

PHOTOGRAMMETRY BRANCH
COASTAL MAPPING PROGRAM

PROJECT CM-9111
COMPLETION REPORT

CALIFORNIA

BODEGA BAY AND TOMALES BAY

SOURCE DATE-1991

UNITED STATES DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NATIONAL OCEAN SERVICE
NATIONAL GEODETIC SURVEY DIVISION

PHOTOGRAMMETRY BRANCH
COASTAL MAPPING PROGRAM

PROJECT CM-9111
COMPLETION REPORT

CALIFORNIA
BODEGA BAY AND TOMALES BAY

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 Photogrammetry Branch Coastal Mapping Program.

Submitted by,

Fay T. Mauldin
Fay T. Mauldin
Special Projects Section

APPROVED:

Patrick L. Wehling 7/17/95
CDR Patrick L. Wehling Date
Chief, Special Projects Section

Robert M. Rodkey 4/16/96
CAPT Richard Floyd Date
Chief, Photogrammetry Branch
National Geodetic Survey Division

COMPLETION REPORT
COASTAL MAPPING PROGRAM
PROJECT CM-9111
BODEGA BAY AND TOMALES BAY
CALIFORNIA

TABLE OF CONTENTS

Clearance.....	ii
Introduction.....	1
Planning.....	1
Field Operations	
Field Surveying.....	1
Photography.....	1
Aerotriangulation.....	2
Compilation.....	2
Final Review.....	3
Dissemination of Project Data.....	5

FIGURES

1. Project Location Diagram.....	7
2. Page Sized Diagram.....	8
3. Project Horizontal Control Placement.....	22
4. Selected Bridging and Compilation Photographs.....	22

LISTINGS

1. Project Geodetic Control.....	6
----------------------------------	---

APPENDICES

A. Project Field Instructions.....	9
B. Field Operations Report.....	13
C. Aerotriangulation Report.....	18
D. Compilation Sources Pages.....	25
E. Memorandum.....	27

COASTAL MAPPING PROGRAM
CM-9111
PROJECT SUMMARY

INTRODUCTION

Project CM-9111 provides high accuracy photogrammetric source data for Bodega Bay and Tomales Bay in California. This report contains specific information, listings of data, and associated documentation pertinent to the completion of the project.

The entire scope 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 coastline photogrammetric data to complement the Nautical Charting Program (NCP) and other geographical information systems.

The project data consists of information measured and extracted from aerial photographs and metadata related to photogrammetric compilation. Base mapping was conducted in a digital environment using analytical photogrammetry and associated cartographic practices. Project survey data is referenced to the North American Datum 1983 (NAD 83).

PLANNING

The Coastal Planning Section (CPS), formulated and coordinated field and photographic requirements. Planning operations included developing the control network design for photo identification, preparing flight maps, and coordinating tide level requirements and photographic operations schedules. The photography was acquired in July 1991. The Pacific Marine Center, Pacific Photogrammetric Party was assigned all horizontal control activities. Field instructions were issued by the Chief, Nautical Charting Division, Office of Charting and Geodetic Services. A copy of these instructions are bound in Appendix A.

FIELD OPERATIONS AND PHOTOGRAPHY

Field operations consisted of aerial photography, and the recovery, establishment, and photoidentification of reference horizontal control necessary for aerotriangulation. Geodetic survey and photoidentification operations were performed in January 1992. There were twelve photoidentified points used in the adjustment. For additional information about field operations, refer to the Field Project Instructions in Appendix A and the Field Report in Appendix B.

Aerial photographic survey operations were conducted during July 1991. Photographic requirements consisted of 1:30,000 scale natural color photographs, taken in July 1991. Color photography

was taken using the Wild RC-10 camera with the "B" cone which has a calibrated focal length of 152.74 millimeters. At the time the color photography was taken, there were no operating tide gages in the immediate areas of Bodega and Tomales Bays. The ranges and times of tide from historical tide stations in the bays were used to correct the tide data from the operating station at Point Reyes, California. Refer to the Memorandum bound with this report for specific information regarding tide data.

Photographs were reviewed by the Coastal Planning Section to ensure proper overlap, the resolution quality for photoidentification of reference ground control points, and adequate coverage. The Quality Assurance Section, headquarters office, evaluated photography for overall image resolution and metric quality to ensure compliance to uniform specifications.

AEROTRIANGULATION

Analytical aerotriangulation methods were employed to establish the network of photo control for mapping and to provide model parameter and orientation elements required for analytical compilation. This work was performed at the headquarters office and was completed in May 1992. Refer to the Aerotriangulation Report in Appendix C. This report describes the overall operations that were performed during this phase, indicates the source photographs that were bridged, includes a diagram which shows the network and distribution of control, and provides information about accuracy performance. A listing of geodetic control used in this project is bound with this report.

During this phase of operation, data files were established to provide for the efficiency of data management and compilation. The geographic boundaries of these data files are shown in Figure 1, the Project Diagram, bound with this report.

COMPILATION

Data compilation consisted of digital base mapping, the production of two digital files and the construction of supplemental data for the Nautical Charting Program. This work was performed by the Field Photogrammetry Section, Atlantic Marine Center, and was accomplished from October 1992 through January 1993.

Digital base mapping was accomplished using the Integrated Digital Photogrammetric Facility (IDPF), a configuration of PWS-1 analytical stereoplotters, computer hardware and software components, and other associated peripheral devices. The serial number of the PWS-1 analytical stereoplotter used was S/N 1002.

Cartographic features were compiled using the bridged (aerotriangulated) natural color photographs and analytical stereo compilation methods. The source photographs used to compile each file are included in Appendix D. Feature

delineation and the assignment of cartographic codes were based entirely on interpretation of these photographs.

Feature delineation was complemented by the use of reference products that share the same geographical area as this project. These included National Ocean Service nautical charts and U. S. Geological Survey quadrangles. These data were consulted to aid in photointerpretation, the assignment of feature attributes, and the cartographic representation of detail. In addition, the 1991 publication of the U. S. Coast Guard Light List - Volume VI was used to complement the assignment of attributes associated with fixed aids to navigation.

This project overlaps the geographical area generally covered by photogrammetric projects PH-159 and PH-6405.

FINAL REVIEW

This phase of operations consisted of an overall evaluation of data collection procedures and the review of digital base mapping and associated data for compliance to program requirements for a shoreline survey. The primary review operations paralleled data compilation and were completed from October 1992 through January 1993. Digital base mapping and related products were evaluated as meeting established accuracy standards and were constructed using established disciplines of photogrammetry and digital cartography.

The project data is structured according to approved IDPF guidelines. Feature positioning is relative to aerotriangulation which meets National Ocean Service requirements for new mapping. For additional information on data accuracy, refer to Appendix C of this report. Cartographic feature codes are assigned in accordance with program standards which are consistent with the suite of codes specified for the approved Nautical Charting Division (NCD) Standard Digital Data Exchange Format (SDDEF), Version I, dated April 1, 1985.

