

**AIR PHOTO SURVEY OF COASTAL AREAS, UPOLU
AND SAVAII, WESTERN SAMOA**

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SUMMARY

At the request of the Government of Western Samoa, personnel from the SOPAC Technical Secretariat conducted a vertical air photo survey of portions of the islands of Upolu and Savai'i over the four days 19-22 February 1992. The air photo survey was conducted primarily to assist the Government of Western Samoa with recovery operations associated with the serious damage of coastal areas caused by cyclone Val in December 1991. In particular, the areas to be surveyed were requested after consultation with various government departments, particularly Public Works and Lands and Environment. Areas were selected for survey for a variety of reasons including: cyclone damage assessment, road reconstruction planning, assessment of existing and proposed nearshore sand mining sites, coastal environment conservation and tourism development planning. During the survey SOPAC personnel were assisted by staff from Lands and the Environment and the Apia Observatory.

The air photo survey was conducted using the SOPAC aerial photo camera (Hasselblad 553 ELX) which was mounted in a Britten-Norman Islander under local charter from Polynesian Airlines at Faleolo Airport. During the four days of suitable weather for aerial photography, 6 1/2 hours of flying time were needed to photograph approximately 150 km of coastline. A total of 376 colour photographs were obtained, each photograph covering a ground area of approximately 600 x 600 metres.

The rolls of negative film have been sent to Melbourne, Australia for developing and printing of contact proofs. Upon their return to SOPAC, colour photographs will be printed locally in Fiji at a scale of approximately 1:3,000 to provide high resolution images of nearshore and coastal features. A subsequent SOPAC report will document in detail the air photo survey track lines and series of photographs obtained. This air photo survey documentation report along with two sets of prints of the air photos will be available to the Government of Western Samoa in approximately one month (April 1992).

ACKNOWLEDGEMENTS

This work was carried out at the request of the Government of Western Samoa. While conducting field work in Western Samoa the support of the following personnel was greatly appreciated:

Steve Kamu - Acting Superintendent, Apia Observatory
Sam Toape - Field Assistant/Driver, Apia Observatory
Leo'o Polutea - Chief Photogrammetist, Department of Lands and Environment

Funds for this project were contributed by the New Zealand Government, the International Centre for Ocean Development (ICOD), Canada; the Australian International Development Assistance Bureau (AIDAB); and the UNDP/ESCAP RAS/86/125.

INTRODUCTION

SOPAC has been requested to do a number of work tasks in Western Samoa associated with coastal areas, including problems associated with damage from cyclone Ofa in 1990 (Rearic 1990), coastal resource mapping and management (Richmond 1991a, 1991b, 1991c, 1991d) and coastal erosion associated with nearshore mining of sand (Carter 1987, 1990, 1991; Holden 1991). Most of these tasks have required the use of air photos and have recommended further historical shoreline analysis using air photographs to identify rates and potential causes of shoreline erosion.

Following cyclone Val in December, 1991 the SOPAC Governing Council endorsed an air photo survey of Western Samoa as being particularly relevant since such a survey would have multipurpose objectives, all aimed at assisting with coastal development and management.

In early February, 1992 the SOPAC Deputy Director (Mr Jim Eade) visited Western Samoa to discuss priority areas for an air photo survey. During the week of 17-23 February a SOPAC team comprising a Coastal Geologist (Dr Rick Gillie), Chief Cartographer (Mr Phil Woodward) and Electronics Technician (Mr Peni Musunamasi) visited Western Samoa to conduct the air photo survey. A log of field activities during the week is contained in Appendix 1. Personnel from the Government of Western Samoa also took part in the survey (Appendix 2).

