VERSION 13B
January, 2008

SCOPE OF WORK
SHORELINE MAPPING

NOAA COASTAL MAPPING PROGRAM
REMOTE SENSING DIVISION
NATIONAL GEODETIC SURVEY
NATIONAL OCEAN SERVICE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE

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UNDER THE
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SCOPE OF WORK

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1. INTRODUCTION

This Scope of Work (SOW) includes remote sensing, digital shoreline mapping, surveying, and associated tasks for the U.S. Department of Commerce, National Oceanic and Atmospheric Administration (NOAA), National Ocean Service (NOS), National Geodetic Surveys (NGS), Coastal Mapping Program in support of NOAAs nautical chart production. NOAAs charting responsibilities date back to 1807 when President Thomas Jefferson founded the Survey of the Coast. Over the years the agency name has changed several times but the enormous responsibility for producing accurate maps and charts of the nations entire shoreline has remained. The nautical chart has been called the most fundamental of navigation instruments making the chart=s accuracy and completeness essential. A nautical chart contains water depths, shoreline, topographic features, navigational hazards, aids to navigation, landmarks, vertical (overhead) clearances and other navigational information. Vessel navigators use charts to determine their position, the location of their destination, and the safest and most economical route between these points. Charts are now available both on paper and electronically. Contract personnel working on this contract must have a comprehensive understanding of nautical charts and a thorough familiarity with the charts depicting the project area. See: http://nauticalcharts.noaa.gov/staff/charts.htm .

2. SCOPE

Projects may include one or more phases of shoreline mapping or other surveying and mapping including: planning; collecting remotely sensed imagery from aircraft or satellite, with positioning and orientation parameters; conducting ground geodetic surveys using conventional and/or precise Global Positioning System (GPS) methods; installing water level gauges and tidal bench marks, making tidal and leveling observations, and processing this data; performing aerotriangulation (AT); performing digital map compilation, with attribution; controlling quality, including equipment calibrations; and writing reports. Projects may also include: aerial photography or other remotely sensed data over airports, ground control surveys and obstruction surveys on airports, emergency response to disasters, and other special case tasks. Specifications for aerial photography over airports are in Attachment A. The remotely sensed data may include: LIDAR (see Attachment Y), film camera imagery (see Attachment C), or digital camera imagery (see Attachment Z), hyperspectral data (see Attachment AA), Interferometric Synthetic Aperture Radar (IFSAR) (see Attachment AB) and/or gravity data. The Project Instructions will define any unique project specific requirements.

3. PROJECT PARAMETERS

3.1 PROJECT LIMITS - Coastal Mapping Program projects may be along any portion of the U.S. shoreline including U.S. possessions in the Caribbean and the Pacific. Individual project limits will be defined in the Project Instructions (see sample in Attachment B) and will be outlined on government provided nautical chart(s) of the area. Note: A diagram of the project location may be included in the Project Instructions. Typically a rectangle will be used to define the project area boundaries. Usually the entire rectangle does not need to be covered with imagery, just the shoreline and adjacent areas. The photo coverage is planned to include all of the shoreline within the project area and all of the land within 2000 feet of that shoreline.

Airport and other surveying and mapping projects may be anywhere in the U.S., including possessions and adjacent areas.

3.2 PRIORITY - The Project Instructions may define priority between Task Orders and within a Task Order.

3.3 ACCURACY – For the Coastal Mapping Program, general guidance on HORIZONTAL accuracy at a 95% confidence level for well defined points compiled in the Digital Cartographic Feature File:

Harbors, ports, channels, etc.	1 meter
Approach areas to ports	3 meters
Open coastal areas	5 meters

For specific requirements, see Project Instructions.

3.4 COMPLIANCE REQUIREMENTS

A. PROJECT INSTRUCTIONS PRECEDENCE - The Project Instructions will take precedence over this Scope of Work, since the Project Instructions provide detailed and often unique information about each project.

B. TERMS - The following conventions have been adopted for this document. The term –shall- means that compliance is required. The term –should- implies that compliance is not required, but is strongly recommended.

C. MODIFICATION - Requests to exceed or deviate from this SOW or the Project Instructions will be considered if written justification is provided in advance. No deviation is permitted until written approval is received from NGS. All requests for modification to this SOW and/or the Project Instructions shall be submitted by the Contractor in writing to the Contracting Officer prior to the due date on the Task Order and as soon as identified. Send a copy of the request to the NGS point of contacts. If the Contractor anticipates not meeting a required deadline, the Contractor shall request, in writing, an extension from the Contracting Officer. Provide a copy of the extension request to NGS. Extensions may be granted if extenuating circumstances exist.

D. UNUSUAL CIRCUMSTANCES - The Contractor shall also notify NGS immediately of any unusual circumstances that occur during the performance under this SOW which might affect the deliverables or their quality, and especially of any deviation from this SOW.

E. ORIGINAL DATA - Observation logs and other records generated during this project are legal records which will be archived by the government. It is very important that these logs be original, legible, neat, clear, and fully completed in indelible black ink. Original data shall be saved, unmodified, whether in hand written or computer recorded form, and shall be marked -ORIGINAL DATA-. In the original records (paper or digital), nothing is ever erased or obliterated. All available spaces on the recording forms should be completed. If a space on a form does not apply, then enter -N.A.- for -Not Applicable-. If a mistake is made on a form, draw a single line ~~through the mistake~~ and write the correction above or to the side. If space is too limited to permit a field correction, restart with a new log sheet, however, the form should not be recopied in the office in order to make a –clean- copy. An explanatory note shall be made, and initialed for all corrections to the original recorded figures. It is essential that all recorded figures be neat and legible. All editing of computer recorded data shall be done on a copy of the original. Always submit the original version of the data, not a hand-made copy nor a photo-copy nor a digital copy.

F. DATA BACKUP - The Contractor shall back-up all data and take steps to ensure the safety of all data, especially original, raw data. The contractor shall save all data back-ups for six months after NGS has accepted all data for that Task Order. At the end of that time period, the contractor shall destroy all copies of this data and notify NGS in writing that the back-up data has been destroyed.

G. GOVERNMENTAL RULES AND REGULATIONS - The Contractor shall ensure that they comply with applicable regulations of government agencies, including the:
Federal Aviation Administration (FAA), http://www.faa.gov/regulations_policies/
U.S. Coast Guard (USCG), http://www.navcen.uscg.gov/mwv/regulations/regs_home.htm
Environmental Protection Agency (EPA), http://www.epa.gov/lawsregs/
Occupation Safety & Health Admin. (OSHA), http://www.osha.gov/comp-links.html
National Park Service (NPS), http://www.nps.gov/history/laws.htm
and other federal, tribal, state, and local governmental rules and regulations.

3.5 NATIONAL SPATIAL REFERENCE SYSTEM (NSRS) - All surveying, positioning, and mapping shall be tied to the NSRS
http://www.ngs.noaa.gov/INFO/OnePagers/One-Pager_NSRS.pdf

A. HORIZONTAL CONTROL - North American Datum (NAD) 83 (YYYY), where YYYY is the year of the most recent adjustment. Note, the year of the adjustment is on the NGS Data Sheet next to the latitude and longitude.

B. VERTICAL REFERENCE -
- VERTICAL CONTROL:
  - North American Vertical Datum (NAVD) 88
  - Alaska and other areas outside the continental U.S., see Section 6.2A
  - or other local datums if required by the Project Instructions
- SHORELINE COMPILATION:
  - MEAN LOWER LOW WATER (MLLW), see Section 8.5
  - MEAN HIGH WATER (MHW), see Section 8.5

C. MODEL - Use the most recent NGS model, currently GEOID03 (for the lower 48 states http://www.ngs.noaa.gov/GEOID/GEOID03/) and GEOID 06 for Alaska.. For projects in Alaska and other areas outside the conterminous 48 states, see the Project Instructions for any special requirements.

3.6 REFERENCES AND GLOSSARIES

A. NOAA Nautical Chart Information - http://nauticalcharts.noaa.gov/staff/charts.htm

B. -NOAA Chart #1- at: http://nauticalcharts.noaa.gov/mcd/chartno1.htmgov/mcd/chartno1.htm

C. Dates of Latest Editions of charts: http://nauticalcharts.noaa.gov/mcd/dole.htm

D. NOAA CHART CATALOG - The NOAA catalog shows chart coverage and lists nautical chart dealers. See: http://nauticalcharts.noaa.gov/mcd/ccatalogs.htm

E. -U.S. Coast Guard Light List- available on-line at:
http://www.navcen.uscg.gov/pubs/LightLists/LightLists.htm

~~F. USCG Light List Nav Aid Reference Guide available for separate download from the www site in 3.4 G.~~ (no longer on-line)

F. See also Attachments F and M.

G. Manual Of Photogrammetry, Fifth Edition, 2004.

H. Manual of Color Aerial Photography, First Edition, 1968.

4. <u>GOVERNMENT SUPPLIED INFORMATION AND MATERIALS</u>

4.1 SOW, WITH ATTACHMENTS (this document)

4.2 PROJECT INSTRUCTIONS

Possible enclosures:

A. Copies of nautical charts with project limits marked by NGS - Chart(s) of the project area showing rectangular project limits; compilation limits, if different from the 2000 foot requirement; and, as required, limits of tide-coordination areas (if different from compilation limits).

B. One set of blank, pertinent nautical charts covering the project area - Note, the Contractor is responsible for procuring new editions, as required, to ensure that they are using the latest edition of all nautical charts. A listing of the latest editions may be found at: http://nauticalcharts.noaa.gov/mcd/dole.htm
C. Tidal zoning diagram
D. Tidal zoning memo
E. Flight line map
F. Waypoint file

4.3 LABORATORY PHOTOGRAPHIC SERVICES AND PRODUCTS - All laboratory photographic services and products used in the performance of this contract shall be supplied at government expense by the NOAA Photographic Services contractor. These include: film processing, film duplicating, diapositive production, print production, film scanning, film storage, and film shipment from the Laboratory. These products shall remain the property of the Government, and shall be returned to NOAA at the conclusion of each project. See Attachment C for further information.

4.4 EED FILE CHECKING SOFTWARE - The Contractor shall check every EED file with government supplied software prior to submitting each EED file to NGS. The software checks the EED file for proper formatting and checks for value limits on various fields within the file. The software also computes and displays the aerial photography footprints, enabling the checker to immediately see problems with positioning, spacing, and/or orientation. See Attachment H for documentation.

4.5 SOFTWARE (TIDE 8+ or other) - This software computes tidal windows given times of high and low tides. NGS will provide training. See Attachment J for details. NGS is currently (mid-2005) developing new software. The Project Instructions will specify the required software.

4.6 NGS SURVEY MARKS - NGS will supply NGS survey disks and NGS logo caps (protective cover over a rod mark) if required.

The Contractor shall acknowledge receipt of Government Supplied Items by inventorying the shipment, signing the Transmittal Letter, and FAXing the Letter to NGS. At this time contractors can not use TOMIS to acknowledge receipt of Government Supplied Items sent by the Government.

5. TECHNICAL AND COST PROPOSALS

5.1 TECHNICAL PROPOSAL

A. TECHNICAL - After receiving and reviewing the Project Instructions, the Contractor shall submit a Technical Proposal summarizing their proposed implementation plan. This report shall include at least the following:

i. contractor planned flight lines with a nautical chart background, if required (see Attachment C, Section 8.2),
ii. proposed ground control locations (using different symbols for: CORS, new survey control, old survey control, photo control, and airborne KGPS Ground Base Stations),
iii. proposed tide/water level stations, if required,
iv. proposed approximate date range of imagery acquisition,
v. summary of all field and office data collection,
vi. data processing (methods, equipment, hardware, and software)
vii. personnel,
viii. TOMIS Deliverable Tracking Log (format with Project Instructions),

See Attachment AD for the full requirements.

B. QUALITY CONTROL - The Contractor shall have the responsibility for the overall quality of the Project. The Contractors Final Reviewer and other Contractor personnel, as required, shall become intimately familiar with the Project Instructions, the SOW, the SOW Attachments, and References. The Contractor shall submit a written Quality Control Plan prior to beginning work (as part of their Technical Proposal), to include at least the following:
i. checking manually recorded data,
ii. checking data manually entered into a computer system,
iii. checking data at various points in the over-all process,
iv. reviewing the compilation data on-line (see Attachment K),
v. comparing the compilation data with the largest scale nautical charts of the same area,
vi. comparing compilation data with the aerial photographs of the same area,
vii. checking all documents and reports submitted.

The Plan shall include both Quality Control (QC) and Quality Assurance (QA), as defined in Attachment M - Coastal Mapping Program Glossary.

5.2 COST PROPOSAL - The Contractor shall submit a proposal with the costs broken down into at least the following categories:
A. Mission planning,
B. ~~Aerial Survey,~~ GPS Surveys Planning
C. Ground and photo control,
D. Tides and water levels,
E. Imagery acquisition,
F. Aerotriangulation,
G. Compilation,
H. Final Product Preparation.
Include number of labor hours, labor costs, and non-labor costs for each category.

6. DATA ACQUISITION

6.1 REMOTELY SENSED DATA

A. AERIAL PHOTOGRAPHY

i. Flight Line Planning - The Project Instructions may require the Contractor to plan flight lines or may state that NGS has planned the lines.

- Contractor Planned Flight Lines - The Contractor may be required to plan the flight lines given the project area and other information contained in the Project Instructions. Flight line maps shall be depicted with a NOAA nautical chart as the background. The photo coverage shall be planned to include all of the shoreline within the project area, all of the land within 2000 feet of that shoreline, and offshore features such as islands, rocks, man-made obstructions, fixed aids to navigation, piers, and jetties. See Attachment C for additional requirements.

- Government Planned Flight Lines - If NGS plans the flight lines, NGS will supply flight line maps and waypoint files in standard NGS format (see Attachment C, Annex 4 for format).

ii. Exposure Test and Production - The Contractor shall conduct and submit an exposure test over an area similar to the project area for each type of emulsion and each camera system to be used. After NGS review and approval of the exposure test, the Contractor may begin production photography; see Attachment C, Section 3. The Contractor shall ship all exposed film to the NOAA film processing Contractor, along with a completed, original -Photographic Flight Report- (NOAA Form 76-15), the Raw Navigation File, and a Transmittal Letter, see Attachment AC. The Electronic Exposure Data (EED) file is sent to NGS within three working days. All manual data entries shall be checked. See Attachment C, Aerial Photography Requirements for complete details. Note, the Project Instructions will state if new exposure tests are required for future Task Orders.

iii. Tide Coordination - The Project Instructions may require that remotely sensed imagery be tide coordinated. When digital shoreline is to be compiled using aerial photographs, color negative and black-and-white InfraRed (IR) films may be required to be captured when the water level is at observed or predicted Mean High Water (MHW), observed or predicted Mean Lower Low Water (MLLW), and/or below or between these water levels. Normally NGS allows a tolerance on either side of MHW and MLLW, see Attachments C and J. See the Project Instructions for detailed project information.

iv. Airborne Positioning and Orientation - All remotely sensed imagery (including color and infrared) shall be positioned using airborne Kinematic GPS (KGPS) (with dual-frequency, carrier-phase measurements). The collection of exposure station orientation parameters (using an Inertial Measurement Unit (IMU)) simultaneously with the photography is normally not required, but may be used. See Attachment C.

v. Camera Ports - An aircraft with dual camera ports may be required so that two sensors can collect data simultaneously.

B. OTHER REMOTELY SENSED DATA - The Project Instructions may include requirements for any photographic systems and/or remote sensors that convert energy from
the electromagnetic spectrum into analog or digital data obtained from any airborne or spaceborne satellite platform. Also gravity data may be required. See Project Instructions for any specific requirements.

6.2 GROUND CONTROL SURVEYS

A. CHECK POINTS - For shoreline mapping projects under this SOW using film or digital cameras, at least four check points are required. These points shall have horizontal and vertical positions. In Alaska and other areas outside the continental United States where NAVD 88 bench marks are not available, the Contractor shall make GPS ties to existing tidal bench marks within the project area. Additional information may be supplied in the Project Instructions. The check points shall be approximately evenly spaced in the project area and shall be positioned using specifications listed below. On large projects, use at least one check point for every four strips, and at least one near each corner of a block. **These four points shall not be used in the aerotriangulation computations, but rather serve as an independent check of the photogrammetric solution.** The contractor shall hold these back until the aerotriangulation is complete. The contractor shall compare the ground positions of the check points to the results derived from the aerotriangulation solution and shall report these results to NGS in table form in the Ground Control Report.

B. GROUND CONTROL - The contractor may propose additional ground control to be used in the aerotriangulation. The Contractor shall determine an adequate number and distribution of photo control points. A description of the plan and the number, type and spacing of these points shall be included in the Technical Proposal. Contractors should use Continuously Operating Reference Stations (CORS) and Online Positioning User Service (OPUS) (including OPUS-RS) to position the photo ground control. Note, NGS is currently (2008) developing new versions of OPUS ~~which may shorten the required GPS observation sessions and may fulfill Blue-Booking requirements.~~ Any updates in this SOWs OPUS requirements will be included in the Project Instructions. See Attachment O for ground photo control requirements.

C. GROUND SURVEYS - See Attachment P for requirements for Ground Control Extension Surveys (marks used to position other marks). In most cases this type of point should not be required.

D. AIRBORNE KGPS BASE STATIONS - GPS Base Stations are required to control airborne data collections. The Contractor shall use existing CORS, and/or use existing NSRS control points, and/or establish new ground control points, in that order of priority. See Attachment C, Section 13 for details.

E. OTHER CHECK POINTS - Check points for other types of sensors will be specified in the Project Instructions.

F. GENERAL - Additional survey related requirements may include: recovering survey marks, setting marks, constructing photo panels, photo identifying control points, writing digital mark descriptions and/or mark recovery notes, using conventional and/or GPS survey methods, taking digital photographs of the ground surveys, preparing visibility diagrams, GPS observation logs, station sketches, and reports. Detailed specifications for ground control surveys, including recommended forms, formats, and procedures are contained in Attachments N, O, P, Q, R, S, T, U, V, W, and X. Additionally, ground truth for various remote sensing instruments may be required.

6.3   TIDE/WATER LEVEL REQUIREMENTS - When required, specifications for predicting water levels, observing water levels in real time, installing water level gauges and tidal bench marks, collecting these data, GPS observations on tidal bench marks, and processing these observations will be included in the Project Instructions. Data shall be submitted in NOAA, Center for Operational Oceanographic Products and Services [CO-OPS] and NGS specified formats. In any cases where the requirements conflict or would cause duplicate effort, contact NGS for clarification. See Attachment J for information on tidal acquisition windows and Attachment P for information on GPS ties to tidal bench marks. For additional information on tides and water levels, see the CO-OPS site at: http://www.co-ops.nos.noaa.gov/, especially the link to -Our Restless Tides- at: http://www.co-ops.nos.noaa.gov/restles1.html , and -Fantastic Tidal Datums- at: http://tidesandcurrents.noaa.gov/publications/fantastic_tidal_datums.pdf . For a summary of NGS and CO-OPS surveying related requirements, see Attachment AH.

Note, predicted tides may not be accurate in time or height. The following is from the CO-OPS Frequently Asked Questions section on the CO-OPS WWW site.

Q: How accurate are the predictions?

The accuracy of the tide predictions is different for each location. Periodically we do a comparison of the predicted tides vs. the observed tides for a calendar year. The information generated is compiled in a Tide Prediction Accuracy Table. We work to insure that the predictions are as accurate as possible. However, we can only predict the astronomical tides we cannot predict the effect that wind, rain, freshwater runoff, and other short-term meteorological events will have on the observed tides.

In general, predictions for stations along the outer coast are more accurate than those for stations farther inland; along a river, or in a bay or other estuary. Inland stations tend to have a stronger non-tidal influence; that is, they are more susceptible to the effects of wind and other meteorological effects than stations along the outer coast. An example of an inland station which is difficult to predict is Baltimore, Maryland. This station is located at the northern end of Chesapeake Bay. Winds which blow along the length of the bay have been known to cause water levels to be 1-2 feet above or below the predicted tides.
Stations in relatively shallow water, or with a small tidal range, are also highly susceptible to meteorological effects and thus difficult to accurately predict. At these stations, short-term weather events can completely mask the astronomical tides. Many of the stations along the western Gulf of Mexico fall into this category. An example is Galveston, Texas. This station is in

a bay which is relatively shallow and has a small opening to the sea. At this station it is possible for meteorological events to delay or accelerate the arrival of the predicted tides by an hour or more.

7.0 DATA PROCESSING

7.1 GROUND PHOTO CONTROL SURVEYS - Data shall be processed with NGS approved software (NGS PAGES and ADJUST not required for photo control) and submitted in required formats. A final report is required. Specifications for ground control survey data processing and reports are in Attachment O. Requirements for positioning the GPS Base Station for the ground GPS receiver for the airborne KGPS are found in Attachment C, Section 13.

7.2 TIDE/WATER LEVELS - When required by the Project Instructions, tide/water level data shall be processed in accordance with Attachment J and its references.

7.3 AEROTRIANGULATION - The contractor is required to perform the standard processes of aerotriangulation for all photographs (including color and IR) used in the shoreline mapping project. The contractor shall include in the project Technical Proposal a plan explaining how the AT work will be performed. If the contractor intends to divide the project photography into sub-blocks for AT purposes, specific details shall be included in the Technical Proposal. The Contractor shall provide a written report which includes the listed requirements as found in Attachment I. See requirements regarding the four check points in Section 6.2A.

7.4 Other types of data shall be processed according to standard industry procedures and any requirements specified in the Project Instructions.

8. OFFICE DATA COLLECTION

8.1 DIGITAL CARTOGRAPHIC FEATURE FILE (DCFF) - The DCFF is the digital file, or set of files, containing the geometry and attribution of the features compiled from the imagery. The original compilation data will necessarily be in whatever file format used by the contractors digital mapping system, but the data submitted to the government shall be in the ESRI Shapefile format as defined in Attachment D. The Contractor shall supply two sets of cartographic feature files, the first being for the NGS quality assurance process (interim files) and the second as the final deliverable product to NGS. These interim shapefiles use an attribution schema that can be imported into NGSs digital photogrammetric softcopy workstations for stereoscopic review purposes.

8.2 COASTAL CARTOGRAPHIC OBJECT ATTRIBUTE SOURCE TABLE - The final product shapefiles use the NGSs -Coastal Cartographic Object Attribute Source Table- (C-COAST) attribution schema which is listed in Attachment E. There is a one-to-one translation from the interim to C-COAST attribution. The C-COAST attribution scheme was developed to conform the attribution of various sources of shoreline data into one attribution catalog. C-COAST is not a recognized standard, but was influenced by the International Hydrographic Organizations S-57 Object-Attribute Standard so the data would be more accurately translated into S-57. The glossary for the C-COAST feature attribute description is in Attachment F or may be found on the web at: http://www.ngs.noaa.gov/newsys_ims/shoreline/c_coast_def.htm . The shapefile attributes and attribute values are case sensitive. All shapefile attribute labels shall be upper case. See Attachment D for interim and final shapefile attribute requirements, including character and case sensitivity. General cartographic feature definitions within the Coastal Mapping Program are included in a second Glossary in Attachment M.

8.3 FILE NAMING CONVENTION

A. GENERAL - The Contractor shall clearly label file names on all submitted media. All data submitted shall be labeled with a systematic naming convention. All label and file naming conventions shall be documented and explained with each data submission. All original data shall be marked –ORIGINAL- on the data medium.

B. SHAPEFILES - The final deliverable shapefile product shall be one shapefile that stores the geometry and attribute information for the spatial coastal mapping features within the project limits as defined in the Project Instructions. This final deliverable shapefile shall have the prefix name of the project identifier as defined in the Project Instructions. The interim shapefile should also have the prefix name of the project unless the project limits are large enough to warrant subdividing it into more than one region for data management purposes in which case, the interim shapefiles should be named the Geographic Cell identifier that corresponds to a given subdivided region. The interim shapefile that was subdivided should be named in the following manner: GCxxxxx where -xxxxx- is a sequential number assigned by NGS. The Contractor shall request geographic cell file names from NGS via e-mail. NGS will normally respond within five working days of the request. Note that the final deliverable shapefiles SOURCE_ID attribute value is the corresponding Geographic Cell identifier.

8.4 COMPILATION METHODOLOGY - Aerial photographic data shall be compiled using stereo models in either an analytical or a digital photogrammetric system that meets the accuracy requirements set forth in this SOW and that produces data in a format(s) compatible with SOCET SET7 software. Compile within the limits of the stereoscopic neat model. See Attachment K.

8.5 FEATURE COMPILATION

A. VECTOR COLLECTION INTERVAL AND ACCURACY –
As a line of natural shoreline is digitized, the Contractor shall measure vertices frequently enough to ensure that the agreement between the digital shoreline and the shoreline visible on the mapping imagery is equal or better than the allowed discrete point accuracy, for 95% of points along the digital shoreline. Point-to-point mode of compilation should be used when collecting well-defined points such as corners of a pier or wharf. See Attachment K.

B. DISCRETE POINTS - Many well defined point features, such as landmarks, fixed aids to navigation, and small rocks, serve as check points and supplemental control for various remotely sensed images. The cartographer should exercise extreme care in the measurement of well defined discrete points. See Attachment K.

C. LINEAR FEATURES CONNECTIVITY - Collected linear data shall be topologically cleaned by removing all erroneous dangles and gaps, caused by inadequate snapping, so that linear features are continuous.

D. COMPILATION LIMITS - In all project areas, the features to be compiled include: the shoreline; physical and cultural features visible from the water and thus of value to the mariner; and other significant features on the land for a distance inland of 2000 feet from the shoreline. When within the photo coverage, landmarks shall be compiled even if they are beyond the 2000-foot limit. See Attachment K.

E. COMPILATION CONTENTS AND LEVEL OF DETAIL - In general provide approximately the same level of detail as on the sample nautical chart listed in the Project Instructions. However, provide additional detail on and along land areas facing navigational channels (those waterways with Aids To Navigation). U.S. Geological Survey (USGS) Quadrangle maps are recommended for help in interpretation.

Significant types of features include, but are not limited to: shoreline; fixed aids to navigation; landmarks; major roads; major buildings; railroads; canals; bridges; tanks (other than landmarks); pipelines; and power lines. See Attachment K.

8.6 CHART COMPARISON PRINT ANNOTATION - See Attachment K.

9. QUALITY CONTROL AND FINAL PRODUCT PREPARATION

9.1 QUALITY CONTROL - The contractor shall conduct Quality Control of all the work performed and all deliverables produced in accordance with the Quality Control Plan, which was submitted with the Technical Proposal and accepted by NGS. The feature compilation shall undergo a final quality review ensuring accuracy of delineation, correct feature attribution, completeness, clarity, and adherence to all project requirements (see Attachment K). A summary of the QC and QA work performed shall be included in the Final Review section of the Project Completion Report (see Attachment L, Section 4.8).

9.2 FINAL SHAPEFILE PREPARATION - After the Interim Shapefiles have been reviewed and accepted by NGS, the Final Shapefiles shall be prepared and submitted. The preparation of the Final Shapefiles typically consists of merging the multiple accepted Interim Shapefiles into one, changing the coordinate system, editing existing attributes, adding additional attributes, topologically cleaning the files of stray dangles and gaps, and other work of this nature. The actual data processing steps required for a project will depend on the particular systems, software, and methodology used by the contractor, and may differ from the procedures listed here. See Attachment D, Section 2.

9.3 CHART EVALUATION FILE - The Chart Evaluation File (CEF) is an ESRI shapefile containing polygons intended to overlay the largest scale nautical chart(s) covering the project area. The purpose is to document navigational hazards, landmarks, fixed aids, and coastline features portrayed on NOAA nautical chart products whose existence or geographic position can not be confirmed photogrammetrically, or whose size, shape, orientation or position appear to have changed significantly from the current chart portrayal. The CEF shall contain the necessary annotations made on the Chart Comparison Print (CCP) by the compiler during the feature collection process, as described in Attachment K. The annotations in the CEF are used by the Office of Coast Survey to aid in the application of the DCFF data when updating charts and when performing hydrographic survey operations. Any additional notes from the CCP that are not relevant to these uses shall not be transferred to the CEF. See Attachment AE, for details and examples.

9.4 PROJECT COMPLETION REPORT (PCR) - The contractor shall prepare a final report which summarizes all phases of the work performed for the project. If more than one project is assigned in a single task order, then a separate and complete PCR is required for each project. The PCR shall conform to all of the requirements outlined in Attachment L, which includes a sample PCR for reference. It is important that the discussion of the work performed includes any unusual circumstances that may have occurred, and any deviations from the SOW, Project Instructions, and/or normal operating procedures. The PCR shall be delivered in both the Microsoft (MS) Word format and the Adobe Acrobat (PDF) format; except for the Project Diagram on the final page of the report, which is only required to be delivered in PDF format, and may be omitted from the Word version at the contractors discretion. The PCR (in PDF format) will be made available on the NOAA Shoreline Data Explorer website for download along with the project shapefiles. See Attachment L.

10. <u>DELIVERABLES</u>

~~The digital data required under this SOW shall be submitted via provided to NOAA on CD-ROM.~~

The web-based Task Order Management and Information System (TOMIS) is designed to help manage geospatial services contracts for the National Ocean Service. TOMIS allows Government contractors to submit and track deliverables, as well as monitor deliverables that are upcoming or delinquent. E-mail notifications remind contractors when actions are required and contractors will be evaluated on their performance at the completion of all task orders, with a score automatically generated via TOMIS. The TOMIS system is located at https://maps.csc.noaa.gov/TOMIS/index2.jsp.

The Contractor shall submit all task order deliverables and progress reports to NGS using the TOMIS system. All progress reports shall be submitted directly to TOMIS by 2:00 pm EST every Monday, and not via email as formerly required. All deliverables smaller than 3 MB in size shall be submitted to TOMIS as an attachment. If the deliverable is over 3 MB (or hardcopy) the contractor shall submit a report to TOMIS expressly stating what the deliverable is and how the deliverable is being delivered, i.e. via FedEx, FTP, etc Once the deliverable is received by NGS, NGS will mark it as received in TOMIS and TOMIS will send an e-mail confirming receipt of the deliverable.

The contractors shall submit a deliverable tracking spreadsheet in the TOMIS format (the format will be supplied with the Project Instructions). The percentages assigned to each of the deliverables in the spreadsheet will be used as a basis for payment. The Government will not pay an invoice unless a deliverable has been received and at least partially accepted. The last 10% of payment shall be assigned to the shipment of the Government Supplied Materials back to the government. The contractor will be held accountable to the dates that are placed in the spreadsheet. If the contractor determines that they will not be able to meet a due date, it is their responsibility to request an extension.

TOMIS will track the submission dates of all deliverables, and the subsequent review comments generated when deliverables are submitted. As a last step the information within TOMIS will be used to generate a final evaluation for the project.

Photos taken of ground surveyed points shall be submitted on a separate CD.

All deliverables shall be submitted ~~sent~~ by the prime contractor to NGS, not from a sub-contractor, except for film which a sub-contractor may ship directly to NGS film processing contractor. This shipment to the prime contractor enables the prime contractor to check all data prior to shipment to NOAA.

The Contractor shall continue to use a transmittal letter to acknowledge receipt of Government Supplied Materials. ~~include a transmittal letter with every shipment to NOAA.~~ The Transmittal Letter shall list all items sent, each individually. See Section 10.10 below and Attachment AC for details and an example.

All reports except weekly ~~email~~ status reports shall be delivered in both digital (MS Word), and paper formats. In addition, Adobe Acrobat (PDF) may also be submitted.

10.1 LABOR, EQUIPMENT, ETC. - The Contractor shall provide all labor, equipment, supplies, materials, and transportation to produce and deliver the products required under this SOW.

10.2 GOVERNMENT SUPPLIED ITEMS - The Contractor shall return all government supplied items to NGS. This shall include all photographic products, see Section 4.

10.3 ~~EMAIL~~ STATUS REPORTS - The Contractor shall submit project status reports via TOMIS ~~email~~ ~~to the contacts in Section 11~~ every Monday by 2:00 PM Eastern Time, from the date of a Task Order award until the work is complete and accepted by NGS. See Attachment G for details.

10.4 GROUND CONTROL DATA AND REPORT - The Contractor shall prepare a report covering the ground control survey portion of the work. See Attachments N, through X for detailed instructions for ground surveys and the report. Submit this data and report within six weeks of the conclusion of the ground control survey work. See also Attachment C, Section 18, DELIVERABLES.

10.5 AERIAL PHOTOGRAPHY ASSOCIATED DELIVERABLES - Deliverables are listed below:

A. EXPOSURE TEST(S) - See Attachment C, Section 6.2

B. FLIGHT LINE MAPS (Final), if the actual lines flown differ from the planned flight line maps. See Attachment C, Sections 3 and 6.

C. TABULATION OF AERIAL FILM AND TIDAL COORDINATION, See Attachment

C, Section 11.

D. PHOTOGRAPHIC FLIGHT REPORTS (NOAA Form 76-15), See Attachment C, Sections 6 and 18.4, and Annexes 1 and 2;

E. RAW NAVIGATION FILE, See Attachment C, Section 6.1C.

F. ELECTRONIC EXPOSURE DATA (EED) FILES, See Attachment C, Section 18.6 and Annex 3

G. AIRBORNE POSITIONING & ORIENTATION REPORT, See Attach. C, Section 18.8.

H. CAMERA CALIBRATION REPORT, if the current version has not already been submitted. See Attachment C, Section 18.11.

I. CAMERA MAINTENANCE REPORT, if the current version has not already been submitted. See Attachment C, Section 18.12.

J. CAMERA WINDOW INFORMATION, if the current version has not already been submitted. See Attachment C, Sections 18.13.

K. FILM SHIPMENT, See Attachment C, Section 15.

L. FILM SHIPMENT REPORTING, See Attachment C, Section 18.5.

M. PHOTO FINAL REPORT, See Attachment C, Section 18.16.

Submit all of the above requirements within three weeks of the completion of the aerial photography. Note, the items in the above Sections C, D, and F have other specific delivery requirements which are explained in Attachment C.

10.6 AEROTRIANGULATION DATA AND REPORT - The Contractor shall prepare a report covering the AT portion of the work. The AT files should include all the files necessary to review the original data using SOCET SET software. See Attachment I for detailed instructions. Submit this data and report within three weeks of the completion of the AT.

10.7 CHART ANNOTATIONS – For requirements on annotating Chart Evaluation Files ~~and Chart Maintenance Prints.~~ see Attachment K and Attachment AE

10.8 PROJECT COMPLETION REPORT - This is a final report covering all phases of the work performed. See SOW Section 9.4 and Attachment L. This report should accompany the final data submission.

10.9 DIGITAL CARTOGRAPHIC FEATURE FILES - The Contractor shall supply two sets of ESRIs 3-D shapefiles, one for quality control purposes (interim files) and the other as the final product. The final shapefiles shall be supplied to NGS after the interim shapefiles have been quality reviewed and approved by NGS personnel. See Attachment D, Shapefile Requirements.

10.10 TRANSMITTAL LETTER - ~~The Contractor shall prepare a Transmittal Letter for every shipment to NGS. One copy of the Letter is sent with the shipment and another copy is emailed or FAXed to NGS. NGS will return the receipted Letter and will also use Transmittal Letters when shipping information. The Contractor shall maintain a copy of all transmittal letters. See Attachment AC.~~

With the new TOMIS system, a Transmittal Letter will seldom be used for Contractor Deliverables. For Deliverables the Contractor submits to TOMIS, the system will acknowledge receipt after NGS marks the item as received. For all large digital files (greater than 3MB) and for hard copy materials that the Contractor submits outside of TOMIS, (hardcopy data being sent via express mail, regular mail, etc.) the Contractor shall submit a report to TOMIS stating the material submitted and the method of shipment. Transmittal Letters will continue to be used for items the Government ships to the Contractor. See sample Transmittal Letters in Attachment AC.

11. DELIVERY SCHEDULE

11.1 DATE - All deliverables (Section10) shall be submitted to NGS (TOMIS) by the project completion date listed in the Task Order. If the Contractor anticipates that the project will not be complete by the deadline date, the Contractor shall request an extension prior to the deadline. Extensions will normally be granted if there are extenuating circumstances. Interim reports and data sets should be submitted within three weeks of completion of that portion of the project. All materials submitted by the Contractor shall be delivered at the Contractors expense.

11.2 REQUESTS FOR MODIFICATIONS - All requests for modification shall be submitted by the Contractor in writing to the Contracting Officer prior to the due date and as soon as possible.

11.3 MODIFICATIONS - In the event the schedule is exceeded due to causes beyond the control and without fault or negligence of the Contractor, as determined by the Contracting Officer, the Task Order will be modified in writing and the Task Order completion date will be extended one (1) calendar day for each calendar day of delay.

12. POINTS OF CONTACT:

NOAA:

George E. Leigh	Jeffrey Hale
Contracts Technical Manager & COR	Contracting Officers Representative
National Geodetic Survey	National Geodetic Survey
ATTN: N/NGS; SSMC3, Sta. 8609	ATTN: N/NGS; SSMC3, Sta. 8753
1315 East-West Highway	1315 East-West Highway
Silver Spring, Maryland 20910	Silver Spring, Maryland 20910
301-713-3167	301-713-3171 x 132
Fax: 301-713-4315	Fax: 301-713-4315
email: George.Leigh@noaa.gov	email:Jeffrey.hale@noaa.gov

Version 15A
January 25, 2008

ATTACHMENT A
AIRPORT AERIAL PHOTOGRAPHY

TO
SCOPE OF WORK FOR SHORELINE MAPPING
UNDER THE
NOAA COASTAL MAPPING PROGRAM

REMOTE SENSING DIVISION
NATIONAL GEODETIC SURVEY
NATIONAL OCEAN SERVICE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE

TABLE OF CONTENTS

ANNEXES

ATTACHMENT A: GENERAL SPECIFICATIONS FOR AERONAUTICAL SURVEYS VOLUME II AIRPORT AERIAL PHOTOGRAPHY

1. GENERAL

These General Specifications (Volume II) specify requirements for aerial photography needed to support the Aeronautical Survey Program (ASP). The ASP is administered by the National Geodetic Survey (NGS), National Ocean Service (NOS) in accordance with a Federal Aviation Administration (FAA)/National Ocean Service Interagency Agreement.

The following conventions have been adopted for this document. The term "shall" means that compliance is required. The term "should" implies that compliance is not required, but is strongly recommended. All times shall be recorded in Coordinated Universal Time (UTC).

The Contractor shall comply with all applicable laws, ordinances, regulations and procedures (federal, state, county, city, or otherwise) and shall be responsible for obtaining all necessary permits for work performed under this contract.

The information furnished under these standards may include runway and stopway data, Navigational aid (NAVAID) data, Obstruction data, and various airport features, including taxiways, aprons, and landmark features. Most of this information is source data, being acquired by field survey and/or remote sensing methods. This information is used to develop instrument approach, and departure procedures, certify airports for certain types of operations, determine maximum takeoff weights, update aeronautical publications, provide geodetic control for engineering projects, assist in airport planning and land use studies, and for other miscellaneous activities.

2. DELIVERABLES

2.1 CONTRACTOR:

A. LABOR, EQUIPMENT AND SUPPLIES - The Contractor shall provide all labor, equipment (including an aircraft and metric camera), supplies and material (including film) to produce and deliver exposed film and related products as required under this Attachment.

B. FLIGHT LINE PLANNING AND MAPS - The Project Instructions may require the Contractor to plan flight lines and/or produce maps showing flight lines.

C. IMAGERY - The Contractor shall capture and deliver both an Exposure Test(s) and Regular Production (see Section 3). The Project Instructions may specify film and/or digital camera usage. Note, a separate exposure test is required for each combination of a camera, emulsion, and filter planned to be used. Exposure tests will not be accepted as regular production coverage. For both exposure tests and production, the Contractor shall deliver the original, near-vertical, metric quality, undeveloped aerial photography exposed over airports. For the Exposure Test(s), the Contractor shall determine a flight line approximately over the center of a convenient airport and collect at least five photographs. This test should be flown over an airport that has varying terrain and vegetation (preferably trees). For Regular Production, the Contractor shall fly predetermined flight lines, normally supplied by the Government (this information will be supplied in the Project Instructions). The Photographic Flight Report and Electronic Exposure Data (EED) file shall be submitted for both test and production photography. For further film requirements, see Sections 3.1 (Exposure Test), 3.2 (Regular Production), 4.2 (Film), and 14 (Film Shipment and Processing).

D. FLIGHT REPORTS - Submit the original Photographic Flight Reports (NOAA Form 76-15) completed in black ink (except the **word "ORIGINAL" at the top printed in BLUE ink),** with the film. Forward a copy of the Flight Report directly to NGS**.** For samples see Annex 4 and 5, and for shipment instructions see Section 14.

E. ELECTRONIC EXPOSURE DATA (EED) FILES - The Contractor shall submit the original, raw navigation data file (which will be used by the Contractor to create the EED file) with the film. The "raw navigation file" is the standard output of the Contractor's flight navigation system. The Contractor shall prepare an EED file, in NGS format, for each roll of film. This EED file shall contain information for all exposures on that roll. The Contractor shall submit this final EED file to NGS via TOMIS ~~directly to NGS, to arrive at NGS~~ within three working days of shipment of the corresponding roll of film. Note, a 3.5" floppy disk with the EED file no longer required. **The Contractor shall submit the format of the raw navigation file to NGS** and shall explain any and all changes to the raw navigation data in the Final Report. See EED format in Annex 6, and shipment instructions in Section 14.

F. GROUND CONTROL (If required) - Refer to Project Instructions, Attachment O and P and Section 6, Ground Control Survey and Data Delivery Format.

G. GEO-REFERENCING (If required) - Refer to Project Instructions and Section 7, Geo-Referencing and Data Delivery Format.

H. TRANSMITTAL LETTERS - Send film transmittal letters with each film shipment (see the sample in Annex 9, and further information in Sections 2.1K, 3.1, 3.2, & 14), ~~and a transmittal letter with the Final Report.~~

The Contractor shall also return receipted copies of any Transmittal Letters that the Government sends. Other Deliverables shall be submitted via TOMIS, see Main Text of SOW, Section 12.

I. CAMERA CALIBRATION - Supply the current USGS Camera calibration certificate for each camera planned for use, directly to NGS prior to any photography.

J. CAMERA MAINTENANCE - Provide a preventive maintenance certification for each camera to be used to acquire aerial photography directly to NGS (see Section 4.1).

K. CAMERA WINDOW - Report the physical characteristics of any camera window to NGS prior to use (see Section 4.3).

L. FILM SHIPMENT - See Sections 3 and 14 for instructions.

M. FILM SHIPMENT REPORTING - The Contractor shall notify NGS of each film shipment's contents and date of shipment by transmitting to NGS a ~~paper or~~ digital copy of the Photographic Flight Report (marked "copy" at the top) and a digital copy of the film transmittal letter via TOMIS. ~~email or facsimile~~. This shall be done the same day the film is shipped to the film processing contractor.   See Section 14.

N. UNUSUAL CIRCUMSTANCES - The Contractor shall also notify NGS of any unusual circumstances that occur during the performance of this Attachment, which might affect the deliverables or their quality and especially of any deviation from this Attachment. This may be included in the weekly status report required below, unless urgent.

O. STATUS REPORTS - After an award, the Contractor shall submit project status reports via TOMIS ~~email~~ to the Points of Contact (POCs) in Section 18 every week, until the work is complete**. These reports are due at NGS by 2:00 P.M. EST each Monday afternoon**. These reports shall include: a list of airports where photography is completed, with dates completed; film shipped, and dates; and any unusual circumstances, deviations from this Attachment, equipment malfunctions, and/or any disturbance of the camera. **A Weekly Status Report is required even if no progress has been made.** See Attachment G for detailed requirements.

P. FINAL REPORT - The Contractor shall supply to NGS a Final Report including, at least, these sections:

i.   Work performed under this Attachment A, discuss each deliverable including: the mean overlap, the mean tilt, the mean crab, and explanation of the photograph labeling;
ii.   Equipment used to perform this work, including hardware models and serial numbers, and software names and versions;
iii.   Flight planning, if performed;
iv.   Discussion of exposure settings used, filters used;
v.   Discussion of the Contractor's Quality Control Plan, and film quality;
vi.   Ground Control Survey, if this work was done:
vii. Geo-referencing procedures, if this work was done;
viii. Aircraft navigation;
ix.   Weather, solar altitude, and time of year;

x. Any unusual circumstances or problems, including equipment malfunctions, (including those already reported);
xi. Any deviations from this Attachment (including those already reported); and
xii. Any recommendations for changes in the Attachment for future work.

Requests to exceed or deviate from this Attachment or the Project Instructions will be considered when written justification is provided to NGS in advance. No deviation is permitted until written approval is received from NGS.

All original aerial negatives, from the instant of exposure, and other deliverables obtained through this Attachment, are and shall remain the property of the United States Government. This includes exposures outside the project area. These items include the 5 7/8 inches Contractor-furnished film containers, and 5 3/16 inch film spools, and 3.5 inch floppy disks. However, film integrity is the responsibility of the contractor until it is received at its destination.

2.2 GOVERNMENT:
The government will provide to the Contractor:

A. PROJECT INSTRUCTIONS - Project Instructions (a separate document) provide specific project information containing any unique project requirements and have the following attachments:

i. A listing of airports to be photographed;
ii. Flight maps, showing the labeled flight lines;
iii. Digital waypoint files, indicating the two end-points of the required flight lines for each airport (Annex 7 details the required waypoint file format);
iv. Ground control survey requirements, (Annexes 1 and 2 for ground control data format and sketch examples);
v. Geo-Referencing requirements, (Annex 3 for geo-referencing data format example);
vi. Blank film processing instruction labels, “Do Not Expose To” labels, and address labels, see Section 14 and Annex 8.

B. GENERAL SPECIFICATIONS – Attachment A, Airport Aerial Photography (this document).

C. CAMERA DESIGNATORS - The government will assign unique camera designators (see Section 4.1).

D. REJECTED FILM - If photography is rejected by NGS, NGS will have sample scans and/or prints made showing the problem areas and will have these items sent to the Contractor upon the Contractor’s request.

3. DELIVERY SCHEDULES & ORIGINAL DATA

3.1 EXPOSURE TEST - An exposure test(s) is required prior to beginning the project. A separate exposure test is required for each combination of camera, emulsion, and filter planned to be used. This test shall be flown at 15,000 feet above the airport elevation and should be flown over an airport that has varying terrain and vegetation (preferably trees). The test is a test and will not be used as anything other. After test flight(s) over the approximate center of a convenient airport, the Contractor shall cut the film and ship the exposed sections with their corresponding original Photographic Flight Report, an original raw navigation file, and transmittal letter directly to the NOAA film-processing contract laboratory. The 3.5 inch floppy disk containing the original raw navigation file shall be taped to the outside of the film canister lid for shipment. The Contractor shall notify NGS when the film is shipped, see Section 14.2.

The Contractor shall prepare and submit the final EED file ~~(on a 3.5" floppy disk) directly~~ to NGS via TOMIS within three working days of film shipment. The film will be processed by the NOAA film processing contract laboratory and then forwarded to NGS for review. NGS will review all of this data as soon as possible and notify the Contractor of the results of the processing and the review. The Contractor shall not proceed with production until they have received approval from NGS. If NGS rejects the exposure test, a repeat exposure test is required.

3.2 REGULAR PRODUCTION - Exposed film, with its corresponding, original Photographic Flight Report, original raw navigation files, and a transmittal letter shall be shipped directly to the NOAA film-processing contract laboratory within 30 days of exposure, see Section 14.1. If necessary to meet this time constraint, the Contractor may cut the film and ship the exposed section. Normally, only FULLY exposed rolls should be shipped to the NOAA film processing contract laboratory. The film will be processed by the NOAA film processing contract laboratory and then forwarded to NGS for review. NGS will review this data (film, PFR, and EED) as soon as possible, notify the Contractor of the results of the processing and the review, and, if requested, ship the film to the Contractor for review. If NGS rejects the data, corrections and/or re flight(s) may be required. The Contractor shall notify NGS when the film is shipped, see Section 14.2. The Contractor shall prepare and submit the final EED file ~~(on a 3.5" floppy disk) directly~~ to NGS via TOMIS within three working days of film shipment. See Section 14, FILM SHIPMENT AND PROCESSING, for shipping address and additional requirements.

3.3 ORIGINAL DATA - Reports and other original records generated during this project are legal records, which will be retained for data accountability and stored in the National Archives. It is very important that these logs be original, legible, neat, clear, and fully completed in indelible black ink. Original data shall be saved, unmodified, whether in handwritten or computer-recorded form and shall be marked "ORIGINAL DATA". In the original records (paper or digital), nothing is to be erased or obliterated. All available spaces on the recording forms should be completed. If a space on a form does not apply, then enter "N.A." for "Not Applicable". If a mistake is made on a form, draw a single line ~~through the mistake~~ and write the correction above or to the side. The person making the change shall initial all corrections. If space is too limited to permit a field correction, restart with a new sheet, however, do not recopy the form in the office in order to make a "clean" copy. An explanatory note should be made for all corrections to the original recorded figures. It is essential that all recorded information be neat and legible. All editing of the computer recorded data shall be done on a copy of the original. Always submit the original version of the data, not a handmade copy, a photocopy, nor a digital copy.

3.4 COMPLETION DATE - All deliverables shall be received by the film processing contract laboratory and/or NGS, as specified, no later than the date in the Project Instructions.

4. EQUIPMENT AND MATERIAL

4.1 CAMERA

The aerial camera used for this Attachment shall meet the following specifications:

A. Single lens metric camera with quality equivalent to or better than a Wild RC 20/30 or Zeiss RMK-A 15/23, with Forward Motion Compensation;

B. 9 inch x 9 inch format;

C. Between-the-lens, variable speed shutter;

D. Six inch (153 ±3 mm) focal length lens having a usable angular field not less than 90 degrees;

E. Minimum resolution of 15 lines/mm with an Area Weighted Average Resolution (AWAR) not less than 55 lines/mm;

F. Decentering (formerly called tangential) distortion must not exceed 0.008 mm and radial distortion must not exceed 0.010 mm;

G. Model Flatness; total difference, +/- 0.019 mm;

H. The indicated principal points (fiducial centers) must fall within a 0.030 mm radius circle around the principal point of autocollimation;

I. The calibrated principal point (point of symmetry) must fall within a 0.015 mm radius circle around the principal point of autocollimation for 153 mm focal length lenses and 0.030 mm for all others;

J. Equipped with a vacuum or pressure device for holding film flat against a platen at the instant of exposure. Platen departure from a true plane must not exceed +/- 0.0005 in. (0.013 mm) when the camera/magazine vacuum is applied;

K. Record on each exposure at least 8 fiducial marks. Marks must be located in each corner of the format and at the center of each side. The fiducial marks must be clearly visible and sharp on every negative;

L. TIMES AND DATES - Record on each exposure a clock displaying correct Coordinated Universal Time (UTC), and the correct date, if data recording is available. Note that the time is also recorded in the EED file and on the Photographic Flight Report. **ALL THREE SHALL AGREE WITH EACH OTHER AND SHALL BE ACCURATE WITHIN TWO MINUTES OF UTC TIME (SAME AS GMT).** See: http: //www.time.gov. A daily time check for all clocks is recommended. Also ensure that all dates recorded are correct (double check that the clocks are not set 12 hours off so that the date cycles incorrectly at noon);

M. Record on each exposure the lens identification number and focal length, see also Section 13;

N. Record a level bubble on each exposure, if possible;

O. Record a film title on each exposure, if the camera is capable (see Section 13). Note, any label(s) on the photographs shall conform to the specifications in Section 13;

P. The camera shall be installed in a mounting which attenuates the effects of aircraft vibration;

Q. The camera's Forward Motion Compensation feature shall be used for all photography under this Attachment.

In addition to the specific camera requirements, a valid certificate of calibration (no older than three years) from the Optical Science Laboratory of the U.S. Geological Survey (USGS) shall be submitted to NGS for each camera to be used during this contract. The fees for the tests and the arrangements to have the tests performed are the responsibility of the Contractor. The calibration certificate(s) shall be submitted to and **approved by NGS prior to camera use under this contract**. Upon approval of a calibration certificate, NGS will assign a unique camera designator for the camera and notify the Contractor. The Contractor shall ensure that the correct camera designator appears on each exposure (see Section 13 and Annex 6).

Also, the Contractor shall supply certification to NGS that preventive maintenance has been satisfactorily completed within the last two years for each camera to be used for this Attachment.

All camera system malfunctions shall be recorded, and NGS notified. A malfunction is defined as a failure anywhere in the camera system that causes an interruption to the normal operation of the camera. Also, record and report any malfunctions in the EED collection system.

After any disturbance of the camera that might affect its calibration, or when there is any reason to believe the dimensional relationship of the lens, fiducial marks, and film plane have been disturbed by partial disassembly or unusual mechanical shock, the Contractor shall notify NGS, the camera shall be recalibrated before further use, at the Contractor's expense, and the Contractor shall submit the new certificate of calibration to NGS.

NOTE: Digital Imaging System - The requirements will be stated in the Project Instructions, see Attachment Z - Digital Imagery Acquisition Requirements.

4.2. FILM

The Contractor should submit only full (or nearly full) rolls of film, unless meeting the 30-day deadline discussed in Section 3. However, rolls approximately 2/3 full will be acceptable, if necessary, to allow for faster turnaround for review. Splicing shall not be performed.

The film used for this Attachment shall be AGFA Pan 80, Kodak 2444 (color negative), AGFA X100, or equivalent, and shall be purchased by the Contractor. A proposal for the use of "equivalent" film shall be submitted to NGS prior to use. NGS will notify the Contractor if the "equivalent" film is approved, and also the appropriate gamma for that film. A roll of film shall not be exposed after its expiration date.

Only optical filters provided by the lens manufacturer or meeting the same optical specifications shall be used. An antivignetting filter shall be used during all photography under this Attachment. AGFA Pan 80 and AGFA X100 have an extended red layer in the emulsion allowing the use of a 420 Nanometer (Color) filter. The contractor shall use a 420-nanometer filter with both AGFA films. This filter will facilitate photography of yellow, red, and orange leaves in autumn. The low contrast target resolution of color negative emulsions shall be rated at greater than or equal to 80 lp/mm (line pairs per millimeter). Emulsion and filter combinations selected must be sensitive to and record on the film the green, yellow, orange, and red hues of the tree leaf canopy. All filters used under this Attachment should have been mounted and calibrated as part of the camera system during the most recent camera calibration.

Film shall be stored, handled, and shipped in accordance with manufacturer's recommendations, especially regarding the storage temperature and humidity. Kodak recommends that unexposed natural color films be stored in a refrigerator at 55 degrees Fahrenheit or lower, or in a freezer at 0 to -10 degrees Fahrenheit, in the original sealed container. Film shall be treated with extreme care both before and after photography, especially with regard to temperature and humidity. Keep film in its original container until as close to flight time as possible to reduce moisture transfer once the container is opened. Photographic film containers shall not be exposed to direct sunlight or other sources of heat. At the end of each flying day, film (including loaded film magazines and cassettes) shall be removed from the aircraft if the inside temperature of the aircraft is expected to exceed 85 degrees Fahrenheit. Likewise remove the film if the temperature may go below freezing.

The beginning of each roll of film should have a 7-foot leader of blank film, and a 3-foot trailer at the end. Note, unexposed film that exceeds 10 feet in length should be cut from a roll of film before shipping for processing. A roll of aerial film shall consist only of exposures made with the same camera system (lens, cone, and magazine). **Standard film spools having a flange diameter of approximately 5 3/16 inches (13.3 cm) shall be used**, and only that length of film which can be wound on a spool without strain, leaving at least 1/8 inch (3 mm) of flange exposed, shall be placed on each spool. Standard film canisters approximately 5 7/8" in diameter shall be used.

Accompanying each roll of film shall be a filled-in film processing instruction label defining the characteristics of the film (wrap inside/outside, leader lengths, etc.), a “DO NOT EXPOSE TO” label, and an address label. Instructions for using these labels and the shipping address are included in Section 14.1, and samples in Annex 8.

4.3 AIRCRAFT

The type of aircraft and the aircraft tail number shall be stated on the Photographic Flight Report (Annex 4, Item #11 and #12). Aircraft used in the performance of this Attachment shall be maintained and operated in accordance with all regulations required by the Federal Aviation Administration. Any inspections or maintenance of the aircraft for performance of this Attachment which result in missed photographic weather will not be considered as an excusable cause for delay. The Contractor shall ensure that the aircraft has a proven service ceiling, with operating load (fuel, crew, camera, film, and other required equipment), of not less than the highest altitude required to acquire the exposures.

The design of the camera opening in the aircraft shall be such that the field of view is unobstructed when a camera is mounted with all its parts above the outer structure. The field of view shall, so far as is practicable, be shielded from air turbulence and from any outward flows, such as gases and oil.

NGS recommend that a camera port window not be used. If a camera port window is used, it shall be: (1) optical quality; (2) mounted in material eliminating mechanical stress to the window; (3) free of blemishes, dirt, significant scratches, etc.; (4) and shall not degrade the resolution or the accuracy of the camera (see Section 4.1). The physical characteristics of the window (such as size, thickness, smoothness, flatness, parallelism, glass quality, and optical transmissivity) shall be reported to NGS prior to use. Any window should meet the ASPRS Aerial Photography Standards, 1995, which states, “If an aircraft camera has a port glass it shall be preferable 50 mm thick but not less than 37 mm thick. The surface finish shall be 80/50 or better. Glass material shall be polished crown, group category M. Mil Specs Mil-W-1366F (ASG) October 1975, C-1 optical quality or better.”

5. FLYING HEIGHT

The flying height above the airport elevation should be calculated from the scale provided in the waypoint files. Normally the flying height is between 12,000 feet and 15,500 feet above the airport elevation. Departures from the specified flying height shall not exceed 2 percent low or 5 percent high for all flying heights up to 12,000 feet above mean ground elevation. Above 12,000 feet, departures from specified flying height shall not exceed 2 percent low or 600 feet high. Note, the altitudes entered into the Photographic Flight Report (see Annex 4) and the EED file (see Annex 6) are the altitudes above mean sea level (MSL), both in feet.

Note, altimeter corrections for barometric pressure, temperature, etc. may be required in order to meet the above tolerances. NGS will verify the flying height by multiplying the focal length of the camera (in feet) by the denominator of the calculated scale of the aerial film. The photographic scale is calculated by dividing the distance between two identifiable points as measured on one of the photographs (as near as possible at the mean ground elevation) by the actual ground distance as measured from the best available map or from known ground coordinates.

5.1 FLIGHT CLEARANCES - The Contractor shall comply with all required Federal Aviation Administration Regulations, including obtaining all required clearances.

6. GROUND CONTROL SURVEY (if required)

6.1 CONTROL POINTS - Approximately ten (10) ground surveyed, photogrammetric control points may be required at each airport. The control point locations shall be nonlinear and well distributed around the airport at a fixed, non-random, interval. NGS may provide a graphic for each airport with suggested general locations for each pair of control points (5 pairs for a total of approximately ten ground surveyed control points). The required coordinate system is the Universal Transverse Mercator (UTM) in NAD 83. Specify the UTM zone used. CORS & OPUS should be used to position the ground control points.

6.2 DATA FORMAT - Provide an ASCII file for all points with:

- Station Name
- Northing (UTM; meters, to 2 decimal places)
- Easting (UTM; meters, to 2 decimal places)
- Orthometric Height (meters, to 2 decimal places; relative to NAVD 88)
- Ellipsoid Height (meters, to 2 decimal places)

See Annex 1 “Ground Control Points,” for an example.

6.3 SKETCH - Two types of sketches are required. The first is a sketch of the entire airport area showing all control points with different symbology for new points and for existing control. Secondly, prepare a separate sketch of each control point, showing its immediate vicinity. See Annex 2 “Field Survey Sketch,” for an example. Include a brief description of the point under “Notes” at the bottom of this document. See Attachment R for photo requirements.

6.4 ACCURACY AND DATUMS

A. Horizontal positions shall be determined with an accuracy of 0.3 meters relative to the National Spatial Reference System (NSRS) NAD 83.

B. Orthometric elevations shall be determined with an accuracy of 0.3 meters relative to the NSRS (NAVD 88).

C. In Alaska and other areas outside the continental United States where NAVD 88 bench marks are not available, the Contractor shall make GPS ties to tidal bench marks within the project area.

7. GEO-REFERENCING (If required)

7.1 REQUIREMENTS - Use standard photogrammetric techniques.

7.2 FORMATS - Submit an ASCII file in the following format and explain the file naming convention. The required coordinate system is the Universal Transverse Mercator (UTM) in NAD 83. Specify the UTM zone used.

UTM COORDINATES

Strip #
Image #
Easting (meters, to 2 decimal places)
Northing (meters, to 2 decimal places)
Orthometric Height (meters, to 2 decimal places)
Omega (radians, to 7 decimal places)
Phi (radians, to 7 decimal places)
Kappa (radians, to 7 decimal places)

See Annex 3 for an example of the ASCII Image file format.

8. WEATHER, SOLAR ALTITUDE, AND TIME OF YEAR

8.1 CLOUDS - No clouds or cloud shadows may appear on the photographs. High, thin overcast clouds will be permitted above the flying altitude if they do not cause ground mottling or a discernable reduction in light levels and/or ground object shadows. Under no circumstances shall Black & White Panchromatic (B/W Pan) films be exposed under a solid overcast sky.

8.2 TREE LEAVES - Note, all photography under this Attachment shall show full tree leaf coverage to facilitate photogrammetric tree height determination. Photography shall cease when the tree leaves begin to change color.

8.3 WELL-DEFINED IMAGES - Photography shall be undertaken only when well-defined images can be obtained. In addition to no clouds, photography shall not be attempted where the ground is obscured by haze, smoke, smog, dust, or falling snow, sleet, rain, etc. Also, photography shall not be conducted when the airport ground area is covered by water (flood), snow, or ice.

8.4 VISIBILITY - The minimum visibility at the time of exposure is 10 miles. Visibility is determined by looking at objects on the ground toward the sun. The distance at which the details of tree crowns are clearly defined is the visibility. If the visibility is satisfactory, details of ground objects will be clearly defined at the edge of the view through the drift sight.

8.5 SUN ANGLE - Sun angle shall never be less than 30 degrees above the horizon at the time of exposure. Ideally, the sun angle should be between 40 and 60 degrees above the horizon because of the intermediate-size shadows produced. In mountainous areas with steep terrain and/or areas with tall trees, the minimum sun angle shall be increased. The Project Instructions may contain additional information about sun angle requirements for each project. See also Section 15 and "Manual of Photogrammetry", Fourth Edition, Section 5.8.3.

Sun angle for a given day can be determined from a "Solar Altitude Diagram" or from appropriate computer software. See the U.S. Naval Observatory's WWW site: http://aa.usno.navy.mil/data/docs/RS_OneDay.php that computes sun altitudes and sun azimuths for U.S. locations and world-wide positions.

8.6 CLEAR DAY MAP – Refer to http://www.ncdc.noaa.gov/oa/ncdc.html . See Attachment C, Section 9.6 for direction on obtaining the maps from the above website.

9. NAVIGATION

The aircraft shall be navigated using pseudo-range GPS, or another system with equivalent accuracy or better. The cross-track flight-line deviation from the lines specified in the waypoint files shall not exceed 5% of the flying height (750 feet for normal flying height of 15,000 feet). Changes in the course of the aircraft between successive overlapping photographs within a flight line shall not exceed three (3) degrees.

Exposure stations shall be positioned to approximately the absolute accuracy of +/- 20 meters, or better. An electronic pulse shall be used to accurately mark the mid-point of the exposure. These exposure station positions and other information shall be recorded in the EED file (see Annex 6).

The NGS supplied waypoint files will automatically center one photograph over (or near) the center of the airport.

Note that flight lines may be flown in either direction, but adjacent lines should be flown in opposite directions.

All flight lines shall be continuous. No flight lines may be broken or patched. Note, a line reflown shall have the original flight line number.

The datum for the horizontal positions is the North American Datum of 1983 (NAD 83). The vertical datum is the North American Vertical Datum of 1988 (NAVD 88). For areas outside the continental United States see Section 6.4.

10. TILT

Care shall be taken to keep tilt (departure from the vertical) of the camera to a minimum. Tilt shall not exceed +/- three (3) degrees for any photographic frame. The average tilt for the entire project shall not exceed +/- one (1) degree.

11. CRAB

While exposing aerial photography, the camera shall be compensated for crab of the aircraft, with a resultant error not exceeding +/- five (5) degrees, as measured from the average line of flight, and the differential between any two successive exposures shall not exceed +/- five (5) degrees.

12. OVERLAP AND SIDELAP

Forward overlap shall be 60 percent, plus 5% to minus 2% percent between consecutive exposures.

Sidelap is defined by the flight line, and waypoint files (normally about 50%).

13. PHOTOGRAPH LABELING

When the camera is equipped for titling, each usable frame shall be titled within, or adjacent to, the image area between 1/16 and 1/4 inch from the format border using machine lettering approximately 1/5 inch high. Each title shall consist of the agency initials (NOAA), date of photography, UTC time of exposure, Contractor camera designator (see Section 4.1 and Annex 6), film type (P for panchromatic or CN for color negative), lens serial number, and exposure number. Also, including the latitude, longitude, height, aperture, shutter speed, focal length, etc. in the labeling is desirable (and in the same format as in the EED file, if possible). Note, any label(s) on the photographs shall conform to the above specifications.

Example: NOAA 06-23-99 GMT-18:14:27 XXP UAG332 No 2501

The title may be along any edge of the frame but the preferred location is along the leading edge. See also Section 4.1.

For each lens system used, usable exposures shall be numbered in an unbroken sequence starting at 0001 for the first exposure and continuing through the last exposure by that lens system, in a given year. The numbering sequence shall not be broken even though more than one airport is photographed, or more than one roll of film is used.

Blanks and test exposures should not be included in the exposure numbering sequence and shall not be labeled. Rejected exposures shall keep their numbering.

14. FILM SHIPMENT AND PROCESSING

14.1 SHIPMENT - The Contractor shall ship: (1) completed (normally full) film rolls, (2) the original Photographic Flight Reports (one Report per roll) completed in black ink (but marked "ORIGINAL" in BLUE ink at the top) and filled-in front and back, (3) original raw navigation files, and (4) the transmittal letters via next-day air freight directly to the NOAA film processing contract laboratory. For an explanation of "completed film rolls" see Section 3.2, REGULAR PRODUCTION.

The Contractor shall send ~~ship~~ final, **checked** EED files, in NGS format ~~(on a 3.5" floppy disk), directly~~ to NGS via TOMIS, ~~to arrive at NGS~~ within three working days from the date the film was shipped. Copies of the Photographic Flight Report and the raw navigation files may be made and used by the Contractor to produce and check the final deliverables.

The Contractor shall ship (1), (2), (3), and (4) to:

HAS Inc.
136 North Clair Street
Suite 300
Dayton, OH 45402
937-222-3856
hasimage@ix.netcom.com

The following labels shall be typed or neatly lettered by the Contractor with the required data and securely affixed to each film container:

(1) Commercial or HAS, Inc. shipping label
(2) Film processing instruction label (see Annex 8)
(3) "DO NOT EXPOSE TO" label (see Annex 8)

All rolls of aerial film shall be shipped in sturdy, cylindrical containers (approximately 5 7/8" in diameter) in such a manner that shall ensure acceptance by common carrier and safe delivery at the destination. Containers and closures shall comply with the Interstate Commerce Commission Regulations, Uniform Freight Classification Rules, or regulations of other carriers as applicable to the mode of transportation.

The Contractor should not ship film on a Friday. The photographic processing Contractor does not receive film on Saturdays or Sundays, so the film could be subject to excessive environmental conditions during temporary storage.

14.2 NGS NOTIFICATION - The same day as shipping, the Contractor shall notify NGS of each film shipment's contents and date of shipment by submitting to TOMIS ~~transmitting to NGS~~ a ~~paper or~~ digital copy of the Photographic Flight Report (marked "COPY" at the top) and a digital copy of the film transmittal letter ~~via email or facsimile~~.

14.3 REJECTED FILM - If photography is rejected by NGS, NGS will have sample scans or prints made showing the problem areas and will have these scans or prints sent, upon request, to the Contractor.

15. IMAGE QUALITY

Image quality on the original negative film shall meet the highest professional standards. Dark areas shall not bleed together and individual objects shall be readily discernable. Detail shall be sufficiently sharp to allow photogrammetric measurement of tree heights, compilation of runway/ taxiway edges and other fine map features, and accomplishment of other intended uses for the film. Photographic products shall also be free of abrasions, blemishes, scratches, tears, and irregularities. Fiducial marks shall be clearly visible and sharp on every negative. The camera panel of instruments and titling recorded on the film shall be clearly legible on all processed negatives.

16. EXPOSURE

Extreme care shall be exercised to insure proper exposure. Use an ASA of 40 with the AGFA Pan 80 film. For Kodak Aerocolor 3 Negative Film 2444, an ASA of 125 should be used and a 420 nanometer filter shall be used.

The film exposure settings normally will be controlled from the camera's Photographic Exposure Meter (PEM) and should produce a gamma at processing time of 0.90 +/- 0.05. Base fog density shall not exceed 0.10 with a minimum density above base fog of 0.30 and maximum density above base fog of 1.35. For those areas where abnormal exposure objects exist, such as snow, water, etc., the PEM shall be manually overridden to produce an equivalent exposure without the abnormality. A shutter speed shall be chosen that meets the requirements of minimal image movement, at an adequate lens aperture for the prevailing lighting conditions.

17. REVIEW

Photography and other deliverables not meeting these specifications may be rejected.

18. POINTS OF CONTACT:

George E. Leigh
Contracts Technical Manager & COTR
National Geodetic Survey
ATTN: N/NGS; SSMC3, Sta. 8609
1315 East-West Highway
Silver Spring, Maryland 20910
301-713-3167
Fax: 301-713-4315
email: George.Leigh@noaa.gov

Brian M. Baldwin
Remote Sensing Division
National Geodetic Survey
ATTN: N/NGS3; SSMC3, Sta. 8350
1315 East-West Highway
Silver Spring, Maryland 20910
301-713-2670 x197
Fax: 301-713-4572
email: Brian.Baldwin@noaa.gov

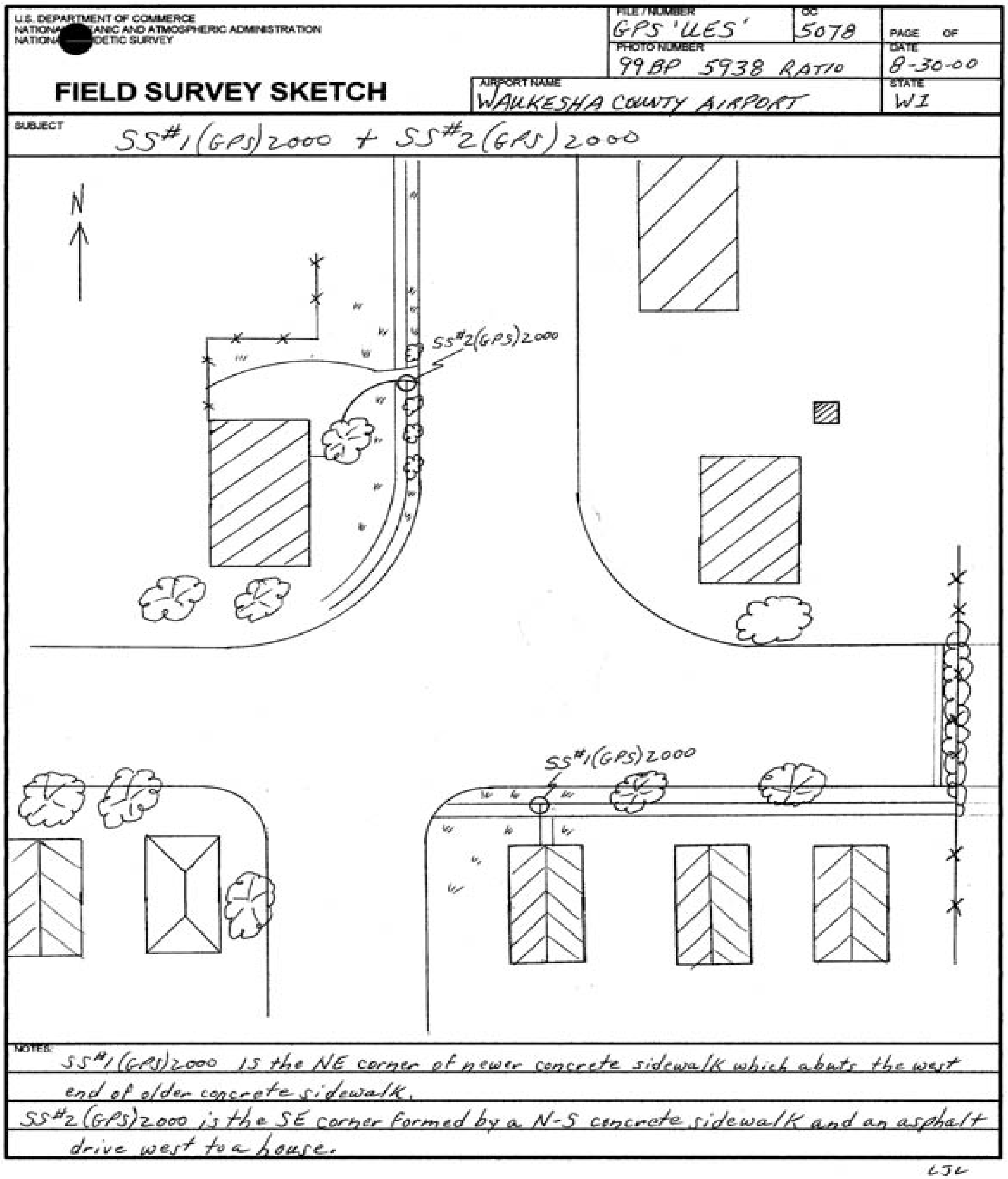
ANNEX 1 - Sample Ground Control Coordinates

Airport Name:
Coordinate system:
Zone:
Reference Ellipsoid:
Horizontal and Vertical Datum:

Station Name	Northing	Easting	Ortho. Height	Ellipsoidal Height
P01	2086849.62	3579322.68	115.48	83.34
P02	2086905.37	3583818.97	78.47	46.29
P03	2092134.98	3584776.85	93.59	61.45
P04	2093245.00	3586869.35	97.09	64.94
P05	2089958.84	3591583.70	88.78	56.53
P06	2084575.11	3596417.02	51.81	19.39
P07	2080281.03	3598531.32	12.47	-20.02
P08	2075655.30	3602180.66	3.04	-29.52
P09	2075499.76	3599408.29	11.76	-20.77
P10	2071002.61	3598110.64	63.01	30.49
P11A	2070470.79	3593392.50	40.61	8.13
P13	2081879.33	3591462.22	59.19	26.81
P14A	2080413.30	3585137.48	108.09	75.78

All heights are in Meters

ANNEX 2 - Sample Field Survey Sketch



ANNEX 3 - Sample ASCII Image File (Results of the Geo-referencing)

Results of the geo-referencing of frame imagery shall be reported in an ASCII file, each with 8 columns (Strip ID, Image ID, X, Y, Z, omega, phi, kappa). The file shall report positions in the appropriate UTM coordinates and Zone. The file shall report orthometric heights in meters. Frame orientation elements (Omega, Phi, Kappa) shall be in radians. Columns shall be separated by open spaces. The files shall contain a line of header information and conform to the following examples:

Airport Name:
Coordinate System:
Zone:
Reference Ellipsoid:
Horizontal and Vertical Datum:

Strip #	Image #	Easting	Northing	Ortho Height	Omega	Phi	Kappa
1	1	3579254.35	2089643.60	3824.12	-.0001358	.0107300	-.8732658
1	2	3580688.07	2087953.67	3823.95	-.0162651	.0005193	-.8841331
1	3	3582126.18	2086260.81	3829.93	-.0404605	.0022521	-.8826661
2	1	3582017.30	2092108.36	3821.09	-.0306452	.0034061	-.8539204
2	2	3583490.60	2090446.64	3833.50	-.0095850	.0067647	-.8527867
2	3	3584965.37	2088806.15	3825.61	-.0219045	-.0030697	-.8461040

ANNEX 4- Photographic Flight Report (Page 1 of 2)

NOAA FORM 76–15
(7–77)

U.S. DEPARTMENT OF COM
NATIONAL OCEANIC AND ATMOSPHERIC ADMINIST

PHOTOGRAPHIC FLIGHT REPORT

SPOT NO.	ROLL NO.	EMULSION NO.	EXPIRATION DATE	SHEET OF SHEETS

TYPE FILM	A.S.A. INDEX USED	FILTER	CASSETTE/MAGAZINE NO. FEED TAKE–UP	CAMERA/DRIVE UNIT NO.

MISSION NO.	AIRCRAFT	PILOT	COPILOT	PHOTOGRAPHER

FLIGHT MAP NO. / TIDE STAGE	STATE AND LOCALITY	DATE / LINE NO.	C.U.T. (*Coord. Univ. Time*)		ADD NUMBER	NO. OF EXPOSURES	COMP. HEAD. / DRIFT	VISIBILITY	CLOUDS	TEMP.	ALTITUDE	VACUUM	SHUTTER	APERTURE	RHEOSTAT	ENDLAP PERCENT	NO. OF BLANKS TO START ROLL / METER READINGS AND REMARK
				S													
				E													
				B													
				S													
				E													
				B													
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ANNEX 4 - Photographic Flight Report (Page 2 of 2)

AERIAL FILM PROCESSING RECORD

RECOMMENDATIONS	LABORATORY DEVELOPMENT		
	DATE		
	FORMULA		
	pH READINGS:	1st Dev.	S.S. Hardener
	Color Dev.	2nd S.S. *(Cl. Bath)*	Hardener
	Bleach	Fixer	Stabilizer
	SENSE STRIP EXPOSURES: Begin		
	Middle	End	
	☐ CONTROL STRIP CUT FROM ROLL		
	☐ UNEXPOSED PORTION STORED		
	☐ EXPOSED PORTION PROCESSED		
	TEMPERATURE:	F	C
	DEVELOPMENT TIME: 1st Developer		
	PROCESSED TO GAMMA		
	PROCESSING MACHINE:	Motor	Reel
	CHEMISTRY MIXED – DATE		
	TALLY OF ROLL THROUGH CHEMISTRY *(Indicate 1st, 2nd, 3rd, etc.)*		
	POST DEVELOPMENT INSPECTION: *Obvious defects or failures which require reflight of any portion of this roll must be reported immediately by phone direct to the office of the Chief, Photographic Operations Branch; details shall also be recorded, signed and dated below.*		
AERIAL PHOTOGRAPHER / DATE			
ROLL TITLED BY / DATE	PROCESSED BY	DATE	

SENSITOMETRY READINGS

	CYAN	MAGENTA	YELLOW	B & W
BASE				
STEP 1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
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13				
14				
15				
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19				
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21				

REMARKS

NOAA FORM 76-15 (7-77)

ANNEX 5

SAMPLE
INSTRUCTIONS FOR COMPLETING THE PHOTOGRAPHIC FLIGHT REPORT FOR AIRPORT PHOTOGRAPHY

PHOTOGRAPHIC FLIGHT REPORT FRONT PAGE

(1) **DATE -** Film is first loaded into the cassette of Magazine, Print "LOADED" & Date

(2) **To Remain Blank**

(3) **ROLL NUMBER** - Year, Camera System Designator, Film Type (P = Pan, CN = Color Negative) , and Sequential Roll Number for that Calendar Year.

(4) **EMULSION NUMBER –** Taken directly from the Film Can upon loading.

(5) **EXPIRATION DATE** - Taken from Film Can upon loading.

(6) **SHEET NUMBER** - of 4 sheets = 1 of 4, 2 of 4, etc.

(7) **FILM TYPE** - Plus-X Pan, X-100 Color Negative, etc…

(8) **ASA INDEX** - Film Speed actually used (**NOT** EAFS from Film Can).

(9) **FILTER -** Wavelength of Filter used, in Nanometers.

(10) **CASSETTE/MAGAZINE** - Feed and Take-up Cassettes or Magazine Identification Number.

(11) **CAMERA/DRIVE UNIT NUMBERS -** Camera Identification Number or Lens Serial Number/ Drive Unit Number.

(12) **MISSION No. -** Aircraft Type (Cessna Citation II).

(13) **AIRCRAFT** - Aircraft Tail Number (N52RF)

(14) **PILOT** - Printed Surname.

(15) **COPILOT** - Printed Surname.

(16) **PHOTOGRAPHER** - Printed Surname.

(17) **FLIGHT MAP No./TIDE STAGE –** Airport AL Number or OC Number/ Airport Identification

(18) **STATE and LOCALITY** - Enter Airport Name (CLEAR Abbreviations are acceptable: Apt, Fld, Muni, Reg, etc…), Place or Region, then indicate the state.

(19) **DATE and LINE No.** -Date of Photography (Month, Day, Year), Flight Line Number (30-002, indicating a Scale of 1:30,000 and Line No. 2). Add Note **"NEW DAY"** to indicate Date Change. Place near DATE entry.

(20) **CUT** - Time (Coordinated Universal Time or GMT) in Hours and Minutes. **DO NOT** Enter LOCAL Time.

(21) **To Remain Blank**

(22) **No. of EXPOSURES -** This is a running count of Frames Taken per Line over the course of the Roll. It <u>may</u> not coincide with the Frame Numbers. Its purpose is to allow a quick Reference of Frames remaining on the roll.

(23) **COMP HEAD/DRIFT** - Enter the Magnetic Heading in Degrees/Variances in Degrees LEFT or RIGHT of the path of the Aircraft and Ground Tracking over the Planned Flight Line.

(24) **VISIBILITY -** Distance in Statute Miles out from the Aircraft, **in the Direction of the SUN**, at which Tree Crowns are still Separately Discernable.

(25) **CLOUDS** - Enter an Estimate of Cloud-Cover from Choices at the Bottom of the Photographic Flight Report.

(26) **TEMPERATURE** - Enter the Temperature in Degrees Celsius at the Time of the Photography.

(27) **ALTITUDE** - Feet Above Ground Level (AGL) over Airports.

(28) **VACUUM** - Enter Vacuum Reading from Gauge or from Camera Display Panel (600 mmWs, or nominally 64 mb standard)

(29) **SHUTTER** - Enter Speed of Shutter During Line of Photography. Enter, if in Automatic Mode, Variances in Shutter Speeds (450-550).

(30) **APERTURE** - Enter the Actual Aperture Used. Final Adjustment from Camera Indicator, **NOT** Base Exposure from an Automatic Light meter.

(31) **RHEOSTAT** - Enter the Rheostat Setting as a Function of the ASA ("PER xxx ASA").

(32) **ENDLAP** - Enter the Planned Endlap as a Whole Number (10, 60, 80, etc.).

(33) **Number of Blanks to Start of Roll** - “6" is Standard.

(34) **METER READINGS and REMARKS** - Record the Automatic Light Meter Readings (4 @ 1000), a Description of the Terrain, and Local Ambient Conditions.

(35) **TO PATCH or To RE-DO -** Enter Pertinent Choice to Indicate REJECTION of LINE Section or of Complete LINE, and Future Action, and REASON (Smoke, Signal Failure, ATC, etc.).

(36) **PATCH or RERUN -** Enter pertinent Choice to Identify Frames as “the PATCH” or “the RE-RUN” of a Previous Line, and indicate which roll has a previous attempt.

(37) **CASSETTE REMOVAL** - Add a Note to Indicate 3 added blanks and removal of Cassettes or Magazine.

(38) **CASSETTE REPLACEMENT** - Add a Note to Indicate Replacement of Cassettes or Magazine, with 3 Blanks ADDED.

(39) **CUT ROLL or ROLL ENDS** - Add a Note to Indicate a Cut Roll or a Roll Ended Normally, each with the Addition of 10 Blanks.

(40) **SIGNATURE/DATE** - Enter the Signature of the Mission Commander and the Date (Month, Day, Year) of Completion of the Roll.

(41) **COMMENTS -** Space for Additional Recommendations or Comments is Available on the Back of the Photographic Flight Log.

Note:
1. Submit the original version of the Report, not a hand-made copy nor a photo-copy.
2. Neither the “Spot Number” nor the “Add Number” columns are filled-in by flight crews.
3. All other spaces shall be completed. If non-applicable, enter “NA”.
4. Use three rows on the form for each flight line.

Example: Photographic Flight Report for Airports

NOAA FORM 76-15 (7-77) (1) LOADED 09-21-04 **PHOTOGRAPHIC FLIGHT REPORT** U.S. DEPARTMENT OF COMMERCE NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

SPOT NO. (2)	ROLL NO. (3) 04 99 P 07	EMULSION NO. (4) AH-897-67130751	EXPIRATION DATE (5) MAR 2005
SHEET (6) 2 OF 3 SHEETS	TYPE FILM (7) AGFA PAN 80	A.S.A. INDEX USED (8) 125	FILTER (9) 420
CASSETTE/MAGAZINE NO. (10) FEED 2189 TAKE-UP 2673	CAMERA/DRIVE UNIT NO. (11) 99/4391	MISSION NO. (12) CESSNA CITATION II	AIRCRAFT (13) N24 SQ
PILOT (14) SMITH	COPILOT (15) JONES	PHOTOGRAPHER (16) CAMPBELL	NO. OF BLANKS TO START ROLL (33) 6

(17) FLIGHT MAP NO. / TIDE STAGE	(18) STATE AND LOCALITY	(19) DATE / LINE NO.	(20) C.U.T. (Coord. Univ. Time)		(21) ADD NUMBER	(22) NO. OF EXPOSURES	(23) COMP. HEAD. / DRIFT	(24) VISIBILITY	(25) CLOUDS	(26) TEMP.	(27) ALTITUDE	(28) VACUUM	(29) SHUTTER	(30) APERTURE	(31) RHEOSTAT	(32) ENDLAP	(34) METER READINGS AND REMARKS
OC-9479	SUSANVILLE	09-21-04	2207	S		1	114	12	O	-9	18,500	600	250	5.6	PER	60	PEM: 5.6 @ 250
SVE	MUNI	30-01	2210	E		9	3R								125		BROWN SAND
	SUSANVILLE, CA			B		10									ASA		GREEN FARMLAND
OC-1032	NERVINO FLD		2219	S		11	073	10	O	-11	19,200		333	5.6		60	PEM: 5.6 @ 333
O02	BECKWORTH	30-001	2222	E		20	3R	(35)	TO	RE-DO		(SMOKE)					GREEN FARMLAND
	CA	(35) TO RE-DO		B		21											LIGHT WOODS LT HAZE
OC-524	RENO-STEAD		2226	S		22	140	15	O	-12	19,300		333	5.6			PEM: 5.6 @ 333
4SD	RENO	30-001	2231	E		36	4R	(36)	RERUN		(ROLL	0	499	P06)			BROWN SAND
	NV	(36) RERUN		B		37											CITY, GREEN FARMLND
			2238	S		38	261										
		30-002	2243	E		52	3L										
				B		53											
OC-9430	MINDEN-TAHOE		2259	S		54	160	20	O	-10	19000		400	5.6			PEM: 5.6 @ 400
MEV	MINDEN	30-001	2304	E		67	2R	(35)	TO	RE-DO		(ATC)					YELLOW-BROWN SAND
	NV	(35) TO RE-DO		B		68											
OC-445	YOUNG REGIONAL		2333	S		69	259	15	O	-9	18,870		415	5.6			PEM: 5.6 @ 415
ENV	WENDOVER	30-001	2343	E		75	2L	(36)	RERUN		(ROLL		04	99 P04)			GREEN FARMLAND
	UT	(36) RERUN		B		76											LIGHT WOODS
OC-1294	ELKO MUNI	09-23-04	2208	S		77	251	12	O	-12	19,200		333	5.6			PEM: 5.6 @ 333
EKO	ELKO	30-001	2216	E		89	1L										GREY, BROWN SAND
	NV	NEW DAY		B		93	(37)	REMOVE	CASSETTES				+3	BLANKS			LIGHT WOODS
OC-9969	MARIPOSA-YOSEMITE		2236	S		94	081	12	O	-14	16,800		250	5.6			PEM: 5.6 @ 250
MPS	REG APT	30-001	2256	E		99	1L	(38)	REPLACE	CASSETTES			+ 3	BLANKS			GREEN FARMLAND
	YOSEMITE, CA			B		100											LIGHT WOODS
OC-6938	NORMAN-MINETA		2310	S		101	302	15	O	-7	14,500		300	5.6			PEM: 5.6 @ 300
SJC	INT'L APT	30-001	2318	E		109	1L										CITY, GREEN FARMLAND
	SAN JOSE, CA			B		110											BROWN SAND HVY HAZE
John	Smith		~~2328~~	S	(39)	+	ROLL	ENDS		+ 10	BLANKS						
(40)	09-23-04	~~30-002~~	~~2335~~	E					OR								
				B		+	10	BLANKS		& CUT	ROLL						

NOAA FORM 76-15 (7-77) ○ Clear ◐ Scattered or Broken ⊖ High Thin ⊕ Solid Overcast SUPERSEDES NOAA FORM 76-15 (5-74).

ic

ANNEX 6 - Electronic Exposure Data File Format

FILM ROLL NUMBER
For each camera, NGS will assign a unique camera designation character “xx” which shall be used in the film roll number. The film roll number consists of a two digit year; a two digit camera designation number; a one or two digit film designation character (P=PAN, CN=COLOR NEG., CR=COLOR IR, R=B/W IR); and a two digit sequence number. For each successive roll of film per camera the sequence number shall be incremented by one. See sample at #1 below.

ELECTRONIC EXPOSURE DATA (EED) SPECIFICATIONS
Each roll of film shall have an accompanying EED file. The file shall be in ASCII form ~~on an IBM formatted 3.5" floppy disk~~ capturing the attributes of each frame in the order they appear on the roll of film. The file shall be named using the film roll number and the extension "EED". Each frame of photography shall consist of a record in the file. Each record shall contain the following fields of data separated by commas. No commas may be used in the contents of the field. Sample:

Field	Title	Format	Explanation	Sample Field Length
1	Film roll number	yyxxf01	year, camera desig., film type, number	99xxP01 up to 8 characters
2	Frame number	nnnn	number	0102 4 or 5 digits
3	Flight line ID	lidsc-nnn	lid scale - sequential number at that scale*	BWI 30-001 up to 12 digits
4	Time since last exposure	sss.s	seconds**	23.2 up to 5 digits
5	Date of exposure	dd:MMM:yy	day:MONTH:year (Month in CAPS)	07:JUN:99 9 characters
6	Time of exposure in UTC	hh:mm:ss	hour:minute:second	18:11:19 8 characters
7	Latitude of frame center	dd:mm.mmmmN/S	degrees:minutes to 4 places***	26:52.8201N 11 characters
8	Longitude of frame center	ddd:mm.mmmmE/W	degrees:minutes to 4 places***	097:23.1234W 12 characters
9	Az of photo (or aircraft)	ddd	degrees, true	010 up to 3 digits
10	Altitude of photograph	fffff	feet above mean sea level	15000 up to 6 digits
11	Acquisition ID	rrryynn	FAA Region, year, waypoint seq. no.****	AEA9901 up to 8 characters

Example: 99xxP01(film roll #),0102(frame #),BWI30-001(flight line ID),23.2(time since last exposure),07:JUN:99(Date of exposure), 18:11:19(Time of exposure in UTC),26:52.8201N(Latitude of frame center),097:23.1234W(Longitude of frame center), 010(Azimuth of photo),15000(Altitude of photograph),AEA9901(Project identifier)

Field #:	1	2	3	4	5	6	7	8	9	10	11
Field Contents:	99xxP01	0102	BWI 30-001	23.2	07:JUN:99	18:11:19	26:52.8201N	097:23.1234W	010	15000	AEA9901

Complete Record Format: 99xxP01,0102,BWI 30-001,23.2,07:JUN:99,18:11:19,26:52.8201N,097:23.1234W,010,15000,AEA9901

There are no spaces after the comma field separators
* Flight Line ID Sample: LID = the three letter identifier for the airport; Scale = 1:30,000; number =001; The number used for scale omits “1:” and the “thousands” place holder of the trailing zeros. 1:30,000 becomes simply 30. LID scale - number = BWI30-001
****** For the first exposure in each flight line enter 0.0 in this field.
******* The Latitude and Longitude are shown to 4 decimal places in order to compute end lap and side lap. The absolute accuracy should be +/- 20 meters, or better, with relative accuracy considerably better, as is typical with pseudo-range GPS.
**** Same as waypoint file name, without suffix. For the test strip, use “TS”, two digit year, and then the test number, e.g. “TS9901"

The Azimuth of the photograph is calculated by performing a series of “Inverse” calculations between the position of each photo and the one immediately succeeding it. The azimuth of the last two images on a flight line will be the same.

ANNEX 7
AERONAUTICAL SURVEY PROGRAM - WAYPOINT FILE SAMPLE

REC	LINE	FEET	SCALE	MILES	FAZI	BAZI	SWP	LAT1	LONG1	EWP	LAT2	LONG2	EMUL	END LAP	NO PH	GRND ELEV	MAG DEC	CENTER LAT.	CENTER LONG.
1	SDL 30-1	72000	30000	13.6	46	226	1	N 33 30 50	W 112 02 28	2	N 33 39 14	W 111 52 25	P	60	10	1508	12	N 33 34 00	W 111 56 00
2	FLG 30-1	71999	30000	13.6	222	42	3	N 35 15 06	W 111 33 05	4	N 35 06 10	W 111 42 36	P	60	10	7011	14	N 35 09 00	W 111 38 00
3	TUS 30-3	81000	30000	15.3	135	315	5	N 32 00 14	W 110 48 23	6	N 32 09 38	W 110 59 32	P	60	10	2641	12	N 32 04 00	W 110 53 00
4	PHX 30-4	108000	30000	20.5	91	271	7	N 33 26 14	W 112 11 30	8	N 33 25 57	W 111 50 16	P	60	13	1133	12	N 33 26 00	W 112 01 00

FILE NAME EXPLANATION (AWP9801.WPT):

AWP - FAA Region
98 - Year, last two digits
01 - Sequence number of waypoint file in current year
WPT - Waypoint file identifier

FIELD EXPLANATIONS:

REC - Record, numbered consecutively
LINE - Flight line designation (FAA airport designator (LID), scale, the number of the flight line at that scale and that airport)
FEET - Flight line length, in feet
SCALE - “X”, as in 1:”X”
MILES - Flight line length, in miles, to nearest tenth
FAZI - Forward azimuth, degrees (clockwise from north, true)
BAZI - Back azimuth, degrees (clockwise from north, true)
SWP - Starting way point, number*
LAT1 - Starting latitude (N/S dd mm ss)*
LONG1 - Starting longitude (W/E ddd mm ss)*
EWP - Ending way point, number*
LAT2 - Ending latitude (N/S dd mm ss)*
LONG2 - Ending longitude (W/E ddd mm ss)*
EMUL - Emulsion (CN = color neg., P = pan)
END LAP - End lap (or forward overlap), as a percent
NO PH - Number of photographs, on that line
GRND ELEV - Airport elevation, in feet
MAG DEC - Magnetic declination; degrees, to nearest tenth (E (east) or W (west))
CENTER LAT - Airport Reference Point (ARP), latitude (N/S dd mm ss)
CENTER LONG - Airport Reference Point (ARP), longitude (W/E ddd mm ss)
(The ARP is the approximate geometric center of all usable runways.)

* Lines may be flown either way, but adjacent lines should be in opposite directions.

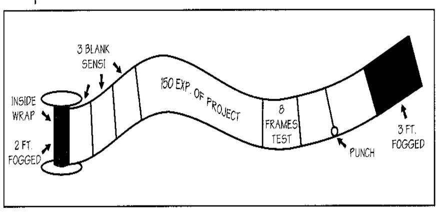
Blank Forms

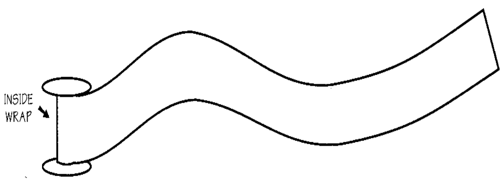
FILM TYPE ______________________________

COATING IDENTIFICATION ______________________________

FILM TEST: YES____ NO____ SENSITOMETRY: YES____ NO____

Example:





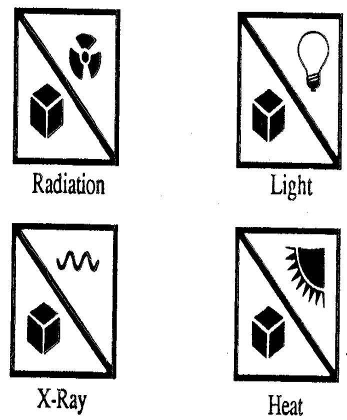
DESCRIBE YOUR ROLL: (Where to TEST/place SENSI)

____

____

HRS Images, Inc.
937-222-3856
FAX 937-222-2443

UNPROCESSED FILM
DO NOT EXPOSE TO:



HRS Images, Inc.
937-222-3856
FAX 937-222-2443

From:

Photographic Materials

HANDLE with CARE

937-222-3856

HRS Images, Inc.

136 North St. Clair Street, Suite 300
Dayton, OH 45402

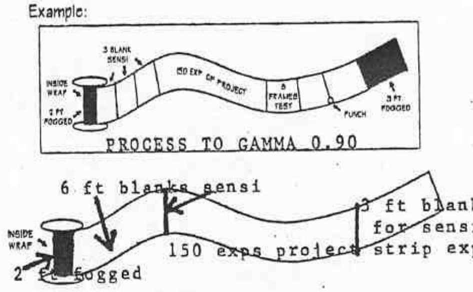
SAMPLE FILM LABELS FOR B/W (PROCESSING TO GAMMA)

FILM TYPE Agfa Pan 80PE ZP-1

COATING IDENTIFICATION ______

FILM TEST: YES X NO ___ SENSITOMETRY: YES X NO ___

Example:



DESCRIBE YOUR ROLL: (Where to TEST/place SENSI)

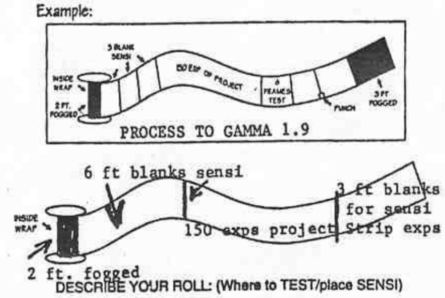
HAS Images, Inc.
937-222-3856
FAX 937-222-2443

FILM TYPE 2424 B/WIR ZR-1

COATING IDENTIFICATION ______

FILM TEST: YES X NO ___ SENSITOMETRY: YES X NO ___

Example:



DESCRIBE YOUR ROLL: (Where to TEST/place SENSI)

HAS Images, Inc.
937-222-3856
FAX 937-222-2443

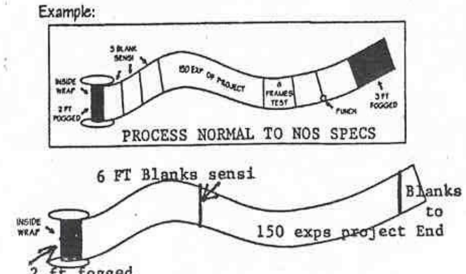
SAMPLE FILM LABEL FOR COLOR (NORMAL PROCESS)

FILM TYPE 2445 Aero Neg. & SO-134 Color IR

COATING IDENTIFICATION ______

FILM TEST: YES ___ NO X SENSITOMETRY: YES X NO ___

Example:



DESCRIBE YOUR ROLL: (Where to TEST/place SENSI)

HAS Images, Inc.
937-222-3856
FAX 937-222-2443

ANNEX 9 **Contractor Letterhead**

NOAA FORM 61-29 (12-71)

U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

LETTER TRANSMITTING DATA

REFERENCE NO.
GA0401-XX*

DATA AS LISTED BELOW WERE FORWARDED TO YOU BY (Check):

- [ ] ORDINARY MAIL
- [ ] AIR MAIL
- [ ] REGISTERED MAIL
- [x] EXPRESS
- [ ] GBL (Give number) ____________

TO:
"Photo Processing Lab"

DATE FORWARDED
July 15, 2004

NUMBER OF PACKAGES
2 Boxes

NOTE: A separate transmittal letter is to be used for each type of data, as tidal data, seismology, geomagnetism, etc. State the number of packages and include an executed copy of the transmittal letter in each package. In addition the original and one copy of the letter should be sent under separate cover. The copy will be returned as a receipt. This form should not be used for correspondence or transmitting accounting documents.

Dear Sir or Madam:

This letter of transmittal regarding the National Oceanic and Atmospheric Administration (NOAA) film listed below is forwarded for processing under the U.S. Department of Commerce contract number "XXXXXX XXXXXX" for the NOAA, National Ocean Service, National Geodetic Survey, Remote Sensing Division.

Please process the enclosed film roll(s) in accordance with the requirements and then forward the film, Photographic Flight Reports, and Raw Navigation files to:

Robert B. Clark
Contracting Officer Technical Representative
National Geodetic Survey, Remote Sensing Division
NOAA, N/NGS31
Building SSMC3, Station 5147
1315 East-West Highway
Silver Spring, MD 20910

Roll Identification Number	Film Type	Quantity (Rolls)
(See Annex 2, #2)	Aviphot X100 CN	2

Thank you for your assistance.

FROM: (Signature)

RECEIVED THE ABOVE
(Name, Title, Date)

Return receipted copy to:

Name
Title
(Shoreline Photographic Contractor/
Shoreline Contractor Representative)
Fax #:

NOAA FORM 61-29 SUPERSEDES FORM C & GS 413 WHICH MAY BE USED.
This form was electronically produced by Elite Federal Forms, Inc.

*Note: The Reference Number is the Project Identifier (GA0401) plus the sequential number (01-99) of transmittal letters sent. Example: GA0401-01 is the first transmittal letter sent for this project, GA0401-25 is the 25th.

Version 1
September 30, 2004

ATTACHMENT B
SAMPLE PROJECT INSTRUCTIONS

TO
SCOPE OF WORK FOR SHORELINE MAPPING
UNDER THE
NOAA COASTAL MAPPING PROGRAM

REMOTE SENSING DIVISION
NATIONAL GEODETIC SURVEY
NATIONAL OCEAN SERVICE
NATIONAL OCEANIC & ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE

MEMORANDUM FOR: Shoreline Mapping Contractor

FROM: CDR Brian Taggart, NOAA
Chief, Remote Sensing Division

SUBJECT: State of XXXXX Shoreline Mapping Project Instructions

This document is the **Project Instructions** for Project XX0501 - Location, State; which consists of shoreline mapping in the State of XXXXX.

1.0 GENERAL - These Project Instructions contain project specific information for a shoreline mapping project and take precedence over the “Scope of Work, Shoreline Mapping for the Coastal Mapping Program” (SOW), Version 13, Dated September 30, 2004. All parts of the SOW not altered in these Project Instructions remain in effect.

1.1 INTRODUCTION - This project is being undertaken to provide digital shoreline for NOAA nautical charts and other uses. Note, all nautical charts referred to in this document are NOAA nautical charts.

1.2 COVERAGE - The project includes mapping of the Mean High Water Line (MHW), Mean Lower Low Water Line (MLLW), and alongshore features From: Point A To Point B.

The project limits are:

NW	XX° YY' ZZ" N XX° YY' ZZ" W
SW	XX° YY' ZZ" N XX° YY' ZZ" W
SE	XX° YY' ZZ" N XX° YY' ZZ" W
NE	XX° YY' ZZ" N XX° YY' ZZ" W

These limits are for the purpose of finding the general area in which aerial imagery and compilation are to take place. Imagery acquisition and map compilation are not required within the entire boxed area. See the accompanying marked-up copies of nautical charts to see where shoreline mapping is required. If the limit of compilation differs from the SOW requirement of 2000 feet from the waterline, the limit of compilation will also be shown on the chart(s). The charts also show the different levels of horizontal accuracy required, and may show the areas in which tide coordination is required.

Enclosed is one blank set of nautical charts covering the project area.

1.3 SCOPE - The work of the project will be divided into two separate phases. The first phase (Phase I) shall include planning, tide prediction, tide monitoring, aerial photography, ground control surveys, airborne GPS surveys, data reduction, and preparing reports. The second phase (Phase II) shall include aerotriangulation, compilation, feature attribution, and preparing reports. All deliverables listed in the SOW are required. The contractor shall not begin work on the second phase of this project without approval of the NOAA COTR.

1.4 PRIORITY - Not applicable to this survey.

1.5 START/COMPLETION DATES - The aerial photographic acquisition aspect of this project shall be initiated upon receipt of a Task Order authorizing the contractor to begin photographic operations.

Completion of Phase II shall be within eight months of the receipt by the contractor of the order from the NOAA COTR authorizing Phase II activity to begin. No aerotriangulation or compilation or other Phase II work shall take place before the contractor receives this authorization.

1.6 INTERIM DELIVERY SCHEDULE - The following schedule for the delivery of interim products shall be adhered to:

Photographic Flight Report (PFR) (NOAA Form 76-15): To be delivered to the NGS photo processing contractor with the associated original roll of film. A copy of the PFR shall be FAXed to NGS when the original is sent to the photo lab contractor.

The Ground Control Report, the Final Photo Report, and the Tabulation of Aerial Photography shall be delivered to NGS within two weeks of the time that the verified tide levels for the tide stations used to make the tidal window predictions become available on the CO-OPS web site.

All other reports are due within **three** weeks of the time that work for that particular segment of the cartographic process is completed.

2.0 <u>DATA ACQUISITION REQUIREMENTS</u>

2.1 IMAGERY ACCURACY AND FLIGHT PLANNING- Imagery Scale - Imagery shall be acquired along the flight lines provided with these Project Instructions at an altitude of 18,000 feet above the subject shoreline. Digital Way Point files representing the end points of the flight lines and other parameters are provided using the Coastal Mapping Program way point format. (See SOW Attachment C, Annex 4)]

There are approximately 2000 statute miles of shoreline within the project area.

There are approximately 500 photographic exposures required to provide coverage of the project area.

2.2 FLIGHT LINE PRIORITY - There is no priority order under which the project flight lines shall be flown.

2.3 PROJECT IDENTIFIER - The Project Identifier for this project is XX0501

2.3.1 PHOTOGRAPHIC FLIGHT REPORT - In addition to the data normally required on the Photographic Flight Report (PFR), clearly record data for all test exposures, accidentally taken exposures, and any exposures taken when not navigating a flight line, interruptions of imagery acquisition, or any situation that causes a break in imagery or data acquisition. In general; if the camera shutter trips and/or a data pulse is recorded, an entry in the PFR is required. The tripping of the camera shutter and associated data pulses that occur during normal camera system start-up procedures shall not be recorded on the PFR or in the Electronic Exposure Data file (EED). Record on the PFR any GPS failure, data logger failure, failure to start the system, or any data recording failures. Also, record in the PFR recommendations section the reasons for the exposure settings chosen. The Recommendations section is located on the back side of the PFR. (For instance: If underexposing by an *f*-stop and a half, record why this exposure was chosen.) Reminder: All camera systems used shall have passed the NGS Exposure Test as required in SOW, Attachment C, Section 6.2.

2.3.2 LIDAR FLIGHT LOG - Not required for this survey.

2.3.3 HYPER SPECTRAL FLIGHT LOG - Not required for this survey.

2.4 FILM MAILING LABELS - Blank HAS labels will be provided by the Government if requested.

3.0 SENSOR REQUIREMENTS

3.1 ANALOG AERIAL CAMERA –

> **A. FILM** - The Contractor shall collect both color negative and black & white infrared images. See SOW, Attachment C, Section 7.2 for film requirements and specifications.
>
> **B. CAMERA FILTERS** - All black & white infrared imagery shall be collected using either a 700, 705, 720, or a 740 nm filter on the acquisition camera. A 740 nm filter is preferred. Detailed requirements for the filter(s) to be used during color emulsion operations are found in the SOW, Attachment C, Section 7.2.E.

3.2 DIGITAL AERIAL CAMERA - The use of a digital aerial camera is not authorized for this project.

3.3 LIDAR - No LIDAR data acquisition is required for this project.

3.4 IFSAR - No IFSAR data acquisition is required for this project.

3.5 HYPERSPECTRAL SCANNER - No hyperspectral scanner data acquisition is required for this project.

4.0 TIDE/RIVER LEVEL COORDINATION

The contractor shall determine the times of the correct stages of tide or river level for aerial imagery data acquisition and for coordinating imagery data acquisition with the predicted tide levels. NGS will supply tidal zoning diagrams to assist the contractor in developing predicted tidal imagery windows.

4.1 RIVER LEVELS - Prediction of river levels on a datum other than MLLW is not required for this project.

4.2 TIDAL IMAGERY REQUIREMENTS - Color negative imagery shall be collected over the entire project area, and shall be collected at any stage of tide that is within or below the MHW tolerance level. Black & white infrared imagery shall be collected over the entire project within the tolerance for both the MHW and MLLW.

NOTE: If the contractor's aircraft is equipped with dual camera ports, and the contractor has two cameras that have received camera designators from the NGS, Remote Sensing Division (RSD), NGS prefers that the color negative imagery be taken in tandem with the MLLW black & white infrared imagery. If it is not possible to acquire the color negative imagery in tandem with the black & white IR imagery NGS prefers that the color negative be acquired within or just below the MHW tolerance.

The contractor should be aware that tidal heights and times may be considerably different for two adjacent bodies of water that are separated by strips of land or connected by narrow passages. The contractor should also be aware that non-local meteorological conditions can significantly change water levels to the point where they are outside the MLLW and/or MHW tolerance.

The Contractor is responsible to ensure that all imagery acquired for this project, in any tidal zone, is within the appropriate tidal tolerance at the time of acquisition.

It is the Contractor's responsibility to check with an appropriate local authority on a daily basis to determine if off-shore storm conditions, unusual meteorological conditions, or any other condition that might alter normal tide heights exist.

5.0 <u>TIDE/WATER LEVEL GAUGE INSTALLATION</u>
No tide gauge/water level gauge installation is required.

Monitoring, observing, and/or data processing may be required for already existing tide gauges.

6.0 <u>AEROTRIANGULATION</u>
Aerotriangulation is required for this project, but shall not begin until Phase II authorization is received by the contractor from the NOAA COTR. See SOW, Section 7.3 for aerotriangulation requirements.

6.1 SENSOR POSITION - Airborne kinematic GPS (KGPS) data is required for all imagery, see SOW, Attachment C, Section 13.0.

6.2 SENSOR ORIENTATION - Inertial Measurement Unit (IMU) data is not required but may be collected.

6.3 PHOTO GROUND CONTROL - At least four check points are required in each project area. See SOW, Attachment O. The number and distribution of any additional ground control shall be proposed by the Contractor in their Survey Plan.

6.4 AEROTRIANGULATION REPORT - Required, see SOW, Attachment I. NGS requires the aerotriangulation report and accompanying data files be completed and delivered for Government review within three weeks of the completion of aerotriangulation and before the compilation test data set has been completed.

7.0 COMPILATION

Shoreline compilation for this project is required, but shall not begin until Phase II authorization is received by the contractor from the NOAA COTR.

7.1 SCALE OF DEPICTION - For the purposes of shoreline delineation and feature depiction the scale of compilation shall be 1:20,000 or two times the largest scale chart or inset scale covering a particular area of the project whichever is larger. Different areas of the project may have different scale requirements based on chart coverage. See SOW Attachment K.

7.2 APPROXIMATE MEAN LOWER LOW WATER LINE AND MEAN HIGH WATER LINE - The approximate Mean Lower Low Water (MLLW) line shall be investigated and compiled as per the SOW, Attachment K for the entire length of shoreline within the project area. See SOW Attachment K, for a definition of the approximate MLLW line and SOW Attachment F, under the definition of Approximate for the accuracy standard of approximate lines.

The Mean High Water (MHW) line shall be depicted for the entire length of shoreline within the project area.

7.3 ACCURACY OF DEPICTION - All vector compilation shall meet the relative accuracy requirement of Section 8.5 of the SOW. Discrete point features along the shoreline shall be measured and depicted to a horizontal accuracy at the 95% confidence level as indicated on the accompanying charts. The vertical accuracy of discrete point features shall equal three meters or better. The entire project area shall be compiled to a horizontal accuracy of 3 meters.

7.4 LIMIT OF COMPILATION - Three factors to consider:

(1) Project area boundaries as depicted from the coordinates given in Section 1.2 of these Project Instructions,
(2) 2000 foot limit from shoreline (see SOW, Section 8.5D),
(3) Other Limits of Compilation that may be depicted on the accompanying marked up nautical charts. Do not compile any floating aids to navigation.

