

COASTAL MAPPING PROGRAM

PROJECT NJ9901A  
COMPLETION REPORT

NEW JERSEY  
HUDSON RIVER

A Photogrammetric Survey based  
on 1999 Aerial Photographs

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

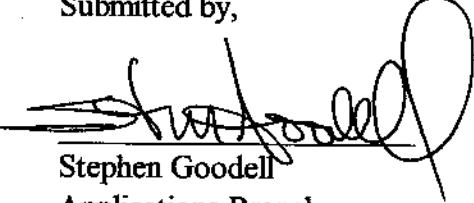
Agency Archive Copy

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HUDSON RIVER

Clearance

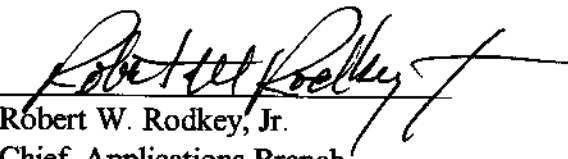
This report summarizes the photogrammetric operations related to project completion and is submitted for approval. The project data and this report meet the requirements and standards of the Remote Sensing Division's Coastal Mapping Program.

Submitted by,



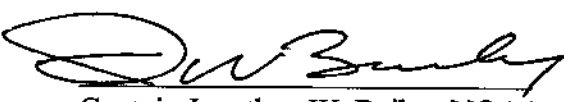
Stephen Goodell  
Applications Branch

Approved:



Robert W. Rodkey, Jr.  
Chief, Applications Branch  
Remote Sensing Division

4/30/01  
Date



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

4/30/07  
Date

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## **COASTAL MAPPING PROGRAM**

### **PROJECT NJ9901A SUMMARY**

#### **Introduction**

Project NJ9901A Hudson River, New Jersey provides a highly accurate database of new digital shoreline data of the Hudson River. NJ9910A is a sub-project of the larger project NJ9901 which covers primarily the New Jersey coast and the Intracoastal Waterway from Cape May to the Manasquan River. The area of coverage for this sub-project is the Hudson River from the George Washington Bridge to the Tappan Zee Bridge. Refer to the project diagram located in Appendix B.

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

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

#### **Planning**

The Requirements Branch of the Silver Spring Office formulated the mission instructions for this project following the guidelines of the Photo Mission Standard Operating Procedure Version II (7/01/93).

These instructions discussed the project's purpose, coverage, scope and priority; photographic requirements; flight line priority; tide coordination; GPS data collection procedures and guidelines for both kinematic and static surveys; data recording and handling instructions; and contact and communication.

The Requirements Branch created a Project Layout Diagram, flight maps and input files for the aircraft's flight management system. The branch provided copies of the descriptions of selected geodetic control stations at airports that may have been used as bases of operation. A briefing was held to review the mission instructions and to distribute the data to the field personnel.

#### **Field Operations**

Kinematic GPS operations were used to acquire precise camera positions and to establish the control network necessary for aerotriangulation. See the GPS Processing Report (Appendix A) for further information regarding this phase. Aerial survey operations for acquiring the photographs were conducted during October 12<sup>th</sup> of 1999 with the NOAA Cessna Citation II aircraft. The color photographs were taken using the Wild RC-20 camera with the NOS "A" lens cone. All the

photographs were acquired at the nominal scale of 1:48,000.

### **Aerotriangulation**

Softcopy aerotriangulation methods were applied to establish the network of precise GPS camera positions and other control for mapping, and to provide model parameters and orientation elements required for softcopy compilation. The photo strips were measured and adjusted as one block. This work was achieved by the Applications Branch in the Silver Spring Office and was completed in January of 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, indicates the source photographs that were bridged and includes diagrams that show the geographical coverage as well as the photographic flight lines used in the project.

Softcopy aerotriangulation was accomplished using Digital Photogrammetric Workstations (DPWs), which are a configuration of computer hardware and software components and other associated peripheral devices. Refer to the Aerotriangulation Report for more information.