OBJECTIVES

This work task was undertaken as part of Project WS.5: "Coastal Development Studies". The specific objective of the air photo survey was to obtain low level, colour air photographs for segments of the Upolu and Savai'i coastlines. The priority areas were defined as follows:

- (1) northern Upolu, especially around Apia and to the east and west where the road is immediately adjacent to the coast;
- (2) northwest and north Savai'i, again where the road follows the coast and where cyclone damage was especially bad as a result of cyclone Val;
- (3) eastern Savai'i where sand resources suitable for roading have been identified by SOPAC;
- (4) the area around Mulifanua Wharf on western Upolu where there has been dredging and there are problems with siltation and erosion;

- (5) Aleipata wharf area on eastern Upolu were sand resources suitable for roading have been identified by SOPAC.

The areas were chosen taking into account the formal requests from SOPAC's official contacts in Western Samoa (Foreign Affairs and the Apia Observatory) and informal discussions in early February between the SOPAC Deputy Director and officers of Public Works and Lands and Environment.

METHODS, EQUIPMENT AND OPERATIONS

Prior to the survey team arriving in Western Samoa, the SOPAC Deputy Director had made a visit to the country to identify suitable target areas for the survey and a local aircraft to conduct the survey. The results of this initial visit were very useful. In particular, the identification and priority attached to proposed survey areas simplified any on-site decisions. The availability of the Britten-Norman Islander aircraft was ideal for the intended survey. A general description of the SOPAC vertical aerial photography capability is contained in Gillie (1991). The following methods, equipment and operations were used in the Western Samoa survey.

Flight Planning

On 18 February the weather was unfavourable for any type of flying with heavy rain and low clouds. A meeting at the Polynesian Airline's hangar between the SOPAC team and Polynesian staff confirmed that the camera frame and safety harness for the camera operator were acceptable.

The parameters of the air photo survey, such as flying height, photo scale, etc were determined before hand. These are summarised in Table 1.

Prior to each day's survey, flight lines were drawn on suitable maps at 1:25,000 or 1:20,000 scale. Before each flight the pilot was briefed on the area to be covered and an estimate was made of the time required to undertake the survey. In some cases, weather conditions caused survey activities to be aborted early. Weather problems arose because of low clouds, rain and turbulent cloud formations (Figure 1).

Table 1. Air Photo Survey Parameters.**Aircraft Flying Parameters**

Flying Height	:	3,500 feet (1,067 metres)
Flying Speed	:	100 knots
Photo Ground Coverage	:	589 x 589 metres
Distance Between Photos for 30% Endlap	:	421 metres
Interval Between Photos	:	8 seconds

Negative and Photo Enlargement Parameters

Negative Size	:	55 x 55 millimetres
Negative Scale	:	1:10,670
Enlargement Size	:	203 x 203 mm (8 x 8 inches)
Enlargement Scale	:	1:2,891

Summary Statistics

Flying time	:	6 hours, 33 minutes
Total Number of Photos	:	376
Total Length of Coastline Photographed	:	150 km



Figure 1. Oblique view from rear door of aircraft of the north coast of Upolu with the Mulinu'u Peninsula and Apia in the middle distance of the photo. The cloud base is at approximately 2,500 feet, which is below the design flying height of 3,500 feet, but the clouds are mostly located inland and do not obscure the coastline.

The importance of navigation was discussed in detail with the pilot. During the survey Dr Rick Gillie and Mr Phil Woodward alternated in the role as navigator and sat in the co-pilot seat to assist the pilot. A head set was provided for communications with the pilot. The camera was operated by either Mr Peni Musunamasi or Mr Leo'o Polutea. Communications regarding the start and end of a survey line and the number of photographs to be taken on a line were made by the navigator to the camera operator using a raised hand signal and numbered card. This proved to be quite simple and reliable. However, future surveys would benefit from an additional head set for communications with the camera operator.

Survey Aircraft

The Britten-Norman Islander is a twin engine aircraft (Figure 2) and is considered necessary for over water operations. It is commonly used in South Pacific island countries



Figure 2. Britten-Norman Islander aircraft chartered from Polynesian Airlines for the air photo survey. The camera is mounted outside of the rear door of the aircraft.

because of its short take off and landing capabilities. The aircraft can be flown safely at a speed of 100 knots with the rear door removed and its size offers greater stability over smaller aircraft and helicopters. Wind disturbance and noise in the interior rear of the aircraft was not a serious problem, although it is usually necessary for the camera operator to wear a light jacket and pants to prevent becoming chilled by the wind.

