

**COASTAL MAPPING PROGRAM**

**PROJECT AK9702D  
COMPLETION REPORT**

**ALASKA  
ZIMOVIA STRAIT**

**A Photogrammetric Survey based  
on 1997-98 Aerial Photographs**

**UNITED STATES DEPARTMENT OF COMMERCE  
National Oceanic and Atmospheric Administration  
National Ocean Service  
National Geodetic Survey  
Remote Sensing Division**

**Agency Archive Copy**

REMOTE SENSING DIVISION  
COASTAL MAPPING PROGRAM

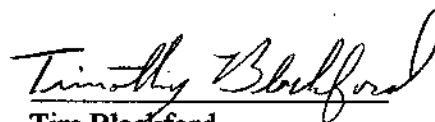
PROJECT AK9702D  
COMPLETION REPORT

ALASKA  
ZIMOVIA STRAIT


Clearance

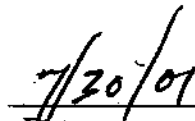
This report summarizes the photogrammetric operations related to project completion and is submitted for approval. The project data and this report meet the requirements and standards of the Remote Sensing Division's Coastal Mapping Program.

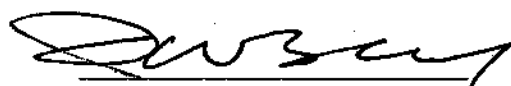
Submitted by,

  
Tim Blackford  
Applications Branch

Approved:

  
Robert W. Rodkey  
Chief, Applications Branch

  
Date

  
Captain Jon W. Bailey, NOAA  
Chief, Remote Sensing Division  
National Geodetic Survey, NOS, NOAA

  
Date

COMPLETION REPORT  
COASTAL MAPPING PROGRAM  
PROJECT AK9702D  
ALASKA  
ZIMOVIA STRAIT

TABLE OF CONTENTS

Clearance.....	ii
Introduction.....	1
Planning.....	1
Field Operations.....	1
Aerotriangulation.....	2
Compilation.....	2
Final Review.....	2
Project Final Data & Products.....	3

DIAGRAMS

1. Photo Strip Coverage (Color).....	9
2. Photo Strip Coverage (IR).....	10
3. Project Coverage.....	11
4. Relative Error Ellipses (Color).....	12
5. Relative Error Ellipses (IR).....	13

APPENDICES

A. GPS Report.....	4
B. Aerotriangulation Report.....	7
C. Data Compilation Sources.....	14
D. DCFF Plot of Project Area.....	15

# **COASTAL MAPPING PROGRAM**

## **AK9702D**

### **PROJECT SUMMARY**

#### **Introduction**

Project AK9702D provides highly accurate, digital shoreline data of the Zimovia Strait and surrounding region, covering an area ranging from 56deg 38min to 56deg 02min North latitude, and 131deg 52min to 132deg 43min West longitude. Area includes the eastern shoreline of Etolin Island, the northern and western shorelines of Wrangell Island, the northeastern shore of Zarembo Island, Woronofski Island, and all other smaller islands in and around the Dry Strait. Refer to project diagram located in Appendix D.

The outcome of this project resulted in the densification of control for the National Spatial Reference System (NSRS), a set of controlled metric quality aerial photographs and digital cartographic feature files (DEFF) of the coastal zone which meet the requirements of the NOAA Coastal Mapping Program.

The project database consists of information measured and extracted from digital scans of aerial photographs and metadata related to photogrammetric compilation. Base mapping was conducted in a digital environment using digital photogrammetry and associated cartographic practices. Project survey data is referenced to the North American Datum 1983 (NAD83).

#### **Planning**

The Requirements Branch, Silver Spring Office, formulated photographic requirements for this project. Planning operations included establishing flight strips and aerial photography schedules.

#### **Field Operations**

No ground control (panels) were established prior to aerial photographic operations. To establish a control network necessary for aerotriangulation, airborne kinematic GPS data was processed to determine precise camera positions. Refer to GPS Processing Report located Appendix A for details.

Aerial photographic survey operations acquiring natural color and panchromatic photographs were conducted in August 1997. Infrared photographs were acquired in May 1998. The aerial photographic platform was the NOAA Cessna Citation II (N52RF) aircraft which contained a Wild RC-30 camera system with the NOS "A" lens cone. Six strips of natural color, two strips of panchromatic, and seven strips of infrared photographs were acquired at the nominal scale of 1:40,000.