### **Compilation**

Compilation of the project was accomplished by the Applications Branch in Silver Spring, Maryland and completed in March of 2001. Digital mapping was accomplished using Digital Photogrammetric Workstations (DPWs), which are a configuration of personal computers and monitors, softcopy photogrammetric software (Socet Set v4.2.1.1, Feature Extraction Module), stereo viewing equipment and other associated peripheral devices. Feature identification and the assignment of cartographic codes were based on the interpretation of 1:48,000 scale natural color photographs in conjunction with the utilization of NOS Nautical Charts, the USCG Light List and USGS quadrangles. Nomenclature was assigned to cartographic features that needed further descriptions.

Cartographic features were compiled to meet a horizontal accuracy of 4.0 meters at the 95% confidence level. This predicted accuracy of compiled, well defined points is derived from a deductive estimate based on aerotriangulation statistics. The source photographs used to compile the project are described in Appendix C.

### **Final Review**

The final review was initiated in March of 2001. The digital cartographic feature file was evaluated for completeness and accuracy. Cartographic feature codes conform with the C-COAST (Coastal Cartographic Object Attribute Source Table).

Data review consisted of an on-line and off-line evaluation of digital compilation and hard copy products. The on-line review comprised of reviewing stereo models on a DPW for cartographic feature codes selection, positional accuracies of features, and nomenclature. The offline evaluation compared

hard copy plots with the largest scale nautical charts available and with color photographs. The charts used for this comparison were the NOS nautical charts 12341 Hudson River, Days Point to George Washington Bridge, 1:10,000, 24<sup>th</sup> ed., 12342 Harlem River, 1:10,000 scale, 22<sup>th</sup> ed., 12343 Hudson River, New York to Wappinger Creek, 1:40,000, 17<sup>th</sup> ed., 12345 Hudson River, George Washington Bridge to Yonkers, 1:10,000, 9<sup>th</sup> ed., 12346 Hudson River, Yonkers to Piermont, 1:10,000, 10<sup>th</sup> ed. The results of these comparisons can be examined by reviewing the Chart Maintenance Print (CMP) which was generated by the compiler.

### **Project Final Data and Products**

#### **Agency Archives:**

- Original Project Completion Report

#### **Remote Sensing Division Electronic Data Library:**

- Project Database

- Digital Cartographic Feature File: GC-10496

- Copy of DCFF in Shapefile format

#### **OCS Marine Chart Division:**

- Abbreviated copy of PCR

- Annotated Chart Maintenance Print

- Copy of DCFF in Shapefile format

## APPENDIX A

# **NJ9901A**

## **HudsonRiver - Yonkers**

### **New Jersey / New York**

#### **GPS Processing Report**

January 2001

#### 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 NJ9901A (Hudson River - Yonkers). The datasets processed and the aerial photography covered by those datasets are listed in the table below:

<b>Dataset</b>	<b>Date</b>	<b>Project(s)</b>	<b>Description / Flight Lines</b>
99GON279.S	10/6/99	NJ9901, NY9904, NY9905, MA9901	Static session for reference station (PGON)
99GON285.k1	10/12/99	same as above	60-01, 70-01, 48-03, 48-08, 48-09, 48-10, 48-12

#### DATA COLLECTION

GPS data was collected in October 1999, 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. In October 1999, before the first session, a PK-nail was set in a convenient location at Groton - New London Airport (GON) in Groton, CT. For the first session a Trimble Compact L1/L2 antenna with Ground Plane was set up on a 2 meter fixed height tripod over a the PK-nail, which was given the designation PGON, and two hours of static data were collected.

The second session, on October 12<sup>th</sup>, was a kinematic survey with the rover receiver in the NOAA Cessna Citation II (N52RF) aircraft, and the reference receiver set up over PGON. This session was of 4 hours 32 minutes duration with a measurement interval of 1 second. Seven flight lines were flown, and 108 photo events were recorded. No problems were reported by the field personnel in the observation log, though it was noted that a second session was flown later the same day.