7.5 OFF-SHORE ROCKS - Several areas of off-shore rocks exist within the project area. Investigate the charts and imagery thoroughly to ensure all rocks that are charted can be seen and their existence and position verified. See SOW Attachment K.

8.0 CONTACTS/COMMUNICATIONS - Contact NGS whenever questions or unusual circumstances arise. The points of contact are:

George E. Leigh
Contracts Technical Manager & COTR
National Geodetic Survey
ATTN: N/NGS; SSMC-3 Sta. 8609
1315 East West Highway
Silver Spring, MD 20910
Phone: 301-713-3167
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email: George.Leigh@noaa.gov

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1315 East West Highway
Silver Spring, MD 20910
Phone: 301-713-2670x197
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email: Brian.Baldwin@noaa.gov

Exposed film shall be sent to:

HAS Images
Suite 300
136 North Clair Street
Dayton, Ohio 45402

9.0 ENCLOSURES

One marked-up copy each of nautical chart(s): #####, #####, #####
One set of pertinent Nautical Charts covering the project area
One copy of a tidal zoning diagram
One copy of a Tidal Zoning memo
One digital copy of waypoint file XX0401.wpt

Version 15B
February 1, 2008

ATTACHMENT C
COASTAL AERIAL FILM PHOTOGRAPHY REQUIREMENTS

TO
SCOPE OF WORK FOR SHORELINE MAPPING
UNDER THE
NOAA COASTAL MAPPING PROGRAM

REMOTE SENSING DIVISION
NATIONAL GEODETIC SURVEY
NATIONAL OCEAN SERVICE
NATIONAL OCEANIC & ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE

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ANNEXES:

ATTACHMENT C: COASTAL AERIAL FILM PHOTOGRAPHY REQUIREMENTS

1. INTRODUCTION

These Coastal Aerial Film Photography Requirements (CAFPR) include specifications for aerial photography and associated data to support NOAA's Coastal Mapping Program (CMP). In addition, Project Instructions will provide project specific information. The CMP is administered by the National Geodetic Survey (NGS), National Ocean Service (NOS), NOAA. This CAFPR document may be used as a stand-alone Scope of Work (SOW) or as an Attachment to the comprehensive "Scope of Work for Shoreline Mapping".

2. SCOPE

This document contains specifications for metric quality, tide-coordinated, Global Positioning System (GPS) controlled, aerial photography over the shoreline, including controlling quality, calibrating equipment, and writing reports. The scope of the project will be fully described in the Project Instructions and may include additional phases of shoreline mapping work.

Projects may also include: aerial photography of airports, aerial imagery of disaster areas, and other special case aerial imagery tasks.

3. PROJECT PARAMETERS

3.1 PROJECT LIMITS - Projects can be along any portion of the U.S. shoreline including U.S. possessions in the Caribbean and the Pacific, or other areas of interest. Individual project limits will be defined in the Project Instructions (see sample in Attachment B) and will be outlined on government provided nautical chart(s) of the area. Typically a rectangle will be used to define the project area boundaries. Usually the entire rectangle does not need to be covered with imagery, just the shoreline and adjacent areas. Photo coverage shall be planned to include all of the shoreline within the project area and all of the land within 2000 feet of that shoreline.

3.2 PRIORITY - Priority within the project area will be defined in the Project Instructions.

3.3 ACCURACY OF IMAGE MENSURATION - General guidance on HORIZONTAL accuracy at a 95% confidence level for well defined points.

Harbors, ports, channels, etc.	1 meter
Approach areas to ports	3 meters

Open coastal areas	5 meters

For project specific requirements, see Project Instructions.

3.4 COMPLIANCE REQUIREMENTS

A. PROJECT INSTRUCTIONS PRECEDENCE - The Project Instructions will take precedence over these CAFPR, since the Project Instructions provide detailed and often unique information about each project.

B. TERMS - The following conventions have been adopted for these CAFPR. The term “should” implies that compliance is not required, but is strongly recommended. The term “shall” means that compliance is required.

C. MODIFICATION - Requests to exceed or deviate from these CAFPR or the Project Instructions will be considered if written justification is provided in advance. No deviation is permitted until written approval is received from NGS. All requests for modification to these CAFPR and/or the Project Instructions shall be submitted by the Contractor in writing to the Contracting Officer prior to the due date on the Task Order and as soon as identified. Send a copy of the request to the NGS points of contact. If the Contractor anticipates not meeting a required deadline, the Contractor shall request, in writing, an extension from the Contracting Officer. Provide a copy of the extension request to NGS. Extensions may be granted if extenuating circumstances exist.

D. UNUSUAL CIRCUMSTANCES - The Contractor shall notify NGS of any unusual circumstances that occur during the performance under these CAFPR which might affect the deliverables or their quality, and especially of any deviation from these CAFPR.

E. ORIGINAL DATA - Observation logs and other records generated during this project are legal records which will be archived. It is very important that these logs be original, legible, neat, clear, and fully completed in indelible black ink. Original data shall be saved, unmodified, whether in hand written or computer recorded form and shall be marked “ORIGINAL DATA”. In the original records (paper or digital), nothing is ever erased or obliterated. All available spaces on the recording forms should be completed. If a space on a form does not apply, then enter “N.A.’ for “Not Applicable”. If a mistake is made on a form, draw a single line ~~through the mistake~~ and write the correction above or to the side. If space is too limited to permit a field correction, restart with a new log sheet, however, do not recopy the form in the office in order to make a “clean” copy. An explanatory note should be made for all corrections to the original recorded figures. It is essential that all recorded figures be neat and legible. All editing of computer recorded data shall be done on a copy of the original. Always submit the unmodified version of the data.

F. DATA BACKUP - The Contractor shall back-up all data and take whatever steps necessary to ensure the safety of all data, especially original, raw data. The contractor shall save all data back-ups for six months after NGS has accepted all data for that Task Order. At the end of that time period, the contractor shall destroy all copies of this data and notify NGS in writing that the back-up data has been destroyed.

G. GOVERNMENTAL RULES AND REGULATIONS - The Contractor shall ensure that they comply with applicable regulations of government agencies, including the:
Federal Aviation Administration (FAA), http://www.faa.gov/regulations_policies/
U.S. Coast Guard (USCG), http://www.navcen.uscg.gov/mwv/regulations/regs_home.htm
Environmental Protection Agency (EPA), http://www.epa.gov/lawsregs/
Occupation Safety & Health Admin. (OSHA), http://www.osha.gov/comp-links.html
National Park Service (NPS), http://www.nps.gov/history/laws.htm
and other federal, tribal, state, and local governmental rules and regulations.

H. STATUS REPORTS - The Contractor shall submit project status reports via TOMIS ~~email to the contacts in Section 11~~ **every Monday by 2:00 PM Eastern Time**, from the date of a Task Order award until the work is complete and accepted by NGS. See Attachment G for details. Also include any unusual circumstances, deviations from these CAFPR, equipment malfunctions, and/or any disturbance of the camera. **A weekly status report is required even if no progress has been made.**

3.5 REFERENCE SYSTEMS

A. HORIZONTAL CONTROL - North American Datum (NAD) 83 (YYYY), where YYYY is the year of the most recent observations. Note, the year of observations is on the NGS Data Sheet next to the latitude and longitude.

B. VERTICAL REFERENCE -
VERTICAL CONTROL - North American Vertical Datum (NAVD) 88; for Alaska and other areas outside the continental United States see SOW Section 6.2.

C. SHORELINE REFERENCE
MEAN LOWER LOW WATER (MLLW), see SOW, Section 8.5.
MEAN HIGH WATER (MHW), see SOW, Section 8.5.

D. NATIONAL SPATIAL REFERENCE SYSTEM (NSRS) – All positioning shall be tied to the NSRS http://www.ngs.noaa.gov/INFO/OnePagers/One-Pager_NSRS.pdf

E. GEOID MODEL - Use the most recent NGS model, currently GEOID03 for the lower 48 states, see: http://www.ngs.noaa.gov/GEOID/GEOID03/ and GEOID 06 for Alaska, see: http://www.ngs.noaa.gov/PC_PROD/GEOID06/ . For projects in Alaska and other areas outside the conterminous 48 states, see the Project Instructions for any special requirements.

3.6 REFERENCES AND GLOSSARIES

A. NOAA Nautical Chart Information - http://nauticalcharts.noaa.gov/staff/charts.htm ;

B. National Geodetic Survey homepage - http://www.ngs.noaa.gov/ ;

C. U.S. Naval Observatory's WWW site at:
http://aa.usno.navy.mil/data/docs/RS_OneDay.php

D. Manual of Photogrammetry (MOP), Fifth Edition, 2004, American Society for Photogrammetry and Remote Sensing;

E. Manual of Color Aerial Photography, 1968, American Society of Photogrammetry.

3.7 FILM OWNERSHIP - All original aerial negatives, from the instant of exposure, and other deliverables required through these CAFPR including prints and scans, are and shall remain the property of the United States Government. This includes frames outside the project area. These items include the Contractor-furnished film containers, 5 3/16 inch film spools (250' roll), 3.5 inch floppy disks, compact disks (CDs), and any other data transfer media. Data integrity is the responsibility of the Contractor until it is received at its destination.

4. GOVERNMENT SUPPLIED MATERIALS

4.1 PROJECT INSTRUCTIONS - Project Instructions are a separate document providing specific project information, containing any unique project requirements, and containing the following information:

A. MAPS - small scale maps showing the coastline and/or coastal ports to be photographed;

B. DIGITAL FILES - GIS files showing the shoreline and/or coastal ports to be photographed; and an ASCII text file of the flight line waypoints, if applicable;

C. ADDITIONAL INSTRUCTIONS - Instructions regarding tidal coordination, ground control, and any other project specific requirements;

D. PROJECT IDENTIFIER - The "Project Identifier," a six character alpha-numeric ID unique to each project;

E. LABELS - Blank film processing instruction labels, "DO NOT EXPOSE TO" labels, and address labels, if requested, see Section 14 and Annex 5.

4.2. COASTAL AERIAL FILM PHOTOGRAPHY REQUIREMENTS (this document)

4.3. CAMERA DESIGNATORS - The government will assign a unique camera designator to each of the Contractor's camera systems that are intended to be used under this contract. To get a camera designator the Contractor needs to submit to NGS a camera calibration report and a camera maintenance log (see Section 7). Upon approval of a calibration certificate and maintenance log, NGS will assign a unique camera designator for the camera and notify the Contractor. The Contractor shall ensure that the correct camera designator appears on each exposure and in the EED file (see Section 14, Section 6.1 and Annex 3). A camera designator issued by NGS stays with that camera system for all work done by that camera system, even if the work is done on a different NGS contract. A new designator is not issued when a new camera calibration is done, but a new designator is issued if any element of a camera that can change the system calibration is changed. See Section 7 for definitions of camera systems.

4.4 PHOTOGRAPHIC SERVICES AND PRODUCTS - Laboratory photographic services and products, such as film processing, production of prints and diapositives, scanning, media, and storage, used in the performance of this contract shall be supplied at government expense by the NGS film processing contract laboratory, not by the Shoreline Contractor. All photographic products supplied shall remain the property of the Government, and shall be returned to NGS at the conclusion of each project.

4.5 EED FILE CHECKING PROGRAMS - The Contractor shall check every EED file with government supplied software prior to submitting each EED file to NGS. The software checks the EED file for proper formatting and checks for value limits on various fields within the file. The software also computes and displays the aerial photography footprints, enabling the checker to immediately see problems with positioning, spacing, and/or orientation.

4.6. REJECTED FILM - If photography is rejected by NGS, NGS will, if requested, have sample scans or prints made showing the problem areas and will have these scans or prints sent to the Contractor as soon as possible.

The Contractor has no authority to reject photographs. They may, in the comments section of the Photographic Flight Report (PFR) comment on recommended rejections and provide a reason for the recommendation.

4.7 NOAA SURVEY MARKS ~~DISKS~~ - If required and when requested by the Contractor, NGS brass survey disks and/or NGS aluminum logo caps will be supplied to mark horizontal and/or vertical geodetic survey points. If required and when requested by the Contractor, NOS brass survey disks and/or NOS aluminum logo caps will be supplied for use as tidal bench marks.

5. QUALITY CONTROL

The Contractor shall check all data to ensure that it is complete, reliable, and accurate. Note, accuracy requirements may be in the Project Instructions. The Contractor's personnel shall become thoroughly familiar with these CAFPR; the Project Instructions; the definitions of terms; and the material covered in the other references and publications, as required. See Section 3.6 for a list of References.

QUALITY CONTROL PLAN (QCP) - The Contractor shall have the responsibility for the overall quality of the Project. The Contractor's Final Reviewer and other Contractor personnel, as required, shall become intimately familiar with the Project Instructions, these CAFPR, the Annexes to these CAFPR, and References. The Contractor shall submit a written Quality Control Plan prior to beginning work (as part of their Technical Proposal), to include at least the following:

i. checking manually recorded data;
ii. checking data manually entered into a computer system;
iii. checking all digital data output formats;
iv. checking data at various points in the over-all process;
v. checking all documents and reports submitted.

The Contractor shall also describe how data will be backed up and how it will be ensured that original data are not modified. See Section 18, Deliverables.

A summary of how the steps of the QCP were met shall be included in the Photo Final Report.

6. DATA ACQUISITION

6.1 DATA

A. AERIAL FILM - The Contractor shall capture frames over the project area, using the specified emulsions and the pre-approved flight lines. See Section 7.2 for film details. A blank frame shall be inserted between each flight line of imagery.

B. PHOTOGRAPHIC FLIGHT REPORT - The Contractor shall complete the NOAA format Photographic Flight Report (PFR) during each flight. Note, each flight line fills three rows on the form. The form shall be filled-in completely, as shown in Annexes 1 and 2 to these CAFPR. NGS will supply heavy weight original, two-side forms, when available. When not supplied, use heavy weight paper as possible.

The PFR is the written record of the film that was captured. The original copy is marked "ORIGINAL" in blue ink across the top, and stays with the film.

C. ELECTRONIC EXPOSURE DATA FILE – The contractor shall capture meta-data related to each exposure at the time of exposure. In this SOW, this file is called the "Raw Navigation File" (RNF). This RNF provides the input for creating the Electronic Exposure Data (EED) file required as a deliverable. The Contractor shall submit this EED file, in NGS format, for each roll of film. See Annex 3 for format. Submit this file via TOMIS ~~on a 3.5" floppy disk or CD (CD preferred)~~ ~~and send it directly to NGS to arrive~~ within three working days of shipment of the corresponding roll of film. Note, a 3.5" floppy disk is no longer required. The time and date in this file indicate the time and date of the frames. This file is the metadata for the aerial photography and is entered into the NGS database as a permanent record of the photography.

This EED file shall contain information for all frames on that roll, one record (line) of 11 fields for each frame. This includes all frames, except those that are automatically taken when a camera is turned on, even if they are outside the project area. In general: if the camera shutter trips and/or a data pulse is recorded, an entry in the EED is required. The Contractor shall check the EED file formatting prior to submission to NGS, especially positions and azimuths.

D. OTHER PFR and EED CONSIDERATIONS - In addition to the data normally required on the PFR and in the EED, clearly record on the PFR and in the EED data for all test frames, accidentally taken frames, and any frames taken when not navigating a flight line. On the PFR record the reasons for any interruptions of imagery acquisition, or any situation that causes a break in imagery or data acquisition. In general: if the camera shutter trips and/or a data pulse is recorded, an entry in the PFR and the EED is required. However, tripping of the camera shutter and associated data pulses that occur during normal camera system start-up procedures shall not be recorded on the PFR or in the EED.

Record on the PFR any GPS failure, data logger failure, failure to start the system, or any data recording failures. The Contractor shall not, normally, reject any imagery or associated data.

If NGS rejects the PFR or EED data, corrections and/or re-flight(s) may be required at the Contractors expense.

E. TRANSMITTAL LETTER – With the new TOMIS system, a Transmittal Letter will seldom be used for Contractor Deliverables. For Deliverables the Contractor submits to TOMIS, the system will acknowledge receipt after NGS marks the item as received. For all large digital files (greater than 3MB) and for hard copy materials that the Contractor submits outside of TOMIS, (hardcopy data being sent via express mail, regular mail, etc.) the Contractor shall submit a report to TOMIS stating the material submitted and the method of shipment.- Transmittal Letters will continue to be used for items the Government ships to the Contractor. See sample Transmittal Letters in Attachment AC and Annex 6 to this Attachment.

~~The Contractor shall prepare a Transmittal Letter for every shipment to NGS. The Letter shall list all contents of the shipment. One copy of the Letter is sent with the shipment and another copy is emailed or FAXed to NGS. NGS will return the receipted Letter and will also use Transmittal Letters when shipping information. See sample in Annex 6 for a sample NOAA Transmittal.~~

6.2 EXPOSURE TEST - An exposure test is required for each different combination of camera system, emulsion, and filter planned to be used. The test flight(s) shall be over an area of shoreline similar to the upcoming project area, but are not required to be in the project area. The test flight(s) do not require airborne Kinematic GPS (KGPS) nor tide coordination, but do require the submission of a

PFR, RNF, and an EED file for each test flight. This exposure test will not be accepted as regular production coverage. NGS recommends that the Contractor bracket their exposure settings during the test.

The NGS exposure test will be no less than 5 lines of photography, each line consisting of no less than 5 exposures. The Contractor will expose one line as NORMAL (a base exposure), and then will vary the exposures over the remaining 4 lines as follows: B/W IR lines will be exposed at -2/3, -1/ 3, +1/ 3, and +2/ 3 Stops; For Color Negative films, the remaining 4 lines will be exposed at -1, -1/ 2, +1/ 2, and +1 Stops. The expected results should give a clear separation of tones by increasing or decreasing exposure, but in no way should the exposures be manipulated to give equivalent exposures.

Before performing an exposure test using Kodak's 2424 B/W IR film, it will be necessary to firmly establish film sensitivity by sending a small section of film to the current NOAA film processing lab for a speed test. B/ W IR emulsions have very narrow latitude, so before any testing is done, this one parameter must be established.

Test photography for both film types should be avoided between the hours of 11am and 1pm, Local Standard Time.

Steps after exposure:

A. SHIPPING CONTENTS - Contractor ships the following items directly to the NGS film-processing contract laboratory (LAB):

- i. Cut film (aerial photography film with the test frames on it, in proper container);
- ii. Original, two-sided PFR with film, (completed NOAA form 76-15, see Annex 1);
- iii. Raw Navigation File (RNF) containing meta-data on each exposure in native format (used to create EED file);
- iv. Transmittal Letter listing above 2 items (See Annex 6).

B. LETTER - Contractor sends NGS copy of Transmittal Letter (via TOMIS ~~FAX or e-mail)~~;

C. EED - Contractor prepares EED file within 3 working days and submits via TOMIS ~~ships it on either a 3.5" floppy disk or a CD (CD preferred) to NGS.~~

See Section 15, for additional shipping requirements.

D. FILM FLOW FOR EXPOSURE TESTS

- i. Acquisition Contractor (AC) exposes film;
- ii. AC ships film to LAB;
- iii. LAB receives film, processes film, and forwards it to NGS;
- iv. NGS receives film and reviews it, notifies Contractor of the results of the processing and review;
- v. If requested, NGS ships film to the Contractor for review.

The Contractor shall not proceed with production until the test strip data is accepted by NGS and they have received approval from NGS to proceed. If NGS rejects the exposure test, a repeat exposure test is required. An exposure test does not have to be re-flown for subsequent Task Orders unless photographing a type of shoreline for which an exposure test was not previously approved.

6.3 REGULAR PRODUCTION PHOTOGRAPHY - The process is the same as in Section 6.2, Steps A - C, above. If a roll is not completely exposed within 60 days of the first exposure on that roll, the Contractor should cut and ship the film. Normally only fully exposed rolls should be shipped to the NGS film processing contract laboratory.

6.4 FILM FLOW FOR PRODUCTION PHOTOGRAPHY

The film flow for production photography shall follow the outline below.

A. Acquisition Contractor (AC) exposes film;
B. AC ships film to NGS film processing contract laboratory (LAB);
C. LAB receives film, assumes responsibility, and processes film;
D. LAB ships film to NGS;
E. NGS receives film, reviews for damage, assumes responsibility, reviews film for photogrammetric usability, notifies AC of review outcome, and, if requested, ships film to AC, otherwise, ships film to LAB;
F. If AC receives film, assumes responsibility, reviews film, determines products required (prints/scans), emails product request to NGS, and ships film to NGS;
G. If NGS receives product request and film, assumes responsibility, reviews film again, notifies AC of review outcome, emails product request and ships film to LAB;
H. LAB receives product request and film, assumes responsibility, produces ordered products, ships products to NGS, and stores film;
I. NGS receives products, reviews products, and ships products to the AC.

If during the second NGS review (Subsection G above), the film is found to be in poor condition (tears, finger prints, etc.), the Contractor may be required by NGS to re-fly the photography at the Contractor's expense.

See Section 15, for additional shipping requirements.

6.5 ORDERING OF PRINTS AND SCANS - The Contractor shall send NGS an email listing requirements for prints, scans, etc. This email shall include the desired frame numbers, roll numbers, format, scan resolution (microns), delivery media, etc. NGS will then order these items from the NGS film processing contract laboratory, have them shipped to NGS for review, and forward them to the Contractor.

6.6 COMPLETION DATE - All deliverables shall be received by the film processing Contractor and/or NGS, as specified, no later than the date in the Task Order.

7. EQUIPMENT AND MATERIAL

7.1 CAMERA SYSTEMS (These CAFPR contain the specifications for film camera systems only.)

A. DEFINITIONS - A Wild RC 20/30 camera system is comprised of the lens cone, filter, and drive unit. A Zeiss RMK or LMK camera system is comprised of the lens cone, filter, drive unit, and film magazine.

B. SPECIFICATIONS - The aerial camera systems used for these CAFPR shall meet the following specifications:

i. Single lens metric camera with quality equivalent to or better than a Wild RC 20/30 or Zeiss RMK-A 15/23. If a Wild RC 20 is used, the largest aperture used should be F 5.6.

ii. Forward Motion Compensation The camera's Forward Motion Compensation feature shall be used for all photography under these CAFPR.

- 9 inch x 9 inch format

- Between-the-lens, variable speed shutter

iii. Six inch (153 ±3 mm) focal length lens having a usable angular field not less than 90 degrees.

iv. Minimum resolution of 15 lines/mm on a glass plate, with an Area Weighted Average Resolution (AWAR) not less than 55 lines/mm.

v. Decentering (formerly called tangential) distortion shall not exceed 0.008 mm and radial distortion shall not exceed 0.010 mm.

vi. Model Flatness; total difference, +/- 0.019 mm

vii. The indicated principal points (fiducial centers) shall fall within a 0.030 mm radius circle around the principal point of autocollimation.

viii. The calibrated principal point (point of symmetry) shall fall within a 0.015 mm radius circle around the principal point of autocollimation.

ix. Equipped with a vacuum or pressure device for holding film flat against a platen at the instant of exposure. Platen departure from a true plane shall not exceed +/- 0.0005 in. (0.013 mm) when the camera/magazine vacuum is applied.

x. Record on each exposure at least 8 fiducial marks. Marks shall be located in each corner of the format and at the center of each side. The fiducial marks shall be clearly visible and sharp on every negative.

xi. TIMES AND DATES - Record on each exposure the time in correct Coordinated Universal Time (UTC) (not GPS time), and the correct date, if data recording is available. Note, the time is also recorded in the EED file and on the Photographic Flight Report. All three times shall agree with each other within two minutes, and **THE TIME IN THE EED FILE SHALL AGREE WITH UTC TIME (SAME AS GMT) WITHIN TWO SECONDS.** A daily time check for all clocks is recommended. Also ensure that all dates recorded are correct (double check that the clocks are not set 12 hours off so that the date cycles incorrectly at noon). See: http://www.time.gov/ . Note, deliverables with incorrect time(s) may be rejected causing a large additional expense to the contractor in re-acquiring film of the project area.

For additional information on GMT, zone times and day light saving time, see: http://wwp.greenwichmeantime.com/ . For a world time zone map in PDF format see: https://www.cia.gov/library/publications/the-world-factbook/reference_maps/pdf/time_zones.pdf

xii. Record on each exposure the lens identification number and focal length, see also Section 14.

xiii. Record a level bubble on each exposure, if camera is equipped to do so.

xiv. Record a film title on each exposure if the camera is capable (see Section 14). Note: any label(s) on the photographs shall conform to the specifications in Section 14.

xv. The camera shall be installed in a mounting which attenuates the effects of aircraft vibration.

xvi. The camera shall have an electrical connection to the GPS positioning system and the aircraft navigation system in order to accurately record the position and time of the midpoint of the exposure. See Sections 12 and 13.

xvii. All exposures shall be positioned with pseudo-range GPS, or better, for the positions in the EED file (and for aircraft navigation).

C. CALIBRATION - In addition to the specific camera requirements, a valid certificate of calibration (no older than three years) from the Optical Science Laboratory of the U.S. Geological Survey (USGS) shall be submitted to NGS for each camera system to be used during this contract. The fee for the tests and the arrangements to have the tests performed are the responsibility of the Contractor. The calibration certificate(s) shall be submitted to and approved by NGS prior to production camera use under this contract. Filters to be used under this SOW shall have been tested by the USGS at the time of each three-year camera calibration.

D. PREVENTIVE MAINTENANCE - The Contractor shall supply to NGS a log of all maintenance performed on each camera system, to be used for these CAFPR, including the dates when maintenance was performed and the nature of the maintenance performed, to show that preventive maintenance has been satisfactorily completed within the previous three years.

E. MALFUNCTIONS - All camera system malfunctions shall be recorded, and NGS notified. A malfunction is defined as a failure anywhere in the camera system that causes an interruption to the normal operation of the camera. Also, record and report any malfunctions of the EED collection system.

F. DISTURBANCE OF THE CAMERA SYSTEM - After any disturbance of the camera that might affect its calibration, or when there is any reason to believe the dimensional relationship of the lens, fiducial marks, and film plane have been disturbed by partial disassembly or unusual mechanical shock, the Contractor shall notify NGS, the camera shall be recalibrated before further use, at the Contractor's expense, and the Contractor shall submit the new certificate of calibration and maintenance log to NGS. Any partial disassembly, change, or unusual mechanical shock that may effect the camera - antenna - IMU relationship shall also be reported to NGS and appropriate re-measurements and/or re-calibrations performed. The remedial action taken to prevent further disturbance of the camera system shall also be reported to NGS.

7.2. FILM

A. FULL ROLLS - The Contractor should submit only full rolls of film, unless meeting the 60 day deadline discussed in Section 6. Splicing of film rolls shall not be performed.

B. EMULSIONS - Several types of film may be required:

i. Kodak Aerocolor 3 Negative Film 2444 (9.5 inch), batch 1131 or higher, or equivalent;
ii. AGFA X100 color negative film, or equivalent;
iii. Kodak Aerographic Black & White Infrared (B&W IR) Film 2424 (9.5 inch), or equivalent;
iv. AGFA PE80 panchromatic, or equivalent;
v. on occasion, color IR may also be required by the Project Instructions.

Film shall be purchased by the Contractor. A proposal for the use of "equivalent" film shall be submitted to NGS prior to use. NGS will notify the Contractor if the "equivalent" film is approved, and also the appropriate gamma for that film. Each emulsion requires a test strip in each camera system proposed to do the imagery acquisition prior to production usage. A roll of film shall not be exposed after its expiration date.

C. EMULSION VARIANCES IN INFRARED FILM- Significant variances in film speed frequently occur between different batches of Kodak's 2424 B&W IR emulsions. As much as

+/- 1 3/4 difference in f-stop has been observed between different emulsion batches. The speed difference between these “cold” and “hot” rolls can yield results that could compromise the position of the waterline. Past studies indicate that when the B&W IR medium is used for coastal mapping overexposure due to speed shifts (crossover) with “hot” rolls can result in unacceptable water penetration. Conversely, underexposure due to speed crossover shifts with “cold” rolls result in critical detail being lost.

The way to determine if rolls are of different speeds is to run time/gamma series tests on samples of the emulsion that are cut from the B&W IR film rolls when a switch to a different batch occurs. The resulting information, obtained from test strips, will indicate if any crossover speed shift has occurred. If a shift has occurred, it is compensated for by adjusting the ASA values at which the film is exposed. Close monitoring of B&W IR batch numbers is required when performing photography with this emulsion.

Every effort should be made to avoid switching between emulsion batch numbers when exposing B&W IR on a shoreline mapping project. If the switch to a different batch number is unavoidable an unexposed three (3) foot sample test strip shall be cut from the film roll with the new emulsion batch number. This unexposed test strip shall be sent to the NGS film processing contract laboratory for time/gamma testing. The photo laboratory will test the film strip and compute the characteristic curve of the emulsion. The photo lab’s curve is then compared to a previously established curve of known parameters and the shift in the tested film’s speed is calculated.

D. TIDE COORDINATION - The Project Instructions may require color negative film to be tide coordinated, may require B&W IR film to be captured at Mean High Water (MHW), may require B&W IR film to be captured at Mean Lower Low Water (MLLW); may require simultaneous exposure of color negative and IR (dual-camera aircraft).

E. FILTERS - Only optical filters provided by the lens manufacturer or meeting the same optical specifications may be used. A 36% transmission antivignetting filter shall be used during all photography under these CAFPR. Filters must have surfaces parallel within 10 seconds of arc, and their optical quality must be such that their addition to the camera enhances the uniformity of focal plane illumination and does not cause an undesirable reduction in image resolution. Use a 420 nanometer filter with color negative film to absorb the ultra-violet rays scattered by aerial haze. **Use a 740 nanometer filter with B&W IR film so that only the reflected near IR wavelengths shall reach the emulsion.** If a 740 nm filter can not be obtained, NGS may approve the use of an alternate filter. Contact NGS prior to any usage of an alternate filter. Filters to be used under this SOW shall have been tested by the USGS at the time of each three-year camera calibration. See also Section 17.

F. STORAGE AND HANDLING - Film shall be stored, handled, and shipped in accordance with manufacturer's recommendations, especially regarding the storage temperature and humidity. Kodak recommends that **unexposed natural color films** be stored in a refrigerator at 55 degrees Farenheit or lower, or in a freezer at 0 to -10 degrees Farenheit, in the original sealed container. Kodak also recommends that **unexposed B&W IR film** be kept at 55 degrees Farenheit or colder, in the original sealed container. Further, Kodak recommends that **exposed film** be stored in a cool, dry place and that it be processed as soon as possible after exposure. If necessary to hold **exposed B&W IR film** for several days (such as over a weekend), it should be refrigerated below 40 degrees Farenheit.

Film shall be treated with extreme care both before and after photography, especially with regard to temperature and humidity. Keep film in its original container until as close to flight time as possible to reduce moisture transfer once the container is opened. Frozen film should be allowed 24 hours to adjust to room temperature. Cooled film should be allowed to sit in its original unopened container at room temperature over night prior to use. Photographic film containers shall not be exposed to direct sunlight or other sources of heat. At the end of each flying day, color negative film (including loaded film magazines and cassettes) shall be removed from the aircraft if the inside temperature of the aircraft is expected to exceed 85 degrees Fahrenheit. High humidity may cause film to stick to the camera's film platen when left on the aircraft overnight. IR film (B&W and color) shall be removed if the inside temperature of the aircraft is expected to be above 55 degrees Farenheit over night. Likewise all film shall be removed if the temperature may go below freezing inside the aircraft.

G. LEADERS AND TRAILERS - Each roll of film should have a 6 foot leader of blank film at the beginning, and a 3 foot trailer at the end. Note, partial rolls with unexposed film that exceeds 10 feet in length should have the excess cut from the roll of film before shipping for processing. A roll of aerial film shall consist only of frames made with the same camera system.

H. SPOOL SIZE - The Contractor shall only use film spools having a flange diameter of approximately 5 3/16 inches (13.3 cm) (250 foot roll), and only that length of film which can be wound on a spool without strain, leaving at least 1/8 inch (3 mm) of flange exposed.

I. LABELS - Accompanying each roll of film shall be a filled-in film processing instruction label defining the characteristics of the film (wrap inside/outside, leader lengths, etc.), a "DO NOT EXPOSE TO" label, and an address label. For color negative film, add the comment "PUSH 4" to the film processing label. Instructions for using these labels are included in Section 15, the shipping address is in the Project Instructions, and samples are in Annex 5.

J. TABLULATION OF AERIAL PHOTOGRAPHY - The Contractor shall also prepare a "Tabulation of Aerial Photography" containing at least the information as the sample in Annex 7.

7.3 AIRCRAFT

A. AIRCRAFT GENERAL - The type of aircraft and the aircraft tail number used shall be stated on the Photographic Flight Report (Annex 2, Item #12 and 13) and all aircraft used in the performance of these CAFPR shall be maintained and operated in accordance with all regulations required by the FAA. Any inspections or maintenance of the aircraft for performance of these CAFPR which results in missed photographic weather shall not be considered an excusable cause for delay. The Contractor shall ensure that the aircraft has a proven service ceiling, with operating load (fuel, crew, camera, film, and other required equipment), of not less than the highest altitude required to acquire the exposures.

B. DUAL CAMERA PORTS - NGS may require that an aircraft with dual camera ports be used to allow the simultaneous capture of color negative and tide coordinated black & white infrared imagery.

C. CAMERA PORT - The design of the camera opening(s) in the aircraft shall be such that the field of view is unobstructed when a camera is mounted with all its parts above the outer structure. The field of view shall, so far as is practicable, be shielded from air turbulence and from any outward flows, such as exhaust gases, oil, etc.

D. CAMERA PORT WINDOW - NGS recommends that a camera port window(s) not be used. If a camera port window is used, it shall be: (1) of optical quality; (2) mounted in material that eliminates mechanical stress to the window; (3) free of blemishes, dirt, significant scratches, etc.; (4) and shall not degrade the resolution or the accuracy of the camera (see Section 7.1). The physical characteristics of the window (such as size, thickness, smoothness, flatness, parallelism, glass quality, and optical transmissivity) shall be reported to NGS prior to use. Any window should meet the American Society of Photogrammetry and Remote Sensing Aerial Photography Standards, 1995, which states, “If an aircraft camera has a port glass it shall be preferable 50mm thick but not less than 37mm thick. The surface finish shall be 80/50 or better. Glass material shall be polished crown, group category M. Mil Specs Mil-W-1366F (ASG) October 1975, C-1 optical quality or better.” See also MOP, Fifth Edition, 2004, pages 396-397.

8. FLIGHT LINE PLANNING AND CLEARANCES

8.1 FLIGHT LINES - The Project Instructions may require the Contractor to plan flight lines for the project area and ensure complete stereoscopic coverage of the project area. The flight line planning parameters of: film type, overlap, sidelap, navigation, airborne KGPS, sun angle, visibility, tide-coordination, tilt, crab, etc. shall be considered in the planning and are discussed in these CAFPR and the Project Instructions. NGS may supply the flight lines (with associated waypoint files), or recommendations and/or requirements for planning parameters in the Project Instructions. The photo coverage shall be planned to include all of the shoreline within the project areas and all of the land within 2000 feet of that shoreline.

8.2 FLIGHT LINE MAPS

A. MAPS WITH PROPOSED FLIGHT LINES - If required to plan flight lines, the Contractor shall, as part of the technical proposal, submit to NGS paper map(s) and digital ESRI shapefiles that clearly show all proposed flight lines. The maps shall show the flight lines numbered using the NGS flight line numbering system (see Annex 3), and include the photographic coverage of each flight line, scale (photo and map), film type (B&W IR/CN), tide stage, proposed ground control, if required (with existing points and proposed points, each identified separately), and project area boundaries. Prepare a separate map for each emulsion if the flight line layout will be different for different emulsions. The base map shall be the largest scale nautical chart(s) covering the entire project area.

B. MAPS WITH FLIGHT LINES AS FLOWN- Similar map(s) showing the as flown flight lines, photograph centers, and beginning and ending frame numbers for each flight line shall be included in the Photo Final Report, see Section 18.17.

C. NGS SUPPLIED FLIGHT LINES -NGS may supply the flight lines to be used for a project. The Contractor shall use the NGS flight lines to acquire the required photographs.

8.3 FLYING HEIGHT - The flying height above the coastline and/or coastal port is normally between 5,000 and 25,000 feet. The project area(s) and final product accuracy will be defined in the Project Instructions. The flying height(s) and other parameters may be defined in the Project Instructions also.

Departures from planned flying height shall not exceed 2 percent low or 5 percent high for all flying heights up to 12,000 feet above mean ground elevation. Above 12,000 feet, departures from specified flight height shall not exceed 2 percent low or 600 feet high. Note, the altitudes entered into the Photographic Flight Report (see Annex 2) and the EED file (see Annex 3) are the altitudes above mean sea level (MSL), both in feet.

Flying height over the Great Lakes must take into account the correction needed for the elevation of the lake above MSL.

Note, altimeter corrections for barometric pressure, temperature, etc. may be required in order to meet the above tolerances.

8.4 WAYPOINT FILES - If NGS supplies the project flight lines, NGS will also supply waypoint files in NGS format. The format is explained, with an example, in Annex 4.

8.5 FLIGHT CLEARANCES - The Contractor shall comply with all required FAA Regulations, including obtaining all required clearances. The Contractor shall obtain all clearances for the aerial survey aircraft to enter into any restricted airspace, civilian or military.

9. WEATHER, SOLAR ALTITUDE, AND TIME OF YEAR

9.1 CLOUDS - No clouds or cloud shadows shall appear on the photographs. High, thin overcast clouds will be permitted above the flying altitude if it does not cause ground mottling or a discernable reduction in light levels and/or ground object shadows. Under no circumstances shall color negative or black & white IR films be exposed under a solid overcast sky.

9.2 TREE LEAVES - Leaf-off condition is not required but is preferred.

9.3 WELL-DEFINED IMAGES - Photography shall be undertaken only when well-defined images can be obtained. In addition to no clouds, photography shall not be attempted where the ground is obscured by haze, smoke, smog, dust, or falling snow, sleet, rain, etc. In addition, photography shall not be conducted when the shoreline and adjacent area is covered by water (flood), snow, or ice, and shall not be conducted when the land-water interface is obscured by snow, ice, etc.

9.4 VISIBILITY - The minimum visibility at the time of exposure is 8 miles for color negative or black-and-white IR film. Visibility is determined by looking at objects on the ground toward the sun. The distance at which the detail of ground objects is clearly defined is the visibility. If the visibility is satisfactory, details of ground objects shall be clearly defined at the edge of the view through the drift sight.

9.5 SUN ANGLE

A. SUN ANGLE TOLERANCE - Sun angle shall not be less than 30 degrees above the horizon at the time of exposure. The Project Instructions may require a larger sun angle for certain projects. Ideally, the sun angle should be between 30 and 45 degrees for shoreline photography. Areas with steep terrain may require higher sun angles. Photography should be collected while the sun is over the water so that any shadows created by elevated objects will point inland and will not obscure the shoreline.

B. SUN SPOTS - The size and number of hot spots (no sun shadow points) and "sun spots" (bright, sun reflectance areas) on the water and shoreline shall be kept to a minimum and eliminated if possible because these bright spots can obscure important features. During flight planning, flight line directions and times should be arranged to preclude the occurrence of these spots in critical areas of the photographs (especially shoreline and near shoreline areas). See "Manual of Color Aerial Photography", First Edition, American Society of Photogrammetry, 1968, For a copy of Sub-chapter 2.2, see the nine pages showing the procedure to pre-determine the occurrences of sun reflections inAttachment AF. With a six inch focal length camera, sun reflections occur with high sun angles (over about 53 degrees), normally near mid-day. See also MOP, Fifth Ed. Page1115. Increasing end-lap to 80% helps ensure that significant features will not be obscured by sun reflections.

C. SUN ANGLE DETERMINATION - Sun angles for a given day can be determined from a "Solar Altitude Diagram" or from appropriate computer software. For on-line sun angle solutions, see the U.S. Naval Observatory's WWW site at: http://aa.usno.navy.mil/data/docs/RS_OneDay.php which computes sun altitudes and sun azimuths for U.S. locations and world-wide positions. (Click on "Data Services" and then on "Altitude and Azimuth of the Sun...") See also MOP, Fifth Edition, 2004, pages 1114-1115, and Attachment AF.

9.6 CLEAR DAY MAP – Refer to www.ncdc.noaa.gov . Please see the directions below for help navigating the website.

1. In the left column under "Data & Products", click on "Start Here"
2. Scroll down and click on the blue dot next to "Inventories"
3. In the second, red row, click on "Get/View Data"
4. In the first blue row, click on Graphs/Maps"
5. Under "Surface Data: Graphs & Maps", click "Climate Maps of the United States"

6. In the left column, click on "Quick Search"
7. In the "Region" column, highlight the desired region
8. In the "Map Category" column, highlight "Sky Cover/Visibility"
9. Click on "Continue"
10. Highlight first choice, "Mean Number of Clear Days (Sunrise to Sunset)"
11. Click on "Continue"
12. Click on month(s) of interest
13. To download the high resolution PDF file for this map, click on the blue link (below this statement), or, to download the ESRI Shape Files for this map, click on one of the blue links (below this statement). Note, there is a charge.

10. TILT, CRAB, OVERLAP AND SIDELAP

10.1 TILT - Care shall be taken to keep tilt (departure from the vertical) of the camera to a minimum. Tilt shall not exceed +/- three (3) degrees for any photographic frame. The average tilt for the entire project shall not exceed +/- one (1) degree.

10.2 CRAB - While exposing aerial photography, the camera shall be compensated for crab of the aircraft, with a resultant error not exceeding +/- five (5) degrees, as measured from the average line of flight, and the difference between any two successive exposures shall not exceed +/- five (5) degrees.

10.3 OVERLAP - Forward overlap (Endlap) shall normally be 60 percent, plus 5% to minus 2% percent between consecutive exposures. However, when a project is over an area that is primarily open water or rugged terrain, an overlap of 80% should be used.

10.4 SIDELAP - Sidelap between adjacent flight lines is normally 30%.

11. TIDE COORDINATION

11.1 NGS SUPPLIED WINDOWS - NGS may supply exposure time/tide windows for each coastal area to be photographed. These “windows” will cover an extended range of possible flying dates. These time/tide windows will be determined by NGS initially to help ensure that all exposures meet the NGS tolerances for tide-coordinated photography. If tide windows for additional dates are required, contact NGS.

11.2 CONTRACTOR DETERMINED WINDOWS - The Contractor shall determine predicted exposure time/tide windows (exposure times for tide coordination) for MHW and/or MLLW unless exempted from this requirement by the Project Instructions. See the Project Instructions and Attachment J for additional instructions and explanations of how MHW and MLLW are determined.

11.3 COORDINATION - The Contractor shall expose all film within the predicted exposure time/tide windows unless real-time observations indicate that the actual water level is significantly different from the predictions, and is outside the allowable tolerance. See Attachment J. Be sure to take into account time zones, daylight savings time, and to use UTC time. Consulting NOAA CO-OPS (tides and water levels) real-time www site may assist in determining unusual water level conditions, see: http://tidesonline.nos.noaa.gov/ .

The Contractor shall prepare a "Tabulation of Aerial Photography" showing the times of the time/tide windows and the times of the exposures for both color negative and IR film. The Table shall contain, at least, the same information as the sample in Annex 7. Explain any discrepancies between the time of photography and the predicted tidal window. Submit within two weeks of the time that verified tide gauge data is available for the
tide gauge(s) used to make tide window predictions. This Tabulation of Aerial Photography shall be included as part of the Photo Final Report. See Section 18.17.

11.4 TIDE GAUGE INSTALLATION AND OBSERVATION - The Project Instructions may also require the Contractor to install, operate, observe, and/or process data from tide/water level gauges in the project areas for either real-time or post-flight tidal height comparisons. See Attachment J for additional information.

12. NAVIGATION

12.1 METHODOLOGY - The aircraft shall be navigated using pseudo-range GPS, or another system with equivalent or better accuracy.

12.2 NAVIGATIONAL ACCURACY - The cross-track flight-line deviation from the lines specified in the waypoint files (see Annex 4) shall not exceed 5% of the flying height (750 feet for a flying height of 15,000 feet). Changes in the course of the aircraft between successive overlapping photographs within a flight line shall not exceed three (3) degrees.

12.3 EXPOSURE STATION ACCURACY (for EED file) - Exposure stations shall be positioned to an absolute accuracy of +/- 20 meters, or better. An electronic pulse shall be used to accurately mark the mid-point of the exposure. The pulse shall be used to determine the exposure station position. These exposure station positions and other information shall be recorded in the EED file (see Annex 3). Note, airborne KGPS positioning is discussed in Section 13.

12.4 FLIGHT DIRECTION - Flight lines may be flown in either direction, but adjacent, parallel lines should be flown in opposite directions to help identify certain systematic errors.

12.5 LINES OVER WATER - If a flight line for aerotriangulation begins or ends over water, or a large body of water is contained within the flight line, care should be taken to ensure that an exposure is made with the photo center just offshore. Also, for lines over a large amount of water the Contractor should use an endlap of 80%, see Section 10.3 and consider usage of an Inertial Measuring Unit (IMU).

12.6 CONTINUOUS FLIGHT LINES - Each flight line should normally be flown continuously from beginning to end. If it is necessary to break a line, that flight line shall be patched. The patched flight line shall begin 2 to 3 frames before the break, be flown at the same altitude, at approximately the same time of day and tide level, and as soon as possible after originally flown. Note, a line re-flown shall have the original flight line number.

13. POSITIONING AND ORIENTATION OF THE AERIAL PHOTOGRAPHS

13.1 AIRBORNE GPS POSITIONING - All exposures (color and infrared) shall be positioned using airborne Kinematic GPS (KGPS) techniques.

A. AIRCRAFT GPS RECEIVER/ANTENNA - The aircraft GPS receiver used for positioning the aerial photographs shall be a dual-frequency, geodetic quality receiver. The receiver shall be electrically connected to the aerial camera in order to record an event mark at the precise time of the midpoint of exposure for each photograph. The antenna connected to each aircraft receiver shall be an appropriate type for use with that receiver model for airborne KGPS operations. The offset between the external nodal point of the camera and the phase center of the antenna used for positioning the photographs shall be determined (through actual measurement, and/or other techniques) to an accuracy of ±0.02 meters. The entire camera-GPS system shall be capable of determining the three-dimensional position of the camera external nodal point within 0.5 m relative to the NSRS.

B. AIRBORNE GPS OBSERVATIONS - During the KGPS survey the aircraft receiver shall be set to kinematic (roving) mode, and shall collect carrier phase data on both frequencies (L1 and L2) at a data collection rate of one second or better. The receiver shall also record camera event marks with the raw GPS data. This receiver may also be connected to the aircraft navigation system to enable the recording of time and position information on the film and in the EED file, or another aircraft GPS receiver may be used for this purpose. At least two ground base stations are required for each KGPS survey. The ground base stations shall be positioned, or the flight arranged, such that the aircraft will pass in close proximity (less than ten kilometers) to each ground base station at least once during the flight. The aircraft receiver should maintain signal lock on a minimum of four (five or more is preferred) GPS satellites at all times during the airborne survey. If the minimum satellite lock is lost, the aircraft should attempt to fly within ten kilometers of one of the base stations as soon as it is practical to allow for more accurate integer ambiguity resolution. All GPS data should be collected during periods of favorable satellite configuration such that the Position Dilution Of Precision (PDOP) remains less than 7.

C. AIRBORNE ORIENTATION - A camera mounted, Inertial Measurement Unit (IMU) is generally not required but may be used. The Project Instructions may require the use of an IMU. If used, the IMU system should be capable of determining the absolute orientation (roll, pitch, and yaw) of the camera exposure stations within 25 arc-seconds.

See also MOP, Fifth Edition, 2004, page 1112-1113.

13.2 GROUND GPS BASE STATIONS - At least two ground GPS base stations are required to support the airborne KGPS survey. The contractor should use National Continuously Operating

Reference Stations (CORS) as ground GPS base stations whenever possible.

A. BASE STATION RECEIVER/ANTENNA - All GPS receivers used as base stations for the KGPS survey shall be dual-frequency, geodetic quality receivers. Each base station shall use an antenna model which is appropriate for that model of receiver, and which has been calibrated by NGS. See http://www.ngs.noaa.gov/ANTCAL/ for information on GPS antennas calibrated by NGS. A choke-ring antenna to minimize multipath is preferred but not required.

B. BASE STATION LOCATION - Ground GPS base stations should be located within or near the project area. During the airborne survey the aircraft shall never be more than 100 kilometers from the nearest ground base station, and there shall always be at least two base stations within 200 kilometers of the aircraft. If a CORS is used as a base station, the aircraft should fly over the CORS before and after the data collection to help improve the GPS data quality. If a National CORS cannot be used for a base station, the contractor shall set up a new GPS base station over a known (or to-be-determined) marked point. If a known base station is used, it must be in the NGS database and hence part of the National Spatial Reference System (NSRS). If a new base station is used, it may be marked permanently (to NGS "Blue Book" specifications) or temporarily (such as with a PK type nail or iron pin). The ground GPS base stations should preferably be located on opposite sides of the project area, and no closer than 50 kilometers to each other.

C. MARK DESCRIPTIONS AND MARK RECOVERY -

i. Mark Descriptions - If a new, permanent survey mark is set, a digital description in NGS format using NGS software WDDPROC or WinDesc (http://www.ngs.noaa.gov/PC_PROD/pc_prod.shtml#WinDesc) is required, see Attachment S. If a temporary survey mark (iron pin, PK nail, etc.) is set, a short paragraph (in Word format) describing the location is sufficient. Include these paragraphs in the Ground Surveys Report. Digital photographs are required in both cases, see Attachment R.

ii. Mark Recovery - For all NSRS survey marks recovered, the NGS on-line recovery method may be used, see: http://www.ngs.noaa.gov/FORMS_PROCESSING-cgi-bin/recvy_entry_www.prl. Complete all required fields and enter recovery information in the text box at the bottom of the form. Include in the Ground Surveys Report a list of all marks recovered using this on-line system and a paper print-out of the on-line recovery page. Recoveries may also be made using NGS software WDDPROC or WinDesc see Attachment S. Digital photographs are required in both cases, see Attachment R.

D. BASE STATION OBSERVATIONS -

i. Using CORS Base Station - The contractor shall check the status of the CORS station http://www.ngs.noaa.gov/CORS/ before and after the KGPS survey, to verify that the station was operational. If a CORS is used as a base station, the aircraft should fly over the CORS before and after the data collection to help improve the GPS data quality. The data shall be downloaded for processing as soon as it is available on the NGS web site. CORS data collected at a data rate of 1-second is preferred if available, but data from 5-second, 10-second, or 15-second CORS stations may be used, when interpolated to a 1-second rate. CORS stations with a 30-second (or longer) data rate shall not be used as GPS base stations.

Note: The CORS map on the NGS web page shows “National CORS” and “Cooperative CORS.” The former data are in the NGS database, the latter data are not. Cooperative CORS operations hold their own data and are only required to hold data for 30 days.

ii. Using Non-CORS Base Station - During the KGPS survey the base station receiver shall be set to static mode, and shall collect carrier phase data on both frequencies (L1 and L2) at the same data collection rate as the airborne receiver. Regardless of the duration of the Airborne KGPS Survey, the ground GPS base stations shall collect at least four hours of data. All GPS data should be collected during periods of favorable satellite configuration such that the receivers maintain signal lock on at least 4 GPS satellites, and the PDOP remains below 7. The contractor shall take care in the accurate recording of the height of the antenna both before and after the flight. **Meteorological data is not required**. For sample Visibility Obstruction Diagram and GPS Observation Log (see Attachment Q).

- Checking Existing Marks - If the base station is set up over an existing NSRS mark, then the position of the mark shall be checked by submitting at least 4 hours of dual-frequency carrier-phase data collected over the mark to the NGS Online Positioning User Service (OPUS) at: http://www.ngs.noaa.gov/OPUS/. The computed position from OPUS shall be compared to the NGS published position of the mark. Any difference from the published position greater than 0.05 m shall be investigated, and resolved. Additional survey operations may be required to tie the ground GPS base station to the NSRS to an accuracy of 0.05 m or better.
- Positioning New Marks - A new temporary mark to be used for a ground GPS base station shall be tied to the NSRS to an accuracy of 0.05 meters or better. The contractor shall observe at least two independent static sessions, each at least four hours long, of dual-frequency carrier-phase GPS data collected over the mark, and should submit the data to the NGS OPUS. The separate OPUS solutions shall be evaluated for quality and compared. Any difference between the solutions greater than 0.05 meters shall be investigated, and resolved. Additional survey operations may be required to accurately tie the ground GPS base station to the NSRS. The final position of the mark shall be based on the highest quality solution obtained or on the average of the solutions if they are of similar quality. This final position for each base station shall be used in processing the airborne KGPS data.

E. SUBMITTING DATA TO OPUS - The use of OPUS for determining/checking the positions of ground GPS base stations is required, unless the project is “BlueBooked” and has internal checks. When OPUS is run, the default is that OPUS only uses National CORS. Cooperative CORS can be selected manually within OPUS.

One-second data can take a long time to upload and process through OPUS, especially from slower internet connections in the field. To speed up the process, the contractor may prefer to compress or decimate the GPS file prior to submission to OPUS. For all OPUS submissions the contractor shall select the correct antenna model used in the session from the pull-down list of NGS calibrated antennas. The contractor shall also enter the correct measured height (in meters) from the mark to the Antenna Reference Point (ARP) into the appropriate field on the OPUS data submission web page. For more guidance on using OPUS see: http://www.ngs.noaa.gov/OPUS/Using_OPUS.html .

Note, NGS is currently (mid-year 2005) developing new versions of OPUS which may shorten the required GPS observation sessions and may fulfill Blue-Booking requirements. Any updates in this SOW's OPUS requirements will be included in the Project Instructions.

13.3 KGPS DATA PROCESSING - All KGPS solutions shall primarily use differential, ionosphere-free, carrier-phase combinations with phase ambiguities resolved to their integer values. Differential KGPS solutions for the aircraft shall be obtained using each ground base station independently. All KGPS solutions shall model the tropospheric delay using average surface meteorological values measured at the ground base stations near the midpoint of the survey. Meteorological values at the altitude of the aircraft should be estimated using scale heights of eight kilometers for the dry components and two kilometers for the wet components. If some other meteorological model is used it shall be described and reported in the Airborne Positioning and Orientation Report. The independent KGPS solutions shall be compared to determine their differences in the north-south, east-west, and vertical components during the operational portions of the flight, and the differences shall be reported in the Airborne Positioning and Orientation Report, see Section 13.4. The RMS of these differences should not exceed five centimeters in the horizontal, and ten centimeters in the vertical. The final KGPS solution shall be an average of the separate independent solutions from each base station.

13.4 AIRBORNE POSITIONING AND ORIENTATION REPORT

The Report shall include at least the following paragraphs:

A. Introduction;
B. Positioning;
    - Data Collection
    - Static Processing
    - Kinematic Processing
    - Data Sets
C. Orientation (if collected);
    - Data Collection
    - Data Processing
    - Data Sets
D. Final Results.

Within the Introduction Paragraph, describe the general purpose for processing the data and list the data sets in table form with the following columns: Dataset ID, Date of Acquisition, Projects covered by the data set, and Description/Flight Line(s) Identification.

In the Positioning Paragraph, discuss the following:

- Methodology;
- Hardware and software used (including models, serial numbers, and versions),
- CORS station(s) used;
- General description of the data sets, flight lines, dates and times of sessions,
- Processing (including the type of solution i.e.float, fixed, ion-free, etc.);
- The results (discussion of the coordinates and accuracy).

Submit a description of the data sets, and the raw and processed data.

If the NGS OPUS website was used to process the static data, the Contractor shall provide a copy of the OPUS report. If a known station was used from the NGS database, the Contractor shall identify the station by name and PID, and provide the published coordinates used in the kinematic position step. If multiple base stations were used, provide processing details, coordinates, and accuracy for all stations.

In the Orientation Paragraph (if IMU data is collected), discuss the factors listed above for Positioning.

In the Final Results Paragraph, describe the method of reformatting the final results into a format suitable for application in the aerotriangulation process, describe any unusual circumstances or rejected data, and comment on the quality of the data.

13.5 GROUND PHOTO CONTROL - Ground photo check points are required. Ground photo control may be required by the Project Instructions. See Attachment O for requirements.

14. PHOTOGRAPH LABELING

14.1 FRAME NUMBERING - The frame numbers imbedded in the exposure by the camera system shall agree with the frame number in the photograph label. Frame numbering starts at 0001 for each camera system, for each type of emulsion, and within a given year. If any one of the three parameters change, the numbering sequence starts over at 0001. If a contractor or sub-contractor begins working on a different NGS contract, the numbering sequence will CONTINUE if the camera system, emulsion and year remain unchanged. Usable frames (those that are not tests or blanks) shall be numbered in an unbroken sequence. The numbering sequence shall not be broken even though more than one coastal area or coastal port is photographed, or more than one roll of film is used. For example, infrared film shall start at 0001 as shall color, even though both were captured with the same camera in the same year.

14.2 REQUIRED LABEL - Each usable frame shall be titled on the film within, or adjacent to, the image area. Each title shall consist of the agency initials (NOAA), date of photography, UTC time of exposure, Contractor camera designator (see Section 4.3 and Annex 3), film type (CN for color negative, R for black & white IR), lens serial number, and frame number.

Example: NOAA 06-23-99 GMT-18:14:27 XXCN UAG332 No 2501

14.3 ADDITIONAL LABEL INFORMATION - If the project camera system will record latitude, longitude, height, aperture, and shutter speed, then these records are required to be recorded on the film as well. Latitude and longitude shall be recorded in degrees and decimal minutes to four (4) decimal places.

14.4 BLANK, TEST, AND REJECTED FRAMES - Blanks and test frames shall not be included in the frame numbering sequence and shall not be labeled. Exposed photographic frames shall not be rejected by the Contractor except for catastrophic camera failure. Data, whether photographic or digital, is not normally rejected in the field by Contractors.

15. FILM SHIPMENT AND PROCESSING

15.1 SHIPMENT - The Contractor shall ship; (1) completed, normally full film rolls, (2) the original Photographic Flight Reports (marked "ORIGINAL" in blue ink) and filled-in front and back in black ink, (3) Raw Navigation File, and (4) transmittal letters via next-day air freight directly to the NGS film processing contract laboratory. See Annex 6. For an explanation of full rolls see Sections 7.2.A and 7.2.G.

The Contractor shall submit ~~ship~~ final, **correct** EED files, in NGS format via TOMIS ~~(on a 3.5" floppy disk or CD), directly to NGS, to arrive at NGS~~ within three working days from the date the film was shipped. Copies of the Photographic Flight Report and the raw navigation files may be made and used by the Contractor to produce and check the final deliverables.

The Contractor shall ship (1), (2), (3) and (4) to the NGS film processing contract laboratory listed in the Project Instructions.

The following labels shall be typed or neatly lettered by the Contractor with the required data and securely affixed to each film container:

(1) Commercial shipping label
(2) Film processing instruction label (see Annex 5)
(3) "DO NOT EXPOSE TO" label (see Annex 5)

All rolls of aerial film shall be shipped in sturdy, cylindrical containers (approximately 5 7/8" in diameter), inside a box in such a manner that shall ensure acceptance by common carrier and safe delivery at destination. Containers and closures shall comply with the Interstate Commerce Commission Regulations, Uniform Freight Classification Rules, or regulations of other carriers as applicable to the mode of transportation.

The Contractor should not ship film on a Friday. The NGS film processing contract laboratory does not receive film on Saturdays or Sundays, so the film could be subject to excessive environmental conditions during temporary storage.

15.2 NGS NOTIFICATION - The same day as shipping, the Contractor shall notify NGS of each film shipment's contents and date of shipment by submitting to TOMIS ~~transmitting to NGS a paper or~~ a digital copy of the Photographic Flight Report (marked "COPY" at the top) and a digital copy of the film transmittal letter ~~via e-mail or facsimile.~~

16. IMAGE QUALITY

Image quality on the original negative film shall meet the highest professional standards for metric aerial photography. Dark areas shall not bleed together and individual objects shall be readily discernable and have sharp edge definition. Detail shall be sufficiently sharp to allow photogrammetric measurement of beach and land features. Photographic products shall also be free of abrasions, blemishes, scratches, tears, and other irregularities. Fiducial marks shall be clearly visible and sharp on every negative. The camera panel of instruments, (i.e. clock, level, altimeter, camera ID plate) and titling recorded on the film shall be clearly legible on all processed negatives.

17. EXPOSURE

Extreme care shall be exercised to insure proper exposure, especially with infrared film. For Kodak Aerocolor 3 Negative Film 2444, and AGFA X100 (film speeds based on the exposure test) a 420 nanometer filter shall be used. For Kodak Aerographic Black & White Infra-Red Film 2424, a 740 nanometer filter is required. See discussion of possible exception in Section 7.2. For infrared film, the ASA may depend on the batch of film, the camera window (if used), and other factors. Record the ASA and filters used on the Photographic Flight Report.

The film exposure settings shall normally be controlled from the camera's Photo Exposure Meter (PEM) and for black & white IR, the settings should produce a gamma at processing time of 1.9, ±- 0.05. For those areas where abnormal exposure objects exist, such as snow, water, etc., the PEM shall be manually overridden to produce an equivalent exposure without the abnormality. A shutter speed shall be chosen that meets the requirements of minimal image movement, at an adequate lens aperture for the prevailing lighting conditions.

18. DELIVERABLES

18.1 LABOR, EQUIPMENT, SUPPLIES, AND TRANSPORTATION - The Contractor shall provide all labor, equipment (including aircraft and metric aerial camera system), supplies, material (including film), and transportation to produce and deliver exposed film and related products as required under these CAFPR.

18.2 FLIGHT LINE MAPS - If required by the Project Instructions, the Contractor shall plan flight lines and submit a proposed flight line map prior to flying for NGS review and approval. See Section 8.

18.3 FILM - The Contractor shall capture and deliver both an Exposure Test and Regular Production (see Section 6.2 and 6.3). Submit full production rolls if possible, but within 60 days of exposure.

18.4 PHOTOGRAPHIC FLIGHT REPORTS - Submit the completed, original, two-sided Photographic Flight Reports (PFR) (NOAA Form 76-15) **marked "ORIGINAL" in blue ink,** with the film. For samples, see Annexes 1 & 2, and for delivery instructions see Section 15. The PFR shall be filled-out completely and correctly. See Annex 2. Submit with film.

18.5 RAW NAVIGATION FILE – Submit the film's meta-data file, captured at the time of each exposure, in the format of the aircraft's on-board navigation system, with the film. Report the data format.

18.6 FILM SHIPMENT REPORTING - The Contractor shall submit via TOMIS ~~FAX or e-mail to NGS~~ a digital copy of the PFR (marked "copy") and a digital copy of the Transmittal Letter that accompanied the film to the NGS film processing contract laboratory. See Section 15. Submit the same day the film is shipped.

18.7 ELECTRONIC EXPOSURE DATA FILE - The Contractor shall submit an EED file for each roll of film. See Section 6.1.C and Annex 3. Submit within 3 working days of submitting the film.

18.8 GROUND CONTROL - See Project Instructions, Section 13.5 and O and P. ~~Ground Control Requirements and Report.~~ Submit within six weeks of the completion of the ground control, with the Final Photo Report

18.9 AIRBORNE POSITIONING AND ORIENTATION DATA - The Contractor shall submit raw and processed data, and a report covering the positioning and orientation of the aerial photography. See Section 13. Submit within six weeks of completion of the aerial photography with the Final Photo Report.

18.10 STATION DESCRIPTIONS & RECOVERY NOTES - The Contractor shall prepare and submit digital station descriptions (for new, permanent marks) and digital recovery notes (for all recovered stations) in NGS format using NGS software WDDPROC or WINDESC. See Section 13 and Attachment S. Submit within two weeks of completion of the ground control.

18.11 NGS SURVEY FORMS - The Contractor shall prepare and submit at least the following NGS forms: Visibility Obstruction Diagram, and GPS Observation Log. See Section 13 and Attachment Q. Submit within two weeks of completion of the ground control.

18.12 CAMERA CALIBRATION - The Contractor shall supply a copy of the current USGS Camera calibration certificate for each camera system planned for use under these CAFPR unless a still valid certificate has previously been submitted. Also submit new certificates for calibrations that occur during the course of the Contract. See Section 7.1. Submit prior to production photography.

18.13 CAMERA SYSTEM MAINTENANCE - The Contractor shall provide a preventive maintenance log for each camera system to be used to acquire aerial photography. See Section 7.1. Submit prior to production photography. Submit an updated log every three years.

18.14 CAMERA PORT WINDOW - The Contractor shall report the physical characteristics of any camera port window used to NGS. See Section 7.3. Submit prior to production photography.

18.15 UNUSUAL CIRCUMSTANCES - The Contractor shall also notify NGS of any unusual circumstances that occur during the performance of these CAFPR which might affect the deliverables or their quality and especially of any deviation from these CAFPR. This may be included in the weekly status report required below, unless urgent. A synopsis of all unusual occurrences shall also be included in the Final Photo Report.

18.16 STATUS REPORTS - The Contractor shall submit project status ~~e-mail~~ reports weekly via TOMIS. See Section 3.4.

18.17 PHOTO FINAL REPORT - The Contractor shall supply to NGS a Photo Final Report including, at least, these sections:

A. Work performed under these CAFPR. Discuss each deliverable including: the maximum range from the base station, the mean overlap and sidelap, the mean tilt, the mean crab, and an explanation of the photograph labeling;
B. Equipment used to perform this work, including hardware models and serial numbers, calibration reports, and software names and versions; include aircraft and camera(s));
C. Flight line (as flown) map(s) showing the footprints of imagery actually obtained with the first and last frame of each flight line, or patched flight line, labeled with the frame number;
D. Discussion of emulsions, exposure settings used, filters used, etc;
E. Discussion of film image quality;
F. Ground Control Report, if this work was done;
G. Discussion of Aircraft Navigation, including software, hardware, methods and any problems;
H. Discussion of Airborne KGPS Report, including ground station(s);
I. Discussion of Weather, solar altitude, and time of year;
~~J. Tabulation of Aerial Photography;~~
J. Any unusual circumstances or problems, including equipment malfunctions, (including those already reported) and any deviations from these CAFPR (including those already reported) and;
K. Any recommendations for changes in these CAFPR of the SOW for future work.

18.18 TRANSMITTAL LETTERS - The Contractor shall send Transmittal Letters with film shipments and return receipted copies of any Transmittal Letters that the Government sends. Other Deliverables shall be submitted via TOMIS, see Main Text of SOW, Section 12.

~~send a transmittal letter with each data shipment (see blank copy and sample in Attachment AC), and a transmittal letter with the Photo Final Report.~~

18.19 Tabulation of Aerial Photography – See Annexes 7A and 7B, and Sections 7.2J and 11.3.

19. POINTS OF CONTACT:

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Contracts Technical Manager
National Geodetic Survey, NOAA
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Contracting Officer's Representative
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NOAA FORM 76-15
(7-77)

U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

PHOTOGRAPHIC FLIGHT REPORT

SPOT NO.	ROLL NO.	EMULSION NO.	EXPIRATION DATE	SHEET OF SHEETS

TYPE FILM	A.S.A. INDEX USED	FILTER	CASSETTE/MAGAZINE NO. FEED TAKE-UP	CAMERA/DRIVE UNIT NO.

MISSION NO.	AIRCRAFT	PILOT	COPILOT	PHOTOGRAPHER

FLIGHT MAP NO. / TIDE STAGE	STATE AND LOCALITY	DATE / LINE NO.	C.U.T. (Coord. Univ. Time)		ADD NUMBER	NO. OF EXPOSURES	COMP. HEAD. / DRIFT	VISIBILITY	CLOUDS	TEMP.	ALTITUDE	VACUUM	SHUTTER	APERTURE	RHEOSTAT	ENDLAP PERCENT	NO. OF BLANKS TO START ROLL / METER READINGS AND REMARKS
				S													
				E													
				B													
				S													
				E													
				B													
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NOAA FORM 76-15 (7-77)   SUPERSEDES NOAA FORM 76-15 (5-74).

AERIAL FILM PROCESSING RECORD

RECOMMENDATIONS

LABORATORY DEVELOPMENT

DATE

FORMULA

pH READINGS:	1st Dev.	S.S. Hardener
Color Dev.	2nd S.S. *(Cl. Bath)*	Hardener
Bleach	Fixer	Stabilizer

SENSE STRIP EXPOSURES: Begin

Middle | End

- [ ] CONTROL STRIP CUT FROM ROLL
- [ ] UNEXPOSED PORTION STORED
- [ ] EXPOSED PORTION PROCESSED

TEMPERATURE: F C

DEVELOPMENT TIME:
1st Developer

PROCESSED TO GAMMA

PROCESSING MACHINE: Motor | Reel

CHEMISTRY MIXED – DATE

TALLY OF ROLL THROUGH CHEMISTRY *(Indicate 1st, 2nd, 3rd, etc.)*

POST DEVELOPMENT INSPECTION:
Obvious defects or failures which require reflight of any portion of this roll must be reported immediately by phone direct to the office of the Chief, Photographic Operations Branch; details shall also be recorded, signed and dated below.

SENSITOMETRY READINGS

	CYAN	MAGENTA	YELLOW	B & W
BASE				
STEP 1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				
16				
17				
18				
19				
20				
21				

REMARKS

AERIAL PHOTOGRAPHER	DATE
ROLL TITLED BY	DATE

PROCESSED BY	DATE

NOAA FORM 76-15 (7-77)

ANNEX 2 – SAMPLE INSTRUCTIONS FOR COMPLETING THE PHOTOGRAPHIC FLIGHT REPORT FOR SHORELINE PHOTOGRAPHY

PHOTOGRAPHIC FLIGHT REPORT FRONT PAGE

(1) **DATE -** Film is first loaded into the cassette of Magazine, Print "LOADED" & Date

(2) **To Remain Blank**

(3) **ROLL NUMBER -** Year, Camera System Designator, Film Type, and Sequential Roll Number for that Calendar Year.

(4) **EMULSION NUMBER** - Taken from Film Can upon loading.

(5) **EXPIRATION DATE** - Taken from Film Can upon loading.

(6) **SHEET NUMBER** - of 4 sheets = 1 of 4, 2 of 4, etc.

(7) **FILM TYPE** - Plus-X Pan, X-100 Color Negative, BWIR, etc.

(8) **ASA INDEX** - Film Speed actually used (**NOT** EAFS from Film Can).

(9) **FILTER** - Wavelength of Filter used, in Nanometers.

(10) **CASSETTE/MAGAZINE -** Feed and Take-up Cassettes or Magazine Identification Number.

(11) **CAMERA/DRIVE UNIT NUMBERS** - Camera Identification Number or Lens Serial Number/ Drive Unit Number.

(12) **MISSION No. -** Aircraft Type (Cessna Citation II).

(13) **AIRCRAFT** - Aircraft Tail Number (N52RF).

(14) **PILOT** - Printed Surname.

(15) **COPILOT** - Printed Surname.

(16) **PHOTOGRAPHER** - Printed Surname.

(17) **FLIGHT MAP No./TIDE STAGE -** Project Identifier (NC0401 / MHW or MLLW and Tandem Roll Reference to Roll Flown Simultaneously).

(18) **STATE and LOCALITY** - Enter Locality information first, then indicate State.

(19) **DATE and LINE No. -**Date of Photography (Month, Day, Year), Flight Line Number (30-002, indicating a Scale of 1:30,000 and Line No. 2). Add Note **"NEW DAY"** to indicate Date Change. Place near DATE entry.

(20) **CUT or UTC** - Time (Coordinated Universal Time) in Hours and Minutes. **DO NOT** Enter LOCAL Time. Same as GMT.

(21) **To Remain Blank**

(22) **No. of EXPOSURES -** This is a running count of Frames Taken per Line over the course of the Roll. It <u>may</u> not coincide with the Frame Numbers. Its purpose is to allow a quick Reference of Frames remaining on the roll.

(23) **COMP HEAD/DRIFT** - Enter the Magnetic Heading in Degrees/Variances in Degrees between the path of the Aircraft and Ground Tracking over the Planned Flight Line.

(24) **VISIBILITY -** Distance in Statute Miles out from the Aircraft, **in the Direction of the SUN**, at which Tree Crowns are still Separately Discernable.

(25) **CLOUDS** - Enter an Estimate of Cloud-Cover from Choices at the Bottom of the Photographic Flight Report.

(26) **TEMPERATURE** - Enter the Temperature in Degrees Celsius at the Time of the Photography.

(27) **ALTITUDE** - Altitude in Feet Above Mean Sea Level (Coastal), or Feet Above Ground Level (AGL) over Airports.

(28) **VACUUM** - Enter Vacuum Reading from Gauge or from Camera Display Panel (600 mmWs, or nominally 64 mb standard)

(29) **SHUTTER** - Enter Speed of Shutter During Line of Photography. Enter, if in Automatic Mode, Variances in Shutter Speeds (450-550).

(30) **APERTURE** - Enter the Actual Aperture Used. Final Adjustment from Camera Indicator, **NOT** Base Exposure from an Automatic Light meter.

(31) **RHEOSTAT** - Enter the Rheostat Setting as a Function of the ASA ("PER xxx ASA").

(32) **ENDLAP** - Enter the Planned Endlap as a Whole Number (10, 60, 80, etc.).

(33) **Number of Blanks to Start of Roll** - "6" is Standard.

(34) **METER READINGS and REMARKS** - Record the Automatic Light Meter Readings (4 @ 1000), a Description of the Terrain, and Local Ambient Conditions.

(35) **TO PATCH or To RE-DO -** Enter Pertinent Choice to Indicate REJECTION of LINE Section or of Complete LINE, and Future Action, and REASON (Smoke, Signal Failure, ATC, etc.).

(36) **PATCH or RERUN -** Enter pertinent Choice to Identify Frames as "the PATCH" or "the RE-RUN" of a Previous Line.

(37) **CASSETTE REMOVAL -** Add a Note to Indicate 3 added blanks and removal of Cassettes or Magazine.

(38) **CASSETTE REPLACEMENT -** Add a Note to Indicate Replacement of Cassettes or Magazine, with 3 Blanks ADDED.

(39) **CUT ROLL or ROLL ENDS -** Add a Note to Indicate a Cut Roll or a Roll Ended Normally, each with the Addition of 10 Blanks.

(40) **SIGNATURE/DATE -** Enter the Signature of the Mission Commander and the Date (Month, Day, Year) of Completion of the Roll.

(41) **COMMENTS -** Space for Additional Recommendations or Comments is Available on the Back of the Photographic Flight Log.

Note:
1. Submit the original version of the Report, not a hand-made copy nor a photo-copy.
2. Neither the "Spot Number" nor the "Add Number" columns are filled-in by flight crews.
3. All other spaces shall be completed. If non-applicable, enter "NA".
4. Use three rows on the form for each flight line.

NOAA FORM 76-15 (7-77) (1) LOADED 09-19-04

PHOTOGRAPHIC FLIGHT REPORT

U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

SPOT NO. (2)	ROLL NO. (3) 04 99 CN06	EMULSION NO. (4) AH 897-68553050-624	EXPIRATION DATE (5) 10-2004	SHEET (6) 2 OF SHEETS 5	
TYPE FILM (7) AGFA X100 COLOR NEG	A.S.A. INDEX USED (8) 160	FILTER (9) 420	CASSETTE/MAGAZINE NO. (10) FEED 1620 TAKE-UP 1864	CAMERA/DRIVE UNIT NO. (11) 99/51468	
MISSION NO. (12) CESSNA CITATION II	AIRCRAFT (13) N 24 SQ	PILOT (14) SMITH	COPILOT (15) JONES	PHOTOGRAPHER (16) CAMPBELL	

NO. OF BLANKS TO START ROLL (33) 6

(17) FLIGHT MAP NO. / TIDE STAGE	(18) STATE AND LOCALITY	(19) DATE / LINE NO.	(20) C.U.T. (Coord. Univ. Time)		(21) ADD NUMBER	(22) NO. OF EXPOSURES	(23) COMP. HEAD. / DRIFT	(24) VISIBILITY	(25) CLOUDS	(26) TEMP.	(27) ALTITUDE	(28) VACUUM	(29) SHUTTER	(30) APERTURE	(31) RHEOSTAT	(32) ENDLAP	(34) METER READINGS AND REMARKS
NC 04 02	NEUSE RIVER to	09-20-04	1900	S		1	275	12	O	-9	19100	600	500	5.6	PER	60	PEM: 4 @ 1000 GREEN FARMLAND
MLLW	WHITE OAK RIVER	40-002	1911	E		15	3L								160		LIGHT WOODS
TNDM 98R01	NC			B		16									ASA		LIGHT HAZE
FL 04 01	MIAMI BEACH To		2146	S		17	061	15	O	-16	22,400	600	600	5.6	PER	60	PEM: 5.6 @ 600 GREEN FARMLAND
	OLD RHODES KEY	48-003	2152	E		23	Ø	35	TO PATCH – SMOKE						160		LIGHT WOODS, LIGHT SHOAL
	FL	35 TO PATCH		B		24									ASA		WATERS
FL 04 01	NEW DAY	09-23-04	1515	S		25	062	15	O	-17	22,400	600	600	5.6	PER	60	PEM: 5.6 @ 600 GREEN FARMLAND
	MIAMI BEACH TO OLD RHODE	48-003	1520	E		30	Ø	36	PATCH						160		LIGHT WOODS, LIGHT SHOAL
	KEY FL	36 PATCH		B		31									ASA		WATERS.
ME 04 01	FRENCHMANS BAY TO	09-24-04	1420	S		32	195	12	O	-23	24,100	600	500	5.6	PER	60	PEM: 5.6 @ 500 GREEN FARM
MHW	BLUE HILL BAY	50-001	1425	E		36	3R								160		LIGHT WOODS
TNDM 98R01	ME	NEW DAY		B		37									ASA		MED HAZE
			1450	S		38	012									60	
MHW		50-002	1456	E		41	3L	35	TO RE-DO			SIGNAL FAILURE					
TNDM 98 R02		35 TO RE-DO		B		42											
			1510	S		43	012	12	O	-23	24,100	600	500	5.6	PER	60	PEM: 5.6 @ 500 GREEN FARM
MHW		50-002	1516	E		49	3L	36	RERUN						160		LIGHT WOODS
TNDM 98R02		36 RERUN		B		50									ASA		LIGHT HAZE
HI 0401	EASTERN SHORE	09-27-04	2157	S		51	038	20	O	-5	16,500	600	450	5.6	PER	80	PEM: 4 @ 900 GREEN FARM,
	MOLOKAI	35-001	2200	E		64	1R								160		LIGHT WOODS, LIGHT SHOAL
	HI	NEW DAY		B		65	37	+3	BLANKS & REMOVE CASSETTES						ASA		WATERS
				S													
				E				38	REPLACE CASSETTES +3 BLANKS								
				B													
HI 04 04	NORTH COAST	09-28-04	2215	S		72	085	20	O	-5	16,500	600	450	5.6	PER	80	PEM: 5.6 @ 450 GREEN FARM,
	MOLOKAI	35-002	2220	E		79	4L								160		LIGHT WOODS, LIGHT SHOAL
	HI	NEW DAY		B		80									ASA		WATERS
	John Smith			S	39	+	10	BLANKS & CUT ROLL									
40				E						OR							
	09/29/2004			B		+	10	BLANKS & ROLL ENDS									

NOAA FORM 76-15 (7-77) ○ Clear ◐ Scattered or Broken ⊖ High Thin ⊕ Solid Overcast SUPERSEDES NOAA FORM 76-15 (5-74).

ELECTRONIC EXPOSURE DATA FILE FORMAT

ROLL NUMBER

For each camera the Government will assign a unique camera designation “xx” that shall be used in the roll number of the film. The roll number consists of a two digit year; a two digit camera designation number; a one or two digit film designation character (P=PAN, CN=COLOR NEG, CR=COLOR INFRARED, R=B&W INFRARED); and a two digit sequence number. For each successive roll of film the sequence number shall be incremented by one, for the same camera system, same emulsion, and same year. So, color film starts with 01 and IR film starts with 01. See sample at #1 below. Note, a test roll does not count as #1. Roll #1 is the first roll of production for that year.

ELECTRONIC EXPOSURE DATA (EED) SPECIFICATIONS

Each roll of film shall have an accompanying EED file. The file shall be in ASCII form on an IBM formatted 3.5" floppy disk and capture the attributes of each frame in the order that they appear on the roll of film. The file shall be named using the film roll number and the extension “EED”. Each frame of photography shall consist of a record in the file, and each record a separate line. Each record shall contain the following 11 fields of data separated by commas. No commas shall be used in the contents of the field. There shall be a separate file for each roll of film.

Field Explanation:

Field	Contents of Field	Format of Data	Explanation	Sample of Data	Field Width
1	Film Roll Number	yyxxFFnn	year, camera desig, film type, film roll sequence nucmber	9904CN01	7 or 8 spaces
2	Frame Number	nnnn	number (same as PFR roll number)	0102	4 or 5 spaces
3	Flight line ID	scnnn	scale(sc)+flight line number(nnn)*	30001	up to 12 spaces
4	Time since last exposure	sss.s	seconds**	23.2	3 to 5 spaces
5	Date of exposure	dd:MMM:yy	day:MONTH:year(Month in CAPS)	07:JUN:99	9 spaces
6	Time of exposure in UTC	hh:mm:ss	hour:minute:second	18:11:19	8 spaces
7	Latitude of frame center	dd:mm.mmmmN/S	degrees:minutes to 4 decimal places***	26:52.8201N	11 spaces
8	Longitude of frame center	ddd:mm.mmmmE/W	Degrees:minutes to 4 decimal places***	097:23.1234W	12 spaces
9	Azimuth of photo	ddd	degrees, true heading	010	3 spaces
10	Altitude of photograph	fffff	feet above mean sea level	15000	3 to 5 spaces
11	Project identifier	STyynn	state,year,project sequence number****	MD9901	6 spaces

Example: 99xxP01(film roll #),0102(frame #),30001(flight line ID),23.2(time since last exposure),07:JUN:99(Date of exposure), 18:11:19(Time of exposure in UTC),26:52.8201N(Latitude of frame center),097:23.1234W(Longitude of frame center), 010(Azimuth of photo),15000(Altitude of photograph),MD9901(Project identifier)

Field #:	1	2	3	4	5	6	7	8	9	10	11
Field Contents:	99xxCN01	0102	30001	23.2	07:JUN:99	18:11:19	26:52.8201N	097:23.1234W	010	15000	MD9901

Complete Record Format: 99xxCN01,0102,30001,23.2,07:JUN:99,18:11:19,26:52.8201N,097:23.1234W,010,15000,MD9901

There are no spaces after the comma field separators

***** The number used for scale omits “1:” and the “thousands” place holder of the trailing zeros. 1:30,000 becomes simply 30

****** For the first exposure in each flight line enter 0.0 in this field.

******* The Latitude and Longitude are shown to 4 decimal places in order to compute end lap and side lap. The absolute accuracy should be +/- 20 meters, or better, with relative accuracy considerably better, as is typical with pseudo-range GPS). For latitude, enter “N” for north latitude or “S” for south latitude. For longitude, enter “E” for east longitude or “W” for west longitude.

******** For the test strip use “TS” as the 2 digit state ~~year~~, and then the test number, eg. TS9901

The Azimuth of the photograph is calculated by performing a series of “Inverse” calculations between the position of each photo and the one immediately succeeding it. The azimuth of the last two images on a flight line will be the same.

ANNEX 4: Page 1 of 2
COASTAL MAPPING PROGRAM - WAYPOINT FILE SAMPLE

RECORD,LINE,FEET,SCALE,MILES,FAZI,BAZI,SWP,LAT1,LON1,EWP,LAT2,LON2,EMULSION,LAP,PHOTOS,GRND_EL,MAGDEC,LAT3,LON3
1,34-5,91800.4,34000,17.4,26,206,1,N 39 08 25,W 76 37 22,2,N 39 22 10,W 76 29 16,COLOR,60,10,0.0,11.3,N 39 15 18,W 76 33 20
2,34-6,51000.8,34000,9.7,27,207,3,N 39 11 55,W 76 39 36,4,N 39 19 30,W 76 34 57,COLOR,60,6,0.0,11.2,N 39 15 43,W 76 37 16
3,34-7,163200.3,34000,30.9,26,206,5,N 39 14 23,W 76 21 31,6,N 39 38 48,W 76 07 00,COLOR,60,17,0.0,11.6,N 39 26 36,W 76 14 17
4,34-8,153000.7,34000,29.0,26,206,7,N 39 15 11,W 76 16 59,8,N 39 38 03,W 76 03 18,COLOR,60,16,0.0,11.6,N 39 26 37,W 76 10 10
5,34-10,41820.8,34000,7.9,25,205,9,N 39 11 45,W 76 24 05,10,N 39 18 01,W 76 20 25,COLOR,59,5,0.0,11.4,N 39 14 53,W 76 22 15
6,30-5,117000.4,30000,22.2,27,207,11,N 39 07 42,W 76 35 27,12,N 39 25 03,W 76 24 38,B&W,60,14,0.0,11.3,N 39 16 23,W 76 30 03
7,30-6,63001.2,30000,11.9,27,207,13,N 39 10 05,W 76 37 39,14,N 39 19 25,W 76 31 48,B&W,60,8,0.0,11.3,N 39 14 45,W 76 34 44
8,30-7,45000.5,30000,8.5,27,207,15,N 39 12 28,W 76 39 51,16,N 39 19 08,W 76 35 39,B&W,60,6,0.0,11.2,N 39 15 48,W 76 37 45
9,30-8,143999.5,30000,27.3,27,207,17,N 39 17 01,W 76 18 42,18,N 39 38 20,W 76 05 16,B&W,60,17,0.0,11.6,N 39 27 41,W 76 12 00
10,30-9,117000.1,30000,22.2,27,207,19,N 39 19 52,W 76 13 15,20,N 39 37 08,W 76 02 13,B&W,60,14,0.0,11.6,N 39 28 30,W 76 07 44
11,30-10,81000.7,30000,15.3,27,207,21,N 39 24 45,W 76 06 23,22,N 39 36 43,W 75 58 46,B&W,60,10,0.0,11.7,N 39 30 44,W 76 02 35
12,30-11,27000.4,30000,5.1,341,161,23,N 39 15 45,W 76 15 20,24,N 39 19 56,W 76 17 16,B&W,60,4,0.0,11.5,N 39 17 51,W 76 16 18
13,30-1,46125.6,30000,8.7,27,207,25,N 38 56 51,W 76 27 40,26,N 39 03 41,W 76 23 24,B&W,59,6,0.0,11.3,N 39 00 16,W 76 25 32
14,30-2,64575.0,30000,12.2,27,207,27,N 38 58 07,W 76 30 33,28,N 39 07 41,W 76 24 35,B&W,59,8,0.0,11.3,N 39 02 54,W 76 27 35
15,30-3,212175.8,30000,40.2,27,207,29,N 38 59 45,W 76 33 12,30,N 39 31 09,W 76 13 28,B&W,59,24,0.0,11.4,N 39 15 28,W 76 23 22
16,30-4,166050.5,30000,31.4,27,207,31,N 39 01 01,W 76 36 01,32,N 39 25 37,W 76 20 38,B&W,59,19,0.0,11.3,N 39 13 19,W 76 28 21
17,34-1,41820.1,34000,7.9,25,205,33,N 38 57 01,W 76 27 23,34,N 39 03 18,W 76 23 44,COLOR,59,5,0.0,11.3,N 39 00 09,W 76 25 34
18,34-2,62730.7,34000,11.9,25,205,35,N 38 59 49,W 76 29 56,36,N 39 09 14,W 76 24 28,COLOR,59,7,0.0,11.3,N 39 04 31,W 76 27 12
19,34-3,198646.0,34000,37.6,25,205,37,N 39 01 37,W 76 33 01,38,N 39 31 24,W 76 15 35,COLOR,59,20,0.0,11.4,N 39 16 31,W 76 24 20

The waypoint file is a comma separated, alpha-numeric file, with one line of header information as the first line. This file is edited as necessary and uploaded to the aircraft navigation system. It contains the information necessary to identify and locate the required flight lines.

Parsed through a spreadsheet program, the data looks like this:

RECORD	LINE	FEET	SCALE	MILES	FAZI	BAZI	SWP	LAT1	LON1	EWP	LAT2	LON2	EMULSION	LAP	PHOTOS	GRND_EL	MAGDEC	LAT3	LON3
1	34-5	91800.4	34000	17.4	26	206	1	N 39 08 25	W 76 37 22	2	N 39 22 10	W 76 29 16	COLOR	60	10	0	11.3	N 39 15 18	W 76 33 20
2	34-6	51000.8	34000	9.7	27	207	3	N 39 11 55	W 76 39 36	4	N 39 19 30	W 76 34 57	COLOR	60	6	0	11.2	N 39 15 43	W 76 37 16
3	34-7	163200.3	34000	30.9	26	206	5	N 39 14 23	W 76 21 31	6	N 39 38 48	W 76 07 00	COLOR	60	17	0	11.6	N 39 26 36	W 76 14 17
4	34-8	153000.7	34000	29	26	206	7	N 39 15 11	W 76 16 59	8	N 39 38 03	W 76 03 18	COLOR	60	16	0	11.6	N 39 26 37	W 76 10 10
5	34-10	41820.8	34000	7.9	25	205	9	N 39 11 45	W 76 24 05	10	N 39 18 01	W 76 20 25	COLOR	60	5	0	11.4	N 39 14 53	W 76 22 15
6	30-5	117000.4	30000	22.2	27	207	11	N 39 07 42	W 76 35 27	12	N 39 25 03	W 76 24 38	B&W	60	14	0	11.3	N 39 16 23	W 76 30 03
7	30-6	63001.2	30000	11.9	27	207	13	N 39 10 05	W 76 37 39	14	N 39 19 25	W 76 31 48	B&W	60	8	0	11.3	N 39 14 45	W 76 34 44
8	30-7	45000.5	30000	8.5	27	207	15	N 39 12 28	W 76 39 51	16	N 39 19 08	W 76 35 39	B&W	60	6	0	11.2	N 39 15 48	W 76 37 45
9	30-8	143999.5	30000	27.3	27	207	17	N 39 17 01	W 76 18 42	18	N 39 38 20	W 76 05 16	B&W	60	17	0	11.6	N 39 27 41	W 76 12 00
10	30-9	117000.1	30000	22.2	27	207	19	N 39 19 52	W 76 13 15	20	N 39 37 08	W 76 02 13	B&W	60	14	0	11.6	N 39 28 30	W 76 07 44
11	30-10	81000.7	30000	15.3	27	207	21	N 39 24 45	W 76 06 23	22	N 39 36 43	W 75 58 46	B&W	60	10	0	11.7	N 39 30 44	W 76 02 35
12	30-11	27000.4	30000	5.1	341	161	23	N 39 15 45	W 76 15 20	24	N 39 19 56	W 76 17 16	B&W	60	4	0	11.5	N 39 17 51	W 76 16 18
13	30-1	46125.6	30000	8.7	27	207	25	N 38 56 51	W 76 27 40	26	N 39 03 41	W 76 23 24	B&W	60	6	0	11.3	N 39 00 16	W 76 25 32
14	30-2	64575	30000	12.2	27	207	27	N 38 58 07	W 76 30 33	28	N 39 07 41	W 76 24 35	B&W	60	8	0	11.3	N 39 02 54	W 76 27 35
15	30-3	212175.8	30000	40.2	27	207	29	N 38 59 45	W 76 33 12	30	N 39 31 09	W 76 13 28	B&W	60	24	0	11.4	N 39 15 28	W 76 23 22
16	30-4	166050.5	30000	31.4	27	207	31	N 39 01 01	W 76 36 01	32	N 39 25 37	W 76 20 38	B&W	60	19	0	11.3	N 39 13 19	W 76 28 21
17	34-1	41820.1	34000	7.9	25	205	33	N 38 57 01	W 76 27 23	34	N 39 03 18	W 76 23 44	COLOR	60	5	0	11.3	N 39 00 09	W 76 25 34
18	34-2	62730.7	34000	11.9	25	205	35	N 38 59 49	W 76 29 56	36	N 39 09 14	W 76 24 28	COLOR	60	7	0	11.3	N 39 04 31	W 76 27 12
19	34-3	198646	34000	37.6	25	205	37	N 39 01 37	W 76 33 01	38	N 39 31 24	W 76 15 35	COLOR	60	20	0	11.4	N 39 16 31	W 76 24 20

FILE NAME EXPLANATION (Ex. MD0401.WPT): The file name is the Project Identifier (MD0401) with the computer file name extension WPT

FIELD EXPLANATIONS:

RECORD	- Record, numbered consecutively
LINE	- Flight line designation (scale/1000, dash, the number of the flight line at that scale)
FEET	- Flight line length, in feet
SCALE	- “X”, as in 1:”X”
MILES	- Flight line length, in miles, to nearest tenth
FAZI	- Forward azimuth, degrees (clockwise from north, true)
BAZI	- Back azimuth, degrees (clockwise from north, true)
SWP	- Starting waypoint, number*
LAT1	- Starting latitude (N/S dd mm ss)*
LON1	- Starting longitude (W/E ddd mm ss)*
EWP	- Ending waypoint, number*
LAT2	- Ending latitude (N/S dd mm ss)*
LON2	- Ending longitude (W/E ddd mm ss)*
EMULSION	- Emulsion (CN = color neg., B&W= infrared, CR = color infrared) (If color & BWIR are to be flown using the same lines only one emulsion will be listed. See Project Instructions for complete emulsion requirements.)
END LAP	- End lap (or forward overlap), as a percent
PHOTOS	- Number of photographs, on that line
GRND EL	- Ground elevation, not used (Not relevant to shoreline mapping)
MAG DEC	- Magnetic declination, degrees, to nearest tenth (E (east) or W (west)) (Not relevant to shoreline mapping)
LAT3	- Middle of the flight line, Latitude (N/S dd mm ss) (Not relevant to shoreline mapping)
LON3	-Middle of the flight line, Longitude (W/E ddd mm ss) (Not relevant to shoreline mapping)

* Lines may be flown in either direction, but adjacent lines should be in opposite directions.

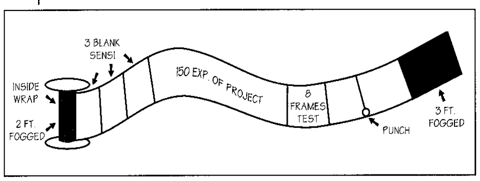
Blank Forms

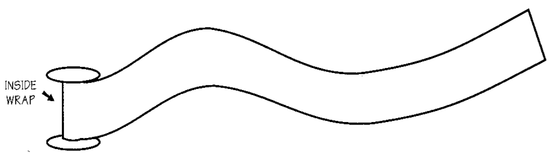
FILM TYPE ______________________________

COATING IDENTIFICATION ______________________________

FILM TEST: YES____ NO____ SENSITOMETRY: YES____ NO____

Example:





DESCRIBE YOUR ROLL: (Where to TEST/place SENSI)

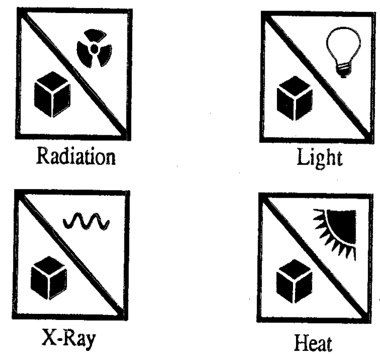
____

____

HRS Images, Inc.
937-222-3856
FAX 937-222-2443

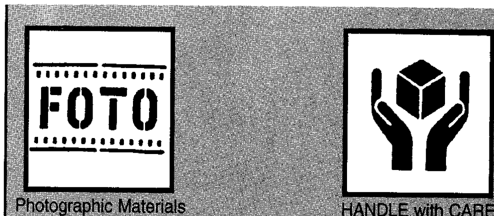
UNPROCESSED FILM

DO NOT EXPOSE TO:



HRS Images, Inc.
937-222-3856
FAX 937-222-2443

From:

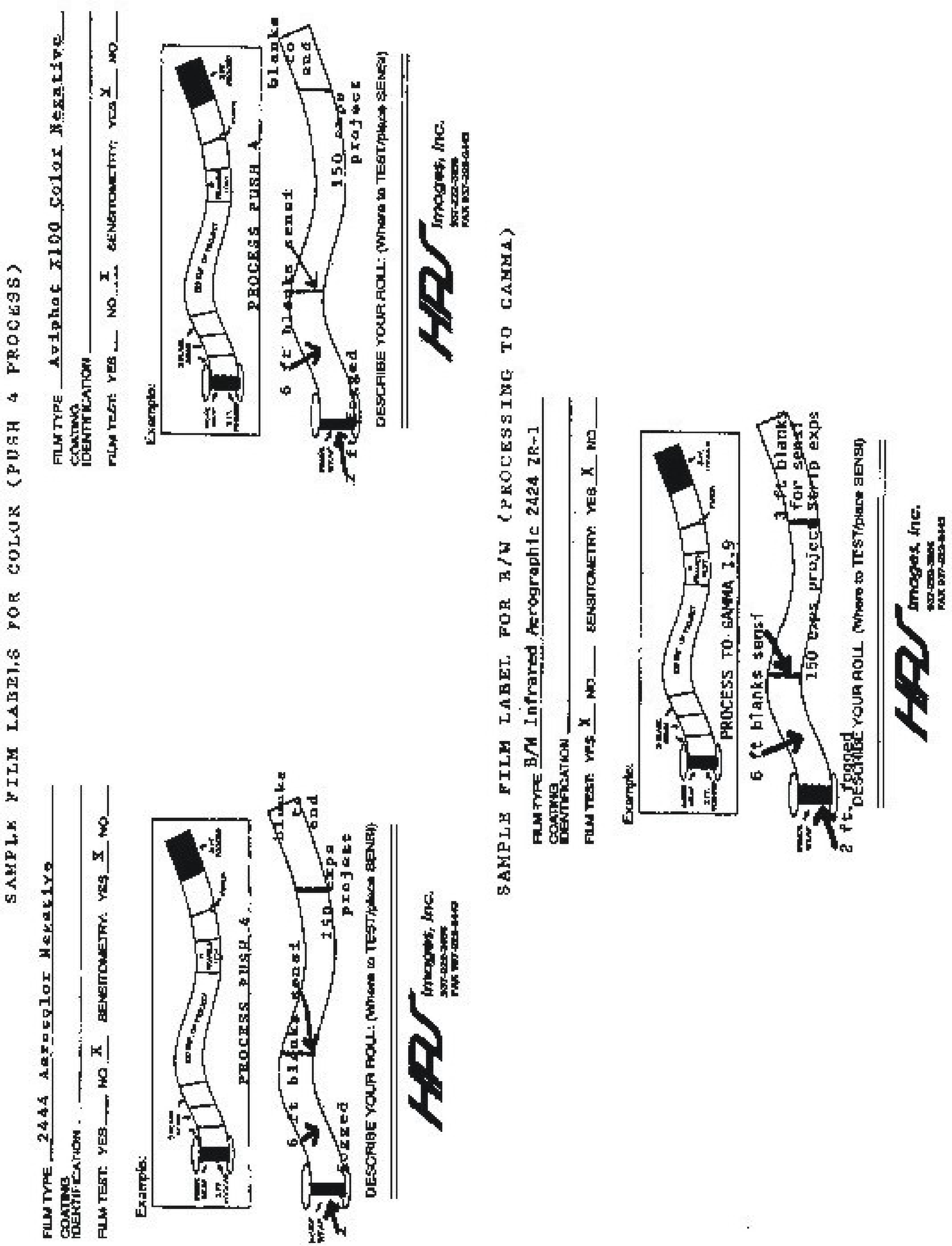


937-222-3856

HRS Images, Inc.

136 North St. Clair Street, Suite 300
Dayton, OH 45402

Samples



SAMPLE FILM LABELS FOR COLOR (PUSH 4 PROCESS)
FILM TYPE 2444 Aerocolor Negative
COATING IDENTIFICATION
FILM TEST: YES ___ NO X SENSITOMETRY: YES X NO ___
Example:
PROCESS PUSH 4
6 ft blanks sensi
150 exps project
blanks to end
fogged
DESCRIBE YOUR ROLL: (Where to TEST/place SENS)
HRS Images, Inc.
FILM TYPE Aviphot X100 Color Negative
COATING IDENTIFICATION
FILM TEST: YES ___ NO X SENSITOMETRY: YES X NO ___
Example:
PROCESS PUSH 4
6 ft blanks sensi
150 exps project
blanks to end
2 ft fogged
DESCRIBE YOUR ROLL: (Where to TEST/place SENS)
HRS Images, Inc.
SAMPLE FILM LABEL FOR B/W (PROCESSING TO GAMMA)
FILM TYPE B/W Infrared Aerographic 2424 ZR-1
COATING IDENTIFICATION
FILM TEST: YES X NO ___ SENSITOMETRY: YES X NO ___
Example:
PROCESS TO GAMMA 1.9
6 ft blanks sensi
150 exps project
3 ft blanks for sensi strip exps
2 ft. fogged
DESCRIBE YOUR ROLL (Where to TEST/place SENS)
HRS Images, Inc.

ANNEX 6

Contractor Letterhead

NOAA FORM 61-29
(12-71)

U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

REFERENCE NO.
GA0401-XX*

LETTER TRANSMITTING DATA

DATA AS LISTED BELOW WERE FORWARDED TO YOU BY (Check):

- ☐ ORDINARY MAIL
- ☐ AIR MAIL
- ☐ REGISTERED MAIL
- ☒ EXPRESS
- ☐ GBL (Give number) ______________

TO:
"Photo Processing Lab"

DATE FORWARDED
July 15, 2004

NUMBER OF PACKAGES
2 Boxes

NOTE: A separate transmittal letter is to be used for each type of data, as tidal data, seismology, geomagnetism, etc. State the number of packages and include an executed copy of the transmittal letter in each package. In addition the original and one copy of the letter should be sent under separate cover. The copy will be returned as a receipt. This form should not be used for correspondence or transmitting accounting documents.

Dear Sir or Madam:

This letter of transmittal regarding the National Oceanic and Atmospheric Administration (NOAA) film listed below is forwarded for processing under the U.S. Department of Commerce contract number "XXXXXX XXXXXX" for the NOAA, National Ocean Service, National Geodetic Survey, Remote Sensing Division.

Please process the enclosed film roll(s) in accordance with the requirements and then forward the film, Photographic Flight Reports, and Raw Navigation files to:

Robert B. Clark
Contracting Officer Technical Representative
National Geodetic Survey, Remote Sensing Division
NOAA, N/NGS31
Building SSMC3, Station 5147
1315 East-West Highway
Silver Spring, MD 20910

Roll Identification Number	Film Type	Quantity (Rolls)
(See Annex 2, #2)	Aviphot X100 CN	2

Thank you for your assistance.

FROM: (Signature)

RECEIVED THE ABOVE
(Name, Title, Date)

Return receipted copy to:

Name
Title
(Shoreline Photographic Contractor/
Shoreline Contractor Representative)
Fax #:

NOAA FORM 61-29 SUPERSEDES FORM C & GS 413 WHICH MAY BE USED.

This form was electronically produced by Elite Federal Forms, Inc.

*Note: The Reference Number is the Project Identifier (GA0401) plus the sequential number (01-99) of transmittal letters sent. Example: GA0401-01 is the first transmittal letter sent for this project, GA0401-25 is the 25th.

Annex 7A - PARTIALLY FILLED-IN SAMPLE

TABULATION OF AERIAL PHOTOGRAPHY

LOCATION	ALT.	FILM TYPE	TIDE STAGE	TIDE HT(ft)	DATE	FLIGHT LINE	FRAME NUMBERS START	FRAME NUMBERS END	PHOTOGRAPHY TIME START	PHOTOGRAPHY TIME END	TIDE WINDOW TIME START	TIDE WINDOW TIME END	PHOTOS WITHIN WINDOW
MIAMI	7200	Color Neg	-	1.4	1-Feb-98	9932P01	1	12	1005	1009	1002	1019	YES
					1-Feb-98	9932P02							
					1-Feb-98	9932P03							
					1-Feb-98	9932P04							
MIAMI	7200	B&W IR	MHW										
MIAMI	7200	B&W IR	MLLW										
FT LAUDERDALE	7200	Color Neg	MHW										
FT LAUDERDALE	7200	B&W IR	MHW										
FT LAUDERDALE	7200	B&W IR	MLLW										
FL HIGH ALT	20,000	Color Neg	MHW										
FL HIGH ALT	20,000	B&W IR	MHW										
FL HIGH ALT	20,000	B&W IR	MLLW										

NOTES:
Add an additional row for each flight line in each category, as shown for the Miami color.

If the photography is tide coordinated, enter MHW or MLLW under “TIDE STAGE”.

If the photography is not tide coordinated, enter the tidal height (in feet) under “TIDE HT.” This should be the actual tidal height.

Annex 7B - BLANK SAMPLE

TABULATION OF AERIAL PHOTOGRAPHY

							FRAME NUMBERS		PHOTOGRAPHY TIME		TIDE WINDOW TIME		
LOCATION	ALT.	FILM TYPE	TIDE STAGE	TIDE HT(ft)	DATE	FLIGHT LINE	START	END	START	END	START	END	PHOTOS WITHIN WINDOW

Version 6
September 30, 2004

ATTACHMENT D
SHAPEFILE REQUIREMENTS

TO
SCOPE OF WORK FOR SHORELINE MAPPING
UNDER THE
NOAA COASTAL MAPPING PROGRAM

REMOTE SENSING DIVISION
NATIONAL GEODETIC SURVEY
NATIONAL OCEAN SERVICE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE

TABLE OF CONTENTS

ATTACHMENT D: SHAPEFILE REQUIREMENTS PAGE

ATTACHMENT D: SHAPEFILE REQUIREMENTS

1. INTRODUCTION - The contractor shall supply two sets of ESRI 3-D shapefiles (PolyLineZM and PointZM), one for NGS quality control purposes (interim files) and the other as the final deliverable product to NGS. The final product shapefiles shall be supplied to NGS after the interim shapefiles have been reviewed and approved by NGS personnel. The final delivery shapefiles are the approved interim shapefiles with additional informative data fields and re-attribution of features to comply with NGS's Coastal Cartographic Object Attribute Source Table (C-COAST). The glossary for the C-COAST feature attribute description may be found in Attachment F, or is available on the web at http://www.ngs.noaa.gov/newsys_ims/shoreline/c_coast_def.htm . The final set of deliverable shapefiles shall consist of the entire project area having one shapefile containing linear data and if applicable, a second shapefile containing point data. The data fields and attributes are character and case sensitive for both the interim and final shapefiles.

2. INTERIM SHAPEFILES - The interim shapefiles shall be sent in incremental submissions. The first interim shapefiles should include an area with a good representation of different types of features. The results of the NGS review should be received by the cartographer(s) before continuing into other areas of the project, thereby reducing the number of repeatable edits. These interim shapefiles will be imported into NGS's digital photogrammetric workstations for stereoscopic review purposes. The unique requirements for the interim shapefiles include:

2.1 COORDINATE SYSTEM AND DATUM - The interim shapefiles shall be in the same coordinate system, datum(s), zone, projection and units as the aerotriangulation output.