A safety harness comprising a body harness, short length of rope and locking hook which is attached to the seat frame is worn by the camera operator at all times. He is also secured by the aircraft seat lap belt. The safety harness is considered to be an essential item when the door of the aircraft is removed. The camera operator only needs to release the seat lap belt to raise and lower the camera mount and to change film magazines. During this period the safety harness restrains the operator from reaching the door.

Camera and Film

Details of the camera and film used are contained in Table 2. The camera has a motor drive and remote shutter release to advance the film. Each film magazine provides for up to 70 photographs. Each magazine contains a loaded and takeup film cassette. SOPAC presently has three film magazines allowing for up to 200 photographs during a flight. Additional film cassettes are available for re-loading magazines each day.

The camera was operated at its fastest shutter speed of 1/500 second. An aperture of f/4 was used for dull conditions (high overcast) and f/5.6 for bright conditions (full sun).

The film is only available from Australia or the United States in bulk rolls (30 metres) and is designed for aerial photography purposes. The film is developed in Australia and contact proofs are also printed there. After receipt of the negatives and contact proofs at SOPAC, printing of enlargements at a scale of 1:3,000 can be done in Suva.

Camera Frame

The camera frame is mounted to the floor and projects through the rear door opening of the aircraft (Figure 3). The frame actually consists of two parts: a floor frame which is designed to fit to the seat mounts of the Islander aircraft and the camera mount which has adjustments to level

Table 2. Camera and Film Specifications

Camera	:	Hasselblad model 553 ELX, with motor drive and 1.5 m remote shutter release cord
Lens	:	Zeiss, 100 mm Planar CF, f/3.5
Settings	:	Shutter = 1/500 sec Aperture = f/4 (dull) - f/5.6 (bright)
Negative Format	:	55 x 55 mm (2 1/4 x 2 1/4 inches)
Film Magazine	:	Roll film magazine 70
Film Type	:	KODAK AEROCOLOUR Negative Film 2445 Estar base, fine-grain colour-negative film for photogrammetric and general aerial use. Effective aerial film speed: 100. Purchased as 30 m rolls and loaded into 70 frame Hasselblad cassettes.
Film Purchase	:	Caines Photographic Distributors, Suva, Fiji Islands
Film Developing	:	United Photo and Graphic Services P/L, Factory 4/2 Apollo Court P.O. Box 407, Blackburn 3130, Australia

