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O A L S BULLETIN 3

NATURAL RESOURCE INVENTORY FOR URBAN PLANNING UTILIZING REMOTE SENSING TECHNIQUES

by

K.E. Foster, P.F. Mackey, & C.D. Bonham

A report of work performed under
NASA grant No. NGL 03-002-313
in cooperation with the City of Tucson,
Planning Department

OFFICE OF ARID LANDS STUDIES
College of Earth Sciences
University of Arizona
Tucson, Arizona

October 1972

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FOREWORD

This Bulletin is published in furtherance of the purposes of NASA grant NGL 03-002-313 entitled "Research for Application of Remote Sensing to State and Local Governments." The purpose of the grant is to assist, with the use of NASA high-altitude photography and satellite imagery, state and local agencies whose responsibility lies in planning, zoning, and environmental monitoring and/or assessment.

This report is the third in a series of publications designed to present information bearing on remote sensing research and applications in Arizona. This present study utilizes high-altitude color photography as a data base for producing a seven category vegetation map of the Lower Pantano Wash Area. Desert vegetation is being scrutinized closely by planners for its esthetic, wildlife harboring, and erosion controlling values, therefore this study served a dual role of testing high-altitude photography for vegetation mapping utility and providing data for future planning. The vegetation mapping was based upon correlation of land form with vegetation types and positive identification of a given vegetation type on the high-altitude transparencies.

The hydrologic geometry of the Wash was also compared over a thirty year period utilizing enlarged photographic overlays.

INTRODUCTION

In an effort to learn more of the natural resources of the lower Pantano Wash area which will facilitate better urban planning, the Office of Arid Lands Studies, University of Arizona and the City of Tucson Planning Division initiated a data collection effort for the area shown in Figure 1.

The purpose of the study was to use remote sensing techniques to learn of existing vegetation, soils, and hydrologic conditions along the Wash. This information can then be used as a basis for planning which will better account for the ecological balance sought between an expanding metropolis and the environment.

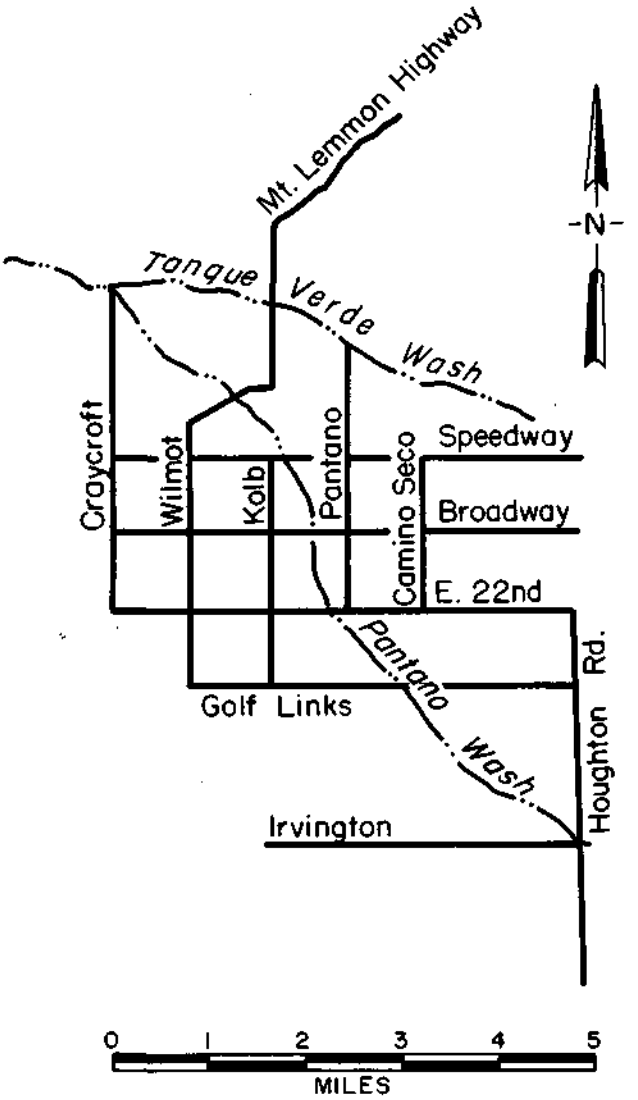
Urban environmental planning requires information concerning the natural vegetation, hydrology, and soils of the area under consideration. Broad vegetation characteristics and their distribution are available in map form. However, these broad vegetation maps are inadequate in order to meet the needs related to urban environmental planning and proposed open space or esthetic areas. Ecological impacts of urban development on natural vegetation can be made only if detailed information is available concerning the vegetation base of the region, therefore vegetation types and their associated distribution were determined for the lower Pantano Wash area of Tucson, Arizona.