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 each film roll.



### REFERENCE RECEIVER POSITIONING

Static GPS data collected over the PK-nail, PGON, on Oct. 6<sup>th</sup>, 1999 were converted to RINEX2 format using Trimble DAT2RIN software. The RINEX files were then uploaded to the web-based NGS Online Processing User Service (OPUS) for processing. Baseline solutions were computed by OPUS from three CORS stations (CHT1, MOR1, & SHK1) to PGON using the uploaded static data. The baselines were then averaged to produce the final coordinates in NAD83 with an overall RMS of 1.6 cm:

Latitude:	41° 20' 02.62937" N
Longitude:	72° 02' 33.52657" W
Ellipsoidal Height:	-27.755 m.

### KINEMATIC PROCESSING

The airborne kinematic GPS dataset, 99GON285.k1, was processed in January 2001 using Trimble GPSurvey (ver. 2.35), and utilizing the NGS computed precise satellite ephemeris, and standard meteorologic data. A continuous kinematic iono-free phase solution was obtained. The RMS of the phase residuals had spikes around 4 cm near the beginning of the session, and 3 cm near the middle and end, but generally ranged from 0.5-2 cm for most of the time. The average iono-free RMS for the session was 1.2 cm. The RDOP value varied between 1.7 and 4.0 during the session. The product, RMS x RDOP (which is a reasonable estimate of the mean square positional error), generally varied between 2 and 4 cm, with only a short period at the 9-12 cm range near the beginning, and a very brief spike to 12 cm in the middle of the session. The folder (NJ9901/etc. Day 285.k1) on file in the RSD GPS Archive contains this report, the field GPS Observation Log, the OPUS Static Processing Report, and the GPSurvey Detailed Kinematic Solution Summary report including plots of RMS and RDOP and a solution diagram (network map).

## APPENDIX B

# **NJ9901A Hudson River New Jersey**

**Aerotriangulation Report  
February 2001**

## **AREA COVERED**

Project NJ9901A is a subset of the larger project NJ9901, which covers primarily the New Jersey Coast and the Intracoastal Waterway from Cape May to the Manasquan River. The area of coverage for this sub-project is the Hudson River from the George Washington Bridge to the Tappan Zee Bridge between 40° 51' and 41° 03' north latitude, and 73° 52' and 73° 58' west longitude. See the Project Diagram for a depiction of the area covered.

## **PHOTOGRAPHY**

The photography used in the aerotriangulation phase consisted of two strips of 13 natural color photographs. The photographs were acquired at a nominal scale of 1:48,000 using the NOS A-cone camera. The strips were flown on 10/12/1999 between 16:06 and 16:39 UTC. The layout of the photographs is shown in an attached diagram. Photographic coverage, resolution, overlap, and metric quality were adequate for the performance of the aerotriangulation phase.

## **CONTROL**

No horizontal ground control stations (panels) were established prior to the collection of photographs. The photographs were controlled using airborne kinematic GPS positioning techniques with sufficient accuracy to control the digital adjustment. Refer to the NJ9901A GPS Processing Report for further information on the techniques used.

## **METHOD**

The 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, which consists of a stereo-enabled PC-based graphics workstation running the Windows NT operating system and a suite of digital photogrammetric software known as SocetSet (version 4.2.1.1). The ORIMA program was used in conjunction with SocetSet to perform the aerotriangulation and evaluate the accuracy of the adjustment.

The RMS of the standard deviations of the residuals for each aerotriangulated ground point was calculated using the ORIMA software aerotriangulation module. These values were used to compute a predicted horizontal circular error of 2.0 meters based on a 95% confidence level.