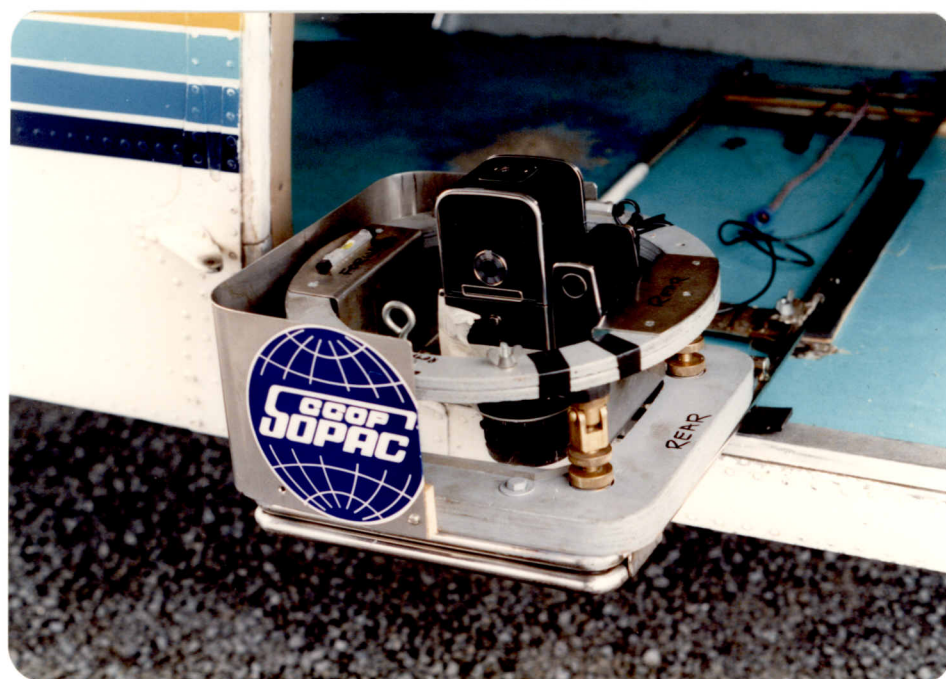


Figure 3. Camera mounted outside of the rear door of the aircraft. The frame is bolted to the rear seat mounts. The frame includes vertical adjustments to level the camera and a hinge to allow the camera to be withdrawn into the aircraft for film magazine changes.

the camera. It is also possible to hinge the camera mount portion of the frame into the aircraft for take off and landings and to change film magazines.

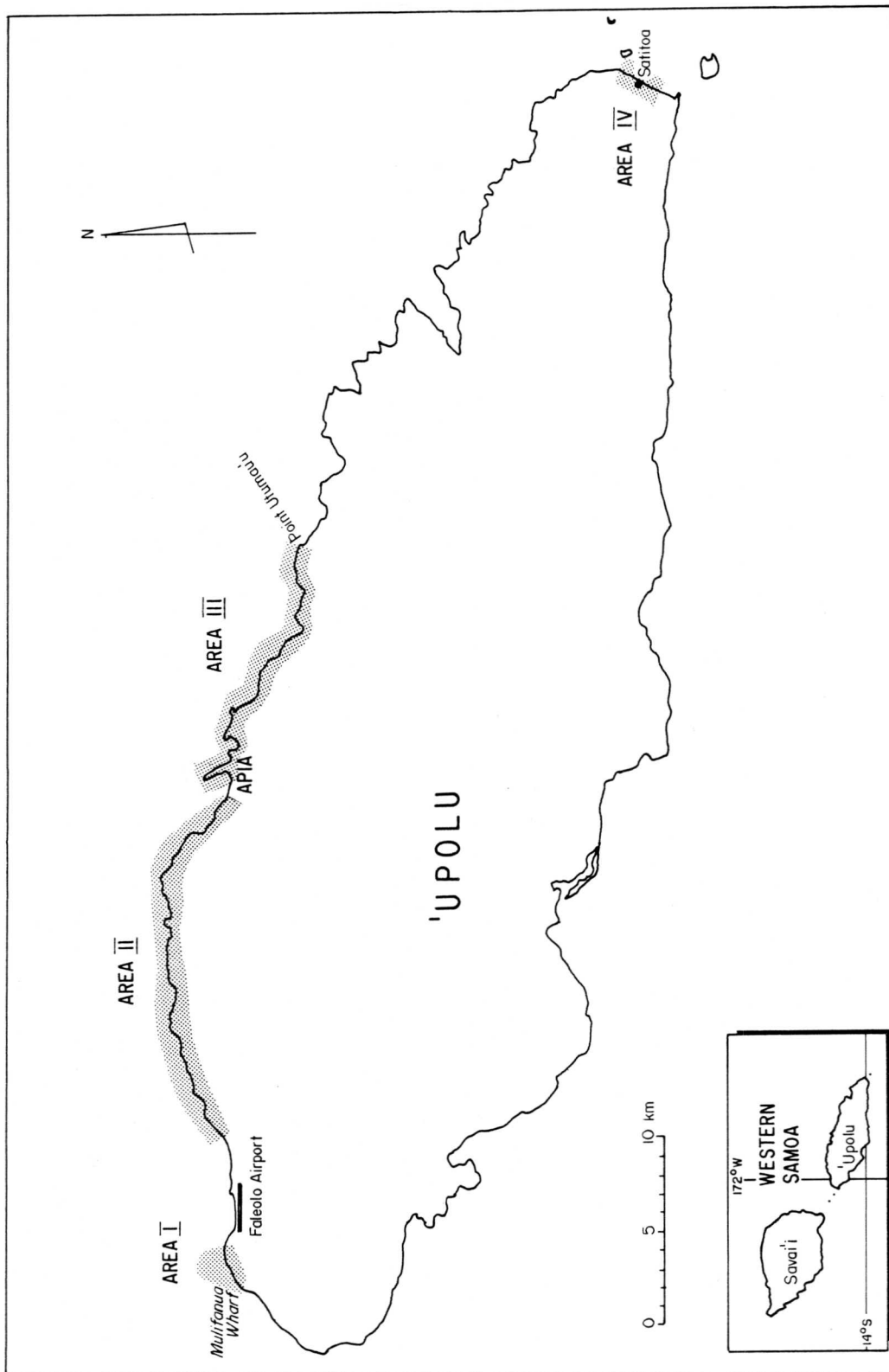
As the camera projects outside of the aircraft, it is not possible to site through the camera at the ground. However, it is eventually hoped to be able to use a small video camera and monitor to confirm photograph coverage while conducting the survey.

