences should be reinforced by similar visits by American experts to Morocco who would provide advice on the application of such techniques in the Moroccan program. A visit by an experienced weather modification pilot to familiarize air traffic controllers on weather modification aircraft operations and a visit by an experienced weather modification operator to provide advice on specific operational procedures is a high priority in order to assure maximum safety in the operation.

It is anticipated that during the first year of the project the Director of the National Meteorological Organization will make a trip to the United States to meet with senior officals who are responsible for the planning, management and financing of water resources related weather modification programs to become familiar with their programs. In each of the subsequent years, one key official of the program will make a similar visit which will focus on the observation of active scientifically based weather modification programs in the United States to observe particular aspects according to their scientific, technical or managerial area of interest and expertise.

b. General Training

Development of a cadre of specially trained personnel will be accomplished through short- and long-term training using both formal and informal techniques. The short-term technical training will focus on equipment operation and maintenance, familiarization with particular aspects of the program and reinforcement of primary learning activities. Long-term training will emphasize the development and application of scientific and technical skills to the design, planning and evaluation of weather modification related issues.

Training in Morocco of personnel involved in the operation, maintenance, interpretation and analysis of data from the radar, radiosondes, satellite system and airborne cloud physics systems is an early priority. Training should be on actual equipment to be used in the program. The assistance of Moroccan scientists and technicians during the installation and initiation of operation of this equipment will be a valuable part of this training.

40

Training in Morocco of personnel involved in the economic evaluation of the weather modification demonstration program is a high priority. Familiarization with techniques for ascertaining the incremental increase in water derived from cloud seeding and its hydrologic and agricultural benefits are needed. It is intended that these evaluations will provide the basis for the Government of Morocco decisions during project implementation or after completion of the project to terminate, intensify or geographically expand their investments in weather modification operations.

An advanced training program is recommended for the pilots who would fly the seeding missions. Information on actual cloud conditions from the seeding aircraft is important in making certain that the right clouds are being seeded in the right way and, in some instances, the pilot of the seeding aircraft makes the final seeding decision. The pilot training should cover both fundamental meteorological principals and practical flying experiences.

Longer term academic training at universities in the United States is planned to fill the longer range scientific needs of both the operational and evaluation components of the project. It is anticipated that key scientists in the program will receive specialized training in advanced meteorology with emphasis on cloud physics, physical meteorology and statistics.

c. English Language Training

English language training for all key Moroccan scientists and technicians is to be provided by a Peace Corps volunteer assigned to the project for this purpose (see Section IV, 6 for details).

4. TECHNICAL ASSISTANCE REQUIREMENTS

With foreign assistance and advice, the existing Moroccan weather modification program can be enhanced to maximize water production in the target area during the current drought. With foreign assistance and specialized training, an entirely Moroccan-run weather modification program for long-term water resources development, including capabilities in the more complex analysis and evaluation areas, should be possible with sustained effort at the end of five years.

Technical assistance will be provided in the following areas:

a. Resident Scientific Advisor

The project will provide funding for a Resident Scientific Advisor (see Annex G for Position Description) from the Division of Atmospheric Resources Research, Bureau of Reclamation. The Advisor will have specialized expertise and experience in weather modification. The Advisor will be stationed in Morocco on a long term basis and have an office at the Headquarters of the National Meteorological Organization in Casablanca. The Advisor will provide scientific management, field technical monitoring of contractors and project coordination. This weather modification expert will work with the Moroccans on a day-to-day basis in developing and implementing a scientifically sound

program and providing advice and training in the execution of all its components. It is anticipated that the Advisor will spend significant periods of time at the Beni Mellal operations center and at the radar site near Oued Zem during peak operating periods.

b. Short-Term Technical Assistance

The project will provide funding for short-term technical assistance from the Bureau of Reclamation and commercial firms. Assistance will be provided as needed to resolve design issues and to provide recommendations and guidance in the management and conduct of the program. Technical assistance will be available for problems relating to operational details and overall project development, integration and evaluation. Technical assistance will also be provided in the area of water resources planning and management and will serve to identify ways in which the incremental increase in water developed by the weather modification project can be best utilized. All individuals providing technical assistance will be expected to serve as instructors to assist directly in the transfer of technology and development of management capability.

The project will provide significant amounts of scientific equipment which will require the extensive technical assistance to assure proper installation and training in the use of this equipment under Moroccan conditions. Technical assistance associated with equipment will place strong emphasis on both operation and maintenance training. In addition assistance will be provided in the logistical support area to improve support services for equipment.

c. Scientific and Economic Evaluation

The project will support extensive technical assistance in the area of scientific and economic evaluation. These studies will be conducted by private sector contractors in coordination with the National Meteorological Organization and cooperating Government of Morocco organizations. The studies will have a large number of subcomponents, including the development of suspension criteria, and all will require the participation and training of Moroccan personnel. A major emphasis in the program is the development of Moroccan skills to determine the actual physical and economic impacts of investments made in weather modification. Assistance will include transfer of techniques for evaluation of alternative investment opportunities in water resources development and conservation so that future interventions can be economically examined on a case by case basis.

5. COOPERATION WITH THE NATIONAL OCEANOGRAPHIC AND ATMOSPHERIC ADMINISTRATION (NOAA), DEPARTMENT OF COMMERCE

The World Meteorological Organization of the United Nations facilitates a voluntary cooperators program by which participating member nations can provide assistance to requesting nations to upgrade their meteorological capabilities so they can participate more effectively in the World Weather Watch. The National Oceanic and Atmospheric Administration (NOAA) represents

the United States in the World Meteorological Organization and participates as a donor in its voluntary cooperators program. Morocco has made a request for assistance in a number of technical areas under the World Meteorological Organization program.

Following discussions with the Bureau of Reclamation and AID, the National Oceanographic and Atmospheric Administration has agreed to respond favorably to a portion of Morocco's request and in a manner compatible with the requirements of AID's weather modification assistance program. Specifically NOAA has agreed to provide Morocco with a complete applied meteorological satellite ground station and the associated technical training in its operation and maintenance. NOAA will provide a Secondary Data Utilization Station (SDUS) capable of receiving, displaying and printing WEFAX images from both METEOSAT and NOAA orbiting satellites including a colorgraphics display unit, both standard hardcopy and laserfax recording units and a tape recording unit. AID will provide for the recurring costs of supplies and maintenance after the manufacturer's warranty on the equipment expires until the project completion date.

The SDUS should be located at the offices of the National Meteorological Organization in Casablanca to serve the widest range of meteorological applications for Morocco. AID will provide a second laserfax recorder for installation at the Operations Control Center at Beni Mellal to serve the weather modification program. In addition, AID will provide scientific training in the analysis and use of the satellite data products for weather modification and other general meteorological purposes.

6. COOPERATION WITH THE PEACE CORPS

The Peace Corps program in Morocco will support implementation of the project by providing the services of a volunteer to the National Meteorological Organization to instruct staff in scientific and technical English (See Annex H for a position description). The volunteer will work under the direct supervision of the Resident Scientific Advisor and will be responsible for the development of a curriculum specifically tailored to the needs of the Organization. In addition to instruction, the volunteer will be responsible for the identification and ordering of all necessary materials for use in language instruction and the development of a reference section on scientific and technical English in the library of the National Meteorological Organization. The volunteer will also participate in other training and research activities of the project as deemed appropriate.

Funding for the volunteer will be provided from the general budget of the Peace Corps in Morocco. The volunteer will be provided office space and secretarial support from the National Meteorological Organization. AID will provide under the project for teaching materials, library purchases and costs associated with special transportation requirements of the volunteer due to project related assignments.

V. FINANCIAL PLAN

A. SOURCE OF FUNDS

The project will be financed from USAID/Morocco Economic Support Funds and the Government of Morocco.

B. APPLICATION OF FUNDS

All AID funds will be provided on a grant basis and the cooperating country grantee will be the National Meteorological Organization, Ministry of Transportation. AID funds will be used to finance the costs of U.S. source and origin goods and services and for local currency costs of goods and services required for the project. The cooperating country will provide all foreign and local currency costs for the operations of the Royal Moroccan Air Force and will provide local currency support and in-kind services for civilian organizations involved in project implementation.

AID funds will be restricted to support of civilian organizations in compliance with the provisions of the Foreign Assistance Act of 1961, as amended, Section 531 (c). In addition, no United States Government funds will be used for direct financing of cloud seeding equipment, materials or operation costs in compliance with current policy.

C. BUDGET

The summary estimated budget for the project by fiscal year is presented in Table 3 and the comprehensive estimated budget for the project by fiscal year is presented in Table 4. The project budget has been developed on the basis of Government of Morocco, AID and Bureau of Reclamation cost experience and costs are current as of February 1984. Estimates have been adjusted for inflation both in Morocco and the United States. Personnel costs include salaries, benefits and projected wage increases during the life of the project. The estimated budgets for the Government of Morocco have been developed from information provided by the National Meteorological Organization and the Royal Moroccan Air Force and have been reviewed in detail by senior representatives of those organizations.

The estimated budget is for illustrative purposes and represents the most accurate projection of costs by fiscal year available at the time of project design. Under the terms of the Participating Agency Service Agreement (PASA) with the Bureau of Reclamation for direct support (Tables 4 and 5) and administration of subcontracts (Tables 4 and 6) adjustments of plus or minus fifteen percent will be allowed between line items. This flexibility is especially important given that a significant amount of equipment must be specially fabricated for the project and the difficulty of developing extremely accurate estimates for such procurements.

It should be noted that the budget provides for the extensive financing of recurrent costs ($510,000)during the life of the project which require foreign exchange. The majority of these funds ($430,000) are provided for purchase of balloons and sondes to conduct the critical radiosonde measurements of the atmosphere in vertical profile. Given the current shortage of foreign exchange available to the Government of Morocco, the substantial commitment of funds it is making available to the project and the critical need for this data on a timely basis it is believed that AID funding of these costs is justified.

TABLE 3. SUMMARY ESTIMATED PROJECT BUDGET BY FISCAL YEAR*

(In Thousands of United States Dollars**)

	FY-84***	FY-85	FY-86	FY-87	FY-88	TOTAL
I. GOVERNMENT OF THE UNITED STATES						
A. A.I.D. (47.9%)						
1. A.I.D. Administered Funds	28.3	42.8	47.3	51.1	53.5	223.0
2. Bureau of Reclamation Contract (PASA)	283.9	265.1	314.3	230.3	317.4	1411.0
3. Subcontracts Administered by Bureau of Reclamation	694.3	1250.5	1192.5	601.8	626.9	4366.0
Subtotal (A.I.D. Only)	1006.5	1558.4	1554.1	883.2	997.8	6000.0
B. National Oceanographic and Atmospheric Adminsitration (0.9%)	114.0	-	-	-	-	114.0
C. Peace Corps (0.5 %)	-	14.0	16.0	18.0	20.0	68.0
Subtotal (49.3%)	1005.2	1678.5	1547.7	929.8	1020.2	6182.0
II. GOVERNMENT OF MOROCCO						
A. National Meteorological Organization (18.9%)	1051.7	302.7	319.0	337.6	359.0	2370.0
B. Royal Moroccan Air Force (31.5%)	563.4	897.4	830.9	846.0	862.3	4000.0
C. Royal Air Maroc (0.3%)	12.0	16.0	4.0	4.0	4.0	40.0
Subtotal (50.7%)	1627.1	1216.1	1153.9	1187.6	1225.3	6410.0
ESTIMATED TOTAL PROJECT COST	2747.6	2788.5	2724.0	2088.8	2243.1	12592.0

* The fiscal year of the Government of the United States is from October 1 through September 30.
** All costs in Moroccan Dirhams have been converted at a rate of 8.0 dh to $1.00 U.S.
*** All cost estimates assume that the project begins March 1984.

