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A SUMMARY OF ACTIVITIES OF THE EARTH RESOURCES LABORATORY AT THE MISSISSIPPI TEST FACILITY DURING 1971

by

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ORIGINAL CONTAINS COLOR ILLUSTRATIONS

INTRODUCTION

The NASA Earth Resources Laboratory at the Mississippi Test Facility was approved for implementation in the latter part of 1970, consequently 1971 represents the first full year of operation. A short paper was presented at the Third Annual Earth Resources Aircraft Program Review approximately a year ago which described initial concepts and plans for the Laboratory. The five papers which follow describe activities at the Laboratory during 1971. They are presented in the context of status reports. Technical reports covering various aspects of the program are published separately and in addition to the present papers.

The initial concepts for the Laboratory may be summarized as follows:

(1) Conduct research investigations in the Mississippi/Louisiana/Gulf area in the application of remote sensing.

(2) Stress the interests and/or needs of agencies in the area in the selection of activities.

(3) Utilize existing aircraft and satellite programs as a source of data.

(4) Collect and analyze surface data for correlation with flight data.

(5) Conduct systems studies to consider all aspects of potential applications to guide selection of research investigations.

The first item was intended to delineate the geographical area within which investigations were to be undertaken. It was not intended to encompass this total area. The second item is self-explanatory. The third item emphasizes the fact that the new activity will not be directly involved in the development of satellite systems

or sophisticated aircraft operations such as at MSC-Houston or Goddard. Conversely, the fourth item indicates the requirement for significant data acquisition at or near the surface for correlation activities. The last item indicates a need for an overall look at the potential application so that undue emphasis will not be placed on one technical aspect of an area, but that balanced R&D support will be directed towards the definition of a total future operational application system.

The initial plan for the Laboratory also outlined a general implementation plan. Elements of the plan were as follows:

First Year

Recruit Personnel

Bring Support Contractor Onboard

Procure Specialized Equipment

Second Year

Continue Personnel Buildup

Initiate Technical Investigations with Aircraft and Surface Measurements

Implement Data Processing Techniques

Third Year

Extend Projects to Include Data from ERTS and Skylab Projects

This plan recognizes the fact that the Laboratory was being started from essentially a zero capability. No existing groups or organizational elements nor equipments were being transferred from existing Earth Resources activities.

In addition to the items listed, there was the inherent requirement to develop a technical program which is by far the most difficult task for a new organization. Such a program must complement rather than duplicate existing efforts, it must be paced to the development of capability to conduct the activity, and it must properly direct itself towards technique development or demonstration type experiments in lieu of operational activities.

The remainder of the paper will be directed towards summarizing our activities in carrying out the implementation plan and developing and initiating a technical program. Specifically, the following

elements are treated:

Personnel

Organization

Technical Equipments

University Program

Agency Relationships

Minor Projects

Technical Program

Reports/Products

Milestone Summary

PERSONNEL

Personnel buildup is presented in figure 1. Authorization to hire 25 civil service personnel was received in October 1970. These personnel were onboard in September 1971. A procurement plan for a technical support contract was approved in November, 1970. After a competitive selection, the Lockheed Electronic Corporation was selected and initiated work on February 1, 1971. A buildup to approximately 70 personnel was reached in the early fall of 1971. Consequently, the staff of the Laboratory has remained essentially constant for the last four months at approximately 95.

ORGANIZATION

The organization of the Laboratory is presented in figure 2 for the NASA and contractor groups. The Laboratory reports to the Director of the Manned Spacecraft Center, Houston. The Land and Sea Remote Sensing Applications Groups are concerned with land and water projects respectively. These groups consist of specialists including a hydrologist, forester, agronomist, ecologist, cartographer, regional planner and an oceanographer, meteorologist, and a microwave engineer, mathematician and computer specialists, photographic scientist, instrumentation and data systems engineers. The numbers next to the organizational blocks on figure 2 indicate the number of personnel in the group.

The Lockheed Electronics Technical Support Contractor is organized as shown on the lower half of figure 2. A modest complement of disciplinary specialists support the data analysis activity with larger groups involved in data preparation, instrumentation, and data systems. The latter two being heavily involved in the operations related to surface data acquisition.

TECHNICAL CAPABILITY
(Equipments)

The Mississippi Test Facility and nearby Slidell Computer Complex have been primarily involved in the testing of large scale rockets over the past several years. While these pursuits lead to a firm basic technical laboratory capability, items uniquely related to the remote sensing activities were not available. Consequently, in this first year of operation, a significant effort has had to be directed towards the planning and purchasing of necessary equipments. The following paragraphs describe the major items involved.

In the area of remote sensors for surface measurements to be used from boat, truck or light aircraft the plan was to obtain relatively inexpensive, commercially available devices requiring no development. These sensors would cover the same general spectral bands or ranges as those on ERTS, Skylab EREP, or used in the Earth Resources Aircraft Program. With these criteria we have acquired the following:

A set of general purpose cameras (Yashicas, Hasselblads, Nikons)

An I^2S Multiband Camera System

Barnes Precision Radiation Thermometers (PRT-5 and 6)

A Texas Instruments Single Channel Scanner

An Exotech Field Spectrometer

These equipments have all been delivered with the exception of the field spectrometer which will be delivered within the next month.

In addition to the remote sensors a family of relatively simple in-situ sensors and associated equipments have been obtained. These range from simple thermometers to Secchi disks to a pyronometer.