### PROJECT DATABASE

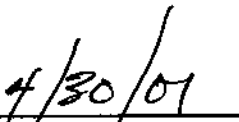
A project database was created under the reference number NJ9901A and includes the following:

- Project Parameters and Options
- Camera Calibration Data
- Interior Orientation Parameters
- Airborne GPS Antenna Position and Offset Data
- Adjusted Exterior Orientation Parameters
- Positional Listing of All Measured Points Used in the Project

Positional data is based on the North American Datum of 1983, and is referenced to the UTM Coordinate System. The models were visually reviewed to insure the horizontal and vertical integrity of the adjustment and to determine the suitability of the database for use in the compilation phase.

Approved and Forwarded:

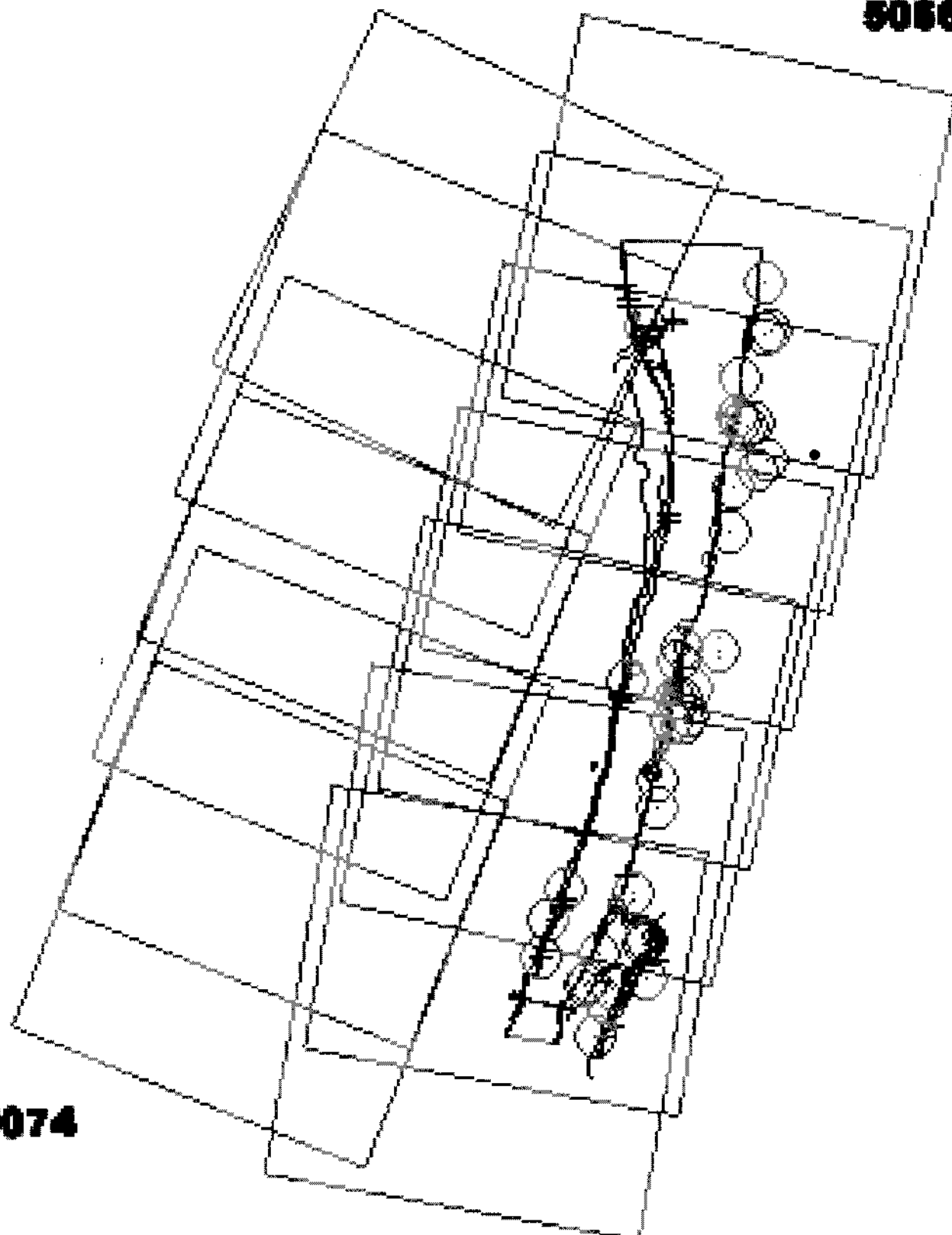
  
Robert W. Rodkey  
Chief, Applications Branch

  
Date

**NJ9901A- Hudson River  
Frame Index of Color Photographs**