2.2 SHAPEFILE NAMING CONVENTION - Each class that is used within C-COAST will be a separate shapefile. The shapefiles shall have the following names:

1) Shoreline
2) Alongshore_Feature
3) Obstruction_Point
4) Obstruction_Linear
5) Freestanding_Marine_Feature
6) Landmark
7) Aid_To_Navigation
8) Cultural_Feature_Miscellaneous
9) Transportation
10) Natural_Feature_Miscellaneous
11) Danger_Area
12) Aquatic_Vegetation_Area
13) Contour
14) Vertical_Measurement
15) Cartographic_Limit

2.3 SHAPEFILE ATTRIBUTION

1) Shoreline

Attribute: TYPE

Data type: Text
Width: 39
Domain: Mean_High_Water
Mean_High_Water__Approximate
Apparent__Marsh_Or_Swamp
Apparent__Mangrove_Or_Cypress
Bulkhead_Or_Sea_Wall
Bulkhead_Or_Sea_Wall__Ruins
Canal__Navigable
Canal__Navigable__Approximate
Canal__Non_navigable
Drydock__Permanent
Glacier
Great_Lake_Or_Lake_Or_Pond
Great_Lake_Or_Lake_Or_Pond__Approximate
Lock
Mean_Water_Level
Ramp
Rip_Rap
River_Or_Stream
River_Or_Stream__Approximate
Slipway
Wharf_Or_Quay
Wharf_Or_Quay__Ruins
Undetermined
Undetermined__Approximate
Shoreline__Alongshore_Feature_Boundary

Attribute: INFORMATIO

Data type: Text
Width: 50
Domain: Ancillary Information (e.g. Describing a feature)

2) Alongshore_Feature

Attribute: TYPE

Data type: Text
Width: 45
Domain: Pier__Fixed
Pier__Floating
Pier__Ruins
Breakwater__Bare

Breakwater__Covers__Uncovers_Or_Submerged
Bridge__Fixed
Bridge__Fixed__Ruins
Bridge__Fixed__Under_Construction
Bridge__Footbridge
Bridge__Footbridge__Ruins
Bridge__Footbridge__Under_Construction
Bridge__Opening
Bridge__Opening__Ruins
Bridge__Opening__Under_Construction
Bridge__Pontoon
Bridge__Pontoon__Ruins
Bridge__Pontoon__Under_Construction
Fender
Gate
Groin__Bare
Groin__Covers__Uncovers_Or_Submerged
Jetty__Bare
Jetty__Covers__Uncovers_Or_Submerged
Marine_Railway__Bare
Marine_Railway__Covers__Uncovers_Or_Submerged
Training_Wall
Undetermined_Alongshore_Feature

Attribute: INFORMATIO
Data type: Text
Width: 50
Domain: Ancillary Information (e.g. Describing a feature)

3) Obstruction_Point
Attribute: TYPE
Data type: Text
Width: 31
Domain: Rock__Bare
Rock__Covers__Uncovers
Rock__Submerged
Obstruction__Bare
Obstruction__Covers__Uncovers
Obstruction__Submerged
Coral__Covers__Uncovers
Coral__Submerged
~~Snag_Or_Stump__Bare~~
Snag_Or_Stump__Covers__Uncovers
Snag_Or_Stump__Submerged
Wreck__Mast__Bare
Wreck__Mast__Covers__Uncovers

Attribute: INFORMATIO
Data type: Text
Width: 50
Domain: Ancillary Information (e.g. Describing a feature or defining an obstruction)

4) Obstruction_Linear
Attribute: TYPE
Data type: Text
Width: 37
Domain: Platform__Floating
Platform__Mineral
Platform__Observation
Platform__Ruins
Platform__Undetermined
Wreck__Hull__Bare
Wreck__Hull__Covers__Uncovers
Wreck__Submerged__Dangerous
Wreck__Submerged__Non_dangerous
Ruins__Undetermined__Bare
Ruins__Undetermined__Covers__Uncovers
Ruins__Undetermined__Submerged
Obstruction__Bare
Obstruction__Covers__Uncovers
Obstruction__Submerged
Permanently_Docked_Vessel
Crib__Bare
Crib__Covers__Uncovers
Crib__Submerged
Fish_Stakes
Fish_Trap
Floating_Barrier__Log_Boom
Floating_Barrier__Oil_Barrier
Floating_Barrier__Undetermined
Floating_Drydock

Attribute: INFORMATIO
Data type: Text
Width: 50
Domain: Ancillary Information (e.g. Describing a feature)

5) Freestanding_Marine_Feature
Attribute: TYPE
Data type: Text

Width: 32
Domain: Pile__Bare
Pile__Covers__Uncovers
Pile__Submerged
Dolphin__Bare
Dolphin__Ruins__Bare
Dolphin__Ruins__Submerged
Dolphin__Ruins__Covers__Uncovers
Tripodal__Bare
Stake__Bare
Stake__Covers__Uncovers
Stake__Submerged

Attribute: INFORMATIO
Data type: Text
Width: 50
Domain: Ancillary Information (e.g. Describing a feature)

6) Landmark
Attribute: TYPE
Data type: Text
Width: 16
Domain: Tower
Water_Tower
Chimney_Or_Stack
Cross
Dish_Antenna
Dome_Or_Cupola
Flagpole
Flare_Stack
Grain_Elevator
Mast
Silo
Spire_Or_Minaret
Tank
Windmill
Other
Attribute: VALUE
Data type: Text
Width: 20
Domain: Landmark
Recommended_Landmark

Attribute: INFORMATIO
Data type: Text
Width: 50

Domain: Ancillary Information (e.g. Describing a feature)

7) Aid_To_Navigation
Attribute: TYPE
Data type: Text
Width: 24
Domain: Daybeacon
Marine_Light__Pile
Marine_Light__Tripodal
Marine_Light__Tower
Marine_Light__Lighthouse

Attribute: INFORMATIO
Data type: Text
Width: 50
Domain: Ancillary Information (e.g. Describing a feature)

8) Cultural_Feature_Miscellaneous
Attribute: TYPE
Data type: Text
Width: 32
Domain: Building
Tank
Silo
Water_Tower
Levee_Or_Dike
Cable__Overhead
Cable__Submerged
General_Transport__Ferry_Cable
General_Transport__Aerial_Cable
General_Transport__Conveyor_Belt
Grain_Elevator
Pipeline__Submerged_Or_Surface
Pipeline__Overhead
Dam
Fort
Fence
Wall

Attribute: INFORMATIO
Data type: Text
Width: 50
Domain: Ancillary Information (e.g. Describing a feature)

9) Transportation
Attribute: TYPE
Data type: Text
Width: 19
Domain: Road
Road__Path
Railroad
Railroad__Abandoned
Runway
Helicopter_Pad
Tunnel_Entrance

Attribute: INFORMATIO
Data type: Text
Width: 50
Domain: Ancillary Information (e.g. Describing a feature)

10) Natural_Feature_Miscellaneous
Attribute: TYPE
Data type: Text
Width: 27
Domain: Marsh_Or_Swamp__Extent
Mangrove_Or_Cypress__Extent
Glacier__Extent
Cliff_Or_Bluff
Stream__Perennial
Stream__Intermittent
Rapids
Waterfall
Sand_Dune
Lava__Extent
Landslide__Extent
Moraine__Extent

Attribute: INFORMATIO
Data type: Text
Width: 50
Domain: Ancillary Information (e.g. Describing a feature)

11) Danger_Area
Attribute: TYPE
Data type: Text
Width: 26
Domain: Foul
Ledge__Covers__Uncovers
Ledge__Submerged

Reef__Covers__Uncovers
Reef__Submerged
Wreckage__Bare
Wreckage__Covers__Uncovers
Wreckage__Submerged
Shoal
Shallow
Breakers

Attribute: INFORMATIO
Data type: Text
Width: 50
Domain: Ancillary Information (e.g. Describing a feature)

12) Aquatic_Vegetation_Area
Attribute: TYPE
Data type: Text
Width: 14
Domain: Kelp
Sea_Grass
Grass_In_Water

Attribute: INFORMATIO
Data type: Text
Width: 50
Domain: Ancillary Information (e.g. Describing a feature)

13) Contour
Attribute: TYPE
Data type: Text
Width: 30
Domain: Depth_Contour__Approximate
Elevation_Contour
Elevation_Contour__Approximate

Attribute: INFORMATIO
Data type: Text
Width: 50
Domain: Ancillary Information (e.g. Describing a feature or modifying Depth Contour to be MLLW)

14) Vertical_Measurement
Attribute: TYPE
Data type: Text
Width: 21
Domain: Spot_Elevation

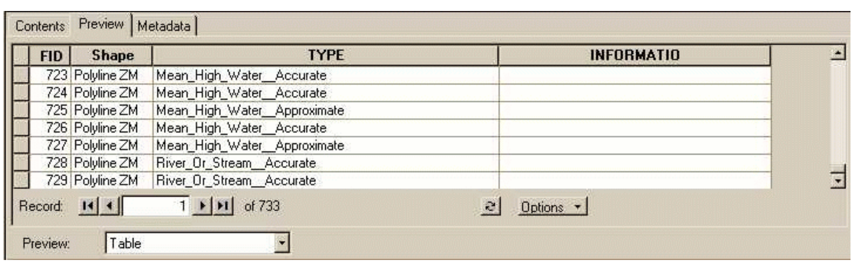
Sounding
Sounding__Wreck
Sounding__Rock
Sounding__Obstruction
Sounding__Coral

Attribute: INFORMATIO
Data type: Text
Width: 50
Domain: Ancillary Information (e.g. Describing a feature)

15) Cartographic_Limit
Attribute: TYPE
Data type: Text
Width: 20
Domain: Feature_Limit
Low_Visibility_Limit
Source_Data_Limit

Attribute: INFORMATIO
Data type: Text
Width: 50
Domain: Ancillary Information (e.g. Describing a feature)

Example of interim shoreline attribute table:



FID	Shape	TYPE	INFORMATIO
723	Polyline ZM	Mean_High_Water__Accurate	
724	Polyline ZM	Mean_High_Water__Accurate	
725	Polyline ZM	Mean_High_Water__Approximate	
726	Polyline ZM	Mean_High_Water__Accurate	
727	Polyline ZM	Mean_High_Water__Approximate	
728	Polyline ZM	River_Or_Stream__Accurate	
729	Polyline ZM	River_Or_Stream__Accurate	

3. FINAL DELIVERABLE SHAPEFILES - The final deliverable shapefiles shall merge all the approved interim line files (PolyLineZM) into one shapefile and all the approved interim point files (PointZM) into another shapefile. Polygon shapefiles shall not be used. The final delivery shapefiles are the approved interim shapefiles with additional information about the shoreline data and a re-attribution of features to comply with NGS's C-COAST. Note that for Recommended Landmarks (excluding Charted Landmarks) the TYPE field and the VALUE field from the interim shapefile are merged to form the ATTRIBUTE field in the final shapefile. The cartographer shall not use C-COAST features or attributes with a ~~strikeout~~ since they are reserved for importing from other sources, such as vectorized historic shoreline manuscripts, into

the NGS shoreline database. These final deliverable shapefiles will be imported into the NGS shoreline database and be made available through the NOAA Shoreline Data Explorer website. The unique requirements for the final deliverable shapefiles include:

3.1 COORDINATE SYSTEM AND DATUM

The final shapefiles shall be in geographic decimal degrees using double precision and referenced to the NAD 83 horizontal datum.

3.2 SHAPEFILE NAMING CONVENTION:

llyynn_x where:

- ll - a two character local identifier utilizing the two character code for a state
- yy - a two digit year identifier
- nn - a two digit sequence number
- x - a one character spatial primitive indicator indicating “a” for arcs (lines) and “p” for point feature geometry

The llyynn project ID will be supplied by the government.

3.3 SHAPEFILE ATTRIBUTION

Submit one project shapefile for all point features and another for all line features. Polygon shapefiles are <u>not</u> permitted. The shapefile data fields include:

Attribute_Label: DATA_SOURC
Data type: Text
Width: 1
Definition: Data Source describing the type of imagery used in compilation
Domain: A-AERIAL PHOTOGRAPHY - Film used in stereoplotter
D-DIGITAL PHOTOGRAPHY - Scanned from film or from digital camera
M-MULTIPLE SOURCES - Other sources i.e. Satellite, LIDAR, IFSAR, HyperSpectral Scanner, etc.

Attribute_Label: FEATURE
Data type: Integer
Width: 5
Definition: Cartographic feature code number from the Coastal Cartographic Object Attribute Source Table's (C-COAST) attribution scheme
Domain: 1 - 205 See Attachment E for the assigned numbers associated with each C_COAST attribute

Attribute_Label: EXTRACT_TE
Data type: Text
Width: 1
Definition: Technology used to extract feature from source

Domain: A-ANALOG PLOTTER
B-ANALYTICAL PLOTTER
S-SOFTCOPY

Attribute_Label: RESOLUTION
Data type: Integer
Width: 5
Definition: Integer indicating level of generalization (use '0' = full resolution)
For this SOW the value of this attribute shall always equal 0.
Domain: 0 - 5

Attribute_Label: CLASS
Data type: Text
Width: 32
Definition: C-COAST Feature class
Domain: SHORELINE
ALONGSHORE FEATURE
OBSTRUCTION POINT
OBSTRUCTION LINEAR
FREESTANDING MARINE FEATURE
LANDMARK
AID TO NAVIGATION
CULTURAL FEATURE MISCELLANEOUS
TRANSPORTATION
NATURAL FEATURE MISCELLANEOUS
DANGER AREA
AQUATIC VEGETATION AREA
CONTOUR
VERTICAL MEASUREMENT
CARTOGRAPHIC LIMIT

Attribute_Label: ATTRIBUTE
Data type: Text
Width: 50
Definition: C-COAST Feature attribute description
Domain: ~~Man-made~~
Man-made.Bulkhead Or Sea Wall
Man-made.Bulkhead Or Sea Wall.Ruins
Man-made.Canal.Navigable
Man-made.Canal.Navigable.Approximate
Man-made.Canal.Non-navigable
Man-made.Drydock.Permanent
Man-made.Lock
Man-made.Ramp
Man-made.Rip Rap
Man-made.Slipway

Man-made.Wharf Or Quay
Man-made.Wharf Or Quay.Ruins
~~Natural~~
Natural.Apparent.Marsh Or Swamp
Natural.Apparent.Mangrove Or Cypress
Natural.Glacier
Natural.Great Lake Or Lake Or Pond
Natural.Great Lake Or Lake Or Pond.Approximate
Natural.Mean High Water
Natural.Mean High Water.Approximate
Natural.Mean Water Level
Natural.River Or Stream
Natural.River Or Stream.Approximate
Undetermined
Undetermined.Approximate
Undetermined.Estimated
Shoreline/Alongshore Feature Boundary
Breakwater.Bare
Breakwater.Covers/Uncovers Or Submerged
~~Bridge~~
Bridge.Fixed
Bridge.Fixed.Ruins
Bridge.Fixed.Under Construction
Bridge.Footbridge
Bridge.Footbridge.Ruins
Bridge.Footbridge.Under Construction
Bridge.Opening
Bridge.Opening.Ruins
Bridge.Opening.Under Construction
Bridge.Pontoon
Bridge.Pontoon.Ruins
Bridge.Pontoon.Under Construction
Fender
Gate
Groin.Bare
Groin.Covers/Uncovers Or Submerged
Jetty.Bare
Jetty.Covers/Uncovers Or Submerged
Marine Railway.Bare
Marine Railway.Covers/Uncovers Or Submerged
~~Pier~~
Pier.Fixed
Pier.Floating
Pier.Ruins
Training Wall
Undetermined Alongshore Feature

Coral.Covers/Uncovers
Coral.Submerged
~~Rock~~
Rock.Bare
Rock.Covers/Uncovers
Rock.Submerged
~~Snag Or Stump.Bare~~
Snag Or Stump.Covers/Uncovers
Snag Or Stump.Submerged
Obstruction.Bare
Obstruction.Covers/Uncovers
Obstruction.Submerged
Wreck.Mast.Bare
Wreck.Mast.Covers/Uncovers
Crib.Bare
Crib.Covers/Uncovers
Crib.Submerged
Fish Facility.Fish Stakes
Fish Facility.Fish Trap
Floating Barrier.Log Boom
Floating Barrier.Oil Barrier
Floating Barrier.Undetermined
Floating Drydock
Obstruction.Bare
Obstruction.Covers/Uncovers
Obstruction.Submerged
Platform.Floating
Platform.Mineral
Platform.Observation
Platform.Ruins
Platform.Undetermined
Permanently Docked Vessel
Ruins.Undetermined.Bare
Ruins.Undetermined.Covers/Uncovers
Ruins.Undetermined.Submerged
Wreck.Hull.Bare
Wreck.Hull.Covers/Uncovers
Wreck.Submerged.Dangerous
Wreck.Submerged.Non-dangerous
Dolphin.Bare
Dolphin.Ruins.Bare
Dolphin.Ruins.Submerged
Dolphin.Ruins.Covers/Uncovers
Pile.Bare
Pile.Covers/Uncovers
Pile.Submerged

Stake.Bare
Stake.Covers/Uncovers
Stake.Submerged
Tripodal.Bare
Chimney Or Stack
Chimney Or Stack.Recommended Landmark
Cross
Cross.Recommended Landmark
Dish Antenna
Dish Antenna.Recommended Landmark
Dome Or Cupola
Dome Or Cupola.Recommended Landmark
Flagpole
Flagpole.Recommended Landmark
Flare Stack
Flare Stack.Recommended Landmark
Grain Elevator
Grain Elevator.Recommended Landmark
Mast
Mast.Recommended Landmark
Other
Other.Recommended Landmark
Silo
Silo.Recommended Landmark
Spire Or Minaret
Spire Or Minaret.Recommended Landmark
Tank
Tank.Recommended Landmark
Tower
Tower.Recommended Landmark
Water Tower
Water Tower.Recommended Landmark
Windmill
Windmill.Recommended Landmark
Daybeacon
Marine Light.Lighthouse
Marine Light.Pile
Marine Light.Tower
Marine Light.Tripodal
Building
Cable.Overhead
Cable.Submerged
Dam
Fence
Fort
General Transport.Aerial Cable

General Transport.Conveyor Belt
General Transport.Ferry Cable
Grain Elevator
Levee Or Dike
Pipeline.Submerged Or Surface
Pipeline.Overhead
Silo
Tank
Wall
Water Tower
Helicopter Pad
Road
Road.Path
Railroad
Railroad.Abandoned
Runway
Tunnel Entrance
Cliff Or Bluff
Glacier.Extent
Landslide.Extent
Lava.Extent
Mangrove Or Cypress.Extent
Marsh Or Swamp.Extent
Moraine.Extent
Rapids
Sand Dune
Stream.Intermittent
Stream.Perennial
Waterfall
Breakers
Foul
Ledge.Covers/Uncovers
Ledge.Submerged
Reef.Covers/Uncovers
Reef.Submerged
Shallow
Shoal
Wreckage.Bare
Wreckage.Covers/Uncovers
Wreckage.Submerged
Grass In Water
Kelp
Sea Grass
Depth Contour.Approximate
Elevation Contour
Elevation Contour.Approximate

Sounding
Sounding.Coral
Sounding.Obstruction
Sounding.Rock
Sounding.Wreck
Spot Elevation
Feature Limit
Low Visibility Limit
Source Data Limit
~~User Added Line~~

Attribute_Label: INFORM
Data type: Text
Width: 50
Definition: Ancillary Information (e.g. Describing or defining a feature or modifying Depth Contour to be MLLW) For certain features specific rules govern the exact text that shall be entered in this attribution field. See Attachment K.
Domain: Free text

Attribute_Label: HOR_ACC
Data type: Text
Width: 6
Definition: Horizontal positional accuracy (meters) as reported in the PCR (see Attachment L)
Domain: 0 - 200

Attribute_Label: VERT_ACC
Data type: Text
Width: 6
Definition: Vertical ground based accuracy in meters at the 95% confidence level.
Domain: 0 - 200

Attribute_Label: SRC_DATE
Data type: Text
Width: 8
Definition: Date of source imagery (YYYYMMDD) for the feature
For shapefiles with DATA_SOURC = M (Multiple Sources) only include the Year and Month (YYYYMM).
Domain: 18340101 - Present

Attribute_Label: SOURCE_ID
Data type: Text

Width: 8
Definition: Geographic Cell Identifier Number, or GC number (e.g. GC12345) The value of this attribute will be assigned by NGS upon granting permission to proceed with phase 2 of the project
Domain: Free text

Attribute_Label: EXT_METH
Data type: Text
Width: 1
Definition: Method used to extract feature from source
Domain: M-MONO
S-STEREO

Example of an attribute table for final deliverable line shapefile:

Attributes of GC10522_a

FID	Shape	DATA_S	FEATURE	EXTRACT_TE	RES	CLASS	ATTRIBUTE	INFORM	HOR_ACC	VERT_ACC	SRC_DATE	SOURCE_ID	EXT_MET
0	Polyline ZM	D	32	S	0	ALONGSHORE FEATURE	Bridge.Fixed		10.0	50	19990301	GC10522	S
1	Polyline ZM	D	32	S	0	ALONGSHORE FEATURE	Bridge.Fixed		10.0	50	19990301	GC10522	S
2	Polyline ZM	D	32	S	0	ALONGSHORE FEATURE	Bridge.Fixed		10.0	50	19990301	GC10522	S
3	Polyline ZM	D	32	S	0	ALONGSHORE FEATURE	Bridge.Fixed		10.0	50	19990301	GC10522	S
4	Polyline ZM	D	38	S	0	ALONGSHORE FEATURE	Bridge.Opening		10.0	50	19990301	GC10522	S
5	Polyline ZM	D	204	S	0	CARTOGRAPHIC LIMIT	Source Data Limit		10.0	50	19990301	GC10522	S
6	Polyline ZM	D	194	S	0	CONTOUR	Elevation Contour	Crater_Ridge	10.0	50	19990301	GC10522	S
7	Polyline ZM	D	194	S	0	CONTOUR	Elevation Contour	vocano_caldera	10.0	50	19990301	GC10522	S
8	Polyline ZM	D	180	S	0	DANGER AREA	Foul		10.0	50	19990301	GC10522	S
9	Polyline ZM	D	180	S	0	DANGER AREA	Foul		10.0	50	19990301	GC10522	S
10	Polyline ZM	D	180	S	0	DANGER AREA	Foul		10.0	50	19990301	GC10522	S
11	Polyline ZM	D	180	S	0	DANGER AREA	Foul		10.0	50	19990301	GC10522	S
12	Polyline ZM	D	180	S	0	DANGER AREA	Foul		10.0	50	19990301	GC10522	S
13	Polyline ZM	D	180	S	0	DANGER AREA	Foul		10.0	50	19990301	GC10522	S
14	Polyline ZM	D	180	S	0	DANGER AREA	Foul		10.0	50	19990301	GC10522	S
15	Polyline ZM	D	180	S	0	DANGER AREA	Foul		10.0	50	19990301	GC10522	S

Record: 1 Show: All Selected Records (0 out of 480 Selected.) Options

4. ENTERING DATA IN ATTRIBUTE FIELDS - All shapefile database (.dbf) records shall have values entered into each attribute field according to the valid case sensitive domains of the fields as defined in 1.3 and 2.3. Generally, the INFORM field may be left blank, except for certain features which are governed by specific requirements as stated in Attachment K.

The HOR_ACC attribution field entry for each feature shall be the reported accuracy for the block of imagery used to compile the feature. This value is the circular error (meters) at the 95% confidence level as reported in the COMPILATION section of the Project Completion Report. (See Attachment L, Section 4.7)

Version 14A
January 31, 2008

ATTACHMENT E
C-COAST FEATURES

TO
SCOPE OF WORK FOR SHORELINE MAPPING
UNDER THE
NOAA COASTAL MAPPING PROGRAM

REMOTE SENSING DIVISION
NATIONAL GEODETIC SURVEY
NATIONAL OCEAN SERVICE
NATIONAL OCEANIC & ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE

Feat	C-COAST ***CLASS*** / Attribute	S-57 Translation
	SHORELINE	
1	Man-made	SLCONS
2	Man-made.Bulkhead Or Sea Wall	SLCONS;catslc 10
3	Man-made.Bulkhead Or Sea Wall.Ruins	SLCONS;catslc 10;condtn 2
4	Man-made.Canal.Navigable	CANALS;catcan 1
5	Man-made.Canal.Navigable.Approximate	CANALS;catcan 1;quapos 4
6	Man-made.Canal.Non-Navigable	CANALS;catcan 2
7	Man-made.Drydock.Permanent	DRYDOC;status 1
8	Man-made.Lock	LOKBSN
9	Man-made.Ramp	SLCONS;catslc 12
10	Man-made.Rip Rap	SLCONS;catslc 8
11	Man-made.Slipway	SLCONS;catslc 13
12	Man-made.Wharf Or Quay	SLCONS;catslc 6
13	Man-made.Wharf Or Quay.Ruins	SLCONS;catslc 6;condtn 2
14	Natural	COALNE
15	Natural.Apparent.Marsh Or Swamp	COALNE;catcoa 8;quapos 4
16	Natural.Apparent.Mangrove Or Cypress	COALNE;catcoa 7;quapos 4
17	Natural.Glacier	COALNE;catcoa 6;quapos 9
18	Natural.Great Lake Or Lake Or Pond	LAKSHR;quapos 1
19	Natural.Great Lake Or Lake Or Pond.Approximate	LAKSHR;quapos 4
20	Natural.Mean High Water	COALNE
21	Natural.Mean High Water.Approximate	COALNE;quapos 4
22	Natural.Mean Water Level	COALNE
23	Natural.River Or Stream	RIVBNK;quapos 1
24	Natural.River Or Stream.Approximate	RIVBNK;quapos 4
25	Undetermined	COALNE;quapos 10
26	Undetermined.Approximate	COALNE;quapos 4
27	Undetermined.Estimated	COALNE;quapos 9
28	Shoreline/Alongshore Feature Boundary	COALNE;quapos 4
	ALONGSHORE FEATURE	
29	Breakwater.Bare	SLCONS;catslc 1;watlev 2
30	Breakwater.Covers/Uncovers Or Submerged	SLCONS;catslc 1;watlev 3
31	Bridge	BRIDGE;catbrg -999
32	Bridge.Fixed	BRIDGE;catbrg 1
33	Bridge.Fixed.Ruins	BRIDGE;catbrg 1;condtn 2
34	Bridge.Fixed.Under Construction	BRIDGE;catbrg 1;condtn 1
35	Bridge.Footbridge	BRIDGE;catbrg 9
36	Bridge.Footbridge.Ruins	BRIDGE;catbrg 9;condtn 2
37	Bridge.Footbridge.Under Construction	BRIDGE;catbrg 9;condtn 1
38	Bridge.Opening	BRIDGE;catbrg 2
39	Bridge.Opening.Ruins	BRIDGE;catbrg 2;condtn 2
40	Bridge.Opening.Under Construction	BRIDGE;catbrg 2;condtn 1

41	Bridge.Pontoon	BRIDGE;catbrg 6
42	Bridge.Pontoon.Ruins	BRIDGE;catbrg 6;condtn 2
43	Bridge.Pontoon.Under Construction	BRIDGE;catbrg 6;condtn 1
44	Fender	SLCONS;catslc 14
45	Gate	GATCON
46	Groin.Bare	SLCONS;catslc 2;watlev 2
47	Groin.Covers/Uncovers Or Submerged	SLCONS;catslc 2;watlev 3
48	Jetty.Bare	SLCONS;catslc 4;watlev 2
49	Jetty.Covers/Uncovers Or Submerged	SLCONS;catslc 4;watlev 3
50	Marine Railway.Bare	SLCONS;catslc 12;watlev 2
51	Marine Railway.Covers/Uncovers Or Submerged	SLCONS;catslc 12;watlev 3
52	Pier	SLCONS;catslc 4
53	Pier.Fixed	SLCONS;catslc 4
54	Pier.Floating	PONTON
55	Pier.Ruins	SLCONS;catslc 4;condtn 2
56	Training Wall	SLCONS;catslc 7
57	Undeterminded Alongshore Feature	SLCONS
	OBSTRUCTION POINT	
58	Coral.Covers/Uncovers	UWTROC;natsur 14;watlev 4;quasou 2
59	Coral.Submerged	UWTROC;natsur 14;watlev 3;quasou 2;valsou -999
60	Rock	UWTROC;natsur 9
61	Rock.Bare	LNDARE
62	Rock.Covers/Uncovers	UWTROC;natsur 9;watlev 4;quasou 2
63	Rock.Submerged	UWTROC;natsur 9;watlev 3;quasou 2;valsou -999
64	Snag Or Stump.Bare	OBSTRN;catobs 1;watlev 2;height -999
65	Snag Or Stump.Covers/Uncovers	OBSTRN;catobs 1;watlev 4;quasou 2
66	Snag Or Stump.Submerged	OBSTRN;catobs 1;watlev 3;quasou 2;valsou -999
67	Obstruction.Bare	OBSTRN;watlev 2;height -999
68	Obstruction.Covers/Uncovers	OBSTRN;watlev 4;quasou 2
69	Obstruction.Submerged	OBSTRN;watlev 3;quasou 2;valsou -999
70	Wreck.Mast.Bare	WRECKS;catwrk 4;watlev 2;height -999
71	Wreck.Mast.Covers/Uncovers	WRECKS;catwrk 4;watlev 4;quasou 2
	OBSTRUCTION LINEAR	
72	Crib.Bare	OBSTRN;catobs 4;watlev 2;height -999
73	Crib.Covers/Uncovers	OBSTRN;catobs 4;watlev 4;quasou 2
74	Crib.Submerged	OBSTRN;catobs 4;watlev 3;quasou 2;valsou -999
75	Fish Facility.Fish Stakes	FSHFAC;catfif 1
76	Fish Facility.Fish Trap	FSHFAC;catfif 2
77	Floating Barrier.Log Boom	LOGPON
78	Floating Barrier.Oil Barrier	OILBAR;catolb 2
79	Floating Barrier.Undetermined	OBSTRN;catobs 10
80	Floating.Drydock	DRYDOC;status -999
81	Obstruction.Bare	OBSTRN;watlev 2;height -999
82	Obstruction Covers/Uncovers	OBSTRN;watlev 4;quasou 2

83	Obstruction.Submerged	OBSTRN;watlev 3;quasou 2;valsou -999
84	Platform.Floating	PONTON
85	Platform.Mineral	OFSPLF;catofp 2
86	Platform.Observation	OFSPLF;catofp 3
87	Platform.Ruins	OFSPLF;catofp -999;condtn 2
88	Platform.Undetermined	OFSPLF;catofp -999
89	Permanently Docked Vessel	HULKES
90	Ruins.Undetermined.Bare	OBSTRN;condtn 2;watlev 2;height -999
91	Ruins.Undetermined.Covers/Uncovers	OBSTRN;condtn 2;watlev 4;quasou 2
92	Ruins.Undetermined.Submerged	OBSTRN;condtn 2;watlev 3;quasou 2;valsou -999
93	Wreck.Hull.Bare	WRECKS;catwrk 5;watlev 2;height -999
94	Wreck.Hull.Covers/Uncovers	WRECKS;catwrk 5;watlev 4;quasou 2
95	Wreck.Submerged.Dangerous	WRECKS;catwrk 2;watlev 3;quasou 2;valsou -999
96	Wreck.Submerged.Non-dangerous	WRECKS;catwrk 1;watlev 3;quasou 2;valsou -999
	FREESTANDING MARINE FEATURE	
97	Dolphin.Bare	MORFAC;catmor 1
98	Dolphin.Ruins.Bare	MORFAC;catmor 1;condtn 2;watlev 2
99	Dolphin.Ruins.Submerged	MORFAC;catmor 1;condtn 2;watlev 3
100	Dolphin.Ruins.Covers/Uncovers	MORFAC;catmor 1;condtn 2;watlev 4
101	Pile.Bare	PILPNT;catple 3
102	Pile.Covers/Uncovers	OBSTRN;catobs 1;watlev 3
103	Pile.Submerged	OBSTRN;catobs 1;watlev 4
104	Stake.Bare	PILPNT;catple 1
105	Stake.Covers/Uncovers	OBSTRN;catobs 1;watlev 4;quasou 2;valsou -999
106	Stake.Submerged	OBSTRN;catobs 1;watlev 3;quasou 2;valsou -999
107	Tripodal.Bare	PILPNT;catple 4
	LANDMARK	
108	Chimney Or Stack	LNDMRK;catlmk 3;convis 1
109	Chimney Or Stack.Recommended Landmark	LNDMRK;catlmk 3;convis 1
110	Cross	LNDMRK;catlmk 14;convis 1
111	Cross.Recommended Landmark	LNDMRK;catlmk 14;convis 1
112	Dish Antenna	LNDMRK;catlmk 4;convis 1
113	Dish Antenna.Recommended Landmark	LNDMRK;catlmk 4;convis 1
114	Dome or Cupola	LNDMRK;catlmk 15;convis 1
115	Dome or Cupola.Recommended Landmark	LNDMRK;catlmk 15;convis 1
116	Flagpole	LNDMRK;catlmk 5;convis 1
117	Flagpole.Recommended Landmark	LNDMRK;catlmk 5;convis 1
118	Flare Stack	LNDMRK;catlmk 6;convis 1
119	Flare Stack.Recommended Landmark	LNDMRK;catlmk 6;convis 1
120	Grain Elevator	SILTNK;catsil 3;convis 1
121	Grain Elevator.Recommended Landmark	SILTNK;catsil 3;convis 1
122	Mast	LNDMRK;catlmk 7;convis 1
123	Mast.Recommended Landmark	LNDMRK;catlmk 7;convis 1
124	Other	LNDMRK;catlmk -999

125	Other.Recommended Landmark	LNDMRK;catlmk -999
126	Silo	SILTNK;catsil 1;convis 1
127	Silo.Recommended Landmark	SILTNK;catsil 1;convis 1
128	Spire Or Minaret	LNDMRK;catlmk 20;convis 1
129	Spire Or Minaret.Recommended Landmark	LNDMRK;catlmk 20;convis 1
130	Tank	SILTNK;catsil 2;convis 1
131	Tank.Recommended Landmark	SILTNK;catsil 2;convis 1
132	Tower	LNDMRK;catlmk 17;convis 1
133	Tower.Recommended Landmark	LNDMRK;catlmk 17;convis 1
134	Water Tower	SILTNK;catsil 4;convis 1
135	Water Tower.Recommended Landmark	SILTNK;catsil 4;convis 1
136	Windmill	LNDMRK;catlmk 18;convis 1
137	Windmill.Recommended Landmark	LNDMRK;catlmk 18;convis 1
	AID TO NAVIGATION	
138	Daybeacon	BCNLAT
139	Marine Light.Lighthouse	BUISGL;functn 33
140	Marine Light.Pile	BCNLAT
141	Marine Light.Tower	BCNLAT
142	Marine Light.Tripodal	BCNLAT
	CULTURAL FEATURE MISCELLANEOUS	
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185	Shallow	CTNARE
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Version 1
September 30, 2004

ATTACHMENT F
COASTAL CARTOGRAPHIC OBJECT ATTRIBUTE SOURCE TABLE
(C-COAST)

GLOSSARY

TO

SCOPE OF WORK FOR SHORELINE MAPPING
UNDER THE
NOAA COASTAL MAPPING PROGRAM

REMOTE SENSING DIVISION
NATIONAL GEODETIC SURVEY
NATIONAL OCEAN SERVICE
NATIONAL OCEANIC & ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE

ATTACHMENT F: C-COAST DEFINITIONS BY CLASS

SHORELINE

Defined as the intersection of the land, including man-made waterfront structures, with the water surface. The shoreline depicted on NOS maps and charts represents the line of contact between the land and a selected water elevation. In areas affected by tidal fluctuations, the shoreline is the interpreted mean high water line. In confined coastal water of diminished tidal influence, the mean water level line may be used. In non-tidal waters, the line represents the land/water interface at the time of survey. In areas where the land is obscured by marsh grass, cypress or similar marine vegetation, the actual shoreline can not be accurately represented. Instead, the outer limit line of the vegetation area is delineated (where it would appear to the mariner as the shoreline) and is referred to as the apparent shoreline. (2)

Accurate

A modifier that indicates shoreline delineated in a regular, sufficiently controlled survey of any date. Shoreline features with no accuracy modifier should be considered **Accurate** unless specified **Approximate** or **Estimated**. (6)

Apparent

The outer limit line of a vegetation area, such as marsh or mangrove, delineated as shoreline; the shoreline as it would appear to the mariner. (5)

Approximate

A modifier that indicates shoreline which does not meet the definition of **Accurate**, but is generally considered to be within 100 feet (30.5 meters) of its correct geographic location. Used to denote shoreline obscured by shadows or line-of-sight blockage, such as under bridges. (6)

Bulkhead Or Sea Wall

An embankment or wall for protection against waves or tidal action along a shore or water front. (6)

Canal

An artificial waterway with no flow, or a controlled flow, used for navigation, or for draining or irrigating land. (6)

Drydock

An artificial basin fitted with a gate or caisson, into which vessels can be floated and the water pumped out to expose the vessel's bottom. Also called graving dock. (5)

Estimated

A modifier that indicates shoreline which is generally considered to be outside of 100 feet (30.5 meters) of its correct geographic location .

Glacier

A mass of snow and ice continuously moving from higher to lower ground or, if afloat, continuously spreading. (6)

Great Lake Or Lake Or Pond

The Great Lakes, and other small and large bodies of water entirely surrounded by land, both natural and artificial. (6)

Lock

A wet dock in a waterway, permitting a ship to pass from one level to another. (5)

Mangrove Or Cypress

An area composed of one of several genera of tropical trees or shrubs which produce many prop roots and grow along low lying coasts in shallow water; or a deciduous conifer which thrives in swamps and tidal flows, and is found primarily in the coastal tidewaters of the Gulf of Mexico in Florida and Mississippi. (6, 11)

Man-made

Composed of artificially constructed features or non-natural materials.

Marsh Or Swamp

An area made up of spongy land saturated with water. It may have a shallow covering of water, usually with a considerable amount of vegetation appearing above the surface. (6)

Mean High Water

A tidal datum. The average of all the high water heights observed over the National Tidal Datum Epoch (19 years). For stations with shorter series, simultaneous observational comparisons are made with a control tide station in order to derive the equivalent datum of the National Tidal Datum. (2)

Mean Water Level

A datum. The mean surface elevation as determined by averaging the heights of the water at equal intervals of time, usually hourly. Mean water level is used in areas of little or no range in tide. (10)

Natural

Composed of naturally occurring materials, or created, or appearing to have been created, by natural processes.

Navigable

Affording passage to a craft; capable of being navigated. (5)

Non-navigable
Not affording passage to a craft; incapable of being navigated. (5)

Permanent
Lasting or intended to last indefinitely. (6)

Ramp
A sloping structure that can be used as a landing place, at variable water levels, for small vessels, landing ships, or a ferry boat, or for hauling a cradle carrying a vessel. (6)

Rip Rap
A layer of broken rock, cobbles, boulders, or fragments of sufficient size to resist the erosive forces of flowing water and wave action. (6)

River Or Stream
A course of running water. (5)

Ruins
A structure in a decayed or deteriorated condition resulting from neglect or disuse; a damaged structure in need of repair. (5)

Shoreline/Alongshore Feature Boundary
The demarcation of the inland limit, along the SHORELINE, of an ALONGSHORE FEATURE.

Slipway
A prepared and usually reinforced inclined surface on which keel- and bilge-blocks are laid for supporting a vessel under construction. (6)

Undetermined
Of unspecified and/or unknown composition.

Wharf Or Quay
A structure serving as a berthing place for vessels consisting of a solid or open wall of concrete, masonry, wood, etc. (6)

<u>ALONGSHORE FEATURE</u>
An object that intersects, abuts, or is adjacent to and seaward of the shoreline.

Bare
Always dry; not covered at high water under average meteorological conditions. (6)

Breakwater

A structure protecting a shore area, harbor, anchorage, or basin from waves. (6)

Bridge

A structure erected over a depression or an obstacle such as a body of water, railroad, etc., to provide a roadway for vehicles or pedestrians. (5)

Covers/Uncovers Or Submerged

Covered at high water under average meteorological conditions.

Fender

A protective structure designed to cushion the impact of a vessel and prevent damage, for example, cushioning devices adjacent to bridges. (6)

Fixed

Attached to the land or seabed and having a permanent horizontal and vertical alignment. (6)

Floating

Resting on the surface of the water; buoyant. (8)

Footbridge

A bridge structure intended only for pedestrian traffic. (6)

Gate

A moveable barrier across an opening or passageway. (8)

Groin

A low artificial wall-like structure of durable material extending from the land to seaward for a particular purpose, such as to prevent coast erosion. (6)

Jetty

A structure built out into the water to restrain or direct currents, usually to protect a river mouth or harbor entrance from silting. (5)

Marine Railway

A track, usually sloping, for hauling a cradle carrying a vessel out of the water so that the hull can be exposed. (5)

Opening

Refers to a bridge, a portion of which moves to allow marine traffic to pass through the waterway it crosses. (6)

Pier

A long, narrow structure extending into the water to afford a berthing place for vessels, to serve as a promenade, etc. (6)

Pontoon

A floating structure, usually rectangular in shape used, for example, to support a bridge. (5)

Ruins

A structure in a decayed or deteriorated condition resulting from neglect or disuse; a damaged structure in need of repair. (5)

Training Wall

A wall or bank, often submerged, built to direct or confine the flow of a river or tidal current, or to promote a scour action. (6)

Under Construction

In the process of being built. (6)

Undetermined Alongshore Feature

Unspecified and/or unknown type of feature.

<u>OBSTRUCTION POINT</u>

In marine navigation, any object, such as a sunken rock or pinnacle, that hinders or prevents movement, particularly anything that endangers or prevents passage of a vessel. (6)

Bare

Always dry; not covered at high water under average meteorological conditions. (6)

Coral

The hard calcareous skeletons of many types of marine polyps. (6)

Covers/Uncovers

Periodically extending above and being submerged below the surface of the water. Also referred to as dries or uncovers. (6)

Mast

A straight vertical piece of timber or a hollow cylinder. (6)

Obstruction

An OBSTRUCTION POINT feature, the nature of which is undetermined or unspecified.

Rock

Any formation of natural origin that constitutes an integral part of the lithosphere. The naturally occurring material that forms firm, hard, and solid masses. (6)

Snag Or Stump

A tree, branch or broken pile embedded in the ocean floor, river, or lake bottom, forming thereby a hazard to vessels. (6)

Submerged

Always under water; covered by water at all times under average meteorological conditions. (6)

Wreck

The ruined remains of a vessel which has been rendered useless. (5)

<u>OBSTRUCTION LINEAR</u>

In marine navigation, any continuous, non-isolated danger that hinders or prevents movement, particularly anything that endangers or prevents passage of a vessel. (6)

Bare

Always dry; not covered at high water under average meteorological conditions. (6)

Covers/Uncovers

Periodically extending above and being submerged below the surface of the water. Also referred to as dries or uncovers. (6)

Crib

A permanent structure set in the water, framed with wooden beams and usually filled with rocks or boulders. A crib is generally used to anchor log booms or support other constructions, e.g. submerged outfalls, water intakes, etc. (6)

Dangerous

Perilous, hazardous, or unsafe to maritime navigation.

Fish Facility

A structure in shallow water related to the fishing industry. (6)

Fish Stakes

A group of poles or stakes placed in shallow water to outline a fishing ground or to catch fish. (6)

Fish Trap

A structure (usually portable) for catching fish. (6)

Floating

Resting on the surface of the water; buoyant. (8)

Floating Barrier

A structure resting on the surface of the water which may be used to constrain the movement of water-borne objects or materials.

Floating Drydock

An artificial basin, resting on the surface of the water and fitted with a gate or caisson, into which vessels can be floated and the water pumped out to expose the vessel's bottom. Also called graving dock. (5)

Hull

The main structure of a vessel. (1)

Log Boom

A device used to contain floating timbers.

Mineral

Relating to a structure associated with oil and gas exploration, production, etc.

Non-dangerous

Considered not perilous, hazardous, or unsafe to maritime navigation.

Observation

Relating to a structure which provides visual access to the surrounding area, e.g., a duck blind.

Obstruction

An OBSTRUCTION LINEAR feature, the nature of which is undetermined or unspecified.

Oil Barrier

A floating tube-shaped structure, with a curtain hanging under it, below the surface, which prevents the spread of oil. (6)

Permanently Docked Vessel

A ship or other marine vessel which is attached to a pier, wharf, etc., and which does not or is not intended to move. Examples could include museum ships or floating restaurants.

Platform

A structure erected on or over the seabed. (7)

Ruins

A structure in a decayed or deteriorated condition resulting from neglect or disuse; a damaged structure in need of repair. (5)

Submerged

Always under water; covered by water at all times under average meteorological conditions. (6)

Undetermined

An unspecified and/or unknown type of feature.

Wreck

The ruined remains of a vessel which has been rendered useless. (5)

<u>FREESTANDING MARINE FEATURE</u>

A fixed, isolated object consisting of an oblong member or group of members, and related to maritime functions.

Bare

Always dry; not covered at high water under average meteorological conditions. (6)

Covers/Uncovers

Periodically extending above and being submerged below the surface of the water. Also referred to as dries or uncovers. (6)

Dolphin

A post or group of posts used for mooring or warping a vessel, or as an aid to navigation. (6)

Pile

A long heavy timber or section of steel, wood, concrete, etc. forced into the earth, which may serve as a support, as for a pier, or a free standing pole within a marine environment. (6)

Ruins

A structure in a decayed or deteriorated condition resulting from neglect or disuse; a damaged structure in need of repair. (5)

Stake

A thin, elongated wood or metal pole embedded in the bottom to serve as a marker or support. (6)

Submerged

Always under water; covered by water at all times under average meteorological conditions. (6)

Tripodal

A single structure comprising 3 or more piles held together and forced into the earth or seabed. (6)

<u>LANDMARK</u>

Any fixed natural or artificial object, generally on land, which is prominent from seaward and can be used in determining a vessel's direction or position. The term excludes objects expressly erected for navigational purposes such as lights or daybeacons.

Chimney Or Stack

A vertical structure containing a passage or flue for discharging smoke and gasses. (6)

Cross

A monument, or other structure in the form of a cross. (6)

Dish Antenna

A parabolic antenna for the receipt and/or transmission of high frequency radio signals. (6)

Dome Or Cupola

A hemispherical or spheroidal structure rising from a building. (6, 7)

Flagpole

A staff or pole on which flags are raised. (6)

Flare Stack

A tall structure used for burning-off waste oil or gas. (6)

Grain Elevator

A structure used for storing grain. Usually a tall frame, metal, or concrete structure with a compartmented interior. (6)

Mast

A straight vertical piece of timber or a hollow cylinder. (6)

Other

Of an unspecified nature.

Recommended Landmark

A fixed object which may be of value for inclusion on a NOAA nautical chart, since it may be useful in determining a vessel's direction or position.

Silo

A cylindrical tower used for storing fodder or grain. (6)

Spire Or Minaret

A tall conical or pyramid-shaped structure often built on the roof or tower of a building, especially a church or mosque. (6)

Tank

A fixed container generally used for storing liquids. (6)

Tower

A relatively tall structure which may be used for observation, support, storage, communication, etc. (6)

Water Tower

A tower with an elevated container used to hold water. (6)

Windmill

A wind driven system of vanes attached to a tower-like structure (excluding wind-generated power plants). (6)

AID TO NAVIGATION

A fixed, man-made structure or device designed to assist in determining a vessel's position and safe course, and to warn of dangers or obstructions.

Daybeacon

An unlighted, fixed structure which is equipped with a daymark (a marker presenting one of several standard shapes and colors) for daytime identification. (3)

Lighthouse

A building on some conspicuous point of the coast, a pier or jetty, an island or rock, from which a light is exhibited at night as an aid to navigation. (7)

Marine Light

A luminous device which may be used at night or in poor visibility to assist in maritime navigation.

Pile

A long heavy timber or section of steel, wood, concrete, etc. forced into the earth, which may serve as a support, as for a pier, or a free standing pole within a marine environment. (6)

Tower

A relatively tall structure which may be used for observation, support, storage, communication, etc. (6)

Tripodal

A single structure comprising 3 or more piles held together, and forced into the earth or seabed. (6)

CULTURAL FEATURE MISCELLANEOUS

Any man-made object which may be of importance to the mariner, but is not included in other classes.

Aerial Cable

Overhead cables supporting buckets, cable cars, etc. (6)

Building

A relatively permanent structure, roofed and usually walled, designed for some particular use. (6)

Cable

An assembly of wires or fibers, or a wire rope or chain. (6)

Conveyor Belt

A moving chain or band along which material or people are transported. (6)

Dam

A barrier to hold back water and raise its level to form a reservoir, or to prevent flooding. (6)

Fence

A man-made barrier used as an enclosure or boundary, or for protection. (6)

Ferry Cable

The guide cable for a ferry that follows a fixed route. (6)

Fort

A fortified structure, building, or partition able to be defended against an enemy. (6)

General Transport

A device used in the movement of materials or people.

Grain Elevator

A structure used for storing grain. Usually a tall frame, metal, or concrete structure with a compartmented interior. (6)

Levee Or Dike

An artificial embankment to contain or hold back water. (6)

Overhead

Refers to an object which is supported by pylons and passing over or nearby navigable waters.

Pipeline

A string of interconnected pipes used for the transport of matter, usually oil or gas. (5)

Silo

A cylindrical tower used for storing fodder or grain. (6)

Submerged

Always under water; covered by water at all times under average meteorological conditions. (6)

Submerged Or Surface

Refers to an object which lies at or below the water level, or upon the land.

Tank

A fixed container generally used for storing liquids. (6)

Wall

A fence constructed from masonry or stone. (6)

Water Tower

A tower with an elevated container used to hold water. (6)

TRANSPORTATION

The means of carrying, moving, or conveying from one place to another. (8)

Abandoned

No longer used for the purpose intended; disused. (7)

Helicopter Pad

A small designated area, usually with a prepared surface, on a heliport, airport, landing/takeoff area, apron/ramp, or movement area used for takeoff, landing, or parking of helicopters. (9)

Path

A way or track for walking or light vehicle traffic. (6)

Railroad

A set of parallel rails on which a train or tram runs. (8)

Road

An open way with a prepared surface for the passage of vehicles. (6)

Runway

A defined rectangular area on a land airport prepared for the landing and takeoff run of aircraft along its length. (9)

Tunnel Entrance

The visible terminus of a passage that is buried under the seabed, laid over the sea floor, or bored under the ground. (6)

NATURAL FEATURE MISCELLANEOUS

Any non-man-made object which may be of importance to the mariner, but is not included in other classes.

Cliff Or Bluff

A line marking the top of a slope that rises abruptly for a considerable distance above the water or surrounding land. (6)

Extent

The spatial limits of an area feature.

Glacier

A mass of snow and ice continuously moving from higher to lower ground or, if afloat, continuously spreading. (6)

Intermittent

Recurring at intervals. (6)

Landslide

The scar left by a mass of land which has slid down a steep slope; may include the mass of land which has also slid. (6)

Lava

The substance that results from the cooling of molten rock. (6)

Mangrove Or Cypress

An area composed of one of several genera of tropical trees or shrubs which produce many prop roots and grow along low lying coasts in shallow water; or a deciduous conifer which thrives in swamps and tidal flows, and is found primarily in the coastal tidewaters of the Gulf of Mexico in Florida and Mississippi. (6, 11)

Marsh Or Swamp

An area made up of spongy land saturated with water. It may have a shallow covering of water, usually with a considerable amount of vegetation appearing above the surface. (6)

Moraine

Any accumulation of loose material deposited by a glacier. (6)

Perennial

Lasting indefinitely; enduring. (8)

Rapids

Any portion of a stream with accelerated current, descending rapidly, but without a break in the slope of the bed sufficient to form a waterfall. (5)

Sand Dune

A mound, ridge, or hill of drifted sand along the coast. (6)

Stream

A course of running water. (5)

Waterfall

A sudden descent of water over a step in the bed of a river. (6)

<u>DANGER AREA</u>

A spatial extent in the marine environment which may contain hazards or perils to maritime navigation.

Bare

Always dry; not covered at high water under average meteorological conditions. (6)

Breakers

Waves that break over areas of shallow water. (6)

Covers/Uncovers

Periodically extending above and being submerged below the surface of the water. Also referred to as dries or uncovers. (6)

Foul

An area of numerous unidentified dangers to navigation which are not individually located . (6)

Ledge

A rocky formation continuous with and fringing the shore. (6)

Reef

A rocky or coral elevation dangerous to surface navigation which may or may not uncover at the sounding datum. A rocky reef is always detached from shore; a coral reef may or may not be connected with the shore. (7)

Shallow

An area composed of unconsolidated material where the depth of water is relatively less than its surroundings. (5)

Shoal

An offshore hazard to surface navigation that is composed of unconsolidated material. (6)

Submerged

Always under water; covered by water at all times under average meteorological conditions. (6)

Wreckage

The scattered remains of one or more stranded or sunken vessels.

<u>AQUATIC VEGETATION AREA</u>

A spatial extent in the marine environment characterized by the presence of living plant matter which in its natural form grows under water or is inundated with water.

Grass In Water

A non-woody stemmed vascular plant (which may or may not be a true grass) which is attached to the bottom below the sounding datum. (7)

Kelp

A giant plant sometimes 60 meters long with no roots, it is anchored by hold-fasts or tendrils up to 10 meters long, that cling to rock. Gas filled bubbles on fronds act as floats keeping the kelp just below the surface. (6)

Sea Grass

Marine flowering plant which usually grows in shallow, subtidal, or intertidal unconsolidated sediments. Eelgrass is one of the best known examples. (4, 6)

<u>CONTOUR</u>

A line connecting points of equal value.

Accurate

A modifier that indicates contours delineated in a regular, sufficiently controlled survey of any date. Contour features with no accuracy modifier should be considered **Accurate** unless specified **Approximate**. (6)

Approximate

A modifier that indicates a contour which does not meet the definition of **Accurate**, but is generally considered to be within 100 feet (30.5 meters) of its correct geographic location. Used to denote contours obscured by shadows or line-of-sight blockage, such as under bridges. (6)

Depth Contour

A line connecting points of equal water depth. (6)

Elevation Contour

A line connecting points of equal elevation. (5)

<u>VERTICAL MEASUREMENT</u>

An expression of the distance of an isolated point above or below a specified datum. (6)

Coral

The hard calcareous skeletons of many types of marine polyps. (6)

Obstruction

In marine navigation, any object, the nature of which is undetermined, that hinders or prevents movement, particularly anything that endangers or prevents passage of a vessel.

Rock

Any formation of natural origin that constitutes an integral part of the lithosphere. The naturally occurring material that forms firm, hard, and solid masses. (5)

Sounding

Measured or charted depth of water. (5)

Spot Elevation

A measured point indicating the height above a specified vertical datum. (5)

Wreck

The ruined remains of a vessel which has been rendered useless. (5)

<u>CARTOGRAPHIC LIMIT</u>

A user-defined line drawn for cartographic convention or due to source data limitations.

Feature Limit

The extent of feature delineation.

Low Visibility Limit

The extent of compilation restrictions due to an obscured or inadequate data source.

Source Data Limit

The extent of the data source used for compilation.

User Added Line

A connection of linear features created during the GIS processing to eliminate gaps for the purpose of maintaining continuity.

REFERENCES

The following is a list of sources from which many of the definitions in this glossary were derived. The number in parentheses following a definition refers to the numbered entries below. The absence of a number after a definition indicates that the term was defined by National Geodetic Survey/Remote Sensing Division personnel.

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Version 1A
January 28, 2008

ATTACHMENT G
~~E-MAIL~~ WEEKLY STATUS REPORT

TO
SCOPE OF WORK FOR SHORELINE MAPPING
UNDER THE
NOAA COASTAL MAPPING PROGRAM

REMOTE SENSING DIVISION
NATIONAL GEODETIC SURVEY
NATIONAL OCEAN SERVICE
NATIONAL OCEANIC & ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE

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ATTACHMENT G: WEEKLY STATUS REPORT

1.GENERAL

1.1 Format - The Prime Contractor shall submit project status reports via TOMIS every Monday by 2:00 PM Eastern Time, from the date of a Task Order award until the work is complete and accepted by NGS. These reports shall show the status of each Deliverable in order to help track the progress. A suggested format is shown below (the percent complete and date are required).

Submit the status report to TOMIS as an attachment in MS Word, MS Excel, or PDF format. The table boxes shown below are not required, but ensure that the information is in columns so that it is more readable.

Prime Contractor Firm Name:____
Sub-Contractor(s) Firm Name:____

Project ID & Location Dates:	TX0401/South TX (sample)	CA0401/SF Bay Area (sample)
Date Task Order Awarded		
Date Project Due		

Project ID Project Deliverables	TX0401 (Approx. % Complete)	Date Complete or Planned Complete	CA0401 (Approx. % Complete)	Date Complete or Planned Complete
Deliverable #1	100%	1 MAR 05		
Deliverable #2	75%	1 APR 05		
Deliverable #3		1 MAY 05		
Deliverable #4		1 NOV 05		
Etc.		1 DEC 05		
Overall Completeness		15 DEC 05		

1.2 Sample percentages and dates filled in above.

1.3 Include the above information for each project underway; add 2 columns for each project.

1.4 Flag entries that have been changed from the previous week.

2. DELIVERABLES SUBMITTED - List deliverables submitted

3. FUTURE PLANS - Briefly state plans for the coming week.

4. COMMENTS - Include comments/unusual circumstances/approved modifications from this SOW or Project Instructions.

Version 2
September 30, 2004

ATTACHMENT H
EED FILE CHECKING PROGRAMS

TO
SCOPE OF WORK FOR SHORELINE MAPPING
UNDER THE
NOAA COASTAL MAPPING PROGRAM

REMOTE SENSING DIVISION
NATIONAL GEODETIC SURVEY
NATIONAL OCEAN SERVICE
NATIONAL OCEANIC & ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE

ATTACHMENT H: EED FILE CHECKING PROGRAMS

EED-Checking Program

This software, entitled “Shoreline Check.exe”, is used to help ensure that the EED files are in the correct NGS format. In the software, fields and portions of fields are tested for minimum and maximum allowable values, for the type of data (alpha or numeric), the number of characters, correct punctuation, etc. This software will not catch all problems with an EED file, so other checking needs to be done. Another excellent test is to plot the photograph’s outlines using a footprint-plotting program. Plotting the footprint will enable checking of the position and azimuth fields of the EED file, and the photographic coverage of the project area.

A few useful steps/hints to follow:

1. This program must be placed in the same folder as the file you are checking.
2. To execute the program simply double click it.
3. Type in the complete name of the file you are checking, including the extension
4. Type in the output name of your choice, include an extension such as “.txt” so it is easily viewable.
5. When a mistake is found the program will ask you if you want to correct the mistake and then will show you the correct format that it needs to be in. Simply type in the correction and press enter.
6. Keep correcting the errors until the program tells you the corrected file name and asks if you would like to check another file.
7. You may want to recheck the corrected file when you are complete as you may have typed a mistake when typing .

This program may still have a few bugs in it. If you experience anything strange while checking a file, please send the file in an e-mail to us so that we may try to figure out the problem. If you are able to figure it out for yourself, please draft an e-mail to us so that we may fix the problem and send out a new version of the program.

EED-Viewer Program

This program allows the end user to view the photographic footprint plots of their photography. The program currently does not have the capability to load a background map, however, it possibly will in future versions. The contractor shall use this program to check the EED file's azimuth record before submission to NGS.

The instructions for installation of the program are fairly standard:

1) Unzip the program file
2) Run setup.exe
3) Follow the installation instructions

The program functions are fairly straightforward. Below are basic instructions for use of the program:

- Open the program by double clicking the icon
- File Tab
  - Click Load EED file
  - Navigate to the EED file on your hard drive; NOTE: The program will only open files with the ".eed" extension
  - Click Exit to close the program
- Settings Tab
  - Click Properties
  - Under this heading there are multiple settings that can be chosen
  - Under the emulsion section of the Properties function choose the emulsion type (Pan, IR, Color, Color IR) that you would like to view; Note: It is best to leave all options checked as this function sometimes does not always work properly.
  - Under the Frames section of the Properties function choose what you would like to view on the display, i.e. the footprints, flight lines, or photo centers. All three can be displayed or you may pick and choose what you like.
  - Under the Highlighted section of the Properties function choose what you would like to be highlighted when clicking in the main screen.
  - Apply and accept changes, then Exit
- Units Tab
  - Click Cursor
  - Choose the format in which you would like the Latitude and Longitude displayed. The Latitude and Longitude are then shown at the bottom of the main screen in the format chosen. Note: this format can be changed as many times as needed.
- General Function
  - Right clicking anywhere on the main screen or overview screen will give you the option to Pan, Identify, Print, Zoom In (2X), or Zoom Out.
    - If the Identify button is clicked, the properties of the frame are shown in the boxes of the "selected frame" area under the overview screen.

        - All of these functions, except Print, are available as clickable buttons above the overview screen on the right of the main screen.
    - The Identify, Pan, Zoom In, and Zoom Out functions work on both the small overview screen and the main screen. For instance, if you use the Zoom function in the overview screen it zooms in on the main screen, but not on the overview screen. The overview screen always stays the same, however, it is clickable and functions will be reflected in the main screen.
    - Under the selected frame box on the overview screen you can choose what is highlighted by frame. You can choose None, Frame Only, or Flight Line. The Frame Only function highlights only the frame. The flight line highlight highlights all frames in the flight line. This differs from the options under the Settings tab. The highlight options under the Settings tab do not highlight in this fashion. They simply outline the image, flight line, or photo center. The selected frame highlight fills either the frame or the flight line of the frame.

The above directions should provide a general overview of how this program functions. If you have any problems or discover an error in the program please contact the Points of Contact listed in the main body of this Scope of Work. This program is in its early stages of development and any suggestions for improvement are welcome.

Version 2
September 30, 2004

ATTACHMENT I
AEROTRIANGULATION

TO
SCOPE OF WORK FOR SHORELINE MAPPING
UNDER THE
NOAA COASTAL MAPPING PROGRAM

REMOTE SENSING DIVISION
NATIONAL GEODETIC SURVEY
NATIONAL OCEAN SERVICE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE

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ATTACHMENT I: AEROTRIANGULATION

1. AEROTRIANGULATION METHODS

The process of analytical aerotriangulation (AT) was developed as a time and cost efficient method of extending a sparse network of horizontal and vertical control throughout a large block of photographs. Aerotriangulation utilizes a rigorous mathematical adjustment process of simultaneous resection and intersection of image rays, based upon measured photo coordinates, control coordinates, and camera parameters. The control used is typically in the form of surveyed ground points, but may also include directly measured exposure station coordinates, as from the Global Positioning System (GPS) and/or an Inertial Measurement Unit (IMU); or may even include known geometric parameters of line and area features measured in the images.

1.1. STANDARD INDUSTRY PRACTICES - The use of overlapping, near-vertical photographs, taken with a calibrated, metric, aerial mapping camera is standard practice in the industry, and is normally required for work under this contract. The process of aerotriangulation is well understood and commonly practiced throughout the mapping industry, thus the detailed techniques involved will not be explained here. The contractor shall follow the standard and accepted practices of analytical aerotriangulation (whether film based or digital) with all blocks of images (both IR and Color) used for the shoreline mapping project. The contractor shall utilize the latest camera calibration data when performing aerotriangulation to properly account for any distortions in the interior orientation of the camera system. All fiducial marks on every image shall be measured, and the root-mean-square (RMS) error should normally not exceed 15 microns.

1.2. SUBDIVIDING BLOCKS - If necessary, the contractor can divide the project photography into sub-blocks for aerotriangulation purposes. This might be desirable, for instance, when different areas of the project have different accuracy requirements. Dividing a project into sub-blocks should not be done as a matter of course, however, but only if time and cost efficiency savings would result. The contractor shall perform a separate analytical adjustment and accuracy assessment for each sub-block.

1.3. SYSTEM REQUIREMENTS - The photogrammetric software used must be capable of outputting the horizontal (X and Y) RMS values of the standard deviations for each measured ground point, including all pass points and tie points. These values are required to compute the accuracy for each photogrammetric block (see Section 6.D).

2. SHORELINE MAPPING ISSUES

A number of issues associated with shoreline mapping can significantly affect the quality of the AT solution, and must be taken into account when planning the photogrammetric project.

2.1. FLIGHT LINE LAYOUT

A. FOLLOWING THE COAST - Aerial surveys for shoreline mapping projects typically have flight lines that are not laid out in large parallel blocks typical of other mapping projects, but are designed to follow the meandering coast using shorter strips oriented parallel to the shoreline. The curves of the coast are covered by short segments intersecting at their ends, often at angles as shallow as twenty degrees.

B. PARALLEL STRIPS - Since NGS began using airborne kinematic GPS positioning to reduce the need for ground control, shoreline projects have been planned to avoid single strips, in favor of parallel overlapping pairs of strips. Parallel strips improve the geometric stability of the aerotriangulation, avoiding the need to add additional ground control points.

2.2. WATER AREAS

A. POINT DISTRIBUTION - Shoreline mapping photographs typically have large areas of the image showing mostly water, and very little land areas on which suitable ground points can be measured. In some areas of the country, especially Alaska, the coastal areas can be heavily forested making point measurement on the ground difficult as well. It will usually not be possible to measure points in an ideal pattern (evenly distributed throughout each frame) and the aerotriangulation will be somewhat weaker as a result.

B. SUN GLARE - The large water areas in shoreline photography often leads to a sun glare problem on many of the images. Sun glare can cause severe exposure problems in an image with overly bright or completely saturated areas in the water. The camera or film processing will sometimes overcompensate for the glare, causing excessively dark areas on nearby land or other parts of the image. It is often difficult or impossible to measure ground points in areas affected by sun glare. Careful flight line planning will take into account the elevation and azimuth of the sun in relation to the water areas, and how the relationship changes during the scheduled aerial survey mission.

3. CONTROLLING THE IMAGERY

3.1. USE OF GLOBAL POSITIONING SYSTEM (GPS) - The contractor is required to use standard airborne kinematic carrier-phase differential GPS positioning techniques to accurately determine the X, Y, and Z coordinates of the camera station at the time of each exposure (see Attachment C, Section 13). The purpose of this requirement is to reduce the number of photo control points needed to perform the aerotriangulation. This reduction of control points should, in turn, reduce the cost of the ground control survey portion of the project. The contractor shall incorporate these appropriately weighted GPS camera coordinates into the analytical block adjustment. Care shall be taken to account for the correct offset between the aircraft's GPS antenna and the external nodal point of the camera. This offset is normally incorporated as a parameter in the aerotriangulation to account for the variable orientation of the aircraft and camera with respect to the GPS coordinate system, but if the orientation angles are directly measured (as with an IMU) then the offset is often applied to the camera station coordinates prior to aerotriangulation.

3.2. USE OF INERTIAL MEASUREMENT UNIT (IMU) - Modern airborne navigation systems have been developed that utilize high-accuracy Inertial Measurement Units (IMU) to provide position and orientation information. When used as a stand-alone system, an IMU derived position will tend to drift over time, accumulating errors. When integrated with accurate GPS positioning however, both systems can work together to provide highly accurate position and orientation parameters for aerial photographs. Though they may not be accurate enough to directly determine the exterior orientation elements required for photogrammetric mapping, these parameters can be incorporated into the analytical block adjustment to further reduce the requirement for photo control points. This is especially useful in portions of the imagery covering large areas of water or forest, with limited clear land visible for measuring reliable pass points or locating good control points.

The use of IMU data to determine position and orientation parameters of film-based camera stations is not normally required, but it is permitted, and is encouraged when time and cost efficiency savings would result. The use of IMU data with film or digital cameras does not remove the requirement for a full analytical aerotriangulation to ensure the highest accuracy and quality control. Certain other remote sensing systems (Hyperspectral, LIDAR, IFSAR, etc.) may require the use of an integrated GPS/IMU system for their general operation.

3.3. GROUND CONTROL POINTS - The contractor shall determine whether or not ground control points are required, and if so, the number and locations of the points necessary to adequately supplement the required airborne GPS control.

3.4. PHOTOGRAMMETRIC CHECK POINTS - As part of the Ground Control Survey the contractor is required to locate and position at least four independent photo-identifiable check points for each block (or sub-block) of the project, see SOW Section 6.2. These points shall be measured in the aerotriangulation, but **shall not** be held as control in the final analytical adjustments. The differences between the check point coordinates determined by the Ground Control Survey and the coordinates from the final aerotriangulation adjustment shall be included in a table in the Aerotriangulation Report.

4. AEROTRIANGULATION REPORT FORMAT

The Aerotriangulation Report consists of a few pages of narrative describing the project and the work performed during the aerotriangulation phase, and a number of annexes showing a geographic depiction of the stereo coverage, ground control, flight lines, error distribution of adjusted points, and the computation of horizontal accuracy. The report should be written soon after the aerotriangulation work is complete, so that the details are still fresh in the mind of the photogrammetrist. See the sample AT Report in Annex 1

4.1. TITLE - The AT Report shall have a title section near the top of the first page that includes the words “Aerotriangulation Report”, along with the Project Identifier and the date (month and year) the report was completed, as in the following example:

Aerotriangulation Report
VA0101
July 2001

4.2. AREA COVERED - This section shall contain a brief description of the limits of the project area. The description should include place names, and latitude and longitude (to nearest minute) as required. Include a reference to the AT Report's Annex 1 - Project Coverage Diagram.

4.3. IMAGERY - This section shall contain descriptive information for the images used in the aerotriangulation, including:

- Number of images used in the AT
- Number of strips
- Type of emulsion(s)
- Scale(s) of strips
- Date(s) of images
- Source(s) of the images (government or contractor)
- Camera(s) used
- Tide coordination (mean high water, mean lower low water, or non-tide coordinated)

Also include a statement regarding the adequacy of the imagery for aerotriangulation. Factors which should be considered in the adequacy statement include: coverage, exposure, resolution, overlap, metric quality, and quality of scans (or diapositives). Any unusually large distortions discovered during fiducial measurement (RMS greater than 15 microns) should be discussed in this section. Include a reference to the AT Report's Annex 2 - Flight Line Diagram.

4.4. CONTROL - This section shall indicate what type(s) of control were used in the AT. Include in the discussion any unusual difficulties or problems related to controlling the aerotriangulation.

A. AIRBORNE GPS/IMU - Discuss the overall adequacy of using GPS and/or IMU to control the block adjustment. Include a reference to the Airborne Positioning and Orientation Report for further details. (See Attachment C, Section 13.4)

B. GROUND CONTROL - Discuss the adequacy of surveyed ground control points (horizontal and vertical) to supplement the GPS control of the block adjustment. Include any additional vertical control determined from water levels. Include a reference to the Ground Surveys Report. (See Attachment O, Section 13)

4.5. METHODOLOGY - This section shall state whether analytical, or softcopy equipment was used in the AT. Briefly describe AT methodology including: hardware and software versions used, block vs. strip adjustment, whether or not automatic tie point generation was used, the pixel size of the scans, and other significant information.

4.6. ANALYSIS OF RESULTS - This section shall discuss the analysis of each adjustment. Discuss any deviations from standard procedures or specifications, and comment on any rejected or removed points. This section shall include a comparison between the adjusted AT results and the surveyed photogrammetric check points. The contractor shall state the overall horizontal accuracy of the final block adjustment at the 95% confidence level, in meters rounded to the nearest tenth, as computed in Annex 4. This value should be less than or equal to half of the allowed final accuracy for the project. A senior photogrammetrist should review no fewer than 10% of the stereo models to insure the horizontal and vertical integrity of the AT solution. The models reviewed should be evenly distributed throughout the project and should include models at the intersection of flight lines. List the models reviewed and discuss the suitability of the database for use in compilation. If the project was divided into sub-blocks, a separate analysis and accuracy statement shall be provided for each adjusted block. Include a reference to the AT Report's Annex 3 - Horizontal Standard Deviations Diagram if one was prepared.

4.7. PROJECT DATABASE - The Project Database is the collection of data files and other information required for and resulting from the aerotriangulation phase of the project. This section of the report shall state that a Project Database exists and includes most, if not all, of the following data files and other information:

- Project identifier
- Camera calibration data
- Interior orientation parameters for each frame
- Adjusted coordinates of all measured points
- Ground Control File (See 5.1)
- Refined Image Points File (See 5.2)
- Airborne GPS Control File (See 5.3)
- IMU Orientation Angles File (If applicable, see 5.4)
- Adjusted exterior orientation parameters for each frame (See 5.5)
- Horizontal and vertical datums, coordinate system, and projection used

4.8. ANNEXES - All annexes in the AT Report shall be page size (8.5" x 11") and shall include a title (ex. "Project Coverage Diagram") and the Project Identifier (ex. "VA0101"). Annexes 1 and 2 shall include an uncluttered map base which contains a grid of latitude and longitude, a simple shoreline, and the names of a few major geographic features (from the NOAA nautical chart, if possible). Additional requirements for each annex are below.

A. ANNEX 1 - PROJECT COVERAGE DIAGRAM - This diagram shall depict an outline of the approximate stereo coverage of the images used in the aerotriangulation. This diagram shall also depict and label the ground control points (if any) and the photogrammetric check points used.

B. ANNEX 2 - FLIGHT LINE DIAGRAM - This diagram shall depict the project flight lines including the flight line IDs, starting and ending image IDs for each line, and tick marks or dots at each image center along the lines. This diagram shall also include a table with a row for each flight line and a column for each of the following:

- Flight Line ID
- Film Roll ID
- Starting and Ending Image IDs
- Date Flown

C. ANNEX 3 - HORIZONTAL STANDARD DEVIATIONS DIAGRAM - This diagram shall depict the error ellipses for the horizontal standard deviation for all triangulated ground points. Include a graphic scale for the ellipses (for example, a circle plotted at the same scale as the ellipses indicating a horizontal error of 1.0 meters.) In addition, the diagram should show the image footprints, or, for large projects, an outline of the image coverage, if doing so will not overly clutter the diagram. This diagram is optional if the contractor's photogrammetric software does not include the capability of plotting error ellipses.

D. ANNEX 4 - HORIZONTAL ACCURACY COMPUTATION - The Horizontal Accuracy Statement reported in the Analysis Of Results section is based on the predicted circular horizontal accuracy of all adjusted points in the aerotriangulation solution. This circular accuracy equals the radius of the 95% confidence circle as calculated from the horizontal (X and Y) root-mean-square (RMS) values of the standard deviations for all triangulated points, and rounded to the nearest tenth of a meter. For a well designed and executed photogrammetric project, this value should approximate the predicted horizontal accuracy standard of one part in 10,000 of the flying height [ex. 0.5 m at 5000 m (16400 ft.) flying height.] This Annex demonstrates the calculation procedures, and explains the computational methods. The 95% confidence circle radius shall be computed for each block, if more than one photo block was adjusted separately.

See the following example for guidance on how to compute a 95% confidence circle radius:

The root mean square of all standard deviations of triangulated ground points:

RMS(x) = 0.416 meters RMS(y) = 0.337 meters

The value for the confidence circle radius is given by the following expression:

$$R = K * Sx$$

where Sx is defined as the larger of the two (X and Y) RMS values (0.416 m. in this case), and K is interpolated using the C ratio from the Table of Cumulative Probability.

The C ratio equals the smaller of the RMS values divided by the larger:

C = 0.337 / 0.416 = 0.810 in this example

The following line (95% probability level) from the Table of Cumulative Probability was used to determine the value of K by a simple linear interpolation between the two nearest values of C:

C	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
K (95%)	1.95996	1.96253	1.97041	1.98420	2.00514	2.03586	2.08130	2.14598	2.23029	2.33180	2.44775

*K = 2.23029 + [(0.81-0.80)/(0.90-0.80) * (2.33180 - 2.23029)]*
*= 2.23029 + (0.1 * 0.10151)*
= 2.23029 + 0.01015 = 2.24044
K = 2.24
*R = K * Sx = 2.24 * 0.416 = 0.932*

The Radius of the 95% Confidence Circle = 0.9 meters

<u>5. AEROTRIANGULATION DATA FILES</u>

Certain data files used for and resulting from aerotriangulation of the imagery (see Section 4.7 Project Database) shall be delivered on CDROM with the Aerotriangulation Report. These data files shall not be printed, as many are rather large, but rather shall be delivered in the ASCII formats defined below. There is no preferred directory structure or naming convention for the files, but the contractor should organize the files on the CD into a sensible structure using a systematic and defined folder and file naming convention.

5.1. GROUND CONTROL FILE - The ground control file is an ASCII file, which lists all of the ground control points used in the project. The control file is restricted to one ground point per line. Each ground point contains a point ID along with X, Y, Z coordinates. This information can be in any order; however, it is preferred to have it in the order of Point ID, X, Y, and Z. Data fields must be separated by spaces; do not use commas. Ground point control types of horizontal, vertical, or both (full) will be identified in the file by placement of an exact value of 0.0 in the field that is unknown. If a point is listed as 0.0 0.0 3.0, the point is considered a vertical (Z only) control point. If a point is listed as 123456.0 345678.0 0.0, the point is considered a horizontal (X and Y only) control point. If a point lists non-zero coordinates for all three fields, the point is considered a full (X, Y, and Z) control point.

The ground point coordinate system can be Geographic, UTM, or State Plane. For geographic coordinates the units can be either decimal radians, or degrees-minutes-seconds. Degrees-minutes-seconds shall be entered as “+-DDD:MM:SS.SSS.” The presence of two colons is mandatory. For grid coordinates (UTM or State Plane) the units can be either feet or meters. In any case, the coordinate system in the ground point file must match the coordinate system in the Project Database. A sample Ground Control File is shown below:

```
PT1         941588.193  535343.375  3.00
PT2         935742.625  511980.691  3.34
PT3         924011.881  534891.451  2.03
V001        0.0                0.0  5.71
V002        0.0                0.0  4.63
H3836A      931603.992  526800.789  0.0
H3849A      934509.600  506828.869  0.0
H3878A      941718.861  521547.665  0.0
18102       929399.754  512024.524  -2.55
18101       928988.370  512663.612  1.38
18103       930077.219  511370.631  -1.24
18121       920153.273  514176.910  5.14
```

5.2. REFINED IMAGE POINTS FILE - This image point file contains the refined image coordinates in the PATM format. This is an ASCII file which lists all the Image IDs, Image Point IDs, and the X and Y image coordinates for each point. The Image IDs are limited to ten characters. The image point coordinates (x_um and y_um) must be in micrometers. A minimum of one space is required between fields. The fields labeled “dummy” following the Image IDs must be present but are ignored. The file is column independent except for the 10-character Image ID which must be in the first 10 columns of the first line of each image frame. Each image frame, including the last frame, must end with a line containing only the characters “-99”. The general format and a sample Refined Image Points File is shown below:

image_id1 dummy
point_id1 x_um y_um
point_id2 x_um y_um
...
point_idn x_um y_um
-99
image_id2 dummy
point_id1 x_um y_um
point_id2 x_um y_um
...
point_idn x_um y_um
-99
image_idn dummy
point_id1 x_um y_um
point_id2 x_um y_um
...
-99

```
    1_3810 0
  pp1     -46609      89166
18102     -32454      95721
18103     -17309     107643
18121    -103229     -88088
18122     -96008      -0785
18123     -80036      77483
28411     -87158      41403
28431      10230     111453
-99
    1_3812 0
  pp1      38662      83506
18102      52730      90647
18103      67695     103351
18121     -11068     -95917
18122      -6597      -9288
18123       5199      70547
28431      95517     108070
18141     -88978     -91060
18142     -90758     -64152
18143     -98706     -26223
-99
    1_3814 0
18121      77016    -101928
18122      83115     -16365
18123      94622      63874
18141       0025     -97260
18142      -1735     -70785
18143      -9746     -33250
28414      62097      79090
18161     -88832     -80210
18162     -89594       8354
18163     -96513      97905
-99
```

5.3. AIRBORNE GPS CONTROL FILE - The Airborne GPS Control File contains antenna coordinates for each image, given in a ground coordinate system, with the time of the exposure. Also included are the offset vector between projection center and antenna center given in the camera coordinate system, and the standard deviation (sigmas) of the computed antenna centers. To compensate for certain systematic effects, the time of the exposure is needed for each antenna center. The file with antenna coordinates must be an ASCII file with each data entry separated by at least one space character. Note, to minimize the influence of the crab angle on the offset vector, the antenna should be mounted above the camera.
The GPS file shall have the following format:

SigmaX	*SigmaY*	*SigmaZ*		
OffsetX	*OffsetY*	*OffsetZ*		
Strip#_Image#	*X*	*Y*	*Z*	*time*
Strip#_Image#	*X*	*Y*	*Z*	*time*
Strip#_Image#	*X*	*Y*	*Z*	*time*
separation line				
Strip#_Image#	*X*	*Y*	*Z*	*time*
Strip#_Image#	*X*	*Y*	*Z*	*time*
…				

The sigmas shall be given in units of the ground control system. The offset vector between projection center and antenna center is given in the camera system in units of the ground control system. The origin is the projection center of the camera. The separation line must start with the dash character (-). Therefore, the image IDs must not start with the dash character. If the separation line contains two entries, the second one is used to distinguish between profiles or strips. If it is a '0', then a new strip begins, but not a new profile. If it is a '1', then a new profile begins. A profile may span several strips or a strip could also have several profiles.

With the exception of the first two lines, this file format is also the input format for PATB GPS. If a GPS post processing software can create a file for PATB GPS this can be easily edited by adding the standard deviation a priori values and offset vector to the beginning. A sample Airborne GPS Control File is shown below:

```
0.1  0.1  0.1
0.824  -0.632  2.561
1_001    95163.095  108713.446  1491.274  158572.278
1_002    95926.540  108707.461  1489.148  158584.234
1_003    96691.574  108696.921  1485.680  158596.287
1_004    97452.224  108697.465  1490.618  158608.347
1_005    98217.473  108701.708  1489.599  158620.429
1_006    98990.130  108712.875  1484.036  158632.490
1_007    99760.962  108729.933  1487.206  158644.562
1_008   100528.878  108721.784  1487.500  158656.608
1_009   101299.687  108697.050  1486.199  158668.680
1_010   102071.151  108665.098  1485.016  158680.763
-qqq  1
2_026   115106.914  107316.137  1480.266  159282.853
2_025   114240.398  107312.185  1480.149  159296.815
```

```
2_024   113372.536   107318.571   1480.374   159310.787
2_023   112495.617   107325.892   1486.163   159324.883
2_022   111615.037   107334.265   1486.104   159339.274
2_021   110734.205   107357.527   1488.943   159353.659
2_020   109854.396   107370.690   1490.251   159368.022
```

Note: The time shall be in chronological ascending order and shall be in seconds. There shall be at least two images in each GPS strip (i.e. between separation lines).

5.4. IMU ORIENTATION ANGLES FILE - This file contains the angles which transform the axes of the ground system into the axes of the camera system by simple rotations Omega, Phi and Kappa. The angles needed are the exterior orientation angles used by photogrammetry. Also included are the standard deviations (sigmas) of the angle observations. The units of the angles may be either grads or decimal degrees, but they should correspond to the angle units used in the Project Database. The file with IMU angles shall be an ASCII file with each data entry separated by at least one space character. The general format and a sample IMU Orientation Angles File are shown below:

Strip#_Image#   Omega   Phi   Kappa   SigmaOmega   SigmaPhi   SigmaKappa
...

```
2_14  -0.38425   0.13713   97.45835   0.00100  0.00100  0.00100
2_12   0.16211  -0.04376   98.83179   0.00100  0.00100  0.00100
2_10   0.80612   0.52176  101.15521   0.00100  0.00100  0.00100
2_8   -1.49483  -2.28511   98.78287   0.00100  0.00100  0.00100
```

5.5. ADJUSTED EXTERIOR ORIENTATION FILE - This file contains the results of the triangulation that has been performed for a block of images in a simple ASCII text format. This is the most important file of the aerotriangulation deliverables as it will be used by the government to position and orient the project images for review. The other files will be used only if the government decides it is necessary to redo the aerotriangulation using its own photogrammetric system. The Exterior Orientation File contains one line of data for each photo. Each line starts with the strip number (integer) and photo number (integer), followed by the three coordinates of the camera position in the project units; and then the three camera angles omega, phi, and kappa, in grad units. The file shall be an ASCII file with each data entry separated by at least one space character. The general format and a sample Adjusted Exterior Orientation File are shown below:

Strip#   Image#   X   Y   Z   Omega   Phi   Kappa
...

```
03   054   195624.478   95276.878   8312.474    2.0160    1.6723   -159.6628
03   055   194687.791   94404.678   8301.586   -1.0906   -2.6767   -159.3310
```

Sample Aerotriangulation Report

Aerotriangulation Report
CA0401
December, 2004

Area Covered

The project area extends from Cape Mendocino south to Point Arena along the coast of northern California, including the navigable bays and rivers. The project is located approximately between 38°56' and 40°27' latitude, and 123°41' and 124°29' longitude. See Annex 1 – Project Coverage Diagram for a depiction of the photographic coverage and the locations of the ground control and check points.

Imagery

Project imagery consisted of three sets of aerial photographs: Black and White Infrared (B&W IR) photos coordinated with Mean High Water (MHW) tide levels, B&W IR coordinated with Mean Lower Low Water (MLLW) tide levels, and natural color photos that did not have a tide-coordination requirement but were flown in tandem with the MLLW IR imagery. All three sets of photographs were acquired using the same flight line layout as shown in Annex 2 – Flight Line Diagram. This layout consisted of 12 flight lines (144 photos) at 1:40,000 scale covering the whole project area, and 10 flight lines (52 photos) at 1:20,000 scale covering the five larger scale chart insets within the project area, for a total of 196 photos for each of the three sets of imagery (588 in all).

All photography was acquired by Aerial Images, Inc. using a Cessna Caravan aircraft with dual camera ports, at a nominal 60% end lap, and 30% side lap. The Color photographs were all acquired using a Wild RC-30 (NOAA camera ID #07) with a 420 nm haze filter, and the B&W IR photographs were all acquired using a Wild RC-30 (NOAA camera ID #08) with a 740 nm filter. The color and MLLW IR photos were collected in tandem on 9-13-2004, and the MHW IR photos were acquired on 9-22-2004. All images were scanned by SRU Images, Inc. at a resolution of 22 microns.

Photographic coverage, resolution, overlap and metric quality were adequate for the performance of the aerotriangulation for all of the color and B&W IR photographs for this project. There is some moderate sun glare in the southwest corners of most of the MHW IR photographs, but it is not severe enough to affect the quality of the aerotriangulation or shoreline mapping. The image quality and geometric fidelity of the scans were very good for nearly all of the images. All eight fiducials were measured on every photograph, and on only one photograph was the root-mean-square (RMS) of the fiducial residuals greater than 15 microns. IR photo #113 initially had an RMS of 53 microns (2.4 pixels), mostly in the X direction, with the three fiducials on the leading edge of the image having residuals in the 80-90 micron range. We suspected a problem with the scan, and informed NOAA. SRU Images, Inc. was asked to rescan photo #113, and the second attempt was used with good results, having an RMS less than 15 microns.

Control

A combination of standard ground control points and airborne kinematic GPS was used to control the photography for aerotriangulation. IMU data was not collected.

> Airborne GPS: Kinematic GPS data was collected and processed to determine the photo centers for the color and MLLW IR photographs. The airborne GPS data collection failed during the acquisition of the MHW IR imagery, so photo center positions could not be determined. During GPS data processing it was discovered that the offset from the aircraft antenna to the entrance node of the camera in the left-side port (camera #08) was not correct. Fortunately the camera had not been removed, and subsequent measurements were able to establish an accurate offset vector. The final processed photo center coordinates for the color and MLLW IR imagery were very good, and were found suitable for use in aerotriangulation. See the Airborne Positioning and Orientation Report for further details.
>
> Ground Points: Ten targeted ground control points and six photo-identified check points were surveyed in well-distributed locations throughout the project area. See the Ground Survey Report for further details. Unfortunately, three of the targeted points could not be clearly seen in the IR imagery, but the other seven targets and all of the check points were visible and measured on the IR photos. All targets and check points were visible and measured in the color photos. Because of the airborne GPS failure for the MHW IR mission, and because of the difficulty of seeing some of the surveyed ground control in the IR imagery, 12 points were selected from the color photography that were also visible in the IR images. These points were measured in the color photographs after the final bundle adjustment of that block, and their coordinates were used as additional control for the IR. Supplemental vertical control points were selected and measured in several locations along the shoreline in both the color and IR images. Elevations were assigned to these "shoreline" points based on actual tide levels at the time of photography. The purpose of including shoreline points is to improve the vertical accuracy and leveling of the stereo-models, especially in the near-shore areas. Overall, the ground control points were found to be adequate to supplement the airborne GPS control.

Methodology

Aerotriangulation for this project was performed by the contractor using a softcopy (digital) stereo photogrammetric system to establish the network of control required for the compilation phase. The project photography was bridged as two separate blocks. The first block included all of the 1:40,000 and 1:20,000 scale color photographs; and the second block included all of the MHW and MLLW IR photographs, also at both scales. The softcopy system hardware consisted of a high-end Dell Precision™ Workstation with the Windows® XP Professional operating system, and stereo viewing capability. BAE Systems SOCET SET® v. 5.2 softcopy photogrammetry suite was used for both project setup and aerotriangulation, using its MultiSensor Triangulation (MST) module.

The project workflow began by creating the project in SOCET SET, setting the datum to NAD83 and the coordinate system to UTM Zone 10, and identifying the correct calibration files to use for the two cameras. We then imported the image scans, building reduced resolution image pyramids at the same time. Image fiducials were measured in batch mode using the Automatic Interior Orientation tool, which was when the bad scan for photo #113 was discovered. We were able to proceed with the aerotriangulation of other parts of the project while waiting for the replacement scan to arrive. The ground control was imported into the SOCET SET project, and the first block of images (color) was set up and initialized using the airborne GPS derived photo centers.

The ground control points were measured in the color images, and then we were ready to measure the tie and pass points. We suspected that the Automatic Point Measurement tool would not be very successful due to the heavy forest cover, steep terrain, and proportion of water in the images. But we did a test run anyway. Our guess was correct, as APM picked many bad points in the water and on the tops of trees. It was clear that selecting points manually would be quicker and easier that attempting to edit the hundreds of bad points selected automatically. Manual point measurement proceeded smoothly, and a good bundle adjustment was achieved with very few edits required.

The aerotriangulation of the second block (IR images) was more complicated. A similar workflow was used to set up and initialize the two sets of IR photos, but the MHW IR did not have a file with GPS derived photo centers. A pseudo-GPS file was created from approximate photo centers extracted from the flight management system. This file was used to simplify the block set up for the MHW IR, but was not used to control the images. Pass points were manually selected and measured within each set of IR images, and common points were measured between the MHW and MLLW IR photos to tie the two sets of images together into one block. The 7 visible targeted control points, 12 points transferred from the color images, and vertical "shoreline" points were measured in both sets of images to supplement the MLLW airborne GPS file. In this way all of the IR photos were successfully adjusted together as a single block.

Analysis of Results

Visualization tools within MST were used for evaluation of the triangulation adjustment, providing a display of the image and point residuals and connections between frames. Weak points and blunders were identified and corrected. The final bundle adjustments for both image blocks were computed in MST as full-covariance simultaneous solutions, allowing for the output of standard deviation values for all triangulated points. The RMS of the standard deviations in both X and Y directions were calculated and used to determine the radius of the 95% confidence circle for each image block. The predicted horizontal accuracy is 0.6 m. for the color photos, and 0.9 m. for the IR photos (see Annex 4 for details of the computations). This accuracy refers to each overall block, but in the bundle adjustments the error was distributed such that the largest errors are associated with points around the edges of the project, where the strength of the solution is weakest, while points down the middle of each block have the smallest errors because those points are measured on a greater number of images. The relative error distributions for the two block adjustments are depicted in Annex 3 – Horizontal Standard Deviations Diagrams.

All six photogrammetric check points in the project were visible and measured in the color photos and in both sets of IR photos. The coordinates of these check points were not constrained at all in any of the block adjustments, but were treated as pass points, and adjusted coordinates were computed. The adjusted coordinates from each block were compared to the surveyed coordinates, and the differences are shown below:

POINT	COLOR			IR		
ID	ΔX	ΔY	ΔZ	ΔX	ΔY	ΔZ
Check1	+0.34	+0.08	+0.33	+0.43	-0.14	+0.38
Check2	+0.12	-0.36	+0.35	+0.18	-0.29	+0.48
Check3	-0.31	+0.34	-0.29	-0.36	+0.33	+0.14
Check4	+0.15	-0.07	+0.44	+0.24	+0.08	+0.51
Check5	-0.27	-0.19	-0.28	-0.30	-0.26	-0.41
Check6	+0.20	+0.11	-0.36	+0.28	+0.21	-0.50

Select models from each strip of photography were examined in SOCET SET to insure the horizontal and vertical integrity of the ORIMA solution, and to verify the suitability of the database for use in the compilation phase.

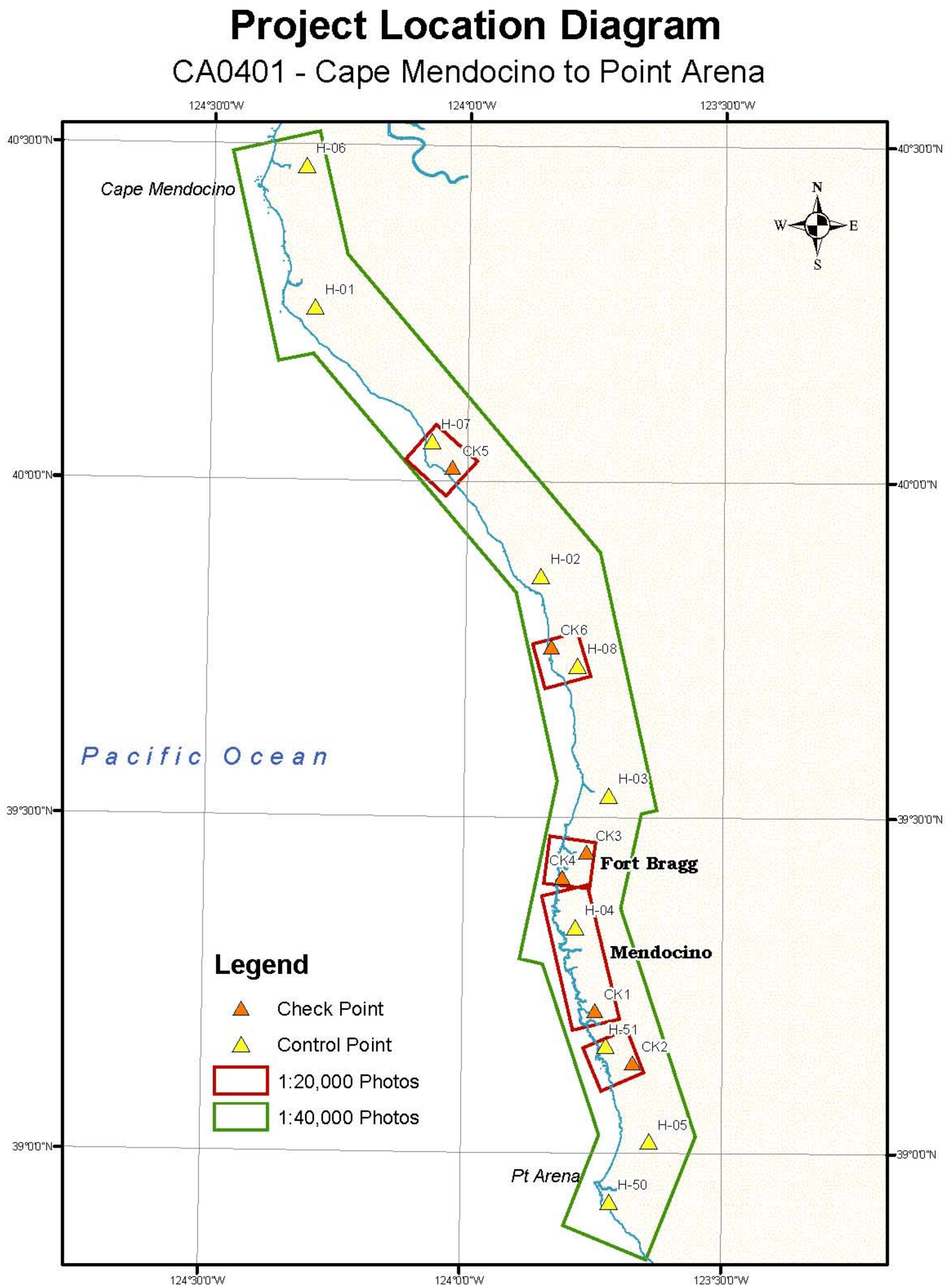
Project Database

Performance of the aerotriangulation phase included the creation of a Project Database under the reference number CA0401, which includes the following data files and other information required for and resulting from the aerotriangulation process:

- Project Identifier and other general parameters
- Camera calibration data
- Interior orientation parameters for each frame
- Adjusted coordinates of all measured points
- Ground Control File
- Refined Image Points File
- Airborne GPS Control File
- Adjusted exterior orientation parameters for each frame

Positional data is based on the North American Datum of 1983 (NAD83), and is referenced to the Universal Transverse Mercator (UTM) Zone 10 coordinate system.

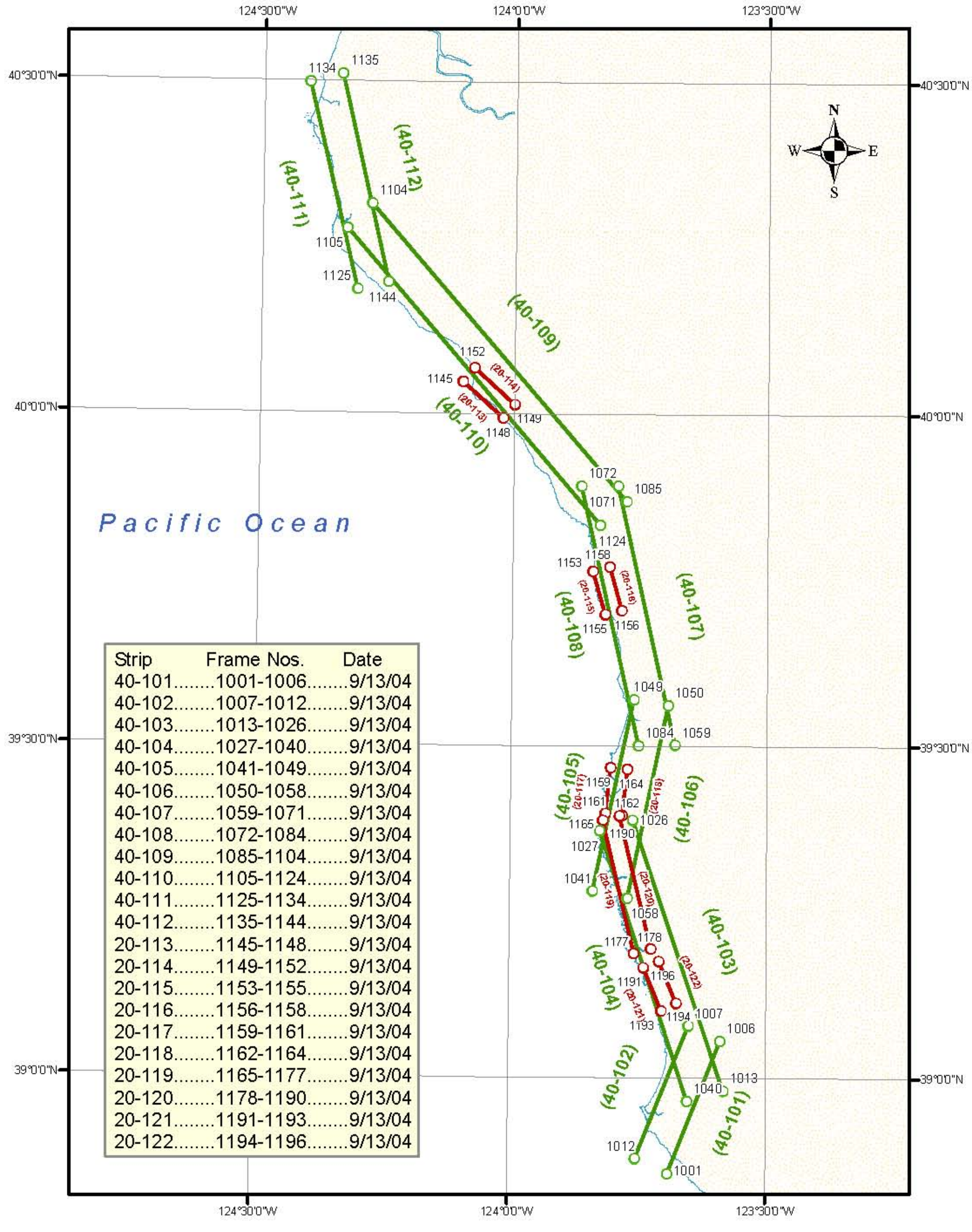
ANNEX 1 – Project Location



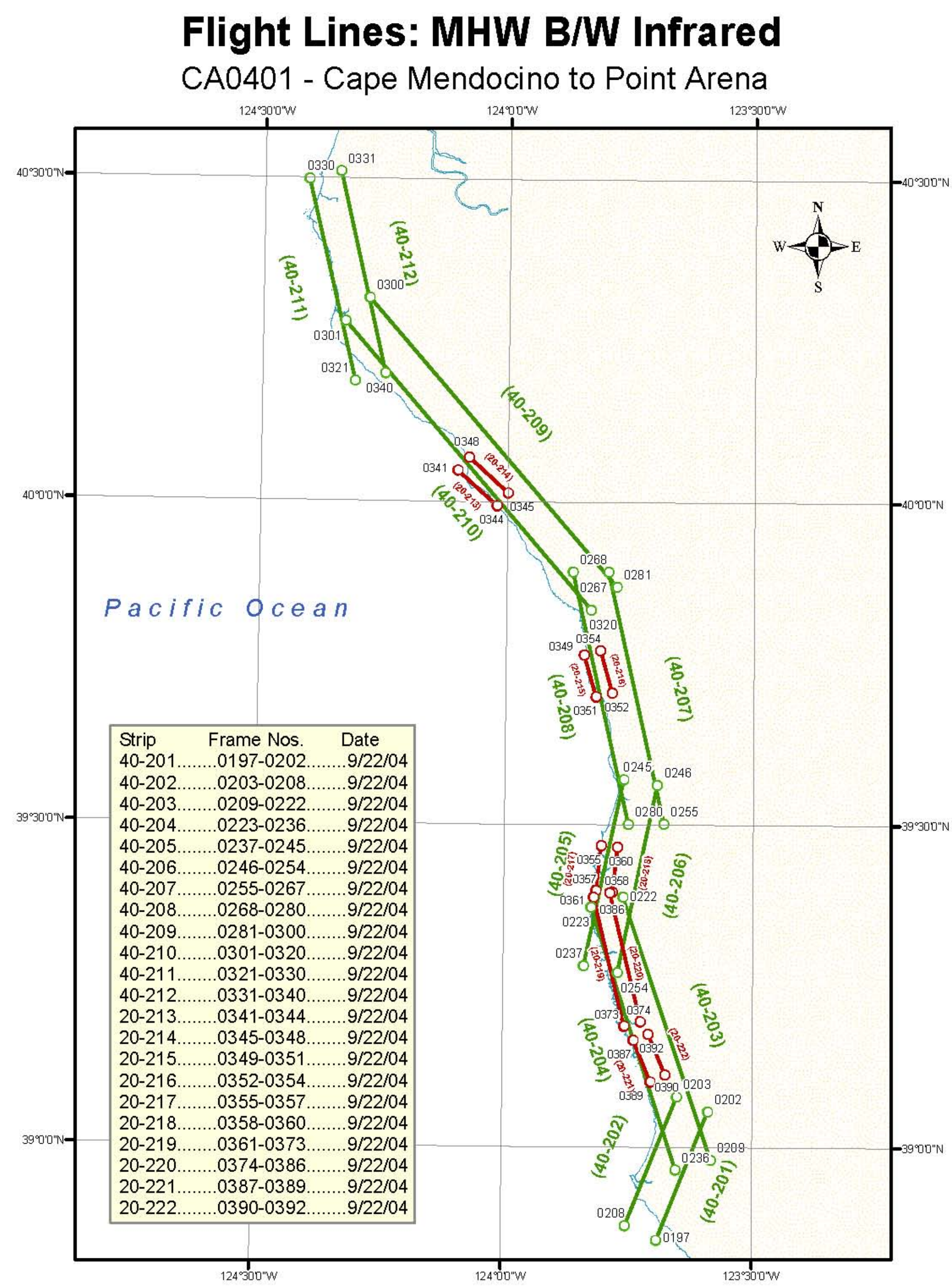
ANNEX 2a – Color Flight Lines

Flight Lines: Color (Non-tide Coordinated)

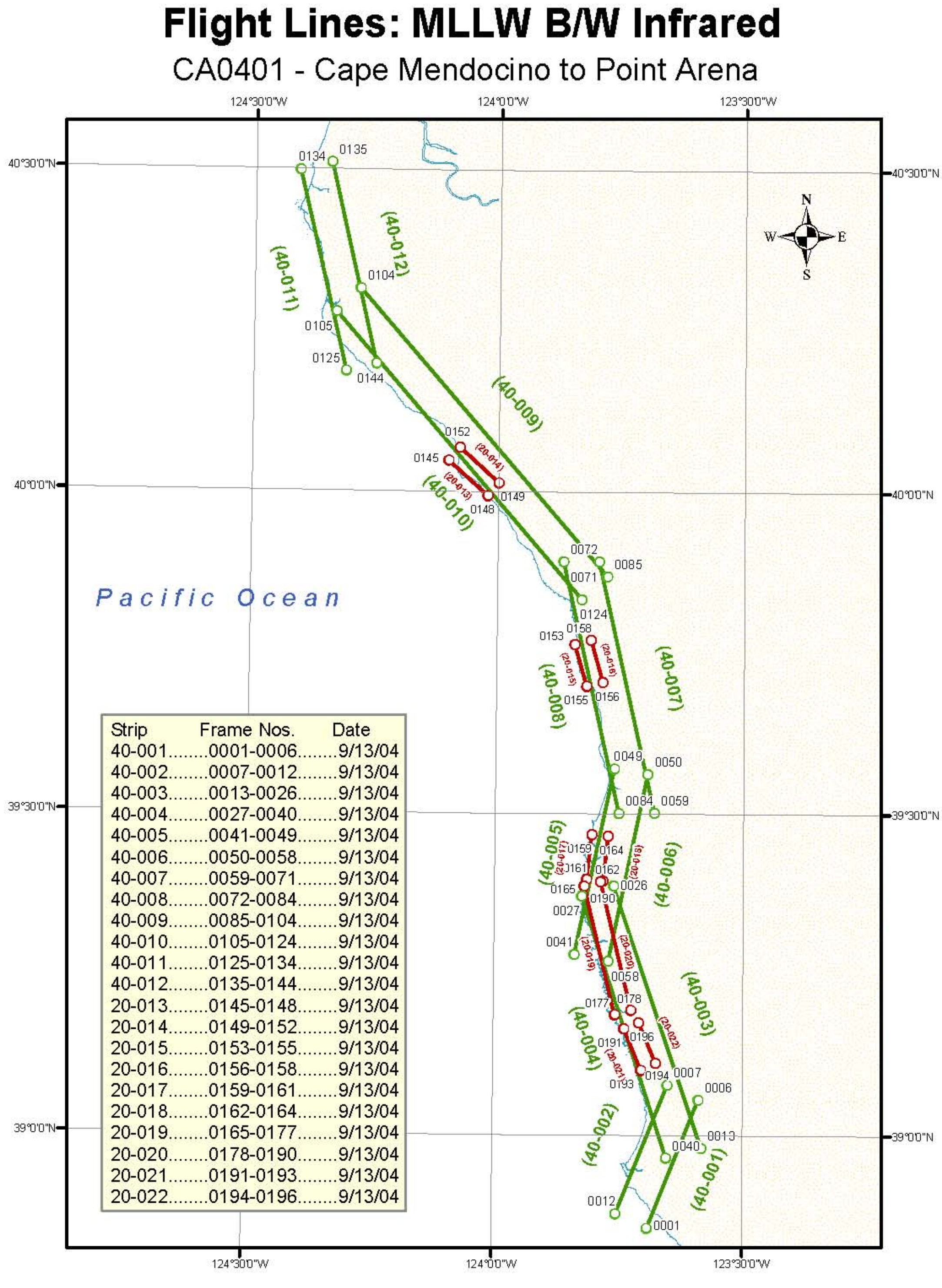
CA0401 - Cape Mendocino to Point Arena



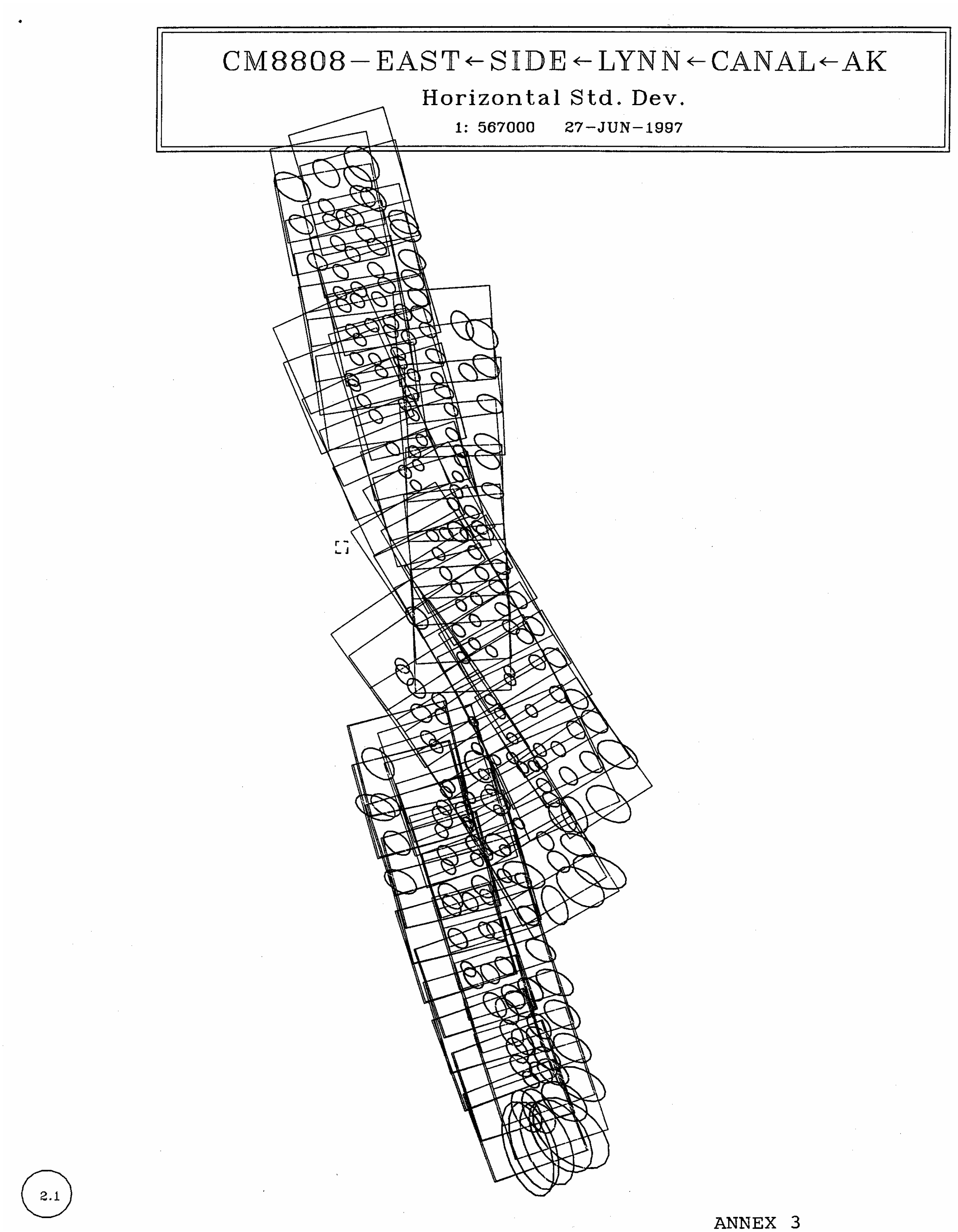
ANNEX 2b – Mean High Water Black & White Infrared Flight Lines



ANNEX 2c – Mean Lower Low Water Black & White Infrared Flight Lines



ANNEX 3 – Standard Deviation



ANNEX 4 - Horizontal Accuracy Computation

CA0401 – Cape Mendocino to Point Arena, CA

The Horizontal Accuracy Statement reported in the Analysis of Results is based on the predicted circular horizontal accuracy of adjusted points in the aerotriangulation solution. This circular accuracy equals the radius of the 95% confidence circle as calculated from the horizontal (x and y) root-mean-square (RMS) values of the standard deviations for all triangulated ground points, rounded to the nearest tenth of a meter.

The root mean square of all standard deviations of triangulated ground points:

Block 1 (color): RMS(x)=0.251 meters RMS(y)=0.232 meters
Block 2 (IR): RMS(x)=0.379 meters RMS(y)=0.316 meters

The value for the confidence circle radius is given by the following expression:

R=K*Sx

Where Sx is defined as the larger of the two (X and Y) RMS values, and K is interpolated using the C ratio from the Table of Cumulative Probability.

The C ratio equals the smaller of the RMS values divided by the larger:

Block 1 (color): C=0.232/0.251=0.924303
Block 2 (IR): C=0.316/0.379=0.833773

The following line (95% probability level) from the Table of Cumulative Probability was used to determine the value of K by a simple linear interpolation between the two nearest values of C:

C	0	.1	.2	.3	.4	.5	.6	.7	.8	.9	1.0
K(95%)	1.95996	1.96253	1.97041	1.98420	2.00514	2.03586	2.08130	2.14598	2.23029	2.33180	2.44775

BLOCK 1 (COLOR)

K =2.33180+[(0.924303-0.9)/(1.0-0.9)*(2.44775-2.33180)]
=2.33180+(0.24303*0.11595)
=2.33180+0.028179
K =2.35998
R=K*Sx=2.35998*0.251=0.592

The Radius of the 95% Confidence Circle = **0.6 meters**

BLOCK 2 (IR)

K =2.23029+[(0.833773-0.8)/(0.9-0.8)*(2.33180-2.23029)]
=2.23029+(0.33773*0.10151)
=2.23029+0.034283
K =2.26457
R=K*Sx=2.26457*0.379=0.858

The Radius of the 95% Confidence Circle = **0.9 meters**

Version 1A
February 1, 2008

ATTACHMENT J
TIDE COORDINATION REQUIREMENTS

TO
SCOPE OF WORK FOR SHORELINE MAPPING
UNDER THE
NOAA COASTAL MAPPING PROGRAM

REMOTE SENSING DIVISION
NATIONAL GEODETIC SURVEY
NATIONAL OCEAN SERVICE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE

TABLE OF CONTENTS

ATTACHMENT J: TIDE COORDINATION REQUIREMENTS PAGE

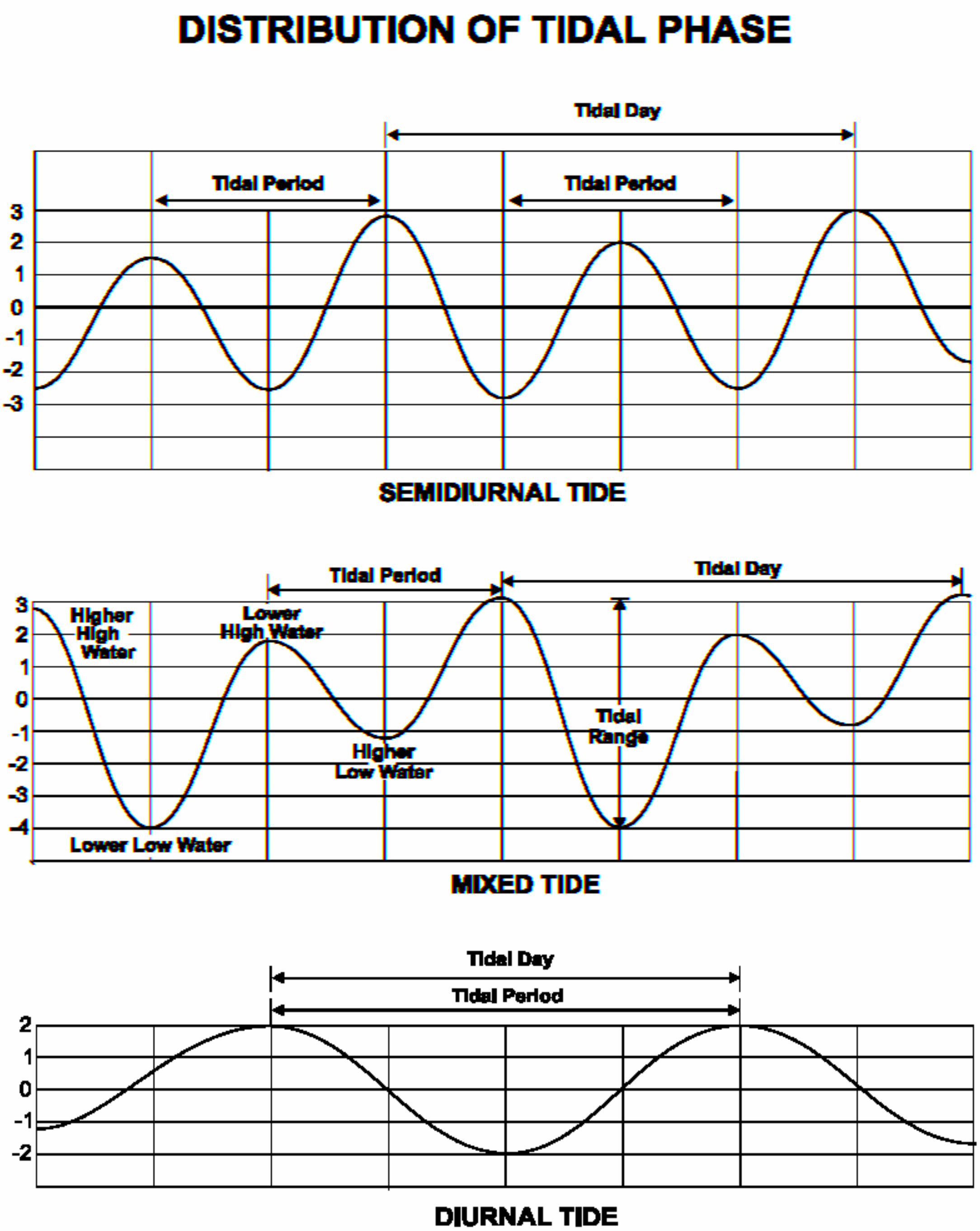
ATTACHMENT J: TIDE COORDINATION REQUIREMENTS

1. GENERAL - The purpose of this section is to provide an overview of tidal terms, tidal variations, tidal characteristics, calculation of photogrammetric tidal windows, and requirements for various types of data sensors.