Hydrologic changes along the Pantano Wash due to urbanization and man related activities are apparent when comparing photography over a 35 year period. Activities such as gravel pit operations, channel straightening, and bank stabilization have caused less stream channel meander and resulted in a deeper channel. A soils classification

and suitability criteria has been developed for the area under separate cover (Richardson, 1972).

This study was conducted jointly by the Office of Arid Lands Studies, University of Arizona and the Planning Division, City of Tucson in order to explore remote sensing's expanding role as a tool for planners. Funding was provided through NASA grant NGL 03-002-313 entitled Research for Application of Remote Sensing to State and Local Governments.

Figure 1. Delineation of Study Area


Mt. Lemmon Highway
-N-
Tanque Verde Wash
Craycroft
Wilmot
Kolb
Pantano
Camino Seco
Speedway
Broadway
E. 22nd
Pantano Wash
Golf Links
Houghton Rd.
Irvington
0 1 2 3 4 5
MILES

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METHODS

Small scale color and color infrared photography acquired by NASA's high altitude RB-57 aircraft (mission 101, 10 August '69) was used in mapping the vegetation types, their characteristics, and hydrologic changes. Additional information was also available from large scale aerial photos taken in 1936, 1954, 1956, and 1971. These photos were made available by the Soil Conservation Service and the Arizona Highway Department.

A vegetation map was constructed using NASA high (60,000 ft.) altitude color photography (320 square miles per frame) as a data base. Additional vegetation data was obtained by use of large scale black and white aerial photos which were used principally to determine more accurate boundaries for the vegetation types. Vegetation types determination by use of the black and white photography proved difficult, however, it was found that the high altitude color photography could be used to resolve discrimination uncertainty. The color photography was most beneficial in the interpretation of topographic features which are correlated with vegetation types. Frequently, level areas consisting of creosote bush could not be distinguished from certain areas that had been cultivated in the past. Again it was found that high altitude color photography could make these important separations.

Definite boundaries for the vegetation types were established after a limited field check was conducted. A specific list of species was prepared for each of the types after a visit was made to several representatives of the type. However, specific information cannot be obtained with regard to species composition from the photographic data. Vegetation characteristics were also noted to occur over several soil types. Comparison of the vegetation map with the soil map developed by the Soil Conservation Service will indicate that the vegetation types often overlap the soil units identified.

Description of the Vegetation Map

The natural vegetation and its distribution along Pantano Wash is divided generally into seven different categories as shown on Plate I at the back of this report and described below. For ease of interpretation the map is presented in an enlarged scale of 1" = 2 miles. The boundaries of each of these types are not to be taken as distinct, but rather as relative. Quite often the boundaries of a type do correlate with topographic and soil features of an area; however, this is not necessarily true for all the vegetation types. In a number of cases a vegetation type overlaps several soil categories. The seven categories which describe the vegetation in Pantano Wash and are distinguishable on small scale photography are as follows:

1. Mesquite-Cottonwood association
2. Vegetation of the wash and adjacent banks
3. Vegetation of slopes and small hills
4. Creosote bush association
5. Creosote bush-Palo Verde mesquite association
6. Vegetation of previously cultivated fields
7. Vegetation of abandoned gravel pit or gravel pit boundary areas.

Mesquite-Cottonwood Association

The mesquite-cottonwood Association occurs along the confluence of the Pantano Wash and Tanque Verde Creek area. This association extends along the Tanque Verde Creek eastward past the Mount Lemmon road, however is not found on the Pantano Wash south of the confluence area.