## **Aerotriangulation**

Digital aerotriangulation methods were applied to establish a network of precise GPS camera positions and other control for mapping and to provide model parameter and orientation elements required for digital compilation. This work was completed by the Applications Branch, Silver Spring Office in March 2001. Refer to the Aerotriangulation Report in Appendix B for further discussion pertaining to this phase of operation. This report describes the overall operations that were performed during this phase, including an accuracy statement detailing the overall fit to control.

Measurements were made utilizing a digital photogrammetric workstation (DPW), which is a hardware configuration containing a suite of digital photogrammetric SocetSet software modules. Analytical adjustments to the measurements were effected using the ORIMA software triangulation module.

## **Compilation**

Routine program requirements applied for the feature extraction phase.

Data compilation consisted of digital base mapping and the construction of supplemental data for the Nautical Charting Program. This work was accomplished by the Applications Branch in Silver Spring, Maryland from January 2001 through May 2001. Digital mapping of project cartographic data was accomplished via the Feature Extraction module of the Socet Set suite of software.

Cartographic features were compiled using the aerotriangulated 1:40,000 natural color, panchromatic, and infrared photographs. The source photographs used to compile each strip are presented in the Data Compilation Sources page in Appendix C.

The project was compiled to meet 3.6 meters horizontal accuracy (5.0 meters in infrared) at a 95 % confidence level. This predicted accuracy of well-defined points is a deductive estimate based on triangulation statistics.

## **Final Review**

The final office review was completed in July 2001. The digital cartographic feature files were evaluated for completeness and compliance to established NOS accuracy standards. Digital cartographic feature attribution conforms with CCOAST (version 5, dated 7/5/00).

Nautical charts used for comparison with the dcff data include: Chart 17382 Zarembo Island and Approaches 1:80,000, Chart 17384 Wrangell Harbor and Approaches 1:20,000, and Chart 17385 Ernest Sound-Eastern Passage and Zimovia Strait 1:80,000. The results of the comparison can be examined by reviewing the Chart Maintenance Prints (CMP).

## **Project Final Data and Products**

### Agency Archive

- Original Project Completion Report

### Photogrammetric Electronic Data Library

- Project Database
- Digital Cartographic Feature File GC-10493
- Copy of DCFF in Shape File format

### OCS Marine Chart Division

- Chart Maintenance Print
- Abbreviated Copy of PCR
- Note: A partial dcff was released as preliminary to the OCS Hydrographic Surveys Division, to support hydrographic survey operations in the project area in Spring 2001. The final dcff supercedes the partial, preliminary dataset.

## APPENDIX A

4

# AK9702

## Ketchikan and N. Clarence Strait Alaska

GPS Processing Report  
February 2000

### INTRODUCTION

The Global Positioning System (GPS) data referred to in this report was processed to provide precise positions of camera centers, to be used as photogrammetric control in the aerotriangulation phase of the Coastal Mapping Program project AK9702 - Ketchikan and Northern Clarence Strait, Alaska. The datasets processed and the aerial photography covered by those datasets are listed in the table below:

Dataset	Date	Project(s)	Description / Flight Lines
97KTN221	8/9/97	AK9702	40-8, 9, 12, 10, 11, 31, 32, 18, 19, 20
97KTN222	8/10/97	AK9702	40-26, 27, 28, 29, 16, 13, 15, 17, 21, 22
97KTN228	8/16/97	AK9702 & OC6053	40-14, 25, 30, 23, 24; 30-1, 2, 3

### DATA COLLECTION

GPS data was collected in August 1997, as detailed in the table above. The procedures followed are described in the GPS Controlled Photogrammetry Field Operations Manual, of Jan. 2, 1996. All data was collected using Trimble 4000SSI geodetic receivers. At the start of the project a PK-nail was set in a convenient location at Ketchikan International Airport (KTN) in Ketchikan, AK, and given the designation PKTN. The three kinematic surveys were all conducted with the rover receiver in the NOAA Cessna Citation II (N52RF) aircraft, and the reference receiver was connected to a Trimble Compact L1/L2 antenna with Ground Plane and set up on a 2 meter fixed height tripod over PKTN. The base station data from the first kinematic session was also used with CORS data for static positioning of the PK-nail.