Digital shoreline data and listings of selected features were copied from the data to complement the Nautical Charting Program. This required the translation of IDPF digital mapping files into the approved Nautical Charting Division SDDEF. The data was processed and transmitted to the appropriate offices in accordance with established policy.

In addition, a comparison was made between the shoreline data that resulted from this survey and the following published National Ocean Service nautical chart:

<u>CHART</u>	<u>EDITION</u>	<u>SCALE</u>	<u>DATE</u>
18643	14	1:30,000	April 21, 1990

The purpose of the comparison was to evaluate the adequacy of these charts in the representation of shoreline data and report any area where significant change has occurred. The comparison revealed that no major shoreline changes have occurred to warrant immediate new chart construction.

In summary, project data was evaluated for accuracy and all mapping products and associated data sets comply with the general requirements for a standard shoreline mapping project.

DISSEMINATION OF PROJECT DATA AND PRODUCTS

National Archives/Federal Records Center

Duplicate of the Project Completion Report

Project Folder contents, e.g. field data, aerotriangulation records, etc.

Agency Records

Project Completion Report

Photogrammetric Electronic Data Library

SDDEF File of all IDPF Digital Mapping Files (magnetic tape)

Nautical Charting Production Office

SDDEF File of all IDPF Digital Mapping Files (magnetic tape)

PROJECT GEODETIC CONTROL LISTING

PROJECT: CM-9111

GEODETIC DATUM: North American Datum of 1983

The following permanent geodetic control was recovered during photogrammetric operations. Data pertaining to stations is resident in the National Geodetic Survey Division (NGSD) Horizontal Control Databank.

Refer to Nautical Charting Division Standard Digital Data Exchange Format documentation for quality codes (QC) criteria.

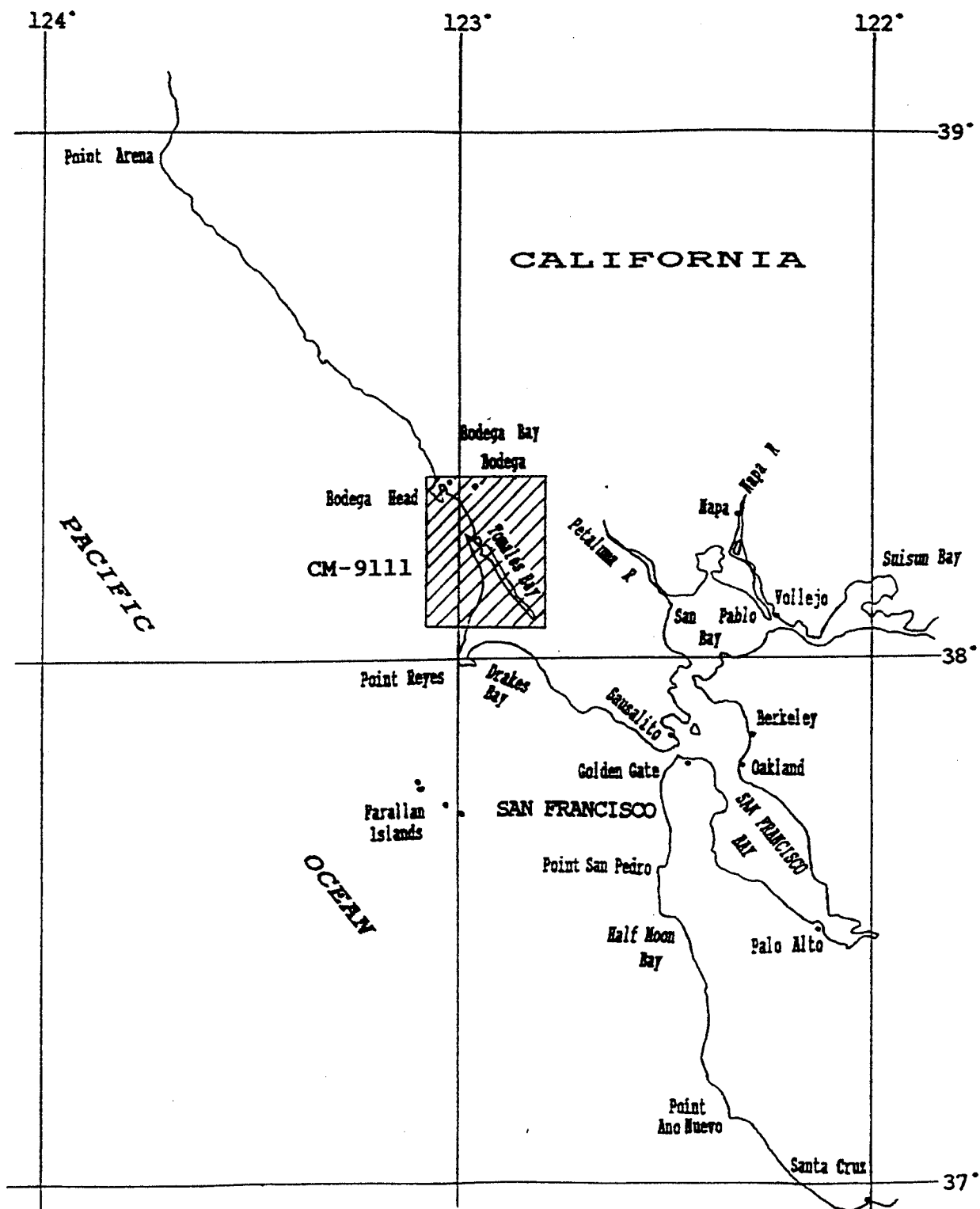
STATION NAME	QUAD	LATITUDE LONGITUDE	QC	DAY/YEAR
ANDY, 1930	381232	38°22'40.690" 123°04'52.525"	3	001/1930
TOMASI, 1930	381231	38°05'07.493" 122°47'43.885"	3	001/1930
ROCKY POINT 2, 1929	381232	38°23'39.619" 123°05'40.698"	3	001/1929

Remarks:

All geodetic survey operations were performed in January 1992.