We have employed a number of platforms or carriers in conjunction with obtaining measurements on or near the surface. A 27 foot power boat (J-Boat) was available at MTF. Evaluation of this craft indicated it to be suitable for work in the calm waters of the nearby river but its slow speed and limited stability made it unusable in the coastal

waters such as the Mississippi Sound. For major coastal experiments we have depended on agencies, universities and individuals located in the area.

A truck has been purchased suitable to accommodate an extensible boom, instrumentation and data recording systems. This will be available in May. Its primary use will be in the local area relative to correlation measurements in agricultural and natural target areas to obtain information on variables for which it is impractical to maintain long term or very frequent aircraft coverage.

As stated earlier our investigations have been built around the data gathering capability of the Earth Resources Aircraft Program including the P3A, C130 and RB57. Locally a smaller aircraft supports our near surface measurements on a rental basis. This allows for the gathering of preliminary data prior to large aircraft coverage, limited but frequent data acquisition between large scale missions and low altitude measurements during the course of the mission. We have obtained out-the-window photography and PRT-5 and camera data employing a simple mount on the door. In the near future we will be able to obtain vertical data through floor areas where removable hatches have been installed.

In addition to measurements in natural areas of interest we have found it necessary to have a limited laboratory capability for spectral tests and calibration and several outdoor calibration areas. Two spectrometers, a Cary 17 with a spectral range of .18μ to 2.65μ and a Perkin-Elmer instrument with a range of 1.0μ to 15.5μ have been obtained. The former has been used for a variety of tasks including the analysis of sea water content for chlorophyll as will be discussed by a subsequent speaker.

An optical bench and associated equipment has been obtained for limited camera and lens calibration and black body sources have been obtained for calibrating the thermal IR equipment.

For use outside the Laboratory (figure 3 a) we have obtained and are using a set of Data Corporation photographic targets (figure 3 b) and have instrumented a 13 acre reservoir (figure 3 c) on the site with thermocouples to support calibration of the thermal sensor operation. In the summer we will have access to a series of agricultural fields on a nearby farm (figure 3 d) where arrangements with the owner will provide a series of forty-acre fields containing cotton, soy beans, rice, wheat and milo. The first three, plus sugar cane, represent the major crops of the Mississippi-Louisiana area. Their nearby location and size will allow a convenient site for ERTS and Skylab investigations and a variety of near surface investigations of second order variables.

The discussion to this point has emphasized equipment relating to the acquisition of data. Our activity in the past year has been equally concerned with acquiring data preparation equipment and

arranging for data processing. Processing of data for the Laboratory is accomplished primarily at the Slidell Computer Complex and the MTF Photographic Laboratory. The former is equipped with a series of Univac 1108 computers and the latter has been equipped in the last year to provide up to 9 inch format, automatic color processing as well as a variety of related capabilities. The MTF photo processing capability is augmented by a small, manually operated, processing capability in ERL which is used for special purposes. While the Univac 1108's represent a significant capability, their usefulness is directly geared to available and suitable programs. A considerable effort has been directed towards the transfer of a series of pattern recognition programs into these computers. Mr. Whitley will describe this activity in more detail in a later paper.

The data processing capability must be augmented with the necessary equipments for data preparation and analysis. A variety of light tables ranging from field units to photo interpretation stations have been acquired. The previously mentioned I^2S Mini-Addcol Color Additive Viewer for registration, combining, and display of the several bands for analysis. A second I^2S device, consisting of a Digicol Image Color Transformer was obtained to provide a capability for enhancing discrimination between features in an image. The most significant capability which will be located at the Laboratory will be a Data Analysis Station to be delivered in May. This equipment is similar to that located at MSC-Houston and will allow for the screening, editing and tape reformatting of multispectral data from the C130, 24-channel scanner, the Skylab EREP and ERTS scanners. This equipment will be described in more detail in a subsequent discussion.

UNIVERSITY PROGRAMS

The initial plan for the implementation of this Laboratory envisioned the development of relations with a number of universities in the area. It was felt that the universities, with their specialized personnel, afforded a knowledge of the area and represented one of the bridges to operating groups who hopefully will desire to use remote sensing techniques as they develop.

Contracts were let with the following universities:

Louisiana State University

Tulane

Mississippi State University

University of Southern Mississippi

Gulf Coast Research Laboratory

The purpose of this initial activity was not to conduct specific remote sensing investigations but to gather a set of information regarding the area, to evaluate it in the context of helping to guide the development of projects at the Laboratory, and to afford the universities an opportunity to increase their familiarity with the remote sensing program.

These studies have been completed and are now being evaluated. Two of the universities, Mississippi State and Tulane, have submitted ERTS and/or Skylab proposals which have been favorably received. All have proposed continuing activities with the Laboratory and we hope funding will allow continued support of these universities.

AGENCY RELATIONSHIPS

Contacts with federal and state agencies have been many and diverse. As you know, a number of government agencies, including USGS, NOAA, and EPA, have laboratories and activities located at MTF. We have had minor cooperative activities with a number of these groups and would expect these efforts to grow. Particular elements of those groups with which we see expanding activity include the EROS office, National Marine Fisheries, and the Data Buoy Project of NOAA.

There is also located at MTF a State Liaison Officer who reports to the Governor. He provides convenient access to state agencies and officials and, conversely, a channel into our operation for these interested groups.

During the first several months at MTF we conducted a series of visits to a variety of state and federal agencies located in the area. These are too numerous to list in this paper but they provided us with an excellent assessment of current interests in the area and the status of current use of remote sensing techniques. Subsequent papers will detail areas where we have entered into more definitive collaborative areas with local groups such as the Mississippi Sound and the Atchafalaya Basin Projects.

