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# 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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## 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 Survey's (NGS), Coastal Mapping Program (CMP) in support of NOAA's nautical chart production. NOAA's 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 nation's entire shoreline has remained. The nautical chart has been called the most fundamental of navigation instruments making the chart's accuracy and completeness essential for maritime safety. A nautical chart depicts 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://www.nauticalcharts.noaa.gov/mcd/learn aboutcharts.html.

This SOW also supports data collection for NGS' Aeronautical Survey Program (ASP), including remote sensing and ground surveys. Airport data is critical to the safety of aircraft in the National Air Space and on the ground. In addition, this SOW supports data collection for NGS' Gravity for the Redefinition of the American Vertical Datum (GRAV-D) program. Data from this SOW may also be used to support the Integrated Ocean Observing System (IOOS), the Integrated Ocean and Coastal Mapping (IOCM) programs, and other NOAA programs.

## 2. SCOPE

Projects may include one or more phases of shoreline mapping or other surveying and mapping tasks including: planning; collecting remotely sensed data from ground, aircraft, and/or satellite based sensors, with positioning and orientation parameters; conducting ground geodetic surveys using conventional and/or precise Global Positioning System (GPS) methods; installing tide gauges and tidal bench marks, making tidal and leveling observations, and processing this data to determine tidal datums, predicted tide values, and actual tide values; performing AeroTriangulation (AT); performing digital map compilation, with attribution; producing orthophotos; controlling quality, including equipment calibrations; processing data; and writing reports. Projects may also include: airport aerial photography (see Attachment A), LIDAR or other remotely sensed data over airports, ground control surveys and obstruction surveys on airports, emergency response to disasters; and/or leveling, gravity surveys, and other special case surveying and mapping tasks. Attachment A contains specifications for aerial photography over airports. The remotely sensed data may include: LIDAR (see Attachments Y), film camera imagery (see Attachment C), 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, and other areas of interest. ASP projects may be at any airports across the U.S. including U.S. possessions in the Caribbean and the Pacific, and 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 diagrams (paper or digital) of the area. The CMP 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 and sufficiently seaward to include all offshore hazards to navigation (e.g. islands and rocks).

3.2 PRIORITY - Priority, if any, will be defined in the Project Instructions.

3.3 ACCURACY - For the CMP, general guidance on HORIZONTAL accuracy at a 95% confidence level for well defined points compiled in the Geographic Cell (GC) File is:

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

Airport survey specifications are contained in the latest versions of:

A. FAA Advisory Circular: General Guidance and Specifications for Aeronautical Surveys: Establishment of Geodetic Control and Submission to the National Geodetic Survey. AC No. 150/5300-16A, September 15, 2007 (AC-16A);

B. FAA Advisory Circular: General Guidance and Specifications for Aeronautical Surveys: Airport Imagery Acquisition and Submission to the NGS, AC No. 150/5300-17B, September 29, 2008 (AC-17B);

C. FAA Advisory Circular: General Guidance and Specifications for Aeronautical Surveys to NGS; Field Data Collection and Geographic Information System Standards AC No. 150/5300-18B, May 21, 2009 (AC-18B).

For specific requirements, see Project Instructions.

3.4 COMPLIANCE REQUIREMENTS -

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

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 NOAA. 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 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 that prevent on-time completion 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 and/or the Project Instructions.

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 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,
Homeland Security, http://www.dhs.gov/index.shtm,

and other federal, tribal, state, commonwealth, and local governmental rules and regulations. The Contractor shall be responsible for identifying, obtaining, completing, and submitting required applications or forms; and for obtaining approval of all necessary permits for work performed under this contract.

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

A. HORIZONTAL CONTROL - North American Datum 1983 (NAD 83).

B. VERTICAL REFERENCE -

i. North American Vertical Datum 1988 (NAVD 88).

ii. Alaska and other areas outside the continental U.S., see SOW Main Text, Section 6.2.

iii. or other local datum if required by the Project Instructions.

C. SHORELINE REFERENCE -

i. MEAN LOWER LOW WATER (MLLW)

ii. MEAN HIGH WATER (MHW)

D. GEOID MODEL - Use the most recent NGS model, currently GEOID09, see: http://www.ngs.noaa.gov/GEOID/ . 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. OBTAINING CHART PRODUCTS - http://nauticalcharts.noaa.gov/staff/charts.htm

B. NOAA CHART No. 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. NOAA ON-LINE CHART VIEWER – This web site allows viewing the entire suite of NOAA charts. See: http://www.nauticalcharts.noaa.gov/mcd/OnLineViewer.html

F. NOAA Center for Operational Oceanographic Products and Services (CO-OPS) web Site: http://tidesandcurrents.noaa.gov/

G. NOAA NGS web Site: http://www.ngs.noaa.gov/

H. U.S. COAST GUARD LIGHT LIST:
http://www.navcen.uscg.gov/pubs/LightLists/LightLists.htm

I. See Glossaries in Attachments F and M.

J. Manual Of Photogrammetry, Fifth Edition, 2004.

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

L. "NOS Hydrographic Surveys Specifications and Deliverables, Chapter 4: Tides and Water Levels Requirements" dated April, 2008, at:
http://www.nauticalcharts.noaa.gov/hsd/docs/Specs2008.pdf (mainly superseded by reference"M" below).

M. "Water Level Station Specifications and Deliverables for Shoreline Mapping Projects,", CO-OPS publication, May 2009, at:
http://tidesandcurrents.noaa.gov/publications/Water_Level_Station_Specifications_and_Deliverables_for_Shoreline_Mapping_Projects,_Updated_May_2009.pdf . Note, this document is an update of Chapter 4 of the Hydrographic Specifications and Deliverables and is now the primary CO-OPS reference for shoreline mapping.

4. GOVERNMENT SUPPLIED INFORMATION AND MATERIALS

4.1 SOW, WITH ATTACHMENTS (this document).

4.2 PROJECT INSTRUCTIONS - Project Instructions are a separate document providing specific project information, containing any unique project requirements, and may contain any or all of the following information:

A. PROJECT DIAGRAMS - Diagrams (paper or digital) with the project limits marked by NGS. These Diagram(s) of the project area show the shoreline to be compiled; compilation limits, if different from the 2000 foot requirement; and, as required, limits of tide-coordination areas (if different from compilation limits);

B. TIDAL ZONING DIAGRAM;

C. TIDAL ZONING MEMO;

D. FLIGHT LINE MAP (CMP and/or ASP);

E. WAYPOINT FILE (CMP and/or ASP);

F. ADDITIONAL INSTRUCTIONS - Instructions regarding tidal coordination, ground control, Gravity for the Redefinition of the American Vertical Datum (GRAV-D), and any other project specific requirements;

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

H. AIRPORT MAPS for Aeronautical Survey Program.

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 Electronic Exposure Data (EED) file with, at a minimum, the government supplied software prior to submitting each EED file to NGS. The first software checks the EED file for proper formatting and checks for typical value limits on various fields within the file. The second software 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 TIDAL SOFTWARE - The contractor may use any software, commercial or proprietary, to calculate the times wherein the tides in the project area are at the appropriate height to acquire tide coordinated imagery. The only restriction on the use of contractor supplied software for this purpose is that the times calculated by such software must coincide with the times calculated by the Government's in-house tide window prediction software. The Government will, at the contractor's request, provide the most current version of the software that the Remote Sensing Division (RSD) uses, and is able to freely distribute, to predict such tide windows. The Government will, at the contractor's request, provide training in the use of the RSD program. Such training will be at a time and place mutually convenient to both the contractor and the Government. See Attachment J for an explanation of tides and tide windows.

4.6 NGS AND NOS SURVEY MARKS – 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.

The Contractor shall acknowledge receipt of Government Supplied Items by inventorying the shipment, signing the Transmittal Letter (TL), and FAXing the TL to NGS. At this time Contractors cannot use the Task Order Management and Information System (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 Project Instructions and Attachment C, Section 8),

ii. proposed ground control methods and locations (using different symbols for: Continuously Operating Reference Stations (CORS), new survey control, old survey control, photo control, and airborne KGPS Ground Base Stations, if required),

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, IT security methodology for securing the system(s), and software)

vii. personnel.

See Attachment AD for the full Technical Proposal requirements.

B. QUALITY CONTROL PLAN - 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, the SOW, the SOW Attachments, and References. The Contractor shall submit a written Quality Control Plan (QCP) 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.

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.

C. TOMIS SPREADSHEET – The Contractor shall submit a completed TOMIS spreadsheet containing a listing of all Deliverables, percents, and due dates, and in the specified format. See Attachment AI.

5.2 COST PROPOSAL - The Contractor shall submit a proposal with the costs broken down into at least the following categories, for all work required by the Project Instructions:

A. MISSION PLANNING,

B. GPS SURVEY 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 – The Contractor may be required to acquire aerial photography, digital or film. Aerial photography for the CMP is required to meet three main parameters: sun angle of at least 25 degrees for digital (30 degrees for film), clear sky, and tide coordination. See information below and in Attachments: Z, C, J, and AF.

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 (paper or digital) and waypoint files in standard NGS format (see Attachment C, Annex 4 for format). The Contractor shall review these flight lines to ensure adequate coverage as defined in the paragraph immediately above, and immediately notify NGS of any problems.

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 6.3. If film was collected, the Contractor shall ship all exposed film to the NOAA film processing Contractor, along with a completed, original Photographic Flight Report (PFR) (NOAA Form 76-15), the Raw Navigation File and a TL, see Attachment AC. The Electronic Exposure Data (EED) file shall be sent to NGS within three working days via email. The Contractor shall check all manual data entries. See Attachments Z and C, for complete details. Note, the Project Instructions will state if new exposure tests are required for future Task Orders. Normally an unaltered camera system that has already had an Exposure Test in a similar geographic area will not require a new Exposure Test.

iii. Tide Coordination - The Project Instructions may require that remotely sensed imagery for the CMP be tide coordinated. When digital shoreline is to be compiled using aerial photographs, color negative (CN), RGB, Color Infra-Red (Color IR), and/or Black-and-White IR (B&W IR) images may be required to be captured when the water level is at observed or predicted MHW, observed or predicted 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) for the CMP shall be positioned using airborne Kinematic GPS (KGPS) (with dual-frequency, carrier-phase measurements). Airborne KGPS is normally not required for airport photography. 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 for CMP projects 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 or local sensors that convert energy from the electromagnetic spectrum into analog or digital data obtained from any ground, airborne, or space borne satellite platform. Also gravity data may be required. See Project Instructions for specific requirements.

6.2 GROUND CONTROL SURVEYS -

A. CHECK POINTS - For CMP 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 may be required to make GPS ties to existing tidal bench marks. 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 or more 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 Aerotriangulation Report.

For ASP projects, Check Points are usually not required.

B. PHOTO CONTROL POINTS – For CMP projects, the Contractor may propose additional ground control points, these to be used in the aerotriangulation. These points are called “Photo Control Points” to distinguish them from the “Check Points” described above. The Contractor shall determine an adequate number and distribution of these 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 CORS and

Online Positioning User Service (OPUS) (including OPUS-Rapid Static (OPUS-RS)) to position both types of photo ground control. Any updates in this SOW's OPUS requirements will be included in the Project Instructions. See Attachment O for ground photo control requirements.

If Photo Control Points are required for ASP projects, they will be specified in the Project Instructions. See also Attachment A, Section 6.

C. GROUND SURVEYS - See Attachment P for requirements for Ground Control Extension Surveys (marks used to position other marks). In most CMP 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, including leveling, taking digital photographs during the ground surveys, and 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, X, AG, and AJ.

G. GROUND SURVEYS AT AIRPORTS – The Contractor may be required to perform ground surveys at airports including: runways, air navigation aids, aircraft obstructions, and other related surveys.

H. GROUND TRUTH FOR REMOTE SENSING – Ground truth for various ground, airborne or space sensors may be required.

6.3 TIDE/WATER LEVEL REQUIREMENTS – See the CO-OPS reference listed in Section 3.6M, above. When required, additional specifications for predicting water levels, observing water levels in real time, installing water level gauges and tidal bench marks, collecting water level data, leveling between bench marks, GPS observations on tidal bench marks, or processing all these observations will be included in the Project Instructions. Data shall be submitted in CO-OPS and NGS specified formats. In any cases where the requirements conflict or would cause duplicate effort, consult Attachment AH and then contact NGS for clarification. See Attachment J for information on tidal acquisition windows and Attachments: Z, C, and P for other requirements. For additional information on tides and water levels, see the CO-OPS site at: http://tidesandcurrents.noaa.gov/ , especially the link to "Our Restless Tides" at: http://tidesandcurrents.noaa.gov/restles1.html , "Fantastic Tidal Datums" at: http://tidesandcurrents.noaa.gov/publications/fantastic_tidal_datums.pdf , and

"Understanding Tides" at:
http://tidesandcurrents.noaa.gov/publications/Understanding_Tides_by_Steacy_finalFINAL11_30.pdf

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 are not required for photo control), and submitted in required formats. A final report is required. Specifications for ground photo 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 the CO-OPS reference in Section 3.6.M, above, its references, and Attachment J.

7.3 AEROTRIANGULATION – For CMP projects, the Contractor is required to perform the standard processes of aero-triangulation for all photographs (including color and IR) used in the shoreline mapping project. All imagery (color and IR) for an entire project shall be included in the same AT solution. The Contractor shall include in the project Technical Proposal a plan explaining how the AT work will be performed.  Upon completion of the AT, 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.

Aero-triangulation may be required for ASP projects.

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

## 8.  OFFICE DATA COLLECTION

8.1  GEOGRAPHIC CELL (GC) – The GC  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 Contractor's 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 NGS's digital photogrammetric softcopy workstations for stereoscopic review purposes.

Each project shall be broken into sub-areas (about four).  For each sub-area there shall be the following Deliverables:

Pilot Area, Sub-Area X, Interim Files
Sub-Area X, 50% complete Interim Files
Sub-Area X, 100% complete Interim Files.

See also Section 8.6, below.

8.2  COASTAL CARTOGRAPHIC OBJECT ATTRIBUTE SOURCE TABLE -  The final product shapefiles use the NGS's "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 Organization's 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 CMP are included in a second Glossary in Attachment M.

See Section 8.6, below, for information on sub-dividing projects and pilot areas.

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. The following image naming convention shall be used: **130001_**0001
Where the STRIP (prefix) is a **6-digit** designator:

Digit **1** holds _Data Type_

- 1 = color/non-tide coordinated
- 2 = IR/MHW
- 3 = IR/MLLW
- 4 = IR/non-tide coordinated
- 5 = color/MHW
- 6 = color/MLLW

Digits **2-3** hold _Scale_

- Digits **4-6** hold the actual _Strip #_ assigned by the Requirements Branch.

And the FRAME (suffix) uses the remaining **4-digits** and holds the frame # as designated by the photographer.

C. SHAPEFILES – The Contractor shall request geographic cell file names from NGS via e-mail. NGS will normally respond within five working days of the request.

The interim shapefiles, including pilot areas, should be named for 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.

This final deliverable shapefile shall have the prefix name of the project identifier as defined in the Project Instructions.

The final deliverable shapefile's SOURCE_ID attribute value is the corresponding Geographic Cell identifier.

8.4 COMPILATION METHODOLOGY - Aerial photographic data shall be compiled using stereo models in 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 SET® 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. Manual point-to-point mode of compilation should be used for all feature extraction, particularly when collecting well-defined points such as corners of a pier or wharf. If stream mode is used, parameters should be carefully set in order to avoid unnecessarily large file sizes. 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. Other important general topological considerations include:

i. Line features that cross other line features shall not be split into multiple features where they cross (e.g. overhead cable crossing a shoreline).

ii. Line features must never cross over themselves.

iii. All individual line features compiled to form closed polygons must begin and end precisely at the same node (w/no dangles or gaps).

iv. Multiple instances of a feature with the same attribution occupying the same geographic space (duplicate features) are never allowed in final line and point shapefiles or Chart Evaluation File (CEF).

v. Short (tiny) line features must not be created solely for the purpose of establishing topological connectivity. In general, line features < 0.5 mm at the compilation scale should not be compiled except in specific circumstances (see Attachment K).

D. COMPILATION LIMITS - In all project areas, the features to be compiled include: the shoreline; hazards to navigation in the water (rocks, islands, etc.), 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. All landmarks meeting requirements and within the photo coverage, shall be compiled. See Attachment K.

E. COMPILATION CONTENTS AND LEVEL OF DETAIL - In general provide approximately the same level of detail as on the largest scale nautical chart of the area. 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 DATA SUBMISSION -

A. PILOT AREA – The contractor shall select a Pilot Area from within each sub-area of the project area and submit these proposed Areas as part of their Technical Proposal. These Pilot Areas shall contain a representative sample (less than 10%) of the shoreline and shoreline features contained in the sub-area. These Pilot Areas shall become part of the sub-area of which they are part. Once the Technical Proposal is accepted and the notice to proceed has been received, the Contractor shall compile these areas and then submit interim shapefiles covering these Pilot Areas. The Contractor shall not begin compilation on other portions of the sub-area until NGS approves the corresponding Pilot Area.

B. INTERIM SHAPE-FILES - Most projects shall be divided into two to four sub-areas. There shall be a pilot area for each sub-area. After the "pilot" areas are approved by NGS, **the Contractor shall submit interim shape-files for the pilot area, for the sub-area when 50% complete, and for the sub-area when 100% complete.** These three levels of submission will be a means of conveying compilation progress, and giving NOAA review personnel the opportunity to scrutinize compilation and submit interim comments, as a means of catching erroneous feature compilation practices, and correcting errors before they occur. Sub-areas, should be submitted one area at a time. After NGS approves each sub-area, the next sub-area may be submitted.

C. FINAL SHAPE-FILES – After the Interim Shapefiles have been reviewed and accepted by NGS, the Final Shapefiles shall be prepared and submitted. The final deliverable shapefile products shall be two shapefiles (one consisting of all point features, and one consisting of all line features) that store the geometry and attribute information for the spatial coastal mapping features within the project limits as defined in the Project Instructions. 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 Contractor shall submit these Final Shapefile after all Interim ShapeFiles have been approved by NGS. 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.

## 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 Contractor's Quality Control Plan, which was submitted with the Technical Proposal and approved by NGS. The Contractor shall check all data to ensure that it is complete, reliable, and accurate. Accuracy requirements may be in the Project Instructions. The Contractor's personnel shall become thoroughly familiar with the SOW, 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.

The Contractor shall conduct a final quality review of the feature compilation to ensure 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).

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.

9.3 CHART EVALUATION FILE - The Chart Evaluation File (CEF) is a 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 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 GC data when updating charts and when performing hydrographic survey operations. Any additional notes 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. If a project is broken into sub-areas (A, B, C, etc.), then a separate and complete PCR is required for each sub-area. Submit the PCR after all other work has been completed.

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 the following formats: paper, Microsoft (MS) Word®, and the Adobe Acrobat® Portable Document Format (PDF). NGS will make the PCR (in PDF format) available on the NOAA Shoreline Data Explorer website for download along with the project shapefiles. See Attachment L.

10. <u>DELIVERABLES</u>

The Contractor shall submit all Task Order Deliverables and Weekly Status Reports to NGS using the TOMIS system. All Deliverables shall be named exactly the same as they are listed in TOMIS. All Weekly Status 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 about 10 MB in size shall be submitted to TOMIS as an attachment. This should include almost all digital files except large, final shapefiles and aerial imagery. Larger files may be compressed and submitted to TOMIS in compressed format. If the Deliverable is still too large (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. The Contractor shall submit the data delivery report to TOMIS the same day that the Deliverable is sent. Use a Transmittal Letter (TL) for all shipments of data outside TOMIS. 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. For complete details, see Attachment AI.

Deliverables too large for submission through TOMIS shall be submitted on Digital Versatile Discs (DVDs), portable hard drives, secure FTP servers, or similar, pre-approved mediums. Poor quality DVDs and/or poor handling of DVDs may result in a very short life for the data stored on the disk. To help ensure data longevity, all DVDs used for Deliverable submission shall be archival quality DVDs such as Taiyo Yuden DVD+R. **Do not apply labels to DVDs**. Use only special DVD archival pens (with solvent-free ink) to mark on DVDs and ideally mark only in the central, clear portion of the disc. Some additional procedures to help ensure longevity include: handle disks by the outer edge or the center hole, keep the disk clean, store upright in a plastic, jewel case, return disks to the case immediately after use, open new disc packages only when ready to record, clean carefully using DVD approved cleaners, and store discs in a cool, dry place with clean air.

The Contractors shall submit a Deliverable Tracking Spreadsheet in the TOMIS format as part of their Technical Proposal. The Spreadsheet format and procedures for using TOMIS are included in Attachment AI.

All Deliverables shall be submitted by the Prime Contractor to NGS via TOMIS, not from a Sub-Contractor, except for film which a Sub-Contractor may ship directly to NGS' film processing Contractor. Shipment of Deliverables to the Prime Contractor enables the Prime Contractor to check all data prior to shipment to NOAA.

TOMIS is not operational for items shipped to the Contractor by NOAA. Upon receiving Government Supplied Items, the Contractor shall check off the items on the TL, sign and date the TL, and FAX or email the signed TL back to NOAA. See Section 10.10 below and Attachment AC for details and an example.

All reports except Weekly Status Reports shall be delivered in the following formats: paper, MS Word®, and PDF, to provide for immediate ease of use and also to help ensure that the data will be available many decades into the future. Contractors shall submit the MS Word and PDF formats together as one Deliverable. After NGS approves the Deliverable, the Contractor shall submit the paper copy. The TOMIS spreadsheet of Deliverables shall have two lines, one for the two digital formats, and one for the paper copy.

MicroSoft Word format to be Version 97, or later; composed on 8 ½ by 11 inch sized pages; using one inch margins; using double line-spacing; and using "Times New Roman" font, sized 12 pitch, or equivalent.

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 (GSI) to NGS, except for any paper nautical charts supplied by NGS. This shall include all photographic products, see Section 4. The GSI shall be the last Deliverable submitted. NGS will hold back payment of the final 10% of all Task Orders until all Deliverables, including the GSI, are submitted, reviewed, and accepted by NGS.

10.3 STATUS REPORTS

A. WEEKLY TEXT - The Contractor shall submit Weekly Status Reports to NGS 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. See Attachment G for details.

B. MONTHLY GRAPHIC – If the contractor was tasked with collecting remotely sensed data, the contractor shall submit graphic(s) showing the status of data collection, on the first Monday of each month via TOMIS. The contractor shall submit a separate graphic for each required dataset (color/RGB, MHW IR, MLLW IR, etc.). The graphic(s) shall show the numbered flight lines; the specific shorelines to be compiled highlighted or drawn in bold, using the shoreline vectors supplied by NOAA; the area of ground coverage; and shall use a NOAA nautical chart as background. The graphic(s) shall show all required imagery differentiating the frames acquired from those not yet acquired as follows:

No highlighting = areas not collected,<br>
Orange highlighting = areas collected but not yet accepted by NGS, and<br>
Green highlighting = areas accepted by NGS.

The required formats for the graphic(s) are PDF and JPEG, unless otherwise approved by NGS.

10.4 GROUND PHOTO CONTROL DATA AND REPORT - The Contractor shall prepare a report covering the ground photo control portion of the work. See Attachments N through X, and AJ 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, and Attachment O. Most projects will require Check Points and may have Ground Photo Control Points and thus this report. This report shall be submitted in paper and digitally in PDF format. Ground photos of photo control points may be submitted as part of the paper and PDF Ground Control Report. Ground photos of NSRS database points (or newly surveyed points to be entered into the NSRS), shall be submitted on a separate DVD, see Section 10.5 below.

10.5 GROUND CONTROL DATA AND REPORT (NSRS MARKS) - The Contractor shall prepare a report covering the ground control survey portion of the work, if any is done. See Attachments N through X and AJ 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, and Attachment P. Most projects may not require ground control surveys and thus in that case, this Report would not be required. Photos taken of ground surveyed points (NSRS points) shall be submitted on a separate DVD.

10.6 AERIAL PHOTOGRAPHY ASSOCIATED DELIVERABLES - Deliverables are listed below:

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

B. FLIGHT LINE MAPS (Final) - Map(s) showing the actual lines flown. See Attachment C, Section 8;

C. TABULATION OF AERIAL PHOTOGRAPHY , See Attachment C, Section 11.4;

D. PHOTOGRAPHIC FLIGHT REPORTS (NOAA Form 76-15), See Attachment C, Sections 6.1B and 18.4, and Annexes 1 and 2; or for digital, see Attachment Z;

E. RAW NAVIGATION FILE, See Attachment C, Sections 6.1C, 6.2A, 15.1, and 18.5;

F. ELECTRONIC EXPOSURE DATA (EED) FILES, See Attachment C, Sections 4.3, 4.5, 6.1C, 6.2, 12.3, 15.1, 18.7 and Annex 3. This file should be submitted digitally through TOMIS;

G. AIRBORNE POSITIONING & ORIENTATION REPORT, See Attach. C, Sections 13.3, 13.4, 18.9;

H. CAMERA CALIBRATION REPORT, if the current version has not already been submitted. See Attachment C, Sections 4.3, 18.12; for digital, see Attachment Z;

I. CAMERA MAINTENANCE LOG, if the current version has not already been submitted. See Attachment C, Sections 4.3, 18.13;

J. CAMERA WINDOW INFORMATION, if the current version has not already been submitted. See Attachment C, Sections 7.3D, 17, 18.14;

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

L. FILM SHIPMENT REPORTING, See Attachment C, Sections 15.2, 18.6;

M. PHOTO FINAL REPORT, See Attachment C, Section 18.17.

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, F and K have other specific delivery requirements which, for film, are explained in Attachment C, and Attachment Z for digital.

10.7 AEROTRIANGULATION DATA AND REPORT - The Contractor shall prepare a report covering the AT portion of the work. The AT files shall 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.

10.8 CHART ANNOTATIONS – For requirements on annotating Chart Evaluation Files, see Attachment K and Attachment AE.

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

10.10 GEOGRAPHIC CELL SHAPEFILES - PILOT AREA SHAPEFILES - The Contractor shall supply ESRI 3-D shapefiles (points, lines) of the Pilot Area for each sub-area. The Pilot Areas become part of the sub-areas. See Attachment D.

10.11 GEOGRAPHIC CELL SHAPEFILES - INTERIM SHAPEFILES - The Contractor shall supply ESRI 3-D shapefiles (points, lines) for quality control purposes, one set for each of the project's sub-divided areas, e.g. areas A, B, C, etc. when 50% complete and another set when 100% complete. NGS prefers that the areas be submitted one at a time, with NGS review between each submission. See Attachment D.

10.12 GEOGRAPHIC CELL SHAPEFILES - FINAL SHAPEFILES - The Contractor shall supply the final set of ESRI 3-D shapefiles (points, lines), one for each of the Project's sub-divided areas, e.g. areas A, B, C, etc. These shall be submitted after NGS has reviewed and approved the Interim Shapefiles. See Attachment D.

10.13 TRANSMITTAL LETTER - Transmittal Letters (TL) are not required for Deliverables that the Contractor submits through TOMIS, because once NGS acknowledges receipt in TOMIS, the system will automatically send an email to the sender stating that the item has been received. For Deliverables sent outside TOMIS (larger than 10MB or paper items) and for items that NGS ships to the Contractor, TL shall be used, and, in addition, the Contractor shall make a TOMIS entry stating what they shipped and how it was shipped. One copy of the TL is sent with the shipment and another copy is emailed or FAXed to the office receiving the data. For items sent by NGS, when the data arrives, the Contractor inventories the shipment against the TL, signs, and FAXes or emails the TL back to NGS. Both offices should maintain files of TL. A special type of TL is required for hard drives and other government property that are sent back and forth. Both parties should use these forms and follow standard TL procedures in signing and returning a copy to the sender. See Attachments AC and AI.

10.14 TIDE STATION DATA – The Deliverables required by CO-OPS are listed in the reference in Section 3.6.M.

## 11. DELIVERY SCHEDULE

11.1 DATE - All Deliverables (Section10) shall be submitted to NGS, via 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. 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 Contractor’s expense.

11.2 REQUESTS FOR MODIFICATIONS - All requests for modification shall be submitted by the Contractor in writing to the Contracting Officer (with a copy to NGS) 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. POINT OF CONTACT:

NOAA:

Gregory E. Stinner
COR
National Geodetic Survey
ATTN: N/NGS; SSMC3, Sta. 8622
1315 East-West Highway
Silver Spring, Maryland 20910
301-713-3167
Fax: 301-713-4315
email: gregory.stinner@noaa.gov

Mike Espey, Chief, Applications Br.
Remote Sensing Division,
National Geodetic Survey
ATTN: N/NGS3; SSMC3, Sta. 5342
1315 East-West Highway
Silver Spring MD 20910
301-713-2684
301-713-2183
email: mike.espey@noaa.gov

13. SECURITY

13.1 INFORMATION TECHNOLOGY SECURITY – The applicability of Commerce Acquisition Regulation (CAR) clause 1352.239-72, Security Requirements for Information Technology Resources (APR 2010), in the performance of NGS requirements as described herein, will be determined at the task order level. Familiarization with this clause as well as DOC IT Security Program Policy & Minimum Implementation Standards (internal access only: http://home.commerce.gov/CIO/ITSITnew/IT_Security_Program_Documentation.html) is recommended.

13.2 NOAA BUILDING SECURITY – When visiting NOAA offices, all contractors must obtain a Visitor's Pass by showing show the Security Officer a valid picture ID (drivers license, military ID, etc.). Visitors will be required to sign-in at the building security desk, process through the walk-through magnetometer, and have their items x-rayed or searched. Visitors are issued a time expiring NOAA Visitor Badge valid for one day only. For additional information see: http://www.osec.doc.gov/osy/noaa/1.htm .

13.3 DATA SECURITY – NGS source data and products will generally be at the UNCLASSIFIED level (with/without caveats) but could be at any classification level/handling methodology. Current unclassified requirements are approximately 75% of the program. The remainder is classified. See also SOW, Sections 3.4E and 3.4F, above.

13.4 SECURE FACILITIES – At a minimum, contractors shall possess personnel And facilities clearances to the SECRET (S) (with/without caveats) level in accordance with the National Industrial Security Program (NISP) to support NGS requirement production. The personnel and facilities clearances must be maintained throughout the contract period of performance.

14. PLACE OF PERFORMANCE

Field work will take place within the project area, as required. Office work will be in facilities provided by the Contractor.

15. PERIOD OF PERFORMANCE

Work shall begin when the Contractor receives a Task Order against an existing contract.

April 13, 2010

# 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

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ATTACHMENT A: AIRPORT AERIAL PHOTOGRAPHY PAGE

ANNEXES

# ATTACHMENT A:
# SPECIFICATIONS FOR AIRPORT AERIAL PHOTOGRAPHY

## 1. GENERAL

These Specifications 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, tribal, or otherwise) and shall be responsible for identifying, obtaining, completing, submitting, and gaining approval of 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 imagery 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, below. The Project Instructions may specify film and/or digital camera usage. If digital, see Attachment Z. 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 (PFR) 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 PFR (NOAA Form 76-15) completed in black ink (except the **word "ORIGINAL" at the top printed in BLUE ink),** with the film. Submit a copy of the Flight Report to NGS via the Task Order Management and Information System (TOMIS)**.** For samples see Annex 4 and 5, and for shipment instructions see Section 14.

E. RAW NAVIGATION & ELECTRONIC EXPOSURE DATA (EED FILES - The Contractor shall submit the original, Raw Navigation File (RNF ) captured at the time of each exposure, in the formation of the aircraft's on-board navigation system (which may be used by the Contractor to create the EED file) with the EED file.

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. See Annex 6.

The Contractor shall submit the final EED file and the RNF file to NGS via TOMIS within three working days of shipment of the corresponding roll of film. Note, a 3.5" floppy disk containing the EED file is no longer required. **The Contractor shall submit the format of the RNF to NGS** and shall explain any and all changes to the RNF 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, Attachments O and P, and Section 6 of this document, Ground Control Survey.

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

H. TRANSMITTAL LETTERS - Send a Transmittal Letter (TL) with each film shipment (see the sample in Annex 9, and further information in this Section below and

Section 14 below. The Contractor shall also return receipted copies of any TL that the Government sends. See Section M, below for TOMIS reporting requirements. Other Deliverables shall be submitted via TOMIS, see Attachment AI.

I. CAMERA CALIBRATION - Supply the current U.S. Geological Survey (USGS) camera calibration certificate for each camera planned for use, directly to NGS prior to any photography. See Section 4.1, below.

J. CAMERA MAINTENANCE - Provide a preventive maintenance log for each camera to be used to acquire aerial photography directly to NGS, see Section 4.1 below.

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

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

M. FILM SHIPMENT REPORTING – The Contractor shall submit via TOMIS a copy of the PFR (marked “copy”) and a digital copy of the TL that accompanied the film to the NGS film processing contract laboratory. See Section 14. Submit the same day the film is shipped.

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. WEEKLY STATUS REPORTS - The Contractor shall submit Weekly Status Reports via TOMIS to NGS every week from Task Order award until the work is complete and accepted by NGS**. 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. A summary of the 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 the Contracting Officer (CO), and copy to NGS, in advance. No deviation is permitted until written approval is received from the CO.

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 inch Contractor-furnished film containers, and 5 3/16 inch film spools. However, film integrity is the responsibility of the contractor until the film 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 may 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, (see 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. SCOPE OF WORK – SOW and 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 shall not be used as production photography. NGS recommends that the Contractor bracket their exposure settings during the test. After the 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 PFR, and TL directly to the NOAA film-processing contract laboratory. The Contractor shall notify NGS when the film is shipped by submitting a copy of the PFR and a copy of the TL via TOMIS, see Section 14.2.

The Contractor shall prepare and submit the final EED file to NGS, along with the RNF, 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 PFR, and a TL 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 by submitting a copy of the PFR and a copy of the TL via TOMIS, see Section 14.2. The Contractor shall prepare and submit the final EED file and the RNF 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 (unless a digital camera or other sensor is specified in the Project Instructions):

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 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 PFR. 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 GREENWICH MEAN TIME (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: http://www.worldtimezone.com/ .

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.

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 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).

PREVENTIVE MAINTENANCE - The Contractor shall supply to NGS a log of all maintenance performed on each camera system, to be used for this work, 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.

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 in the EED collection system.

CAMERA DISTURBANCES - 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 - Any requirement for digital imaging will be stated in the Project Instructions.

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. 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 anti-vignetting 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. Filters to be used under this SOW shall have been tested by the USGS at the time of each three-year 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 PFR (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 American Society of Photogrammetry and Remote Sensing (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, Military Specifications 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 PFR (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 applicable Federal Aviation Regulations (FARs). This includes but is not limited to obtaining any and all clearances necessary to carry out the assigned data collection. Contractor aircrews shall check local and FDC NOTAM's prior to each flight. No work may be attempted in Restricted, Prohibited, ATCAA, or TFR (Temporary Flight Restriction) airspace without prior clearance. In addition, the contractor's aircrews must meet all applicable FAA requirements for training and currency required for operations within the Washington D.C. /Metropolitan Special Flight Rules Area (SFRA), or any other SFRA.

6. GROUND CONTROL SURVEY (if required)

6.1. GROUND CONTROL POINTS – Ground control points may be required at each airport to help reference the imagery. 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 control points. The required coordinate system is the Universal Transverse Mercator (UTM) in the North American Datum of 1983 (NAD 83). Specify the UTM zone used. Continuously Operating Reference Stations (CORS) & On-Line Positioning User System (OPUS) shall be used to position the ground control points. See also Attachment O.

6.2 CHECK POINTS - In addition to any ground image control points, a minimum five check points are required in the project area. Check points must meet the same standards as control points. Note, check points shall not be used in controlling the imagery. A position determined through the NGS OPUS program is required for each check point. Submit a copy of the OPUS solution for each check point.

6.3. 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 North American Vertical Datum of 1988 (NAVD 88)
Ellipsoid Height (meters, to 2 decimal places)

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

6.4. 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 versus 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.

6.5. 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 may be required to 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 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.

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”(MOP), Fourth Edition, Section 5.8.3.

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://www.usno.navy.mil/USNO/astronomical-applications/data-services/rs-one-day-us. This site computes sun altitudes and sun azimuths for U.S. locations and world-wide positions. See also MOP, Fifth Edition, 2004, pages 1114-1115, and Attachment AF.

8.6 CLEAR DAY MAP - For a Clear Day Map, refer to: http://cdo.ncdc.noaa.gov/cgi-bin/climaps/climaps.pl. Please see the directions below for help navigating the website.

1. In the left column, click on "Quick Search"
2. In the "Region" column, highlight the desired region
3. In the "Map Category" column, highlight "Sky Cover/Visibility"
4. Click on "Continue"
5. Highlight first choice, "Mean Number of Clear Days (Sunrise to Sunset)"
6. Click on "Continue"
7. Click on month(s) of interest
8. To download the high resolution PDF file for this map, click on the blue link

(below this statement on the web site), or, to download the ESRI Shape Files for this map, click on one of the blue links (below this statement on the web site). Note, there is a charge.

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).

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 to help improve the strength of the solution.

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 NAD 83. The vertical datum is the 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 camera 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 PFR (one Report per roll) completed in black ink (but marked “ORIGINAL” in BLUE ink at the top) and filled-in front and back, and (3) the TL 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 submit final, **checked** EED files, in NGS format, and the RNF to NGS via TOMIS within three working days from the date the film was shipped. Copies of the PFR and the RNF 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 a digital copy of the PFR (marked “COPY” at the top) and a digital copy of the film TL.

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

Roger Strouse
Remote Sensing Division
National Geodetic Survey
ATTN: N/NGS32; SSMC3, Sta. 8307
1315 East-West Highway
Silver Spring, Maryland 20910
301-713-2670 x186
Fax: 301-713-4572
email: Roger.Stouse@noaa.gov

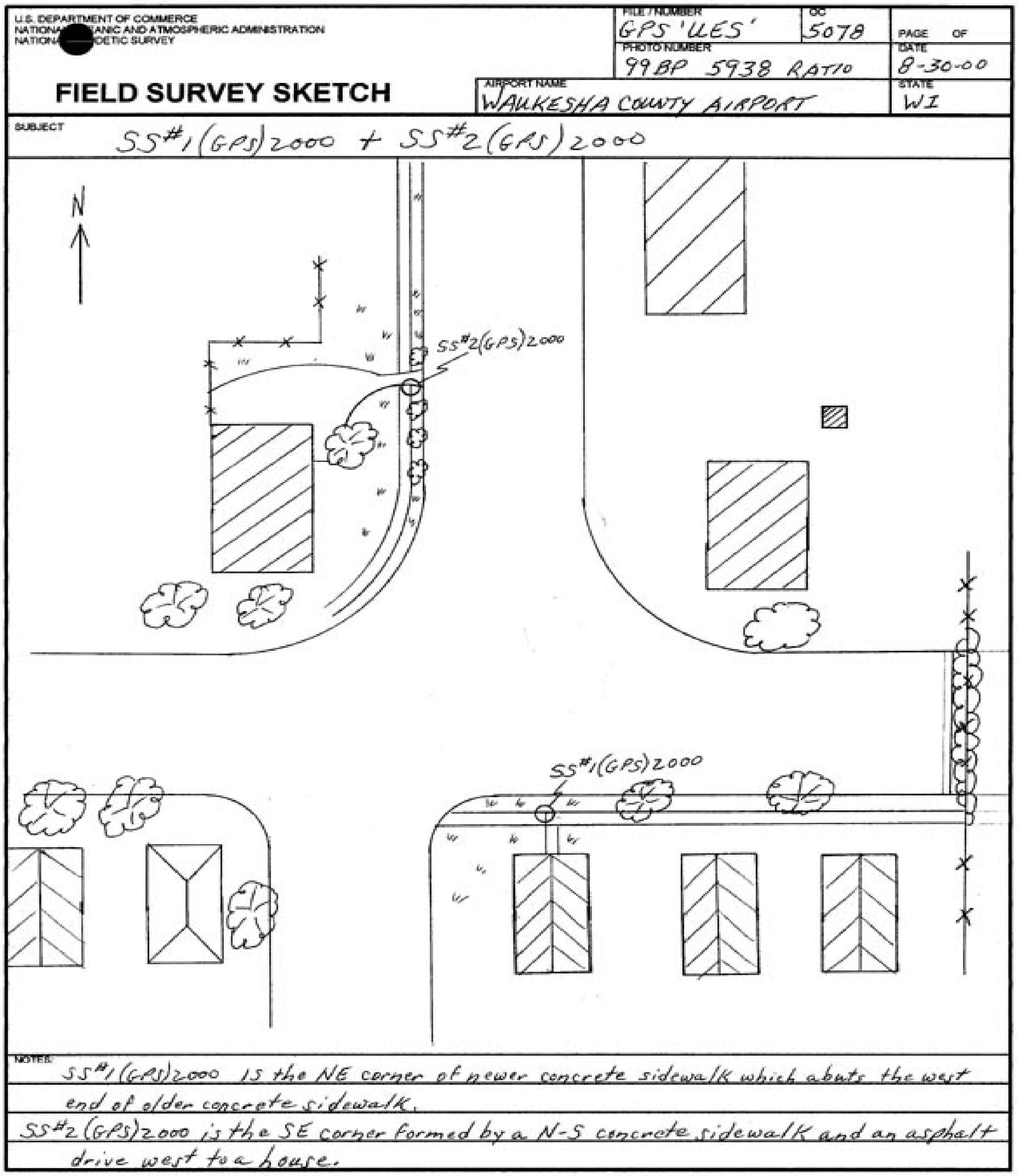
## ANNEX 1 - Sample Ground Control Coordinates

**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 CO**
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 REMAR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | S | | | | | | | | | | | | | |
| | | | | E | | | | | | | | | | | | | |
| | | | | B | | | | | | | | | | | | | |
| | | | | S | | | | | | | | | | | | | |
| | | | | E | | | | | | | | | | | | | |
| | | | | B | | | | | | | | | | | | | |
| | | | | S | | | | | | | | | | | | | |
| | | | | E | | | | | | | | | | | | | |
| | | | | B | | | | | | | | | | | | | |
| | | | | S | | | | | | | | | | | | | |
| | | | | E | | | | | | | | | | | | | |
| | | | | B | | | | | | | | | | | | | |
| | | | | S | | | | | | | | | | | | | |
| | | | | E | | | | | | | | | | | | | |
| | | | | B | | | | | | | | | | | | | |
| | | | | S | | | | | | | | | | | | | |
| | | | | E | | | | | | | | | | | | | |
| | | | | B | | | | | | | | | | | | | |
| | | | | S | | | | | | | | | | | | | |
| | | | | E | | | | | | | | | | | | | |
| | | | | B | | | | | | | | | | | | | |
| | | | | S | | | | | | | | | | | | | |
| | | | | E | | | | | | | | | | | | | |
| | | | | B | | | | | | | | | | | | | |
| | | | | S | | | | | | | | | | | | | |
| | | | | E | | | | | | | | | | | | | |
| | | | | B | | | | | | | | | | | | | |
| | | | | S | | | | | | | | | | | | | |
| | | | | E | | | | | | | | | | | | | |
| | | | | B | | | | | | | | | | | | | |

## 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.*

**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 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)** **AIRPORT INFORMATION –** 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

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

(33) NO. OF BLANKS TO START ROLL 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 |
| 0Ø2 | 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 | 0499P06) | | | | | | 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 | 19,000 | | 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 | 99P04) | | | GREENFARMLAND |
| | 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).

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## 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 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.

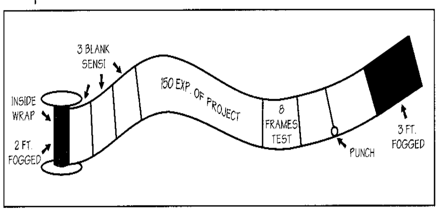
Blank Forms

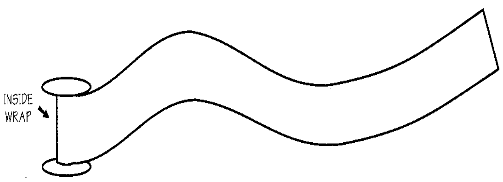
FILM TYPE ______________________________

COATING IDENTIFICATION ______________________________

FILM TEST: YES___ NO___ SENSITOMETRY: YES___ NO___

Example:




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

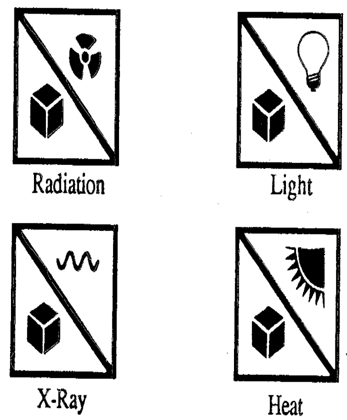
______________________________

______________________________

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

UNPROCESSED FILM

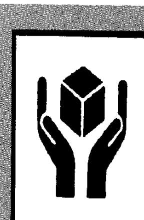
DO NOT EXPOSE TO:




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

From:


Photographic Materials



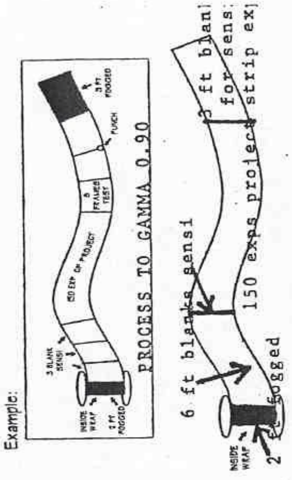
HANDLE with CARE

937-222-3856
HAS 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:

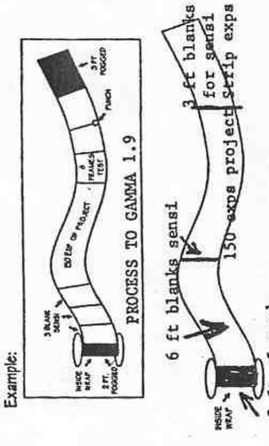



DESCRIBE YOUR ROLL: (Where to TEST/place SENSI)

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:



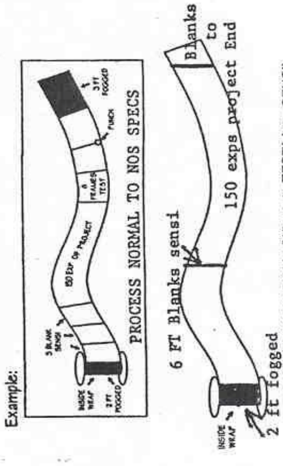

DESCRIBE YOUR ROLL: (Where to TEST/place SENSI)

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)

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

| 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)*:<br>☐ ORDINARY MAIL ☐ AIR MAIL<br>☐ REGISTERED MAIL ☒ EXPRESS<br>☐ GBL *(Give number)* ______ |
| TO:<br>"Photo Processing Lab" | DATE FORWARDED<br>July 15, 2004<br>NUMBER OF PACKAGES<br>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:<br>Name<br>Title<br>(Shoreline Photographic Contractor/<br>Shoreline Contractor Representative)<br>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.

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**SOW MAIN TEXT**
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October 3 , 2012

# 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 AND ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE

January 14, 2010

MEMORANDUM FOR: Shoreline Mapping Contractor

FROM: Michael L. Aslaksen Jr.
Chief, Remote Sensing Division

SUBJECT: State of Maryland Shoreline Mapping Project Instructions

This document is the **Project Instructions** for Project MD0701- Potomac River, which consists of shoreline mapping in the State of Maryland.

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 14, dated XXX 2010. 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 and to create a digital orthophoto mosaic of the projects' color imagery. All nautical charts referred to in this document are NOAA nautical charts.

1.2 COVERAGE - The project includes mapping of the Mean High Water (MHW) line, Mean Lower Low Water (MLLW) line, and alongshore features within the Potomac River from the project's junctions previous projects MD0502 and VA0501 near the river's confluence with the Chesapeake Bay, and upstream to the charted limits at approximately the District of Columbia – Maryland Border. The project includes the charted limits of the Anacostia River within the District of Columbia.

See the accompanying project planning diagram to see where delineation of shoreline is required. If the landward limit of compilation extends beyond 2000 feet from the main body/bodies of water, the limits of delineation will also be shown on the shapefiles of the project area. It is also noted that the project limits shall encompass the entire area of stereo neat model coverage in order to verify all charted landmarks and to capture features that may be of landmark value to a mariner. (See SOW, § 8.5D.) The diagram also shows which portion of the project is to be compiled first.

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. Additionally, Phase I may include aerotriangulation, tide gage installation, positioning and leveling surveys of the tide gage(s), obtaining at least thirty continuous days of data from the tide gage(s), processing the data to obtain a tidal datum for the tide gage(s), maintaining the tide gage(s) throughout aerial photographic operations, and the associated required reports. The second phase (Phase II) shall include compilation, feature attribution, creation of digital orthorectified mosaic images in the project area, and preparing reports. All deliverables listed in the SOW are required. The contractor may begin work on Phase II of this project only after NOAA Contracting Officer authorizes the contractor to begin such work. All Phase I tasks should be performed during the same aerial survey flight season. This includes all field survey work and aerial imagery acquisition. This way, any installed tide gages need not be maintained over the winter following their installation.

Compilation in Phase II shall be broken into four separate work areas. These areas are shown on the accompanying planning diagram. The contractor shall include, as part of their technical proposal, separate line item costs for each of the four work areas. See § 11 of these instructions.

1.4 PRIORITY – Project priority is not applicable to this survey.

1.5 START/COMPLETION DATES – Phase I of this project shall be initiated upon receipt of a Task Order from the NOAA Contracting Officer authorizing the contractor to begin operations.

Completion of Phase II shall be within 12 months of the date the National Geodetic Survey (NGS) approves the final imagery for the project

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

The contractor shall include in their Technical Proposal as separate line items the costs of planning tide gage installation, positioning and leveling surveys of the tide gage(s), obtaining at least thirty continuous days of data from the tide gage(s), processing the data to obtain a tidal datum for the tide gage(s), maintaining the tide gage(s) throughout aerial photographic operations, and removal of the tide gage(s).

The contractor shall supply, in their Technical Proposal, a Gantt chart showing their proposed start date and all milestones toward completion of Phase I and Phase II tasks

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 Tabulation of Aerial Photography shall be delivered to NGS within three weeks of the time that the verified tide levels for the tide stations used to make the tidal window predictions become available on the Center for Operational Oceanographic Products and Services (CO-OPS) web site. The Ground Control Report shall be delivered within six weeks of the time the field work is completed.

All other reports are due within three weeks of the time that work for that particular segment of the cartographic process is completed. (See SOW § 10.)

Reports – All reports shall be clearly written, logically arranged, and concise. They should reference other reports rather than duplicate information. They shall summarize activities of data collection and processing and fully describe changes from proposed procedures, unusual circumstances, problems, conditions affecting progress, and analysis of results. All reports shall contain references to data and shall be prepared such that they will describe the project to a reviewer who reads the report many years in the future. All descriptive reports shall comment on the adequacy and accuracy of the results. As an example, see the requirements for the Ground Control Report found in the SOW, Attachment O, § 11.

1.7: IT SECURITY REQUIREMENTS – The Contractor must describe how it implements a secure data processing of the information being collected, processed and transmitted. The Contractor must describe their process for ensuring the information being transmitted (via removable media) is free from malicious software, spyware and other unwanted code.

2.0 DATA ACQUISITION REQUIREMENTS

2.1 IMAGERY , CONTROL, AND FLIGHT PLANNING- Imagery Scale - Imagery shall be acquired along the flight lines provided with these Project Instructions at an altitude of 15,000 feet Above Ground Level (AGL) of the subject shoreline, resulting in a nominal imagery scale /or/ Ground Sample Distance (GSD)of 1:30,000. 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).

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

B. SENSOR ORIENTATION - Inertial Measurement Unit (IMU) data is required for all imagery. IMU data shall be used in the aerotriangulation process.

C. PHOTO GROUND CONTROL - At least four check points are required in the project area (See SOW Section 6.2A and Attachment O). In the Technical Proposal and in the Ground Control Report, state whether the ground control points and check points are photo panels and/or photo identified (ID) points. For photo ID points, select well-defined discrete points, not the center of a large object.

D. FLIGHT LINE DATA - There are approximately 1,145 statute miles of U.S. shoreline within the project area.

Compilation area A has approximately 439 miles of shoreline.
Compilation area B has approximately 281 miles of shoreline.
Compilation area C has approximately 264 miles of shoreline.
Compilation area D has approximately 161 miles of shoreline.

There are approximately 308 photographic exposures in each specified photographic emulsion or spectral band at each specified tide stage required to provide coverage of the project area.

2.3 FLIGHT LINE PRIORITY - There is no priority order under which the project flight lines are required to be flown.

2.4 PROJECT IDENTIFIER - The Project Identifier, to be included in all flight reports, for this project is MD0701

2.5 PHOTOGRAPHIC FLIGHT REPORT – See SOW Attachment C, Section 18.4.

2.6 LIDAR FLIGHT LOG – Not required for this survey.

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

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

2.9 B&W IR FILM REQUIREMENTS – The contractor, based on the final approved flight plan and way point file, shall estimate in their Technical Proposal the amount of B&W IR film necessary to comply with the tidal imagery requirements of this project. NGS will supply the B&W IR film to the contractor. NGS recommends that the contractor, when estimating the amount of film needed, include extra for testing, starting the camera early, removal of the film from the camera, etc. The contractor shall be responsible for stating in their Technical Proposal the date by which they require film to be delivered. The contractor shall be responsible for paying for additional B&W IR film if a shortage results from rejections of bad imagery or from improper handling or storage by the contractor. This payment will be deducted from the total amount agreed to on the Task Order. If NGS determines that the contractor was not at fault for the rejected imagery, additional B&W IR film will be sent to the contractor at no additional cost to the contractor. At the end of the imagery acquisition portion of the Task Order the contractor shall report to NGS how many unused exposures of B&W IR film remain. NGS will determine what is to be done with the extra film at that time.