The word "tides" is a generic term used to define the alternating rise and fall of the oceans with respect to the land, produced by the gravitational attraction of the moon and the sun. Additional non-astronomical factors including configuration of the coastline, local depth of water, ocean-floor topography, and other hydrographic and meteorological influences may play an important role in altering the range of tide, and the time interval between high and low waters, and times of arrival of the tides.

The words "water level" are used to define the height of the surface of a non-tidal body of water, such as a river or lake, above or below datum. The astronomical factors that create a tide have little or no measurable effect on water levels. Water levels are most affected by rain, snow melt, drought, and the release of water from dam created impoundments. Because these factors can not be accurately predicted over a long period of time, accurate long range water level predictions can not be made either.

1.1 TYPES OF TIDES - There are three basic types of tides: semidiurnal (twice-daily), mixed (also twice daily), and diurnal (daily). The first type, semidiurnal, has two high waters (high tides) and two low waters (low tides) each tidal day. A tidal day is the time of rotation of the Earth with respect to the Moon, and its mean value is approximately 24.84 hours. To have a semidiurnal tide, the two high waters for each tidal day must be almost equal in height. The two low waters of each tidal day also must be approximately equal in height. The second type, mixed, is similar to semidiurnal except that the two high waters and the two low waters of each tidal day typically have marked differences in their heights. When there are differences in the heights of the two high waters, they are designated as higher high water and lower high water; when there are differences in the heights of the two lows, they are designated as higher low water and lower low water. The third type, diurnal, has only one high water and one low water for each tidal day.


DISTRIBUTION OF TIDAL PHASE
Tidal Day
Tidal Period
Tidal Period
3
2
1
0
-1
-2
-3
SEMIDIURNAL TIDE
Tidal Period
Tidal Day
Higher High Water
Lower High Water
Higher Low Water
Tidal Range
Lower Low Water
3
2
1
0
-1
-2
-3
-4
MIXED TIDE
Tidal Day
Tidal Period
2
1
0
-1
-2
DIURNAL TIDE

1.2 SPRING AND NEAP TIDES - The most important modulations of the tides are those associated with the phases of the Moon relative to the Sun. Spring tides are tides occurring during the new and full moon phases. These are the tides of the greatest amplitude, thus the highest and lowest waters are recorded at these times during each lunar month. Neap tides are tides occurring approximately midway between the time of new and full moon. The neap tide is usually ten to thirty percent less than the mean tidal range. In addition to spring and neap tides, there are lesser, but significant monthly modulations due to the elliptical orbit of the Moon about the Earth (perigee and apogee) and yearly modulations due to the elliptical orbit of the Earth about the Sun (perihelion and aphelion). Modulations in mixed and diurnal tides are especially sensitive to the monthly north and south declinations of the moon relative to the earth's equator (tropic and equatorial tides), and to the yearly north and south declinations of the sun (equinoxes and solstices). The astronomical influence of the moon and the sun upon the earth would seem to imply a uniformity in the tide. However, because of the non-uniformity of the shape and hydrography of the coast, the type of tide can vary over time at a single location and between geographically separated points along the coast. The transition from one type to another is usually gradual either temporally or spatially, resulting in hybrid or transition tides. A further discussion of tide types can be found on the NOAA CO-OPS web site at: http://tidesandcurrents.noaa.gov/publications/Computational_Techniques_for_Tidal_Datums_handbook.pdf .

1.3 MEAN HIGH WATER AND MEAN LOWER LOW WATER **-** The two phases of the tidal cycle that the Shoreline Mapping Program is principally concerned with are Mean High Water (MHW) and Mean Lower Low Water (MLLW). MHW is the arithmetic mean of all high water recordings made during the tide's 18.6 year tidal epoch. Similarly, the MLLW is the arithmetic mean of all lower low water recordings made during the same time period. As these are both arithmetic means of long term recorded values they do not represent the actual high water or low water values for any given tide on any given day.

The accuracy to which the MHW line shall be compiled is given in the individual project instructions. See SOW Section 8.5A for further information regarding shoreline vector accuracy. The line depicting MLLW on the manuscript should be mapped with the same care as the MHW, but is considered an approximate depth contour. See Attachment K for further information regarding the definition of an approximate contour.

Coordination of remotely sensed data acquisition with the stage of tide is necessary to be able to confidently delineate the two required tide lines. As the tide rises and falls it scours the shoreline of most of the visible vestiges of the previous tidal cycle, and as we have seen from the above definitions, semidiurnal and mixed tides rise to two different heights during each tidal day, neither of which may be at the mean level during imagery acquisition operations. The use of a debris line on a beach to determine the MHW line is not acceptable because the debris line shows the landward intrusion of the most recent highest high tide or even a storm surge, not the MHW line. The difficulty in delineating the MLLW line from non-tide coordinated imagery lies in not being able to accurately contour through the surf zone. Additionally, tidal coordination of MLLW imagery is necessary to account for any land, such as a sand bar, that projects above the water surface during the low water portion of the tidal cycle. Additionally, MLLW imagery is used to detect any rocks or other obstructions that may be a hazard to navigation.

1.4 SUN ANGLE, CLOUD COVER, VISIBILITY, AND OTHER ATMOSPHERIC PHENOMENA **-** Coordination of imagery acquisition with the tidal cycle is more involved than simply determining when the tide will be at MHW or MLLW and taking imagery at that time. Factors such as sun angle, visibility, cloud cover and offshore weather all come into play to determine when and if imagery can be obtained using passive sensor systems. For obtaining optimum imagery the angle of the sun with respect to the horizon MUST be 30° or higher when using a passive imagery system. When lower than 30° deep shadows of tall features on land can fall over the shoreline and obscure the water level or features at the water line or in the water. This effect is especially pronounced when using black & white infrared film. Once the sun rises higher than 30° shadows tend to lighten, allowing better visual penetration. However, it is preferable that the sun angle not be near 90°. When the sun is at or near 90° shadows become shorter and the value of the imagery for identifying objects of a color similar to the surrounding ground diminishes. As the sun rises to 90° the position of the associated sun spot, the reflection of the sun off the water, moves toward the center of the image resulting in an image with features that may be completely washed out. Clearly, it is inefficient to fly tide coordinated imagery only when the sun is at some optimum angle above the horizon as we have no control over the rise and fall of the tides or the rotation of the earth. For this reason it is acceptable to obtain tide coordinated imagery at or near local noon. If tide coordinated imagery is obtained at or near local noon, steps must be taken to ensure that the image is not too washed out for accurate shoreline compilation to occur. When acquiring tide coordinated imagery using an active imagery system sun angle is not a consideration. Indeed, tide coordinated imagery can be obtained in the middle of the night when using an active system.

For the requirements regarding cloud cover and visibility see SOW Attachment C Section 9.1 and Section 9.4.

Offshore weather can play a large part in determining whether or not the tides in a project area will actually be within the predicted tide windows. It is critical that the aerial survey crew, or someone who can control the survey crew's actions, check the conditions of offshore weather daily. A large offshore storm may not affect the amount of local cloud cover within a project area, but it is possible for it to push a storm surge well in front of it or to generate waves that will wash up on the shoreline farther than would happen if the storm were not present. Either of these two situations will provide false data for the mapping of the MHW and/or the MLLW.

Barometric pressure can also play a large part in determining whether or not the tides in a project area will actually be within the predicted tide windows. A high pressure cell can be strong enough to depress the surface of the ocean sufficiently that the water level will not come up to MHW, or drop below MLLW sooner than predicted. Similarly, a low pressure cell can allow the water level to reach MHW sooner than predicted, and to not reach MLLW.

The aerial survey crew MUST be aware that the current sea state or surf conditions are normal for the project area. A smooth sea state is preferred.

2. METHODS OF OBTAINING TIDE COORDINATED IMAGERY

2.1 PASSIVE IMAGERY SYSTEMS - Are those systems that rely on reflected sunlight to provide image illumination.

A. FILM PHOTOGRAPHY - Film photography requires the use of a metric quality aerial camera using Kodak 2424 Black & White infrared film, or an approved equivalent. See SOW Attachment C, Section 7.2. This film, when properly exposed and processed, provides the best differentiation between water and land at the land/water interface.

A deep red, 740 nm filter is used with black & white infrared film to block all wavelengths other than those in the near infrared portion of the electromagnetic spectrum. Tests have indicated this combination of film and filter produces an image of the land-water interface that is very close to its actual position.

The camera used to obtain black & white infrared tide coordinated imagery must have a current certificate of calibration and have been assigned a camera designator by NGS. See SOW Attachment C, Section 7.1

B. DIGITAL PHOTOGRAPHY - Digital Photography requires the use of a metric quality digital aerial camera. See SOW Attachment Z for Digital Imagery Acquisition Requirements.

The camera used to obtain digital infrared tide coordinated imagery must have a current certificate of calibration and have been assigned a camera designator by NGS. See SOW Attachment Z, Section 5.

C. HYPERSPECTRAL SCANNER - No current technical requirements or technical specifications exist as yet for obtaining tide coordinated imagery with a hyperspectral scanner. As such, they are unacceptable for obtaining operational shoreline mapping data at this time.

2.2 ACTIVE IMAGERY SYSTEMS - Are those systems that provide their own image illumination.

A. LIDAR - For specifications and requirements concerning LIDAR acquisition see SOW Attachment Y.

B. IFSAR - For specifications and requirements concerning IFSAR acquisition see SOW Attachment AB.

Tabulation of Imagery Requirements

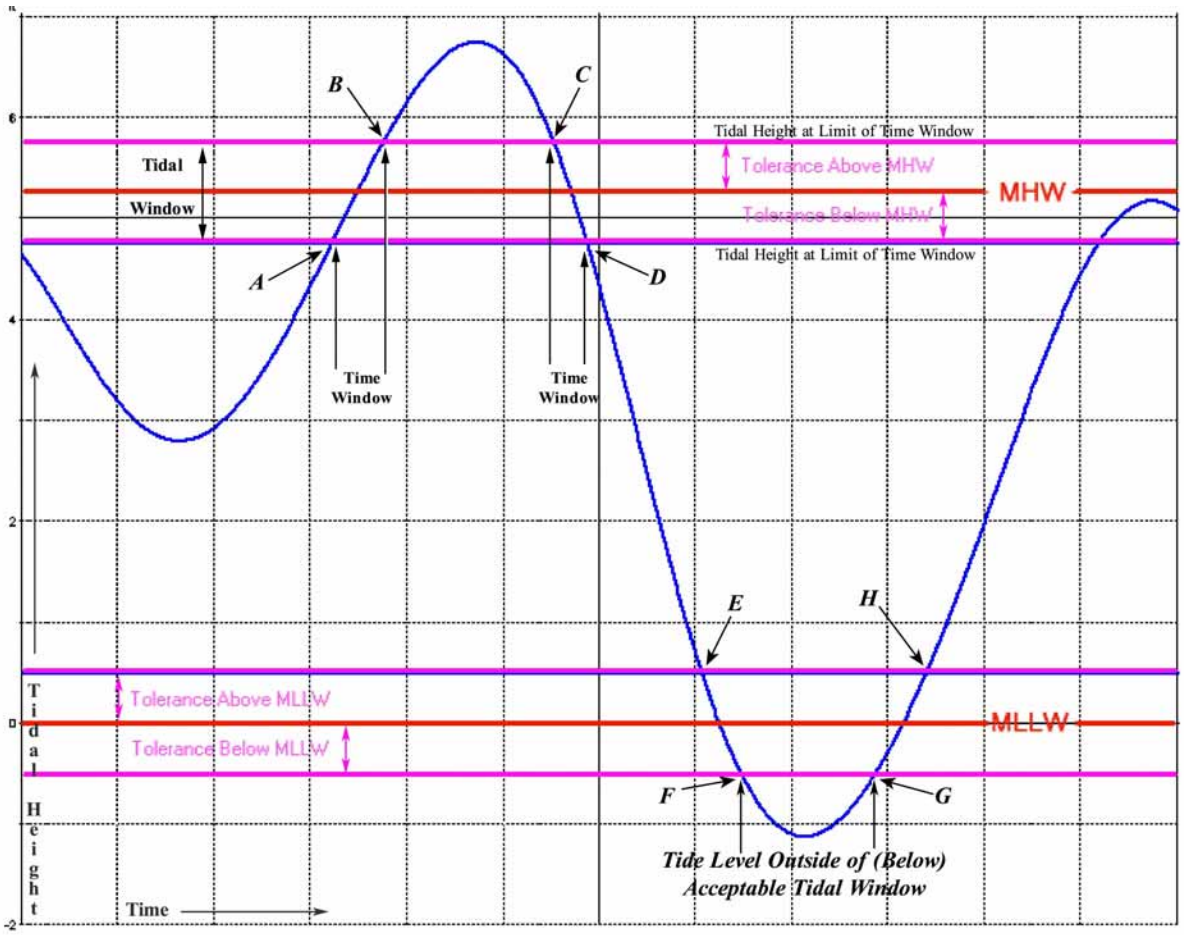
	Solar Illumination Required	Cloud Free	Clear (8mi.) Visibility	Tide Coordination
Film Photography	Yes, Sun Angle > 30°	Yes	Yes	Yes
Digital Photography	Yes, Sun Angle > 30°	Yes	Yes	Yes
LIDAR	No	Clouds allowed above aircraft	Yes	Yes
Hyperspectral	No Specs	No Specs	No Specs	Yes
IFSAR	No	No, but no thunderstorm clouds	No	Yes

The above table shows the basic phenomena that must come together to allow shoreline imagery acquisition.

3. TIDAL PREDICTION - The tides at each end of a long stretch of beach or from the seaward to landward sides of an estuary may have different times of tidal occurrence. Because of this tidal disparity it is clearly impossible to obtain imagery over an extended stretch of beach or shoreline within an estuary at the exact moment of MHW or MLLW. To overcome this difficulty NGS calculates a height tolerance, within which the tidal level is considered to be at either MHW or MLLW. All tide coordinated imagery must be acquired while the stage of tide is within a calculated range or tolerance of MHW or MLLW. Even with this tolerance it may be necessary to break up a project area into several sub-projects. Each sub-project may need to be flown at different times to acquire imagery within the required tolerance.

Because the tolerance is plus or minus some calculated value, the combination of the plus and minus is referred to as the predicted tide window, or tidal window.

TYPICAL TIDAL CURVE



The above diagram shows the relation of the ± tolerance value in relation to the MHW and MLLW in a tidal cycle. As the level of the tide rises from its previous low point it enters the predicted MHW tide window at point **A**. Imagery can be obtained beginning at this point. The tide continues to rise, eventually reaching point **B**, rising above the tide tolerance, and exiting the tidal window. As the cycle continues and the tide begins to fall again it enters a second MHW tidal window at point **C**. The tide continues to fall until it reaches point **D** and exits the second tidal window. Similarly, the tide continues to fall until it reaches point **E** and enters a MLLW window. It continues to fall until it reaches point **F** and passes out of the predicted window. Upon rising to point **G** the tide again enters the predicted window until it reaches point **H**. Note that not all tide cycles contain two tidal imagery windows. The low water level indicated by the curve on the left side of the diagram does not drop far enough to reach the predicted MLLW window. The curve at the extreme right of the diagram reaches the predicted MHW window, but stays inside it for the entire high water period. Most tide cycles contain no usable tide windows, and most commonly those that do contain windows only have one. The relationship of the ± tolerance to the MHW is the same as to the MLLW.

3.1 DATA NEEDED TO CALCULATE A PREDICTED TIDE WINDOW - There are three sets of data that are needed to correctly calculate a predicted tide window. 1) The time when the sun will rise above 30° and when it will set to 30°, 2) the heights of predicted highs and lows of tidal movement and the times when they occur, usually for an entire month, and 3) the calculated height tolerance within which imagery can be obtained.

It is of no consequence as to which set of data is determined first, so long as the data is all at hand for input to program Tide8+. For the sake of this example the order will be: Sun angle, calculation of the tolerance, and export/import of tide highs & lows.

To determine the sun angle NGS uses a commercial program that is, unfortunately, no longer available on the open market. The contractor can use any available sun angle calculator. There is an effective one on the U.S. Naval Observatory web site at:
http://aa.usno.navy.mil/data/docs/RS_OneDay.php .

To calculate the height tolerance and export the monthly highs & lows NGS uses the commercial program Tides & Currents, published by Nobeltec. The contractor is free to purchase any program that they wish, provided it can provide the necessary data and export the data in the required format. (NGS makes no endorsement of any commercial product mentioned in this document.)

To calculate the times that the tide is predicted to be within the acceptable tolerance NGS uses a Government developed program Tide 8+. This program will be provided to the contractor. Training in its use and tide window prediction will be provided to the contractor at a time mutually acceptable to both the contractor and the Government.

For this example tide stations Clearwater, Florida; Savannah River Entrance, Georgia; and San Francisco, California for the month of June 2004 will be used.

The sun angle program predicts the sun will rise to 30° at approximately 0900 hrs during the entire month of June, and will set to 30° at approximately 1745 hrs. (It is important to note here that all times used in this process MUST be based on a 24 hour clock for the program Tide 8+ to properly work. All calculations for tide prediction are done in local time not UTC.)

For greater precision in predicting tidal windows it may be necessary to calculate rising and setting times for the sun for several dates through a month. This is especially true near the solar solstices when the apparent movement of the sun in declination is faster.

3.2 TIDAL TOLERANCE CALCULATION - The numerical values needed to calculate the tidal tolerance for each tide station can be found in the privately published books of tide tables for the east and west coasts. The books necessary are East Coast of North and South America, Including Greenland and West Coast of North and South America, Including the Hawaiian Islands. These books, previously published by NOAA, are available from several vendors. A search of internet web sites can locate these vendors. The Mean Range and Mean Tide Level for each tide station are listed in Table 2.

The numerical values may also be found included within the data for each tide station listed by one of the commercial tide prediction programs.

Example: Clearwater, Florida (Diurnal Tide)
Find the published value for the Mean Range: Clearwater = 1.8 ft

When the Mean Range of the tide station is 5 feet or less, imagery shall be obtained within a tolerance of ± 0.3 ft. of the MHW and MLLW. For the example: MHW imagery could be obtained at Clearwater when the tide stage is between 1.5 ft. and 2.1 ft. The MLLW could be obtained when the tide level is between +0.3 ft and -0.3 ft. MLLW defined as being a tide level of 0.0 ft.

Example: Savannah River Entrance, Georgia (Semi-diurnal Tide)
Find the published value for the Mean Range: Savannah River Ent. = 6.9 ft

When the Mean Range of the tide station is greater than 5 feet, imagery shall be obtained within a tolerance of ± 10% of the mean range. For example: MHW imagery could be obtained at Savannah River Ent. when the tide stage is between 6.21 ft and 7.59 ft. Imagery to capture the MLLW could be obtained when the tide level is between -.69 ft and +.69 ft. The tolerance being 10% of 6.9 or 6.9 x .1 = ±.69 ft.

Example: West Coast; San Francisco (Golden Gate) (Mixed Tide)
Due to the diurnal inequality of tides in Alaska and on the West Coast, the Mean Range of tide must be computed. This is done as follows:

Find the published Mean Range and Mean Tide Level for San Francisco (Golden Gate).
Mean range = 4.10 ft. Mean Tide Level = 3.2 ft

The new Mean High Water Level, and thus the new Mean Range = 1/2 the original Mean Range + the Mean Tide Level. (4.10 / 2) + 3.2 or 2.05 + 3.2 = 5.25 ft.

Because the new Mean Range is greater than 5 feet the tolerance is calculated as 10% of 5.25 ft. or ±0.52 ft. (Rounding up shall only be done if the last digit of the Mean Range is greater than 5.) If the new Mean Range was 5 feet or less the 0.3 ft tolerance would have been used.

3.3 TIMES OF TIDAL HIGHS AND LOWS **-** A computer file must be created that holds the daily predicted times and heights of the separate high and low water for the tide station being investigated. There are two ways to do this: type a file that includes the times and heights of the highs and lows, or export the highs, lows and times of occurrence from a commercial tide prediction program for importation to Tide 8+. The data for typing can be found for each tide station in Table 1 of the tide books: East Coast of North and South America, Including Greenland and West Coast of North and South America, Including the Hawaiian Islands.

The data MUST be typed or exported from the commercial tide prediction program in the following format. Failure to use the format exactly will result in Tide 8+ crashing or returning erroneous data.

Additionally, the typed or exported file MUST have a *.TXP file extension.

Example Data Format for importation to Tide 8+:

```
Tides-SAVANNAH RIVER ENTRANCE                32° 2 N 80° 54 W
From 06 ,01, 2004 to 06 ,30, 2004
06 ,01, 2004,01:16,6.8,07:33,0.8,13:41,6.0,19:36,1.3
06 ,02, 2004,02:07,6.5,08:24,0.9,14:33,6.0,20:35,1.5
06 ,03, 2004,02:57,6.3,09:17,1.0,15:23,6.1,21:37,1.5
06 ,04, 2004,03:46,6.2,10:08,0.9,16:13,6.3,22:36,1.4
06 ,05, 2004,04:35,6.1,10:55,0.7,17:02,6.6,23:29,1.2
06 ,06, 2004,05:25,6.1,11:40,0.5,17:50,6.9
06 ,07, 2004,00:18,1.0,06:14,6.2,12:24,0.4,18:36,7.2
06 ,08, 2004,01:04,0.8,07:00,6.3,13:07,0.2,19:19,7.5
06 ,09, 2004,01:49,0.5,07:44,6.4,13:51,0.1,20:00,7.8
06 ,10, 2004,02:33,0.4,08:25,6.4,14:35,0.0,20:40,8.0
06 ,11, 2004,03:17,0.2,09:06,6.4,15:19,0.0,21:21,8.1
06 ,12, 2004,04:01,0.1,09:48,6.4,16:04,-0.1,22:04,8.0
06 ,13, 2004,04:44,0.1,10:33,6.4,16:50,0.0,22:51,7.9
06 ,14, 2004,05:29,0.1,11:25,6.4,17:38,0.1,23:43,7.8
06 ,15, 2004,06:17,0.1,12:23,6.4,18:31,0.2
06 ,16, 2004,00:40,7.6,07:08,0.1,13:23,6.6,19:29,0.3
06 ,17, 2004,01:38,7.4,08:03,0.0,14:23,6.9,20:33,0.4
06 ,18, 2004,02:36,7.3,09:02,0.0,15:21,7.2,21:41,0.4
06 ,19, 2004,03:33,7.1,10:02,-0.2,16:19,7.5,22:47,0.2
06 ,20, 2004,04:31,7.0,11:00,-0.4,17:17,7.8,23:48,0.0
06 ,21, 2004,05:30,6.9,11:55,-0.5,18:14,8.1
06 ,22, 2004,00:45,-0.2,06:27,6.9,12:48,-0.6,19:09,8.3
06 ,23, 2004,01:39,-0.3,07:21,6.9,13:40,-0.6,19:59,8.4
06 ,24, 2004,02:31,-0.4,08:12,6.9,14:30,-0.5,20:47,8.3
06 ,25, 2004,03:20,-0.4,09:01,6.8,15:18,-0.3,21:33,8.1
06 ,26, 2004,04:07,-0.2,09:48,6.6,16:04,-0.1,22:19,7.8
06 ,27, 2004,04:50,-0.1,10:36,6.4,16:48,0.2,23:05,7.4
06 ,28, 2004,05:32,0.2,11:24,6.2,17:30,0.6,23:52,7.1
06 ,29, 2004,06:13,0.4,12:14,6.1,18:13,0.9
06 ,30, 2004,00:39,6.7,06:54,0.6,13:04,6.1,18:58,1.2
```

File is comma separated ASCII and need not contain one full calendar month of data. However, NGS recommends that a full month of data be exported and processed through Tide 8+ at a time.

First line is: Name of tide gauge being predicted & location of gauge. (The location of the gauge is not necessary to the operation of Tide 8+ and may be omitted. It is shown here because it is part of the data that the commercial program used by NGS exports.)

Second line is the dates of the data

Third and all subsequent lines:
Month, Day, Year, Time, Height, Time, Height, Time, Height, Time, Height
(The spaces shown after the Month and the Day comma are not necessary. Those shown are remnants of the program used to export the data. Tide 8+ will work with or without them.)

All heights are referenced to MLLW. All heights are to .1 of a foot.

All times are based on a 24 hr clock and are in local time, Local Standard Time or Daylight Savings Time. That the times are in 24 hour format is critical. The use of a 12 hr civilian clock will cause erroneous data to be returned by Tide 8+.

4. TIDE 8+ - Tide 8+ is the Government written program that actually calculates the time when imagery tide windows will open and close. These calculations are based on the predicted highs and lows, the sun angle beginning and ending times, and the calculated tolerance.

4.1 OVERVIEW - Because Tide 8+ is an old DOS base program it will not accept input from a mouse or other pointing device. It may also have trouble printing over a network. NGS recommends that the computer on which this program is run has a local printer.

Start the Tide 8+ program.

Over view of Main Menu Functions:

Open TD4 file:	Use this option to recall a saved *.TD4 (tide input parameters) file.
Save TD4 file:	Use this option to save a *.TD4 file
Path:	Use this option to tell the program the directory where you wish to save TD4 files and the path where the TXP data files exported from the commercial tide prediction program are saved. (For convenience sake, these should be in the same directory.)
Edit Parameters:	Use this option to manually enter the time and height correctors, the calculated tolerance as well as the starting and ending flight times for the tide station under consideration and other variable data.
View Tide Data:	Use this option to view the High and Low water tide window predictions before printing them.

Hard Copy of Tide Data:	Use this option to print the High and Low water tide window predictions
Change Time Zone:	Do Not use this option. Do Not Change the time zone unless you want the tide window predictions done in Greenwich Time. This option is the number of tide zones away from the photo project that Greenwich time falls. Local time = 0. <u>As all input and output will be in local time no correction is warranted</u>. Changing the time zone after importing data will scramble the data into uselessness.
Import Other Tide Data:	Use this option to import the TXP file that was manually typed or exported from the commercial tide prediction program.
e**X**it:	<Return to DOS>

4.2 <u>TIDE 8+ PROCEDURE</u> - Set the path for a TXP file to be the same path used to save the exported data from the commercial tide prediction program.

Set the path for the TD4 file to be a directory where the input tide station parameters will be saved. (TD4 files are useful for saving all of the input data for a particular tide station for a particular month in case there is any reason to go back and review it. A different TD4 file must be created for each tide station for each month. They also assist in creating a file of the tide window prediction out-put. <u>Tide 8+</u> has no direct function for saving the high and low water tide window predictions.)

Import Other Tide Data: A menu of all the TXP files that have been saved to the specified directory will appear. Use the Cursor control keys to scroll down to the desired file and press ENTER. No confirmation message will appear.

Edit Parameters: A screen with all of the parameters necessary to predict tide windows will appear.

Check to see that the tide station name and the number of days of data are correct. (<u>Tide 8+</u> will not crash if less than a month's worth of data are used to calculate tide windows. The output will simply be only for that time period chosen, possibly missing days of adequate tide windows.)

Edit the station name. This is useful if predicting the tide windows in a tide zone rather than on an individual station.

Enter the tide height at MLLW. This equals 0 feet always.

Enter the Range value (The range value is the same as the tolerance. When <u>Tide 8+</u> was written the programmer did not realize that the word "Range" was used for more than one tidal value. Because all of the people using the program knew what was meant by Range the label was never changed.)

The low tide corrector = 0 (In rare cases there is a constant difference in tide height between a primary and subordinate tide station. When this difference is known the value goes here.)

The low tide ratio =1 if calculating for a specific tide gauge. For tide zones the ratio will equal some other value that will be supplied to the contractor as part of a tidal zoning diagram. (This value is the ratio of tidal height at a subordinate station to that of its primary station.)

The low tide time corrector = 0 if calculation for a specific tide gauge. For tide zones the corrector will equal some other value that will be supplied to the contractor as part of a tidal zoning diagram. (This value is the time difference in minutes that it takes a subordinate station to reach the same height as its primary station.)

The correctors and ratio are set to equate to no corrections if they have been already accounted for by the commercial tide prediction program before the data was exported. The same holds true for the high tide correctors.

Enter the tide height at MHW. This equals the value of the Mean Range or the new Mean High Water/New Mean Range value that was previously calculated. See 3.2 of this Attachment.

The high tide corrector = either .3 or the calculated Tolerance

The high tide ratio = 1 if calculation for a specific tide gauge. For tide zones the ratio will equal some other value that will be supplied to the contractor as part of a tidal zoning diagram.

The high tide time corrector = 0 if calculation for a specific tide gauge. For tide zones the corrector will equal some other value that will be supplied to the contractor as part of a tidal zoning diagram.

The window begin and end times come from the calculation of when the sun rises to 30° and sets to 30°. They must be in a 24 hour clock format.

Page Down through the remaining data to get back to the Main Menu.
View Tide Data to be sure the output is reasonable.

Print a Hard Copy of the predicted tide windows.

Save the work as a TD4 file.

To save the tide window predictions as a file:

Open the just saved TD4 file

View the data (The data will be saved in a temporary file called *TD4filename*.TXT in the directory where the TD4 file was saved.)

Before viewing the data for the other stage of tide predictions, go to the directory and rename the temporary TXT file. (If it is not renamed, viewing any other data will over-write the data already in the file.)

Repeat the above steps for each month of data for each tide station or tide zone.

Exit the program

Informational Note: If the program used to export tide times and heights can automatically account for the daylight savings time - standard time change that occurs in April and October, the switching of the time within the exported data may cause Tide 8+ to return an Invalid TXP file error message. This problem is easily fixed by opening the original exported data file, looking at the data for the day of the time change and correcting for the change. NGS personnel have found that the most common error is that one day will be listed twice in the first column of data. The data is fixed by simply changing the date of the second one listed.

5. TIDAL ZONING AND TIDE ZONES **-** Because tide levels and/or the time of a tide can vary considerably within a project area, NGS will supply a Preliminary Tidal Zoning diagram to the Contractor. The diagram delineates various areas within a project area in which all of the tidal parameters are equal. Each zone can be considered to be a subordinate tide station to the main station on which its corrector values are calculated. Tide predictions for each zone used are then calculated as if the zone is a separate tide station. The correctors provided are: High Tide Time Corrector, Low Tide Time Corrector, and Range Corrector. These values are used in Tide 8+ as the input for: High and Low Time Correctors and the Ratio.

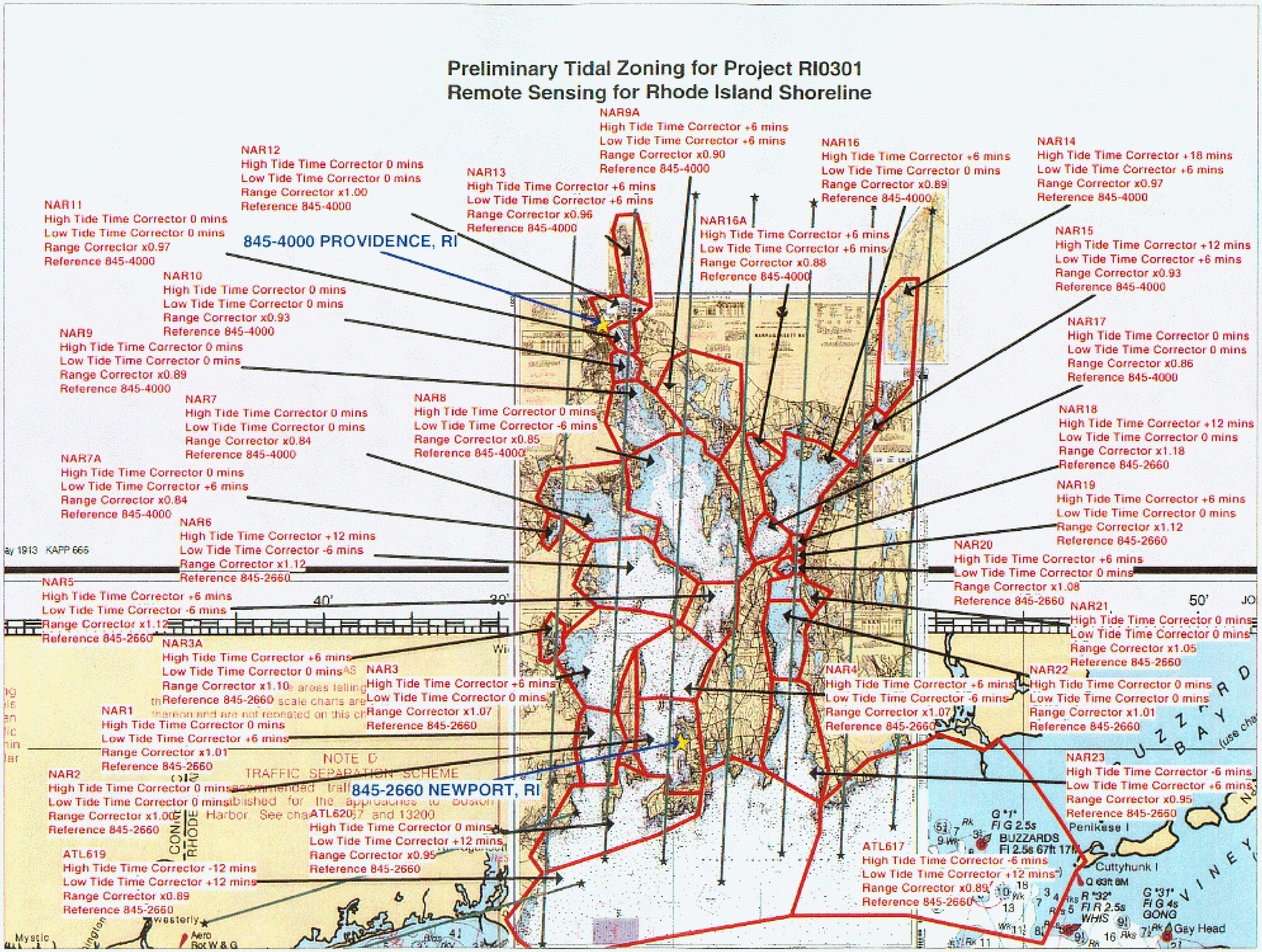
The diagram below shows the preliminary tide zones for Narragansett Bay, Rhode Island. Each of the Red polygons is a tide zone. Each zone has a block of data associated to it by an arrow. The block of data contains the Tide Zone Name, the High Tide Time corrector value, the Low Tide Time Corrector, the Range Corrector, and the main tide station used to calculate the correctors. The main tide stations are shown as gold stars on the diagram. Their label is shown in blue. The black lines running north to south are flight lines, which may or may not appear on a diagram.

The High Tide Time Corrector is ± the number of minutes that the high water event occurs within the zone relative to the time it occurs at the primary tide station. A positive value indicates that the high water event within the zone occurs after that of the primary tide station. A negative value indicates that the high water event occurs before that at the primary station.

The Low Tide Time Corrector is ± the number of minutes that the low water event occurs within the zone relative to the time it occurs at the primary tide station. The relationship of the ± time is the same as for high water.

The Range Corrector is the ratio of height of the water within the zone to the height of the water at the primary station.

Because the tide zones are calculated for hydrographic surveys, it is not practical to use every zone when determining the predicted tidal imagery windows. Clearly, an aircraft can obtain data from an entire zone or zones much faster than can a hydrographic survey vessel.


Preliminary Tidal Zoning for Project RI0301
Remote Sensing for Rhode Island Shoreline
NAR9A
High Tide Time Corrector +6 mins
Low Tide Time Corrector +6 mins
Range Corrector x0.90
Reference 845-4000
NAR12
High Tide Time Corrector 0 mins
Low Tide Time Corrector 0 mins
Range Corrector x1.00
Reference 845-4000
NAR13
High Tide Time Corrector +6 mins
Low Tide Time Corrector +6 mins
Range Corrector x0.96
Reference 845-4000
NAR16
High Tide Time Corrector +6 mins
Low Tide Time Corrector 0 mins
Range Corrector x0.89
Reference 845-4000
NAR14
High Tide Time Corrector +18 mins
Low Tide Time Corrector +6 mins
Range Corrector x0.97
Reference 845-4000
NAR11
High Tide Time Corrector 0 mins
Low Tide Time Corrector 0 mins
Range Corrector x0.97
Reference 845-4000
845-4000 PROVIDENCE, RI
NAR16A
High Tide Time Corrector +6 mins
Low Tide Time Corrector +6 mins
Range Corrector x0.88
Reference 845-4000
NAR15
High Tide Time Corrector +12 mins
Low Tide Time Corrector +6 mins
Range Corrector x0.93
Reference 845-4000
NAR10
High Tide Time Corrector 0 mins
Low Tide Time Corrector 0 mins
Range Corrector x0.93
Reference 845-4000
NAR9
High Tide Time Corrector 0 mins
Low Tide Time Corrector 0 mins
Range Corrector x0.89
Reference 845-4000
NAR17
High Tide Time Corrector 0 mins
Low Tide Time Corrector 0 mins
Range Corrector x0.86
Reference 845-4000
NAR7
High Tide Time Corrector 0 mins
Low Tide Time Corrector 0 mins
Range Corrector x0.84
Reference 845-4000
NAR8
High Tide Time Corrector 0 mins
Low Tide Time Corrector -6 mins
Range Corrector x0.85
Reference 845-4000
NAR18
High Tide Time Corrector +12 mins
Low Tide Time Corrector 0 mins
Range Corrector x1.18
Reference 845-2660
NAR7A
High Tide Time Corrector 0 mins
Low Tide Time Corrector +6 mins
Range Corrector x0.84
Reference 845-4000
NAR19
High Tide Time Corrector +6 mins
Low Tide Time Corrector 0 mins
Range Corrector x1.12
Reference 845-2660
NAR6
High Tide Time Corrector +12 mins
Low Tide Time Corrector -6 mins
Range Corrector x1.12
Reference 845-2660
NAR20
High Tide Time Corrector +6 mins
Low Tide Time Corrector 0 mins
Range Corrector x1.08
Reference 845-2660
NAR5
High Tide Time Corrector +6 mins
Low Tide Time Corrector -6 mins
Range Corrector x1.12
Reference 845-2660
NAR21
High Tide Time Corrector 0 mins
Low Tide Time Corrector 0 mins
Range Corrector x1.05
Reference 845-2660
NAR3A
High Tide Time Corrector +6 mins
Low Tide Time Corrector 0 mins
Range Corrector x1.10
Reference 845-2660
NAR3
High Tide Time Corrector +6 mins
Low Tide Time Corrector 0 mins
Range Corrector x1.07
Reference 845-2660
NAR4
High Tide Time Corrector +6 mins
Low Tide Time Corrector -6 mins
Range Corrector x1.07
Reference 845-2660
NAR22
High Tide Time Corrector 0 mins
Low Tide Time Corrector 0 mins
Range Corrector x1.01
Reference 845-2660
NAR1
High Tide Time Corrector 0 mins
Low Tide Time Corrector +6 mins
Range Corrector x1.01
Reference 845-2660
NAR23
High Tide Time Corrector -6 mins
Low Tide Time Corrector +6 mins
Range Corrector x0.95
Reference 845-2660
NAR2
High Tide Time Corrector 0 mins
Low Tide Time Corrector 0 mins
Range Corrector x1.00
Reference 845-2660
845-2660 NEWPORT, RI
ATL620
High Tide Time Corrector 0 mins
Low Tide Time Corrector +12 mins
Range Corrector x0.95
Reference 845-2660
ATL617
High Tide Time Corrector -6 mins
Low Tide Time Corrector +12 mins
Range Corrector x0.89
Reference 845-2660
ATL619
High Tide Time Corrector -12 mins
Low Tide Time Corrector +12 mins
Range Corrector x0.89
Reference 845-2660
NOTE D
TRAFFIC SEPARATION SCHEME
BUZZARDS BAY
Penikese I
Cuttyhunk I
Gay Head
Westerly
Mystic

5.1 USING THE TIDAL ZONES IN TIDE WINDOW PREDICTION - First find the two zones that are at the ends of a flight line.
Import into Tide 8+ the monthly tide data for the Primary Station on which the zones are based. Edit the stations parameters in Tide 8+.

Choose one of the zones and rename the station to reflect the tide zone being worked. Apply the zone's corrector values to the appropriate inputs for the Primary Station.

The Low Tide Corrector value from the zoning diagram goes in the Low Tide Time Corrector parameter of Tide 8+.

The High Tide Corrector value from the zoning diagram goes in the High Tide Time Corrector parameter of Tide 8+.

The Range Corrector value from the zoning diagram goes into BOTH the Low Tide Ratio and High Tide Ratio in Tide 8+.

Supply the correct starting and ending times.

Run the program and get hard copies of both the MHW windows and MLLW windows.

Choose the other zone, rename the station to reflect the tide zone being worked and apply the correctors, ratio, and start/end times for that zone.

Run the program and get hard copies of both the MHW windows and MLLW windows.

Compare the output for each zone against the output for the other. If all has gone well each zone should have a series of windows that overlap with the other zone on a daily basis. The window within which that flight line can be flown is from the latest starting time in one zone to the earliest ending time in the other.

If there are no times of overlap, or no windows within which an aircraft could reasonably be expected to fly an entire line, pick a zone approximately half way between the first two.

Perform the calculations for it.

Check the output again for overlap with the other two zones.

It sometimes happens that two distant zones will not overlap with each other, but will with a zone between them. In this case the flight line will have to be broken and flown in pieces so that all of the imagery will be within tolerance.

Repeat this procedure with each flight line to get the windows for a project.

6. REAL TIME MONITORING OF TIDE GAUGES - In certain areas of the country such as the Gulf Coast or the North Slope of Alaska the tidal range may be so small or so affected by weather that predictions are not useful. In such cases the only way to obtain imagery within the appropriate tolerance may be to observe a tide gauge before and during the imagery flight mission. This is accomplished in one of two ways: 1) Physically monitoring one or more tide gauges in the project area and 2) Monitoring a real-time tide gauge through a radio or cell phone link or from an internet web page. Real time monitoring of tide gauges may be required by NGS. If so, a requirement will be included in the individual project instructions. If NGS does not require real time monitoring the contractor is not precluded from suggesting its usage.

6.1 PHYSICAL MONITORING **-** Physical monitoring requires a person or persons to be at a tide gauge before the expected level of tide occurs. The person stays in contact with the flight crew via radio or cell phone. The person then keeps the flight crew informed of the actual stage of tide on a continuing basis, telling them when it is proper to begin taking imagery and also when to stop.

6.2 MONITORING NOAA REAL TIME TIDE GAUGES **-** In certain areas of the country NOAA has Real Time Tide Gauges that can be monitored by the flight crew via radio, cell phone, or internet connection. The flight crew can then tell when it is appropriate to begin or stop taking imagery. These tide gauges are listed on the CO-OPS web site: http://tidesandcurrents.noaa.gov/.

7. POST MISSION ACTUAL TIDE LEVELS - The contractor is responsible for determining the actual tidal level when imagery was taken, and for ensuring that the imagery falls within the allowable tolerance for an NOS primary tide gauge or a monitored subordinate gauge. The actual level of tide can be obtained from the CO-OPS web site at: http://co-ops.nos.noaa.gov/data_res.html. Choose the tide station and tide zone used for the original predictions. Get the height and time given in the CO-OPS six minute verified tide listing for the primary station used for the predictions. Apply the tide zone correctors to the time and height of the actual data and compare to the height prediction for the time the imagery was taken to determine if it was actually within the tolerance.

It should be necessary to do this only with the zones at the ends of actually flown flight lines. If there was a break in a flight line it will be necessary to do it for both times and dates that the line was flown.

8. CONTRACTOR INSTALLED TIDE GAUGES - The contractor shall, when required by the Project Instructions, install tide gauges. Tide gauge installation shall be in accordance with the Project Instructions, this SOW, the "NOS HYDROGRAPHIC SURVEYS, SPECIFICATIONS AND DELIVERABLES" (HYDRO. SPECS.), Chapter 4 (April 2007), and other CO-OPS documents. Also see Attachment AH, "NGS Requirements for Tide Gauge Stations". ~~the CO-OPS publication: Specifications and Deliverables for Installation, Operation, and Removal of Water Level Stations. This publication is available at URL: http://co-ops.nos.noaa.gov/pub.html.~~

Tide gauges shall be installed at locations that will be determined by consultation between NGS and the contractor.

9. CONTRACTOR DETERMINED TIDAL DATUM - The contractor shall, when required by the Project Instructions, determine the local tidal datum for the project area. Datum computation shall be in accordance with CO-OPS publication: Computational Techniques for Tidal Datums Handbook. This publication is available at URL: http://tidesandcurrents.noaa.gov/publications/Computational_Techniques_for_Tidal_Datums_handbook.pdf .

10. QUALITY ASSURANCE / QUALITY CONTROL - The contractor shall be responsible for all Quality Control / Quality Assurance of the tidal and geospatial data created and submitted in the course of a project.

NGS will provide the contractor training in how to calculate the predicted tide tolerance at a mutually acceptable time and place. After training, the contractors shall submit predictions to NGS so that NGS can be confident that the Contractor fully understands the procedure for calculating the tolerance. When NGS is satisfied that the Contractor can successfully make the calculations, they will notify the contractor that submission of tide window data is no longer necessary. The Contractor shall be fully responsible to ensure that all tide coordinated imagery is obtained within the acceptable tolerance windows.

The contractor shall obtain actual verified times and heights of tides during the time of imagery acquisition from the verified and accepted data set available at CO-OPS web site. The verified and accepted data set is generally available within a month for primary stations and subordinate stations, or within a week if the primary and/or subordinate stations are monitored and are listed with priority processing on CO-OPS hydro hot list. The actual data will be compared to the times and heights of the predictions to ensure the imagery was taken within the tolerances.

NGS will provide refresher training in tide window tolerance prediction upon request, at a mutually acceptable time and place.

Version 2A
January 31, 2008

ATTACHMENT K
FEATURE COMPILATION

TO
SCOPE OF WORK FOR SHORELINE MAPPING
UNDER THE
NOAA COASTAL MAPPING PROGRAM

REMOTE SENSING DIVISION
NATIONAL GEODETIC SURVEY
NATIONAL OCEAN SERVICE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE

ATTACHMENT K – FEATURE COMPILATION

ATTACHMENT K - FEATURE COMPILATION

1. INTRODUCTION

The primary goal of the NOAA Coastal Mapping Program is to provide maps of the shoreline, and associated natural and cultural features of the coast, in support of NOAA's nautical chart production. The digital shoreline data produced through the Shoreline Mapping Contract include hazards and aids to navigation, and port infrastructure critical to the safe and economical use of the marine transportation system. This mapping data shall be created through digital compilation and attribution from stereo aerial imagery, and possibly other remote sensing sources. The contractor shall follow the procedures described in the Quality Control Plan for the project to ensure that data of the highest quality is delivered.

2. SYSTEM REQUIREMENTS

The contractor shall perform feature compilation using high quality analytical or digital photogrammetric mapping systems. The hardware and software used shall be capable of achieving the accuracy requirements of the project. The digital format in which the original data is compiled will be determined by the contractor's particular mapping system, but when the compiled data is delivered it shall be in the ESRI Shapefile format as defined in Attachment D. Whatever format the mapping data is in, it is generally referred to as the Digital Cartographic Feature File (DCFF).

3. PREPARATION

Prior to beginning feature compilation certain materials and information should be made readily available to the compiler to aid in the successful completion of this phase of the project.

3.1. AEROTRIANGULATED IMAGERY – The feature compilation shall be accomplished using the aerotriangulated images of all emulsion types acquired that cover the project area. It is also desirable for the compiler to have a copy of the Aerotriangulation Report, as it contains information useful for feature compilation.

3.2. PROJECT INSTRUCTIONS – The compiler shall be fully aware of any unique requirements associated with the particular project as defined in the Project Instructions. These unique requirements may include, but are not limited to:

- The different photographic emulsions or other remote sensing systems used
- Areas of tide coordination
- The largest scale NOAA nautical charts covered by the project
- The limit of feature compilation
- Target scale and level of detail for feature selection and generalization
- Horizontal and vertical accuracy requirements
- The completion date

3.3. CHART COMPARISON PRINT (CCP) – The contractor will be supplied copies of the largest scale NOAA nautical charts covering the project area for use as Chart Comparison Prints. The compiler should examine the land and near shore water areas to identify charted features to be investigated during feature compilation. The compiler should use a high-lighter (marker) to mark these features on the CCP for easy reference. During feature compilation, the compiler shall compare the charted features with the aerial imagery, and make annotations on the CCP as to confirmation or non-confirmation of the existence of the charted features. Confirmed features are normally compiled and simply checked off. Features that could not be confirmed in the imagery are normally circled in red and marked "NC". Significant changes to charted features shall also be noted on the CCP. The annotated CCP is used to create the Chart Evaluation File (see Attachment AE), and to assist in the DCFF review.

3.4. ACTUAL TIDE LEVELS – The compiler will usually need to know what the actual measured tide/water levels were for all areas of the project at the time the images for each area were acquired, and not simply the predicted tide/water levels. Knowledge of the differences between the tide level in an image and the MLLW and MHW tidal datums in the area is necessary for the compiler to accurately interpret and position the shoreline and associated features. This tide level information should be available from the Tabulation of Aerial Photography prepared following the imagery acquisition. (See Attachment C, Section 7.2.J.)

3.5. ADDITIONAL REFERENCE SOURCES – See the SOW Section 3.6 for additional references needed for feature compilation. The contractor should become especially familiar with Chart #1 as an aid to understanding the symbology of features on the chart.

4. <u>GENERAL FEATURE COMPILATION</u>

4.1. REQUIRED FEATURES – In general, the contractor shall compile those relatively permanent and fixed features visible in aerial imagery, which are useful for marine navigation, and are commonly depicted on NOAA nautical charts. These features include: Shoreline (both natural and man-made), alongshore port infrastructure, obstructions, landmarks, fixed navigational aids, dangerous areas, and other significant cultural and natural features in the coastal zone.

> A. MILITARY INSTALLATIONS – Apart from features already shown on the chart, features in the Natural_Feature_Miscellaneous class, and lights in the USCG Light List, the contractor shall not collect any features landward of the shoreline located within an active military reservation, unless explicit permission to do so is provided in the Project Instructions.

4.2. NEAT LIMITS – For the best accuracy, features should be compiled within a stereomodel's "neat limits", which is understood to be a rectangular shaped area between adjacent principal points and extending halfway into each sidelap area. Errors caused by image distortion typically increase the closer one compiles to the edge of the stereomodel. The contractor shall not compile features beyond the fiducial mark limits of an image.

4.3. FEATURE ATTRIBUTION – All cartographic features measured must be correctly classified with the appropriate attribution according to the requirements in Attachment D. A glossary of terms used in the Coastal Cartographic Object Attribute Source Table (C-COAST) attribution scheme is included in Attachment F. (Also see SOW Section 8 for Office Data Collection requirements.)

4.4. VECTOR CONNECTIVITY – Certain types of linear features are required to connect (snap) exactly to themselves or each other, in order to provide topologically clean data from which a user can easily build polygons for a Geographic Information System (GIS). Specific guidance is provided in Section 5 below as to which features require vector connectivity.

4.5. COMPILATION SCALE – The Compilation Scale is used to determine the general level of detail and feature generalization the compiler should use in a particular area of a project. Many features have guidelines for their collection based on a particular map distance at the Compilation Scale. This Compilation Scale will normally be defined in the Project Instructions, which takes precedence over this attachment to the SOW, but generally the following rule is used:

> For any portion of a project area the Compilation Scale within that portion is equal to two times the scale of the largest scale chart or chart inset that includes that portion. However, the Compilation Scale will be neither smaller than 1:20,000 nor larger than 1:2,500.

Example 1: For the area of Zarembo Island, the largest scale chart covering that area is chart 17382 at 1:80,000 scale. Two times the chart scale would be 1:40,000, which is smaller than 1:20,000, so the Compilation Scale would be equal to the minimum allowed scale of 1:20,000.

Example 2: The harbor at Rockport Landing is shown on a 1:10,000 scale inset on chart 18620. The portion of the project area covered by the inset should be mapped at a Compilation Scale of 1:5,000, which is two times the scale of the inset.

4.6. ACCURACY – The compiler should take great care to measure the features in the imagery as accurately as possible, while keeping in mind the required level of detail as represented by the Compilation Scale.

A. ACCURACY REQUIREMENTS – The horizontal and vertical accuracy requirements for a project will be defined in the Project Instructions, which may refer to an attached chart depicting different accuracy requirements for different portions of the project area. The actual horizontal and vertical accuracies shall be equal to or better than the accuracy requirements as defined in the Project Instructions. See SOW Section 3.3.

B. DETERMINING ACTUAL ACCURACY – The actual horizontal accuracy for a project is defined to be two times the horizontal circular error (95% confidence level) as computed from the aerotriangulation results (see Attachment I, Section 4.8.D.) This doubling of the computed error is intended to account for any additional positioning error introduced during the compilation process. The actual vertical accuracy for features should be estimated by the contractor in a similar fashion accounting for known or expected error sources. If project images were divided into separate blocks for aerotriangulation, then features compiled from different blocks will likely have different accuracies. The contractor shall determine the actual accuracy for each block of images.

C. WELL DEFINED POINTS – The term "well defined points" refers to small, sharp, clear features that can be unambiguously measured to a high level of precision in the imagery as well as in the field. Well defined points might be actual point type features such as piles, fixed navigational aids, or certain types of landmarks like spires, crosses, or flagpoles. Or a well defined point might be an intersection of clearly identifiable linear features, such as the square corner of a pier, bulkhead, wharf, or other features with sharply defined edges; or maybe the perpendicular intersection of a railroad line with the painted centerline of a narrow road.

D. REPORTING ACCURACY – The reported accuracy of a project is a predicted accuracy based on tested methodology. It is understood that the stated accuracy applies to well-defined points compiled in the DCFF, and not necessarily to other compiled features that are less sharply defined. Nevertheless, the actual horizontal and vertical accuracies (as determined in B above) shall be entered into the appropriate data fields for **all features** in the final delivered shapefiles, based on the image block from which the features were compiled. The actual horizontal accuracy is also reported in the Compilation section of the Project Completion Report (see Attachment L, Section 4.7.)

4.7. BARE, COVERS/UNCOVERS, AND SUBMERGED – Many features are compiled using different attribute types based on the relationship between the features' elevation and a particular vertical (usually tidal) datum. These include some features in the following classes: Alongshore Feature, Obstruction Point, Obstruction Linear, Danger Area, and Freestanding Marine Feature. These features are classified as Bare, Covers__Uncovers, or Submerged; though some may combine the latter two into one classification: Covers__Uncovers_Or_Submerged. Some of these feature types are lines and some are points. A point feature is always compiled using just one TYPE code based on the elevation of its highest point. A linear feature may have different portions at various heights relative to the vertical datum, in which case the different parts should be compiled as individual connected linear sections using the appropriate feature types. The definitions of Bare, Covers/Uncovers, and Submerged in Attachment F apply to all feature types with the exception of ledges, reefs, discrete rocks, and coral heads. Due to their particularly hazardous nature, these features have different specifications for Bare, Covers/Uncovers, and Submerged, depending on which coast of the United States the project is located, as indicated below. Note that ledges and reefs may only be Covers/Uncovers or Submerged, never Bare.

CLASSIFICATION OF ROCK, CORAL, LEDGE, & REEF
(Based on the height of the top of the object rounded to the nearest foot)

	BARE	COVERS/UNCOVERS	SUBMERGED
Atlantic & Gulf of Mexico	More than 1 foot above MHW	From exactly 1 foot above MHW to exactly 1 foot below MHW	More than 1 foot below MLLW
Pacific	More than 2 foot above MHW	From exactly 2 foot above MHW to exactly 2 foot below MHW	More than 2 foot below MLLW
Great Lakes	More than 4 feet above Low Water Datum	From exactly 4 feet above LWD to exactly 2 feet below LWD	More than 2 feet below Low Water Datum
Other Non-Tidal Areas	Above water level at time of imagery capture	NOT APPLICABLE	At or below water level at time of imagery capture

The project instructions may supersede these specifications based on water level coordination requirements in a particular area, especially in the Great Lakes region.

5. CARTOGRAPHIC FEATURE COMPILATION GUIDELINES

This section contains collection guidance for all of the features in the C-COAST attribution scheme that the contractor is expected to compile. It is intended to help answer the most common questions of the new shoreline compiler, and provide a useful reference to the more experienced compiler. However, every project is unique, and a document such as this cannot cover every possibility. The shoreline compiler is likely to have many more questions that cannot be answered here, and he or she is strongly encouraged to contact the NOAA representative assigned to the project whenever additional guidance is needed. The features referred to in this section will be in the sequence and attribution format of the Interim Shapefiles as presented in Attachment D, Section 2.3. Refer to the glossaries in Attachments F and M of the SOW, for definitions of many of the terms discussed in this section.

5.1. SHORELINE – The shoreline is the primary product of the Coastal Mapping Program, and the most important feature type compiled under this contract.

A. CONTINUITY – The shoreline shall be compiled as a continuous unbroken line representing the boundary between a land area and a body of water. This concept of the shoreline as a boundary is useful, as the line must always represent land on one side and water on the other side. To maintain this topology the shoreline can never split, or fork, into two lines; and two shorelines can never merge into one. A shoreline can only end by closing on itself, as when surrounding an island or lake; or when connecting to a cartographic limit line indicating the designated extent of feature delineation, an area of low visibility, or the extent of the project imagery. The shoreline may be compiled using any combination of attributes in the Shoreline feature class, though there are certain usage rules for the various types of shoreline as detailed below. Adjacent lines shall connect exactly, endpoint to endpoint, typically by snapping the endpoints together during compilation. There shall be no duplicate segments, overlapping dangles, or gaps in the shoreline.

B. APPROXIMATE TYPES – The contractor is required to produce a complete and continuous shoreline within the project area. But sometimes the shoreline cannot be accurately compiled, because it cannot be seen. It may be obscured by overhanging cliffs, trees, buildings; or by wide bridges or piers; or by shadows cast from any of these features. To compile in areas where the shoreline is obscured we use the modifying attribute “Approximate”. This modifier only applies to certain shoreline types, specifically:

Mean_High_Water__Approximate
River_Or_Stream__Approximate
Great_Lake_Or_Lake_Or_Pond__Approximate
Canal__Navigable__Approximate
Undetermined__Approximate

The first three are the major natural shoreline types (not including Apparent, Glacier, and

Mean_Sea_Level which, due to their transient or indeterminate nature, already imply an approximate positioning quality.) Canals are man-made, but typically have a natural appearing shoreline, and so in this case are grouped with the natural shoreline types. All the non-canal man-made shoreline types shall be compiled using the Undetermined__Approximate attribute when the shoreline is obscured. The compiler should make every attempt to minimize the use of approximate shoreline, by examining the obscured area on all applicable images for the best possible view, and by adjusting the image display (brightness, contrast, etc.) to enhance details in shadow areas.

C. ISLETS – A separate area of shoreline with its longest dimension less than 0.5 mm at the compilation scale is too small to show as a linear feature, but shall instead be compiled as a point feature in the Obstruction_Point class (see 5.3 below). But if several of these small islets are grouped within 0.5 mm of each other, the compiler may delineate them with a generalized shoreline around the whole group; though a collection of separate rocks is usually better shown as a foul area.

D. MEAN HIGH WATER – The Mean High Water (MHW) attribute is used to delineate the line where a tidally influenced body of open water intersects the natural solid ground, when the water level is equal to the local MHW tidal datum. The MHW attribute is not used for shoreline in non-tidal areas (such as lakes or some rivers), or in areas where the water does not intersect with dry ground (as with marshes or glaciers), or where the shoreline is engineered (as with bulkhead, rip rap, canals, ramps, etc.)

i. The Ideal Case – When mapping the MHW line from aerial imagery the ideal situation would be to have the water level exactly equal the MHW elevation at the time the imagery was acquired, for the water to be perfectly still and unchanging during the imagery acquisition, and for the imaging system to show a perfectly sharp contrast between areas of water and areas of dry land.

ii. Reality – In practice the tidal dynamics in the project area are often not fully defined, and the changing tides and wave action cause the water level to vary, so imagery is rarely collected exactly at the local MHW stage. In addition, shallow water is semi-transparent causing a gradual change in brightness between land and water in an aerial image, rather then a sharp contrast. We try to minimize these effects by collecting tide-coordinated aerial photographs on black and white infrared film using the appropriate filters to maximize the contrast between the land and the water. But even so, this can only narrow the zone of possible choices for delineating the MHW line.

iii. Interpretation – A certain amount of interpretation based on knowledge, training, and experience is still required. The compiler should know the actual tide levels in the images, and how the tide may vary over time (rising or falling) and from one area to another throughout the project.

iv. Berms – Distinct beach features such as berms and debris lines can aid in the interpretation of the MHW line. Many sandy beaches have a visible berm located slightly landward of the MHW line, but this must not be confused with a storm berm, debris line, or vegetation line which may be seen on the backshore further inland. A beach may have no berm or several berms.

v. Tone & Texture – When distinct beach features are not present, differences in tone and texture may help distinguish the foreshore from the backshore. Depending on beach sediments, wave action in the swash zone tends to make the foreshore area appear darker and smoother than the backshore.

vi. Wave Action – The run-up and retreat of waves must also be taken into account by the compiler. If the actual tide level is at MHW then the shoreline would be delineated approximately half-way between the average run-up and retreat limits of the waves. A lower actual tide level would make the MHW line appear closer to the run-up limit, and a higher actual tide level would make it appear closer to the retreat limit.

vii. Elevation – If the elevations of the actual water level in the image and the local MHW datum can be determined to a high degree of confidence, then this knowledge can often assist in the interpretation of the MHW line, especially in limited areas where very few other visual clues are present. But the shoreline should not be contoured over broad areas unless the stereo models are very level and the detailed tidal dynamics of the area are very well known.

viii. Tidal Rivers – The water level in some rivers may rise and fall in a regular tidal cycle for some distance upstream due to the influence of the tide at the mouth of the river where it meets a large body of tidal water. This tidal influence can extend 100 miles or more upstream in some cases. The shoreline in rivers with a tidal cycle is compiled using the MHW attribute up to the limit of tidal influence. That is, upstream to the point where changes in the water level due to the tide no longer affect the position of the shoreline of the river (officially, where the tide range becomes less than 0.2 ft.) This point is called the Head of Tide. Lacking detailed tidal measurements on the river, the compiler will have to make a judgment as to where this point occurs, based on the information at hand, and stereo observations of the elevation of the water surface and the surrounding terrain and vegetation. Beyond the head of tide a river is compiled using the attribute: SHORELINE – River_Or_Stream. See 5.1.O below for more details.

E. APPARENT SHORELINE – Wetlands often occur in low lying areas near the coast subject to regular or frequent inundation, and are usually heavily vegetated with plants adapted to grow in saturated conditions. There is usually a considerable amount of vegetation growing up through the water, appearing above the surface, and obscuring the ground below. Theoretically, a MHW shoreline could be delineated by measuring the extent of the inundated area when the tide is at MHW, but this line is very difficult to see (even from the ground) due to the dense vegetation. Also, depicting a true MHW shoreline in a wetland area would not be very useful to the navigating mariner, as the line on the chart would not represent any feature that could actually be seen from the vessel. Instead, the shoreline is collected along the seaward limit of the wetland, where the open water meets the vegetation. This is where the shoreline appears to be from the mariner's point of view, and is thus termed the Apparent Shoreline.

i. Types of Apparent Shoreline – There are two types of Apparent Shoreline in C-COAST, Marsh_Or_Swamp and Mangrove_Or_Cypress. See their definitions in Attachment F. Mangrove/Cypress can be distinguished in aerial imagery by its relatively taller, tree or shrub-like appearance compared to the lower grassy appearance of marsh or swamp, but local knowledge of the area being mapped is the best resource for interpretation of wetland types. It is important to distinguish areas of Mangrove/Cypress on the chart because the surrounding area is more likely to contain hazardous submerged stumps or snags. Note that Apparent Shoreline is different from the aquatic vegetation feature types, which normally grow under the water but may be visible at or above the surface, especially at low tide stages. See section 5.12 below on the Aquatic_Vegetation_Area feature class.

ii. Application – As with all shoreline, Apparent Shoreline must be continuous and connect exactly at its endpoints with other shoreline types. At the point where an Apparent Shoreline vector connects with another shoreline type, it must also connect with the appropriate wetland extent line (Marsh_Or_Swamp__Extent or Mangrove_Or_Cypress__Extent) from the Natural_Feature_Miscellaneous class. See section 5.10.A below for more details on wetland extent lines.

F. BULKHEAD – Bulkhead is the most common type of man-made shoreline. As stated in the glossary, Bulkhead_Or_Sea_Wall refers to an embankment or wall constructed for protection against waves or tidal action along a shore or water front. A bulkhead can be either sloping or vertical. It may be constructed of concrete, or wood, or some other material. The face may be solid, or of open-pile construction. When a bulkhead is vertical it should be compiled along the top edge of the face, not down at the water level. This allows for a more accurate delineation of the bulkhead's horizontal position. Often a vertical bulkhead will be compiled along the top edge up to its endpoint, which is then collected lower down in order to connect both horizontally and vertically with another shoreline type at a lower elevation. A sloping bulkhead should be delineated along the face approximately where the water would be at the MHW tide stage; or at the waterline for non-tidal areas. Generally a bulkhead does not consist of broken chunks of concrete or other unconsolidated material (like rip-rap) unless it is in ruins, in which case it would be compiled as Bulkhead_Or_Sea_Wall__Ruins. Also, a bulkhead is typically not used for berthing, launching, or landing vessels. Other feature codes apply to shoreline used for these purposes, and for the interiors of drydocks or locks. As such, the compiler will often need to determine how a shoreline is being used, and not just how it appears.

G. CANAL – A canal is a man-made waterway, but it can often be mistaken for a natural shoreline. When a canal is cut through the land as a simple ditch, without any other development of the shoreline, as with a bulkhead or rip rap, it has the appearance of a natural stream bank. The characteristic that distinguishes the waterway as a canal is its overall shape. Natural streams tend to meander along winding paths of varying width and curvature, while canals are made with straight lines and broad curves. Canals usually have a fairly constant width, and may intersect other canals at near right angles. Canals are classified as either navigable or non-navigable. Non-navigable canals are used for drainage or irrigation, and only need to be compiled if they connect with navigable waterways. In reality, the canal code is not used very often, since it is often superseded by other types of man-made shoreline (bulkhead, rip rap, etc.) or by apparent shoreline when the canal is cut through a wetland area.

H. DRY DOCK – A permanent dry dock is a fixed basin into which ships can be floated and secured. Then the dry dock is closed and the water pumped out to expose the hull of the ship, typically for repair or maintenance. When a dry dock is open it is full of water, and appears similar to a bulkhead, wharf, or the docking space between two piers. The difference is that a dry dock will have a mechanism at its entrance, such as a gate or caisson, which can be used to seal the basin and allow the water to be pumped out. Dry docks are easier to identify when they are closed and dry, especially if a ship is inside being repaired. The top edge of the interior of the basin (inside the gate) is compiled using the shoreline feature type Drydock__Permanent. There is also a Floating_Drydock feature type in the Obstruction_Linear class, but that code does not apply to a permanent fixed part of the shoreline, and is only compiled in certain circumstances. See 5.4.J for further details on floating dry docks.

I. GLACIER – This shoreline feature type is used to delineate the line where a marine glacier meets the sea. This line is the interface between the ice mass and the water. The seaward face of a glacier is typically a tall vertical wall of ice, subject to frequent change as the river of ice flows and icebergs calve off. The top of the face often overhangs the base, making it difficult to delineate the interface at the surface of the water. But the exact position of the glacial shoreline is not that important; since the face never remains fixed for very long, it is always considered to be an approximate line. It is usually easiest to compile along the top edge of the face, though the endpoints must be down at the normal shoreline elevation to connect to any adjacent shoreline of a different type. The Glacier code is not used for the landward limits of the ice. Similar to an Apparent Shoreline vector, a Glacier vector must be paired with Glacier__Extent lines (from the Natural_Feature_Miscellaneous class) connected at its endpoints. See 5.10.B below for more details on glacier extent lines.

J. LAKE OR POND – A lake is any non-tidal body of water mostly or completely surrounded by land. The shoreline of any lake that contains marine facilities (e.g. piers, wharves), or is connected to the coastline by a navigable waterway, shall be compiled using the feature type Great_Lake_Or_Lake_Or_Pond. As indicated by its name, this feature type is used for all bodies large and small, from Lake Superior to the smallest navigable pond, as long as they meet the criteria above.

K. LOCK – A lock is used where the surface of a navigable waterway changes level, to allow vessels to be raised or lowered from one water level to the other. A lock is constructed as a basin with gates or caissons at each end, which can be closed to allow water to be pumped in or out, raising or lowering the water level in the lock basin. The shoreline between the gates, inside the basin, is compiled using the feature type Lock. This shoreline is usually vertical, like a bulkhead, and is best compiled along the top edge.

L. MEAN WATER LEVEL – This feature type shall only be used to delineate the shoreline if the contractor is directed to do so in the Project Instructions, or after consultation with NOAA personnel assigned to monitor the compilation phase of the project. Mean_Water_Level is occasionally used in place of Mean_High_Water in areas of little or no tide range, where the MHW level cannot be accurately determined; most commonly in certain back-bays and lagoons where a tidal signal is uncertain or irregular.

M. RAMP – A Ramp is a sloping area of shoreline used for landing or launching vessels. It is typically constructed of concrete, and is associated with a parking or driveway area (usually paved) on its landward side. Often small piers or fenders project into the water on either side of the ramp to help direct the movement of the vessel, or of the equipment used for hauling the vessel in or out of the water. In tidal areas, the Ramp line shall be compiled at the MHW level along the slope. In non-tidal areas the Ramp is simply delineated along the land/water interface in the imagery.

N. RIP RAP – Rip rap can be mistaken for natural shoreline since it has a sloping surface and a rough texture, and it is often placed along a naturally curving shore. But it can be distinguished by the regularity of the texture, and the relative steepness of the slope. Rip rap in general can be made of various materials, such as rock or concrete, but a particular layer will tend to be homogeneous in size, depth, and construction. In tidal areas a Rip_Rap shoreline should be delineated along the MHW level of the slope, but due to the rough surface this line can be difficult to determine. Usually, since rip rap has a fairly steep slope, the horizontal position of the waterline doesn't vary much with the tide level.

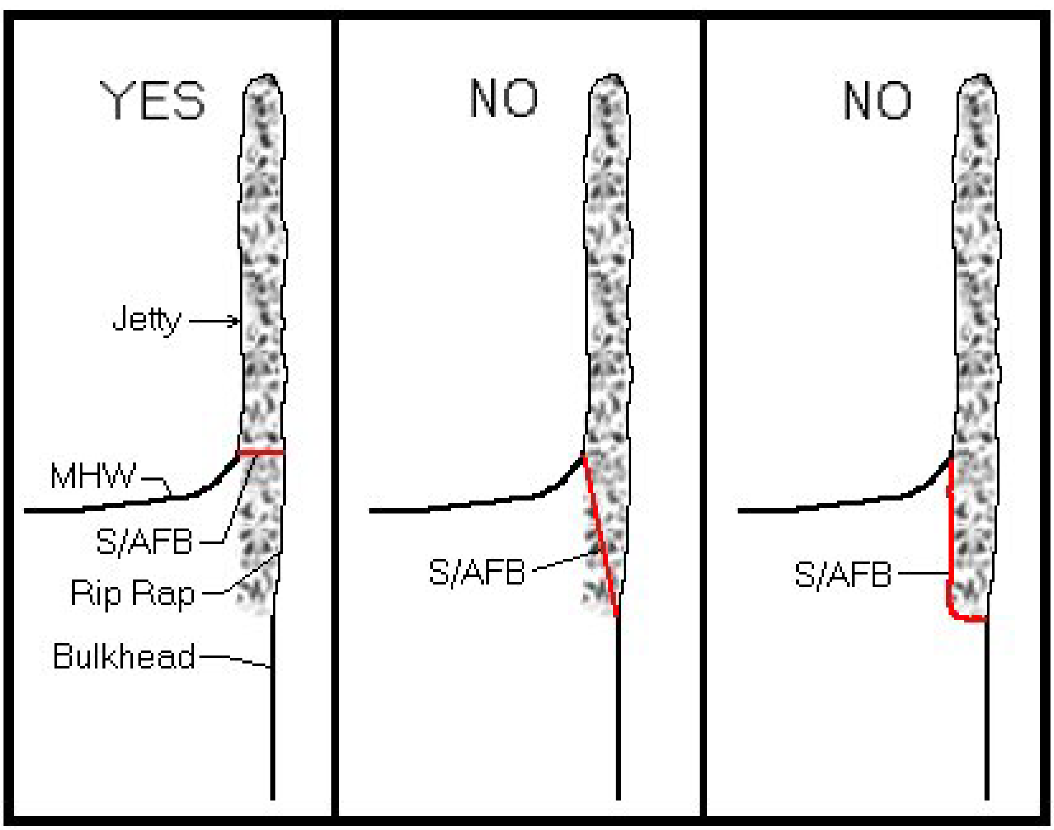
O. RIVER OR STREAM – This code should be used to compile the shoreline of non-tidal rivers and streams which are wide enough to be depicted at scale as double-line features, i.e. 0.5 mm or more separating the lines at the compilation scale. As stated above (5.1.D.viii), tidal rivers are compiled using the MHW shoreline type up to the Head of Tide. The River_Or_Stream feature type is used beyond the Head of Tide, upstream to where the banks narrow to less than 0.5 mm separation at compilation scale. At that point the compiler should pinch the stream down by collecting a point in the middle of the water, and then continue compiling downstream on the other bank. See section 5.10.D below for guidance on compiling streams less than 0.5 mm wide.

P. SLIPWAY – A slipway, especially when not being used, may appear similar to a ramp since it is a sloping hard surface leading down to the water, but is not used for general landing and launching of vessels. Rather a slipway is used for construction or repair of a ship. There will often be rails, blocks, and other structures to support a ship under construction. In tidal areas a Slipway shoreline is delineated along the MHW level of the slope.

Q. WHARF OR QUAY – A wharf or quay provides a place for vessels to berth against one side in order to load or unload passengers or cargo, in other respects it may appear similar to a bulkhead. A wharf or quay is distinguished from a bulkhead by how it is used. Therefore, a compiler must recognize various characteristics that indicate the shoreline's purpose. The presence of a ship tied up alongside in the process of loading or unloading cargo or passengers is an unmistakable sign. Also large amounts of bulk cargo, shipping containers, cranes, conveyor systems, and other equipment for handling cargo are often found on a wharf or quay. Note that a pier is also used for berthing vessels in a similar way, but a pier projects out from the shoreline into the water to provide berthing space on both sides, while a wharf or quay is part of the shoreline having only one long side running parallel to the general trend of the coast. A wharf or quay may project out a bit, but normally no more than its width along the shore.

R. UNDETERMINED – When the compiler is unable to confidently interpret the type of shoreline in a particular area, then one of the Undetermined shoreline types should be used. Most often this is due to the shoreline being obscured in some way, so the Undetermined feature type is almost never used without the “Approximate” modifier (see 5.1.B above). This feature type is most often used for shoreline under certain bridges and wide piers where it is unclear whether bulkhead, rip rap, or natural shoreline (or some combination) is present in the obscured area.

S. SHORELINE / ALONGSHORE FEATURE BOUNDARY (S/AFB) – The purpose of this feature code is to provide an imaginary line connecting gaps in the shoreline, caused by certain wide (double-line) alongshore features, in order that the shoreline will be continuous. Some alongshore feature types (Breakwater, Groin, and Jetty) do not have a true land/water interface (shoreline) running underneath them, but are solid down to the ground. They project directly out from the shore, but since they are in the Alongshore_Feature class, they cannot substitute for Shoreline. When these features are wide enough to compile as outlines, there will be a gap in the shoreline where the feature abuts the land. This gap shall be closed by a straight line segment using the S/AFB code. The exact inland limit of the Alongshore Feature, and thus the placement of the S/AFB line, is up to the compiler's judgment. But one should attempt to depict this inland limit in such a way as to minimize the length of imaginary shoreline digitized, while still maintaining a realistic outline of the feature. See example diagram below:



Some large piers also are solid to the ground and project directly out from a vertical man-made shoreline (bulkhead or wharf) and do not cross over the shoreline. These piers need to connect (snap) to the shoreline on both sides, and an S/AFB line must be snapped to these points as well to fill the gap in the shoreline.

5.2. ALONGSHORE FEATURE – Alongshore Features include various objects constructed in the water near the shore that may cross over the shoreline, abut the shoreline directly, or be completely surrounded by water.

A. WIDTH/LENGTH LIMIT – All alongshore features may be compiled as either a single line along the center of the object, or as an outline around the perimeter of the object, depending on the width of the feature and the accuracy requirements of the project. As indicated in section 3.3 of the SOW, the project accuracy is usually based on whether the area of interest is a harbor or port, an approach to a port, or a general open coastal area. The width limit for single-line vs. double-line delineation of alongshore features is 3 meters for harbor/port areas, 5 meters for approaches to ports, and 10 meters for the open coast. Note that these widths are actual ground distances, and are independent of the compilation scale. All alongshore features narrower that the width limit for a particular area shall be compiled as a single line along the center. Alongshore features of equal or greater width than the limit shall be compiled as a closed outline around the perimeter. Some alongshore features will have a combination of wide sections and narrow sections; so it may be necessary to compile a feature as separate connected sections, some parts as single-line and some parts as double-line. All alongshore features with a length less than 0.5 mm, or that project less than 0.5 mm from the shoreline at the compilation scale shall not be compiled.

B. CONNECTIVITY – Double-line alongshore features shall have no gaps, dangles, or overlaps. Features consisting of multiple connected sections shall be compiled such that the sections snap together exactly. Certain alongshore features also must connect (snap) exactly to the shoreline from which they project (see 5.1.S above).

C. PIERS – Piers may be fixed, floating, or in ruins. The entire extent of a pier shall be compiled, even any portion that may be landward of the shoreline.

i. Connection To Shoreline – Intact piers (fixed or floating) shall always connect to or cross over the shoreline, and shall never be completely on the land or in the water. Piers in ruins may be completely in the water. An intact long and narrow mooring structure, that may appear similar to a pier but is completely surrounded by water with no connection to the shoreline, would be compiled as a Platform (see section 5.4.C below).

ii. Shoreline Under Piers – Large piers that cross over the shoreline may obstruct the compiler’s view of the shoreline beneath, and may require the use of an “Approximate” shoreline feature type (see 5.1.B) in the obscured area. Large solid piers that abut directly to a vertical man-made shoreline do not have an actual land/water interface running underneath, and will typically require the compiler to delineate a Shoreline/Alongshore Feature Boundary line in the same location (duplicate line) as the landward edge of the pier (see 5.1.S above).

iii. Finger Piers – Often a large pier will have a number of smaller "finger piers" extending from it. These finger piers shall only be compiled if greater than or equal to the 0.5 mm minimum length for Alongshore Features, and there can be no less than 0.5 mm separation between them. If the finger piers are closer together than 0.5 mm it will be necessary to compile only a representative selection of them. Usually in this case compiling every other finger pier is sufficient.

iv. Floating Piers – Small piers in areas with variable water levels are often constructed so that the pier floats on the surface, rising and falling with the changing water level. Often floating piers will have a fixed part connected to the shoreline, and an articulated sloping section that connects the fixed part to the floating part. Floating piers are most easily distinguished in imagery acquired at low water stages, since in that situation a pier appearing down near the water level would have to be floating, otherwise at higher water levels the pier would cover making it unsuitable as a mooring structure.

D. BREAKWATERS – A breakwater is a structure found at the seaward side of a harbor or other anchorage area, placed to protect the area from waves. It may extend from the shore, or from another feature such as a pier, or it may stand out in the water by itself. A breakwater is usually bare, but some may have parts that cover and uncover, or are submerged. It is often made of piled up stone, but may be built from a variety of materials, though it is usually fixed and solid. The compiler can often see a distinct calming of the wave action on the protected side of a breakwater compared with the seaward side. A breakwater is not normally used for mooring vessels, but occasionally one may see a vessel anchored beside, or even tied to a breakwater.

E. BRIDGES – There are four types of bridges: Fixed, Opening, Footbridge, and Pontoon. Each of these types can be further classified as intact, in ruins, or under construction; leading to 12 different possible feature codes used for bridges. The contractor shall only compile bridges that cross over some body of water, including streams or wetlands. The water body does not need to be navigable, but it must be more than a simple drainage culvert. A bridge must be open underneath, elevated above the surface. Solid causeways are not compiled as bridges. An intact bridge can never be completely offshore with no connection to the land, though a bridge in ruins or under construction can be entirely surrounded by water. Bridges will often obscure a portion of the shoreline, and may require the compiler to use an "Approximate" shoreline feature type underneath (see 5.1.B).

i. Bridge Supports – Any bridge abutments and supports (pylons) within a navigable waterway are a hazard to the mariner, and should be compiled if possible. Bridge supports landward of the shoreline can be ignored. Often, due to relief displacement (especially with a high bridge) the compiler can see part, if not all, of the line where the support intersects the water. The portion of the bridge support that can be seen in the imagery should be compiled as shoreline using the Bulkhead_Or_Sea_Wall code and the portion that cannot be seen should be compiled as Undetermined__Approximate shoreline. Make an effort to view the bridge on every image on which it appears, in order to accurately measure as much of the support as possible. If you suspect a bridge support exists, but no part of the feature is visible, do not try to compile it.

ii. Roads and Bridges – A road or railroad overpass that does not cross a body of water shall not be compiled as a bridge. A road or railroad supported by a bridge shall not be compiled on or through the bridge, but shall connect (snap) to the bridge at both ends. Roads or railroads that cross under bridges (or other roads for that matter) should be continuous with no break for the underpass. See 5.9 below for more on roads.

F. FENDERS – Fenders are often found under bridges to protect the supporting structure from collisions with vessels; and at the entrances to locks to help guide vessels through the gates. They usually appear as rather narrow linear structures, often with slight curves especially at the ends. It is rare to see a fender wide enough to compile as a double-line feature. Fenders at locks are usually attached to the outer lock structure, extending into the water on one or both sides of the entrance channel. Fenders under bridges may be connected to the bridge supports, but are often not connected, standing free just beside the supports. Fenders are often obscured by bridges. The compiler shall delineate as much of the fender as can possibly be seen in the imagery. If the fender can be seen on both sides of a bridge, and the obscured part is not too long, the compiler might be confident that the fender continues in a straight line under the bridge, and the obscured section could be delineated. But if the compiler is not confident of the existence or position of the obscured portion of the fender then that section should not be compiled, as there are no "approximate" feature types in the Alongshore_Feature class.

G. GATES – These features are found at the entrances of locks and permanent dry docks. Gates are used to seal these openings, and are therefore always delineated as connected (snapped) to the lock or dry dock structure. A gate should be compiled in the closed position, even if it appears open in the imagery. If a gate is in two parts, then each part should be collected as a separate feature, though they should normally snap together.

H. GROINS AND JETTIES – These features are similar in that they both extend into the water from the shoreline in order to direct the alongshore current flow, and control the scouring and deposition patterns of coastal sediments. The difference is that a jetty is typically constructed at the entrance to a river, channel, or harbor in order to maintain the opening and protect it from silting; while a groin is usually a much smaller structure designed to control beach erosion. Like breakwaters, groins and jetties are fixed and solid, may have bare parts and covered or submerged parts, and they are usually made of piled boulders or concrete blocks.

I. MARINE RAILWAY – A marine railway is unusual among the alongshore features in that it is typically at the same level as the ground, sloping at the shore, and the majority of the feature is located landward of the shoreline. The visible part of the marine railway located seaward of the shoreline shall be compiled as Covers__Uncovers_Or_Submerged, and the landward part shall use the Bare code. Sometimes a vessel or empty cradle can be seen, which simplifies the identification of this feature type, but often the only sign is a set of tracks sloping down into the water. Of course they are usually only located in port areas, where vessel repair and maintenance facilities are commonly available.

J. TRAINING WALL – The function of a training wall is similar to that of a groin. But a training wall is different in that it is often submerged and separated from the shoreline, and may be aligned at various angles to the shoreline, rather than just perpendicular to the shoreline like the typical groin. Training walls are also relatively rare, and may only be seen in projects that include large rivers or areas with strong tidal currents, where dredged channels are subject to frequent heavy silting. Training walls may be referred to by other local terms, such as Wing Dam or Pile Dike.

K. UNDETERMINED – This feature type shall be used for other man-made near shore structures that seem to be in the Alongshore Feature category, but cannot be fit into any of the classifications above. This code shall not be used for other structures in the coastal zone that are included in other feature classes, such as obstructions and cultural features. If the Undetermined_Alongshore_Feature type is used then the compiler should enter descriptive information about the feature into the INFORMATION field, if possible.

5.3.   OBSTRUCTION POINT – An obstruction can be natural or man-made, but it will always be fixed to the seabed. An obstruction must be at least 1 mm seaward of the shoreline (at the compilation scale) to be compiled. Any obstructions closer than 1 mm, or on the landward side of the shoreline, shall be ignored. An obstructing feature cannot be compiled as a point unless it is smaller than 0.5 mm at the compilation scale. A feature equal to or larger than 0.5 mm would have to be compiled as a line using a different feature class. The size of a feature is determined by the longest dimension of the object's outline as it would appear at the level of the shoreline (usually MHW). Also, a point obstruction shall not be compiled within 0.5 mm of another compiled feature. With a small group of obstructions that are too close together to compile individually, the most navigationally significant (most prominent and seaward) ones that are at least 0.5 mm from each other should be compiled. With a larger group, a representative pattern of the most significant obstructions should be compiled within a Foul line (Danger_Area class). If a feature in one of the other point classes is in the same location as an Obstruction_Point feature (such as when an Aid_To_Navigation is fixed to a rock) then the other feature takes precedence and the obstruction is not compiled.

Note that when classifying a point type obstruction as Bare, Covers/Uncovers, or Submerged, only rocks and coral heads use the specifications in the table in section 4.7 above. The classification of all other obstructions is based on the definitions of these terms in the C-COAST Glossary (Attachment F).

A. ROCK – In most projects rocks are the most common obstructions a compiler will see. A rock is a discrete object, separated from other rocks by deep water or unconsolidated sediments. A bare rock should be compiled at the center point of the area above the shoreline level (usually MHW). This center point is not necessarily at the highest point of the rock, nor is it usually at the center of the entire visible rock mass. A covering or submerged rock should be compiled at the center point of the entire rock mass visible in the imagery. High points on ledges and reefs should be compiled as rocks (Bare or Covers/Uncovers) if they protrude a significant amount above the feature, and are thus of value to the mariner.

B. CORAL – A discrete head of living coral is compiled using the same rules of application as a rock, except that it can never be bare, as the organisms that make up the coral would die if allowed to dry out. A bare coral head is assumed to be dead, and is compiled using the Rock__Bare feature code. It is difficult to distinguish coral from non-living rock without extensive local knowledge of the project area, but it is generally found in the warmer waters of the lower latitudes. Coral is common throughout southern Florida, and islands in the Caribbean and tropical Pacific. Charts in these regions will often have labels and symbols indicating areas of coral. The compiler should use this information from the charts, and other available sources, to help differentiate rock from coral in the imagery. Note that in many Pacific islands the natural rock is often basalt, which is much darker (even black) compared to most corals.

C. SNAG/STUMP – This feature can be only Covers/Uncovers or Submerged now. The feature type Snag_Or_Stump__Bare may no longer be used. See the glossary in Attachment F for the definition of Snag or Stump, but it should be noted that this feature, like any other obstruction, must be fixed to the bottom. A floating branch or log shall not be compiled.

D. WRECK MAST – Occasionally with a sunken shipwreck only a mast is still visible. In this case the wreck is compiled using one of the Wreck__Mast feature codes (Bare or Covers/Uncovers). Note that this feature does not include a Submerged type. In reality, the Mast feature is very rare, and it is highly unlikely that the compiler will have the occasion to use it. If a wreck is encountered, it is much more common to see a significant area of the wreck's hull, which would be outlined as a linear obstruction.

E. GENERAL OBSTRUCTION – Any other fixed discrete point object that hinders, endangers, or prevents the passage of a vessel, and cannot be classified as any of the above feature types or as a feature in another point class, shall be compiled as an Obstruction__Bare, Obstruction__Covers__Uncovers, or Obstruction__Submerged. The compiler shall enter descriptive information about the feature into the INFORMATION field of the DCFF. For example, an individual bare tree (or small group of trees) standing in the water at least 1 mm (at the compilation scale) from the shoreline would be collected as an Obstruction__Bare, with "Tree" (or "Trees") entered in the INFORMATION field.

5.4. OBSTRUCTION LINEAR – The Obstruction_Linear class has several different feature types and sub-types with some unique rules of application.

A. FLOATING FEATURES – This class includes a number of floating feature types, such as platforms, vessels, barriers, and dry docks. In general, the compilation of floating objects is not desirable under this contract, since providing a highly accurate position (at the time of imagery) of a feature that is temporary or moves about, is of little use to marine navigation. In some cases it is permitted, or even required, to delineate floating obstructions; such as when confirming the existence and position of previously charted features, or when the compiler has access to older imagery that shows a feature in approximately the same position as in the current imagery. But in most cases, when the compiler identifies one of these floating obstructions that is not already on the chart, and has no reasonable expectation that the object is permanent, then it should not be compiled.

B. SIZE LIMITS – The minimum length for a linear obstruction is 0.5 mm, and it must be at least 0.5 mm wide to be compiled as a double-line feature. A long obstruction, narrower than 0.5 mm shall be collected with a single line along its center. Double-line obstructions should normally be closed outlines, with no overlaps or gaps.

C. PLATFORM – Platforms must be separated from the shoreline, completely surrounded by water. If any part of a platform-like object connects to or crosses over the shoreline, then it cannot be a platform, and probably should be collected as a Pier. A mineral platform could be a massive oil or gas drilling structure, or a small maintenance landing beside a well-head. Observation platforms are typically elevated to provide a view of the surroundings, and may support a roof, though the sides are normally of open construction. Any other platforms that don't fit in the named categories should be collected as Undetermined, with descriptive text entered in the INFORMATION field. A platform in ruins should also include a description of its former function if known.

D. WRECK – The outline of the hull of a single wrecked ship is compiled using this feature type. An area of multiple wrecks, or broken and scattered remains of a vessel, would be delineated using the Wreckage code (see 5.11.D below). For charting purposes, submerged (or sunken) refers to a wreck, or part of a wreck, that is below the sounding datum for the chart. A sunken wreck is considered "dangerous" if its depth below the sounding datum is less than 11 fathoms (66 feet, or 20 meters). It is extremely unlikely that any wreck deeper than 11 fathoms would be visible in aerial imagery, and so the Wreck__Submerged__Non_dangerous feature type is practically never used. Wrecks may be sloping, and are often compiled with their Bare, Covers/Uncovers, or Submerged portions delineated as individual connected lines. The bare part of a wreck may even cross over the shoreline.

E. PERMANENTLY DOCKED VESSEL – A vessel should only be considered to be permanently docked if some fixed structure has been constructed around it or in its path which physically prevents the vessel from being moved. It may still be able to float up and down with changing water levels. This code shall only be used to outline the vessel itself. The enclosing structure would be compiled using some other appropriate code. A Permanently Docked Vessel must be located seaward of the shoreline. A vessel displayed on land is not an obstruction, but it could possibly be a building.

F. CRIB – See the glossary in Attachment F for a good description of this feature. Note that most cribs are too small to show as a line, and should be collected as a point type obstruction, with "Crib" entered in the INFORMATION field. Cribs that do meet the minimum size requirement shall be delineated as a closed (snapped) outline.

G. FISH STAKES – This row, outline, or area of stakes may appear like a fence in shallow water. The stakes may be used to define a fishing area, as supports for netting, or as a system for catching or confining fish. A collection of stakes may be the remains of a fish trap that is no longer functional (see section H below).

H. FISH TRAP – Fish traps can vary greatly in size, from small basket-like devices only a meter or two long, to extensive structures many tens of meters across. They are found in shallow water, most typically in or near the mouth of a stream or narrow inlet. Only large fish traps are likely to be identifiable in the imagery. They may be constructed of various materials and designs, but generally consist of some fencing or netting supported by piles or stakes, arranged in the waterway in such a manner as to funnel fish through a small opening into a larger area or chamber from which they cannot easily escape. Some fish traps are floating structures. Only those that are fixed in place, and appear to be relatively permanent should be compiled.

I. FLOATING BARRIER – These features appear as long thin objects floating on the surface, either curving, or as a series of connected straight segments. They are often secured at one or several points along their lengths. A floating barrier may be compiled as a closed or open linear feature. As with other floating features it should only be compiled under the circumstances defined in Section A above.

J. FLOATING DRY DOCK – See the glossary in Attachment F for a good description of this feature. Floating Drydocks are typically quite large, and when compiled should always be delineated as a closed outline. As with other floating features it should only be compiled under the circumstances defined in Section A above.

K. UNDETERMINED RUINS – This is a general code used for any fixed obstructing linear feature in the water that is in a ruined state, and that cannot be fit into any other category of ruined structure, in this or in another feature class. This feature may be compiled as a single line along the center of a narrow length of ruins, or as a closed or open outline around an area of ruins. If the Ruins_Undetermined feature type is used then the compiler should enter descriptive information about the feature into the INFORMATION field, if possible.

L. GENERAL OBSTRUCTION – Any other fixed linear object that hinders, endangers, or prevents the passage of a vessel, and cannot be classified as any of the above feature types or as a feature in another linear class, shall be compiled as an Obstruction__Bare, Obstruction__Covers__Uncovers, or Obstruction__Submerged. The compiler shall enter descriptive information about the feature into the INFORMATION field of the DCFF.

5.5.   FREESTANDING MARINE FEATURE – This feature class includes Piles, Dolphins, and Stakes (also Tripodals which are a special case of Dolphins). Freestanding Marine Features shall not be compiled within 0.5 mm of each other. In the case of a small group of these features that are too close together to compile individually, the most navigationally significant ones that are at least 0.5 mm from each other should be compiled. For a larger group or long row of many Freestanding Marine Features they should be delineated by a closed outline around the group, or by an open line along the row, using the linear Obstruction code, with the type of feature entered into the INFORMATION field (ex. “Piling”). A large group of closely spaced stakes that are used for the collection or confinement of fish would be delineated with the Obstruction_Linear type Fish_Stakes. If a feature in the Aid_To_Navigation class is in the same location as a Freestanding Marine Feature (such as a Daybeacon mounted on a pile), then the navigational aid takes precedence and the Freestanding Marine Feature is not compiled. Freestanding Marine Features should only be compiled if they are in the water, and shall always be collected at the top center of the feature.

Except for those in ruins, Dolphins (and Tripodals) are always collected as Bare. Piles and Stakes can be Bare, Covers/Uncovers, or Submerged. Individual stakes are quite small, and often cannot be seen in aerial imagery. See the Glossaries in Attachments F and M for further descriptions of these features.

5.6. LANDMARK – The requirement for compiling Landmarks in coastal mapping projects has two purposes:

- Verifying the existence, identity, and position of currently charted landmarks
- Recommending the addition of new landmarks to the chart

A. CHARTED LANDMARKS – The contractor shall search within the limits of the stereo imagery for all landmarks shown on the nautical charts covering the project area. For each landmark identified, the contractor shall verify that the type of feature seen in the image agrees with the type of landmark shown on the chart (ex. "TOWER"), and shall accurately compile the landmark using the appropriate feature code. If the text of the Landmark TYPE code in C-COAST does not exactly match the label on the chart (such as if the label is abbreviated or contains a secondary name) then the contractor shall enter the full label into the INFORMATION field of the compiled landmark, using all uppercase letters. If a charted landmark's label or position does not match the feature in the image, then the contractor shall compile the landmark with the correct position and attributes, and shall make a notation on the Chart Comparison Print (CCP) and in the Chart Evaluation File (CEF) indicating that the charted position or label is incorrect. When a label is incorrect, the contractor should enter a suggested new label in the INFORMATION field that appropriately describes the feature. For any landmarks not found, the contractor shall add an appropriate notation (either Not Confirmed or Gone) to the CCP and CEF. Since most landmarks are very prominent features, easily seen in aerial imagery, a landmark that is not seen should usually be marked as "Gone" instead of "Not Confirmed". This will allow a landmark that no longer exists to be permanently removed from the chart.

B. NAMES AND DESCRIPTIONS – A charted landmark will be labeled with a Primary Name, and possibly a Secondary Name and/or Description as well. The primary name is that most likely to identify the nature of the object for the majority of chart users. The secondary name is an alternate name for the object which may be useful to some marine interests. The description is an explanatory term which elaborates on the primary name. Secondary names and descriptions are enclosed in parentheses.
An example of a primary name with a description could be:

⊙ GRAIN ELEV (HIGHEST PART)

Or a primary name with both a secondary name and a description:

◦ Stack (Flare)
(Westerly of two)

Sometimes when a landmark is both well known and unusually prominent, the proper name of the object may be shown as the primary charting name, ex. "EMPIRE STATE BLDG"; but in general proper names are usually only used as secondary names, ex. "BUILDING (RITZ TOWER)".

C. ACCURACY AND SYMBOLS AND LABELS – There are three levels of positional accuracy associated with charted landmarks (Accurate, Approximate, and Inexact). These accuracy levels are represented on the nautical chart by the symbology and labeling of the landmark features.

i. Accurate Position – A Landmark that has a positional accuracy within 10 feet (3 m.) of its correct geographic location is symbolized on the chart by an encircled dot, and it is labeled using all uppercase lettering, as in the following example:

⊙ STACK (TALLEST OF THREE)

ii. Approximate Position – A Landmark that has a positional accuracy within 100 feet (30 m.) of its correct geographic location, but does not meet the specifications for an Accurate Landmark, is symbolized on the chart by a small (1 mm) open circle, and it is labeled using uppercase for the first letter and lowercase for the rest of each word in the primary and secondary names. Only the first letter of the first word of any description would be capitalized, as in the following example:

◦ Radio Tower (Center of five)

iii. Inexact Position – An object located with less accuracy than that required by the "Approximate" specification (but normally better than 300 feet) is usually not charted unless it is determined to meet a critical need. If shown, an Inexact Landmark is symbolized in the same manner as an Approximate Landmark, but the abbreviation "PA" is included in the label to emphasize the object's weak positional accuracy, as in the following example:

◦ Tank PA

D. UPGRADING LANDMARKS – If the contractor locates a landmark in the imagery that is shown on the chart with an Approximate or Inexact position symbol, the contractor shall accurately compile the landmark, and enter the full charted label into the INFORMATION field using all uppercase lettering. This will indicate to the NOAA chart compiler that the symbology and label of that landmark need to be upgraded to the "Accurate Position" type.

E. RECOMMENDED LANDMARKS – In areas within the project where the nautical charts show few or no landmarks, and a prominent feature is identified in the imagery that would be of landmark value to the mariner, the contractor may decide to compile the feature as a Recommended_Landmark.

i. Selection – Prominence is the first requisite for a landmark. Landmarks selected for charting should be visible over a large area from the sea and should be easily identifiable. Because ease of positive identification is also important, an unusual or unique feature may qualify as a landmark because it is easy to identify even if it is not particularly prominent. Radio towers and stacks are most useful for this purpose as they are not only good daytime references but their flashing red and strobe lights can be seen for long distances at night.

ii. Type And Label – The contractor shall compile any Recommended Landmarks using the most appropriate feature type from the list in C-COAST. See the Glossary in Attachment F for definitions of the various landmark types. The contractor shall enter a suggested new label in the INFORMATION field (using all uppercase lettering) that appropriately describes the recommended landmark feature. Do not use abbreviations in recommended landmark labels.

iii. Spacing – Dense spacing of landmarks is neither useful nor desired. For example, many smoke stacks all close together and plotted as landmarks would be very difficult for the mariner to identify individually. The selection of a few easily identifiable stacks with appropriate descriptors may be more useful to the mariner than the charting of many closely spaced stacks. The same is true of radio towers.

iv. Features To Avoid – Temporary and moveable structures shall not be used as landmarks. These might include: cranes used for construction, exploratory drill rigs, or dredges. Signs and signboards, in general, do not make good recommended landmarks. However, an unusually conspicuous sign, especially in an area devoid of other suitable landmarks, or signs supplying navigational information may be considered as landmarks.

F. GENERAL COLLECTION – Landmarks are normally compiled at the most prominent point of a feature, usually the center of the highest point. With some features, such as tall thin towers or masts, it can be difficult to see the very top. In such a case the contractor should collect the point as close to the top as can be accurately measured. Sometimes, especially for features with open lattice construction like radio towers, it is easiest to center the compilation cursor on the feature at ground level, and then raise the elevation (Z) of the cursor to as close to the top as can be seen. Landmarks are usually on land, but they are occasionally charted in the water. For a landmark in water, the structure might be considered as obstruction, but in this case the Landmark feature class takes precedence, and an Obstruction_Point feature would not be compiled.

5.7. AID TO NAVIGATION – See the Glossary in Attachment F for definitions in this class.

A. AUTHORITY – The waters of the United States and its territories are marked to assist navigation by the U.S. Aids to Navigation System. This system employs a simple arrangement of colors, shapes, numbers and light characteristics to mark navigable channels, waterways and obstructions adjacent to these. The United States Coast Guard (USCG) is the principal authority for the establishment and maintenance of this system. Complete information concerning aids and their characteristics can be found in the USCG Light List publications. See SOW 3.6.D for a link to on-line copies of the Light Lists. An aid to navigation (ATN) which is not established and maintained by the USCG or equivalent authority (private aids) is identified on the chart by the label “Priv”.

B. REQUIREMENTS – The contractor shall compile all daybeacons and fixed lights (both public and private) that are shown on the charts and can be identified in the project imagery. The contractor shall not compile floating aids (buoys, articulated lights), radiobeacons, or fog signals. The purpose of the requirement to compile ATNs in coastal mapping projects is simply to verify the existence and position of fixed aids that are already shown on the nautical charts. The nautical charts and the USCG Light Lists shall be the principal sources used to determine if a feature seen in the imagery is an ATN. Aerial imagery alone is not sufficient for the identification of most ATNs, therefore the contractor shall not attempt to compile any new ATNs that are not already shown on the chart or in the Light List. If the contractor strongly suspects that a feature in the imagery is an uncharted fixed light or daybeacon, then it may be collected as an Obstruction or Freestanding Marine Feature with “Possible new light” or some other such description in the INFORMATION field. If a charted ATN cannot be verified, or if its position is incorrect, the contractor shall add an appropriate notation to the CCP and CEF.

C. CHART SYMBOLS – Fixed lights are charted as a standard 0.7 mm black dot with an accompanying teardrop shaped magenta flare. Daybeacons are charted as either small triangles or squares, which may be green or magenta filled (corresponding to green or red daymarks), or open with no fill color (for daymarks of other colors). Daybeacons in the Intracoastal Waterway may be colored yellow. All ATNs are also labeled on the chart with identifying characteristics, which may include names, colors, periods, height, visibility, etc. See NOAA Chart No. 1 and the USCG Light List for further explanation and depictions of the symbology and labeling of ATNs.

D. AERONAUTICAL LIGHTS – These lights are actually navigational aids for aircraft rather than marine vessels, but when they are visible from the water they make useful aids to marine navigation. Aeronautical beacons are usually located on a high structure at an airport, and will be shown on the nautical chart using the standard fixed light symbol, and the label “AERO”. Additional characteristics, such as the light color, may be in the label as well. The contractor shall compile Aeronautical Lights using the appropriate Marine_Light code corresponding to the light’s supporting structure, and shall enter “AERO” into the INFORMATION field (other characteristics should not be entered). If the light is mounted on a building, then the Marine_Light__Lighthouse feature type shall be used.

5.8. CULTURAL FEATURE MISCELLANEOUS – There are many man-made features in the coastal area (in the water, over the water, or on land) that may be useful for, or an impediment to safe marine navigation. Those cultural features that are typically shown on the nautical chart, but cannot be categorized in any of the other feature classes, shall be compiled using the various feature types in this class.

A. BUILDING – Most buildings visible in aerial imagery should not be compiled, with a few notable exceptions (see below). Those that are compiled should be delineated as accurately as possible around the top edge (roof line) of the building, snapping the beginning and end points together to form a closed polygon. Some buildings may have an open area within them exposed to the outside which should also be compiled, so that a correct representation of the building as viewed from above is shown. If a building depicted on the chart appears in the imagery to have been torn down, modified, or replaced, then the new or modified building(s) – if any – shall be collected, and the contractor shall add make notation on the CCP and in the CEF.

i. Minimum Size – Under no circumstances shall any building with its longest dimension less than 0.5 mm long at the compilation scale be compiled.

ii. Large Buildings – Large prominent buildings close to the shoreline that are of navigational significance should be collected, especially if they are already shown on the nautical chart. In developed areas most buildings along the shoreline are not navigationally significant, so the compiler will use his or her judgment as to which buildings to collect.

iii. Small Buildings – Small buildings such as houses are rarely collected, except in remote areas devoid of other objects of landmark value. But even so, only the most prominent small buildings in the area, that are visible from the water, and that fulfill the minimum size requirement, should be considered.

iv. On Piers or Over Water – Buildings constructed on piers or over the water (up on piles), including boathouses, shall be compiled, so long as they fulfill the minimum size requirement. Note that boathouses are not the same as houseboats. Boathouses are used to shelter docked boats and are permanently fixed to the shoreline or to a pier. A boathouse is compiled as a building with “Boathouse” entered into the Information field. Houseboats (also called Floating Homes) are considered to be vessels that can be driven or towed to another location, and they shall not be compiled.

B. TANK – These features are usually either the more common cylindrical shape for storing liquids such as water or petroleum, or the less common hemispherical shape for storing gases. These should not be confused with a water tower, which is described in section D below. Compile the outline of cylindrical tanks at the top, and compile hemispherical tanks at their widest part, which is generally at the ground. As with buildings, the contractor should only compile prominent navigationally significant tanks visible from the water. Some tank farms along the shoreline can be quite large, so the compiler shall use his or her judgment as to which tanks to collect. No tank with a diameter less than 0.5 mm at the compilation scale shall be compiled.

C. SILO – A silo, being cylindrical, may appear similar to a tank, but it is generally much taller than it is wide, and often has a domed roof. A silo should generally be distinct. If a silo is part of a connected array of silos then the entire structure should be compiled as a grain elevator (see below), rather than a group of individual silos. Compile silos only if they are prominent and visible from the water, and at least 0.5 mm in diameter at the compilation scale. They should be delineated at the widest part just below the domed section.

D. WATER TOWER – Many water towers may already be depicted as a landmark on the nautical chart (or recommended for addition to the chart as a landmark), in which case the landmark classification will take precedence, and the water tower would not be compiled as a cultural feature. Compile non-landmark water towers only if they are prominent and visible from the water, and at least 0.5 mm in diameter at the compilation scale. A water tower should be delineated at the widest part of the tank portion.

E. LEVEE OR DIKE – These two terms are considered synonymous in the coastal mapping program, though Levee is the more commonly used word. These features appear as regular narrow linear ridges, generally running parallel to the shoreline. They are usually found in areas of relatively flat topography that are naturally subject to seasonal flooding, especially around marshes and along inland waterways. They typically rise at least 2 meters above the surrounding terrain, though older or poorly maintained levees may be heavily obscured by overgrown vegetation. All visible levees or portions of levees within 2000’ of the shoreline should be compiled. Levees shall be delineated as a single line along the top center of this feature. Roads, walls, or fences are sometimes constructed along the top of a levee. In such a case the levee feature shall be compiled, and the other features would be omitted. A causeway, however, is not considered a levee, and should be compiled as a road or railroad (see 5.9 below).

F. CABLE – Cables in this category include power and communication wires and support cables not involved in the transport of people or materials. There are two types of cable, overhead and submerged.

> i. Overhead Cables – All cables that cross over water, even single line streams, may pose a hazard to navigation and shall be compiled as Cable__Overhead. The entire portion of a cable over the water shall be compiled to where it crosses the shoreline, and then continued over the land at least to the first supporting pole or tower. A continuous cable that alternately crosses over the water and land in multiple places should be compiled continuously along its length, rather than broken into disconnected segments. Cables that are completely over the land, and do not cross the shoreline, shall not be compiled. It is common to find cables supported by poles or towers in the water. These poles or towers are hazards to navigation, and are normally collected as obstructions, or possibly as landmarks if that would be more appropriate. Cables are compiled at their actual elevation, normally as a single line with vertices collected at the top of each support along its length. A group of closely spaced parallel cables should be generalized to a single line in the middle of the group. Cable lines may split, cross, and merge, but parallel cables should not be collected with less than 0.5 mm separation between them at the compilation scale.
>
> ii. Submerged Cables – Submerged (or submarine) cables may interfere with marine navigation or may be damaged by a vessel or anchor. The submerged portion of a submarine cable usually cannot be seen in aerial imagery, unless the water is exceptionally clear. But sometimes the cable can be seen where it emerges from the water and crosses the shoreline. As much of a submarine cable as can be seen in the water, and a short length on land, shall be collected as Cable__Submerged, so long as the compiled line is at least 1 mm in length at the compilation scale.

G. GENERAL TRANSPORT – General transport has three categories: ferry cable, aerial cable, and conveyor belt. As the name implies, these features are involved in the transport of material and/or people. Ferry cables are very hazardous to other vessels, and are often visible at or near the surface of the water, though they may be submerged. All ferry cables shall be compiled wherever they are seen. Aerial cables and conveyor belts shall be compiled only if and where they cross over the water, and for a short distance landward. If these features connect to another compiled cultural feature (such as a building, tank, silo, or grain elevator) then they should be collected over the land up to the other connected feature. A general transport feature should be collected as a single line at its actual elevation. As with cables, the lines may split, cross, and merge, but a group of parallel features spaced closer than 0.5 mm should be generalized to a single line in the middle of the group.

H. GRAIN ELEVATOR – This feature is generally very tall and narrow, and is comprised of several cylindrical structures (similar to silos) grouped in an array. It will usually have one or more conveyor belts leading from the top of the structure, and connecting different parts of the structure. Compile a grain elevator similar to a building, delineating the outer edge of the top.

I. PIPELINE – There are two types of pipelines: Overhead and Submerged_Or_Surface. A single pipe can have portions of it compiled as either subcategory, since a pipe could be overhead and then go below the water. Pipelines are generally compiled in the same manner as cables in section F above. Pipelines that are completely over the land, and do not cross the shoreline, shall not be compiled.

J. DAM – Dams come in a variety of shapes, sizes, and materials, but are fixed and permanent, and do not swing open like a gate. A dam narrower than 0.5 mm at the compilation scale shall be collected as a single line down the middle of the feature. A wider dam shall be compiled as a closed outline at its actual size and shape. A dam is a barrier to navigation, unless it includes a lock system to allow the passage of vessels. Therefore it is usually not required to compile the shoreline of any water body behind a dam, unless that body contains charted marine facilities, or the shoreline behind the dam has changed significantly from that shown on the chart. A dam line cannot substitute for shoreline. Where the face of a dam meets the shoreline, both features shall be compiled as congruent lines. Normally the Bulkhead_Or_Sea_Wall code should be used. A compiled road that runs along the top of a dam should be continued unbroken over the dam feature.

K. FORT – Many charts have forts of historical significance that were built near the shoreline, especially at harbor entrances. All non-active forts shall be compiled in a similar manner to buildings. If the name of the fort is known then it should be included in the Information field. See Section 4.1.A regarding restrictions on feature compilation in active military installations.