PRELIMINARY RESULTS

A summary of the areas and survey lines completed are contained in Tables 3 and 4, respectively for the islands of Upolu and Savai'i. The locations of the air photo survey areas are shown in Figures 4 and 5.

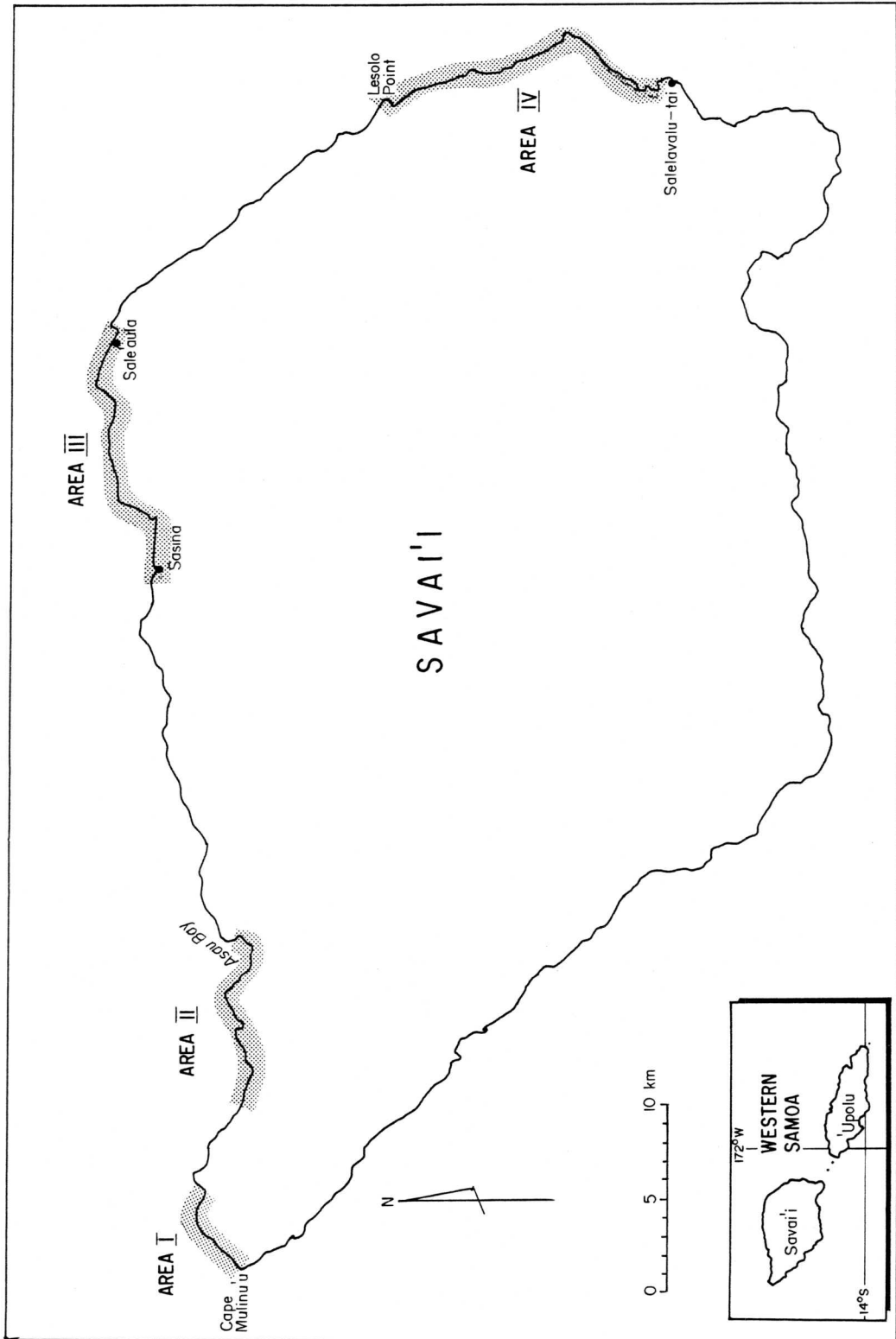
In total, during the four days of suitable weather for aerial photography, 6 1/2 hours of flying time were needed to photograph approximately 150 km of coastline. A total of 376 colour photographs were obtained during the survey. Each photograph covers a ground area of approximately 600 x 600 metres.