Vegetation of the Wash and Adjacent Banks

The vegetation of the immediate Pantano Wash and its adjacent banks consists of shrubs and small herbaceous vegetation. A few mesquite trees are found on the banks, but were not found in abundance. These two vegetation types are associated with flood plains in the Pantano Wash.

Vegetation of the Slopes

Vegetation of the slopes consists of Palo Verde trees with scattered Saguaro cactus and creosote bush. A number of other species occurs with these species and are locally abundant. However, this vegetation type could not be broken down into smaller categories unless more detail were of interest in drainage patterns. The topographic features of this vegetation type are mainly indicated by broken land characteristics.

Creosote Bush Association

The creosote bush association occurs extensively on level areas. There is an occasional Palo Verde tree found scattered throughout this type and it is very noticeable from the photographic information. The land form is characteristically of a terrace nature.

Creosote Bush-Palo Verde Association

The creosote bush-Palo Verde association differs from the previous creosote bush association in that Palo Verde trees are found more abundantly in this latter type. It is a judgement factor as to the number of trees and spacing of trees required before one type grades into the other.

Vegetation of Previously Cultivated Areas

The vegetation of previously cultivated areas gives different characteristics on the aerial photography than the previous types. There are several areas that were obviously denuded of vegetation sometime in the past and have not yet reached the natural vegetation previously exhibited.

Vegetation of Gravel Pits

The vegetation of gravel pits cannot be distinguished from aerial photographic information, but rather was identified strictly by field observation. This vegetation consists mainly of annuals and willows growing along the peripheral areas of these pits.

Discussion of the Vegetation Map

Some of the vegetation types which occurred near housing development projects were difficult to distinguish. One of the major problems in typing natural vegetation in these areas was in the interpretation of whether or not the area was previously cultivated or was sparsely covered with creosote bushes. Also, in a few localized areas the creosote bush association is often difficult to distinguish from the vegetation of slopes. This problem arises because creosote bush and Cholla cactus integrate to the extent that this type has to be strictly separated on the basis of topographic characteristics. Topographic features have to be clearly visible in order to distinguish accurate boundaries for these two types on photography. This is not always possible and some error may arise in boundary determinations as a result; however, this was not a significant problem in mapping the vegetation along Pantano Wash.

Another source of error with regard to vegetation typing occurred as a result of mesquite trees becoming quite dense in a localized area of the creosote bush-Palo Verde mesquite association. The aerial photography indicated that this type in a localized area may be the slope vegetation type. However, direct field observation revealed that this type had dense mesquite trees. There was an occasional Saguaro cactus in this small area, but this problem was not significant to the identification of vegetation types.

Much of the natural vegetation of Pantano Wash is open to public use. In a number of places this use has not been controlled and has resulted in some alteration of the vegetation. A comparison of the military controlled land of Davis-Monthan Air Force Base (DMAFB) reveals that the vegetation structure is different than those areas used by the public. Data from the DMAFB area may be useful in the future to determine the environmental impacts which are being inflicted on the adjacent area. The impact of vehicular traffic on the open areas is being observed through vegetation changes with physical destruction accounting for the largest change.

The delineation of vegetation types of the Pantano Wash by the use of high altitude photography was particularly easy in that shrubs and trees characterize the vegetation. However, little information if any could be obtained concerning the understory and small herbaceous species of the Pantano Wash area.

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HYDROLOGIC ASPECTS

Hydrologic aspects of the Wash are limited in this report to those parameters that were mappable through the use of remote sensing techniques.

Plate II compares stream channel geometry over a 34 year period from 1936 to 1969. The 1936 photography was provided by the Soil Conservation Service at a scale of two inches per mile. In order to more accurately portray any changes in stream channel movement one frame of Mission 101 high altitude color photography was enlarged to that same scale to provide overlay capability. As seen from Plate II, the periodic flow along the Wash prior to 1936 had a tendency to meander over the broad, flat, and shallow stream channel. Each flow tended to follow old scour areas or completely innundate the channel and produce new courses in the alluvial material.