3.0 SENSOR REQUIREMENTS

3.1 ANALOG AERIAL CAMERA –

A. FILM - The Contractor shall collect both color negative and Black & White (B&W) infrared images. See SOW, Attachment C, § 7.2 for film requirements and specifications. Note: NGS will supply B&W infrared film to the contractor, see details in § 2.9 above. The contractor shall supply color negative film.

B. CAMERA FILTERS - All B&W infrared imagery shall be collected using, 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, § 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, or Tidal Constituent And Residual Interpolation (TCARI) data, 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. Black & white infrared imagery shall be collected over the entire project within the tolerance for both the MHW and MLLW.

Because tide-coordinated B&W IR imagery is required at MHW, the color negative imagery should be collected close to MLLW, but shall be collected below MHW to allow for maximum visibility of features in the inter-tidal zone.

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.

5.0 TIDE/WATER LEVEL GAUGE INSTALLATION

Tide gauge/water level gauge installation may be required. See CO-OPS reference, "Water Level Station Specifications and Deliverables for Shoreline Mapping Projects", May 2009 for requirements and specifications regarding tide gage installation and operation. It is available on line at http://tidesandcurrents.noaa.gov/publications/Water_Level_Station_Specifications_and_Deliverables_for_Shoreline_Mapping_Projects,_Updated_May_2009.pdf .

5.1 INSTALLATION – The contractor shall be responsible for the acquisition, installation, and surveying (positioning and leveling) of a tide gage of a type acceptable to NOAA CO-OPS at Colonial Beach, VA. The gage shall be designated gage 863-5150. The location of the gage is to be at or near the position of NOAA gage that was previously there. See the accompanying documentation for the location of the previously installed gage. See CO-OPS reference above.

5.2 MONITORING – After the gage has been determined ready to go into operation by CO-OPS the contractor shall collect at least thirty (30) days of tide data from the gage so that the tidal datum for the gage can be calculated. The data should be continuous with no breaks in the data stream.

A. OPERATION DURING IMAGERY ACQUISITION – The contractor shall operate the gage and collect data during the actual time of imagery acquisition operations. The gage should be left continuously running after the initial thirty days of data have been collected.

B. OTHER INSTALLED GAGES - Monitoring, observing, and/or data processing may be required for already existing tide gauges or staffs.

5.3 DATUM COMPUTATION – The contractor shall calculate the datum for the newly installed gage.

5.4 REMOVAL – The tide gage shall not be removed until all required imagery has been approved and accepted by NGS.

5.5 DATA HANDLING – All raw tidal from the initial thirty day data recording period and original datum calculations shall be delivered to NGS within three weeks of the end of the initial thirty day data recording so that CO-OPS can verify that the contractor calculated datum is correct and the gage is working properly before imagery acquisition takes place. All other raw tidal data shall be delivered to NGS with the submission of the contractor's final project report. All data shall be on DVDs for submission to NGS. All data shall be in a format that is acceptable to NOAA CO-OPS.

## 6.0 AEROTRIANGULATION

Aerotriangulation is required for this project. See SOW, § 7.3 and Attachment I for aerotriangulation requirements.

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

6.2 SENSOR ORIENTATION - Inertial Measurement Unit (IMU) data is not required but may be collected and used in the aerotriangulation process.

6.3 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.

All imagery (CN, MHW IR, MLLW IR) should be included in the same aerotriangulation adjustment. If the contractor has a compelling reason not to do this, their proposed plan shall be stated and justified in their Technical Proposal, for NGS consideration.

## 7.0 COMPILATION

Shoreline compilation for this project is required. To increase the ease of reviewing and approving, the project has been broken into four separate areas. See the accompanying planning diagram for the limits of these areas. A task order may be issued for the compilation of any number of these areas or for all of them. A task order may, at NGS' discretion, not be issued at all.

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 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 § 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 planning diagram. 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 - Four factors to consider:

(1) Project area boundaries as depicted with the highlighted shoreline and planned imagery footprints on the project diagram with these Project Instructions,
(2) the landward 2000 foot limit from shoreline (see SOW, § 8.5D,
(3) compile all rivers and other charted water courses to the stereoscopic limit of the imagery, regardless of the landward 2000 foot limit above,
(4) other Limits of Compilation that may be depicted on the accompanying project diagram

7.5 OFF-SHORE ROCKS - Areas of off-shore rocks or other obstructions to navigation may exist within the project area. Investigate the charts and imagery thoroughly to ensure all rocks and obstructions that are charted can be seen and their existence and position verified. See SOW Attachment K for instructions regarding when to compile new point obstructions.

7.6 FLOATING AIDS TO NAVIGATION **-** Do not compile any floating aids to navigation.

7.7 COMPILATION PRIORITY **–** There is no priority order in which the four work areas must be compiled.

## 8. GROUND PHOTO CONTROL

Four ground control check points are required. The contractor may propose additional ground control for use in the AT. See SOW Attachments C, O, and P.

9. ORTHOPHOTOGRAPHY

Orthophotography is required for this project. See SOW, Attachment AK.

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


Gregory E. Stinner
COR
National Geodetic Survey
ATTN: N/NGS; SSMC3, Sta. 8622
1315 East-West Highway
Silver Spring, Maryland 20910
301-713-3167
Fax: 301-713-4315
email: gregory.stinner@noaa.gov

Mike Espey, Chief, Applications Br.
Remote Sensing Division,
National Geodetic Survey
ATTN: N/NGS3; SSMC3, Sta. 5342
1315 East-West Highway
Silver Spring MD 20910
301-713-2684
301-713-2183
email: mike.espey@noaa.gov


Exposed film shall be sent to:

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

**11.0 ENCLOSURES**

One marked-up copy of the project planning diagram made up of nautical chart(s): 12233, 12286, 12287, 12288, and 12289 showing the shoreline to be mapped and the flight lines to be flown
One digital copy of waypoint file MD0701.wpt
One digital copy of the ARC Shapefiles that show the various shoreline work areas.
One digital copy of the ARC Shapefiles that show the flight lines, end points, and possible photo centers
One paper copy of each Tidal Bench Mark data sheet where NOAA/CO-OPS recommends a tide gage be installed

**12.0 MISCELLANEOUS**

Refer to SOW Attachment AD for the required contents of the Technical Proposal

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Feb. 1, 2011

# 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 include specifications for aerial film photography and associated data to support the National Oceanic and Atmospheric Administration's (NOAA) Coastal Mapping Program (CMP).  In addition, Project Instructions (PI) will provide project specific information.  The CMP is administered by the National Geodetic Survey (NGS), National Ocean Service (NOS), NOAA.

See also Attachment Z, DIGITAL AERIAL CAMERA USAGE AND DATA PROCESSING FOR THE CMP.

## 2.  SCOPE

This document contains specifications for metric quality, tide-coordinated, Global Positioning System (GPS) controlled, aerial film photography over the shoreline, including planning, acquisition, data processing, controlling quality, calibrating equipment, and writing reports.  The scope of the project will be fully described in the PI and may include additional phases of shoreline mapping work. Throughout this document where "GPS" is mentioned, Global Navigation Satellite Systems (GNSS) may be substituted.

Projects may also include:  aerial imagery of disaster areas, and other special case aerial imagery tasks. Specifications for aerial photography of airports are in Attachment A, Airport Aerial Photography.

## 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 PI (see sample in Attachment B) and may be outlined on government provided project diagram.  If Contractor planning of photo coverage is required, that coverage shall be planned to include all shoreline within the project area, all land within 2000 feet of that shoreline, and all seaward rocks and/or obstructions on the existing nautical chart of the project area.

3.2  PRIORITY – Project priority, if any, will be defined in the PI.

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 PI.

3.4 COMPLIANCE REQUIREMENTS -

A. PROJECT INSTRUCTIONS PRECEDENCE - The PI will take precedence over the Scope of Work (SOW) since the PI provide detailed and often unique information about each project.

B. TERMS - The following conventions have been adopted. 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 the SOW or the PI will be considered if written justification is provided in advance to the Contracting Officer (CO) and the Contracting Officer’s Representative (COR). No deviation is permitted until written approval is received from the CO. All requests for modification to the SOW and/or the PI shall be submitted by the Contractor in writing to the CO prior to the due date on the Task Order and as soon as a possible need for modification is identified. Send a copy of the request to the NGS points of contact (including the COR). If the Contractor anticipates not meeting a required deadline, the Contractor shall request, in writing, an extension from the CO. Provide a copy of the extension request to the COR. Extensions may be granted if extenuating circumstances exist.

D. UNUSUAL CIRCUMSTANCES - The Contractor shall notify the COR of any unusual circumstances that occur during the performance of the project which might affect the deliverables or their quality, and especially of any deviation from the SOW, or the PI.

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 until 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/
US Coast Guard (USCG),  http://www.navcen.uscg.gov/?pageName=regContent
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
Homeland Security, http://www.dhs.gov/index.shtm
Surface Transportation Board, http://www.stb.dot.gov/
and other federal, tribal, state, commonwealth, and local governmental rules and regulations. The Contractor shall be responsible for identifying, obtaining, completing, and submitting applications, forms, and permits, and obtaining approval of all necessary permits for work performed under this contract.

H.  WEEKLY STATUS REPORTS - The Contractor shall submit Weekly Status Reports via the Task Order Management and Information System (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, see Attachment G for details.  Also include any unusual circumstances, deviations from the SOW the PI, 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 1983 (NAD 83)

B.  VERTICAL REFERENCE - North American Vertical Datum 1988 (NAVD 88); for Alaska and other areas outside the continental United States, see the PI.

C.  SHORELINE REFERENCE -
MEAN LOWER LOW WATER (MLLW),
MEAN HIGH WATER (MHW).

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 GEOID09, see: http://www.ngs.noaa.gov/GEOID/ . For projects in Alaska and other areas outside the conterminous 48 states, see the PI for any special requirements.

3.6 REFERENCES AND GLOSSARIES

A. Obtaining Nautical Chart Products - http://nauticalcharts.noaa.gov/staff/charts.htm

B. "NOAA Chart #1" (Chart symbols, abbreviations, and terms) at: http://nauticalcharts.noaa.gov/mcd/chartno1.htmgov/mcd/chartno1.htm

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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. NOAA On-Line Chart Viewer – This WWW site allows viewing the entire suite of NOAA charts, see: http://www.nauticalcharts.noaa.gov/mcd/OnLineViewer.html

F. NOAA CO-OPS WWW Site: http://tidesandcurrents.noaa.gov/

G. NOAA NGS WWW Site: http://www.ngs.noaa.gov/

H. "U.S. Coast Guard Light List" available on-line at: http://www.navcen.uscg.gov/?pageName=lightLists

I. Glossaries in Attachments F and M,

J. Manual Of Photogrammetry (MOP), Fifth Edition, 2004,

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

L. Water Level Station Specifications and Deliverables for Shoreline Mapping Projects, May 2009, at: http://tidesandcurrents.noaa.gov/publications/Water_Level_Station_Specifications_and_Deliverables_for_Shoreline_Mapping_Projects,_Updated_May_2009.pdf . Note, this document is an update of Chapter 4 of the Hydrographic Specifications and Deliverables and is now the primary CO-OPS reference for shoreline mapping.

3.7 FILM OWNERSHIP - All original aerial negatives, from the instant of exposure, and other deliverables required through the SOW 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), Digital Video Disks (DVD), and any other data transfer media. Data integrity is the responsibility of the Contractor until it is received at its destination and checked by NGS.

## 4. GOVERNMENT SUPPLIED MATERIALS

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

A. Project Diagrams - small scale copy of one or more nautical charts showing the coastline and/or coastal ports to be photographed.

B. Digital Files with the above information;

C. The Contractor is responsible for procuring new editions of nautical charts, 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 ;

D. Tidal zoning diagram;

E. Tidal zoning memo; Tidal Constituent And Residual Interpolation (TCARI) data, TCARI memo;

F. Waypoint file;

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

H. PROJECT IDENTIFIER - The "Project Identifier," a six character alpha-numeric Identifier (ID) unique to each project.

4.2. This SOW.

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 Electronic Exposure Data (EED) file, see Sections 6.1, 14, 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 Mapping 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, at a minimum, the 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.

4.6. 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. All images collected shall be submitted to NGS. Contractors shall check the time of all images against verified tides to ensure that the images were collected within the Tide Tolerance. Images outside the Tide Tolerance shall be re-flown, but the out-of-tolerance images will still be submitted. Contractors shall, in the comments section of the Photographic Flight Report (PFR), comment on recommended rejections and provide a reason for the recommendation.

4.7 NGS and NOS SURVEY MARKS - 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. See Attachments O and P for requirements.

4.8 TRANSMITTAL LETTERS - The Contractor shall acknowledge receipt of Government Supplied Items by inventorying the shipment, signing the Transmittal Letter (TL), and FAXing or emailing the TL back to NGS. At this time, TOMIS does not support the tracking of items sent by the Government to Contractors.

## 5. QUALITY CONTROL

5.1 GENERAL - The Contractor shall check all data to ensure that it is complete, reliable, and accurate. Note, accuracy requirements may be in the PI. The Contractor's personnel shall become thoroughly familiar with the SOW; the PI; 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.

5.2 QUALITY CONTROL PLAN - The Contractor shall have the responsibility for the overall quality of the Project. The Contractor shall submit a written Quality Control Plan (QCP) as part of their Technical Proposal, prior to beginning work. It shall include checking at least the following:

A. Manually recorded data;
B. Data manually entered into a computer system;
C. All digital data output formats;
D. Data at various points in the over-all process;
E. All Deliverables (including documents , data, reports, etc.) submitted.

The Contractor shall also describe how data shall be backed up and how it shall be ensured that original data are not modified, see Section 18, Deliverables and Section 3.4, Compliance Requirements.

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 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. NGS will supply heavy weight original, two-side forms, when available. When not supplied, use heavy weight paper when 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. The Contractor shall submit a copy of the PFR via TOMIS.

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 EED file. Both the RNF and the EED files are submitted as Deliverables via TOMIS. 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 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. 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 record on the PFR explanations for images re-flown.

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

E. TABULATION OF AERIAL PHOTOGRAPHY - The Contractor shall also prepare a "Tabulation of Aerial Photography" containing at least the information as the sample in Annex 7. A "Tabulation of Aerial Photography" shall be submitted for each roll of film exposed, and shall be submitted within three weeks of the date that the verified tide data is available.

F. TRANSMITTAL LETTER – Transmittal Letters (TL) are not required for Deliverables submitted via TOMIS. Use a TL for all shipments of Deliverables outside TOMIS and make an entry in TOMIS stating that the Deliverable was shipped outside TOMIS.

Transmittal Letters shall continue to be used for items the Government ships to the Contractor. See sample TL in Attachment AC and Annex 6 to this Attachment. Also see Attachment AI which covers TOMIS.

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 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.

The NGS exposure test shall be no fewer than 5 lines of photography, each line consisting of no fewer than 5 exposures. The Contractor shall expose one line as NORMAL (a base exposure), and then shall vary the exposures over the remaining four lines as follows: Black & White (B&W) Infra-Red (IR) lines shall be exposed at -2/3, -1/ 3, +1/3, and +2/ 3 Stops; For Color Negative (CN) films, the remaining four lines shall 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, the Contractor shall 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 shall 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. Transmittal Letter listing above two items, see Annex 6.

B.  LETTER - Contractor sends NGS copy of TL (via TOMIS);

C.  RNF and EED - Contractor prepares EED file within three working days and submits RNF and EED via TOMIS.

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.  If NGS rejects the exposure test, a repeat exposure test is required.

An additional exposure test does not have to be flown for subsequent Task Orders if the Contractor is using the same camera system, unless photographing a type of shoreline for which an exposure test was not previously approved.

6.3 REGULAR PRODUCTION PHOTOGRAPHY - 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. Use only 250 foot film spools.

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 - This SOW 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 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 shall be used for all photography.

iii. 9 inch x 9 inch format

iv. Between-the-lens, variable speed shutter

v. Six inch (153 millimeters (mm) +/–3 mm) focal length lens having a usable angular field not less than 90 degrees.

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

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

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

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

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

xi. 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.

xii. Record on each exposure at least eight 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.

xiii. TIMES AND DATES - Record on each exposure the time in 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 PFR. 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 GREENWICH MEAN TIME (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/ . 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/graphics/ref_maps/pdf/time_zones.pdf

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

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

xvi. 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.

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

xviii. 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.

xix. 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 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, see: http://calval.cr.usgs.gov/osl/ . The calibration certificate shall be no older than three years. The fee and the arrangements to have the calibration 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. After each camera system's three-year calibration, the Contractor shall submit copies of the calibration reports to NGS.

D. PREVENTIVE MAINTENANCE AND REPAIR LOG - The Contractor shall supply to NGS a Preventive Maintenance and Repair Log noting work performed on each camera system including the dates when work was performed and the nature of the work performed, to show that preventive maintenance and repairs have been satisfactorily completed within the previous three years.

E. MALFUNCTIONS - All camera system malfunctions shall be recorded in the Weekly Status Reports and in the Photo Final Report. 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 affect the camera – GPS antenna – Inertial Measuring Unit (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 6.3. 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), or equivalent;
- ii. AGFA X100 color negative film, or equivalent;
- iii. Kodak Aerographic 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 PI.

Film shall be purchased by the Contractor. Any 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 batch 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 emulsion is used for coastal mapping, over exposure due to speed shifts (crossover) with “hot” rolls can result in unacceptable water penetration. Conversely, under exposure 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. This unexposed test strip shall be sent to the NGS film processing contract laboratory for time/gamma testing. The photo laboratory shall 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 PI may require CN film to be captured at, above, or below a certain tide level. The PI may require B&W IR film to be captured at MHW, may require B&W IR film to be captured at MLLW; and may require simultaneous exposure of CN and IR (using a dual-camera aircraft).

E. FILTERS - A 36% transmission anti-vignetting filter shall be used during all photography under this SOW. Filters shall have surfaces parallel within 10 seconds of arc, and their optical quality shall 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 CN film to absorb the ultra-violet rays scattered by aerial haze. Ideally, use a 740 nanometer, or higher, filter with B&W IR film so that only the reflected near IR wavelengths shall reach the emulsion. If a 740 nm filter cannot be obtained, filters ranging from 700 to 740nm may be used. 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 Fahrenheit or lower, or in a freezer at 0 to -10 degrees Fahrenheit, in the original sealed container. Kodak also recommends that **unexposed B&W IR film** be kept at 55 degrees Fahrenheit 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 Fahrenheit.

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, CN 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 Fahrenheit 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 six foot leader of blank film at the beginning, and a three foot trailer at the end. 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 CN 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 PI, and samples are in Annex 5.

## 7.3 AIRCRAFT

A. AIRCRAFT GENERAL - The type of aircraft and the aircraft tail number used shall be stated on the PFR, see Annex 2, Items #12 and 13, and all aircraft used in the performance of Task Orders under this SOW shall be maintained and operated in accordance with all regulations required by the FAA. Any inspections or maintenance of the aircraft 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 tide coordinated CN and B&W IR 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, see below; (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 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." See also MOP, Fifth Edition, 2004, pages 396-397.

## 8. FLIGHT LINE PLANNING AND CLEARANCES

8.1 FLIGHT LINES - The PI 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 at least: film type, overlap, sidelap, navigation, airborne KGPS, sun angle, visibility, tide-coordination, tilt, crab, unit detection size, shall be considered in the planning. NGS may supply the flight lines, with associated waypoint files, or recommendations and/or requirements for planning parameters in the PI. The photo coverage shall be planned to include all of the shoreline within the project areas, including offshore islands and rocks, and all of the land within 2000 feet of that shoreline.

8.2 FLIGHT LINE MAPS -

A. PROPOSED FLIGHT LINE DATA - If required to plan flight lines, the Contractor shall, as part of the technical proposal, submit to NGS digital ESRI shapefiles (non-projected geographic format in NAD 83) that clearly show all proposed flight lines. The shapefiles shall show the photo footprints, the nadir point of each image and the beginning and end points for each line. End points of flight lines may fall at the same point as the photo nadir points but they shall be in a separate data file so lines can be plotted independent of photos. The shapefiles 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 or CN), tide stage, proposed check points and ground control, if required (with existing points and proposed points, each identified separately), and project area boundaries. Prepare a separate shapefile for each emulsion if the flight line layout will be different for different emulsions. The shapefile shall be such that it can be digitally laid over the top of the largest scale NOAA nautical chart(s) covering the entire project area

B. "AS FLOWN" FLIGHT LINE DATA - Shapefiles 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 LINE DATA - NGS may supply shapefiles (digital ESRI shapefiles in non-projected geographic format, NAD 83) showing the flight lines to be used for a project. The Contractor shall check these flight line data and waypoint files to ensure adequate coverage for mapping and aerotriangulation (AT), including coverage of offshore rocks and islands. The Contractor shall notify NGS immediately of any problems found with the flight lines. 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 PI. The flying height(s) and other parameters may be defined in the PI 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 PFR, (see Annex 2) and the EED file (see Annex 3) are the altitudes above mean sea level (MSL), both in feet.

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

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. The Contractor shall check these waypoints to ensure adequate coverage of the project area.

8.5 FLIGHT CLEARANCES - The Contractor shall comply with all applicable Federal Aviation Regulations. This includes but is not limited to obtaining any and all clearances necessary to carry out the assigned data collection. Contractor aircrews shall check local and Flight Data Center (FDC) NOtice To AirMen (NOTAM) prior to each flight. No work may be attempted in Restricted, Prohibited, Air Traffic Control Assigned Airspace (ATCAA), or TFR (Temporary Flight Restriction) airspace without prior clearance. In addition, the contractor's aircrews must meet all applicable FAA requirements for training and currency required for operations within the Washington D.C. /Metropolitan Special Flight Rules Area (SFRA), or any other SFRA.

## 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 they do not cause ground mottling or a discernable reduction in light levels and/or ground object shadows. Under no circumstances shall CN or B&W IR films be exposed under a solid overcast sky.

9.2 TREE LEAVES - Leaf-off condition is not required but is preferred. Trees along a shoreline can obscure the shoreline if care is not taken in planning.

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 eight miles for CN or B&W 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 PI 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 than normal 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, page 67. For a copy of Sub-Chapter 2.2, see the nine pages showing the procedure to pre-determine the occurrences of sun reflections in Attachment 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., page 1115. 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://www.usno.navy.mil/USNO/astronomical-applications/data-services/rs-one-day-us. This site computes sun altitudes and sun azimuths for U.S. locations and world-wide positions. See also MOP, Fifth Edition, 2004, pages 1114-1115, and Attachment AF.

9.6 CLEAR DAY MAP – Refer to: http://cdo.ncdc.noaa.gov/cgi-bin/climaps/climaps.pl. Please see the directions below for help navigating the website.

A. In the left column, click on "Quick Search"

B. In the "Region" column, highlight the desired region

C. In the "Map Category" column, highlight "Sky Cover/Visibility"
D. Click on "Continue"
E. Highlight first choice, "Mean Number of Clear Days (Sunrise to Sunset)"
F. Click on "Continue"
G. Click on month(s) of interest
H. 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 currently no charge.

## 10. TILT, CRAB, OVERLAP AND SIDELAP

10.1 TILT - Care shall be taken to keep tilt 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 TIDE-COORDINATION 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 may 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 TIDE-COORDINATION 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 PI. See the PI 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 the NOAA Center for Operational Oceanographic Products and Services (CO-OPS) (tides and water levels) real-time www site may assist in determining unusual water level conditions, see: http://tidesonline.nos.noaa.gov/ .

11.4 TABULATION OF AERIAL PHOTOGRAPHY – After the Verified Tides are obtained, the Contractor shall compare the actual flying times and the verified tide times and notify NGS of any flights lines that are out of the allowable tolerance by submitting a “Tabulation of Aerial Photography”. For all flight lines, 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 CN and IR film. The Tabulation shall contain, at least, the same information as the sample in Annex 7. A column shall compare the actual times of photography to the Verified Tides. The Contractor shall flag any out-of-tolerance flight lines.

The Contractor shall submit a Tabulation for each film roll submitted within three weeks of the time that verified tide gauge data is available for the tide gauge(s) used to make tide window predictions.

11.5 TIDE GAUGE INSTALLATION AND OBSERVATION - The PI 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 and the reference in Section 3.6.L, above, 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 shall not exceed 5% of the flying height (750 feet for a flying height of 15,000 feet), see Annex 4. 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. Airborne KGPS positioning for use in the AT is discussed in Section 13, below.

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 AT 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 IMU. Take extra care in flight line planning or review, for lines with a significant portion over water, including situations with offshore islands and/or rocks.

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 two to three 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. 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 B&W IR) shall be accurately positioned using airborne 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 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 GPS Base Stations are required for each KGPS survey. The Ground GPS 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 GPS 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 Ground GPS Base Stations as soon as it is practical to allow for an 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 recommended but generally not required. An IMU is highly recommended for special cases such as projects with offshore islands and/or rocks. The PI 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. Consider usage of an IMU for flight lines mostly over water. 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) (http://www.ngs.noaa.gov/CORS/ ) as ground GPS base stations whenever possible. 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, using NGS approved interpolation software. CORS stations with a 30-second (or longer) data rate shall not be used as GPS base stations. A temporary Ground GPS Base Station at the airport is also good insurance.

A. GROUND GPS BASE STATION RECEIVER/ANTENNA - All GPS receivers used as Ground GPS Base Stations for the KGPS survey shall be dual-frequency, geodetic quality receivers. Each Ground GPS 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. GROUND GPS BASE STATION LOCATION - Ground GPS Base Stations should be located within or near the project area. Use a CORS whenever possible. See the CORS map at: http://www.ngs.noaa.gov/CORS/GoogleMap/ which is color coded by the collection rate of each CORS. Note, a high percentage of CORS east of the Mississippi River collect at a 1-second rate. During the airborne survey the aircraft shall never be more than 100 kilometers from the nearest Ground GPS Base Station, and there shall always be at least two Ground GPS Base Stations within 200 kilometers of the aircraft. The aircraft should fly over Ground GPS Base Stations before and after the data collection to help improve the GPS data quality. If a National CORS cannot be used for a Ground GPS Base Station, the Contractor shall set up a Ground GPS Base Station over a known (or to-be-determined) marked point. If a known Ground GPS Base Station is used, it must be in the NGS database and hence part of the NSRS. If a new Ground GPS 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 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 MS Word format) describing the location is sufficient. Include these paragraphs in the Ground Control 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 Control 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 WinDesc see Attachment S. Digital photographs are required in both cases, see Attachment R.

D. GROUND GPS BASE STATION OBSERVATIONS -

i. Using CORS Base Station - The Contractor shall check the status of the CORS station at: http://www.ngs.noaa.gov/CORS/ shortly before and after the KGPS survey, to verify that the station was operational. The data shall be downloaded for processing as soon as it is available on the NGS web site. All NGS CORS data are available from NGS at their original sampling rate for 30 days. After that time, the data are decimated to a 30 second sampling rate.

Note, “Cooperative CORS have merged with National CORS.

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 four GPS satellites, and the PDOP remains below seven. 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**. Visibility Obstruction Diagrams and GPS Observation Log are required, see Attachment Q.

- Checking Existing Marks - If the Ground GPS Base Station is set up over an existing NSRS mark, then the position of the mark shall be checked by submitting at least four 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 Ground GPS 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. The use of OPUS Rapid Static (RS) for positioning Ground GPS Base Stations is not permitted.

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/about.html .

NGS is developing new versions of OPUS which may change the required GPS observation sessions and may fulfill Blue-Booking requirements. Any updates in this SOW's OPUS requirements will be included in the PI.

## 13.3 KGPS DATA PROCESSING

A. The Contractor shall collect, process, and submit the ground and airborne GPS data, both raw data and final processed data shall be submitted.

B. Differential KGPS solutions for the aircraft shall be obtained independently using each Ground GPS Base Station.

C. These independent KGPS solutions shall be compared and any differences in the north-south, east-west, and vertical components during the operational portions of the flights shall be displayed and reported.

D. The RMS of these differences shall not exceed 5cm in the horizontal and 10cm in the vertical.

E. The KGPS solutions shall model the tropospheric delay using average surface meteorological values at the Ground GPS Base Stations collected near the midpoint of operations.

F. The final KGPS solution will be an average of the separate Ground GPS Base Station solutions.

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 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) and NSRS 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 OPUS 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, the observed coordinates, and the coordinates used in the kinematic position step. If multiple base stations were used, provide processing details, coordinates, and accuracy for all stations.

If IMU data is collected, discuss in the Orientation Paragraph, 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 AT process, describe any unusual circumstances or rejected data, and comment on the quality of the data.

13.5 GROUND CHECK POINTS - Four or more Check Points are required, see: SOW, Section 6.2A

13.6 GROUND PHOTO CONTROL - Ground photo control may be required by the PI, and may be proposed by the Contractor. See Attachment O for requirements.

## 14. PHOTOGRAPH LABELING

14.1 FRAME NUMBERING - The frame numbers embedded 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 changes, the numbering sequence starts over at 0001. If a Contractor or Sub-Contractor begins working on a different NGS contract or project, the numbering sequence shall 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.

14.2 REQUIRED LABEL - Each usable frame shall be titled on the film within, or adjacent to the edge of 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 B&W 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. The Contractor shall make a note on the Tabulation of Aerial Photography listing all images that their QC process finds to be out of specifications or unsuitable for cartographic compilation. The Contractor shall submit all images both those within tide tolerance and those outside the tolerance.

## 15. FILM SHIPMENT AND PROCESSING

15.1 SHIPMENT - The Contractor shall ship; (1) completed, normally full, film rolls, (2) the original PFRs (marked “ORIGINAL” in blue ink) and filled-in front and back in black ink, and (3) TLs 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 (4) the RNF file and final, checked EED files, in NGS format via TOMIS within three working days from the date the film was shipped. Copies of the PFR and the RNF may be made and used by the Contractor to produce and check the final deliverables.

The Contractor shall complete and submit (5) a "Tabulation of Aerial Photography" for each roll, within three weeks of the date that verified tides are available.

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

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 that are 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 government regulations and those of carriers as applicable to the mode of transportation.

The Contractor should not ship film on a Friday or just before a Holiday. The NGS film processing contract laboratory does not receive film on Saturdays, Sundays, or Holidays, 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 a digital copy of the PFR (marked "COPY" at the top) and a digital copy of the film TL.

## 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. The film exposure settings shall normally be controlled from the camera's Photo Exposure Meter (PEM) and for B&W IR the settings should produce a gamma at processing time of $1.9 \pm 0.05$. 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.

For Kodak Aerocolor 3 Negative Film 2444, and AGFA X100 film a 420 nanometer filter shall be used. For Kodak Aerographic B&W IR Film 2424, a 740 nanometer filter is highly recommended. See discussion of possible alternatives in Section 7.2.E. 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 PFR.

## 18. DELIVERABLES

18.1 LABOR, EQUIPMENT, SUPPLIES, AND TRANSPORTATION - The Contractor shall provide all labor, equipment (including aircraft, metric aerial camera system(s), GPS receiver(s), and photo-grammetric work station(s)), supplies, material (including film), and transportation to produce and deliver exposed film and related products as required.

18.2 FLIGHT LINE MAPS - If required by the PI, the Contractor shall plan flight lines and submit a proposed flight line shapefile (digital ESRI shapefiles in non-projected geographic format, NAD 83) 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 submit within 60 days of the date of the first exposure.

18.4 PHOTOGRAPHIC FLIGHT REPORTS - Submit the completed, original, two-sided 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. Submit copy to TOMIS.

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 recommendation 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, § 6.2.

18.5 RAW NAVIGATION FILE - Submit the film's 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 to NGS via TOMIS a digital copy of the PFR (marked "copy") and a digital copy of the TL 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 through TOMIS, see Section 6.1.C and Annex 3.  **Submit within three working days of submitting the film.**

18.8  GROUND CONTROL AND REPORT - See Section 13.5 of this Attachment, and Attachments O and P.  Submit data and Report within six weeks of the completion of the ground control.

18.9  AIRBORNE POSITIONING AND ORIENTATION DATA AND REPORT - 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 three weeks of completion of the aerial photography.

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 NSRS stations) in NGS format using NGS software WINDESC, see Section 13 and Attachment S.  Recovery notes may be submitted using the NGS on-line page at: http://www.ngs.noaa.gov/ngs-cgi-bin/recvy_entry_www.prl .  Submit with the Ground Control Report.

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 with the Ground Control Report.

18.12  CAMERA CALIBRATION - The Contractor shall supply a copy of the current USGS Camera Calibration Certificate for each camera system planned for use 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 beginning to acquire production photography.

18.13  CAMERA SYSTEM MAINTENANCE - The Contractor shall provide a Preventive Maintenance and Repair Log for each camera system to be used to acquire aerial photography, see Section 7.1.  Submit prior to beginning to acquire 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 which might affect the Deliverables or their quality and especially of any deviation from the SOW, or the PI.  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 Weekly Status Reports via TOMIS each Monday, 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 this SOW. Discuss each deliverable including: the maximum range from the Ground GPS 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, and software names and versions; include aircraft and camera(s);

C. Flight line (as flown) shapefiles 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. Discussion of Aircraft Navigation, including software, hardware, methods and any problems;

G. Summary of Airborne KGPS Report, including Ground GPS Base Station(s);

H. Discussion of weather, solar altitude, and time of year;

I. Any unusual circumstances or problems, including equipment malfunctions, (including those already reported) and any deviations from the PI or SOW(including those already reported) and;

J. Any recommendations for changes in the SOW, or the PI for future work.

18.18 TRANSMITTAL LETTERS – When shipping an item, the Contractor shall send a TL with film shipments and with any Deliverable submitted outside of TOMIS. After receiving an item, the Contractor shall inventory items received, sign and return, via FAX or email, copies of any TL that the Government sends. Other Deliverables shall be submitted via TOMIS, see Attachment AI.

18.19 TABULATIONS OF AERIAL PHOTOGRAPHY – A Tabulation is required for each roll of film. See Annexes 7A and 7B, and Sections 6.1E, 11.4, 14.4 and 15.1.

ANNEX 1 - Photographic Flight Report
Blank

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 | | | | | | | | | | | | | |
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| | | | | E | | | | | | | | | | | | | |
| | | | | B | | | | | | | | | | | | | |
| | | | | S | | | | | | | | | | | | | |
| | | | | E | | | | | | | | | | | | | |
| | | | | B | | | | | | | | | | | | | |

NOAA FORM 76-15 (7-77)    SUPERSEDES NOAA FORM 76-15 (5-74).

# AERIAL FILM PROCESSING RECORD

| RECOMMENDATIONS | LABORATORY DEVELOPMENT | SENSITOMETRY READINGS | | | | |
|---|---|---|---|---|---|---|
| | DATE | | CYAN | MAGENTA | YELLOW | B & W |
| | FORMULA | BASE | | | | |
| | pH READINGS: 1st Dev. / S.S. Hardener | STEP 1 | | | | |
| | Color Dev. / 2nd S.S. *(Cl. Bath)* / Hardener | 2 | | | | |
| | Bleach / Fixer / Stabilizer | 3 | | | | |
| | SENSE STRIP EXPOSURES: Begin | 4 | | | | |
| | Middle / End | 5 | | | | |
| | ☐ CONTROL STRIP CUT FROM ROLL | 6 | | | | |
| | ☐ UNEXPOSED PORTION STORED | 7 | | | | |
| | ☐ EXPOSED PORTION PROCESSED | 8 | | | | |
| | TEMPERATURE: F C | 9 | | | | |
| | DEVELOPMENT TIME: 1st Developer | 10 | | | | |
| | PROCESSED TO GAMMA | 11 | | | | |
| | PROCESSING MACHINE: Motor / Reel | 12 | | | | |
| | CHEMISTRY MIXED – DATE | 13 | | | | |
| | TALLY OF ROLL THROUGH CHEMISTRY *(Indicate 1st, 2nd, 3rd, etc.)* | 14 | | | | |
| | | 15 | | | | |
| | 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.* | 16 | | | | |
| | | 17 | | | | |
| | | 18 | | | | |
| | | 19 | | | | |
| | | 20 | | | | |
| AERIAL PHOTOGRAPHER / DATE | | 21 | | | | |
| | | REMARKS | | | | |
| 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 PFR.

**(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 (marked ORIGINAL in blue ink), 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 5 SHEETS |
| 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 |

| FLIGHT MAP NO. (17) / TIDE STAGE | (18) STATE AND LOCALITY | DATE (19) / LINE NO. | (20) C.U.T. (Coord. Univ. Time) | | (21) ADD NUMBER | (22) NO. OF EXPOSURES | COMP. HEAD. (23) DRIFT | (24) VISIBILITY | (25) CLOUDS | (26) TEMP. | (27) ALTITUDE | (28) VACUUM | (29) SHUTTER | (30) APERTURE | (31) RHEOSTAT | (32) ENDLAP | NO. OF BLANKS TO START ROLL (33) 6 / (34) METER READINGS AND REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NC 04 02 | NEUSE RIVER to | 09-20-04 | 1900 | S | | 1 | 275 | 12 | ○ | -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 | ○ | -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 | ○ | -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 | ○ | -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 | ○ | -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 | ○ | -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 CASSETES +3 BLANKS | | | | | | | | |
| | | | | B | | | | | | | | | | | | | |
| HI 04 04 | NORTH COAST | 09-28-04 | 2215 | S | | 72 | 085 | 20 | ○ | -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 |
| | | | | S | 39 | + | 10 BLANKS & CUT ROLL | | | | | | | | | | |
| 40 | John Smith | | | 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 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, 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 shall 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.

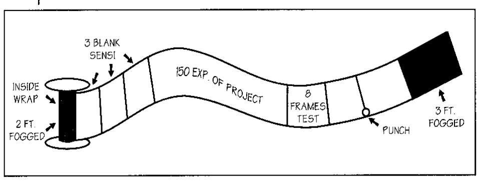
Blank Forms

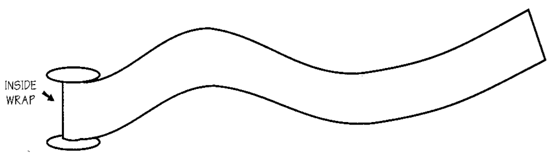
FILM TYPE ____________________

COATING IDENTIFICATION ____________________

FILM TEST: YES____ NO____ SENSITOMETRY: YES____ NO____

Example:




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

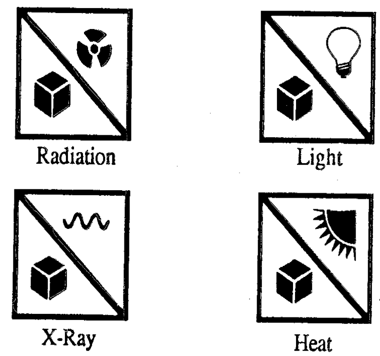
______________________________

______________________________

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

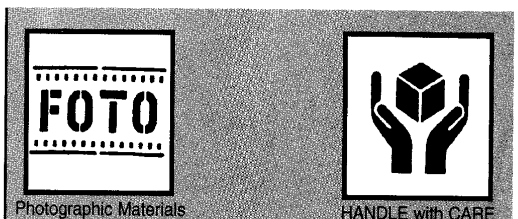
UNPROCESSED FILM

DO NOT EXPOSE TO:




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

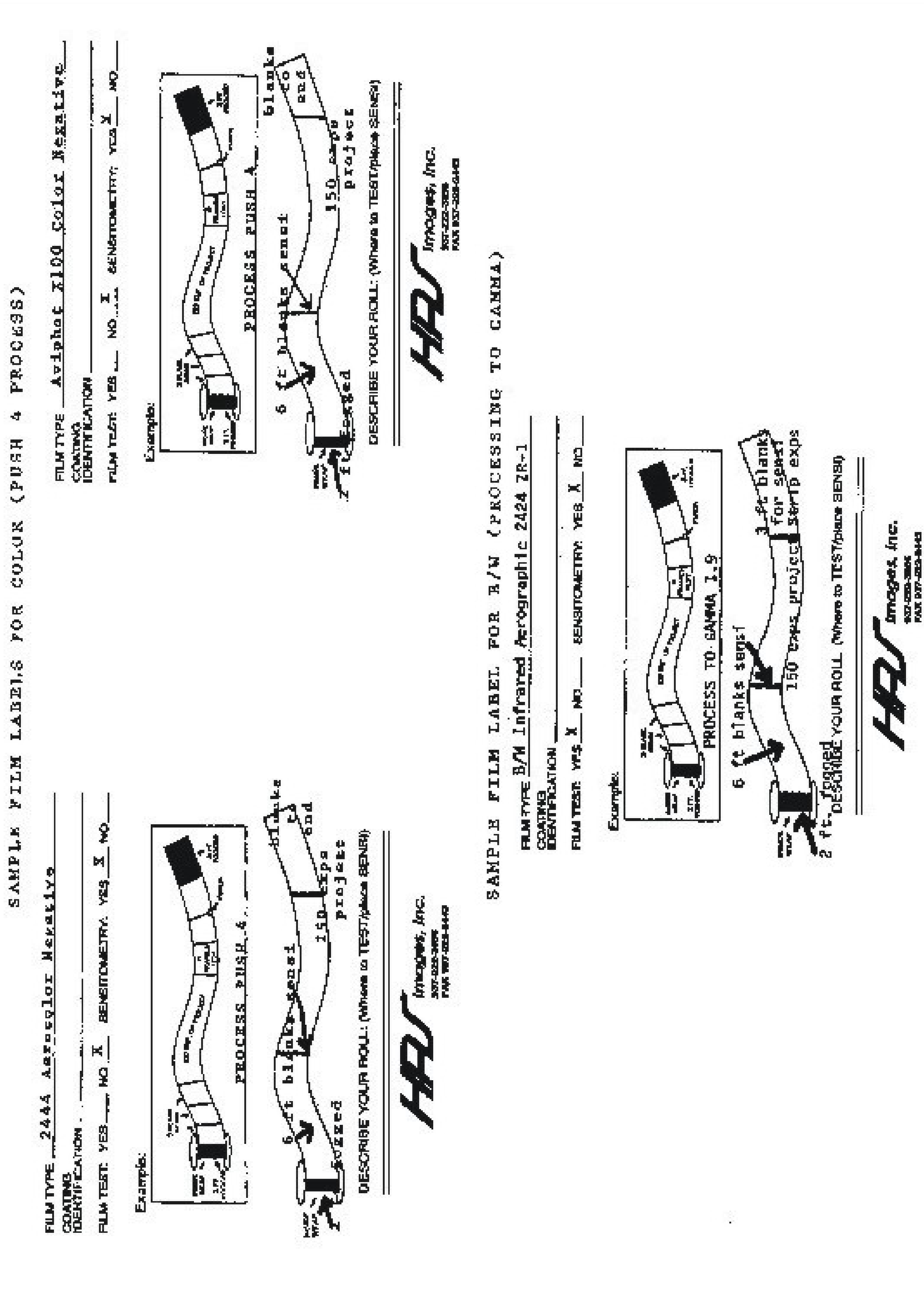
From:




937-222-3856

HRS Images, Inc.

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



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
2 ft fogged

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

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 SENSI)

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 SENSI)

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<br>Title<br>(Shoreline Photographic Contractor/<br>Shoreline Contractor Representative)<br>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 (TL) sent. Example: GA0401-01 is the first TL letter sent for this project, GA0401-25 is the 25th.

# ANNEX 7A – SAMPLE, TABULATION OF AERIAL PHOTOGRAPHY

PROJECT IDENTIFIER: MD8901

| Location | Altitude | Film Type | Tide Stage | Tide Height (ft) | Date | Line Number | Frame Number Start | Frame Number End | Photography Time (UTC) Start | Photography Time (UTC) End | Tide Window Time (UTC) Start | Tide Window Time (UTC) End | Photos Within Window | Tide Gage | Tide Range Max | Tide Exceeded Range | Tide Mean Range | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Chesapeake Bay, MD | 15500 | COLOR NEG | NA | 3.86 | 10-May-12 | 30005 | 0001 | 0044 | 12:58:19 | 13:17:32 | | | NA | Crumpton | | | | |
| Chesapeake Bay, MD | 15500 | COLOR NEG | NA | 3.06 | 10-May-12 | 30004 | 0045 | 0085 | 13:22:04 | 13:39:21 | | | NA | Crumpton | | | | |
| Chesapeake Bay, MD | 15500 | COLOR NEG | NA | 2.36 | 10-May-12 | 30003 | 0086 | 0110 | 13:44:13 | 13:54:50 | | | NA | Annapolis | | | | |
| Chesapeake Bay, MD | 15500 | COLOR NEG | NA | 2.30 | 10-May-12 | 30002 | 0111 | 0132 | 13:59:51 | 14:08:59 | | | NA | Annapolis | | | | |
| Chesapeake Bay, MD | 15500 | COLOR NEG | NA | 2.26 | 10-May-12 | 30001 | 0133 | 0147 | 14:13:14 | 14:19:23 | | | NA | Annapolis | | | | |
| Chesapeake Bay, MD | 15500 | COLOR NEG | NA | 2.22 | 10-May-12 | 30006 | 0148 | 0162 | 14:25:32 | 14:31:51 | | | NA | Annapolis | | | | |
| Chesapeake Bay, MD | 15500 | COLOR NEG | NA | 1.80 | 10-May-12 | 30008 | 0163 | 0173 | 14:36:44 | 14:41:22 | | | NA | Cambridge | | | | |
| Chesapeake Bay, MD | 15500 | COLOR NEG | NA | 1.42 | 10-May-12 | 30013 | 0174 | 0193 | 16:35:16 | 16:44:13 | | | NA | Cambridge | | | | |
| Chesapeake Bay, MD | 15500 | COLOR NEG | NA | 1.40 | 10-May-12 | 30012 | 0194 | 0214 | 16:48:47 | 16:57:59 | | | NA | Cambridge | | | | |
| Chesapeake Bay, MD | 15500 | COLOR NEG | NA | 1.40 | 10-May-12 | 30011 | 0215 | 0231 | 17:01:53 | 17:09:26 | | | NA | Cambridge | | | | |
| Chesapeake Bay, MD | 15500 | COLOR NEG | NA | 1.98 | 10-May-12 | 30009 | 0232 | 0248 | 17:23:33 | 17:30:51 | | | NA | Tolchester | | | | |
| Chesapeake Bay, MD | 15500 | COLOR NEG | NA | 1.87 | 10-May-12 | 30007 | 0249 | 0270 | 17:35:25 | 17:45:11 | | | NA | Tolchester | | | | |
| Chesapeake Bay, MD | 15500 | COLOR NEG | NA | 1.80 | 10-May-12 | 30010 | 0271 | 0281 | 17:51:08 | 17:55:40 | | | NA | Tolchester | | | | |
| Chesapeake Bay, MD | 15000 | B&W IR | MLLW | 0.21 | 12-Nov-12 | 30002 | 0542 | 0548 | 15:46:27 | 15:49:32 | 15:12 | 16:02 | YES | Tolchester | 0.3 | -0.09 | | |
| Chesapeake Bay, MD | 15000 | B&W IR | MLLW | 0.29 | 12-Nov-12 | 30003 | 0549 | 0557 | 15:54:46 | 15:58:12 | 15:12 | 16:02 | YES | Tolchester | 0.3 | -0.01 | | |
| Chesapeake Bay, MD | 15000 | B&W IR | MHW | 1.23 | 12-Nov-12 | 30003 | 0558 | 0566 | 16:01:11 | 16:04:37 | 15:52 | 16:37 | YES | Annapolis | 1.5 | -0.27 | | |
| Chesapeake Bay, MD | 15000 | B&W IR | MHW | 0.99 | 12-Nov-12 | 30002 | 0567 | 0574 | 16:09:41 | 16:13:26 | 15:52 | 16:37 | YES | Annapolis | 1.5 | -0.51 | | |
| Chesapeake Bay, MD | 15000 | B&W IR | MHW | 1.32 | 12-Nov-12 | 30004 | 0575 | 0582 | 16:19:01 | 16:22:11 | 15:42 | 16:37 | YES | Annapolis | 1.5 | -0.18 | | |
| Chesapeake Bay, MD | 15000 | B&W IR | MHW | 1.35 | 12-Nov-12 | 30005 | 0583 | 0590 | 16:26:53 | 16:30:34 | 15:42 | 16:37 | YES | Annapolis | 1.5 | -0.15 | | |
| Chesapeake Bay, MD | 15000 | B&W IR | MLLW | 2.33 | 12-Nov-12 | 30005 | 0591 | 0595 | 16:41:16 | 16:43:24 | 15:57 | 18:57 | YES | Tolchester | 0.3 | 2.03 | 1.20 | |
| Chesapeake Bay, MD | 15000 | B&W IR | MLLW | 0.82 | 12-Nov-12 | 30005 | 0596 | 0607 | 16:43:56 | 16:49:51 | 16:02 | 18:47 | YES | Ches.Cty. | 0.3 | 0.52 | 2.86 | |
| Chesapeake Bay, MD | 15000 | B&W IR | MLLW | 0.70 | 12-Nov-12 | 30007 | 0608 | 0623 | 16:53:20 | 17:00:01 | 16:22 | 18:47 | YES | Ches.Cty. | 0.3 | 0.40 | 2.86 | |
| Chesapeake Bay, MD | 15000 | B&W IR | MHW | 1.57 | 12-Nov-12 | 30006 | 0624 | 0638 | 17:05:49 | 17:12:03 | 16:57 | 18:02 | YES | Annapolis | 1.5 | 0.07 | 0.97 | |
| Chesapeake Bay, MD | 15000 | B&W IR | MHW | 1.95 | 12-Nov-12 | 30008 | 0639 | 0649 | 17:17:13 | 17:22:26 | 16:57 | 18:02 | YES | Cambridge | 2.1 | -0.15 | 1.62 | |
| Chesapeake Bay, MD | 15000 | B&W IR | MLLW | 0.48 | 12-Nov-12 | 30009 | 0650 | 0661 | 17:33:35 | 17:39:24 | 16:17 | 18:47 | YES | Ches.Cty. | 0.3 | 0.18 | 2.86 | |
| Chesapeake Bay, MD | 15000 | B&W IR | MHW | 3.32 | 12-Nov-12 | 30010 | 0662 | 0669 | 17:43:28 | 17:46:38 | 16:17 | 17:47 | YES | Tolchester | 1.7 | 1.62 | 1.20 | |
| Chesapeake Bay, MD | 15000 | B&W IR | MHW | 1.82 | 12-Nov-12 | 30012 | 0670 | 0690 | 17:52:08 | 18:01:06 | 17:52 | 18:22 | YES | Cambridge | 2.1 | -0.28 | 1.62 | |
| Chesapeake Bay, MD | 15000 | B&W IR | MHW | 1.73 | 12-Nov-12 | 30011 | 0691 | 0707 | 18:05:15 | 18:13:35 | 17:52 | 18:22 | YES | Cambridge | 2.1 | -0.37 | 1.62 | |
| Chesapeake Bay, MD | 15500 | COLOR NEG | NA | 1.71 | 18-Apr-13 | 30008 | 0059 | 0061 | 14:36:44 | 14:41:22 | 13:00 | 21:06 | NA | Cambridge | | | | |
| Chesapeake Bay, MD | 15500 | B&W IR | MHW | 1.77 | 29-Apr-13 | 30002 | 0344 | 0349 | 14:43:38 | 14:46:24 | 14:20 | 15:20 | YES | Annapolis | 1.5 | 0.27 | 0.97 | |
| Chesapeake Bay, MD | 15500 | B&W IR | MHW | 1.73 | 29-Apr-13 | 30003 | 0350 | 0355 | 14:50:18 | 14:52:19 | 14:20 | 15:20 | YES | Annapolis | 1.5 | 0.23 | 0.97 | |
| Chesapeake Bay, MD | 15500 | B&W IR | MHW | 1.80 | 29-Apr-13 | 30005 | 0356 | 0362 | 14:58:12 | 15:01:31 | 14:40 | 15:35 | YES | Annapolis | 1.5 | 0.30 | 0.97 | |
| Chesapeake Bay, MD | 15500 | B&W IR | MHW | 1.74 | 29-Apr-13 | 30004 | 0363 | 0369 | 15:06:03 | 15:08:26 | 14:40 | 15:35 | YES | Annapolis | 1.5 | 0.24 | 0.97 | |
| Chesapeake Bay, MD | 15500 | B&W IR | MHW | 1.22 | 29-Apr-13 | 30009 | 0467 | 0472 | 17:14:57 | 17:17:40 | 17:10 | 18:10 | YES | Crumpton | 2.6 | -1.38 | 2.40 | |
| Chesapeake Bay, MD | 15500 | B&W IR | MHW | 1.18 | 29-Apr-13 | 30010 | 0473 | 0476 | 17:21:12 | 17:22:23 | 17:10 | 18:10 | YES | Crumpton | 2.6 | -1.42 | 2.40 | |
| Chesapeake Bay, MD | 15500 | B&W IR | MHW | 0.82 | 23-May-06 | 30001 | 0504 | 0518 | 18:00:08 | 18:06:03 | 16:18 | 19:08 | YES | Annapolis | 0.9 | -0.08 | 0.97 | |
| Chesapeake Bay, MD | 15500 | B&W IR | MLLW | 0.31 | 23-May-06 | 30002 | 0519 | 0526 | 18:18:08 | 18:21:43 | 17:48 | 21:28 | YES | Tolchester | 0.3 | 0.01 | 1.20 | |
| Chesapeake Bay, MD | 15500 | B&W IR | MHW | 0.49 | 23-May-06 | 30003 | 0527 | 0536 | 18:26:03 | 18:29:50 | 17:48 | 21:28 | YES | Tolchester | 1.1 | -0.61 | 1.20 | |
| Chesapeake Bay, MD | 15500 | B&W IR | MHW | 0.67 | 23-May-06 | 30005 | 0537 | 0541 | 18:34:42 | 18:36:46 | 17:13 | 19:38 | YES | Tolchester | 1.1 | -0.43 | 1.20 | |
| Chesapeake Bay, MD | 15500 | B&W IR | MHW | 0.63 | 23-May-06 | 30004 | 0542 | 0546 | 18:41:01 | 18:42:42 | 17:13 | 19:38 | YES | Tolchester | 1.1 | -0.47 | 1.20 | |
| Chesapeake Bay, MD | 15500 | B&W IR | MLLW | 0.31 | 23-May-06 | 30013 | 0547 | 0566 | 18:54:10 | 19:02:20 | 17:28 | 19:13 | YES | Cambridge | 0.3 | 0.01 | 1.62 | |
| Chesapeake Bay, MD | 15500 | B&W IR | MHW | 1.18 | 23-May-06 | 30011 | 0567 | 0568 | 19:05:27 | 19:05:58 | 17:28 | 19:13 | YES | Cambridge | 1.5 | -0.32 | 1.62 | |
| Chesapeake Bay, MD | 15500 | B&W IR | MHW | 0.67 | 25-May-07 | 30013 | 78 | 97 | 16:55:15 | 17:04:19 | 15:55 | 17:55 | YES | Cambridge | 1.5 | -0.83 | 1.62 | |
| Chesapeake Bay, MD | 15500 | B&W IR | MHW | 1.45 | 25-May-07 | 30011 | 98 | 100 | 17:08:42 | 17:09:37 | 14:55 | 18:10 | YES | Cambridge | 1.5 | -0.05 | 1.62 | |
| Chesapeake Bay, MD | 15500 | B&W IR | MHW | 1.07 | 25-May-07 | 30001 | 105 | 119 | 17:31:53 | 17:38:10 | 16:25 | 19:40 | YES | Annapolis | 1.5 | -0.43 | 0.97 | |
| Chesapeake Bay, MD | 15500 | B&W IR | MHW | 1.37 | 25-May-07 | 30003 | 120 | 125 | 17:42:57 | 17:45:24 | 16:55 | 20:00 | YES | Annapolis | 1.5 | -0.13 | 0.97 | |
| Chesapeake Bay, MD | 15500 | B&W IR | MHW | 1.07 | 25-May-07 | 30002 | 126 | 131 | 17:49:23 | 17:51:38 | 16:55 | 20:00 | YES | Annapolis | 1.5 | -0.43 | 0.97 | |
| Chesapeake Bay, MD | 15500 | B&W IR | MHW | 1.26 | 25-May-07 | 30004 | 132 | 138 | 17:56:16 | 17:59:12 | 17:35 | 21:00 | YES | Annapolis | 1.5 | -0.24 | 0.97 | |
| Chesapeake Bay, MD | 15500 | B&W IR | MHW | 1.35 | 25-May-07 | 30005 | 139 | 145 | 18:02:54 | 18:05:35 | 17:35 | 21:00 | YES | Annapolis | 1.5 | -0.15 | 0.97 | |
| Chesapeake Bay, MD | 15500 | B&W IR | MHW | 1.15 | 21-Jun-07 | 30002 | 146 | 153 | 14:52:23 | 14:55:35 | 12:30 | 14:50 | NO* | Tolchester | 1.7 | -0.55 | 1.20 | |
| Chesapeake Bay, MD | 15500 | B&W IR | MHW | 1.16 | 21-Jun-07 | 30003 | 154 | 163 | 15:00:37 | 15:04:28 | 12:30 | 14:50 | NO* | Tolchester | 1.7 | -0.54 | 1.20 | |
| Chesapeake Bay, MD | 15500 | B&W IR | MHW | 1.74 | 21-Jun-07 | 30005 | 164 | 169 | 15:18:51 | 15:21:15 | 13:20 | 15:30 | YES | Tolchester | 1.7 | 0.04 | 1.20 | |
| Chesapeake Bay, MD | 15500 | B&W IR | MHW | 2.02 | 21-Jun-07 | 30007 | 170 | 175 | 15:19:20 | 15:28:20 | 13:20 | 15:30 | YES | Tolchester | 1.7 | 0.32 | 1.20 | |
| Chesapeake Bay, MD | 15500 | B&W IR | MHW | 1.71 | 21-Jun-07 | 30004 | 176 | 181 | 15:39:55 | 15:42:06 | 13:55 | 16:00 | YES | Tolchester | 1.7 | 0.01 | 1.20 | |

NOTE: TIDE HEIGHT FOR COLOR PHOTOGRAPHY IS FOR ACTUAL TIDE STATION SHOWN.
MHW WAS EXCEEDED DURING FLIGHT ON ANY DAY COLOR WAS FLOWN.
NOTE: RANGE OF TIDES FOR MHW IS 12.5' TO 15.3' FOR BANGOR AND 9.8' TO 12.0' FOR BAR HARBOR.
RANGE OF TIDES FOR MLLW IS -0.3' TO +0.3' FOR ALL GAGES.
TIDAL ZONES ARE BASED ON GAGES AS NOTED.
NOTE: ON 21-JUN-07 MLLW WAS FLOWN ON LINES 2 & 3. TIDES WERE AS PREDICTED. COMPUTED TIDES ARE WITHIN SUN ANGLE AND

## Annex 7B - BLANK SAMPLE of “TABULATION OF AERIAL PHOTOGRAPHY”

| | | | | | | | | | | | Tide Window | | Photos | | Tide | Tide | Tide | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Film | Tide | Tide | | Line | Frame Number | | Photogr. Time (UTC) | | Time (UTC) | | Within | Tide | Range | Exceeded | Mean | |
| Location | Altitude | Type | Stage | Ht (Ft) | Date | No. | Start | End | Start | End | Start | End | Window? | Gauge | Max. | Range? | Range | Comments |
| | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | |

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March 24, 2011

# 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

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ATTACHMENT D: SHAPEFILE REQUIREMENTS PAGE

## ATTACHMENT D:  SHAPEFILE REQUIREMENTS

1. INTRODUCTION - The contractor shall supply two sets of ESRI 3-D shapefiles (PolyLineZ and PointZ), 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 ***feature class*** that is used within C-COAST will be a separate shapefile. The shapefiles shall have the following names and be of the specified ***geometry type*** (line, point).