It is expected that the majority of photographs will be on the target line and suitable for enlargement. However, it is also expected that some will not be suitable for further use, either being over water or inland of the shoreline. On some lines clouds may also have obscured some of the ground images. All of the potential photographs will be evaluated by examination of the contact proofs. A final list of frames suitable for enlargement and printing will then be prepared. In addition, a report documenting all survey areas, track lines and photographs will be prepared with accompanying maps at a scale 1:20,000 to properly document and archive the results of the air photo survey. The documentation report along with two sets of prints of the air photos will be sent to the Government of Western Samoa. The negatives, contact prints and one set of prints will be archived at SOPAC in their Air Photo Library.



SOPAC WS92.1

Figure 4. Location of air photo survey areas on Upolu. Refer to Table 3 for survey lines in each area.



SOPAC.WS92.2

Figure 5. Location of air photo survey areas on Savai'i. Refer to Table 4 for survey lines in each area.

Table 3. Summary of Air Photo Survey Lines on Upolu.

Area and Lines	Number of Frames
AREA I	
Mulifanua Wharf, Line 1	6
Mulifanua Wharf, Line 2	5
Mulifanua Wharf, Line 3	5
AREA II	
Nofoali'i	7
Fasito'outa	9
Tufulele	12
Sale'imoa, Line 1	8
Sale'imoa, Line 2	8
Afega, Line 1	10
Afega, Line 2	10
Apia Concrete, Line 1	16
Apia Concrete, Line 2	16
AREA III	
Mulinu'u Peninsula, Line 1	9
Mulinu'u Peninsula, Line 2	9
Apia Harbour, Line 1	6
Apia Harbour, Line 2	7
Moata'a, Line 1	8
Moata'a, Line 2	9
Apia East	7
Vailele	5
Letogo	7
Lauli'i	6
Luatuanu'u, Line 1	14
Luatuanu'u, Line 2	14
AREA IV	
Satitua, Line 1	6
Satitua, Line 2	6

Table 4. Summary of Air Photo Survey Lines on Savai'i.