Listing approved by: *Fay T. Mauldin*

Date: May 13, 1993



CM-9111

PROJECT LOCATION DIAGRAM

JOB CM-9111
BODEGA BAY AND TOMALES BAY
CALIFORNIA

DM-10148

DM-10149

SCALE 1:20,000

123° 00' 00" +

PACIFIC

38° 07' 30" +

38° 15' 00" +

38° 22' 00"

122° 57' 30"

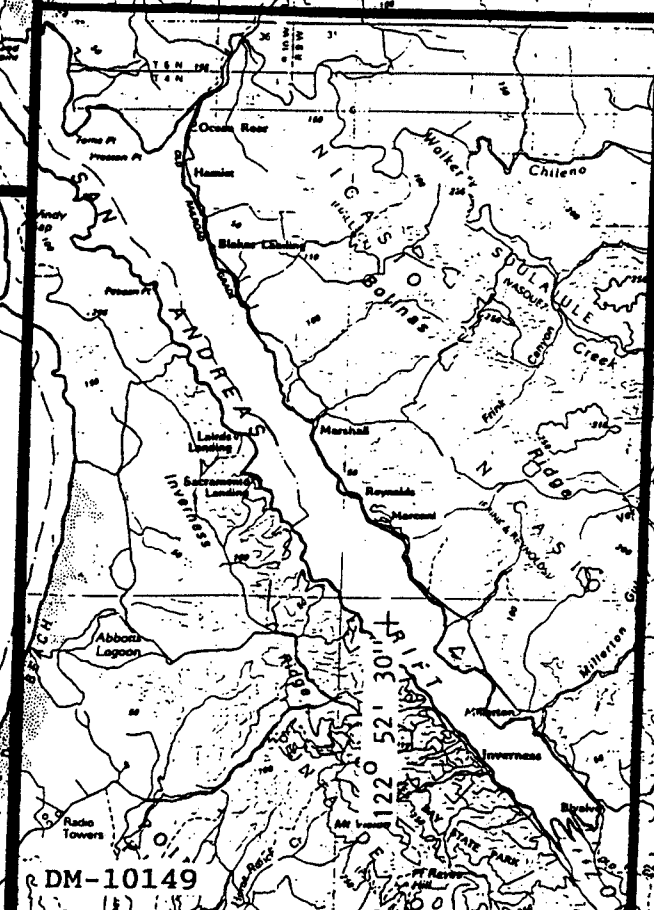
122° 49' 00"

38° 14' 05"

38° 12' 00"

38° 04' 00"

OCEAN



APPENDICES

APPENDIX A
PROJECT FIELD INSTRUCTIONS

DRAFT

November 4, 1991

Chief, Field Photogrammetry Section
Photogrammetry Branch

PROJECT INSTRUCTIONS: FIELD - Photogrammetric Survey
Bodega Bay and Tomales Bay, California, Shoreline Map

Unsigned copy
Original never
received

1.0. PURPOSE

These instructions provide field survey specifications and other data requirements in support of the Coastal Mapping Program (CMP). The entire photogrammetric project will result in data to complement the National Geodetic Reference System, controlled metric quality aerial photographic coverage, and digital shoreline data and maps for the NOS Nautical Charting Program and other geographical information systems.

2.0. GENERAL

2.1. Scope. Field survey operations are required to provide photoidentified control for mapping. Photoidentification is required in six areas throughout the project to provide the reference geodetic network to control aerial photography using analytical aerotriangulation methods. Control requirements are outlined in Section 5.0. The estimated elapsed time to complete the field observations is 7 days.

2.2. Mapping. This photogrammetric project will provide new shoreline survey coverage of Bodega Harbor, Bodega Bay, and Tomales Bay. Digital shoreline surveys will be compiled using analytical stereo photogrammetry.

3.0. PHOTOGRAPHY

Natural color aerial photography at 1:30,000 scale was acquired for mapping on July 25, 1991 using the Wild RC-10(B) camera. Contact prints of the photography will be provided.

4.0 ASSIGNMENT

You are assigned all field operations required to establish and photoidentify the horizontal control stations required for the project.

DRAFT

2

5.0. CONTROL REQUIREMENTS

5.1. Horizontal control stations will be recovered or established and photoidentified in the areas indicated on the control requirements diagram which has been provided. At least two stations or substitute stations shall be photoidentified in each designated area. General survey specifications for positioning these control points are outlined in Section 3 of the CMP Operations Manual.

5.2. If possible, position at least one tidal bench mark using GPS methods.

5.3. Limit recovery of geodetic control to those needed to meet project requirements. Submit recovery notes for each station for which a search is made. Station descriptions and recovery notes for all monumented points occupied during the project must be submitted in computer-readable form using approved software. Include the name, address, and telephone number of a property owner or other contact.

5.4. Monumented stations, where needed, shall be established by triangulation, trilateration, traverse, satellite positioning, or a combination of the four methods, in accordance with Federal Geodetic Control Committee (FGCC) specifications.

5.5. GPS Surveys. Unless otherwise indicated in these technical instructions, GPS survey methods shall be consistent with the specifications outlined in the "Geometric Geodetic Accuracy Standards and Specifications for using GPS Relative Positioning Techniques," version 5.0, dated May 11, 1988, reprinted with corrections August 1, 1989.

5.5.1. GPS surveys to establish geodetic control are to be conducted from First- or Second-order National Geodetic Reference System (NGRS) published control. Basic requirements are that three First-order (or four Second-order) stations evenly distributed throughout the project area be used as base reference stations for initializing or completing all traverse loops.

5.5.2. Horizontal positioning requirement using GPS methods is for Second-order, Class I accuracy (relative accuracy between panels of $5 \text{ cm} + 1:50,000$ at the 95 percent confidence level for each component of the measured vectors). Redundancy in baseline measurements is required for thirty-percent of the control points located. Maintain a log documenting the vector quality.

5.5.3. GPS survey methods will be conducted using the Trimble 4000SST dual-frequency receivers. Station occupation and observing procedures must be carried out according to appropriate sections of the current Trimble receiver field manual, TRIMBLE 4000SST GPS Surveyor Operation Manual, December 1989, Revision A.

DRAFT

3

Data collection must be accomplished in the compressed format. The data collection rate is 15 seconds with the elevation mask set at 15 degrees.

5.5.4. Record weather data just before and immediately after each session. The temperature and relative humidity measurements must be made near and at about the height of the GPS antenna phase center. Height of the instrument shall be measured by both the rod (slope distance) and a metric tape.

6.0. DATA

6.1. All records in connection with this project shall be properly titled followed by the CM number. This includes all digital data sets collected during the operations. All personal computer project data directories and backup files will be maintained until photogrammetric mapping is completed, at which time they can be discarded.

6.2. Data formats and digital file definitions are given in Input Format and Specifications of the National Geodetic Survey Data Base, Volume 1, Horizontal Control Data, Federal Geodetic Control Committee, January 1989.

6.3. Preparation and processing of control identification and descriptive data will be in accordance with standing practices.

7.0. REPORTS

A field operations report covering all pertinent field work performed is required. The original report will be inserted into the project completion report (PCR) as described under Section 14, CMP Operations Manual.

8.0. SCHEDULE

Scheduling of survey operations will be at your earliest opportunity. The target date for completion of the field work is February 1, 1992.*

9.0. MODIFICATIONS OF INSTRUCTIONS

If changes in procedures and methods seem advisable, please make appropriate recommendations to this office. Departures from basic requirements as necessitated by unique circumstances, shall be contained in supplementary instructions and/or described in the text of the field report.