MINOR PROJECTS

During the first year as we were striving to develop a capability and define a longer range program, we undertook a number of minor projects, some by choice and some by plan. These projects hopefully served a technical purpose, but also were valuable in orienting our staff and developing procedures.

The projects included the following:

- Tornado Survey
- Pine Blight
- Corn Blight
- Land Use Update
- Soil Moisture

All of these activities have been reported with the exception of the Pine Blight Project. In addition, the appendix of Mr. Mooneyhan's paper will describe these activities in more detail.

TECHNICAL PROGRAM

Earlier in the paper it was noted that one of the most difficult but important tasks of the first year's activity was to develop a technical program. Such a program has been developed based on studies, discussions with university and agency personnel, and knowledge of the ongoing program. Three technical areas of activity have been selected for study, as follows:

- Automated techniques for the annual updating of land use.
- Circulation and associated characteristics of a semi-enclosed water body and a deep water current.
- Definition and monitoring of the characteristics of a wetland area.

These areas are recognized as being quite broad in scope, however we have selected detail technical objectives within these broad areas and these will be described by Messrs Tilton and Mooneyhan respectively.

The program is structured to proceed from an initial base of technique development to one of demonstration experiments. The latter is being done in conjunction with operating agencies and the former may or may not depending on the status of the technique.

Figure 4 presents a summary of test areas within which work is going on or is planned for the future. The automated techniques for land use classification is concentrated in the Mississippi Gulf Coast counties with a planned extension to the rich "delta" farming region in the coming year. Mississippi State University will work in both

these areas with satellite data. Techniques related to the preparation of high altitude photography for land use and other application is being studied in the Jackson area. Additionally, the University of Southern Mississippi will attempt to exploit multiband photography in relation to sedimentation in the neighborhood of a reservoir and associated land use in the Jackson area.

Water studies were initiated in the Mississippi Sound and Mobile Bay. The Sound is defined by the coast and a string of barrier islands extending from Lake Pontchartrain to Mobile Bay. The Gulf Coast Research Laboratory will participate with ERL in a more concentrated study of an estuary emptying into the Sound, namely Biloxi Bay. Tulane's ERTS proposal relates to a preliminary study of Lake Pontchartrain and we hope to support a more concentrated study of the eastern area of the Lake employing light aircraft.

We have received a specific request to study Barataria Bay in Louisiana using an approach similar to that used in the Sound. This would be an example of a demonstration experiment after previously exercising the techniques. We have delayed answering this request until we could evaluate initial results of the Sound Study.

We have also initiated a study extending into the deep Gulf built around the Gulf East Loop Current. Initial tests cover the area in the figures but since the current varies in its location through the year, subsequent tests will move with the current.

Our wetlands study is being conducted in the Atchafalaya Basin in Louisiana which is defined by the Atchafalaya River, a distributary of the Mississippi and a series of levees. Louisiana State University proposes to conduct a more concentrated study of the Bayou La Fourche and the land area contained within its levee system. Details of this water system offer controlled conditions which make the site of interest.

As stated earlier, the ERL projects mentioned here will be discussed in more detail by subsequent speakers. The university projects have not developed sufficiently at this time to warrant further detail at this review.

1971 REPORTS/PRODUCTS

Table I presents a list of reports prepared by ERL in 1971. These include primarily the results of the minor projects previously mentioned and the documentation of surface measurements or ground truths for a number of the projects.

SUMMARY

In summary, figure 5 presents a milestone chart which presents typical highlights of our year's activity. We received authorization to hire personnel in October of 1970 and initial funding in January of 1971. During February the Technical Support Contractor initiated work, the university contracts were let, and our first project activity was initiated with the Tornado Survey. The I^2S Multiband System was received in June and the first Mississippi Sound measurements were obtained in July. The Gulf Coast Counties Land Use tests were initiated in September and the Atchafalaya tests in October. The first Deep Gulf tests were in November and the infrared scanner was delivered in December.

We feel we have developed a reasonable foundation for the Laboratory in this first year. The second and third years will be more critical as the results of our efforts reach a position which will allow us to evaluate their usefulness in terms of the overall Earth Observation Program.

EARTH RESOURCES LABORATORY 1971 REPORTS/PRODUCTS

Earth Resources Activity at Mississippi Test Facility - A Proposal and Implementation Plan August 12, 1970

Photographic Survey in Post Tornado Relief Activities February 21, 1971

Observations of the Southern Corn Leaf Blight November 1971

Soil Moisture Remote Sensing Study, Part 1, Surface Measurements July 20, 1971

Hancock County Land Use Study, Experiment 1, Part 1, Surface Measurements September 9, 1971 (draft)

Mississippi Test Sites Land Use Study Photographic Experiment, Mississippi Land Use Study Preliminary Report September 30, 1971 (draft)

Mississippi Sound Remote Sensing Study, Experiment 1, Part 1, Surface Measurements July 22, 1971

Mississippi Sound Remote Sensing Study, Experiment 2, Part 1, Surface Measurements November 10, 1971

Eastern Gulf of Mexico Remote Sensing Study, Experiment 1, Part 1, Surface Measurements November 21, 1971

Atchafalaya River Basin Study, Experiment 1, Part 1, Surface Measurements October 29, 1971 (draft)

Atchafalaya Basin Mosaic with Surface Classification Overlay from October 1970 data December 1971