TABLE 4: COMPREHENSIVE ESTIMATED PROJECT BUDGET BY FISCAL YEAR*

(In Thousands of United States Dollars**)

	FY-84	FY-85	FY-86	FY-87	FY-88	TOTAL
I. GOVERNMENT OF THE UNITED STATES						
A. A.I.D.						
1. Project Costs Administered by A.I.D.						
a. House Rent for Resident Scientific Advisor	3.0	13.5	15.2	17.3	19.4	68.4
b. Utilities	.5	3.6	4.2	4.7	5.3	18.3
c. School Tuition	-	1.5	2.4	2.6	2.8	9.3
d. Watchman	.6	2.4	2.6	2.9	3.3	11.8
e. Temporary Lodging	1.5	-	-	-	-	1.5
f. Local and European Travel	.5	2.0	2.0	2.0	1.5	8.0
g. Local and European Per Diem	1.0	4.0	4.0	4.0	3.0	16.0
h. Office Equipment and Supplies	6.0	1.0	1.0	1.0	1.0	10.0
i. Procurement of Project Vehicle	10.0	-	-	-	-	10.0
j. Salary for Administrative Assistant (FSN 9 Pay Level)	4.2	9.1	9.5	9.9	10.3	43.0
k. Salary for Bilingual Secretary (FSN 7 Pay Level)	1.0	5.7	6.4	6.7	6.9	26.7
Subtotal	28.3	42.8	47.3	51.1	53.5	223.0
2. Bureau of Reclamation Contract (PASA)						
a. Resident Scientific Advisor	63.1	68.0	74.1	72.2	72.8	350.2
b. Scientific Support (TDY)	61.7	42.8	35.4	35.4	35.4	210.7
c. Bureau of Reclamation Scientific Support (Denver)	23.0	45.8	48.5	48.5	48.5	214.3
d. Administration and Contracting Support	83.5	52.3	28.6	20.6	29.1	214.1
e. Project Monitoring	14.5	17.6	17.6	17.6	16.6	83.9
f. Participant Training Costs	14.7	14.8	14.8	14.8	14.8	73.9
g. Reports, Publications, etc.	-	-	66.9	-	72.0	138.9
h. Project Vehicle Support	1.0	5.0	5.0	5.0	5.0	21.0
i. Other Costs	22.4	18.8	23.4	16.2	23.2	104.0
Subtotal	283.9	265.1	314.3	230.3	317.4	1411.0

* The fiscal year of the Government of the United States is from October 1 through September 30.

** All costs in Moroccan Dirhams have been converted at a rate of 8.0 dh to $1.00 U.S.

(TABLE 4: CONTINUED)

	FY-84	FY-85	FY-86	FY-87	FY-88	TOTAL
Subcontracts Administered by the Bureau of Reclamation						
a. French Language Training for Resident Scientific Advisor	7.0	2.0				9.0
b. Short Term Scientific Training	4.8	3.8	3.8	1.8	3.7	19.9
c. Long Term Scientific Training		0.0	20.0	1.0	0.0	80.0
d. Air Traffic Control Training	25.0	-	-	-	-	25.0
e. High Altitude Weather Station						
Capital Cost	32.0	-	-	-	-	32.0
Recurrent Cost	.5	.3	.2	-	-	1.0
f. Snow Measurement Courses	26.0	-	-	-	-	26.0
g. Aircraft Instrumentation						
Capital Cost	-	-	50.0	6.0	6.0	62.0
Recurrent Cost	-	-	-	1.0	3.0	6.0
h. Communication System						
Capital Cost	45.0	5.0	10.0	-	-	120.0
Recurrent Cost	-	2.0	1.0	.0	1.0	5.0
i. Satellite Receiver (Hardware)						
Capital Cost	25.0	8.0	8.0	1.0	8.0	57.0
Recurrent Cost	-	7.0	7.0	7.0	7.0	28.0
j. Satellite Data Analysis	50.0	5.0	-	-	-	65.0
k. Radiosonde						
Capital Cost	90.0	6.0	5.0	5.0	5.0	111.0
Recurrent Cost	50.0	5.0	95.0	95.0	95.0	430.0
l. Radar						
Capital Cost	239.0	0.0	110.0	100.0	100.0	669.0
Recurrent Cost	-	0.0	10.0	10.0	10.0	40.0
m. Cloud Physics Aircraft (Lease)	-	5.0	375.0	-	-	750.0
n. Scientific Design and Evaluation	55.0	195.0	195.0	110.0	110.0	665.0
o. Economic Design and Evaluation	-	180.0	180.0	180.0	180.0	720.0
p. External Evaluation	-	25.4	25.5	-	25.5	76.4
q. Other Costs	45.0	121.0	97.0	53.0	52.7	368.7
Subtotal	694.3	1250.5	1192.5	601.8	626.9	4366.0
Subtotal Recurrent Costs Only	(50.5)	(114.3)	(113.2)	(116.0)	(116.0)	(510.0)
Subtotal A.I.D. Only	1006.5	1558.4	1554.1	883.2	997.8	6000.0
B. NATIONAL OCEANOGRAPHIC AND ATMOSPHERIC ADMINISTRATION						
1. Satellite Receiver (Hardware)	114.0	-	-	-	-	114.0
C. PEACE CORPS						
1. Volunteer to Teach English	-	14.0	16.0	18.0	20.0	68.0
SUBTOTAL GOVERNMENT OF THE UNITED STATES	1120.5	1572.4	1570.1	901.2	1017.8	6182.0

(TABLE 4: CONTINUED)

	FY-84	FY-85	FY-86	FY-87	FY-88	TOTAL
II. GOVERNMENT OF MOROCCO						
A. NATIONAL METEOROLOGICAL ORGANIZATION						
1. Personnel (Salary and Benefits)						
a. Class I (4)	27.3	48.0	49.8	51.6	54.0	230.7
b. Class II (7)	44.1	78.8	81.9	85.1	89.3	379.1
c. Class III (9)	45.7	81.0	83.7	86.4	90.4	387.2
d. Other (10)	24.5	45.0	48.0	51.0	54.0	222.5
Subtotal	141.6	252.8	263.4	274.1	287.7	1219.6
Operational Expenses						
a. Water and Electricity	2.6	4.7	4.9	5.2	5.6	23.0
b. Telephone and Telex	1.8	3.2	3.4	3.7	3.9	16.0
c. Radar Station	1.3	2.4	2.7	3.0	3.2	12.6
d. High Altitude Weather Station	2.6	4.9	5.1	5.3	5.6	23.5
e. Gas and Oil for Vehicles	6.8	7.2	8.0	8.6	9.0	39.6
f. Other Costs	25.0	27.5	31.5	37.7	44.0	165.7
Subtotal	40.1	49.9	55.6	63.5	71.3	280.4
Investment						
a. Land for Radar Station	15.6	-	-	-	-	15.6
b. Access Road for Radar Station	100.0	-	-	-	-	100.0
c. Installation of Dedicated Telephone Lines	650.0	-	-	-	-	650.0
d. Building for Personnel at Radar Station	50.0	-	-	-	-	50.0
e. Balloon Shelter	12.5	-	-	-	-	12.5
f. Office Furniture	15.0	-	-	-	-	15.0
g. Air Conditioners for Beni Mellal station	4.4	-	-	-	-	4.4
h. Vehicles (1 Four Wheel Drive and 1 Microbus)	22.5	-	-	-	-	22.5
Subtotal	870.0	-	-	-	-	870.0
Subtotal National Meteorological Organization Only	1051.7	302.7	319.0	337.6	359.0	2370.0

(TABLE 4: CONTINUED)

	FY-84	FY-85	FY-86	FY-87	FY-88	TOTAL
B. ROYAL MOROCCAN AIR FORCE						
1. Personnel (Salary and Benefits)						
a. Captain (1) (Full Time)	3.4	6.4	7.1	7.8	8.5	33.2
b. 1st Lieutenant (13) (4 Full Time, 1/2 Time)	27.6	52.2	57.5	63.2	69.5	270.0
c. 2nd Lieutenant (13) (4 Full Time, 1/2 Time)	22.2	41.9	46.1	50.7	55.8	216.7
d. Electronics Specialists (2) (Full Time)	2.0	5.4	5.8	6.6	7.2	27.0
e. Ground Control Specialists (2) (1/2 Time)	1.0	2.7	2.9	3.3	3.6	13.5
f. Enlisted (50) (1/2 Time)	14.2	26.8	29.5	32.4	35.7	138.6
Subtotal	70.4	135.4	148.9	164.0	180.3	699.0
2. Training						
a. Pilot Familiarization Visit	6.0	-	-	-	-	6.0
b. Training of Trainer Pilot for Weather Modification	-	80.0	-	-	-	80.0
Subtotal	6.0	80.0	-	-	-	86.0
3. Equipment and Materials						
a. Seeding Equipment and Chemicals	80.0	68.0	68.0	68.0	68.0	320.0
b. Seeding Aircraft Flight Time (Lease Value)	90.0	180.0	180.0	180.0	180.0	810.0
c. Seeding Aircraft Operations (Fuel)	117.0	234.0	234.0	234.0	234.0	1053.0
Subtotal	287.0	482.0	482.0	482.0	482.0	2215.0
4. Maintenance						
a. Engine Maintenance	100.0	100.0	100.0	100.0	100.0	500.0
b. Spare Parts	100.0	100.0	100.0	100.0	100.0	500.0
Subtotal	200.0	200.0	200.0	200.0	200.0	1000.0
Subtotal Royal Moroccan Air Force Only	563.4	897.4	830.9	846.0	862.3	4000.0
C. ROYAL AIR MAROC						
1. International Travel	12.0	16.0	4.0	4.0	4.0	40.0
SUBTOTAL GOVERNMENT OF MOROCCO	1627.1	1216.1	1153.9	1187.6	1225.3	6410.0
ESTIMATED TOTAL PROJECT COST	2747.6	2708.5	2724.0	2088.8	2243.1	12592.0

TABLE 5: ESTIMATED COSTS FOR DIRECT PROJECT SUPPORT FROM BUREAU OF RECLAMATION*

(In Thousands of United States Dollars)