L. FENCE OR WALL – Fences and walls shall only be compiled if they are in the water. If a fence or wall crosses the shoreline, then a short length on the landward side should be collected as well. A fence or wall shall be collected as a single line along the top center of the feature.

5.9. TRANSPORTATON – See the Glossary in Attachment F for definitions in this class.

A. ROAD – Generally only major public highways within 2000 feet of the shoreline, and roads leading from highways toward the shore, need to be compiled. In urban areas with numerous roads and highways, only the first major hard surface road that runs parallel to the shoreline, and other roads leading from the major road toward the shoreline, need to be compiled. Compiling a dense network of roads is not acceptable, and at no time shall two parallel roads be compiled within 0.5 mm of each other at the compilation scale. In remote areas, where few roads exist, usually most of the roads within 2000 feet of the shoreline would be considered important enough to compile, but this determination shall be left up to the compiler's judgment. All roads connecting to bridges and boat ramps shall be compiled. Small undivided roads are delineated as single lines along the centerline of the roadway. Larger roads with a median separating the lanes of traffic moving in opposite directions, shall be delineated with a line along the center of each set of lanes of the same traffic direction, so long as the two lines are least 0.5 mm apart. Even very wide roads with many lanes in each direction are collected with only two lines, one for each set of lanes in the same direction. Roads are collected at their actual elevation. A road passing under another road (overpass) or bridge shall continue unbroken beneath the other feature. A road leading to a bridge shall not cross over the bridge, but shall stop at (and snap to) one end of the bridge, and start again on the other side. To provide topological continuity, connecting roads should snap to each other at their intersections. Roads under construction should generally not be compiled.

B. ROAD PATH – A non-hard surface road often used for light vehicle traffic. A path should only be compiled if it may reasonably be considered to be of importance to the mariner, such as if it connects to a boat ramp, or in remote areas where there are few (if any) hard surface roads. In such situations paths would be delineated using the same general rules as roads (see A. above).

C. RAILROAD – All charted railroads and other major railroads shall be compiled at least to the 2000 foot compilation limit, and possibly farther if the same railroad comes closer to the shoreline again farther down the line. It is up to the compiler's judgment to determine which railroads are "major", but generally the closer a rail is to the shoreline, the more important it is to collect it. All railroads that connect to bridges and marine facilities shall be compiled. Parallel railroads shall not be compiled within 0.5 mm of each other at the compilation scale. If there are two railroads closer than this limit, one should be collected and the other ignored. If they start farther apart, and then come together within the 0.5 mm limit, select one to continue, and merge the second one into the first. If there are multiple parallel railroads, show the outermost railroads, and as many interior railroads as are judged important enough to collect, so long as they are not within 0.5 mm of each other. A railroad yard shall be collected in a similar fashion, delineating only the outer perimeter railroads, and whatever interior railroads are judged necessary or desirable in order to provide cartographic continuity with the lines entering or leaving the yard. Railroad lines shall be delineated along the center of the track halfway between the two main rails. Urban subway, light-rail, and streetcar tracks shall not be compiled unless they connect to a bridge or marine facility.

D. RAILROAD ABANDONED – Abandoned railroad are those that are no longer in active use. Sometimes they may be identified by the presence of vegetative growth or other debris on the tracks, or by areas where the tracks have been removed or paved over at road crossings. They are compiled in a similar manner as active railroads, but have less cartographic importance.

E. RUNWAY – Runways are delineated as a closed outline around the outer edges of the runways themselves. Multiple intersecting runways should be compiled as a single outlined area. Taxiways, and other aircraft movement areas that are not used for takeoffs and landings, should not be compiled. All runways within 2000 feet of the shoreline shall be compiled.

F. HELICOPTER PAD – A helicopter pad typically appears as a small square, circle, octagon, or other compact shape. They are often marked by a large white “H” painted in the center of a white circle. All helicopter pads on the ground within the 2000 foot compilation limit shall be collected. Other helicopter landing areas on building roofs shall be ignored.

G. TUNNEL ENTRANCE – When a road or railroad that is being compiled enters a tunnel, the road or railroad feature shall be ended. The tunnel entrance shall be compiled as a single line across the roadway delineating the headwall and wing walls in their actual size and configuration. The endpoint of the road or railroad shall connect (snap) exactly to the tunnel entrance. Tunnel entrances that are not associated with compiled roads and railroads shall be ignored.

5.10. NATURAL FEATURE MISCELLANEOUS – There are many natural features on coastal lands that may be useful for marine navigation. Those natural features that are typically shown on the nautical chart, but cannot be categorized in any of the other feature classes, shall be compiled using the various feature types in this class.

A. WETLANDS – A wetland area is classified as one of two categories, marsh/swamp or mangrove/cypress. On the nautical chart these areas are shown with a dashed outline and an identifying label: Marsh, Mangrove, Swamp, or Cypress. Marsh areas have a green tint, while the other types of wetlands are charted with a gold tint. Pictorial marsh or mangrove symbols may also be used. See section 5.1.E above for interpretation guidance of the different types. The landward extents (back limits) of a wetland area shall be delineated using the Marsh_Or_Swamp__Extent or Mangrove_Or_Cypress__Extent feature codes. This line shall follow the boundary between the wetland area and the higher dry ground around it, or between two wetland areas of different types. Land-locked wetlands, those which are surrounded by dry land and do not connect directly to the shoreline, do not need to be compiled. Therefore all compiled wetland areas will have some portion collected as Apparent Shoreline. The wetland extents line(s) shall connect exactly (snap) to the endpoints of the corresponding apparent shoreline feature, to form a closed polygon. If the wetland area extends inland beyond the limit of compilation, then the wetland polygon would be cut short, and closed off using the Feature_Limit code in the Cartographic_Limit class.

B. GLACIER EXTENT – The inland extent of a marine glacier shall be delineated to at least the 2000 foot compilation limit using the Glacier_Extent code. This extent line shall always be paired with a line where the glacier meets the sea, compiled as Glacier in the Shoreline class (see 5.1.I above), snapping to its endpoints and forming a closed polygon. Often the glacier will extend inland beyond the limit of compilation, in which case the glacier polygon would be cut short, and closed off using the Feature_Limit code in the Cartographic_Limit class. Land-locked glaciers, which do not have a face meeting the sea, shall not be compiled.

C. CLIFF/BLUFF – See the glossary for a definition of this feature. Technically, the feature is considered a Bluff if it is not rocky, and a Cliff if it is rocky, but in the Coastal Mapping Program the two terms are synonymous. The slope should be very sharp and conspicuous. Cliffs and Bluffs are useful to the mariner as a locating reference, especially where they alternate with low-lying coast along the shoreline. The Cliff/Bluff line should be compiled as a single line along the top edge of the slope. Ideally there would be a sharp change in the slope of the land (from mostly vertical to mostly horizontal) at this line, but in reality the slope often changes somewhat gradually, and it is difficult to determine exactly where the line should be placed, especially if there is heavy tree cover. The compiler should use his or her judgment to decide approximately where along the top of the slope the Cliff/Bluff line would appear from the mariner's perspective. It should be noted that the Cliff/Bluff line is not a contour line. The elevation will often change up and down along the edge, and the line will frequently disappear and reappear.

D.   STREAM – These two codes shall be used to depict intermittent and perennial single-line streams only, i.e. streams less than 0.5 mm wide at the compilation scale. Streams that are connected to the shoreline, and at least 0.5 mm wide, would be compiled using the Shoreline code River_Or_Stream. Use of the Stream code is not required, and is, in fact, discouraged for most projects. However, there are exceptions. Normally, small bodies of water that are not connected by a navigable waterway to the coastline need not be delineated unless they contain mappable marine facilities. Therefore any small, disconnected water bodies that contain mappable facilities should be delineated, and if they connect to the shoreline via a narrow (single-line) stream, this code should be used to depict the stream. Another exception is often applied in remote areas (especially in Alaska), where a narrow stream running down to the shoreline may be used to help define the nature of the coastal zone or to aid in orientation. An exception to the “single-line only” rule would be the unusual case where a narrow stream becomes wider up-stream. In that case at the point where the stream widens this code would continue to be used, but would "split" to a double-line configuration. Unfortunately, there would be no way to distinguish this feature (topologically speaking) as a wide stream, as opposed to two, narrow branch streams running parallel. See the glossary for definitions of “Intermittent” and “Perennial”.

E.   RAPIDS AND WATERFALLS – Rapids and waterfalls shown on the chart can indicate the limit of the navigable portion of a waterway, or when visible from the sea, they can be useful points of reference to the mariner, especially in remote areas. Visible rapids and waterfalls on wide compiled rivers and streams shall be indicated by collecting a line in the water perpendicular to the stream, snapping to the banks, using the appropriate feature code. For single-line streams the rapids/waterfall line shall be drawn 1.5 mm in length at the compilation scale, perpendicular to and centered on the stream. For sharply dropping waterfalls with a horizontal extent in the direction of the stream flow that is less than 1 mm at the compilation scale, a single waterfall line is sufficient. For rapids and waterfalls extending farther (at least 1 mm) along the length of the river or stream, two lines shall be delineated across the water: one indicating the upstream extent of the turbulent area, and another indicating the downstream extent. When two lines are used to indicate the area of rapids or waterfall, the portion of the river or stream feature(s) between the two lines shall have the term “Rapids” or the term “Waterfall” entered into the Information field.

F.   SAND DUNE – Sand dunes, due to their drifting nature, are normally not compiled. But in some areas with large, prominent, and relatively stable sand dunes, that may be a useful reference to the mariner, these features may be compiled. The compiler should be cautioned to delineate sand dunes only when they are very high (at least dozens of meters) and extensive. If collected, the extent of the sand dune area shall be outlined as a closed polygon.

G. LAVA/LANDSLIDE – Prominent landslides and lava flows often show up as scars on an otherwise vegetated terrain. When charted, these features can be useful as orientation references for the navigating mariner, as they can often be identified from a significant distance away. All charted and new landslide and lava flow areas, that are visible from seaward, shall be delineated as closed polygon features.

I. MORAINE – The extent of a prominent moraine area may be indicated in glaciated regions, if doing so would be useful to the navigating mariner.

5.11. DANGER AREA – This class includes various features of the natural environment that are hazardous to navigation, which are compiled as areas rather than discrete points.

A. FOUL – Rocks, boulders, coral heads, and various other features can pose a danger to navigation and should be compiled. In areas where the number of dangers to navigation is too dense to compile each danger individually based on the compilation scale, then a foul line should be used around the area. A foul area must extend at least 1 mm at the compilation scale in order to be compiled. Foul areas adjacent to the shoreline can be delineated as an open outline with both ends coming close to, but not touching or crossing over the shoreline. Foul areas disconnected from the shoreline, or surrounding a reef or island, should be delineated as a closed (snapped) outline. Within a foul area a representative pattern of the most significant obstructions should be compiled.

B. LEDGE – A ledge is a consolidated rocky mass extending from the shore or foreshore that is generally below the level of the shoreline. See section 4.7 above for guidance on classifying ledges as Covers/Uncovers or Submerged. The seaward limit of a ledge shall be delineated with the appropriate feature code, so long as the line extends at least 1 mm from the shoreline at the compilation scale. High points on ledges should be compiled as rocks (Bare or Covers/Uncovers) if they protrude a significant amount above the ledge, and are thus of value to the mariner. The ends of the ledge line should never cross the shoreline, nor do they need to snap to the shoreline. The compiler should collect the ledge from the imagery acquired closest to the sounding datum (usually MLLW) to depict the largest extent of this feature. ~~A ledge would only be compiled as a closed outline if it completely surrounds an island.~~

C. REEF – A reef is a consolidated rocky formation which is detached from the foreshore and below the level of the shoreline. See section 4.7 above for guidance on classifying reefs as Covers/Uncovers or Submerged. The seaward limit of a reef shall be delineated as a closed outline using the appropriate feature code, so long as the reef area is at least 0.5 mm across at the compilation scale. A reef that is smaller than the minimum size shall be compiled as a rock. High points on reefs may be compiled as rocks (Bare or Covers/Uncovers) within the reef area if they protrude a significant amount above the reef, and are thus of value to the mariner. The compiler should collect the reef from the imagery acquired closest to the sounding datum (usually MLLW) to depict the largest extent of this feature.

D. WRECKAGE – An area with numerous wrecks closer than 0.5 mm apart at the compilation scale, or a wreck broken and scattered over a wide area, should be compiled using this feature type. A wreckage area adjacent to the shore should be compiled as an open outline with the endpoints near to, but not crossing the shoreline. A wreckage area farther away from the shore should be compiled as a closed outline.

E. SHALLOW – An area of unconsolidated material along the shore that is below the level of the shoreline, but is relatively shallow, and extends at least 1 mm from the shoreline at the compilation scale, might be compiled as shallow. However, use of this feature type in tidal areas is strongly discouraged, as the MLLW line and other depth contours provide a better indication of the depth of the sea floor. The shallow code is generally only used in non-tidal areas, such as the Great Lakes, or in some back-bay areas where the tide is irregular or undefined.

F. SHOAL – This feature type has similar characteristics to Shallow, only it is detached from the shoreline. A shoal is always compiled as a closed outline, at least 1 mm long at the compilation scale. As with Shallow, use of this feature type is not usually recommended, as the interpretation of these features from aerial imagery can be difficult. Often sediment laden waters can appear in the imagery to be shallow or shoal, when in reality they are quite deep.

G. BREAKERS – Waves breaking immediately along the shore do not in themselves indicate a danger, but an extensive area of breakers farther offshore may indicate an area of shallow and hazardous rocks or shoal. All images that show the area should be examined carefully to be sure the breakers are not caused by gusts of wind. If waves are observed breaking at the same point on successive images, an obstruction is probably the cause. The approximate area where the breakers occur should be delineated as a closed outline. Breakers on a compiled reef or shoal shall not be delineated.

5.12. AQUATIC VEGETATION AREA – Living vegetation located in the water may be considered hazardous to surface navigation as it may obscure dangerous hazards beneath the water surface, or vessels may become entangled or damaged in densely vegetated waterways. Certain types of aquatic vegetation may also serve as an indicator for possible dangers to navigation such as rocky bottoms. Offshore limits of vegetation areas shall be enclosed to form a polygon. When vegetation areas occur directly adjacent to the shore, only the outer limits extending from the shore need be compiled. There is no requirement to snap such limit lines to the shoreline or to other compiled features which border vegetation areas. Vegetation lines must never cross over the shoreline. To be considered for extraction, vegetation areas shall measure at least 1 mm in the longest dimension at the scale of compilation, and shall extend at least 1 mm from the shoreline. There are three varieties of aquatic vegetation included in C-COAST: Kelp, Sea_Grass, and Grass_In_Water. See the Glossary in Attachment F for descriptions.

5.13. CONTOUR – In shoreline mapping contracts where acquisition of an approximate MLLW line is required, the Depth_Contour__Approximate feature code shall be used. Normally this feature is only compiled from MLLW tide-coordinated InfraRed photography, utilizing an appropriate IR filter, but the Project Instructions may include different requirements. This feature type shall only be used to delineate the MLLW line in areas with "soft" bottom characteristics (ie. sand or mud) or around man-made features which frequently slope gently into the water, such as ramps, breakwaters, and jetties. A MLLW line shall only be delineated when the outer limit of bare ground exposed at low tide is at least 1 mm from the shoreline at the compilation scale. There is no requirement to snap a MLLW line to the shoreline, or to other compiled features located at the terminus of a MLLW line. A MLLW line must never cross over the shoreline.

The other two feature codes in the Contour class (Elevation_Contour, and Elevation_Contour__Approximate) shall only be used if the contractor is given specific instructions to do so.

5.14. VERTICAL MEASUREMENT – Feature codes in this class shall only be used if the contractor is given specific instructions to do so.

5.15. CARTOGRAPHIC LIMIT – Features in this class will not be used to update the nautical chart, but are compiled simply to provide the user of shoreline data an indication of the geographic extent of the other compiled features.

A. FEATURE LIMIT – Large polygon features on the land (marshes, glaciers, etc.) within the extent of the source imagery, yet extending well beyond the designated limit for compilation, shall not be compiled significantly beyond that limit to prevent the unnecessary delineation of irrelevant detail. Where these polygon features are cut short, the contractor shall use a Feature Limit line to close off the polygon. The endpoints of this artificial limit shall be coincident with (snapped to) the endpoints of the polygon feature which it completes.

B. LOW VISIBILITY LIMIT – When smoke, clouds, haze, or other serious degradations in the imagery limit or prevent the ability to successfully delineate features, the contractor shall enclose the problem area with a Low Visibility Limit line. The endpoints of this line shall coincide to form a closed polygon; or, if at the edge of the imagery, the endpoints shall connect (snap) to the Source Data Limit line (see below). There shall be no other features compiled within the extent of a Low Visibility Limit line. Features compiled up to this limit line shall connect (snap) to the limit line.

C. SOURCE DATA LIMIT – The contractor shall delineate the limits of stereo photo coverage using a Source Data Limit line, thus defining the full geographic extent of a project. If multiple emulsions are used in a project and the extents of coverage significantly differ between the various emulsions, then further Source Data Limit lines shall be used to subdivide the project area, designating the limit(s) of each emulsion type. Source Data Limits shall form enclosed polygons, whether a single limit is delineated around the perimeter of a project or interior Source Data Limits are included as well. No features, either part or whole, may be compiled beyond the outermost Source Data Limit. Features compiled up to this limit line shall connect (snap) to the limit line.

Version 4A
July, 2005

ATTACHMENT L
PROJECT COMPLETION REPORT

TO
SCOPE OF WORK FOR SHORELINE MAPPING
UNDER THE
NOAA COASTAL MAPPING PROGRAM

REMOTE SENSING DIVISION
NATIONAL GEODETIC SURVEY
NATIONAL OCEAN SERVICE
NATIONAL OCEANIC & ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE

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ATTACHMENT L: PROJECT COMPLETION REPORT

1. INTRODUCTION – A Microsoft Word format, an Adobe Portable Document Format (PDF) copy, and a printout of the Project Completion Report (PCR) shall be required. NOAA will forward the report to the agency archives. References to individuals by name should be held to a minimum when completing the Project Completion Report. General references to organizational units should be made in lieu of names of personnel. For contracted projects, the company name may be used in lieu of operational units within the company.

In all sections of the PCR, discuss any unusual circumstances and any deviations from the Project Instructions, the Supplemental Instructions, or normal hardware and software operations.

2. GENERAL REQUIREMENTS - Final review personnel, whether contractor or agency, shall have overall responsibility for the content and assembly of the PCR. The designated project final reviewer shall have access to the original documents in all phases of the project so that accurate summaries are included in the PCR.

3. PROPER SEQUENCE OF ASSEMBLY - The sequence of topics and diagram(s), as they apply, shall be as follows:

Introduction
Project Design
Field Operations (aerial photography and ground surveys)
Data Processing
Aerotriangulation
Compilation
Final Review
Project Final Data and Products
Project Completion Diagram

4. SPECIFIC REQUIREMENTS

4.1 REPORT HEADING - The heading shall consist of the following: First line - **NOAA COASTAL MAPPING PROGRAM**; Second Line - **PROJECT COMPLETION REPORT**; Third line, **PROJECT** llyynn. Where “ll” is a two character local identifier utilizing the two character code for a state, “yy” the two digit year identifier, and “nn” is the two digit sequence number. For example, FL9701 was the first project of 1997 in Florida. The fourth line of the report heading shall include the locality of the project and the fifth line of the report heading shall include the general location of the project, including the state. See the sample copy in the Annex at the end of this Attachment.

4.2 INTRODUCTION - The introduction section should describe the geographic location of the project site. Also, include any other general or distinctive information dealing with the setup and location of this project. The project's purpose and scope (see Project Instructions) should also be stated in this section as well as any changes to the Project Instructions.

Also describe the source of the contents found in the project database and the photogrammetric methods utilized in completion of the project; e.g., analytical versus digital soft copy.

4.3 PROJECT DESIGN AND PLANNING - Provide a general synopsis of the project-planning phase including the project's area coverage, flight line planning, sun angle requirements, weather and visibility considerations, tidal coordination, and photo control. Include any additional instructions and requirements that were set up during the project planning phase and cite any references pertaining to these instructions and procedures. Include a reference to the quality control report.

4.4 FIELD OPERATIONS - Field operations consist of two distinct functions: ground surveys and the photographic mission. The narrative for this section should state what the field operation consisted of, e.g., recovery and/or establishment of horizontal control, aerial photography or both. Discuss the data acquisition methodologies, the types of data collected, and the data reduction ground data sets. Include a reference to the ground control and aerial photography reports.

4.5 DATA PROCESSING - A paragraph summarizing the data processing (i.e. LIDAR, IFSAR GPS, IMU, etc.) shall include the following: methods of acquiring control, equipment used for each method, post mission data reduction procedures and software used. The paragraph should also cite any references, manuals, and other materials used for proper execution of acquiring control data.

4.6 AEROTRIANGULATION - The PCR aerotriangulation summary should describe the procedures used in completion of this phase. Discuss unique requirements related to the project. The paragraph should also identify the hardware and software utilized in this phase. Identification of the hardware/software used in the aerotriangulation and compilation phases will assist in potential quality control operations. An accuracy statement defining the predicted horizontal circular error at the 95% confidence level shall be included in the summary.

The summary should include another paragraph stating the contents of the database that was created during this process. This may include: the project parameters, camera calibration, interior orientation parameters, adjusted or final exterior orientation parameters and any other listed contents that are in the database. A statement giving the horizontal datum and reference system used in the project shall be included. Include a reference to the aerotriangulation report.

4.7 COMPILATION - Specify what organization accomplished the compilation phase, what type of hardware and software was used, and the techniques applied. Create a Data Compilation Sources (DCS) table, which includes the data sources and descriptive information on water levels at the time the imagery was acquired. In the DCS table, include the date and time of acquisition, film and roll numbers, film type (Infrared, Natural Color, Color Negative or Panchromatic), scale, and stages of tides.

Also include a statement discussing the cartographic feature attribution process and how it is in compliance with the Cartographic Object Attribute Source Table (C-COAST) and mention that nomenclature was assigned to selected features for additional identification.

A 95% Circular Error (CE) horizontal accuracy statement from the compilation process is required to be written in this summary.

4.8 FINAL REVIEW - Specify when the final review was initiated. The on-line review shall address the comparison of the data within the Digital Cartographic Feature File (DCFF) against the current edition of nautical charts, proper cartographic feature selection, and the positional accuracies. Off-line review shall mention comparing hard copy plots with the largest scale charts and imagery. List chart numbers, edition information, and scale. Mention that the results of the comparison can be examined by reviewing the Chart Evaluation File, which are generated from the Chart Comparison Print. Note that the Chart Evaluation File is defined in Attachment AE and a description of the Chart Comparison Print is in Attachment K.

4.9 PROJECT FINAL DATA AND PRODUCTS - This section of the report is a listing. The major topics to be covered are:

RSD Applications Branch Project Archive
- Hard copy of Airborne Positioning and Orientation Report
- Hard copy of Aerotriangulation Report
- Hard copy of the Project Completion Report, including the Project Completion Diagram, see below

RSD Electronic Data Library:
- Project Database
- DCFF: GC- #####
- Digital copy of DCFF in Shapefile format
- Digital Copy of Project Completion Report in MS Word and Adobe PDF Format

NOAA Shoreline Data Explorer
- DCFF: GC- #####
- Metadata file for GC- #####

- Digital Copy of the Project Completion Report in MS Word and Adobe PDF Format

4.10 PROJECT COMPLETION DIAGRAM - The project diagram is the page size diagram generated from all of the final compilation data. It shows DCFF coverage in relationship to the geographic features of the survey site. The page size diagram shall include the following items:

A. Top center heading, with a general location description on first line, and the state on the second line.

B. Large Map display including:

(1) Graticule of latitude and longitude.
(2) Final shape files with Lapis Lazuli (bluish hue) for lines and black for points.
(3) Descriptive names for orientation purposes.

C. Legend

(1) NOAA symbol on lower left
(2) Smaller Map Display showing general state location in Olivine Yellow with a black outline around state of 0.40 width. Also a Ginger Pink colored box will display the specific project location on the state. The two letter state abbreviation will be placed on the state.
(3) Project ID and GC Number(s) will be placed in the lower right
[See an example of a project diagram at the end of the Sample Completion Report in the Annex at the end of this Attachment].

ANNEX 1

NOAA COASTAL MAPPING PROGRAM
PROJECT COMPLETION REPORT
PROJECT FL9701
MIAMI TO FORT LAUDERDALE, FLORIDA

Introduction

Coastal Mapping Program (CMP) Project FL9701 provides a highly accurate database of new digital shoreline data along the southeast coast of Florida. The southern area coverage includes the Miami Harbor, northern Biscayne Bay, Virginia Key, Fisher Island, and the northern coverage includes Port Everglades at Fort Lauderdale.

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 (DCFF) of the coastal zone which meet the requirements of the NOAA CMP.

The project was produced under two separate task orders contracted through the St. Louis District of the U.S. Army Corps of Engineers (USACE) for EarthData International (EDI) of Maryland to perform digital photogrammetric surveys and coastal mapping of this project. The first task order (Contract DACW43-96-D0525 task order #7), which addressed the project design, aerial photography, ground control and analytical aerotriangulation, was negotiated in 1997. The second task order (Contract DACW43-00-D0501 task order #7), which addressed feature extraction, feature attribution, topological data structure, and final review, was negotiated in 2000. For detailed instructions concerning the Scope of Work of these task orders, refer to Section I of the EDI Project Completion Report, located in the Remote Sensing Division (RSD) Applications Branch (AB) Project Archive.

Project Design

The Requirements Branch (RB) of RSD formulated the photographic mission instructions for this project following the guidelines of the Photo Mission Standard Operating Procedure Version II (7/01/93). The instructions discussed the project's purpose, geographic area of coverage, scope and priority, photographic requirements, flight line priority, tide coordination, Global Positioning System (GPS) data collection procedures and guidelines for both kinematic and static surveys, data recording and handling instructions, and contact and communication information. These instructions were provided to EDI personnel.

The Project Layout Diagram and flight maps were developed by EDI planning staff members and reviewed by RB and USACE St. Louis personnel. Refer to the EDI Project Completion Report for further information dealing with the project design and planning.

Field Operations

EDI photographic mission operation was conducted on January 18, 1997, February 1, 1997, February 1, 1998, and February 5, 1998. Aerial photographic coverage of the project site consisted of natural color and black & white infrared photographs at nominal scales of 1:14,400 and 1:40,000. Tide-coordinated photography was conducted at both the mean high water (MHW) and mean lower low water (MLLW) levels. Natural color and black & white infrared photographs were acquired at MHW and only black & white infrared photographs were acquired at MLLW.

Ground Survey Operations provided a total of 35 ground points. Of these, eleven points were paneled and included in the first phases of production in 1997/98. The remaining 24 were photo-identifiable and were acquired to strengthen the aerotriangulation adjustment to ensure the resulting mapping would meet the requirements of the Scope of Work section 10.1.

Additional information can be found in the EDI Field Survey Operations Report (30 July 2001) located in the RSD AB Project Archive.

GPS Data Reductions

Global Positioning System (GPS) data was collected and processed to provide precise positions of camera centers for application as photogrammetric control for the natural color photographs. During the aerial photography acquisition, two duel-frequency GPS receivers were used. One receiver was used for kinematic GPS and the second used as a base station collecting static GPS data at Fort Lauderdale Executive Airport set up on a temporary point designated “BAN”. The coordinate of “BAN” was determined to have an accuracy of first order horizontally. All GPS phase data collected was post-processed with continuous kinematic survey techniques using Ashtech’s PNAV software program. The results from each process were combined to yield a single fixed integer phase differential solution of the aircraft trajectory. The processing solutions were analyzed and found to be valid and correct.

Aerotriangulation

A fully analytical block and bundle adjustment was performed for the MHW color and MLLW black & white infrared photographs at both scales (1:14,400 and 1:40,000). However, EDI did not perform aerotriangulation for the MHW black & white infrared. The original task order specified a one meter accuracy for 1:2,400 scale digital orthophotographs and five meter accuracy for 1:40,000. This data was verified by RSD personnel and found to be compliant with the task order. Upon the award of the second task order, EDI staff determined the need to strengthen the original aerotriangulation solution with additional ground control prior to the collection of vectors during the compilation phase. The mensuration operations were performed on EDI instruments consisting of Wild Pug 4 point-transfer devices and Wild BC2 analytical stereoplotters. The block and bundle adjustments for this project were completed using the Interactive Simultaneous Block and Bundle Adjustment (ISBBA) package. Based on the summary statistics for all of the aerotriangulated ground point standard deviations provided by EDI, the predicted horizontal circular error at the 95% confidence level is 0.25 meters for the 1:14,000 scale adjustments and 0.50 meters for the 1:40,000 scale adjustments. Additional information can be found in the EDI Aerotriangulation Report (15 August 2001)

Compilation

The Compilation phase of the project was accomplished by EDI personnel in December 2001. Digital mapping was performed in the softcopy environment using Z/I Imaging SSK Digital Photogrammetric Workstations (DPW). These systems are equipped with MicroStation for initial data collection and editing. Feature identification and the assignment of cartographic codes were based on image analysis of 1:14,400 and 1:40,000 scale natural color photographs and information extracted from the appropriate NOAA Nautical Charts. Cartographic feature attribution was assigned in compliance with the National Geodetic Survey's Coastal Cartographic Object Attribute Source Table (C-COAST). Nomenclature was assigned to selected cartographic features to refine general classification.

Cartographic features were compiled to meet a horizontal accuracy of one (1) meter at the 95% confidence level for the port areas of Miami and Ft. Lauderdale and five (5) meters for the open shoreline area between the two main port areas.

The following provides information on aerial photographs used in the project completion process:

Date of Acquisition	Location of Acquisition	Film Emulsion	Photograph Numbers	Scale (Nominal)	Stage of Tide
02/01/98	Miami	Color	3810-3824	1:14,400	MHW
02/01/98	Miami	Color	3830, 3832-3845	1:14,400	MHW
02/01/98	Miami	Color	3848-3862	1:14,400	MHW
02/01/98	Miami	Color	3871-3879	1:14,400	MHW
01/18/97	Miami	B&W IR	4014-4026	1:14,400	MLLW
01/18/97	Miami	B&W IR	4034-4048	1:14,400	MLLW
01/18/97	Miami	B&W IR	4054-4066	1:14,400	MLLW
01/18/97	Miami	B&W IR	4075-4083	1:14,400	MLLW
02/01/98	Ft. Lauderdale	Color	3909-3931	1:14,400	MHW
02/01/98	Ft. Lauderdale	Color	3935-3957	1:14,400	MHW
02/01/98	Ft. Lauderdale	Color	3961-3983	1:14,400	MHW
01/18/97	Ft. Lauderdale	B&W IR	4114-4118	1:14,400	MLLW

01/18/97	Ft. Lauderdale	B&W IR	4119-4131, 4133	1:14,400	MLLW
01/18/97	Ft. Lauderdale	B&W IR	4140-4160	1:14,400	MLLW
01/18/97	Ft. Lauderdale	B&W IR	4165-4183	1:14,400	MLLW
02/01/97	Miami	Color	6848-6864	1:40,000	MHW
02/01/97	Miami	Color	6866-6882	1:40,000	MHW
02/05/98	Miami	B&W IR	3987-4019	1:40,000	MLLW
02/05/98	Miami	B&W IR	4034-4066	1:40,000	MLLW

Final Review

The final review phase of project completion was completed by an AB CMP team member in January 2002. The digital cartographic feature files (DCFF) were evaluated for completeness and accuracy. Data review consisted of an on-line and off-line evaluation of digital compilation and hard copy products. The on-line review consisted of reviewing stereographic models utilizing a DPW for cartographic feature codes selection, positional accuracies of features, and nomenclature. The cartographic feature attribution was judged to conform to C-COAST specification. The offline evaluation process consisted of the comparison of hard copy plots of the project data with the largest scale nautical charts available and the natural color photographs.

Copies of NOAA nautical charts used for comparison and chart maintenance print purposes include:

11466	Jupiter Inlet to Fowley Rocks	1:80,000	35th Edition
11467	West Palm Beach to Miami	1:40,000	36th Edition
11468	Miami Harbor	1:10,000	38th Edition
11470	Fort Lauderdale - Port Everglades	1:10,000	35thEdition

Project Final Data and Products

The following specifies the location and identification of the products generated during the completion of this project:

RSD Applications Branch Project Archive

- Hard copy of EDI Aerotriangulation Report
- Hard copy of the EDI Project Completion Report
- Hard copy of the RSD Project Completion Report
- Page size graphic plot of DCFF contents

RSD Electronic Data Library:

- Project Database
- Digital copy of DCFF GC10465, GC10466, GC10467 and GC10468 in Shapefile format

- Digital copy of Project Completion Report in MS Word and Adobe Acrobat (pdf) format

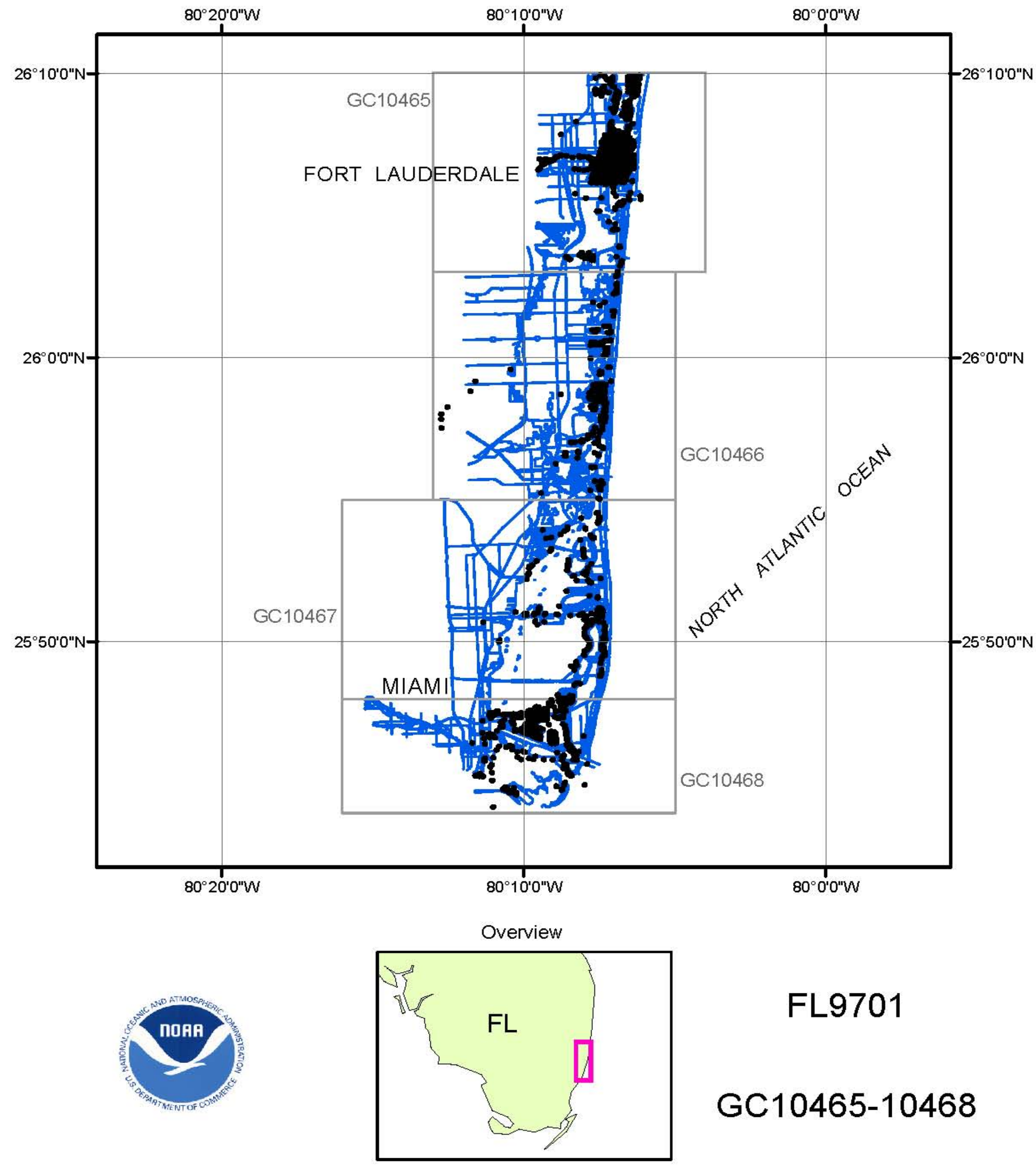
NOAA Shoreline Data Explorer

- DCFF: GC10465, GC10466, GC10467, GC10468
- Metadata file for GC10465, GC10466, GC10467, GC10468
- Digital copy of Project Completion Report in MS Word and Adobe Acrobat (pdf) format

End of Report

MIAMI TO FORT LAUDERDALE

MIAMI, FLORIDA



FL9701

GC10465-10468

ANNEX 2

NOAA COASTAL MAPPING PROGRAM
PROJECT COMPLETION REPORT

PROJECT NC0301

OREGON INLET
NORTH CAROLINA

Introduction

Coastal Mapping Program (CMP) Project NC0301 provides coastal zone mapping data for the Oregon Inlet vicinity. Digital cartographic feature file (DCFF) GC10552 covers the area around the Oregon Inlet vicinity from approximately three miles north on Bodie Island to approximately two and a third miles south on Hatteras Island. The DCFF may be utilized in support of NOAA's Nautical Charting Program (NCP) and coastal zone management activities.

Project Design

This project was designed as a Response and Restoration effort within the Remote Sensing Division Research and Design Group, which assist in providing timely and accurate shorelines. The primary objective of this project was to help support safe navigation through the ever-changing inlet. Congress assigned NOAA the responsibility of helping with navigation after the United States Army Corps of Engineers' proposal for a dual jetty system was abandoned. The project goal is to provide contemporary digital cartographic data in support of a variety of applications within the NCP as well as supporting research and design initiatives. Based on an analysis of project requirements, it was determined that CMP procedures for multiple source projects would apply for this project. A one-meter ground sample distance LiDAR point cloud, later used to produce a five-meter ground sample distance Digital Elevation Model (DEM), acquired on June 22, 2003 was deemed appropriate to meet project requirements. Overlaying the shoreline contoured from a high resolution LiDAR derived DEM on a NOAA digital raster nautical chart allows for analysis of discrepancies between data sources. This effort allows the Remote Sensing Division to focus its shoreline compilation efforts where they can provide the greatest assistance to areas of need, importance, and high variability. The DEM was supplemented with 0.125 meter ground sample distance North Carolina Department of Transportation (NCDOT) Orthophoto Imagery acquired March 23, 2002 and July 12, 2002. The orthophoto imagery was used for a visual comparison of stable features for a horizontal accuracy assessment. North Carolina FEMA LiDAR acquired January through March 2001 was also used for an inter-comparison of vertical accuracy.

Field Operations

On June 22, 2003 the NOAA Citation equipped with an Optech ALTM 2050 flew a LiDAR data acquisition mission over the Oregon Inlet, North Carolina vicinity. Operating at an altitude of 4,000 feet from approximately 14:52:35 to 16:07:39 (UTC), 10 strips of LiDAR returns were collected. The swath of the LiDAR was approximately 400 meters in width. Two Ashtech Z-Xtreme Global Positioning System base stations were operating during the LiDAR collection to assure an acceptable trajectory for accurate LiDAR post-processing. The acquisition of the NGS LiDAR elevation data occurred while the water level was near mean sea level, approximately 0.40m above Mean Lower Low Water (MLLW), see Table 1.

Table 1: Source Data for Extraction

Date	Time (GMT)	Altitude (ft)	LIDAR	Swath Width (m)	Water Level Above MLLW (m)
06/22/03	14:52:35-16:07:39	4000	Derived Digital Elevation Models (NC0301_ss1 and NC0301_ss2)	400	0.40

Data Processing

The LiDAR data were processed using the Optech REALM Survey Suite version 3.1. The airborne navigation data (airborne GPS and inertial measurement unit (IMU)) were processed using Applanix's POSPAC software. LiDAR point cloud editing was performed using the TerraScan Viewer software package.

In preparation for shoreline extraction, the LiDAR point cloud was converted through VDatum from ellipsoid to orthometric heights utilizing Geoid99. Since tide model and sea surface topography fields were not currently available for VDatum in this area, a local tidal datum relationship was derived. This tidal datum was calculated utilizing two outside (barrier island system) tide gauges and one inside (barrier island system) tide gauge. The outside tide gauges consisted of Duck FRF Pier, NC (Station # 8651370) and Cape Hatteras Fishing Pier, NC (Station # 8654400). The inside tide gauge that was used is Oregon Inlet Marina, Pamlico Sound, NC (Station # 8652587). A NAVD88 height of 0.24 meters was used for Mean High Water (MHW), giving a greater weight to the outside tide station gauges. The one meter post spacing of LiDAR returns were interpolated using an inverse distance weighting algorithm in Surfer version 8, into a DEM with a horizontal resolution of 5 meters.

Extraction

A MHW contour was derived from the LiDAR derived DEM using the ESRI ArcMap software package. A high-resolution orthophoto created by the North Carolina Department of Transportation was used to help in performing the classification of the vector. Many charted discrete point features (such as aids to navigation, piles and dolphins) could not be clearly distinguished, confidently identified, or positioned accurately, and therefore were not compiled. Also, linear features other than a MHW line were not included. Without concurrent digital imagery or intensity, LiDAR alone does not allow for the features to be extracted. The DCFF attribution conforms to the Coastal Cartographic Object Attribute Source Table (C-COAST), the NOAA National Geodetic Survey's attribution schema for coastal data.

Cartographic features were extracted to meet a horizontal accuracy of 3.0 meters at a 95% confidence level. This predicted accuracy of the extracted shoreline vector is a deductive estimate based on the ALTM 2050 specifications and published research of topographic LiDAR accuracy. Optech states an accuracy of 15 centimeters in the vertical component if LiDAR is acquired at an altitude of 1,200 meters. The horizontal accuracy is stated to be better than 1/2,000 x altitude. Brock et al., 2002; Brock et al., 1999; Hodgson et al., 2004; Hofton et al., 2000; Huising et al., 1998; Krabill et al., 2000; Krabill et al., 1995; Wright et al., 1997 have depicted vertical elevation accuracies of 15-30 centimeters with topographic lidar sensors.

Final Review

Final office review operations were conducted after completion of the compilation phase. The process included review of the identification and attribution of cartographic features based on image analysis and criteria defined in C-COAST. Visual inspection indicated that the charted and newly compiled shorelines matched in some areas. However, there were many areas where the differences were significant enough to indicate that the new compilation provides a better representation of the shoreline than is depicted on the chart. The following NOAA nautical chart was used for chart comparison:

12205, 28th Edition; Cape Henry To Pamlico Sound Including Albemarle Sound

The last step in the quality control process was the evaluation of the DCFF contents focusing on the integrity of topology.

Project Products

The following specifies the location and identification of the products generated during the completion of this project:

RSD Applications Branch Archive

- Hard copy of the Project Completion Report (PCR)
- Hard copy graphic plot of GC10552 file contents

RSD Electronic Data Library

- DCFF for GC10552 in ESRI Shapefile format
- Digital copy of the PCR in MS Word and Adobe Acrobat PDF format
- Digital copy of NC0301_ss1 and NC0301_ss2 in ESRI Grid format
- Digital copy of NC0301_strip01-strip10 in ASCII format

NOAA Shoreline Data Explorer

- DCFF for GC10552 in ESRI Shapefile format
- Metadata file for GC10552
- Digital copy of the PCR in MS Word and Adobe Acrobat PDF format

Version 1A
August 8, 2005

ATTACHMENT M
COASTAL MAPPING PROGRAM OPERATIONS MANUAL

TO
SCOPE OF WORK FOR SHORELINE MAPPING
UNDER THE
NOAA COASTAL MAPPING PROGRAM

REMOTE SENSING DIVISION
NATIONAL GEODETIC SURVEY
NATIONAL OCEAN SERVICE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE

ATTACHMENT M: COASTAL MAPPING PROGRAM GLOSSARY

abutment, bridge - A supporting or buttressing structure, as in the center or at the end of a bridge. Syn. bridge pier. (11)

accepted values (tide) - Tidal datums and Greenwich high and low water intervals obtained through primary determination or simultaneous observational comparisons made with primary control tide stations in order to derive the equivalent of a 19-year value.

accretion - Accumulation resulting from the action of natural forces; the gradual accumulation or build-up of land through the deposition of waterborne or airborne material as a result of natural forces or act of man. Accretion is the act, while alluvion is the deposit itself.

accuracy - The quality or state of being accurate or exact; exactness. The degree of conformity with a standard, or the degree of perfection attained in a measurement. Accuracy relates to the quality of a result, and is distinguished from precision which relates to the quality of the operation by which the result is obtained.

adjustment - Equitable distribution of errors and known distortions, which affect a computed result.

aerotriangulation (aerial triangulation) - Triangulation for the extension of horizontal and (or) vertical control accomplished by means of aerial photographs.

aid to navigation - A device external to a boat or vessel designed to assist in determination of position, a safe course, or to warn of dangers. Examples are: lighthouses, lights, buoys, daybeacons, radiobeacons, and electronic devices.

air base (photogrammetry) - The line joining two air stations, or the length of this line; also the distance (at the scale of the stereoscopic model) between adjacent perspective centers as reconstructed in the plotting instrument. photobase - the length of the air base as represented on a photograph. The distance between principal points of two adjacent prints of a series of vertical aerial photographs. It is usually measured on one print after transferring the principal point of the other print.

Airborne Global Positioning System (Airborne GPS) - A system using a GPS receiver mounted in an aircraft which produces data used to navigate the aircraft and/or position the photo centers.

altitude (aerial photography) - Vertical distance above the datum, usually mean sea level, of an object or point in space above the earth's surface.

area navigation approach (ANA) - Airport surveys which provide runway, obstruction, and other information to support precision and nonprecision instrument approach procedure development for conventional aircraft using area navigation systems, such as GPS. In addition these surveys provide positions and elevations for selected navigational aids associated with the airports.

analog instruments - Devices that represent numerical quantities by means of physical variables; e.g., by translation; by rotation, as in a mechanical gear system; and by voltage or current as in analog networks that use resistance to represent mechanical losses, capacitors and inductors to store energy and simulate the action of springs, etc. Analog is contrasted with analytical and digital. Wild B-8 stereoscopic plotters are examples of photogrammetric analog instruments.

analytic aerotriangulation - A method for accurately determining the ground positions of objects throughout a strip or block of overlapping aerial photographs, using relatively few known ground positions, by means of digital calculations based on coordinate measurements of pertinent image positions on each photograph. This method differs from the more conventional instrument method that is based on measurements of a stereographic model which is perfected or solved through use of an analog device (first-order stereoscopic plotter). The analytic method offers certain worthwhile advantages occurring from automation, digital accuracy, least-square adjustment, and freedom from mechanical discrepancies contributed by the plotting instrument.

analytical stereoplotter - A stereocomparator which allows photogrammetric mensuration through application of mathematical solutions utilizing computer real-time or applications programs replacing the optical/mechanical components of the conventional analog stereoscopic instrument. The precision of devices available on the commercial market vary greatly to meet the requirements and fiscal limitation of the user. The analytical stereoplotter was invented by Dr. U. V. Helava and first described in a 1957 paper.

angle - The difference in direction between two convergent lines. It may be classed as horizontal, vertical, oblique, spherical, or spheroidal, according to whether it is measured in a horizontal, vertical, or inclined plane, or in a curved surface.

angle of view - Twice the angle whose tangent is one-half the length of the diagonal of the format divided by the calibrated focal length. (12)

archived data (digital) - The data that has been purged from an on-line data base, written to magnetic tape or other storage media and placed in a library facility. This data has been determined to be no longer valid for active program purposes, but transferred to the library based on policy requirements.

attribute - A characteristic of a feature, such as numbers or text. (13)

average deviation (statistics) - The average or arithmetic mean of the deviations, taken without regard to sign, from some fixed value, usually the arithmetic mean of data. Also called mean deviation.

awash - Flush with or washed by the waves. (23)

azimuth (angle) - The direction of one point or object, with respect to another where the direction of the line is expressed as the clockwise angle from 0^o to 360^o, from the reference meridian. The azimuth angle is measured from South (NAD 83) in geodesy and North (NAD 83) in navigation. Either is acceptable in cadastral surveys. Quadrantal azimuths are properly called bearings; half-circle azimuths are used in astronomy. The reference meridian can be assumed, grid, magnetic, astronomic, or geodetic.

azimuth mark (geodetic) - A marked point established in connection with a triangulation or traverse station to provide a starting azimuth for dependent.

bathymetry - The art and science of measuring water depths to determine the configuration of the sea floor.

Bench Mark (BM) - A marked vertical control point which has been located on a relatively permanent material object, natural or artificial, and whose elevation above or below an adopted datum has been established. It is usually monumented to include bench mark name or number, and the name of the responsible agency.

block adjustment - The adjustment of strip coordinates or photograph coordinates for two or more contiguous strips of photographs.

block of photographs - Two or more overlapping strips of photography.

breakwater - A structure protecting a shore area, harbor, anchorage, or basin from waves. May be floating or constructed upon the bottom. A breakwater may be attached to or separated from the shore.

bridge - A lawful bridge over navigable waters of the U.S., including approaches, fenders, and appurtenances thereto, which is used and operated for the purpose of carrying passenger, road or railroad traffic. (6)

> Bascule bridge - A single or double leaf span (usually counterbalanced), with the shoreward ends hinged, allowing the span to be elevated vertically, or nearly vertically. (6)
> Draw bridge - A general name for bridges of which part or the entire span of the bridge may be raised or drawn aside to allow ships to pass through. (23)
> Fixed bridge - A single or multiple span bridge without a moveable span. It has fixed vertical and horizontal clearance. (6)
> Lift bridge - A moveable bridge which is capable of being lifted vertically to allow vessels to pass beneath. (23)
> Pontoon bridge - A bridge supported on pontoons. (6)
> Swing bridge - A bridge that can be rotated in a horizontal plane about a vertical pivot to allow vessels to pass. (23)

C-factor - An empirical value which expresses the vertical measuring capability of a given stereoscopic system; generally defined as the ratio of the flight height to the smallest contour interval accurately measured. The C-factor is not a fixed constant, but varies over a considerable range, according to the elements and conditions of the photogrammetric system. In planning for aerial photography, the C-factor is used to determine the flight height required for a specific contour interval, camera and instrument system. Also called altitude-contour ratio. See S-factor.

calibrated focal length - An adjusted value of the equivalent focal length so computed as to distribute the effects of lens distortion over the entire field used in an aerial camera. Also, the distance along the lens axis from the interior perspective center to the image plane, the interior center of perspective being selective so as to distribute the effects of lens distortion over the entire field.

calibration - The act or progress of determining certain specific measurements in an instrument or device by comparison with a standard, for use in correcting or compensating errors or for purposes of record.

calibration constants (photogrammetry) - The results obtained by calibration which give the relationship of the principal point to the fiducial marks of a camera and the calibrated focal length of the lens-camera unit.

camel - A device let down between the side of a ship and a wharf or pier or another ship to protect from chafing when lying alongside or to take the shock of a bump when going alongside. Also called “fender”. (23)

camera - A light-proof chamber or box in which the image of an exterior object is projected upon a sensitized plate or film or light sensor, through an opening usually equipped with a lens or lenses, shutter, and variable aperture. aerial camera - A camera specially designed for use in aircraft. The prefix "aerial" is not essential where the context clearly indicates an aerial camera rather than another type of camera.

cartographic license - The freedom to select, adjust, add, or omit map features within allowable limits to attain the best cartographic expression. License must not be construed as permitting the cartographer to deviate from specifications.

cartography - The art and science of expressing graphically and/or digitally by means of maps and charts (graphic and electronic), the known physical features of the Earth or another celestial body; usually including the works of man and his varied activities.

certified digital data - Digital data which has undergone a review process which guarantees that the data meet requirements specified in the project instructions, will meet or exceed the intended application by the user, and that all attributes associated with each digital record within the data set has been verified as correct. Additional procedures and requirements are unique within each of the Marine Charting Division branches because of the major differences in data acquisition and processing systems.

chart - A special purpose map that includes, in addition to physical features, other data critical to its intended use. This is frequently navigation or weather information.

chart, aeronautical - A chart intended primarily for air navigation. The chart portrays all information (topographic features and aeronautical data) necessary for the safe conduct of aircraft.

chart, nautical - A chart intended primarily for marine navigation. The chart portrays all information (bathymetric data, topographic features and marine navigation data) necessary for the safe conduct of waterborne navigation.

chart letters and blueprints - The terms chart letter and blueprint are designations applied to charting data source documents received by the Mapping and Charting Branch. These documents may originate from within or from outside NOS. Many photogrammetric survey products, including revision prints, revised topographic maps, and photogrammetrically revised charts become chart blueprints. Data listings forwarded in support of the nautical charting program become chart letters. The essential difference between a chart letter and a blueprint is the size of the document. Chart letters are normal letter size or smaller or can be conveniently folded to letter size. Documents larger than this are designated blueprints.

chart maintenance print - An annotated copy of a shoreline map, a revision print, a revised topographic map, a photogrammetrically revised chart, or other graphic generated by the Remote Sensing Division, showing the differences between that document and the latest edition of the largest scale nautical chart of a survey area. The label "Chart Maintenance Print" is clearly shown along with the dates of photographs and other sources used in the compilation.

Chart Revision Program - The series of activities resulting in the revision of nautical chart drawings and survey manuscripts directly from photographs and other source data. The graphic products of the program are assigned an alpha-numeric identifier for tracking purposes; e.g. CRS-00000.

classifications of photogrammetric survey maps - Classifications of photogrammetric survey maps indicate the field and office operations used in their production. Since 1980, all photogrammetric survey maps have been produced through methods which comply with Registered Shoreline Map criteria and are referred to as Registered Shoreline Maps. Information on the former classifications is presented for historic purposes only.

> Registered Shoreline Map - This map is based on aerotriangulation that meets the requirements for National Standards of Map Accuracy and has received a final review. If a copy was issued prior to final review, one of the following notes was annotated on the copy:

Class I - This map is based on aerotriangulation that meets the requirements for National Standards of Map Accuracy and has been field edited. It is subject to correction by final review.

Class II - This map is based on aerotriangulation that meets the requirements for National Standards of Map Accuracy and a precompilation field inspection of mapping photographs. It is subject to correlation by field edit and final review.

Class III - This map is based on aerotriangulation that meets the requirements for National Standards of Map Accuracy and an office interpretation of the mapping photographs. It is subject to correction by field edit and a final review.

Class IV - This map is based on aerotriangulation that does not meet the requirements for National Standards of Map Accuracy and a precompilation field inspection of the mapping photographs. The map will be recompiled after aerotriangulation is readjusted and field edit is completed. A horizontal datum shift can be expected.

Class V - This map is based on aerotriangulation that does not meet the requirements for National Standards of Map Accuracy and compilation by office interpretation of the mapping photographs. The map will be recompiled after aerotriangulation is readjusted and field edit is completed. A horizontal datum shift and extensive changes in compiled details can be expected.

coast - General region of variable width that extends from the land/water interface inland to the first major change in terrain features.

(U.S.) Coast and Geodetic Survey (USC&GS) - A former name of the National Ocean Service. The organization was known as: The Survey of the Coast from its foundation in 1807 to 1836. Coast Survey from 1836 to 1878, Coast and Geodetic Survey from 1878 to 1970, and National Ocean Survey from 1970 to 1982. In 1982, it was named National Ocean Service (NOS). From 1965 to 1970, the Coast and Geodetic Survey was a component of the Environmental Science Services Administration (ESSA). The National Ocean Survey was a component of the National Oceanic and Atmospheric Administration (NOAA). NOAA became the successor to ESSA in 1970. NOS is a component of NOAA, U.S. Department of Commerce.

coast line (coastline) - According to Public Law 31 defined as the line of ordinary low water along that portion of the coast which is in direct contact with the sea and the line marking the seaward limit in inland waters. Also considered as the line of contact between land and sea without regard to a specified vertical datum. In NOS, the term is considered synonymous with shoreline.

coastal zone (coastal zone management) - The coastal waters (including the lands therein and there under) and the adjacent shorelands (including the waters therein and there under), strongly influenced by each and in proximity to the shorelines of several coastal states, and includes islands, transitional and intertidal areas, salt marshes, wetlands, and beaches. The zone extends, in the Great Lakes, to the international boundary between the United States and Canada, on either coast, seaward to the outer limit of the United States territorial sea. The zone extends inland from the shorelines only to the extent necessary to control shorelands, the uses of which have a direct and significant impact on the coastal waters. Excluded from the coastal zone are lands the use of which is by law subject solely to the discretion of or which is held in trust by the Federal Government, its officers, or agents.

collinearity condition - The fundamental equation of analytical photogrammetry; that the exposure station, the ground point and its corresponding image point all lie on a straight line.

compilation - The production of a new or recompiled map, chart, or related product from aerial photographs and geodetic control data by use of photogrammetric instruments. Also called photogrammetric compilation; stereo compilation. (12)

compilation, digital -Same as above in digital format.

compilation manuscript - The original graphic compilation of a map or chart constructed from original sources such as ground survey data and photographs. A compilation manuscript may include one or more overlays, which are part of the manuscript. Compilation manuscript is also referred to as base manuscript. The compilation manuscript is the direct source for the generation of a map manuscript.

conformal projection - A projection that retains shapes and angles; e.g. depicting small areas, such as lakes and ponds, with the same shapes as they have on the globe. To do so, the parallels and meridians must meet at right angles, and the local scale around any point must not vary. Most modern maps, particularly at larger scales, are constructed on conformal projections because of the importance of true shape and direction.

contiguous zones - Zones beyond the marginal sea over which a nation exercises certain types of jurisdiction without affecting the character of the area as high seas.

contour (mapping) - An imaginary line on a land surface connecting points of equal elevation; also, the line representing this feature on a map or chart (properly called a contour line). depression contour - a closed contour inside of which the ground is at a lower elevation between adjacent contours. accurate contour - a contour line which is accurate within one-half of the basic contour interval; also called normal contour. approximate contour - a contour line is substituted for a normal contour whenever its accuracy is questionable. carrying contour - a single contour line representing two or more contours, used to show vertical or near-vertical topographic features, such as steep slopes and cliffs.

control, geodetic - A system of horizontal and/or vertical control stations that have been established and adjusted by geodetic methods and in which the shape and size of the earth (geoid) have been considered in positional computations.

control, horizontal - Control with horizontal positions only. The positions may be referenced to the geographic parallels and meridians or to other lines of reference, such as plane coordinate axes.

control, photo - Any station in a horizontal and/or vertical control system that is identified on a photograph and used for correlating the data shown on that photograph; also termed photo control point, picture control point, and ground control point.

control, photogrammetric - Control established by photogrammetric methods as distinguished from control established by ground or other methods.

control, vertical - The measurements taken by surveying methods for the determination of elevation only with respect to an imaginary level surface, usually mean sea level.

control points (photogrammetry) - Any station (in a horizontal - and/or vertical-control system) that is identified on a photograph and used to aid in fixing the attitude and/or position of a photograph or group of photographs. Sometimes identified as supplemental control point, photo control point, picture control points, and ground control point.

control station, horizontal - A station whose position has been accurately determined in X and Y, or latitude and longitude.

coordinate system - A set of rules for specifying how coordinates are to be assigned to points. The rules usually specify an origin of coordinates, and a set of axes from which distances or angles are measured to yield coordinates. (14)

Coordinated Universal Time (UTC) - A time referencing term which supersedes, but is generally equivalent to Greenwich Mean Time. The new UTC time scale is almost perfectly constant, since it is based upon ultra-stable atomic clocks. GMT was based upon a form of solar time keeping and was roughly the same as UTC.

Continuously Operating Reference Stations (CORS) - The NGS network of continuously operating GPS reference stations (CORS) that provide Global Positioning System (GPS) carrier phase and code range measurements in support of 3-dimensional positioning activities throughout the United States and its territories. (15)

crab - The angle between the aircraft track or flight line and the fore and aft axis of a vertical camera, which is in line with the longitudinal axis of the aircraft. (16)

culture (mapping) - Features of the terrain that have been constructed by man. Included are such items as roads, buildings, canals, boundary lines, and in a broad sense, all names and legends on a map.

dangling node - A digital line that does not close to form a polygon. (17)

data bank - Refers to the digital data base, plus new data arrivals transformed, where necessary, into digital form. The term data bank also includes the digital data storage, retrieval, and update systems used to manipulate the data.

data base - Refers to the mass of data presently existing, most of which must be transformed into digital format before entering into a data bank.

datum - Any quantity or set of such quantities that may serve as a reference or basis for calculation of other quantities. chart datum -a datum to which depths (soundings) in a hydrographic survey or on a chart are referred. geodetic datum - a set of constants specifying the coordinate system used for geodetic control, i.e., for calculating coordinates of points on the Earth. tidal datum - a surface with a designated elevation from which heights or depths are reckoned, defined by a certain phase of the tide.(14)

day of year - The sequentially numbered day of the year. The date of source required as an attribute for each digital record within a data set. Day of year is often confused with Julian Day.

depth curve - A line on a map or chart connecting points of equal depth below the hydrographic datum. Also called bathymetric contour or isobath. (12)

Descriptive Report (DR) - A collection of NOAA forms, tabulated and narrative reports which summarize the activities and practices executed in the completion of a map. The report summarizes the unique and standard methods, requirements, and procedures performed to achieve an acceptable level of quality for acceptance of the shoreline map and associated data. A DR was prepared for each shoreline map produced within a project. This requirement was superceded on February 16, 1989 with the approval of Section 14, Project Completion Report of the Coastal Mapping Program Operations Manual.

diapositive (photogrammetry) - A positive photograph on a transparent medium, usually polyester or glass. The term is generally used to refer to a transparency used in a plotting instrument, a projector, or a comparator.

Differential Global Positioning System (DGPS) - The technology of increasing the accuracy of an electronic navigation system by monitoring the system error from a known, fixed location and transmitting corrections to system users. (18)

digital - The representation of integers in a number system. The term is generally used to indicate data conveyed in a purely numerical form to permit the manipulation by automated techniques and procedures.

digital elevation model (DEM) - A numerical model of the elevations of points on the earth's surface. Digital records of terrain elevations for ground positions at regularly spaced horizontal intervals.(12)

Digital Terrain Elevation Data (DTED) - A uniform matrix of terrain elevation values produced in an NGA format. Level 2 post spacing is one arc second latitudinally. Level 1 post spacing is three arc seconds latitudinally, longitudinal spacing varies with latitude. (12)

digital photogrammetric workstation -See softcopy workstation.

digital terrain model (DTM) - A statistical representation of the continuous surface of the ground by a large number of selected points with known rectangular coordinates in an arbitrary coordinate field. (12)

digitize - To use numeric characters to express, or represent data; e.g., to obtain from an analog representation of a physical quantity, a digital representation of the same quantity.

disk - A thin metal plate about 9 cm in diameter, with a stem attached to the center of the bottom used to indicate a survey point. The plate is slightly convex (in vertical), usually round (in horizontal) and contains the mark for which survey information is known, or to be determined. The plate usually also contains a designation, year, and the name of the agency setting the plate. It is usually made of bronze, brass, or aluminum and may be set in a drill hole or embedded in concrete.

dock - A dock (not the same as a pier) is the water area between two piers; also called a slip. Or a water basin for reception of vessels, such as a dry dock.

dodging, of image -A process used to increase or decrease the brightness of a portion of an image.

dolphin - A post or group of posts (or pilings), used for mooring or warping a vessel, as an Aid To Navigation, or as protection for other vessels or structures. The dolphin may be in the water, on a wharf, or on land. (18)

editing - Revising a data field within a data record; e.g., changing a geographic coordinate value.

ellipsoid - A closed surface, whose planar sections are either ellipses or circles. (12). Reference ellipsoid - an ellipsoid of specified dimensions and associated with a geodetic reference system or a geodetic datum. (12)

emulsion - A suspension of light-sensitive silver chloride or silver bromide usually in a gelatin, which is used for coating photographic film, plates, and papers.(2)

ephemeris - A tabulation of the locations and related data for a celestial body for given epochs (dates) at uniform intervals of time. (14)

exposure station -The three-dimensional position of the perspective center of an aerial camera at the time of exposure. Also called camera station or air station.

exterior orientation - The three-dimensional position and rotation of an aerial camera's perspective center at the time of exposure, expressed by ground coordinates in a specified map projection, and three rotation angles (**S**, **N**, and **6**) around the coordinate axes.

feature – An object located on the surface of the earth, such as roads, building, lakes, and rivers. (13)

feature attribute - A characteristic of a feature, for example, the size or material of an object.(13)

feature collection - The process of identifying, delineating, labeling, and storing various types of natural and man-made characteristics from remotely-sensed images. Also called feature extraction. (17)

fender - A device let down between the side of a ship and a wharf or pier or another ship to protect from chafing when lying alongside or to take the shock of a bump when going alongside. Also called "camel". (23)

fiducial mark - Index marks, rigidly connected with the camera body, which form images on the negative. These images are used to determine the position of the optical center or principal point of the imagery. All called collimating marks. (12)

field evaluation - A quality of assurance operation in which field observations are compared with office interpretation of the same data. The scope and criteria for field evaluation operations is defined in the approved field evaluation instructions for each test.

field inspection - The process of comparing aerial photographs with conditions as they exist on the ground and of obtaining information to supplement or clarify that which is not readily discernable on the photographs themselves. A field inspection is completed prior to the office phases of a project.

Federal Geodetic Control Subcommittee (FGCS) - A subcommittee of the Federal Geographic Data Committee which concentrates on geodetic control matters.

field of view - The angle between two rays passing through the perspective center (rear nodal point) of a camera lens to the two opposite sides of the format. Not to be confused with angle of view. (12)

final review - The office function during which all quality control efforts are evaluated in the culmination of project products and associated data accepted for registration and dissemination. The final reviewer evaluates maps, digital cartographic feature files and other products, and completes the Project Completion Report.

flight maps - Maps are generated during the planning phase depicting the proposed location and direction of flight for executing aerial photography. Information on photograph scale, type of film emulsion, aerial camera criteria, endlap and sidelap percentages and the approximate number of exposures required to meet desired coverage of the project site is included.

focal length - The distance measured along the optical axis from the rear nodal point of the lens to the film plane, when a very distant object is sharply focused on the film plane. (2)

foreshore - That part of the shore or beach which lies between the low water mark and the upper limits of normal wave action.

forward motion compensation - An aerial camera feature which compensates for the forward motion of the aircraft during the time the shutter is open for each exposure.

foul area - An area of numerous uncharted dangers to navigation. The area marked serves a warning to the mariner that all dangers are not charted individually and that navigation through the area may be hazardous. The term “foul” should not be applied to a soft continuum with indefinite boundaries such as mud or sand; to areas congested with marine vegetation such as kelp or grass in water’ or to materials not likely to cause damage to a vessel. (6)

geocentric coordinate system - Any coordinate system with its origin at a specified and defined center of the Earth, such as the center of mass or the geometric center. (14)
geodetic control - See “control, geodetic”.

Geographic Information System (GIS) - The generic term used for a system of computer software programs and equipment that is used to acquire, store, manipulate, analyze, and display spatial data. (12)

geoid - The figure of the earth considered as a sea level surface extended continuously through the continents. The actual geoid is an equipotential surface to which, at every point, the plumbline (direction in which gravity acts) is perpendicular. It is the geoid which is obtained from observed deflections of the vertical and is the surface of reference for astronomical observations and for geodetic leveling.

georeferencing - The process of assigning map coordinates to image data and resampling the pixels of the image to conform to the map projection grid. (17)

Global Positioning System (GPS) - A navigation and positioning system, consisting of 24 satellites, with which the three-dimensional position and the velocity of a user at a point on or near the Earth can be determined in real time, or more accurately, after post-processing. Its reference system is WGS 84. The user's receiver will require tracking of a minimum of four of the satellites from any location at any time to establish position and velocity (three on the surface of the ocean). (12)

graving dock - A form of dry dock consisting of an artificial basin fitted with a gate or caisson, into which vessels can be floated and the water pumped out to expose the vessels bottoms. (6)

Greenwich Mean Time (GMT) - Mean solar time at the meridian of Greenwich, England. It has been used as a basis for standard time throughout the world. Also called Zulu Time. See Coordinated Universal Time.

groin - A structure projecting from the shore and designed to break the current and thereby check erosion.

gyro-stabilized mount - A device which allows an aerial camera to be maintained in a desired attitude within an airborne vehicle.

H - Height or elevation of camera stations above sea level datum, unless specified otherwise.

horizontal control - See "control, horizontal".

horizontal datum - The position on the spheroid of reference assigned to the horizontal control (triangulation and traverse) of an area and defined by 1) the position (latitude and longitude) of one selected station in the area and 2) the azimuth from the selected station on an adjoining station. The horizontal-control datum may extend over a continent or be limited to a small area. A datum for a small area is usually called a local datum and is given a proper name.

hydrographic survey - A survey having for its principal purpose the determination of data relating to a body of water for the purpose of promoting safe navigation. A hydrographic survey may consist of the determination of one or several of the following classes of data: depth of water configuration and nature of the bottom, velocity of currents; heights and times of tides and water stages; location of aids and dangers to navigation and survey purposes; configuration of marginal land areas, and determination of magnetic compass. Information on geographic names and harbor facilities is also often documented.

hydrography - The art and science which deals with the measurement and description of the physical features of the oceans, seas, lakes, rivers, and other waters and their littoral areas. Special emphasis is placed on the elements that effect safe navigation and commerce, and the publication of this information for use in navigation. Hydrography encompasses nautical or offshore surveying; determining winds, tides, and currents, as well as cartography.

hyperspectral sensor - A line-scanning array of sensors that detect and quantify electromagnetic radiation simultaneously in multiple spectral bands, such as the AVIRIS with 224 bands.

image - The record of the likeness of any natural or manmade features, objects and activities by the use of a camera or sensor. (2)

index map - (project) A small scale map of the project depicting the configuration of project maps and containing map coordinate identification information.

Infrared film - Film carrying an emulsion especially sensitive to "near-infrared." Land appears light and water dark, making infrared film particularly useful for shoreline mapping. (12)

inset - A small map placed within the border of a physically larger map. Most often refers to a small graphic depicting a specific area of the mother graphic at a larger scale. It may also refer to the graphic representation of a small area, falling outside, but coincident to the limits of a designate host graphic and plotted within the limits of that graphic, at either the same or differing scale, to prevent the need for a separate graphic.

Interferometric Synthetic Aperture Radar (IFSAR) - A SAR technique using the phase difference of SAR observations of a same scene taken from slightly different sensor positions. The interferogram derived from different scenes has the potential to detect small changes on the Earth's surface. (19)

Integrated Digital Photogrammetric Facility (IDPF) - IDPF includes all hardware and software items residing as part of the local area network which makes up the digital photogrammetric environment used by the Remote Sensing Division (RSD) in direct support of its imagery data extraction activities. The IDPF shall also be construed to include any additional hardware and software items used by either RSD or the NOAA Charting Research and Development Laboratory (NCRDL) to simulate the IDPF environment for the purpose of developing and maintaining IDPF applications software. IDPF shall not be construed to include any hardware or software that does not reside on the IDPF local network. Hardware items shall include analytical viewing devices, control computers, alphanumeric and graphic terminals, peripheral digital data storage devices and their controllers, hardcopy printers, plotters, modems and interconnectivity hardware. IDPF system software shall include those computer programs provided by hardware manufacturers or other third-party suppliers required by IDPF application software. IDPF application software shall be construed as those computer programs developed by, or under the supervision of NCRDL to enable IDPF to perform specific photogrammetric data extraction, manipulation, presentation, or data storage and retrieval functions.

interior orientation - The determining (analytically or in a photogrammetric instrument) of the interior perspective of the photograph as it was at the instant of exposure. Elements of interior orientation are the calibrated focal length, location of the calibrated principal point, and the calibrated lens distortion. (12)

International Great Lakes Datum of 1985 (IGLD 85) - See "Low Water Datum".

isobath - An imaginary line connecting points of equal depth below the surface of a body of water, or line drawn on a map to portray those imaginary lines of equal depths. Isobath and discrete depths are analyzed in the generation of depth curves depicted on nautical charts. See also “Depth Curve”.

jetty - A structure built out into the water to restrain or direct currents, usually to protect a river mouth or harbor entrance from silting.

Julian day - The consecutive number of each day commencing January 1, 4713 BC. The Julian day number denotes the number of days elapsed since noon on the initial day of the epoch; e.g. noon on May 17, 1985 marks the beginning of Julian day 2,446,203. For NOS purposes, the sequential 3-digit day number of the year should be referred to as the "day-of-the-year" rather than Julian day.

kappa (6) - In the exterior orientation of a photograph, the rotation about the z-axis.

Lambert conformal conic projection - A projection devised in 1772 by Johann Heinrich Lambert. It assumes a cone intersecting (secant to) the Earth along two parallels passing through the mapped area. The axis of the cone coincides with the Earth's axis. Scale is correct along both standard parallels, too small between them, and too large beyond them. Because scale is correct along two parallels, the Lambert projection is often preferred to the simple conic projection with only one standard parallel. Because of the north-south distortions, the Lambert projection is most suitable for mapping areas that are elongated east-west.

land information system (LIS) - A geographical information system for managing geographically referenced data related to a range of land characteristics including land cover, land use and other land records. It is capable of capturing, storing, manipulating, analyzing and displaying data. (19)

latitude - 1. Angular distance measured on a meridian; distance, north or south to 90 degrees, from the equator. The length of a degree of latitude varies due to the flattened figure of the earth, being 68.704 statute miles at the equator, and 69.407 at the poles. 2. The orthographic projection of a course upon the meridian (either true or assumed) of a survey. It is equal to the length of the course multiplied by the cosine of the bearing. 3. The perpendicular distance from a point of the bearing.

ledge - A rocky formation connected with and fringing the shore, and generally uncovered at the sounding datum. (4)

line - a series of related points, the path of a moving point. A line has only one dimension; length. (18)

linear - Of or pertaining to a line; or, having a relation such that a change in one quantity is accompanied by an exactly proportional change in a related quantity. (18)

<u>linear least squares transformation</u> -A statistical technique that calculates a curve of best fit for given points. The curve minimizes the sum of the squares of the deviations of the points from the curve.(19)

<u>lock</u> - A basin in a waterway with caissons or gates at each end by means of which vessels are passed from one water level to another materially affecting the higher level.

<u>longitude</u> - The angle between the plane of a given meridian and the plane of an arbitrary initial meridian, generally the meridian of Greenwich England. It may be measured as the angle at the poles between the two meridians, as the arc of the equator intercepted between the meridians, or as the arc of a parallel of latitude intercepted between the meridians.

<u>low water</u> - The minimum height reached by a falling tide. The low water is due to the periodic tidal forces and the effects of meteorological, hydrologic, and/or oceanographic conditions. For tidal datum computational purposes, the minimum height is not considered a low water unless it contains a tidal low water.

<u>Low Water Datum (LWD)</u> - 1. The dynamic elevation for each of the Great Lakes and Lake St. Clair and the corresponding sloping surfaces of the St. Mary's, St. Clair, Detroit, Niagara, and St. Lawrence Rivers to which are referred the depths shown on the navigational charts and the authorized depths for navigation improvement projects. Elevations of these planes are referred to the International Great Lakes Datum of 1985 (IGLD 85) and are: Lake Superior - 601.1 feet, Lakes Michigan and Huron - 577.5 feet, Lake St. Clair - 572.3 feet, Lake Erie - 569.2 feet, and Lake Ontario - 243.3 feet. 2. An approximation of mean low water that has been adopted as a standard reference for a limited area and is retained for an indefinite period regardless of the fact that it may differ slightly from a better determination of mean low water from a subsequent series of observations. Used primarily for river and harbor engineering purposes. Boston low water datum is an example.

<u>Lower Low Water (LLW)</u> - The lowest of the low waters (or single low water) of any specified tidal day due to the declinational effects on the Moon and Sun.

<u>Lower Low Water Datum (LLWD)</u> - An approximation of mean lower that has been adopted as a standard reference for a limited area and is retained for an indefinite period regardless of the fact that it may differ slightly from a better determination of mean lower low water from a subsequent series of observations. Used primarily for river and harbor engineering purposes. Columbia River lower low water datum is an example.

<u>lunar day</u> - The time of the rotation of the Earth with respect to the Moon, or the interval between two successive upper transits of the Moon over the meridian of a place. The mean lunar day is approximately 24.84 solar hours in length, or 1.035 times as great as the mean solar day.

magnetic declination – See variation.

map - A representation (usually on a flat medium) of all or a portion of the earth or other celestial body, showing the relative size and position of features to some given scale or projection; also, a representation of all or part of the celestial sphere. A map may emphasize, generalize, or omit the representation of certain features to satisfy specific requirements. Maps are frequently categorized and referred to according to the type of information which they are designed primarily to convey, to distinguish them from maps of other types.

> topographic map - A map which represents the horizontal and vertical positions of the features represented; distinguished from a planimetric map by the addition of relief in measurable form. A topographic map shows mountains, valleys, and plains; and in the case of hydrographic charts, symbols, and numbers to show depths in bodies of water.
>
> contour map - A topographic map which portrays relief by means of contour lines.
>
> planimetric map - A map which represents only the horizontal positions for the features represented; distinguished from a topographic map by the omission of relief in measurable form.
>
> base map - A map showing certain fundamental information, used as a base upon which additional data of specialized nature are compiled with or placed for purpose of comparison or geographical correlation. Also, a map containing all the information from which maps showing specialized information can be prepared; a source map.
>
> cadastral map - A map showing the boundaries of subdivisions of land, usually with the bearing and lengths thereof and the areas of individual tracts, for the purposes of describing and recording ownership. A cadastral map may also show culture, drainage and other features relating to the value and use of land.
>
> hydrographic map - A map showing a portion of the waters of the earth, including shorelines, the topography along the shores and of the submerged portions, and as much of the topography of the surrounding country as is necessary for the purpose intended.
>
> map manuscript - The original drawing of a map as compiled or constructed on a suitable medium from various data, such as ground surveys or photographs, and from which direct reproduction copies may be made.
>
> special-purpose map - Any map designed primarily to meet specific requirements. Usually the map information portrayed on a special-purpose map is emphasized by omitting or subordinating nonessential or less important information. A word or phrase is usually employed to describe the type of information which a special-purpose map is

designed to present; e.g. route, tax, or index map.

map projection -An orderly system of lines on a plane representing a corresponding system of imaginary lines on an adopted terrestrial datum surface. A map projection may be derived by geometrical construction or by mathematical analysis. (12)

mark - (1) A dot, the intersection of a pair of crossed lines, or any other physical point corresponding to a point in a survey; (2) The object, such as a disk, on which the mark is placed; (3) The entire monument, consisting of the mark, the object on which it occurs and the structure to which the object is fastened.

mean - The average of a number of quantities, obtained by adding the values and dividing the sum by the number of quantities involved. Also called average, arithmetic mean. (18)

Mean High Water (MHW) - A tidal datum. The average of all the high water heights observed over the National Tidal Datum Epoch (19 years). For stations with shorter series, simultaneous observational comparisons are made with a control tide station in order to derive the equivalent datum of the National Tidal Datum Epoch.

Mean High Water Line (MHWL) - The line on a chart or map which represents the intersection of the land with the water surface at the elevation of the MHW.

Mean Low Water (MLW) - A tidal datum. The average of all the low water heights observed over the National Tidal Datum Epoch (19 years). For stations with shorter series, simultaneous observational comparisons are made with a control tide station in order to derive the equivalent datum of the National Tidal Datum Epoch.

Mean Lower Low Water (MLLW) - A tidal datum. The average of the lower low water heights of each tidal day observed over the National Tidal Datum Epoch (19 years). For stations with shorter series, simultaneous observational comparisons are made with a control tide station in order to derive the equivalent datum of the National Tidal Datum Epoch.

mean range of tide (Mn) - The difference in height between mean high water and mean low water.

Mean Sea Level (MSL) - A tidal datum. The arithmetic mean of hourly heights observed over the National Tidal Datum Epoch. Shorter series are specified in the name; e.g., monthly mean sea level and yearly mean sea level.

Mean Water Level (MWL) - The mean surface elevation as determined by averaging the heights of water at equal intervals of time, usually hourly, over the National Tidal Datum Epoch. Mean water level is used in areas of little or no range in tide.

merged (digital data) - The combination of two or more digital files by automated data processing techniques. The process generates one digital data file which is equal in the number of data records to the sum of the individual files before merging. Merged digital files may be the combination of digital data files representing different stereographic models or a combination of digital data files created from the same stereographic model.
Examples of merged digital data are:

> 1. digital discrete point and linear data from different stereographic models merged to provide one digital file which represents a photogrammetric survey of a specified geographic area,
>
> 2. a merge of digital photobathymetric data files to provide one digital file for plotting machine processing in the generation of a photobathymetric data overlay.

meridian - A north-south reference line, particularly a great circle through the geographical poles of the earth. A meridian is a line connecting points having the same longitude. The prime meridian passes through longitude 0 degrees. (18)

micron - A unit of length equal to one-millionth of a meter. (18)

mixed tide - Type of tide with a large inequality in either the high and/or low water heights, with two high water and two low waters occurring each tidal day. In strictness, all tides are mixed but the name is usually applied to the tides intermediate to those predominantly semidiurnal and those predominantly diurnal.

monument - A structure that marks the location of a point determined by surveying. In the case of a disk in concrete, the monument would be the entire structure. Mark, monument, and station can mean the same thing.

mosaic - An assembly of overlapping aerial photographs which have been matched to form a continuous photographic representation of a portion of the Earth's surface. (12)

multispectral scanner - A line-scanning array of sensors that detect and quantify electromagnetic radiation simultaneously in several spectral bands. (19)

nadir - The point at which a vertical line through the perspective center of the camera lens pierces the plane of the photograph. Also, nadir point. Ground nadir - The point on the ground vertically beneath the perspective center of the camera lens. (2)

National Aerial Photography Program (NAPP) - See National High Altitude Photography (NHAP) Program below.

National Geodetic Vertical Datum of 1929 (NGVD 29) - The former fixed reference adopted as a standard geodetic datum for elevations determined by leveling, now replaced by the North

American Vertical Datum of 1988 (NAVD 88). The NGVD 29 datum was derived from a general adjustment of the first-order leveling nets of both the United States and Canada. In the adjustment, mean sea level was held fixed as observed at 21 tide stations in the United States and 5 in Canada. The geodetic datum is fixed and does not take into account the changing stands of sea level. Because there are many variables affecting sea level, and because the geodetic datum represents a best fit over a broad area, the relationship between the geodetic datum and local mean sea level is not consistent from one location to another in either time or space. For this reason, neither NGVD 29 nor NAVD 88 should be confused with mean sea level.

National High Altitude Photography (NHAP) Program - The National High Altitude Photography (NHAP) program was initiated in 1980 and coordinated by the U.S. Geological Survey (USGS) to acquire aerial photography of the 48 conterminous states every five years. This interagency program was designed to eliminate duplicate efforts in various government programs and to maximize the use of government funds to build a uniform archive for multiple uses. In 1987 the program name was changed to the National Aerial Photography Program (NAPP) in recognition of modifications in the user requirements and flight specifications. NHAP photography was acquired at 40,000 feet above mean terrain and flight lines were centered on the 1:24,000-scale USGS map series. Two different camera systems were used; a 6 inch focal length lens was used to acquire black-and-white film at an approximate scale of 1:80,000 and an 8.25 inch lens was used to acquire color-infrared film at an approximate scale of 1:58,000. A duel port camera system was used to acquire simultaneous coverage. NAPP photography is acquired at 20,000 feet above mean terrain with a 6 inch focal length lens. The flight lines are quarter quad-centered on the 1:24,000-scale USGS maps. NAPP photographs have an approximate scale of 1:40,000, and are flown in black-and-white or color infrared, depending on state or federal requirements.

National Map Accuracy Standards - see United States National Map Accuracy Standards.

National Spacial Reference System (NSRS) - The National Spatial Reference System (NSRS), defined and maintained by the National Geodetic Survey (NGS), is a consistent National coordinate system that specifies latitude, longitude, elevation, scale, gravity, and orientation throughout the Nation, as well as how these values change with time. (15)

National Tidal Datum Epoch - The specific 19-year period adopted by the National Ocean

Service as the official time segment over which tide observations are taken and reduced to obtain mean values; e.g., mean lower low water, etc., for tidal datums. It is necessary for standardization because of periodic secular trends in sea level. The present National Tide Datum Epoch is 1960 through 1978. It is reviewed annually for possible revision and must be actively considered for revision every 25 years.

neatline - That border line which indicates the limit of the body of a map or chart. (18)

neat model - In a stereoscopic model, the rectangular-shaped area between adjacent principal points and extending half way into each sidelap area. (21 & 22)

National Ocean Service (NOS) - National Ocean Service, NOAA. Disks inscribed with this NOS name were set from about 1983 to the present, for generally third-order surveys.

National Ocean Survey (NOS) - National Ocean Survey, NOAA. Disks inscribed with this NOS name were set from about 1970 to December, 1982, for generally third-order surveys.

North American Datum of 1927 (NAD 27) - The former official datum for the United States established by the U.S. Coast & Geodetic Survey (predecessor to NGS). The origin is located at Meades Ranch, Kansas. Based on the Clarke spheroid of 1866, the geodetic position of a triangulation station at Meades Ranch and azimuth from that station to station Waldo are as follows: Latitude of Meades Ranch: 39° 13' 25.686"N; Longitude of Meades Ranch: 98° 32' 30.506"W Azimuth to Waldo: 75° 28' 09.64" The geoidal height at Meades Ranch is assumed to be zero. Replaced by NAD 83. (18)

North American Datum of 1983 (NAD 83) - The modern geodetic datum for North America, established by the National Geodetic Survey, NOAA. NAD 83 removed network distortions present in NAD 27 and changed the origin to the center of mass of the Earth. It is the functional equivalent of the World Geodetic System (WGS 84). NAD 83 is based on the Geodetic Reference System of 1980 (GRS 80) ellipsoid, which fits the size and shape of the earth more closely. (18)

North American Vertical Datum of 1988 (NAVD 88) - The modern vertical datum for North America produced by the National Geodetic Survey, NOAA. It is a minimally-constrained adjustment of Canadian, Mexican, and U.S. leveling observations holding fixed the height of the primary tidal benchmark at Father Point/Rimouski, Quebec, Canada. The difference between NAVD 88 and NGVD 29 varies depending on one's location in the United States.

Notes to Hydrographer Print - An annotated copy of a shoreline map, revision print, photogrammetrically revised chart, revised topographic map, or any other graphic generated by the Remote Sensing Division intended to complement hydrographic survey operations. Annotations may include the identification of areas that have been revised, notes indicating differences between that document and the latest edition of the largest scale nautical chart of a survey area, items that require further investigation, and general information about source photographs. All field survey data generated in response to notes to hydrographer will be retained as part of the hydrographic survey record.

office review - The office function involving a series of quality control checks in the office compilation phase of a project. Office review involves on-line reviews of stereographic model/base manuscript relationship, photo-interpretation results, drafting and cartographic feature symbol quality, and review of draft narratives or completed forms relating to the project. This is a collaboration of effort by the cartographer and lead cartographer.

omega (S) -In the exterior orientation of a photograph, the rotation about the x-axis.

orbit - The path of a body or particle under the influence of a gravitational or other force. For example, the orbit of a celestial body or satellite is its path relative to another body around which it revolves. (12)

orthophoto - A photographic copy, prepared from a perspective photograph, in which the displacements of images due to tilt and relief have been removed.(12)

panchromatic film - A film sensitive to light of all colors; produces a black-and-white image (12)

parallax - In photography, the apparent displacement of the position of an object in relation to a reference point due to a change in the point of observation. In stereo photogrammetry, the absolute stereoscopic parallax of a point is the algebraic difference of the distances of the two images from their respective photograph nadirs, measured in a horizontal plane and parallel to the air base. (2 & 12)

pass points - In photogrammetry, a point whose horizontal and/or vertical position is determined from measurements on photographs using photogrammetric methods for use in the orientation of other photographs. (2)

perspective center - The point of origin or termination of bundles of perspective rays.(2)

phi (N)- In the exterior orientation of a camera, the rotation about the y-axis.

photogrammetric survey - A survey based on the correlation and extraction of data from ground and/or aerial photographs. At NOS, this type of survey is often complemented by limited field survey operations; i.e., field evaluation surveys, item investigations, and ground control surveys. The graphic representation of survey data is generally recorded in the form of a map manuscript or suite of map manuscripts.

photogrammetry - The art, science, and technology of obtaining reliable measurements and information through processes of recording, measuring, and interpreting images and patterns of electromagnetic radiant energy and other phenomena. (2)

photograph - A general term applying to either a positive or negative exposed on light sensitized material by use of a camera. Also the print made photographically from the negative or positive. The photograph may be exposed or printed, using one of these types of emulsion: panchromatic, negative or positive color, infrared color, or infrared black and white.

photographic model - see “stereomodel”.

photography - The art, science, and process of producing images on sensitized material through the action of light. The term photography is sometimes incorrectly used in place of photographs; however, the distinction between the process and the product is a valuable one and should be observed.

pier - A pier is a long, narrow structure extending into the water approximately perpendicular to a shore to provide a berthing place for vessels, to serve as a promenade, etc.

pile - A long, heavy timber or section of steel, concrete, etc., forced into the earth to serve as a support, as for a pier, or to resist lateral pressure. (6)

piling - A group of piles set in a row. As opposed to a group of piles banded together into a circle, called a dolphin. (6)

pitch, of airplane - The rotation of an aircraft about the horizontal axis which is perpendicular to the longitudinal centerline of the aircraft, and which causes a nose-up or nose-down situation. See also roll and yaw. (2)

pixel - A picture element, smallest unit of information in a grid cell map or scanner image. Abbreviated from "picture element;" the smallest part of a picture (image). (12 & 17)

planimetry - Applies to the horizontal placement of all natural and man-made features that are graphically represented on a map or chart. This excludes portrayals of relief in measurable form and all annotations.

polygon - A closed, plane figure that encloses an area. (13)

polynomial - An arithmetic expression composed by summing multiples of powers of some variable.

P(x) = sum a_i x^in for in = 0 .. N

The multipliers, a_i, are known as "coefficients" and N, the highest power of x with a non-zero coefficient, is known as the "degree" of the polynomial. If N=0 then P(x) is constant, if N=1, P(x) is linear in x. N=2 gives a "quadratic" and N=3, a "cubic".

principal point -The foot of the perpendicular to the photo plane through the perspective center.(12)

Product Standards (PS) - The minimum levels of Quality Measure with which the product is passable. It is generally a function of user requirements/values, technical capabilities, and costs to produce.

production cycle - The series of activities, organized into units referred to as phases, which take place during the life cycle of a mapping project. The major phases of the production cycle are planning, field operations, photographic operations, source data evaluation, aerotriangulation, analog or digital data extraction (compilation), approval, registration, and data dissemination.

project completion report (PCR) - The assembly of all official project instructions, reports and listings specified as being necessary to establish a sufficient reference for a coastal mapping project and supersedes the former requirement for a descriptive report for each map within a project.

pushbroom - A scanner in which all scanning parts are fixed and scanning is accomplished by the forward motion of the scanner. (17)

quadrangle - A four-sided figure, bounded by parallels of latitude and meridians of longitude, used as an area unit in mapping. The dimensions are not necessarily the same in both directions. The map of such an area is termed quadrangle map; sometimes shortened to quad.

quality - The totality of features and characteristics of a product or service that bear on its ability to satisfy given needs.

Quality Assurance (QA) –

1. A continuing evaluation of the QC process. It is not a double check on each product, but rather a "check on the checkers." QA techniques often employ a statistical sampling method to examine just enough of the products to determine that the QC system is effective. QA is not intended to catch all the mistakes, but only to determine if the rate of mistakes that pass through the QC system is within the acceptable limits established by management. Any problem identified by the QA process should result in corrective action in the QC process. Since QA evaluates part of the production system, e.g. QC, it must be organizationally separate from the production manger in order to ensure objectivity.

2. All those planned or systematic actions necessary to provide adequate confidence that a product or service will satisfy given needs.

Quality Control (QC) –

1. A routine inspection to ensure that the product conforms with certain minimum standards and specifications that have been established by management. QC is usually performed at the work site by supervisors or by designated inspectors. Products that fail to meet minimum standards are reprocessed or destroyed.

2. The operational techniques and the activities which sustain a quality of product or service that will satisfy given needs; also the use of such techniques and activities.

Quality Evaluation (QE) - The overall system of activities whose purpose is to provide assurance that the quality control activities are being done effectively. It involves a continuing evaluation of performance of the production system and the quality of the products produced. Auditing is one QE technique.

Quality Measure (QM) - A quantitative measure of the features and characteristics of a product or service. The general term used for accuracy, skill score, number of errors, clarity, or other appropriate measures of goodness. In general, QM is not a function of any specific use.

quality program - The documented plans for implementing the quality system. The term quality program refers to the "total quality program" whereas the term "quality assurance program" and "quality control program" refer to the programs associated with the functions of quality assurance and quality control, respectively.

quality, relative - The degree of excellence of a product or service. The word quality is often used by the layman in a relative sense that does not include many of the quantitative attributes of quality such as the economic aspect of given needs.

quality system - The collective plans, activities and events that are provided to ensure that a product, process, or service will satisfy given needs. The quality system encompasses all of the elements of quality assurance and quality control.

quay - A quay is a structure approximately parallel to the shoreline, accommodating ships on one side only, and usually of solid construction. A wharf is similar to a quay, but with open construction.

radar -Radio detection and ranging equipment that determines the distance and usually the direction of objects by transmission and return of electromagnetic energy. (12)

RADARSAT - RADARSAT is a Canadian Earth observation satellite developed to monitor the environment. RADARSAT has a planned lifetime of five years, and is equipped with a Synthetic Aperture Radar (SAR). The SAR is a powerful microwave instrument that can transmit and receive signals through clouds, haze, smoke, and darkness, and obtain high quality images of the Earth in all weather at any time. RADARSAT SAR has the unique ability to shape and steer its radar beam over a 500 kilometer range. The beam width can be varied from a swath of 35 kilometers to 500 kilometers with resolutions from 10 meters to 100 meters respectively. Incidence angles range from less than 20 degrees to more than 50 degrees.(17)

ramp - A sloping structure that can either be used as a landing place at variable water levels, for small vessels, landing ships, or a ferry boat; or for hauling a cradle carrying a vessel.

range of tide - The difference in height between consecutive high and low waters. The mean range is the difference in height between mean high water and mean low water. The great diurnal range or diurnal range is the difference in height between mean higher high and lower low water.

raster data - A matrix of measurements ordered by layers, columns and rows with each cell in the matrix being implicitly addressable by its coordinates (x, y). (19)

ratio print - A print in which the scale has been changed from that of the transparency by projection printing. The term enlarged photographic print is encouraged over “ratio print”.

rectification - The process of projecting a tilted or oblique photograph onto a horizontal reference plane. (12)

reef - A rocky or coral elevation dangerous to surface navigation which may or may not uncover at the sounding datum. A rocky reef is always detached from the shore, a “ledge” is connected to the shore. A coral reef may or may not be connected with the shore. (4)

reference mark (RM) - A survey mark of permanent character close to a survey station, to which it is related by an accurately measured distance and azimuth. For a triangulation station, reference marks are pre-stamped survey disks, usually within 30 meters (one tape length) of the triangulation station. Standard procedure was to set two reference marks, numbered clockwise from north, with the next consecutive reference number used if an earlier number was destroyed.

reference station - A tide or current station for which independent daily predictions are given in the Tide Tables and "Tidal Current Tables," and from which corresponding predictions are obtained for subordinate stations by means of differences and ratios. The term tide reference station records refers to the documentation and tabulation generated by the appropriate authority within NOS for each reference station.

reformatting - Adding, deleting, or rearranging data fields within a digital record usually done by software. Reformatting frequently includes a form of filtering.

registration (final products) - A series of record keeping and documentation actions that prepare the approved map manuscript, descriptive documentation (descriptive reports and/or project completion report), source data, and other supporting documents and records for permanent storage. Registration is considered complete when the Photogrammetry Branch Support Section has entered all appropriate registration information in the "Permanent Registration Log Book" and the registration copy of the final map manuscript and approved accompanying descriptive documentation have been sent to the NOS vault, and a receipt has been received. Support documents and data are sent to the Physical Sciences Support Section of the Aeronautical Charting Division for subsequent transmittal to the Federal Records Center (National Archives).

relief (mapping) - Inequalities in the elevations of terrain. Similar inequalities of the sea bed or other bodies of water are called submarine relief.

remote sensing - The measurement or acquisition of information of some property of an object or phenomenon by a recording device that is not in physical or intimate contact with the object or phenomenon under study. Sometimes restricted to the practice of data collection in the wavelengths from ultraviolet to radio regions. (12)

resolution (quality) - The minimum difference between two independently measured or computed values which can be reliably distinguished by the measurement or analytical method being considered or used.

revised topographic map - Similar to a revision print except that the base map is a copy of a topographic map published by the U. S. Geological Survey or other non-NOS agency.

revision print - A copy of an NOS registered shoreline map revised by application of shoreline and other features from aerial photographs held to map detail or plotted survey control. The revision print may contain selected revisions only and should not be considered a complete revision of the registered map. The original revision print will show revision in red. The label "Revision Print" will be clearly shown along with the dates of photographs and other sources used in the revision. The revision print will be forwarded to the charting program as a blueprint.

roam - The process of moving across a display so that different areas of the image appear on the display screen. (17)

rock - Rocks are classified as bare, awash, or submerged. A submerged rock is potentially the most dangerous natural hazard to navigation. Rocks with tops near the MLLW tidal datum are of particular importance in establishing offshore boundaries. A bare rock (islet) is an extremely important positional reference for the mariner since it can be seen at all tide stages. Chart symbology for rocks of different heights varies, see Chart No. 1, Section K 1-17, a-h.
roll, of aircraft - The rotation of an aircraft about its longitudinal axis causing a wing-up or wing-down situation. See also pitch and yaw. (2)

rubber sheeting - The application of a nonlinear rectification (2nd-order or higher). (17)

S-Factor - Since the C-Factor has been derived as a guide to planning for the achievement of a specified contour accuracy, it follows that a corresponding factor can be determined for achieving specified accuracies of spot elevations. This factor can be stated as the ratio of the flight height to the allowable spot-elevation error, or:

$$\text{Spot-elevation factor (S-factor)} = \frac{\text{Flight height}}{\text{Allowable Spot Elevation Error}}$$

Since plotting contours results in an error approximately twice as great as plotting a discrete point, the accuracy of a spot elevation can be assumed to be one-fourth the contour interval. The resultant S-factor can therefore be predicted as four times the C-factor. This increased accuracy results from the fact that the operator has the ability to read the elevation of a specific point with greater precision than to track a contour across terrain of varying characteristics.

scale - Relationship existing between a distance on a map, chart, or photograph, and the corresponding distance on Earth. Scale may be expressed as a ratio, 1:24,000; a representative fraction, 1/24,000; or an equivalence, 1 inch = 2,000 feet.

scanner - A device that examines an area or region point by point in a continuous systematic manner, repeatedly sweeping across until the entire area or region is covered. (19)

sea level - Height of the surface of the sea at any time.

sea wall - A structure separating land and water areas, primarily designed to prevent erosion and other damage due to wave action. See also bulkhead.

secondary control tide station - A tide station at which continuous observations have been made over a minimum period of 1 year but less than 19 years. The series is reduced by comparison with simultaneous observations from a primary control tide station. This station provides for a 365-day harmonic analysis including the seasonal fluctuations of sea level.

semidiurnal - Having a period or cycle of approximately one-half of a tidal day. The predominant type of tide throughout the world is semidiurnal, with two high waters and two low waters each tidal day. The tidal current is said to be semidiurnal when there are two flood and two ebb periods each day.

sensor - A technical means to extend man's natural senses. Also a sensing device or equipment which detects and records in the form of imagery, the energy reflected or emitted by environmental areas, features, objects, and events, including natural and cultural features and physical phenomena, as well as man-made features, objects and activities.(12)

server - Hardware and software on a computer in a network that makes resources and/or services available to the other computers on the network. (17)

shoreline - The intersection of the land, including man-made waterfront structures, with the water surface. The shoreline depicted on NOS maps and charts represents the line of contact between the land and a selected water elevation. In areas affected by tidal fluctuations, this line of contact is the mean high water line. In confined coastal water of diminished tidal influence, the mean water level line may be used. In non-tidal waters, the line represents the land/water interface at the time of survey. In areas where the land is obscured by marsh grass, cypress or similar marine vegetation, the actual shoreline can not be accurately represented. Instead, the outer limit line of the vegetation area is delineated (where it would appear to the mariner as the shoreline) and is referred to as the apparent shoreline. The seaward limits of kelp, low grass in water, and other low-lying vegetation normally do not constitute an apparent shoreline. The approximate shoreline is shown on larger scale charts by a dashed line delimiting the gold tint. This is used to show that the coast has been inadequately surveyed.

shoreline maps - A special purpose map manuscript prepared to provide data required for nautical charting operations and serves as a base map for various NOS products; e.g. nautical charts, hydrographic surveys, coastal zone maps, and shoreline movement studies. Coverage is limited to a relatively narrow zone along the shoreline. The cartographic representation of features shown includes the shoreline, alongshore natural and manmade features and selected physical and cultural features inland from the shoreline. Shoreline maps primarily comprise the "T" and "TP" series of NOS maps and provide the graphic representation and correlation of information that has originated from field and photogrammetric survey operations.

softcopy photogrammetry - Photogrammetry using digital images that are stored, viewed, and processed on computers. The digital images may be scanned from photographs or captured by a digital camera. Also called digital photogrammetry. (17)

softcopy workstation - The computer system (hardware and software) used in softcopy or digital photogrammetry. Also called digital photogrammetric workstation.

solar day - The period of the rotation of the Earth with respect to the Sun. The mean solar day is the time of the rotation with respect to the mean Sun. The solar day commencing at midnight is called a civil or calendar day, but if the day is reckoned from noon it is known as an astronomical day because of its former use in astronomical calculations.

spatial resolution - A measurement of the smallest detail which can be distinguished by a sensor system under specific conditions (12)

standard deviation - The plus and minus points of inflection of a probability curve. Calculated by taking the square root of the sum of the squares of the residuals divided by n - 1. (20)

standard time - Time based on the transit of the Sun over a certain specified meridian, called the time meridian, and adopted for use over a considerable area. With a few exceptions, standard time is based upon some meridian which differs by a multiple of 15^{o} from the meridian of Greenwich. The United States first adopted standard time in 1883 on the initiative of the American Railway Association, and at noon on November 18 of that year the telegraphic time signals from the Naval Observatory at Washington were changed to this system.

state plane coordinate system - The plane-rectangular coordinate systems established by the U.S. Coast and Geodetic Survey, one for each state of the union, for use in defining positions of geodetic stations in terms of place-rectangular (X and Y) coordinates. Each state is covered by one or more zones, over each of which is placed a grid imposed upon a conformal map projection. The relationship between the grid and the map projection is established by mathematical analysis. Zones of limited east-west dimension and indefinite north-south extent have the transverse Mercator map projection as the base for the state coordinate system; while zones for which the above order of magnitude is reversed use the Lambert conformal conic map projection with two standard parallels.

station - A definite point on the Earth whose location has been determined by surveying methods. It may or may not be marked on the ground. A station usually is defined by the addition of a term which describes its origin or purpose, such as “triangulation station”. Usually marked on the ground by a monument of special construction, or by a natural or artificial structure. See also “mark” and “monument”.

stereomodel - The three-dimensional model formed by the intersecting rays of an overlapping pair of photographs. (2)

stereoscopy - The science and art that deals with the use of binocular vision for observation of a pair of overlapping photographs. (2)

stereo pair - Two photographs taken from different positions with sufficient overlap of detail to make possible stereoscopic examination of an object or an area common to both. Also called stereoscopic pair. (12)

strip of photographs - A series of overlapping aerial photographs taken along a single flight line. (2)

subordinate tide station –

1. A tide station from which a relatively short series of observations is reduced by comparison with simultaneous observations from a tide station with a relatively long series of observations.

2. A station listed in the Tide tables from which predictions are to be obtained by means of differences and ratios applied to the full predictions at a reference station.

superimposition - The placing of an image or map over the top of one or more other images or maps with corresponding locations aligned. Also called Image Registration.

survey - The orderly process of determining data relating to the physical characteristics of the Earth. The list of orderly processes which can be properly termed surveys is long; it may be divided into classes according to type of data obtained, the methods and instruments used, and the purposes to be served.

survey, geodetic - A survey in which account is taken of the figure and size of the Earth. Geodetic surveys are usually prescribed where the areas or distances involved are so great that results of desired accuracy and precision can be obtained only by the processes of geodetic surveying.

survey, photogrammetric - A survey utilizing either ground photographs or aerial photographs.

Synthetic Aperture Radar (SAR) - A radar in which a synthetically long apparent or effective aperture is constructed by integrating multiple returns from the same ground cell, taking advantage of the Doppler effect to produce a phase history film or tape that my be optically or digitally processed to reproduce an image. Signal processing uses magnitude and phase of the received signals over successive pulses from elements of a synthetic aperture to create an image. (12 & 19)

target - The distinctive marking or instrumentation of a ground point to aid in its identification on a photograph. In photogrammetry, target designates a material marking so arranged and placed on the ground so as to form a distinctive pattern over a geodetic or other control-point marker, on a property corner or above an underground facility or feature. A target is also the image pattern on aerial photographs of the actual marks placed on the ground prior to photography.

tertiary tide station - A tide station at which continuous observations have been made over a minimum period of 30 days but less than 1 year. The series is reduced by comparison with simultaneous observations from a secondary control tide station. This station provides for a 29-day harmonic analysis.

theodolite - A precision surveying instrument consisting of an alidade with a telescope. It is mounted on an accurately graduated circle and is equipped with necessary levels reading devices. Sometimes the alidade carries a graduated vertical circle.

tidal day - Same as lunar day.

tidal wave - A shallow water wave caused by the gravitational interactions between the Sun, Moon and Earth. Essentially, high water is the crest of a tidal wave and low water, the trough. Tidal current is the horizontal component of the particulate motion, while tide is manifested by the vertical component. The observed tide and tidal current can be considered the result of the combination of several tidal waves, each of which may vary from nearly pure progressive to nearly pure standing and with differing periods, heights, phase relationships, and direction.

tide - The periodic rise and fall of the water resulting from gravitational interactions between the Sun, Moon, and Earth. The vertical component of the particulate motion of a tidal wave. Although the accompanying horizontal movement of the water is part of the same phenomenon, it is preferable to designate this motion as tidal current.

tide gauge - An instrument for measuring the rise and fall of the tide. Some examples of gauge types are automatic tide gauge, bubbler tide gauge, electric tape gauge, pressure gauge, and tide staff.

tide observation records - The records of tidal cycle observation during coastal mapping project field operations; generally conducted to coordinate photography at predetermined stages of tide. Tide observation records should not be confused with tide reference station records.

tide staff - A tide gauge consisting of a vertical graduated staff from which the height of the tide can be read directly. It is called a fixed staff when secured in place so that it can not be easily removed. A portable staff is one that is designed for removal from the water when not in use. For such a staff a fixed point is provided. The support has a metal stop secured to it so that the staff will always have the same elevation when installed for use.

tide station - The geographic location at which tidal observations are conducted. Also, the facilities used to make tidal observations. These may include a tide house, tide gauge, tide staff, and tidal bench marks.

tide station reference records - The records of tidal cycle observations conducted at a tide or current station for which independent daily predictions are given in the "Tide Tables" and "Tide Current Tables", and from which corresponding predictions are obtained for numerous other places.

Tide Tables - Tables which give daily predictions of the times and heights of high and low waters. These predictions are usually supplemented by tidal differences and constants through which additional predictions can be obtained for numerous other places.

tidelands - The zone between the mean high water and mean low water lines. It is identical with intertidal zone when the type of tide is semidiurnal or diurnal. Also commonly known as "shore" or "beach."

tie points - Image points identified on photographs in the overlap area between two or more adjacent strips of photography and serving to tie the individual strips of photographs into a single flight unit, or block. (12)

time, kinds - Time is measured by the rotation of the Earth with respect to some point in the celestial sphere and may be designated as sidereal, solar, or lunar, according to whether the measurement is taken in reference to the vernal equinox, the Sun, or the Moon. Solar time may be apparent or mean, according to whether the reference is to the actual Sun or the mean Sun. Mean solar time may be local or standard, according to whether it is based upon the transit of the Sun over the local meridian or a selected meridian adopted as a standard over a considerable area. Greenwich time is standard time based upon the meridian of Greenwich. In civil time the day commences at midnight, while in astronomical time, as used prior to 1925, the beginning of the day was reckoned from noon of the civil day of the same date. The name universal time is now applied to Greenwich mean civil time.

topography - Features of the surface of the Earth considered collectively as to form. A single feature (such as a mountain or valley) is called a topographic feature. Topography is subdivided into hypsography (relief features), hydrography (water and drainage features), and culture (manmade features).

T-Sheet (map) - The term "T-Sheet" refers to compilation manuscripts resulting from planetable and photogrammetric surveys conducted by the Coast Survey, Coast and Geodetic Survey, ESSA, and National Ocean Survey (NOS) during the period 1834 to 1980. These surveys are recorded graphically in the form of a map manuscript. The "T" series products include topographic, planimetric, shoreline, and special-purpose map manuscripts. The preferred term is "T series map" and the discontinuance of the term "T-Sheet" is encouraged.

TP-Sheet (map) - The term "TP-Sheet" refers to a series of map manuscripts produced by ESSA, the National Ocean Survey, and National Ocean Service after 1968. Although the majority are shoreline maps, the "TP" series of products also includes topographic, planimetric, and other special-purpose map manuscripts. These maps provide the graphic representation of photogrammetric survey data. In special survey projects, such as shoreline/photobathymetry surveys, the shoreline map may consist of the base map and one or more overlays. The overlays are considered part of the map and will be registered with the shoreline map. The preferred term is "TP series map" and the discontinuance of the term "TP-Sheet" in encouraged.

transverse Mercator projection - A map projection of the cylindrical type, being in principle equivalent to the regular Mercator map projection turned (transversed) 90^o in azimuth. The central meridian is represented by a straight line, corresponding to the line which represents the equator on the regular Mercator map projection. Neither the geographic meridian, except the central meridian, nor the geodetic parallels, except for the equator (if shown) are represented by straight lines. It is a conformal projection and is the base used in the state plane coordinate system for the grids of those zones whose greater dimension is in a north and south direction. The transverse Mercator projection, originally devised by Lambert, is used for large-scale mapping throughout the world (in Europe it is sometimes called the Gauss-Kruger projection).

traverse - A method of surveying in which the lengths and directions of lines between points on the earth are obtained by or from field measurements and used in determining positions of the points. A survey traverse may determine the relative positions of the points which it connects in series, and if tied to control stations on an adopted datum, the positions may be referred to that datum. Survey traverses are classified and identified in a variety of ways: according to methods used, as an astronomical traverse, according to quality of results, as a first-order traverse; according to purpose served, as a geographical-exploration traverse; and according to form, as a closed traverse.

Triangulated Irregular Network (TIN) - A terrain model created from continuously connected triangles derived from the Delauney algorithm. The vertices of the triangles form irregularly spaced elevation posts. Unlike a grid, the TIN allows extra information to be displayed in areas of complex relief without displaying dense or redundant data gathered in areas of simple relief.

triangulation - A method of surveying in which the points whose locations are to be determined, together with a suitable number (at least two) of points of known location, are connected in such a way as to form the vertices of a network of triangles. The angles in the network are measured and the lengths of the sides are either measured or calculated from known points and lengths.

United States Coast & Geodetic Survey (USC&GS) - see “Coast and Geodetic Survey”.

United States National Map Accuracy Standards - Specifications promulgated by the U.S. Office of Management and Budget to govern accuracy of topographic and other maps produced by Federal agencies.

Universal Time (UT) - Same as Greenwich Mean Time (GMT).