LINE SHAPEFILES:
1) Shoreline
2) Alongshore_Feature
3) Obstruction_Linear
4) Cultural_Feature_Miscellaneous
5) Transportation
6) Natural_Feature_Miscellaneous
7) Danger_Area
8) Aquatic_Vegetation_Area
9) Contour
10) Cartographic_Limit

POINT SHAPEFILES:
11) Obstruction_Point
12) Freestanding_Marine_Feature
13) Landmark
14) Aid_To_Navigation
15) Vertical_Measurement

2.3 SHAPEFILE ATTRIBUTION (listed by ***class***; see 2.2 above for correct ***geometry type***)

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_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)

4) 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)

5) 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)

6) 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)

7) 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)

8) 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)

9) Contour
Attribute: TYPE
Data type: Text
Width: 30
Domain: Depth_Contour
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)

10) 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)

11) 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__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)

12) 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)

13) 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)

14) 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)

15) 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)

Example of interim shoreline attribute table:

Contents | Preview | Metadata

| 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 | |

Record: 1 of 733 Options

Preview: Table

3. FINAL DELIVERABLE SHAPEFILES - The final deliverable shapefiles shall merge all the approved interim line files (PolyLineZ) into one shapefile and all the approved interim point files (PointZ) into another shapefile. See section 2.2 for a listing of which classes are lines and which are points. 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 Aa@ for arcs (lines) and Ap@ 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 not permitted. The final shapefiles shall include the following data fields, *ordered as they are listed below:*

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 *(line features)*:
SHORELINE
ALONGSHORE FEATURE
OBSTRUCTION LINEAR
CULTURAL FEATURE MISCELLANEOUS
TRANSPORTATION
NATURAL FEATURE MISCELLANEOUS
DANGER AREA
AQUATIC VEGETATION AREA
CONTOUR
CARTOGRAPHIC LIMIT

*(point features)*:
OBSTRUCTION POINT
FREESTANDING MARINE FEATURE
LANDMARK
AID TO NAVIGATION
VERTICAL MEASUREMENT

Attribute_Label: ATTRIBUTE
Data type: Text
Width: 50
Definition: C-COAST Feature attribute description
Domain *(line features)*:
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.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.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.Fixed
Pier.Floating
Pier.Ruins
Training Wall
Undetermined Alongshore Feature
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
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
Depth Contour.Approximate
Elevation Contour
Elevation Contour.Approximate
Feature Limit
Low Visibility Limit
Source Data Limit

*(point features)*:

Coral.Covers/Uncovers
Coral.Submerged
Rock.Bare
Rock.Covers/Uncovers
Rock.Submerged
Snag Or Stump.Covers/Uncovers
Snag Or Stump.Submerged
Obstruction.Bare
Obstruction.Covers/Uncovers
Obstruction.Submerged
Wreck.Mast.Bare
Wreck.Mast.Covers/Uncovers
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
Sounding
Sounding.Coral
Sounding.Obstruction
Sounding.Rock
Sounding.Wreck
Spot Elevation

Attribute_Label: INFORM
Data type: Text
Width: 50
Definition: Ancillary Information (e.g. Describing or defining a feature). 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 compilation.
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. <u>ENTERING DATA IN ATTRIBUTE FIELDS</u> - 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 2.3 and 3.3. 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 normally be the reported accuracy for the block of imagery used to compile the feature unless another method is required by NGS for a given project. 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)

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April, 2010

# 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 AND ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE

| Code | C-COAST ***CLASS*** / Attribute | S-57 Code |
|---|---|---|
| | ***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 4 |
| 18 | Natural.Great Lake Or Lake Or Pond | COALNE;inform Lakeshore |
| 19 | Natural.Great Lake Or Lake Or Pond.Approximate | COALNE;quapos 4 |
| 20 | Natural.Mean High Water | COALNE;inform Meanhighwater |
| 21 | Natural.Mean High Water.Approximate | COALNE;quapos 4 |
| 22 | Natural.Mean Water Level | COALNE;inform Meanwaterlevel |
| 23 | Natural.River Or Stream | COALNE;inform River |
| 24 | Natural.River Or Stream.Approximate | COALNE;quapos 4 |
| 25 | Undetermined | COALNE |
| 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 | Undetermined 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;valsou -999 |
| 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;height -999 |

***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 | OBSTRN;catobs 10;watlev 7;valsou -999 |
| 78 | Floating Barrier.Oil Barrier | OILBAR;catolb 2 |
| 79 | Floating Barrier.Undetermined | PONTON |
| 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;inform Floating platform |
| 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;valsou -999 |
| 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 4 |
| 103 | Pile.Submerged | OBSTRN;catobs 1;watlev 3 |
| 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;inform Daybeacon position |
| 139 | Marine Light.Lighthouse | BUISGL;functn 33 |
| 140 | Marine Light.Pile | BCNLAT;inform Light position |
| 141 | Marine Light.Tower | BCNLAT;inform Light position |
| 142 | Marine Light.Tripodal | BCNLAT;inform Light position |
| | ***CULTURAL FEATURE MISCELLANEOUS*** | |
| 143 | Building | BUISGL;functn -999 |
| 144 | Cable.Overhead | CBLOHD |
| 145 | Cable.Submerged | CBLSUB |
| 146 | Dam | DAMCON;catdam 2 |
| 147 | Fence | FNCLNE;catfnc 1 |
| 148 | Fort | FORSTC;catfor 2 |
| 149 | General Transport.Aerial Cable | CONVYR;catcon 1 |
| 150 | General Transport.Conveyor Belt | CONVYR;catcon 2 |
| 151 | General Transport.Ferry Cable | FERYRT;catfry 2 |
| 152 | Grain Elevator | SILTNK;catsil 3 |
| 153 | Levee Or Dike | DYKCON |
| 154 | Pipeline.Submerged Or Surface | PIPSOL |
| 155 | Pipeline.Overhead | PIPOHD |
| 156 | Silo | SILTNK;catsil 1 |
| 157 | Tank | SILTNK;catsil 2 |
| 158 | Wall | FNCLNE;catfnc 4 |
| 159 | Water Tower | SILTNK;catsil 4 |
| | ***TRANSPORTATION*** | |
| 160 | Helicopter Pad | RUNWAY;catrun 2 |
| 161 | Road | ROADWY |
| 162 | Road.Path | ROADWY;catrod 4 |
| 163 | Railroad | RAILWY;status -999 |
| 164 | Railroad.Abandoned | RAILWY;status 4 |
| 165 | Runway | RUNWAY;catrun 1 |
| 166 | Tunnel Entrance | TUNNEL |
| | ***NATURAL FEATURE MISCELLANEOUS*** | |
| 167 | Cliff Or Bluff | SLOTOP;catslo 6 |
| 168 | Glacier.Extent | ICEARE;catice 5 |
| 169 | Landslide.Extent | LNDRGN;catlnd 13 |

| | | |
|---|---|---|
| 170 | Lava.Extent | LNDRGN;catlnd 14 |
| 171 | Mangrove Or Cypress.Extent | VEGATN;catveg 7 |
| 172 | Marsh Or Swamp.Extent | LNDRGN;catlnd 2 |
| 173 | Moraine.Extent | LNDRGN;catlnd 16 |
| 174 | Rapids | RAPIDS |
| 175 | Sand Dune | SLOGRD;catslo 3;natsur 4 |
| 176 | Stream.Intermittent | RIVERS;status 5 |
| 177 | Stream.Perennial | RIVERS;status 1 |
| 178 | Waterfall | WATFAL;convis 1 |

***DANGER AREA***

| | | |
|---|---|---|
| 179 | Breakers | WATTUR;catwat 1 |
| 180 | Foul | OBSTRN;catobs 6;watlev 4;quasou 2;valsou -999 |
| 181 | Ledge.Covers/Uncovers | SBDARE;watlev 4;inform Ledge |
| 182 | Ledge.Submerged | SBDARE;watlev 3;inform Ledge |
| 183 | Reef.Covers/Uncovers | OBSTRN;watlev 4;inform Reef |
| 184 | Reef.Submerged | OBSTRN;watlev 3;inform Reef |
| 185 | Shallow | CTNARE;inform Shallow |
| 186 | Shoal | CTNARE;inform Shoal |
| 187 | Wreckage.Bare | WRECKS;catwrk 3;watlev 2;height -999 |
| 188 | Wreckage.Covers/Uncovers | WRECKS;catwrk 3;watlev 4;quasou 2 |
| 189 | Wreckage.Submerged | WRECKS;catwrk 3;watlev 3;quasou 2;valsou -999 |

***AQUATIC VEGETATION AREA***

| | | |
|---|---|---|
| 190 | Grass In Water | WEDKLP;catwed 3 |
| 191 | Kelp | WEDKLP;catwed 1 |
| 192 | Sea Grass | WEDKLP;catwed 3 |

***CONTOUR***

| | | |
|---|---|---|
| 206 | Depth Contour | DEPCNT;valdco 0;inform MLLW |
| 193 | Depth Contour.Approximate | DEPCNT;valdco 0;quapos 4;inform MLLW |
| 194 | Elevation Contour | LNDELV;elevat -999;verdat 16 |
| 195 | Elevation Contour.Approximate | LNDELV;elevat -999;verdat 16;quapos 4 |

***VERTICAL MEASUREMENT***

| | | |
|---|---|---|
| 196 | Sounding | SOUNDG;quasou 1;valsou -999 |
| 197 | Sounding.Coral | SOUNDG;watlev 3;quasou 1;valsou -999 |
| 198 | Sounding.Obstruction | OBSTRN;watlev 3;quasou 2;valsou -999 |
| 199 | Sounding.Rock | UWTROC;natsur 9;watlev 3;quasou 1;valsou -999 |
| 200 | Sounding.Wreck | WRECKS;watlev 3;quasou 1;valsou -999 |
| 201 | Spot Elevation | LNDELV;elevat -999;verdat 16 |

***CARTOGRAPHIC LIMIT***

| | | |
|---|---|---|
| 202 | Feature Limit | M_COVR;catcov 1 |
| 203 | Low Visibility Limit | M_COVR;catcov 2 |
| 204 | Source Data Limit | M_COVR;catcov 1 |
| 205 | User Added Line | Blkclo |

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November 9, 2009

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

# GLOSSARY

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

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 or derived 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 entire vessel. 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.

**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**

An enclosure as in a canal used in raising or lowering ships as they pass from one level to the other. (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. Mangroves are typically found in the tropical or sub-tropical regions. They occur both in estuaries and along open coastlines. Mangroves dominate three quarters of tropical coastlines. Because of their sensitivity to sub-freezing temperatures, mangroves in the continental United States are limited to the Florida peninsula and isolated growths along the coast of southern Louisiana and south Texas. (6, **12, 13**)

**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 natural channel through which water flows (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)

ALONGSHORE FEATURE

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, thereby forming 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 entire vessel. 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 day beacons.

**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)

<u>AID TO NAVIGATION</u>

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)

<u>CULTURAL FEATURE MISCELLANEOUS</u>

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)

<u>TRANSPORTATION</u>

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)

<u>NATURAL FEATURE MISCELLANEOUS</u>

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 Extents**

See feature definition in the Shoreline Class. This represents the back (landward) limits of this area feature.

**Intermittent Stream**

A type of stream that only flows for part of the year and is usually symbolized on a map with a line of blue dashes and dots. (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 Extents**

See feature definition in the Shoreline Class. This represents the back (landward) limits of this area feature.

**Marsh Or Swamp Extents**

See feature definition in the Shoreline Class. This represents the back (landward) limits of this area feature.

**Moraine**

Any accumulation of loose material deposited by a glacier. (6)

**Perennial Stream**

Lasting indefinitely; enduring. A type of stream that flows throughout of the year and is usually symbolized on a map with a solid blue line. (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)

**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.

**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)

CONTOUR

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)

VERTICAL MEASUREMENT

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)

CARTOGRAPHIC LIMIT

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.


1. Bradford, Gershom. *The Mariner's Dictionary*. New York: Weathervane Books, 1972.

2. "Coastal Mapping Program Operations Manual, Chapter 12, Cartographic Feature Definitions". 2nd Edition. United States Department of Commerce, National Oceanic and Atmospheric Administration, National Ocean Service, National Geodetic Survey, Remote Sensing Division, August 1999.

3. "Coast Pilot Manual". 5th Edition. Washington, DC: U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Ocean Service, 1994.

4. Fonesca, Mark S., W. Judson Kenworthy, and Gordon W. Thayer. "Guidelines for the Conservation and Restoration of Seagrasses in the United States and Adjacent Waters". *NOAA's Coastal Ocean Program Decision Analysis Series No. 12*. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, Coastal Ocean Office. November, 1998.

5. *Hydrographic Dictionary, Part I, Volume I, English, Special Publication No. 32*. 5th Edition. Monaco: International Hydrographic Organization, 1994.

6. *IHO Transfer Standard for Digital Hydrographic Data, Special Publication No. 57*. 3rd Edition. Monaco: International Hydrographic Bureau, 1996.

7. "Nautical Chart Manual, Volume Two: Definitions, Abbreviations, Symbology & References". 7th Edition. U.S. Department of Commerce, Coast and Geodetic Survey, 1992. Digital update January 31, 2009

8. *The Random House College Dictionary*. Revised Edition, Jess Stein ed. New York: Random House, 1980.

9. AC 150/5300-18B – "General Guidance And Specifications For Submission Of Aeronautical Surveys To NGS: Field Data Collection And Geographic Information System (GIS) Standards", on-line at: http://www.faa.gov/regulations_policies/advisory_circulars/index.cfm/go/document.information/documentID/74204

10. Tide and Current Glossary http://co-ops.nos.noaa.gov/publications/glossary2.pdf (January 2000).

**11.** Wood Products Council. (May 2, 2000).

12. Coastal Mangrove-Marsh Shrubland *Conservation Habitats & Species Assessments*. Louisiana Department of Wildlife & Fisheries. December 2005. http://media.wlf.state.la.us/pdfs/experience/Coastal%20Mangrove-Marsh%20Shrubland.pdf .

13. Mangrove Swamps http://www.epa.gov/owow/wetlands/types/mangrove.html

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Version 14A
October 2010

# ATTACHMENT G
# 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 the Task Order Management and Information System (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, and the status of the Quality Control of the Interim Shapefiles, 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 MicroSoft (MS) Word, MS Excel, or Adobe Acrobat® Portable Document Format (PDF).  The table boxes shown below are not required, but ensure that the information is in columns so that it is more readable.  Note that two or more projects should be shown in the same table or spreadsheet.

Prime Contractor Firm Name:_______________________________________
Sub-Contractor(s) Firm Name:_______________________________________

| Project Identifier & Location Dates: | TX0401/South TX (sample) | CA0401/SF Bay Area (sample) |
|---|---|---|
| Date Task Order Awarded | | |
| Date Project Due | | |

| Project ID<br>Project Deliverables | TX0901 (Approx. % Complete) | Date Complete or Planned Complete | CA0901 (Approx. % Complete) | Date Complete or Planned Complete |
|---|---|---|---|---|
| Deliverable #1 | 100% | 1 MAR 09 | | |
| Deliverable #2 | 75% | 1 APR 09 | | |
| Deliverable #3 | | 1 MAY 09 | | |
| Deliverable #4 | | 1 NOV 09 | | |
| Interim Shapefile QC | | 1 DEC 09 | | |
| Overall Completeness | | 15 DEC 09 | | |

1.2 EXAMPLE - Sample projects, percentages and dates filled in above.

1.3 ALL PROJECTS - Include the above information for each project underway; add 2 columns for each project.

1.4 CHANGES - Highlight entries that have been changed from the previous week in green.

1.5 ITEMS OF CONCERN – Highlight item(s) of concern in red.

## 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.

## 5. SPECIAL REQUESTS

Special requests, such as orders for film products, should be submitted to NGS in a separate email and just mentioned in this Weekly Status Report.

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Feb. 1, 2011

# ATTACHMENT H
# EED FILE CHECKING PROGRAMS
# FOR FILM IMAGERY

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

REMOTE SENSING DIVISION
NATIONAL GEODETIC SURVEY
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U.S. DEPARTMENT OF COMMERCE

# ATTACHMENT H: EED FILE CHECKING PROGRAMS

## EED-Checking Program

1. GENERAL - This software, entitled “Shoreline Check.exe”, is used to help ensure that the Electronic Exposure Data (EED) files are in the correct National Geodetic Survey (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, see page 3 below. Plotting the footprint will enable checking of the position and azimuth fields of the EED file, and the photographic coverage of the project area.

2. USEFUL HINTS - A few useful steps/hints to follow:

2.1 This program must be placed in the same folder as the file you are checking.

2.2 To execute the program simply double click it.

2.3 Type in the complete name of the file you are checking, including the extension

2.4 Type in the output name of your choice, include an extension such as “.txt” so it is easily viewable.

2.5 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.

2.6 Keep correcting the errors until the program tells you the corrected file name and asks if you would like to check another file.

2.7 You may want to recheck the corrected file when you are complete as you may have typed a mistake when attempting to correct an error.

This program may still have a few bugs in it. If you experience any problems or issues while checking a file, please send the file in an e-mail to the Contracting Officer Representative (COR) so that NGS 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

1. GENERAL - This program allows the 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.

2. INSTRUCTIONS - The instructions for installation of the program are as follows:

2.1 Unzip the program file
2.2 Run setup.exe
2.3 Follow the installation instructions

3. PROGRAM FUNCTIONS - The program functions are straightforward. Below are the instructions for use of the program:

Open the program by double clicking the icon

3.1 FILE TAB

A. Click Load EED file
B. Navigate to the EED file on your hard drive. The program will only open files with the ".eed" extension
C. Click Exit to close the program

3.2 SETTINGS TAB

A. Click Properties
B. Under this heading there are multiple settings that can be chosen
C. Under the emulsion section of the Properties function choose the emulsion type (black and white infra-red (IR), color, color IR) that you would like to view; Note: It is best to leave all options checked as this function does not always work properly.
D. Under the Frames section of the Properties function choose what to view on the display, i.e. the footprints, flight lines, or photo centers. Any or all three can be displayed simultaneously.
E. Under the Highlighted section of the Properties function choose what is to be highlighted when viewing the main screen.
F. Apply and accept changes, then Exit

3.3. UNITS TAB

A. Click Cursor
B. Choose the format in which the Latitude and Longitude is to be 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.

3.4. GENERAL FUNCTION

A. Right clicking anywhere on the main screen or overview screen will give the option to Pan, Identify, Print, Zoom In (2X), or Zoom Out.

i. 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.

ii. All of these functions, except Print, are available as clickable buttons above the overview screen on the right of the main screen.

iii. The Identify, Pan, Zoom In, and Zoom Out functions are reflected on the main screen only. For instance, if the Zoom function is used in the overview screen it zooms in on the main screen, but not on the overview screen. The overview screen always remains the same.

B. Under the selected frame box on the overview screen, what data is highlighted within the frame can be chosen. The choices are None, Frame Only, or Flight Line. The Frame Only function highlights only the frame. The Flight Line function highlights all frames in the flight line. This differs from the options under the Settings tab. The highlight options under the Settings tab outlines the image, flight line, or photo center. The selected frame highlight fills either the frame or the flight line of the frame.

These directions should provide a general overview of how the program functions. If the contractor experiences any problems or discovers an error in the program please contact the Points of Contact listed in the main body of this Scope of Work.

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Feb. 1, 2011

# 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
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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 may request permission to 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. <u>CONTROLLING THE IMAGERY</u>

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 or eliminate the need 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 accuracy (especially over off-shore islands and/or rocks), and/or time and cost 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 - 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.

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

D. ANNEX 3 - 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:

*<u>The root mean square of all standard deviations of triangulated ground points</u>:*

*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:*

$$C = 0.337 / 0.416 = 0.810 \text{ in this example}$$

*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 |

$$\begin{aligned} K &= 2.23029 + [(0.81-0.80)/(0.90-0.80) * (2.33180 - 2.23029)] \\ &= 2.23029 + (0.1 * 0.10151) \\ &= 2.23029 + 0.01015 = 2.24044 \\ K &= 2.24 \\ R &= K * Sx = 2.24 * 0.416 = 0.932 \end{aligned}$$

*The Radius of the 95% Confidence Circle = 0.9 meters*

## 5. AEROTRIANGULATION DATA FILES

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 PATB ~~M~~ 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.

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.

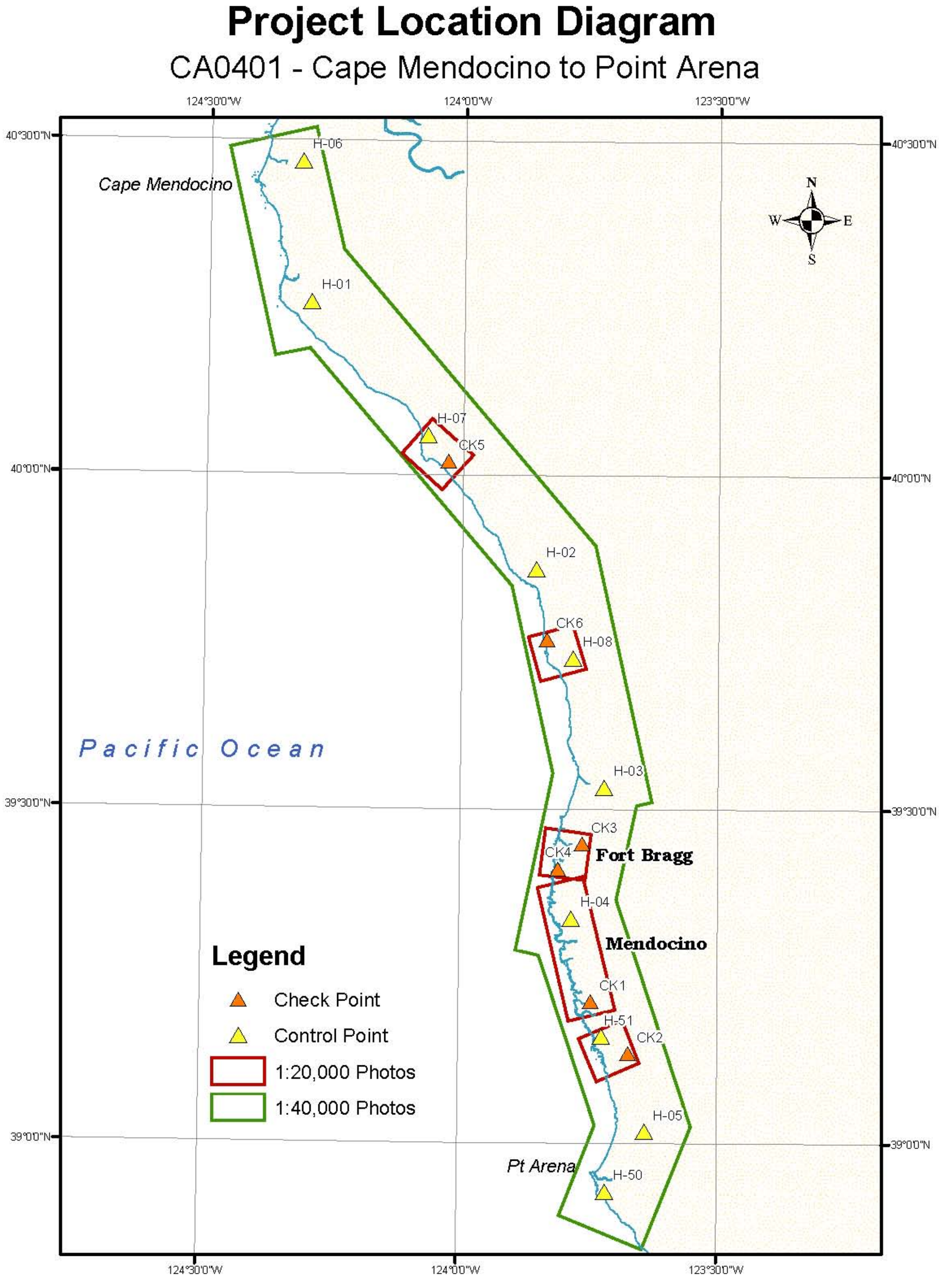
## Project Database

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:

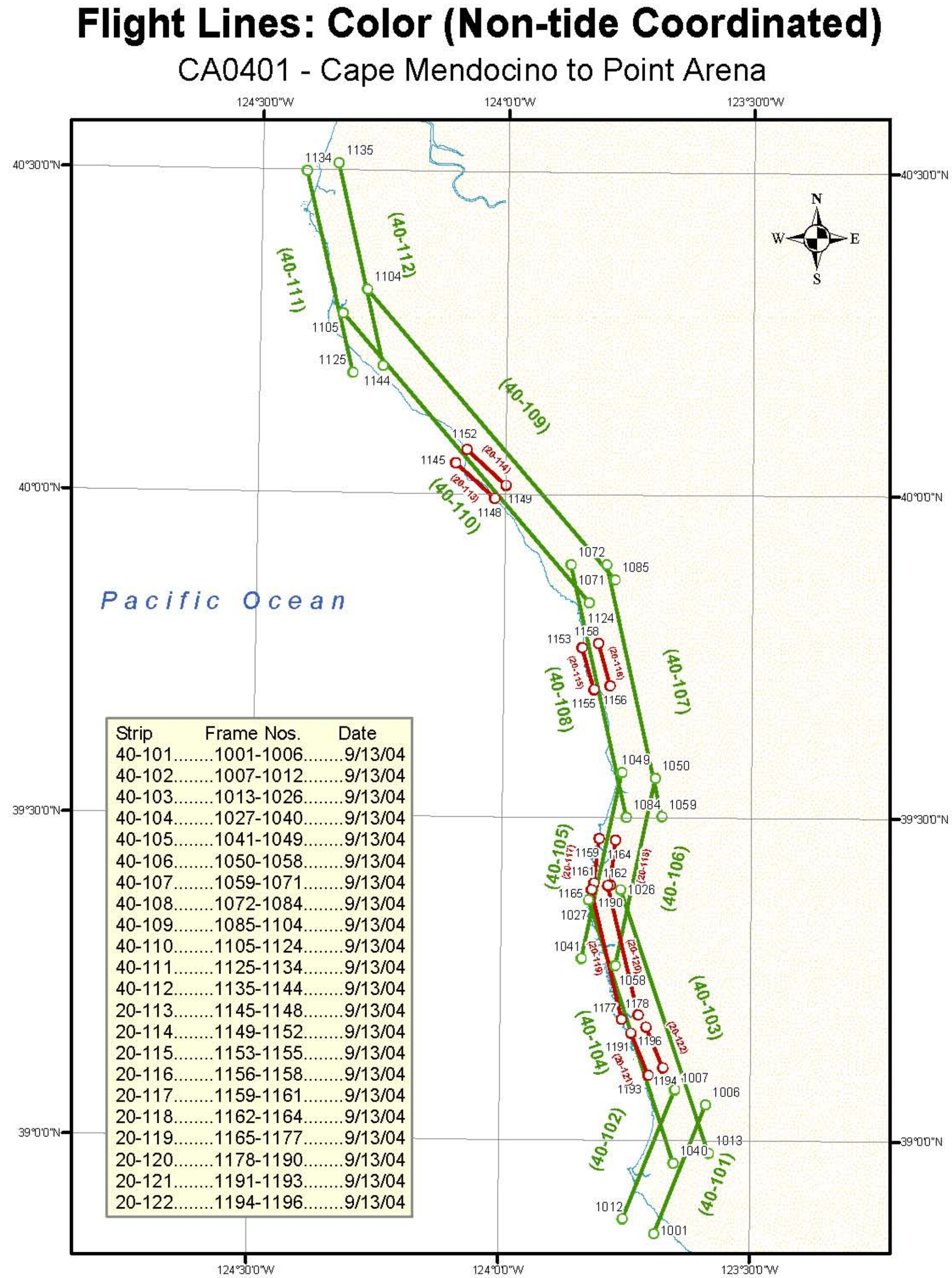
- Project Identifier and other general parameters
- Camera calibration data
- Interior orientation parameters for each frame
- Adjusted coordinates of all measured points
- Ground Control File
- Refined Image Points File
- Airborne GPS Control File
- Adjusted exterior orientation parameters for each 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.

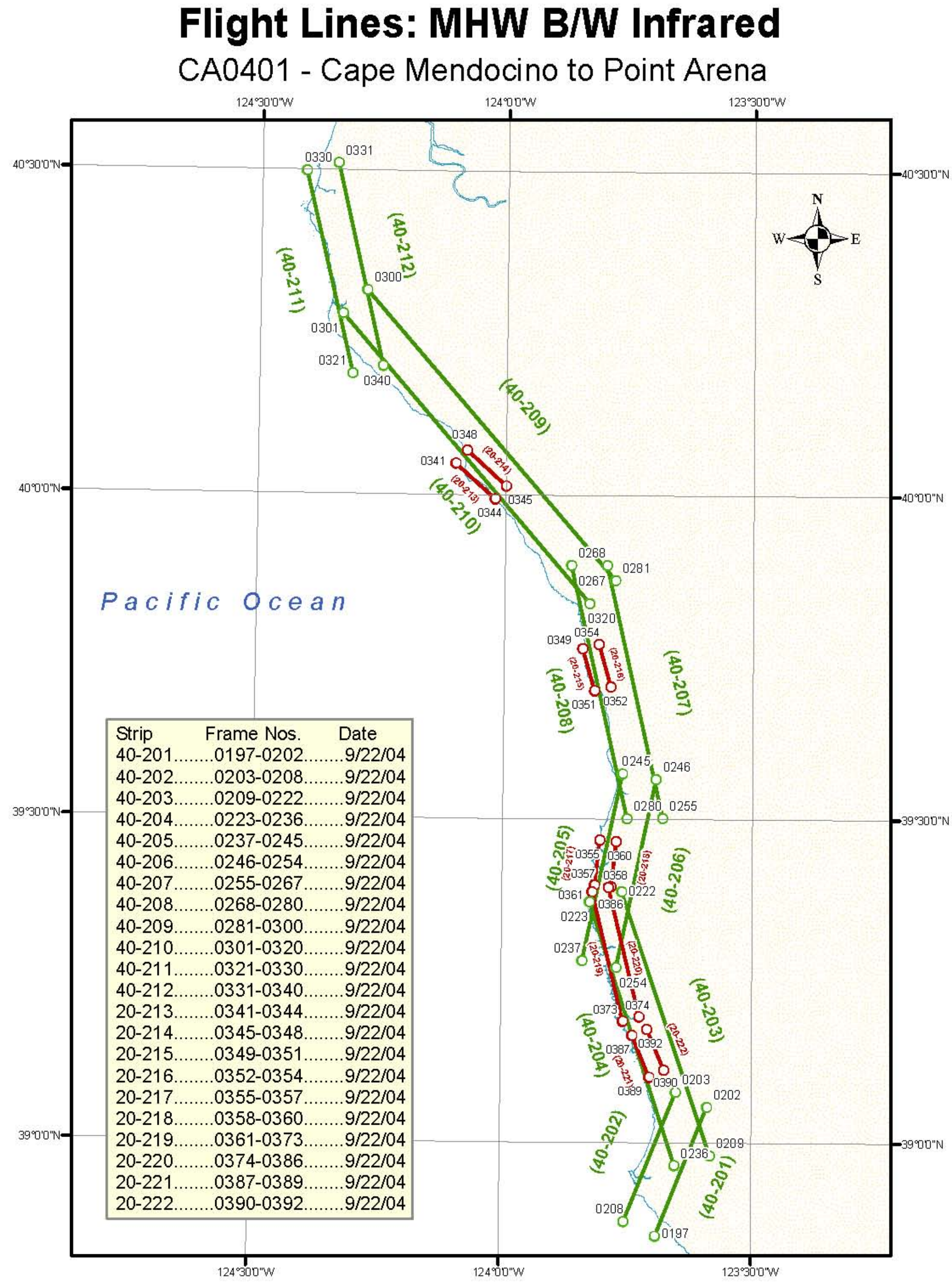
## ANNEX 1 – Project Location



## ANNEX 2a – Color Flight Lines



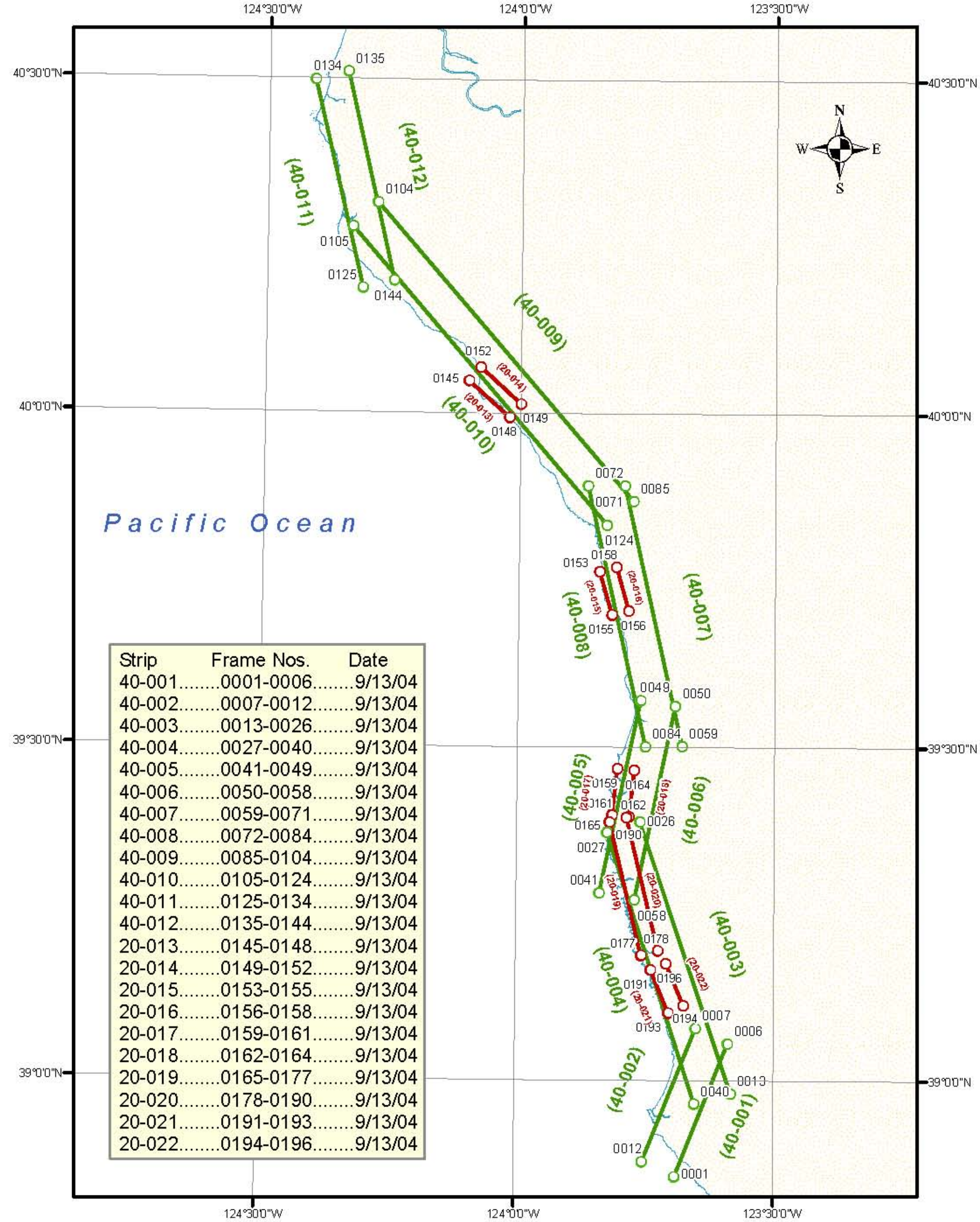
## ANNEX 2b – Mean High Water Black & White Infrared Flight Lines



## ANNEX 2c – Mean Lower Low Water Black & White Infrared Flight Lines

**Flight Lines: MLLW B/W Infrared**

CA0401 - Cape Mendocino to Point Arena



# ANNEX 3 - 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**

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Feb. 1, 2011

# 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

***Note: All of the procedures described herein may change in the near future, if the current (2011) research into tidal tolerance and the development of a fully distributable PYDRO program comes to fruition.***

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# ATTACHMENT J: TIDE COORDINATION REQUIREMENTS

1. GENERAL - The purpose of this section is to provide the requirements for tide coordinated imagery/data acquisition.

Discussions of tide types can be found on the NOAA CO-OPS web site at:
http://co-ops.nos.noaa.gov/restles1.html and

http://co-ops.nos.noaa.gov/publications/Water_Level_Station_Specifications_and_Deliverables_for_Shoreline_Mapping_Projects,_Updated_May_2009.pdf and

http://co-ops.nos.noaa.gov/publications/Computational_Techniques_for_Tidal_Datums_handbook.pdf

Coordination of remotely sensed data acquisition with the stage of tide is necessary to be able to confidently delineate the two required tide lines.

2. SUN ANGLE, CLOUD COVER, VISIBILITY, AND OTHER ATMOSPHERIC PHENOMENA - When obtaining imagery with a film camera the angle of the sun with respect to the horizon MUST be 30° or higher. When obtaining imagery with a digital camera the angle of the sun with respect to the horizon MUST be 25° or higher. When acquiring tide coordinated imagery using an active imagery system sun angle is not a consideration.

For the requirements regarding cloud cover and visibility see SOW Attachment C § 9.1 and § 9.4.

The aerial survey crew must make themselves aware that the surf conditions, also called sea-state, at the time of attempting aerial data acquisition are normal for the project area. A calm sea state is preferred. No off-shore storm should be creating an unusual surf condition in the project area.

3.0 METHODS OF OBTAINING TIDE COORDINATED IMAGERY

3.1 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. See SOW Attachment C, Section for film imagery acquisition requirements.

B. DIGITAL PHOTOGRAPHY - Digital Photography requires the use of a metric quality digital aerial camera. See SOW Attachment Z for Digital Imagery Acquisition Requirements.

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.

3.2 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. SAR (Synthetic Aperture Radar) - For specifications and requirements concerning SAR acquisition see SOW Attachment AB.

3.3 TABULATION OF IMAGERY REQUIREMENTS:

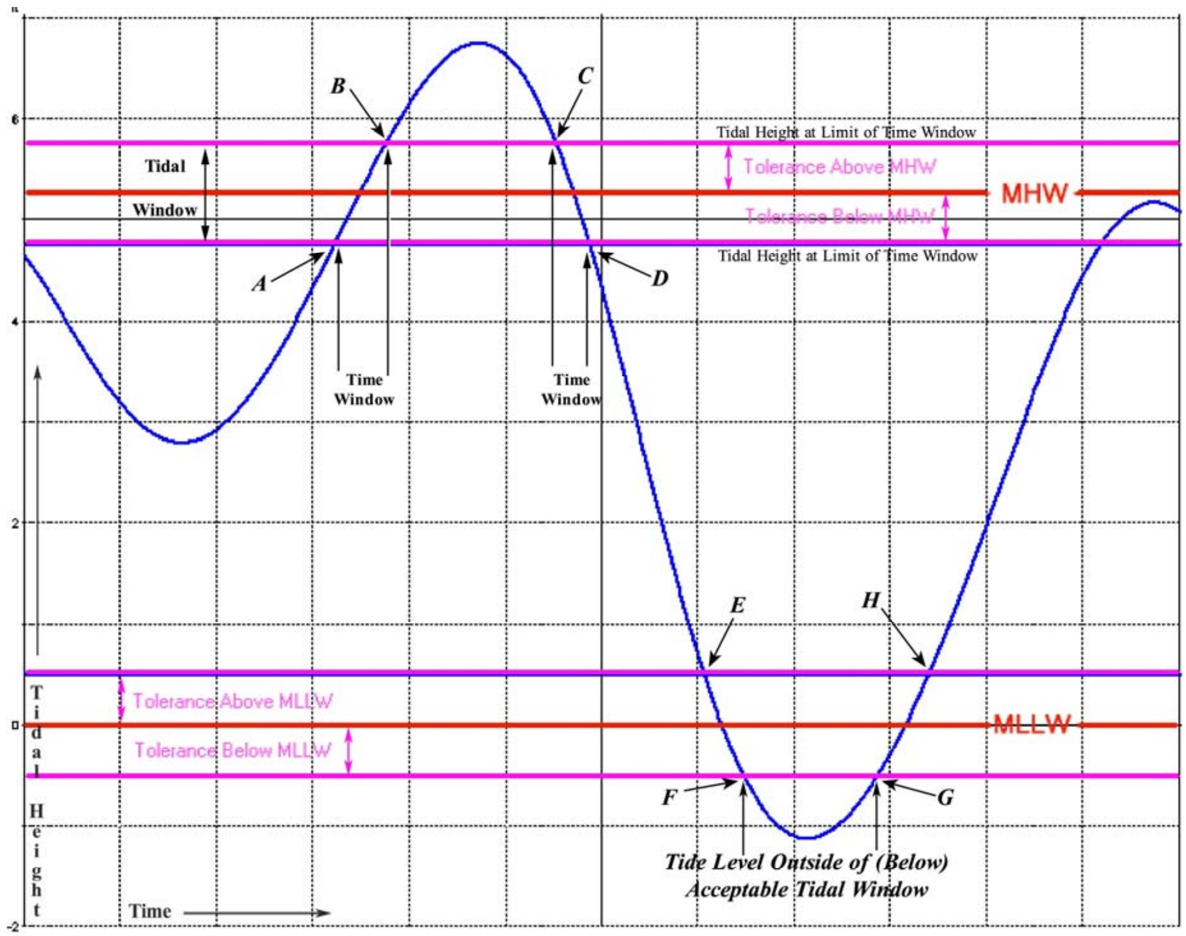
| | Solar Illumination Required | Cloud Free | Clear (8mi.) Visibility | Tide Coordination |
|---|---|---|---|---|
| Film Photography | Yes, Sun Angle > 30° | Yes | Yes | Yes |
| Digital Photography | Yes, Sun Angle > 25° | Yes | Yes | Yes |
| LIDAR | No | Clouds allowed above aircraft | Yes | Yes |
| Hyperspectral | No Specs | No Specs | No Specs | Yes |
| SAR | No | No, but no thunderstorm clouds | No | Yes |

The above table shows the basic phenomena that must come together to allow shoreline imagery acquisition.

4. <u>TIDAL PREDICTION</u> - NGS requires that all tide coordinated imagery be obtained within 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 the tolerance to the MLLW.

4.1 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°/25° and when it will set to 30°/25°;
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, and the local tide gauge water level and datum data as given on the CO-OPS web site. An example of the CO-OPS data can be found at:

http://co-ops.nos.noaa.gov/data_menu.shtml?stn=1611347%20Port%20Allen,%20Hanapepe%20Bay,%20Kauai%20Island,%20HI&type=Datums

Similar data is available for every tide gauge in the National Water Level Observation Network (NWLON).

It is of no consequence which set of data is determined first, so long as the data is all at hand for input to which ever computer program is used to calculate the predicted tide windows.

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/AltAz.php

For greater precision in predicting tidal windows it is necessary to calculate rising and setting times for the sun for several dates through the month. This is especially true near the solstices.

It is important to note that all times used in this process must be based on a 24 hour clock.

NGS does all calculations for tide predictions in Local Standard Time (LST) not daylight savings or Greenwich Mean Time. This is done to provide a standard that all of the NGS aerial survey flight missions can follow. The Contractor is free to use any time standard they may choose. The contractor shall label the time standard that they use in all forms submitted in relation to that data.

To calculate the height tolerance and the monthly highs & lows NGS uses a program written in-house. The Contractor may use any software, commercial or proprietary, to calculate the times wherein the tides in the project area are at the appropriate height to acquire tide coordinated imagery. The only restriction on the use of contractor supplied software for this purpose is that the times calculated by such software must coincide with the times calculated by the Government's in-house tide window prediction software. The Government will, at the Contractor's request, provide the most current version of the software that the Remote Sensing Division (RSD) uses, and is able to freely distribute, to predict such tide windows. The Government will, at the Contractor's request, provide training in the use of the RSD program. Such training will be at a time and place mutually convenient to both the Contractor and the Government.

4.2 TIDAL TOLERANCE CALCULATION – If using the NGS tide window prediction program the Contractor does not need to calculate the tide tolerance. The program makes the calculation. However, because it is necessary to have the tolerance value available when determining whether or not the actual stage of tide during imagery acquisition was within tolerance, the process for calculating it is provided here.

The numerical values needed to calculate the tidal tolerance for each tide station can be found on the CO-OPS web site in the DATUM section for each NWLON tide gage. Example calculations are provided here to further understanding of this concept. For these examples Clearwater, Florida; Savannah River Entrance, Georgia; and San Francisco, California for the month of June 2004 will be used.

The appropriate numerical values might also be found included in commercial tide prediction programs within their data for each tide station.

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. (1.8 ft ± .3ft) 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. ( 6.9 -.69 = 6.21 and 6.9 + .69 = 7.59) The tolerance being 10% of 6.9 or 6.9 x .1 = ±.69 ft.
Imagery to capture the MLLW could be obtained when the tide level is between -.69 ft and +.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. If the new Mean Range was 5 feet or less the 0.3 ft tolerance would have been used.

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.

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.

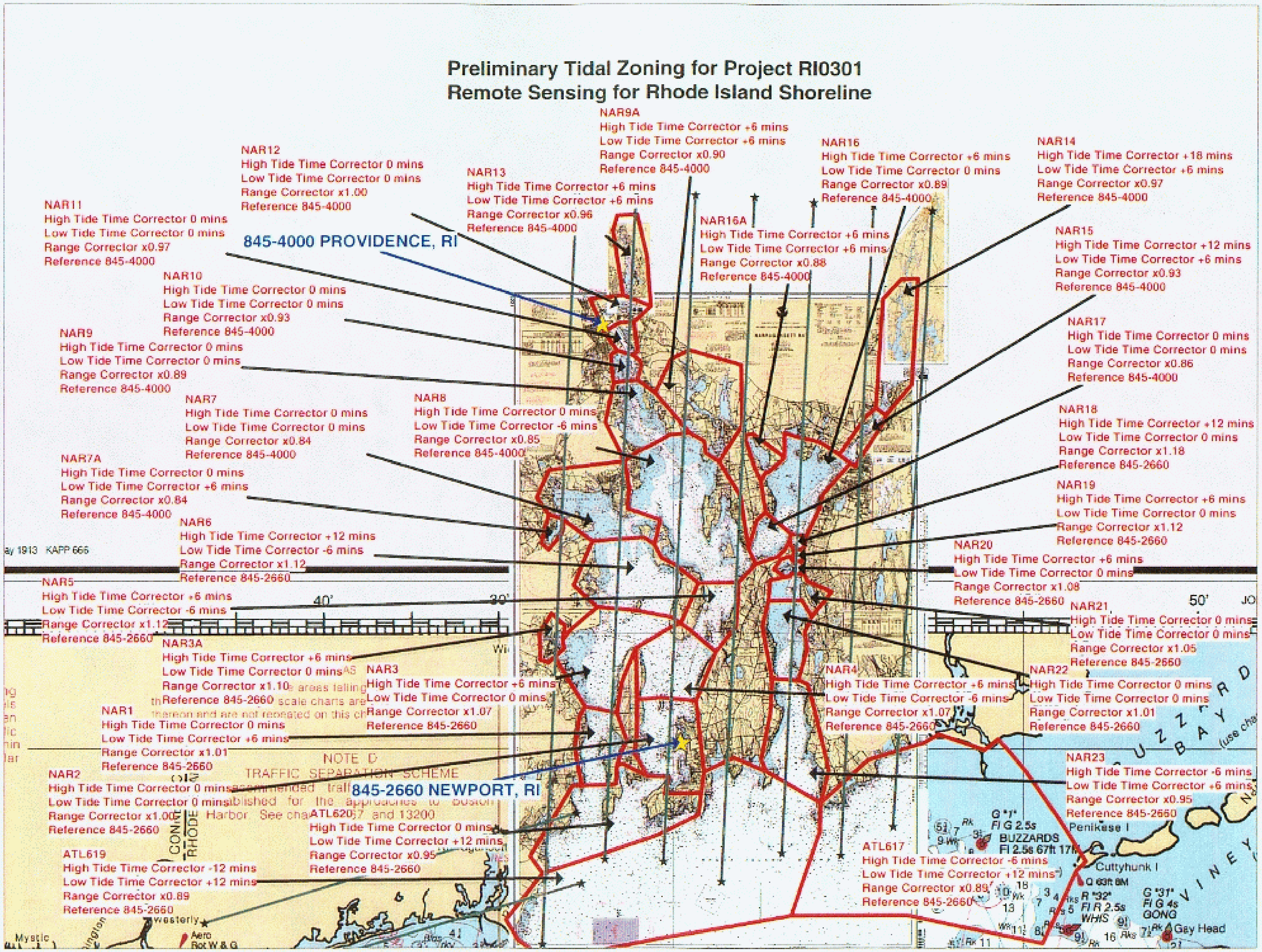
The High Tide Time Corrector is ± the number of minutes that MHW occurs within the zone relative to the time it occurs at the primary tide station. A positive value indicates that the high water event within the zone occurs after that of the primary tide station. A negative value indicates that the high water event occurs before that at the primary station.