ITEM	Direct Salaries	Benefits (11.3% of Salaries)	Space Charges (10% of Salaries)	Leave Factors (20% of Salaries)	Travel	Per Diem	Relocation Expenses	Other Costs and Allowances	Overhead (50% of Salaries Benefits and Leave Factors)	TOTAL
1. Resident Scientific Advisor	223.6	25.2	1.2	44.6	-	-	35.6(a)	12.0(b)	8.0	350.2
2. Scientific Support (IDY)	53.8	6.1	5.4	10.8	68.0	21.7	-	9.5	35.4	210.7
3. Scientific Support (Denver)	71.2	8.0	7.1	14.2	-			67.1	46.7	214.3
4. Administrative and Contracting Support	48.3	5.5	4.8	9.7	-			114.1(d)	31.7	214.1
5. Project Monitoring	23.2	2.6	2.3	4.6	4.0	8.0	-	4.0(e)	15.2	83.9
6. Training Costs	25.4	2.9	2.5	5.1	0.0	11.3	-	-	16.7	73.9
7. Reports and Publications	53.1	6.0	5.3	10.6	-	-	-	29.0(f)	34.9	138.9
8. Project Vehicle Support	-	-	-	-	-	-	-	21.0	-	21.0
9. Other Costs	34.2	3.9	3.4	6.8	8.2	4.8	3.5	16.8	22.4	104.0
TOTAL	532.8	60.2	32.0	106.4	110.2	45.8	39.1	273.5	211.0	1411.0

* Estimated budget is for illustrative purposes, under terms of the the Participating Agency Services Agreement (PASA) adjustments of plus or minus 15% will be allowed between line items.

a. Relocation Expenses: Includes (a) security check 3.0, medical examinations 1.6, movement of household effects 12.0, shipment of automobile 4.0, travel 6.6, per diem .8 and storage 7.6.

b. Other Costs and Allowances: Home leave 11.7 and transfer allowance .3.

c. Automatic data processing and interpreter costs.

d. Foreign Activities Administrative costs for all items.

e. Interpreter costs.

f. Word processing, printing and automatic data processing costs.

TABLE 6: ESTIMATED COSTS FOR SUBCONTRACTS ADMINISTERED BY BUREAU OF RECLAMATION BY FUNCTION*

(In Thousands of United States Dollars)

ITEM	Equipment	Recurring Costs (Supplies, Spare Parts)	Technical Assistance and Analysis	Training (Includes Personnel, Travel, Training and Materials)	TOTAL
1. French Language Training for Resident Scientific Advisor	-	-	-	9.0	9.0
2. Short Term Scientific Training	-	-	-	19.9	19.9
3. Long Term Scientific Training	-	-	-	80.0	80.0
4. Air Traffic Control Training	-	-	-	25.0	25.0
5. High Altitude Weather Station	12.0	1.0	-	20.0	33.0
6. Snow Measurement Courses	5.0	-	-	21.0	26.0
7. Aircraft Instrumentation	35.0	6.0	-	27.0	68.0
8. Communication System	90.0	5.0	-	30.0	125.0
9. Satellite Receiver** (Software Only)	25.0	28.0	-	32.0	85.0
10. Satellite Analysis	-	-	35.0	30.0	65.0
11. Radiosonde	70.0	430.0	-	41.0	541.0
12. Radar	610.0	40.0	-	59.0	709.0
13. Cloud Physics Aircraft			750.0		750.0

(TABLE 6: CONTINUED)

ITEM	Equipment	Recurring Costs (Supplies, Spare Parts)	Technical Assistance and Analysis	Training (Includes Personnel, Travel, Training and Materials)	TOTAL
14. Scientific Design and Evaluation	-	-	472.0	193.0	665.0
15. Economic Design and Evaluation	-	-	554.0	166.0	720.0
16. External Evaluation	-	-	76.4	-	76.4
17. Other Costs	77.0	48.9	168.6	74.2	368.7
TOTAL	924.0	558.9	2056.0	827.1	4366.0

* Estimated budget is for illustrative purposes, under terms of the Participating Agency Service Agreement (PASA) adjustments of plus or minus 15% will be allowed between line items.

** The National Oceanographic and Atmospheric Administration (NOAA) will fund the acquisition of the primary satellite receiver system, associated hardware training and first year supplies (total of $114,000) through the World Meteorological Organization.

VI. PROJECT IMPLEMENTATION

A. IMPLEMENTATION RESPONSIBILITIES

1. GOVERNMENT OF THE UNITED STATES

Project implementation will involve four United States Government Organizations supported by private sector contractors. AID will have lead responsibility for project management, implementation, monitoring and evaluation among Government of the United States organizations. The responsibilities of these organizations are summarized in Table 7.

a. Agency for International Development

Within AID responsibility for project management will rest with the Division of Technical Projects, USAID/Morocco which will receive scientific and technical support from the Environmental Coordinator, Bureau for Near East, AID/W. Day to day project supervision will be under the direction of the Mission Project Officer. The Environmental Coordinator will participate in an annual scientific monitoring visit to Morocco.

b. Bureau of Reclamation, Department of the Interior

AID will implement the project through a Participating Agency Services Agreement (PASA) with the Bureau of Reclamation, U.S. Department of Interior (A justification is provided in Annex I). The Bureau of Reclamation will provide overall scientific management and serve as a procurement agent for scientific commodities and services for AID. In addition, under the terms of the PASA the Bureau of Reclamation will be providing general administrative support for PASA activities through the Office of Foreign Activities. The Bureau's Procurement and Contracts Branch will be the specific procurement agent for AID. Once a specific contract is included in the AID approved procurement plan and schedule as required by the terms of the PASA, no further approval by AID is required. The Bureau's Procurement and Contracts Branch will initiate, negotiate, award and administer all subcontracts under the PASA for the project equipment, supplies and services. The Chief, Procurement and Contracts Branch, will serve as the Contracting Officer with responsibility for all procurement actions and contractor performance compliance in support of the project. The Procurement and Contracts Branch will be designated for the scientific and technical monitoring of each contract and to advise the Contracting Officer.

Technical supervision of the project will rest with the Division of Atmospheric Resources Research which will be responsible for overall project management, scientific direction, supervision of scientific and economic evaluations and the development of suspension criteria. Day to day training, operational advice and contract coordination and monitoring will be under the direction of a Resident Scientific Advisor provided to the project by the Bureau of Reclamation. The Director of the Division of Atmospheric Resources Research will provide overall scientific direction and participate in an annual scientific monitoring visit to Morocco.

c. National Oceanographic and Atmospheric Administration (NOAA), Department of Commerce

As detailed in Section IV, 5, the National Oceanographic and Atmospheric Administration (NOAA) will support the project through the financing of the hardware components of a METEOSAT receiver through United States contributions to the World Meteorological Organization. It is planned that this activity will be completed within the first year of the project.

d. Peace Corps

As detailed in Section IV, 6, the Peace Corps will support the project through the provision of a volunteer to the National Meteorological Organization to teach scientific and technical English.

2. GOVERNMENT OF MOROCCO ORGANIZATIONS

Government of Morocco support for the project will be coordinated by the National Steering Committee for Weather Modification which includes in its membership all organizations involved in data collection, data analysis and programs of intervention. Project implementation will require the participation of nine organizations whose responsibilities are summarized in Table 8. As project implementation proceeds additional organizations may be added to the support group depending on the needs of the project.

The National Meteorological Organization, Ministry of Transportation will have lead responsibility for scientific aspects of the project while the Royal Moroccan Air Force will have lead responsibility for seeding operations. AID will limit itself in the provision of funds and technical support under this project only to civilian authorities and the Ministry of Transportation will serve as the grantee.

PRIMARY ORGANIZATIONS

a. National Meteorological Organization, Ministry of Transportation

The National Meteorological Organization will provide the principal scientific expertise for the Government of Morocco. It will be responsible for the planning, design, scientific implementation and evaluation of the program. It will also conduct applied research to support the project. Responsibility for scientific aspects of project implementation will rest with the Director; however, day-to-day operations will be under the direction of the Program Director.

b. Royal Moroccan Air Force

The Royal Moroccan Air Force will provide the principal operational expertise for the Government of Morocco. It will be responsible for the provision of aircraft, pilots, systems operators, aircraft operations controllers, seeding equipment and materials. This will require significant support services for operation, maintenance and logistical support. The Royal Moroccan Air Force

will provide logistical support for the cloud physics aircraft during years 2 and 3 while this aircraft is in Morocco. Responsibility for operational aspects of project implementation will rest with the Inspector General; however, day-to-day operations will be under the direction of the Program Coordinator.

SECONDARY ORGANIZATIONS

c. Water and Forest Service, Ministry of Agriculture

The Water and Forest Service of the Ministry of Agriculture will be responsible for the provision of climatic data to the project from their network of stations on forest lands and in the mountains. In addition, they will provide support for the high altitude weather stations and snow course measurements.

d. National Office of Electricity, Ministry of Energy and Mines

The National Office of Electricity of the Ministry of Energy and Mines will be responsible for the provision of reservoir level and inflow/outflow data to tbe project. It is anticipated that they will assist the scientific and economic evaluations through the provision of data on power generation and releases of water for irrigation in accordance with suspension criteria and evaluation requirements.

e. Hydraulic Service, Ministry of Equipment

The Hydraulic Service of the Ministry of Equipment will be responsible for the provision of stream discharge data to the project. They will be highly involved in the scientific and economic evaluations due to the need for their assistance in the analysis of stream discharge records and their correlation with climatic events.

f. Ministry of Interior

The Ministry of Interior will be responsible for provison of data concerning the availability of domestic water supply and its quality. They will also be involved in providing the governors and other responsible local officals (civil and religious) with information concerning project activities.

g. Ministry of Post and Telecommunications

The Ministry of Post and Telecommunications will be responsible for the provision of telecommunications support to the project. They will have critical responsibilities during the first year when the project design calls for the installation of up to 1400 km of dedicated lines.

h. Royal Air Maroc

Royal Air Maroc will be responsible for the provision of international travel for Government of Morocco personnel which must visit the United States or other foreign countries in support of the project.

S/C

i. National Center for the Coordination and Planning of Scientific and Technical Research

The National Center is reponsible for the provision of specialized scientific and technical support to the project as needed. They will be expected to provide support to the scientific and economic evaluation component.

j. National Police Force

The National Police Force will be responsible for the provision of data from weather stations they manage. They may also become involved in collection of snowfall data.

k. National Radio and Television of Morocco

National Radio and Television of Morocco will be responsible for the provision of support to the project through their telecommunications network which includes a microwave transmission system.

