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# NATURAL RESOURCES PROGRAM

## SPACE APPLICATIONS PROGRAMS

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TECHNICAL LETTER NASA-21

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U.S. Geological Survey  
Department of the Interior



UNITED STATES  
DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY  
WASHINGTON, D.C. 20242

Technical Letter  
NASA - 21  
June 1966

Dr. Peter C. Badgley  
Chief, National Resources Program  
Office of Space Science and Applications  
Code SAR, NASA Headquarters  
Washington, D.C. 20546

Dear Peter:

Transmitted herewith are 3 copies of:

TECHNICAL LETTER NASA-21

LAKE SURVEYING TECHNIQUES IN THE GEOLOGICAL SURVEY

PROGRESS REPORT\*

by

H. E. Skibitzke\*\* and C. J. Robinove\*\*\*

Sincerely yours,

William A. Fischer  
Research Coordinator for  
USGS/NASA Natural Resources Program

\*Work performed under NASA Contract No. R-09-020-009  
\*\*U.S. Geological Survey, Water Resources Division, Phoenix, Ariz.  
\*\*\*U.S. Geological Survey, Water Resources Division, Washington, D.C.

UNITED STATES  
DEPARTMENT OF THE INTERIOR  
GEOLOGICAL SURVEY

TECHNICAL LETTER NASA-21  
LAKE SURVEYING TECHNIQUES IN THE GEOLOGICAL SURVEY  
PROGRESS REPORT\*

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H. E. Skibitzke and C. J. Robinove

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Prepared by the Geological Survey  
for the National Aeronautics and  
Space Administration (NASA)

\*Work performed under NASA Contract No. R-09-020-009

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## Lake Surveying Techniques in the Geological Survey

by

H. E. Skibitzke and C. J. Robinove

### Introduction

Even though lakes are transient features in a geological sense, they are important hydrologic features. They act as storage reservoirs for water, sources of ground water recharge, sinks for evaporation, collectors of pollution, sediment, and vegetation and sources of water supply. The Geological Survey is one of many agencies investigating lakes and limnological problems. The rationale behind the lake studies involves a broad view of lake data to determine how it may be collected synoptically in a repetitive manner and analyzed in a meaningful way for water resource classification and management.

Lake studies have been carried out by the Geological Survey for many years but they have involved basically point measurements at individual lakes. These point measurements are difficult, if not impossible, to extrapolate to other lakes or lake regions. It is worthwhile, therefore, to develop means of collecting lake data over large areas in a meaningful way. Airborne measurements of significant lake data are a possible approach to the problem.

### Work to Date

Studies of airborne measurement at lakes are being carried out by the Phoenix research office of the Water Resources Division in several areas. They are listed below.

#### Lake Cachuma, California

Color photography with various filters to assess depth penetration of the water. A 24-hour airborne infrared radiometer survey to determine the diurnal variation in radiation over both land and water surfaces.

Definition of light penetration and turbidity of water.

Definition of water surface heterogeneity with respect to temperature and color.

## Great Lakes System

Color and infrared color photography to map mixing of pollutants at the water-surface boundary.

Infrared radiometry in Maumee Bay on Lake Erie.

## Great Salt Lake

Color and infrared color photography for identification of water surface color and identification of bottom features.

## Florida Lakes

Color and infrared color photography to map the stage of eutrophication of lakes and the color as an indication of biological and chemical character.

## Prairie potholes in North Dakota

Color and infrared color photography to aid in description of potholes as sources or sinks for ground water and their usefulness as wildlife breeding grounds.

## Sandhills Lakes in Nebraska

Color and infrared color photography to delineate lake characteristics significant in biological description of water bodies.

## Salton Sea

Color and infrared color photography to delineate mixing patterns in the water. Infrared radiometry to determine diurnal variation in water surface temperature. Light penetration and turbidity measurement.

## Minnesota Lakes

Color and infrared color photography to aid in description of lakes and their classification for water resource and recreational purposes.