DRAFT

4

10.0. COSTS

All costs incurred on this assignment shall be charged to Task 8K6C08.

Lewis A. Lapine
Chief, Photogrammetry Branch

APPENDIX B

FIELD OPERATIONS REPORT

I. AUTHORITY

The Pacific Photogrammetric Field Party executed this survey in response to project instructions "FIELD - Photogrammetric Survey CM-9111, Bodega Bay and Tomales Bay, California, Shoreline Mapping." These instructions are dated November 4, 1991.

II. DATES

Members of the Field Party performed reconnaissance, photoidentification and GPS observations between January 14 and January 17, 1992.

III. PURPOSE

This survey was undertaken to provide photoidentified control for mapping. Photoidentification was required in 6 areas throughout the project to provide the reference geodetic network to control aerial photography.

IV. TERRAIN AND WORKING CONDITIONS

The project area lies in Tomales Bay, Bodega Bay and north to Duncans Point, California, approximately 30 miles north-northwest of San Francisco.

Access to stations was either by four wheel drive vehicle or rental car.

The field party worked out of Petaluma due to the fact that lodging in the project area was incredibly expensive.

The project area is sparsely populated, consisting of scattered small towns surrounded by beach house developments. The terrain varies from remote cow pastures to rolling hills with valleys forested with conifers. A number of the photoidentification sites are on private property, however, no difficulty was experienced in acquiring permission for conducting GPS observations.

Weather conditions were favorable with the exception of very dense fog which occasionally made it difficult to recover existing stations and to relocate photoidentification sites. These were normal conditions for the region at that time of year.

V. PERSONNEL

J. Richard Minton,	NOS	Pacific Photo Field Party
David O. Neander,	NOAA Corps	Pacific Photo Field Party

VI. EQUIPMENT

Trimble 4000SST GPS Receivers	#0463, #0464, #0465 & #2235
1 Four Wheel Drive Vehicle	
1 Rental Car	

VII. FIELD METHODS

Based on the photoidentification diagram provided by N/CG232, twelve photoidentifiable sites were positioned. All sites are defined in detail on the "PHOTOGRAMMETRIC CONTROL - SITE IDENTIFICATION" diagrams included with the survey data for this project. In addition, the sites are defined on their respective photographs which are also included with the survey data.

All photoidentifiable sites were positioned by GPS survey. The centers of the sites were marked by non-permanent methods. Stations GAFFNEY (First Order), TOMASIS (First Order), and FOG (Second Order) were selected as control stations for the GPS survey. In addition, stations ROCKY PT 2 (Third Order) and ANDY (Third Order, Bench Mark elevation) were occupied and tied in with the network.

GPS data was downloaded and computed with Trimble software. All vectors were computed as single baselines in the L1 mode to determine if cycle slip fixing was required. The standard Modified Hopfield Tropospheric Model and the broadcast ephemeris were used in all solution computations.

All work was executed in the NAD83 datum.

VIII. STATISTICS

Horizontal Control Stations Recovered	5
Photoidentifiable Sites positioned with GPS	12

IX. DISCUSSION OF RESULTS

The GPS survey included forty-five vectors between 17 stations. Seven baselines were observed twice. Vector qualities were computed for each baseline and are listed in a separate section of the report. In addition, loop closures of the individual sessions were used to monitor the quality of the data. These are also included in a separate section of the report.

A 3-dimensional constrained adjustment of the data produced a variance of unit weight of 1.92 with mean abstract residuals of 0.025, 0.052, and 0.034 meters, in delta x, y, and z, respectively. A scaling factor of 22.222 was applied to the GPS vectors using NGS program MODGEE. The horizontal constraints were stations GAFFNEY, TOMASI, and FOG. The vertical constraints were stations GAFFNEY, TOMASI, FOG and ANDY.

The NAD83 positions of all twelve photoidentification sites follow. Positions were taken from the constrained adjustment. All GPS positions exceed the required 2nd order horizontal positioning requirements.