The first session (97KTN221) was of about 3 hours 45 minutes duration for the combined data (5:23 for the static data alone) with a measurement interval of 1 second. Ten flight lines were flown, and 140 photo events were recorded. Event #128 (corresponding to photo #2070) was not recorded in the Trimble receiver data file, but it was captured by the EDILOGR software. No problems were reported by the field personnel in the observation log.

The second session (day 222) resulted in almost 5 hours of 1second kinematic data. Eleven lines were flown, and 190 photo events were recorded. No problems were reported by the field personnel in the observation log.

The third session (day 228) was a 3 hour and 35 minute kinematic survey at a 1 second epoch interval. Four lines of coastal photography were acquired at 20,000 ft. and three lines were flown over the Ketchikan Airport (OC6053). Overall, 95 photo events were recorded, with no problems reported.

All observed data was downloaded from the receivers to a portable computer. At the end of each week the data files were copied to zip disks and forwarded to headquarters for processing. Upon receipt in the office, the datasets were backed up to optical disk and project folders were created for each session. As it became available, additional data was downloaded from the network for use in the processing stage. This supplementary data included NGS precise ephemeris files for each session, and FIF files for the film rolls.

### REFERENCE RECEIVER POSITIONING

Static GPS data from the nearest CORS station (AIS1) and base station data from the first kinematic session were processed in August 1997 using NGS's OMNI (ver. 22Jan96) software. The static data was divided into two 2-hour sessions. Two independent ion-free fixed baseline solutions were computed, and the baselines were then averaged to produce the final coordinates for PKTN (NAD83 epoch 1996.0):

Latitude:	55° 21' 24.99344"
Longitude:	131° 42' 40.05341"
Ellipsoidal Height:	6.2942 m.

### KINEMATIC PROCESSING

The first dataset, 97KTN221, was processed in March 1999 using Trimble GPSurvey (ver. 2.30), and utilizing the NGS computed precise satellite ephemeris, and standard meteorologic data. A continuous kinematic ion-free phase solution was obtained. The RMS of the phase residuals generally ranged around 1-3 cm throughout the roving part of the survey. The average ion-free RMS for the session was 1.5 cm. The RDOP value varied between 1.5 and 3.0 throughout the session. The product, RMS x RDOP (which is a reasonable estimate of the mean square positional error), generally varied between 1 and 6 cm, averaging about 4 cm.

The second dataset, 97KTN222, was processed in November 1999 using GPSurvey, but a solution could not be obtained. The raw data was then converted to RINEX format and an attempt was made to process the dataset using NGS's KARS (ver. 3/28/95) software, but that attempt was unsuccessful as well. The data was forwarded to the Geosciences Research Division for analysis. The GRD determined that the data was somewhat corrupted, in that there were several brief gaps in the data scattered throughout the session. KARS could not handle these gaps, but GPSurvey should be able to process through them. They suggested importing the data into GPSurvey in RINEX format instead of the raw form. This was tried, and a weak, but complete solution was obtained in January 2000. The RMS of the phase residuals varied wildly between 5 and 20 cm. The average ion-free RMS for the session was 10.1 cm. The RDOP value varied between 2 and 3 until 22:56 when it jumped above 7. Fortunately this was right at the end of a flight line, and the RDOP quickly dropped. By the time the next line started the RDOP was down to about 4, and continued to drop to 3, and finally 2, where it hovered until the end of the roving segment. The product, RMS x RDOP generally varied between 10 and 45 cm (averaging about 25 cm), except for the brief period between strips when it peaked just under a meter.

The third dataset, 97KTN228, was processed in January 2000 using GPSurvey, and utilizing the precise ephemeris, and standard meteorologic data. Again the data was not very clean, and a good solution for

the entire session could not be obtained. However, only the first strip was required for the sub-project being aerotriangulated. So the processing time was set to stop at 21:15, just after the third strip. A continuous kinematic ion-free phase solution was obtained. The RMS of the phase residuals generally ranged around 1-3 cm throughout the period. The average ion-free RMS for the session was 1.3 cm. The RDOP value varied between 1.5 and 3. The product, RMS x RDOP (which is a reasonable estimate of the mean square positional error), generally varied between 2 and 8 cm, averaging about 3 cm.