## Outline of Comprehensive Report

A report on the lake surveying techniques is in preparation. Its tentative outline follows:

## Introduction

### Lake problems

- Lake level and water supply
- Choking by vegetation
- Contamination by chemical and bacterial changes
- Sedimentation
- Lake development in terms of human use

### Types of data to be collected

- Statistical
- Descriptive
- Point measurement

### Types of Lakes to be surveyed

- Natural lakes closely tied to the water table
- Impoundments of large size
- The Great Lakes
- Others that are a composite of types

## Factors shaping lake studies

### Large number of lakes

- Statistics are of little value to individual lake users

- Need for large amounts of information on many lakes prevents going into each lake

- Airborne measurements solve the problem of covering huge areas but create a problem in remote sensing

- Accurate point measurements extrapolated would have much less accuracy than measurements over a wide range interpolated

### Large size of some lakes

- Need measurements in a synoptic sense, which requires covering vast areas quickly and cheaply

- Airborne measurements with their complications become necessary



## Impounded lakes

Their nature requires much detail in relation to depth, involving:

- Conductivity measurements
- Temperature measurements
- Water sampling
- Bottom sampling
- Depth measurements (Sonar)
- Light penetration measurements (Secchi Discs)
- Transmissometer measurements

## Basic equipment

Land and water

Aerial

Aircraft

Cameras

- Mapping camera
- Sonne strip
  - 70mm
  - 9"

Films

- Color and black and white
- Infrared photo materials

Infrared sensors

- Radiometer (range and speed)
- Progress in plotting equipment

Vapor measurement systems under development

Demonstration aerial surveys

Extensive systems of lakes

Aerial photographs of selected areas in Florida, Minnesota, North Dakota, and Nebraska

Leads to area measurement  
Stage changes by comparing successive area measurements  
Chemistry, by color and infrared photos  
Plant activity by color photos and infrared  
Turbidity by measurement

#### Survey costs

Areas to be covered vs. height limitations

6000' for color  
Variable for infrared

Flying costs

Removal of topo specification because of type of  
data being collected

Costs of developing film and processing data

#### Data use

Index maps  
Photo availability  
Evaluation and report for area

#### Great Lakes system

Complete coverage in short times, particularly with respect  
to any measurement system going on

Measurement of activity (currents and chemistry) along  
lake surfaces wherein lie important boundary conditions

Turnover of lake or boiling action could only be defined by  
airborne measurement system

Turbulence limits point measurement

#### Demonstration surveys by boat

Data collected and techniques used on Lake Cachuma helpful in  
defining a valid approach

Critical control and guidance through concurrent airborne surveys  
for:

Boat placement

Defining water-surface heterogeneity with respect to  
temperature and color

Defining light penetration of water

Defining turbidity of water

Surveying the complete area rapidly at close time intervals

## ILLUSTRATIONS

Several illustrations of color and infrared color photographs are appended to show some of the data and data-collection methods. Because of the expense of reproducing the color photographs in quantity, they are reproduced in black and white in this report. The color photographs are on file in the Geological Survey, Water Resources Division, Washington, D. C.

1. Water transparency measurements at Lake Cachuma, Calif.
2. Mouth of Maumee River at Lake Erie.
3. Lake Color
4. Florida lake partially filled with vegetation
5. Delta at mouth of Alamo River in Salton Sea

REPRODUCIBILITY OF THE ORIGINAL PAGE IS POOR.