Universal Transverse Mercator (UTM) - A military grid system based on the transverse Mercator projection, applied to maps of the Earth’s surface extending to 84E N and 80E S latitudes, with 60 identical zones, each 6E in longitude wide. (12)

uplands - Land above the mean high water line (shoreline) and subject to private ownership, as distinguished from tidelands, the ownership of which is prima facie in the state but also subject to divestment under state statutes.

upper limit of navigability - The character of a river will, at some point along its length, change from navigable to non-navigable. Very often that point will be at a major fall or rapids, or other place where there is a marked decrease in the navigable capacity of the river. The upper limit will therefore often be the same point traditionally recognized as the head of navigation, but may, under some tests, be at some point yet farther upstream.

variance - The square of the standard deviation. (14)

variation (of compass) - Difference between true north as determined by the Earth's axis of rotation and magnetic north as determined by the Earth's magnetism. Variation is designated as east or positive when the magnetic needle is deflected to the east of true north, and as west or negative, when the deflection is to the west of true north. Also called magnetic declination.

vector - A directed line segment, with magnitude commonly represented by the coordinate for the pair of end points. A quantity possessing both magnitude and direction. (12)

vector data - Geometrical data such as points, lines, and polygons. The representation of spatial features by explicitly recording their geospatial co-ordinates and their attributes using points, lines, and polygons. Raster data is an alternative representation technique to vector data. (13 & 19)

way point - The vertexes of a flying route. The end points of aerial photographic flight lines.(13)

wharf - A wharf is a structure approximately parallel to the shoreline, accommodating ships on one side only, and usually of open pile construction. A quay is similar to a wharf, but with solid construction.

World Geodetic System of 1984 (WGS 84) - A set of quantities, developed by the U.S. Department of Defense for determining geometric and physical geodetic relationships on a global scale, based on a geocentric origin and the Geodetic Reference System 1980. Used for GPS. (14)

wreck - The ruined remains of a vessel which has been rendered useless, usually by violent action, as by the action of the sea and weather on a stranded or sunken vessel. Charted wrecks are of two kinds: stranded wreck, where any portion of the hull is above the chart datum; and sunken wreck, where the hull is below the chart datum or where the masts only are visible.

yaw, of airplane - The rotation of an aircraft about its vertical axis so as to cause the aircraft's centerline to deviate from the flight line. See also roll and pitch. (2)

y parallax - The difference between the perpendicular distances of the two images of a point from the vertical plane containing the air base. The existence of y parallax is an indication of tilt in either or both photographs and/or a difference in the flying height. Y parallax interferes with stereo viewing, measurement, etc. (2)

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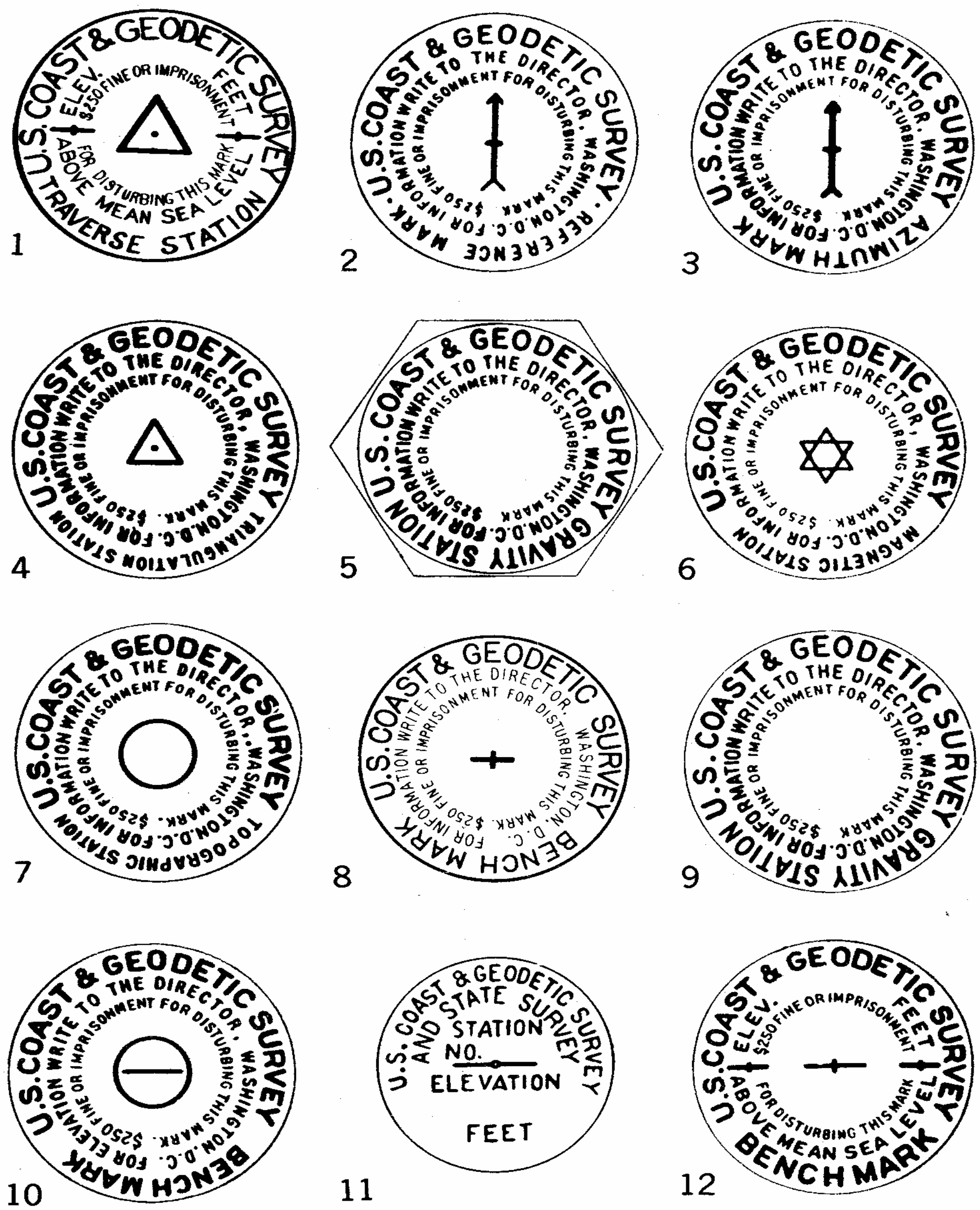
Version 1
September 30, 2004

ATTACHMENT N
SURVEY DISK DIAGRAMS

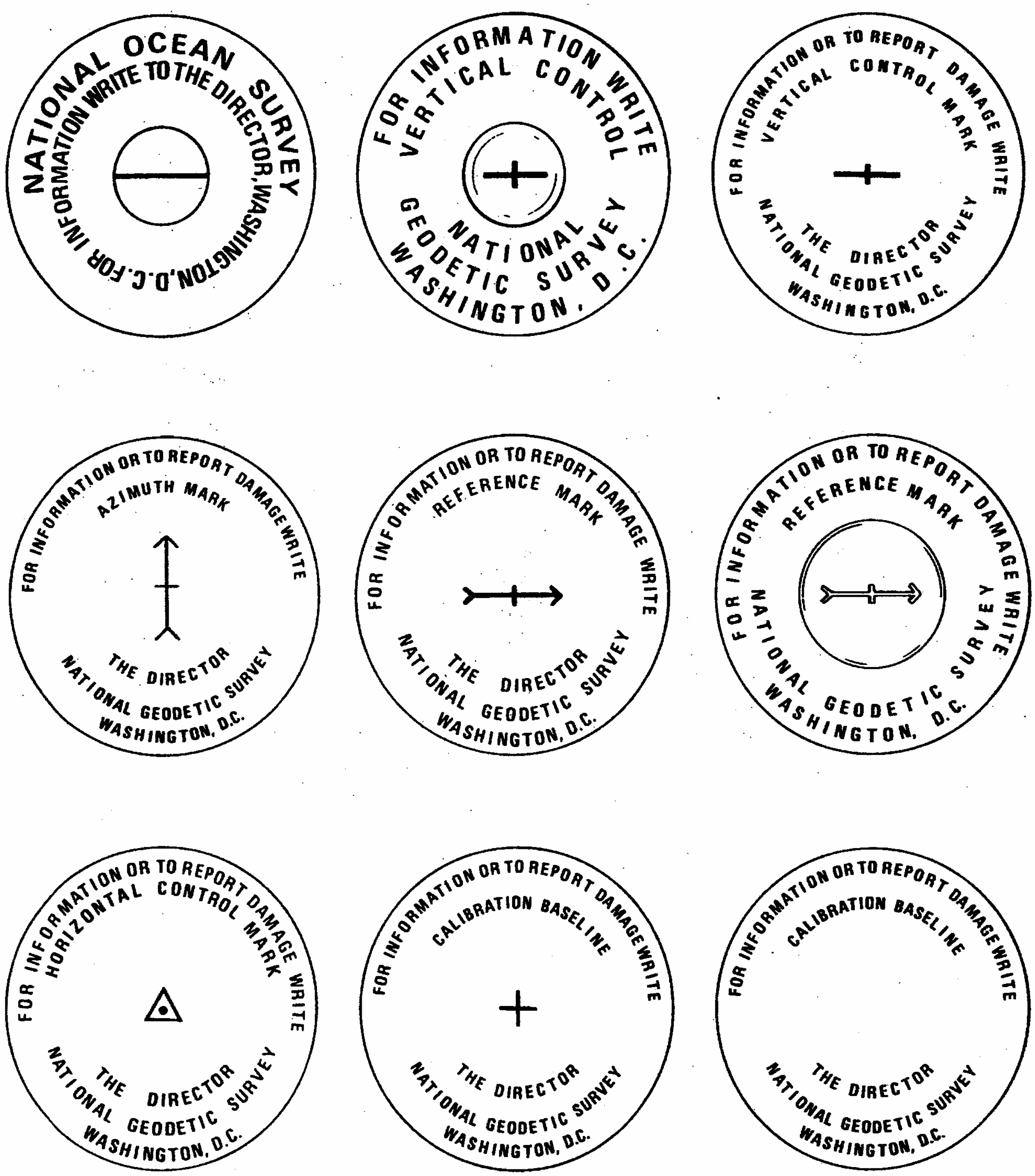
TO
SCOPE OF WORK FOR SHORELINE MAPPING
UNDER THE
NOAA COASTAL MAPPING PROGRAM

REMOTE SENSING DIVISION
NATIONAL GEODETIC SURVEY
NATIONAL OCEAN SERVICE
NATIONAL OCEANIC & ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE

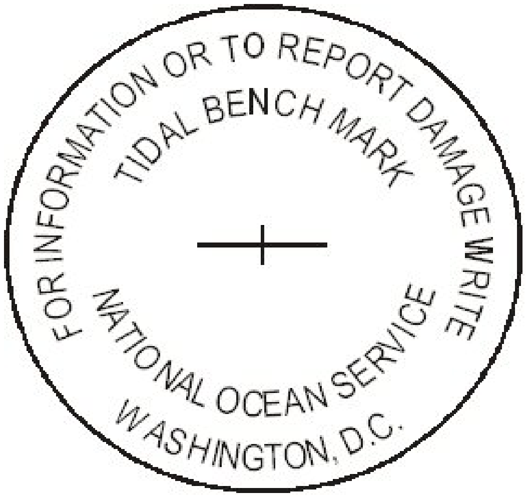


1. Traverse station mark.
2. Reference mark.
3. Azimuth mark.
4. Triangulation station mark.
5. Gravity station mark (old type).
6. Magnetic station mark.
7. Topographic station mark.
8. Geodetic bench mark (new type).
9. Gravity station mark (new type).
10. Tidal bench mark.
11. State Survey mark.
12. Geodetic bench mark (old type).

Standard marks of the U.S. Coast and Geodetic Survey



Standard marks of the National Ocean Survey/National Geodetic Survey



National Ocean Service
Tidal Bench Mark

National Ocean Service
General Usage Disk

National Geodetic Survey
New Geodetic Control Disk

Version 3B
February 1, 2008

ATTACHMENT O
GROUND PHOTO CONTROL

TO
SCOPE OF WORK FOR SHORELINE MAPPING
UNDER THE
NOAA COASTAL MAPPING PROGRAM

REMOTE SENSING DIVISION
NATIONAL GEODETIC SURVEY
NATIONAL OCEAN SERVICE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE

TABLE OF CONTENTS

ATTACHMENT O: GROUND PHOTO CONTROL

1. INTRODUCTION - Ground photo control is used to establish scale, azimuth, and a coordinate system. For photography, pre-marked photo panels or photo identified control points may be used.   Blue-booking (entering data into NGS' data entry format) is not required for check points, ground photo control points, or for temporary survey points. If permanent survey marks are set, then Blue-Booking including digital descriptions in NGS format are required, see 2.3, below.

1.1. CHECK POINTS - For shoreline mapping projects under this SOW using film or digital cameras, at least four check points are required. These points shall have horizontal and vertical positions. In Alaska and other areas outside the continental United States where NAVD 88 bench marks are not available, the Contractor shall make GPS ties to tidal bench marks within the project area. The check points shall be approximately evenly spaced in the project area and shall be positioned using specifications listed below. On large projects, use at least one check point for every four strips, and at least one near each corner of a block. **These four, or more, check points shall not be used in the aerotriangulation computations, but rather serve as an independent check of the photogrammetric solution.** The contractor shall compare the ground positions of the check points to the results derived from the aerotriangulation solution and shall report these results to NGS in table form in the Ground Control Report. Note, it is recommended that at each of the four, or more, locations, multiple points be positioned.

1.2. GROUND CONTROL - The contractor may propose additional ground control to be used in the aerotriangulation. The Contractor shall determine an adequate number and distribution of ground control points. A description of the plan and the number, type and spacing of these points shall be included in the Technical Proposal. See also SOW, Section 6.2, Section 2.3 below, and MANUAL OF PHOTOGRAMMETRY (MOP), Fifth Edition, 2004.

1.3. AIRBORNE KINEMATIC GPS (KGPS) USED - For shoreline mapping projects relying mainly on airborne KGPS, the Contractor shall use at least four check points and may use additional control as described above in Section 1.2. See MOP, Fifth Edition, pages 1112-1113.

1.4. GROUND CONTROL ONLY USED - For Coastal Mapping Program (CMP) projects using ground control exclusively, the amount and distribution of the required photo control will depend on the project size, shape, and number of models, (for general guidelines, see MOP, Fifth Edition, pages 1111-1112. CMP projects performed under this Scope Of Work (SOW), (with no airborne KGPS) shall have at least the following photo control: a point at the beginning and end of each strip, a point every five photos along a single strip, points near the corners of a block, a point every seven photos around the perimeter of a block, and additional vertical points in the interior of the block. In addition, at least four check points are required as described in Section 1.1 above.

1.5 NGS FORMS – The required forms and photographs are listed in Attachment Q, Introduction.

2. CONTROL RECOVERY - All surveys shall be tied to the National Spatial Reference System (NSRS) using at least two points (CORS and/or survey marks). The specified datums are NAD 83 and NAVD 88.

2.1. CONTINUOUSLY OPERATING REFERENCE STATION (CORS) TIES - NGS recommends that all surveys be tied to the NSRS by using the CORS system. If a CORS is used, no recovery is required for that CORS. See the CORS map on the NGS www site at: http://www.ngs.noaa.gov/CORS/ .

2.2. SURVEY MARK TIES - If the NSRS tie is done through survey marks, the marks shall be at least second-order horizontal and third-order vertical, and on-line or NGS format digital recovery notes are required. NSRS survey marks may be found in the NGS database at: http://www.ngs.noaa.gov/cgi-bin/datasheet.prl .

2.3. MARK DESCRIPTIONS AND MARK RECOVERY -

A. Mark Descriptions - If a new, permanent survey mark is set, a digital description in NGS format using NGS software WinDesc or WDDPROC is required, see Attachment S. If a temporary survey mark (iron pin, PK nail, etc.) is set, complete NOAA Form 76-82, "Control Station Identification". Digital photographs are required in both cases, two for temporary points and three photos for permanent marks. See Section 8 below, and Attachment R. For NGS specifications for setting new marks, see Attachments T, U, V, and AG.

B. Mark Recovery - For NSRS survey marks recovered, the NGS on-line recovery method may be used (see: http://www.ngs.noaa.gov/FORMS_PROCESSING-cgi-bin/recvy_entry_www.prl), unless Ground Surveys under Attachment P are also being conducted in which case NGS software WinDesc or WDDPROC shall be used. For the on-line recovery system, complete all required fields and enter recovery information in the text box at the bottom of the form. Include in the Ground Surveys Report a list of all marks recovered using this on-line system, and a printout of each recovery note with photos. Recoveries may also be made using NGS software WinDesc or WDDPROC. Digital photographs are required in both cases, see Attachment R.

2.4. CARE OF RECOVERY - Recovery of survey marks shall be done with the utmost care to provide accurate information. The description of an existing station shall be carefully evaluated and checked with ground details, and the distances and directions to reference marks should be checked. This will help ensure that the mark found is in fact the station being searched for and not a replacement station, a reference mark, an azimuth mark, or a nearby mark set by another agency with the same or similar name. The stamping and the agency name must agree exactly with the datasheet from the NGS database. See Attachment N for drawings of different types of survey disks used by this agency. Note that azimuth marks and the main triangulation station have the same name and date stamping, just different words factory stamped or cast into the disk

("AZIMUTH MARK" or "TRIANGULATION STATION or HORIZONTAL CONTROL MARK".

2.5. NGS DATASHEETS - Datasheets can be downloaded from the NGS WWW site at: http://www.ngs.noaa.gov/cgi-bin/datasheet.prl by clicking on "DATASHEETS", then on "Radial Search". Enter the approximate latitude and longitude, scroll down to "Horizontal Order-2 or better", and then click on "Submit Query". GPS connections may also be made to PACS (scroll down the list), which are located at many airports. The NGS database may also be searched by station name, Permanent IDentifier (PID), etc. Datasheets should be downloaded at the beginning of each project to ensure that the most recent data is available. See sample in Attachment Q. Data sheets for CORS may be found at: http://www.ngs.noaa.gov/CORS/ and then click on "DOWNLOADS", then on "Standard Files", and then on "Data Sheet".

2.6. SURVEY DISKS - NGS and its parent organization NOS and its predecessor organization USC&GS have used many different letter castings on disks. To help eliminate erroneous mark recoveries, review the drawings of these many disk styles in Attachment N. Note, the letters cast or stamped into a disk generally include the agency name and the type of disk (reference mark, azimuth mark, etc.), and are produced during the manufacture of the disk. These letters are different from the designation (name) and year stamped by the surveyor when the mark is set. Disk stampings shall not be altered at any time.

2.7. INTERSECTION STATIONS - Intersection stations such as stacks, tanks, navigational aids, and radio masts may be used to establish an azimuth, but must have an azimuth check since they are subject to erroneous recovery. Such structures may be demolished and rebuilt close to but not in exactly the same location, or structures of similar appearance may exist in the same vicinity. The recovery of such stations should be verified not only by visiting the station site but also by questioning local officials. Note, on-line recovery notes are not allowed for Intersection Stations, but WinDesc or WDDPROC recoveries are allowed.

3. SURVEY METHODS - Either conventional or GPS surveying techniques may be used.

3.1. CONVENTIONAL SURVEY POSITIONING TECHNIQUES - If conventional techniques are used, survey methods utilizing leveling, traverse, triangulation, and/or trilateration may be used to position photo panels or to perform photo identification. Surveys should result in horizontal accuracies of 0.1 meters, and vertical accuracies of 0.2 meters, or better. All surveys shall have an observational check including closing position and closing azimuth checks for horizontal surveys and an elevation check for vertical surveys.

3.2. GPS SURVEY POSITIONING TECHNIQUES - GPS techniques, such as static GPS or kinematic GPS (stop & go, etc.), which result in horizontal accuracies of 0.1 meter (vertical 0.2 meter) or better may be used to position photo panels and/or for photo identification and for photo check points. Each new point should be occupied twice, independently, and for the length of time necessary to meet the accuracy requirements. Positioning should be done by ties to

CORS. Note: the CORS map on the NGS web page shows "National CORS" and "Cooperative CORS." The data for the former are in the NGS database, the latter data are not. Cooperative CORS may be used. Cooperative CORS operators hold their own data and are only required to hold data for 30 days. Download data as soon as possible, especially if the collection rate was one second. **Weather data is not required**, and weather (meteorological) data is not available at CORS.

3.3. CONNECTIONS TO NSRS - Both horizontal and vertical surveys shall be connected to the National Spatial Reference System (NSRS). Connections should be made to at least two NSRS stations (this may be two CORS). Panels may be constructed directly over third-order or better, NSRS stations.

4. PENCIL RUBBINGS - The contractor shall capture a pencil rubbing of a marks' stamping (disk or logo cap) each time the mark is occupied for observations. Use the form found at: http://www.ngs.noaa.gov/PROJECTS/FBN/ (Click on "Forms," and then click on "Pencil Rubbing Form"), and in Attachment Q. When not feasible to make the required rubbing, a sketch of the mark shall be substituted accurately recording all markings. Photographs are not required at each occupation.

5. PRE-MARKED PHOTO CONTROL POINTS - The Contractor shall mark photo control panels (or targets) with a temporary point such as an iron pin or PK type nail. Photo control points should have the following characteristics: be in the required location on the photograph, allow positive identification of the image point, and provide good measurement characteristics of the image point. Of these, location is the over-riding factor. The photographic images of the control panels must have sufficient quality for positive identification without excessive bleeding or blending with the background allowing repeat readings to at least 3 microns on an analytical plotter and 1/3 of a pixel on softcopy work station. Panels may be installed directly over third-order or better, NGS NSRS stations, and also over newly positioned temporary marks accurate to 0.1 meter, or better, relative to the NSRS.

A triangular or square panel should be centered directly over the photo control point, with locating "wings" placed perpendicular to each side of the center panel. See Annex A, "Specifications for Premarking Control Stations" for recommended panel shapes and sizes. Modifications to the wings may be made as required by local circumstances. Wings may be placed further from the panel than the preferred distances listed on the diagram, but may not be located closer. A wing or wings may be deleted if the panel can be positively identified and the location of the panel precludes the placement of all wings. The identification and positioning of a nearby photo identifiable point is recommended in all cases and such a point shall be established when fewer than two wings can be placed at the panel. See also the Manual Of Photogrammetry, Fifth Edition, 2004, Sections 15.1.2.6, 15.1.3.2, and page 1114 for a target designed for softcopy photogrammetry.

6. PHOTO IDENTIFICATION POINTS - Photograph identified (photo ID) points should be temporarily marked, if possible. If photo ID points are used, the Contractor shall search for features that can be seen and identified in the aerial photographs. The points identified shall be on a feature minimally elevated from the ground, if possible, such as a lone boulder along a shoreline. A point with high contrast such as the intersection of two sidewalks, an intersection of two highway paint stripes, or similar is ideal. Extreme care must be exercised to ensure that the point can be positively identified on a photo-pair and that the point has not changed since the date of the photography.

7. CONTROL STATION FORM - **Control Station Identification (CSI) (NOAA Form 76-53) shall be completed for each check point, photo panel and photo ID point**. See Attachment Q for sample forms (blank and filled-in), and sample ground photos. All modifications to the standard panel must be depicted on the CSI form. In cases where the target panels have a high probability of vandalism, it is recommended that two nearby photo identifiable objects be positioned for redundancy.

8. PHOTOGRAPHS AND MAPS - **While at the site, three digital photographs shall be taken of each permanent mark, and two photographs shall be taken of each check point, panel, and/or photo identifiable point used**. Photographs are only required during one visit to a mark.

TABLE OF DIGITAL PHOTOGRAPH REQUIREMENTS

	Permanent Marks	Check Points, Photo Control Points
Close-Up	V, Stamping legible	not required
Eye-Level	V, Mark & vicinity	H, vicinity
Eye-Level	H, show obstruction(s)	H, vicinity

V = vertical camera line-of-sight H = horizontal camera line-of-sight

For horizontal photos show the mark in the foreground (with tripod in place, if possible) and the nearest obstruction or feature, such as trees, roads, bridges, telephone poles and buildings in the background. Arrange the photograph so that the tripod and the mark are visible. See Attachment R for detailed specifications. For photographs of photo control points, the two horizontal views shall show the photo point from two different angles, with the tripod in place, if possible. Check points, photo control points, and temporary survey points all require the same formats for photo captions and photo file names. These are explained in Attachment R Sections 3 and 4. Note, file names for photographs of all three of these type points shall begin with “RE”. For these three type points, leave the “PID” field blank and the “Station Type” field blank.

Place a sign in each photo (except the close-up) showing the name of the mark, panel, or point (may use a white board and heavy marker). Ensure that the sign does not hide the mark in the photograph.

In addition, the location of each panel, photo identifiable point, and survey mark used shall be marked on a large scale map or chart of the area. See Attachment Q for samples of both.

9. DATA PROCESSING - Survey ties using CORS data should be processed using the On-line Positioning User Service (OPUS), see: . The OPUS www site states that at least two hours of data is required for standard OPUS. Make sure the Rapid Orbits are available (usually one work day) before uploading data to OPUS. When using OPUS-RS, http://www.ngs.noaa.gov/OPUS/ , shorter sessions may be used. OPUS-RS may be used for photo control points and photo check points. When OPUS is run, the default is that OPUS uses only National CORS. Cooperative CORS may be closer to the project area and may be selected manually within OPUS. (See Section 3.2 above for definitions, and see Attachment C, Section 13.2D for more information on CORS and OPUS.). Note, NGS is currently (2008) developing new versions of OPUS.~~ which may shorten the required GPS observation sessions and may fulfill Blue-Booking requirements.~~ Any updates in this SOW's OPUS requirements will be included in the Project Instructions. Non-CORS Survey data shall be processed using standard techniques, including adjustment. All raw and processed data shall be submitted with formats and file naming conventions explained. The software used for data processing shall be pre-approved by NGS, but NGS software PAGES, ADJUST, etc. are not required to be used.

10. QUALITY CONTROL - The Contractor shall prepare and use a written Quality Control Plan, with a section on Photo Control. The Plan shall be supplied to NGS at the beginning of the project. The section shall include all phases of this work. NGS requires that all manually collected data be checked (e.g. Heights of Instruments (HI)) and recommends that all manually recorded and manually computer entered data be checked.

11. GROUND CONTROL REPORT - The Report shall include a discussion of:

- Project Identifier and location,
- Purpose,
- Firm and individuals performing work,
- Methodologies used (stop-and-go GPS, etc.),
- Equipment used (including model and serial numbers),
- Software used (including name and versions),
- Data processing,
- Data, raw and processed,
- Data formats and file naming convention,
- NOAA Form 76-53, "Control Station Identification", for each photo control point,

- Recovery Notes for survey marks used,
- Whether or not any data was submitted in “Blue-Book” format,
- A listing of all stations recovered using NGS’ On-line “Mark Recovery Form,”
- photographs of points surveyed, paper and digital copies,
- Accuracy,
- Unusual circumstances,
- Equipment malfunctions,
- A statement as to whether or not the work meets the SOW and Project Instructions, and recommendations,
- the NGS Visibility Obstruction Diagram” and the NGS “GPS Station Observation Log” may be used but are not required.

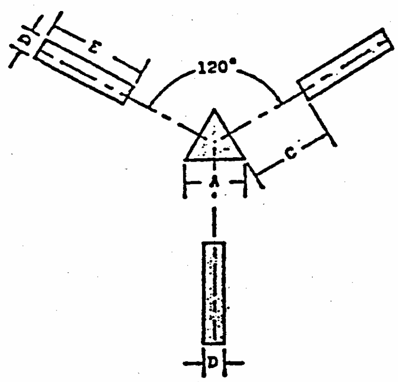
Any work not meeting specifications must be fully discussed in the report, including dates of prior communication with NGS.

If Ground Surveys under Attachment P were also performed, submit one combined report.

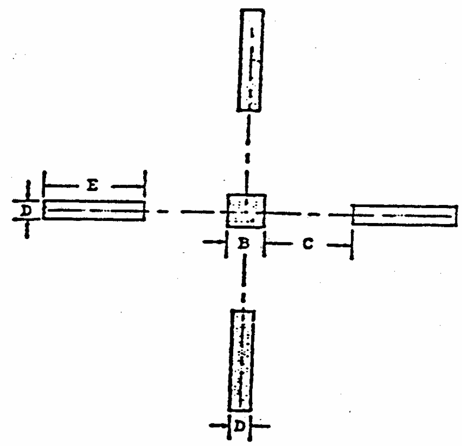
ANNEX A

SPECIFICATIONS FOR PREMARKING CONTROL STATIONS
Revised November 23, 1976

ARRAY NO. 1



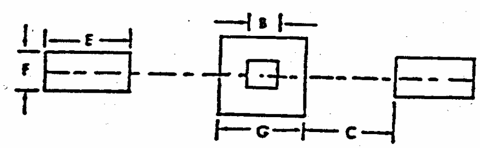
ARRAY NO. 2



NOTE:

1. The dimensions and centering of center panel over station or substitute station are critical.
2. Panel array No. 1 is preferred but No. 2 is acceptable.
3. Array No. 3 - for contrast in very light colored areas. The border surrounding center panel and the recognition panels shall be black.
4. Chief of party will select array that makes best application of field conditions and is authorized to adjust or omit one of the recognition panels if terrain is not suitable for placement of entire array.

ARRAY NO. 3



Photography Scale	PANEL AND SPACING DIMENSIONS (IN METERS) A	B	C	D	E	F	G
1:10:000	0.5	0.3	1.3	0.2	0.9	0.9	1.5
1:20,000	1.1	0.7	2.6	0.4	1.8	0.9	1.9
1:30,000	1.6	1.0	3.9	0.5	2.7	0.9	2.2
1:40,000	2.2	1.3	5.2	0.7	3.6	0.9	2.5
1:50,000	3.2	2.0	7.8	1.1	5.4	1.8	3.8
1:60,000	3.8	2.3	9.1	1.3	6.3	1.8	4.1
1:70,000	4.4	2.6	10.4	1.4	7.2	1.8	4.4
1:80,000	5.0	3.0	11.7	1.5	8.0	1.8	4.8

Version 2A
February 5, 2008

ATTACHMENT P
GROUND SURVEYS

TO
SCOPE OF WORK FOR SHORELINE MAPPING
UNDER THE
NOAA COASTAL MAPPING PROGRAM

REMOTE SENSING DIVISION
NATIONAL GEODETIC SURVEY
NATIONAL OCEAN SERVICE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE

TABLE OF CONTENTS

ATTACHMENT P: GROUND SURVEYS PAGE

ATTACHMENT P: GROUND SURVEYS

1. INTRODUCTION - Ground surveys may be required to extend control into a project area and thereby ensure connection to the National Spatial Reference System (NSRS). In most shoreline mapping projects however, ground surveys under this Attachment P will not be required because ground photo control connections to the NSRS can and should be made via the Continuously Operating Reference Station (CORS) network, see Attachment O for photo ground control requirements. Blue-booking (entering data into NGS data entry format), is required for Ground Surveys.

1.1. CHECK POINTS - The four or more check points required by the SOW and described in Attachment O, Section 1.1 shall be connected to any Ground Surveys performed.

1.2. GROUND PHOTO CONTROL - Ground photo control surveyed for this project (see Attachment O) shall be connected to any Ground Surveys performed.

1.3. AIRBORNE KINEMATIC GPS (KGPS) USED - See Attachment C, Section 13 for requirements for airborne KGPS.

1.4 NGS FORMS – The required forms and photographs are listed in Attachment Q, Introduction.

2 CONTROL RECOVERY - All surveys shall be tied to the National Spatial Reference System (NSRS) using at least two points, CORS and/or survey marks. The specified datums are NAD 83 and NAVD 88.

2.1. CORS TIES - NGS recommends that all surveys be tied to the NSRS by using the CORS system. If a CORS is used, no recovery is required for the CORS. See the CORS map on the NGS www page at: http://www.ngs.noaa.gov/CORS/

2.2. SURVEY MARK TIES - If the NSRS tie is done through survey marks, the marks shall be at least second-order horizontal and third-order vertical, and digital recovery notes are required. NSRS survey marks may be found in the NGS database at:
http://www.ngs.noaa.gov/cgi-bin/datasheet.prl

2.3. MARK DESCRIPTIONS AND MARK RECOVERY

A. Mark Descriptions - All new survey marks shall be set to NGS standards, see Attachments T, U, V, and AG. In addition, the contractor shall write a digital description in NGS format using NGS software WinDesc or WDDPROC, see Attachment S.   Digital photographs are required, see Attachment R.

B. Mark Recovery - When performing Ground Surveys, the contractor shall write a digital recovery note using NGS software WinDesc or WDDPROC for all NSRS survey marks recovered (including those recovered under Attachment O).

The NGS on-line recovery method may not be used. Digital photographs are required, see Attachment R.

2.4. CARE OF RECOVERY - Recovery of survey marks shall be done with the utmost care to provide accurate information. The description of an existing station shall be carefully evaluated and checked with ground details, and the distances and directions to reference marks should be checked. This will help ensure that the mark found is in fact the station being searched for and not a replacement station, a reference mark, an azimuth mark, or a nearby mark set by another agency with the same or similar name. The stamping and the agency name must agree exactly with the datasheet from the NGS database. See Attachment N for drawings of different types of survey disks used by this agency. Note that azimuth marks and the main triangulation station have the same stamping, just different words factory stamped or cast into the disk (AZIMUTH MARK or TRIANGULATION STATION or HORIZONTAL CONTROL MARK).

2.5. NGS DATASHEETS - Datasheets can be downloaded from the NGS WWW site at: http://www.ngs.noaa.gov/cgi-bin/datasheet.prl by clicking on –DATASHEETS-, then on -Radial Search-. Enter the approximate latitude and longitude, scroll down to -Horizontal Order-2 or better-, or –Vertical-, etc.), and then click on -Submit Query-. GPS connections may also be made to PACS (scroll down the list), which are located at many airports. The NGS database may also be searched by station name, Permanent IDentifier (PID), etc. Datasheets should be downloaded at the beginning of each project to ensure that the most recent data is available. See sample in Attachment Q. Data sheets for CORS may be found at:
http://www.ngs.noaa.gov/CORS/
and then click on –DOWNLOADS-, then on -Standard Files-, and then on -Data Sheet-.

2.6. SURVEY DISKS - NGS and its parent organization NOS and its predecessor organization USC&GS have used many different letter castings on disks. To help eliminate erroneous mark recoveries, review the drawings of these many disk styles in Attachment N. Note, the letters cast or stamped into a disk generally include the agency name and the type of disk (reference mark, azimuth mark, etc.), and are produced during the manufacture of the disk. These letters are different from the designation (name) and year stamped by the surveyor when the mark is set. Disk stampings shall not be altered at any time.

2.7. INTERSECTION STATIONS - Intersection stations such as stacks, tanks, navigational aids, and radio masts may be used to establish an azimuth, but must have an azimuth check since they are subject to erroneous recovery. Such structures may be demolished and rebuilt close to but not in exactly the same location, or structures of similar appearance may exist in the same vicinity. The recovery of such stations should be verified not only by visiting the station site but also by questioning local officials. Note, on-line recovery notes are not allowed for Intersection Stations, but WDDPROC or WINDESC recoveries are allowed.

3 SURVEY METHODS - Either conventional or GPS surveying techniques may be used to connect the surveys to the NSRS.

3.1. CONVENTIONAL SURVEY POSITIONING TECHNIQUES - If conventional techniques are used, survey methods utilizing leveling, traverse, triangulation, and/or trilateration may be used. Surveys should result in horizontal accuracies of 0.05 meters, and vertical accuracies of 0.1 meters, or better. All surveys shall have an observational check including closing position and closing azimuth checks for horizontal surveys and an elevation check for vertical surveys.

3.2. GPS SURVEY POSITIONING TECHNIQUES - If GPS techniques are used, static GPS techniques with dual frequency GPS receivers shall be used. Each new point shall be occupied twice. All surveys should be connected to the NSRS via connections to CORS. NGS recommends observing two independent, 2-hour sessions for distances less than 50 miles (longer times for increased distances), collecting data at 15 second epochs, and using a 15 degree elevation mask. See also Attachment C, Section 13.2. Connections should be made to the nearest NGS CORS, or if none available, to the nearest two NGS NSRS second-order or better stations. Connections shall also be made to two NGS bench marks, within 50 miles, if possible. For additional information on geodetic quality GPS observations see: http://www.ngs.noaa.gov/AERO/aerospecs.htm#vol1 , and http://www.ngs.noaa.gov/PROJECTS/FBN/. Note: the CORS map on the NGS web page shows -National CORS- and -Cooperative CORS-. The data for the former are in the NGS database, the latter data are not. Cooperative CORS may be used but note that -Cooperative CORS- operators hold their own data and are only required to hold data for 30 days. Download Cooperative CORS data as soon as possible, especially if the collection rate was one second. **Weather data is not required**, and weather (meteorological) data is not available for CORS.

3.3. FINDING CORS - CORS may be found by visiting the NGS WWW homepage at: http://www.ngs.noaa.gov/ and clicking on –CORS-. Note: the CORS map on the NGS web page shows -National CORS- and -Cooperative CORS-. The data for the former are in the NGS database, the latter data are not. Cooperative CORS operators hold their own data and are only required to hold data for 30 days. Download data Cooperative CORS as soon as possible, especially if the collection rate was one second.

3.4. FINDING SECOND-ORDER OR BETTER STATIONS - NSRS second-order or better stations may be found in the NGS database by visiting the NGS WWW Homepage at: http://www.ngs.noaa.gov/ , then clicking on –DATASHEETS-, then on -Radial Search-. Enter the approximate latitude and longitude, scroll down to -Horizontal Order-2 or better-, and then click on -Submit Query-. GPS connections may also be made to PACS (next item down the scroll list), which are located at many airports.

For additional information, see -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 and -NAVSTAR GPS Surveying-, USACE, 1996.

3.5 GPS TIES TO TIDAL BENCH MARKS – A GPS tie to a tidal bench mark should consist of two, independent sessions, each four hours or more in length. See additional specifications in Section 3.2 above.

4 VISIBILITY OBSTRUCTION DIAGRAMS AND MARK RUBBINGS

4.1 VISIBILITY OBSTRUCTION DIAGRAMS - These diagrams shall be prepared for each station to depict any trees, buildings, mountains, wires, or other obstructions which may interfere with the GPS line-of-sight satellite signals. These diagrams are useful during processing to explain signal losses, multipath, or radio-interference. To fill out or check this form, use a magnetic compass to measure bearings and an inclinometer to measure vertical angles to obstructions. Sketch the surrounding obstructions as seen from the antenna viewpoint. The diagram depicts a -fish-eye- or -bubble view- of the sky over the antenna. The edges of the circle are the horizon, and the center of the circle is zenith. The NGS -Visibility Diagram- is available in Attachment Q, and a digital version at: http://www.ngs.noaa.gov/PROJECTS/FBN/

4.2 PENCIL RUBBINGS - The contractor shall capture a pencil rubbing of a marks stamping (disk or logo cap) each time the mark is occupied for observations. Use the form found at: http://www.ngs.noaa.gov/PROJECTS/FBN/ (Click on –Forms-, and then click on -Pencil Rubbing Form-). When not feasible to make the required rubbing, a sketch of the mark shall be substituted accurately recording all markings. Photographs are not required at each occupation.

5 GPS OBSERVATION LOGS - GPS Logs shall be used to record all equipment, activities, and other metadata associated with a GPS observing session. Please be very careful and thorough when filling out this form. GPS receivers and antennas must be uniquely identified by manufacturer, model names and numbers, and complete serial numbers. The antenna setup and height measurements must be explicitly described, using sketches and photographs if possible. All height measurements shall be checked. Any non-standard conditions shall be noted and explained. To ensure that all entries are correct, have another person check all data on the log and sign the bottom of the form as -Checked by- with their full name. The NGS -GPS Station Observation Log- is available in Attachment Q and the digital version at: http://www.ngs.noaa.gov/PROJECTS/FBN/ . See Attachment Q for form requirements, sample forms (blank and filled-in), and sample ground photographs.

Also, see http://www.ngs.noaa.gov/PROJECTS/FBN/ for instructions on correctly measuring GPS antenna heights. Weather data is not required.

6 CONTROL STATION FORM **- Control Station Identification (CSI) (NOAA Form 76-53)** is not required.

7 PHOTOGRAPHS AND MAPS - **While at the site, three digital photographs shall be taken of each permanent mark, and two photographs shall be taken of each panel, and/or photo identifiable point used**.

TABLE OF DIGITAL PHOTOGRAPH REQUIREMENTS

	Permanent Marks	Photo Control Points
Close-Up	V, Stamping legible	not required
Eye-Level	V, Mark & vicinity	H, vicinity
Eye-Level	H, show obstruction(s)	H, vicinity

V = vertical camera line-of-sight H = horizontal camera line-of-sight

For horizontal view photos, show the mark in the foreground (with tripod in place, if possible) and the nearest obstruction or feature, such as trees, roads, bridges, telephone poles and buildings in the background. See Attachment R for detailed specifications.

For photographs of photo control points, the two horizontal views shall show the photo point from two different angles, with the tripod in place, if possible. Photo and file naming conventions are not required for photo points.

Place a sign in each photo (except the close-up) showing the name of the mark, panel, or point (may use a white board and heavy marker.

In addition, the location of each panel, photo identifiable point, and survey mark used shall be marked on a large scale map or chart of the area. See Attachment Q for samples of both.

8 DATA PROCESSING – Survey ties using CORS data should be processed using the On-line Positioning User Service (OPUS), see: http://www.ngs.noaa.gov/OPUS/ . The OPUS www site states that at least two hours of data is required for standard OPUS. Make sure the Rapid Orbits are available (usually one work day) before uploading data to OPUS. When using OPUS-RS (http://www.ngs.noaa.gov/OPUS/Using_OPUS-RS.html), shorter sessions may be used. OPUS-RS may be used for Ground Surveys under this Attachment. When OPUS is run, the default is that OPUS uses only National CORS. Cooperative CORS may be closer to the project area and may be selected manually within OPUS. (See Section 3.2 above for definitions, and see Attachment C, Section 13.2D for more information on CORS and OPUS.). Non-CORS Survey data shall be processed using standard techniques, including adjustment. All raw and processed data shall be submitted with formats and file naming conventions explained. The software used for data processing shall be pre-approved by NGS, but NGS software PAGES, ADJUST, etc. are not required to be used.

Note, NGS is currently (2008) developing new versions of OPUS which ~~may~~ shorten the required GPS observation sessions and may fulfill Blue-Booking requirements. Any updates in this SOWs OPUS requirements will be included in the Project Instructions.

9 QUALITY CONTROL - The Contractor shall prepare and use a written Quality Control Plan. The Plan shall be supplied to NGS at the beginning of the project. The plan shall include all phases of this work. NGS requires that all manually collected data be checked (e.g. Heights of Instruments (HI)) and recommends that all manually recorded and manually computer entered data be checked.

10 GROUND CONTROL REPORT - The Report shall include a discussion of:

- Project Identifier and location,
- Purpose,
- Firm and individuals performing work,
- Methodologies used (static GPS, etc.),
- Equipment used (including model and serial numbers),
- Software used (including name and versions),
- Data processing,
- Data, raw and processed,
- Data formats and file naming convention,
- WDDPROC or WINDESC format Descriptions and Recovery Notes,
- -Blue-Book- required files (see Attachment O, Annex A),
- photographs of points surveyed, paper and digital copies,
- Accuracy,
- Unusual circumstances,
- Equipment malfunctions,
- A statement as to whether or not the work meets the SOW and Project Instructions, and Recommendations,
- NGS Visibility Obstruction Diagrams,
- NGS -GPS Station Observation Log-.

Any work not meeting specifications must be fully discussed in the report, including dates of prior communication with NGS. If photo control under Attachment O was also performed, submit one combined report.

ANNEX A - PROJECT SUBMISSION CHECKLIST - GPS PROJECTS

Project Title:________________________________
Accession Number:______________________________
Submitting Agency:____________________________
Observing Agency:_____________________________
Receiver Type:________________________________

PACKAGE CONTENTS

Project Report and Attachments	**Required For**
( ) Project Report	All Projects
( ) Approved Reconnaissance and Project Sketch	All Projects
( ) Project Instructions or Contract Specifications	All Projects
( ) Final Station List	All Projects
( ) Station Visibility Diagrams	All Projects
( ) Final Observing Schedule	All Projects
( ) Observation Logs	All Projects
( ) Equipment Failure Logs	NGS Projects
( ) Loop Misclosures	Optional
( ) Free Adjustment with Analysis	All Projects
( ) Free Adjustment with Accuracies	All Projects
( ) Constrained Horizontal Adjustment	All Projects
( ) Constrained Vertical Adjustment (NAVD 88 Heights)	All Projects
( ) Meteorological Instrument Comparison Logs	If Specified
( ) Photographs of Views from Stations	If Specified
( ) Photographs or Rubbings of Station Marks	All Projects
( ) COMPGB Output (Validation program-B/G file)	All Projects
( ) OBSDES Output (Validation program-D-file)	All Projects
( ) OBSCHK Output (Validation program-D-file)	All Projects
( ) CHKDESC Output (Validation program-D-file)	All Projects
( ) ELLACC Output	All Projects
( ) BBACCUR Output	All Projects

Digitized Data Files ( ) Diskettes ( ) Other:______________________

( ) Raw Phase Data (R-files)	All Projects
( ) Base Line Vectors (G-file)	All Projects
( ) Project and Station Occupation Data (Final B-file)	All Projects
( ) Descriptions or Recovery Notes (D-file)	All Projects
( ) Terrestrial Horizontal Observations (T-file)	If Applicable
( ) Differential Leveling Observations (L-file)	If Applicable

Comments - Enter on the reverse side of this form.

	Org Code	**Name**	**Date**
Received by:			
Reviewed by:			
Reviewed by:			

Version 2
July 22, 2005

ATTACHMENT Q
HORIZONTAL CONTROL FORMS

TO
SCOPE OF WORK FOR SHORELINE MAPPING
UNDER THE
NOAA COASTAL MAPPING PROGRAM

REMOTE SENSING DIVISION
NATIONAL GEODETIC SURVEY
NATIONAL OCEAN SERVICE
NATIONAL OCEANIC & ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE

ATTACHMENT Q - HORIZONTAL CONTROL FORMS

Q1. WDDPROC printout of NGS Station Description (1p)
To download, see: http://www.ngs.noaa.gov/PC_PROD/DDPROC4.XX/ddproc.index.html

Q2. "Mark Recovery Entry" form on NGS WWW site (blank)
Q3. "Mark Recovery Entry" form on NGS WWW site (filled in sample)
For entries on-line, see: http://www.ngs.noaa.gov/ and scroll to bottom of page.

Q4. NGS Station Description/Recovery Form (Short paper version, 2p), (blank)
Q5. NGS Station Description/Recovery Form (Short paper version, 2p), (filled-in sample)
For on-line versions (blank and filled-in) see: http://www.ngs.noaa.gov/PROJECTS/FBN/

Q6. NGS - GPS Observation Log (Info. at time of GPS observations, 2p), (blank)
Q7. NGS - GPS Observation Log (Info. at time of GPS observations, 2p), (filled-in sample)
For on-line versions (blank and filled-in) see: http://www.ngs.noaa.gov/PROJECTS/FBN/

Q8. NGS Visibility Obstruction Diagram (GPS satellite visibility, 1p), (blank)
Q9. NGS Visibility Obstruction Diagram (GPS satellite visibility, 1p), (filled-in sample)
For on-line versions (blank and filled-in) see: http://www.ngs.noaa.gov/PROJECTS/FBN/

Q10. Station Pencil Rubbing Form (blank)
Q11. Station Pencil Rubbing Form (filled-in sample)
For on-line versions (blank and filled-in) see: http://www.ngs.noaa.gov/PROJECTS/FBN/

Q12. "Station Location Sketch and Visibility Diagram" (New), (blank)
Q13. "Station Location Sketch and Visibility Diagram" (New), (filled in sample)
For on-line versions (blank and filled-in) see: http://www.ngs.noaa.gov/PROJECTS/FBN/

Q14. Control Station Identification (NOAA Form 76-53)(Photo panel desc. and sketch, 1p), blank
Q15. Control Station Identification (NF 76-53)(Photo panel desc. and sketch, 1p), filled-in
Above form is not available on-line, but is included on CD with SOW.

Q16. Three Digital Photographs - For samples of the three required digital photographs, see Attachment R.

Q17. Two Digital Photographs - Sample photos of check points, photo control panels, and photo control ID points (13 sample photos).

Q18. Sample map showing flight lines, survey points, and approximate photo panel locations.

Q19. NGS Data Sheet printout of survey station (Sample output from NGS database, 2p)
To search for a data sheet, see: http://www.ngs.noaa.gov/cgi-bin/datasheet.prl

Notes:
1. See Attachment R for digital ground photography specifications and samples.
2. The www sites listed above contains PDF versions of the forms which may be printed out or completed on-line.

REQUIREMENTS FOR SHORELINE MAPPING PROJECTS

REQUIRED TYPE SURVEY	WDDPROC (FORM Q1) OR WINDESC	NGS WWW ON-LINE REC FORM Q2-3	STATION DESC/ RECOVERY FORM FORM Q4-5	NGS GPS OBSERVA LOG FORM Q6-7	VISIBILITY DIAGRAM FORM Q8-9	PENCIL RUBBING Q10-11	CONTROL STATION ID. (NF 76-53) Q14-15	3 DIGITAL PHOTOS Q16	2 DIGITAL HORIZONTAL PHOTOS Q17	PROJECT AREA MAP Q18
NEW GROUND BASE STATION (MK SET)	YES	-----	RECOM.	YES	YES	AT EACH OBSERVA	-----	YES	-----	YES
NEW GROUND BASE STATION (TEMP PT)	-----	-----	-----	YES	YES	AT EACH OBSERVA	YES	-----	YES	YES
GROUND BASE STA. (EXISTING MARK)	-----	YES	RECOM.	YES	YES	AT EACH OBSERVA	-----	YES	-----	YES
CHECK POINT	-----	-----	-----	RECOM.	RECOM.	-----	YES	-----	YES	YES
PHOTO CONTROL PT	-----	-----	-----	RECOM.	RECOM.	-----	YES	-----	YES	YES
GROUND SURVEY PT (BLUE-BOOK PROJECT)	YES	-----	RECOM.	YES	YES	AT EACH OBSERVA	-----	YES	-----	YES

Notes:
1. All NSRS stations found will be recovered using WDDPROC or WINDESC (for Blue-Book projects), or using the NGS on-Line “Mark Recovery Entry” system.
2. The new “Station Location Sketch and Visibility Diagram” form (three windows + page 2) may be used to replace the “Visibility Diagram,” the “Pencil Rubbing,” and the “Station Description/Recovery” forms.
3. See Attachment R for digital photograph requirements.

******* O R I G I N A L   D E S C R I P T I 0 N *******

SSN: 0002
Designation: MAGO
PID:
Approx. Latitude: 441042N   State: MI
Approx. Longitue: 0862159W   County: MANISTEE
Approx. Elevation: 162.9M   Disk From:
Stamping: MAGO

Surface Mark-
Type: Survey disk
Magnetic code: N
Setting: SURROUNDED BY A MASS OF CONCRETE
Rod depth: Sleeve Depth:

****Mark is suitable for GPS

Set by NOS in 1993, Chief of party ALG.

THE STATION IS LOCATED 4.0 MI (6.4 KM) WEST OF MANISTEE, MICHIGAN, IN THE NORTHWEST QUADRANT OF 'THE INTERSECTIONS OF COUNTY LINE ROAD AND RED APPLE ROAD.

TO REACH FROM THE INTERSECTION OF U.S. HIGHWAY 31 AND COUNTY LINE ROAD AT THE MANISTEE-MASON COUNTY LINE, GO WEST ON COUNTY LINE FOR 3.3 MI (5.3 KM) TO A ROAD RIGHT JUST BEFORE THE END OF THE PAVED ROAD SURFACE AND THE STATION ON THE RIGHT IN A GRASSY RIGHT OF WAY IN THE NORTHEAST QUADRANT OF THE INTERSECTION OF COUNTY LINE ROAD AND RED APPLE ROAD.

THE STATION IS 43.0 FT (13.1 M) NORTH OF A DEAD END SIGN, 47 FT (14.3 M) NORTHWEST OF A STOP SIGN, 57.0 FT (17.4 M) WEST OF CENTERLINE OF RED APPLE ROAD AND 62.0 FT (18.9 M) NORTH OF CENTERLINE OF COUNTY LINE ROAD.

Mark Recovery Entry

This form can be used to submit recovery information for survey marks to the National Geodetic Survey. If the data sheet for this mark shows a recovery within the past 12 months and the status has not changed, please do not report it.

Enter PID: [ ]

Select condition of mark:
- ○ Good
- ○ Not recovered, not found
- ○ Poor, disturbed, mutilated, requires maintenance

For Destroyed condition, see **Note** below

Note: For destroyed marks do one of the following:

1) If you have found the actual marker separated from its setting, you can report the point as destroyed. To do so please send the report on the destroyed mark as an email to Deb Brown (Deb.Brown@noaa.gov). If you send this email, please do not submit the current form, Deb Brown will submit the report for you. **In addition, please submit proof of the mark's destruction via actual disk, rubbing, photo, or digital picture (preferred) to Deb Brown:**

Deb Brown, N/NGS143
National Geodetic Survey, NOAA
1315 East West Highway
Silver Spring, MD 20910

2) If you did not find the actual marker, then you should enter notes concerning evidence of its possible destruction as text records and select "Not recovered, not found" as the condition of mark.

Enter agency code of the recovering organization/agency:

- ○ USPSQD - U.S. Power Squadron
- ○ INDIV - Local Surveyor or Engineer
- ○ NGS - National Geodetic Survey
- ○ Other - Enter the approved agency code of the organization which recovered the mark in the textbox below.

If you do not know your approved agency code, you can generate the latest contributors' list from NGS' integrated database (NGSIDB). On this list the agency code starts in column 1 and the agency full name follows it. The list is sorted alphabetically by agency code. If your agency or firm is not on this list and you would like to be assigned a specific agency code, please contact Deb Brown at NGS to make the appropriate arrangements.

Enter initials of the person who recovered the mark (Optional):

The date of recovery must be expressed as a numerical month (between 1 and 12), a numerical day of the month, and a four character numerical year. The month, day, and year may be separated by spaces or by commas.

Valid examples are:
`4,25,1998` for April 25, 1998
`4 25 1998` for April 25, 1998

The current program is not valid for dates before 1990.

Enter date of recovery:

Enter your name and email address:

Privacy Statement: Your name and email address will be used only to contact you if there is a problem in loading your recovery. They will not be used for any other purpose.

Enter name:
Enter email address:

You can, if you wish, enter up to 15 lines of text in the space below. The only characters that are allowed are: letters, numbers, blank or space ( ), comma (,), period or decimal (.), apostrophe or single quote ('), asterisk (*), plus sign (+), minus sign or hyphen (-), equal sign (=), slash (/), left parenthesis ((), and right parenthesis ()).

Warning: Do not enter personal phone numbers.

Note: Text such as RECOVERED AS DESCRIBED, or MARK NOT FOUND, or DESCRIPTION IS ADEQUATE, etc. is not necessary.

Mark Recovery Entry

This form can be used to submit recovery information for survey marks to the National Geodetic Survey. If the data sheet for this mark shows a recovery within the past 12 months and the status has not changed, please do not report it.

Enter PID: AB1234

Select condition of mark:
◉ Good
○ Not recovered, not found
○ Poor, disturbed, mutilated, requires maintenance

For Destroyed condition, see **Note** below

Note: For destroyed marks do one of the following:

1) If you have found the actual marker separated from its setting, you can report the point as destroyed. To do so please send the report on the destroyed mark as an email to Deb Brown (Deb.Brown@noaa.gov). If you send this email, please do not submit the current form, Deb Brown will submit the report for you. **In addition, please submit proof of the mark's destruction via actual disk, rubbing, photo, or digital picture (preferred) to Deb Brown:**

Deb Brown, N/NGS143
National Geodetic Survey, NOAA
1315 East West Highway
Silver Spring, MD 20910

2) If you did not find the actual marker, then you should enter notes concerning evidence of its possible destruction as text records and select "Not recovered, not found" as the condition of mark.

Enter agency code of the recovering organization/agency:

○ USPSQD - U.S. Power Squadron
○ INDIV - Local Surveyor or Engineer
◉ NGS - National Geodetic Survey
○ Other - Enter the approved agency code of the organization which recovered the mark in the textbox below.

If you do not know your approved agency code, you can generate the latest contributors' list from NGS' integrated database (NGSIDB). On this list the agency code starts in column 1 and the agency full name follows it. The list is sorted alphabetically by agency code. If your agency or firm is not on this list and you would like to be assigned a specific agency code, please contact Deb Brown at NGS to make the appropriate arrangements. [ ]

Enter initials of the person who recovered the mark (Optional): [MS]

The date of recovery must be expressed as a numerical month (between 1 and 12), a numerical day of the month, and a four character numerical year. The month, day, and year may be separated by spaces or by commas.

Valid examples are:
`4,25,1998` for April 25, 1998
`4 25 1998` for April 25, 1998

The current program is not valid for dates before 1990.

Enter date of recovery: [8,4,2004]

Enter your name and email address:

Privacy Statement: Your name and email address will be used only to contact you if there is a problem in loading your recovery. They will not be used for any other purpose.

Enter name: [Mark Surveyor]
Enter email address: [MS@surveyor-firm.com]

You can, if you wish, enter up to 15 lines of text in the space below. The only characters that are allowed are: letters, numbers, blank or space ( ), comma (,), period or decimal (.), apostrophe or single quote ('), asterisk (*), plus sign (+), minus sign or hyphen (-), equal sign (=), slash (/), left parenthesis ((), and right parenthesis ()).

Warning: Do not enter personal phone numbers.

Note: Text such as RECOVERED AS DESCRIBED, or MARK NOT FOUND, or DESCRIPTION IS ADEQUATE, etc. is not necessary.

```
MARK RECOVERED AS DESCIRBED, EXCEPT A NEW FENCE IS NOW 6 METERS WEST
OF THE STATION.
```

[submit]

For assistance contact Deb Brown

--> Click here to clear the sample data <--

NATIONAL GEODETIC SURVEY STATION DESCRIPTION / RECOVERY FORM

4-char ID: __________ Designation: ______________________________________

PID: ______________ Alias: ____

Country: (USA / ______) State: ___________ County: _________________________

Latitude: N ____ o ____ ' ____ " Longitude: W ____ o ____ ' ____ " Elevation:________ (meter / ft)

Original Description (check one):	
❐ P	Preliminary (mark has not been set yet)
❐ D	A newly set mark
❐ R	A recovered mark
Established by: (NGS / CGS / Other:)	
Date:	Chief of Party (initials):

Recovery Description (check one):	
❐ F	Full description of a station *not* in the database
❐ T	Full description of a station *in* the database
❐ M	*Partial* description of a station in the database
Recovered by: (NGS / Other:)	
Date:	Chief of Party (initials):

Monument Stability (check one):	
❐ A	Of the most reliable nature; expected to hold well
❐ B	Will probably hold position and elevation well
❐ C	May hold well, but subject to ground movement
❐ D	Of questionable or unknown reliability

Recovery Condition (check one):	
❐ G	Recovered in good condition
❐ N	Not recovered or not found
❐ P	Poor, disturbed, or mutilated
❐ X	Surface mark known destroyed

Setting Information:	
Marker Type: (Rod / Disk / Other)	
Setting Type: (Bedrock / Concrete / Other:)	
Y / N / ?	Monument contains magnetic material?

Stamping:	
Agency Inscription: (NGS / CGS / Other:)	
Rod Depth: (m/ft)	Sleeve Depth: (m/ft)
Monument is: (flush / projecting / recessed)	(cm/ft)

Special Type (check all applicable):	
❐ F	Fault monitoring site
❐ T	Tidal Station
❐ --	Control Station: (FBN / CBN / Bench mark)
❐ --	Airport Control Station: (PACS / SACS)
Y /N	Mark is suitable for GPS use?

Transportation (check one):	
❐ C	Car
❐ P	Light truck (pickup, carry-all, etc.)
❐ X	Four-Wheel Drive Vehicle
❐__	Other (SnowCat, Plane, Boat; describe)
Y /N	Pack Time (hike) to mark? (hh:mm):

See Back of Form to add Text Description

General Station Location: "The station is located in ______________________________

____

____

____

____

______________________________(Describe general location; include airline distances to three towns or mapped features.)

Ownership: ______________________________

______________________________(name, address, phone of landowner)

To Reach Narrative: "To reach the station from the intersection of ______________________________

____

____

____

____

____

______________________________(Leg-by-leg distances and directions from major road intersection to mark)

Monument Description and Measurements: "The station is ______________________________

____

____

____

____

____

____

____

___________ (Add at least three measurements to permanent, identifiable, nearby objects; and a description of the monument size, shape, height, etc.)

NOTE: - Include a pencil rubbing, sketch, or photographs of mark.

Described by:____________________ Phone:(_____)______________ e-mail:______________

--> Click here to clear the sample data <--

NATIONAL GEODETIC SURVEY STATION DESCRIPTION / RECOVERY FORM

4-char ID: __________ Designation: ______________________________________

PID: ______________ Alias: ____

Country: (USA / ______) State: ___________ County: _________________________

Latitude: N ____ ° ____ ' ____ " Longitude: W ____ ° ____ ' ____ " Elevation:_______ (meter / ft)

Original Description (check one):	
❐ P	Preliminary (mark has not been set yet)
❐ D	A newly set mark
❐ R	A recovered mark
Established by: (NGS / CGS / Other:)	
Date:	Chief of Party (initials):

Recovery Description (check one):	
❐ F	Full description of a station *not* in the database
❐ T	Full description of a station *in* the database
❐ M	*Partial* description of a station in the database
Recovered by: (NGS / Other:)	
Date:	Chief of Party (initials):

Monument Stability (check one):	
❐ A	Of the most reliable nature; expected to hold well
❐ B	Will probably hold position and elevation well
❐ C	May hold well, but subject to ground movement
❐ D	Of questionable or unknown reliability

Recovery Condition (check one):	
❐ G	Recovered in good condition
❐ N	Not recovered or not found
❐ P	Poor, disturbed, or mutilated
❐ X	Surface mark known destroyed

Setting Information:	
Marker Type: (Rod / Disk / Other)	
Setting Type: (Bedrock / Concrete / Other:)	
Y / N / ?	Monument contains magnetic material?

Stamping:	
Agency Inscription: (NGS / CGS / Other:)	
Rod Depth: (m/ft)	Sleeve Depth: (m/ft)
Monument is: (flush / projecting / recessed)	(cm/ft)

Special Type (check all applicable):	
❐ F	Fault monitoring site
❐ T	Tidal Station
❐ --	Control Station: (FBN / CBN / Bench mark)
❐ --	Airport Control Station: (PACS / SACS)
Y /N	Mark is suitable for GPS use?

Transportation (check one):	
❐ C	Car
❐ P	Light truck (pickup, carry-all, etc.)
❐ X	Four-Wheel Drive Vehicle
❐__	Other (SnowCat, Plane, Boat; describe)
Y /N	Pack Time (hike) to mark? (hh:mm):

See Back of Form to add Text Description

General Station Location: "The station is located in ______________________________

____

____

____

____

______________________________(Describe general location; include airline distances to three towns or mapped features.)

Ownership: ____

____(name, address, phone of landowner)

To Reach Narrative: "To reach the station from the intersection of ______________________

____

____

____

____

____

________________________________(Leg-by-leg distances and directions from major road intersection to mark)

Monument Description and Measurements: "The station is ______________________

____

____

____

____

____

____

____

__________ (Add at least three measurements to permanent, identifiable, nearby objects; and a description of the monument size, shape, height, etc.)

NOTE: - Include a pencil rubbing, sketch, or photographs of mark.

Described by:____________________ Phone:(_____)______________ e-mail:______________

--> Click here to clear the sample data <--

GPS STATION OBSERVATION LOG
April 16, 2003

Station Designation: (check applicable:__FBN__CBN__PAC__SAC __BM)		Station PID, if any:	Date (UTC): 31 Dec 2002
General Location: Boiler Bay Wayside	Airport ID, if any: ---	Station 4-Character ID:	Day of Year: 365
Project Name: Sample GPS, 2002	Project Number: GPS- 1234	Station Serial # (SSN): leave blank	Session ID:(A,B,C etc) A

NAD83 Latitude o ' "	NAD83 Longitude o ' "	NAD83 Ellipsoidal Height -6.44 meters NAVD88 Orthometric Ht. meters GEOID99 Geoid Height -23.52 meters	Agency Full Name: Operator Full Name: Phone #: ( ) e-mail address:
Observation Session Times (UTC): Sched. Start 12:00 Stop 17:30 Actual Start 11:55 Stop 17:32	Epoch Interval= 15 Seconds Elevation Mask = 10 Degrees		

Receiver Brand & Model: Leica SR530
p/n 667122
P/N:
S/N: s/n 0030354
Firmware Version: Version 3.0
☑ CamCorder Battery, ❐ 12V DC, ❐ 110V AC, ❐ Other

Antenna Code*, Brand & Model: Trimble Choke Ring
p/n 29659-00
P/N:
S/N: s/n 02200-63591
Cable Length, meters: 30 meters
Vehicle is Parked 25 meters N (direction) from antenna.

Antenna plumb before session?	(✓/ N)	Circle Yes or No -If no, explain
Antenna plumb after session?	(✓/ N)	
Antenna oriented to true North?	(✓/ N)	
Weather observed at antenna ht.	(✓/ N)	
Antenna ground plane used?	(✓/ N)	"
Antenna radome used?	(Y / ✓)	If yes, describe. Use Vis. form
Eccentric occupation (>0.5 mm)?	(Y / ✓)	
Any obstructions above 10°?	(Y / ✓)	
Radio interference source nearby	(Y / ✓)	

Tripod or Antenna Mount: Check one:
☑ Fixed-Leg Tripod, ❐ Collapsible-leg tripod ❐ Fixed Mount
Brand & Model: SECO
P/N: none.
S/N: 97-G
Last Adjustment date: 2002-11-01

Psychrometer (if used) Brand & Model:
P/N: Psychrodyne
S/N: J.Q.S.
Last Calibration or check Date:

** ANTENNA HEIGHT **	Before Session Begins: Meters	Feet	After Session Ends: Meters	Feet
A= Datum point to Top of Tripod (Tripod Height)	2.000		2.000	
B=Additional offset to ARP if any (Tribrach/Spacer)	-0.003		-0.003	
H= Antenna Height = A + B = Datum Point to Antenna Reference Point (ARP)				

Meters = Feet x (0.3048)
Height Entered Into Receiver = 2.000 meters.
Note &/or sketch **ANY** unusual conditions. Be **Very Explicit** as to where and how Measured!

Barometer (if used) Brand & Model: pretel altiplus A2
S/N: J.Q.S.
none.
01-Nov-02

Weather Data	Weather Codes	Time (UTC)	Dry-Bulb Temp Fahrenheit	Celsius	WetBulb Temp Fahrenheit	Celsius	Rel. % Humidity	Atm. Pressure inches Hg	millibar
Before	00000	12:00	74.0		68.0		74	29.44	
Middle	00001	14:45	77.0		72.5		81	29.55	
After	00102	17:30	82.5		78.0		82	29.66	

Remarks, Comments on Problems, Sketches, Pencil Rubbing, etc:

Calculate

1. Winds, calm at start, gradually increased to 20 knots by end of session.

2. Semi-trailer parked 12 meters SSE of antenna from 15:17 to 15:32 UTC, possibly blocking satellites and causing multipath environment.

Weather codes are required. Weather data are optional but encouraged. *Antenna code comes from ant_info file furnished by project coordinator.

Data File Name(s): BALD365A.dat
(Standard NGS Format = aaaaddds.xxx)
where aaaa=4-Character ID, ddd=Day of Year, s=Session ID, xxx=file dependant extension

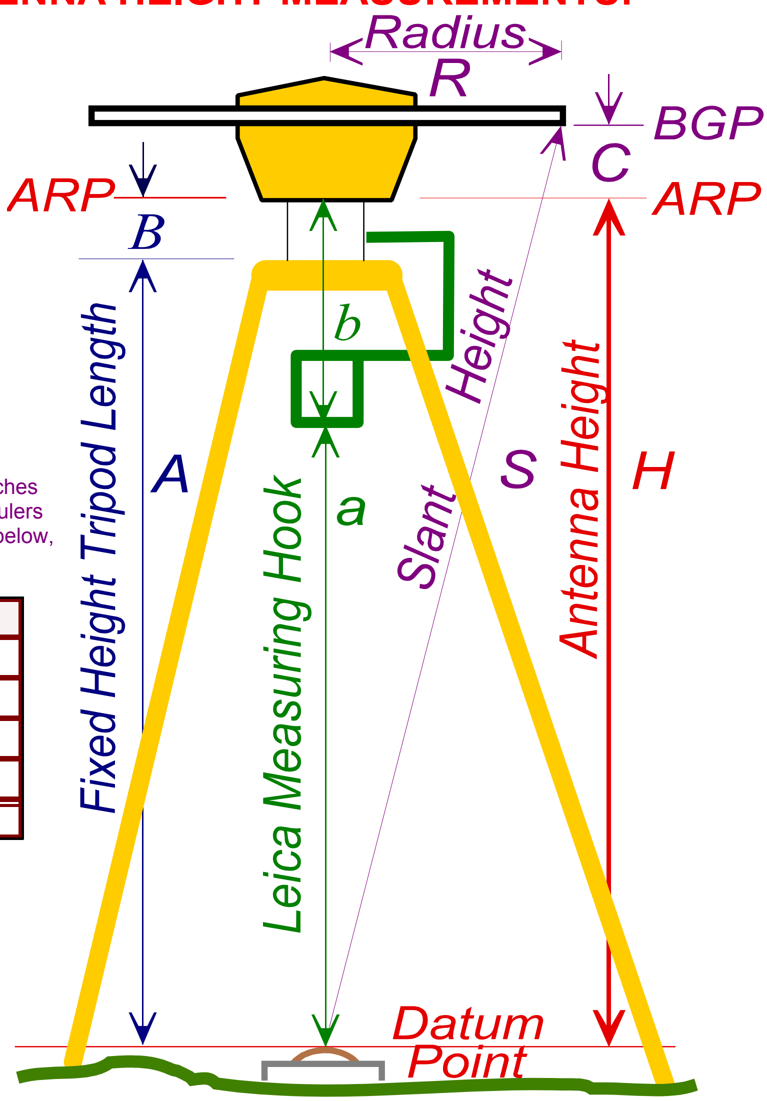
Updated Station Description:	☑ Attached	❐ Submitted earlier
Visibility Obstruction Form:	☑ Attached	❐ Submitted earlier
Photographs of Station:	☑ Attached	❐ Submitted earlier
Pencil Rubbing of Mark:	☑ Attached	

LOG CHECKED BY: JGE

Table of Weather Codes	CODE	PROBLEM	VISIBILITY	TEMPERATURE	CLOUD COVER	WIND
	0	did not occur	Good, over 15 miles	Normal, 32° F- 80° F	Clear, below 20%	Calm, under 5mph (8km/h)
	1	did occur	Fair, 7-15 miles	Hot, over 80°F (27 C)	Cloudy, 20% to 70%	Moderate, 5 to 15 mph
	2	- not used -	Poor, under 7 miles	Cold, below 32° F (0 C)	Overcast, over 70%	Strong, over15 mph (24km/h)

Examples: 00000 = No problem, good visibility, normal temp, clear, calm wind 12121 = Problems, poor visibility, hot, overcast, moderate wind

ILLUSTRATION FOR ANTENNA HEIGHT MEASUREMENTS:



I. Instructions for Fixed-Height Tripods:

Measure & record the fixed-height tripod length **(A)** and other offsets, if any, between the tripod and the Antenna Reference Point (ARP) **(B)**

$$Antenna.Height = H = A + B$$

II. Instructions for Slip-Leg Tripods:

1. Measure the Slant Height (S)

Measure the slope distance from the mark to at least three notches on the Bottom of Ground Plane (BGP) using two independent rulers (e.g., metric and Imperial). Record measurements in the table below, and compute the average.

Measure S	Notch #_	Notch #_	Notch #_	Average
Before, cm	223.40	223.30	223.30	
Before, inch	87.95	87.94	87.93	
After, cm	223.40	223.40	223.30	
After, inch	87.97	87.96	87.95	
Note: cm= inch x (2.54)		Overall average, cm		

S = ________________ cm

2. Record the Antenna Radius (R) and the Antenna Constant (C)

The antenna radius (R) is the horizontal distance from the center of the antenna to the measurement notch. The antenna constant (C) is the vertical distance from the ARP to the BGP. Consult your antenna users manual for exact measurements.

R = 19.05 cm

C = 3.50 cm

3. Compute Antenna Height (H)

Use the following Pythagorean equation:

$$Antenna.Height = H = ((\sqrt{S^2 - R^2}) - C)$$

III. Instructions for using the Leica Brand Measuring Hook:

Follow the Leica operating instructions, being sure to reduce the height to the Antenna Reference Point (ARP), NOT the L1 Phase Center.

$$Antenna.Height = H = a + b$$

Table of Weather Codes -- for entry into Weather Data Table on front of form:					
CODE	**PROBLEM**	**VISIBILITY**	**TEMPERATURE**	**CLOUD COVER**	**WIND**
0	NO PROBLEMS encountered	GOOD More than 15 miles	NORMAL 32° F to 80°F	CLEAR Below 20%	CALM Under 5mph (8km/h)
1	PROBLEMS encountered	FAIR 7 to 15 miles	HOT Over 80°F (27 C)	CLOUDY 20% to 70%	MODERATE 5 to 15 mph
2	-- NOT USED --	POOR Less than 7 miles	COLD Below 32° F (0 C)	OVERCAST Over 70%	STRONG over15mph (24km/h)
Examples: Code 00000 = Code 12121 =	0 - No problems, 1 - Problems,	0 - good visibility, 2 - poor visibility,	0 - normal temperature, 1 - hot temperature,	0 - clear sky, 2 - overcast,	0 - calm wind 1 - moderate wind

--> Click here to clear the sample data <--

GPS STATION OBSERVATION LOG
April 16, 2003

Station Designation: (check applicable:__ FBN__ CBN__ PAC__ SAC __BM)		Station PID, if any:	Date (UTC): 31-Dec-02
General Location: Boiler Bay Wayside	Airport ID, if any: ---	Station 4-Character ID:	Day of Year: 365
Project Name: Sample GPS, 2002	Project Number: GPS- 1234	Station Serial # (SSN): leave blank	Session ID:(A,B,C etc) A

NAD83 Latitude o ' "	NAD83 Longitude o ' "	NAD83 Ellipsoidal Height -6.44 meters NAVD88 Orthometric Ht. meters GEOID99 Geoid Height -23.52 meters	Agency Full Name: Operator Full Name: Phone #: ( ) e-mail address:
Observation Session Times (UTC): Sched. Start 12:00 Stop 17:30 Actual Start ________ Stop 17:32	Epoch Interval= 15 Seconds Elevation Mask = 10 Degrees		

Receiver Brand & Model: Leica SR530
P/N: p/n 667122
S/N: s/n 0030354
Firmware Version: Version 3.0
❐ CamCorder Battery, ❐ 12V DC, ❐ 110V AC, ❐ Other

Antenna Code*, Brand & Model: Trimble Choke Ring
P/N: p/n 29659-00
S/N: s/n 02200-63591
Cable Length, meters: 30 meters
Vehicle is Parked 25 meters N (direction) from antenna.

Antenna plumb before session?	(Y / N)	Circle Yes or No -If no, explain
Antenna plumb after session?	(Y / N)	
Antenna oriented to true North?	(Y / N)	
Weather observed at antenna ht.	(Y / N)	
Antenna ground plane used?	(Y / N)	"
Antenna radome used?	(Y / N)	If yes, describe. Use Vis. form
Eccentric occupation (>0.5 mm)?	(Y / N)	
Any obstructions above 10º?	(Y / N)	
Radio interference source nearby	(Y / N)	

Tripod or Antenna Mount: Check one:
❐ Fixed-Leg Tripod, ❐ Collapsible-leg tripod ❐ Fixed Mount
Brand & Model: SECO
P/N: none.
S/N: 97-G
Last Adjustment date: 2002-11-01

Psychrometer (if used) Brand & Model:
P/N: Psychrodyne
S/N: J.Q.S.
Last Calibration or check Date:

** ANTENNA HEIGHT **

	Before Session Begins: Meters	Feet	After Session Ends: Meters	Feet
A= Datum point to Top of Tripod (Tripod Height)	2.000		2.000	
B=Additional offset to ARP if any (Tribrach/Spacer)	-0.003		-0.003	
H= Antenna Height = A + B = Datum Point to Antenna Reference Point (ARP)				

Meters = Feet x (0.3048)
Height Entered Into Receiver = 2.000 meters.
Note &/or sketch **ANY** unusual conditions. Be **Very Explicit** as to where and how Measured!

Barometer (if used) Brand & Model: pretel altiplus A2
S/N: J.Q.S.
none.
01-Nov-02

Weather Data	Weather Codes	Time (UTC)	Dry-Bulb Temp Fahrenheit	Celsius	WetBulb Temp Fahrenheit	Celsius	Rel. % Humidity	Atm. Pressure inches Hg	millibar
Before	00000	12:00	74.0		68.0		74	29.44	
Middle	00001	14:45	77.0		72.5		81	29.55	
After	00102	17:30	82.5		78.0		82	29.66	

Remarks, Comments on Problems, Sketches, Pencil Rubbing, etc:

Calculate

1. Winds, calm at start, gradually increased to 20 knots by end of session.

2. Semi-trailer parked 12 meters SSE of antenna from 15:17 to 15:32 UTC, possibly blocking satellites and causing multipath environment.

Weather codes are required. Weather data are optional but encouraged. *Antenna code comes from ant_info file furnished by project coordinator.

Data File Name(s): BALD365A.dat
(Standard NGS Format = aaaaddds.xxx)
where aaaa=4-Character ID, ddd=Day of Year, s=Session ID, xxx=file dependant extension

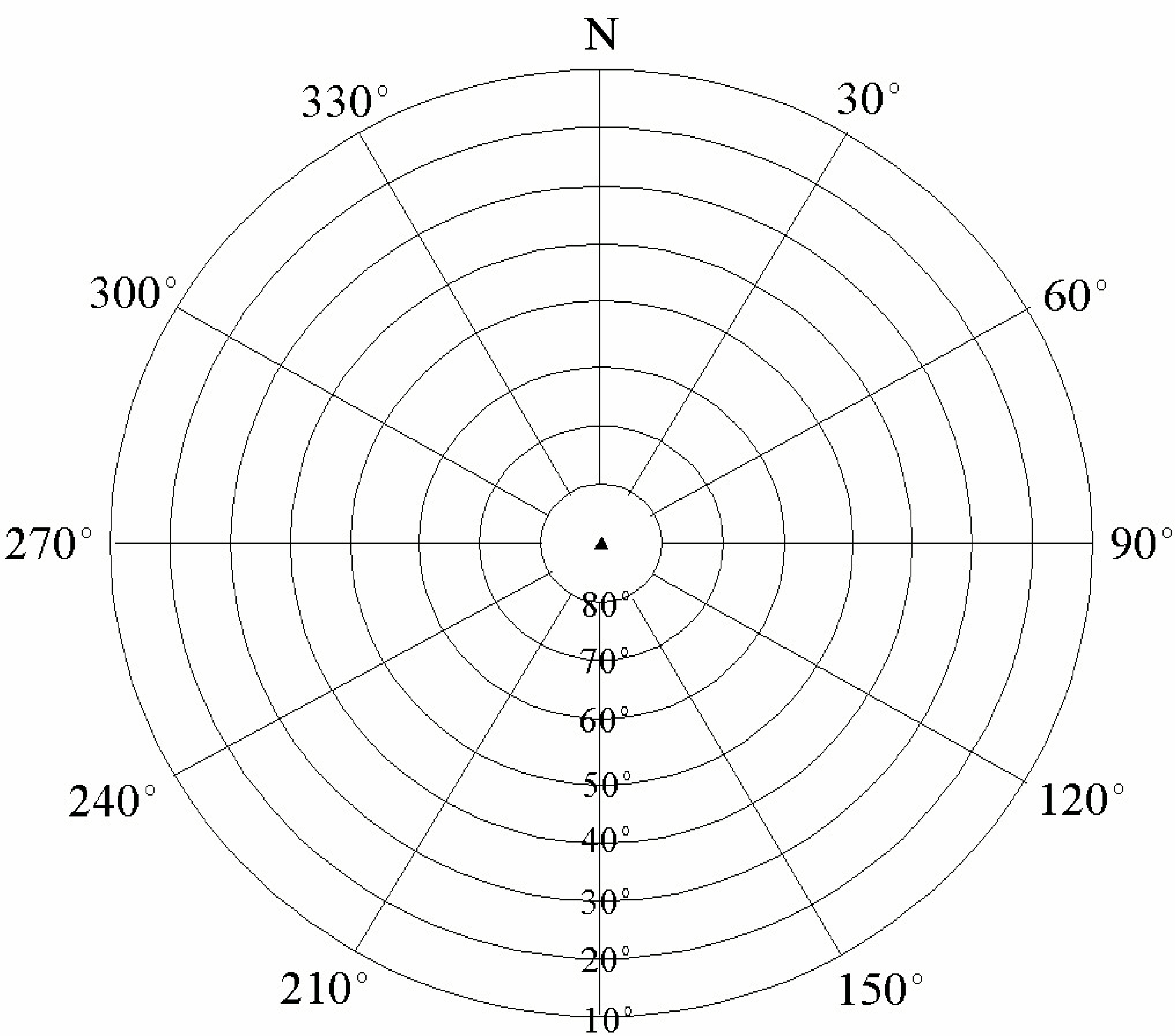
Updated Station Description:	❐ Attached	❐ Submitted earlier
Visibility Obstruction Form:	❐ Attached	❐ Submitted earlier
Photographs of Station:	❐ Attached	❐ Submitted earlier
Pencil Rubbing of Mark:	❐ Attached	

LOG CHECKED BY: JGE

Table of Weather Codes	CODE	PROBLEM	VISIBILITY	TEMPERATURE	CLOUD COVER	WIND
	0	did not occur	Good, over 15 miles	Normal, 32º F- 80º F	Clear, below 20%	Calm, under 5mph (8km/h)
	1	did occur	Fair, 7-15 miles	Hot, over 80ºF (27 C)	Cloudy, 20% to 70%	Moderate, 5 to 15 mph
	2	- not used -	Poor, under 7 miles	Cold, below 32º F (0 C)	Overcast, over 70%	Strong, over15 mph (24km/h)
Examples:	00000 = No problem, good visibility, normal temp, clear, calm wind			12121 = Problems, poor visibility, hot, overcast, moderate wind		

--> Click here to clear the sample data <--

NATIONAL GEODETIC SURVEY VISIBILITY OBSTRUCTION DIAGRAM



INSTRUCTIONS:

Identify obstructions by azimuth (magnetic) and elevation angle (above horizon) as seen from station mark.
Indicate distance and direction to nearby structures and reflective surfaces (potential multipath sources).

4-char ID: ____________ Designation: ______________________________

PID: ______________ Location: Boiler Bay Wayside

County: ____________________ Reconnaissance By: ______________________

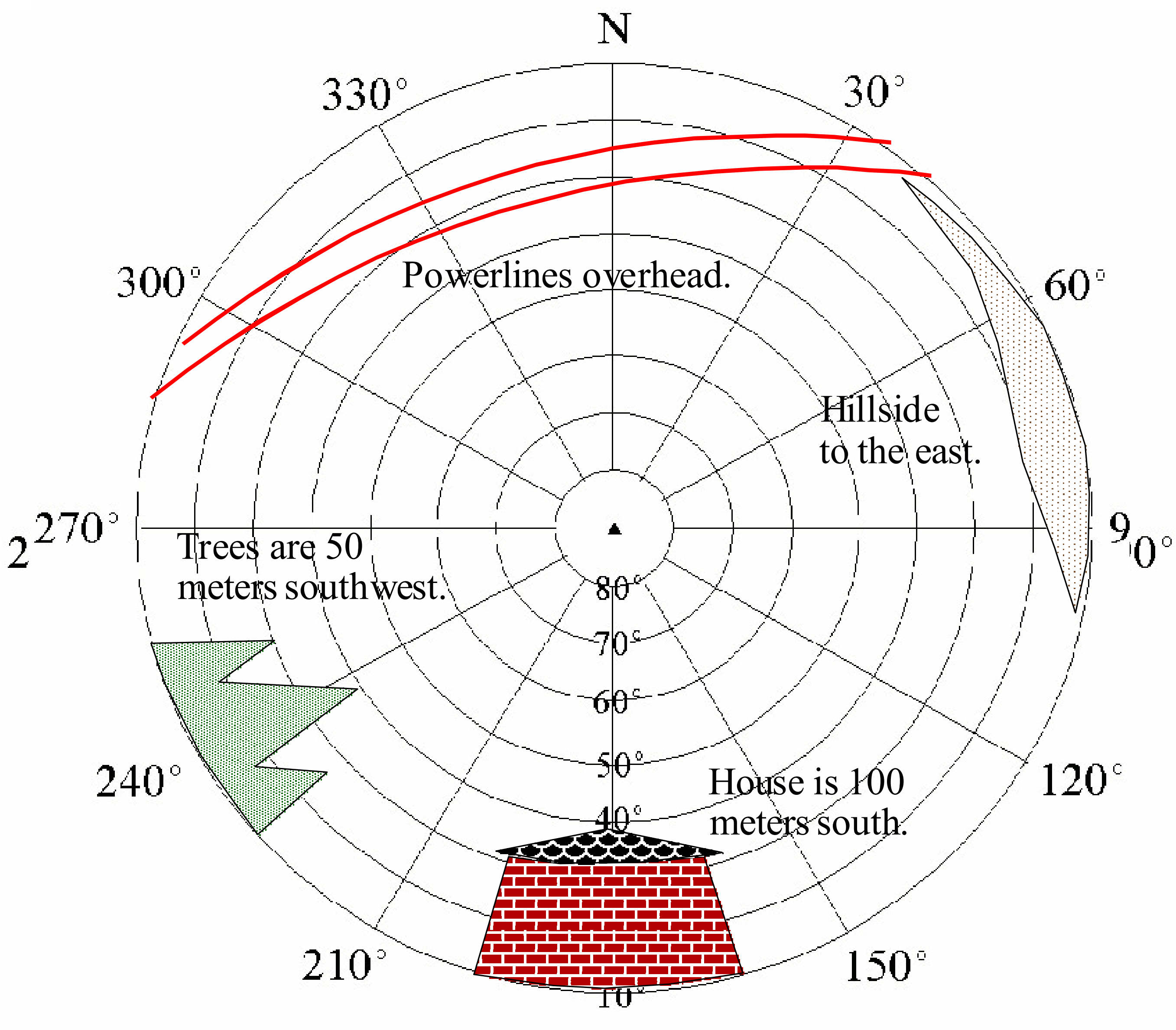
Height above mark, meters: ________ Agency/Company: ______________________

Phone: (_____) ____________________ Date: 31-Dec-02

Check if no obstructions above 10 degrees □

--> Click here to clear the sample data <--

NATIONAL GEODETIC SURVEY VISIBILITY OBSTRUCTION DIAGRAM



INSTRUCTIONS:

Identify obstructions by azimuth (magnetic) and elevation angle (above horizon) as seen from station mark.
Indicate distance and direction to nearby structures and reflective surfaces (potential multipath sources).

4-char ID: ____________ Designation: ________________________________

PID: ______________ Location: Boiler Bay Wayside

County: ____________________ Reconnaissance By: ______________________

Height above mark, meters: ________ Agency/Company: ____________________

Phone: (______) ____________________ Date: 31-Dec-02

Check if no obstructions above 10 degrees □

--> Click here to clear the sample data <--

NATIONAL GEODETIC SURVEY PENCIL RUBBING FORM

4-char ID: _ _________

Day of Year ("Julian Day"): 365

Designation: ____________________________

PID: ____________________________

Stamping: ____

Mark Type / Agency Inscription: _______________________________________

Location: Boiler Bay Wayside

County: ________________________

Rubbing By: ____________________________

Date: 31-Dec-02

Agency: ________________________________

Phone: (____) __________________

Remarks: ____

____

INSTRUCTIONS:

Place the blank form (or other blank paper) over the mark and rub over the entire disk with a pencil. For rod marks, rub only the designation and date stamping from the rim of the aluminum logo cap. If it is impossible to make a rubbing of the mark, or if the rubbing appears indistinct, a sketch and/or photograph may be substituted.

--> Click here to clear the sample data <--

NATIONAL GEODETIC SURVEY PENCIL RUBBING FORM

4-char ID: ____________ Day of Year (“Julian Day”): 365

Designation: ____________________ PID: ____________________

Stamping: ____________________

Mark Type / Agency Inscription: ____________________

Location: Boiler Bay Wayside County: ____________________

Rubbing By: ____________________ Date: 31-Dec-02

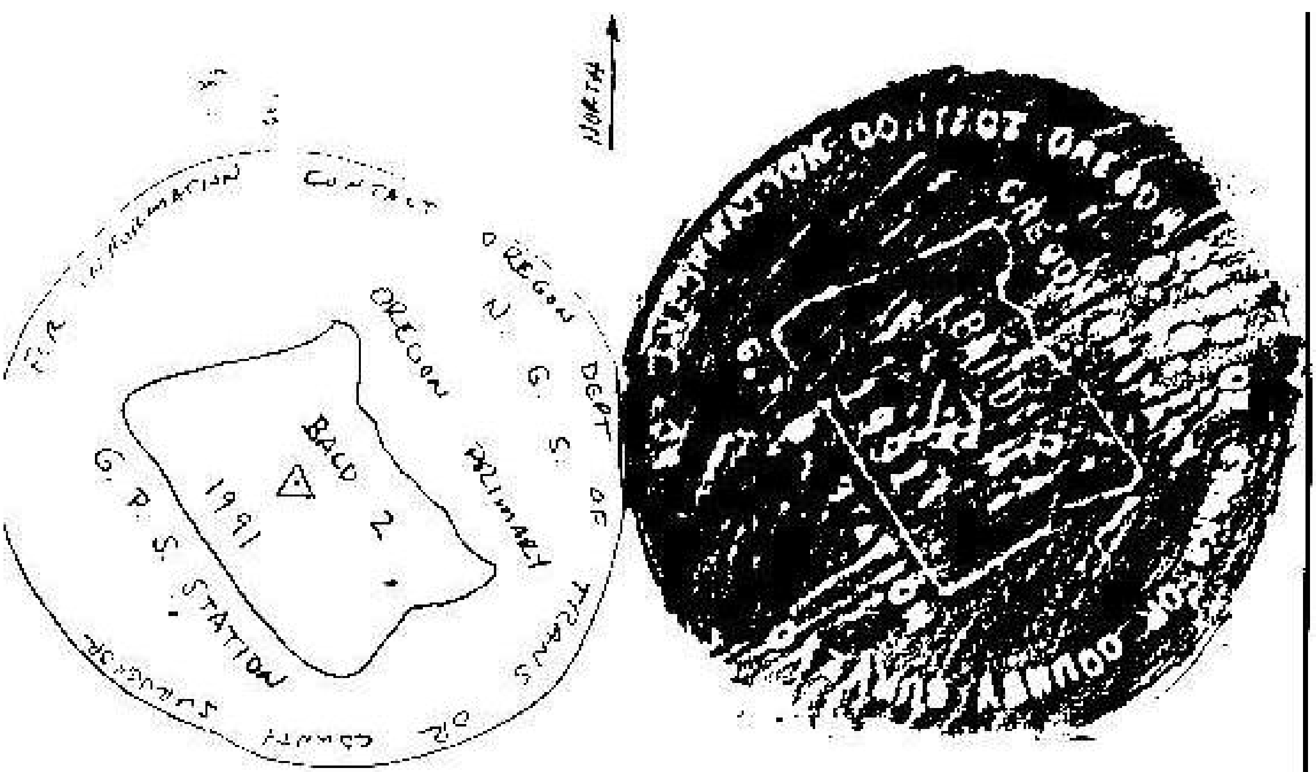
Agency: ____________________ Phone: (____) ____________

Remarks: ____________________

____

INSTRUCTIONS:

Place the blank form (or other blank paper) over the mark and rub over the entire disk with a pencil. For rod marks, rub only the designation and date stamping from the rim of the aluminum logo cap. If it is impossible to make a rubbing of the mark, or if the rubbing appears indistinct, a sketch and/or photograph may be substituted.



--> Click here to clear the sample data <--

Station Location Sketch and Visibility Diagram

Location / Airport Name and ID Boiler Bay Wayside

Project Sample GPS, 2002

Station Designation ____________ PID ____________ Date 31-Dec-02

Circle all applicable:

PACS SACS BM FBN CBN OTHER________

Observer & Organization____________

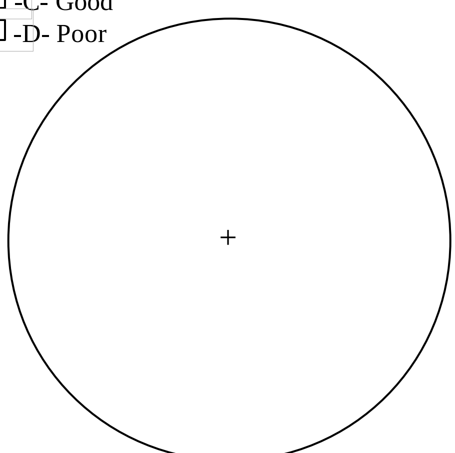
Station Location Sketch

Sketch of Disk

Monument Stability Quality:

☐ Photos Available

☐ -A- Most stable
☐ -B- Excellent
☐ -C- Good
☐ -D- Poor



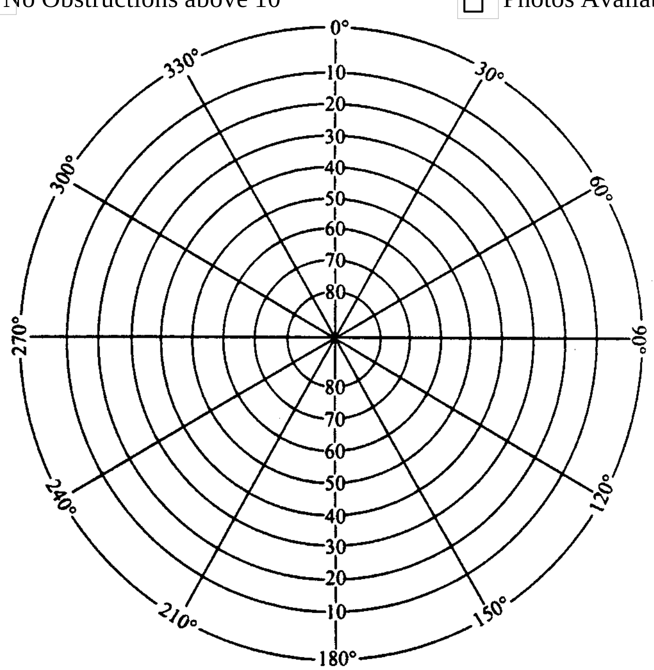
Monument is:
☐ Recessed ___ cm
☐ Flush with ground surface
☐ Projecting ___ cm

Disk is set:
☐ in bedrock.
☐ in concrete.
☐ in structure.

Visibility Diagram

☐ No Obstructions above 10^{o}

☐ Photos Available



General Station Location: "*The station is located in . . .*

(Describe general location; include airline distances to three towns or mapped features.)

Ownership:

(OPTIONAL: name, address, phone of landowner)

To Reach Narrative: *"To reach the station from the intersection of . . .*

(Leg-by-leg distances and directions from major road intersection to mark.)

Monument Description and Measurements: "*The station is . . .*

(Add at least 3 measurements to permanent, identifiable, nearby objects; and a description of the monument size, shape, height, etc.)

--> Click here to clear the sample data <--

Station Location Sketch and Visibility Diagram

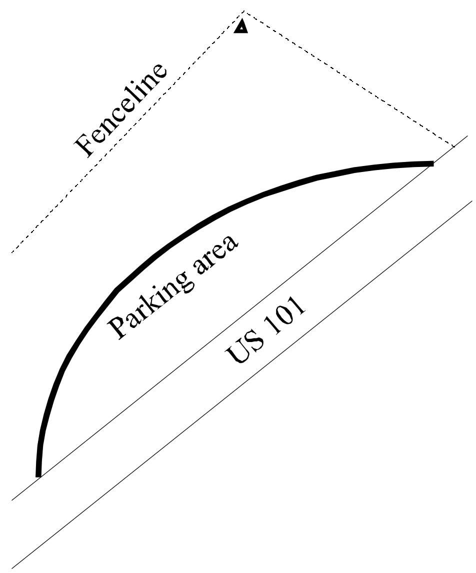
Location / Airport Name
and ID Boiler Bay Wayside Project Sample GPS, 2002

Station Designation ______________ PID ______ Date 31-Dec-02

Circle all applicable:
PACS SACS BM FBN CBN OTHER________

Observer &
Organization________________

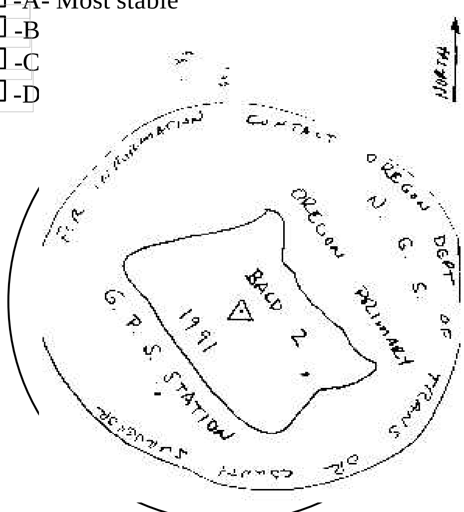
Station Location Sketch



Sketch of Disk

Monument Stability Quality:
☐ -A- Most stable
☐ -B
☐ -C
☐ -D

☐ Photos Available



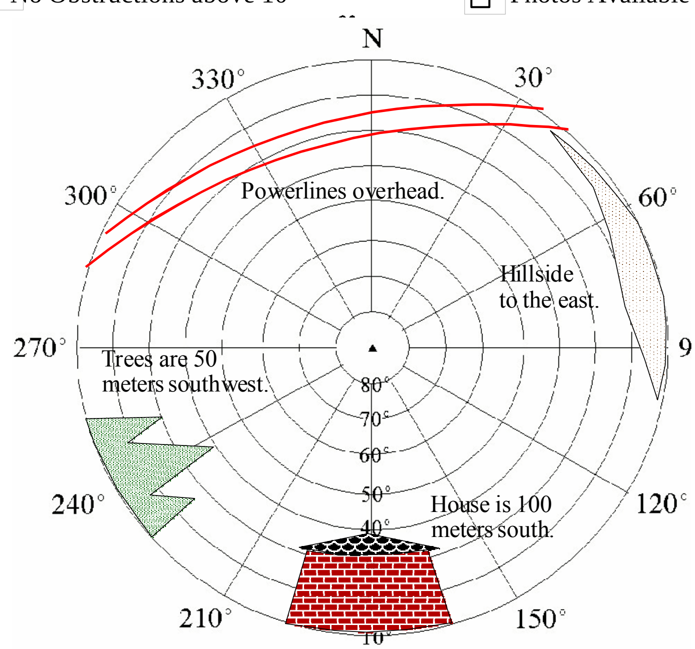
Monument is:
☐ Recessed ___ cm
☐ Flush with ground surface
☐ Projecting ___ cm

Disk is set:
☐ in bedrock.
☐ in concrete.
☐ in structure.

Visibility Diagram

☐ No Obstructions above 10°

☐ Photos Available



General Station Location: "*The station is located in . . .*

(Describe general location; include airline distances to three towns or mapped features.)

Ownership:

(OPTIONAL: name, address, phone of landowner)

To Reach Narrative: *"To reach the station from the intersection of . . .*

(Leg-by-leg distances and directions from major road intersection to mark.)

Monument Description and Measurements: "*The station is . . .*

(Add at least 3 measurements to permanent, identifiable, nearby objects; and a description of the monument size, shape, height, etc.)

NOAA FORM 76-53
(3-76)

U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND
ATMOSPHERIC ADMINISTRATION

CONTROL STATION IDENTIFICATION

STATION		CONTROL DATA REF.
STATE	COUNTY	IDENTIFIED BY
DATE	ACCURACY	CHIEF OF PARTY
MAP NUMBER	JOB NUMBER	PHOTO NUMBER

DESCRIPTION OF SUBSTITUTE STATION A

SKETCH (SUBSTITUTE STATION A)

N

INFORMATION REQUIRED-SUBSTITUTE STATION A

INST. STATION		
AZ. STATION		
< TO STA. (RIGHT)		
DISTANCE	FT.	M.

DESCRIPTION OF SUBSTITUTE STATION B OR STATION IDENTIFIED DIRECT.

SKETCH (SUBSTITUTE STATION B)

N

INFORMATION REQUIRED-SUBSTITUTE STATION B

INST. STATION		
AZ. STATION		
< TO STA. (RIGHT)		
DISTANCE	FT.	M.

SUPERSEDES FORM C&GS152.

NOAA FORM 76-53
(3-78)

U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND
ATMOSPHERIC ADMINISTRATION

CONTROL STATION IDENTIFICATION

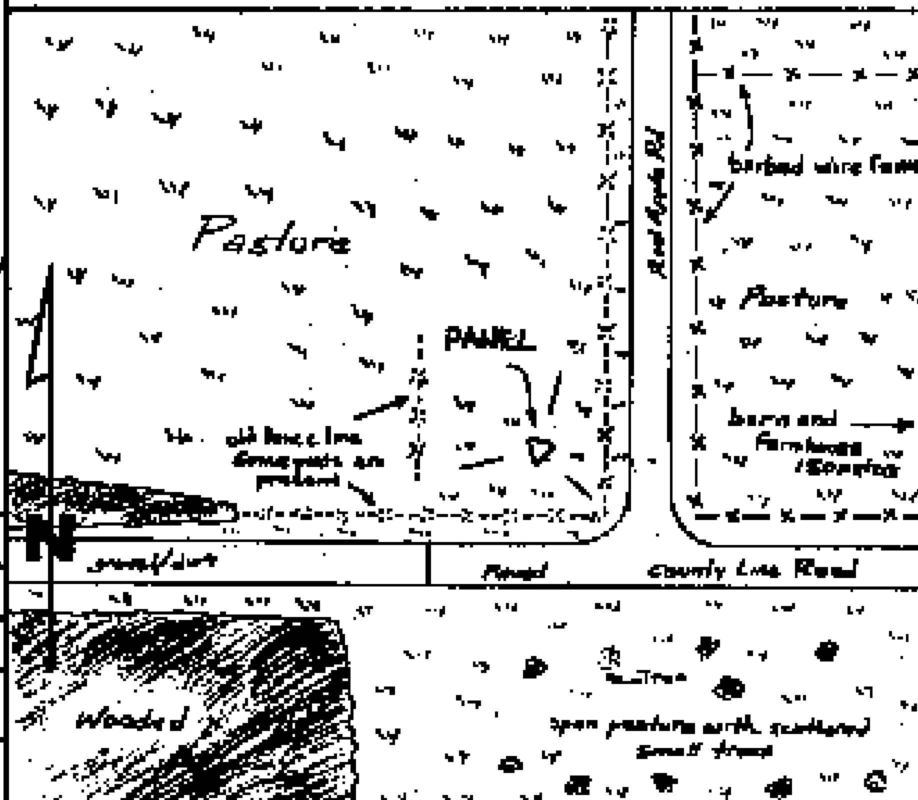
MANISTEE 7.5' Quad.

STATION PANEL No 2		CONTROL DATA REF. MAGO
STATE MICHIGAN	COUNTY MANISTEE	IDENTIFIED BY C.S. MIDDLETON JR.
DATE 6/16/93	ACCURACY	CHIEF OF PARTY A.L. GRIMES III
MAP NUMBER	JOB NUMBER CM-9303	PHOTO NUMBER

DESCRIPTION OF SUBSTITUTE STATION A

The panel consists of a standard array No.1 for 1:40,000 of Matte white material. It is located about 4.2 mi SSW of Manistee, 1.1 mi East of Lake Michigan, 1 mi South of Magoon Creek in the NW quadrant of a "T" intersection of paved roads in grassy pasture 16 meters North of the E-W road (County Line Rd) and 15 meters West of the North-South road (Red Apple Road). It is placed over new station "MAGO" positioned by GPS.

SKETCH (SUBSTITUTE STATION A)



INFORMATION REQUIRED-SUBSTITUTE STATION A

INST. STATION		
AZ. STATION		
∠ TO STA. (RIGHT)		
DISTANCE	FT.	M.

DESCRIPTION OF SUBSTITUTE STATION B OR STATION IDENTIFIED DIRECT-

SKETCH (SUBSTITUTE STATION B)

LAKE MICHIGAN

INFORMATION REQUIRED-SUBSTITUTE STATION B

INST. STATION		
AZ. STATION		
∠ TO STA. (RIGHT)		
DISTANCE	FT.	M.

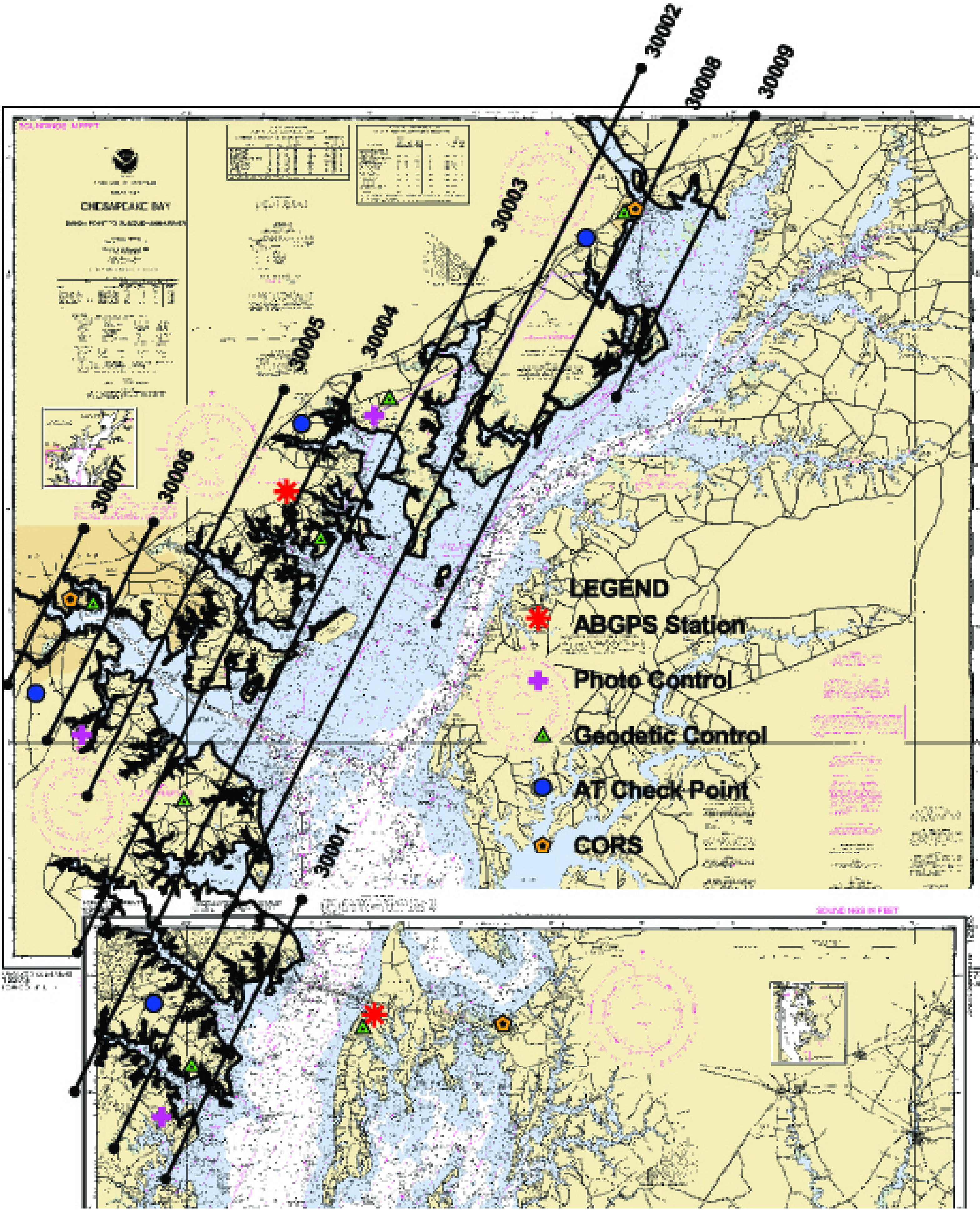
NOAA FORM 76-53
(3-78)

SUPERSEDES FORM C&GS-11.

LAYTON,JV4425,1,28FEB01


LAYTON
LAYTON,JV4425,2,28FEB01


LAYTON NE
LAYTON,JV4425,3NE,28FEB01



30002
30008
30009
30003
30004
30005
30006
30007
30001
CHESAPEAKE BAY
LEGEND
ABGPS Station
Photo Control
Geodetic Control
AT Check Point
CORS

The NGS Data Sheet

See file dsdata.txt for more information about the datasheet.

```
DATABASE = Sybase ,PROGRAM = datasheet, VERSION = 6.55
1        National Geodetic Survey,   Retrieval Date = NOVEMBER  1, 2001
 PM0610 ***********************************************************************
 PM0610  DESIGNATION -  MAGO
 PM0610  PID         -  PM0610
 PM0610  STATE/COUNTY-  MI/MANISTEE
 PM0610  USGS QUAD   -
 PM0610
 PM0610                         *CURRENT SURVEY CONTROL
 PM0610  ___________________________________________________________________
 PM0610* NAD 83(1994)-  44 10 42.42614(N)    086 21 59.07961(W)     ADJUSTED
 PM0610* NAVD 88     -       198.7    (meters)     652.     (feet)  VERTCON
 PM0610  ___________________________________________________________________
 PM0610  X           -     290,374.115 (meters)                     COMP
 PM0610  Y           -  -4,572,586.816 (meters)                     COMP
 PM0610  Z           -   4,422,447.482 (meters)                     COMP
 PM0610  LAPLACE CORR-          5.74  (seconds)                     DEFLEC99
 PM0610  ELLIP HEIGHT-        163.48  (meters)                      GPS OBS
 PM0610  GEOID HEIGHT-        -35.11  (meters)                      GEOID99
 PM0610
 PM0610  HORZ ORDER  -  SECOND
 PM0610  ELLP ORDER  -  FOURTH    CLASS I
 PM0610
 PM0610.The horizontal coordinates were established by GPS observations
 PM0610.and adjusted by the National Geodetic Survey in February 1997.
 PM0610
 PM0610.The NAVD 88 height was computed by applying the VERTCON shift value to
 PM0610.the NGVD 29 height (displayed under SUPERSEDED SURVEY CONTROL.)
 PM0610
 PM0610.The X, Y, and Z were computed from the position and the ellipsoidal ht.
 PM0610
 PM0610.The Laplace correction was computed from DEFLEC99 derived deflections.
 PM0610
 PM0610.The ellipsoidal height was determined by GPS observations
 PM0610.and is referenced to NAD 83.
 PM0610
 PM0610.The geoid height was determined by GEOID99.
 PM0610
 PM0610;                    North         East     Units   Scale      Converg.
 PM0610;SPC MI C     -    97,734.994 5,840,105.658   MT  1.00000112 -1 24 45.5
 PM0610;UTM  16      - 4,891,888.539   550,644.965   MT  0.99963154 +0 26 29.6
 PM0610
 PM0610                          SUPERSEDED SURVEY CONTROL
 PM0610
 PM0610  NAD 83(1986)-  44 10 42.43156(N)    086 21 59.08087(W) AD(       ) 2
 PM0610  NGVD 29     -       198.8    (m)          652.     (f) GPS OBS
 PM0610
 PM0610.Superseded values are not recommended for survey control.
 PM0610.NGS no longer adjusts projects to the NAD 27 or NGVD 29 datums.
 PM0610.See file dsdata.txt to determine how the superseded data were derived.
 PM0610
 PM0610_MARKER: DD = SURVEY DISK
 PM0610_SETTING: 4 = SURROUNDED BY MASS OF CONCRETE
```

```
PM0610_STAMPING: MAGO
PM0610_MARK LOGO: NOS
PM0610_MAGNETIC: N = NO MAGNETIC MATERIAL
PM0610_STABILITY: A = MOST RELIABLE AND EXPECTED TO HOLD
PM0610+STABILITY: POSITION/ELEVATION WELL
PM0610_SATELLITE: THE SITE LOCATION WAS REPORTED AS SUITABLE FOR
PM0610+SATELLITE: SATELLITE OBSERVATIONS - 1993
PM0610
PM0610  HISTORY     - Date     Condition        Report By
PM0610  HISTORY     - 1993     MONUMENTED       NOS
PM0610
PM0610                          STATION DESCRIPTION
PM0610
PM0610'DESCRIBED BY NATIONAL OCEAN SERVICE 1993
PM0610'THE STATION IS LOCATED 4.0 MI (6.4 KM) WEST OF MANISTEE, MICHIGAN, IN
PM0610'THE NORTHWEST QUADRANT OF THE INTERSECTIONS OF COUNTY LINE ROAD AND
PM0610'RED APPLE ROAD.
PM0610'TO REACH FROM THE INTERSECTION OF U.S HIGHWAY 31 AND COUNTY LINE ROAD
PM0610'AT THE MANISTEE-MASON COUNTY LINE, GO WEST ON COUNTY LINE FOR 3.3 MI
PM0610'(5.3 KM) TO A ROAD RIGHT JUST BEFORE THE END OF THE PAVED ROAD
PM0610'SURFACE AND THE STATION ON THE RIGHT IN A GRASSY RIGHT OF WAY IN THE
PM0610'NORTHEAST QUADRANT OF THE INTERSECTION OF COUNTY LINE ROAD AND RED
PM0610'APPLE ROAD.
PM0610'THE STATION IS 43.0 FT (13.1 M) NORTH OF A DEAD END SIGN, 47.0 FT
PM0610'(14.3 M) NORTHWEST OF A STOP SIGN, 57.0 FT (17.4 M) WEST OF
PM0610'CENTERLINE OF RED APPLE ROAD AND 62.0 FT (18.9 M) NORTH OF CENTERLINE
PM0610'OF COUNTY LINE ROAD.

*** retrieval complete.
Elapsed Time = 00:00:02
```


PT1,3NW,14JUN05


PT2,3SE,23MAY05


PT3,3SE,24JUN05

P08,3E,30OCT03

P08,3W,30OCT03

P09,3E,30OCT03

P09,3N,30OCT03

P11A,3N,30OCT03

P11A,3S,30OCT03


P12,3E,30OCT03

P12,3S,30OCT03

ATTACHMENT R
REQUIREMENTS FOR DIGITAL PHOTOGRAPHS OF SURVEY CONTROL

TO
SCOPE OF WORK FOR
THE
COASTAL MAPPING PROGRAM

NATIONAL GEODETIC SURVEY
NATIONAL OCEAN SERVICE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE

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ATTACHMENT R - REQUIREMENTS FOR DIGITAL PHOTOGRAPHS OF SURVEY CONTROL

ATTACHMENT R: REQUIREMENTS FOR DIGITAL PHOTOGRAPHS OF SURVEY CONTROL

1. PURPOSE - This document describes digital photographic standards for images of survey marks that will be stored in the National Geodetic Survey (NGS) database and for other reconnaissance photographs (including photo ground control). Since many of these images will be in the NGS database and available to the public, the subject matter (survey equipment, personnel, background, etc.) shall be in good taste and professional in nature.