PHOTOIDENTIFICATION SITE POSITIONS

PHOTO ID SITE

LATITUDE

LONGITUDE

PHOTO ID SITE 1A
38 22 25.37474 ✓

123 04 33.66097 ✓

PHOTO ID SITE 1B
38 22 55.95648 ✓

123 04 47.88901 ✓

PHOTO ID SITE 2A
38 18 34.88919 ✓

123 03 10.94631 ✓

PHOTO ID SITE 2B
38 18 36.73773 ✓

123 03 13.58075 ✓

PHOTO ID SITE 3A
38 15 38.28591 ✓

122 58 05.03934 ✓

PHOTO ID SITE 3B
38 15 26.19912 ✓

122 57 44.78387 ✓

PHOTO ID SITE 4A
38 09 39.50299 ✓

122 56 16.17057 ✓

PHOTO ID SITE 4B
38 09 15.88137 ✓

122 56 16.87098 ✓

PHOTO ID SITE 5A
38 08 46.73812 ✓

122 52 45.94850 ✓

PHOTO ID SITE 5B
38 08 48.08213 ✓

122 52 45.02160 ✓

PHOTO ID SITE 6A
38 04 16.11316 ✓

122 48 11.47506 ✓

PHOTO ID SITE 6B
38 04 12.36724 ✓

122 48 09.82413 ✓

✓ JGF
Don

X. DISTRIBUTION OF DATA

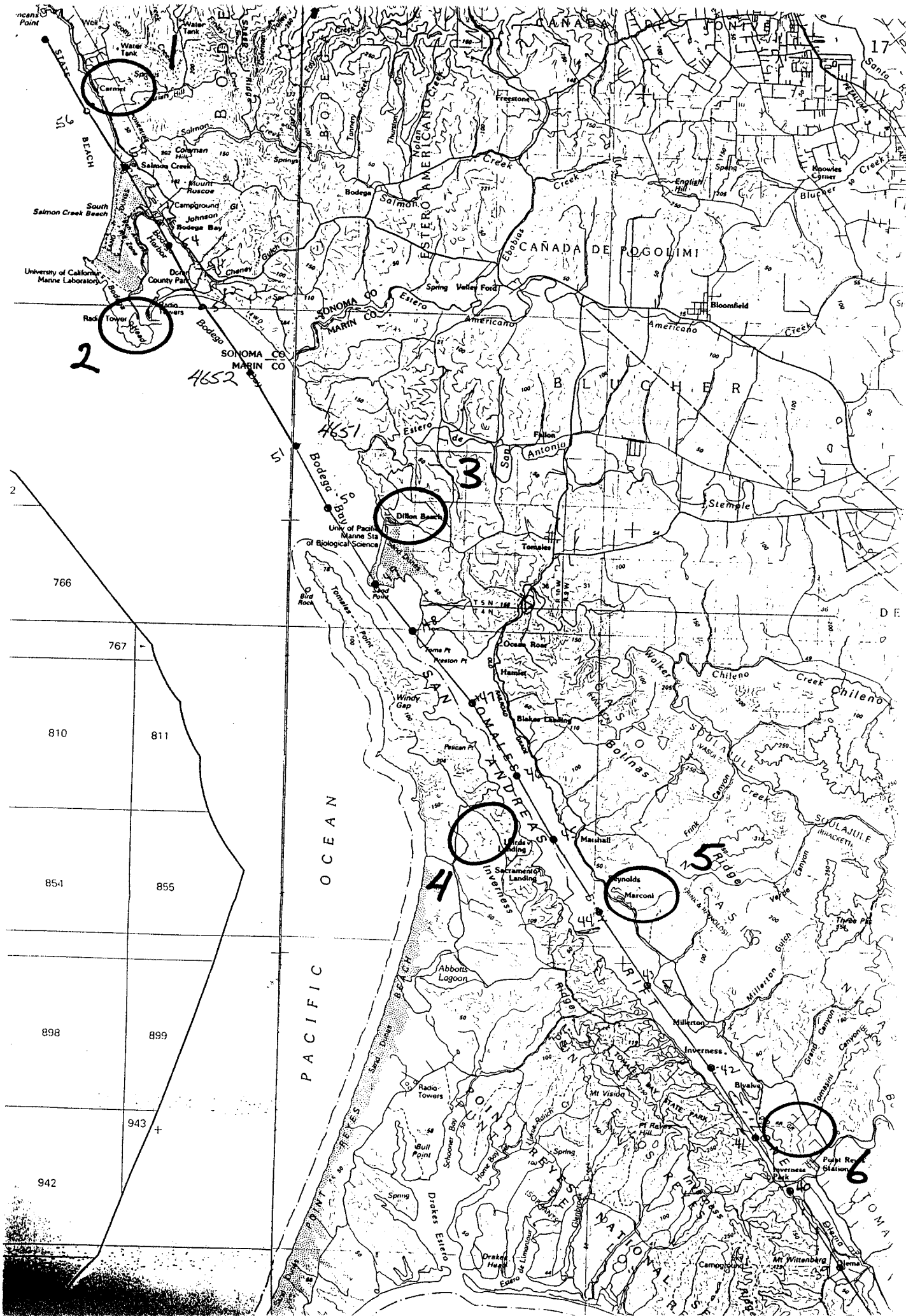
The Photo party will retain copies of all digital records until notification of project completion from the Photogrammetry Branch.

Respectfully submitted by:



Date: 02/04/92

Jeffrey G. Fredrick
Chief, Pacific Photogrammetric Field Party



APPENDIX C
AEROTRIANGULATION REPORT

AEROTRIANGULATION REPORT
PROJECT CM-9111
BODEGA BAY AND TOMALES BAY
CALIFORNIA
MAY, 1992

AREA COVERED

The project site includes Tomales Bay, Bodega Bay and extends north to Duncan's Point. The area is approximately 30 miles north of the San Francisco Bay area. Refer to the project diagram (Diagram #1) for the representation of these and other surrounding geographic areas.

METHOD

A single strip of 1:30,000 color photography was bridged using analytical aerotriangulation methods to establish the network of photocontrol required for the mapping phase. Tie points were not required for this project. Measurements were made using an analytical stereoplotter and the associated software and hardware configuration designated as the Integrated Digital Photogrammetric Facility (IDPF). Analytical adjustments were effected using the General Integrated Analytical Triangulation (GIANT) software program. As a check on the quality of the geodetic positions furnished for the reference control, intermediate executions of GIANT were performed while allowing selected reference control to float unconstrained within the adjustment. The adjusted values were then compared with the published geodetic positions. Refer to listing A of this report for a mathematical comparison of the reference horizontal control to the final adjusted aerotriangulation positions.

The project falls within the California State Plane Coordinate System Zone 3 (code #0403) and is referenced to the Lambert Projection. The positional data for this project is NAD 83.

ADEQUACY OF CONTROL

Twelve photoidentified positions were established by using GPS survey methods. The selection and distribution of the photoidentified points by the survey party were ample. See diagram #2 for the positioning of the control network coverage relative to the approximate photo flight line.

The predicted circular horizontal accuracy of the aerotriangulated control for this project is documented on listing B and is specified in meters.

Bench Marks and sea level positions from US Geological Survey Quadrangles at 1:24,000 scale were the source for vertical control in the GIANT solution. The contour interval for the USGS Quadrangles is 40 feet.

PHOTOGRAPHY

Photographic coverage, resolution, overlap, and metric quality were ample for the performance of the aerotriangulation phase.

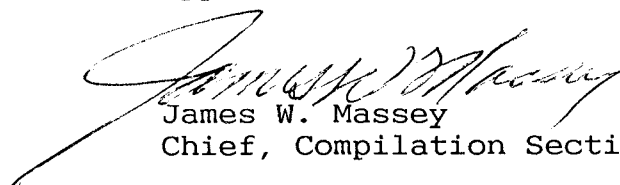
PROJECT DATA BASE

Upon completion of aerotriangulation related activities, a project data base was created under project number CM-9111 and includes the following:

- Camera Calibration Data
- Control File (Horizontal and Vertical)
- Frame Numbers by Strip (Adjusted Photographic Centers)
- Listing of Rotations Associated with each Frame
- Refined Image Coordinates
- GP Listing of all points used in the project

Selected models were set in the compilation scanning mode to insure the integrity of the horizontal and vertical solutions determined by GIANT and to determine the suitability of the data base for use in the compilation phase.

Approved and Forward:

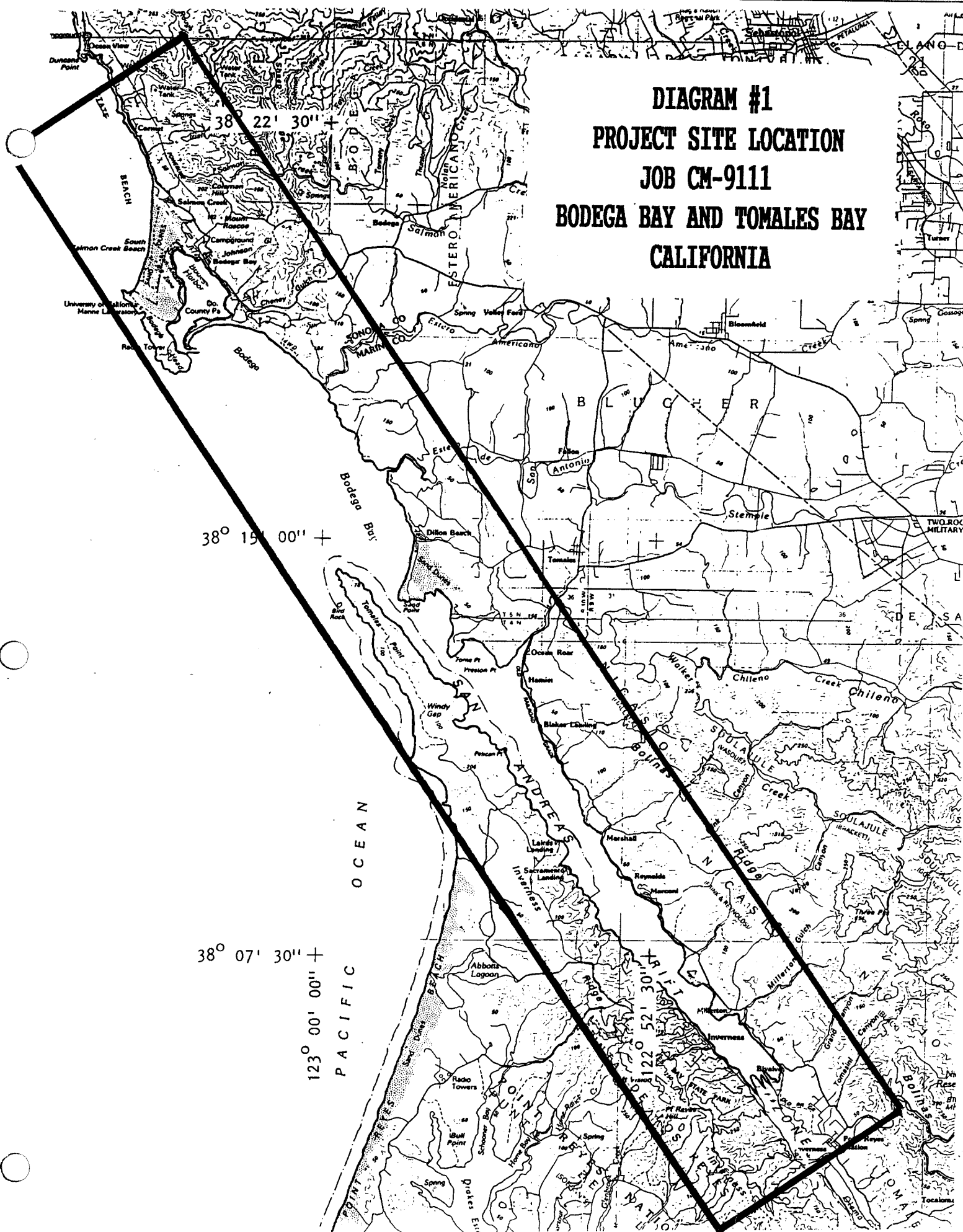

James W. Massey
Chief, Compilation Section A

COMPARISON
ADJUSTED POSITIONS TO GEODETICALLY DETERMINED POSITIONS

SITE #	SITE NAME	PHOTO ID NUMBER	VALUES IN FEET	
			X	Y
#1.	----- PHOTO ID SITE 1A -----	657_1A -----	-0.2	0.2
	----- PHOTO ID SITE 1B -----	657_1B -----	0.2	-0.2
#2.	----- PHOTO ID SITE 2A -----	654_2A -----	0.3	0.0
	----- PHOTO ID SITE 2B -----	654_2B -----	-0.2	0.0
#3.	----- PHOTO ID SITE 3A -----	649_3A -----	-0.5	0.8
	----- PHOTO ID SITE 3B -----	649_3B -----	0.4	-0.9
#4.	----- PHOTO ID SITE 4A -----	645_4A -----	0.1	-0.4
	----- PHOTO ID SITE 4B -----	645_4B -----	0.0	0.3
#5.	----- PHOTO ID SITE 5A -----	644_5A -----	0.5	0.1
	----- PHOTO ID SITE 5B -----	644_5B -----	-0.5	0.1
#6.	----- PHOTO ID SITE 6A -----	640_6A -----	0.2	-0.9
	----- PHOTO ID SITE 6B -----	640_6B -----	-0.2	0.8