Area and Lines	Number of Frames
AREA I	
Falealupo	10
Cape Vaitoloa	6
AREA II	
Papa	8
Sataua	6
Vaisala	7
Auala	6
Asau	6
AREA III	
Fagae'e	10
Samauga	7
Safotu	8
Manase	6
Lelepa	5
Sato'alepai, Line 1	9
Sata'olepai, Line 2	5
AREA IV	
Pu'apu'a, Line 1	6
Pu'apu'a, Line 2	6
Lano	10
Sa'asa'ai	6
Faga	9
Sapapali'i	10
'Iva	5

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APPENDIX 1

LOG OF FIELD ACTIVITIES

18 FEBRUARY 1992 (Fiji)

- Rick Gillie, Phil Woodward and Peni Musunamasi travel Suva to Nadi to Apia, Western Samoa.

17 FEBRUARY 1992 (Western Samoa)

- Met at Faleolo Airport, Western Samoa by Leo'o Polutea (Department of Lands and Environment) and Sam Toape (Apia Observatory). Drive to Apia.
- Meeting at Polynesian Airlines office with Shane Le Gale (Chief Domestic Pilot) to discuss flight planning and scheduling of aircraft use. The aircraft is available for SOPAC use between 10:00 and 14:00 each day.
- Check-in Hotel Kitano Tusitala.

18 FEBRUARY 1992

- Telephone call from Shane Le Gale (Islander Pilot) regarding flight planning. Weather is forecast as rain showers for the day. Arrange to meet at airport hanger at 12:00 anyway.
- Visit to Lands and Environment. Examine Hasselblad camera owned by Lands and review additional components (motor drive, remote shutter release) required to conduct air photo surveys
- Visit to Apia Observatory
- Meet with Islander Pilot at airport hanger. Moderate rain showers and low cloud ceiling. Demonstrate use of camera, mounting frame and safety harness in hanger. Arrange for telephone call each morning from pilot to plan day's activities.
- Return to Tusitala. Moderate rain and low clouds for rest of day.

19 FEBRUARY 1992

- Rain has ended and weather improved. Mostly high overcast and calm.
- Arrive airport mid-morning and install camera frame and camera. Run through air photo procedures with SOPAC personnel and pilot. Review flight plan with pilot.
- Conduct air photo survey of north coast of Upolu east of Faleolo Airport between Nofoli'i and Sale'imoa, along Mulinu'u Peninsula in Apia and at Mulifanua Wharf at the west end of Upolu. Total flying time was 1:40.

20 FEBRUARY 1992

- Weather high overcast. Plan to fly Savai'i areas. Request Administration Officer at Apia Observatory to make brief radio announcement to the public regarding the purpose of the Islander flights over Savai'i.
- Arrive airport. Islander not available until later. Decide to conduct air photo survey of remainder of north coast of Upolu. Heavy thundershow cloud build-up over Savai'i later in day.
- Conduct air photo survey of coast east of Apia including Apia Harbour to Lau'i'i. Also survey east end of Upolu at Satitua. Total flying time was 1:33.

21 FEBRUARY 1992

- Weather partly overcast. Plan to survey Savai'i.
- Take-off from airport at 10:45 and arrive west end of Savai'i approximately 11:15.
- Survey portions of northwest, north and east coast of Savai'i. Total flying time was 2:20.

22 FEBRUARY 1992

- Weather mostly clear with less than 10% high cloud cover.
- Survey remaining portions of north coast of Upolu east and west of Apia. Return to Faleolo Airport by south coast of Upolu. Total flying time was 1:00.

23 FEBRUARY 1992

- Return to Fiji late in day.

APPENDIX 2

PERSONNEL PARTICIPATING IN THE SURVEY

SOPAC Technical Secretariat

Rick Gillie	Coastal Geologist
Phil Woodward	Chief Cartographer
Peni Musunamasi	Electronics Technician

Government of Western Samoa

DEPARTMENT OF LANDS AND ENVIRONMENT

Leo'o Polutea	Senior Photogrammetrist
Godfrey Day	Senior Surveyor

APIA OBSERVATORY

Steve Kamu	Acting Superintendent
Sam Toape	Field Assistant/Driver

Polynesian Airlines

Shane Le Gale	Chief Domestic Pilot
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