Digital photographs are useful for station (mark) reconnaissance, mark recovery, mark stability assessment, quality control, and as an aid during data processing and data verification. Some projects may require digital photographs during several stages of the project. Generally three photographs per station will be stored in the NGS database, which will make them accessible to future users. The table below summarizes the required photographs. Detailed descriptions of the photographs follow.

2. SURVEY MARK PHOTOGRAPHS - This section states the requirements for digital photographs of new and existing survey marks. For the requirements for reconnaissance photographs, including photo control points, runways, etc., see Section 3.

Take all photographs during daylight hours.

2.1. NUMBER OF SURVEY MARK PHOTOGRAPHS - At least three digital photographs are required for each mark recovered or described. This means marks for which a written, NGS format, digital description or recovery note was prepared. The three photographs are described as numbers: (1) extreme close-up, (2) eye-level (5-6 feet distant), and (3) horizontal view (approx. 10-30 feet distant). All three photographs require a digital caption and the correct file name. Photographs 2 and 3 require a **small, temporary sign** in the photograph. Use a small sign with large, clear letters (e.g. white board with dark marker). Ensure that the sign does not block the camera view of any portion of the mark, the monument, or any important feature.

REQUIRED PHOTOGRAPHS

All Marks Recovered and/or Described
1. Close-up (Taken Vertically; so stamping is legible)
2. Eye level (Taken Vertically; shows mark and area)
3. Horizontal view(s), mark in foreground, feature(s) in background

Take sufficient photographs to describe the stamping, appearance, condition, and location of the mark and points of potential interest including visibility obstructions, roads, runways, taxiways, or other dangers, any special set-up requirements, etc. Alter the orientation of the photographs as necessary to include this information in as few photographs as possible (For example, for a tall obstruction, rotate the camera 90 degrees so that the long axis of the image is vertical). Capture the tops of nearby obstructions, if possible. If a station already has acceptable photographs in the NGS database, additional photographs are not required, unless changes have occurred or more than one year has passed. An "acceptable photograph" is defined as an image that meets the requirements of this document, is of good visual quality, and that no changes have taken place that a new photograph would help clarify.

2.2. CAPTION - The photographer shall write a caption for each photograph and add the caption to the image. The block containing the caption shall not cover any portion of the mark, the monument, or any important feature. The caption should contain the following comma-separated information:

- Station designation (name),
- Station Permanent IDentifier (PID), for existing stations in the NGS database, leave blank if new station,
- Airport Location IDentifier (LID), if on airport, leave blank if not on airport,
- Photo number with cardinal direction (N, NE, E, SE, etc) that the camera is pointing, note, only photo #3 has a direction
- Station type (PACS, SACS, FBN, CBN), otherwise leave blank
- Date photo was taken (yyyymmdd).

SAMPLE CAPTION FOR NEW MARK

JONES, 2, 20040825

SAMPLE CAPTION FOR PHOTO CONTROL POINT

PH1,2,20040825

SAMPLE CAPTION FOR EXISTING PACS ON AIRPORT

SMITH, AB1234, LAX, 3N, PACS, 20040825

Note, the cardinal direction should not be included on photographs 1 and 2 since they were taken vertically. Do not leave blank spaces for missing data, see JONES example above with no PID, no LID, no station type, and no extra "commas".

The caption may be digitally captured on the image at the time of exposure or may be inserted later, off-line. Record at least the date on-line, if possible. If caption information is added later, take careful notes at the time of exposure to help ensure that the correct caption is added. **Note, the caption shall not obstruct any pertinent aspects of the station or surroundings.** To ensure that the letters of the caption are visible, use software to "erase" a rectangular area for the caption's lettering; see samples in section 2.3 and Attachment Q.

2.3. DESCRIPTION OF PHOTOGRAPHS:

A. CLOSE-UP - For survey marks, the first photograph (photo no.1) will be a close-up, taken vertically. It will be oriented downward to show the survey mark from directly above with the disk or logo cap nearly filling the image. The tripod shall not be in place when this photograph is captured. Brush any dirt or debris off the mark to show the disk. If it has a logo cap, the logo cap should be open. The intent of this photograph is to **clearly show the mark, its condition, and all stamping on the mark or logo cap so that it is clearly legible**. Use extra care to ensure that the stamping is clear. Suggestions: set the camera to its highest quality and resolution modes; **rub a yellow crayon across the stamping to highlight the letters;** set the camera to "macro" mode, if available; consider the minimum focusing distance of the camera (take test photographs to determine the minimum focusing distance and consult the camera owner's manual) ; and, if a flash is used, hold the camera above and off to the side so that the flash does not create a bright spot in the middle of the disk's image. Note, medium quality and resolution camera modes may be used for photographs other than the close-ups. If additional photographs are required, number these close-ups as 1A, 1B, etc. Rather than using a yellow builder's crayon, a white, non-toxic powder, such as talcum powder, may be used to highlight the stamping.

B. EYE-LEVEL - For survey marks, this photograph (photo no.2) will be oriented vertically downward from eye level to show the monument from directly above and cover an area about 1 meter in radius, all around the mark. The tripod shall not be in place when this photograph is captured. Brush any dirt or debris off the mark to show the disk and the setting. If it is a concrete monument, clear off debris to the edge of the monument. If it has a logo cap, the logo cap should be closed ~~open~~. **Include a small, temporary sign in this photograph with the station designation (name) printed so it is clearly visible in the photograph.** The intent of this photograph is to show the general condition of the mark and the immediate surrounding area. If additional photographs are required, number these eye-level photos as 2A, 2B...

C. HORIZONTAL VIEW(S) - For survey marks, take at least one additional, daylight photograph oriented near horizontal, and show the mark, with tripod and antenna (if possible), in the foreground, and the mark's identifying surroundings and any significant obstructions or possible sources of multi-path in the background. Show the top of nearby obstructions, if possible. Consider rotating the camera 90 degrees to use the long axis of the image to capture an entire obstruction. **Place a temporary sign in this photograph with the station designation (name) and the direction the camera is pointing, both printed so they are clearly visible in the photograph.** If additional photographs are taken, ideally move around the mark to locations which are 90 degrees apart (preferably cardinal directions). Name these photographs number 3XX, where the "XX" is the cardinal direction the camera is pointing, for example, 3N or 3NE.

3. RECONNAISSANCE PHOTOGRAPHS - Some, none, or all of the digital images described in this section may be required on a given project; refer to the Project Instructions. Each of these photographs requires a sign, a caption, and the correct file name. **The names for all of these files shall begin with "RE" to indicate reconnaissance.**

Required Item	Contents	Description
Sign in Photo	Name & Direction (unless vertical photo)	Place a sign in this photograph with the station designation (name) and the direction the camera is pointing, both printed so they are clearly visible in the photograph.
Digital Caption	Name, PID, LID, Number, Type, Date	See Section 2.2 above
Photo File Name	RE-PID-Name-Number-Date.jpg	See Section 4.4 below

All of the images required by this section shall be designated as reconnaissance (recon) with the letters “RE” at the beginning of their file names. Generally these recon images will not be loaded in the NGS data base but may be required for use during planning, review, etc. All reconnaissance photographs will have digital captions. These captions may be captured on the image or added later. Note, in these specifications, **“RE” stands for “REconnaissance”** and “R” stands for “Right” runway.

See the Project Instructions to determine which of the following are required:

3.1. PROPOSED LOCATIONS FOR MARKS - Take two photographs of each proposed permanent mark location. These may be one photo number 2 and one number 3, or two number 3 (3A and 3B), depending on which combination better shows the proposed mark location. Include a tripod, stake, sign, or other device showing the proposed mark location.

3.2. RUNWAY END PHOTOGRAPHS - Take at least three photographs at the end of each runway (including thresholds and stopways), as follows:

- Eye-Level (photo type #1) - photo from directly above the mark, showing about 1 meter in diameter,
- Approach (photo type #3) - photo showing tripod over mark in foreground and approach in background
- Across runway (photo type #3) - photo taken from the side of the runway looking across the end of the runway, with a tripod or arrow indicating the end point; include any features used to identify the runway end.

3.3. NAVIGATION AIDS (NAVAIDS) - Take photo(s) (type #3) of all NAVAIDS surveyed. Show the survey tripod in place to indicate the exact point surveyed, or if positioned remotely, add arrows and labels to the photograph indicating the horizontal and/or vertical point(s) surveyed.

3.4. DEPTH OF HOLE PHOTOGRAPHS - Take at least one photograph showing the hole dug or drilled for a concrete or rod mark. Place a measuring device (e.g., tape measure or level rod) in the hole, clearly showing the depth of the hole.

3.5. PHOTOGRAMMETRIC CONTROL POINTS AND CHECK POINTS - (Paneled and photo identified) **- Take two number 3 type photographs** of all photogrammetric control points clearly showing the point. These photos will be used later as an aid in identifying the point on the aerial photographs. Show the mark in the foreground and the nearest identifiable feature in the background. The two photographs should be taken from two different directions, ideally 90 degrees apart (such as from the East and the South). It may be helpful to have the survey tripod in the photograph.

3.6. OTHER REQUIRED PHOTOGRAPHS - as may be required by other instructions.

4. GENERAL:

4.1. IMAGE SIZE - Each image should be about 800 by 1000 pixels when submitted.

4.2. FILE SIZE - Maximum file size for each image is 500 KB, typical file size should be about 50 - 100KB.

4.3. IMAGE FORMAT - Store the digital photographs in JPEG format, approximately 50% reduction.

4.4. PHOTOGRAPH FILE NAME - Use the following file naming convention: “RE” (for reconnaissance photographs only), dash, the PID, dash, the station designator~~, dash, the PID,~~ dash, the photo number (1, 1A, 2, 3N, or 3NE, etc.), dash, date, dot, jpg. For new marks, there is no PID. Use a maximum of 30 alpha-numeric characters to the left of the dot.

Sample File Names

For new stations:	SMITH-3-date.jpg
For existing stations:	AB1234-JONES-1-date.jpg
For recon/photo control photos:	RE-MILLER-3N-date.jpg
For runway end point:	RE-LAX_CL_END_RWY_12R-3-date.jpg

For the runway end point example, “RE” = reconnaissance, dash, LAX = LID, dash, “CL END RWY 12R” = runway end point designator (CL = centerline, END = end, RWY = runway, 12 = runway number, and R = right (or C = center, or L = left), dash, “3" = photo number, and date. Note, “_” (underscores) used to fill blanks. Note, in these specifications, “RE” stands for “reconnaissance” and “R” stands for “right” runway (used if there is a parallel set of runways). Also, the LID may be four characters rather than just three.

The format for the date is: “yyyymmdd”, all numeric.

5. STORAGE MEDIUM - Submit all digital photos together on their own medium (CD or DVD), **not on the same medium with other types of data**. For airport work, submit all photos for a given airport in a subdirectory named for that airport.

*Acronyms:
PACS - Primary Airport Control Station
SACS - Secondary Airport Control Station
FBN - Federal Base Network
CORS - Continuously Operating Reference Station (Global Positioning System receiver)
CBN - Cooperative Base Network

ANNEX 1
INFORMATION SHEET FOR TAKING PHOTOGRAPHS OF SURVEY MARKS

EQUIPMENT REQUIRED:
CAMERA (WITH MEMORY CHIP, OR FILM FOR LATER SCANNING)
STIFF BRUSH TO CLEAN OFF MARK AND CLEAN LETTERING
SMALL SHOVEL OR SCRAPER TO CLEAN OFF MARK
YELLOW CONSTRUCTION CRAYON
WHITE BOARD WITH DARK MARKER
WEED WACKER (OR OTHER CUTTING DEVICE) TO CUT BACK GRASS AND WEEDS
COMPASS TO DETERMINE DIRECTIONS

PHOTO #1 - CLOSE-UP:
- SET CAMERA TO HIGH RESOLUTION,
- SET CAMERA TO MACRO MODE (IF AVAILABLE),
- DETERMINE MINIMUM FOCUS DISTANCE,
- SET CAPTION OR DATE INTO CAMERA, IF POSSIBLE,
- THOROUGHLY CLEAN OFF TOP OF MARK (INCL. LOGO CAP, CONCRETE, ETC.),
- THOROUGHLY CLEAN LETTERING (DISK OR LOGO CAP),
- CUT BACK GRASS AND WEEDS, AS REQUIRED,
- REMOVE SURVEY TRIPOD,
- OPEN LOGO CAP,
- RUB YELLOW CRAYON ACROSS STAMPING,
- ORIENT CAMERA VERTICALLY, AT APPROX. MINIMUM FOCUS DISTANCE,
- COMPOSE TO INCLUDE ENTIRE DISK, OR TOP OF ROD AND LOGO CAP STAMPING,
- EXPOSE PHOTOGRAPH IN MID-AM OR MID-PM, IF POSSIBLE, TO OBTAIN GOOD LIGHTING OF THE STAMPING
- NOTE, IF FLASH IS REQUIRED, MOVE CAMERA SLIGHTLY OFF CENTER TO MINIMIZE REFLECTION.

PHOTO #2 - EYE LEVEL
- SET CAMERA TO NORMAL RESOLUTION,
- SET CAMERA TO NORMAL MODE (NOT MACRO),
- SET CAPTION OR DATE INTO CAMERA (IF AVAILABLE),
- IF NOT ALREADY DONE, CLEAN OFF MARK AND STAMPING,
- CUT BACK GRASS AND WEEDS, AS REQUIRED,
- REMOVE SURVEY TRIPOD,
- WRITE STATION NAME ON SIGN AND PLACE NEAR (NOT ON) MARK,
- CLOSE LOGO CAP,
- ORIENT CAMERA VERTICALLY AT EYE LEVEL,
- COMPOSE WITH ENTIRE MONUMENT AND AREA AROUND MARK APPROX. 1 M. IN RADIUS,
- EXPOSE PHOTOGRAPH.

PHOTO #3 - HORIZONTAL VIEW(S)
- SET CAMERA TO NORMAL RESOLUTION,
- SET CAMERA TO NORMAL MODE (NOT MACRO),
- SET CAPTION OR DATE INTO CAMERA (IF AVAILABLE),
- IF NOT ALREADY DONE, CLEAN OFF MARK AND STAMPING,
- CUT BACK GRASS AND WEEDS, AS REQUIRED,
- SET-UP SURVEY TRIPOD OVER MARK,
- WRITE STATION NAME AND CAMERA DIRECTION ON SIGN AND PLACE NEAR MARK,
- CLOSE LOGO CAP,
- ORIENT CAMERA HORIZONTALLY AT EYE LEVEL,
- COMPOSE TO INCLUDE MARK, AND IDENTIFYING SURROUNDINGS, ANY OBSTRUCTIONS OR POSSIBLE SOURCES OF MULTI-PATH,
- EXPOSE PHOTOGRAPH.

Version 8A
February 5, 2008

ATTACHMENT S
WRITING STATION DESCRIPTIONS
AND RECOVERY NOTES
~~WITH WDDPROC~~

TO
SCOPE OF WORK FOR SHORELINE MAPPING
UNDER THE
NOAA COASTAL MAPPING PROGRAM

REMOTE SENSING DIVISION
NATIONAL GEODETIC SURVEY
NATIONAL OCEAN SERVICE
NATIONAL OCEANIC & ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE

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ATTACHMENT S: WRITING STATION DESCRIPTIONS AND RECOVERY NOTES ~~WITH WDDPROC~~

Descriptions are one of the end products of surveying, along with the positions and the survey marks themselves. All three shall be of highest quality. The descriptions must be complete, accurate and in standardized format if the station is to be reliably and easily recovered for use in the future. Descriptions shall be in the standard NGS format of three paragraphs as described in Section 2 -Description Format-.

1. GENERAL

1.1 DEFINITION OF DESCRIPTION VS. RECOVERY NOTE

A. A *description* details the location of a new survey mark, or one not previously in the NGS digital database.

B. A *recovery note* is an update and/or refinement to a description already in the NGS digital database, written upon a return visit to a survey mark.

1.2 LEVELS OF COMPLEXITY OF RECOVERY NOTES

A. No Changes - If an existing stations digital description is complete, accurate, and meets Blue Book requirements, the station may be recovered with a brief recovery note, such as -RECOVERED AS DESCRIBED-.

B. Minor Changes - If minor changes or additions to the description are required, they may be added after the above phrase, such as -RECOVERED AS DESCRIBED, EXCEPT A NEW WOODEN FENCE IS NOW 3 METERS NORTH OF THE STATION-. See typical cases listed in Section 1.5 A.

C. Major Changes - Where major changes have occurred, major inaccuracies are found, or where required information is missing (in any portion of the description), a complete three-paragraph recovery note, with the same format as a new description, is required. If a measurement discrepancy is found, state that the new distance was verified, for example, by taping in both English units and metric units or by two separate measurements by two different people. See typical cases in Section 1.5 B.

D. Exemption - If a recovery note has been written for the station within one year and no changes have taken place, a new recovery note is not required. Note, this may cause an error message in the description checking software, which may be ignored.

1.3 SOFTWARE - Descriptions and Recovery notes must be properly encoded into a D-file by using software WinDesc or WDDPROC. For WinDesc information see: http://www.ngs.noaa.gov/PC_PROD/pc_prod.shtml#WinDesc . Also refer to the NGS Web site: http://www.ngs.noaa.gov/FGCS/BlueBook/, Annex P (Geodetic Control Descriptive Data), for information. Note: WinDesc or WDDPROC may be used for both new Descriptions and for Recovery Notes.

For projects that have no new marks and are not being -blue-booked-, the NGS on-line recovery method may be used to submit Recovery Notes, see: http://www.ngs.noaa.gov/ngs-cgi-bin/recvy_entry_www.prl . Submit paper copies (with the final report) for any recovery notes submitted on-line.

1.4 CHECKING - Descriptions shall be written by one person and checked by another. Recovery notes should also be checked. For example, a mark setter can draft a description immediately after setting the mark, and an observer can check the description during observations. For existing marks, the reconnaissance person can draft the recovery note and the observer can check it. Descriptions and Recovery Notes should be written while at the station or immediately after visiting a station so that all details are fresh in the writers mind.

1.5 TYPICAL RECOVERY NOTE CASES

A. A brief, one or two sentence Recovery Note is adequate:

i. When the mark is found and the description is completely accurate, sample: (-RECOVERED AS DESCRIBED-),
ii. When the mark is found and there are one or two minor changes, (-RECOVERED AS DESCRIBED EXCEPT A NEW WOODEN FENCE IS NOW 3 METERS NORTH OF THE STATION-),
iii. When the mark is not found, (-MARK NOT FOUND AFTER 3 PERSON-HOUR SEARCH-),
iv. When the mark is not found and presumed destroyed, (-MARK NOT FOUND AND PRESUMED DESTROYED. CONSTRUCTION FOREMAN STATES THAT THE MARK WAS DESTROYED YESTERDAY-),
v. When the mark is found destroyed, (-THE MARK IS DESTROYED AND THE DISK HAS BEEN SENT TO NGS-or -THE MARK IS DESTROYED AND ITS PHOTOGRAPH HAS BEEN SENT TO NGS-). Note, for a station to be considered destroyed by NGS, the disk or photograph showing the destroyed mark must be received by NGS.

B. A complete, new, three-paragraph Description/Recovery Note is required:

i. When a new mark is set,
ii. When an existing mark does not have a PID,
iii. When an existing mark does not have an NSRS digital description (i.e., description is not in the NGS database),
iv. When an existing mark has only a brief description not meeting the three-paragraph requirement (many bench marks have only short, one-paragraph descriptions),
v. When an existing marks description is no longer accurate or complete.

2. DESCRIPTION FORMAT

The original USC&GS Special Publication No. 247, MANUAL OF GEODETIC TRIANGULATION, page 116, states, -A description must be clear, concise, and complete. It should enable one to go with certainty to the immediate vicinity of the mark, and by the measured distances to reference points and the description of the character of the mark, it should inform the searcher of the exact location of the mark and make its identification certain. It should include only essential details of a permanent character.- NGS still follows these guidelines, so that a person with a minimal background in surveying and no local geographic or historical knowledge can easily find the mark by logically following the text of the description.

2.1 FIRST PARAGRAPH - The **first paragraph** is the *description of locality*. This part of the description begins by referring to the airline distance and direction (cardinal or inter-cardinal point of the compass) from the **three** nearest well-known mapped geographic feature(s), usually the nearest cities or towns. Use three references equally spaced around the horizon, if possible. **In writing the Description, always progress from the farthest to the nearest reference point**. Distances in this part of the description shall be in kilometers (followed by miles), or meters (followed by feet), all distances to one decimal place. Detailed measurements which appear elsewhere in the description should not be repeated in this paragraph. Points of the compass should be fully spelled out. Do not use bearings or azimuths. State the name, address, and phone number of public sector property owners (however, phone numbers of private property owners are NOT included). State any advance notice and security access requirements for reaching the station. Also state any unusual transportation methods that may be required to reach the station.
Sample first paragraph:

> STATION IS LOCATED ABOUT 12.9 KM (8.0 MILES) SOUTHWEST OF EASTON, ABOUT 6.4 KM (4.0 MILES) NORTHWEST OF CAMBRIDGE, AND ABOUT 3.6 KM (2.2 MILES) EAST OF SMITHVILLE ON PROPERTY OWNED BY MR. H.P. LAYTON, AND KNOWN AS OLD GOVERNOR JACKSONS ESTATE.

2.2 SECOND PARAGRAPH - The **second paragraph** contains the *directions **to reach** the station.* This section is one of the most useful parts of a description. It usually enables a stranger to go directly to a station without a delay due to a detailed study of maps or of making local inquiries. It is a route description which should start from a definite point, such as (a) the nearest intersection of named or numbered **main** highways (ideally Interstate and U.S. highways, or at least those which are shown on commonly used road maps), and approximately where that intersection is, or (b) some definite and well-known geographical feature (e.g. main post office or county courthouse) and give its name and general location. Odometer distances shall be given to tenths of kilometers (followed by tenths of miles). For roads with names and numbers, give both in the first occurrence.

A. The format for the first leg of the -To Reach- is:
- i. FROM THE MAIN POST OFFICE IN DOWNTOWN SMITHVILLE, or FROM THE INTERSECTION OF INTERSTATE XX AND STATE HIGHWAY YY, ABOUT 4.8 KM (3 MILES) NORTH OF SMITHVILLE;
- ii. GO A DIRECTION (north, northeast, northerly, northeasterly, etc.);
- iii. ON A ROAD (name or number of road or highway);
- iv. FOR A DISTANCE (km followed by miles in parentheses);
- v. TO SOMETHING (intersection, or fork in road, or T-road left or T-road right).

B. The format for all other legs:

i. TURN LEFT OR RIGHT, OR TAKE RIGHT OR LEFT FORK, OR CONTINUE STRAIGHT AHEAD;
ii.GO A DIRECTION (north, northeast, northerly, northeasterly, etc.),
iii. ON ROAD (name of road or highway);
iv. FOR A DISTANCE (km followed by miles in parentheses);
v. TO SOMETHING (intersection, or fork in road, or side-road left or right, or station on left or right).

All five parts of each leg shall be included in each -To Reach-.

Sample:

TO REACH THE STATION FROM THE INTERSECTION OF INTERSTATE 300 AND MAIN STREET (STATE HIGHWAY 101) IN JONESVILLE, GO EASTERLY ON HIGHWAY 101 FOR 3.7 KM (2.3 MILES) TO AN INTERSECTION. TURN RIGHT AND GO SOUTH ON MILLER ROAD FOR 5.1 KM (3.2 MILES) TO A SIDE-ROAD RIGHT. CONTINUE SOUTH ON MILLER ROAD FOR 6.6 KM (4.1 MILES) TO AN INTERSECTION. TURN LEFT AND GO EASTERLY ON SMITH ROAD FOR 2.4 KM (1.5 MILES) TO STATION ON THE LEFT IN THE FENCE LINE.

Use the word –EAST- if the road goes due east and –EASTERLY- if the road wanders in a general easterly direction. Use intermediate references, such as Miller Road above, if the distance becomes longer than about 5 miles. The place at the end of truck travel should be mentioned. If walking is required, note the approximate time required for packing. If travel to the station is by boat, the place of landing should be stated.

2.3 THIRD PARAGRAPH - The **third paragraph** provides *details of the mark and reference measurements*. It is made up of six parts:

(A) The station mark type;
(B) How the mark is stamped;
(C) How the mark is set;
(D) Reference measurements;
(E) The handheld GPS position; and
(F) PACS or SACS designation, if appropriate.

These sections are not numbered in the description, but shall be in the stated order with the stated information.

SECTION	EXAMPLE
(A) - State what the mark is:	THE MARK IS AN NGS HORIZONTAL DISK, OR A USC&GS TRIANGULATION DISK, OR A STAINLESS STEEL ROD, OR A CHISELED –X-, ETC.),
(B) - State how the mark is stamped (in dashes):	STAMPED --JONES 1952--.

(C) - State how and in what the mark is set:	THE MARK IS SET IN A DRILL HOLE IN BEDROCK, OR SET IN A SQUARE CONCRETE MONUMENT, OR IS A ROD DRIVEN TO REFUSAL, ETC. A GREASE-FILLED SLEEVE ONE M LONG WAS INSTALLED.

The description shall specify whether the rod was driven to refusal or whether it met the slow driving rate (this is specified in Attachment V, Section 4.0 as 60 seconds per foot or 90 feet). Also state if a grease-filled sleeve was installed and its length. For a rod mark, the diameter of the stainless steel rod and the diameter of the PVC pipe with the aluminum cap should be in English units, and the length of the plastic sleeve should be given in metric units only.

- State if the mark projects above the ground, is flush, or is recessed and the amount, (for a rod mark state the above for both the rod and the logo cap):	MARK PROJECTS 15 CM (5 IN), OR MARK IS FLUSH WITH THE GROUND, OR MARK IS RECESSED 20 CM (8 IN); OR LOGO CAP IS FLUSH WITH THE GROUND AND TOP OF ROD IS 10 CM (3.9 IN) BELOW THE TOP OF THE LOGO CAP,
- State the depth of the mark, if known:	CONCRETE MONUMENT, 1.2 M (4 FT) DEEP, OR, ROD DRIVEN TO REFUSAL AT 15 M (49 FT)
(D) - State reference distances and directions from three or more permanent objects in the marks immediate vicinity (farthest to nearest):	IT IS 20.7 M (67.9 FT) SOUTHWEST OF POWER POLE #2345, 15.2 M (49.9 FT) WEST OF THE EDGE OF HIGHWAY 134, AND 3.4 M (11.1 FT) NORTH OF A FENCE LINE.

Examples of objects used as references: existing reference marks, witness posts, center lines of roads, edges of runways, ditches, power or telephone poles, or buildings. Start with the farthest distance. Horizontal distances should be used. If slope distances were measured, that fact should be stated in the paragraph. The distances shall be in meters (followed by English measurement units in parentheses, except as noted in (C) above), and the directions shall be cardinal and inter-cardinal directions, fully spelled out, such as –NORTH-, -NORTHEAST-, or -NORTH-NORTHEAST-. Magnetic bearings from the reference objects are recommended to assist in future recoveries.

(E) Provide a handheld GPS position for all new and recovered marks, and for all proposed mark locations. Include the handheld GPS position in both the scaled position field (in the top portion of the digital description) and in the text, described hereafter. In the text, include the position and the accuracy code of HH1 or HH2, depending on the type of receiver used. HH1 stands for Hand-Held accuracy code 1 (differentially corrected, hand-held GPS), and HH2 stands for Hand-Held accuracy code 2 (stand-alone, hand-held GPS), as follows:

Accuracy code 1 (HH1) = ± 1-3 meters
Accuracy code 2 (HH2) = ± 10 meters

GPS Data Formats:

CODE	LATITUDE	LONGITUDE	SECOND PLACES
HH1	NDDMMSS.ss	WDDDMMSS.ss	(2 places of seconds)
HH2	NDDMMSS.s	WDDDMMSS.s	(1 place of seconds)

Use –N- or –S- for latitude and –W- or –E- for longitude. Use three digits for the degrees of longitude.

(F) If the station is a Primary or Secondary Airport Control Station mark, the third paragraph shall end with the appropriate designation of Primary or Secondary Airport Control Station):

THIS STATION IS DESIGNATED AS A PRIMARY AIRPORT CONTROL STATION.

Sample for a rod mark:

THE STATION IS THE TOP-CENTER OF A 9/16 INCH STAINLESS STEEL ROD DRIVEN TO REFUSAL DEPTH OF 18M. THE LOGO CAP IS STAMPED --SMITH 2003--. THE LOGO CAP IS MOUNTED ON A 5 IN DIAMETER PVC PIPE. A ONE METER LONG GREASE-FILLED SLEEVE WAS INSTALLED. LOGO CAP IS FLUSH WITH THE GROUND AND TOP OF ROD IS 10 CM (3.9 IN) BELOW THE TOP OF THE LOGO CAP. THE MARK IS 32.4 METERS (101.74 FEET) NORTHEAST OF NORTHEAST CORNER OF THE HOUSE, 16.62 METERS (54.5 FEET) NORTH OF WATER PUMP ALONGSIDE OF HEDGE AROUND OLD FLOWER GARDEN, AND 4 METERS (12.96 FEET) NORTH OF NORTHEAST CORNER OF HIGH HEDGE ENCLOSING OLD FLOWER GARDEN. THE HH1 GPS IS: N304050.2, W1201020.4.

Sample for a concrete monument:

THE STATION IS AN NGS HORIZONTAL DISK, STAMPED --JONES 2003-- SET IN A ROUND CONCRETE MONUMENT 1.2 M (4 FT) DEEP AND 0.3 M (12 IN) IN DIAMETER. IT IS SET FLUSH WITH THE GROUND. IT IS 32.4 METERS (101.74 FEET) NORTHEAST OF NORTHEAST CORNER OF THE HOUSE, 16.62 METERS (54.5 FEET) NORTH OF WATER PUMP ALONGSIDE OF HEDGE AROUND OLD FLOWER GARDEN, AND 4 METERS (12.96 FEET) NORTH OF NORTHEAST CORNER OF HIGH HEDGE ENCLOSING OLD FLOWER GARDEN. THE HH1 GPS IS: N304050.2, W1201020.4.

3. IMPORTANT POINTS REGARDING DESCRIPTIONS

3.1 NAMES - Use the station designation (name) and PID, exactly as listed in the NGS database, in all survey records. Do not add dates, agency acronyms, or other information to the name, nor the stamping. Note, frequently the stamping and the official station designation are not the same. For example, stampings include the year set, but designations generally do not.

3.2 TERMINOLOGY - Correct NGS survey terminology shall be used in all station descriptions and reports (see GEODETIC GLOSSARY, NGS, 1986).

3.3 DISTANCES - All measurements are assumed to be horizontal unless labeled –slope-.@ Distances measured from a line (e.g., the center-line of a road or a fence line) are assumed to be measured perpendicular to that line. The origin of measurements at the junction of two roads is assumed to be the intersection of center-lines of both roads. Measurements are assumed to be from the center of an object (i.e. power pole) unless stated otherwise.

3.4 REPAIR - Any work done to repair a mark shall be described completely in the updated recovery note. Note: a repair strengthens the mark but must not change its position. For example, adding concrete or epoxy around a disk where some is missing is a repair.

3.5 REFERENCE MARK NAMES - Note, reference marks are abbreviated -RM x- in descriptions, but on -Reference Mark- disks they are stamped -NO. X-. Also, some reference marks and some azimuth marks have their own PID.

3.6 WCHKDESC - Run the digital D-file through the WCHKDESC program (field-level option), one of several programs within the WDDPROC Software Suite, to identify format and coding errors. This program is accessed by (a) running the WDDPROC program and (b) selecting the option, WCHKDESC, from the main menu.

3.7 METRIC CONVERSION - Use 3.2808333333 feet equals one meter.

3.8 ABBREVIATIONS - Meter = M, kilometer = KM, centimeter = CM, mile = MI, nautical mile = NM, feet = FT, inch = IN.

4. THE WDESC PROGRAM

4.1 GENERAL - The WDESC program, one of several programs within the WDDPROC Software Suite (available over the Web at http://www.ngs.noaa.gov/PC_PROD/DDPROC4.XX/ddproc.index.html), is used to encode descriptions and recovery notes in D-FILE format for the loading of these descriptions into the NGS database. The NGS Blue Book and the WDESC documentation contain information for properly encoding descriptions. Helpful information is contained in the following paragraphs.

4.2 BACKUP FILE - When creating a description file, a backup file is automatically created. Every time a few descriptions are entered, it would be best if they are checked with WCHKDESC and the file corrected. The backup should be renamed **before** reopening the program or it will be overwritten. Always exit from the WDESC program from the pull-down File, option Exit. It is recommended to save the description file as a new filename every time the program is exited; saving after each description is entered is also recommended.

4.3 GPS OBSERVATIONS - Remember to enter –Y- into the satellite usage code field in the *Header Record* if the mark is suitable for GPS observations.

4.4 SETTING CONDITION CODES - Set the *condition code* on the *Description Header* form as described in **<u>The Description Processing Handbook, Chapter 1, D-FILE Format (for Both Microsoft Windows 95/98/NT and UNIX): The Format of a Description File (D-FILE)</u>**, which is available on the Web by downloading dformat.htm from Section 4 of the WDDPROC page **(**http://www.ngs.noaa.gov/PC_PROD/DDPROC4.XX/ddproc.index.html).

4.5 SPACING - Three separate paragraphs are required in the descriptive text field since they make the description much easier to read. Therefore, when entering the text into the *Description Header* form using the WDESC program, separate each paragraph by pressing the [ENTER] key on the keyboard to add a blank line at the end of the first paragraph.

4.6 FLUSH, PROJECTED, RECESSED - The FPR code is a field on the *Description Header* form in the WDESC program. Set the –FPR- field in the Description Header form to –F-, -P-, or –R-, for Flush, Projected, or Recessed, respectively. In the description, include the logo cap relationship to the ground surface (projecting above, flush with, or recessed below), and include the distance that the top of the rod is below the top of the logo cap. It is important to include information regarding the exact placement of the logo cap for future reference.

4.7 AGENCY CODES - A list of the proper agency codes for the WDDPROC Software Suite can be found on the NGS Web site in WDDPROC ANNEX C (http://www.ngs.noaa.gov/FGCS/BlueBook/annexc/annexc.index.html). The agency code to be used for marks that are set by the National Geodetic Survey is NGS. The agency code for marks set by the USC&GS is CGS. Contractors shall use the code assigned to their company. If a contractor does not have a code, a request for one should be emailed to: Burt.Smith@noaa.gov.

<u>5. MARK TYPES</u>

5.1 CONCRETE MARK - For a concrete mark set in accordance with the requirements of Attachment T, use a **setting code** of -07-. This classifies the station with a default **vertical stability code** of –C-.

5.2 ROD MARK GREATER THAN 4 METERS - For an NGS 3-D stainless steel rod mark driven to a depth of 4 meters or GREATER, use a **monumentation code** of –F- and a *setting code* of -59-. This classifies the station with a default **vertical stability code** of –A-. Note, if the standard one meter plastic sleeve is used, the vertical stability code must be downgraded to –B-.

5.3 ROD MARKS LESS THAN 4 METERS - **ARE GENERALLY NOT ACCEPTABLE**, see -Geodetic Bench Marks-, page 27, Table 3.

5.4 DISK IN ROCK OUTCROP - For a disk that is set in solid rock outcrop, use a **monumentation code** of –DH- or –DD- and a **setting code** of -66-. This classifies the station with a default **vertical stability** code of –B-.

Check the listing of valid **monumentation codes** and **setting codes** in **The Description Processing Handbook, Chapter 1, D-FILE Format (for Both Microsoft Windows 95/98/NT and UNIX): The Format of a Description File (D-FILE),** which is available on the Web in Annex P of the blue book, see: http://www.ngs.noaa.gov/FGCS/BlueBook/ for the proper codes to use for other types of marks.

Again, refer to the complete directions available at the Web site for using the ~~NGS~~ software packages WinDesc or WDDPROC to write the required station descriptions, and be sure to check your final product with WCHKDESC.

Version 2
September 30, 2004

ATTACHMENT T
CONCRETE MARKS

TO
SCOPE OF WORK FOR SHORELINE MAPPING
UNDER THE
NOAA COASTAL MAPPING PROGRAM

REMOTE SENSING DIVISION
NATIONAL GEODETIC SURVEY
NATIONAL OCEAN SERVICE
NATIONAL OCEANIC & ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE

TABLE OF CONTENTS

ATTACHMENT T: CONCRETE MARKS

(From NGS OPERATIONS HANDBOOK and
MANUAL OF GEODETIC TRIANGULATION, S.P. 247)

1. CONCRETE CHARACTERISTICS

1.1 GENERAL - Concrete should have properties that make it workable, strong and durable. Workability refers to the ease with which concrete can be effectively placed, consolidated, and finished, while remaining free from segregation. Workability depends on the proportions of the ingredients and the shape of the individual particles of aggregate. Strength refers to the ability to withstand external forces without rupturing. For survey monuments, high strength is not the most important property, although strong concrete usually indicates that it is durable. Durability is the ability to withstand deterioration over a long time and is primarily influenced by the watertightness of the cured concrete.

1.2 DESTRUCTIVE FORCES - Several forces can lead to the weakening or deterioration of concrete. The freezing of water in cured cement exerts great pressure against the inner walls of the pores, tending to break down the concrete. In fresh concrete, the expansion of freezing water breaks the bonds developing between solid particles, making the concrete weak and porous. Leaching and chemical attack also have detrimental effects on concrete. Leaching occurs over a long period when water slowly percolates through concrete and dissolves some of its constituents. Chemical attack is particularly common in alkali soils. Dense, impervious concrete is resistant to these destructive forces.

1.3 INGREDIENTS - The quality of the ingredients and their proportions help determine how dense and impervious the cured concrete will be. The ingredients include aggregate, cement, and water. The aggregate should be clean (free from silt and clay, harmful chemicals, and organic matter) and well-graded, i.e., it contains proportionate amounts of many particle sizes. In specifying mix proportions the aggregate is usually divided into two parts -- sand (particle size less then 2/3 cm) and gravel (particle size greater than 2/3 cm). Both parts should be well-graded. Aggregates that are porous, split easily, or are otherwise weak or permeable result in poor concrete. Examples of poor aggregates include shale, claystone, sandstone, and micaceous rocks.

Portland cement is designated by one of five types. Type I is for general use where no special properties are needed. Type III is a high-early-strength type for use when concrete will be curing during cold weather. Type V is used where the concrete will be subject to an alkali environment. Types II and IV are not suited for setting marks. Local concrete companies should be contacted to determine the best concrete type to use in the work area.

The water used in a concrete mix should be relatively free of impurities such as acids, alkalis, salts, oil, organic matter, and silt. These can decrease the strength and durability of cured concrete. As a rule, do not use water that you would not drink.

1.4 MIXING, PLACING, AND CURING - Pre-mixed concrete materials may be used. If raw materials are used, the suitable proportions (by bulk volume) of cement to sand to gravel are 1:2:3. If the gravel is made up of fragmented or angular particles, use a little less gravel and proportionately more sand. Add only enough water to make the mix workable. About half the water added to the mix is used in the chemical reaction (hydration) that causes the paste to harden into binder. If too little water is used, however, the mix will not compact properly and spaces will be left in the mass. **A good indication of the right amount of water is that the mix neither runs nor falls off the shovel but sluggishly slides off and flattens upon hitting the ground**.

1.5 COLD WEATHER PRECAUTIONS - The freezing of fresh concrete has a damaging effect because the expansion of water as it freezes separates the solid particles in the mix. This reduces the strength of the bond and makes the concrete more porous and correspondingly less durable.

Three protective measures should be taken in cold weather, either singly or in combination. First, use warm ingredients. During the first 24 hours after a mix has been placed, it develops little heat of its own to prevent freezing. After 24 hours some heat is developed as a product of the chemical reactions occurring in the mix. The use of warm ingredients is especially beneficial during the first 24 hours. Note, however, that mixing water above 165 degrees F could cause a flash set. To keep the aggregate and cement warm, store them indoors.

Second, use Type III (high-early-strength) cement or special additives that speed curing. Calcium Chloride is good for this in amounts not exceeding 2 pounds per 94-pound sack of cement. The Calcium chloride should be dissolved in the mixing water instead of mixing it with the other ingredients. Other additives include Thoroguard and Trimix. If a large number of concrete marks are being installed by mass production using a "ready-mix" contractor, fast-curing additives should not be added until the concrete is delivered on site.

Third, insulate the finished mark for a week after the concrete is poured. One method is to cover the mark with boards resting on supports. This is covered with paper or plastic, then by a layer of straw, Styrofoam, or similar insulating materials above 15 centimeters thick and finally by a layer of soil 15 to 30 centimeters thick. Pile snow loosely on top if it is available.

2. CONCRETE MONUMENTS (Note: portions of this paragraph apply to concrete collars around rod marks as well as to concrete monuments.)

2.1 STEPS:

1. Obtain property owner permission prior to proposing new mark locations.

2. Install a tall stake (lath) at each proposed site for a new mark. Write the proposed station name on the stake.

3. Obtain clearance from "MISS UTILITY" type services (underground utilities) before digging.

4. Drill or dig a 12 - 14 inch diameter hole in the ground 4.0 to 8+ feet deep. The depth depends on frost penetration in that area. The minimum depth is 4.0 feet. Keep the sides of the hole as smooth as possible. The rounded, bottom portion of the monument must extend at least one foot below the frost line. See NOAA Manual NOS NGS1, *Geodetic Bench Marks* which contains a diagram showing average frost line depth.

5. Enlarge the bottom portion of the hole using a shovel such as a "sharp-shooter" (also called "drain spade") so that the hole is at least 2 inches larger in radius than the main shaft of the hole. This will make the bottom of the monument bell-shaped; see diagram.

6. Remove or tamp down the loose dirt at the bottom of the hole.

7. Remove any loose dirt that might fall into the hole during concrete installation. A layer of loose dirt from the sides or top of the hole, mixed with the concrete will create a fracture line (or plane) which could lead to the monument breaking, thus destroying the mark.

8. Procure a round, cardboard form 12 inches in diameter to line the top 12 - 18 inches of the hole. Test fit the form in the top of the hole. This form will help avoid any shoulders or mushrooming effect near the top of the monument which might afford purchase for frost heave. The form will also help make a neater looking monument. A cardboard, biodegradable, 12-inch diameter form is commercially available. Allow the form to protrude from the ground 2 - 6 inches.

9. Mix the concrete well before it is placed, otherwise the minute particles of cement will not be sufficiently wet and the aggregate will not be completely covered with paste. Prior to adding water, mix the ingredients well. Then, slowly add water and continue to mix. Do not make the mixture too wet.

10. Dampen the hole before concrete is added so moisture will not be drawn from the fresh concrete into the surrounding soil. In no case should it be so wet as to be muddy

11. Place concrete in the hole. Continuously tamp the mix into a compact mass so it becomes less pervious and consequently more durable. Do not contaminate the interior of the monument with dirt.

12. Place the form into the hole when the level of the concrete is approximately one foot below the surface. Continue to be careful not to allow any dirt to fall into the hole.

13. Add concrete until the top is even with or slightly below the surface of the ground. This helps ensure that the monument is not struck by lawn mowers or snow plows, etc.

14. Smooth off the top of the monument with a trowel. Create a gentle slope towards the outside so that rain water will drain off. Bevel the outside edge of the monument.

15. Stamp the disk prior to installing it in a concrete monument or a drill hole. Stamp the disk on a stamping block which has a curved surface that matches the curvature of the underside of the disk. Neatly stamp the station designation (name) above the triangle, centered below "HORIZONTAL CONTROL MARK" and then stamp the year below the triangle, centered above "THE DIRECTOR".

16. Set the disk into position in the top center of the monument with the top of the triangle below the name pointing north (so that a visitor facing north will be able to read the disk's lettering). Placing a small amount of concrete on the underside of the disk before setting helps ensure that air is not trapped under the disk.

17. Press the disk into the concrete until the disk edge touches the concrete. Then tap the disk with the handle end of the trowel **until the top edge of the disk is flush with or slightly recessed into the concrete** (to the point that vandals can not get a pry bar under the disk). Do not recess the disk a greater amount because this makes a hollow that will collect rainwater and possibly shorten the life of the mark due to freezing action.

18. Clean the disk. Sprinkle some dry cement on the exposed surface of the disk, then rub it with a clean rag or short bristled brush using circular strokes. This will clean the disk, removing all excess mortar from its surface and recessed letters. Rubbing the wet mortar around the edge of the disk in the same manner is done intentionally to finish its surface and help prevent cracking. Brush away loose cement and make sure that the finished product has a neat appearance.

19. Cover the mark for at least 7 days. This prevents rain from making the mix too wet and from ruining the finished surface. It also prevents the surface from drying too rapidly, leaving too little water for complete hydration. In addition, it prevents debris from sticking to the surface of the wet concrete. A 12 inch diameter lid is available that fits on the 12 inch cylindrical form. This lid will also keep out the dirt during the next step and final clean-up.

20. Replace dirt around the form and tamp into place. At the surface, replace dirt and sod around the form and tamp into place.

21. Rake the area until neat and remove excess materials. Do not leave any construction or other materials at the site. Leave the area as neat as or neater than when you arrived. Note: the protruding form and lid shall be removed later during survey observations.

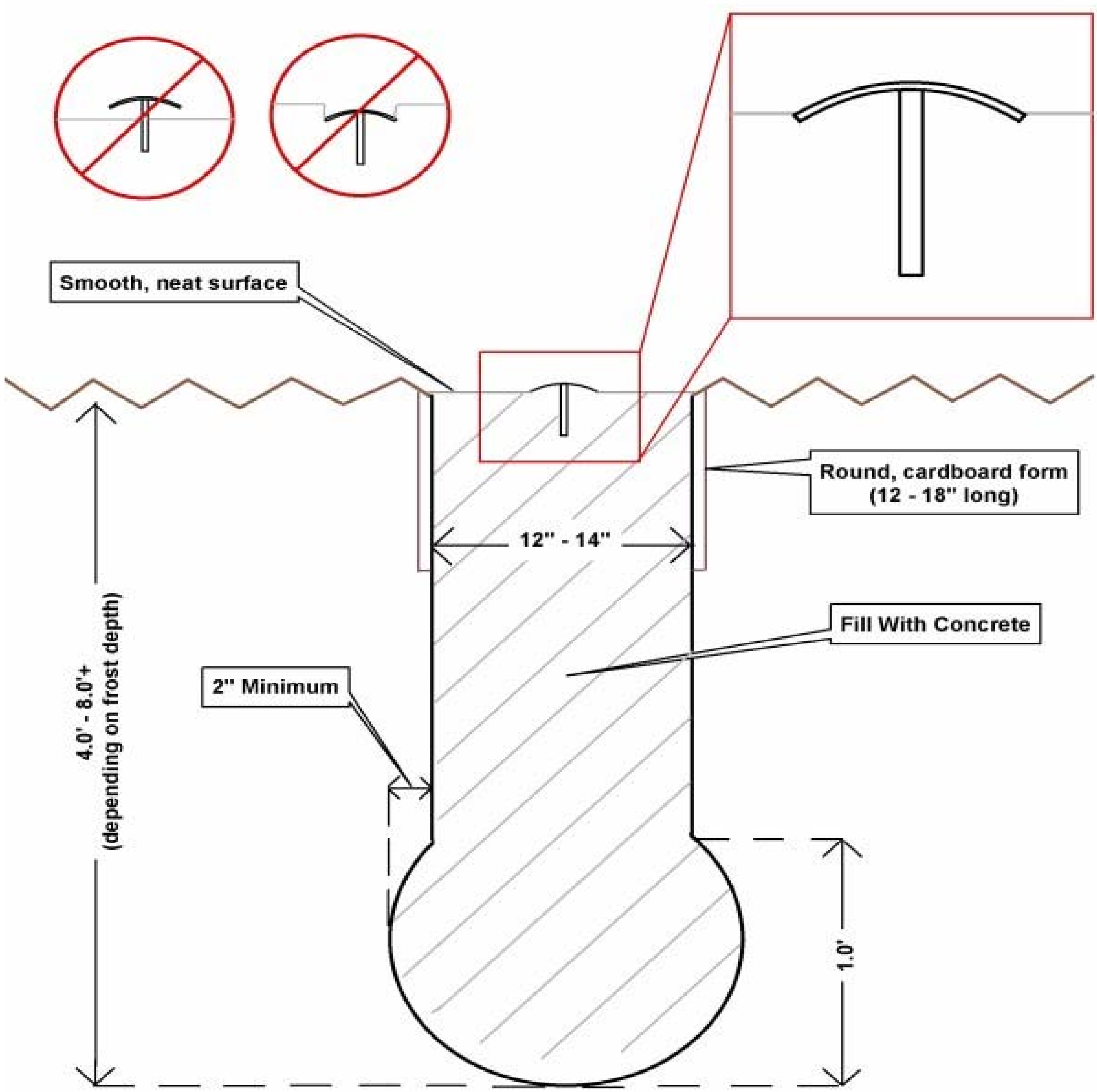
22. Remove excess dirt and dispose of it properly. In some rural areas there may be a logical spot to dump the extra soil where no one will notice. If the mark is in an area consisting of groomed lawns, the dirt shall be removed from the site.

23. Remove excess concrete from the site. Proper planning should minimize excess concrete. Any excess shall not be dumped on-site.

24. Installation of NGS Witness Posts is at the option of the firm. Generally do not use Witness Posts in areas of high population density nor on airports. They are very useful to future surveyors in more remote areas.

25. Do not add magnetic materials to the monument.

Standard NGS Concrete Monument



Cross Section Through Round Monument

Version 1
September 30, 2004

ATTACHMENT U
SETTING A SURVEY DISK IN BEDROCK

TO
SCOPE OF WORK FOR SHORELINE MAPPING
UNDER THE
NOAA COASTAL MAPPING PROGRAM

REMOTE SENSING DIVISION
NATIONAL GEODETIC SURVEY
NATIONAL OCEAN SERVICE
NATIONAL OCEANIC & ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE

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ATTACHMENT U: SETTING A SURVEY DISK IN BEDROCK OR A STRUCTURE

From NOAA Manual NOS, NGS 1, *Geodetic Bench Marks*

1. GENERAL

Sound bedrock is the most desirable setting for geodetic survey control points. Besides the ease and cost effectiveness with which a disk can be installed in bedrock, it provides the most stable setting that can be used in terms of both underground activity and disturbances inflicted by people. Always use bedrock when a suitable outcrop exits. As a rule of thumb, the bedrock is considered potentially good if the distance between joints and fissures is greater than 1 meter.
The National Geodetic Survey geodetic control disks are made of brass or bronze. They are about 9 centimeters in diameter and have a spherical surface to support the foot of a leveling rod and a center point for plumbing survey equipment. Information is imprinted on this surface to identify the monument and to aid the user in obtaining data on it. This logo is recessed so that it does not interfere with the leveling rod or other survey equipment. A deformed shank, about 7.5 centimeters long, is silver-soldered or otherwise attached to the bottom surface of the disk to help prevent the disk from being dislodged.

2. SETTING DISKS IN BEDROCK

2.1 STEPS:
The step-by-step procedure for setting the disk in bedrock utilizing cement is as follows:

1. Stamp the station designation and setting year on the top surface of the disk using 4.75 millimeter (3/16- inch) alpha-numeric steel dies.

2. Pick a fairly level and accessible spot on the outcrop that is intact with the bulk of the rock. A simple test can be performed to help determine the condition and integrity of the rock by placing ones hand in the area that the disk will be set, then striking the outcrop with a moderately heavy hammer and feeling for vibration. Sound outcrop will force the hammer to rebound with each impact and vibration through the rock should be minimal at best.

3. Drill a 2.5 centimeter diameter hole about 10 centimeters into the bedrock and recess the area around the top of the hole to a diameter slightly larger than that of the disk. When the installation is completed, the top of the surface of the disk should sit level and slightly below the surface of the surrounding rock. Chisel a drain channel through the low edge of the drilled recess to allow water to drain from around the finished mark. *Caution*: Safety goggles should be worn when drilling into bedrock or masonry.

4. Remove the rock powder from the hole and recessed area, flush and fill the hole with clean water, then pour cement into it. Mixing of the ingredients is done right in the hole.

By adding more water and cement, make enough mortar so that an extra amount is available to place on the underside of the disk. When the mortar is completely mixed, it should be thick but still workable, like heavy mashed potatoes.

5. Clean the disk by wetting then rubbing all surfaces with cement to remove unwanted oils; rinse. Fill the depression on the underside of the disk with mortar using a trowel. Hold the disk loosely upside-down by the end of the shank then gently tap the domed surface of the disk from below with the handle of the trowel several times to allow the mortar to settle and trapped air to escape. This is very important because it will prevent the existence of highly undesirable voids under the disk once it is in place.

6. Place the shank of the disk into the drilled hole and press the mark firmly into place. A slight rotation of the disk back-and-forth and gentle tapping with the end of the trowel handle helps settle the disk completely and evenly into the drilled recess in the bedrock. The disk is considered set when the slight back-and-forth movement stops and the disk sets firmly in place. Work excess mortar around the outer edge of the disk, making sure that it is smooth and slightly overlapping the top outside edges of the disk for security. An exposed edge of the disk would provide an area which could be used by someone or the elements to dislodge it. Fresh mortar on the upper surface of the disk can be easily cleaned off and out of any stamping.

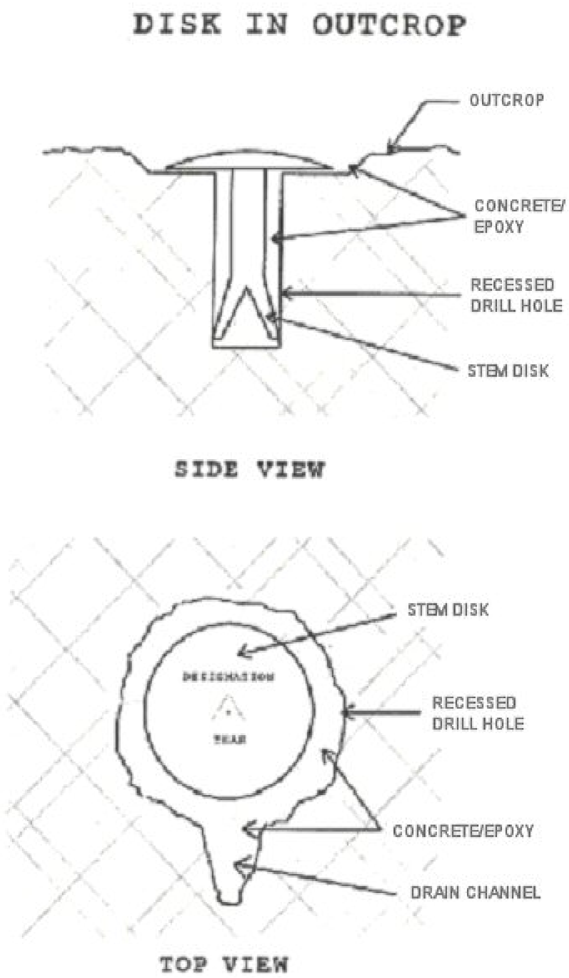
7. Sprinkle some dry cement on the exposed surface of the disk and then rub it with a clean rag or short bristled brush using circular strokes. This will clean the disk very nicely, removing all excess mortar from its surface and recessed letters. Rubbing the wet mortar around the edge of the disk in the same manner is done intentionally to finish its surface and help prevent cracking. Brush away loose cement and make sure that the finished product has a neat appearance.

8. While the mortar is still wet, it must be covered to prevent heavy rains or other foreign debris from ruining its surface and to conceal the disk from people who might tamper with it. A piece of wood, cardboard, heavy paper or similar biodegradable item will suffice.

9. The installation is complete when all accumulated trash has been picked up. Leave the site clean and in good order.

Highway grade epoxy may be used in place of cement if it meets ultraviolet standards and will hold up to all weather conditions. The setting procedures are similar to those described previously except that the drilled hole, though needing to be extremely clean, cannot be wet.

ANNEX 1: DISK IN OUTCROP
DIAGRAM



Version 1
September 30, 2004

ATTACHMENT V
SETTING AN NGS 3D MONUMENT

TO
SCOPE OF WORK FOR SHORELINE MAPPING
UNDER THE
NOAA COASTAL MAPPING PROGRAM

REMOTE SENSING DIVISION
NATIONAL GEODETIC SURVEY
NATIONAL OCEAN SERVICE
NATIONAL OCEANIC & ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE

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ATTACHMENT V: SETTING AN NGS 3-D MONUMENT

Based on "Revised NGS 3-Dimensional (3-D) Rod Mark" [Draft Version] by:
Curtis L. Smith
National Geodetic Survey
July, 1996

1. DISCLAIMER

This document is intended only for the purpose of providing the user with guidelines for planning and implementation of this style of survey monument. The distribution of this document or the mention of a commercial company or product contained herein does not constitute, in any way, an endorsement by the National Geodetic Survey (NGS).

2. INTRODUCTION

The extensive use and accuracies achieved by the Global Positioning System (GPS) for geodetic surveying applications have highlighted the need for increased stability in survey control point monumentation. Repeatability of accurate positions obtained through GPS require that geodetic monuments reflect this accuracy with properties of permanence and stability both horizontally and vertically.

Factors affecting the stability of survey monuments include frost heave action, changes in ground water levels and local settlement. Consult soil and geotechnical specialists about local ground conditions. Manuals, such as NOAA Manual NOS NGS 1, “Geodetic Bench Marks”, document soil types and frost penetration zones nationwide.

The recommended survey marker that produces stability for most conditions is the three-dimensional (3-D) drivable survey monument. The principal component of this monument is a 9/16-inch stainless steel rod driven into the ground, utilizing a gasoline powered reciprocating hammer, until refusal or a reduced driving rate has been achieved. The rounded top of the rod is the survey datum point. The upper 1 meter of the rod is encased in a 1-inch greased filled plastic extruded fin sleeve that is held horizontally stable by back-filled, washed sand. Effects of up and down ground movement during freeze/thaw or wet/dry conditions are removed from the anchored rod by the grease filled sleeve promoting vertical stability. A 5 or 6-inch PVC pipe with attached standard aluminum logo cap protects and identifies the top of the monument. (See documentation in this manual for specific mark setting procedures).

3. REFERENCES

NOAA Manual NOS NGS 1. Geodetic Bench Marks, by Floyd, Richard P., September 1978. Geometric Geodetic Accuracy Standards and Specifications for Using GPS Relative Positioning Techniques, by Federal Geodetic Control Committee, August 1989.

4. REQUIREMENTS

4.1 RECOMMENDED EQUIPMENT FOR SETTING MONUMENTS

A. Rod Drivers and Accessories:
1- Any driver with a minimum impact force of 25 foot pounds per blow, such as Wacker Model BHB 25 (with tool kit) or Pionjar Model 120 (with tool kit), for driving stainless steel rods.
1- Rod Driving Insert, holds machine on rod and acts as impact point while driving rods.
1- Shovel Bit, for machine to help start and dig holes, not required but may be helpful.
1- Pint, Required Oil Type and Calibrated Container, for determining gas/oil mix.
1- Gas Containers and Gasoline, for driving machine and generator.

B. Digging the Hole:
1- Post Hole Digger, capable of digging a hole 4-feet deep.
1- Gas Powered post Hole Digger with Augurs, not required but increases productivity.
1- Digging Bar, for rocks and hard to dig holes.

C. Driving the Rod:
1- 2 lb. Hammer, to start rods, stamp designations, etc.
2- 8" Quality Pipe Wrenches (i.e. Rigid), for attaching lengths of stainless steel rods.
1- Bottle, Loctite, for cementing threads into the stainless steel rods.

D. Finishing the Rod:
1- Hack Saw with extra Quality Blades, for cutting stainless steel rod.
1- 4" or 5" Grinder (electric or battery powered), for finishing top of rod.
1- Gas Powered Electric Generator, to power grinder and/or drill.
2- Sanding Disks (medium grade), for grinder.
1- Steel File(s), for fine finishing top of rod.
1- Centering Sleeve, to help center punch mark on top of rod.
1- Center Punch, to punch plumbing point on top center of rod.
Assorted Sand Paper or Sanding Pad, for fine finish to top of rod.

E. Finishing the Monument:
1- 1/4-inch Stamping Set, for lettering and numbering station designation/date.
1- Hand Saw, for cutting 5 or 6-inch PVC pipe.
1-Bucket or Wheel Barrel, to mix cement/move unwanted dirt.
2- 5 Gallon Water containers and Water, to mix cement and clean equipment.
1- Hoe, to mix cement, can be replaced by “Sharp Shooter Shovel”.
1- Heavy Rubber Mallet, to help lower logo cap/5-inch PVC into cement.
1- Cement Finishing Trowel, to smooth top of concrete for neat appearance.
1- Stiff Vegetable Type Brush, to clean logo cap and hinges.
F. Assorted Accessories:
1- Tool Box with regular assortment of tools, for incidental repairs: slotted and Phillips Head Screw-Drivers, Pliers, Needle Nose Pliers, Wire Cutters, Assorted Wrenches,

Sockets, Allen Wrenches, Wire Brush.
1- Round Nose Shovel, to help dig hole and move unwanted dirt.
1- Tile Spade (“Sharp Shooter Shovel”), to help dig hole and mix cement.
1- Roll Black Tar Paper (Felt Paper), for making a round form for top of monument.
1- 30 Meter Tape Measure, for distances in station description.
Leather or Cotton Gloves, Assorted Rags or Paper Towels.

4.2 MATERIALS REQUIRED FOR EACH MARK

Lengths of 9/16-inch Stainless Steel Rods, 4-foot sections.
1- 4 to 5-inch piece of Stainless Steel Rod, used as impact point and protection while driving rods.

Adequate supply of 3/8-inch Threaded Stainless Steel Studs.
1- Steel Spiral (fluted) Rod Entry Point, standard order.
1- Aluminum Logo Cap, standard order.
1- Schedule 40 PVC Pipe, 5 or 6-inch diameter, 24-inch length.
1- Plastic Extruded Fin sleeve, 1-inch diameter, 3-feet minimum length.
2- Plastic end Cap Alignment Bushings, center drilled to 9/16-inch (for extruded fin sleeve).
1- Pint, PVC cement, can be replaced with adequate Epoxy type.
1- Pint, PVC Cleaning Solvent, when using PVC cement.
1- 17 ounce tube, Non-Toxic, Food Grade Grease, with Applicator (i.e. grease gun).
Ready Mix Concrete (Amount depends on width and depth of hole).
2- Pounds, Portland Cement, added to enhance integrity of ready mix concrete if necessary.
0.5- Cubic feet, Washed Sand, fills bottom of hole and inside of PVC pipe around grease sleeve.

4.3 SETTING PROCEDURES

1. Ensure the monument site selection has been discussed with airport management and/or property owners, and the location meets all station siting requirements. Inquire about future construction which may affect mark longevity.

2. Contact "MISS UTILITY" type services to inquire about underground utilities before digging or driving a rod.

3. The time required toset an average mark using the following procedures and referencing the diagram on the following page is 2 to 3 hours. Several steps, such as steps 4, 5, and 7, can and should be accomplished at a maintenance shop.

4. Stamp station designation and year of establishment into the blank area on the collar of the logo cap.

5. Cut a 20-inch section of 5 or 6-inch PVC pipe. Ensure the end that will receive the logo cap is cut true and is clean. Using primer and solvent cement formulated specifically for PVC, glue the stamped aluminum logo cap to the end of the 20-inch PVC section. If this step is performed on site, allow time for the glue to set by digging the hole and driving the rod after preparing the PVC and logo cap.

6. Using a power auger or post hole digger, drill or dig a round hole in the ground 12 to 14-inches in diameter, and 22 inches deep. Extend the center of the bottom of the hole by drilling or digging a 3 to 6-inch diameter hole an additional 21 inches for a total depth of 43 inches. This extended area will be back-filled with washed sand around grease sleeve.

7. Glue both plastic end cap alignment bushings on a 3-foot section of the plastic extruded fin sleeve. Let glued ends dry completely. Pump food grade grease into capped sleeve until 3/4 full allowing for displacement by rod and completing the grease filled sleeve.

8. Using a standard 3/8-inch threaded stud coated with Loctite (Use Loctite on all *permanent* connections). Attach two 4-foot sections of stainless steel rods together. At one end of the length of rod, attach a standard spiral (fluted) rod entry point with a 3/8-inch threaded stud. On the opposite end, attach a short 4 to 5-inch piece of rod with a 3/8-inch threaded stud. Tighten all connections using two pipe wrenches a good 1/4 to 3/4 turn past the point of contact of all rod ends except the impact point which will be continually removed. This tightening requires a certain "feel" and ensures that the rod ends are seated together with greatest possible tension yet not to the point of breaking a stud. Rods tightened in this fashion should not vibrate loose when they are driven into the ground.

9. The 8-foot long connected rod is centered into the bottom of the hole and driven with a 2-pound hammer until rod is secure and as plumb as possible. A 2x4 with a 1/2" hole can be centered and braced over the hole to help guide the rod straight into the ground. Drive the section of rod to about the top of the hole with a gas powered reciprocating driver such as Whacker model BHB 25, Pionjar model 120, or another machine with an equivalent driving force.

10. Remove the short piece of rod (impact point) leaving the threaded stud section of the rod in the ground. Attach another 4-foot section of rod and, using a new threaded stud, thread on the impact point. This “cycling” of a new stud from impact point into the top of the rods in the ground insures unweakened studs at all connections. Remember to coat threads on the permanent connections with Loctite. Tighten securely utilizing pipe wrenches as described above in step 9. Always tighten rods maintaining a clockwise pressure to avoid loosening rods already in the ground. Drive the new length of rod into the ground with the reciprocating driver.

11. Repeat step 10 until the rod refuses to drive further (anchored), or until a driving rate of 60 seconds per foot is achieved. In the event that the rod will not sufficiently slow down to meet desired driving rate, terminate upon reaching 90 feet (22.5 rods). This will leave about 2 feet of

rod out of the hole. If possible, let the rod set overnight, then drive the remaining 2 feet of rod to determine whether driving rate has reduced. If rod feels secure in ground, use this depth even though minimum driving rate of 60 seconds per foot has not been met. If the rod turns freely in clockwise direction, contact NGS for a decision to drive additional rods. Sometimes, all that is necessary to achieve a well anchored rod is driving it a few more feet. In other instances an additional hundred feet may be required. Indicate in the written station description the depth of rod, and whether it was driven to refusal or met the slow driving rate. Also include a description of any unusual mark setting circumstances.

12. When refusal or prescribed driving rate is reached, cut off the rod with a hacksaw or comparable tool, always removing at least the tapped and threaded portion, leaving the top of rod about 3 inches below ground surface. Shape the top of the rod to a smooth, hemispherical surface using a portable grinding machine using a grinding attachment or sanding wheels, files, and sand paper to produce a nicely finished, rounded surface.Ragged edges or grinding marks are not acceptable on top of the finished rod.

13. The datum point must then be created by center punching a dimple on top of the rod to provide a plumbing (centering) point. Place the centering sleeve over the top of the rounded rod to facilitate locating the exact center of the rod. Punch a substantial dimple 1/16-inch deep, into the top of the rod using a punch and hammer or spring loaded center punch. Several blows may be needed to create a sufficient dimple. Remember, this is the actual survey point, so don't hesitate to spend a few extra minutes to produce a professional, finished product.

14. Insert the grease filled sleeve, produced in step 7, over the rod with the unfilled portion at the top. Upper end of the sleeve will fill as rod displaces grease from the bottom. The datum point on top of the rod should protrude through top of the sleeve about 3-inches with sleeve extending to the bottom of the hole. Clean the residual grease off the exposed top of the rod.

15. Back-fill and pack with washed sand the bottom 23 or more inches of the hole around the outside of grease sleeve. This fills the bottom of the hole and helps stabilize the sleeve.

16. Place the 5 or 6-inch PVC pipe and logo cap over and around the grease sleeve and rod in the center of the hole. The bottom of the PVC pipe should extend into the top of the sand in the bottom of the hole. Leave the top of the logo cap and PVC pipe slightly higher than the top of the ground surface until the concrete is in place. Back-fill the center of the PVC pipe with washed sand around and to within 1-inch from the top of the grease filled sleeve. The rod should be centered in the PVC pipe.

17. Mix concrete in a bucket or wheel barrel to pasty, well moistened consistency like mashed potatoes. Add Portland cement, if necessary, in sufficient quantity (1 to 2 pounds) to enhance concrete mix or dry an over moistened mixture to maintain adequate consistency. A good indication of adequate consistency is that the mix neither runs nor falls off the shovel but sluggishly slides off and flattens upon hitting the ground. Pour concrete into the hole around the logo cap and PVC pipe casing filling to slightly below the ground surface. To avoid frost heaving of the PVC collar, a round form should be used to ensure the outside walls of the concrete are vertical, and do not produce a mushroom shaped wedge at the top of the mark. Open

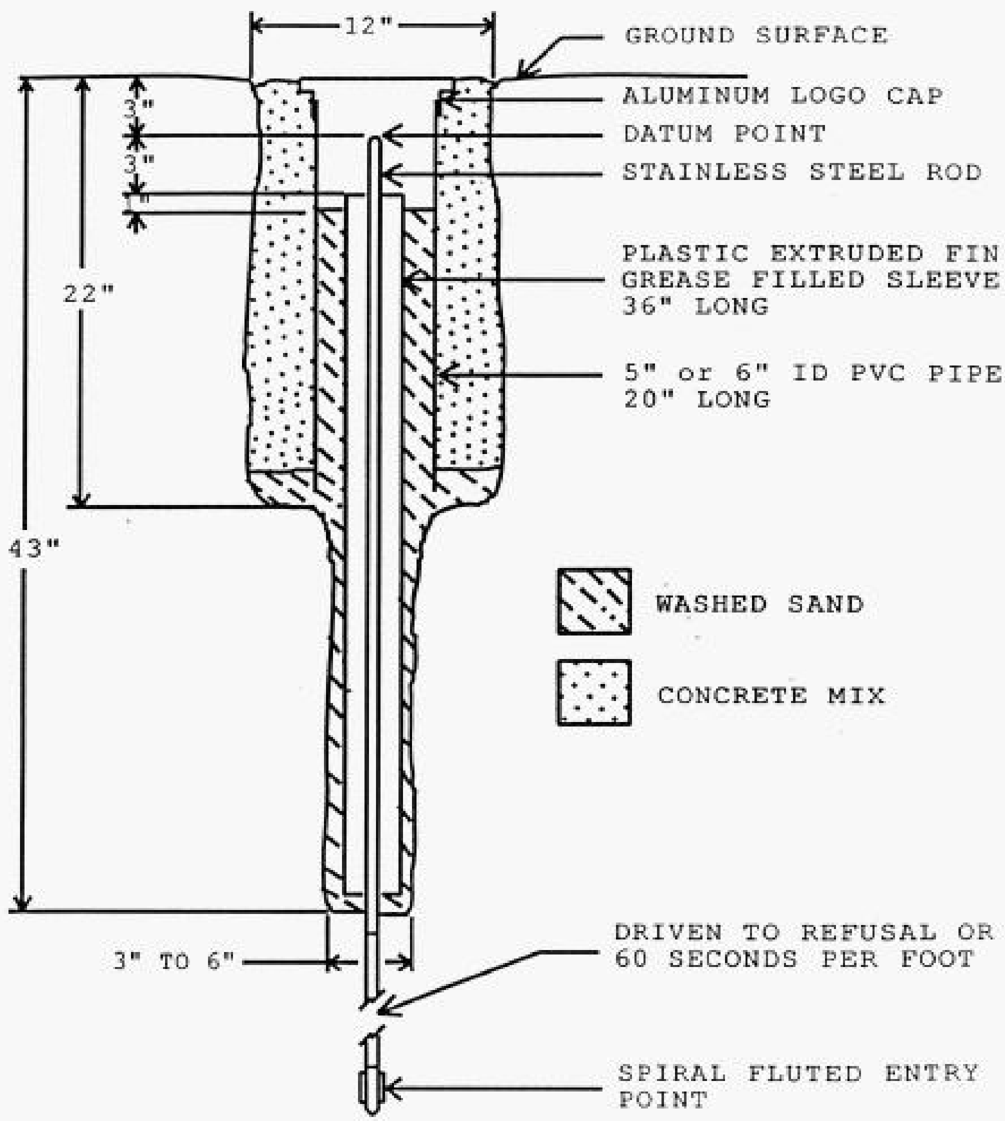
the logo cap and grasp the PVC pipe then shake to settle concrete around the pipe to fill voids. Add concrete to within 1/2-inch of the ground surface.

18. Trowel smooth the top of concrete to a fairly finished surface. Tap alternate edges of the logo cap, using a rubber mallet or hammer and wooden block, lowering it and the attached PVC pipe into the surface of the concrete. Finish the top of the concrete by troweling a smooth, finished surface, round in appearance, and sloped slightly outward to aid drainage of rain water.

19. Add sand to the inside of the PVC pipe to bring its level to within 1-inch of the top of the grease sleeve. Clean any overlapping concrete from the surface of the logo cap using the vegetable brush. The finished height of logo cap and access cover should be slightly lower than the surface of the ground. The logo cap should be approximately in the center of the top of the concrete. Datum point should be about 3-inches below the cover of the logo cap and centered in the 5 or 6-inch PVC pipe. The top of the grease filled sleeve should be about 3-inches below the datum point and the washed sand 1-inch below the top of the sleeve. Clean any cement that may have gotten onto the exposed rod or datum point.

20. Clean all equipment and remove all debris such as extra cement, excess dirt, and trash, leaving the area in the condition it was found.

ANNEX 1: DIAGRAM OF AN NGS 3-D ROD MARK



Schematic of the Revised NGS 3-D Rod Mark, Side View

5

Version 1
September 30, 2004

ATTACHMENT W
STATION SITE SELECTION GUIDE

TO
SCOPE OF WORK FOR SHORELINE MAPPING
UNDER THE
NOAA COASTAL MAPPING PROGRAM

REMOTE SENSING DIVISION
NATIONAL GEODETIC SURVEY
NATIONAL OCEAN SERVICE
NATIONAL OCEANIC & ATMOSPHERIC ADMINISTRATION
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ATTACHMENT W: STATION SELECTION GUIDELINES

1. SELECTION PRIORITIES

Station selection shall be based on the following priorities, which are given in the order of highest priority first. Within each priority category, preference should be given to selection of appropriate older stations having a known history of prior stability as indicated by previous observations.

1.1 STATIONS

A. Existing A- or B-order station, where possible,

B. Primary Airport Control Stations (PACS),

C. Existing National Spatial Reference System (NSRS) station with:
   i. 1^{st}, 2^{nd}, or 3rd-order elevation, and
   ii.1^{st} or 2nd-order horizontal,

D. Existing NSRS station with elevation, higher accuracy classification being preferred,

E. Existing NSRS station with first- or second-order horizontal coordinates, higher accuracy classification being preferred,

F. New station or existing station not in NSRS, suitable for GPS observations, set in bedrock,

G. New station or existing station not in NSRS, suitable for GPS observations, established by setting a 3D monument,

H. New stations or existing station not in NSRS, suitable for GPS observations, established by setting lesser stability mark, such as standard concrete mark.

2. STATION SPACING

Station spacing is project dependent. See project instructions.

3. MONUMENTATION AND STATION ENVIRONMENT

The following is a list of considerations for each station. The intent is to ensure that station monuments will be locally stable and remain usable indefinitely. Each of these considerations is important.

3.1 CONSIDERATIONS

A. Adequate GPS satellite visibility (unrestricted at 15 degrees and higher above the horizon). Minor obstructions may be acceptable, but must be depicted on the Visibility Obstruction Diagram.

B. Accessible by vehicle (two-wheel drive preferred),

C. Stability; bedrock mark being most preferred. (See Section 4.0 below.),

D. Permanency,

E. Ease of recovery,

F. Avoid known multi-path sources,

G. Appropriate geographic location and spacing,

H. Location allows efficient use by surveying community,

I. Accessible by public. (See Section 5.0 below.),

J. No known potential conflict with future development,

K. Open area for possible aerial-photo paneling,

L. Avoid electronic interference where possible.

4. STABILITY

Station monument stability is often difficult to assess in the field with limited resources. For existing NSRS station monumentation, the NGS database contains stability qualifiers which were assigned for the majority of marks when they were set.
Quality Codes are as follow:

4.1 QUALITY CODE A - most reliable; are expected to hold a precise elevation. Examples: rock outcrops; rock ledges; rock cuts; bedrock; massive structures with deep foundations; large structures with foundations on bedrock; or sleeved deep settings (10 ft or more) with galvanized steel pipe or galvanized steel, stainless steel, or aluminum rods.

4.2 QUALITY CODE B - will probably hold a precise elevation. Examples: unsleeved deep settings (10 ft or more) with galvanized steel pipe or galvanized steel, stainless steel, or aluminum rods; massive structures other than those listed under Quality Code A; massive retaining walls; abutments and piers of large bridges or tunnels; unspecified rods or pipe in a sleeve less than 10 ft; or sleeved copper-clad steel rods.

4.3 QUALITY CODE C - may hold precise elevation, but subject to ground movement. Examples: metal rods with base plates less than 10 ft deep; concrete posts (3 ft or more deep); unspecified rods or pipe more than 10 ft deep; large boulders; retaining walls for culverts or small bridges; footings or foundation walls of small to medium-size structures; or foundations such as landings, platforms, or steps. See Section 4.5, below.

4.4 QUALITY CODE D - of questionable stability. Examples: generally, objects of unknown character; shallow set rods or pipe (less than 10 ft); light structures; pavements such as street, curbs, or aprons; piles and poles such as spikes in utility poles; masses of concrete; or concrete posts less than 3 ft deep.

4.5 QUALITY CODE C EXCEPTION - when selecting FBN stations, only Quality Codes A and B are recommended. However, concrete posts may be selected with a C stability if the mark is deemed stable from review of historical re-leveling, soil type, and frost depth. Final selection is subjective, and is based on local knowledge of soil and frost heave, plus knowledge of how well the mark has held its horizontal and vertical positions over the years.

5. ACCESSIBILITY

Accessible public property should be utilized where feasible. If the station is located on private property, permission must be obtained from the land owner for station accessibility. Include the name, address, and, if public ownership, the telephone number of the responsible party. Do not include telephone numbers of private property owners.

Version 1
September 30, 2004

ATTACHMENT X
BENCH MARK TIES

TO
SCOPE OF WORK FOR SHORELINE MAPPING
UNDER THE
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REMOTE SENSING DIVISION
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ATTACHMENT X: BENCH MARK TIES

1. INTRODUCTION

The purpose of these guidelines is to provide the information necessary to transfer an elevation from an existing NAVD88 benchmark that cannot be used for GPS observations to a nearby GPS station. The two stations must be “closeby” which is defined here as no more than four “set-ups” of the level instrument.

2. SINGLE MARK LEVEL TIE (3^{RD} ORDER)

An assumed elevation for the bench mark can be used in the leveling since the principal concern is with the **difference of elevation** between the bench mark and the GPS station. It should be noted that the published elevation of the GPS station would only be published to the nearest centimeter. This is because the absolute elevation of the bench mark cannot be verified without incorporating other bench marks into the survey as a check. Many projects do not provide the resources required for this multiple mark check, but it is still imperative that the GPS station have the best precision allowable.

Record rod readings to millimeters or hundredths of feet. The model and type of instrument and rods (e.g., fiberglass, aluminum, single piece, etc.) as well as rod scale units (e.g., meters, feet, or bar code) should be entered on the “Observations of Bench Mark Ties” form where indicated. See Annex 1.

3. OBSERVING SEQUENCE FOR CONVENTIONAL LEVEL

1. Remove equipment from travel cases, attach level instrument to tripod, and let equipment acclimate to local conditions. Perform instrument check per the manufacturer’s instructions. Set up the instrument about halfway between the stations, but no more than 70 m (230 ft) away from either point or from one of the points and a turning pin in the case of multiple setup requirements. Backsight distance to foresight distance imbalance shall be less than 5 meters. Accumulated backsight to foresight distance imbalance shall be less than 10 meters in the case of multiple setups.

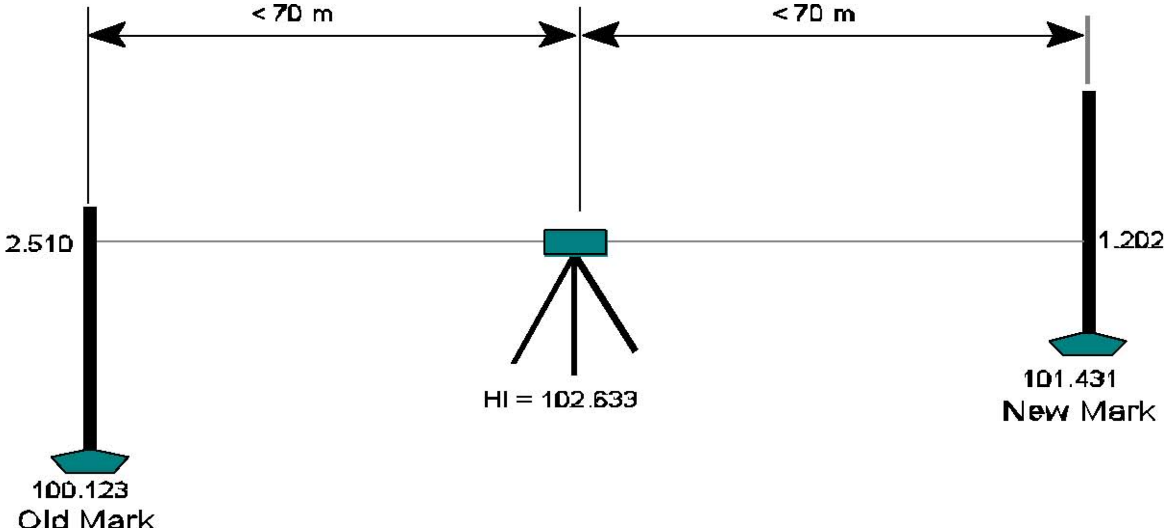

Figure 1. Direct old mark to new mark level tie. **Note:** Backsight-foresight distance imbalance should be less than 5 meters.

2. Plumb the level rod on the highest point of the old mark. Let's call the old mark M 123. Record the designation of the point and its published elevation noting the reference vertical datum and units of measure.

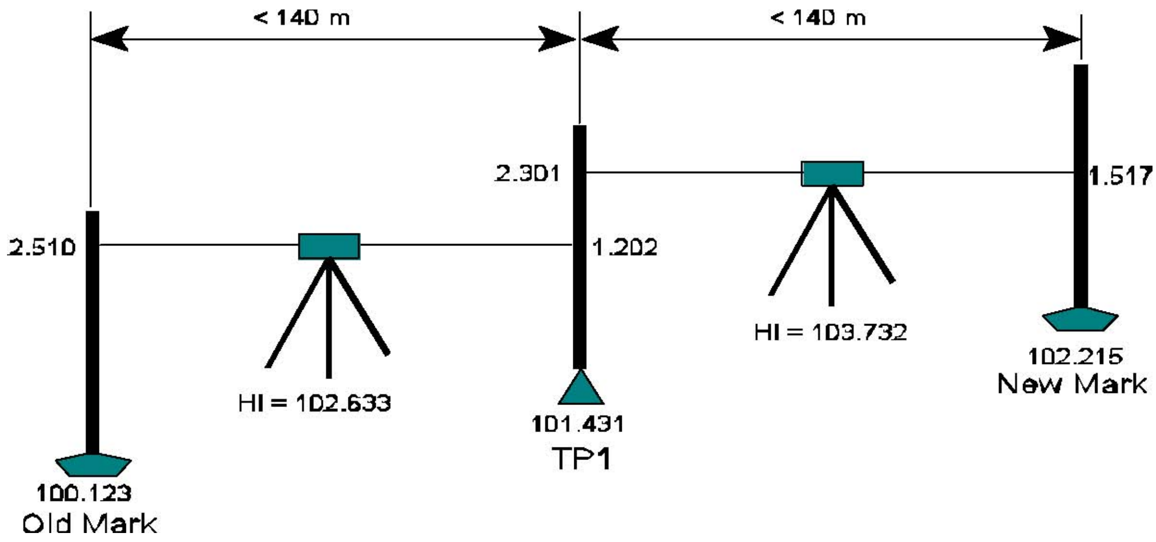

Figure 2. Old mark to new mark level tie for distances over 140 m. **Note:** Accumulated backsight-foresight setup imbalance should be less than 10 m.

3. Backsight Reading: Observe the intercept of the middle reticule of the rod scale as backsight reading. Record the rod reading to the nearest millimeter (or hundredths of a foot) as indicated above. Record the stadia reading to determine distance from the point to the instrument.

4. Compute height of instrument, HI, which is the sum of the backsight and the published elevation.

5. Plumb the rod on the highest point of the new bench mark. Record the designation of the new mark, e.g., M 123 RESET, or TP1 (for turning point 1 in the case of multiple setups).

6. Foresight Reading: Observe the intercept of the middle reticule of the rod scale as foresight reading. Record the stadia reading to determine distance from the point to the instrument.

7. Compute the elevation of the new point, new bench mark, or turning point, which is the difference of the HI minus the foresight.

8. Reset and re-level the instrument. Level backward from the new point to the old, in the same manner as steps 2 through 7.

Note: The elevation computed for the old point as a result of the backward leveling may differ by no more than +/-12D (where D is the shortest length of section in kilometers one-way) from the published elevation.

9. To compute the elevation difference from the old mark to the new, subtract the mean of the two elevations for the old mark from the elevation for the new mark.

4. OBSERVING SEQUENCE FOR DIGITAL LEVEL

These observing procedures are intended for use with digital levels.

1. Remove equipment from travel cases, attach level instrument to tripod, and let equipment acclimate to local conditions. Perform instrument check and adjustment as outlined in the digital level manual.

2. Set up the instrument about halfway between the stations. Limit sight lengths to no more than 70 m (230 ft) from either point or from one of the points and a turning pin in the case of multiple setup requirements, e.g., distance between points is greater than 140 meters. Backsight distance to foresight distance imbalance shall be less than 5 meters. Accumulated backsight to foresight distance imbalance shall be less than 10 meters in the case of multiple setups.

3. Level up the instrument using the three foot screws while observing the bulls-eye bubble. Turn on the instrument and select the backsight/foresight level program. Confirm that you want to start then enter the starting elevation for the old mark. Set and confirm instrument parameters, e.g., meaning 3 measurements, display maximum decimal places, record readings to onboard module, and observing configuration, such as rod type, and metric units.

4. Plumb the level rod on the highest point of the old mark, e.g., domed top of disk M 123. Record the designation of the point and its published elevation, noting the reference vertical datum and units of measure.

5. Backsight Reading: Point using the vertical crosshair of the level instrument on the middle of the rod over the old mark and use the focusing knob to bring the image of the rod into sharp focus Depress the measure button and record the rod reading. Note distance from rod to instrument. It should be less than 70 meters.

6. Plumb the rod on the highest point of the new bench mark. Record the designation of the new mark, e.g., M 123 RESET, or TP1 (for turning point 1 in the case of multiple setups).

7. Foresight Reading: Point and focus the level instrument on the rod over the new mark. Depress the measure button and record the rod reading. Note distance from rod to instrument. It should be less than 70 meters. Note imbalance between backsight and foresight distances. This difference shall be less than 5 meters.

8. The elevation of the new bench mark or turning point is computed as the sum of the backsight reading and the published elevation minus the foresight reading.

9. Reset and re-level the instrument. Level backward from the new point to the old, in the same manner as steps 2 through 7. Use the elevation determined from the forward leveling as the starting elevation for the backward leveling. The elevation computed for the old point as a result of the backward leveling may differ by no more than +/- 12D (where D is the shortest length of section in kilometers one-way) from the published elevation.

10. To compute the elevation difference from the old mark to the new, subtract the mean of the two elevations for the old mark from the elevation for the new mark. The elevation for the new bench mark will be this computed difference, mean of both forward and backward leveling, plus the published elevation of the old bench mark.

5. DATA SUBMISSION

The following **shall be supplied** by the submitting office:

1. Completed “Observations for Bench Mark Ties” form. See Annex 1.

2. Digital Levels: Paper as well as digital copy of leveling observations.

ANNEX 1: Observations for Bench Mark Ties

Original Mark Stamping: PID (if known): Elevation: (ft / m) Datum: NGVD 29 or NAVD 88 (circle one)	Replacement Mark Stamping: Date of Leveling: Computed Elevation: (ft / m) (from below)

State: County: Latitude: N Longitude: W Datum:

Leveling Equipment: Manufacturer Model Number Serial Number Level Instrument: Rod # 1: Rod # 2 (optional): Rod Scale Units:

Point	Backsight	H.I.	Foresight	Elevation	Length (ft/m)	Remarks
Forward Running: Old to New						
Backward Running: New to Old						

Agency / Firm: ____ Signed: ____________________________
Address: ____ Telephone: ( ) ______________________
City / State / Zip: E-mail:

Version 1A
January 28, 2008

ATTACHMENT Y
Light Detection and Ranging (LIDAR) Requirements

TO
SCOPE OF WORK FOR SHORELINE MAPPING
UNDER THE
NOAA COASTAL MAPPING PROGRAM

REMOTE SENSING DIVISION
NATIONAL GEODETIC SURVEY
NATIONAL OCEAN SERVICE
NATIONAL OCEANIC & ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE

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ATTACHMENT Y: LIDAR REQUIREMENTS

1. GENERAL

The Coastal Mapping Program (CMP) works to provide a regularly-updated and consistent national shoreline to define America's marine territorial limits and manage coastal resources. This shoreline is present on National Oceanic and Atmospheric Administration (NOAA) nautical charts and is considered authoritative when determining the official shoreline for the United States. The CMP is administered by the National Geodetic Survey (NGS), National Ocean Service (NOS), NOAA. This Scope of Work defines requirements for LIDAR data acquisition and processing to support the CMP. Project Instructions will provide project-specific information.

The following conventions have been adopted for this document. The term "shall" means that compliance is required. The term "should" implies that compliance is not required, but is strongly recommended. All times shall be recorded in Coordinated Universal Time (UTC).

2. GOVERNMENT

2.1 PROPERTY OF DATA – All original data and imagery, from the instant of acquisition, and other deliverables required through this contract including final images, are and shall remain the property of the United States Government. This includes image collection outside the project area. These items include the Contractor-furnished materials.

2.2 DATA – The government will provide to the Contractor:

A. PROJECT INSTRUCTIONS – Project Instructions are a separate document providing specific project information, containing any unique project requirements, and may have the following attachments:

B. Small scale maps showing the coastline and/or coastal ports to be acquired;

C. Tide coordination time windows for data acquisition, see Section 8;

D. LIDAR ACQUISITION REQUIREMENTS (this document);

E. REJECTED DATA – If data is rejected by NGS, NGS will send sample data upon request showing the problem areas.

3. DELIVERY SCHEDULE AND DATA FLOW

3.1 REGULAR PRODUCTION - Any request to deviate from these standards shall be approved in advance in writing by NGS.

3.2 DATA ACQUISITION STANDARDS

A. PDOP/VDOP shall be < 3;

B. Mass point spacing shall not exceed limits defined in separate Project Instructions;

C. Digital Elevation Model (DEM)/Digital Surface Model (DSM) point spacing shall not exceed limits defined in separate Project Instructions. The Digital Surface Model is defined as the bare earth ground surface.

D. Aircraft bank angle shall not exceed 15 degrees.

3.3 DATA PROCESSING

A. The data shall be projected in Universal Transverse Mercator (UTM) and referenced to the North American Datum 1983 (NAD 83). Only one UTM zone shall be used, even if the project area splits zones. Use the zone in which the majority of the data falls.

B. The vertical datum is the North American Vertical Datum of 1988 (NAVD 88). In Alaska and other areas outside the continental United States where NAVD 88 bench marks are not available, the Contractor shall make GPS ties to tidal bench marks within the project area.

C. The geoid model to be used in converting from GPS-derived ellipsoid heights to NAVD 88 orthometric heights is GEOID03 or the most current version. For GEOID information see: http://www.ngs.noaa.gov/PC_PROD/GEOID03/ .

D. The contractor shall remove outliers in raw data prior to interpolation. Outliers include obvious abnormalities in the data such as returns off of a bird, however be careful to not remove real outliers such as offshore rocks. Contractor shall supply NGS with both sets of raw points and an Outlier Removal File (ORF) indicating number of points removed. Interpolation shall be completed with industry standard software to facilitate validation of DSM. Contractor shall provide details of interpolation process (software and method).

E. There shall be no holidays in the data (no data gaps) unless unavoidable in which case other mapping methods may be used if approved by NGS. Interpolation across or smoothing over holidays is unacceptable and may result in rejection of the data by NGS. Any holidays shall be filled with additional data collection unless approved by NGS.

F. The contractor shall record all process steps and software used including version number.

G. The contractor shall use either the rapid or precise ephemeris for GPS processing.

3.4 ACCURACY STANDARDS - Accuracy reporting, i.e. $RMSE_{X,Y,Z}$, shall follow methods set forth by the Federal Geographic Data Committee at:
http://www.fgdc.gov/standards/standards_publications/

Accuracy shall be determined by the following methods:

A. Contractor shall obtain a minimum of 30 validation check points using geodetic quality derived measurements at evenly-spaced intervals along the entirety of the project area. Using 30 checkpoints allows for a statistically significant error analysis. The X, Y, and Z components shall all be referenced to the NSRS (National Spatial Reference System) and in the same coordinate system and datums used in the rest of the project. As a rule of thumb, the check points should be ten times better than the data they are checking;

B. The contractor should, if possible, acquire at least one flight line across a repeatable and verifiable surface (road, parking lot, tarmac) in order to compare the overlapping swaths to identify any systematic errors;

C. The offsets between both the mass point cloud and the derived DSM from that of the validation check points shall be used to calculate both $RMSE_{X,Y}$ and $RMSE_Z$;

D. The requirements for $RMSE_{X,Y}$ and $RMSE_Z$ will be specified in separate Project Instructions;

E. The contractor shall verify internal consistency of range measurements in areas of overlap among swaths that shall agree with the accepted instrument's error;

F. All validation data shall be submitted to NGS, as well as an accuracy report that includes a statistical summary of the data quality. This shall include presentation of the $RMSE_{X,Y}$ and $RMSE_Z$, a table summarizing the overall statistics of both the $RMSE_{X,Y}$ and $RMSE_Z$ consisting of: number of points, mean, median, mode, skewness, standard deviation, minimum, and maximum representative of each RMSE calculation, as well as a table and separate histogram that illustrate the derived delta between each validation checkpoint and that of both the LIDAR mass point cloud and the derived DSM.

3.5 DATA FORMAT STANDARDS - Format of deliverables shall be:

A. Mass points: Delimited ASCII text containing at the minimum the following columns: All recorded returns (i.e. first, last, and any intermediate returns), GPS time, intensity, and X, Y, Z for points used to generate the DSM;

B. Digital surface model (DSM): GEOTIFF;

C. Shoreline vectors: shape file and/or ASCII nodes;

D. Intensity: GEOTIFF;

E. LAS 1.1 ASPRS LIDAR data format standard, or Version 2.0 or later as available. For information on Version 1.1, see: http://www.asprs.org/publications/pers/2005journal/july/

The media for deliverables shall be DVD. Contractor shall maintain a copy of the data until NGS acknowledges receipt.

3.6 DATA FLOW

A. Acquisition Contractor (AC) acquires data;

B. AC processes data to NGS specifications;

C. AC validates data versus check points;

D. AC ships data to NGS;

E. NGS receives data, assumes responsibility, reviews data, notifies AC of review outcome;

F. If during the NGS review, the data is found to not meet the Scope of Work (SOW), the Contractor may be required to re-acquire the data.

3.7 COMPLETION DATE - All deliverables shall be received by NGS, as specified, no later than the date in the Project Instructions.

4. EQUIPMENT AND MATERIAL

4.1 INERTIAL MEASUREMENT UNIT - The Inertial Measurement Unit (IMU) employed in the LIDAR system shall meet or exceed the following performance specifications:

A. Accuracy in roll and pitch (RMS): 0.015^{o}

B. Accuracy in heading (RMS): 0.050^{o}

4.2 LIDAR SENSOR

A. MAINTENANCE – The Contractor shall supply certification to NGS before the project is commenced that preventive maintenance and factory calibration have been satisfactorily completed within the last two years for the LIDAR sensor.

B. DATA COLLECTION

i. Carrier-phase L1 and L2 kinematic GPS shall be acquired and used in processing the trajectories. See section 9 for further details;
ii. The LIDAR system must acquire and output "intensity" data (i.e., data values proportional to the signal strength for each return);

iii. The LIDAR system shall record the "true" last pulse. For example, in a system that collects three returns, the third return must correspond to the last detectable pulse within the return waveform to maximize the probability of getting the true (or closest to true) terrain measurement below the vegetation; it is not acceptable to simply record the first three events.

C. MALFUNCTIONS – All LIDAR system malfunctions shall be recorded, and NGS notified. A malfunction is defined as a failure anywhere in the LIDAR sensor that causes an interruption to the normal operation of the unit. Also, record and report any malfunctions of the GPS or IMU collection systems.

4.3 AIRCRAFT

A. PLATFORM TYPE – The type of aircraft and the aircraft tail number used shall be stated on the LIDAR Flight Log (Appendix A) and all aircraft used in the performance of this Project shall be maintained and operated in accordance with all regulations required by the Federal Aviation Administration. Any inspections or maintenance of the aircraft for performance of this Project which results in missed data collection shall not be considered as an excusable cause for delay. The Contractor shall ensure that the aircraft has a proven service ceiling, with operating load (fuel, crew, sensor, and other required equipment), of not less than the highest altitude required to acquire the data.

B. PORT OPENING – The design of the port opening(s) in the aircraft shall be such that the field of view is unobstructed when a sensor is mounted with all its parts above the outer structure. The field of view shall, so far as is practicable, be shielded from air turbulence and from any outward flows, such as exhaust gases, oil, etc.

C. OPTICAL FLAT – NGS recommends that an optical flat not be used. If an optical flat is used, the physical characteristics of the window (such as size, thickness, smoothness, flatness, parallelism, glass quality, and optical transmissivity) shall be reported to NGS prior to use. The optical flat shall meet the following specifications:

i. High transmittance at the laser wavelength;
ii. Mounted in material eliminating mechanical stress to the window;
iii. Free of blemishes, dirt, significant scratches, etc.;
iv. Not degrade the accuracy of the range measurements.

5. SYSTEM CALIBRATION

Inadequate calibration or incomplete calibration reports shall be cause for rejection of the data by NGS. Calibration reports for each LIDAR system used shall be supplied to NGS at the beginning and end of the project. The calibration reports shall cover each of the following types of calibration:

5.1 FACTORY CALIBRATION – Factory calibration of the LIDAR system shall address both radiometric and geometric performance and calibration. The following briefly describes the parameters to be tested according to test procedures defined by the manufacturer. Some of these procedures and parameters may be unique to a manufacturer since hardware varies from manufacturer to manufacturer.

A. Radiometric Calibration (sensor response):

i. Ensure that the output of the laser meets specifications for pulse energy, pulse width, rise time, frequency, and divergence for the model of LIDAR being tested;
ii. Measure the receiver response from a reference target to ensure that the response level of the receiver is within specification for the model of LIDAR system being tested;
iii. Check the alignment between transmitter and receiver and certify that the alignment is optimized and within specification;
iv. Measure T0 response of receiver (i.e., the response at the time the laser is fired) to ensure that the T0 level is within specification.

B. Geometric Calibration:

i. Range Calibration – Determine rangefinder calibrations including first/last range offsets, temperature dependence, and frequency offset of rangefinder electronics, range dependence on return signal strength. Provide updated calibration values;
ii. Scanner Calibration – Verify that scanner passes accuracy and repeatability criteria. Provide updated scanner calibration values for scanner offset and scale;
iii. Position Orientation System (POS)-Laser Alignment – Alignment check of output beam and POS. Also, provide updated POS misalignment angles.

Overall, the system shall be tuned to meet the performance specifications for the model being calibrated. The contractor shall ensure that, for each LIDAR system used, factory calibration has been performed within the 24-month period preceding the data collection. Recalibration is required at intervals no greater than 24 months. Contractors who wish to apply for a waiver to this requirement must send a written request to NGS stating the date of the last factory calibration and a detailed justification for the waiver.

5.2 FIELD CALIBRATION – Field calibration is performed by the system operator through flights over a calibration site that has been accurately surveyed using GPS or conventional survey techniques such as triangulation or spirit leveling. Typically, the calibration site may include a large, flat-roofed building whose corners have been accurately surveyed with GPS and a large, flat parking lot or runway. The calibration may include flights over the site in opposing directions, as well as cross flights. The field calibration is used to determine corrections to the roll, pitch, and scale calibration parameters. Field calibration must be performed for each project or every month, whichever is shorter.

5.3 DETERMINATION of sensor-to-GPS-antenna offset vector components (“lever arm”): The offset vector shall be determined with an absolute accuracy (1σ) of 1.0 cm or better in each component. Measurements shall be referenced to the antenna phase center. The offset vector components shall be redetermined each time the sensor or aircraft GPS antenna is moved or repositioned in any way.

6. MISSION PLANNING AND CLEARANCES

6.1 MISSION PLANNING

A. COVERAGE AND PARAMETERS – The Contractor shall plan flight lines for the project area (described in the Project Instructions) and ensure complete coverage of the project area. The mission planning parameters of: mass point spacing, swath width, swath overlap, navigation, GPS, visibility, tide-coordination, and point density shall be considered in planning. NGS may supply recommendations and/or requirements for planning parameters in the Project Instructions. The separate Project Instructions may define the point density of the mass points, Digital Surface Model (DSM), and other requirements.

B. OVERLAP – Adjacent swaths shall have a minimum overlap of no less than 25% of the mean swath width.

C. FLIGHT DIRECTION – Flight lines shall be flown in either direction, but adjacent, parallel lines should be flown in opposite directions to help identify systematic errors.

D. LIDAR SURVEY PLAN REPORT

1. PROPOSED FLIGHT LINES – Prior to data acquisition, the Contractor shall submit paper map(s) clearly showing all proposed flight lines, and include coverage, scale, tide stage, proposed ground control, and project area boundaries. Also included shall be information about scan angle, pulse repetition frequency (PRF), flying height, and flying speed over ground. Prepare a separate, one-sheet map for each stage of the tide. The base map shall be the largest scale nautical chart covering the entire project area, if possible.

2. ACTUAL LINES FLOWN – Similar map(s) showing the actual flight lines shall be included in the Final Report, see Section 13 U.

6.2 FLYING HEIGHT - Sensor shall not be flown at an altitude that exceeds that given in the manufacturer’s specifications or that results in a significant number of “drop-outs” (i.e., pulses for which no return is received.)

6.3 FLIGHT CLEARANCES - The Contractor shall comply with all required Federal Aviation Administration Regulations, including obtaining all required clearances.

7. WEATHER AND TIME OF YEAR

7.1 WEATHER CONDITIONS - LIDAR data acquisition missions shall be flown in generally favorable weather. Inclement weather conditions such as rain, snow, fog, mist, high winds, and low cloud cover shall be avoided. Such weather conditions have been known to affect or degrade the accuracy of the LIDAR data. If clouds are present, data capture is only permitted if cloud coverage is above the height of the sensor and airborne platform. LIDAR shall not be conducted when the ground is covered by water (flood), snow, or ice, and shall not be conducted when the land-water interface is obscured by snow, ice, etc. Storm systems and events (e.g. hurricanes, northeasters, and frontal boundaries) that may cause an increase in water levels, tidal heights, and wave activity shall be avoided.

7.2 TIME OF DAY - Data acquisition operations may occur during either day or night. Unlike aerial photography, sun angle is not a factor in when a mission may be flown. However, time of day needs to be considered when supplemental imagery (e.g., video, digital imagery) is acquired concurrently with the capture of LIDAR data to help assist in identifying features in post-processing production. Video and digital imagery should only be acquired simultaneously with LIDAR during the day, while LIDAR intensity returns can be gathered either day or night.

7.3 TIME OF YEAR - Consideration of the season should be taken into account when trying to depict the ground surface under vegetation. Vegetation should be leaf-off to help maximize the possibility of receiving a LIDAR return from the ground surface. Also, seasonal fluctuations in sandy beach dynamics should be considered. Beach profiles and morphology can significantly vary in response from the energy presented upon the system in relation to the sequencing and fluctuations of weather events and patterns.

8. TIDE COORDINATION

8.1 DATA COLLECTION TIDE CONDITIONS - All data collection shall be at a tide stage below MLLW. Data shall not be collected during strong onshore winds, high waves or other anomalous weather conditions. Contractor shall acquire and submit an offshore buoy report for the project area during time of data acquisition (www.ndbc.noaa.gov).

8.2 NGS SUPPLIED WINDOWS - The government will supply data acquisition time/tide windows for each coastal area to be mapped. These “windows” cover an extended range of possible flying dates. These time/tide windows will be determined by NGS initially to help ensure that all data meet the NGS tolerances for tide–coordinated data acquisition. If tide windows for additional dates are required, contact NGS.

8.3 CONTRACTOR-DETERMINED WINDOWS - If required by the Project Instructions, the Contractor shall determine predicted or actual acquisition time/tide windows (data acquisition times for tide coordination) for MHW and/or MLLW. Note, MHW is the mean of 19 years of high water and is not the high water level for any given day, except by coincidence. The same holds true for MLLW time/tide windows. The Project Instructions may also require the Contractor to install and/or monitor tide gauges in the project areas for either real–time or post–flight tidal height comparisons.

8.4 REQUIREMENTS - The Contractor shall acquire all data within the given time/tide windows and shall produce a table showing the times of the time/tide windows and the times of the data acquisition. Be sure to take into account time zones, daylight savings time, and to use UTC time.

9. POSITIONING AND ORIENTATION FOR THE DATA

9.1 POSITIONING

A. GPS COLLECTION

i. All LIDAR data shall be positioned using kinematic GPS using dual frequency receivers and oriented with an inertial navigation system;
ii. All kinematic GPS (KGPS) solutions should use differential, ionosphere-free, carrier-phase combinations with phase ambiguities resolved to their integer values;
iii. Aircraft trajectories shall be processed using carrier-phase GPS. Dual L1 and L2 frequency receivers and one-second collection shall be used;
iv. All KGPS shall use at least two ground stations. The ground stations shall be accurately tied to the NSRS (stations in the NGS database); shall be positioned to 0.1 m accuracy, or better; shall be within or near the project area; and shall be within 100 kilometers of the entire project area. Additional ground GPS stations may be required; and CORS (Continually Operating Reference Stations) can be used as ground stations. The ground stations should be positioned on opposite sides of the operating area. The ground stations shall be positioned, or the flight path arranged, so that during flight operations the aircraft will pass within 10 kilometers to each ground station at least once.
v. The maximum GPS baseline shall not exceed 100 kilometers at any time during flight. Regardless of aircraft flight time, GPS ground station data shall be collected for four hours;
vi. Ground station data shall be submitted to OPUS (Online Positioning User System – http://www.ngs.noaa.gov/OPUS/) for positioning in the NSRS, except where a ground station is located over a known monument.

B. GPS SOLUTION PROCESSING

i. The Contractor shall collect, process, and submit the ground and airborne GPS data, both raw data and final processed data.

ii. Differential KGPS solutions for the aircraft shall be obtained independently using each ground station.
iii. These independent KGPS solutions shall be compared to display their differences in the north-south, east-west, and vertical components during the operational portions of the flights.
iv. The RMS of these differences shall not exceed 5cm in the horizontal and 10cm in the vertical.
v. The KGPS solutions shall model the tropospheric delay using average surface meteorological values at the ground stations collected near the midpoint of operations.
vi. The final KGPS solution will be an average of the separate ground station solutions.

C. ANTENNA

i. The GPS receivers should be equipped with antennas that have been calibrated by NGS. A choke-ring antenna to minimize multipath is preferred but not required.
ii. The antenna height shall be accurately measured.

9.2 GROUND-BASED GPS RECEIVER

A. MARK – The ground-based receiver shall be set up over a known (or to-be-determined) marked base station and shall run continuously during the mission. If a known base station is used, it must be in the NGS database and hence part of the NSRS. If a new base station is used, it shall be marked permanently (to NGS specifications) or temporarily marked (such as a PK type nail or iron pin).

B. OBSERVATIONS – The position of an existing mark shall be checked by processing one GPS session and comparing the computed position with the NGS published position. A new mark shall be referenced to the NSRS by tying to one or more NGS Continuously Operating Reference Stations (CORS) by static GPS methods. If the distance to the nearest NGS CORS is less than 50 miles, use at least two independent sessions, each 2 hours long. If the distance to the nearest NGS CORS is greater than 50 miles, use at least two sessions, each 4 hours long. **Make a separate tripod set-up and height measurement for each session.** Take care in the accurate recording of the height of the antenna both before and after the flight. Record all heights, equipment serial numbers, etc. on the NGS forms: Visibility Obstruction Diagram and GPS Observation Log (see Attachment Q). For a listing of these and other forms on the NGS www site see: www.ngs.noaa.gov/PROJECTS/FBN/ . Also, static observations may be processed using the NGS On-Line Positioning User Service (OPUS) found at www.ngs.noaa.gov/OPUS/index.html. Observations to establish a new, permanent mark shall be submitted in NGS "Blue Book" format.

C. RECOVERY – For an existing NSRS station, write a digital recovery note using the NGS on-line recovery note method at: http://www.ngs.noaa.gov/ngs-cgi-bin/recvy_entry_www.prl . For new stations, write digital descriptions using WinDesc, found at: http://www.ngs.noaa.gov/PC_PROD/pc_prod.shtml#WinDesc . See description format in

Attachment S. Older software WDDPROC may also be used.
~~in NGS format using NGS software WDDPROC. For a new, permanent station write a digital station description in NGS format using WDDPROC (See Attachment S).~~ For a new, temporary mark write a brief description adequate to recover the station. Take three photographs of the base station (photographs of the CORS station are not required). See Attachment R.