The Low Tide Time Corrector is ± the number of minutes that MLLW 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 at any given time.

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.

The Contractor needs to determine, at a minimum, the predicted time of tide for the two zones nearest to the ends of a flight line. If a comparison of the times within the two zones shows that there is sufficient time to fly the whole flight line while the two zones are within the proper range, and there is no intervening obstruction to the free flow of the tide between the two zones, the Contractor can assume that all of the zones in between are also within the proper range. If there is an intervening obstruction or some other choke point, the Contractor should calculate the predicted tides for the zone, or zones, immediately adjacent to the obstruction. The Contractor can, of course, calculate the predicted tides for as many zones as it takes to be assured that the predicted tides will be within the necessary range for the entire mapping project.


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
RHODE
CONN

6. REAL TIME MONITORING OF TIDE GAUGES - In certain areas of the country such as the Gulf Coast or the North Slope and West Coast 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 in their Technical Proposal.

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. By monitoring these gauges the flight crew can tell if the tides are running true to the predictions and can thus 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/ .

6.3 MONITORING CONTRACTOR INSTALLED REAL TIME TIDE GAUGES –The Contractor may be required to install one or more tide gauges that can be monitored in real time for certain special projects. If such is the case, the requirement will be stated in the Project Instructions.

7. POST MISSION ACTUAL TIDE LEVELS - The Contractor may be 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, or a tide zone. The actual level of tide can be obtained from the CO-OPS web site at: http://tidesandcurrents.noaa.gov/ in the left column.

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 may be necessary to do this only with the zones at the ends of actually flown flight lines. However, depending on the complexity of the shoreline in the project area it may be necessary to determine the actual water level for several tide zones on a flight line. If there was a break in a flight line it will be necessary to determine the actual water levels 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 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/publications/Water_Level_Station_Specifications_and_Deliverables_for_Shoreline_Mapping_Projects,_Updated_May_2009.pdf.

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://co-ops.nos.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 windows at a mutually acceptable time and place. After training, the Contractor 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 for 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 water level height data will be calculated to ensure the imagery was taken within the tolerances.

NGS will check a sampling of the Contractor’s actual verified times and heights of tide using the Tabulation of Aerial Photography that the Contractor submits, or by other electronic means.

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Version 14A
October 2010

# 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 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. The set of shapefiles containing the compiled data are generally referred to as the Geographic Cell (GC).

### 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 imagery types (color, IR) 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 that cover any part of the project area
- 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 EVALUATION FILE (CEF) – The Project Instructions will normally list the largest scale NOAA nautical charts covering the project area. The compiler should use these charts to create the Chart Evaluation File (see Attachment AE for CEF specifications). During feature compilation, the compiler shall compare the charted features with the aerial imagery, and make annotations in the CEF as to significant changes to, or non-confirmation of the existence of important charted features. Features compiled in the GC that are confirmed to be charted in their correct shape and location generally do not need to be included in the CEF.

3.4. ACTUAL TIDE/WATER LEVELS – The compiler will usually need to know what the actual measured tide/water levels were at the time the images were acquired for all areas of the project, and not simply the predicted tide/water levels. Knowledge of the differences between the tide/water level in an image and the MLLW and MHW tidal datums, or lake Low Water Datum, in the area is necessary for the compiler to accurately interpret and position the shoreline and associated features. When required, the actual tide levels shall be determined according to the specifications in Attachment J. The required tide level information should also be available from the Tabulation of Aerial Photography prepared by the contractor following the imagery acquisition (see Attachment C, Section 11.4).

3.5. ADDITIONAL REFERENCE SOURCES – See the SOW Main Section 3.6 for additional references needed for feature compilation. The compiler should become especially familiar with Chart No. 1 as an aid to understanding the symbology of features on the chart.

## 4. GENERAL FEATURE COMPILATION

4.1. REQUIRED FEATURES – In general, the contractor shall compile those relatively permanent and fixed features visible in aerial imagery that 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. Though in some cases certain movable features (opening bridges, lock gates, floating piers, platforms, and barriers) should be compiled, in general those features that are temporary in nature (seasonal piers) or do not remain in a fixed position (cargo cranes, barges, buoys, etc.) should not be compiled. The compiler should use available resources along with the guidance in this SOW to judge whether a feature is of a permanent and fixed nature, and is required to be compiled. Also see SOW Main Section 8 for Office Data Collection requirements.

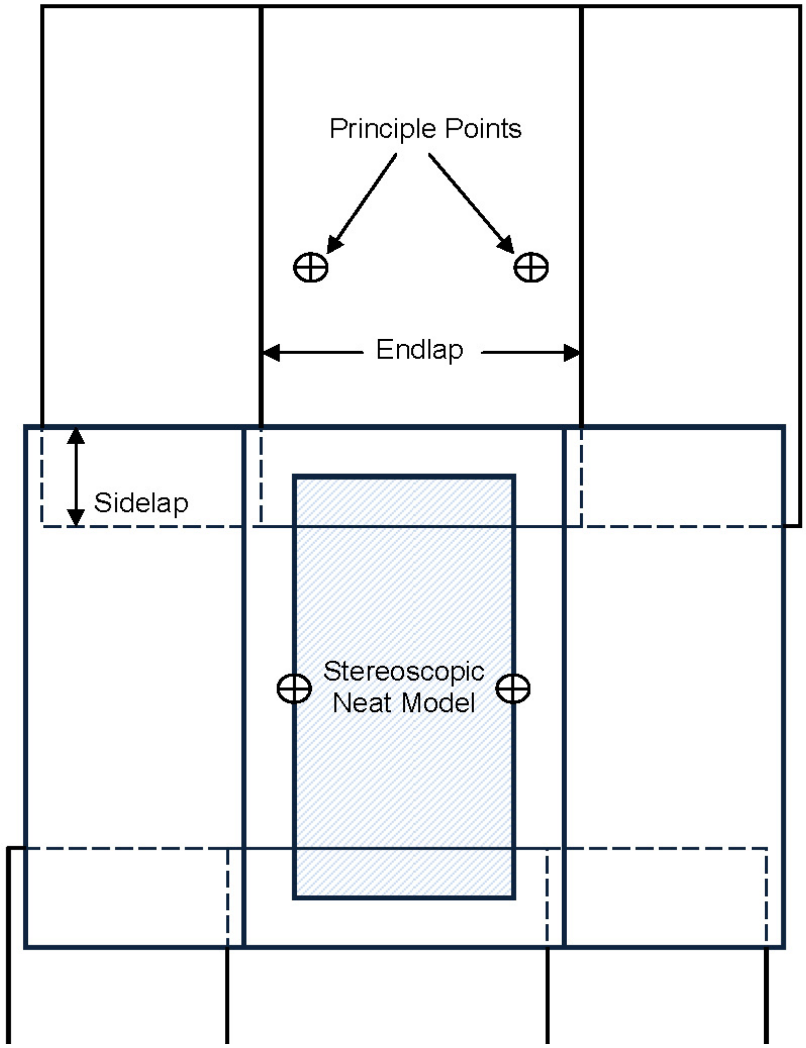
> A. MILITARY INSTALLATIONS – Apart from features already shown on the chart, features in the Natural_Feature_Miscellaneous class, and lights in the USCG Light List, the compiler shall not collect any features landward of the shoreline located within an active military reservation, unless explicit permission to do so is provided in the Project Instructions.

4.2. FEATURE ATTRIBUTION – All compiled features 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.

A. INFORMATION FIELD – Certain features are recommended or required to have additional descriptive text (nomenclature) entered into the Information (INFORMATIO or INFORM) attribution field of C-COAST. Specific guidance is provided in Section 5 below as to when an Information field entry is needed, but the following table provides a brief summary on how to populate this field:

| **Feature** | **Required?** | **Text Format (Case)** | **Examples** |
|---|---|---|---|
| **General features**<br><br>see § 5.8.A.iv, 5.8.K, 5.10.E | **Optional** – as needed or required by SOW | **Sentence case** (or as charted) | • Underpass<br>• Fort McHenry (as charted)<br>• LIFT BRIDGE (as charted)<br>• Abandoned light house<br>• Covered boat slips<br>• Boathouse |
| **'Undetermined'**<br><br>see § 5.2.K, 5.4.C, and 5.4.K | **YES** (if possible) | **Sentence case** | • Mobile crane support<br>• Recreational platform<br>• Numerous piles |
| **General Obstruction**<br><br>see § 5.3.E, 5.4.L, and 5.5 | **YES** | **Sentence case** | • Tree<br>• Concrete ruins<br>• Row of piles<br>• Crib |
| **Danger Area – 'Foul'** | **YES** | **Sentence case** | • Rocks<br>• Trees<br>• Numerous coral heads |
| **Depth Contour** | **YES** | **CAPS** | • MLLW |
| **Charted Landmark**<br><br>see § 5.6.A, 5.6.D | **YES** (if ATTRIBUTE does not match chart label exactly) | **CAPS** | • CUPOLA<br>• TR<br>• TV TOWER<br>• SOUTH STACK (OF TWO) |
| **Recommended Landmark**<br><br>see § 5.6.E.ii | **YES** (Always) | **CAPS** (No abbreviation) | • CUPOLA<br>• TOWER<br>• WATER TOWER<br>• TANK |
| **Aids to Navigation**<br><br>see § 5.7.B, 5.7.D | **Optional** | **Sentence case** (or as charted) | • G24<br>• Possible new light<br>• AERO (as charted/required) |

4.3. STEREOSCOPIC NEAT MODEL – For the best accuracy, features should be compiled within the limits of the stereoscopic neat model, which is understood to be a rectangular shaped area between adjacent principal points and extending halfway into each sidelap area (see diagram below). Errors caused by image distortion typically increase the closer one compiles to the edge of the stereo model. When compiling features, the compiler should attempt to stay within the limits of the stereoscopic neat model as much as is practical, and shall not compile any features beyond the fiducial marks in an image.




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 would 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 accuracy (see below) shall be equal to or better than the accuracy requirements as defined in the Project Instructions. See SOW Main 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.C). 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 GC, and not necessarily to other compiled features that are less sharply defined. Nevertheless, the actual 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<br>(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 MLLW | More than 1 foot below MLLW |
| Pacific | More than 2 feet above MHW | From exactly 2 feet above MHW to exactly 2 feet below MLLW | More than 2 feet 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. Any additional guidance provided by the NOAA representative is intended to clarify, not supersede the feature compilation guidelines in this SOW document or in the associated Project Instructions. 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 is the most important feature type compiled under this contract.

A. GENERALIZATION AND CONTINUITY – The shoreline may be compiled using any combination of attributes in the Shoreline feature class. Each compiled shoreline vector shall be classified with the most appropriate attribute type according to the rules and guidance provided in this section of the SOW. However, the compilation of very short (less than 0.5 mm at the compilation scale) shoreline features should generally be avoided. For instance, when compiling a stretch of natural shoreline, if a short (<0.5 mm) length of bulkhead (or rip rap, or a minor residential boat ramp, etc.) is encountered, it can usually be ignored. In this case, the natural shoreline should be compiled, without interruption, as though the short piece of bulkhead were not there. In a similar manner, very small horizontal deviations in an irregular (usually rocky) shoreline should be slightly generalized to produce a smoother line, with a level of detail appropriate to the designated Compilation Scale for the area. Unfortunately the subject of cartographic generalization involves a certain amount of subjectivity, and different compilers will naturally make different decisions regarding the amount and nature of the generalization applied. The contractor's quality control, review, and feedback process should help produce a consistent level of detail in the compiled shoreline product, but a reasonable amount of cartographic license will be tolerated.

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 converge 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 (see section 5.15). Adjoining lines shall connect exactly, endpoint to endpoint, typically by snapping the endpoints together during compilation. To avoid unnecessarily short features, adjoining shoreline vectors that were compiled with the exact same attribution (including the Information field) should usually be merged together, unless doing so would result in an extremely long vector containing thousands of vertices. There shall be no duplicate segments, overlapping segments, 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 wide bridges or piers, by overhanging cliffs, trees, buildings, or by shadows cast from any of these features. If, under these conditions, the compiler judges that the shoreline cannot be compiled at the reported level of horizontal accuracy (see 4.6.B above), but it can still be compiled within 30 meters of its true position, then the shoreline should be compiled using the appropriate "Approximate" shoreline code. This "Approximate" 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_Water_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 (including bulkhead, drydock, lock, ramp, rip rap, slipway, and wharf) shall be compiled using the Undetermined__Approximate attribute when the shoreline is obscured (see 5.1.R below). 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 natural shoreline with its longest dimension less than 0.5 mm at the compilation scale is too small to show as a linear shoreline feature, but shall instead be compiled as a bare rock 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 (see 5.11.A). If the bare area does not appear to be composed of solid rock, but rather appears to be of a less consolidated nature, then the islet should still be compiled using the Rock_Bare code, but shall have a description of the area (Marsh islet, Sand islet, Gravel islet, Grass islet, etc.) entered into the Information field.

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 than a sharp contrast. We try to minimize these effects by collecting tide-coordinated black and white infrared (B&W IR) imagery 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/water levels in the images, how the tide has varied over time (rising or falling), and how it varies 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 on 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. 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.

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 is difficult to distinguish from woody vegetation of the more generic Marsh/Swamp types, and sole reliance on aerial imagery for interpretation is generally not recommended. Local knowledge of the area being mapped is the best resource for interpretation of wetland types, but the symbology and labels depicted on the existing NOAA nautical charts, and other ancillary data sources, are often very helpful as well. 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.

ii. Interpretation – When mapping most types of shoreline, the land-water interface is most clearly distinguished using black and white infrared (B&W IR) imagery due to the high reflectivity contrast between dry land and open water in this range of the spectrum. But for Apparent Shoreline the reflectivity signatures between open water and wetland vegetation are not as stark, particularly at high tide levels when the wetland area is at its most inundated. In this case, natural color imagery is usually better for delineating the seaward extent of the vegetation. When B&W IR imagery is available the contractor should take care to adjust the brightness and contrast of the IR imagery to most effectively show the seaward limit of the wetland, and the accompanying natural color imagery shall always be used to supplement the IR imagery.

iii. Application – At the endpoints of an Apparent Shoreline vector, where it connects with another shoreline type, it must also connect with the appropriate 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.

iv. Sliver Marshes – Sometimes wetland plants will be growing in a very narrow strip just along the shore, but with dry higher land a short distance inland. While the seaward limit of vegetation would represent an apparent shoreline, it is generally not desirable to depict these narrow slivers of wetland on the nautical chart. If the compiled wetland extent line would not extend at least 0.5 mm inland (at the compilation scale) from the apparent shoreline, then the wetland area shall be ignored, and the shoreline shall be compiled using a different natural shoreline type.

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 dry docks 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 additional development of the shoreline (such as constructing 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.), by apparent shoreline when the canal is cut through a wetland area, or by Mean High Water shoreline in areas of clear tidal influence.

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 at the land-water interface 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, 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 ocean areas (not lakes or rivers) with 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. The Mean_Water_Level code, as used in the Coastal Mapping Program, should not be misconstrued as representing the Mean Sea Level tidal datum, or any other tidal-datum-based shoreline. Rather it is simply used to delineate the land-water interface at the time of the imagery in these non-tidal ocean areas.

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 does not vary much with the tide level.

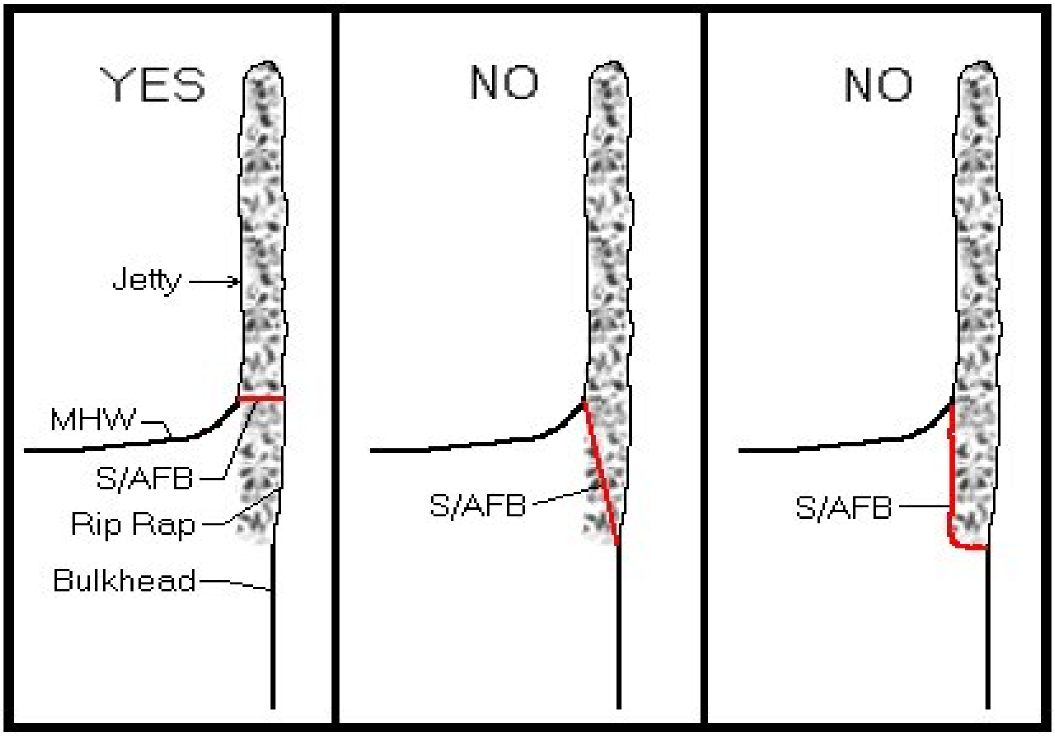
O. RIVER OR STREAM – This code should be used to compile the shoreline of non-tidal rivers and streams which are wide enough to be depicted at scale as double-line features, with a distance of 0.5 mm or more separating the lines at the compilation scale. As stated above (5.1.D.viii), tidal rivers are 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 it 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. Slipways are often associated with Marine Railways (see 5.2.I below).

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 is generally a longer, narrower structure that projects out from the shoreline, on or over the water, to provide berthing space on one or both sides. By its strict definition, a wharf or quay is part of the shoreline, having only one long side running parallel to the general trend of the coast, and which may project out a bit, but normally no more than its width along the shore. That being said, for the purposes of this SOW, a large pier-like structure that projects out from the shore, and appears to be of solid construction down to the base (not of open construction with water underneath), shall be compiled as Wharf_Or_Quay shoreline, as opposed to Pier, even if the feature is labeled as a pier on the nautical chart (see section 5.2.C below).

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. As with “Approximate” shoreline, the compiler should minimize use of “Undetermined” shoreline types as much as possible. For example, if a short length of shoreline is obscured by a narrow bridge or pier (<1.0 mm wide at the compilation scale), then it is usually not necessary to classify the obscured segment as “Undetermined”, especially when the shorelines visible on either side of the obscured area are both of the same type (Bulkhead, Rip Rap, etc.) But if a significant length of shoreline is obscured by a wide bridge or pier (>1.0 mm wide at the compilation scale), then it is often necessary to classify the obscured segment using the Undetermined__Approximate attribute code, especially if the shoreline types are inconsistent on either side of the obscured area, and/or if the shoreline does not appear to pass straight under the alongshore feature in a linear fashion.

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 closed outlines (more than 0.5 mm wide at the compilation scale), 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, coincident with the segment of the Alongshore Feature line compiled along the inland limit of the feature. 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. Note that the vertices of both the Alongshore Feature and S/AFB lines must connect (snap) exactly to each other, and to the compiled shoreline from which it projects. See example diagram below:

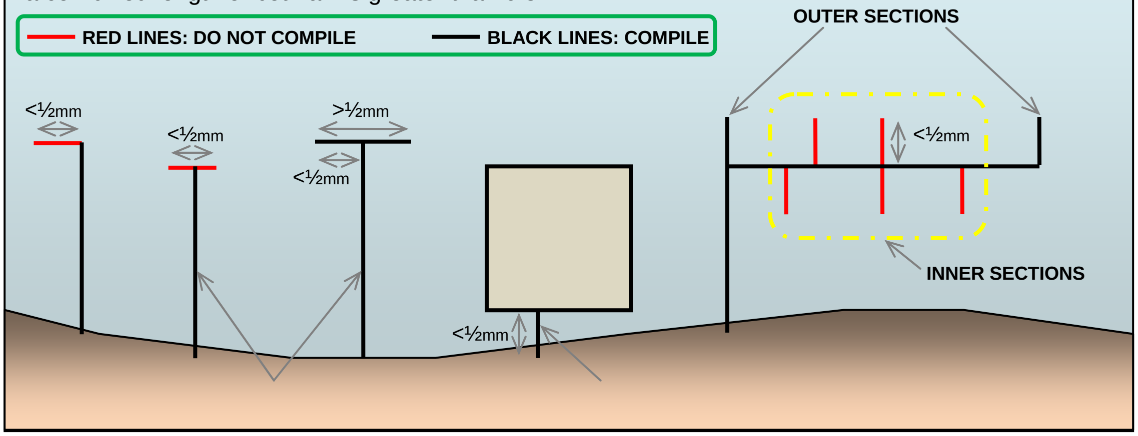



Some large projecting piers also are solid to the ground, with no water flowing and thus no true land-water interface running underneath. But as explained in sections 5.1.Q above and 5.2.C.ii below, these piers shall be compiled as part of the shoreline using the code Wharf_Or_Quay, not as Alongshore Features, and thus do not require an S/AFB line.

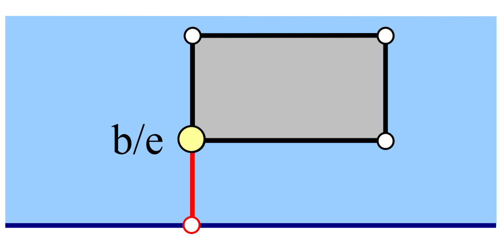
5.2. ALONGSHORE FEATURE – Alongshore Features include various objects constructed in the water near the shore that may cross over the shoreline, abut the shoreline directly, or be completely surrounded by water.

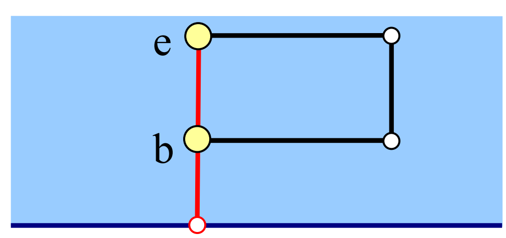
A. WIDTH/LENGTH LIMIT – All alongshore features (except for Marine Railways) may be compiled as either a single line along the center of the object, or as an outline around the perimeter of the object, depending on the width of the feature and the compilation scale. All alongshore features narrower than 0.5 mm at the compilation scale shall be compiled as a single line along the center. Alongshore features of equal or greater width than 0.5 mm at the compilation scale 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. Generally alongshore features with a length less than 0.5 mm at the compilation scale shall not be compiled; though in some cases, distinct sections of a larger structure may need to be compiled, even if they are less than 0.5 mm in length (see diagram below). Any alongshore features that project less than 0.5 mm from the shoreline shall not be compiled. This even applies to very long structures that are parallel to the shoreline. If the furthest point of any part of the feature is still closer than 0.5 mm to the nearest point of shoreline, then the feature shall not be compiled. On the other hand, if any part of the feature is at least 0.5 mm away from the nearest point of shoreline, then the entire structure shall be compiled.

All of these alongshore features project more than 0.5 mm from the shoreline, but contain sections that are less than 0.5 mm in length. Small connector sections shall be compiled. Small outer sections that project seaward from the main structure shall be compiled, but inner sections shall not. Small sections that are parallel to the shore shall not be compiled, except for the end of a T-structure having a combined length of both arms greater than 0.5 mm.




B. CONNECTIVITY – Double-line alongshore features shall have no gaps, dangles, or overlaps. Features consisting of multiple connected sections (such as main piers with one or more attached finger piers) shall be compiled such that the sections snap together exactly at vertices. Alongshore features that meet the shoreline at the same elevation (as opposed to crossing over) shall connect (snap) exactly at vertices on the shoreline to which they are connected. Specific compilation and connectivity rules have been developed for double-line alongshore features to aid NOAA in applying the features, with proper symbolization on the raster nautical chart, and with correct attribution in the Electronic Navigational Chart (ENC). Generally if an alongshore feature (or section of one) is compiled as a closed line that begins and ends at the same point, then it will be considered an area feature surrounding a solid surface. But if a section of an alongshore feature is compiled as an open line, beginning and ending at different points, then it will be considered a narrow perimeter feature surrounding an interior area of open water (see diagrams below).

<table>
<tr><td>Area pier (double-line delineation)</td><td>Perimeter pier (single-line delineation)</td></tr>
<tr><td>

This shows a pier in two sections, including a small linear portion (red) extending from shore and connecting to a larger section (black), which is a solid surface, more than 0.5 mm wide at the compilation scale. The larger section is compiled as one segment beginning (b) and ending (e) at the same vertex, thus representing a polygon.</td><td>

This shows another pier in two sections, although in this case both sections of pier surface are less than 0.5 mm wide. To ensure that the pier is properly symbolized on the chart as “open” (water in the interior) rather than a solid surface, the black segment is intentionally delineated with separate beginning and ending points.</td></tr>
</table>

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. If the compiler has strong reason to believe that a pier is temporary or seasonal, then it should not be compiled; though if permanent piles are visible, which may support the pier, they may need to be compiled as individual piles, or as a linear obstruction.

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 – A large pier of open construction, that crosses over the shoreline may obstruct the compiler's view of the shoreline beneath, and may require the use of an "Approximate" and/or "Undetermined" shoreline feature type (see 5.1.B and 5.1.R) in the obscured area. A large pier of solid construction, which does not have an actual land-water interface running underneath, shall be compiled as shoreline (see 5.1.Q Wharf Or Quay above), and not as an Alongshore Feature – Pier.

iii. Finger Piers – Often a large pier will have a number of smaller "finger piers" extending from it. Most finger piers should only be compiled if their lengths are greater than or equal to the 0.5 mm minimum length for Alongshore Features, and there is at least 0.5 mm separation between them. Though, some small finger piers that project seaward from the outer sections of a larger pier structure should be compiled, even if less than 0.5 mm in length (see diagram in 5.2.A above). If the finger piers are long enough to compile, but are closer together than 0.5 mm, then it will be necessary to compile only a representative selection of them. Usually in this case compiling every other finger pier is sufficient. If the finger piers are obscured by a roof (covered slips) then only the main/central pier should be compiled (see example in 5.8.A.iv – Buildings on Piers below). In cases where structures designed to lift or support boats out of water extend from or are parallel to piers, these should be compiled whenever they meet the compilation specifications above, and the term "Boat lift" should be entered into the Information field.

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 shore, 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 be covered, making it unsuitable as a mooring structure.

v. Pier In Ruins – A pier, or section of a pier, that appears to be dilapidated, often with portions of its surface deck broken or missing, and no longer appears to be used as a functional mooring structure, should usually be compiled as Pier__Ruins. As mentioned above, a pier in ruins may be completely surrounded by water, and may or may not connect to or cross over the shore. A feature compiled with this Pier__Ruins code must be mostly bare at high water. If, on the other hand, pier ruins are visible, but are mostly situated below MHW, then the feature shall be compiled as Obstruction_Linear – Ruins__Undetermined__Covers__Uncovers or Ruins__Undetermined__Submerged, with “Pier ruins” entered into the Information field (see 5.4.K below). A general rule of thumb is if “more water than pier” is visible among the ruins at MHW, then compile it as an Obstruction; but if “more pier than water” is visible, then compile it as an Alongshore Feature. If an area of widely scattered pier ruins is visible in the water, then it should probably be compiled as a Danger_Area – Foul with “Scattered pier ruins” entered into the Information field. Note that this guidance on pier ruins also applies to bridge ruins (see 5.2.E.v below).

D. BREAKWATERS – A breakwater is a structure often 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. Some breakwaters are not associated with harbors, but are constructed just seaward of and parallel to a natural shoreline in order to mitigate erosion, and encourage shore deposition (beach growth) behind the breakwaters. 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 compiler shall only compile bridges that cross over some body of water, including single-line streams or wetlands. The water body does not need to be navigable, but it must be more than a simple drainage culvert. Minor culverts shall be ignored. Bridges must be open underneath, elevated above the surface, with the exception of pontoon bridges which float on the surface of the water body. 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” or “Undetermined” shoreline feature type underneath (see 5.1.B and 5.1.R above).

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. In either case, the compiler shall enter "Bridge support" into the Information field. Make an effort to view the bridge on every image on which it appears, in order to accurately measure the support, and minimize the use of Undetermined__Approximate as much 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.

iii. Opening Bridges – Bridges having sections which open to permit passage of vessels shall have each individual section compiled independently. All sections shall be connected (snapped) at the corner vertices of adjoining sections, and attributed in the following manner:

a. Fixed – Portions of a bridge which are permanently fixed (typically the non-moving sections attached to the shore) shall be compiled as Bridge__Fixed.
b. Opening – The movable section of a bridge that opens, typically the center section, which often allows smaller vessels to pass underneath, but must be opened to allow larger vessels (exceeding a stated vertical clearance) to pass, shall be compiled as Bridge__Opening, except in the case of an opening pontoon bridge (see below). The opening section of a bridge shall always be compiled in the closed position, even if it appears open in the imagery.

iv. Pontoon Bridges – This attribute code shall be used for any bridge, or section of bridge, supported on anchored structures that float on the surface of a water body. Vessels typically cannot pass under sections of bridges supported by pontoons. In cases where a section of a pontoon bridge is able to be moved (floated) open to allow for the passage of vessels, the opening portion shall be compiled (in the closed position) as a separate feature using the same Bridge__Pontoon code as the non-opening portion, but with "Opening section" entered into the Information field.

v. Bridge in ruins – Features compiled using any of the types of bridge "Ruins" codes must be mostly bare (above MHW). Bridge ruins that are mostly below MHW (covers/uncovers or submerged) shall be compiled using the attribute code Ruins__Undetermined, in the Obstruction_Linear class. Follow the same guidance provided for Pier in Ruins (5.2.C.v) above.

F. FENDERS – Fenders are often found under bridges to protect the supporting structure from collisions with vessels; and at the entrances to locks and ferry terminals, to help guide vessels into a narrow opening. 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 and ferry terminals are usually attached to the outer lock or pier 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 often are 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 shall be compiled in the closed position, even if it appears open in the imagery. If a gate is in two parts, then each part shall 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 to 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 a sloping track used for hauling a vessel out of the water, or for lowering a vessel into the water. Typically, the majority of the feature is located landward of the shoreline. Any part of a marine railway that is visible seaward of the shoreline shall be compiled using the Covers__Uncovers_Or_Submerged code, and any part that is landward of the shoreline shall be compiled using the Bare code. In any case, a marine railway shall always be compiled as a single-line along the center of the track, never as an outline (this is an exception to the general width limit specification for Alongshore Features). 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. They are most often located in port areas, where vessel repair and maintenance facilities are commonly available. The sloping shoreline in the vicinity of a marine railway should usually be compiled as a Slipway (see 5.1.P above).

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 or lying on the seabed, not floating. 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. Note that a non-rocky natural islet (small clump of marsh, bare sand bar, etc.) that meets the specifications above for an Obstruction Point may need to be compiled as a bare rock feature, with an appropriate description entered into the Information field (see Section 5.1.C above).

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. If a bare stump is visible, it shall be compiled as a general Obstruction__Bare, with "Stump" entered into the Information field. 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 GC. 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 into 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 within the NOAA Coastal Mapping Program, 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. Nevertheless, 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 (with some exceptions) 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.  A linear obstruction must extend at least 1.0 mm seaward of the shoreline to be compiled.

C.  PLATFORM – Platforms must be separated from the shoreline, and 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 do not fit in the named categories should be collected as Undetermined, with descriptive text entered into the Information field.  A platform in ruins should also include a description of its former function if known.  All platforms shall always be compiled as double-line features (closed outlines) without regard for feature width.  A very narrow feature that extends from or between larger sections of a platform should usually be compiled as a linear obstruction with an appropriate description entered into the Information field ("Berthing structure", "Catwalk", etc.)  A pier shall never extend from a platform.

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 into 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.  This feature type is used for pier and bridge ruins that lie mostly below the MHW datum, and are compiled as covers/uncovers or submerged.

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 GC.

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 only be compiled if they are in the water, at least 0.5 mm (at compilation scale) seaward of the shoreline and any alongshore features.  Any Freestanding Marine Feature closer than 0.5 mm to the shoreline or to an alongshore feature shall be ignored.  Freestanding Marine Features also 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, only the most navigationally significant ones that are at least 0.5 mm from each other should be compiled. A larger group or long row of many Freestanding Marine Features should be delineated by a closed outline around the group, or by an open line along the row, using the Obstruction code (in the Obstruction_Linear class) with the type of feature entered into the Information field (ex. "Row of piles"). 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.

The compiler should generally not compile numerous piles, rows of piles, or pilings, immediately adjacent to or between piers and other alongshore features, even if the piles are more than 0.5 mm from the pier and are spaced at least 0.5 mm apart. Since mariners expect to encounter numerous piles in the vicinity of alongshore features, their inclusion would only create unnecessary congestion of detail on the chart products. In these areas only the most seaward piles that are relatively isolated, hazardous, or otherwise significant, or piles that are already charted should be compiled.

If a Freestanding Marine Feature (such as a pile) is simply functioning as a support structure for an aid to navigation (such as a daybeacon), then the aid to navigation takes precedence and shall always be compiled, while the supporting Freestanding Marine Feature shall be ignored.

Freestanding Marine Features shall always be collected at the top center of the feature. Piles and Stakes can be collected as Bare, Covers/Uncovers, or Submerged; but, except for those in ruins, Dolphins (and Tripodals) can only be collected as Bare. Individual stakes are quite small, and often cannot be seen in aerial imagery.

It is common to encounter Dolphins that are too large to be compiled as point features. A Dolphin having a length equal to or larger than 0.5 mm (in its longest dimension) shall be compiled as a closed outline, using the Bulkhead_Or_Sea_Wall code in the Shoreline feature class, with "Dolphin" entered into the Information field.

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; and Recommending the addition of new landmarks to the chart.

A. CHARTED LANDMARKS – The compiler 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 compiler 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 compiler shall enter the full label, as it is shown on the chart, into the Information field of the compiled landmark, <u>using all uppercase letters</u>. If a charted landmark's label or position does not match the feature in the image, then the compiler shall compile the landmark with the correct position and attributes, and shall make a notation in the Chart Evaluation File (CEF) indicating that the charted position or label is incorrect. When a label is incorrect, the compiler should enter a suggested new label into the Information field that appropriately describes the feature. For any landmarks not found, the compiler shall add an appropriate notation (either Not Confirmed or Gone) to the CEF. Since most landmarks are very prominent features, easily seen in aerial imagery, a landmark that is not found 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 have a label 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:

8 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:

EMPIRE STATE BLDG

But in general proper names are usually only used as secondary names:

BUILDING (RITZ TOWER)

C. ACCURACY, 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:

8 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 (title case) in the primary and secondary names. Only the first letter of the first word would be capitalized (sentence case) for any parenthetical description labels, 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 compiler locates a landmark in the imagery that is shown on the chart with an Approximate or Inexact position symbol, the compiler 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 compiler 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 compiler shall encode 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 compiler shall enter a suggested new label into the Information field (using all uppercase lettering) that appropriately describes the recommended landmark feature. For Water Tower landmarks use "TANK" for the recommended label. Never 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 compiler 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 thought of as an 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 Main Section 3.6 for a link to on-line copies of the Light Lists. An aid to navigation (ATON) which is not established and maintained by the USCG or an equivalent authority (private aid) is identified on the chart by the label “Priv”.

B. REQUIREMENTS – All daybeacons and fixed lights (both public and private) that are shown on the charts and can be identified in the project imagery shall be compiled. Floating aids (buoys, articulated lights), radiobeacons, or fog signals shall not be compiled. The purpose of the requirement to compile ATONs 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 ATON. Aerial imagery alone is not sufficient for the identification of most ATONs, therefore the compiler shall not attempt to compile any new ATONs that are not already shown on the chart or in the Light List. If the compiler strongly suspects that a feature in the imagery is an uncharted fixed light or daybeacon (or fixed channel marker, sign, etc.), then it may be collected as a Freestanding Marine Feature with “Possible new light” or some other such description entered into the Information field. If a charted ATON cannot be verified, or if its position is incorrect, the compiler shall add an appropriate notation to the 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 ATONs 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 ATONs on nautical charts.

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 for 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. Aeronautical Lights shall be compiled using the Marine_Light__Tower code, with "AERO" entered into the Information field (other characteristics of the light should not be entered). The Marine_Light__Tower code shall be used even if the light is mounted on a building. The Marine_Light__Lighthouse feature type shall not be used for Aeronautical Lights.

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 (with "Courtyard" entered into the Information field), so that a correct representation of the building as viewed from above is shown. If a significant 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 compiled, and the compiler shall make an appropriate notation 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.

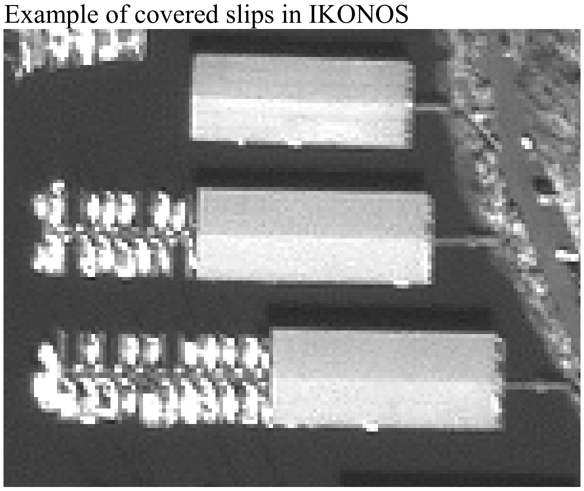
ii. Large Buildings – Large prominent buildings close to the shoreline that are of navigational significance should be collected, especially if they are already shown on the nautical chart. In developed areas most buildings along the shoreline are not navigationally significant, so the compiler will 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.

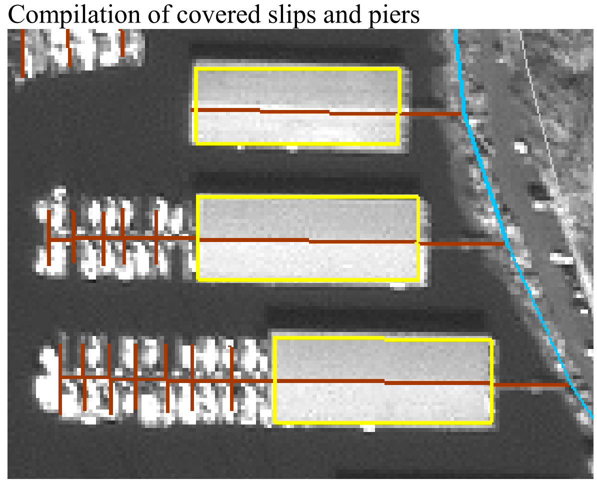
iv. On Piers or Over Water – All buildings constructed on piers or over the water (up on piles), and that fulfill the minimum size requirement, shall be compiled. Often these structures are built to cover boat docking facilities, in which case the feature should be compiled as a building with one of the following entered into the Information field:

- ➢ “Boathouse” – this type of structure typically has walls and a large door, similar to a garage for boats, with the capacity to house 1-2 boats.
- ➢ “Covered Slip” – this structure is usually nothing more than a roof held up by corner supports, with no walls, sheltering a single boat slip or dock.
- ➢ “Covered Slips” – if numerous slips are covered, there is often a network of piers underneath, which cannot be seen; but usually the main/central pier can be assumed to follow a straight line along the middle, and should normally be compiled as in the example below:

Example of covered slips in IKONOS



Compilation of covered slips and piers



Other regular buildings on piers or over the water that do not cover boat slips are not required to have any special nomenclature entered into the Information field. 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. 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, only prominent navigationally significant tanks visible from the water should be compiled. 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 a distinct and separate feature. 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 – Often a water tower will already be depicted as a landmark on the nautical chart (usually with the label "TANK"), or the compiler might recommend one for addition to the chart as a new landmark. In these cases the landmark classification should take precedence, and the water tower should not be compiled as a cultural feature. Compile non-landmark water towers (in the Cultural Feature Miscellaneous class) 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.

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 feet 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 should 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 (including guy wires) 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 navigable water 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 converge, 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 extends at least 1.0 mm seaward of the shoreline 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 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 converge, 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 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 in a similar manner as 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 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. However, the water body behind the dam should be compiled if it contains charted marine facilities, if the shoreline visible in the imagery has changed significantly from that shown on the chart, or if the project instructions indicate that compilation of the water body is required. 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 line cannot substitute for shoreline. Where the face of a dam compiled as a closed outline meets the shoreline, both features shall be compiled as congruent lines. Normally the shoreline feature code Bulkhead_Or_Sea_Wall 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 entered into 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 extend at least 0.5 mm into the water or if they are particularly large and prominent. 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 significant 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 leading to bridges and boat ramps shall be compiled. A small undivided road shall be delineated as a single line 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 at 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 be compiled over or on the bridge, but shall stop at (and snap to) one end of the bridge, and start again on the other side. On the other hand, a road leading toward a boat ramp is not required to continue all the way to the ramp, and it does not need to connect (snap) to the shoreline. 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 leads 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 5.9.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 compile. All railroads that lead to bridges and marine facilities shall be compiled. A railroad leading to a bridge shall stop at (and snap to) one end of the bridge, and start again on the other side. Urban subway, light-rail, and streetcar tracks shall not be compiled unless they lead to a bridge or marine facility. Railroad lines shall be delineated as a single line along the center of the track halfway between the two main rails. Parallel railroad lines 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 in order to provide cartographic continuity with the lines entering or leaving the yard.

D. RAILROAD ABANDONED – Abandoned railroads 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. Abandoned railroads are compiled in a similar manner as active railroads, but only if they are already charted and are visually prominent.

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 and offshore platforms 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.i above for interpretation guidance of the different types. The landward extents 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 bordering it, or between two wetland areas of different types. In the latter case, both extent codes (Marsh/Swamp and Mangrove/Cypress) shall be used to delineate the common border of the adjacent wetlands as two coincident lines. Note that some wetland areas may contain certain reed grasses that are very tall (up to 20 feet) and may appear to be on higher dry land, but are actually part of the wetland, and should be included within the compiled wetland area. The wetland extents line(s) shall connect exactly (snap) to the endpoints of the corresponding apparent shoreline feature, to form a closed polygon. 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 compiled wetland areas should have some portion collected as Apparent Shoreline. If the wetland area is just a sliver along the shore, and does not extend at least 0.5 mm inland (at the compilation scale) from the shoreline, then the wetland shall not be compiled (see section 5.1.E.iv). If the wetland area extends inland beyond the limit of compilation, then the wetland polygon would be cut short, and closed off using a Cartographic Limit line.

B. GLACIER EXTENT – The inland extent of a marine glacier shall be delineated 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 2000 foot limit of compilation, in which case the glacier extent lines should be cut short and the polygon closed off using a Cartographic Limit line. Land-locked glaciers, which do not have a face meeting the sea, shall not be compiled.

C. CLIFF/BLUFF – See the glossary in Attachment F 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 – The two stream type codes (intermittent and perennial) shall be used to depict single-line streams only, that is streams less than 0.5 mm wide at the compilation scale. Streams that are connected to the shoreline, and are at least 0.5 mm wide, are considered to be shoreline themselves and shall be compiled using an appropriate code in the Shoreline class. Use of the Stream code in the Natural_Feature_Miscellaneous class 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 do 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. A stream should generally be compiled as a continuous line, and should not be broken, even when delineated under a possibly obscuring bridge.

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 these two lines are used to indicate the upper and lower extents of a rapids or waterfall area, the portion of the shoreline or stream vector(s) lying 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 shifting 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.

H. 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, and are compiled as areas rather than discrete points. Note that application of all compiled danger area limits to NOAA nautical charts will usually result in any soundings and depth contours that are within the danger area limits being removed from the chart as an indication to the mariner that the area is too hazardous for navigation. Therefore, danger area limits should not be compiled lightly, without careful consideration of the impact on the charted bathymetry.

A. FOUL – Rocks, boulders, coral heads, and various other features can pose a danger to navigation and should be compiled. Where individual dangers to navigation are too closely spaced (at the compilation scale) to be compiled as separate features, then a foul line should be compiled around the area. The longest dimension of a foul area must be at least 1.0 mm long, and the furthest extent of a foul area must be at least 1.0 mm from the shoreline at the compilation scale in order to be compiled. A foul area adjacent to the shoreline can be delineated as an open outline with its ends compiled close to, but not 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. All foul lines shall have the type of obstruction indicated in the Information field, ex. “Rocks”, “Stakes”, “Trees”, etc.

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. The seaward limit is where the relatively flatter and shallower part of a ledge suddenly "drops off" steeply into deeper water. 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.

C. REEF – A reef is a consolidated rocky formation that 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 or coral head. 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 submerged (below the sounding datum), but is relatively shallow, and extends at least 1.0 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, and only when the feature is an impediment to navigation and when there is a significant difference (distinct line) separating the shallower and deeper waters. Shallow lines shall not be used as a substitute for Depth Contour (MLLW) lines in tidal areas, even if tide-coordinated IR imagery is not available.

F. SHOAL – This feature type has similar characteristics to Shallow, except that it is detached from the shoreline. A shoal is always compiled as a closed outline, at least 1.0 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 in the same location on successive images, a hazardous submerged feature 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 1.0 mm in the longest dimension at the compilation scale, and shall extend at least 1.0 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 projects where collection of the MLLW line is required, the Depth_Contour or Depth_Contour__Approximate feature codes shall be used, with "MLLW" entered into the Information field. Normally this feature is only compiled from MLLW tide-coordinated B&W IR imagery, 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 furthest extent of bare ground exposed at low tide is at least

1.0 mm from the shoreline at the compilation scale. This 1.0 mm limit does *not* imply that the MLLW depth contour should not be compiled closer to the shoreline; rather it is intended to prevent the unnecessary delineation of narrow, fringing, low water areas that *never* extend more than 1.0 mm from the shore. Enough of each MLLW depth contour line that is visible in the imagery shall be compiled such that it clearly defines the extent of the corresponding low water area, without ambiguity, even if that requires delineating the line closer than 1.0 mm to the shore. 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 depth contour 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, and of the source imagery from which the features were compiled. No features either part or whole, may be compiled beyond the outermost Cartographic Limit line(s), which, combined, should form a closed polygon around the perimeter of a project area. Features compiled up to a Cartographic Limit line shall connect (snap) to the line.

A. FEATURE LIMIT – Large polygon features on the land (marshes, glaciers, etc.) within the extent of the source imagery, yet extending well beyond the 2000 foot 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 compiler 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. A Feature Limit line shall also be used to delineate the designated boundary of a sub-project area, where the source imagery of the larger acquisition project extends beyond the sub-project area currently being compiled.

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 compiler 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 boundary of the sub-project area or at the limit of source imagery, the endpoints shall connect (snap) to the other respective Cartographic Limit line. There shall be no other features compiled within the extent of a low visibility area.

C. SOURCE DATA LIMIT – The compiler shall delineate the limits of stereoscopic neat model coverage using a Source Data Limit line, thus defining the full geographic extent of a project. If multiple imagery types (color, IR) are used in a project and the extents of coverage significantly differ between the different types, then further Source Data Limit lines shall be used to delineate the limit(s) of each imagery type.

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June, 2010

# 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, as they apply, shall be as follows:

Introduction
Project Design
Field Operations (aerial photography and ground surveys)
Data Processing
Aerotriangulation
Compilation
Quality Control / Final Review
Final Products

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 SSYYNN** where "SSYYNN" is the Project Identifier from the Project Instructions. The fourth line of the report heading shall consist of the project name, taken from the project instructions. Project naming includes locality of the project and the state. See the sample PCRs, included as Annexes.

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. Specify when field operations were conducted. Discuss the data acquisition methodologies, the types of data collected, and the equipment used. This section should also cite any references, manuals, and other materials used for proper execution of acquiring project data. Include a reference to the ground control and aerial photography reports.

4.5 DATA PROCESSING - A brief summary of the data processing (i.e. LIDAR, IFSAR GPS, IMU, etc.) shall include the following for each type of data processed: post mission data reduction procedures, equipment and software used.

4.6 AEROTRIANGULATION - The PCR aerotriangulation summary should describe the procedures used in completion of this phase. Discuss unique requirements related to the project. Specify when aerotriangulation was initiated and completed. The summary 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 state 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. Specify when feature compilation was initiated and completed.

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. For normal photogrammetric projects utilizing aerial imagery, this reported accuracy shall be derived by doubling the computed circular error from the aerotriangulation results.

Create a Data Compilation Sources (DCS) table, which includes the data sources and descriptive information including: the date and time of acquisition (UTC), roll numbers, photo numbers, scale, and the tide/ lake water levels. Include a footnote specifying the tide gauges used in the tide/water level analysis, and mean range of tide or lake datum elevation in the project area.

4.8 QUALITY CONTROL / FINAL REVIEW - Specify when the Quality Control (QC) review was completed. Discuss the quality control process, including the analysis of aerotriangulation results and the interpretation and attribution of features during stereo extraction. Conclude with the evaluation of final products, including assessment of GIS topological connectivity, comparison with NOAA nautical charts and other ancillary data, and creation of the Chart Evaluation File (CEF). List charts used, including editions and scales. Note that the CEF is defined in Attachment AE.

4.9 FINAL PRODUCTS - This section of the report is a listing. The major products typically listed are:

RSD Applications Branch Project Archive
- Hardcopy of Airborne Positioning and Orientation Report (APOR)
- Hardcopy of Aerotriangulation Report
- Hardcopy of the Project Completion Report (PCR)
- Page-size graphic of GC contents, attached to PCR (backpage)

RSD Electronic Data Library:
- GC##### Project Database
- GC##### in shapefile format
- Chart Evaluation File in shapefile format
- Digital Copy of Project Completion Report (Adobe/Word Format)

NOAA Shoreline Data Explorer
- GC##### in shapefile format
- Metadata file for GC#####
- Digital copy of the Project Completion Report (Adobe/Word Format)

ANNEX 1

# NOAA COASTAL MAPPING PROGRAM
# PROJECT COMPLETION REPORT

## *PROJECT NJ0101*

## *Barnegat Inlet to Great Egg Harbor Inlet, New Jersey*

### Introduction

NOAA Coastal Mapping Program (CMP) Project NJ0101 provides a highly accurate database of new digital shoreline data for Atlantic City, New Jersey, and surrounding coastal areas. The project extends from Barnegat Inlet southward to Great Egg Harbor Inlet, New Jersey, and includes a portion of the Intracoastal Waterway.

Successful completion of this project resulted in a densification of the National Spatial Reference System (NSRS), a set of controlled metric-quality aerial photographs, and digital feature data of the coastal zone which complements the Nautical Charting Program (NCP) as well as geographic information systems (GIS) for a variety of coastal zone management applications.

The project database consists of information measured and extracted from aerial photographs and metadata related to photogrammetric compilation. Base mapping was conducted in a digital environment using stereo softcopy photogrammetry and associated cartographic practices.

### Project Design

The Requirements Branch (RB) of the Remote Sensing Division (RSD) formulated the photographic mission instructions for this project following the guidelines of the Photo Mission Standard Operating Procedure Version II (7/1/93). The instructions discussed the project's purpose, geographic area of coverage, scope and priority; photographic requirements; flight line priority; 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.

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

Additional project requirements were submitted by the Office of Coast Survey (OCS) regarding Electronic Navigational Chart (ENC) production which had the effect of increasing the compilation scale and level of feature inclusion.

## Field Operations

The field operations consisted of the collection of static and kinematic GPS data and the acquisition of aerial photographs. The photographic mission operations were conducted from July 21 to July 31, 2001, with the NOAA Cessna Citation II aircraft. Three strips of natural color photographs and four strips of black and white infrared photographs were acquired through use of a Wild RC-30 camera with the NOS "A" lens cone at the nominal scale of 1:30,000. The collection of the B&W Infrared photographs was coordinated with the MLLW tide level, based on predicted tides at the Atlantic City, NJ gauge (#8534720).

A base station was established at the Atlantic City airport using static GPS. Airborne kinematic GPS data was collected to determine precise camera positions in order to establish a control network necessary for aerotriangulation. GPS data collection operations were conducted in accordance with the GPS Controlled Photogrammetry Field Operations Manual (10/25/99). Photo-identifiable ground control was collected to supplement the airborne kinematic GPS.

## GPS Data Reduction

GPS data was processed to provide accurate positions of camera centers for application as photogrammetric control in the aerotriangulation phase of the project, however this data was later deemed unsuitable for the intended purpose and ground control was used instead.