Table I. - Reports/Status Chart

ERL & SUPPORT CONTRACTOR PERSONNEL

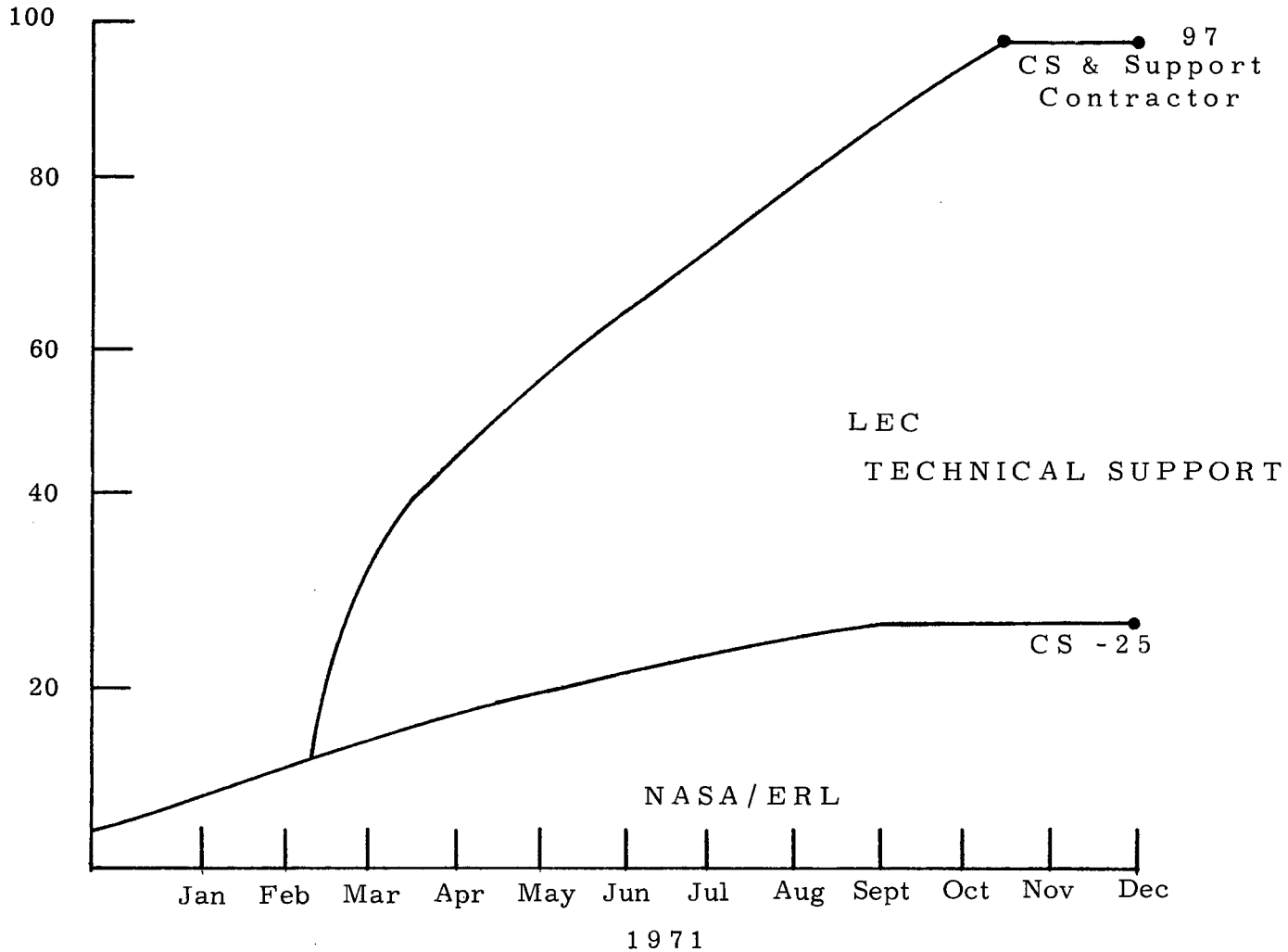

Figure 1. - Personnel Curve