TABLE 7: RESPONSIBILITIES OF GOVERNMENT OF UNITED STATES ORGANIZATIONS

Organization	Responsibilities
1. USAID/Morocco	Overall supervision of project; Support services for PASA resident scientific advisor.
2. Bureau for Near East, AID, Washington, D.C.	Scientific and technical support to USAID/Morocco; Participation in annual monitoring visit.
3. Bureau of Reclamation, Office of Foreign Activities	Provision of the resident advisor and the administrative support of that position; General training support in the U.S.; Provision of monthly and quarterly reports.
4. Bureau of Reclamation, Division of Atmospheric Resources Research	Scientific and technical support for the project; Overall project management and administration of the PASA; Participation in annual monitoring visits; Preparation of technical specifications and review of proposals. Scientific supervision of contracts and provision of phase reports to AID.
5. Bureau of Reclamation, Procurement and Contracts Branch	Initiation, negotiation, award, and and administration of all subcontracts as specified in the PASA and fiscal management of subcontracts; Provision of billing information to AID.
6. National Oceanographic and Atmospheric Administration, Department of Commerce	Provision of funding through World Meteorological Organization for METEOSAT receiver.
7. Peace Corps	Provision of a volunteer to the National Meteorological Organization to teach English.

TABLE 8: RESPONSIBILITIES OF GOVERNMENT OF MOROCCO ORGANIZATIONS

Organization	Responsibilities
PRIMARY ORGANIZATIONS	
1. National Steering Committee for Weather Modification	Policy direction and coordination.
2. National Meteorological Organization, Ministry of Transportation	Principal scientific expertise for Government of Morocco Planning, design, scientific implementation, scientific and economic evaluation, applied research.
3. Royal Moroccan Air Force	Principal operational expertise for Government of Morocco Provision of aircraft, pilots, seeding equipment and materials, logistical support for cloud physics aircraft.
SECONDARY ORGANIZATIONS	
4. Water and Forest Service, Ministry of Agriculture	Provision of climatic data to project, physical and technical support for high altitude weather station and snow courses.
5. National Office of Electricity, Ministry of Energy and Mines	Provision of reservoir level and inflow/ outflow data to project.
6. Hydraulic Service, Ministry of Equipment	Provision of stream discharge data to project.
7. Ministry of Interior	Provision of data on domestic water supply conditions and liaison with governors and other local officials.
8. Ministry of Post and Telecommunications	Provision of telecommunications support for project.
9. Royal Air Maroc	Provision of international transportation for Moroccan personnel.

(TABLE 8: CONTINUED)

Organization	Responsibilities
10. National Center for the Coordination and Planning of Scientific and Technical Research	Provision of scientific and technical support.
11. National Police Force	Provision of climatic data to the project from weather stations under its supervision.
12. National Radio and Television of Morocco	Support to project through use of its transmission network.

B. PROCUREMENT METHODOLOGY

Due to the highly technical nature of the goods and services to be procured under the project the Bureau of Reclamation will act as a procurement agent for AID, utilizing the standard AID procurement procedures as outlined in the PASA. Planned procurements will include scientific equipment (radiosonde, radar), analytical services (cloud physics aircraft lease, analysis of meteorological data), scientific and economic evaluations, technical assistance (short-term advisory services concerning project design and equipment installation) and training (short-term training in data analysis and long-term training in applied meteorology). AID will retain for management by USAID/Morocco project funds to cover housing and education allowances of the Resident Scientific Advisor, procurement of the project vehicle, local travel and per diem for the Resident Advisor and Peace Corps volunteer and pay the salaries of the administrative assistant and the bilingual secretary.

Because of the emergency nature of the program, the critical water shortages in Morocco and the need to be politically responsive, the Project Authorization (Annex K) and the PASA will specifically provide for use of emergency procurement procedures during the first year of the project. These emergency procurements will allow for mobilization and fielding of necessary equipment and personnel as quickly as possible to allow for project supported weather modification interventions by the beginning of the 1984-1985 winter seeding season. After attainment of an initial operational capability all further procurements will utilize standard procedures.

In keeping with the policy directives of AID, the Bureau of Reclamation shall utilize to the fullest extent reasonable the services of private sector contractors to implement the project. It should be noted that under the current PASA budget the Bureau of Reclamation retains 25% of the budget to cover its expenses (Table 5) and allocates 75% to finance private sector contracts managed by the Bureau (Table 6). Anticipated subcontracts and their estimated value are presented in detail in Tables 4 and 6.

The Bureau of Reclamation will be required under the terms of the PASA to provide AID with an annual financial plan for review and concurrence. In addition, it requires the Bureau to provide a procurement plan and schedule at the end of quarter one which is to be updated on a quarterly basis. Reporting on procurements should identify any problems and specify steps which are being taken for their resolution. The PASA will instruct the Bureau of Reclamation to utilize Small Businesses, Minority Owned Firms and Women Owned Firms to the fullest extent reasonable in compliance with current AID contracting policy.

The Bureau of Reclamation will participate fully in monitoring of the project. The PASA provides direct funding for an annual two week visit to Morocco by the the Chief, Division of Atmospheric Resources Research, to participate in a joint monitoring review with the Environmental Coordinator, Bureau for Near East, AID/W. The external evaluation team will be contracted by the Bureau of Reclamation under a PASA subcontract; however, AID will retain the right to approve the scope of work and individual members of the team and the administrative assistant.

Project support provided by the National Oceanographic and Atmospheric Administration and the Peace Corps is provided from either their direct budgets or from funds which they supervise for the United States Government.

C. IMPLEMENTATION PLAN AND SCHEDULE

The 5-year weather modification demonstration project will be conducted in two phases with a combined scientific and economic evaluation report issued after each phase. The main implementation events by fiscal year are provided in Table 9 and a detailed implementation schedule in provided in Table 10. The main objectives of the two phases are as follows:

Phase I (Years 1 - 3)

During the three year period of Phase I efforts will be directed to achieving two main objectives:

(1) Enhancing the existing weather modification operations to help alleviate the social and economic impacts of the current drought, and;
(2) Establishing the organizational structure, equipment, design, operational procedures, training and experience, and a firmer scientific foundation for a long-term weather modification program to contribute to the water resources of Morocco.

All equipment with most of the associated training should be in place by the end of this phase. In addition, program concepts and procedures should be firmly established with Moroccan personnel and suspension criteria for use in Phase II of the project will be developed.

Limited seeding will take place during the latter half of the 1983-84 fiscal year. More extensive seeding operations will take place during the 1984-85 and 1985-86 fiscal years. With only 2 full years of seeding under the operational design, only a preliminary assessment of the seeding effectiveness on water supply will be possible. However, physical and economic studies initiated during this period should provide first estimates of the potential water yield from a long-term program, and its value to hydro-electric power generation, irrigated agriculture, municipal and industrial use.

The Phase I report and the mid-term external evaluation will provide preliminary recommendations on whether to continue or discontinue the project. It will also provide information on whether it is appropriate to itensify the demonstration project, or to expand the project to include additional river basins in the High and Middle Atlas Mountains and additional rainfed agricultural areas. This report will provide proposed revised budgets for any recommended changes to project design.

Phase II (Years 4 - 5)

During Phase II of the project of 2 years duration, full seeding operations and the technical and economic evaluations will continue. The feasibility of recommendations in the Phase I scientific and economic evaluation report would

also be investigated. Suspension criteria will be developed and included with any recommendations for seeding other areas. The results of these studies along with the scientific and economic evaluations of the 4 full years of seeding should determine the scope and magnitude of any long-term strategy for weather modification in Morocco and the scientific, economic, social and environmental foundations for it.

The Phase II report and the final external evaluation will review the scientific feasibility, cost effectiveness and alternative investments for improvement of the water resources base in Morocco. The water resources assessment survey will be completed which will review opportunities for further water resources development and the role of weather modification operations in a total water management program. Combined they will provide the Government of Morocco guidance with which to review future investments in scientifically based weather modification.

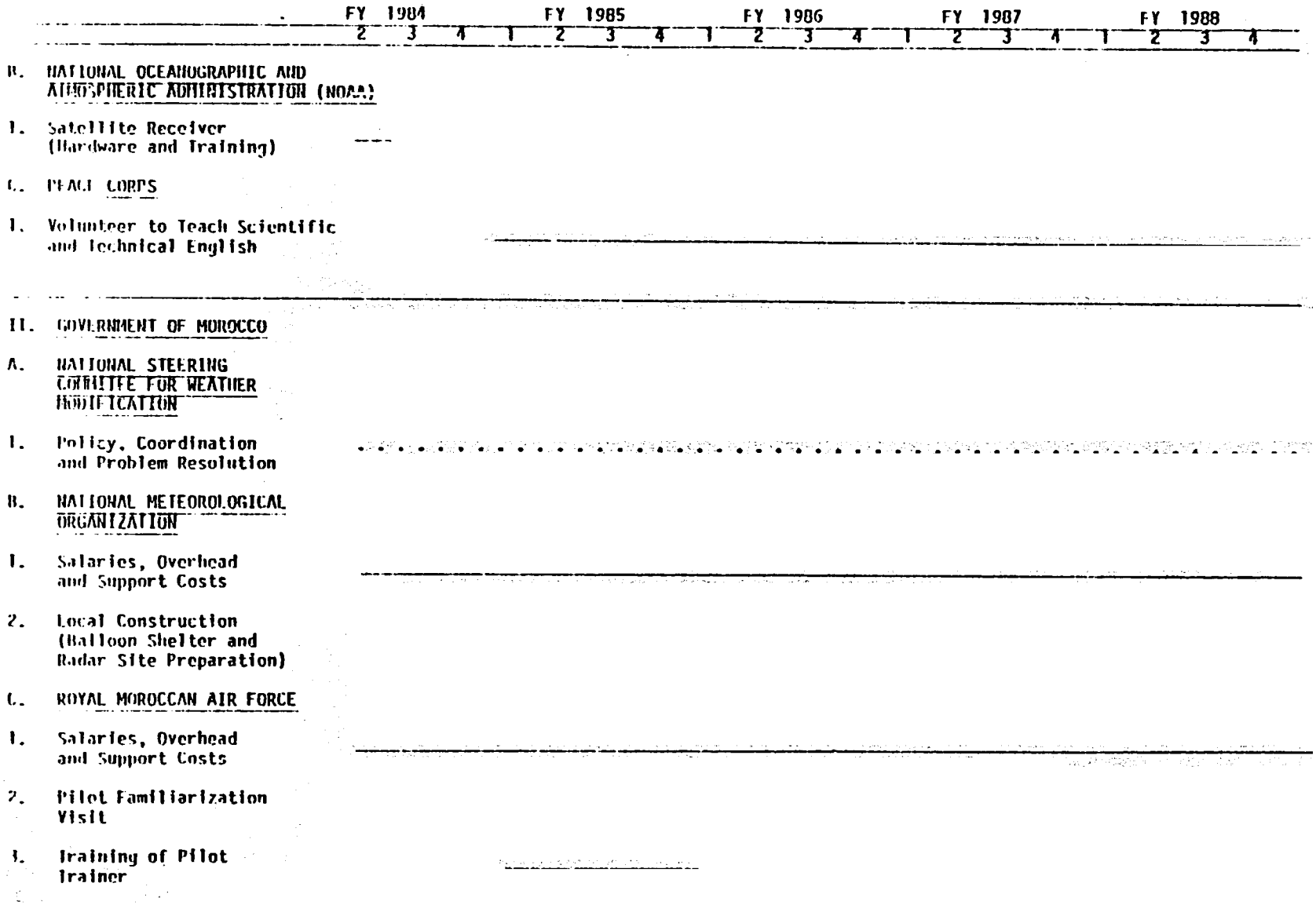
TABLE 9: MAIN IMPLEMENTATION EVENTS BY FISCAL YEAR*