## Aerotriangulation

Routine softcopy aerotriangulation methods were applied to establish the network of precise camera positions and other control for mapping, and to provide model parameters and orientation elements required for digital compilation. This work was initiated by RSD personnel in December 2003 utilizing a Digital Photogrammetric Workstation (DPW), which is a configuration of computer hardware, modular software components and other associated peripheral devices. The color photographs and black and white infrared photographs were measured and adjusted as four separate blocks using BAE Systems' SOCET SET (version 5.2) photogrammetric software in conjunction with the Orientation Management (ORIMA version 6.0) aerotriangulation software. Upon successful completion of the aerotriangulation process, the ORIMA software provided the RMS of the standard deviations of the residuals for each aerotriangulated ground point which were used to compute a predicted horizontal circular error of 2.2 meters for strip 1 of the color photographs and 1.2 meters for the rest of the project photographs based on a 95% confidence level. An Aerotriangulation Report was written and is on file with other project data within the RSD Applications Branch (AB) Project Archive.

The project database consists of project parameters and options, camera calibration data, interior orientation parameters, ground control parameters, adjusted exterior orientation parameters, and positional listing of all measured points. Positional data is referenced to the North American Datum of 1983 (NAD 83).

## Compilation

The data compilation phase of this project was initiated by RSD in February 2004. Digital mapping was performed using a DPW in conjunction with the SOCET SET Feature Extraction software module. Feature identification and attribution within the Geographic Cell (GC) were based on image analysis of 1:30,000 scale photographs and information extracted from the appropriate NOAA nautical charts, US Coast Guard Light List and other ancillary sources. Feature attribution was assigned in compliance with the Coastal Cartographic Object Attribute Source Table (C-COAST), which provides the definition and attribution scheme for the full range of cartographic features pertinent to the CMP. Selected features were further modified with additional descriptive information to refine general classification.

Spatial data accuracies for Project NJ0101 were determined according to standard Federal Geographic Data Committee (FGDC) practices. For the majority of the project, cartographic features were compiled to meet a horizontal accuracy of 2.4 meters at the 95% confidence level. For strip 1 of the color photographs, features were compiled to meet a horizontal accuracy of 4.3 meters at the 95% confidence level. The predicted accuracy of compiled, well defined points is derived by doubling the circular error derived from aerotriangulation statistics.

After data compilation had begun, it was determined that the actual tide levels in the project area, during the time that all of the B&W Infrared photographs were being collected, were well above the predicted levels, outside of the normal ±0.3 foot (0.09 meter) tolerance for delineation of the MLLW line. Therefore, the Infrared photographs were only used to supplement data collection from the color photographs, and the MLLW line was not delineated.

The following table provides information on aerial photographs used in the project completion:

| Date | Time (UTC) | Roll Number | Photo Numbers | Scale (nominal) | Tide Level* |
|---|---|---|---|---|---|
| 7-21-01 | 1432-1439 | 01ACN07 | 1428-1449 | 1:30,000 | 1.0 m |
| 7-27-01 | 1337-1340 | 01ACN07 | 1498-1506 | 1:30,000 | 0.4 m |
| 7-27-01 | 1345-1347 | 01ACN07 | 1507-1515 | 1:30,000 | 0.5 m |
| 7-27-01 | 1252-1259 | 01AR02 | 1457-1481 | 1:30,000 | 0.1 – 0.2 m |
| 7-27-01 | 1311-1314 | 01AR02 | 1485-1495 | 1:30,000 | 0.1 – 0.3 m |
| 7-31-01 | 1509-1521 | 01AR02 | 1538-1562 | 1:30,000 | 0.4 – 0.1 m |
| 7-31-01 | 1529-1534 | 01AR02 | 1563-1573 | 1:30,000 | 0.4 – 0.3 m |

* Tide levels are given in meters above MLLW and are based on actual observations at the Atlantic City station, and at various substations throughout the project area with corrections applied from the Sandy Hook, NJ reference station. The mean tide range in the project area varied between 0.2m and 1.2m.

## Quality Control / Final Review

Quality control tasks were conducted during all phases of project completion by a senior member of AB. The final QC review was completed in June 2005. The review process included analysis of aerotriangulation results and assessment of the identification and attribution of digital feature data within the GC according to image analysis and criteria defined in C-COAST. The quality control process concluded with an inspection of topological connectivity within the GC using ArcGIS 9.1 software. All project data was evaluated for compliance to CMP requirements.

Comparisons of the largest scale NOAA nautical charts with natural color photographs and compiled project data resulted in creation of the Chart Evaluation File (CEF). The following nautical charts were used in the comparison process:

12316, Little Egg Harbor to Cape May, NJ, 1:40,000 scale, $29^{th}$ edition
12324, Sandy Hook to Little Egg Harbor, NJ, 1:40,000 scale, $30^{th}$ edition

## End Products and Deliverables

The following specifies the location and identification of the products generated during the completion of this project:

**RSD Applications Branch Archive**

- Hardcopy of the Airborne Positioning and Orientation Report (APOR)
- Hardcopy of the Aerotriangulation Report
- Hardcopy of the Project Completion Report (PCR)
- Page-size graphic plot of GC10556 file contents, attached to PCR

**Remote Sensing Division Electronic Data Library**

- Project database
- GC10556 in shapefile format
- Digital copy of the PCR in Adobe PDF format
- CEF in shapefile format

**NOAA Shoreline Data Explorer**

- GC10556 in shapefile format
- Metadata file for GC10556
- Digital copy of the PCR in Adobe PDF format

## End of Report

ANNEX 2

# NOAA COASTAL MAPPING PROGRAM
# PROJECT COMPLETION REPORT

## *PROJECT PR0804*

## *Approaches to San Juan, Puerto Rico*

## Introduction

NOAA Coastal Mapping Program (CMP) Project PR0804 provides a highly accurate database of new digital shoreline data for the coastal areas of Puerto Rico in the vicinity of San Juan, between Punta Fraile in the west and Laguna de Pinones in the east.

Successful completion of this project resulted in a densification of the National Spatial Reference System (NSRS), a set of controlled metric-quality aerial photographs, and digital feature data of the coastal zone which complements the Nautical Charting Program (NCP) as well as geographic information systems (GIS) for a variety of coastal zone management applications.

The project database consists of information measured and extracted from digital aerial images and metadata related to photogrammetric compilation. Base mapping was conducted in a digital environment using stereo softcopy photogrammetry and associated cartographic practices.

## Project Design

Project PR0804 was designed per a request from the Navigation Services Division (NSD) of the Office of Coast Survey (OCS) to provide new shoreline to support the creation of a new 1:20,000 scale nautical chart covering the approaches to San Juan Harbor. The Requirements Branch (RB) of the Remote Sensing Division (RSD) formulated the photographic mission instructions for this project following the guidelines of the Photo Mission Standard Operating Procedure. The instructions discussed the project's purpose, geographic area of coverage, scope and priority, image requirements, flight line priority, 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. RB created a Project Layout Diagram, flight maps and input files for the aircraft's flight management system.

## Field Operations

The field operations consisted of the collection of kinematic Global Positioning System (GPS) and Inertial Measurement Unit (IMU) data and the acquisition of digital aerial imagery. The photographic mission operations were conducted on April 09, 2008, with the NOAA Cessna Citation II (N52RF) aircraft. All imagery was acquired through the use of an Applanix DSS-439 dual camera system (RGB/IR) with dual 60 mm lenses at an approximate ground sample distance (GSD) of 0.34 meters. The project consisted of three flight lines, with 114 images acquired by each camera. All imagery was flown in coordination with the MLLW tide stage.

Airborne kinematic GPS/IMU data was collected to determine precise camera positions and orientations in order to establish a control network necessary for aerotriangulation. Data collection operations were conducted in accordance with the GPS Controlled Photogrammetry Field Operations Manual. No ground control survey operations were required for this project.

## GPS Data Reduction

GPS and IMU data was processed by RSD personnel to provide precise positions of camera centers for application as photogrammetric control in the aerotriangulation phase of project completion. The airborne kinematic data was processed using Applanix POSPAC (ver. 4.4) software in May 2008. For further information refer to the Airborne Positioning and Orientation Report (APOR) on file with other project data within the RSD Applications Branch (AB) Project Archive.

## Aerotriangulation

Routine softcopy aerotriangulation methods were applied to establish a network of precise camera positions and other control for mapping, and to provide model parameters and orientation elements required for digital compilation. This work was initiated by RSD personnel in September 2009 utilizing a Digital Photogrammetric Workstation (DPW), which is a configuration of computer hardware, modular software components, and other associated peripheral devices. The digital images were measured and adjusted as a single block using BAE Systems SOCET SET (version 5.4.1) photogrammetric suite in conjunction with the Multi-Sensor Triangulation (MST) software module. Upon successful completion of the aerotriangulation process, the MST software provided the standard deviations for each aerotriangulated ground point, which were used to compute a predicted horizontal circular error of 0.50 meters based on a 95% confidence level. An Aerotriangulation Report was written and is on file with other project data within the RSD Project Archive.

The project database consists of project parameters and options, camera calibration data, interior orientation parameters, ground control parameters, adjusted exterior orientation parameters, and positional listing of all measured points. Positional data is referenced to the North American Datum of 1983 (NAD 83).

## Compilation

The data compilation phase of this project was initiated by RSD in October 2009. Digital mapping was performed using a DPW in conjunction with the SOCET SET Feature Extraction software module. Feature identification and attribution within the Geographic Cell (GC) were based on image analysis of the aerial photographs and information extracted from the appropriate NOAA nautical charts, US Coast Guard Light List, and other ancillary sources. Feature attribution was assigned in compliance with the Coastal Cartographic Object Attribute Source Table (C-COAST), which provides the definition and attribution scheme for the full range of cartographic features pertinent to the CMP. Selected features were further modified with additional descriptive information to refine general classification.

Spatial data accuracies for PR0804 were determined according to standard Federal Geographic Data Committee (FGDC) practices. Cartographic features were compiled to meet a horizontal accuracy of 1.0 meters at the 95% confidence level. This predicted accuracy of compiled, well defined points is derived by doubling the circular error calculated from the aerotriangulation statistics.

The following table provides information on the digital imagery used in the project completion:

| Date | Time (UTC) | Roll Number | Photo Numbers | GSD (Nominal) | Tide Level* |
|---|---|---|---|---|---|
| 04-09-08 | 19:32-19:37 | 08NC03 | 0669-0699 | 0.34 m. | -0.03 |
| 04-09-08 | 19:40-19:47 | 08NC03 | 0700-0750 | 0.34 m. | -0.04 |
| 04-09-08 | 19:52-19:56 | 08NC03 | 0751-0782 | 0.34 m. | -0.05 |
| 04-09-08 | 19:32-19:37 | 08NR02 | 0300-0330 | 0.34 m. | -0.03 |
| 04-09-08 | 19:40-19:47 | 08NR02 | 0331-0381 | 0.34 m. | -0.04 |
| 04-09-08 | 19:52-19:56 | 08NR02 | 0382-0413 | 0.34 m. | -0.05 |

*Tide levels are given in meters above MLLW and are based on verified observations recorded by the NOS gauge at San Juan, PR. The height of Mean High Water at the San Juan gauge is 0.40 m.

## Quality Control / Final Review

Quality control tasks were conducted during all phases of project completion by a senior member of AB. The final QC review was completed in January 2010. The review process included analysis of aerotriangulation results and assessment of the identification and attribution of digital feature data within the GC according to image analysis and criteria defined in C-COAST. The quality control process concluded with an inspection of topological connectivity within the GC using ArcGIS 9.2 software. All project data was evaluated for compliance to CMP requirements.

Comparisons of the largest scale NOAA nautical charts with natural color digital images and compiled project data resulted in creation of the Chart Evaluation File (CEF). The following nautical charts were used in the comparison process:

25668, North Coast of Puerto Rico, PR, 1:100,000, 20th Ed., Oct. 2008
25670, Bahia de San Juan, PR, 1:10,000, 43rd Ed., Jul. 2005

## End Products and Deliverables

The following specifies the location and identification of the products generated during the completion of this project:

**RSD Applications Branch Archive**

- Hardcopy of the Airborne Positioning and Orientation Report (APOR)
- Hardcopy of the Aerotriangulation Report
- Hardcopy of the Project Completion Report (PCR)
- Page-size graphic plot of GC10797 file contents, attached to PCR

**Remote Sensing Division Electronic Data Library**

- Project database
- GC10797 in shapefile format
- Digital copy of the PCR in Adobe PDF format
- Chart Evaluation File in shapefile format

**NOAA Shoreline Data Explorer**

- GC10797 in shapefile format
- Metadata file for GC10797
- Digital copy of the PCR in Adobe PDF format

## End of Report

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Feb.1, 2011

# ATTACHMENT M
# COASTAL MAPPING PROGRAM 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 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.  Synonym bridge pier. (11)

**accepted values (tide)** - Tidal datums and Greenwich high and low water intervals obtained through primary determination or comparison of simultaneous observations made with a control tide station in order to derive the equivalent value that would be obtained with a 19-year series. (8)

**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 with one or more GPS receiver(s) on the ground, 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, geodetic control, navigation aid, 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 geodetic monument carrying a mark whose azimuth from a given point is known either by measurement or by definition. (14)

**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 who's elevation above or below an adopted datum has been established. It is usually monumented to include bench mark name or number, date, 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 process 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 *map* designed for use in navigation, especially a nautical chart or an aeronautical chart. (14)

**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 Nautical Data 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. This print has been replaced by the Chart Evaluation File (CEF) and is no longer used.

**chart comparison print** – A marked-up copy of the largest scale nautical chart of the project area. The Print is used by the compiler to identify charted features to be investigated, to mark charted features found and not found, and to mark changes to features.

**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 cannot be confirmed photogrammetrically, or whose size, shape, orientation or position appear to have changed significantly from the current chart portrayal.  This is a GIS file (ESRI shapefile) with pre-defined attributes.

**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 1985. In 1985, 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). NOAA became the successor to ESSA in 1970. The National Ocean Survey was a component of the National Oceanic and Atmospheric Administration (NOAA). 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 digital or traditional paper map, chart, or related product from remote sensors (aerial, satellite; photographs, LIDAR, IFSAR, etc.) 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 (survey mark) 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 (GMT). 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 arc** - An arc having the same polygon on both its left and right sides and having at least one node that does not connect to any other arc. It often occurs where a polygon does not close properly, where arcs do not close properly (an undershoot), or were an arc was digitized past its intersection with another arc (an overshoot). A dangling arc is not always an error; for example, it can represent a cul-de-sac in a street network. (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 the GPS 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, survey** - 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 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, map** – The process of altering, adapting, or refining attribute or spatial data in its preliminary stages to ensure accuracy, completeness, and conformity to a standard.

**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 ('Ω, Φ, and K) 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 various types of natural and human-made phenomena from remotely-sensed images. (27)

**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 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 was 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** – To georeference something means to define its existence in physical space. That is, establishing its location in terms of map projections or coordinate systems. The term is used both when establishing the relation between raster or vector images and coordinates but also when determining the spatial location of other geographical features. Examples would include establishing the correct position of an aerial photograph within a map or finding the geographical coordinates of a place name or street address. This procedure is thus imperative to data modeling in the field of geographic information systems (GIS) and other cartographic methods. When data from different sources need to be combined and then used in a GIS application, it becomes essential to have a common referencing system. This is brought about by using various georeferencing techniques. Most georeferencing tasks are undertaken either because the user wants to produce a new map or because they want to link two or more different datasets together by virtue of the fact that they relate to the same geographic locations. (28)

**Global Navigation Satellite System (GNSS)** – GNSS is a standard term for world-wide navigation and positioning systems using satellites. As of 2010, these systems include the U.S.’ Global Positioning System, the Russian GLONSS, China’s COMPASS, the European Union’s Galileo, India’s IRNSS, and Japan’s QZSS, all in different stages of development.

**Global Positioning System (GPS)** - A navigation and positioning system, consisting of 24 or more 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 World Geodetic System 1984 (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)

**Global Reference System 1980 (GRS 80)** – GRS 80 is the reference ellipsoid adopted by the XVII General Assembly of the International Union of Geodesy and Geophysics in December 1979.

**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)

**Gravity for the Re-definition of the American Vertical Datum (GRAV-D)** - GRAV-D is an ambitious project initiated by the National Geodetic Survey of NOAA to collect and monitor gravity data suitable for the re-definition of the vertical datum of at least the United States, if not for the entire North American continent. The GRAV-D project consists of three major campaigns: (1) High-resolution "snapshot" of gravity (predominantly airborne campaign); (2) Low-resolution "movie" of gravity (episodic re-visits of absolute gravity sites; and (3) Regional partnership surveys . See: http://www.ngs.noaa.gov/GRAV-D/ .

**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** – Narrow, roughly shore-normal structure built to reduce longshore currents, and/or to trap and retain littoral material. Most groins are of timber or rock and extend from a SEAWALL, or the backshore, well onto the foreshore and rarely even further offshore. See also "jetty".

**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; also an orthometric height.

**horizontal control** - See "control, horizontal".

**horizontal datum** – A set of *constants* specifying the *coordinate* system used for geodetic control, i.e., for calculating coordinates of points on the Earth. At least eight constants are needed to form a *complete datum*: three to specify the location of the origin of the coordinate system, three to specify the orientation of the coordinate system, and two to specify the dimensions of the reference ellipsoid. (14)

**Horizontal Time Dependent Positioning (HTDP)** - The HTDP software enables users to predict horizontal displacements and/or horizontal velocities related to crustal motion in the United States and its territories. The software also enables users to update positional coordinates and/or geodetic observations to a user-specified date.

**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 local disturbances effecting a 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 sensor that acquires data in a large number of very narrow, contiguous spectral bandpass channels, such as the AVIRIS with 224 spectral bands. While some definitions attempt to distinguish hyperspectral imagers from multispectral imagers based on some defined number of spectral bands, a better, if somewhat less concrete, distinction is that hyperspectral data enable the techniques and algorithms of imaging spectroscopy to be applied.

**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.

**Inertial Measuring Unit (IMU)** – An IMU is a navigation device that utilizes accelerometers and a computer to determine the position, orientation, and velocity of the device the IMU is mounted upon. IMUs are often used with airborne remote sensing devices to continuous monitor their orientation.

**Infrared (IR) 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”.

**International Terrestrial Reference Frame (ITRF)** - The International Terrestrial Reference System (ITRS) is a world spatial reference system co-rotating with the Earth in its diurnal motion in space. The International Earth Rotation and Reference Systems Service (IERS), in charge of providing global references to the astronomical, geodetic and geophysical communities, supervises the realization of the ITRS. Realizations of the ITRS are produced by the IERS ITRS Product Center (ITRS-PC) under the name International Terrestrial Reference Frames (ITRF). ITRF coordinates were obtained by combination of individual TRF solutions computed by IERS analysis centers using the observations of Space Geodesy techniques : GPS , Very Long Baseline Interferometry (VLBI) , Satellite Laser Ranging (SLR), Lunar Laser Ranging (LLR) and Doppler Orbitography and Radiopositioning Integrated by Satellite (DORIS). They all use networks of stations located on sites covering the whole Earth. (26)

**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** – On open coastline, a structure extending into a body of water, which is designated to prevent shoaling of a channel by littoral material and to and to direct and confine the stream or tidal flow. Jetties are built at the mouths of rivers or tidal inlets to help deepen and stabilize a channel. See also “groin”.

**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 (K)** - In the exterior orientation of a photograph, the rotation about the z-axis.

**Kinematic GPS (KGPS)** – KGPS is a surveying technique based on carrier phase GPS measurements of satellite signals. The method requires a GPS receiver over a known survey point and then enables the user to position moving GPS receivers.

**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)

**linear least squares transformation** -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)

**lock** - 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.

**longitude** - 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.

**low water** - 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.

**Low Water Datum (LWD)** - 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.

**Lower Low Water (LLW)** - 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.

**Lower Low Water Datum (LLWD)** - 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.

**lunar day** - 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)

**marina** - A harbor facility for small boats, yachts, etc. where supplies, repairs, and various services are available.

**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 MHW and MLW.

**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 imager** – A imaging sensor that can 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 1983 through 2001. It is reviewed annually for possible revision and must be actively considered for revision every 20 - 25 years. Tidal datums in certain regions with anomalous sea level changes (Alaska, Gulf of Mexico) are calculated on a Modified 5-Year Epoch.

**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)** – NOS is a Line Office of NOAA. Disks inscribed with this NOS name were set from about 1983 to the present, generally for third-order surveys and as tidal bench marks.

**National Ocean Survey (NOS)** – National Ocean Survey is the older name for the National Ocean Service, NOAA. Disks inscribed with this NOS name were set from about 1970 to about December, 1982 when the name was changed, generally for third-order surveys and as tidal bench marks.

**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 station MEADES RANCH in Kansas. Based on the Clarke spheroid of 1866, the geodetic position of triangulation station 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. A national readjustment was completed in 2007 and named NAD 83(NSRS 2007). This readjustment, using all available GPS data archived in the NGS database, also allows for the computation of local and network accuracies for each mark. (15 and 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 (Ω)** -In the exterior orientation of a photograph, the rotation about the x-axis.

**On-line Positioning User Service (OPUS)** – OPUS is NGS' on-line GPS data processing service that provides GPS users easier access to the NSRS. OPUS allows users to submit their GPS data files to NGS, where the data will be processed to determine a position using NGS computers and software. Each data file that is submitted will be processed with respect to 3 CORS sites. The sites selected may not be the nearest to the user's site but are selected by distance, number of observations, site stability, etc. The position for the user's data will be reported back via email in both ITRF and NAD 83 coordinates as well as UTM, USNG and State Plane Coordinates (SPC) northing and easting. Several versions of OPUS exist or are being developed including: OPUS Static (S), OPUS Rapid Static (RS), OPUS-Data Base (DB), OPUS Projects, and OPUS GIS.

**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 (Φ)**- 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/or 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)

**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; A sensor made up of a linear detector array of CCDs (Charge Coupled Device) that obtains data in the platform's direction of motion (azimuth or along-track dimension). The sensor's instantaneous field of view extends the length of the swath width. (19)

**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-1 and -2 are Canadian Earth observation satellites developed to monitor the environment. RADARSAT-1 had a planned lifetime of five years when launched in 1995, but has lasted much longer. RADARSAT-2 was launched in December, 2007. They are 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.

**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".

**Real Time Kinematic (RTK)** - **Real Time Kinematic** (RTK) satellite navigation is a technique used in surveying based on the use of carrier phase measurements of GNSS signals where a single reference station provides real-time corrections to a few centimeters of accuracy.

**Real Time Network (RTN)** – A RTN is a collection of permanently mounted **GNSS** receivers that operate 24/7 collecting data from GNSS satellites and communicating data corrections that are interpolated to the site of authorized network users. These updates enable the users to determine positions with their GNSS receiver at longer distances much more accurately than without the Network.

**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 generally 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. It is 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.

**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; adjusting the coordinates of points in a dataset by stretching, shrinking, etc. to match a few known points.

**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” in Attachment F.

**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.

**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.

**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.  See:
http://www.ngs.noaa.gov/PUBS_LIB/ManualNOSNGS5.pdf .

**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 and 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, acoustic, 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, tidal bench marks, and communication devices. See: http://oceanservice.noaa.gov/education/kits/tides/tides09_monitor.html .

**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 Grid (USNG)** - USNG is an alpha-numeric point reference system that has been overlaid on the Universal Transverse Mercator (UTM) numerical grid.  Every modest size home in a discrete area can be described using 8-digits (e.g., 1234 5678).  By adding a two-letter prefix (e.g., XX 1234 5678), the location is identified regionally (state-wide).  This alpha-numeric designator can be used today with many consumer GPS receivers costing less than $100.

**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 and direction commonly represented by the coordinates 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)

**<u>Sources of Definitions</u>**


1. **<u>Definitions of Surveying and Associated Terms</u>**, American Congress on Surveying and Mapping (ACSM), and the American Society of Civil Engineers. Washington: 1978 (new edition of 2005 available from ACSM)

2. **<u>Manual of Photogrammetry</u>**, Paul R. Wolf, ed. 4th ed. American Society of Photogrammetry, Chapter 19, Definitions of Terms and Symbols Used in Photogrammetry," pp. 995-1045. Falls Church: 1980. (Fifth Edition of 2004 available from American Society of Photogrammetry and Remote Sensing.)

3. **<u>Definitions of Terms Used in Geodetic and Other Surveys</u>**, Special Publication No. 242, Hugh C. Mitchell, U.S. Coast and Geodetic Survey, U.S. Department of Commerce, Washington: U.S., Government Printing Officer, 1948, see: http://docs.lib.noaa.gov/rescue/cgs_specpubs/QB275U35no2421948.pdf .

4. **<u>Shore and Sea Boundaries</u>**; With Special Reference to the Interpretation and Use of Coast and Geodetic Survey Data, Vol. 1, Publication 10-1, Aaron L. Shalowitz, U.S. Coast and Geodetic Survey, U.S. Department of Commerce, Appendix A, "Glossary of Terms Used", pp. 279-322, Washington: U.S. Government Printing Office, 1962. (All three volumes available on-line at: http://www.nauticalcharts.noaa.gov/hsd/shalowitz.html .)

5. **<u>Hydrographic Survey Glossary</u>**, Hydrographic Survey Guideline No. 43, National Ocean Service, U. S. Department of Commerce, Rockville, 1985.

6. **<u>Nautical Chart Manual</u>**, Volume 2: Definitions, Abbreviations, Symbology & References, Seventh (1992) Edition, U.S. Coast and Geodetic Survey, U.S. Department of Commerce, 1992.

7. **<u>The Final Report of the Nautical Charting Division Data Management Policy Committee</u>**, Appendix A. "Glossary." Rockville, 1984.

8. **<u>Tide and Current Glossary</u>**, Stacy D. Hicks, National Ocean Survey, U.S. Department of Commerce, Rockville: 1983. (On-line: http://tidesandcurrents.noaa.gov/publications/glossary2.pdf )

9. **<u>Definitions of Some National Ocean Survey Terms</u>**, Walter S. Simmons, Rockville, 1982.

10. **<u>Coastal Mapping Handbook</u>**, Melvin Y. Ellis, ed., U.S. Department of Commerce and U.S. Department of Interior, "Glossary." pp. 103-113, U. S. Government Printing Office, Washington D.C., 1978.

11. **<u>Webster's II New Riverside University Dictionary</u>**, 1st ed. Boston: Houghton Mifflin Co., 1984.

12. **Military Handbook; Glossary of Mapping, Charting, and Geodetic Terms**, U.S. Department of Defense, NIMA, January 21, 1994, (on-line: http://www.everyspec.com/MIL-HDBK/MIL-HDBK+%280800+-+0999%29/MIL_HDBK_850_1758/

13. **SOCET SET User's Manual**, Version 5.4.1, October 2007, Appendix A - Glossary

14. **Geodetic Glossary**, National Geodetic Survey, NOAA, U.S. Department of Commerce, September, 1986.

15. **WWW Homepage**, National Geodetic Survey: http://www.ngs.noaa.gov .

16. **DOD Dictionary of Military Terms**, U.S. Department of Defense, (on-line: http://www.dtic.mil/doctrine/dod_dictionary/

17. **ISRI GIS Dictionary** - http://support.esri.com/index.cfm?fa=knowledgebase.gisDictionary.gateway

18. **American Practical Navigator**, by N. Bowditch, NIMA, U.S. Department of Defense, Glossary, 1995, (on-line: http://msi.nga.mil/NGAPortal/MSI.portal?_nfpb=true&_pageLabel=msi_portal_page_62&pubCode=0002

19. **Remote Sensing Glossary**, Canadian Centre for Remote Sensing, Canadian Department of Natural Resources, (on-line: http://www.ccrs.nrcan.gc.ca/glossary/index_e.php )

20. **Surveying Measurements and their Analysis**, R.B. Buckner, 1983.

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22. **Photogrammetry**, $2^{nd}$ Ed., Francis H. Moffitt, International Textbook Co., Scranton Pa., 1967, p 337.

23. **Hydrographic Dictionary**, Special Publication 32, Fifth Ed., International Hydrographic Organization, 1994. (Now available on-line inter-actively at: http://www.iho-ohi.net/cgi-bin/cms/search.cgi?link=static&DATA=&search=dictionary

24. **Glossary of the Mapping Sciences**, American Society of Civil Engineers, American Congress on Surveying and Mapping, and the American Society for Photogrammetry and Remote Sensing, 1994.

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26. The **International Terrestrial Reference Frame** website at: http://itrf.ensg.ign.fr/ .

27. **ERDAS Field Guide**, Volume Two, August 2008.
http://www.educationgis.com/2009/02/download-free-version-erdas-field-guide.html#

28. **Wikipedia.**

**29. USACE Coastal Engineering Manual** Appendix A – Glossary of Coastal Terminology.
http://140.194.76.129/publications/eng-manuals/ and scroll down.

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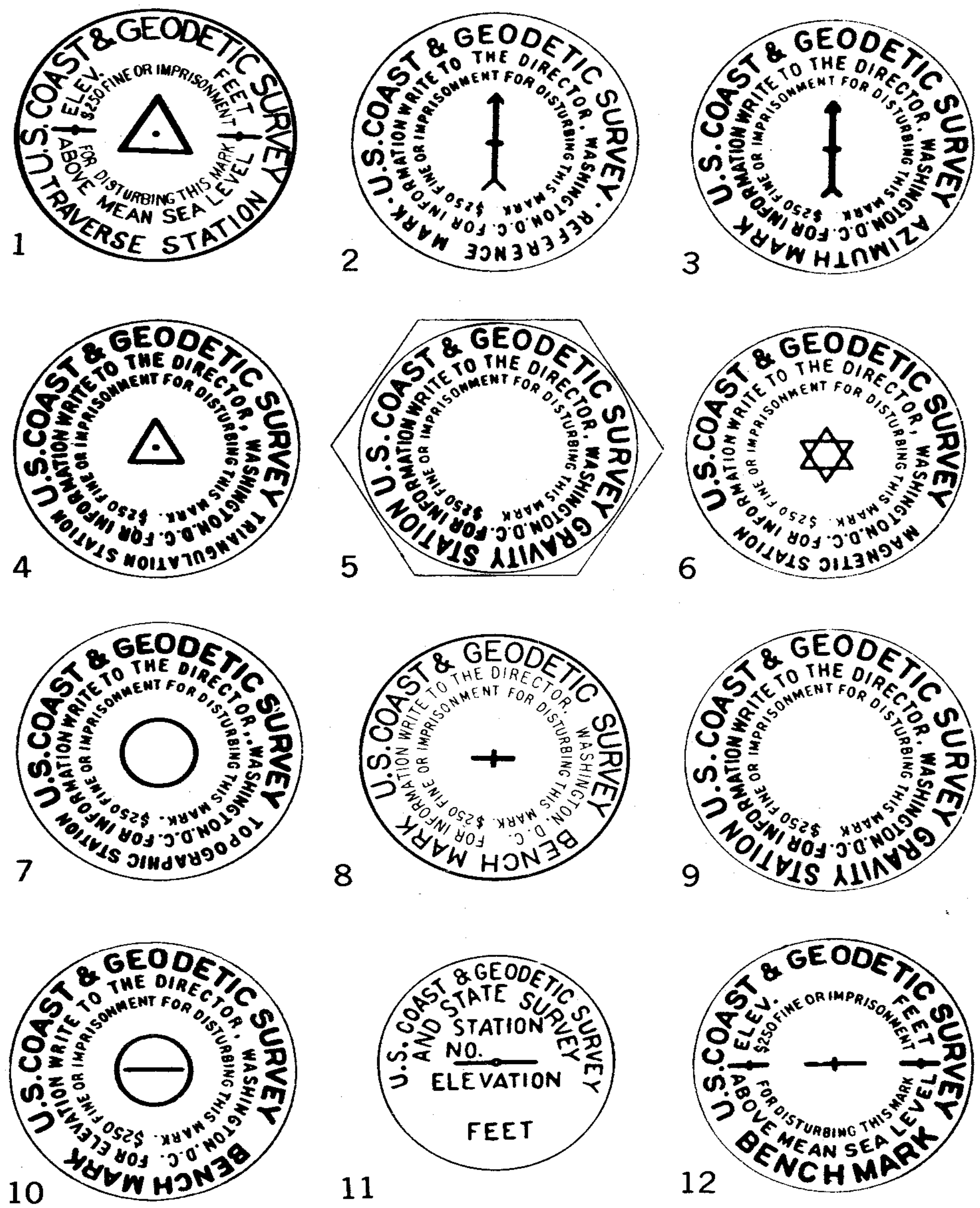
March 30, 2009

# ATTACHMENT N
# SURVEY DISK DIAGRAMS

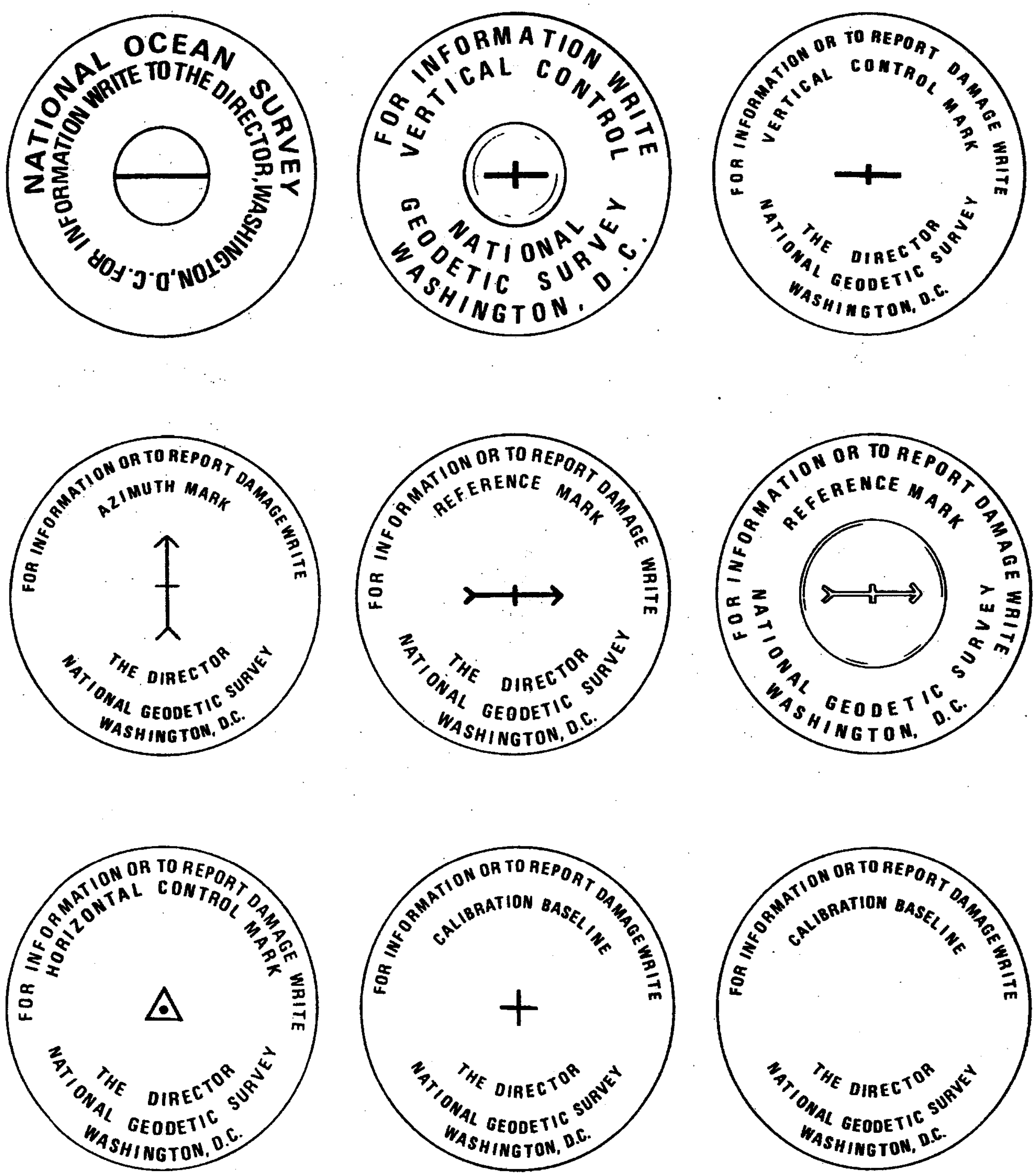
TO
SCOPE OF WORK FOR SHORELINE MAPPING
UNDER THE
NOAA COASTAL MAPPING PROGRAM

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

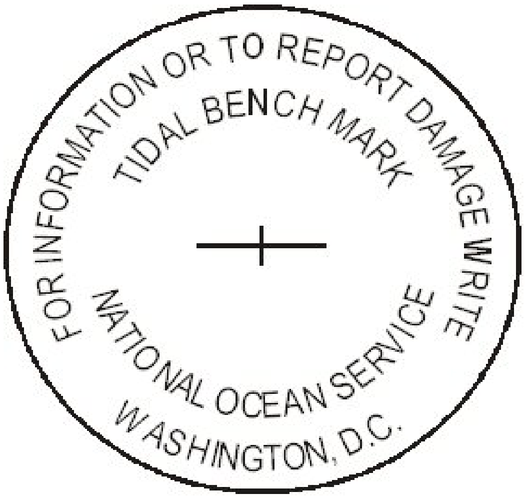



**1.** Traverse station mark.
**2.** Reference mark.
**3.** Azimuth mark.
**4.** Triangulation station mark.
**5.** Gravity station mark (old type).
**6.** Magnetic station mark.
**7.** Topographic station mark.
**8.** Geodetic bench mark (new type).
**9.** Gravity station mark (new type).
**10.** Tidal 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**

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Feb. 1, 2011

# 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

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ATTACHMENT O: GROUND PHOTO CONTROL PAGE

# ATTACHMENT O:  GROUND PHOTO CONTROL

1.  INTRODUCTION - Ground photo control is used to help establish scale, azimuth, and a coordinate system.  For photography, pre-marked photo panels or photo identified control points may be used.  Obtain property owner permission before any work.  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, and Attachment P.

1.1.  CHECK POINTS - For shoreline mapping projects under this Scope Of  Work (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 Project Instructions may require Global Positioning System (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 Report.   Note, it is recommended that at each of the four locations, multiple points be located.

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 - All remotely sensed imagery (including color and infrared) for the Coastal Mapping Program (CMP) shall be positioned using airborne Kinematic GPS (KGPS) with dual-frequency, carrier-phase measurements.  The use of an Inertial Measurement Unit (IMU) is recommended but not required.  The Contractor shall use at least four check points (Section 1.1, above) and may use additional ground control (Section 1.2, above).  See also MOP, Fifth Edition, pages 1112-1113.

1.4.  GROUND CONTROL ONLY USED - For 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.  These projects performed 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. Additional requirements for airport control may be specified in the Project Instructions.

1.5 NGS FORMS – The required forms and photographs are listed in Attachment Q, Horizontal Control Forms.

2. CONTROL RECOVERY - All surveys shall be tied to the National Spatial Reference System (NSRS) using at least two points (Continuously Operating Reference Stations (CORS) and/or survey marks). The specified datums are the North American Datum of 1983 (NAD 83) and the North American Vertical Datum of 1988 (NAVD 88). See Attachment AG for guidance on recovering existing survey marks.

2.1. CONTINUOUSLY OPERATING REFERENCE STATION (CORS) TIES - NGS recommends that all surveys be tied to the NSRS by using the CORS system. No recovery is required for CORS. See the CORS map on the NGS www site at: http://www.ngs.noaa.gov/CORS/ . Note, National CORS and Cooperative CORS have now been combined into NGS CORS.

2.2. SURVEY MARK TIES - . If CORS are not used, the next priority for tie stations are those included in the NAD 83(NSRS 2007) readjustment (see: http://www.ngs.noaa.gov/NationalReadjustment/ ). If the NSRS tie is done through other NSRS survey marks, the marks shall be at least second-order horizontal and third-order vertical. For all non-CORS stations recovered, NGS 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 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.

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 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. Note, this on-line system does not allow entry of new station descriptions nor photographs at this time. Include in the Ground Control Report a list of all marks recovered using this on-line system, and a printout of each recovery note and include photos. Recoveries may also be made using NGS software WINDESC. 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. See Attachment AG for additional guidance. 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 some of the 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").

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 many 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. The name and date on the mark's datasheet must agree exactly with the information stamped on the disk to confirm that the correct mark is being used. In addition, all survey records must use this same exact name and date. Disk stampings shall not be altered at any time.

2.7. INTERSECTION STATIONS - Intersection stations such as smoke stacks, tanks, water towers, navigational aids, church spires, 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 are sometimes 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.

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. In addition, all survey records shall be checked.

3.2. GPS SURVEY POSITIONING TECHNIQUES - GPS techniques, such as static GPS, kinematic GPS, or Real Time (RT) GPS, 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. If Real Time methods are planned, consult the NGS specifications for Single Base line RT and Real Time Networks, both expected to be released during 2010. Each new point should be occupied twice, independently, and for the length of time necessary to meet the accuracy requirements. Static positioning should be done by ties to CORS. **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 NSRS. Connections should be made to at least two NSRS stations (NGS recommends that this is two CORS). Panels may be constructed directly over third-order or better, NSRS stations. Priority should be given to survey stations included in NAD 83(NSRS 2007), see Section 2.2, above.

3.4 TRIPODS - Fixed height tripods are recommended. Tripods with multiple height settings should be set to the highest position. All tripods shall be tested for stability, plumb alignment (straightness of center pole), and height verification at the beginning and end of the project. All tripods shall be examined for stability with each use. Ensure that hinges, clamps, and feet are secure and in good repair. Also, check, and adjust if necessary, the position of the bubble in the circular vial.

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 – When photo control panels (or targets) are used, the Contractor shall mark them 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 1/3 of a pixel on a 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 – When Photograph IDentified (Photo ID) points are used, they should be temporarily marked, if possible. For Photo ID points, 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, that the point is well defined allowing positive identification and exact pointing, and that the point has not changed since the date of the photography. An example of an excellent point would be the intersection of a sidewalk and a driveway. An example of a poor point would be the center of a dirt drive that has poorly defined edges.

7. CONTROL STATION FORM - **Control Station Identification (CSI) (NOAA Form 76-53) shall be completed for each check point, and ground control point, whether they be photo panel or photo ID points**. See Attachment Q for sample forms (blank and filled-in), and sample ground control 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 and ground control point used**. Photographs are only required during one visit to a mark.

TABLE OF DIGITAL PHOTOGRAPH REQUIREMENTS

| | Permanent Marks | Check Points, Ground 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. See Attachment R for detailed specifications. For photographs of check points and ground control points, the two horizontal views shall show the photo point from two different angles, with the tripod in place, if possible. Check points, ground 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 legible sign in each photo (except the close-up) showing the name of the panel or point (may use a white board and heavy marker). Captions on the photograph are no longer required.

In addition, the location of each check point and ground control point, and survey mark used shall be plotted on a large scale nautical chart of the area. See Attachment Q.

9. DATA PROCESSING - Survey ties using CORS data should be processed using the On-line Positioning User Service - Static (OPUS-S), see: http://www.ngs.noaa.gov/OPUS/ , or OPUS-Rapid Static (OPUS-RS, see: http://www.ngs.noaa.gov/OPUS/ . Submit copies of OPUS results and comments on the results in the Ground Control Report. NGS has merged Cooperative CORS with National CORS, and now calls them all NGS CORS.

9.1 OPUS - OPUS-S and OPUS-RS allow users to submit their GPS data files to NGS, where the data will be processed to determine a position using NGS computers and software. Each data file that is submitted will be processed with respect to three CORS sites. The sites selected may not be the nearest to the user's site but are selected by distance, number of observations, site stability, etc. The position for the user's data will be reported back via email in both International Terrestrial Reference Frame (ITRF) and NAD 83 coordinates as well as Universal Transverse Mercator (UTM), U.S. National Grid (USNG) and State Plane Coordinates (SPC) northing and easting. Make sure the Rapid Orbits are available (usually after one work day) before uploading data to OPUS. See Attachment C, Section 13.2D for more information on

CORS and OPUS. The OPUS www site states that at least two hours of data is required, but OPUS will process one hour long data sets.

OPUS-S TWO-HOUR SESSIONS - Two-hour GPS sessions are recommended and will generally give excellent results even for ranges of 100km or more. For longer ranges, use longer sessions. Tests have shown that three hours gives very good results even for ranges up to 600 km. A good OPUS run should typically use 90% or more of the observations. OPUS should have fixed at least 50% of the ambiguities, 70% preferred. The Peak-to-Peak errors should not exceed the required accuracy levels for horizontal (0.1m) and (0.2m) vertical.

OPUS-S ONE-HOUR SESSIONS – One-hour GPS sessions may produce acceptable results, but the data shall be analyzed carefully to ensure that accuracy requirements are met. A good OPUS run should typically use 90% or more of your observations. To help ensure good results from one-hour sessions, OPUS should have fixed at least 70% of the ambiguities, 90% preferred. The Peak-to-Peak errors should not exceed the required accuracy levels for horizontal and vertical.

See detailed OPUS-S analysis information at: http://www.ngs.noaa.gov/OPUS/about.html .

Results obtained with OPUS-S may be improved by resubmitting data when a better ephemeris is available or by changing one of the CORS that OPUS uses.

Two sessions are recommend.

9.2 OPUS-RS - OPUS-RS, introduced in August, 2005, is a version of OPUS designed to obtain geodetic quality positioning results from user data sets as short as 15 minutes. To do this, OPUS-RS uses an entirely different internal processing program. Most of the external interface is the same as the original OPUS-S. Most of the information and explanations offered for the original OPUS-S also apply to OPUS-RS. Some changes to the OPUS-S data sheet will be apparent. OPUS-RS works best when the rover position is surrounded by CORS. This is not the case along the coast lines, so the solution is somewhat weaker. Two independent GPS sessions should be used to position all points.

Before using OPUS-RS, review the on-line information, including:
What is OPUS-RS? - http://www.ngs.noaa.gov/OPUS/
Using OPUS-RS - http://www.ngs.noaa.gov/OPUS/
OPUS-RS FAQ - http://www.ngs.noaa.gov/OPUS/about.html#FAQ , and scroll down.
OPUS-RS map – http://www.ngs.noaa.gov/OPUSI/Plots/Gmap/OPUSRS_sigmap.shtml

If OPUS-S or OPUS-RS is used, a separate least squares adjustment is not required.

9.3 OTHER OPUS VERSIONS - Note, NGS is currently (2010) developing new versions of OPUS. Any updates in this SOW's OPUS requirements will be included in the Project Instructions.

9.4 REAL TIME NETWORKS (RTN) – Check points and ground control points may be positioned using RTN if the following criteria are met. The RTN must be tied to the NSRS (should be tied through at least three stations) and at least one calibration shall be performed and reported. This calibration shall include positioning a point in the project with both RTN and OPUS. The positional comparison must be well within the accuracies stated in Section 3.1. For additional information on RTN see: http://www.ngs.noaa.gov/CORS/Articles/BillProfSurvNov08.pdf and 2011 publication(s) , and NGS publications expected to be published in early 2011.

9.5 PROCESSING NON-CORS DATA - 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 as part of their Technical Proposal. 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 – Paper and PDF copies of the report are required. The Report shall include a discussion of:

- Project Identifier and location,
- Purpose,
- Names of firm(s) and individuals performing work,
- Methodologies used (OPUS, stop-and-go GPS, etc.), including length and number of GPS sessions,
- 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,
- Final coordinates of all control, including whether point is panel or photo ID,
- NOAA Form 76-53, "Control Station Identification", for each photo control point,
- Recovery Notes for survey marks used, (submit on-line and digital),
- A listing of all stations recovered using NGS' On-line "Mark Recovery Form,"
- Whether or not any data was submitted in "Blue-Book" format,

- Photographs of points surveyed, digital copies,
- Unusual circumstances,
- Equipment malfunctions,
- A brief analysis of all results,
- A statement as to whether or not the work meets the SOW and Project Instructions requirements, including accuracy,
- Recommendations,
- The NGS Visibility Obstruction Diagram" and the NGS "GPS Station Observation Log" may be used but are not required.

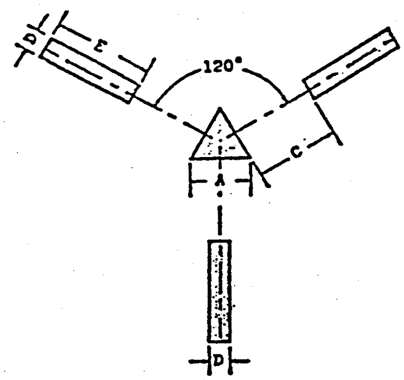
Any work not meeting specifications must be fully discussed in the report, including dates of prior communication with NGS, and justification.

If Ground Surveys under Attachment P were also performed, submit one combined report.

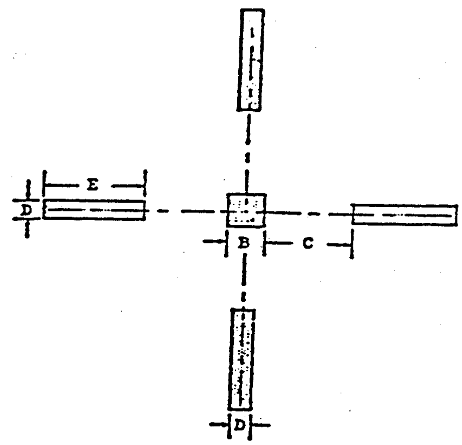
## ANNEX A

**SPECIFICATIONS FOR PREMARKING CONTROL STATIONS**
**Revised November 23, 1976**

ARRAY NO. 1

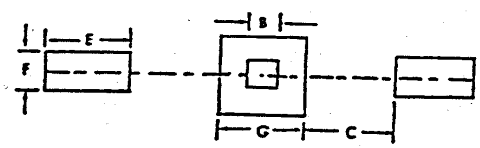



ARRAY NO. 2




**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 |

**RETURN TO**
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Feb. 1, 2011

# 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

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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 National Geodetic Survey (NGS) data entry format), or submitting data into the On-line Positioning User Service - Static (OPUS-S), OPUS –Rapid Static (OPUS-RS), OPUS-Data Base (OPUS-DB), or OPUS – Projects, is required for Ground Surveys, see the Project Instructions for further requirements.

1.1.  CHECK POINTS - The four or more check points required by the Scope of Work (SOW) are described in Attachment O, Section 1.1 should be connected to any Ground Surveys performed.

1.2.  GROUND PHOTO CONTROL - Ground photo control surveyed for this project are described in Attachment O, Section 1.2, and should be connected to any Ground Surveys performed.

1.3.  AIRBORNE KINEMATIC GLOBAL POSITIONING SYSTEM (KGPS) USED - See Attachment O, Section 1.3 and 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 the North American Datum 1983 (NAD 83) and the North American Vertical Datum 1988 (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 CORS are not used, the next priority for tie stations are those included in the NAD 83(NSRS 2007) readjustment (see: http://www.ngs.noaa.gov/NationalReadjustment/ ).  If the NSRS tie is done through other 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 – For all new marks set and for all marks used that were not previously in the NGS database, the Contractor shall write a digital description in NGS format using NGS software WinDesc, see Attachment S. Digital photographs are required, see Attachment R.

B. MARK RECOVERY – For all NSRS marks recovered while performing Ground Surveys, the contractor shall write a digital recovery note using NGS software WinDesc. The NGS on-line recovery method may not be used. See Attachment AG for guidance on recovering marks. Digital photographs are required, see Attachment R.

Submit a copy of all descriptions and recovery notes with the Ground Control Report.

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 triangulation stations 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 – CORS datasheets can be downloaded from: http://www.ngs.noaa.gov/CORS/ , and then click on “DOWNLOADS”, then on “Standard Files”, and then on “Data Sheet”. Survey mark 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 the Horizontal or Vertical accuracy desired, and then click on “Submit Query”. GPS connections may also be made to Primary Airport Control Stations (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.

2.6. MARK SETTING – The importance of setting quality monuments cannot be over emphasized. Monuments that are properly located and set can provide decades of valuable use for surveying operations. Proper attention and workmanship must be given to all the steps in the process including the basic tasks of hole digging, rod driving, concrete mixing and pouring, and finishing the monument. The only physical evidence remaining after a survey has been completed are the monuments; therefore, permanency and neatness of the monument and the surround area are of utmost importance.

After existing marks have been recovered and proposed sites for new marks determined, the Contractor shall obtain permission from the property owner before beginning mark setting. The Contractor shall also inquire about underground utilities and future construction that might affect mark longevity. "MISS UTILITY" type services should be contacted before driving rod or digging, this may be required by state or local regulation.

All new permanent survey marks shall be set to NGS specifications for type, length, material, stability, stamping, driving, etc. outlined in Attachments T, U, V, W, AG, and NGS publication "Geodetic Bench Marks", on-line at: http://www.ngs.noaa.gov/PUBS_LIB/GeodeticBMs/ .

Witness posts should be set unless the property owner objects, the post cannot be driven, or the mark should not be made easily visible because of a high risk of vandalism. Witness Posts are usually not set on airports. Witness posts set shall contain the standard NGS witness post logo.

2.7 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. Confirm that all the information stamped on the disk agrees with the NGS Datasheet. Disk stampings shall not be altered at any time.

2.8. INTERSECTION STATIONS - Intersection stations such as smoke stacks, tanks, water towers, 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.

## 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. In addition, all survey records shall be checked.

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. NGS Tests have shown that three hours gives very good results even for ranges up to 600 km. See also Attachment C, Section 13.2.

3.3. CONNECTIONS TO NSRS – Both horizontal and vertical surveys shall be connected to the NSRS. In order of priority, connections should be made to NGS CORS, survey stations included in NAD 83(NSRS 2007), and second-order, or better, horizontal 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/.

**Weather data is not required**, and weather (meteorological) data is not available for CORS.

3.4. FINDING CORS - CORS may be found by visiting the NGS WWW homepage at:
http://www.ngs.noaa.gov/ and clicking on "CORS".

NGS has merged Cooperative CORS with National CORS and now calls the combination NGS CORS.

3.5. FINDING NAD 83(NSRS 2007) STATIONS – Visit the NGS web page at:
http://www.ngs.noaa.gov/NationalReadjustment/index.html .

3.6. 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. Conduct a similar search for vertical control points.