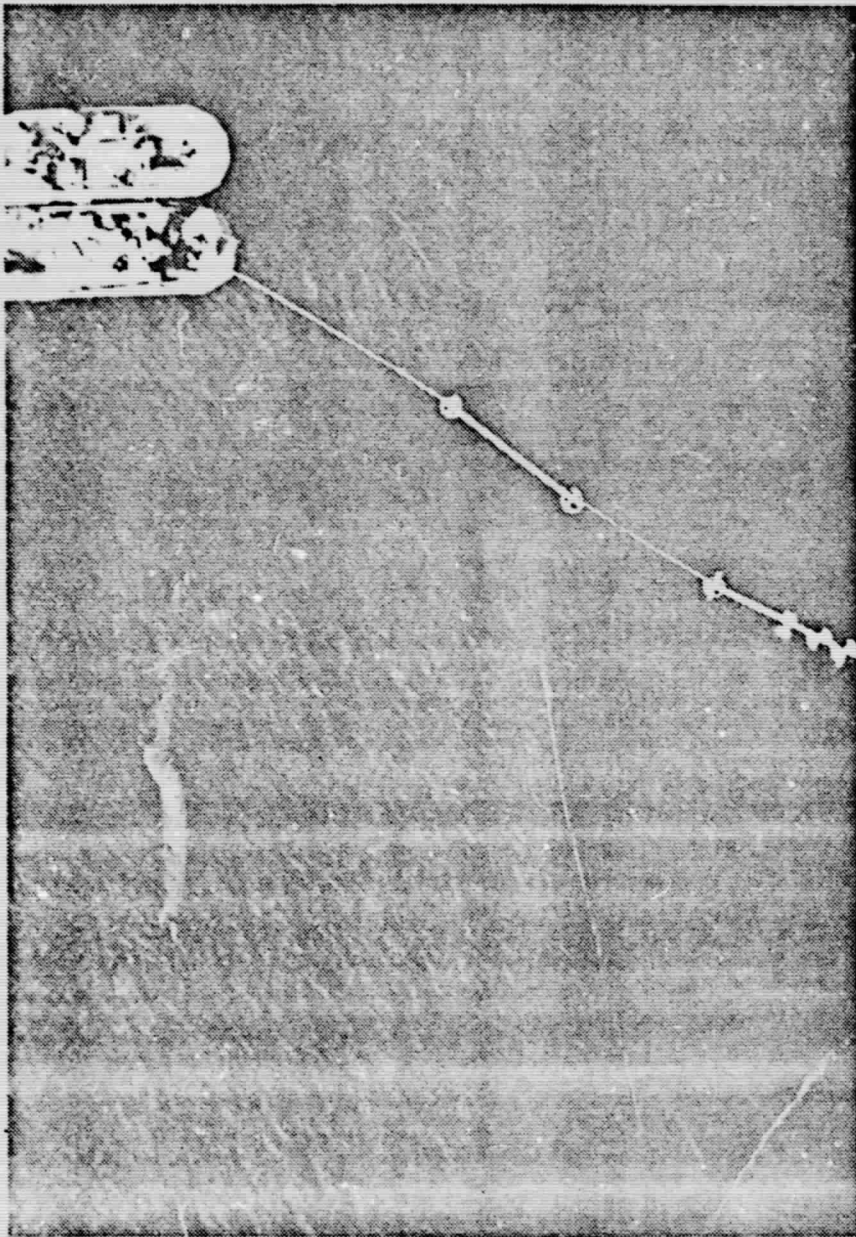


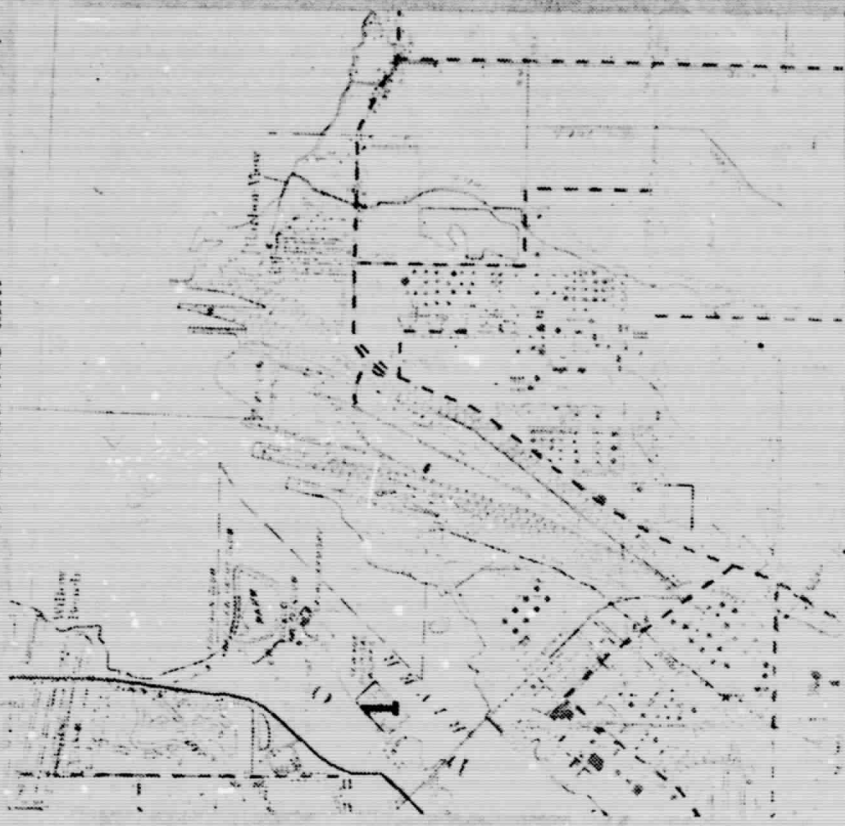
Figure 1. Water transparency measurements at Lake Cachuma, California. Secchi disks suspended at various depths in the water are photographed from aircraft. Three disks at the end of the boom are easily visible; the fourth (2 meters below the surface) is visible in the original photograph.