The channel geometry as seen in 1969 has been altered since 1936. Man-made activity relating to urban development has been the major factor causing a deeper and narrow channel. Gravel operations are currently very active along the Wash in the study area. Tucson's fast growth rate has given rise to increased demands for sand and gravel which is being extracted from the Wash. The gravel pits are readily discernable on high altitude photography of the area. The gravel pits have been responsible for a deeper channel. The gravel is excavated leaving large pock marks at intervals along the stream. Flood events then cause bed movement from undisturbed areas into the pits thus causing a general lowering of the stream channel and silt collection in the pit bottoms.

Channel stabilization is also responsible for less channel meander along developed areas of the Wash. Stabilization is usually accomplished by installing riprack or cement side slopes, or by bulldozing channel side walls.

Morrison (1971) has also made extensive use of the Mission 101 color photography to map surficial geology, geomorphic features, soil associations, local relief, flood hazards, caliche conditions, and general construction conditions. Relating to hydrology of the Wash, Morrison lists three degrees of severity of flooding along the Wash. The stream channel itself is most severe with innundation possible at frequent intervals. Moderate to locally severe flooding may occur along the banks immediately adjacent to the channel and locally moderate to severe flooding may occur on the lower terraces along the main stream.

LITERATURE CITED

1. Richardson, M.L., 1972, "General Soil Map Lower Pantano Wash Area Pima County, Arizona" OALS Bulletin 1, University of Arizona.

2. Morrison, R.B., 1971, "Photointerpretive Geologic-Terrain Mapping and its application to Land-Use Planning in the Tucson Metropolitan Area," Proceedings 2nd ARETS Symposium, University of Arizona, pp. 199-205.

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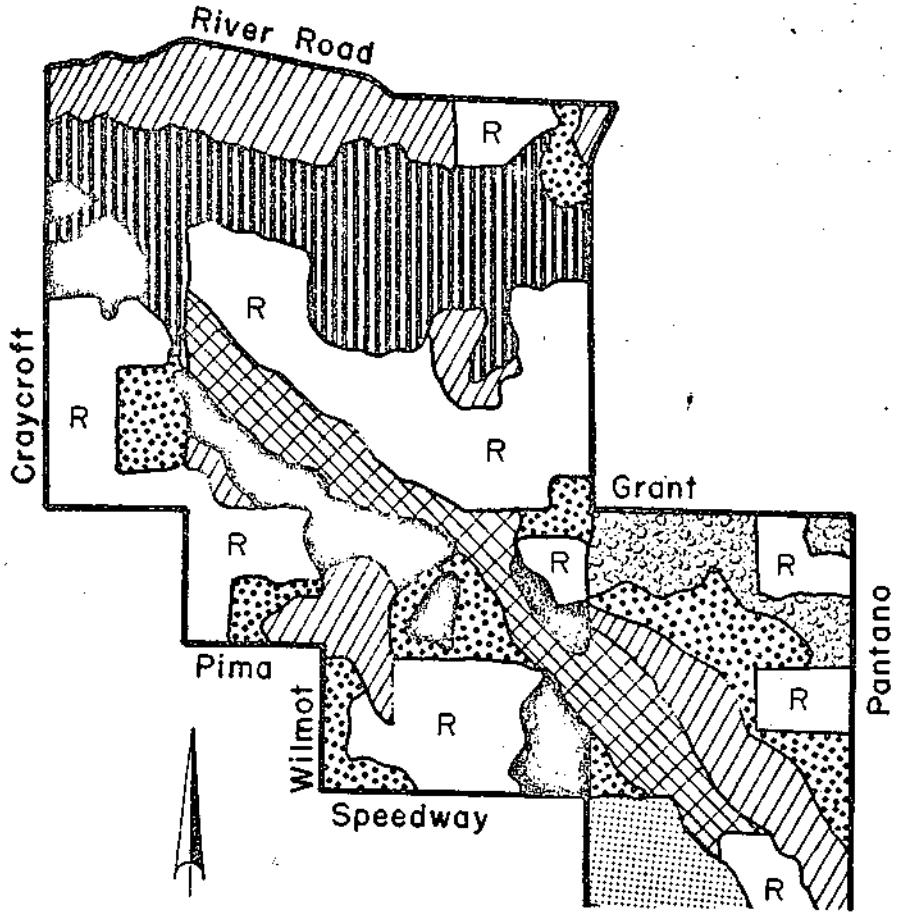
PLATE I