For additional information, see "Geometric Geodetic Accuracy Standards and Specifications for Using GPS Relative Positioning Techniques", Version 5.0, dated May 11, 1988, on-line at:
http://www.ngs.noaa.gov/FGCS/tech_pub/GeomGeod.pdf , and "NAVSTAR GPS Surveying", U.S. Army Corps of Engineers (USACE), 1996.

3.7. 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.

3.8 TRIPODS - Fixed height tripods shall be used. Tripods with multiple height settings should be set to the highest position. All tripods shall be tested for stability, plumb alignment (straightness of center pole), and height verification at the beginning and end of the project. All tripods shall be examined for stability with each use. Ensure that hinges, clamps, and feet are secure and in good repair. Also, check, and adjust if necessary, the position of the bubble in the circular vial.

## 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 mark's 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 legible sign in each photo (except the close-up) showing the name of the mark (may use a white board and heavy marker). Captions on the photograph are no longer required.

In addition, the location of each panel, photo identifiable point, and survey mark used shall be marked on a large scale nautical chart of the area. See Attachment Q for samples of both.

8. DATA PROCESSING

All survey data shall be processed using standard techniques, including adjustment, and submitted in "Blue Book" format or in one of the OPUS formats if this is specified in the Project Instructions. 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.

Survey ties using CORS data may be processed using the On-line Positioning User Service (OPUS), see: http://www.ngs.noaa.gov/OPUS/ as a check prior to performing an adjustment. The OPUS-S www site states that at least two hours of data is required for standard OPUS. Make sure the Rapid Orbits (see: http://www.ngs.noaa.gov/orbits/ ) are available (usually one work day) before uploading data to OPUS. OPUS-RS may also be used as a data quality check prior to adjustment. See Section 3 above for definitions, and see Attachment C, Section 13.2D and E for more information on CORS and OPUS.

## 9. QUALITY CONTROL

The Contractor shall prepare and use a written Quality Control Plan with a section on Ground Control. The Plan shall be supplied to NGS at the beginning of the project as part of the Technical Proposal. 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 requires that all manually recorded and manually computer entered data be checked.

## 10. GROUND CONTROL REPORT

A paper copy is required. Also submit a digital copy of the Report in PDF format.

The Report shall include a discussion of:

- Project Identifier and location,
- Purpose,
- Name of firm(s) 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,
- WINDESC format Descriptions and Recovery Note copies,
- "Blue-Book" required files (see Attachment P, Annex A), or OPUS format
- photographs of points surveyed, digital copies,
- Paragraph summarizing analysis of results,
- Unusual circumstances,
- Equipment malfunctions,
- A statement as to whether or not the work meets the SOW and Project Instruction requirements and accuracies, 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, and justification.

## 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** |
|---|---|
| ( ) Ground Control 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 |
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| ( ) Photographs or Rubbings of Station Marks | All Projects |
| ( ) COMPGB Output (Validation program-B/G file) | All Projects |
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| **( )** 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 |
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| ( ) 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: | | | |

**RETURN TO**
**SOW MAIN TEXT**
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October 28, 2009

# 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

For information explaining which forms are required, see the Table, "Requirements for Coastal Mapping Projects" on Q – Page 4.

Q1. Use program WinDesc to create digital descriptions in National Geodetic Survey (NGS) format. WinDesc prints out descriptions in a format very similar to an NGS Datasheet from the NGS database, see Q19 below. The WinDesc printout contains the following statement warning that it is not an official Datasheet, "Warning – This is a preliminary description not yet in the NGS data base." To download WinDesc, go to:
http://www.ngs.noaa.gov/PC_PROD/pc_prod.shtml#WinDesc .

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.
This recovery method is recommended for non-"Blue Book" projects.

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/ .
This form is good to use in the field, but is not required.

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/ .
For instructions, including measuring an HI, see: http://www.ngs.noaa.gov/PROJECTS/FBN/ , click on "Guidelines" and then on "Observing Procedures" and then on "Antenna Height Measurement".

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/ .
The alternate form, "Station Location Sketch and Visibility Diagram" may be used instead.

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/ .
The alternate form, "Station Pencil Rubbing Form" may be used instead.

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/ .
This form (three windows + page 2) may be used to replace the "Visibility Diagram," the "Pencil Rubbing," and the "Station Description/Recovery" forms.

Q14. "Control Station Identification" (NOAA Form 76-53; 1 page, blank); Use this form to describe photo panels, photo ID points, and other temporary points.


Q - Page 2

Q15. “Control Station Identification” (NF 76-53; 1 page, filled-in
This form is not available on-line, but is included in digital version of SOW.

Q16. Digital Photographs-Close-Up - Samples of the three required digital photographs of permanent marks, see Attachment R for additional details.

Q17. Sample photographs of good quality photo control points.

Q18. Sample project area 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:
The www sites listed above contains PDF versions of the forms which may be printed out or completed on-line.

Acronyms:
GPS – Global Positioning System
WWW – World Wide Web
PDF – Portable Document Format


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## FORM REQUIREMENTS FOR COASTAL MAPPING PROJECTS

| REQUIRED<br>TYPE SURVEY | WINDESC (Station Desc. in NGS format | 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. | AT EACH OBSERVA | YES | ----- | YES | YES |
| PHOTO CONTROL PT | ----- | ----- | ----- | RECOM. | RECOM. | AT EACH OBSERVA | 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 WINDESC (for Blue-Book projects), or using the NGS on-Line “Mark Recovery Entry” system.
2. Forms Q12 and Q13, 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.


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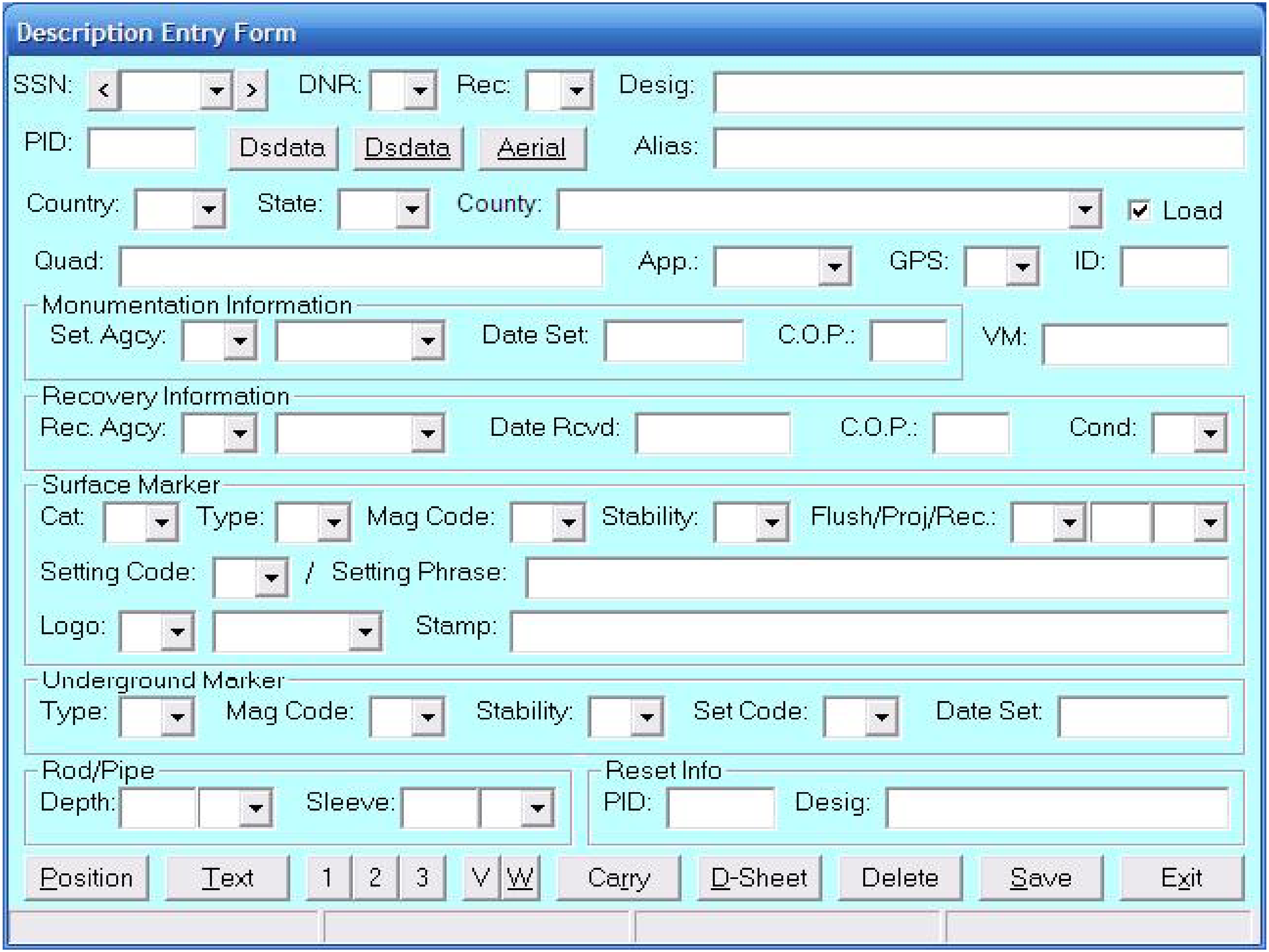

Description Entry Form
SSN:
DNR:
Rec:
Desig:
PID:
Dsdata
Dsdata
Aerial
Alias:
Country:
State:
County:
Load
Quad:
App.:
GPS:
ID:
Monumentation Information
Set. Agcy:
Date Set:
C.O.P.:
VM:
Recovery Information
Rec. Agcy:
Date Rcvd:
C.O.P.:
Cond:
Surface Marker
Cat:
Type:
Mag Code:
Stability:
Flush/Proj/Rec.:
Setting Code:
/
Setting Phrase:
Logo:
Stamp:
Underground Marker
Type:
Mag Code:
Stability:
Set Code:
Date Set:
Rod/Pipe
Depth:
Sleeve:
Reset Info
PID:
Desig:
Position
Text
1
2
3
V
W
Carry
D-Sheet
Delete
Save
Exit

# 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
- GEOCAC - Geocaching

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. Actually, 15 lines means 15 Carriage Returns. I.e., if you use the wrap-around feature you can actually enter up to 6 lines of text for **each** of those 15 lines.

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.

submit

**For assistance contact Deb Brown**
**Email: Deb.Brown@noaa.gov**

# 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
- ( ) GEOCAC - Geocaching

- [ ] INDIV - Local Surveyor or Engineer
- [x] 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:** 4,08,2009

**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:** mark.surveyor@noaa.gov

You can, if you wish, enter up to 15 lines of text in the space below. Actually, 15 lines means 15 Carriage Returns. I.e., if you use the wrap-around feature you can actually enter up to 6 lines of text for **each** of those 15 lines.

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.

Station has good satellite visibility but a chain link fence is about 5 meters to the east of the station.

submit

**For assistance contact Deb Brown**
**Email: Deb.Brown@noaa.gov**

NOTE: This form intended for field use. Unsolicited data submitted to NGS must be converted to bluebook format.

--> 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:______________

NOTE: This form intended for field use. Unsolicited data submitted to NGS must be converted to bluebook format.

# NATIONAL GEODETIC SURVEY STATION DESCRIPTION / RECOVERY FORM

4-char ID: BALD Designation: BALD 2 RESET

PID: QE2736 Alias:

Country: (USA / USA) State: OR County: LINCOLN

Latitude: N 44 49 49.17802 " Longitude: W 124 03 56.23447 " Elevation: 17.0 (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:) Oregon DOT | |
| 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:) Oregon DOT | |
| Date: | Chief of Party (initials): CFS |

| 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: | BALD 2 1991 |
| Agency Inscription: (NGS / CGS / Other:) | Oregon DOT |
| 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): 00:03 |

**See Back of Form to add Text Description**

**General Station Location:** The station is located in about 10 km south from Lincoln Bay, 13 km north from Depoe Bay, and at the US101 Boiler Bay wayside rest area.

(Describe general location; include airline distances to three towns or mapped features.)

**Ownership:** The station is on the property of Oregon State Department of Parks and Recreation.

(name, address, phone of landowner)

**To Reach Narrative:** To reach the station from the intersection of US routes 5 and 101 in Depoe Bay, go north on US 101 for 1 km to the south entrance of the Boiler Bay wayside. Bear left on entrance road for 0.4 km to the parking area on the left. Pack northwest inside fence for about 90 meters to end of fence and the station on the right.

(Leg-by-leg distances and directions from major road intersection to mark)

**Monument Description and Measurements:** The station is set into drill hole in bedrock, 7.6 m south from the north fence corner, 8.8 m east from the west fence corner, and 3.6 m southeast from the northwest end of the outcrop.

(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: John Q. Surveyor Phone:(301)713-3194 e-mail: jqs@ordot.gov

NOTE: This form intended for field use. Unsolicited data submitted to NGS must be converted to bluebook format.

--> 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):

General Location:

Airport ID, if any:

Station 4-Character ID:

Day of Year:

Project Name:

Project Number: GPS-

Station Serial # (SSN):

Session ID:(A,B,C etc)

NAD83 Latitude o ‘ “

NAD83 Longitude o ‘ “

NAD83 Ellipsoidal Height meters

NAVD88 Orthometric Ht. meters

GEOID99 Geoid Height meters

Agency Full Name:

Operator Full Name:

Phone #: ( )

e-mail address:

Observation Session Times (UTC):
Sched. Start ________ Stop ________
Actual Start ________ Stop ________

Epoch Interval=____ Seconds
Elevation Mask = _____ Degrees

Receiver Brand & Model:
P/N:
S/N:
Firmware Version:
❐ CamCorder Battery, ❐ 12V DC, ❐ 110V AC, ❐ Other

Antenna Code*, Brand & Model:
P/N:
S/N:
Cable Length, meters:
Vehicle is Parked _____ meters ____(direction) from antenna.

| | | |
|---|---|---|
| Antenna plumb before session? | (Y / N) | Circle |
| Antenna plumb after session? | (Y / N) | Yes or No |
| Antenna oriented to true North? | (Y / N) | -If no, |
| Weather observed at antenna ht. | (Y / N) | explain |
| Antenna ground plane used? | (Y / N) | “ |
| Antenna radome used? | (Y / N) | If yes, |
| Eccentric occupation (>0.5 mm)? | (Y / N) | describe. |
| Any obstructions above 10°? | (Y / N) | Use |
| Radio interference source nearby | (Y / N) | Vis. form |

Tripod or Antenna Mount: Check one:
❐ Fixed-Leg Tripod, ❐ Collapsible-leg tripod ❐ Fixed Mount
Brand & Model:
P/N:
S/N:
Last Adjustment date:

Psychrometer (if used) Brand & Model:
P/N:
S/N:
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) | | | | |
| B=Additional offset to ARP if any (Tribrach/Spacer) | | | | |
| H= Antenna Height = A + B<br>= Datum Point to Antenna Reference Point (ARP) | | | | |

Meters = Feet x (0.3048)
Height Entered Into Receiver = _______ meters.

Note &/or sketch **ANY** unusual conditions. Be **Very Explicit** as to where and how Measured!

Barometer (if used) Brand & Model:
S/N:

| Weather Data | Weather Codes | Time (UTC) | Dry-Bulb Temp Fahrenheit | Celsius | WetBulb Temp Fahrenheit | Celsius | Rel. % Humidity | Atm. Pressure inches Hg | millibar |
|---|---|---|---|---|---|---|---|---|---|
| Before | | | | | | | | | |
| Middle | | | | | | | | | |
| After | | | | | | | | | |

Remarks, Comments on Problems, Sketches, Pencil Rubbing, etc:

Calculate

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):**

(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:

| 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

NOTE: This form intended for field use. Unsolicited data submitted to NGS must be converted to bluebook format.

**GPS STATION OBSERVATION LOG**
April 16, 2003

| | | | |
|---|---|---|---|
| Station Designation: (check applicable: __ FBN ✓ CBN __ PAC __ SAC ✓ BM) BALD 2 RESET | | Station PID, if any: QE2736 | Date (UTC): 31 Dec 2002 |
| General Location: Boiler Bay Wayside | Airport ID, if any: --- | Station 4-Character ID: BALD | 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: 44 ° 49 ' 49.17802 " | NAD83 Longitude: 124 ° 03 ' 56.23447 " | NAD83 Ellipsoidal Height: -6.44 meters | Agency Full Name: Oregon DOT |
| 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 | NAVD88 Orthometric Ht. 17.0 meters; GEOID99 Geoid Height -23.52 meters | Operator Full Name: John Q. Surveyor; Phone #: ( ) (301) 713-3194; e-mail address: jqs@ordot.gov |

**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 |
| Antenna plumb after session? | (✓Y / N) | Yes or No |
| Antenna oriented to true North? | (✓Y / N) | -If no, |
| Weather observed at antenna ht. | (✓Y / N) | explain |
| Antenna ground plane used? | (✓Y / N) | " |
| Antenna radome used? | (Y / N✓) | If yes, |
| Eccentric occupation (>0.5 mm)? | (Y / N✓) | describe. |
| Any obstructions above 10°? | (Y / N✓) | Use |
| Radio interference source nearby | (Y / N✓) | Vis. form |

**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:

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 | |

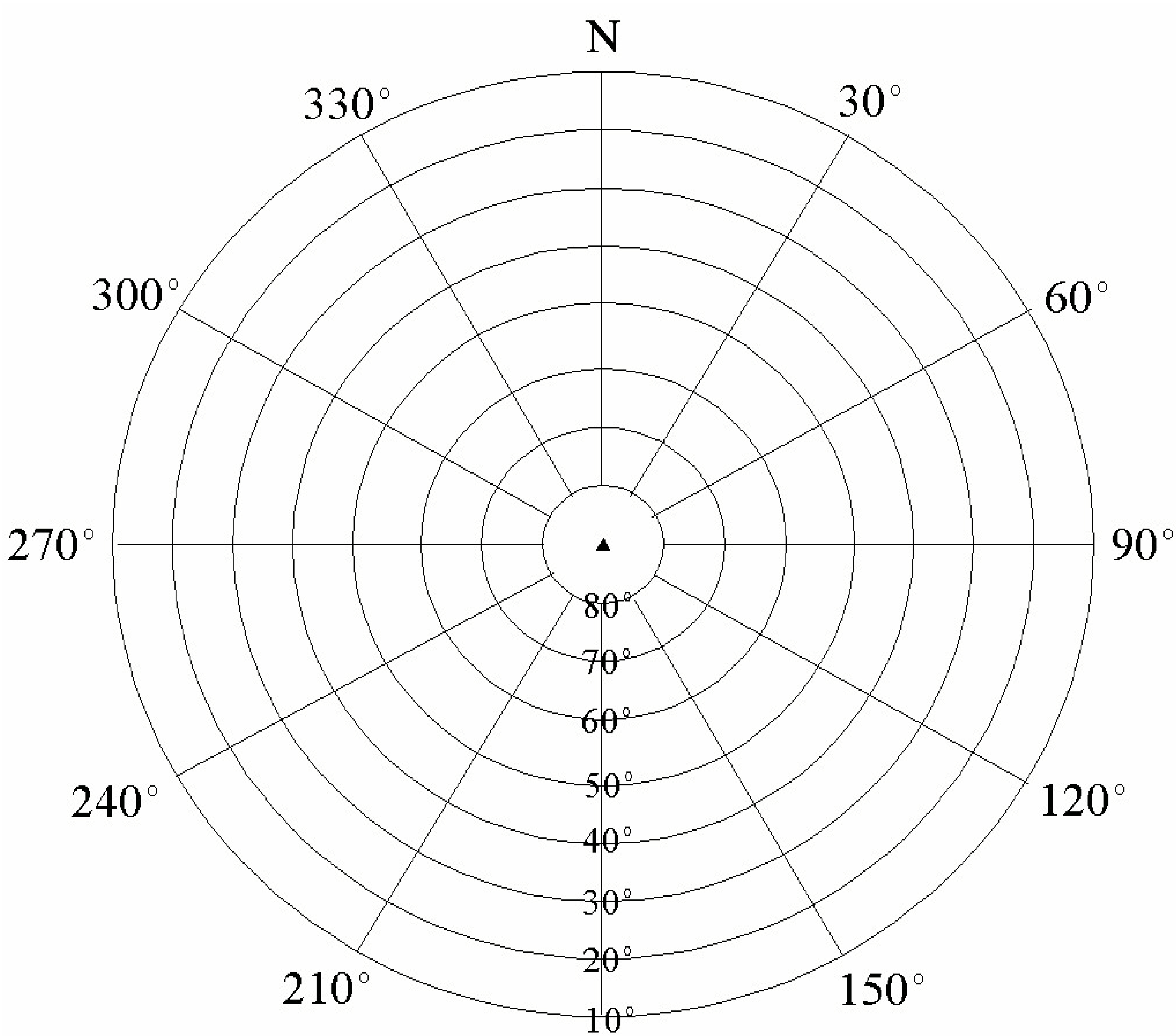
LOG CHECKED BY: JGE

| 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

--> 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: ________________________________________________

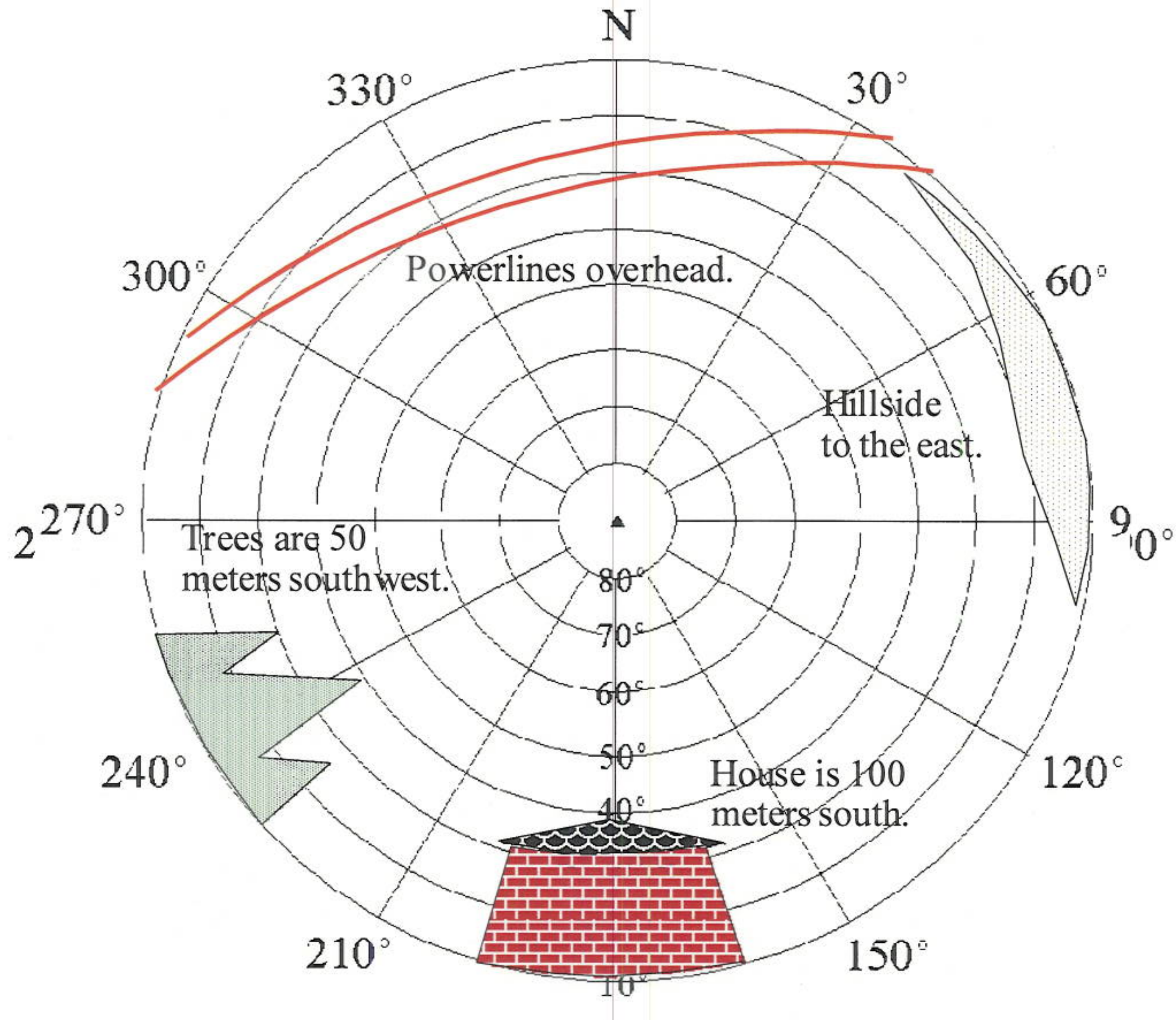
County: ____________________ Reconnaissance By: _________________________________

Height above mark, meters: ________ Agency/Company: ______________________________

Phone: ( _____ ) ___________________ Date:_________________

Check if no obstructions above 10 degrees □

## 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: BALD Designation: BALD 2 RESET

PID: QE2736 Location: Boiler Bay Wayside

County: LINCOLN Reconnaissance By: John Q. Surveyor

Height above mark, meters: 2 Agency/Company: Oregon DOT

Phone: ( _____ ) (301) 713-3194 Date: 1998-12-31

Check if no obstructions above 10 degrees ☐

# NATIONAL GEODETIC SURVEY PENCIL RUBBING FORM

4-char ID: ________ Day of Year ("Julian Day"): ________

Designation: ____________________ PID: ____________________

Stamping: ____________________________________________

Mark Type / Agency Inscription: ______________________________

Location: ____________________ County: ____________________

Rubbing By: ____________________ Date: ____________________

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.

# NATIONAL GEODETIC SURVEY PENCIL RUBBING FORM

4-char ID: BALD

Day of Year ("Julian Day"): 365

Designation: BALD 2 RESET

PID: QE2736

Stamping: BALD 2 1991

Mark Type / Agency Inscription: Brass Disk Oregon DOT

Location: Boiler Bay Wayside

County: LINCOLN

Rubbing By: John Q. Surveyor, ORDOT

Date: 1998-12-31

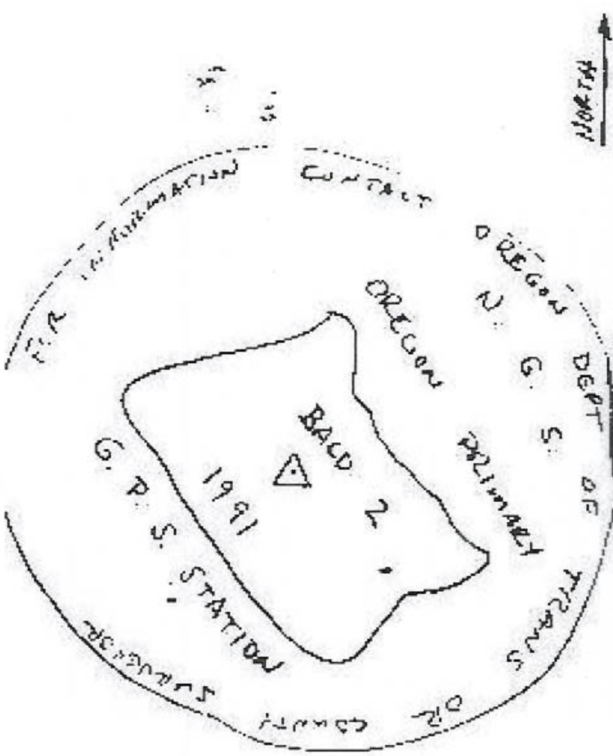
Agency: Oregon DOT

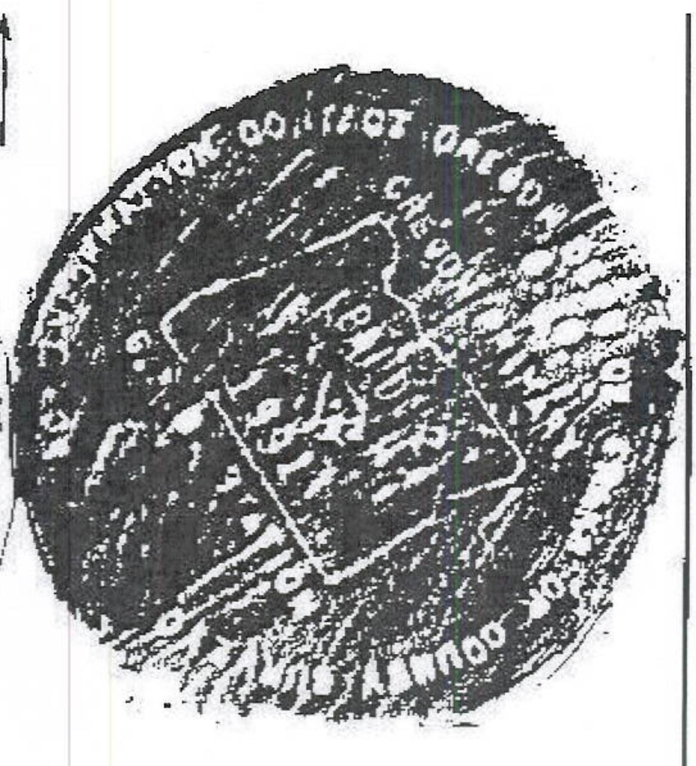
Phone: ( ____ ) (301) 713-3194

Remarks: This disk is reset into the same drill hole as the original station BALD 1962.

## 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____________________________________________ Project ____________________

Station Designation ___________________________________ PID___________ Date_________

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

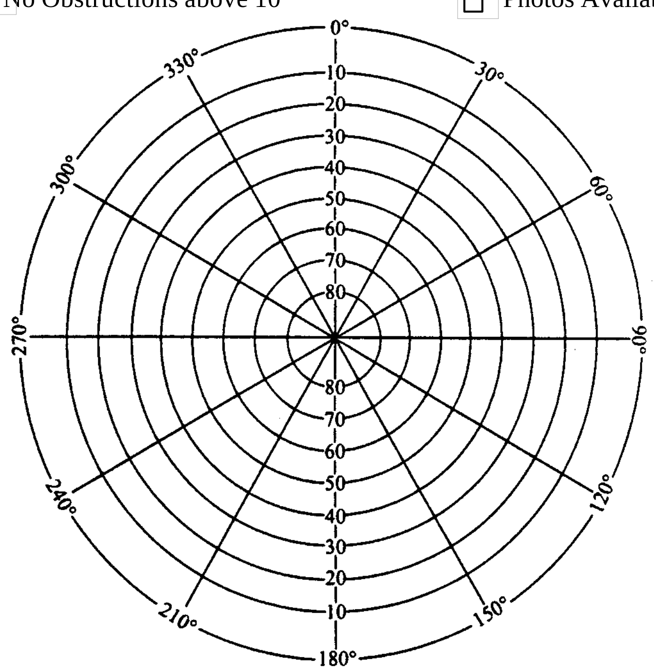
+

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° ☐ Photos Available



**General Station Location:** *"The station is located in . . .*

NOTE: This form intended for field use.

Unsolicited data submitted to NGS must be converted to bluebook format.

(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.)

# Station Location Sketch and Visibility Diagram

Location / Airport Name and ID: Boiler Bay Wayside

Project: Sample GPS, 1998

Station Designation: BALD 2 RESET

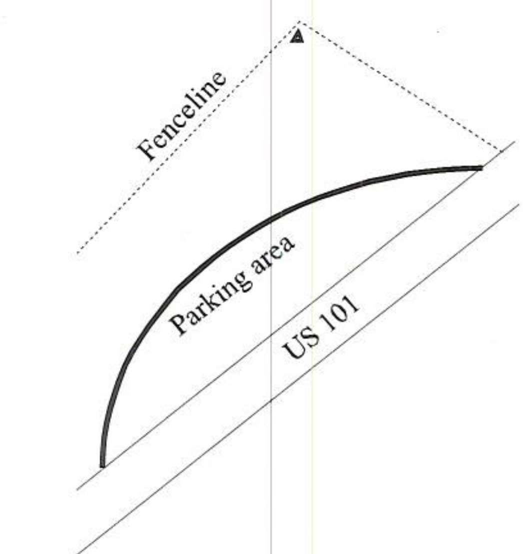
PID: QE2736

Date: 1998-12-31

Circle all applicable: PACS SACS BM ✓ FBN CBN ✓ OTHER____

Observer & Organization: John Q. Surveyor

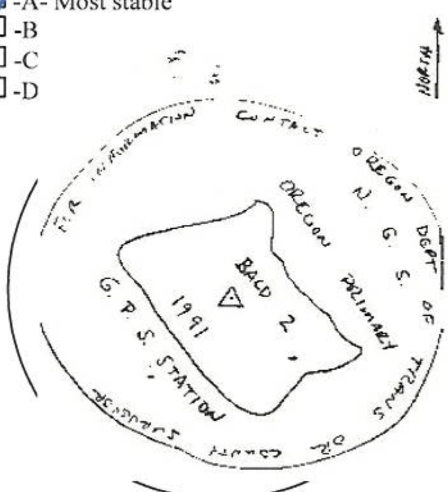
## Station Location Sketch




## Sketch of Disk

Monument Stability Quality: ☑ Photos Available

☑ -A- Most stable
☐ -B
☐ -C
☐ -D

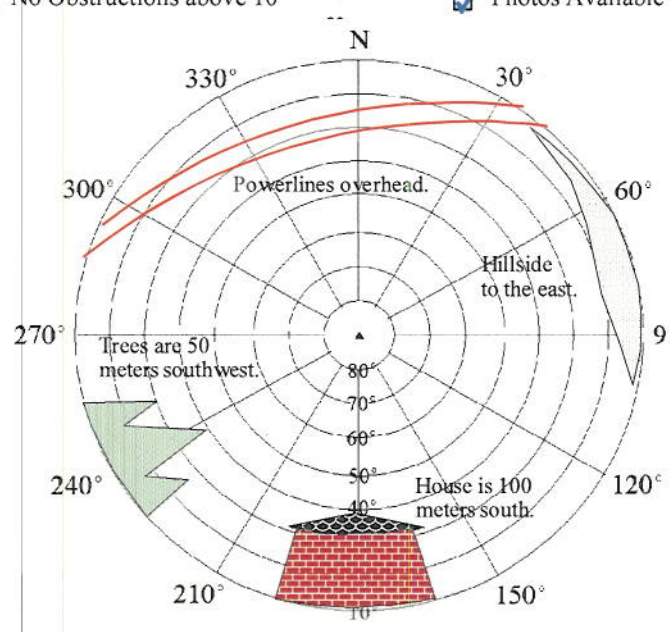



Monument is:
☐ Recessed ___ cm
☑ Flush with ground surface
☐ Projecting ___ cm

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 . . .* about 10 km south from Lincoln City, 13 km north from Depoe Bay, and at the US101 Boiler Bay Wayside.

NOTE: This form intended for field use.

Unsolicited data submitted to NGS must be converted to bluebook format.

(Describe general location; include airline distances to three towns or mapped features.)

**Ownership:** The station is on the property of Oregon State Dept of Parks & Recreation.

(OPTIONAL: name, address, phone of landowner)

**To Reach Narrative:** *"To reach the station from the intersection of . . .* US routes 5 and 101 in Depoe Bay, go north on US 101 for 1 km to the south entrance of the Boiler Bay wayside. Bear left on entrance road for 0.4 km to the parking area on the left. Pack northwest inside fence for about 90 meters to end of fence and the station on the right.

(Leg-by-leg distances and directions from major road intersection to mark.)

**Monument Description and Measurements:** *"The station is . . .* set into drill hole in bedrock, 7.6 m south from the north fence corner, 8.8 m east from the west fence corner, and 3.6 m southeast from the northwest end of the outcrop.

(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. |

NOAA FORM 76-53
(3-76)

SUPERSEDES FORM C&GS152.

NOAA FORM 76-53
(3-78)

# CONTROL STATION IDENTIFICATION

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

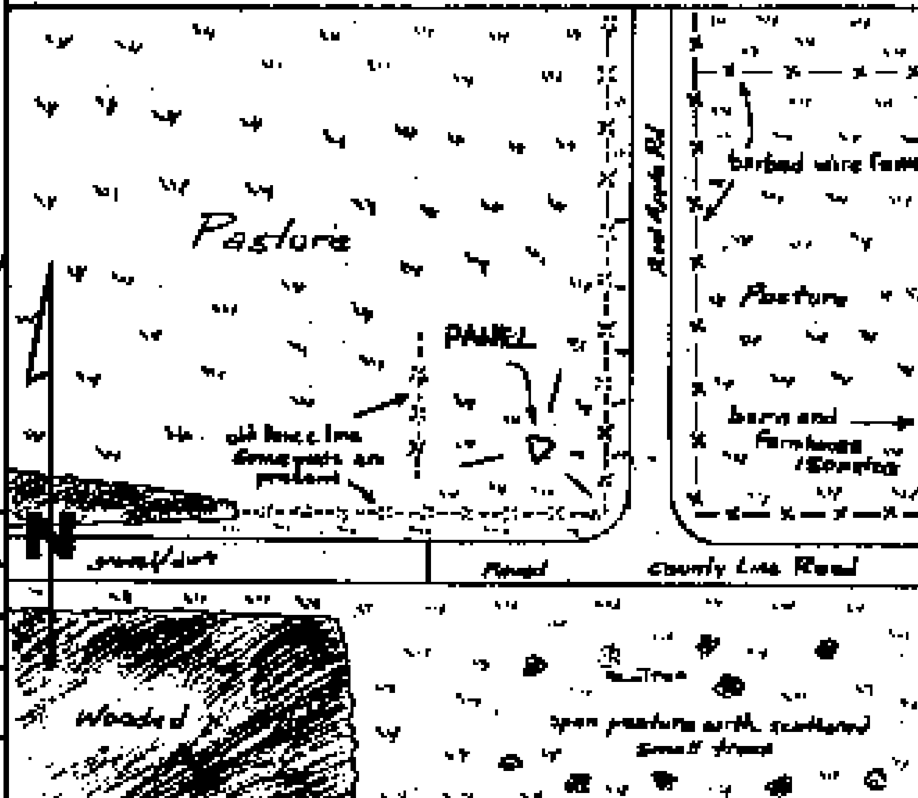
MANISTEE 7.5' Quad.

| STATION | | CONTROL DATA REF. |
|---|---|---|
| PANEL No 2 | | 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 the station "MAGO" positioned by GPS.