As of January 1, 1972

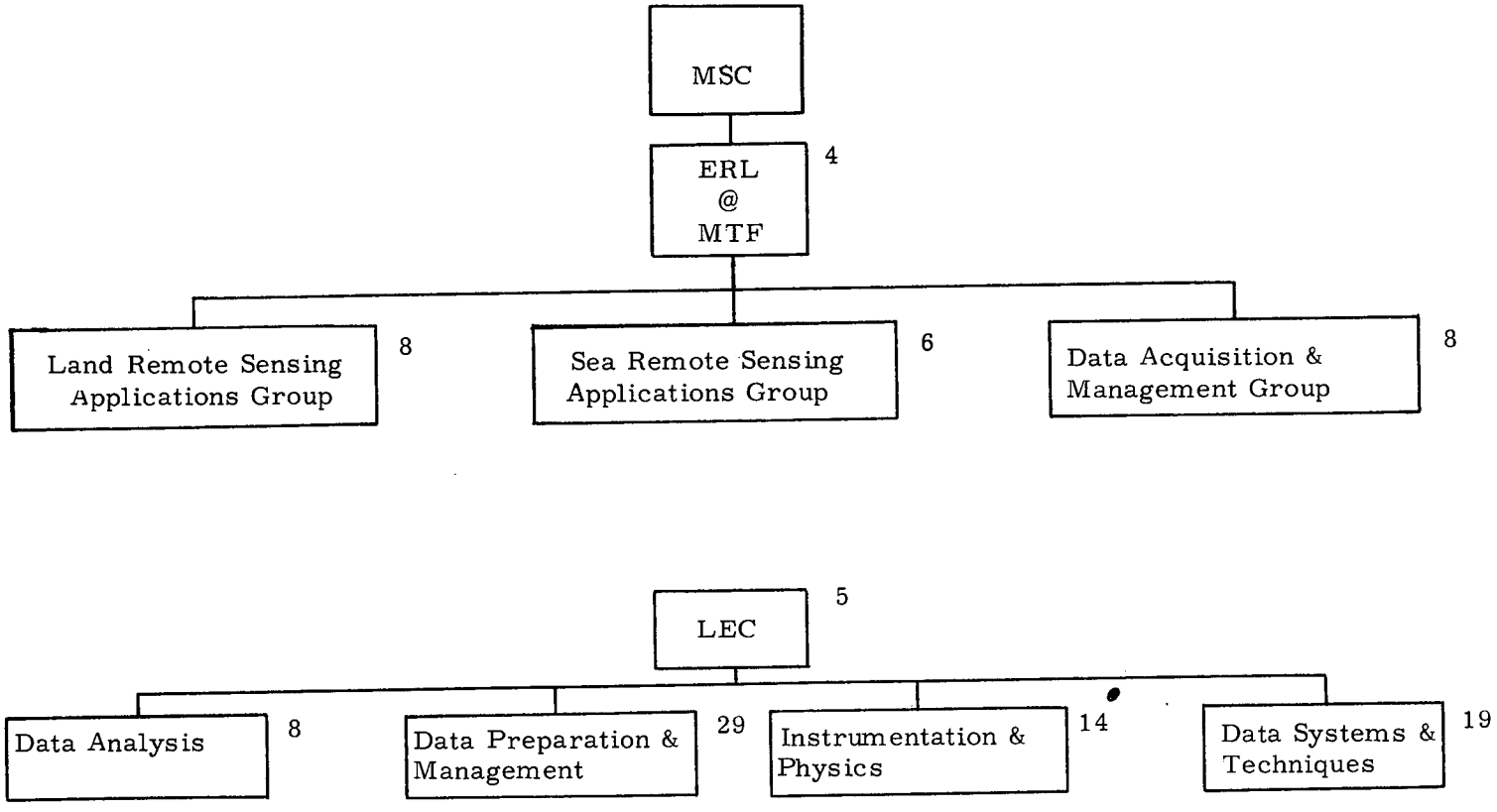

Figure 2. - Organization Chart

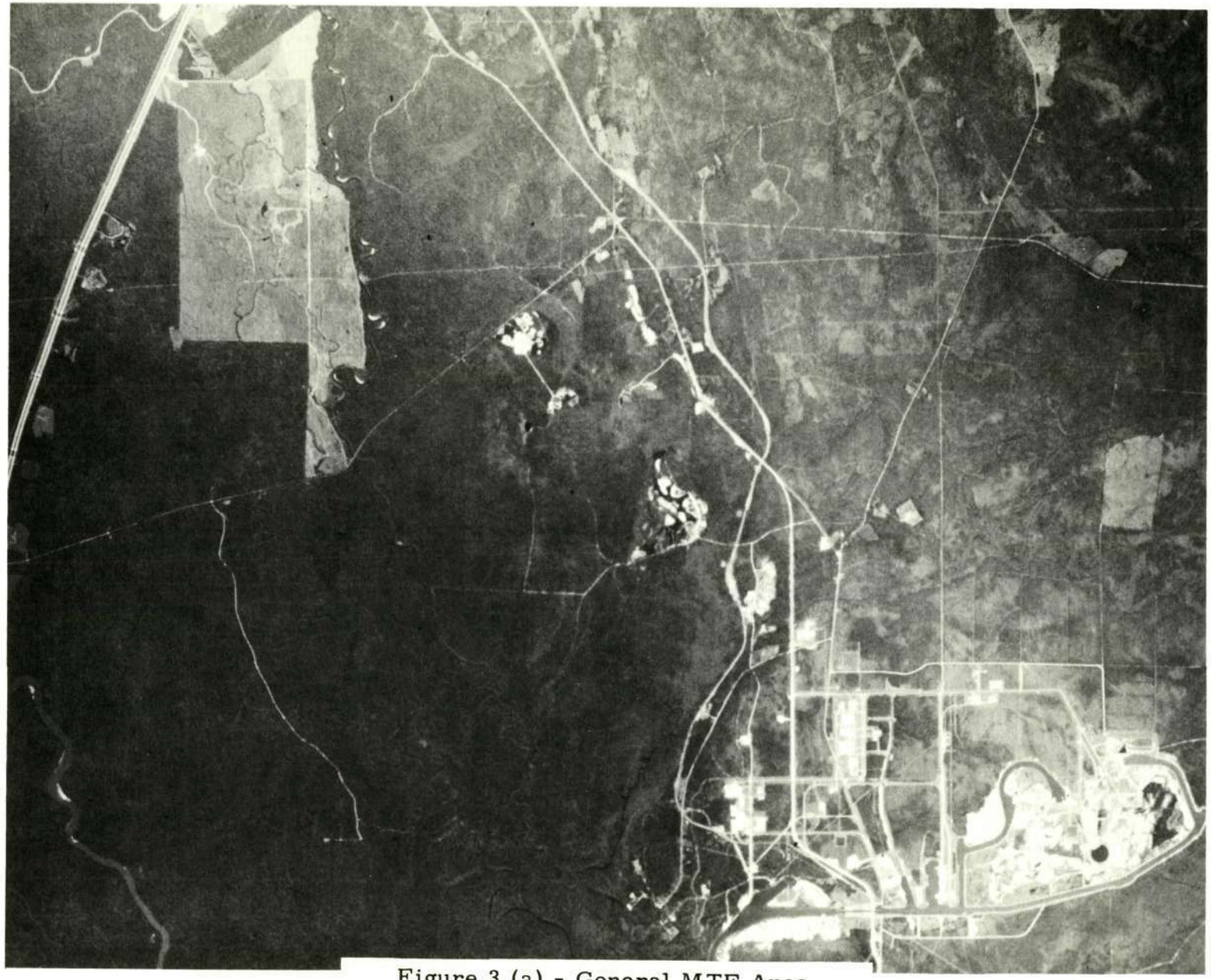