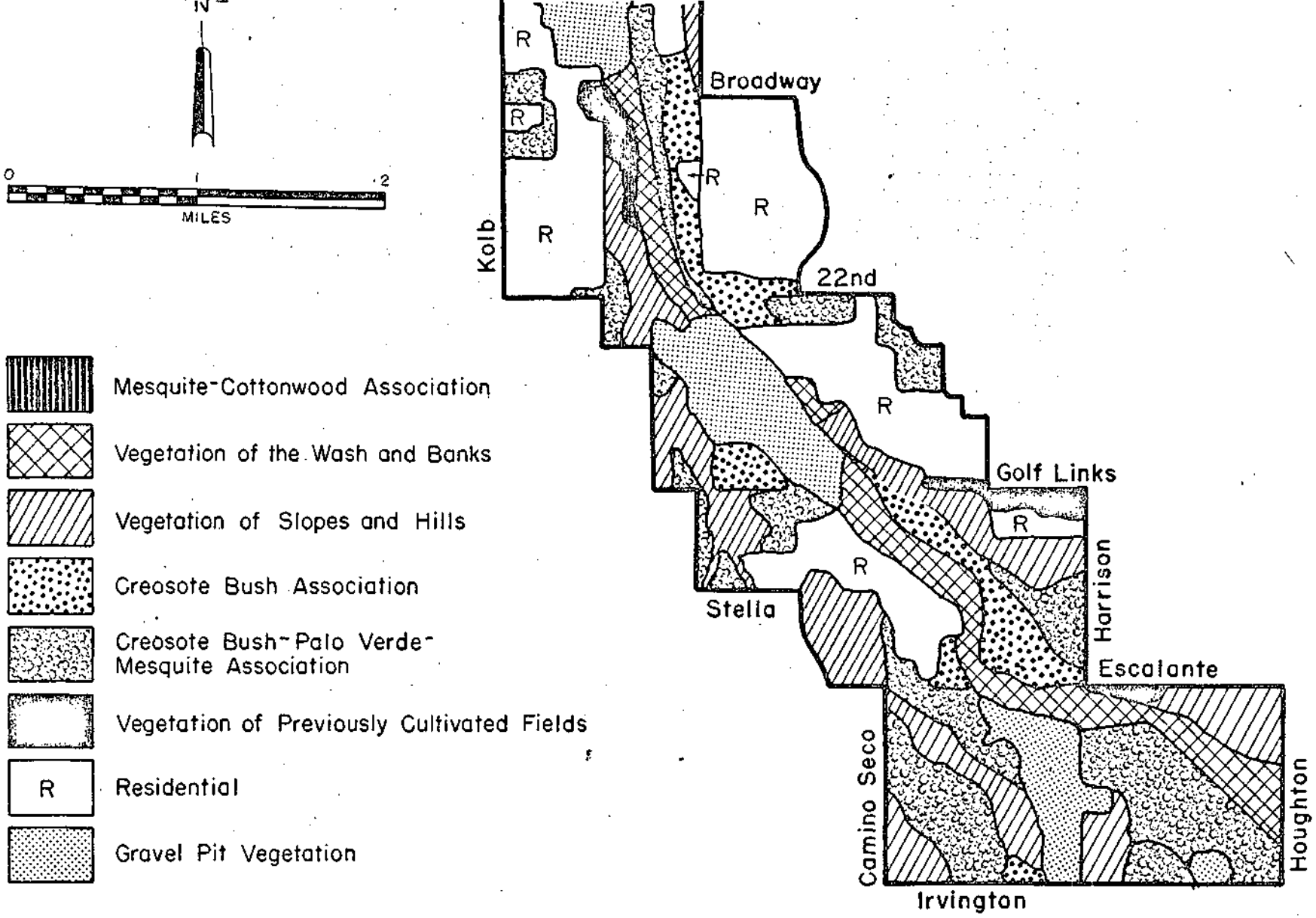
VEGETATION MAP OF THE LOWER PANTANO WASH AREA