The project file, AK9702, on file in the RSD GPS Archive contains a copy of this report, and folders for each session containing detailed solution documentation, including plots of RMS and RDOP, solution diagrams (network maps), and field observation logs.

## APPENDIX B

## **AEROTRIANGULATION REPORT**

**AK9702D**

**Zimovia Strait**

**May 2001**

### **AREA COVERED**

The project area is located around several land areas, between latitudes 56deg 38min and 56deg 02 min North, and longitudes 131 deg 52min and 132deg 43min West. These include: the northeastern shore of Zarembo Island, from Craig Point to South Craig Point; Woronkofski Island; the eastern shore of Etolin Island, from the Chicagof Pass to Menefee Point; the western and northeastern shore of Wrangell Island, from the City of Wrangell to Thom's Point; the western shore of the mainland, from the Stikine River delta to Mill Creek; and the south entrance to the Dry Strait, and islands within (Vank, Sokolof, Rynda, Greys, Kadin, Liesnoi, and Fivemile). See the Project Coverage Diagram in this report for depiction of these areas.

### **PHOTOGRAPHY**

The photographs used in the aerotriangulation phase of this project consisted of six strips of color (taken at varying tide levels, from 5.5 feet to 12.5 feet above MLLW), two strips of panchromatic (taken near high tide, 12.7 feet above MLLW), and seven strips of IR, tide-coordinated at MLLW.

All IR photographs were acquired eight months after the color photographs. The layout of flight lines is shown in the Project Strip Coverage diagram contained in this report. All strips were acquired at a nominal scale of 1:40,000, using the NOS-A camera, with a total of one-hundred and fifty-six photographs bridged. See the Data Compilation Sources table in Appendix C of the PCR for further details.

### **CONTROL**

No horizontal ground control stations (panels) were established prior to the collection of photographs. All color and pan photographs were controlled using airborne kinematic GPS positioning techniques with sufficient accuracy to control the adjustment. Refer to AK9702D GPS Processing Report in Appendix B for further information on the techniques used.

### **METHOD**

All photographs were bridged using digital aerotriangulation methods to establish the network of photogrammetric control required for the compilation phase. Measurements were made utilizing a digital photogrammetric workstation, and the associated software and hardware configuration designated as SOCET SET. All color, panchromatic strips, and IR-strip #21 were tied together as a single block,



while all other IR-strips were tied together as a separate block, using adjusted ground point data—derived from locations visually identified by the cartographer—as control.

The RMS of the standard deviations of the residuals for each triangulated ground point was calculated using the ORIMA software triangulation module. These values were used to compute a predicted horizontal circular error of 1.8 meters for the Color block, and 2.5 meters for the IR block, based on a 95% confidence level.

Final RMS values, errors, and all image iterations data can be found in the printout.0 file in the AK9702D database. (See orima\_color\_final folder for color block data and orima\_IR\_final folder for IR block data).

### PROJECT DATABASE

A project database was created under the reference number AK9702D and includes the following:

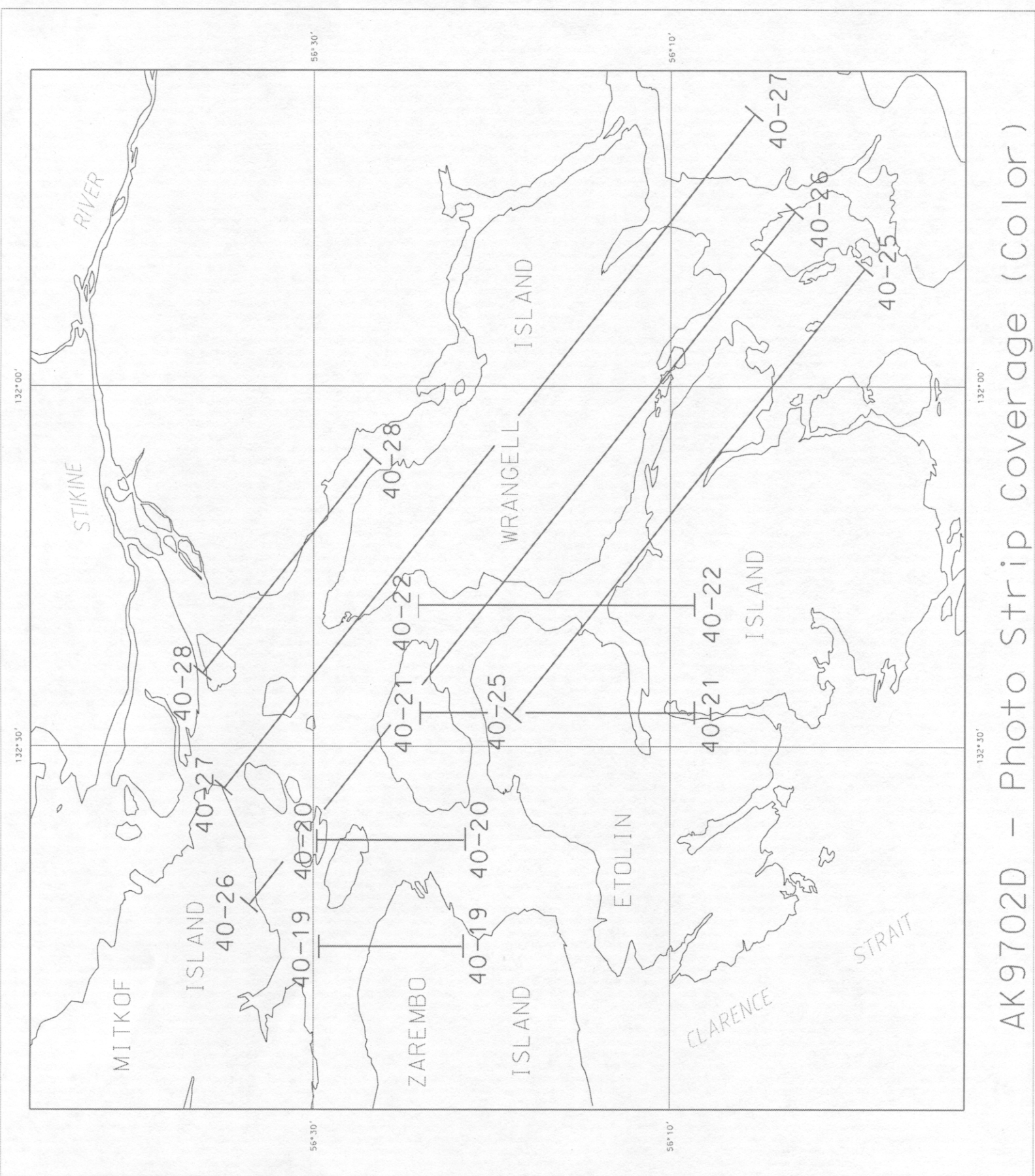
- Airborne GPS Control
- Camera Calibration Data
- Exterior Orientation Parameters
- Frame Numbers by Strip
- Interior Orientation Parameters
- Positional Listing of All Points Used in the Project
- Project Parameters & Options

Positional data is based on the North American Datum 1983 (NAD83), and is referenced to the Universal Transverse Mercator Projection (UTM), zone 8N.