Figure 3 (a) - General MTF Area

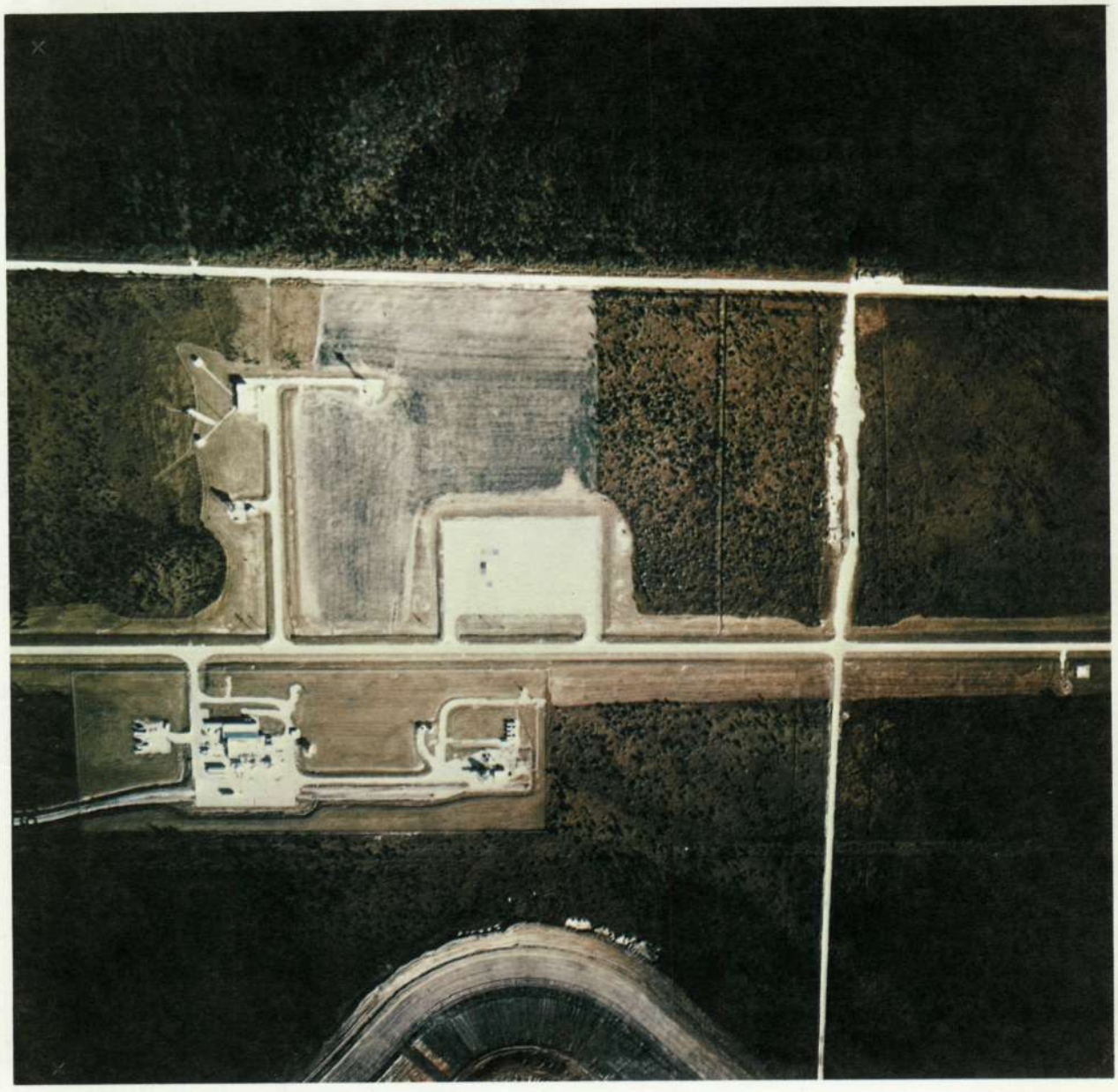

Figure 3 (b) - Target Array