**SKETCH (SUBSTITUTE STATION A)**

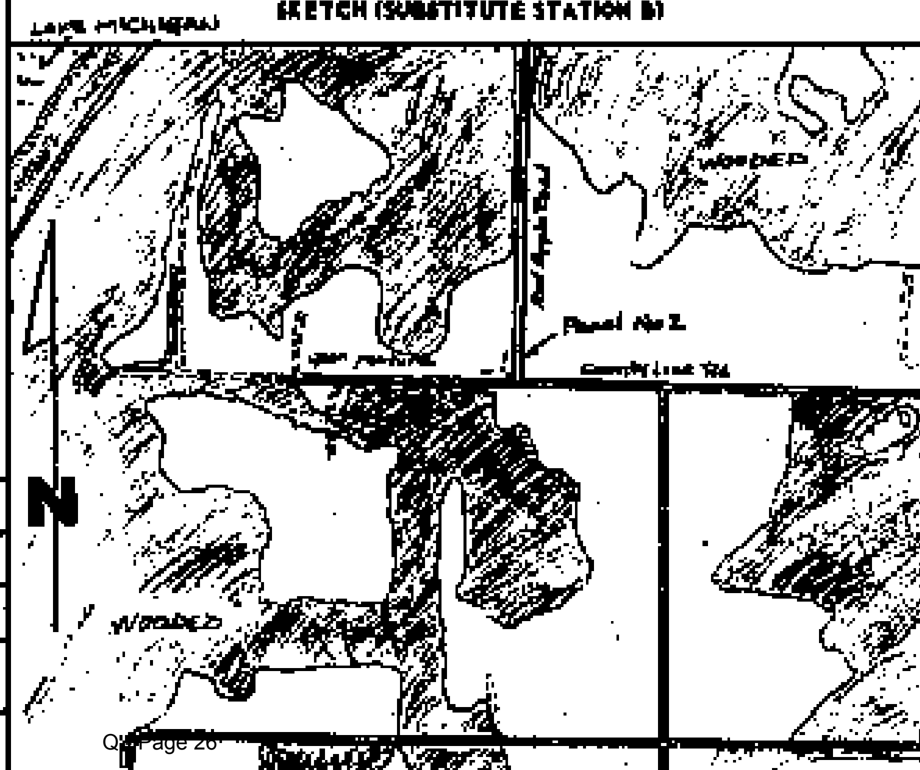



**INFORMATION REQUIRED-SUBSTITUTE STATION A**

| | | |
|---|---|---|
| INST. STATION | | |
| AZ. STATION | | |
| < TO STA. (RIGHT) | | |
| DISTANCE | FT. | M. |

**DESCRIPTION OF SUBSTITUTE STATION B OR STATION IDENTIFIED DIRECT.**

**SKETCH (SUBSTITUTE STATION B)**




**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 1(?).

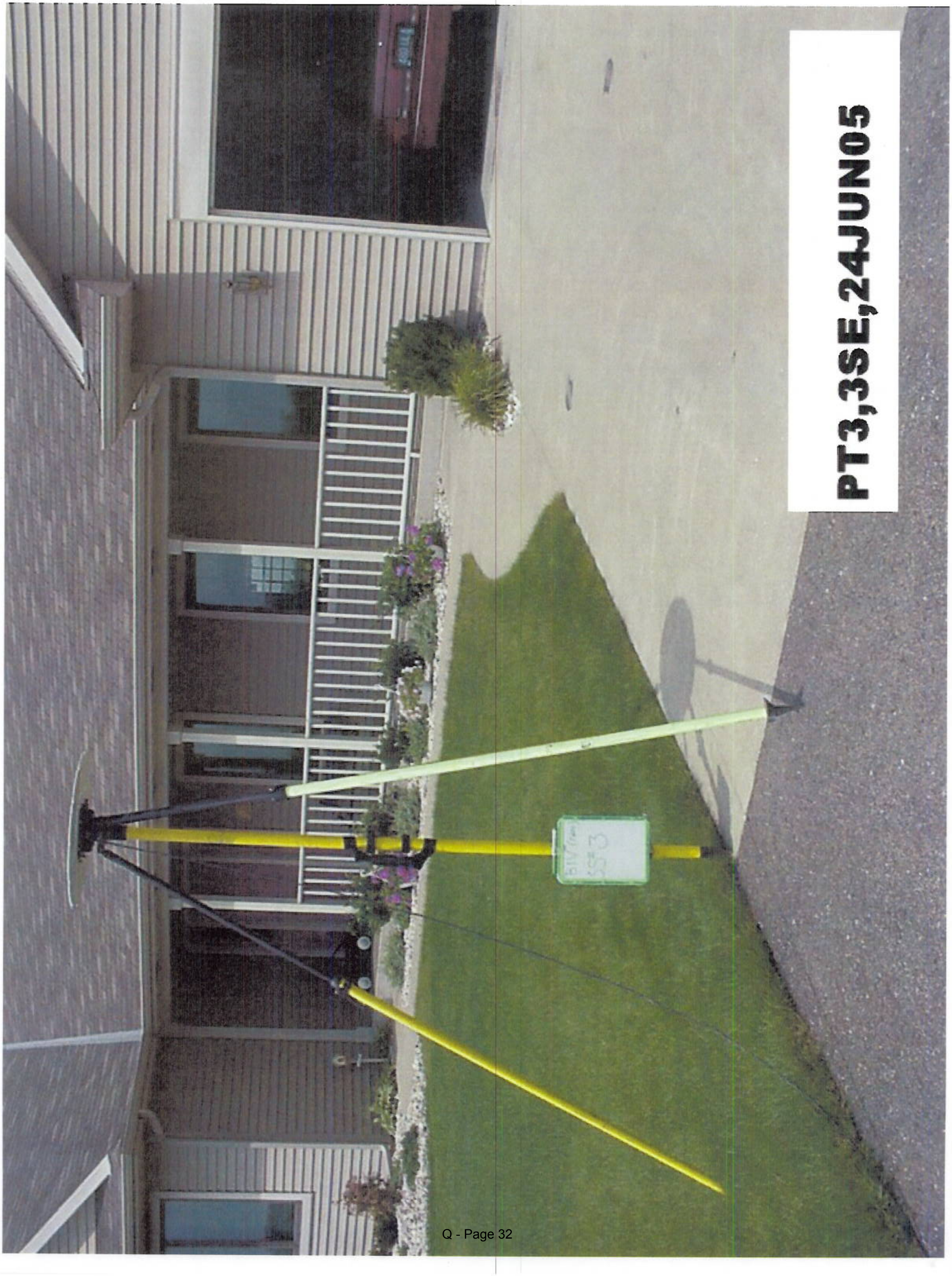

PHOTO TYPE NUMBER 1 – CLOSE-UP


PHOTO TYPE NUMBER 2 – EYE-LEVEL


PHOTO TYPE NUMBER 3 – HORIZONTAL VIEW


PT1,3NW,14JUN05
SS#2


PT2,3SE,23MAY05


PT3,3SE,24JUN05

P08,3E,30OCT03

P08,3W,30OCT03


P09,3E,30OCT03


P09,3N,30OCT03



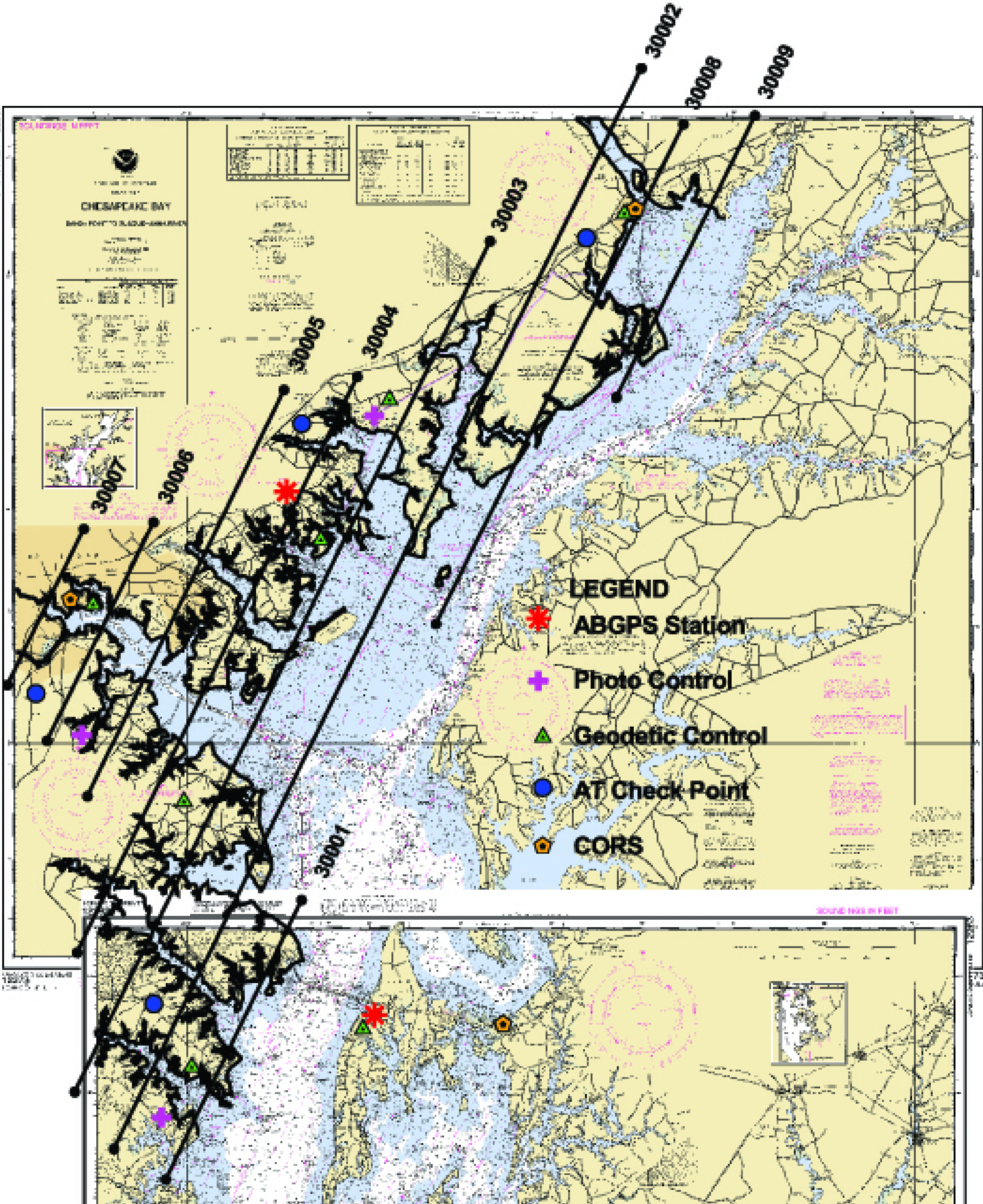
**P11A,3N,30OCT03**




**P11A,3S,30OCT03**


P12,3E,30OCT03

P12,3S,30OCT03


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
```

**RETURN TO**
**SOW MAIN TEXT**
**TABLE OF CONTENTS**

January, 2011

# ATTACHMENT R
# REQUIREMENTS FOR DIGITAL PHOTOGRAPHS OF SURVEY CONTROL

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

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

TABLE OF CONTENTS

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 photograph 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 more than one stage of the project. The photographs stored in the NGS database will be 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, below.

Take all photographs during daylight hours.

Take all photos of the same point consecutively, (photo #1, #2, then #3) so that they are all stored together in the camera's memory. This should help avoid misidentifying photos later.

2.1. NUMBER OF SURVEY MARK PHOTOGRAPHS - At least three digital photographs are required for each permanent 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 correct file names. Photographs type #2 and #3 also 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 is legible in the photograph and that it does not cover any portion of the mark, the monument, or any important feature. Have a tripod in place over the mark for photo #3, if possible.

REQUIRED PHOTOGRAPHS

| All Permanent Marks Recovered and/or Described |
|---|
| 1. Close-up (Taken Vertically; so stamping is clear and 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, buildings, trees, roads, runways, taxiways, or other dangers, and 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 longer axis of the image is vertical. Capture the full heights (including 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 - A caption on each photograph is no longer required. If the camera allows, include the date and time on the image.

2.3. DESCRIPTION OF PHOTOGRAPHS:


A. CLOSE-UP (#1) - For permanent survey marks, the first photograph (type #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. Remove any dirt, debris, water, or snow to show the complete disk. Avoid shadow lines crossing 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, or use a white house-hold powder for highlighting; 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, due to the reflection of the flash. Note, medium quality and resolution camera modes may be used for photographs other than the close-ups. If additional close-up photographs are required, number these close-ups as 1A, 1B, etc.

B. EYE-LEVEL (#2) - For permanent survey marks, this photograph (type #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. Remove any dirt, debris, water, or snow from 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 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, especially any condition that would be a threat to the stability of the mark. If additional photographs are required, number these eye-level photos as 2A, 2B, etc.


C. HORIZONTAL VIEW(S) (#3) - For permanent survey marks, take at least one additional, daylight photograph oriented near horizontal (type #3) 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 entire obstructions. **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. <u>RECONNAISSANCE PHOTOGRAPHS</u> - 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 legible sign and the correct file name. **The file names for all of these photographs 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~~ | No longer required | |
| Photo File Name | RE-PID*-Name-Number-Date.jpg | See Section 4.4 below |

*PID = Permanent Identifier

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. Note, in these specifications, **"RE" stands for "REconnaissance"** and "R" stands for "Right" runway.

See the Project Instructions to determine which, if any, of the following are required:

3.1. PROPOSED LOCATIONS FOR MARKS - Take two photographs of each proposed permanent mark location. These should be two #3 (3A and 3B) photographs. Include a tripod, stake, sign, or other device showing the proposed mark location.

3.2. RUNWAY END PHOTOGRAPHS - For airport projects, 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 photos (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 and clearing showing the readings on the tape or rod.  Also show the measurement of the diameter of the hole, and show the belled-out bottom portion of the hole.

3.5.  PHOTOGRAMMETRIC CONTROL POINTS AND CHECK POINTS (Paneled and photo identified) - **Take two #3 type photographs** (3A and 3B) of all photogrammetric control points clearly showing the point.  This requirement includes both ground control points and ground check points.  These photos may 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).  Indicate the location of the survey point in the photograph.  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 KiloBytes (KB), typical file size should be about 50 – 100 KB.

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 designation, dash, the photo type 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 = Location Identifier (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 for permanent marks (3 photo sets) together on their own archival quality Digital Video Disk (DVD), **not on the same medium with other types of data**. Label this disk with the Project name, number, and the words "Database Photos", and use a DVD safe pen. Submit all RE photos on a separate DVD, also labeled. Do not apply paper labels to DVDs. For airport work, submit all photos for a given airport in a subdirectory named for that airport.

*Acronyms:
CBN - Cooperative Base Network
CORS - Continuously Operating Reference Station (Global Positioning System receiver)
DVD – Digital Video Disk
FBN - Federal Base Network
JPEG (or .jpg) – Joint Photographic Experts Group
KB - KiloByte
LID – Location IDentifier (for airports)
NAVAIDS – NAVigation AIDs
PACS - Primary Airport Control Station
PID – Permanent IDentifier (for NGS control stations)
RE - REconnaissance
SACS - Secondary Airport Control Station
# = Number

**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 DIG OUT AND/OR CLEAN OFF MARK
YELLOW CONSTRUCTION CRAYON, OR WHITE HOUSE-HOLD POWDER (BABY POWDER, CORN STARCH, ETC.)
WHITE BOARD WITH DARK MARKER
WEED WACKER (OR OTHER CUTTING DEVICE) TO CUT BACK GRASS AND WEEDS
COMPASS TO DETERMINE DIRECTIONS
MAP
MARK DESCRIPTION
MEASURING TAPE
GPS RECEIVER
SCREW DRIVER (TO OPEN LOGO CAPS AND TO HOLD END OF TAPE)
TILE PROBE
SCIENTIFIC CALCULATOR

PHOTO #1 - CLOSE-UP:
- SET CAMERA TO HIGH RESOLUTION,
- SET CAMERA TO MACRO MODE (IF AVAILABLE),
- DETERMINE CAMERA'S MINIMUM FOCUS DISTANCE,
- SET DATE AND TIME 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 (OR WHITE, HOUSE-HOLD POWDER) 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,
- AVOID SHADOWS ACROSS THE MARK,
- NOTE, IF FLASH IS REQUIRED, MOVE CAMERA SLIGHTLY OFF CENTER TO MINIMIZE REFLECTION,
- EXPOSE PHOTOGRAPH.

PHOTO #2 - EYE LEVEL
- SET CAMERA TO NORMAL RESOLUTION,
- SET CAMERA TO NORMAL MODE (NOT MACRO),
- SET DATE AND TIME 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, IN LARGE LETTERS, ON SIGN AND PLACE NEAR (NOT ON) MARK,
- OPEN LOGO CAP,
- ORIENT CAMERA VERTICALLY AT EYE LEVEL,
- COMPOSE WITH ENTIRE MONUMENT AND AREA AROUND MARK APPROX. 1 METER IN RADIUS,
- EXPOSE PHOTOGRAPH.

---

PHOTO #3 - HORIZONTAL VIEW(S)
- SET CAMERA TO NORMAL RESOLUTION,
- SET CAMERA TO NORMAL MODE (NOT MACRO),
- SET DATE AND TIME 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, IN LARGE LETTERS, ON SIGN AND PLACE NEAR (NOT ON) MARK,
- CLOSE LOGO CAP,
- ORIENT CAMERA HORIZONTALLY AT EYE LEVEL,
- COMPOSE TO INCLUDE MARK, ANY IDENTIFYING SURROUNDINGS, AND ANY OBSTRUCTIONS OR POSSIBLE SOURCES OF MULTI-PATH,
- EXPOSE PHOTOGRAPH(S), AS REQUIRED.

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SOW MAIN TEXT
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Feb. 1, 2011

# ATTACHMENT S
# WRITING STATION DESCRIPTIONS AND RECOVERY NOTES

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

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 National Geodetic Survey (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 station's 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.  For WinDesc information see: http://www.ngs.noaa.gov/PC_PROD/pc_prod.shtml#WinDesc , use the latest version available. Also refer to the NGS Web site:  http://www.ngs.noaa.gov/FGCS/BlueBook/, Annex P (Geodetic Control Descriptive Data), for information.  Note: WinDesc 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 for any recovery notes submitted on-line.

1.4 CHECKING - Descriptions shall be written by one person and checked by another. Recovery notes shall 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 writer's 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. Otherwise, report the station as "NOT FOUND".

B. A complete, new, three-paragraph Description/Recovery Note is required:

i. When a new, permanent mark is set,
ii. When an existing mark does not have a Permanent Identifier (PID),
iii. When an existing mark does not have an National Spatial Reference System (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 mark's description is no longer accurate or complete.

## 2. DESCRIPTION FORMAT

The original U.S. Coast & Geodetic Survey (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 and 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 additional legs, as needed:

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 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 side-road left or right, or station on left or right).

Repeat Section B as required.

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 the "side-road right" off Miller Road above, if the distance in a leg 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*. A new, Third Paragraph shall contain the following information, unless the same information has already been entered into a special field in the WinDesc software.

(A) The station mark type;
(B) How the mark is stamped;
(C) How the mark is set;
(D) Reference measurements;
(E) Hand-held GPS observations;
(F) Primary Airport Control Station (PACS)or Secondary Airport Control Station (SACS) designation, if appropriate.

Older descriptions will usually be in this format:

| SECTION | EXAMPLE |
|---|---|
| (A) - 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) - How the mark is stamped (in dashes): | STAMPED --JONES 1952--. |
| (C) - 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. |

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). It shall also state the length of rod driven. 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 monument, if known | CONCRETE MONUMENT, 1.2 M (4FT) 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 mark's immediate vicinity (farthest to nearest), and equally spaced around the horizon: | IT IS 20.7 M (67.9 FT) SOUTHWEST OF POWER POLE #2345, 15.2 M (49.9 FT) WEST OF THE WEST EDGE OF HIGHWAY 134, AND 3.4 M (11.1 FT) NORTH OF A CHAIN-LINK FENCELINE. |

Examples of objects used as references: existing reference marks, witness posts, center lines of roads, edges of roads, edges of runways, ditches, power or telephone poles, and buildings. Start with the farthest distance. Horizontal distances should be used. If slope distances were measured, that fact should be stated in the paragraph. Specify whether the reference distance was from the center or the edge of the reference object, and specify which edge, like “north edge”. 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 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, adding one or two leading zeros if required.

(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 AT A 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 CONTROL 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. Do not use abbreviations of the name. 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, elevation, or orientation. 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 METRIC CONVERSION - Use the U.S. Survey Foot conversion, in which 3.2808333333 feet equals one meter.

3.7 ABBREVIATIONS – KM = kilometer, M = Meter, CM = centimeter, and
NM = nautical mile, MI = mile, FT = feet, IN = inch.

3.8 GPS OBSERVATIONS - Remember to enter "Y" into the satellite usage code field in the *Header Record* if the mark is suitable for survey-grade GPS observations.

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Updated Oct 26, 2009
September 30, 2004

# ATTACHMENT T
# SETTING 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

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# ATTACHMENT T: SETTING CONCRETE MARKS

(From NGS OPERATIONS HANDBOOK and MANUAL OF GEODETIC TRIANGULATION, S.P. 247, see: http://docs.lib.noaa.gov/rescue/cgs_specpubs/QB275U35no247rev1959.pdf, pages 90 - 94.)

## 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 water-tightness 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.

See Attachment U which explains the best type of mark given the bedrock situation (at the surface, just beneath the surface, etc.).

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, cement, and water 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* (at: http://www.ngs.noaa.gov/PUBS_LIB/GeodeticBMs.pdf ) which contains a diagram showing average frost line depth. Place the removed dirt on a tarp for easy removal and clean-up.

WATER JET - A high-pressure water jet has also been successfully used to excavate mark holes. A vacuum, with a 4 inch hose and a suction of at least 800 cubic feet per minute, is used with the water jet to remove the loose material. This method has the advantage of not harming any underground utilities encountered during the excavation. Users claim it also is cost efficient and minimizes any debris around the hole. If this method is used, take care to ensure that the sides of the hole are kept smooth and that the hole is drained prior to pouring concrete, see Number 10 below.

**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 in Annex A to this Attachment.

**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. This will provide uniform support to the disk and help avoid flattening the disk when stamping. Use 3/16 inch steel dies. Neatly stamp the station designation (name) above the triangle, centered below "HORIZONTAL CONTROL MARK" or “GEODETIC 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). Place a small amount of concrete on the underside of the disk before setting to help 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 ALL 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, lid, and any insulation shall be removed after seven days or longer during survey observations.

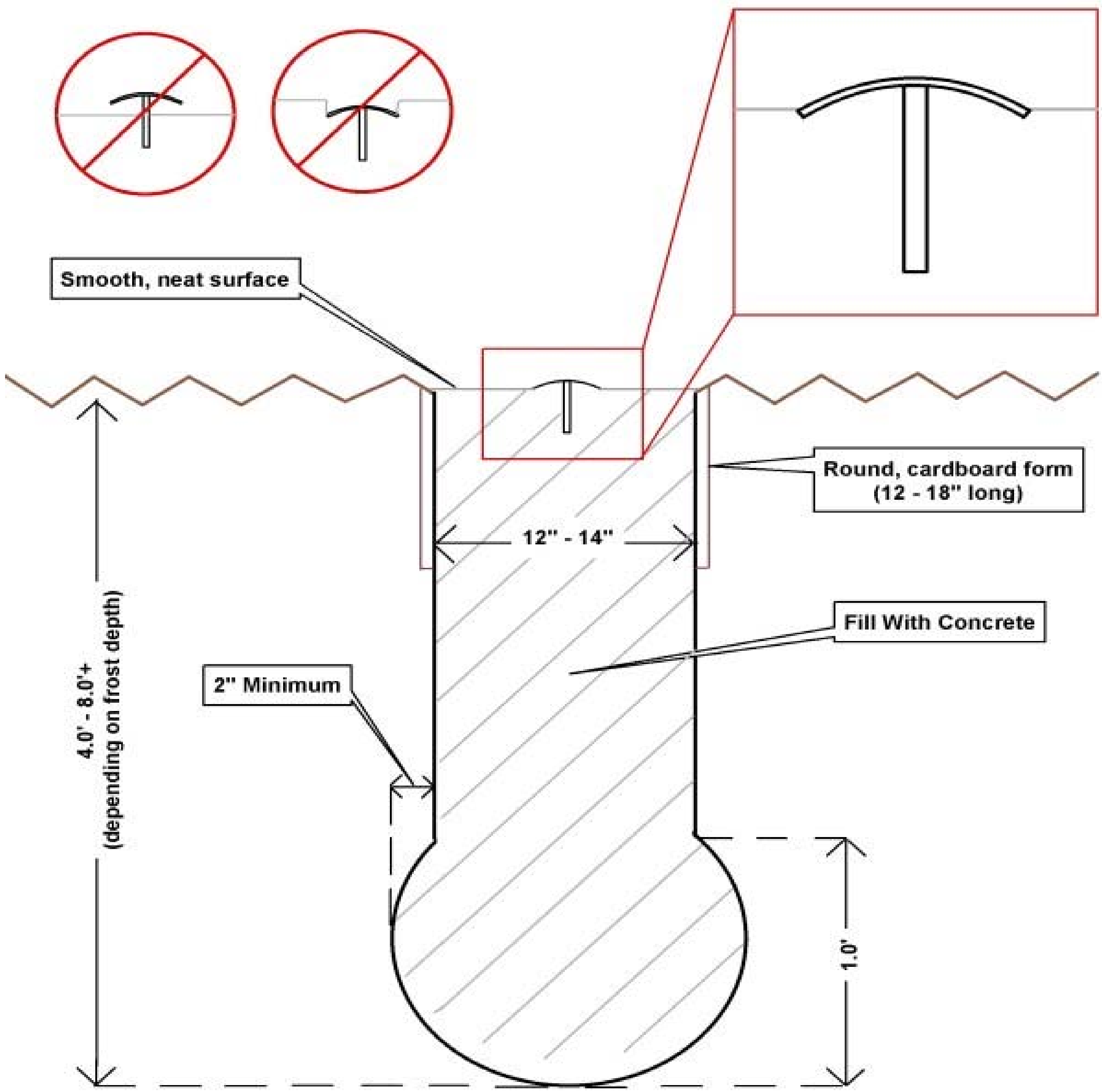
**22.  Remove excess dirt and dispose of it properly.**  In some rural areas there may be a logical spot to dump the extra soil where no one will notice.  If the mark is in an area consisting of groomed lawns, the dirt shall be removed from the site.

**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.**  Generally do not use Witness Posts when the property owner requests that they not be used, in areas of high population density (higher chance of vandalism), 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

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Updated Oct. 21, 2009
September 30, 2004

# ATTACHMENT U
# SETTING A SURVEY DISK IN OR NEAR BEDROCK OR LARGE STRUCTURES

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 OR NEAR BEDROCK OR LARGE STRUCTURES

1. FIVE CASES – See diagram in Annex 2, below.

CASE I – BEDROCK AT GROUND SURFACE
Set a disk in a drill hole per specifications below.

CASE II – BEDROCK LESS THAN ~1.5 FEET (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 type mark.

CASE III – BEDROCK LESS THAN 4 FEET (1.5 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. For further information, see USC&GS Special Publication No. 247, page 93, part (d), at: http://docs.lib.noaa.gov/rescue/cgs_specpubs/QB275U35no247rev1959.pdf .

CASE IV – BEDROCK LESS THAN ~13 FEET (4 METERS) BELOW SURFACE
Do not set a rod mark that will be 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 T entitled, "**SETTING CONCRETE MARK**S"), or move to a different location to set a rod mark (according to the Attachment V "**SETTING A NGS 3-D MONUMENT**").

CASE V – BEDROCK DEEPER THAN ~13 FEET (4 METERS)
Set a rod mark or concrete monument per appropriate Attachments.

From NOAA Manual NOS, NGS 1, *Geodetic Bench Marks*

2. 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."

Mark setting locations other than bedrock may be acceptable if they meet Stability A requirement, as defined in Attachment W, page 4.

Be sure to obtain property owner permission prior to proposing new mark locations. Consider how the mark will be used when selecting a site (tripod set-up, GPS observations, level rod, etc.)

3. SETTING DISKS IN BEDROCK

3.1 STEPS - The step-by-step procedure for setting the disk in bedrock utilizing cement is as follows:

A. 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. Use a stamping block whose top surface is curved to match the underside of the disk. This will provide uniform support to the disk and help avoid flattening the disk when stamping.

B. Pick a fairly level and accessible spot on the bedrock's 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.

C. Drill a 2.5 centimeter diameter vertical 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 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.

D. 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.

E. 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.

F. 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 shall be cleaned off and cleaned out of any stamping. The disk should be readable by an observer facing north.

G. 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.

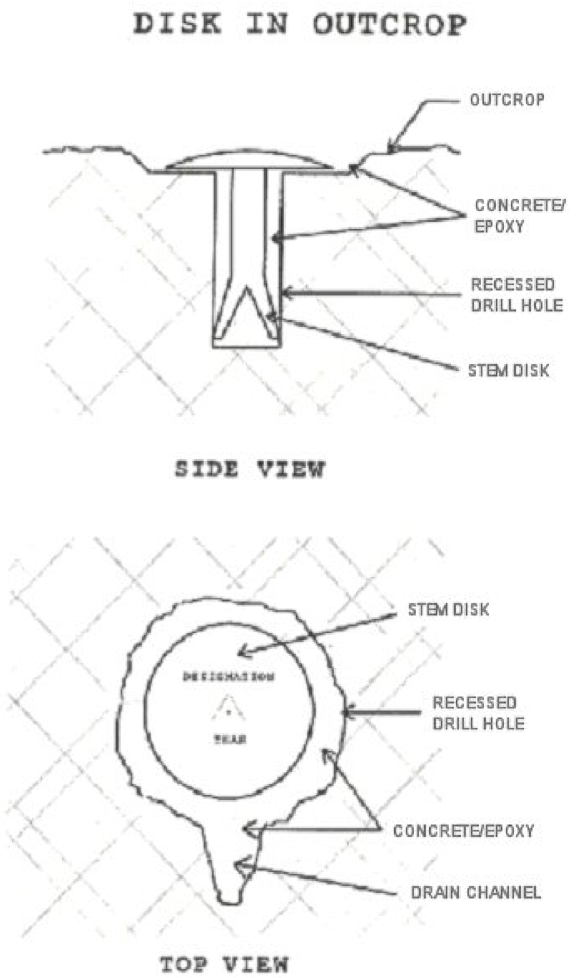
H. While the mortar is still wet, it must be covered to prevent heavy rains or other foreign debris from ruining its surface and to conceal the disk from people who might tamper with it. A piece of wood, cardboard, heavy paper or similar biodegradable item will suffice.

I. The installation is complete when all accumulated trash has been picked up, and the surrounding area in as close to original condition as possible. Leave the site clean and in good order.

J.  Generally do not use Witness Posts when:  the property owner requests that they not be used, in areas of high population density (higher chance of vandalism), nor on airports. They are very useful to future surveyors in more remote areas.

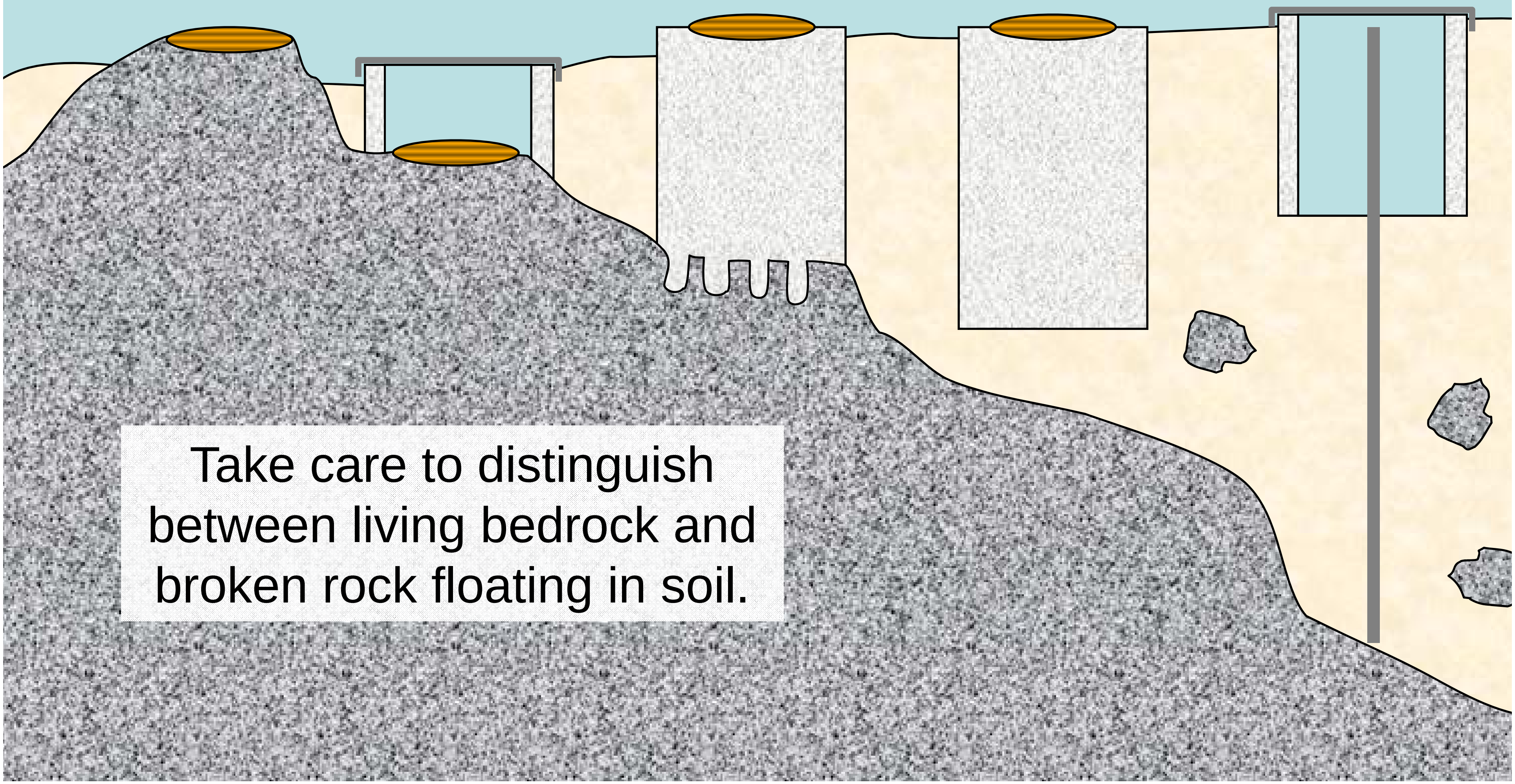
Highway grade epoxy may be used in place of cement if it meets ultraviolet standards and will hold up to all weather conditions. The setting procedures are similar to those described previously except that the drilled hole, though needing to be extremely clean, cannot be wet.

ANNEX 1: DISK IN OUTCROP
DIAGRAM



ANNEX 2

| setting a mark in bedrock | | | | |
|---|---|---|---|---|
| case 1:<br>bedrock at surface | case 2:<br>bedrock < 0.5 m deep | case 3:<br>bedrock < 1.3 m deep | case 4:<br>bedrock < 4 m deep | case 5:<br>bedrock > 4 m deep |
| mark in bedrock | mark in bedrock<br>in a protective well | concrete monument<br>atop bedrock | concrete monument<br>in soil okay | rod mark<br>okay. |



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Updated Oct. 27, 2009
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 requires 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” (http://www.ngs.noaa.gov/PUBS_LIB/GeodeticBMs.pdf), 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. The 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 PolyVinyl Chloride (PVC) pipe with attached, standard, NGS 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, see: http://www.ngs.noaa.gov/PUBS_LIB/GeodeticBMs.pdf .

Geometric Geodetic Accuracy Standards and Specifications for Using GPS Relative Positioning Techniques, by Federal Geodetic Control Committee, August 1989, see: http://www.ngs.noaa.gov/FGCS/tech_pub/GeomGeod.pdf .

## 4. REQUIREMENTS

### 4.1 RECOMMENDED EQUIPMENT FOR SETTING MONUMENTS

A. Rod Drivers and Accessories:
Safety Goggles for each worker.
1- Any driver with a minimum impact force of 25 foot pounds per blow, such as the 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.
2- 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 on 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 on Logo Cap.
1- Hand Saw, for cutting 5 or 6-inch PVC pipe.
1 - Bucket or Wheel Barrel, to mix cement/move unwanted dirt.
2- Five Gallon Water containers and clean 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, Socket-Wrench, 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) or cardboard form, 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

Sufficient lengths of 9/16-inch diameter Stainless Steel Rods, 4-foot sections.
1- Four to five-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 (For photograph documentation of these steps, see: http://www.ngs.noaa.gov/AERO/Genspecs_A/Volume%20A_Attachment%2010.pdf .)

A. Ensure the monument site selection has been discussed with airport management and/or property owners, permission has been obtained, and the location meets all station siting requirements. Inquire about future construction which may affect mark longevity.

B. Contact "MISS UTILITY" type services to inquire about underground utilities before digging or driving a rod.

C. The time required to set 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 D, E, and G, can and should be accomplished at a maintenance shop.

D. Stamp station designation and year of establishment into the blank area on the collar of the logo cap. Use 3/16 inch steel dies.

E. Cut a 20-inch section of 5 or 6-inch PVC pipe. Ensure the end that will receive the logo cap is cut true, smooth, and 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.

F. 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.

G. 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.

H. 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.

I. The 8-foot long connected rod (two sections) 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.

J. 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.

K. Repeat step 10 until the rod refuses to drive further (anchored), or until the driving rate is reduced to 60 seconds per foot. 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.

L. 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.

M. The datum point must then be created by center punching a dimple on the top-center 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.

N. 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.

O. 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.

P. 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.

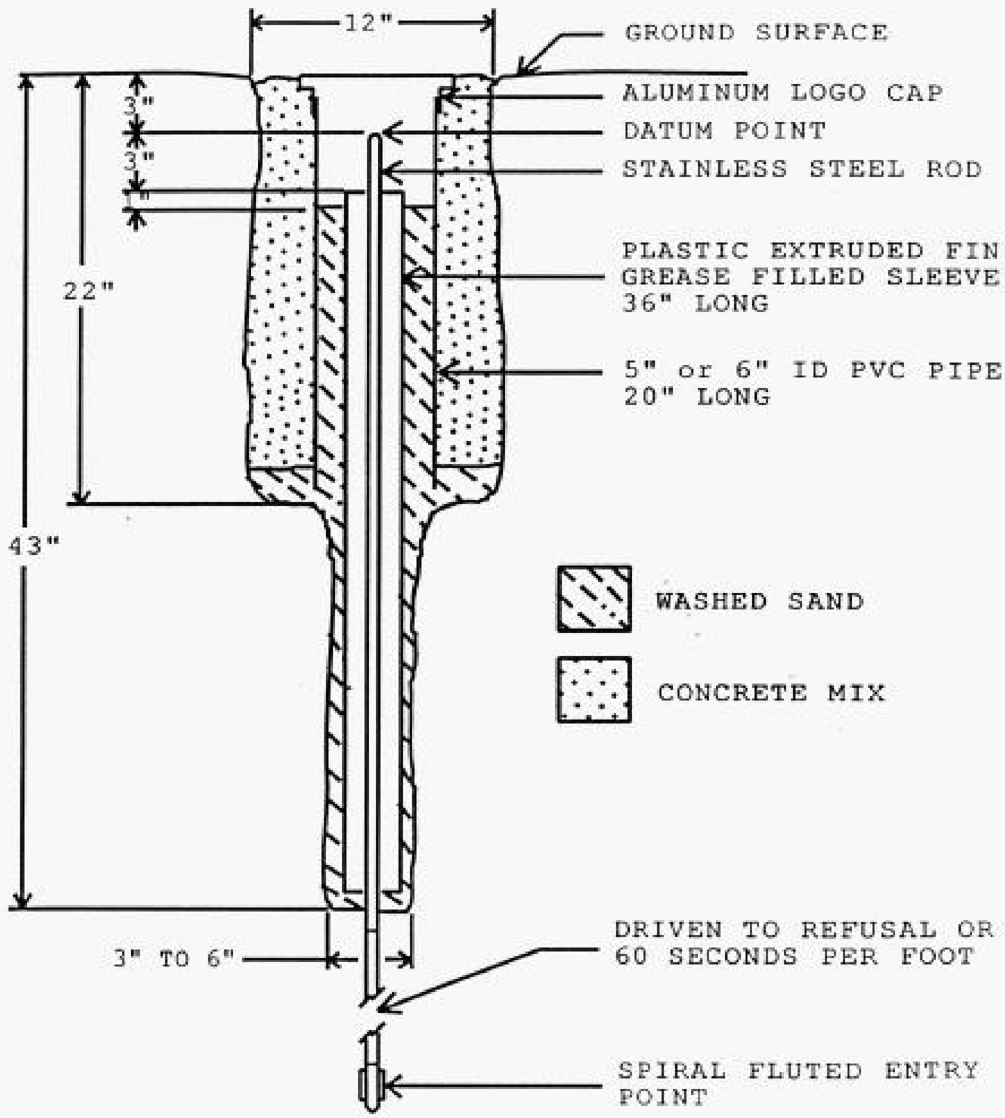
Q. Mix concrete in a bucket or wheel barrel to pasty, well moistened consistency like mashed potatoes. Add Portland cement, if necessary, in sufficient quantity (1 to 2 pounds) to enhance concrete mix or dry an over moistened mixture to maintain adequate consistency. A good indication of adequate consistency 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.

R. 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.

S. 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.

T. Clean all equipment and remove all debris such as extra cement, excess dirt, and trash, leaving the area in the condition it was found, or better.

ANNEX 1: DIAGRAM OF AN NGS 3-D ROD MARK




Schematic of the Revised NGS 3-D Rod Mark, Side View

5

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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
U.S. DEPARTMENT OF COMMERCE

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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 follows:

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.

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October 27, 2009

# ATTACHMENT X
# BENCH MARK TIES

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

For guidance to make optical or digital leveling ties, use the observational procedures in the on-line document “Bench Mark Reset Procedures”, dated May 2007, at:
http://www.ngs.noaa.gov/heightmod/Leveling/Manuals/Benchmark_9_13_07.pdf

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**December, 2009**

# ATTACHMENT Y
# Light Detection and Ranging (LIDAR) Requirements

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

LIDAR REQUIREMENTS

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APPENDICES:

# 1. GENERAL

The National Geodetic Survey (NGS) Remote Sensing Division's (RSD) primary motivation to collect airborne topographic lidar data is to enable accurate and consistent measurement of the national shoreline. The shoreline is defined as the land water interface at a specific tidal datum. Topographic LIDAR is employed as an accurate, efficient way to collect data for generation of a DEM which is in turn used to compile vectors for generating the Mean High Water (MHW) level at the shoreline. This includes areas of wave run up. 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 applied to 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 NGS, the National Ocean Service (NOS), and the NOAA.

This Scope of Work defines requirements for LIDAR data acquisition and processing to support the CMP. In addition, NOAA participates with the Interagency Working Group on Ocean and Coastal Mapping and the Committee on Marine Transportation Safety (IWG-OCM) to develop common standards for airborne coastal mapping and charting data and products. These standards were developed in conjunction with the Joint Airborne Lidar Bathymetry Technical Center of Expertise (JALBTCX) partner agencies (U.S. Army Corps of Engineers (USACE), U.S. Naval Oceanographic Office), and the U.S. Geological Survey (USGS) Center for Coastal and Watershed Studies.

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, from the instant of acquisition, and other deliverables required through this contract including final data, are and shall remain the property of the United States Government. This includes data collection outside the project area. These items include the contractor-furnished materials.

## 2.2 PROVIDED BY GOVERNMENT

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 data acquisition, see Section 8

B. LIDAR ACQUISITION REQUIREMENTS (this document)

C. REJECTED DATA – If data are rejected by NGS, NGS will send sample data upon request showing the problem areas.

## 3.0 DELIVERY SCHEDULE AND DATA FLOW

### 3.1 REGULAR PRODUCTION

Any request to deviate from these standards shall be submitted, in advance of data acquisition, to NGS for written approval.

#### 3.1.1 DATA ACQUISITION STANDARDS

A. Position Dilution of Precision (PDOP) shall be <3.

B. LIDAR point cloud post spacing shall not exceed limits defined in separate Project Instructions.

C. Digital Surface Model (DSM) grid size (spatial resolution) shall not exceed limits defined in separate Project Instructions. The DSM is defined as a regular grid of elevations that depict heights of the top surfaces of vegetation, buildings, towers and other elevated features above the bare earth. Additional guidance on the gridding, vertical datum, and processing instruction may be defined further in the Project Instructions.

Aircraft bank angle shall not exceed 15 degrees.

#### 3.1.2 DATA PROCESSING

A. The point cloud and DSM 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.

B. The vertical datum for the point cloud shall be Ellipsoid North American Datum 1983 (NAD 83), whereas the DSM vertical datum will be specified further in the Project Instructions.

C. Contractor shall remove outliers in raw data prior to interpolation. Outliers include obvious noise or clutter in the data such as returns from birds or atmospheric particles, or due to electronic noise; however be careful to not reclassify real features such as offshore rocks. In the LAS file, no points shall be permanently removed; rather they should be assigned to the appropriate class. Interpolation shall be completed with industry standard software to facilitate validation of DSM. Contractor shall provide details of interpolation process (software and method). If possible, the contractor should utilize Delaunay triangulation with linear interpolation for the gridding of these data sets. This is performed by first creating a Triangular Irregular Network (TIN) from the LIDAR point data. A filter or constraint should be applied to the TIN that limits the length of a triangle side in the surface being created. The maximum triangle side shall be 3X the resolution of the grid being created. Therefore no triangle side greater than 3X the resolution of the grid in meters will be created. In areas beyond 3X the resolution of the grid in any direction of a LIDAR return where another LIDAR return cannot be found, a null value is specified to that particular portion of the surface being generated. A regular grid is then populated through the extraction of elevation information for each grid cell from the corresponding TIN using linear interpolation.

D. There shall be no holidays in the data (no data gaps) unless unavoidable (e.g., water areas) 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.

E. Contractor shall record all process steps and software used including version number.

F. Contractor shall use either the rapid or precise ephemeris for Global Positioning System (GPS) processing.

3.1.3 ACCURACY STANDARDS / SPECIFICATIONS

Accuracy reporting, i.e. Root Mean Square Error (RMSE) $_{X,Y,Z}$, shall follow methods set forth by the American Society of Photogrammetry and Remote Sensing (ASPRS) Lidar Committee (PAD) at http://www.asprs.org/society/committees/lidar/Downloads/Vertical_Accuracy_Reporting_for_Lidar_Data.pdf.

Accuracy shall be determined by the following methods:

A. The contractor shall obtain a minimum of 30 validation check points using geodetic quality measurements distributed throughout the project area on flat terrain, or on uniformly sloping terrain along the entirety of the project area. The X, Y, and Z components shall all be referenced to the NSRS (National Spatial Reference System) and in the same coordinate system and datum used in the rest of the project. As a rule of thumb, the accuracy of the check points should be an order of magnitude better than the LIDAR data. At a minimum, based on the ASPRS LIDAR guidelines, the check point accuracy should be at least three times better than the accuracy of the LIDAR data they are being used to test.

B. Contractor shall verify internal consistency of range measurements in areas of overlap among swaths that shall agree with system specifications of the LIDAR instrument.

C. Computing Errors:

Errors shall be calculated for both Point Clouds and DSM deliverables.

Point Cloud:

The difference or error for each checkpoint shall be computed by subtracting the surveyed elevation of the checkpoint from the LIDAR dataset elevation interpolated at the x/y coordinate of the checkpoint.

DSM:

The difference or error for each checkpoint shall be computed by subtracting the surveyed elevation of the checkpoint from the DSM grid cell that corresponds with the x/y coordinate of the checkpoint.

$\text{Vertical Error}_{(i)} = (Z_{data(i)} - Z_{check(i)})$

Where:

$Z_{data(i)}$ is the vertical coordinate of the $i^{th}$ checkpoint in the data set.

$Z_{check(i)}$ is the vertical coordinate of the $i^{th}$ checkpoint in the independent source of higher accuracy.

i is the integer from 1 to n; n = the number of points being checked

D. Systematic errors shall be identified and eliminated from the delivered data set

E. Calculating and Reporting Vertical Accuracy:

The fundamental vertical accuracy of a dataset must be determined with the checkpoints only in open terrain. Fundamental vertical accuracy shall be calculated at the 95 percent confidence level as a function of $RMSE_{z.}$

i. Compute $RMSE_{(z)} = Sqrt[(\sum(Z_{data(i)} - Z_{check(i)})^2)/n]$

ii. Compute $Accuracy_{(z)} = 1.9600 * RMSE_{(z)}$ = Vertical Accuracy at 95 percent confidence level.

iii. Report $Accuracy_{(z)}$ as:

**"Tested ________ (meters) fundamental vertical accuracy at 95 percent confidence level in open terrain using RMSE(z) x 1.9600."**

F. All validation data shall be submitted to the NGS, as well as an accuracy report that includes a statistical summary of the data quality. This shall include presentation of the $RMSE_{(z)}$, a table summarizing the overall statistics of both the $RMSE_{(Z)}$ consisting of: number of points, mean, median, mode, skewness, standard deviation, minimum, and maximum representative of the $RMSE_{(z)}$ 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.

G. The expected horizontal accuracy of elevation products as determined from system studies or other methods shall be reported.

The contractor shall adhere to the LIDAR Common Specifications issued by JALBTCX as outlined in Table 1 and which can be found in entirety at: http://www.jalbtcx.org/Standards.aspx

| | |
|---|---|
| Vertical Accuracy | 15cm RMSE |
| Horizontal Accuracy | 1m RMSE |
| Spot Spacing | 1m |
| Percent Coverage | Ensure 100% coverage |
| Percent Overlap | Ensure 100% coverage |
| Effective Footprint | 10cm |
| Tide Coordination | When possible low tide |
| Pulse Width | NA |
| Return Logic | Threshold detect -2 returns |
| Classification | LAS 1 and 2 |

**Table 1 Coastal Mapping Specific LIDAR Standard**

In addition to LIDAR data, the contractor may supply ortho-imagery. The standards for the imagery shall adhere to or supersede those outlined in Table 2 below (from JALBTCX, Draft Common Specifications Matrix http://www.jalbtcx.org/Standards.aspx ).

| | |
|---|---|
| Horizontal Accuracy | 2m |
| Spatial resolution | 20cm RGB, 1m |
| Spectral Resolution | 19nm FWHM |
| Spectral Range | VNIR |
| Spectral Bands | 36 |
| Tide Coordination | When possible low tide |
| Camera Calibration | Yes |
| Stereo Coverage | Yes |
| Endlap / Sidelap | 60% / 30% |
| Sun Angle | >20° elevation |
| Max Cloud Cover | 10% |
| Patch | Yes |
| Visibility | 8miles |

Table 2 Ortho-Imagery Specifications

3.2 DATA FORMAT AND STANDARDS

A. Format of deliverables shall be:

i. Point Cloud: LAS 1 and 2 in addition to any more recent version of the LAS standard at time of delivery will be required and specified further in the Project Instructions. The LAS file shall contain all recorded returns (i.e. first, last, and any intermediate returns), return number, scan angle, scan direction, GPS time, intensity, X, Y, Z, and the edge of the flight line (if available) for points used to generate the DSM. If digital aerial imagery is collected concurrently the LAS file should be version 1.2 and contain an associated RGB and/or IR value for each LIDAR point. Details on LAS format standards can be found at: http://www.asprs.org/society/committees/lidar/lidar_format.html

ii. ASCII files

iii. Laser reflectance images

iv. Shoreline output in NAVD 88

v. Land Cover Classification

vi. Hyperspectral reflectance (standards TBD)

vii. Digital Surface Model (DSM) and Digital Elevation Model (DEM): GEOTIFF.

viii. Orthomosaics

ix. Shoreline vectors: shape file.

B. The media for deliverable shall be a portable hard drive formatted as NTFS.

Contractor shall maintain a copy of the data until NGS acknowledges receipt.

3.3 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, acknowledges receipt, reviews data, notifies AC of review outcome.

F. If during the NGS review, the data are found to not meet the Scope of Work (SOW), the contractor may be required to re-acquire the data.

3.4 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 – Prior to commencing data acquisition, the contractor shall provide the following to NGS: certification that both preventive maintenance and factory calibration have been completed either in accordance with the manufacturer's scheduled intervals, or as justified by apparent lack of calibration stability, whichever interval is shorter.

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 amplitude of each received laser echo).

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 inspection 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:

A. 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.

i. Radiometric Calibration (sensor response):

- 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.
- 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.
- Check the alignment between transmitter and receiver and certify that the alignment is optimized and within specification. (Misalignment can lead to poor signal to noise ratios, as well as intensity "banding" or "striping" artifacts.)
- 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.

ii. Geometric Calibration:

- 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.
- Scanner Calibration – Verify that the scanner passes accuracy and repeatability criteria. Provide updated scanner calibration values for scanner offset and scale (or additional parameters [coefficients], if a higher order polynomial correction is used).
- 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 12 month period preceding the data collection. Recalibration is required at intervals no greater than 12 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.

B. 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. The calibration may include flights over the site in opposing directions, as well as cross strips. 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.

C. DETERMINATION of sensor-to-GPS-antenna offset vector components ("lever arm"): The offset vector shall be determined with an absolute accuracy ($1\sigma$) of 1.0 cm or better in each component. Measurements shall be referenced to the antenna phase center. The offset vector components shall be determined each time the sensor or aircraft GPS antenna is moved or repositioned in any way.

D. SPECIAL CONSIDERATIONS – Wavelength
It is recommended that in the majority of shoreline applications, 1.5 micron systems not be used, or at least tightly constrained to NOAA specified operating envelopes.

Eye safety in the deployment of laser-based remote sensing systems is a critical consideration. While 1.5microns are well-suited to providing low-altitude eye safe deployment, they are not necessarily effective in providing reasonable signal returns from the shoreline/littoral zone.

Application (to the shoreline) of LIDAR systems based on lasers with a 1.5micron wavelength is likely to prove problematic.[1] The 1.5micron systems are inherently inferior to 1micron based systems due to the phenomenology of the interaction of the wavelengths with water and surfaces covered in water, such as shorelines. Due to the absorption characteristics of 1.5micron wavelengths, only a fraction of the available energy emitted is available for return to the sensor. This results in drastic reduction in the number of "returns" or points available for mapping the shoreline. Additionally, it implies that to become more effective, the 1.5micron based sensor must be flown at a

[1] *High-Level Analysis & Scientific Assessment of the Utility of Applying a 1.5Micron-Range Wavelength Laser Based Airborne LIDAR System to Shoreline Mapping*, John F. Hahn, August, 2009.

reduced altitude, thereby substantially reducing flight economics and creating potential reduced safety conditions due to the lower altitudes.

The selection of eye-safe wavelengths is based in the ability of water to absorb the energies at 1.5 microns. This means that 1.5 micron based systems will require approximately 10 times the power of a comparably configured 1micron system The inverse way to look at this is that 2 similarly powered systems will result in 1/10$^{th}$ the number of available returns in the case of the 1.5micron system.

Additionally, the detectors typically associated with 1.5micron based systems are usually inferior to the types integrated into 1micron based systems (based primarily on available detector surface area). Therefore, it makes it even more unlikely that 1.5 micron based systems will perform as effectively (collect suitable amount of return signal) as 1micron based systems.

The one area where the disparity between 1micron and 1.5micron is much smaller is in the mapping of wet vegetation. Due to the tendency of water to bead on vegetation/foliage, there remains a large amount of "dry" surface area of the foliage available as a surface to provide a decent return signal.

(See: *High-Level Analysis & Scientific Assessment of the Utility of Applying a 1.5Micron-Range Wavelength Laser Based Airborne LIDAR System to Shoreline Mapping*, John F. Hahn, August, 2009.)

## 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: point cloud post spacing, swath width, swath overlap, navigation, GPS, visibility, and tide-coordination 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 point clouds, DSM, and other requirements.

B. OVERLAP – Adjacent swaths shall have a minimum overlap of no less than 25% of the mean swath width, all the while maintaining 100% coverage.

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