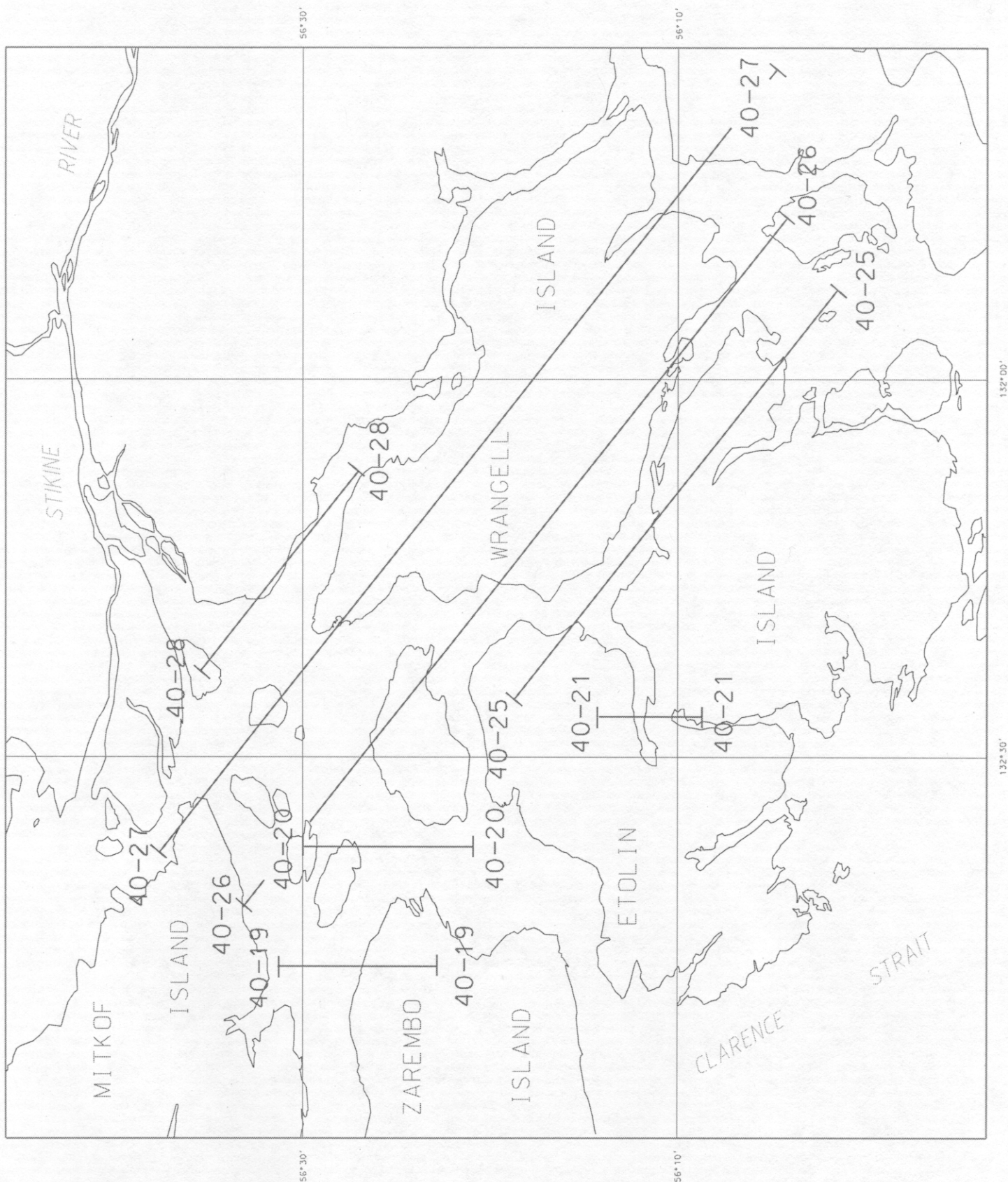
Approved and Forwarded:



Robert W. Rodkey  
Chief, Applications Branch

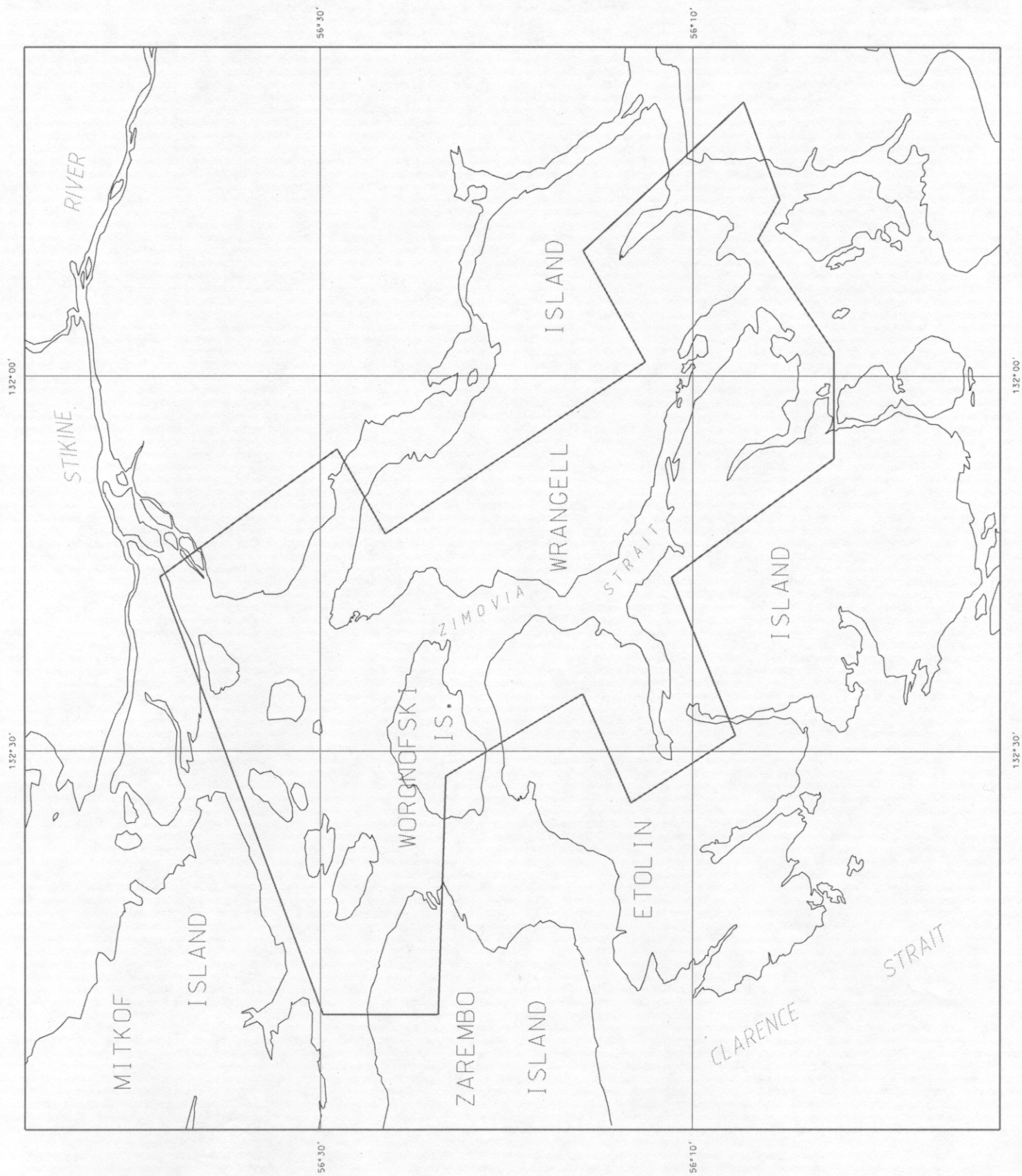


AK9702D - Photo Strip Coverage (Color)



AK9702D - Photo Strip Coverage (IR)