Figure 3 (c) - Instrumentated Thermal Calibration Reservoir

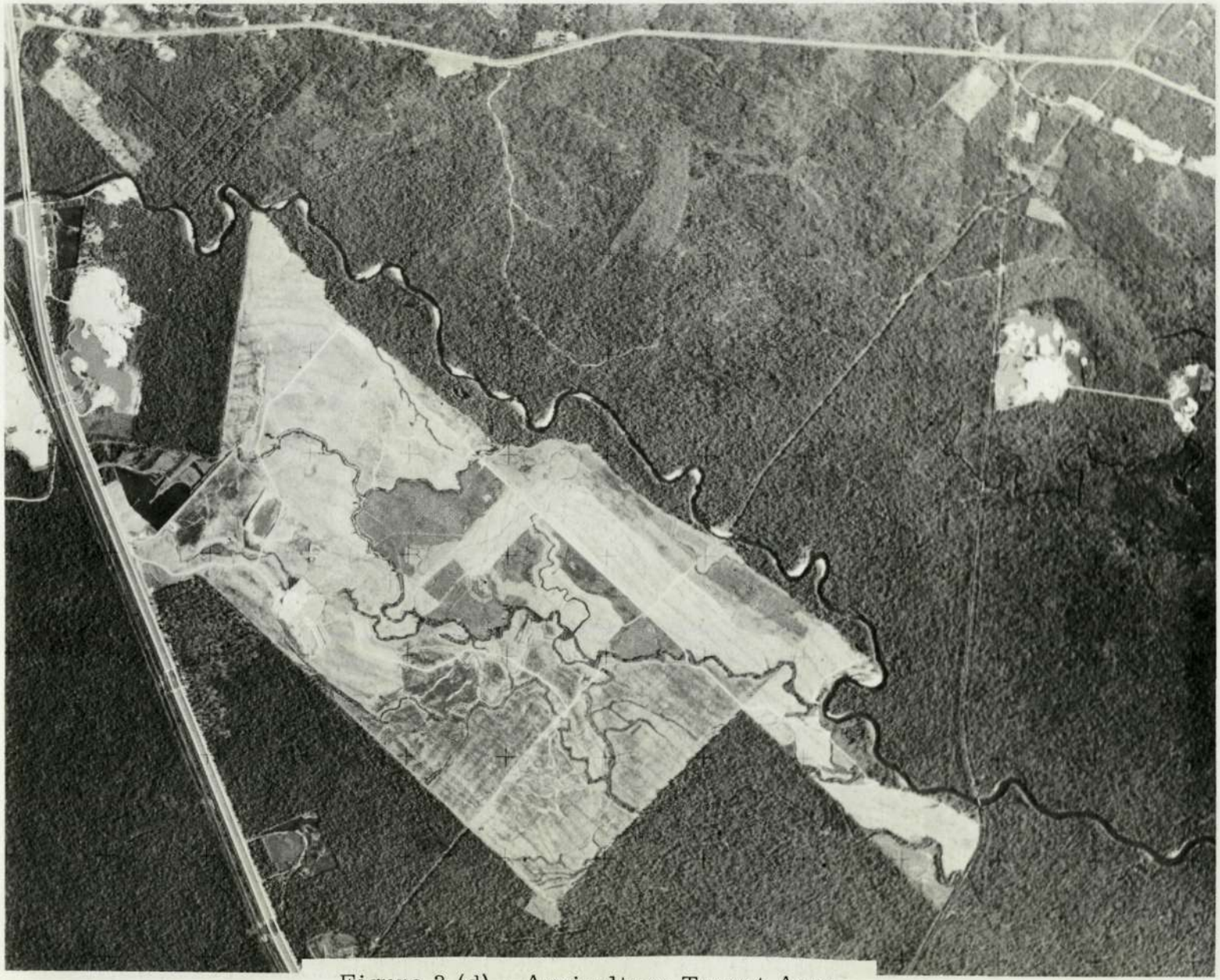

Figure 3 (d) - Agriculture Target Area