**5069**

**5066**



**5074**

**5060**

## APPENDIX C

## DATA COMPILATION SOURCES

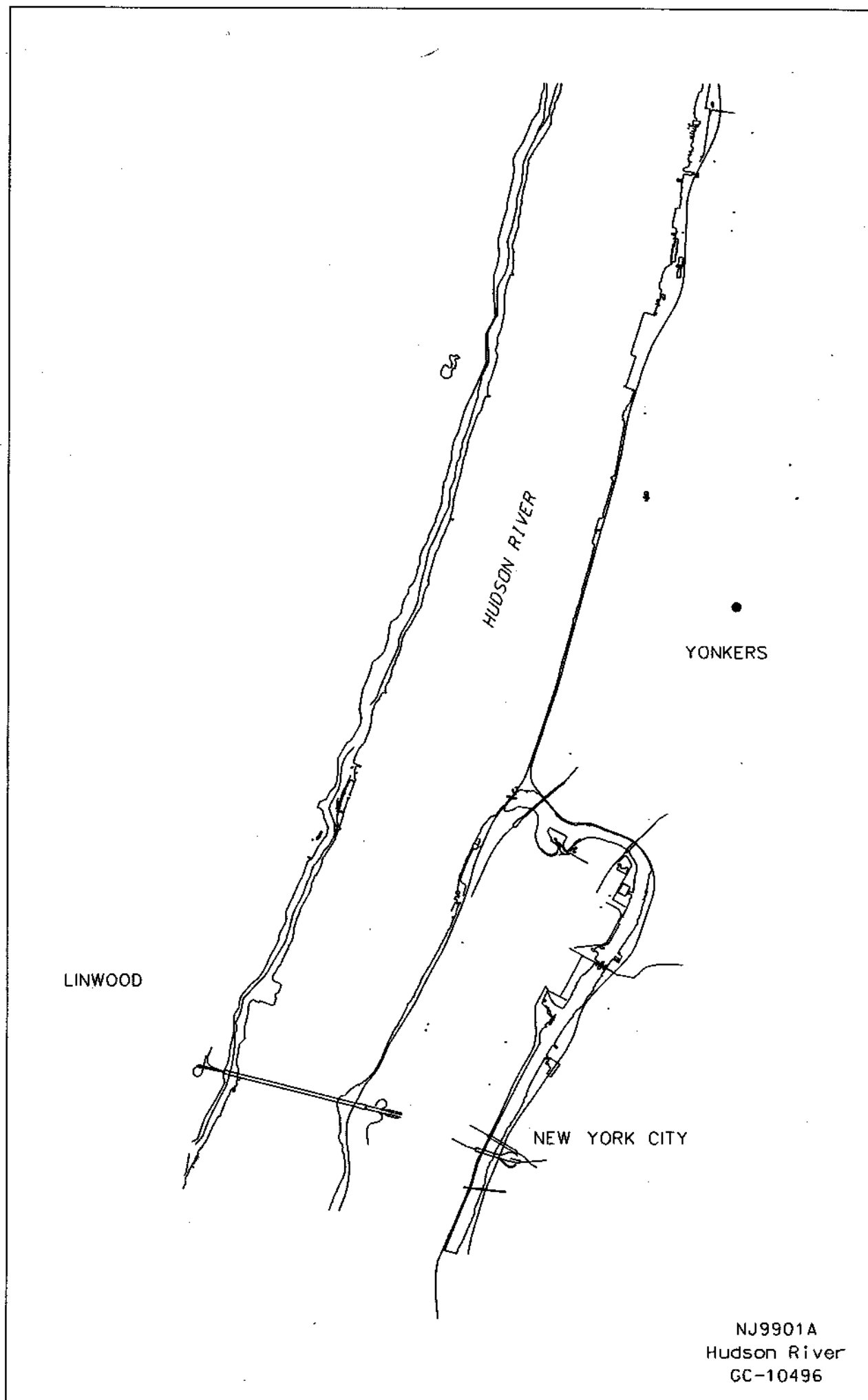
**PROJECT: NJ9901A**

### PHOTOGRAPHY

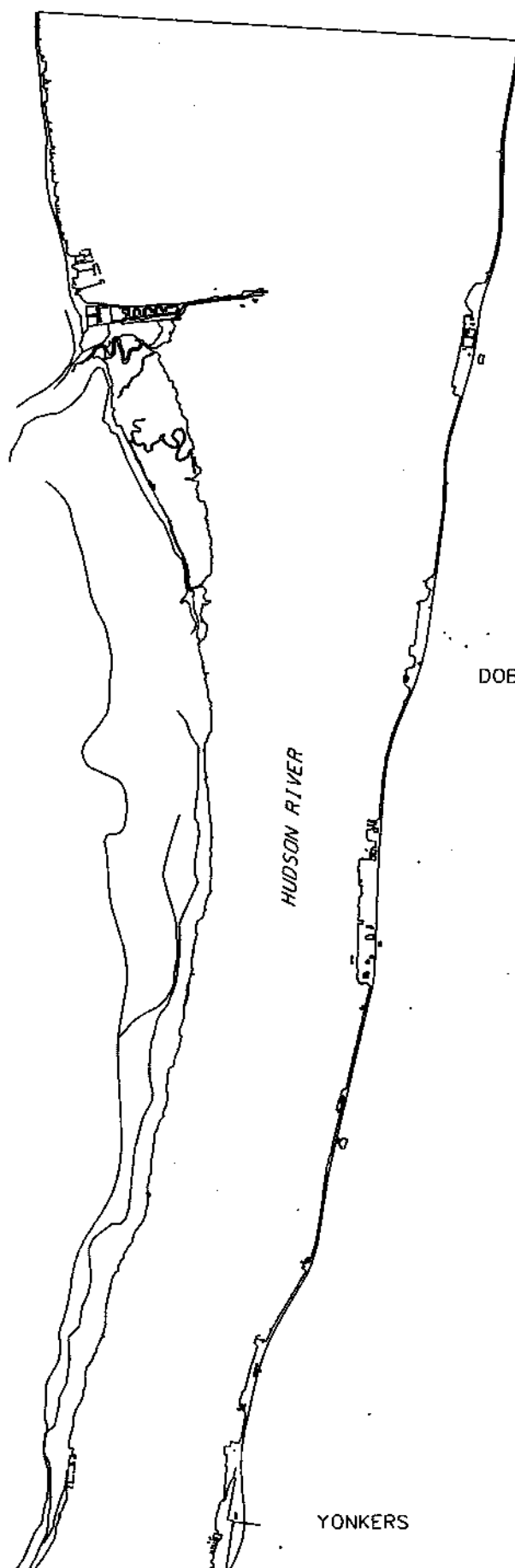
DATE	TIME	NUMBER/ TYPE/ROLL #	PHOTO #	SCALE	TIDE LEVEL (Above Mean Sea Level)
10-12-99	1606-1616	99ACN27	5048-5068	1:48,000	0.5 m
10-12-99	1629-1639	99ACN28	5069-5086	1:48,000	0.5 m

## APPENDIX D





PIERMONT



DOBBS FERRY

HUDSON RIVER

YONKERS

NJ9901A  
Hudson River  
GC-10496