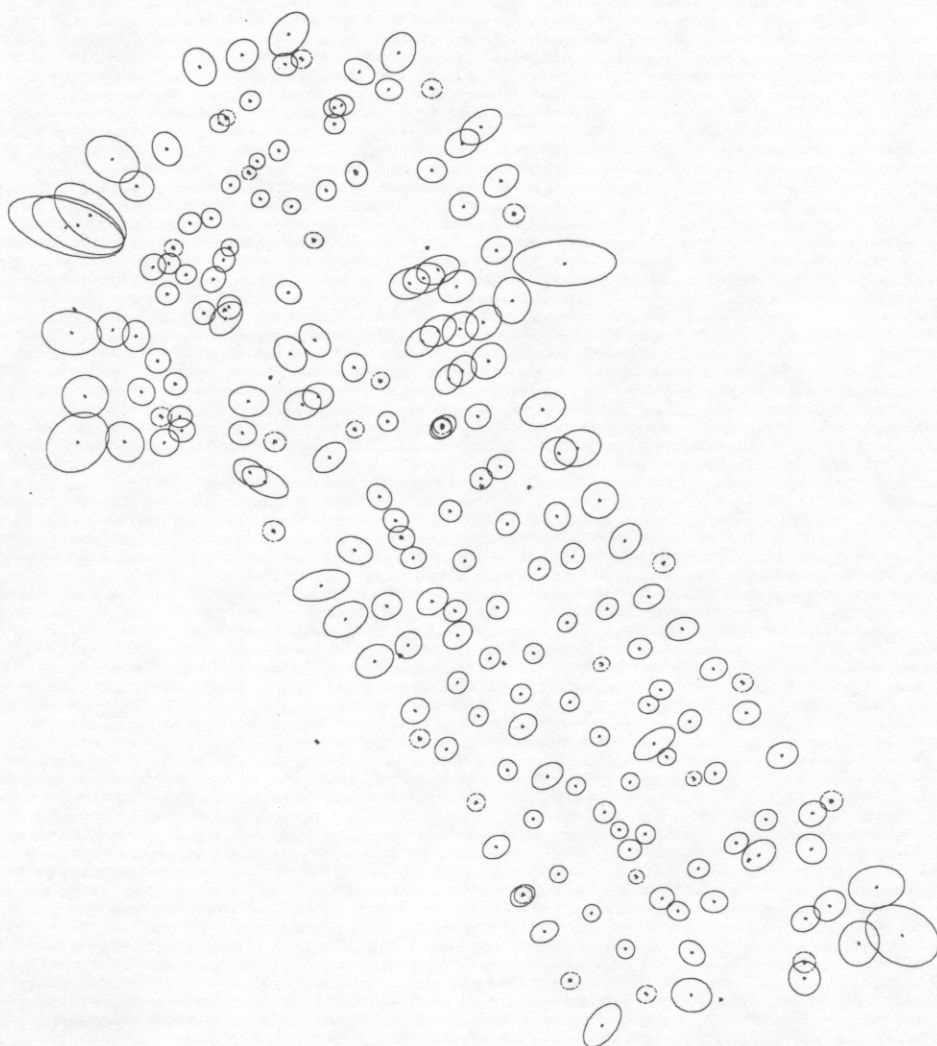
AK9702D - Project Coverage



CNP-A Signed: 1.62  
Control Point:  
RMSE-U: 0.000  
RMSE-V: 0.000  
RMSE-Z: 0.000

### GC 10493 ZIMOVI STRAIT - Relative Error Ellipses (Color)





CAP-A Sigma: 15.8  
 Center Point:  
 RMSE: 0.006  
 RMSE-Y: 0.005  
 RMSE-Z: 0.004

# **GC 10493 ZIMOVIA STRAIT - Relative Error Ellipses (IR)**

## APPENDIX C

# DATA COMPILATION SOURCES

**PROJECT: AK9702D**

## PHOTOGRAPHY

	DATE	TIME (UTC)	ROLL #	PHOTO #	SCALE	TIDE LEVEL*
Strip 13	8-09-1997	2351-2353	97ACN11	2051-2055	1:40,000	3.75m
12	8-10-1997	0011-0012	97ACN11	2082-2086	1:40,000	3.93m
16	8-10-1997	2131-2141	97ACN11	2090-2110	1:40,000	1.61m
17	8-10-1997	2152-2202	97ACN11	2116-2136	1:40,000	1.88m
18	8-10-1997	2212-2214	97ACN11	2139-2144	1:40,000	2.10m
21	8-10-1997	2355-2359	97ACN11	2249-2257	1:40,000	2.61m
22	8-11-1997	0023-0027	97AP02	2261-2268	1:40,000	3.56m
25	8-16-1997	2052-2057	97AP02	2465-2476	1:40,000	4.10m
119	5-15-1998	1912-1914	98AR03	1808-1811	1:40,000	0.07m
120	5-15-1998	1933-1934	98AR03	1837-1840	1:40,000	0.31m
125	5-15-1998	1944-1948	98AR03	1843-1853	1:40,000	0.51m
128	5-30-1998	1831-1833	98AR03	2033-2038	1:40,000	-0.30m
129	5-30-1998	1838-1848	98AR03	2041-2061	1:40,000	-0.33m
130	5-30-1998	1855-1904	98AR03	2066-2084	1:40,000	-0.36m
131	5-30-1998	2021-2022	98AR03	2159-2160	1:40,000	0.22m

\* Tide level above MLLW at the Ketchikan tide station (#9450460) on the indicated dates and times. MHW is 4.69 meters above MLLW.



## APPENDIX D