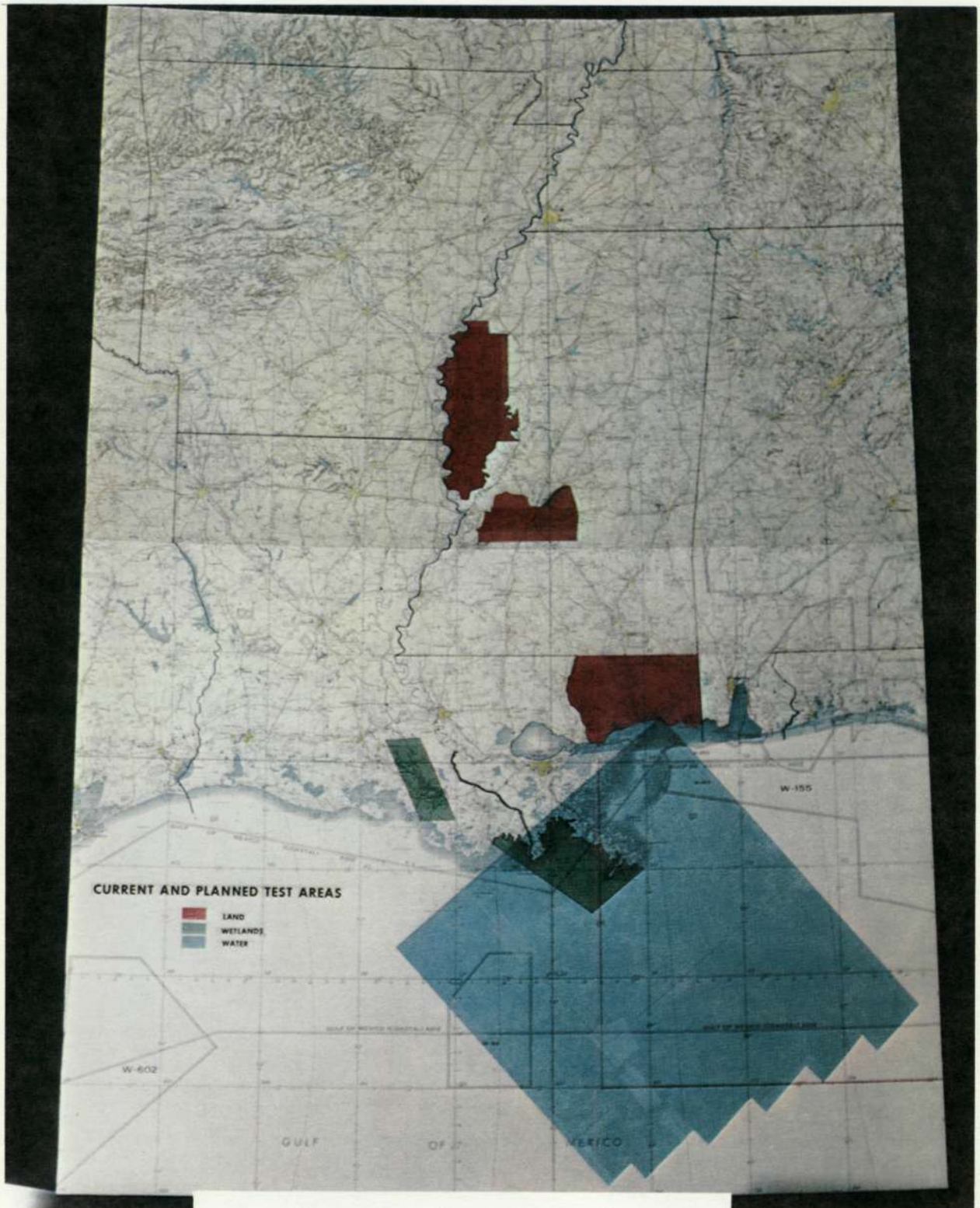

Figure 4. - State Target Areas

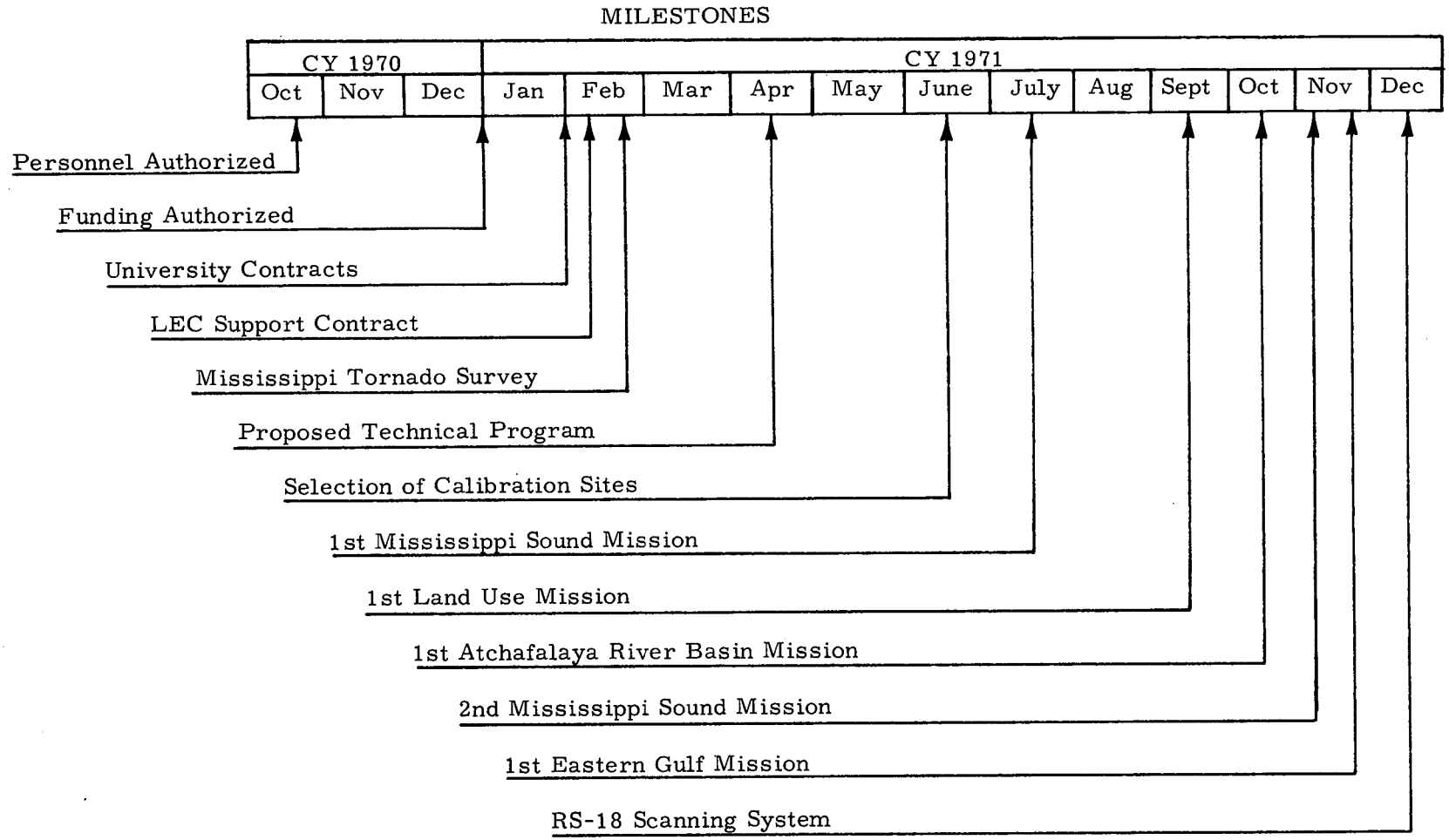

Figure 5. - Milestone Chart