For additional specification guidance (beyond this SOW) on mark setting, GPS observations, data processing, and data submittal in NGS format, see the "General Specifications for Aeronautical Surveys, Volume I, Establishment of Geodetic Control on Airports" at:

www.ngs.noaa.gov/AERO/Supinst.html ;
www.ngs.noaa.gov/FGCS/BlueBook/ ; and
www.ngs.noaa.gov/PROJECTS/FBN/ .

9.3 AIRCRAFT GPS RECEIVER

A. GPS OBSERVATIONS – The aircraft's GPS receiver shall be able to collect carrier phase observations and record, at least, once per second, from a minimum of four satellites (five or more preferred) at both the aircraft and the ground GPS receivers, for off-line processing. All data shall be collected with a Position Dilution of Precision (PDOP) of less than 3. After the post–processing, the GPS observation and ephemeris files are used to determine a flight path trajectory.

B. GPS LOCK – The aircraft shall maintain GPS satellite lock throughout the entire flight mission. If satellite lock is lost, on-the-fly ambiguity resolution methods may be used to recapture lock, while airborne. Report these instances, procedures used, and any other unusual occurrences.

9.4 AIRBORNE ORIENTATION - An Inertial Measurement Unit (IMU) shall be incorporated into the LIDAR unit. The IMU system shall be capable of determining the absolute orientation (roll, pitch, and yaw) at a minimum of 50Hz. See Section 4.1.

9.5 AIRBORNE POSITIONING AND ORIENTATION REPORT - The Report shall include at least the following paragraphs:

- Introduction,
- Positioning
    - Data Collection
    - Static Processing
    - Kinematic Processing
    - Data Sets
- Orientation
    - Data Collection
    - Data Processing

– Data Sets
– Final Results.

A. INTRODUCTION – Provide an overview of the project and the final processed data sets and list the data sets in table form with the following columns: Dataset ID, Date of Acquisition, Projects covered by the data set, and Description/Flight Line(s) Identification.

B. POSITIONING – Discuss the methodology, the hardware and software used (including models, serial numbers, and versions), the CORS station(s) used, a general description of the data sets, flight lines, dates and times of sessions, the processing (including the type of solution– float, fixed, ion–free, etc.), and the results (discussion of the coordinates and accuracy) . Submit a description of the data sets, and the raw and processed data. If the NGS OPUS website was used to process the static data, the Contractor shall provide a copy of the OPUS report. If a known station was used from the NGS database, the Contractor shall identify the station by name and permanent identifier (PID), and provide the published coordinates used in the kinematic position step. If multiple base stations were used, provide processing details, coordinates, and accuracy for all stations.

C. ORIENTATION – Discuss the factors listed above for Positioning.

D. FINAL RESULTS – Describe any unusual circumstances or rejected data, and comment on the quality of the data.

10. EYE SAFETY

Because LIDAR systems typically employ Class 4 lasers, safety is a paramount concern. ANSI standards for safety shall be followed. See ANSI Z136.1 Safe Use of Lasers and ANSI Z136.6 Safe Use of Lasers Outdoors. For further details regarding safety issues in LIDAR data collection, refer to *Eye Safety Concerns in Airborne Lidar Mapping* (Flood, 2001, ASPRS Conference Proceedings). The contractor shall assume sole responsibility for adherence to all safety regulations and shall implement necessary internal controls to ensure the safety of all persons in the aircraft and in the survey area below.

11. DATA LABELING

All DVDs shall be labeled with the **project name**, **collection date(s)**, **Contractor name**, and **disk contents**. LIDAR data DVDs shall be able to be easily matched with the corresponding LIDAR flight log(s).

12. DATA SHIPMENT AND PROCESSING

12.1 SHIPMENT - The Contractor shall ship final deliverables in NGS format (on DVD), directly to NGS, to arrive at NGS within ten working days from the date the data was processed. Copies of the LIDAR Flight Log and the raw navigation files may be made and used by the Contractor to produce and check the final deliverables.

12.2 NGS NOTIFICATION - The same day as shipping, the Contractor shall notify NGS of the data shipment's contents and date of shipment by submitting the information via TOMIS. ~~transmitting to NGS a paper or digital copy of the data transmittal letter via email or fax.~~

13. DELIVERABLES

13.1 LABOR, EQUIPMENT AND SUPPLIES – The Contractor shall provide all labor, equipment (including aircraft and LIDAR system), supplies and material to produce and deliver products as required under this document.

13.2 LIDAR SURVEY PLAN – Prior to data acquisition, submit a proposed LIDAR Survey Plan which specifies the data collection parameters to be used and contains a map of the flight lines and the project coverage area, including flying height and speed over ground, scan angle, and PRF. The separate Project Instructions supplied by NGS will define the project area(s) and may define the point density of the mass points, Digital Surface Model (DSM), and other requirements. See Section 6. NGS will review the proposed mission planning reports, normally within five business days, and will respond in writing with approval and/or comments. The Final Report shall contain map(s) showing the flight lines and boundaries of LIDAR data actually collected.

13.3 LIDAR TEST – The Contractor shall acquire and deliver an example dataset over a section of coastline and/or coastal ports which are similar to the contract work (see separate Project Instructions). Tide coordination and Ellipsoid/Tidal relationship support may be required. If VDatum is available in the project area, it may be used instead of developing a Ellipsoid/Tidal relationship. VDatum is a software tool that converts elevation data (heights and soundings) among 28 different vertical datums (see Milbert and Hess, 2001 or the NGS website at www.ngs.noaa.gov).

13.4 LIDAR RAW DATA – Submit the completed data collection raw output.

13.5 LIDAR PRODUCTS – Required products may include: contour maps, Digital Elevation Models (DEM), Triangulated Irregular Networks (TINS), and intensity images. The Project Instructions will specify which additional products, if any, are required. See Section 3.

13.6 FLIGHT REPORTS – Submit the completed, original LIDAR Flight Logs with the data, and a copy directly to NGS. For a sample flight log see Annex A.

13.7 GLOBAL POSITIONING SYSTEM (GPS)/INERTIAL MEASUREMENT UNIT (IMU) FILES – The Contractor shall submit the original, raw data files and processed trajectory files directly to NGS, to arrive at NGS along with the raw data points and final products. See sections 9.1 and 9.4.

13.8 AIRBORNE POSITIONING AND ORIENTATION REPORT – Submit raw GPS and IMU data along with the final processed GPS trajectory and postprocessed IMU data. Also submit a report covering the positioning and orientation of the LIDAR. See Section 9.5.

13.9 RANGE AND SCANNER ANGLE FILES – The Contractor shall submit the original, raw data files directly to NGS, to arrive at NGS along with the raw data points and final products.

13.10 GPS CHECK POINTS – Submit an organized list of all GPS points used for the project as base stations and check points. Indicate which GPS points are existing ground control and which stations are new and positioned relative to the NSRS. See Project Instructions and sections 3 and 9.2 A and B.

13.11 NGS SURVEY FORMS – The Contractor shall prepare and submit the following NGS forms for each GPS check point and the GPS base station(s): Visibility Obstruction Diagram, GPS Observation Log, Recovery Note or Station Description. See Section 9.2 and Attachment Q for samples.

13.12 TIDE COORDINATION TABLE – Supply table(s) showing the actual times of acquisition flights and the tide coordination time "windows." See Section 8. Explain any discrepancies.

13.13 CALIBRATION REPORTS – There is no standard format for the calibration reports. However, the calibration reports shall contain, at a minimum, the following information:

A. The date the calibration was performed.

B. The name of the person, company, or organization responsible for performing the calibration.

C. The methods used to perform the calibration.

D. The final calibration parameters or corrections determined through the calibration procedures.

13.14 SENSOR MAINTENANCE – Provide maintenance history directly to NGS of the sensor to be used for acquiring LIDAR. See Section 4.2 A.

13.15 SENSOR PORT WINDOW – Report the physical characteristics of any port window used to NGS. See Section 4.3 B.

13.16 DATA SHIPMENT – See Sections 3 and 15 for instructions.

13.17 DATA SHIPMENT REPORTING – The Contractor shall submit via TOMIS ~~FAX or e-mail to NGS~~ a digital copy of the LIDAR Flight Log (marked "copy"). This shall be done the same day the data is shipped. See Section 12.

~~The Contractor shall notify NGS of each data shipment's contents and date of shipment by transmitting to NGS a paper or digital copy of the LIDAR Flight Log (marked "copy" at the top) and a copy of the data transmittal letter via email or facsimile. This shall be done the same day the data is shipped to the data processing contractor. See Section 15.~~

13.18 UNUSUAL CIRCUMSTANCES – The Contractor shall also notify NGS of any unusual circumstances that occur during the performance of this project which might affect the deliverables or their quality and especially of any deviation from this project. This may be included in the weekly status report required below, unless urgent.

13.19 DEVIATIONS FROM SCOPE OF WORK – Requests to exceed or deviate from the Project Instructions will be considered if written justification is provided to NGS in advance. No deviation is permitted until written approval is received from NGS.

13.20 STATUS REPORTS – The Contractor shall submit project weekly status reports to NGS via TOMIS ~~email to the Contracting Officer's Technical Representative (COTR) contacts in Section 14 every week,~~ ~~until the work is complete.~~ **These reports are due at NGS by 2:00 p.m. EST each Monday,** from the date of a Task Order award until the work is complete and accepted by NGS.**.** These reports shall include a summary of completed data acquisition, with dates completed; data shipped, and dates; and any unusual circumstances, equipment malfunctions, and/or any disturbance of the sensor. **A weekly status report is required even if no progress has been made.** See the format in Attachment G.

13.21   FINAL REPORT - The Contractor shall supply to NGS a Final Report incorporating all of the information in this Deliverables section including, at least, the sections suggested below:

A. Work performed under this contract, discuss each deliverable including: the maximum range from the base station, the minimum swath overlap, percent of good laser returns (if available), standard deviation and residuals in GPS trajectories, and an explanation of the DVD labeling;

B. Equipment used to perform this work, including hardware models and serial numbers, calibration reports, and software names and versions (include aircraft and LIDAR info);

C. Flight line map(s), and project coverage area;

D. Discussion of data quality including quality assurance (QA)/quality control (QC) procedures;

E. Ground Control Report, including a station list in table format;

F. Aircraft Navigation;

G. Airborne kinematic GPS Report, including ground stations;

H. Weather, solar altitude, and time of year;

I. Tide Coordination Report and Table;

J. Any unusual circumstances or problems, including equipment malfunctions (including those already reported);

K. Any deviations from this LIDAR SOW, including those already reported;

L. Any recommendations for changes in the LIDAR SOW for future work.

13.22 PROPERTY OF DATA – All original data, from the instant of acquisition, and other deliverables required through this contract including raw data and final products, are and shall remain the property of the United States Government. This includes data collection outside the project area.

14. REVIEW

Data and other deliverables not meeting these specifications may be rejected.

15. POINTS OF CONTACT:

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Contracts Technical Manager
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NOAA
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16. REFERENCES

Flood, M. *Eye Safety Concerns in Airborne Lidar Mapping*. Proceedings of the ASPRS 2001 Annual Convention, 23-27 April, St. Louis, Missouri (American Society for Photogrammetry and Remote Sensing, Bethesda, Maryland), unpaginated CD-ROM, 2001.

Milbert, D. G., and K. Hess. *Combination of Topography and Bathymetry through Application of Calibrated Vertical Datum Transformation in the Tampa Bay Region*. Proceedings of the 2nd Biennial Coastal GeoTools Conference, Charleston, SC, January 8-11, 2001.

ANNEX 1: LIDAR FLIGHT LOG

LIDAR Flight Log Date:____________ Pilots:__________________ Operator:____________

Project:_______________

Strip	Start Time	Stop Time	AGL (ft)	Gnd Speed (kts)	PDOP	SVs	Hdg	Scan F	Scan Angle	Comments

Version 4A
January 29, 2008

ATTACHMENT Z
Digital Imagery Acquisition Requirements

TO
SCOPE OF WORK FOR SHORELINE MAPPING
UNDER THE
NOAA COASTAL MAPPING PROGRAM

REMOTE SENSING DIVISION
NATIONAL GEODETIC SURVEY
NATIONAL OCEAN SERVICE
NATIONAL OCEANIC & ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE

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ATTACHMENT Z: DIGITAL IMAGERY REQUIREMENTS

1. GENERAL

The Coastal Mapping Program (CMP) works to provide a regularly-updated and consistent national shoreline to define America's marine territorial limits and manage coastal resources. This shoreline is present on National Oceanic and Atmospheric Administration (NOAA) nautical charts and is considered authoritative when determining the official shoreline for the United States. The CMP is administered by the National Geodetic Survey (NGS), National Ocean Service (NOS), NOAA. This Scope of Work defines requirements for digital imagery acquisition and processing to support the CMP. Project Instructions will provide project-specific information.

The following conventions have been adopted for this document. The term "shall" means that compliance is required. The term "should" implies that compliance is not required, but is recommended. All times shall be recorded in Coordinated Universal Time (UTC). Any request to deviate from this Scope of Work shall be submitted in advance in writing for possible approval by NGS.

2. GOVERNMENT

2.1 PROPERTY OF DATA – All original data and imagery, from the instant of acquisition, and other deliverables required through this contract including final images, are and shall remain the property of the United States Government. This includes image collection outside the project area.

2.2 DATA - The government will provide to the Contractor:

A. PROJECT INSTRUCTIONS – Project Instructions are a separate document providing specific project information, containing any unique project requirements, and may have the following attachments:

i. Small scale maps showing the coastline and/or coastal ports to be acquired;
ii. Tide coordination time windows for image acquisition, see Section 8.

B. DIGITAL IMAGERY ACQUISITION REQUIREMENTS - this document.

C. REJECTED IMAGERY – If images are rejected by NGS (for reasons that may include, but are not limited to: flooding, smoke, snow, over-exposure, cloud cover, distortion, sun angle), NGS will send sample images upon request showing the problem areas.

3. IMAGERY TESTING AND STANDARDS

3.1 DIGITAL IMAGERY TEST – The Contractor shall acquire and deliver images over a section of coastline and/or coastal ports which is similar to the contract work. The test data set shall include all bands used for imagery collection. NGS will review this imagery test as soon as possible and notify the Contractor of the results of the review. The Contractor shall not proceed with continued imagery collection until it has received approval from NGS. If NGS rejects the imagery test, a repeat test shall be required. See 12.3 and separate Project Instructions.

3.2 GEODETIC STANDARDS FOR IMAGE PROCESSING

A. The horizontal datum is the North American Datum 1983 (NAD 83);

B. The vertical datum is the North American Vertical Datum of 1988 (NAVD 88). In Alaska and other areas outside the continental United States where NAVD 88 bench marks are not available, the Contractor shall make GPS ties to tidal bench marks within the project area;

C. The geoid model to be used in converting GPS-derived ellipsoid heights to NAVD 88 orthometric heights is GEOID03 or the most current version. For GEOID information see: www.ngs.noaa.gov/GEOID/GEOID03/ , in Alaska use GEOID06, see: http://www.ngs.noaa.gov/PC_PROD/GEOID06/ ;

D. The contractor shall record all processing steps and software used including version number;

E. The contractor shall use either the rapid or precise IGS orbit ephemeris for GPS processing.

3.3 DATA FORMAT STANDARDS

A. The format of the digital imagery deliverables shall be uncompressed TIFF images;

B. The media for the deliverables shall be DVD, portable hard drive, or secure FTP server, depending on feasibility of data transfer and the amount of data. Contractor shall maintain a copy of the data until NGS acknowledges receipt.

4. EQUIPMENT AND MATERIAL

4.1 DIGITAL IMAGING SYSTEM

A. SPECIFICATIONS

i. The sensor shall be a geometrically stable and calibrated system suitable to use for high-accuracy photogrammetric mapping;
ii. The sensor shall be of a high enough resolution and have a large enough Field of View (FOV) to provide the required Ground Sample Distance (GSD) and stereo coverage of a ground swath defined in the Project Instructions.

B. MAINTENANCE – The Contractor shall supply certification to NGS before the project is commenced to prove that preventive maintenance and system calibration have been satisfactorily completed for the digital sensor.

C. CALIBRATION – See section 5.

D. IMAGE COLLECTION – The digital imaging system shall acquire visible (RGB) and/or infrared, or Color Infrared (G, R, IR) imagery depending on the Project Instructions. The raw image is defined as the data that is retrieved from the sensor system before any conversion to processed format. If any radiometric image enhancement is performed on the raw images following image collection, the raw images must be submitted along with enhanced images. All use of contrast, brightness, and other radiometric image enhancements shall be discussed in the final report.

E. MALFUNCTIONS – All digital imaging system malfunctions shall be recorded and NGS notified. A malfunction is defined as a failure anywhere in the digital sensor that causes an interruption to the normal operation of the unit. Also, any malfunctions of the GPS or Inertial Measurement Unit (IMU) collection systems shall be recorded and reported directly to NGS.

4.2 INERTIAL MEASUREMENT UNIT - If an IMU is employed in the digital imaging system, the IMU shall be capable of determining the absolute orientation (roll, pitch, and yaw) and meet or exceed the following performance specifications:

A. Post-processed accuracy in roll and pitch: 20";

B. Post-processed accuracy in heading: 30".

4.3 GLOBAL POSITIONING SYSTEM - Carrier-phase L1 and L2 airborne kinematic GPS shall be acquired and used along with IMU measurements (if IMU is used) in processing trajectories. The performance specification for post-processed positioning solution accuracy shall be no worse than 30cm relative to the National Spatial Reference System (NSRS).

The GPS antenna shall be an FAA-approved antenna (following appropriate safety and structural air-worthiness considerations) suitable for geodetic quality carrier-phase L1 and L2 reception and installed in accordance with FAA airframe modification requirements. Antenna should be located in a location near the camera to minimize lever arm lengths, and also in a location to provide optimal GPS signal quality and continuous reception in an appropriate, unobstructed location on the plane.

4.4 AIRCRAFT

A. PLATFORM TYPE – All equipment shall be connected, attached, mounted and secured to the aircraft airframe in a manner to provide a safe environment for the crew. The type of aircraft and the aircraft tail number used shall be stated on the digital sensor Flight Log and all aircraft and airframe modifications used in the performance of this Project shall be maintained and operated in accordance with all regulations required by the Federal Aviation Administration. Any inspections or maintenance of the aircraft for performance of this Project which results in missed data collection shall not be considered as an excusable cause for delay. The Contractor shall ensure that the aircraft has a proven service ceiling, with operating load (fuel, crew, sensor, and other required equipment), of not less than the highest altitude required to acquire the data.

B. PORT OPENING – The design of the port opening(s) in the aircraft shall be such that the field of view is unobstructed when a sensor is mounted with all its parts above the outer structure. The field of view shall, so far as is practicable, be shielded from air turbulence and from any outward flows, such as exhaust gases, oil, etc.

C. OPTICAL FLAT – NGS recommends that an optical flat not be used. If an optical flat is used, the physical characteristics of the window (such as size, thickness, smoothness, flatness, parallelism, glass quality, and optical transmissivity) shall be reported to NGS prior to use. The optical flat shall meet the following specifications:

i. Optical quality;
ii. Mounted in material eliminating mechanical stress to the window;
iii. Free of blemishes, dirt, significant scratches, etc;
iv. Shall not degrade the resolution or the accuracy of the camera.

Any optical flat should meet the American Society of Photogrammetry and Remote Sensing Aerial Photography Standards, 1995, which states, “If an aircraft camera has a port glass it shall be preferable 50mm thick but not less than 37mm thick. The surface finish shall be 80/50 or better. Glass material shall be polished crown, group category M. Mil Specs Mil-W-1366F (ASG) October 1975, C-1 optical quality or better.”

5. SYSTEM CALIBRATION

The digital imaging system shall be calibrated along with a calibration report submitted. Any incomplete reports shall be cause for rejection of the data. Calibration reports for each digital imaging system used shall be supplied to NGS at the beginning and if the system is removed and remounted during the project. The contractor shall follow manufacturer's specifications for appropriate calibration and recalibration.

The calibration reports shall cover each of the following topics:

A. SYSTEM CALIBRATION – System calibration shall address geometric performance. Parameters to be tested include calibrated focal length, lens distortion parameters, and principal point location. Also, any radiometric calibration parameters and files shall be provided to NGS. Some of these procedures and parameters may be unique to a manufacturer since hardware varies from manufacturer to manufacturer. The IMU-to-camera alignment shall be checked. Also, updated IMU misalignment angles should be provided as evaluated.

B. BORESIGHT CALIBRATION VALUES – The boresight calibration is the determination of relative orientation between camera and IMU reference frames. If IMU georeferencing will be used, boresight calibration shall be performed according to manufacturer specifications for each project or any time the camera or IMU is mounted or removed. The contractor shall supply NGS with a boresight calibration report indicating the method used in boresighting and the final values.

C. DETERMINATION OF OFFSETS – The sensor-to-GPS-antenna offset vector components ("lever arm") shall be measured. The offset vector shall be determined with an absolute accuracy (1σ) of 1.0 cm or better in each component. By convention, this vector is measured from the incident nodal point of the camera lens to the GPS antenna phase center in the coordinate system of the camera. The offset vector components shall be redetermined each time the sensor or aircraft GPS antenna is moved or repositioned in any way.

6. MISSION PLANNING AND CLEARANCES

6.1 MISSION PLANNING

A. COVERAGE AND PARAMETERS – The Contractor may be required to plan flight lines for the project area (described in the Project Instructions) and ensure complete coverage of the project area. The mission planning parameters, including: ground space distance, endlap, sidelap, flying speed, flying height, GPS, visibility, and tide-coordination, shall be considered in planning. NGS may supply recommendations and/or requirements for planning parameters in the Project Instructions.

B. IMAGE ACQUISITION STANDARDS

i. PDOP/VDOP shall be < 3;
ii. Aircraft bank angle shall not exceed 15 degrees.

C. GROUND SAMPLE DISTANCE – The ground sample distance (GSD) is the area on the ground represented by each pixel in a digital image. The GSD depends on the project, though 20 to 60 cm should be considered typical. See Project Instructions for final parameters.

D. FLYING HEIGHT AND SPEED – Flying height depends on the required GSD. See Project Instructions. Manufacturer's specifications should be followed for flying speed. If forward motion compensation (FMC) is not used, flying speed shall be limited to keep image smear below 15%. The maximum speed over ground (SOG) for push broom sensors should not exceed manufacturer's guidelines.

E. SIDELAP – Adjacent images shall have a minimum sidelap of 30% of the mean image width if the camera mount provides correction for crab, otherwise 40%. See Project Instructions for final parameters.

F. ENDLAP – Consecutive images in a flight line shall have a minimum endlap of 60% of the mean image width if the camera mount provides correction for crab, otherwise 70%. This section does not apply to push broom sensors. See Project Instructions for final parameters.

G. CRAB – While collecting digital imagery, the camera shall be compensated for crab of the aircraft, with a resultant error not exceeding +/- five (5) degrees, as measured from the average line of flight, and the differential between any two successive exposures shall not exceed +/- five (5) degrees.

H. TILT – Care shall be taken to keep tilt (departure from the vertical) of the camera to a minimum. Tilt shall not exceed +/- five (5) degrees for any photographic frame. The average tilt for the entire project shall not exceed +/- one (1) degree.

I. DIGITAL IMAGE COLLECTION PLAN REPORT

i. PROPOSED FLIGHT LINES – Prior to data acquisition, the Contractor should submit, if tasked, paper map(s) clearly showing all proposed flight lines, and include coverage, scale, tide stage, proposed ground control, and project area boundaries. Also included shall be information about flying height and flying speed over ground. Prepare a separate, one-sheet map for each stage of the tide. The base map shall be the largest scale nautical chart covering the entire project area, if possible;

ii. ACTUAL LINES FLOWN – Similar map(s) showing the actual flight lines as flown shall be included in the Final Report, see Section 12.16.

6.2 FLIGHT CLEARANCES - The Contractor shall comply with all required Federal Aviation Administration Regulations, including obtaining all required clearances.

7. WEATHER CONDITIONS AND TIME OF YEAR

7.1 WEATHER - No clouds or cloud shadows shall appear on the photographs. High, thin overcast clouds will be permitted above the flying altitude if it does not cause ground mottling or a discernable reduction in light levels and/or ground object shadows. Digital imaging shall not be conducted when clouds or cloud shadows appear in the scene or if the land-water interface is obscured by snow, ice, etc. Storm systems and events (e.g. hurricanes, northeasters, and frontal boundaries) that may cause an increase in water levels, tidal heights, and wave activity shall be avoided.

7.2 TREE LEAVES - Any stage of leaf coverage is acceptable as long as the land-water interface is not obscured.

7.3 WELL-DEFINED IMAGES - Imagery collection shall be undertaken only when the land-water interface can be well-defined. Imagery shall not be attempted where the ground is obscured by clouds, haze, smoke, smog, dust, snow, sleet, rain, etc. Also, imagery shall not be conducted when the ground, and especially land-water interface, is covered by water (flood), snow, or ice.

7.4 VISIBILITY - The minimum visibility at the time of exposure is eight (8) miles. Imagery shall not be collected when a haze is present. Visibility is determined by looking at objects on the ground toward the sun. The distance at which the detail of ground objects is clearly defined is the visibility. If the visibility is satisfactory, details of ground objects shall be clearly defined at the edge of the view through the drift sight (assuming the system makes use of a drift sight which may not be the case for some automated digital systems).

7.5 TIME OF DAY - Time of day is determined by the sun angle which shall not be less than 30 degrees above the horizon at the time of exposure. The Project Instructions may require a larger sun angle for certain projects. Ideally, the sun angle should be between 30 and 45 degrees for shoreline photography. Photography should be collected while the sun is over the water so that any shadows created by elevated objects will point inland and will not obscure the shoreline.

The size and number of hot spots (no sun shadow points) and “sun spots” (bright, sun reflectance areas) on the water and shoreline must be kept to a minimum and eliminated if possible because these bright spots can obscure important features. During flight planning, flight line directions and times should be arranged to preclude the occurrence of these spots in critical areas of the photographs (especially shoreline and near shoreline areas).

Sun angles for a given day can be determined from a "Solar Altitude Diagram" or from appropriate computer software. For on-line sun angle solutions, see the U.S. Naval Observatory's WWW site: http://aa.usno.navy.mil/data/docs/RS_OneDay.php which computes sun altitudes and sun azimuths for U.S. locations and world-wide positions.

7.6 CLEAR DAY MAP – Refer to www.ncdc.noaa.gov . Please see Attachment C, section 9.6 for direction on obtaining the maps from the above website.

7.7 TIME OF YEAR - Consideration of the season should be taken into account when trying to image the ground surface. Project Instructions may discuss seasonal fluctuations in sandy beach dynamics. Beach profiles and morphology can significantly vary in response from the energy presented upon the system in relation to the sequencing and fluctuations of weather events and patterns.

8. TIDE COORDINATION

8.1 IMAGE COLLECTION TIDE CONDITIONS - Image collection may need to be at tide-coordinated stages depending on the required tide stage defined by the Project Instructions. Imagery shall not be collected during strong onshore winds, high waves or other anomalous weather conditions. The contractor shall acquire, analyze, and submit an offshore buoy report and other weather data for the project area during time of data acquisition (National Data Buoy Center: www.ndbc.noaa.gov, National Climatic Data Center: lwf.ncdc.noaa.gov/oa/ncdc.html).

8.2 WINDOWS

A. NGS-SUPPLIED – The government may supply image acquisition time/tide windows for each coastal area to be mapped, or the contractor may be tasked with window determination. These "windows" cover an extended range of possible flying dates. These time/tide windows will be determined by NGS initially to help ensure that all data meet the NGS tolerances for tide-coordinated image acquisition. If tide windows for additional dates are required, contact NGS.

B. CONTRACTOR-DETERMINED – If required by the Project Instructions, the Contractor shall determine predicted acquisition time/tide windows (data acquisition times for tide coordination) for MHW and/or MLLW. Note, MHW is the mean of 18.6 years of high water and is not the high water level for any given day, except by coincidence. The same holds true for MLLW time/tide windows. The Project Instructions may also require the Contractor to install and/or monitor tide gauges in the project areas for either real-time or post-flight tidal height comparisons.

8.3 REQUIREMENTS - The Contractor shall acquire imagery within the given time/tide windows as required and shall produce a table showing the times of the time/tide windows and the times of the data acquisition. Be sure to take into account time zones, daylight savings time and to use Coordinated Universal Time (UTC).

9. POSITIONING AND ORIENTATION

9.1 POSITIONING

A. GPS COLLECTION

i. All imagery shall be positioned using kinematic GPS having dual frequency receivers and oriented with an inertial navigation system;
ii. All kinematic GPS (KGPS) solutions should use differential, ionosphere-free, carrier-phase combinations with phase ambiguities resolved to their integer values;
iii. Aircraft trajectories shall be processed using carrier-phase GPS. Dual L1 and L2 frequency receivers and one-second collection shall be used;
iv. All KGPS shall use at least two ground stations. The ground stations shall be accurately tied to the NSRS (stations in the NGS database); shall be positioned to 0.1 meter accuracy, or better; shall be within or near the project area; and shall be within 100 kilometers of the entire project area. Additional ground GPS stations may be required, and CORS (Continually Operating Reference Stations) can be used as ground stations. The ground stations should be positioned on opposite sides of the operating area. The ground stations shall be positioned, or the flight path arranged, so that during flight operations the aircraft will pass within 10 kilometers to each ground station at least once;
v. The maximum GPS baseline shall not exceed 100 kilometers at any time during flight. Regardless of aircraft flight time, GPS ground station data shall be collected for four hours;
vi. Ground station data shall be submitted to OPUS (Online Positioning User System – http://www.ngs.noaa.gov/OPUS/) for positioning in the NSRS, except where a ground station is located over a known monument.

B. GPS SOLUTION PROCESSING

i. The Contractor shall collect, process, and submit the ground and airborne GPS data, both raw data and final processed data;
ii. Differential KGPS solutions for the aircraft shall be obtained independently using each ground station;
iii. These independent KGPS solutions shall be compared to display their differences in the north-south, east-west, and vertical components during the operational portions of the flights;
iv. The RMS of these differences shall not exceed 5cm in the horizontal and 10cm in the vertical;
v. The KGPS solutions shall model the tropospheric delay using average surface

meteorological values at the ground stations collected near the midpoint of operations;
vi. The final KGPS solution will be an average of the separate ground station solutions.

C. ANTENNA

i. The GPS receivers should be equipped with antennas that have been calibrated by NGS. A choke-ring antenna to minimize multipath is preferred but not required.
ii. The antenna height shall be accurately measured.

9.2 GROUND-BASED GPS RECEIVER

A. MARK – The ground-based receiver shall be set up over a known (or to-be-determined) marked base station and shall run continuously during the mission. If a known base station is used, it must be in the NGS database and hence part of the National Spatial Reference System (NSRS).

B. OBSERVATIONS – The position of an existing mark shall be checked by processing one GPS session and comparing the computed position with the NGS published position. A new mark shall be referenced to the NSRS by tying to one or more NGS Continuously Operating Reference Stations (CORS), High Accuracy Reference Network (HARN) stations, or Primary Airport Control Stations (PACS) by static GPS methods. If the distance to the nearest reference receiver is less than 100 kilometers, use at least two independent sessions, each 2 hours long. If the distance to the nearest NGS CORS is greater than 100 kilometers, use at least two sessions, each 4 hours long. Make a separate tripod set-up and height measurement for each session. Take care in the accurate recording of the height of the antenna both before and after the flight. Record all heights, equipment serial numbers, etc. on the NGS forms: Visibility Obstruction Diagram and GPS Observation Log. For a listing of these and other forms on the NGS www site see: www.ngs.noaa.gov/PROJECTS/FBN/ . Also, static observations may be processed using the NGS On-Line Positioning User Service (OPUS) found at: www.ngs.noaa.gov/OPUS/index.html. Observations to establish a new, permanent mark shall be submitted in NGS "Blue Book" format (www.ngs.noaa.gov/FGCS/BlueBook/).

C. RECOVERY – For an existing NSRS station, write a digital recovery note using the NGS on-line recovery note method at: http://www.ngs.noaa.gov/ngs-cgi-bin/recvy_entry_www.prl . For new stations, write digital descriptions using WinDesc, found at: http://www.ngs.noaa.gov/PC_PROD/pc_prod.shtml#WinDesc . See description format in Attachment S. Older software WDDPROC may also be used.
~~in NGS format using NGS software WDDPROC. For a new, permanent station write a digital station description in NGS format using WDDPROC (See Attachment S).~~ For a new, temporary mark write a brief description adequate to recover the station. Take three

photographs of the base station (photographs of the CORS station are not required). See Attachment R.

For additional specification guidance on mark setting, GPS observations, data processing, and data submittal in NGS format, see the "General Specifications for Aeronautical Surveys, Volume I, Establishment of Geodetic Control on Airports" at:

www.ngs.noaa.gov/FGCS/BlueBook/ ;
www.ngs.noaa.gov/PROJECTS/FBN/ ; and
www.ngs.noaa.gov/AERO/Supinst.html .

9.3 AIRCRAFT GPS RECEIVER

A. GPS OBSERVATIONS – The aircraft's GPS receiver shall be able to collect carrier phase observations and record, at least, once per second, from a minimum of four satellites (five or more preferred) at both the aircraft and the ground GPS receivers, for off-line processing. All data shall be collected with a Position Dilution of Precision (PDOP) of less than 3 at a minimum elevation mask angle of 10 degrees. After the post–processing, the GPS observation and ephemeris files are used to determine a flight path trajectory.

B. GPS LOCK – The aircraft shall maintain GPS satellite lock throughout the entire flight mission. If satellite lock is lost, on-the-fly ambiguity resolution methods may be used to recapture lock, while airborne. Report these instances, procedures used, and any other unusual occurrences.

9.4 AIRBORNE POSITIONING AND ORIENTATION REPORT - The Report shall include at least the following paragraphs:

- Introduction,
- Positioning
    - Image Collection
    - Static Processing
    - Kinematic Processing
    - Data Sets
- Orientation
    - Data Collection
    - Data Processing
    - Data Sets
- Final Results.

A. INTRODUCTION – Provide an overview of the project and the final processed data sets and list the data sets in table form with the following columns: Dataset ID, Date of Acquisition, Projects covered by the data set, and Description/Flight Line(s) Identification.

B. POSITIONING – Discuss the methodology, the hardware and software used (including models, serial numbers, and versions), the CORS station(s) used, a general description of the data sets, flight lines, dates and times of sessions, the processing (including the type of solution–float, fixed, ion–free, etc.), and the results (discussion of the coordinates and accuracy). Submit a description of the data sets, and the raw and processed data. If the NGS OPUS website was used to process the static data, the Contractor shall provide a copy of the OPUS report. If a known station was used from the NGS database, the Contractor shall identify the station by name and permanent identifier (PID), and provide the published coordinates used in the kinematic position step. If multiple base stations were used, provide processing details, coordinates, and accuracy for all stations.

C. ORIENTATION – Discuss the factors listed above for Positioning.

D. FINAL RESULTS – Describe any unusual circumstances or rejected data, and comment on the quality of the data.

10. DATA LABELING

All DVDs shall be labeled with the project name, collection date(s), Contractor name, and disk contents. Digital imagery DVDs shall be able to be easily matched with the corresponding flight log.

11. DATA SHIPMENT AND PROCESSING

11.1 SHIPMENT - The Contractor shall ship final deliverables directly to NGS. Copies of the Flight Log and the raw navigation files may be made and used by the Contractor to produce and check the final deliverables. Raw digital images shall be sent on different DVDs or hard disks from all other data.

11.2 NGS NOTIFICATION – The same day as shipping, the Contractor shall notify NGS of the data shipment's contents and date of shipment by submitting the information via TOMIS. ~~transmitting to NGS a paper or digital copy of the data transmittal letter via email or fax.~~

11.3 DELIVERY DATE - All deliverables shall be received by NGS, as specified, no later than the date in the Project Instructions.

12. DELIVERABLES

12.1 LABOR, EQUIPMENT AND SUPPLIES – The Contractor shall provide all labor, equipment (including aircraft and digital imaging system), supplies and material to produce and deliver products as required under this document.

12.2 DIGITAL IMAGE COLLECTION SURVEY PLAN – Prior to data acquisition, submit a proposed Digital Image Collection Survey Plan which specifies the data collection parameters to be used and contains a map of the flight lines and the project coverage area, including flying height and speed over ground, focal length, ground space distance, sidelap, and endlap. The separate Project Instructions supplied by NGS will define the project area(s) and may define the flight lines, ground space distance, endlap, sidelap, and other requirements. See Section 5. NGS will review the proposed mission planning reports, normally within five business days, and will respond in writing with approval and/or comments. The Final Report shall contain map(s) showing the flight lines and boundaries of imagery actually collected.

12.3 DIGITAL IMAGERY TEST – The Contractor shall acquire and deliver images over a section of coastline and/or coastal ports which are similar to the contract work. The test data set shall include all bands used for imagery collection. Tide coordination may be required. See section 3.1 and separate Project Instructions.

12.4 RAW IMAGES – Submit the raw images on separate media from other deliverables.

12.5 DIGITAL IMAGERY PRODUCTS – Required products may include radiometrically enhanced images, ortho-rectified images and mosaics. The Project Instructions will specify which additional products, if any, are required.

12.6 FLIGHT REPORTS – Submit the completed, original Flight Logs with the data, and a copy ~~directly~~ to NGS via TOMIS. For a sample flight log see Annex A.

12.7 AIRBORNE POSITIONING AND ORIENTATION – The Contractor shall submit the original, raw GPS and IMU data files and processed trajectory files ~~directly~~ to NGS via TOMIS, to arrive at NGS along with the raw data points and final products. If IMU georeferencing is employed, submit the exterior orientation file with the EO parameters. See sections 4 and 9.

12.8 GPS POINTS – Submit an organized list of all GPS points used for the project as base stations, ground control, and check points. Indicate which GPS points are existing ground control and which stations are newly positioned relative to the NSRS. See Project Instructions and sections 4.3 and 9.2.

12.9 TIDE COORDINATION TABLE – Supply table(s) showing the actual times of acquisition flights and the tide coordination time “windows.” See Section 8. Explain any discrepancies.

12.10 CALIBRATION REPORTS – The calibration reports shall contain, at a minimum, the following information:

A. The date the calibration was performed;

B. The name of the person, company, or organization responsible for performing the calibration;

C. The methods used to perform the calibration;

D. The final calibration parameters or corrections, including any boresight calibration values, determined through the calibration procedures.

12.11 SENSOR MAINTENANCE – Provide maintenance history before completing project directly to NGS of the sensor to be used for acquiring images. See Section 4.1 B.

12.12 SENSOR PORT WINDOW – Report the physical characteristics of any port window used to NGS. See Section 4.4 B.

12.13 DATA SHIPMENT REPORTING – The Contractor shall submit data via TOMIS. ~~notify NGS of each data shipment's contents and date of shipment by transmitting to NGS a paper or~~ Mark "COPY" at the top of the digital copy of the Flight Log. ~~and a copy of the data transmittal letter via email or facsimile.~~ This shall be done the same day the data is shipped. to t~~he data processing contractor.~~ See Section 14.

12.14 UNUSUAL CIRCUMSTANCES – The Contractor shall also notify NGS of any unusual circumstances that occur during the performance of this project which might affect the deliverables or their quality and especially of any deviation from this project. This may be included in the weekly status report required below, unless urgent.

12.15 WEEKLY STATUS REPORTS – The Contractor shall submit project weekly status reports to NGS via TOMIS ~~email to the Contracting Officer's Technical Representative (COTR) contacts in Section 14 every week,~~ ~~until the work is complete.~~ **These reports are due at NGS by 2:00 p.m. EST each Monday,** from the date of a Task Order award until the work is complete and accepted by NGS.**.** These reports shall include a summary of completed data acquisition, with dates completed; data shipped, and dates; and any unusual circumstances, equipment malfunctions, and/or any disturbance of the sensor. **A weekly status report is required even if no progress has been made.** See the format in Attachment G.

12.16 FINAL REPORT - The Contractor shall supply to NGS a Final Report incorporating all of the information in this Deliverables section including, at least, the sections suggested below:

A. Work performed under this contract, discuss each deliverable including: the maximum range from the base station, standard deviation and residuals in GPS trajectories, and an explanation of the DVD labeling;

B. Equipment used to perform this work, including hardware models and serial numbers, calibration reports, and software names and versions (include aircraft and digital imaging system info);

C. Flight line map(s), and project coverage area;

D. Discussion of data quality including quality assurance (QA)/quality control (QC) procedures;

E. Ground Control Report, including a station list in table format;

F. Airborne navigation and kinematic GPS Report;

G. Weather, solar altitude, and time of year;

H. Tide Coordination Report and Table;

I. Any unusual circumstances or problems, including equipment malfunctions (including those already reported);

J. Any deviations from this Digital Imaging SOW, including those already reported;

K. Any recommendations for changes in the Digital Imaging SOW for future work.

13. REVIEW

Images and other deliverables not meeting these specifications may be rejected.

14. POINTS OF CONTACT

George E. Leigh
Contracts Technical Manager
National Geodetic Survey
NOAA
ATTN: N/NGS; SSMC3, Sta. 8613
1315 East–West Highway
Silver Spring, MD 20910
301-713-3167
email: George.Leigh@noaa.gov

Chris Parrish
Physical Scientist
Remote Sensing Division
NOAA, National Geodetic Survey
ATTN: SSMC3
1315 East–West Highway
Silver Spring, MD 20910
301-713-2663
email: Chris.Parrish@noaa.gov

15. GLOSSARY

CMP - Coastal Mapping Program
CORS - Continuously Operating Reference Stations
FOV - Field of View
GPS - Global Positioning System
GSD - Ground Sample Distance
IMU - Inertial Measurement Unit
MHW - Mean High Water
MLLW - Mean Lower Low Water
NGS - National Geodetic Survey
NOAA - National Oceanic and Atmospheric Administration
NSRS - National Spatial Reference System
OPUS - Online Positioning User System
PACS - Primary Airport Control Station
SACS - Secondary Airport Control Station
SOW - Scope of Work
UTC - Coordinated Universal Time

ANNEX 1: SUMMARY OF DIGITAL CAMERA IMAGERY ACQUISITION REQUIREMENTS

DIGITAL IMAGERY TEST - The contractor shall acquire and deliver images over a section of coastline and/or coastal ports which are similar to the contract work site.

GEODETIC REFERENCES - NAD 83, NAVD 88, and GEOID 03 (or latest version).

DATA FORMAT - TIFF

QUALITY CONTROL - Plan required.

SYSTEM - The sensor shall be geometrically stable and shall be calibrated. It shall also have sufficiently high resolution and have a large enough Field of View to provide the required Ground Sample Distance and stereo coverage. The system shall have had routine maintenance.

IMAGE COLLECTION - The digital imaging system shall acquire visible and/or infrared, or color infrared imagery depending on the project.

INERTIAL MEASUREMENT UNIT - If an IMU is employed it shall meet:

Post-processed accuracy in roll and pitch: 20"
Post-processed accuracy in heading: 30"

POSITIONING - Carrier-phase L1 and L2 airborne kinematic GPS shall be acquired and used in producing trajectories. Positions shall be not be worse than 30 cm relative to the NSRS.

MISSION PLANNING PARAMETERS - Typical photogrammetric parameters (flying height, overlap, crab, etc.) shall be used, except those required to be modified for the particular sensor.

WEATHER CONDITIONS - No clouds or cloud shadows. Data shall be collected only when well-defined images can be obtained. In addition to no clouds, imagery shall not be attempted when the ground is obscured by haze, smoke, smog, dust, or falling: snow, sleet, rain, etc. In addition, imagery shall not be collected when the land-water interface is obscured by snow, ice, flooding, etc.

VISIBILITY - Minimum is 8 miles.

SUN ANGLE - Minimum sun angle is 30 degrees. Sun spots should be avoided.

TIDE COORDINATION - May be required. The contractor may be required to compute tidal acquisition time windows, install and monitor tide gauges (including setting tidal bench marks and leveling), analyze and process tidal data, and monitor water levels, local weather, and off-shore weather conditions.

REPORTS - Produce reports, such as Photographic Flight Report, Electronic Exposure Data File, and Photo Final Report.

DELIVERABLES - Submit raw and processed data, raw and processed imagery, and reports explaining the data.

More detailed technical specifications will be included with the Project Instructions for individual projects.

Version 1
September 30, 2004

ATTACHMENT AA
HYPERSPECTRAL SCANNER REQUIREMENTS

TO
SCOPE OF WORK FOR SHORELINE MAPPING
UNDER THE
NOAA COASTAL MAPPING PROGRAM

REMOTE SENSING DIVISION
NATIONAL GEODETIC SURVEY
NATIONAL OCEAN SERVICE
NATIONAL OCEANIC & ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE

ATTACHMENT AA: HYPRESPECTRAL SCANNER REQUIREMENTS

Hyperspectral scanner imaging has not been approved for data acquisition in the NOAA Coastal Mapping Program (CMP). As such there are no specifications or requirements for its use in the CMP.

Hyperspectral scanner imaging may be requested, during the execution of this SOW, for use in research projects designed to develop specifications and requirements for its usage in the CMP at some future date.

The requirements and specifications particular to any research project will be given in the individual project instructions.

Version 1B
February 1, 2008

ATTACHMENT AB
IFSAR SURVEYS

TO
SCOPE OF WORK FOR SHORELINE MAPPING
UNDER THE
NOAA COASTAL MAPPING PROGRAM

REMOTE SENSING DIVISION
NATIONAL GEODETIC SURVEY
NATIONAL OCEAN SERVICE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE

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ATTACHMENT AB: IFSAR SURVEYS

1. INTRODUCTION - The contractor shall:

A. Set up ground GPS base stations in or near the project area to control the airborne data collection,

B. Make GPS ties to NOAA tidal bench marks,

C. Construct and position radar reflectors to control the data,

D. Collect Interferometric Synthetic Aperture Radar (IFSAR) data over the project area,
E. Process the data,

F. Produce a Digital Elevation Model (DEM), and

G. Produce an orthorectified image (ORI). See Section 8.

2. GENERAL - The following conventions have been adopted for this document. The term "should" implies that compliance is not required, but is strongly recommended. The term "shall" means that compliance is required.

Requests to exceed or deviate from these Project Instructions will be considered if written justification is provided to NGS in advance. The Contractor is encouraged to provide any recommendations for changes in the SOW for future work.

The time zone will be identified for all recorded times. UTC is recommended.

3. LOCATION - The data will be collected in the areas defined in the Project Instructions. ~~four areas shown on the enclosed maps detailing portions of the northwest and north slopes of Alaska. Note: portions of the shoreline in project areas AK0303 are very high and steep.~~ Plan flight lines to maintain the required accuracy in the areas, as possible, and report to NGS the expected accuracy for the areas.

4. DATA COLLECTION - The desired data is to be of as high quality as possible given the collection environment. The data will be collected at an altitude necessary to achieve the horizontal and vertical accuracies designated in the Project Instructions and efforts will be made to optimize the quality of the data including resolution. The Contractor will lay out the flight lines for optimum coverage and maximum accuracy. **Prior to any field work, the Contractor will provide the National Geodetic Survey with the flight line layout, the recommended locations of ground control points (both control points and check points) the planned location of the GPS ground control stations (for controlling the airborne data and for the**

tidal bench mark connections), and other planning parameters including the approximate date for data acquisition. NGS will comment on the above data as soon as possible, normally within five working days.

During airborne data collection, the Contractor shall position and orient the data, see Section 5.5 below.

5. TIDE COORDINATION – Tide coordination may be required by the Project Instructions. If so, the tide stage and meteorological conditions shall be studied to ensure that IFSAR data is collected when the water level is at the level(s) specified in the Project Instructions. ~~Mean High Water (MHW) or lower.~~ The contractor may be required to ~~shall~~ make GPS ties to ~~two (2)~~ NOAA tidal bench mark~~s. In addition, ties should be made to two tidal bench marks at different locations~~ within each project, if existent, and approximately equally spaced, if possible. See Sections 1.4 and 1.2.

6. DATA POSITION AND ORIENTATION - The Contractor shall use airborne kinematic GPS (carrier phase) and an inertial system to position and orient the data. The Contractor shall use a dual-frequency, geodetic quality GPS receiver in the aircraft and at the GPS base station. If an existing NSRS survey point is used, check its position with at least one, four-hour GPS session. If a new station is used, the base station shall be positioned using at least two GPS sessions, each two hours long (less than 50 miles) to four, or more hours long (greater than 50 miles). In addition to corner reflectors required to adequately process the data, two corner reflectors shall be installed at check points in each of the ~~four~~ Project areas and these check points shall not be used in the data processing.

7. DIGITAL ELEVATION MODEL - The DEM will have a post spacing of 5 meters, with an accuracy in the lower elevations of the study area of 2.5 meters or better in each horizontal and vertical. The DEM will be delivered in CD ROM or DVD format.

8. ORTHORECTIFIED IMAGERY - The ORIs will have an image resolution of 1.25 meters (pixel size) with a horizontal accuracy of 2.5 meters, or better. The map projection will be Universal Transverse Mercator (UTM) with a grid of latitude and longitude. The ORI will be delivered in both CD ROM or DVD format and paper format (one set of hard copy plots of the entire project area at 1:50,000 scale).

9. VECTOR SHORELINE DATA - Not required.

10. DATUMS - The horizontal datum will be the North American Datum of 1983 (NAD 83). For projects in Alaska , due to the lack of bench marks tied to the North American Vertical

Datum of 1988 (NAVD 88) within or near the project area, the Contractor shall make GPS connections to NOAA tidal bench marks, see Section 1.4 and 5.4.

See: http://tidesonline.nos.noaa.gov/geographic.html for additional information about NOAA tidal stations (gauges and bench marks). A GPS receiver on a tidal bench mark may also be used as the airborne GPS base station.

11. DATA FORMAT - Digital Elevation Models and ORIs should be delivered in ERDAS IMAGINE (.img) format on CD ROM or DVD.

12. REPORTS

12.1 ~~EMAIL~~ WEEKLY STATUS REPORTS - The Contractor will submit Weekly ~~project~~ Status Reports via TOMIS ~~email to the contacts listed below~~ every Monday before 2:00 P.M. Eastern Standard Time, from the time the Task Order is awarded until the work is complete and accepted by NGS. These reports will include: status of data collection, status of data processing, and expected data delivery date. The report will also discuss: problems, delays, any unusual circumstances, equipment malfunctions, and/or any deviations from these Project Instructions. See Attachment G for detailed requirements. A Weekly Status Report is required even if no progress has been made.

12.2 FINAL REPORT - See Section 16.0, below.

13. DELIVERY DATE - All specified Deliverables should be submitted via TOMIS as completed. All Deliverables shall be submitted to NGS within six months after data collection is completed.

14. GOVERNMENT SUPPLIED INFORMATION - NGS will supply the Scope of Work, Project Instructions, and project area maps. Note, the Contractor shall acknowledge receipt of these materials using standard Transmittal Letters.

15. CONTRACTOR DELIVERABLES - The Contractor shall provide all labor, equipment (including aircraft and radar equipment), supplies, and material to produce and deliver the following:

15.1 PROPOSED FLIGHT LINE LAYOUT;

15.2 GROUND CONTROL - Recommended locations for ground control (both control points and check points);

15.3 GPS GROUND BASE STATIONS - Recommended location of GPS base station, and tidal bench marks selected;

15.4 PLANNING PARAMETERS - Other planning parameters, including collection altitude and planned flight date;

15.5 DIGITAL ELEVATION MODEL;

15.6 IMAGE - Orthorectified Images of entire project (smoothed and unsmoothed) and plots of ORI at 1:50,000;

15.7 KGPS FILES;

15.8 MAPS - Index maps of the project area;

15.9 FILE NAMING CONVENTION - provide description;

15.10 TABLE OF FLIGHTS - A table of flight times compared to the tidal height windows;

15.11 WEEKLY ~~EMAIL PROGRESS~~ STATUS REPORTS;

15.12 FINAL REPORT.

16. FINAL REPORT - The Contractor will supply to NGS a Final Report including, at least, these sections:

16.1 Work performed under these Project Instructions; discuss each deliverable, both data collection and data processing;

16.2 Technical discussion of the data;

16.3 Equipment used to perform this work, including hardware models and serial numbers, and software names and versions;

16.4 Discuss airborne kinematic GPS processing and inertial data processing;

16.5 Tide coordination table discussion;

16.6 Any unusual circumstances or problems, including equipment malfunctions, (including those already reported);

16.7 Any deviations from this SOW (including those already reported); and

16.8 Any recommendations for changes in the SOW for future work.

Version 1
September 30, 2004

ATTACHMENT AC
TRANSMITTAL LETTER

TO
SCOPE OF WORK FOR SHORELINE MAPPING
UNDER THE
NOAA COASTAL MAPPING PROGRAM

REMOTE SENSING DIVISION
NATIONAL GEODETIC SURVEY
NATIONAL OCEAN SERVICE
NATIONAL OCEANIC & ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE

NOAA FORM 61-29
(12-71)

U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

REFERENCE NO.

LETTER TRANSMITTING DATA

DATA AS LISTED BELOW WERE FORWARDED TO YOU BY (Check)

- [ ] ORDINARY MAIL
- [ ] AIR MAIL
- [ ] REGISTERED MAIL
- [ ] EXPRESS
- [ ] GBL (Give number)________________________

TO:

DATE FORWARDED

NUMBER OF PACKAGES

NOTE: A separate transmittal letter is to be used for each type of data, as tidal data, seismology, geomagnetism, etc. State the number of packages and include an executed copy of the transmittal letter in each package. In addition the original and one copy of the letter should be sent under separate cover. The copy will be returned as a receipt. This form should not be used for correspondence or transmitting accounting documents.

FROM: (Signature)

RECEIVED THE ABOVE
(Name, Division, Date)

Return receipted copy to:

NOAA FORM 61-29 SUPERCEDES FORM C AND GS 413 WHICH MAY BE USED.

☆ U.S. GOVERNMENT PRINTING OFFICE: 1988 - 554-006-61309

Reset

NOAA FORM **61-29**
(12-71)

U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

LETTER TRANSMITTING DATA

REFERENCE NO.
ME0401-1

DATA AS LISTED BELOW WERE FORWARDED TO YOU BY *(Check):*

- ☐ ORDINARY MAIL
- ☐ AIR MAIL
- ☐ REGISTERED MAIL
- ☑ EXPRESS
- ☐ GBL *(Give number)* ____________

DATE FORWARDED
17JUN04

NUMBER OF PACKAGES
2 Boxes

TO:

George Leigh
Attn: N/NGS Station 8609
1315 East-West Highway
Silver Spring, MD 20910

NOTE: A separate transmittal letter is to be used for each type of data, as tidal data, seismology, geomagnetism, etc. State the number of packages and include an executed copy of the transmittal letter in each package. In addition the original and one copy of the letter should be sent under separate cover. The copy will be retumed as a receipt. This form should not be used for correspondence or transmitting accounting documents.

Dear Sir or Madam:

This letter of transmittal regarding the National Oceanic and Atmospheric Administration (NOAA) firm listed below is forwarded for processing under the U.S. Department of Commerce contract number "XXXXXX XXXXXX" for the NOAA, National Ocean Service, National Geodetic Survey, Remote Sensing Division.

Please process the enclosed film roll(s) in accordance with the requirements and then forward the film, Photographic Flight Reports, and Raw Navigation files to:

Robert B. Clark
Contracting Officer Technical Representative
National Geodetic Survey, Remote Sensing Division
NOAA, N/NGS31
Building SSMC 3, Station 5147
1315 East-West Highway
Silver Spring, MD 20910

Roll Identification Number	Film Type	Quantity (Rolls)
(See Annex 2, #2)	Aviphot X 100 CN	2

Thank you for your assistance

FROM: *(Signature)*
George Leigh

Return receipted copy to:

Contractor
Program Manager
Shoreline Mapping Contractor
301-713-4315

RECEIVED THE ABOVE
(Name, Company, Date)

George Leigh
National Geodetic Survey
19JUN04

Version 1A
January 30, 2008

ATTACHMENT AD
TECHNICAL PROPOSAL CONTENTS

TO
SCOPE OF WORK FOR SHORELINE MAPPING
UNDER THE
NOAA COASTAL MAPPING PROGRAM

REMOTE SENSING DIVISION
NATIONAL GEODETIC SURVEY
NATIONAL OCEAN SERVICE
NATIONAL OCEANIC & ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE

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ATTACHMENT AD: TECHNICAL PROPOSAL CONTENTS PAGE

ATTACHMENT AD: TECHNICAL PROPOSAL CONTENTS

1. GENERAL - Technical Proposals shall contain at least the sections and information listed below. The Technical Proposals shall not contain the SOW or the Project Instructions, but shall contain information about the methodologies and equipment selected by the contractor and reasoning/justification for these methods.

2. INCLUDED INFORMATION

2.1 PRIME AND SUBS - State which firm(s) will perform which portions of the project.

2.2 TIME LINE - Provide rough time-line.

2.3 PROJECT LIMITS - A brief statement showing that the contractor understands the Project area.

2.4 ACCURACY - A brief statement on the accuracy requirements and how they will be achieved.

2.5 FLIGHT LINES - A brief statement about the flights lines, were they government supplied or produced by the contractor; are they adequate; do they cover the project area adequately; is the scale appropriate.

2.6 TIDE COORDINATION - A brief statement on what tidal coordination is required and who will compute the predicted tidal time windows. Also, state which imagery will be tide coordinated and at which stage(s) of the tide. Mention if the installation of tide gauges are required, and if so, type, location, etc., and discuss tidal data collection and processing. Mention if tide gauges and weather will need to be monitored and how this will be done.

2.7 GROUND CONTROL - Provide a map showing locations of all ground control points using different symbology for existing control, new control and the 4 or more check points. State the total number of points and justify why that number is correct for the project. Discuss how these points will be marked and how they will be positioned and/or checked. State if CORS and OPUS will be used, and why or why not. Note: approximate locations are acceptable.

2.8 TYPES OF IMAGERY - Discuss the types of imagery (emulsions, LIDAR, IFSAR, etc.) that will be collected and with what equipment (including sensor and platform). List the camera filters that will be used and with which emulsions. Discuss data sets that will be produced from the collected data.

2.9 CALIBRATIONS - Discuss equipment calibrations.

2.10 AIRCRAFT NAVIGATION - Discuss how the aircraft will be navigated (what positioning equipment) and what data will be used in the EED file.

2.11 AIRBORNE KGPS - Discuss equipment, data collection, and data processing.

2.12 GROUND BASE STATIONS - Provide map showing locations of ground base stations (approximate locations acceptable). State how they will be positioned and/or checked. State how long data will be collected and how it will be processed. State the distance from each base station to the farthest points in the project area. Justify the number, location, and type of base stations proposed. Discuss use of CORS and nterpolation, if proposed.

2.13 AEROTRIANGULATION (AT) - Discuss method and equipment to be used and types of data that will be input. Discuss comparison with "check points".

2.14 COMPILATION - Discuss method and equipment to be used.

2.15 QUALITY CONTROL (QC) - State how all work will be reviewed and how the prime will oversee their sub-contractors.

2.16 REPORTS - List the reports that will be submitted.

2.17 ADDRESS - State the NGS address where all data and invoices will be sent.

2.18 TOMIS DELIVERABLE TRACKING LOG – In the format specified in the Project Instructions.

Version 1
September 30, 2004

ATTACHMENT AE
CHART EVALUATION FILE

TO
SCOPE OF WORK FOR SHORELINE MAPPING
UNDER THE
NOAA COASTAL MAPPING PROGRAM

REMOTE SENSING DIVISION
NATIONAL GEODETIC SURVEY
NATIONAL OCEAN SERVICE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE

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ATTACHMENT AE: CHART EVALUATION FILE

1. CREATING THE CHART EVALUATION FILE

The purpose of the Chart Evaluation File (CEF) is to document navigational hazards, landmarks, fixed aids, and coastline features portrayed on NOAA nautical chart products whose existence or geographic position can not be confirmed photogrammetrically, or whose size, shape, orientation or position appear to have changed significantly from the current chart portrayal. For each Coastal Mapping Program (CMP) project the contractor shall provide one CEF in ESRI shapefile format (2-D Polygon) as a final deliverable product to NGS.

1.1 COORDINATE SYSTEM AND DATUM

The CEF shall utilize a geographic coordinate system with units expressed in decimal degrees, referenced to the North American Datum of 1983. The specific projection file to be used in ESRI's ArcGIS® software shall be "GCS_North_American_1983."

1.2 SHAPEFILE NAMING CONVENTION

llyynn_CEF where:
- ll – a two character local identifier utilizing the two character code for a state
- yy – a two digit year identifier
- nn – a two digit sequence number

llyynn_CEF.shp - the file storing the feature geometry.

llyynn_CEF.dbf - the dBASE file storing the feature attribute information.

llyynn_CEF.shx - the file storing the index of the feature geometry.

llyynn_CEF.prj - the file storing the projection information.

The llyynn project ID will be supplied by the government.

1.3 SHAPEFILE ATTRIBUTE TABLE STRUCTURE

Shapefile attribute fields to be included upon creation of the CEF consist of the following:

Attribute_Label: Id
- Data type: Long integer
- Precision (or width, the number of digits): 6
- Definition: Unique sequential feature identifier. (This field is automatically created by ESRI's ArcGIS software when a shapefile is created, but the values must be calculated manually.) Values for this field shall be > 0.

Attribute_Label: IMAGE_SOURCE
. Data type: Text
. Width: 32
. Definition: Describes the source of imagery. Use “AERIAL” for aerial photography, and for satellite imagery enter the name of the sensor (e.g. IKONOS).

Attribute_Label: IMAGE_DATE
. Data type: Text
. Width: 8
. Definition: Date of source imagery (YYYYMMDD) for the feature.

Attribute_Label: LAT_DD
. Data type: Double
. Precision: 12
. Scale (the number of decimal places): 8
. Definition: Latitude of the polygon centroid in decimal degrees, with positive values in the northern hemisphere and negative values in the southern hemisphere.

Attribute_Label: LON_DD
. Data type: Double
. Precision: 12
. Scale: 8
. Definition: Longitude of the polygon centroid in decimal degrees, with positive values in the eastern hemisphere and negative values in the western hemisphere.

Attribute_Label: FEATURE
. Data type: Short integer
. Precision: 5
. Definition: Cartographic feature code number from the ‘Coastal Cartographic Object Attribute Source Table’ (C-COAST) attribution scheme.
. Domain: 1 – 205 (See Attachment E for the assigned numbers associated with each C-COAST class/attribute combination.)

Attribute_Label: ATTRIBUTE
. Data type: Text
. Width: 66
. Definition: Concatenation of the C-COAST feature class and attribute.
. Domain: (See Attachment E for a complete list of C-COAST feature classes and attributes.)

Attribute_Label: S57_CODE
. Data type: Text
. Width: 50
. Definition: The International Hydrographic Organization (IHO) S-57 translation of the C-COAST feature attribution.
. Domain: (See Attachment E for the designated S-57 translations for C-COAST class/attribute combinations.)

Attribute_Label: CHG_NOTE
. Data type: Text
. Width: 75
. Definition: Description of discrepancies found between imagery and current editions of the NOAA nautical charts, or a notation that the position/existence of specific features portrayed on NOAA charts could not be confirmed. Examples of appropriately filled CHG_NOTE fields are shown below:

S57_CODE	CHG_NOTE	ENC_vs_RAS	VERIFIABLE	PRIORITY	RSD_REC
	Chart 11491 33rd Ed. Mar 24/01 SIDE A				
	Chart 11490 17th Ed. May 5/01 INSET				
BRIDGE catbrg 1	apparent bridge and supports, attribution uncertain		YES	MEDIUM	MAINTAIN
PILPNT catple 3	identified new piles & obstructions, attribution uncertain		YES	MEDIUM	ADD
COALNE quapos 1	major shoreline changes		YES	MEDIUM	RESHAPE
SLCONS catslc 6	major shoreline changes		YES	HIGH	RESHAPE
UWTROC natsur 9 watlev 4	could not confirm existence of dangerous rock		DOUBTFUL	HIGH	MAINTAIN
LIGHTS PILPNT catple 3	charted position of light could not be confirmed		DOUBTFUL	HIGH	MAINTAIN
LIGHTS PILPNT catple 3	charted position of light could not be confirmed	CONFLICT	DOUBTFUL	HIGH	MAINTAIN
COALNE catcoa 8	major shoreline changes		YES	MEDIUM	RESHAPE
PILPNT catple 3	charted hazardous piles could not be confirmed		NO	MEDIUM	MAINTAIN
PILPNT catple 3	identified a potentially hazardous uncharted pile at this location		DOUBTFUL	MEDIUM	ADD
OBSTRN watlev 2	possible danger to navigation		DOUBTFUL	MEDIUM	ADD
OBSTRN watlev 2	possible danger to navigation		DOUBTFUL	MEDIUM	ADD
OBSTRN watlev 2	possible danger to navigation		DOUBTFUL	MEDIUM	ADD
SLCONS catslc 12 watlev 2	charted boat ramps appear to be gone, other new ramps built		DOUBTFUL	LOW	REMOVE/ADD
SLCONS	unable to identify alongshore features, shoreline construction		YES	LOW	RESHAPE

Attribute_Label: ENC_vs_RAS
. Data type: Text
. Width: 8
. Definition: Disagreements in feature portrayal between current edition NOAA nautical charts and the NOAA Electronic Navigational Chart (NOAA ENC®) suite are flagged with "CONFLICT." Contractors should only populate this field IF instructed to do so in the Project Instructions.

Attribute_Label: VERIFIABLE
. Data type: Text
. Width: 10
. Definition: Expectations of visibility of the feature in the imagery.
. Domain: YES – The feature is expected to be visible.
DOUBTFUL – Under most conditions the feature would likely not be visible in imagery.
NO – Under no conditions would the feature be expected to be visible in imagery.

Attribute_Label: PRIORITY

- Data type: Text
- Width: 10
- Definition: Relative importance of the feature to surface navigation.
- Domain: LOW – Feature of little or no importance to surface navigation.
  MEDIUM – Feature of significant importance to navigation.
  HIGH – Feature of critical importance to navigation.

Attribute_Label: RSD_REC

- Data type: Text
- Width: 15
- Definition: Recommendation to NOAA nautical chart compilers regarding feature in question.
- Domain: ADD – New feature to be added to NOAA chart.
  REMOVE – Feature should be removed from chart.
  MOVE – Charted position is incorrect or has changed, and should be updated or re-evaluated.
  RESHAPE – Shape or alignment of the feature should be changed on the chart.
  MAINTAIN – No change in chart depiction is recommended at this time. Further investigation is required in order to verify the feature's existence or position.

Attribute_Label: RSD_NOTE

- Data type: Text
- Width: 32
- Definition: Descriptions of unresolved issues of importance in the digital cartographic feature file (DCFF). This field should be used by shoreline compilers to document specific issues to be researched by NOAA field personnel.

Attribute_Label: ENC_NOTE

- Data type: Text
- Width: 32
- Definition: A description of an unresolved issue in the corresponding NOAA ENC file, to be populated by the ENC compiler. The contractor shall not populate this field.

Attribute_Label: FIELD_NOTE

- Data type: Text
- Width: 220
- Definition: A description of field findings, to be populated by NOAA field personnel. The contractor shall not populate this field.

Attribute_Label: FIELD_REC
- Data type: Text
- Width: 75
- Definition: A recommendation to the chart compiler from the NOAA field personnel. The contractor shall not populate this field.

Attribute_Label: CARTO_REC
- Data type: Text
- Width: 75
- Definition: A recommendation to the chart compiler from a cartographer assigned to the NOAA field verification office. The contractor shall not populate this field.

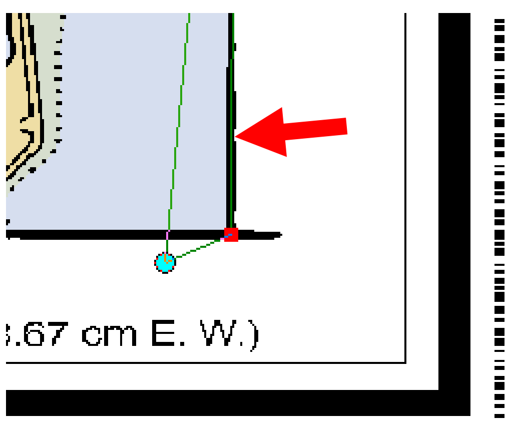
Attribute_Label: DATASRC_ID
- Data type: Text
- Width: 20
- Definition: Unique identifier assigned by the NOAA Office of Coast Survey. The contractor shall not populate this field.

2. POPULATING THE CHART EVALUATION FILE

The CEF shall consist of two categories of polygon features: those that delineate the geographic extents of the NOAA charts used as references and those that refer to individual charted features whose positions or existence were not verified with the project imagery.

2.1 CHART EXTENT POLYGONS

A polygon shall be digitized around the perimeter of each digital raster chart used for chart comparison purposes. The chart outline in the CEF shall represent the edge of the geographic area covered by each chart, excluding chart margins (see below).

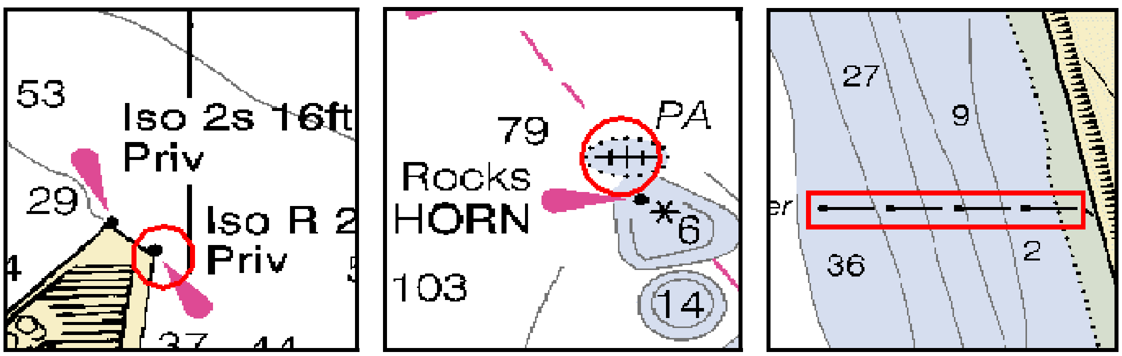


For each chart polygon in the CEF, the NOAA chart edition information shall be entered into the CHG_NOTE attribute field. This information shall include the chart number, edition number, edition date, and abbreviated descriptive information to identify chart insets or individual panels. All other attribute fields (except the “Id” field) shall be left blank. See the example below for proper chart identification in a CEF:

S57_CODE	CHG_NOTE	ENC_vs_RAS	VERIFIABLE	PRIORITY	RSD_REC
	Chart 11491 33rd Ed. Mar 24/01 SIDE A				
	Chart 11490 17th Ed. May 5/01 INSET				

2.2 UNVERIFIED OR CHANGED FEATURE POLYGONS

Each charted hazard, landmark, fixed aid, or coastline feature whose position or existence cannot be verified with the project imagery shall be identified in the CEF by enclosing the chart symbol with a polygon (see examples below, in red) and attributing appropriately. Feature polygons shall be compact and cartographically pleasing in appearance. There must be no uncertainty regarding which charted feature is indicated by the feature polygon.



For each feature polygon, it is mandatory that the following CEF attribute fields be populated by the contractor:

Id
IMG_SOURCE
IMG_DATE
LAT_DD
LON_DD
FEATURE
ATTRIBUTE
S57_CODE
CHG_NOTE
VERIFIABLE
PRIORITY
RSD_REC

For feature polygons identified as verifiable (VERIFIABLE = “YES”) and medium or high priority (PRIORITY = “MEDIUM” or “HIGH”), the RSD_NOTE shall be populated as well.

by E. A. FLEMING

Introduction

FOREKNOWLEDGE of the time during which the sun will be above a specified altitude is an integral part of planning a photographic flight. The aerial photographer must have some means of readily determining this information in advance in order to know at what time in the morning photography can be commenced and at what time in the afternoon it must be ended. These times will vary with the date, the latitude of the project area and the requirements of the contract.

In addition to considering minimum solar altitudes, there is sometimes a need to consider maximum permissible solar altitudes when planning a photographic flight. The forester is concerned with the entry of the "hot spot" into the area of the photograph and the hydrographer is concerned with the sun's reflection from water surfaces; both phenomena are associated with high solar altitudes.

The nomograms given on the following pages provide the air survey photographer with a simple graphical solution to the problem in a form flexible enough to meet a variety of requirements anywhere in the world.

Each nomogram is based on the projection of the solar ray through the camera station to the point at which it intersects the earth. The locus of this anti-solar point, as the sun's altitude and azimuth change, forms the fundamental curve of the nomogram. Since the sun's altitude is not only a function of the time of day, but also of the time of year and the latitude, it is necessary to use a nomogram appropriate to the latitude of the project area and to select on that nomogram the curve for the date at which photography is to be taken.

2.2.2 To determine the length of the photographic day

To determine the length of the photographic day, select the nomogram for the latitude closest to that of the project area, interpolating if necessary. If the requirements of the contract permit photography to start at a solar altitude of 20°, the points at which the time scale intersects the date on the 20° arc give the start and finish of the photographic day. For example, using the nomogram illustrated in Figure 2.2.1, it can be seen that, on May 1 (or August 13) at 45° N Latitude the photographic day would start at 0650 and end at 1710 local solar time.

The length of the photographic day for higher solar altitudes may be determined similarly by drawing the appropriate solar altitude arc and reading time intercepts on this arc. Thus in the above example, the photographic day for 30° minimum altitude would be from 0750 to 1616.

The times determined from the nomogram are converted to Greenwich Mean Time or Standard Time according to the longitude of the project area.

$$\text{G.M.T.} = \text{Solar time} \pm \frac{\text{local longitude}}{15}$$

where west longitude is "plus" and east longitude is "minus." Tables for the conversion of longitude to time, Figure 2.2.2, and the relationship of North American Standard Time zones to G.M.T. are given with the nomograms.

2.2.3 How to determine the "hot spot"

The "hot spot" or "no shadow point" in a photograph appears as a bright area lacking in detail immediately surrounding the anti-solar point. It is particularly noticeable over forested areas and presents problems in forestry interpretation. Therefore, it may be desirable to avoid its occurrence within the area of the photograph, or alternatively, to ensure full stereoscopic coverage of the area affected by adjusting the end-lap or the side-lap.

The locus of the "hot spot" across the field of view, as the day progresses, can be determined by centering a transparent template representing the field of view of the camera at point 'P' of the nomogram. If the template is oriented to correspond to the flight direction—north being considered as the upward direction of the noon line—the time of entry and exit of the "hot spot" can be read at the points where the date line cuts the template area. Template sizes for wide-angle (153 mm.) and super-wide angle (88 mm.) lenses with 23 cm. formats are given in Figure 2.2.3. Templates for use with cameras of other focal lengths and formats can be drawn to the scale of these nomograms using the relationship:

$$\text{template size} = \frac{\text{format size}}{\text{focal length}} \times 19 \text{ mm.}$$

For the east-west orientation of the template indicated in Figure 2.2.1, the "hot spot" would fall within the photo area between 0940 and 1420 on May 1. It can also be seen that the area affected by the "hot spot" could be covered stereoscopically if the flight line to the north had 20–25% side-lap with the line under consideration. If the lines of photography were oriented north-south then an end-lap of at least 65–75% would be required to ensure stereoscopic coverage of the affected area. If mapping as well as interpretation were involved then a choice of 80%

NORTH AMERICAN TIME ZONES

Newfoundland	Std. Time = GMT − 3h. 30m
Atlantic	Std. Time = GMT − 4h
Eastern	Std. Time = GMT − 5h
Central	Std. Time = GMT − 6h
Mountain	Std. Time = GMT − 7h
Pacific	Std. Time = GMT − 8h
Yukon	Std. Time = GMT − 9h
Alaskan	Std. Time = GMT − 10h

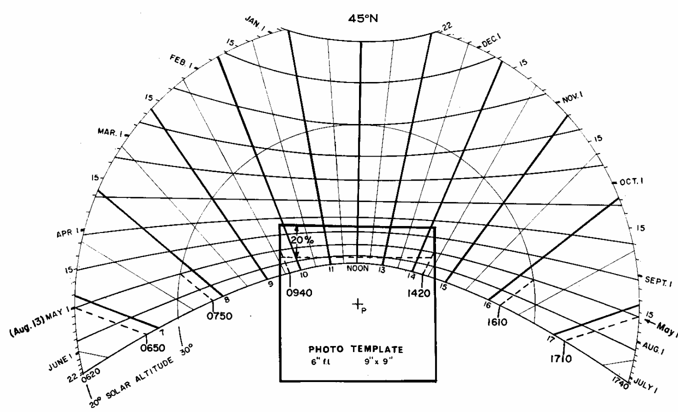


FIGURE 2.2.1—Determination of the length of the photographic day and the position of the "hot-spot".

°	h	m	°	h	m	°	h	m
0	0	0	60	4	0	120	8	0
1	0	4	61	4	4	121	8	4
2	0	8	62	4	8	122	8	8
3	0	12	63	4	12	123	8	12
4	0	16	64	4	16	124	8	16
5	0	20	65	4	20	125	8	20
6	0	24	66	4	24	126	8	24
7	0	28	67	4	28	127	8	28
8	0	32	68	4	32	128	8	32
9	0	36	69	4	36	129	8	36
10	0	40	70	4	40	130	8	40
11	0	44	71	4	44	131	8	44
12	0	48	72	4	48	132	8	48
13	0	52	73	4	52	133	8	52
14	0	56	74	4	56	134	8	56
15	1	0	75	5	0	135	9	0
16	1	4	76	5	4	136	9	4
17	1	8	77	5	8	137	9	8
18	1	12	78	5	12	138	9	12
19	1	16	79	5	16	139	9	16
20	1	20	80	5	20	140	9	20
21	1	24	81	5	24	141	9	24
22	1	28	82	5	28	142	9	28
23	1	32	83	5	32	143	9	32
24	1	36	84	5	36	144	9	36
25	1	40	85	5	40	145	9	40
26	1	44	86	5	44	146	9	44
27	1	48	87	5	48	147	9	48
28	1	52	88	5	52	148	9	52
29	1	56	89	5	56	149	9	56
30	2	0	90	6	0	150	10	0
31	2	4	91	6	4	151	10	4
32	2	8	92	6	8	152	10	8
33	2	12	93	6	12	153	10	12
34	2	16	94	6	16	154	10	16
35	2	20	95	6	20	155	10	20
36	2	24	96	6	24	156	10	24
37	2	28	97	6	28	157	10	28
38	2	32	98	6	32	158	10	32
39	2	36	99	6	36	159	10	36
40	2	40	100	6	40	160	10	40
41	2	44	101	6	44	161	10	44
42	2	48	102	6	48	162	10	48
43	2	52	103	6	52	163	10	52
44	2	56	104	6	56	164	10	56
45	3	0	105	7	0	165	11	0
46	3	4	106	7	4	166	11	4
47	3	8	107	7	8	167	11	8
48	3	12	108	7	12	168	11	12
49	3	16	109	7	16	169	11	16
50	3	20	110	7	20	170	11	20
51	3	24	111	7	24	171	11	24
52	3	28	112	7	28	172	11	28
53	3	32	113	7	32	173	11	32
54	3	36	114	7	36	174	11	36
55	3	40	115	7	40	175	11	40
56	3	44	116	7	44	176	11	44
57	3	48	117	7	48	177	11	48
58	3	52	118	7	52	178	11	52
59	3	56	119	7	56	179	11	56
60	4	0	120	8	0	180	12	0

FIGURE 2.2.2–Conversion of Longitude to Time.

end-lap would permit alternate pictures to be discarded for the mapping operation.

2.2.4 How to determine the sun's reflection

Where water areas are being photographed for hydrographic surveys the reflection of the sun's image into the camera lens can seriously diminish the amount of recorded detail in the area of reflection.

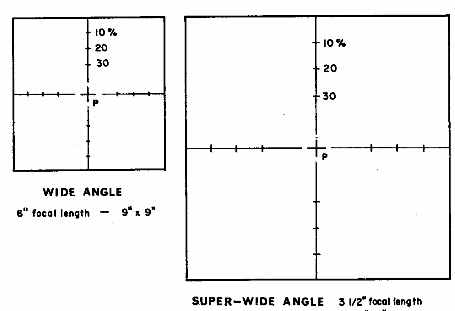
The time of entry of the center of this reflection into the area of the photograph can be determined in the same manner as for the "hot spot" with the exception that its position is given by letting the upward direction of the noon line represent south.

The size of the area affected by reflection will vary depending on the roughness of the water and the obliquity of the sun's rays. Studies by the U. S. Coast and Geodetic Survey have indicated that the sun spot may range in size from 1 1/2 to 2 inches in calm water to as large as 7 inches in rough water on a 9- by 9-inch photograph taken with a 6-inch lens. Under these conditions reflections will occur well into the area of the photograph even though the center of the sun's reflection may fall outside the field of view.

The template illustrated in Figure 2.2.4 can be drawn on transparent material and used to indicate the maximum area of the photograph that may be affected by solar reflections. Point A of this template is placed on the nomogram at the time and date of the proposed photography and line AB is oriented to intersect point P. The graduation on A–B corresponding to the solar altitude at point A will indicate the extent of the reflection under the worst conditions.

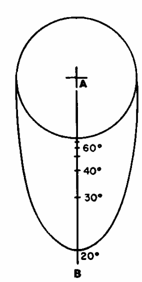
For example, if photography were to be taken on May 22 at 50° north latitude at about 10 A.M. local solar time, the extent of the solar reflection from water areas could be

(Text continues on page 74)



PHOTOGRAPHIC TEMPLATES

FIGURE 2.2.3–Photographic Templates.



SUN-SPOT TEMPLATE

FIGURE 2.2.4–Sun-spot Template.

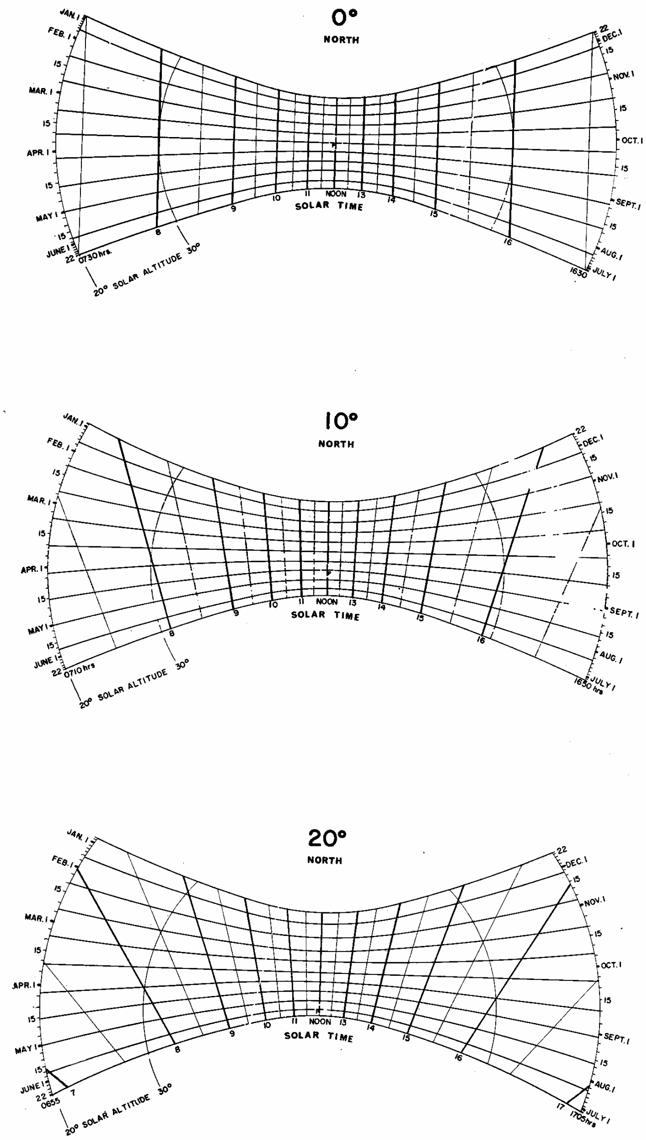


FIGURE 2.2.7–Solar Altitude Nomograms.

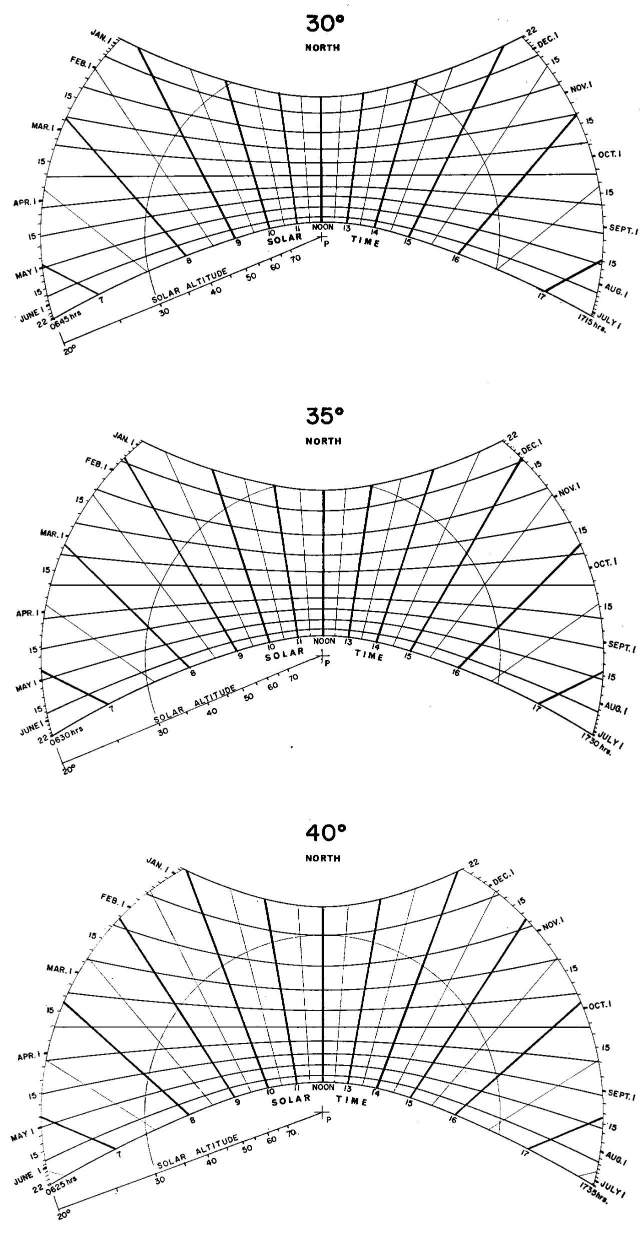


FIGURE 2.2.8–Solar Altitude Nomograms.

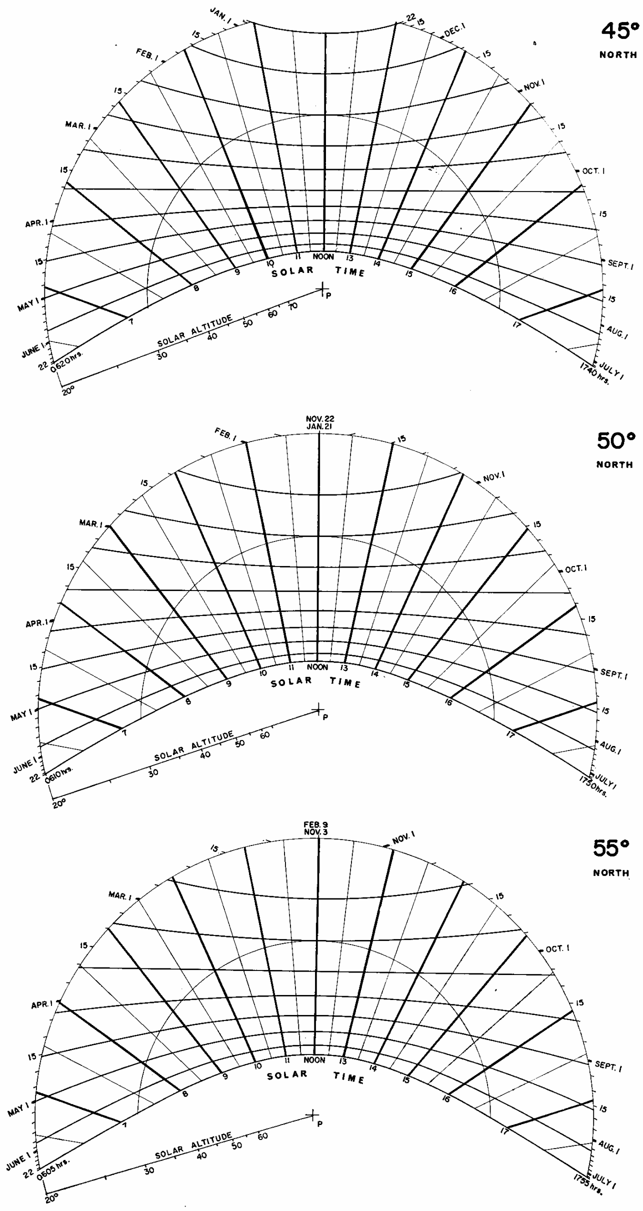


FIGURE 2.2.9–Solar Altitude Nomograms.

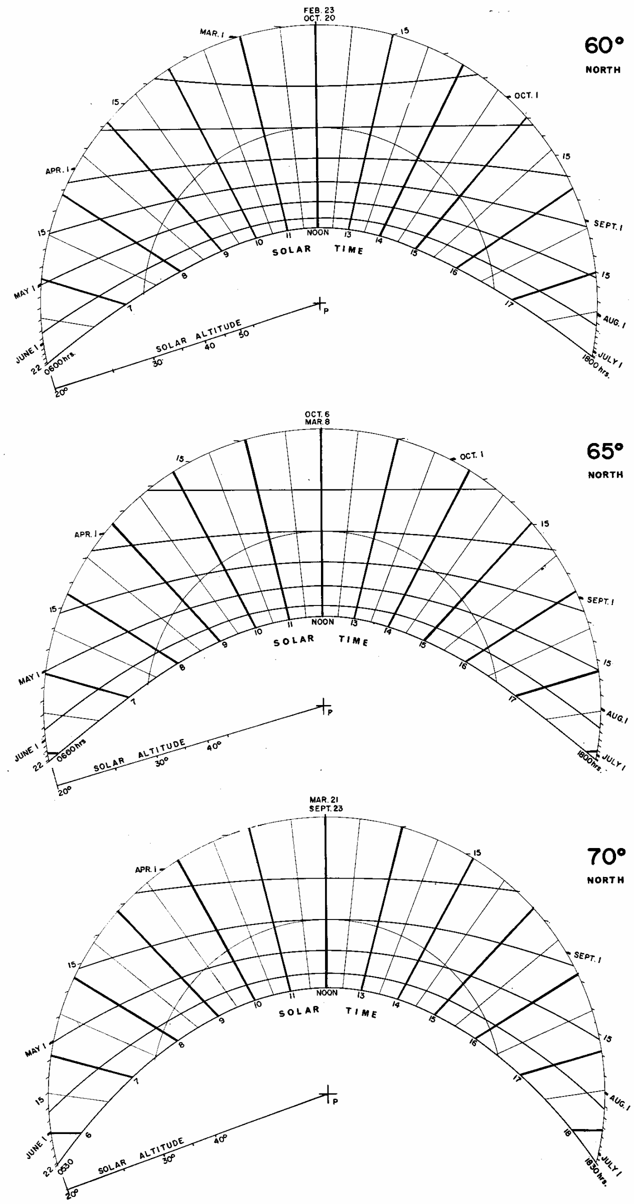


FIGURE 2.2.10–Solar Altitude Nomograms.

predicted as shown in Figure 2.2.5. An arc, centered at P, through the solar altitude scale shows that the solar altitude at 10 A.M. on May 22 is almost 55°. The sun-spot template is therefore rounded off at 55° on the A–B scale and, when positioned, shows that in rough water conditions the entire south-east quadrant of the picture may be sun-struck. Figure 2.2.6 shows a wide angle photograph taken at the time and date of the example, but with something less than rough water conditions. Also illustrated in this photograph is the "hot spot" which occurs diametrically opposite the center of the sun's specular reflection and the same distance from the principal point.

Using this method, it is possible to plan photographic flights so as to avoid the occurrence of the reflection within the photographic area or, alternatively, to ensure that it is covered stereoscopically by either end- or side-lap.

2.2.5 Southern latitudes

For use of the nomograms in southern latitudes, add six months to the date scales so that December 22 becomes June 22, January becomes July, etc. South would be at the top of the page for the "hot spot" determination and north would be at the top of the page for the "sun spot" determination.

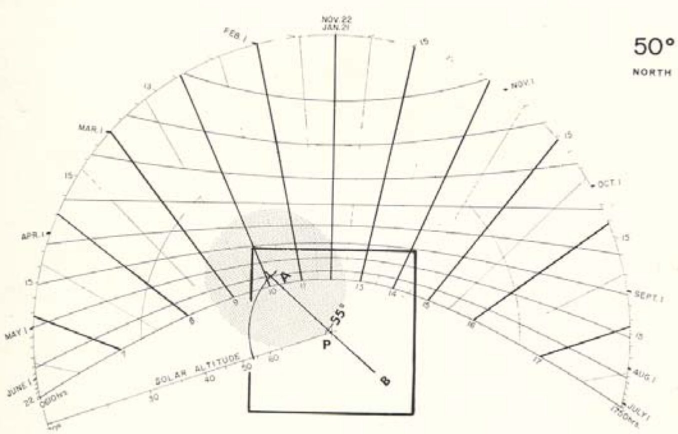


FIGURE 2.2.5–Locating the extent of the sun's reflection from water surfaces.

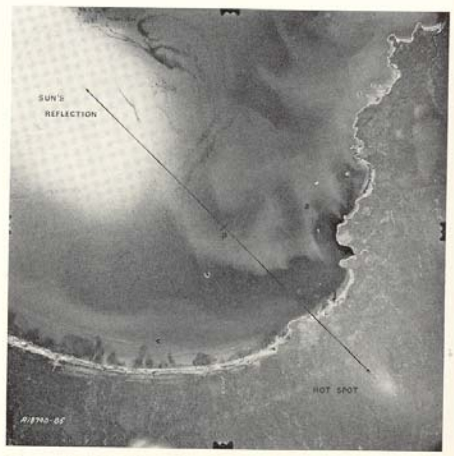


FIGURE 2.2.6–Wide-angle photograph showing the sun's reflection and the hot-spot.

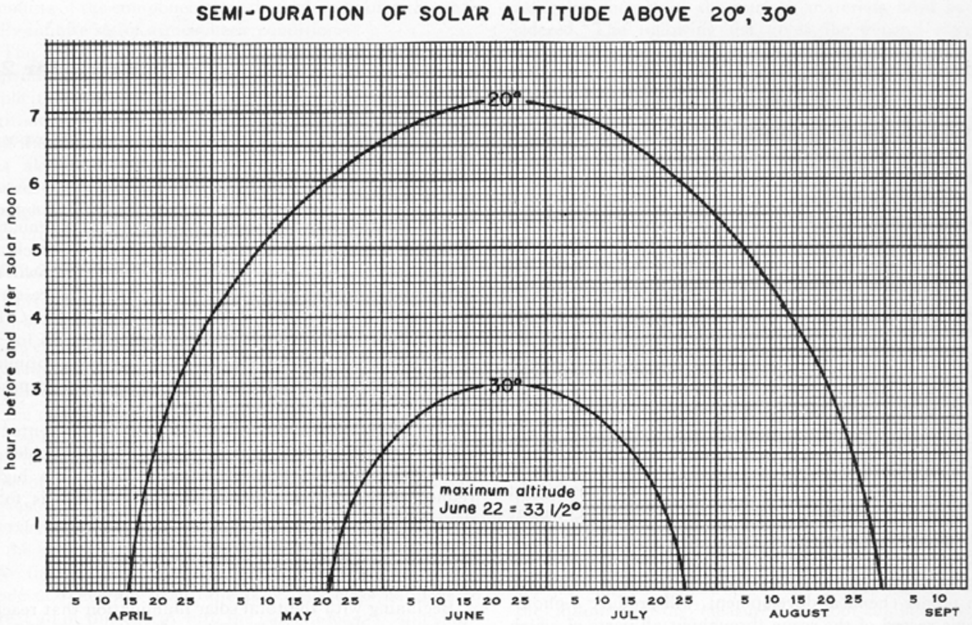


FIGURE 2.2.11–*80° North Latitude.*—Since neither the "hot spot" nor the "sun spot" is of serious significance at this latitude the form of the graph has been changed to give only the hours of photographic light before and after local solar noon. *90° North Latitutde.*—The solar altitude is above 20° for 24 hours a day from May 21 to July 24.

Version 1A
July 2005

ATTACHMENT AF
SUN ANGLE NOMOGRAMS
(AND SUN REFLECTIONS)
FROM
MANUAL OF COLOR AERIAL PHOTOGRAPHY
AMERICAN SOCIETY OF PHOTOGRAMMETRY
1968

TO
SCOPE OF WORK FOR SHORELINE MAPPING
UNDER THE
NOAA COASTAL MAPPING PROGRAM

REMOTE SENSING DIVISION
NATIONAL GEODETIC SURVEY
NATIONAL OCEAN SERVICE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
U.S. DEPRATMENT OF COMMERCE

Version 1
February 1, 2008

ATTACHMENT AG
SETTING A MARK IN OR NEAR BEDROCK

TO
SCOPE OF WORK FOR GROUND SURVEYS

NATIONAL GEODETIC SURVEY
NATIONAL OCEAN SERVICE
NATIONAL OCEANIC & ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE

ATTACHMENT AG - SETTING A MARK IN OR NEAR BEDROCK

CASE I – BEDROCK AT GROUND SURFACE
Set a disk in a drill hole per Attachment entitled, “**SETTING A DISK IN BEDROCK OR A STRUCTURE”**

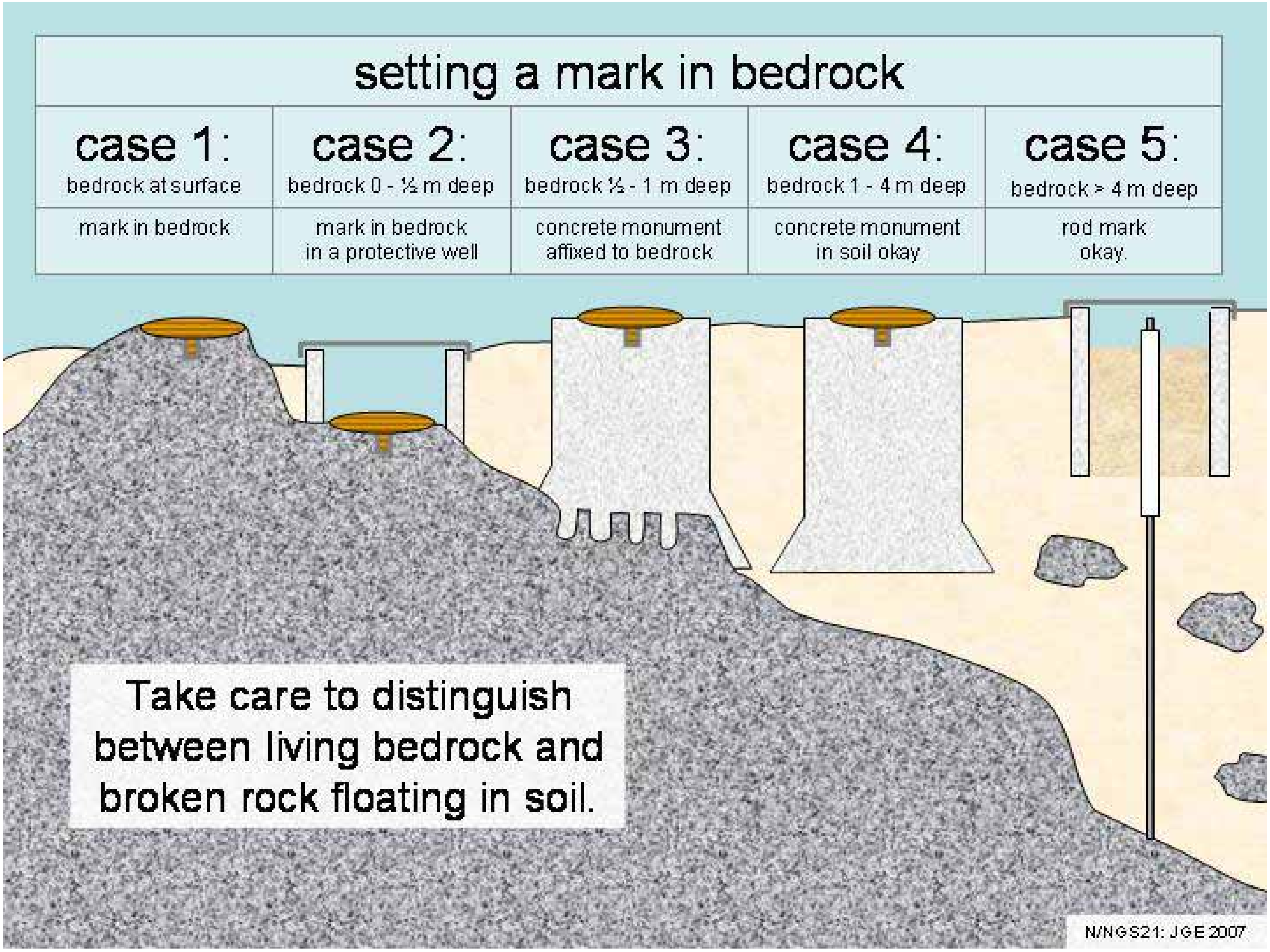
CASE II – BEDROCK LESS THAN ~1.5 FOOT (0.5 METER) BELOW SURFACE
Same as CASE I, then, install a protective monument box, such as an iron utility well cover, plastic valve box, or PVC pipe with aluminum logo cap, surrounding and over the disk for protection and access. Surround the box or pipe with a concrete collar to hold it in place. Also consider a CASE III mark.

CASE III – BEDROCK ~1.5 - 3 FEET (0.5 - 1 METER) BELOW SURFACE
Dig out an area at least 0.5 meter in diameter and clean off the top of the bedrock removing all loose material and washing down the rock to provide a clean surface. If the bedrock is smooth, drill holes or chisel furrows to afford better anchorage for the concrete monument. Set a concrete monument on top of the bedrock with a disk on the surface.

CASE IV – BEDROCK ~ 3 – 13 FEET (1 – 4 METERS) BELOW SURFACE
Do not set a rod mark that is less than 4 meters long. If bedrock is reached less than 4 meters below the surface then either set a concrete mark (according to the Attachment entitled, “**SETTING CONCRETE MARK**S”), or move to a different location to set a rod mark (according to the Attachment “**SETTING A NGS 3-D MONUMENT**”).

CASE V – BEDROCK DEEPER THAN 4 METERS
Set a rod mark or concrete monument per appropriate Attachments.

See graphic on next page.


setting a mark in bedrock
case 1:
bedrock at surface
mark in bedrock
case 2:
bedrock 0 - ½ m deep
mark in bedrock
in a protective well
case 3:
bedrock ½ - 1 m deep
concrete monument
affixed to bedrock
case 4:
bedrock 1 - 4 m deep
concrete monument
in soil okay
case 5:
bedrock > 4 m deep
rod mark
okay.
Take care to distinguish
between living bedrock and
broken rock floating in soil.
N/NGS21: JGE 2007

Version 1
January 29, 2008

ATTACHMENT AH
NGS REQUIREMENTS FOR TIDE GAUGE STATIONS

TO
SCOPE OF WORK FOR SHORELINE MAPPING
UNDER THE
NOAA COASTAL MAPPING PROGRAM

REMOTE SENSING DIVISION
NATIONAL GEODETIC SURVEY
NATIONAL OCEAN SERVICE
NATIONAL OCEANIC & ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE

GENERAL COMMENTS

DOCUMENT PRECEDENCE – In order of precedence: Project Instructions, this document, CMP SOW, “NOS HYDROGRAPHIC SURVEYS, SPECIFICATIONS AND DELIVERABLES” (HYDRO. SPECS.), Chapter 4 (April 2007), and other CO-OPS documents.

CORRECT NAME – Use the exact station designation (name) as found in NOAA records. For marks in the NGS database, use the designation on the NGS datasheet. For tidal bench marks not in the NGS database, use the designation as found on the tide station description. This means the same letters, same numbers, and same spaces.

UPPER CASE – Station names are always recorded using upper case letters.

STAMPING – Record the stamping exactly as on the disk or logo cap. Note, most stampings include the year set, but most station designations do not include the year. Never change the stamping on a disk or logo cap.

SPECIFICATIONS – Do not use the Height Modernization specifications in publication NOS NGS 58 for GPS observations on tidal bench marks, unless specifically directed in the Project Instructions.

NUMBER OF TIDAL BENCH MARKS

Five tidal bench marks are required at each tertiary tidal station (a tide gauge that will be in place between 1 month and 1 year), see HYDRO. SPECS. and CO-OPS document “USER’S GUIDE FOR THE INSTALLATION OF BENCH MARKS AND LEVELING REQUIREMENTS FOR WATER LEVEL STATIONS”, dated October 1987, Section 2.3.2. These five may include existing tidal bench marks, existing NGS geodetic bench marks, and existing marks of other organizations that meet NOAA standards, or any combination of the above. All tidal bench marks should be within one mile of the tide station (“USER’S GUIDE…”, page 5).

If a sufficient number of existing marks are not available, then new marks, meeting NOAA specifications, shall be set to reach a total of five. If none of the existing marks is capable of being occupied with GPS, then a new stability A or B mark should be set.

MARK SETTING

SITE SELECTION – See guidance in SOW, Attachment W, Section 3.1, HYDRO. SPECS., and CO-OPS document, “USER’S GUIDE FOR THE INSTALLATION OF BENCH MARKS AND LEVELING REQUIREMENTS FOR WATER LEVEL STATIONS,” Section 2.8.

STABILITY – At least one of the tidal BM should be NGS stability A or B

SETTING SPECIFICATIONS - All marks will be set according to NGS specifications.

DISKS IN CONCRETE see SOW, Attachment T.
DISKS IN BEDROCK see SOW, Attachment U.
STAINLESS STEEL RODS, see SOW, Attachment V.

MARK MATERIALS
DISKS - For tidal bench marks, use only brass disks with factory inscription including “NATIONAL OCEAN SERVICE BENCH MARK”
ROD MARKS - For rod marks use aluminum logo caps with factory inscription including “TIDAL BENCH MARK NATIONAL OCEAN SERVICE”
WITNESS POSTS – For Witness Posts use those with sticker containing the NOAA logo and printing including “FOR INFO WRITE TO THE DIRECTOR, NATIONAL OCEAN SERVICE DEPT. OF COMMERCE WASH., D.C.”

NGS will supply these items upon request. All other mark setting supplies and equipment are the responsibility of the contractor.

MARK NAMING
Follow CO-OPS specifications for naming tidal bench marks. See HYDRO. SPECS. and “USER’S GUIDE FOR THE INSTALLATION OF BENCH MARKS AND LEVELING REQUIREMENTS FOR WATER LEVEL STATIONS,” Section 2.7.

MARK DESCRIPTIONS & RECOVERY NOTES
NEW MARKS - Descriptions are required for all new marks set and recovery notes are required for all existing marks searched for and found.

Any marks existing in the NGS database require an NGS recovery note. Any marks existing in the CO-OPS database requires a separate, CO-OPS format recovery note. Portions of the text may be the same.

New marks set as tidal bench marks with only leveling survey data collected need only CO-OPS format descriptions. Marks set as tidal bench marks that will be leveled to and occupied with GPS require descriptions in both formats. Existing tidal bench marks that are occupied with GPS for the first time require both format descriptions/recovery notes.

DESCRIPTIONS:

CASE 1, DESCRIPTIONS FOR ENTRY INTO NGS AND CO-OPS DATABASES – Write the descriptions in NGS 3-paragraph format (see CMP SOW, Attachment S), using program WINDESC to create the digital descriptions. After saving the WINDESC files, delete the “To Reach” paragraphs from each tidal bench mark description and save the files as a MS Word files and PDF files. Save these for the CO-OPS database. Note, one copy of the “To Reach” paragraph shall also be saved in MS

Word and PDF formats, also for the CO-OPS database. Name this file per CO-OPS specifications in: "USER'S GUIDE FOR WRITING BENCH MARK DESCRIPTIONS", Page 1, second paragraph.

CASE 2 – DESCRIPTIONS FOR ENTRY INTO NGS DATABASE ONLY – Create and submit digital descriptions using WINDESC.

CASE 3- DESCRIPTIONS FOR ENTRY INTO CO-OPS DATABASE ONLY – Follow CO-OPS specifications. Create descriptions in MS Word and PDF formats without "To Reach" paragraph and create the "To Reach" paragraph separately as in Case 1, above.

RECOVERED MARKS:

Prepare "Recovery Notes" following procedures similar to those in the Description section above. For projects with no new marks and not "blue-booked", the NGS on-line recovery note page at: http://www.ngs.noaa.gov/ngs-cgi-bin/recvy_entry_www.prl may be used. Submit a paper copy of these recovery notes with the report. At this time the on-line system does not support the entry of new descriptions.

Note, recovery notes are required for all marks searched for and found. See CMP SOW, Attachment S. In addition, see CO-OPS document, "USER'S GUIDE FOR WRITING BENCH MARK DESCRIPTIONS", dated January 2002 for guidance on unit conversions.

MARK PHOTOGRAPHS

All new marks set and all marks recovered and used shall have at least three digital photographs. See CMP SOW, Attachment R. Note, all photographs are submitted on a CD separate from other deliverables. In addition, follow CO-OPS requirements for photographs of tide gauge equipment, see HYDRO. SPECS, Section 4.2.10E.

SELECTION OF EXISTING BM FOR GPS TIES

PRIMARY BENCH MARK – Use the mark designated by CO-OPS as the Primary Bench Mark, if possible.

VISIBILITY – An antenna set up over the mark must be able to receive satellite signals, see CMP SOW.

STABILITY – Marks occupied with GPS should be Stability "A" or "B", see CMP SOW, Attachment W.

LEVELING TIES

BETWEEN TIDAL BENCH MARKS – Follow CO-OPS specifications for spirit level ties between tidal bench marks (BM) at a tide station, see HYDRO. SPECS., Section 4.2.9 and "USER'S GUILD FOR THE INSTALLATION OF BENCH MARKS

AND LEVELING REQURIEMENTS FOR WATER LEVEL STATIONS".

BETWEEN GEODETIC BM AND TIDAL BM – If at least two geodetic BMs exist within 1 mile of the tide station, run spirit levels through at least two geodetic BM and at least one tidal BM. If less than two geodetic BM exist within one mile, no leveling is required to the geodetic BM, see "USER'S GUIDE FOR GPS OBSERVATIONS", dated March 2007,
Section 3.1.1.

LEVELING ACCURACY STANDARD – Third-Order permitted, see HYDRO. SPECS. Section 4.2.5.

VERTICAL TIES, BASED ON DISTANCE FROM TIDE STATION

GEODETIC BM LESS THAN 1 MILE – Leveling tie required; do leveling tie to two Geodetic BM.

GEODETIC BM OVER 1 MILE – No tie required.

GPS HORIZONTAL TIE SPECIFICATIONS

MARKS TO OBSERVE – Make static GPS observations on one tidal BM, the primary BM if possible (meets stability, etc. requirements).

EQUIPMENT - Use geodetic quality GPS receivers, fixed height poles, and GPS antennas that have had their phase center calibrated by NGS. See CMP SOW for additional details.

SESSION LENGTH – At least 4 hours, longer as possible, because high accuracy data is desired.

NUMBER OF SESSIONS – One required, two or more recommended.

DATA PROCESSING – Submit data to OPUS-DB for processing and entry into the NGS database..

GPS POSITIONING OF OTHER TIDAL BM - Determine horizontal positions for all other tidal bench marks using hand-held GPS or better method, see "USER'S GUIDE FOR GPS OBSERVATIONS", Section 3.2.5. Note, this positioning alone does not require the writing of an NGS format description.

METEORLOGICAL DATA – Not required.

TIDE GAUGE INSTALLATION, SERVICING, REMOVAL – See HYDRO. SPECS.

TIDE DATA PROCESSING - See HYDRO. SPECS.

DATA SUBMISSION – Submit all reports and data to NGS. NGS will review and forward to CO-OPS.

TIMELINE FOR DATA SUBMISSION - 15 days