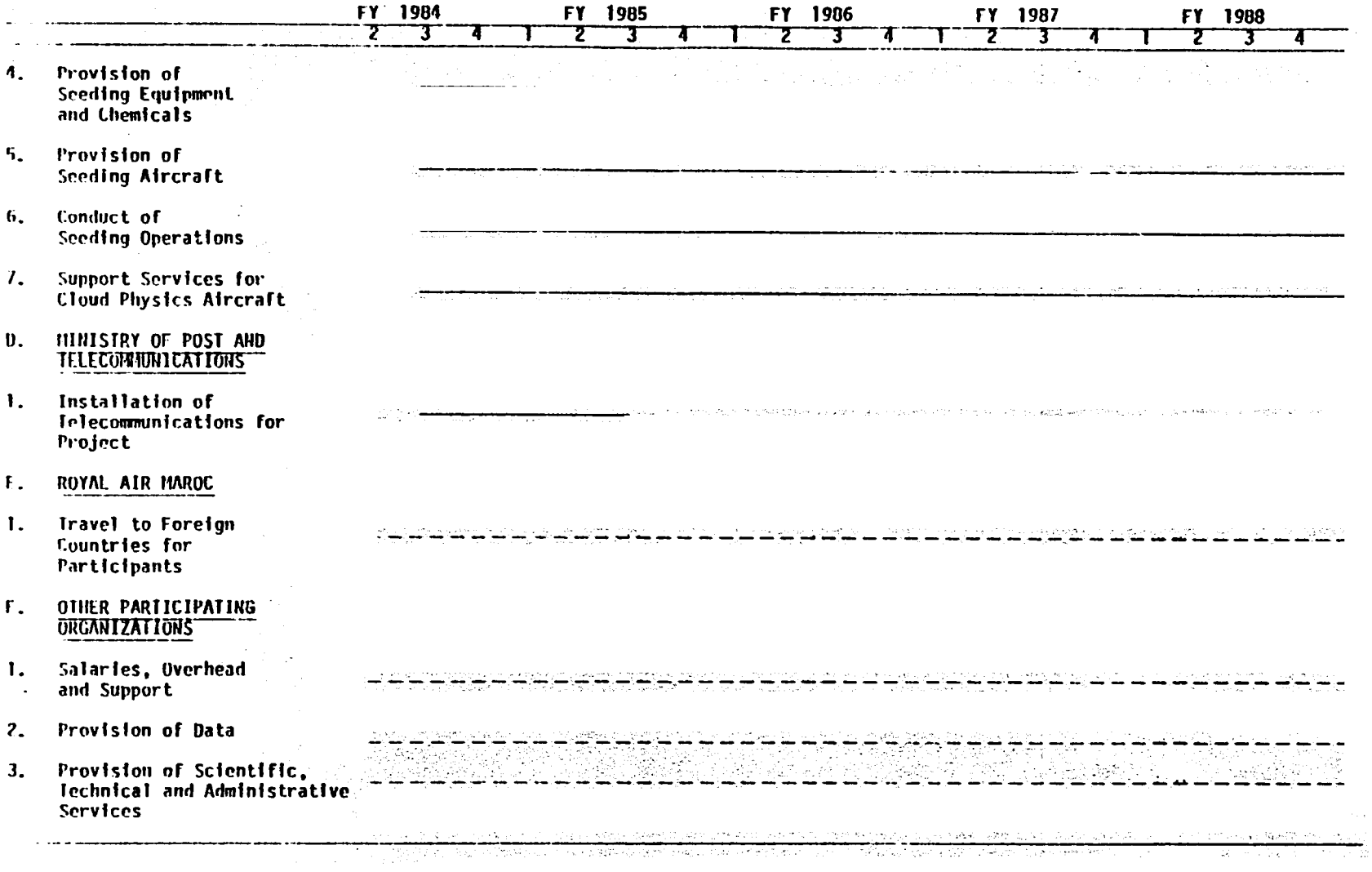
1984	o Training and familiarization with weather modification management and operation begin. o Resident Scientific Advisor arrives in Morocco. o Operations Control Center established. o New radiosonde unit installed and operated daily; loaned unit as a back-up. o Fabrication, installation and start of operations with new weather radar system. o Communication system, mountain weather station, and snow courses installed. o Satellite receiver system installed and background satellite study underway. o Operational procedures review in Morocco. o Scientific and technical design completed. o Seeding equipment installed on aircraft. o Interim suspension criteria established. o Limited seeding operations underway. o Annual monitoring visit.
1985	o First season of full operations under new design with new equipment conducted under interim suspension criteria. o Cloud physics aircraft studies for 3 months. o Overseas training of pilot trainers completed. o Long-term advanced scientific training begins. o Scientific, water resources, and economic evaluation studies begin. o Suspension criteria developed for demonstration area. o Annual monitoring visit. o First external evaluation.
1986	o Full seeding operations continue under site specific suspension criteria. o Instrument system on seeding aircraft installed. o Cloud physics aircraft studies for 3 months. o Scientific, water resources, and economic evaluations continue. o Suspension criteria for other potential areas developed. o Phase I report completed. o Annual monitoring visit. o Mid-term external evaluation.

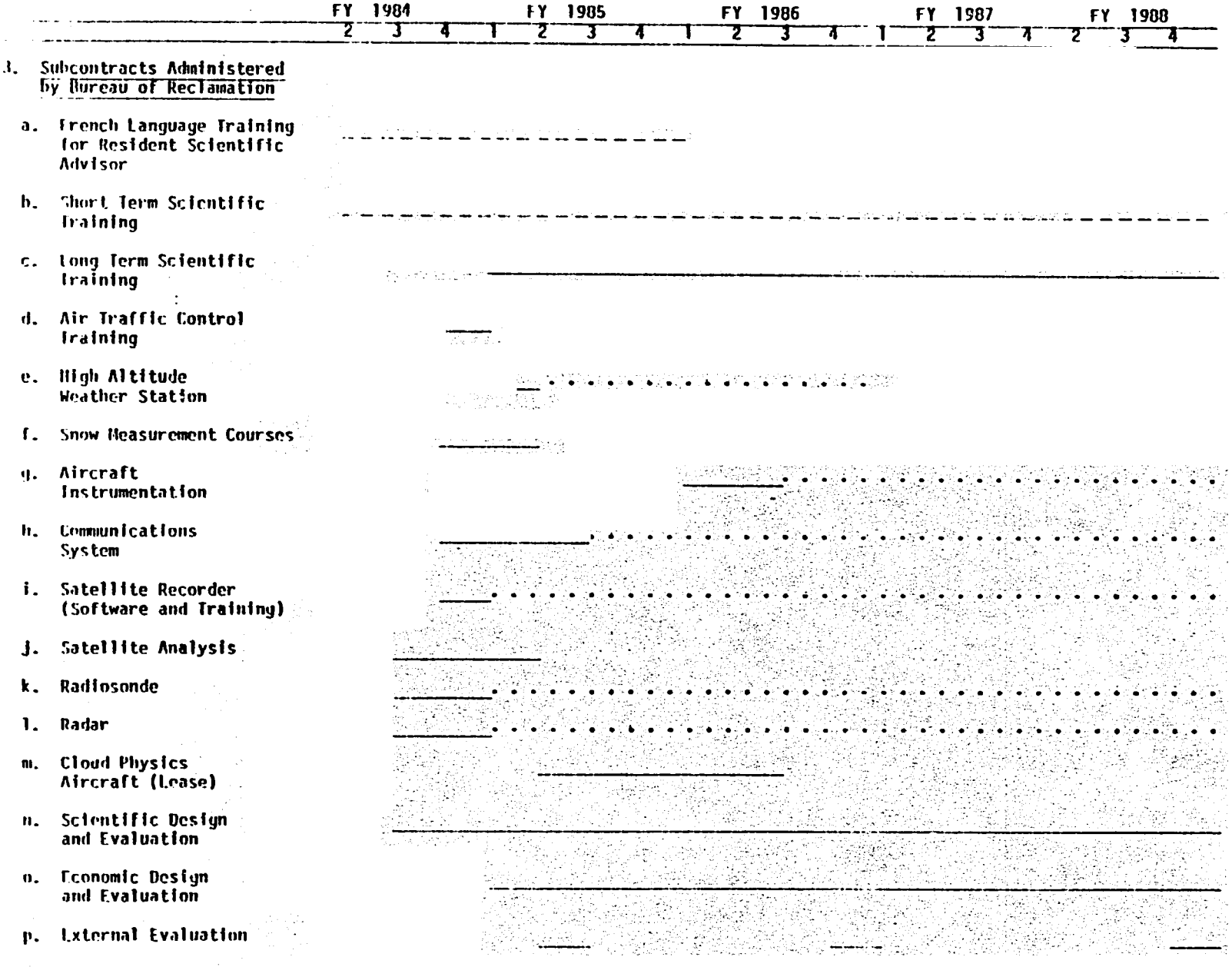
TABLE 9 (CONTINUED)

1987	o Full seeding operations continue. o Scientific, water resources, and economic evaluations continue. o Long- and short-term training continue. o Annual monitoring visit.
1988	o Full seeding operations continue. o Evaluations studies completed. o Phase II report completed. o Annual monitoring visit. o Final external evaluation.
1989	o Project anticipated completion date.