LISTING A

DIAGRAM #1
PROJECT SITE LOCATION
JOB CM-9111
BODEGA BAY AND TOMALES BAY
CALIFORNIA



91 BCN 4657

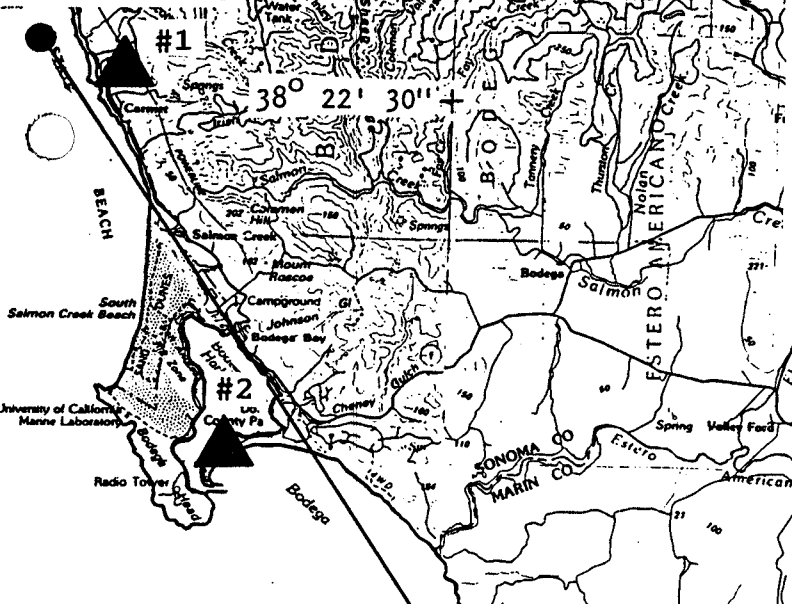
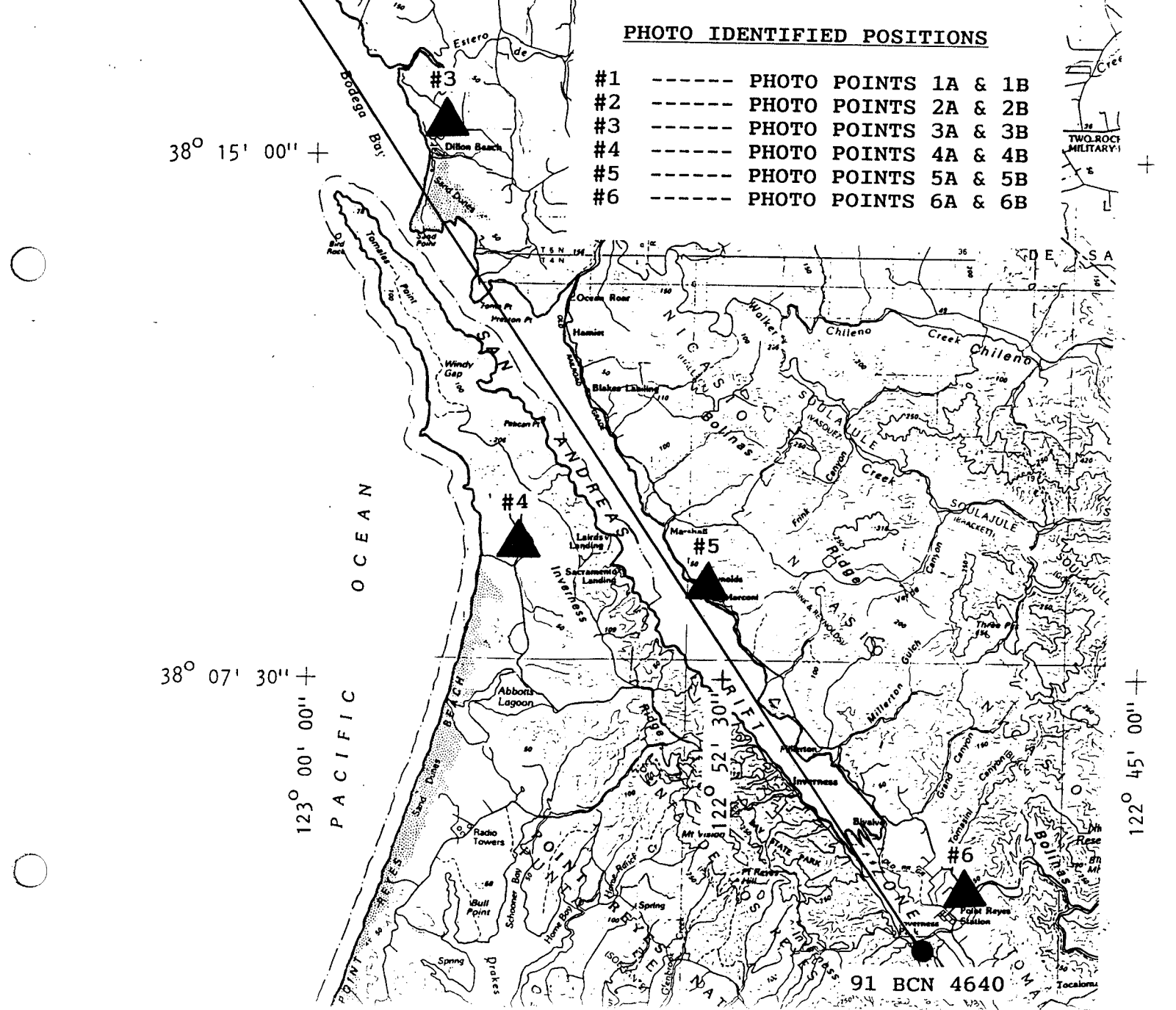


DIAGRAM #2
JOB CM-9111
BODEGA BAY AND TOMALES BAY
CALIFORNIA
1:30,000

PHOTO IDENTIFIED POSITIONS

- | | | |
|----|-------|----------------------|
| #1 | ----- | PHOTO POINTS 1A & 1B |
| #2 | ----- | PHOTO POINTS 2A & 2B |
| #3 | ----- | PHOTO POINTS 3A & 3B |
| #4 | ----- | PHOTO POINTS 4A & 4B |
| #5 | ----- | PHOTO POINTS 5A & 5B |
| #6 | ----- | PHOTO POINTS 6A & 6B |



91 BCN 4640

PROJECT #GEOGRAPHIC AREAPHOTOGRAPHY SCALE

CM-9111

BODEGA/TOMALES BAY, CA

1:30,000

REFERENCE ELLIPSOID - GRS80

AT A LATITUDE OF 38 DEG 12 MIN THERE ARE:

30.833 METERS IN 1 SEC OF MERIDIAN ARC

24.331 METERS IN 1 SEC OF PARALLEL ARC

COMPUTED GROUND COORDINATES ERROR PROPAGATION:

RMS FOR LONGITUDE = 0.0154 SEC = 0.375 METERS

RMS FOR LATITUDE = 0.0111 SEC = 0.342 METERS

C RATIO = 0.913

FOR THIS VALUE OF "C":

THE "K" FACTOR FOR 95% = 2.34732

THE RADIUS OF THE 95% CONFIDENCE CIRCLE = 0.8796 METERS

FOR POINTS DETERMINED TO TWICE THE COMPUTED PRECISION

THE RADIUS OF THE 95% CONFIDENCE CIRCLE = 1.759 METERS

1.759 METERS = 0.3MM AT A MAP SCALE OF 1 TO 5863

NOTE; This is the largest scale at which discrete point data contained in the digital file may be plotted while maintaining National Ocean Service (NOS) Horizontal Accuracy Requirements.