# MOUTH OF MAUMEE RIVER AT LAKE ERIE SHOWS WATER AND CULTURAL FEATURES ASSOCIATED WITH WATER POLLUTION

- 1. SEWAGE DISPOSAL PLANT
  - 2. SEWAGE EFFLUENT DISCHARGED INTO RIVER
  - 3. BREAKWATER THAT IMPEDES CIRCULATION OF EFFLUENTS INTO LAKE
- TOPOGRAPHIC MAP



1/2 MILE



1/2 MILE

PREPARED IN COOPERATION WITH THE U.S. GEOLOGICAL SURVEY

NASA SA66-15340





1/2 MILE

PREPARED IN COOPERATION WITH THE U.S. GEOLOGICAL SURVEY



1/2 MILE

## LAKE COLOR

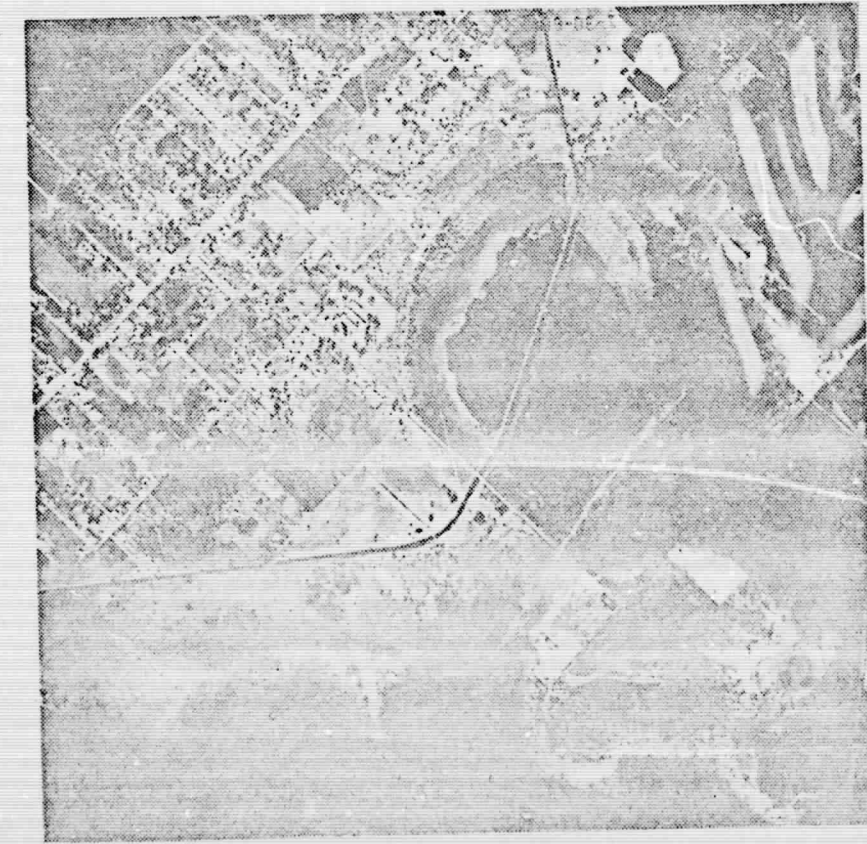
LAKES NEAR TAMPA,  
FLORIDA DIFFER IN  
COLOR DEPENDING ON  
CHEMISTRY, BIOLOGY,  
AND SEDIMENT LOAD  
OF THE WATER

EKTACHROME FILM

NASA SAGG-15339

**FLORIDA LAKE PARTIALLY FILLED WITH VEGETATION**  
**COLOR AND INFRARED COLOR PHOTOGRAPHS AID IN DESCRIBING THE TYPE AND DENSITY**  
**OF VEGETATION THAT GROWS DURING EUTROPHICATION OF LAKES**