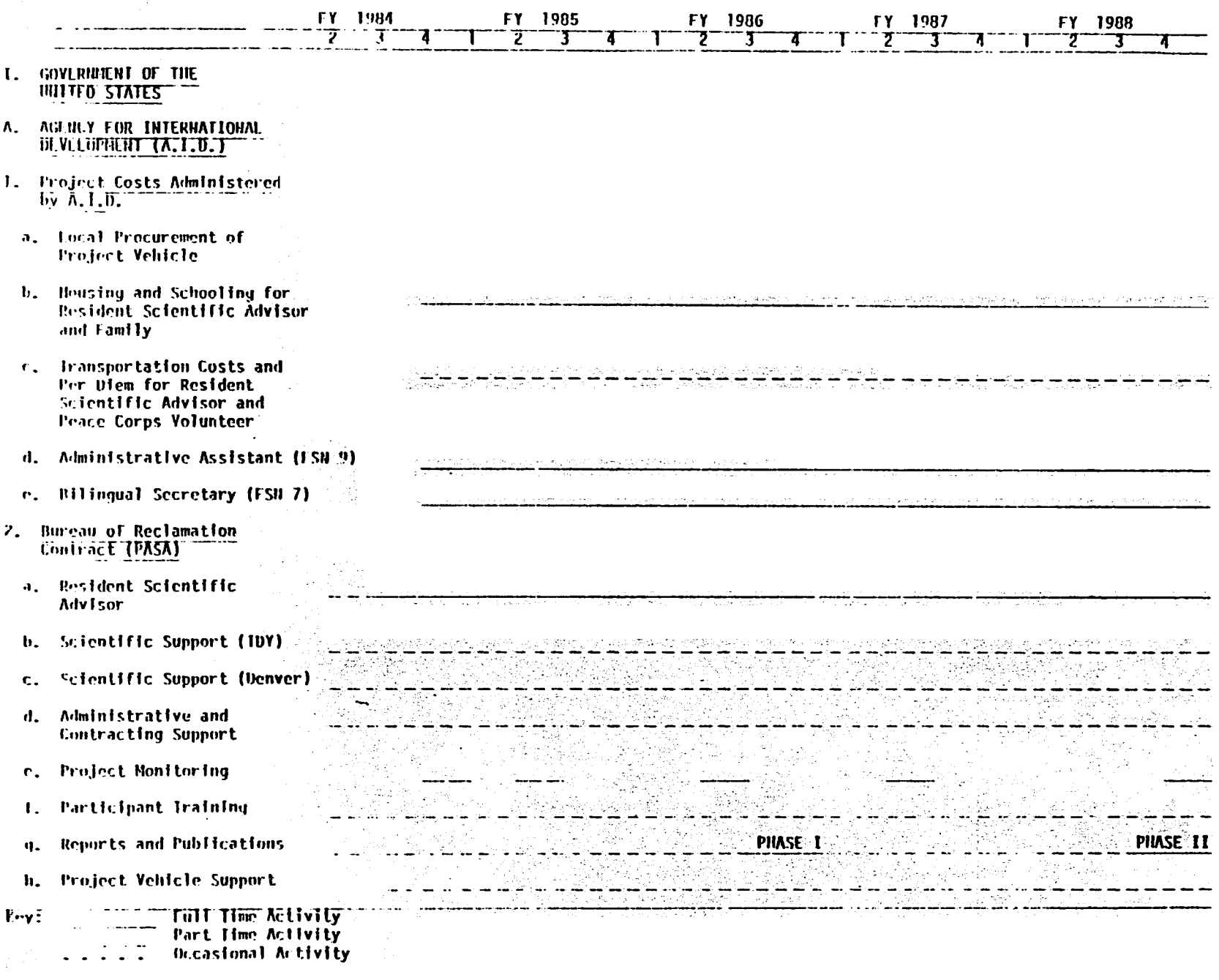
*The fiscal year of the government of the United States runs from October 1 through September 30.


FY 1984
FY 1985
FY 1986
FY 1987
FY 1988
2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4
B. NATIONAL OCEANOGRAPHIC AND ATMOSPHERIC ADMINISTRATION (NOAA)
1. Satellite Receiver (Hardware and Training)
C. PEACE CORPS
1. Volunteer to Teach Scientific and Technical English
II. GOVERNMENT OF MOROCCO
A. NATIONAL STEERING COMMITTEE FOR WEATHER MODIFICATION
1. Policy, Coordination and Problem Resolution
B. NATIONAL METEOROLOGICAL ORGANIZATION
1. Salaries, Overhead and Support Costs
2. Local Construction (Balloon Shelter and Radar Site Preparation)
C. ROYAL MOROCCAN AIR FORCE
1. Salaries, Overhead and Support Costs
2. Pilot Familiarization Visit
3. Training of Pilot Trainer


FY 1984
FY 1985
FY 1986
FY 1987
FY 1988
2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4
4. Provision of Seeding Equipment and Chemicals
5. Provision of Seeding Aircraft
6. Conduct of Seeding Operations
7. Support Services for Cloud Physics Aircraft
D. MINISTRY OF POST AND TELECOMMUNICATIONS
1. Installation of Telecommunications for Project
E. ROYAL AIR MAROC
1. Travel to Foreign Countries for Participants
F. OTHER PARTICIPATING ORGANIZATIONS
1. Salaries, Overhead and Support
2. Provision of Data
3. Provision of Scientific, Technical and Administrative Services


FY 1984
FY 1985
FY 1986
FY 1987
FY 1988
2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 2 3 4
J. Subcontracts Administered by Bureau of Reclamation
a. French Language Training for Resident Scientific Advisor
b. Short Term Scientific Training
c. Long Term Scientific Training
d. Air Traffic Control Training
e. High Altitude Weather Station
f. Snow Measurement Courses
g. Aircraft Instrumentation
h. Communications System
i. Satellite Recorder (Software and Training)
j. Satellite Analysis
k. Radiosonde
l. Radar
m. Cloud Physics Aircraft (Lease)
n. Scientific Design and Evaluation
o. Economic Design and Evaluation
p. External Evaluation

PROJECT IMPLEMENTATION SCHEDULE - MOROCCO WEATHER MODIFICATION DEMONSTRATION PROJECT (608-0190)



D. PROJECT MANAGEMENT

1. THE NATIONAL STEERING COMMITTEE ON WEATHER MODIFCATIION

The National Committee will provide coordination among Government of Morocco organizations involved in the project. It will review plans and progress of the Winter Snowpack Augmentation Project. The Committee will meet annually, or as required, to consider issues that cannot be resolved by the Project Steering Committee described below.

2. PROJECT STEERING COMMITTEE

A Project Steering Committee composed of the Director of the National Meteorological Organization, a senior representative of the Royal Moroccan Air Force, AID Director or his Designee, AID Mission Project Officer and Resident Scientific Advisor will be responsible for overall supervision of the project. The Chief of the Division of Atmospheric Resources Research, Bureau of Reclamation, and the Environmental Coordinator, Bureau for Near East, will serve as ex officio members of the Project Steering Committee when in Morocco and will assist the committee in project determinations, especially the failure to adequately implement suspension criteria.

The Project Steering Committee will be authorized to approve required changes in project design, to discuss problems and to identify solutions to problems in project management, implementation, monitoring and evaluation. The Committee will be responsible for monitoring the development and implementation of suspension criteria. It will identify issues which must be brought before the National Steering Committee on Weather Modification for resolution.

The Project Steering Committee will meet quarterly, or as required, to conduct its business. It will review and approve an annual work plan, quarterly progress reports and other reporting materials developed by the project. The Resident Scientific Advisor will be responsible for supervising the preparation of the annual work plan and the quarterly progress reports. The Resident Scientific Advisor will also be reponsible for preparing minutes of the quarterly Steering Committee meetings which will be part of the permanent project record.

The Project Steering Committee will oversee the preparation of two Phase Reports at the end of years 3 and 5 which will summarize the following information:

a. Status in attainment of objectives
b. Results of technical, economic and local program implementation evaluations
c. Recommendations on whether and how to continue or intensify the demonstration program and/or to expand the program to other areas of Morocco in the next phase of the program
d. Cost accounting summary

3. GOVERNMENT OF MOROCCO PROJECT MANAGEMENT

The Government of Morocco will provide principal project management under the leadership of the Director of the National Meteorological Organization who will be assisted by a senior representative of the Royal Moroccan Air Force. The daily management of the project will be under the scientific direction of the Project Director of the National Meteorological Organization and the operational direction of the Project Coordinator of the Royal Moroccan Air Force.

Daily operations will be conducted at the Casablanca headquarters of the National Meteorological Organization in Casablanca, the field operations center in Beni Mellal and at the base to which project aircraft are assigned. The Project Director and the Resident Scientific Advisor will work together on a daily basis in the planning and management of the project. They will hold periodic meetings as necessary to review project plans and activities with the Mission Project Officer and the Project Coordinator. The supervision of all aircraft support functions, provision of seeding equipment and chemicals and the training of pilots will be under the direction of the Project Coordinator.

4. MISSION PROJECT OFFICER

A Mission Project Officer from USAID/Morocco will provide project adminstration and routine monitoring. He will coordinate with the Resident Scientific Advisor to assure project performance. He will coordinate all project related overseas travel to be conducted by the Resident Scientific Advisor. The Mission Project Officer will be responsible for coordinating with the Regional Contracting Officer concerning any changes to the PASA which may be required during the course of project implementation.

5. RESIDENT SCIENTIFIC ADVISOR

A Resident Scientific Advisor from the Bureau of Reclamation will provide scientific and technical management of the project. He will supervise the Peace Corps volunteer, the administrative assistant, and the bilingual secretary. The administrative assistant will aid him in monitoring the technical performance of all contractors financed under the project. The Advisor will be responsible for day-to-day field guidance of the project.

The Advisor will be supported by the following offices of the Bureau of Reclamation:

- The Office of Foreign Activities will provide administrative assistance to the Resident Advisor, who will be an employee of the Office, and will provide support to the long- and short-term training functions;
- The Division of Atmospheric Resources Research will provide scientific and technical support and administrative management of the PASA;
- The Procurement and Contracts Branch will be the procurement agent and provide administration of all subcontracts.

The Resident Scientific Advisor will be responsible for the preparation and distribution of Monthly and Quarterly Project Status Reports to the Mission Project Officer, Environmental Coordinator, and Bureau of Reclamation which will address the following items:

a. Significant events
b. Progress toward objectives
c. Problems
d. Cost accounting with monthly, quarterly and annual summaries as appropriate

The Resident Scientific Advisor will also be responsible for the procurement of basic meteorological data concerning Morocco from a variety of European organizations which will require periodic trips to selected scientific centers to collect this data. The Resident Scientific Advisor will coordinate all such visits with the Mission Project Officer to assure adequate coverage of field operations in his absence. To facilitate the monitoring and reporting functions, the Resident Advisor will be provided a word processor with scientific and budget handling capabilities at the office in Casablanca.

E. PROJECT MONITORING

In addition to routine project monitoring to be conducted by the Mission Project Officer, an annual monitoring visit will be conducted by the Chief, Division of Atmospheric Resources Research, and the Environmental Coordinator, Bureau for Near East, AID/W, or their designated representatives. They will review the overall program with the Project Steering Committee as part of the annual monitoring visit. This will include site visits to the facilities of the cooperating Government of Morocco organizations and to the project area. The monitoring team will place emphasis on examination of the scientific quality of the program and on verification of development and implementation of suspension criteria. The monitoring team will prepare a report for each visit which will be provided to project personnel for review and discussion prior to their departure from Morocco.

F. PROJECT EVALUATION

The project design requires two types of evaluations: (1) the conventional external expert evaluation which reviews project design, implementation, management, monitoring and results in the routine fashion and (2) scientific and economic evaluations which provide quantitative data and qualitative observation to determine the impact and cost effectiveness of the intervention. The scientific and economic evaluations are viewed as part of the technical design of the project and and will not be discussed further in this section (see Section III, C,1,d and C,2,c for detailed discussion).