THE "K" FACTOR FOR 90% = 2.05623

THE RADIUS OF THE 90% CONFIDENCE CIRCLE = 0.7705 METERS

FOR POINTS DETERMINED TO THREE TIMES THE COMPUTED PRECISION

THE RADIUS OF THE 90% CONFIDENCE CIRCLE = 2.311 METERS

2.311 METERS = 0.5MM AT A MAP SCALE OF 1 TO 4622

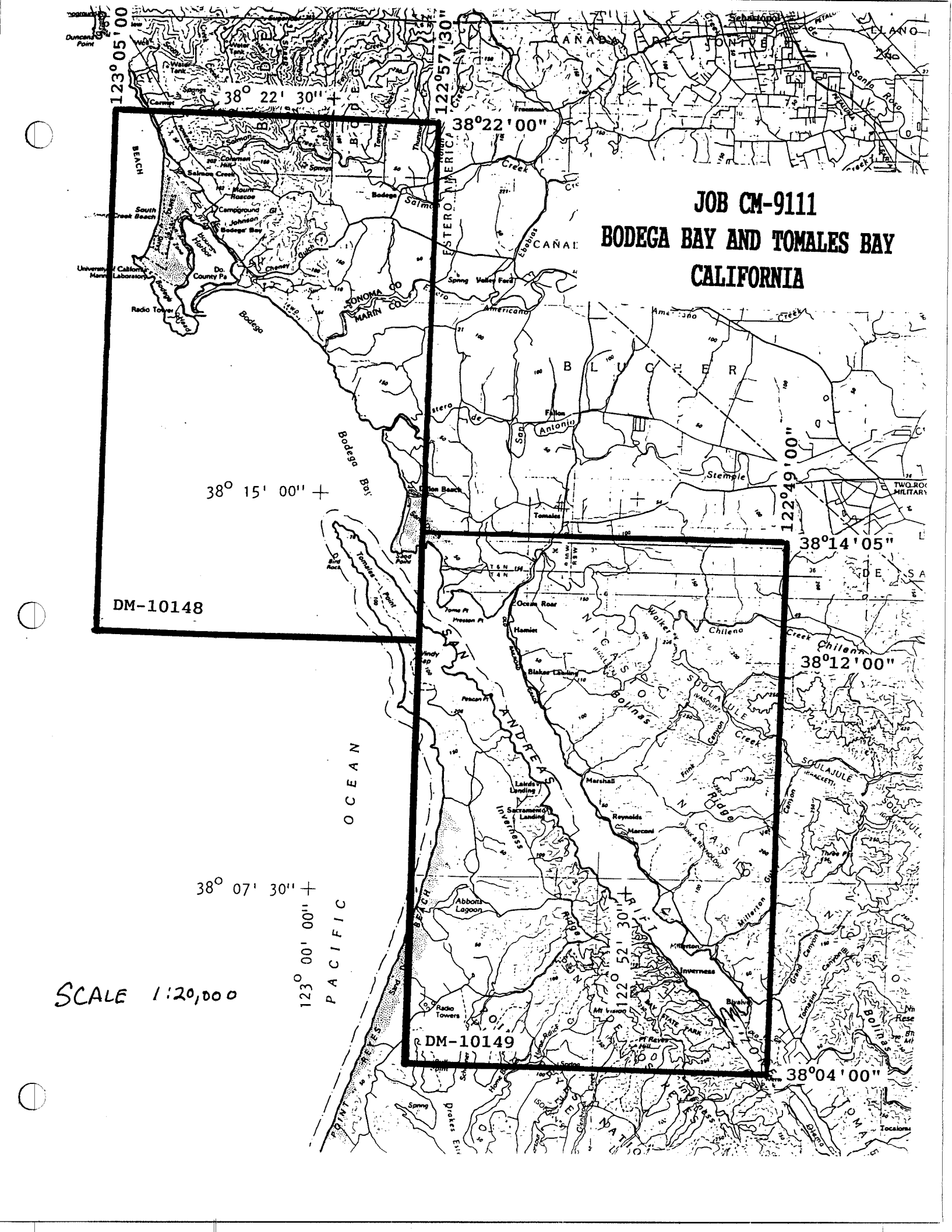
NOTE: This is the largest scale at which data within the digital file may be plotted while maintaining National Standards of Map accuracy.

JOB CM-9111
BODEGA BAY AND TOMALES BAY
CALIFORNIA

DM-10148

DM-10149

SCALE 1:20,000



NOTES TO THE COMPILER

CM-9111

In addition to the data set listed under PROJECT DATA BASE in the Aerotriangulation Report, the project area has been subdivided into two geographical areas assigned DM numbers 10148 and 10149. All areas have an assigned scale factor of 1:20,000. Include this information into the compilation report.

Compile the Pacific Ocean Mean High Water Line to the southern limits of DM-10148. For the area between the two DM limits and the area falling along the Western Boundary of DM-10149, do not compile the Mean High Water Line. Use the "Limit of Controlled Photographic Coverage", cartographic code #1002, to inform users of the fact that no mean high water line was compiled in the aforementioned areas. Reasons for this decision are:

- Photography was flown specifically for Harbor Survey purposes and not as a Coastal Mapping Program Project.

- The areas are at the extreme edges of the stereo-models.

- Terrain along shore in these areas is a high bluff or cliff thereby making the interpretation of the mean high water line extremely difficult.

APPENDIX D
COMPILATION SOURCES PAGES

DESCRIPTIVE DATA

PROJECT: CM-9111

PHOTOGRAPHY

NUMBER AND TYPE	DATE	TIME (CUT)	SCALE	STAGE OF TIDE
*91B (CN) 4647-4649	07-25-91	1911	1:30,000	+4.5 FT MLLW
*91B (CN) 4655-5656	07-25-91	1911	1:30,000	+4.5 FT MLLW
**91B (CN) 4650-4654	07-25-91	1911	1:30,000	+4.4 FT MLLW
				*MHW=5.1 FT
				**MHW=5.0 FT

*Pacific Coast

**Bodega Bay and Harbor

NUMBER AND TYPE	DATE	TIME (CUT)	SCALE	STAGE OF TIDE
*91B (CN) 4640-4644	07-25-91	1911	1:30,000	+3.7 FT MLLW
**91B (CN) 4644-4646	07-25-91	1911	1:30,000	+3.7 FT MLLW
***91B (CN) 4646-4649	07-25-91	1911	1:30,000	+3.6 FT MLLW
				*MHW=4.9 FT
				**MHW=4.7 FT
				***MHW=4.4 FT

*Tomales Bay, south of latitude 38°08.0'

**Tomales Bay, latitude 38°08.0' north to latitude 38°11.3'

***Tomales Bay, latitude 38°11.3' north to latitude 38°14.0'

COMPILATION REMARKS:

Due to the fact that there were no operating tide gages in the immediate area at the time of photography, the stage of tide for the color photography (CN) was based on historical tide data from the station in Tomales Bay used to correct tide data from the station at Point Reyes, California. Refer to the Memorandum dated January 11, 1992, bound with this report.

A combination of excessive glare on the water and heavy surf conditions along the Pacific coast made compilation difficult in many areas.

There was no photographic coverage for the mean high water line along the Pacific Ocean.

APPENDIX E

MEMORANDUM



CM-9111 27
UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL OCEAN SERVICE
Office of Ocean and Earth Sciences
Rockville, Maryland 20852

January 11, 1992

MEMORANDUM FOR: Commander Lewis A. Lapine
Chief, Photogrammetry Branch
FROM: James R. Hubbard
Chief, Datums Section
SUBJECT: Approved Tides for Photogrammetry Project -
Bodega and Tomales Bays, California - 1991

There were no operating tide gages in the immediate area of the Photogrammetry Project in Bodega and Tomales Bays during the times of aerial photography on July 25, 1991. The ranges and times of tide from historical tide stations in Bodega and Tomales Bays were used to correct the tide data from the operating long-term control station at Point Reyes, California. Stages of tide relative to Mean Lower Low Water and Mean High Water were computed for the time requested for each flight.

Photogrammetry flight line 30-1 on July 25, 1991 at 19:11 GMT:

1. Along the Pacific Coast, in the vicinity of Bodega and Tomales Bays, the height of tide was 4.5 ft. above MLLW or 0.6 ft. below MHW.
2. Inside Bodega Bay and Bodega Harbor, the height of tide was 4.4 ft. above MLLW or 0.6 ft. below MHW.
3. Inside Tomales Bay, from Sand Pt. to Pelican Pt., the height of tide was 3.6 ft. above MLLW or 0.8 ft. below MHW.
4. Inside Tomales Bay, from Pelican Pt. to 38° 08.0'N Latitude, the height of tide was 3.7 ft. above MLLW or 1.0 ft. below MHW.
5. Inside Tomales Bay, south of 38° 08.0'N Latitude, the height of tide was 3.7 ft. above MLLW or 1.2 ft. below MHW.