ALTITUDE 5,000 FEET



**INFRARED**



**COLOR PHOTO**

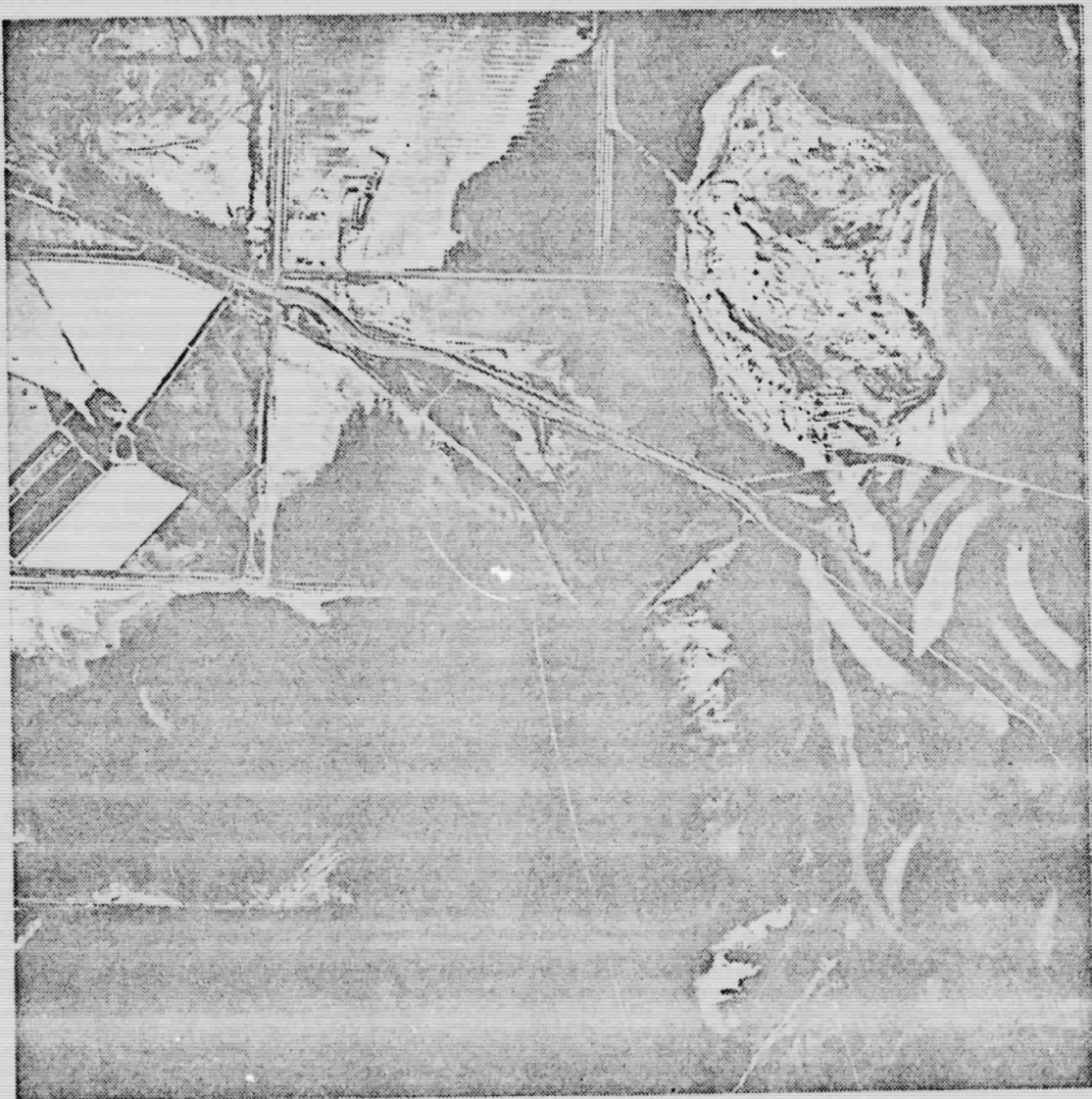
NASA SA66-15335

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REPRODUCIBILITY OF THE ORIGINAL PAGE IS POOR.

DELTA AT MOUTH OF ALAMO RIVER IN THE SALTON SEA HAS FORMED SINCE 1956  
SEDIMENTATION AND CULTURAL CHANGES ARE READILY MAPPED FROM AERIAL COLOR PHOTOGRAPHS  
YELLOW AREAS ARE SALT EVAPORATION PONDS



EKTACHROME FILM ALTITUDE 5000 FEET

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NACA CASE 15337