An External Evaluation Team of three senior experts covering the scientific, operational and water resources aspects of the project will review and critique the design, management, implementation and effectiveness of the program. The External Evaluation Team will conduct such an evaluation 18

months after the program begins, and at the end of Phases I and II. Each evaluation will involve a two-week in-country review of the project and its progress which will be followed by one week in the United States for report finalization. The external evaluation team will be contracted by the Bureau of Reclamation under the PASA; however, AID will retain the right to formally approve the scope of work and individual members of the team.

The scope of work for the External Evaluation Team will focus on the following issues:

A. Scientific Design and Evaluation

1. Review of scientific design
2. Review of scientific and economic evaluation programs
3. Review of suspension criteria development and implementation

B. Project Implementation

1. Project coordination
   a. Role of the National Steering Committee on Weather Modification
   b. Role of the Project Steering Committee
2. Role of the Mission Project Manager
3. Role of the Resident Scientific Advisor
4. Quality control in data collection
5. Methods of data analysis and interpretation

C. Project Management

1. Project support from Government of United States Organizations
2. Project support from Government of Morocco Organizations
3. Review of logistical management
4. Review contractor performance
5. Role of monitoring visits

D. Institutional Development

1. Review the ability of the National Meteorological Organization to:
   a. Successfully integrate new equipment into the routine operations
   b. Integrate new equipment into project specific operations
2. Review the ability of the National Meteorological Organization to plan, design, implement and evaluate a scientifically based weather modification project
3. Review the ability of the National Meteorological Organization to train and retain personnel necessary for weather modification activities

E. Transfer of Technology and Training

1. Operational effectiveness of the National Meteorological Organization with regard to program management, including computerization of data collection and analysis
2. Progress in training of professional, technical and managerial staff
3. Integration of newly trained staff into the general organization and into project related activities
4. Review ability of the National Meteorological Organization in the operation and maintenance of equipment supplied by the project

F. Water Resources Planning and Management

1. Integration of project into national level water resource: planning and management activities
2. Development of predictive models of meteorology in the project area, stream discharge for the target and target-control areas and a snowpack/runoff model and their use in water resources planning and management

The External Evaluation Team will be required by the terms of their contract(s) to prepare a draft report for each visit which will be provided to Mission and project personnel for review and discussion prior to their departure from Morocco.

G. COORDINATION WITH OTHER DONORS

Given the need identified in the Weather Modification Assessment and this Project Paper to improve water resources and land use management the Mission shall attempt to coordinate with other donors, particularly the World Bank. It shall provide information on the findings of the project, especially with regard to institutional development and personnel training needs in water resources planning and management, to other interested parties in multilateral, bilateral and international organizations to attempt to attract additional resources in addressing these problems. As additional information with regard to land use (especially the impacts of siltation) are made available during the scientific and economic evaluations, this information will be provided to other donors particularly those interested in financing capital infrastructure in the water sector, forestry, rangeland and watershed management.

VII. ANALYSES

A. LEGAL ANALYSIS

The enabling legislation for the National Meteorlogical Organization, as published in the Bulletin Officiel of the Government of Morocco (No. 3675, June 4, 1983, p. 250-252, see Annex J), provides broad authority to the Organization for implementation of the proposed program. Project Al Ghait, the current Government of Morocco weather modification program, has used this legislation as its legal basis for project implementation. It should be noted that implementation of this project is further directed by an order of His Majesty King Hassan II.

The project will be implemented in the full compliance of the provisions of the Foreign Assistance Act of 1961, as Amended, Section 531 (c) which states:

> "Amounts appropriated to carry out this chapter shall be available for economic programs only and may not be used for military or paramilitary purposes."

The use of AID funds will be restricted to the support of civilian organizations and interaction with the Royal Moroccan Air Force will be limited to coordination functions to assure successful implementation of the project.

It should be noted that it is the expressed intention of the Government of Morocco to transfer full responsibility of weather modification activities to a wholly civilian authority as soon as a fully operational program is established. The Government has stated that given the current crisis situation with regard to water supply that they will only entrust operational aspects of the project to the Royal Moroccan Air Force; however, they anticipate the use of aircraft assigned to other organizations or private contractors in the future.

B. INSTITUTIONAL ANALYSIS

The National Meteorological Organization of Morocco is a wholly civilian service within the Direction of Air Services of the Ministry of Transportation. It is headed by a Director who is a civil servant with technical expertise in meteorology. The Organization was established during the French Protectorate and is responsible for the collection, interpretation and analysis of basic meteorological and climatological data for Morocco. It provides weather data and forecasts to all Government of Morocco organizations and provides meteorological services for all aviation within Morocco. An organizational chart is provided in Figure 2.

The Organization has executive offices in Rabat which are responsible for liaision with other Government of Morocco organizations and coordination with international organizations. The headquarters for operations, scientific and technical activities is at the old airport in Casabalanca which serves as the

national point for data collection from a national network of over 400 weather stations and weather data collection points.

The Organization has a commendable performance record given their limitations in equipment and staff. During the last two years the Organization has benefited from a United Nations Development Programme project which has provided senior level assistance in planning and management. It should be anticipated that significant improvements can be made in the quality and quantity of work through the provision of more modern equipment, increased emphasis on the development of analytical skills and a greater integration of the Organization into water resources planning and management activities at the national level.

The Organization is being provided with strong professional leadership which is actively committed to a serious upgrading of the service through improved training of all staff, adoption of new technology for data collection and analysis, diversification of sources of technical assistance and use of a realistic series of plans for institutional development. The Organization has current contracts for French manufactured computers which are soon to be installed to allow for automation of data analysis which is currently being done manually. This represents a major change in operations and should result in the increased availability of data for personnel to deal with analytically rather than descriptively.

The major strength of the Organization rests in the substantial investments it has made in the formal and informal training of professional and technical personnel. The Organization recruits personnel both at the professional and technical level through the provision of training opportunities and retains them afterwards through government service requirements for training benefits. Due to the lack of private sector employment opportunities combined with government service requirements the Organization has a high rate of personnel retention. Technicians, particularly those trained in electronics, tend to maintain their positions with the government but engage in afterhours work on a routine basis.

The personnel system includes three classes of meteorologists, engineers and technicians who are aided by a large semi-skilled and unskilled support staff. Highlights of training and staff development include:

- The successful completion of one staff member of a Ph.D. program in climatology in the United States, this individual will head the research branch;

- Class I personnel are trained under a current Moroccan financed contract which is maintained with the Government of France for the training of meteorologists at the National Institute of Meteorology. This graduate level program enrolls 4-5 Moroccan students per year. Individuals who have completed this program are serving as section chiefs in areas such as agrometeorology and hydrometeorology;

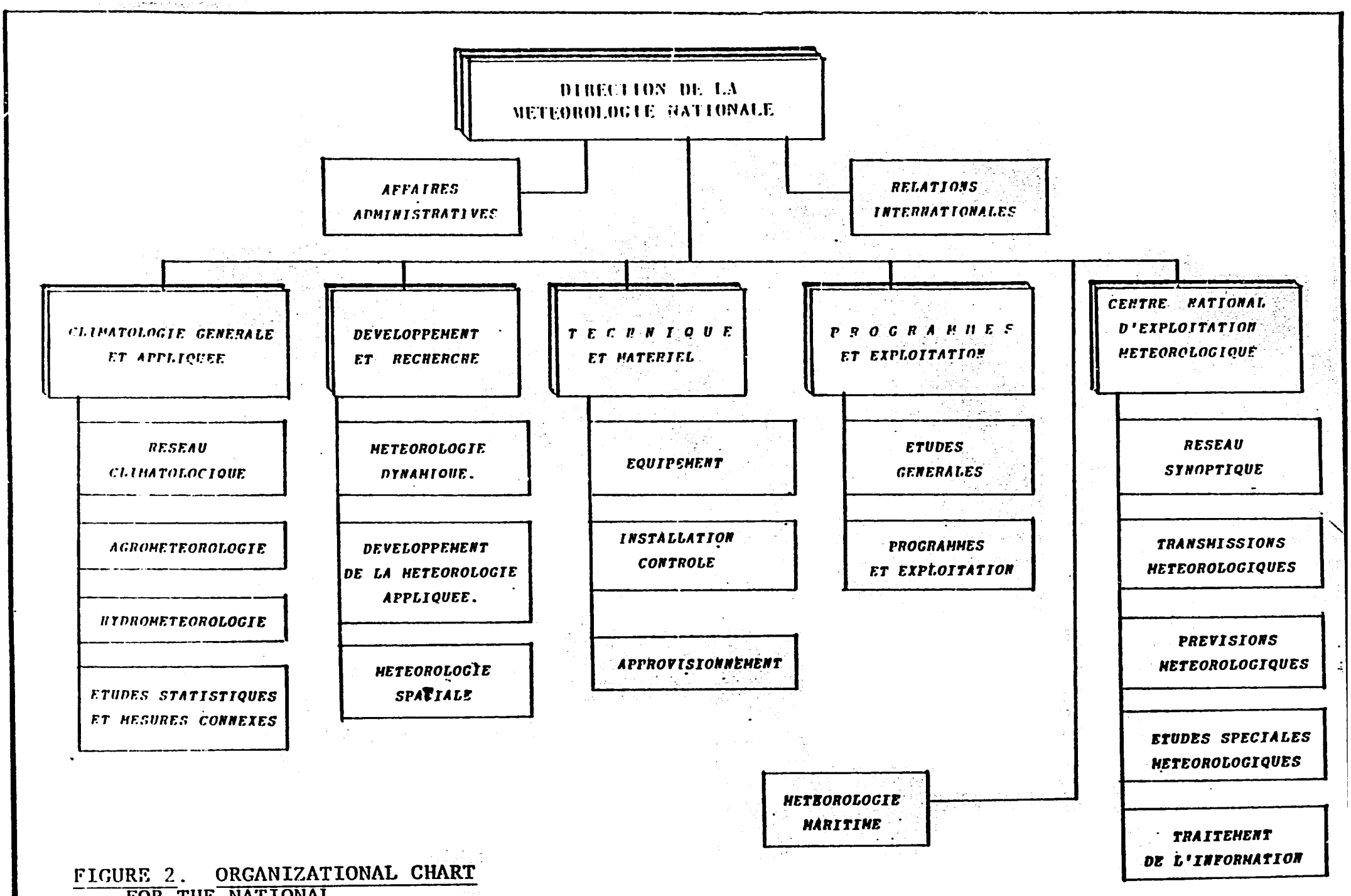


FIGURE 2. ORGANIZATIONAL CHART FOR THE NATIONAL METEOROLOGICAL ORGANIZATION

- Class II personnel receive a two year training program under the supervision of the World Meteorological Organization at a regional training center in Tunisia;

- Class III personnel and specialist technicians are trained at at a school in Casablanca maintained by the Ministry of Transportation.

- Continued training of professional and technical personnel through attendance at short courses offered by the World Meteorological Organization, the Government of France and vendors of equipment.