PIMA COUNTY, ARIZONA 1972

Office of Arid Lands Studies, University of Arizona

City of Tucson, Planning Division





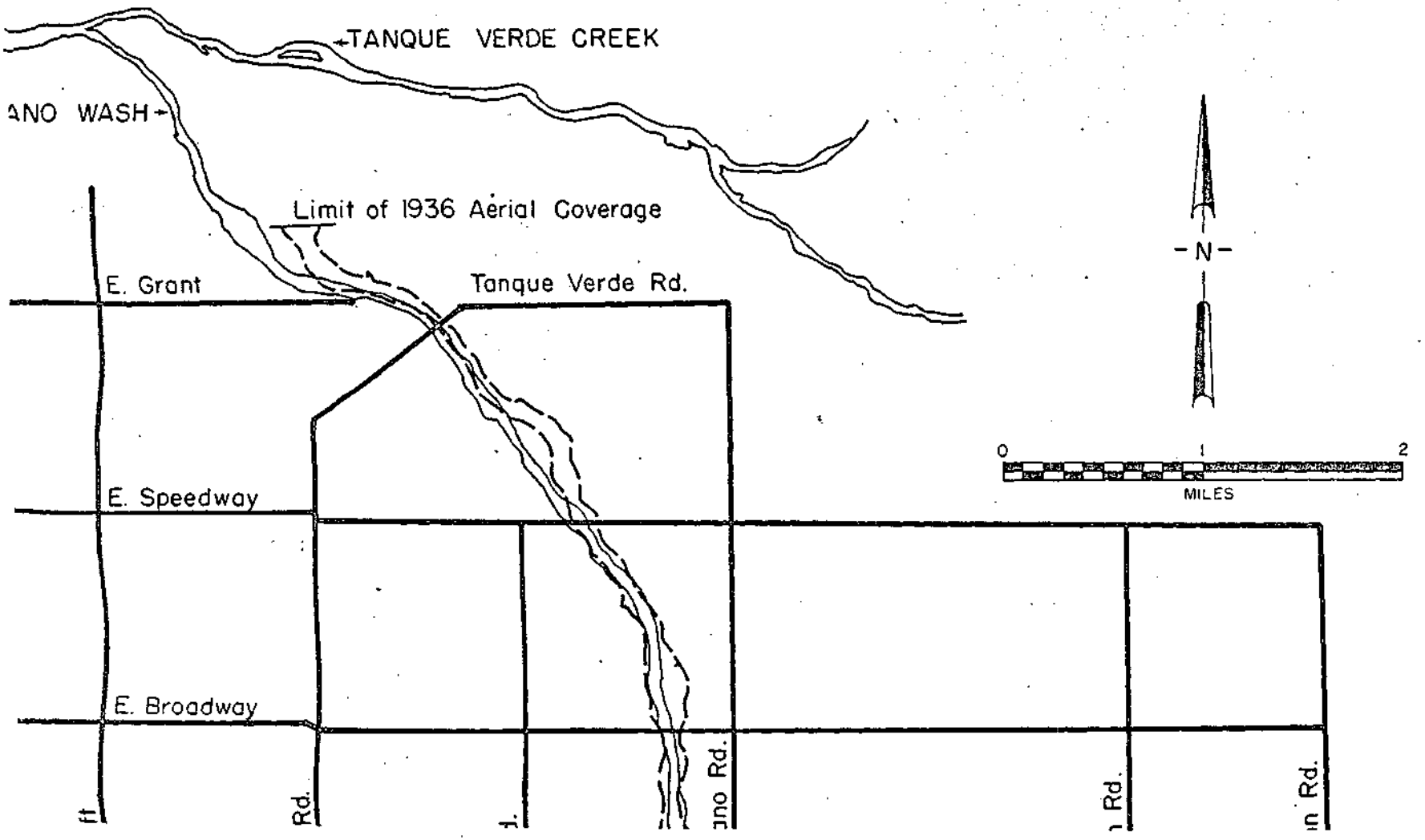
Funds for production of map provided to Office of Arid Lands Studies, University of Arizona by NASA Contract entitled "Application of Remote Sensing to State and Local Governments."