The facilities of the Organization, especially those at the old airport at Casablanca, are quite large, in good physical condition and will allow for significant increases in staff and activities without requiring additional space. The Organization has developed a well-managed operation and maintenance program for equipment which has allowed for continued operation of extremely old recording equipment.

The National Meteorological Organization has demonstrated a good performance record while operating under difficult conditions; however, there exist a number of major problems which could possibly influence the successful implementation of the project:

- The Organization, like those throughout the Government of Morocco, has the continuing problem of an inadequate capital budget. In many instances construction of facilities is delayed or once constructed, facilities cannot be operated due to a lack of adequate electrical and communication systems. In other cases equipment is ordered from international suppliers; however, delivery is delayed or canceled due to inadequate availability of foreign exchange to make payments.

  This problem has been recognized in the design of the project by attempting to utilize existing facilities to the fullest extent possible. Capital budget requirements for construction have been limited to a balloon shelter at the Beni Mellal synoptic station, site preparation costs for the radar trailer near Oued Zem and the installation of additional communications between Casablanca, Beni Mellal and the radar trailer. All foreign exchange costs associated with the civilian side of the program are being funded by AID.

- The Organization, like those throughout the Government of Morocco, has continuing problems of an inadequate operational budget. In most instances this results in declines in the operation and maintenance budget. Most often this has been reflected in greatly reduced inspections of the weather station network due to inadequate funds for fuel for vehicles.

This problem must be recognized to be a constant problem during the course of project implementation due to the current financial status of the Government of Morocco. Given the extremely high priority given to the Project it is anticipated that this should present limited problems to weather modification activities; however, it may be anticipated that this support will be at the expense of support for activities which have a lower priority and do not involve foreign donors. The project will provide for training for those involved in the management of support services which should allow for some improvement in the allocation of the limited resources available to the Organization.

The work of the Organization suffers from poor integration into a national framework for water resources planning and management. The Government of Morocco does not have a strong structure for evaluating needs and making water allocations on the national level.

The project design by formalizing the status of the National Steering Committee for Weather Modification provides a high level forum to discuss the project in a broader context of water resources planning and management. The project focuses on placing weather modification in the context of water resources management and planning, to support this objective by project activities, especially scientific evaluation, economic evaluation and training focus on Moroccan development of an understanding of weather modification in the context of water resources planning and management rather than as an emergency measure to attempt to "break droughts" through "making it rain".

AID will take advantage of the project to attempt to interest the Government of Morocco in examining the sector in a more integrated fashion both through direct efforts and through its attempts at donor coordination. It should be noted that one of the most important impacts of conducting the Weather Modification Assessment was to bring to the attention of Moroccan authorities that the cause of the drought was meteorological in nature, but that the economic and social impacts were largely a function of water demand and allocation issues.

With the exception of aviation, the Organization has not developed an effective network of users for the data and analyses it prepares. Current data are difficult to obtain in a timely fashion and analytical products are limited. Its programs in agrometeorology and hydrometeorology are in early development stages and firm links with users must be cultivated.

This problem should not influence the implementation of the project. However, the coordinating mechanisms put in place as a result of the project should make both the Organization and

potential users aware of the opportunity to expand in this area. The addition of newly trained personnel and the computerization of the data collection system should allow for improvements in both data access and analysis. The exposure of the Organization to organizations in the United States actively involved in applied meteorology should result in an increased awareness and understanding of the opportunities in this area.

- The majority of the equipment that the Organization is using for basic data collection is extremely old and will require replacement over the next decade.

  This will not affect implementation of the project; however, the project will, through training, expose Moroccan personnel to a wide variety of new types of equipment and data collection techniques which will result in an improved equipment evaluation selection process as new materials are purchased.

- The Organization does not have a system in place for the collection of data concerning snowfall and lacks an ability to predict the contribution of snowfall to the national water budget.

  The project will be financing the high altitude weather station, snow measurement devices and development of a snowpack model based on satellite monitoring (Landsat). This data collection and analysis system when combined with training will provide the Organization with a basic understanding and predictive ability for this element of water resources.

- At some weather stations there is a shortage of government owned housing which is a traditional benefit to those stationed at these facilities. Inadequate subsidized housing could be a constraint to the placement of necessary personnel in certain field stations including Beni Mellal.

  Inquiries have been made concerning this issue during the design of the project. It appears that in the case of Beni Mellal there is a surplus of housing so that availability of adequate housing at a reasonable price is not an issue; however, the problem of not receiving a major employment benefit is not resolved.

It must be recognized that a major secondary impact of the project will be the development of significantly improved capabilities for meteorological and climatological services from the National Meteorological Organization to Morocco. The addition of more modern weather-sensing equipment and related training in operations, data management, and analysis that are provided for under the project should significantly enhance the National Meteorological Organization's short- and long-term capabilities and competence in serving the meteorological and climatological needs of Morocco. The provision of additional radiosonde facilities, a modern, application-oriented METEOSAT receiving system, and their first and only weather radar should immediately

enhance their weather forecasting practices. Knowledge and experience gained from the analysis of data from these observation systems, both individually and collectively, should provide for gradual improvements in their weather forecasts. Activities associated with the data management aspects of the program and the technical and economic feasibility studies should provide the basis for improving their climatological capabilities and services. Finally, the interactions and cooperation between the National Meteorological Organization and other government organizations with a stake in water resources as required to implement the project should significantly improve overall water resources planning and management in Morocco.

C. ECONOMIC, SOCIAL AND ENVIRONMENTAL ANALYSIS

The project design includes special elements to assure that the policy concerns of economic and social soundness as well as the legal requirement for environmental soundness (22 CFR 216,"A.I.D. Environmental Procedures") are fulfilled in a pragmatic and cost effective manner. The design places emphasis on the development of a Moroccan capabilty to analyize these issues and provides a structure for their integration directly into the decision making process which is to be used for project management. Main project elements which address these concerns are the basic analytical programs, training in scientific evaluation, training in economic evaluation and the use of suspension criteria.

The economic, social and environmental benefits and impacts of weather modification projects have been extensively examined in the United States in both academic and applied studies. A review of these studies was conducted by the design team and it was determined that for the purposes of project design that they provided a basic understanding of the impacts of the technnology on man and the environment. Due to the direct transfer of technology involved in tne project it was determined that domestic knowledge provides an adequate baseline to provide for project planning and design; however, it is fully recognized that incountry studies of economic, social and environmental conditions are required to place the project on sound long-term basis and funding for such studies constitute a major element of the project budget (see Table 4).

The basic attraction of weather modification as both a short-term and long-term intervention is that when conducted under highly controlled conditions, in an appropriate geographic setting and with adequate water management infrastructure investments already in place it represents a cost effective way to increase the available water resources. Basic estimates of the economic benefit of the project have been provided in Section II, C,1,d and C,2,c. However, even a geographically restricted demonstration project as AID proposes to fund will require extensive and detailed economic evaluation and the incorporation of such findings directly into the project to assure economic, social and environmental soundness. The project design calls for significant efforts in evaluation of the economic impact of weather modification through analysis of in crop production, hydro-electric power generation, fuel substitution costs and water rationing between user groups.

In addition, the economic evaluation studies will examine alternative investment opportunities for water conservation, collection and storage in order to determine the times within the year and geographical locations where weather modification is a scientifically sound and cost effective intervention. It is important that such studies examine regional differences with regard to the anticipated return on investments in weather modification and other types of interventions such as improved water management or the dredging of reservoirs.

Environmental analysis of weather modification activities, including socio-economic impacts, is a routine requirement in the United States and that all recent programs, similiar in concept to that planned in the project, have received a "Determination of No Significant Impact". The principal environmental and social soundness concerns associated with the proposed project relate to real or perceived changes in the hydrological cycle due to weather modification and to the potential for the inadvertent creation of hazardous situations including flooding, hail storms, strong winds, landslides, lowered snow line elevations and their associated impacts. In operational weather modification projects such issues are normally addressed through the development and implementation of suspension criteria.

Extensive studies have been conducted in the United States concerning the potential environmental impacts of silver iodide (AgI) when used as a cloud seeding agent in weather modification activities. These studies have found that when used as planned and in the quantities called for in the project design that it will not have an adverse environmetal impact. Routine monitoring procedures for silver iodide residue will be used during project implementation.

Due to the results of previous environmental studies of weather modification in the United States, the current drought situation in Morocco and the political need to be responsive it was decided to focus efforts to ensure environmental and social soundness through placing emphasis on direct incorporation of these concerns into project design. This approach includes the following design elements:

- Management: Routine project management decisions will be made by the Project Steering Committee. The Committee will include in its membership the Resident Scientific Advisor, a senior scientist with experience in the environmental evaluation of weather modification projects and in their environmentally sound implementation. In addition, the project will be scientifically and technically supported by the Environmental Coordinator, Bureau for Near East, AID/W, to further incorporate environmental concerns into routine project management decisions.

- Suspension Criteria: The project will place high priority on the development of a site specific set of suspension criteria for implementation under Moroccan conditions (see Section III, 4). Prior to the development of site specfic suspension criteria

an interim set of criteria will be employed (see Annex F) which will be transfered from a similiar area in the United States and adopted to Moroccan conditions on the basis of professional experience and judgement.

The development and implementation of the suspension criteria has been identified as a priority project element and the project Steering Committee (see Section VI. D,2 for details) is responsible for monitoring this activity.

Scientific and Economic Evaluation: The scientific and economic evaluation programs have been designed to provide for the collection and analysis of basic information on the social and environmental aspects of the project area. Through examination of historical data concerning weather and streamflow events it is planned that a risk analysis will be developed which will serve as the basic qualitative study for the development of the suspension criteria. These studies will also provide the baseline data for quantitative analysis of the benefits of weather modification interventions on the water resources base and the economy.

It is anticipated on the basis of previous studies and on the analysis of the geographic location of the project area with regard to weather movements that potential downwind effects will be minimal (See Section III, 3). However, the scientific evaluation will study this issue to provide advance notice and allow for either changes in project design or termination if significant negative effects are determined to exist.

Monitoring: The Project will be subject to an annual field monitoring visit of two weeks duration to be conducted by the Chief, Division of Atmospheric Resources Research, Bureau of Reclamation, and the Environmental Coordinator, Bureau for Near East, AID/W. This visit will place emphasis on review of steps being taken to develop and implement suspension criteria. The field operations of the programs will be reviewed to assure they are in compliance with the provisions of AID environmental procedures.

External Evaluation: The external evaluation team has included as an item in their scope of work to review the technical appropriateness and scientific soundness of suspension criteria which are utilized during all stages of the project. The team is to also evaluate the extent to which the use of scientific evaluation is being incorporated into project design and the extent to which personnel are receiving and applying training to problems such as the development and implementation of suspension criteria.

Termination Conditions: The Project Agreement will include specific language that AID will immediately terminate project funding without notice should suspension criteria not be developed as scheduled or fails to rigorously apply them in project management (see Section VIII).