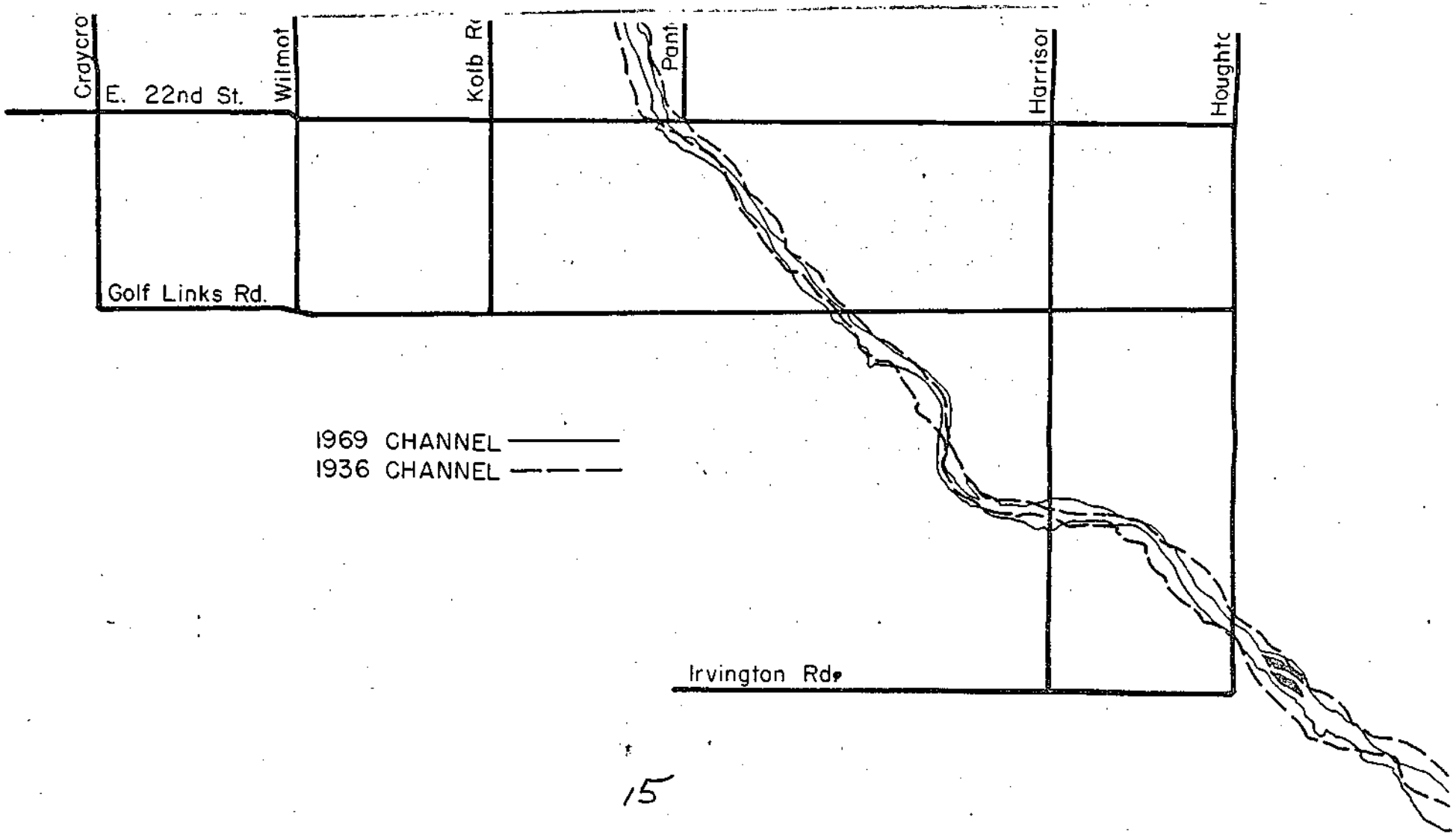
PLATE II

LOWER PANTANO WASH AREA

PIMA COUNTY, ARIZONA 1972

Office of Arid Lands Studies




Craycro
E. 22nd St.
Wilmot
Kolb Rd
Pant
Harrisor
Houghtc
Golf Links Rd.
1969 CHANNEL
1936 CHANNEL
Irvington Rd