i. 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.

ii. ACTUAL LINES FLOWN – Similar map(s) showing the actual flight lines shall be included in the Final Report, see Section 13 U 3.

E. CROSS LINES – At least one cross line (i.e., perpendicular to the primary flight lines) is required per survey. For longer survey areas, one cross line is required every 25 km.

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.) The altitude must be low enough such that the average laser footprint (per survey block) is ≤ 10cm diameter.

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, unless specifically called out in the Project Instructions. Unlike aerial photography, sun angle is not a factor unless supplemental imagery (e.g., digital imagery) is required to be acquired concurrently with the capture of

LIDAR data to help assist in identifying features in post-processing production. Digital imagery should only be acquired simultaneously with LIDAR during the day.

## 8. TIDE COORDINATION

### 8.1 DATA COLLECTION AND TIDE CONDITIONS

All data collection shall be at or below Mean Lower Low Water (MLLW), unless otherwise specified in the individual project instructions. 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 http://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 Mean High Water (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 gages in the project areas for either real–time or post–flight tidal height comparisons.

A recommended approach to tide coordination and suggested software is described in Appendix 3. This method is only an example of how NOAA NGS currently is able to coordinate surveys around tide states. The contractor may elect use their own methods, but they must be approved by NGS prior to commencing project work. The contractor is solely responsible for tide planning, unless otherwise stated in the individual project instructions.

The contractor must account for wave run-up in ensuring continuous coverage across the land-datum interface within the lidar dataset. This is critically important and if not adhered to may be cause for NGS to reject the data.

### 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 and 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 or better 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 0.05 meter accuracy, or better; shall be within or near the project area; and shall be within 50 kilometers of the entire project area. Additional ground GPS stations may be required, and Continuously Operating Reference Stations (CORS) 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 of each ground station at least once.

v. The maximum GPS baseline shall not exceed 50 kilometers at any time during flight. Regardless of aircraft flight time, GPS ground station data shall be collected for a minimum of four hours.

vi. Ground station data shall be submitted to Online Positioning User System (OPUS) – http://www.ngs.noaa.gov/OPUS/ ) for positioning in the NSRS,

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 and any differences in the north-south, east-west, and vertical components during the operational portions of the flights shall be displayed and reported.

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 RECEIVERS

A. MARK – The ground-based receiver shall be set up over a known (or to-be determined) marked ground station and shall run continuously during the mission. If a known ground station is used, it shall be in the NGS database and hence part of the NSRS. If a new ground station is used, it shall be marked permanently (to NGS specifications) or temporarily marked (such as a PK type nail or iron pin). Specifications on the accuracy of horizontal and vertical positioning of the mark will be further defined in the Project Instructions.

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 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 (i.e. before and after each GPS recording session). 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: http://www.ngs.noaa.gov/PROJECTS/FBN/ . Also, static observations may be processed using the NGS "On-Line User Positioning Service" (OPUS) found at: http://www.ngs.noaa.gov/OPUS/ . 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 in NGS format using NGS software WDDPROC. For a new, permanent station write a digital station description in NGS format using Windesc. For a new, temporary mark write a brief description adequate to recover the station. Take three photographs of the ground station (photographs of the CORS station are not required). For additional specification guidance on mark setting, GPS observations, data processing, and data submittal in NGS format, see: http://www.ngs.noaa.gov/ContractingOpportunities/ReferencedLinks!.htm

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 shall be 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. The GPS post-processing software may be capable of providing an output log of all incidents, such as loss of GPS satellite lock. The formatted output log is acceptable as the report.

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 ground 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 portable hard drives shall be labeled with the project name, collection date(s), contractor name, and disk contents. LIDAR data Portable Hard Drives 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 hard disk), directly to NGS, to arrive at NGS within ten working days from the date of completion of data processing. 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 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 AND QUALITY CONTROL PLAN – Prior to data acquisition, submit a proposed LIDAR Survey and Quality Control 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 Pulse Repetition Frequency (PRF). The separate Project Instructions supplied by NGS will define the project area(s) and may define the point density of the point clouds, DEMs/DSMs, 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). VDatum shall be utilized in the project area to convert to the specified vertical datum as stated in the Project Instructions. VDatum is a software tool that converts elevation data (heights and soundings) among 28 different vertical datums (http://vdatum.noaa.gov). Tide coordination and Ellipsoid/Tidal relationship support may be required, and will be further defined in the Project Instructions.

13.4 LIDAR RAW DATA – Submit the completed data collection raw output.

13.5 LIDAR PRODUCTS – Required products may include: Shoreline shape files, LAS files, and DSM. The Project Instructions will specify which additional products, if any, are required.

13.6 FLIGHT REPORTS – Submit the completed, original LIDAR Flight Logs with the data, as well as a copy directly to NGS. For a sample flight log see Appendix 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. The raw data files shall include RINEX files generated from each receiver's proprietary data files. See sections 9.1 and 9.4.

13.8 AIRBORNE POSITIONING AND ORIENTATION REPORT – Submit raw GPS and IMU data (in the manufacturer's format) along with the final processed GPS trajectory and post processed 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 ground stations and check points. Indicate which GPS points are pre-existing ground control and which stations are new, and positioned relative to the NSRS. See Project Instructions and sections 3.1 C 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 ground station(s): Visibility Obstruction Diagram, GPS Observation Log, Recovery Note or Station Description. See Section 9.2.

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, 12, and 15 for instructions.

13.17 DATA SHIPMENT REPORTING – 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 12.

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 email 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 status reports via email to the Contractor Officer's Representative (COR) contacts in Section 15 every week, until the work is complete. **These reports are due at NGS by 2:00 p.m. EST each Monday.** 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.**

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. For work performed under this contract, discuss each deliverable including: the maximum range from the ground station, the minimum swath overlap, percent of good laser returns (if available), standard deviation and residuals in GPS trajectories, and an explanation of the Portable Hard Drive 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

| | |
|---|---|
| George E. Leigh | Christopher Parrish, PhD |
| Contracts Technical Manager | Physical Scientist |
| National Geodetic Survey | Remote Sensing Division |
| NOAA | NOAA, National Geodetic Survey |
| ATTN: N/NGS: SSMC3, Sta. 8613 | ATTN: SSMC3 |
| 1315 East West Highway | 1315 East West Highway |
| Silver Spring, MD 20910 | Silver Spring, MD 20910 |
| 301-713-3167 | 301-713-2663 |
| email: George.Leigh@noaa.gov | email: Chris.Parrish@noaa.gov |

## 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.

Hahn, John F., *High-Level Analysis & Scientific Assessment of the Utility of Applying a 1.5Micron-Range Wavelength Laser Based Airborne LIDAR System to Shoreline Mapping*, August, 2009.

Appendix 1 – LIDAR Flight Log (NOT YET CREATED)

Appendix 2 – JALBTCX Draft Common Specifications Matrix

Draft Common Specification Matrix for Airborne Coastal Mapping and Charting

| *Survey type* | **Engineering** | **Charting** | **Environmental Assessment, Modeling, Regional Coastal Mapping** | **Emergency Response, Reconaissance** |
|---|---|---|---|---|
| **Bathy Lidar** | | | | |
| Vertical accuracy | | 50 cm 2s | 15 RMSE | |
| Horizontal accuracy | | 5 m 2s | 1 m RMSE | |
| spot spacing | | 2 X 2,3X3 | 4 m | |
| Percent coverage | | 100,200 | 100 | |
| Percent overlap | | 30? | ensure 100% coverage | |
| Effective footprint | | NA | NA | |
| tide coordination | | NA | when possible high tide | |
| Pulse width | | NA | NA | |
| | | | | |
| **Topo Lidar** | | shoreline mapping | | |
| Vertical accuracy | | 15 cm RMSE | 15 cm RMSE | |
| Horizontal accuracy | | 1 m RMSE | 1 m RMSE | |
| spot spacing | | 1 m | 1 m | |
| Percent coverage | | 100 | ensure 100% coverage | |
| Percent overlap | | 30 | ensure 100% coverage | |
| Effective footprint | | | 10 cm | |
| tide coordination | | yes | when possible low tide | |
| Pulse width | | NA | NA | |
| Return logic | | "true" last | threshhold detect -2 returns | |
| Classification | | not required | LAS 1 and 2 | |
| | | | | |
| **QA/QC** | | | | |
| GPS PDOP | | <= 3 | <=3.5 | |
| Crossline spacing | | 25 km | 25 km | |
| Crossline number | | 1 per alongshore block | 1 per alongshore block | |
| Combine separation | | 10 cm | 10 cm | |
| Ground control | | 30 checkpoints | 20 points/3 classes/100 miles | |
| TPE Horizontal & vertical | | no | no | |
| Qualitative assessment | | targeted to shoreline | yes | |
| | | | | |
| **Imagery** | | | | |
| Horizontal accuracy | | 2 pixels | 2 m | 2 m |
| Spatial resolution | | 50 cm | 20 cm RGB, 1 m | 35-50 cm |
| Spectral resolution | | NIR >740 nm | 19 nm FWHM hyperspectral | |
| spectral range | | VNIR | VNIR | RGB |
| Spectral bands | | 4 | 36 | 3 |
| Tide coordination | | yes low tide | when possible low tide | NO |
| Camera callibration | | yes and certification | yes | yes |
| Stereo coverage | | yes | yes | yes |
| Endlap sidelap | | 60%/30% | 60%/30% | 60%/30% |
| Sun angle | | >30 elevation | >20 elevation | >10 elevation |
| Max cloud cover | | no on shoreline | 10% | avoid where possible |
| Patch | | yes | yes | yes |
| Visibility | | 8 miles | 8 miles | see the ground |
| | | | | |
| **Products** | | | ASCII | orthomosaics |
| | | | LAS | mosaics |
| | | | DEM | |
| | | | DSM | |
| | | | orthomosaic | |
| | | | laser reflectance images | |
| | | | NAVD88 shoreline | |
| | | | land cover classification | |
| | | | hyperspectral reflectance mosaics | |

Appendix 3 - Tide Coordination

**NGS Remote Sensing Division's Coastal Mapping Program**

***Tide coordination of Airborne Topographic LIDAR collection using TCARI***

The NGS Remote Sensing Division's primary motivation to collect airborne topographic lidar data is to enable accurate and consistent measurement of the national shoreline. The shoreline is defined as the land water interface at a specific tidal datum. NOAA charts both MHW and MLLW shoreline vectors on its nautical charts. This is not trivial as a tidal datum is by definition local, meaning that the vertical reference is only valid for a specific location. In order to define a tidal datum, a gauge must be installed and used to collect data for up to 18.6 years (an astronomical tidal epoch) depending upon the required level of accuracy. Throughout a survey project area of any useful size, the tidal datum can vary significantly. As a matter of practice, it is not viable to measure the MLLW shoreline using topographic lidar. The MHW shoreline however, can be extracted from lidar data so long as the data is collected at a sufficiently low tide stage. In order to accomplish this, NOAA has developed tools for airborne survey planning, as well as data quality assurance. Tidal Constituent and Residual Interpolator (TCARI) is an algorithm that models the tidally driven water level in space and time. It is an efficient method to determine when the water level in a specified area is predicted to be at, above, or below a certain tide level. Following a survey, it can also be used to check the actual water level at time of collection, which can deviate from predictions due to meteorological phenomena.

TCARI begins by establishing a boundary for a particular area using the shoreline vector (Fig 1).

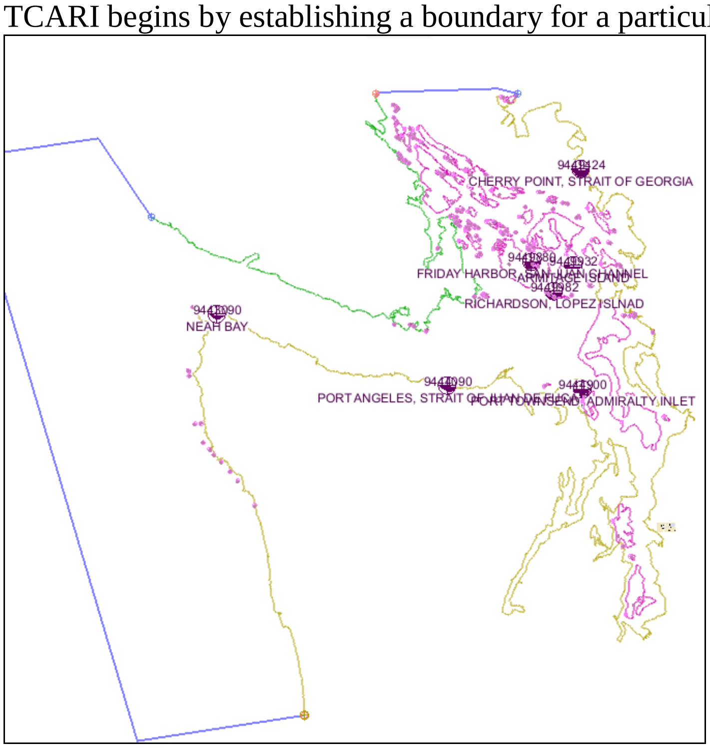

Figure 1 – Example of a TCARI grid boundary

Tidal datum locations as well as active water level gauge sites are applied, and a triangular network is created to enable the constituent and residual interpolation (Fig 2).

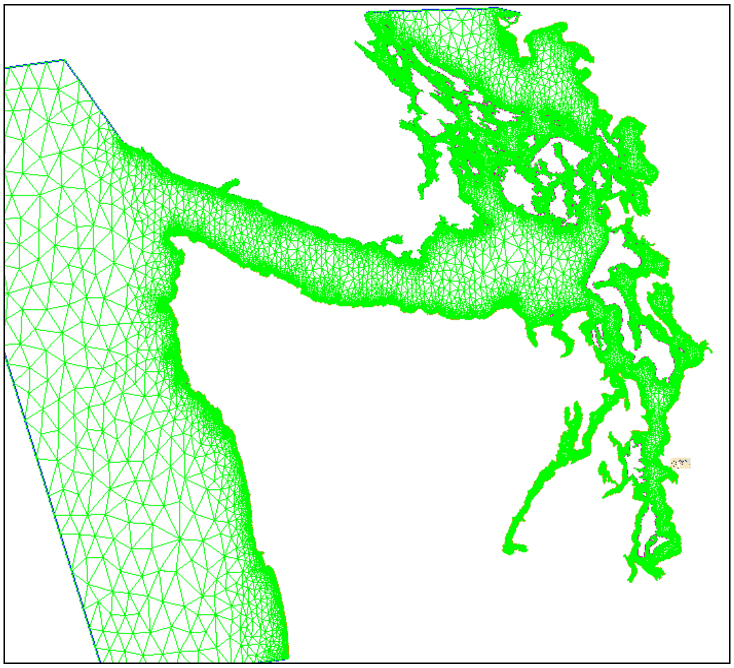

Figure 2 – Triangular network of example area

Once this is done, a predicted or actual (predicted plus residual) water level model can be created (Fig 3).

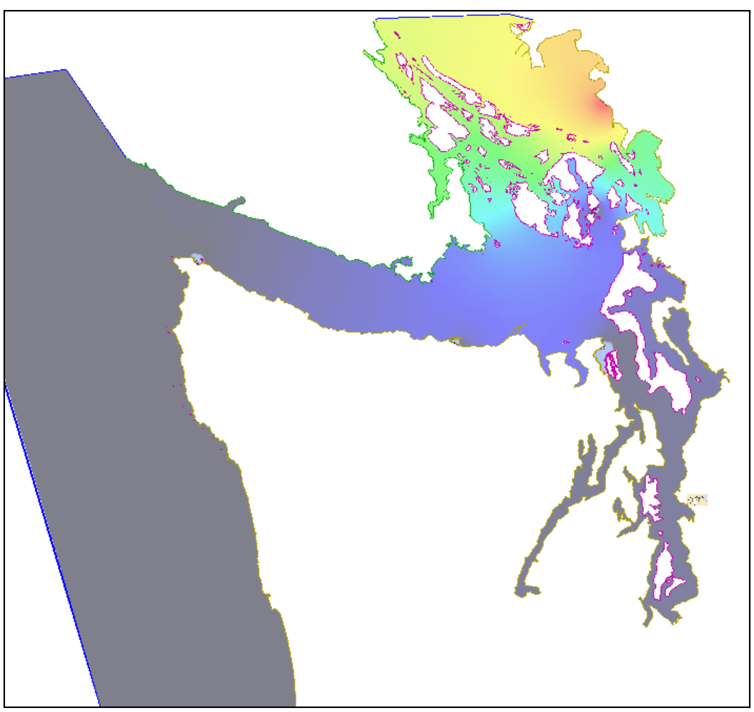

Figure 3 – Color ramped example of water level prediction using TCARI

The technique is scalable and can be used for small and very large project areas. In the case of topographic lidar collection, the requirement is to collect data when the water level is a pre-defined margin below the desired datum. In the case of MHW collection, this can be expressed as $WL<(MHW - x)$, where x is the predefined margin. This margin value will depend upon both the specific instrument characteristics, as well as the meteorological conditions, specifically wave height and run-up on the open coast.

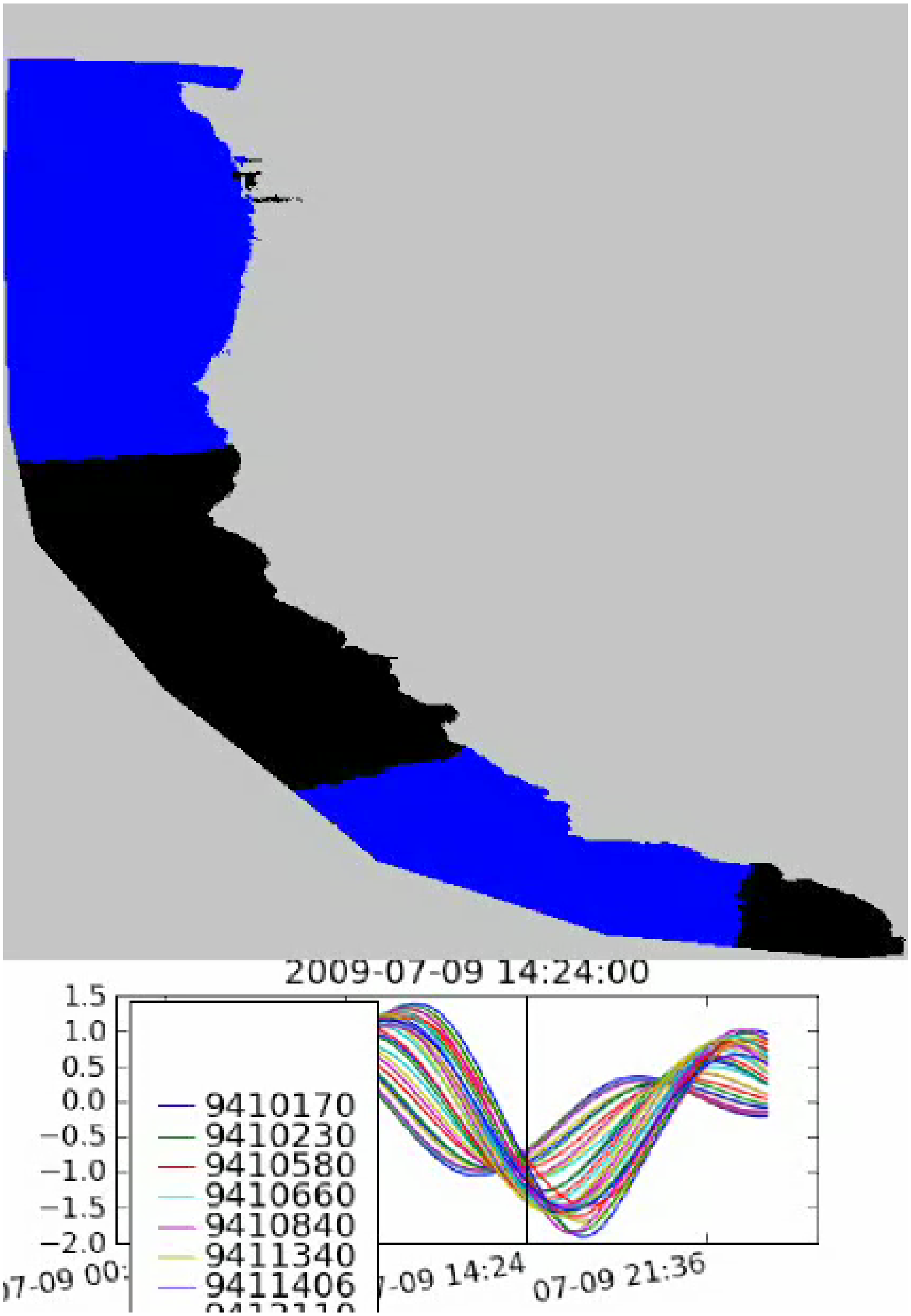

Figure 4 – Map of water level meeting a pre-defined survey condition

Figure 4 above depicts areas that meet a pre-defined water level condition. Using the NOAA developed Pydro software, TCARI is exploited to perform survey planning and QA. Initially, survey lines are planned and imported into Pydro (Fig 5).

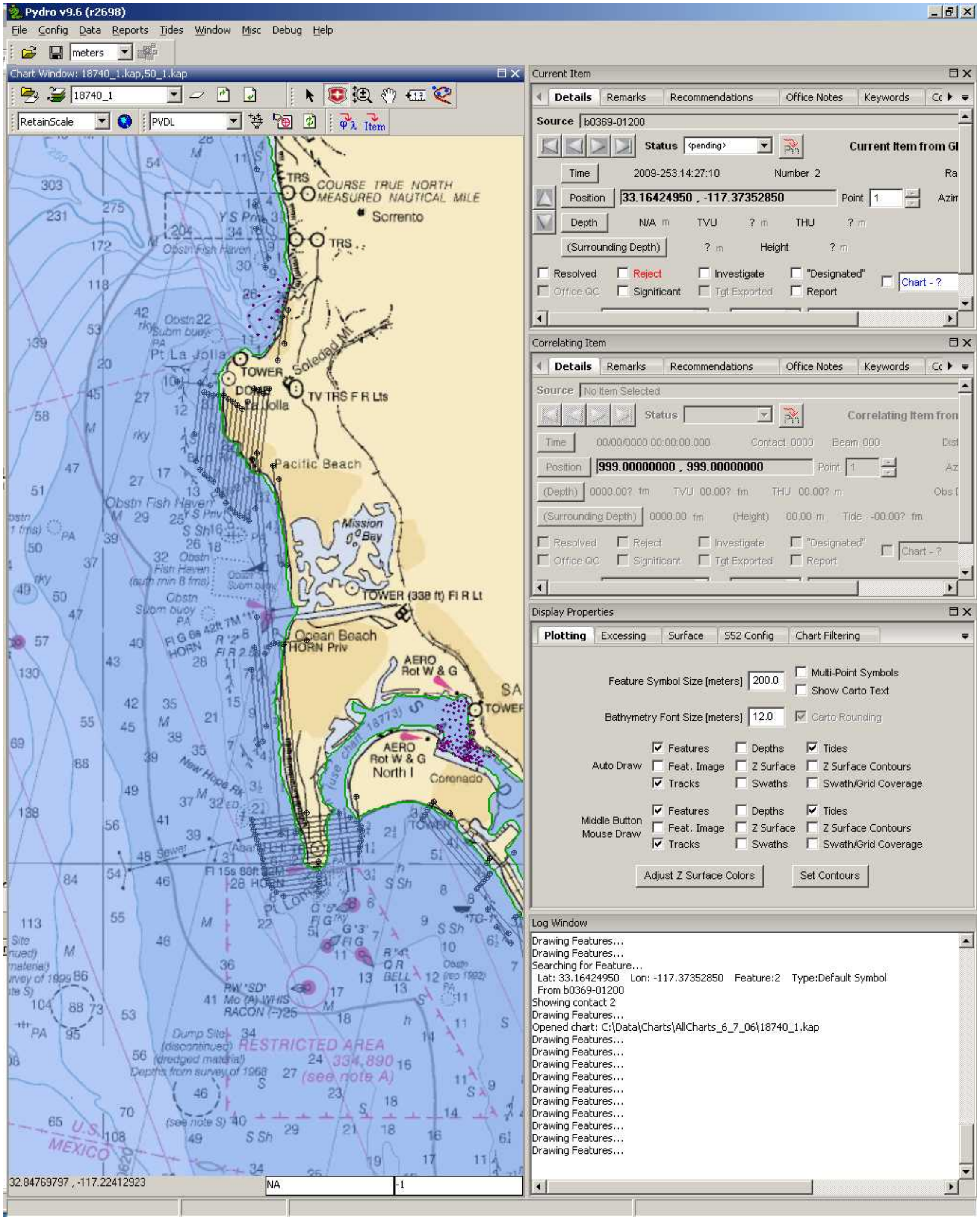


Figure 5 – Survey flight lines imported into Pydro

Once the flight lines are loaded, Pydro can be used to compute time of day windows over a specified interval that satisfy a predefined condition – in this case WL<(MHW-50cm) (Fig 6).

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Feb. 1, 2011

# ATTACHMENT Z
# Digital Aerial Camera Usage & Data Processing

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

This Attachment defines requirements for digital imagery acquisition and processing to support the Coastal Mapping Program (CMP) and other NOAA program requirements.  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 the National Geodetic Survey (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. Project Diagrams with project limits marked and showing the shoreline to be compiled highlighted.  Compilation limits, if different from the 2000 foot requirement; and, as required, limits of tide-coordination areas, if different from compilation limits;

ii. Digital Files with the above information;

iii. Tidal zoning diagram; Tidal Constituent And Residual Interpolation (TCARI) data, TCARI memo;

iv.  Tidal zoning memo;

v.  Waypoint file;

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

vii. PROJECT IDENTIFIER - The "Project Identifier," a six character alpha-numeric Identifier (ID) unique to each project.

Note, the Contractor is responsible for procuring new editions of nautical charts, 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 ;

B. DIGITAL AERIAL CAMERA USAGE & DATA PROCESSING - 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 may be required to make Global Positioning System (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 GEOID09 or the most current version. For GEOID information see: http://www.ngs.noaa.gov/GEOID/

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. <u>EQUIPMENT AND MATERIAL</u>

### 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;

iii. Calibration: Aerial Sensors/Camera(s) used to collect project imagery shall have current U.S. Geological Survey (USGS) certification, or in the case of digital sensors a current USGS digital aerial sensor type certification;

iv. The sensor shall meet the requirements of the Inter-agency Digital Imagery Working Group (IADIWG);

v. The sensor shall not produce bright object edge artifacts;

vi. The sensor shall acquire blue (B), green (G), red (R), and near infrared (NIR) spectral bands. To provide sharp contrast between land and water, it is critical that the NIR passband start at a wavelength greater than 740 nm (ideally, around 800 nm or higher). For example, a well-suited sensor might have a NIR passband of 800-1000 nm with high transmittance inside this band, and very low transmittance below 800 nm. (It is perfectly acceptable for the passband to extend further into the NIR on the high wavelength end.) The justification for this requirement is explained in Parrish et al. (2005). If an optical bandpass filter is used to satisfy the above requirement, this filter must be accounted for in the camera calibration so that the sensor's geometric accuracy is not adversely affected by the use of the filter.

Reference:

Parrish, C.E.; Sault, M.; White, S.A., and Sellars, J., 2005. Empirical Analysis of Aerial Camera Filters for Shoreline Mapping, *Proceedings of the ASPRS Annual Conference*, unpaginated CD-ROM.

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 be able to acquire the following bands: red, green, blue, and black-and-white IR. The IR shall be a separate image and the IR shall meet the accuracy and resolution requirements without pan-sharpening. 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 a Federal Aviation Administration (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 preferably 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 and 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 of each project and again if the system is removed and remounted during the project. The contractor shall follow the 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 shall 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 re-determined 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 in the project area and ensure complete coverage of the area. Photo coverage shall be planned to include the shoreline within the project area and offshore features immediately adjacent to the shoreline as well as all land within 2000 feet of that shoreline, including offshore islands and rocks. Flight lines shall be designed to cover the project area with the fewest flight lines practicable at an altitude that produces a 0.6 meter Ground

Sample Distance (GSD) with the Contractor's digital camera. Other mission planning parameters may include, but are not limited to: endlap, sidelap, flying speed, crab, tilt, tide coordination, PDOP , and aircraft bank angle.

i. GROUND SAMPLE DISTANCE – The GSD is an area on the ground represented by each pixel in a digital image, typically 60 cm (0.6 meter) for a shoreline mapping project.

ii. 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.

iii. 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%.

iv. FLYING SPEED – The camera manufacturer's recommendation should be followed for flying speed. Flying speed shall be limited to keep image smear below 15%. The maximum speed over ground for push broom sensors shall not exceed the manufacturer's guidelines.

v. 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.

vi. TILT - While collecting digital imagery, tilt (departure from the vertical) of the camera shall not exceed +/- five (5) degrees for any photographic frame. The average tilt for the entire project shall not exceed +/- one (1) degree.

vii. TIDE COORDINATION – Coordination of imagery acquisition with specific stages of tide may be required. See Attachment J for tide coordination requirements.

viii. PDOP/VDOP - PODP/VDOP shall be < 3.

ix. AIRCRAFT BANK ANGLE – The aircraft bank angle shall not exceed 15°.

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

6.3. NGS SUPPLIED FLIGHT LINE DATA - NGS may supply shapefiles showing the flight lines to be used for a project. The Contractor shall check this flight line data and waypoint files to ensure adequate coverage for mapping and aerotriangulation (AT), including coverage of offshore rocks and islands.  The Contractor shall notify NGS immediately of any problems found with the flight lines.  The Contractor shall use the NGS flight lines to acquire the required photographs.

## 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 - Leaf-off condition is not required but is preferred.  Trees along a shoreline can obscure the shoreline if care is not taken in planning.

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 25 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 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).

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://www.usno.navy.mil/USNO/astronomical-applications/data-services/alt-az-us/?searchterm=sun%20altitude which computes sun altitudes and sun azimuths for U.S. locations and world-wide positions.

7.6 CLEAR DAY MAP – Refer to: http://cdo.ncdc.noaa.gov/cgi-bin/climaps/climaps.pl . Please see Attachment C, Section 9.6 for directions 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, see (National Data Buoy Center: http://www.ndbc.noaa.gov/ , and the National Climatic Data Center: http://www.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 Mean High Water (MHW) and/or Mean Lower Low Water (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, and also to process tidal data.

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, or faster, collection shall be used in the aircraft.

iv. All KGPS shall use at least two ground stations. The Ground GPS Base 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. NGS recommends that CORS (Continually Operating Reference Stations) be used as ground stations. The Ground GPS Base Stations should be positioned on opposite sides of the operating area. The Ground GPS Base 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. 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, using NGS approved interpolation software. CORS stations with a 30-second (or longer) data rate shall not be used as GPS base stations.

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 at least 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. Observe and submit two sessions for new points and one session for existing survey points.

#### 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 Ground GPS Base Station receivers shall be equipped with antenna models 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). NGS recommends the use of CORS as Ground GPS Base Stations.

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

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 the NGS CORS. If the distance to the nearest reference receiver is less than 100 kilometers, observe at least two independent sessions, each 2 hours long. If the distance to the nearest NGS CORS is greater than 100 kilometers, observe 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: http://www.ngs.noaa.gov/PROJECTS/FBN/ . Also, static observations should be processed using the NGS On-Line Positioning User Service (OPUS) found at: http://www.ngs.noaa.gov/OPUS/ . 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. 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 it appears that lock has been lost, attempt to reacquire lock by flying within 10km of a Ground GPS Base Station or CORS. 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.

9.5 GROUND CHECK POINTS - Four or more Check Points are required, see: SOW, Section 6.2A

9.6 GROUND PHOTO CONTROL - Ground photo control may be required by the PI, and may be proposed by the Contractor. See Attachment O for requirements

## 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 the Task Order Management and Information System (TOMIS).

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 shapefile 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 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 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 shapefiles 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. See section 3.1 and 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 Digital Camera Acquisition Log with the data, and a copy to NGS via TOMIS. For a sample Log see Annex 2. (Use the latest version of NGS' Log for digital imagery.

12.7 ELECTRONIC EXPOSURE DATA (EED) FILE – Complete and submit. Use the latest version of NGS' EED file format for digital imagery.

12.8 AIRBORNE POSITIONING AND ORIENTATION – The Contractor shall submit the original, raw GPS and IMU data files and processed trajectory files to NGS via TOMIS, along with the raw data points and final products. If IMU geo-referencing is employed, submit the exterior orientation file with the EO parameters. See sections 4 and 9.

12.9 GPS POINTS – Submit an organized list of all GPS points used for the project as Ground GPS Base Stations, ground control points, and check points. Indicate which 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. Also indicate which are pre-marked and which are photo-identified points.

12.10 TABULATION OF AERIAL PHOTOGRAPHY – Supply table(s) showing the actual times of acquisition flights and the tide coordination time "windows." See Section 8. Explain any discrepancies.

12.11 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 bore-sight calibration values, determined through the calibration procedures.

12.12 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.

12.13 SENSOR PORT WINDOW – Report the physical characteristics of any port window used to NGS. See Section 4.4 B.

12.14 DATA SHIPMENT REPORTING – The Contractor shall submit Deliverables via TOMIS. Mark “COPY” at the top of the digital copy of the Flight Log. This shall be done the same day the data is shipped. See Section 14

12.15 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.

12.16 WEEKLY STATUS REPORTS – The Contractor shall submit project weekly status reports to NGS via TOMIS **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.

12.17 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 shapefiles, 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
DVD – Digital Video Disc
FOV - Field of View
FTP – File Transfer Protocol
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
TIFF – Tagged Image File Format
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.

# Digital Camera Acquisition Log

| | | |
|---|---|---|
| NOAA/ NOS/ NGS | Aircraft | Pilot |
| Remote Sensing Division | Tail Number | Co-Pilot |
| Silver Spring, MD 20910 | Date | Operator |
| | Camera | Lens |

| | Project | Flight Line | Start Frame | Stop Frame | Hdg | AGL (ft) | PDOP | Clouds | Remarks |
|---|---|---|---|---|---|---|---|---|---|
| | | | Start Time | Stop Time | Speed | | SVs | Vis. | |
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December 14, 2009

# ATTACHMENT AA
# HYPERSPECTRAL SENSOR USAGE & DATA PROCESSING

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 SENSOR USAGE & DATA PROCESSING

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 Scope of Work for use in shoreline mapping and/or 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.

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December 14, 2009

# 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's requirements may include:

1.1. Setting up Ground Global Positioning System (GPS) Base Stations (two or more) in or near the project area to control the airborne data collection,

1.2 Making GPS ties to NOAA tidal bench marks,

1.3Constructing and positioning radar reflectors to control the data,

1.4Collecting Interferometric Synthetic Aperture Radar (IFSAR) data over the project area,

1.5 Processing the data,

1.6 Producing a Digital Elevation Model (DEM), and

1.7 Producing 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 the Scope Of Work (SOW) or the 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.  Coordinated Universal Time (UTC) is recommended.

3. LOCATION - The data will be collected in the areas defined in the Project Instructions.  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 Ground GPS Base 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 6 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. The contractor may be required to make GPS ties to NOAA tidal bench marks within each project, if existent, and approximately equally spaced, if possible. The contractor may also be required to install tide gauges and tidal bench marks, monitor, level, and remove tide gauges, and also to process tidal data as specified elsewhere in this SOW.

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 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 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 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 may be required to make GPS connections to NOAA tidal bench marks, see Section 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 DVD.

12. REPORTS

12.1 WEEKLY STATUS REPORTS - The Contractor will submit Weekly Status Reports via TOMIS 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. See Attachment AI for TOMIS requirements.

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 GROUND GPS BASE STATIONS - Recommended location of Ground GPS Base Stations, 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 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 - Work performed under these Project Instructions; discuss each deliverable, both data collection and data processing;

16.2 TECHNICAL DISCUSSION - Technical discussion of the data;

16.3 EQUIPMENT - Equipment used to perform this work, including hardware models and serial numbers, and software names and versions;

16.4 KGPS - Discuss airborne kinematic GPS processing and inertial data processing;

16.5 TIDES - Tide coordination table discussion;

16.6 UNUSUAL CIRCUMSTANCES - Any unusual circumstances or problems, including equipment malfunctions, (including those already reported);

16.7 DEVIATIONS - Any deviations from this SOW (including those already reported); and

16.8 RECOMMENDATIONS - Any recommendations for changes in the SOW for future work.

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

REFERENCE NO.

ME0401-1

## LETTER TRANSMITTING DATA

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

- ☐ ORDINARY MAIL
- ☐ AIR MAIL
- ☐ REGISTERED MAIL
- ☑ EXPRESS
- ☐ GBL *(Give number)* ____________

**TO:**

George Leigh
Attn: N/NGS Station 8609
1315 East-West Highway
Silver Spring, MD 20910

DATE FORWARDED

17JUN04

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 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

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

**RETURN TO**
**SOW MAIN TEXT**
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Updated October 28, 2009
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

# ATTACHMENT AC - TRANSMITTAL LETTER

1. TOMIS
The Task Order Management Information System (TOMIS) has replaced Transmittal Letters (TL) for most shipments.

1.1 DELIVERABLES SUBMITTED THROUGH TOMIS - Contractor Deliverables that are submitted through TOMIS do not require a TL.

1.2 DELIVERABLES SUBMITTED OUTSIDE TOMIS – For Contractor Deliverables that cannot be submitted through TOMIS, such as: files larger than 3 Mega Bytes (MB), paper copies of Deliverables, large charts, hard drives, Compact Disks (CD), etc., the Contractor shall make a TOMIS entry for them, and shall prepare a TL and include it in the shipment.

1.3 NOAA ACKNOWLEDGEMENT - NOAA will acknowledge receipt of all Deliverables (digital and paper; including those submitted through TOMIS and those submitted outside TOMIS) using TOMIS.

1.4 NOAA SHIPPED ITEMS - TOMIS does not handle items that NOAA ships to Contractors. NOAA will include TL with items shipped to Contractors. Contractors shall verify that the shipment is complete (or note any discrepancies), sign and date the TL, and FAX or email the TL back to NOAA.

See also Attachment AI, TOMIS INSTRUCTIONS.

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

REFERENCE NO.

ME0401-1

## LETTER TRANSMITTING DATA

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

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

**TO:**

George Leigh
Attn: N/NGS Station 8609
1315 East-West Highway
Silver Spring, MD 20910

DATE FORWARDED

17JUN04

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 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

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

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Feb. 1, 2011

# 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

1.  GENERAL - Technical Proposals shall contain at least the sections and information listed below, unless that type of work is not required by the Project Instructions (PI).  The Technical Proposals shall not contain all or parts of the Scope of Work (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 – A Gantt Chart is no longer required.

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.  If there are any offshore islands and/or rocks, discuss how the proposed control will be adequate for the Aero-Triangulation (AT).

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 is 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 proposed locations of all ground control points using different symbology for existing control, new control and the four 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 Continuously Operating Reference Stations (CORS) and On-line Positioning User Service (OPUS) will be used, and why or why not.  Note: approximate locations are acceptable.  Discuss data processing.

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 Electronic Exposure Data (EED) file.

2.11  AIRBORNE KINEMATIC GPS - Discuss equipment, data collection, and data processing. State whether or not an Inertial Measuring Unit (IMU) is proposed to be used.

2.12  GROUND BASE STATIONS – Provide a map showing locations of the two or more 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 data interpolation, if proposed.

2.13  AEROTRIANGULATION - Discuss method and equipment to be used and types of data that will be input. Discuss comparison with "check points".

2.14  COMPILATION – The Contractor shall state that the project will be subdivided into separate work areas according to number and locations in the Project Instructions. Select the location and extent of the Pilot Areas and submit a graphic showing the areas. The Contractor shall state which water line(s) will be compiled, and from which imagery. Discuss methods and equipment to be used.

2.15  QUALITY CONTROL (QC) - State how all work will be reviewed and how the prime will oversee and communicate with 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 – Submit in the specified format, see Attachment AI, entitled “Task Order Management Information System” (TOMIS). Ensure that all Deliverables, listed in the SOW and PI, are included and use the exact Deliverable name as listed in the SOW or PI.

2.19  ORTHORECTIFIED MOSAICS – If these are required by the PI, discuss their creation, methods, and equipment to be used.

3.  FORMAT – See Main Text, Section 5.1 for Report Format.

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March 22, 2010

# 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: IMG_SOURCE

- Data type: Text
- Width: 32
- Definition: Describes the source of imagery. Use "AERIAL/camera" for aerial photography, where camera = camera type (e.g. RC-30 or DSS-439), and for satellite imagery enter the name of the sensor (e.g. IKONOS-2).

Attribute_Label: IMG_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:

| CHG_NOTE | ENC_vs_RAS | VERIFIABLE | PRIORITY | RSD_REC | RSD_NOTE |
|---|---|---|---|---|---|
| Chart 11424 19th Ed., Aug. 06/05, Scale 1:80,000 | | | | | |
| Chart 11415 8th Ed., Aug. 05/06, Scale 1:40,000 (Extension) | | | | | |
| Chart 11415 8th Ed., Aug. 05/06, Scale 1:40,000 | | | | | |
| Unable to confirm existence of charted pile with imagery | | DOUBTFUL | LOW | MAINTAIN | |
| Unable to confirm existence of charted piles with imagery | | DOUBTFUL | LOW | MAINTAIN | |
| Pier is gone | | YES | MEDIUM | REMOVE | Disprove ruins |
| Piers are gone | | YES | MEDIUM | REMOVE | Disprove ruins |
| Unable to confirm existence of charted piles with imagery | | DOUBTFUL | LOW | MAINTAIN | |
| Unable to confirm existence of charted pile with imagery | | DOUBTFUL | LOW | MAINTAIN | |
| R Tower is gone | | YES | MEDIUM | REMOVE | |
| Unable to confirm presence of overhead cable with imagery | | DOUBTFUL | LOW | MAINTAIN | |
| Unable to confirm wreck location/existence with imagery | CONFLICT | DOUBTFUL | HIGH | MAINTAIN | |
| Unable to confirm existence of charted pile with imagery | | NO | LOW | MAINTAIN | |

*(note new graphic)*

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: 8
- Definition: Degree of confidence in the ability to verify the position or existence of the feature in the imagery. Answers question, *should the feature be visible?* (Takes into account all factors including imagery quality, depth of feature, etc.)
- Domain: YES – The feature should be visible in the imagery.
  DOUBTFUL – It is doubtful the feature would be visible.
  NO – The feature should not be visible.

Attribute_Label: PRIORITY

- Data type: Text
- Width: 8
- 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: 8
- 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: 50
- Definition: Description of unresolved issues of importance in the geographic cell (GC), documenting items for further investigation by NOAA hydrographic personnel. A common case when this field would be populated is to flag the possible presence of submerged ruins where a charted pier has been removed (e.g. "Disprove subm ruins").

Attribute_Label: ENC_NOTE

- Data type: Text
- Width: 75
- 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.

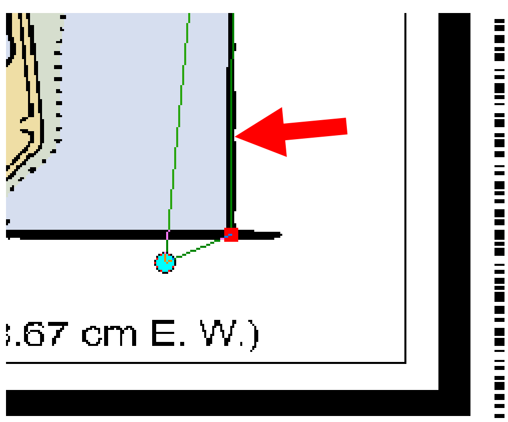
Attribute_Label: DATASRC_ID
. Data type: Text
. Width: 20
. Definition: Unique identifier assigned by the NOAA Office of Coast Survey. The contractor shall not populate this field.

## 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 features whose charted positions are no longer valid or could not be verified.

### 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).



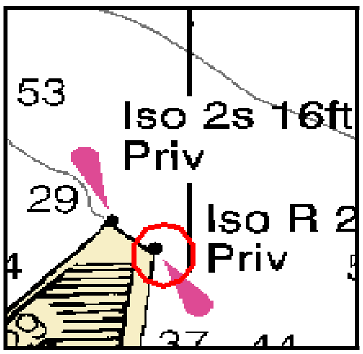

For each chart polygon in the CEF, the NOAA chart edition information shall be entered into the CHG_NOTE attribute field. This information shall include the chart number, edition number, edition date, and abbreviated descriptive information to identify chart insets or individual panels. All other attribute fields (except the “Id” field) shall be left blank. See the example below for proper chart identification in a CEF:

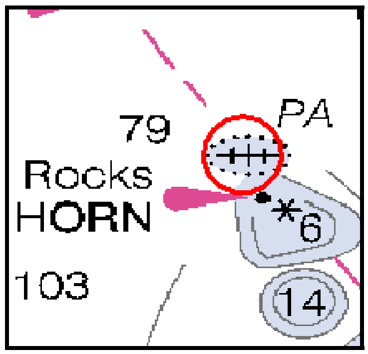
| CHG_NOTE | ENC_vs_RAS | VERIFIABLE | PRIORITY | RSD_REC | RSD_NOTE |
|---|---|---|---|---|---|
| Chart 11424 19th Ed., Aug. 06/05, Scale 1:80,000 | | | | | |
| Chart 11415 8th Ed., Aug. 05/06, Scale 1:40,000 (Extension) | | | | | |
| Chart 11415 8th Ed., Aug. 05/06, Scale 1:40,000 | | | | | |

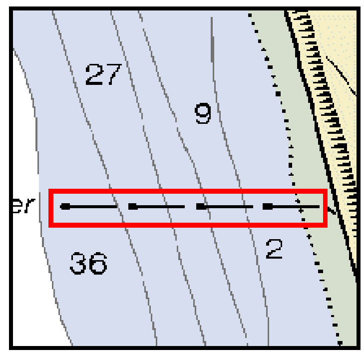
*(note new graphic)*

## 2.2 UNVERIFIED OR CHANGED FEATURE POLYGONS

Each charted hazard, landmark, fixed aid, or coastline feature (e.g. pier) in the project area which is gone, has moved significantly, or 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

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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

## Solar altitude nomograms

**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 |

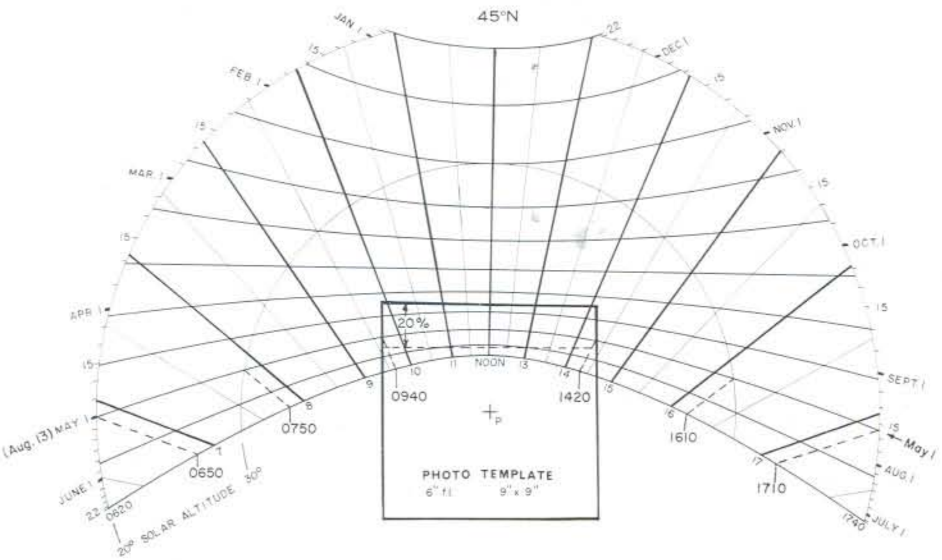



FIGURE 2.2.1—Determination of the length of the photographic day and the position of the "hot-spot".

| ° | 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)

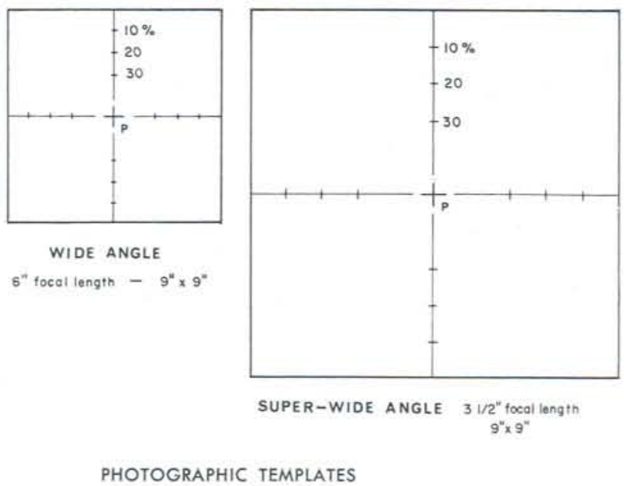



FIGURE 2.2.3–Photographic Templates.

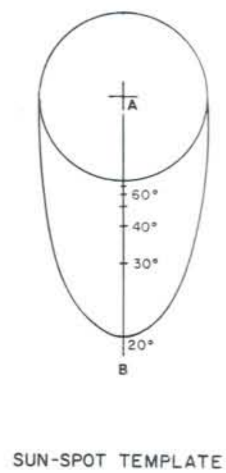
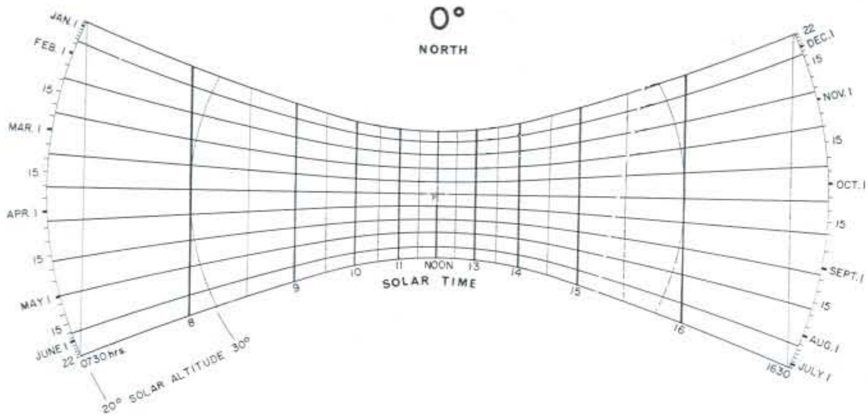
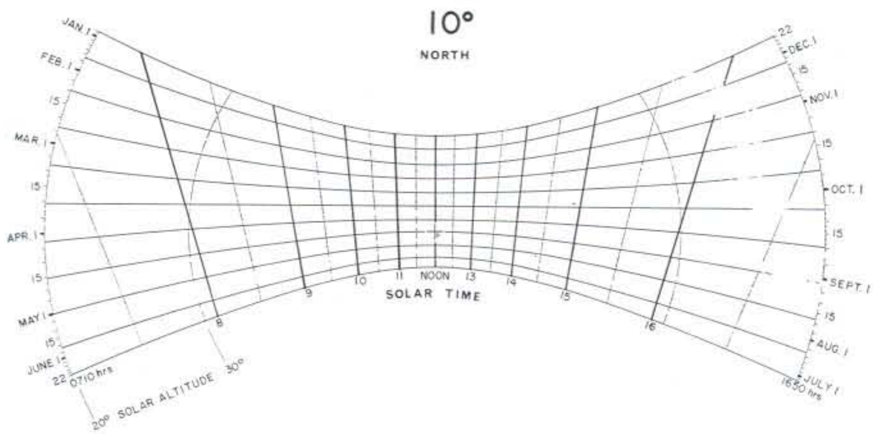



FIGURE 2.2.4–Sun-spot Template.



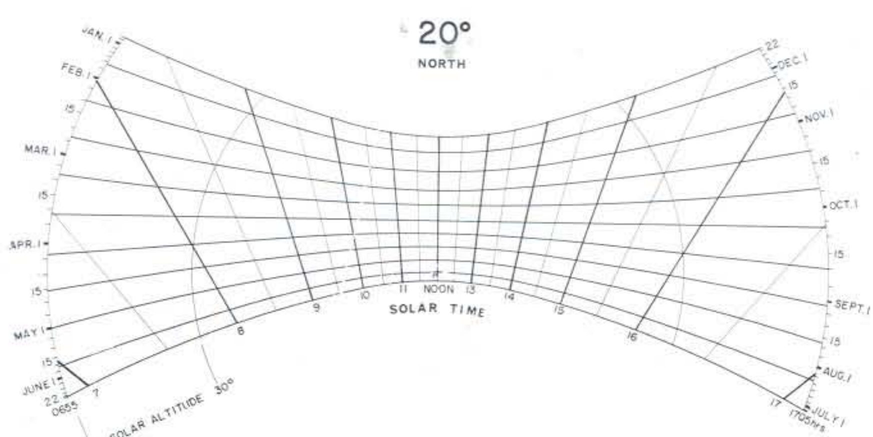




FIGURE 2.2.7–Solar Altitude Nomograms.

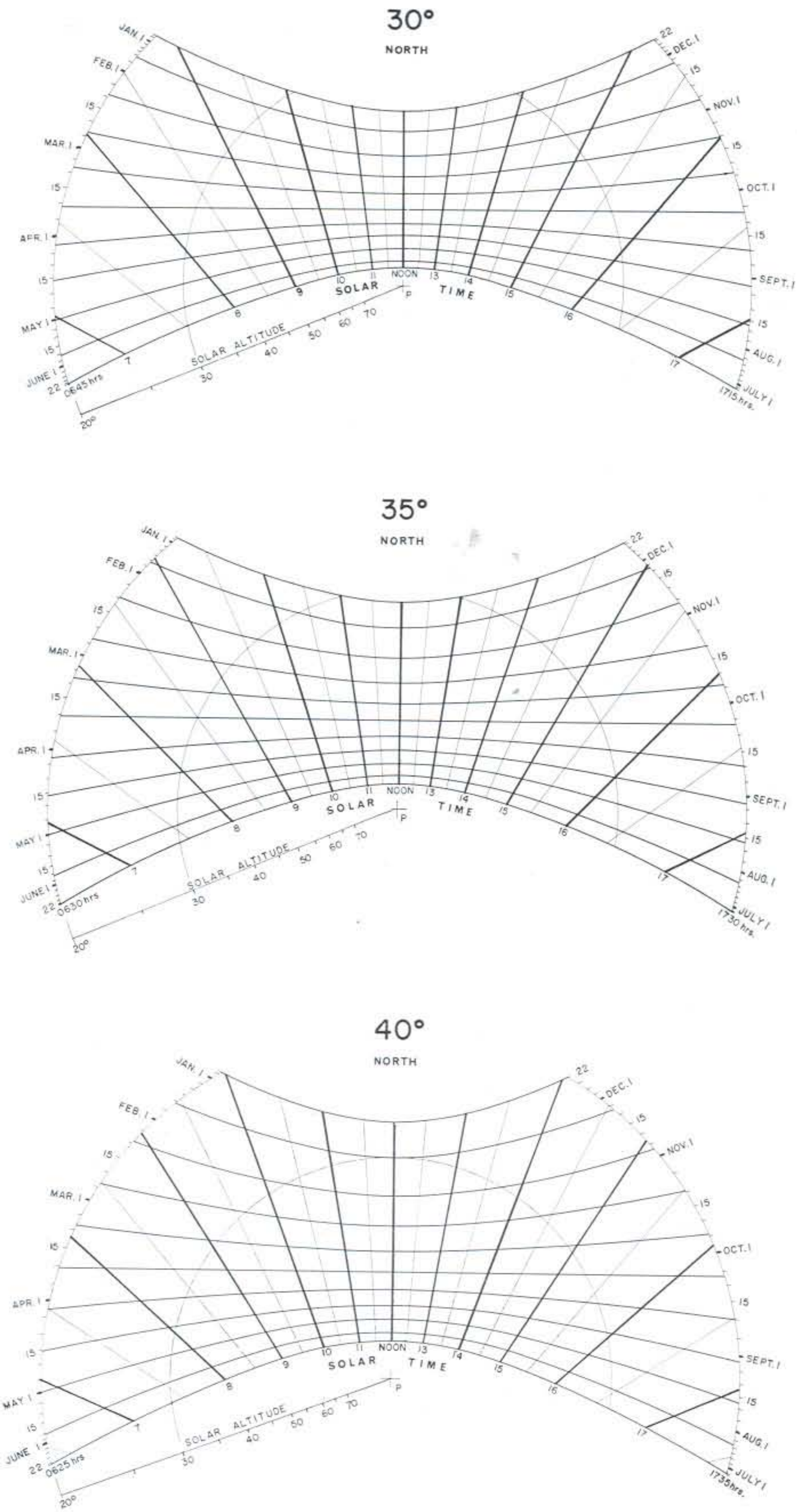



FIGURE 2.2.8–Solar Altitude Nomograms.

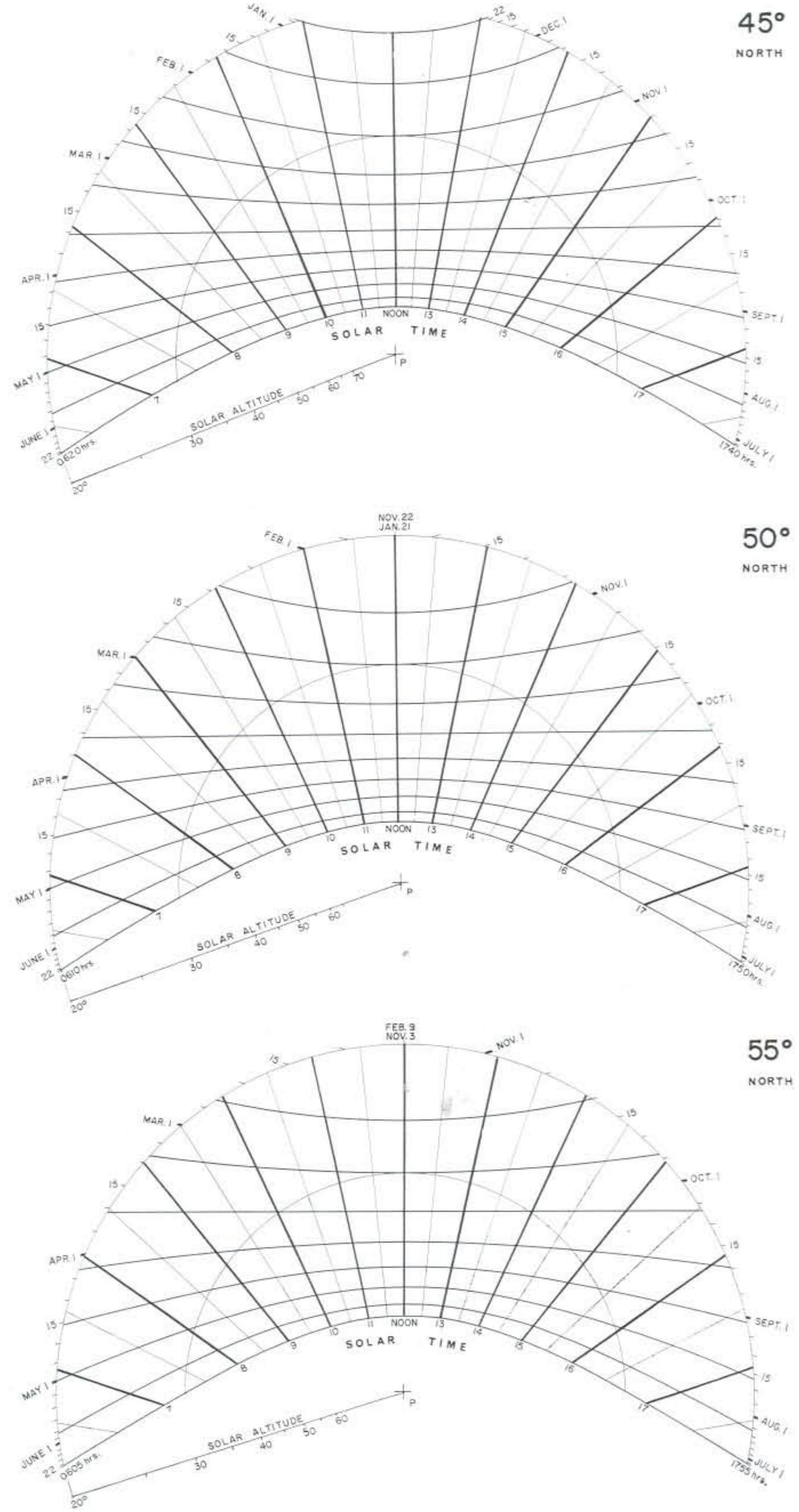



FIGURE 2.2.9–Solar Altitude Nomograms.

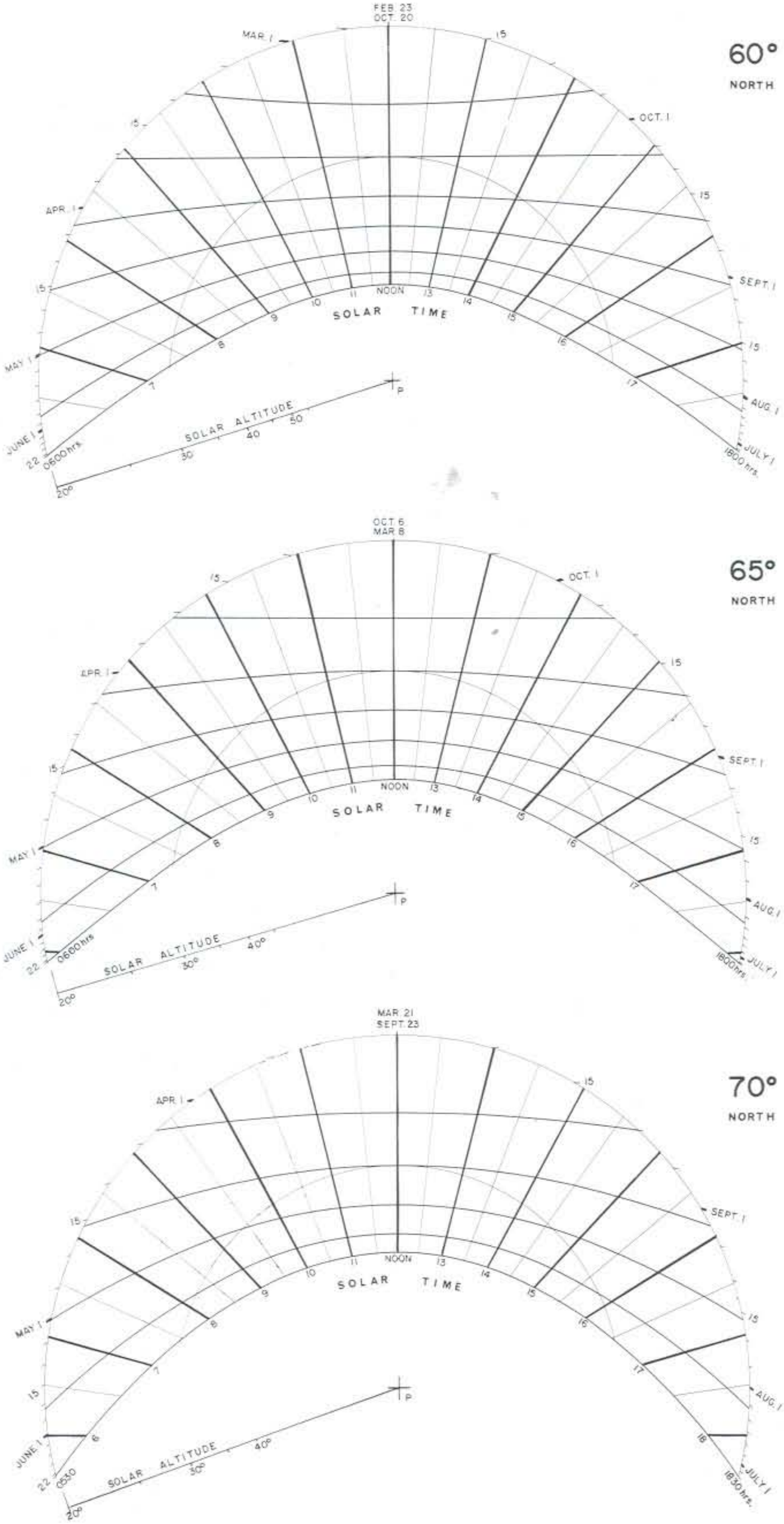



FIGURE 2.2.10–Solar Altitude Nomograms.

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.

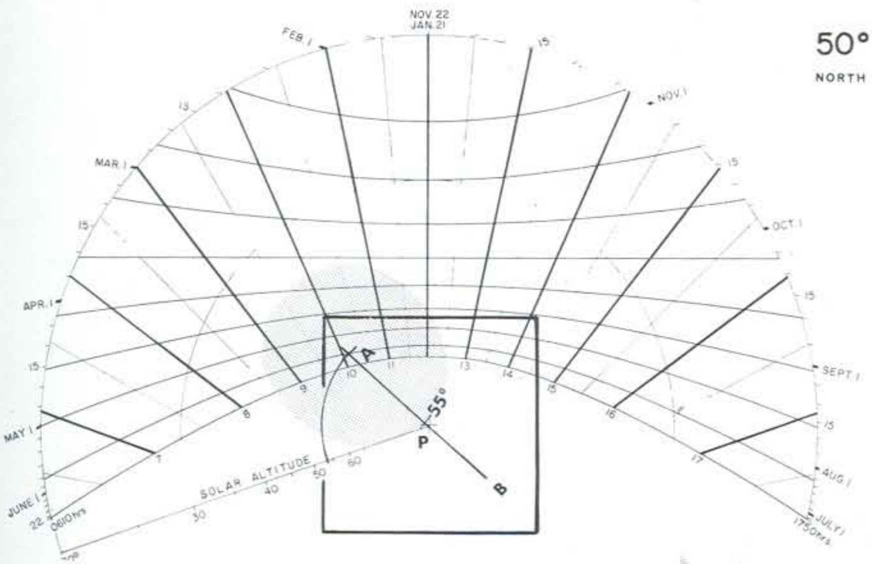



FIGURE 2.2.5–Locating the extent of the sun's reflection from water surfaces.

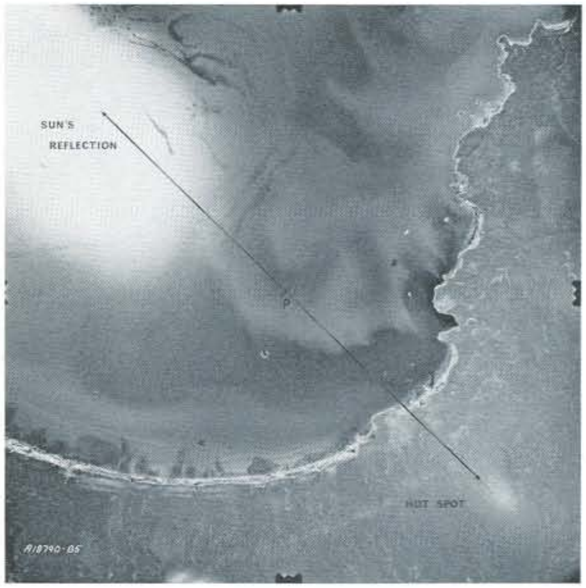



FIGURE 2.2.6–Wide-angle photograph showing the sun's reflection and the hot-spot.

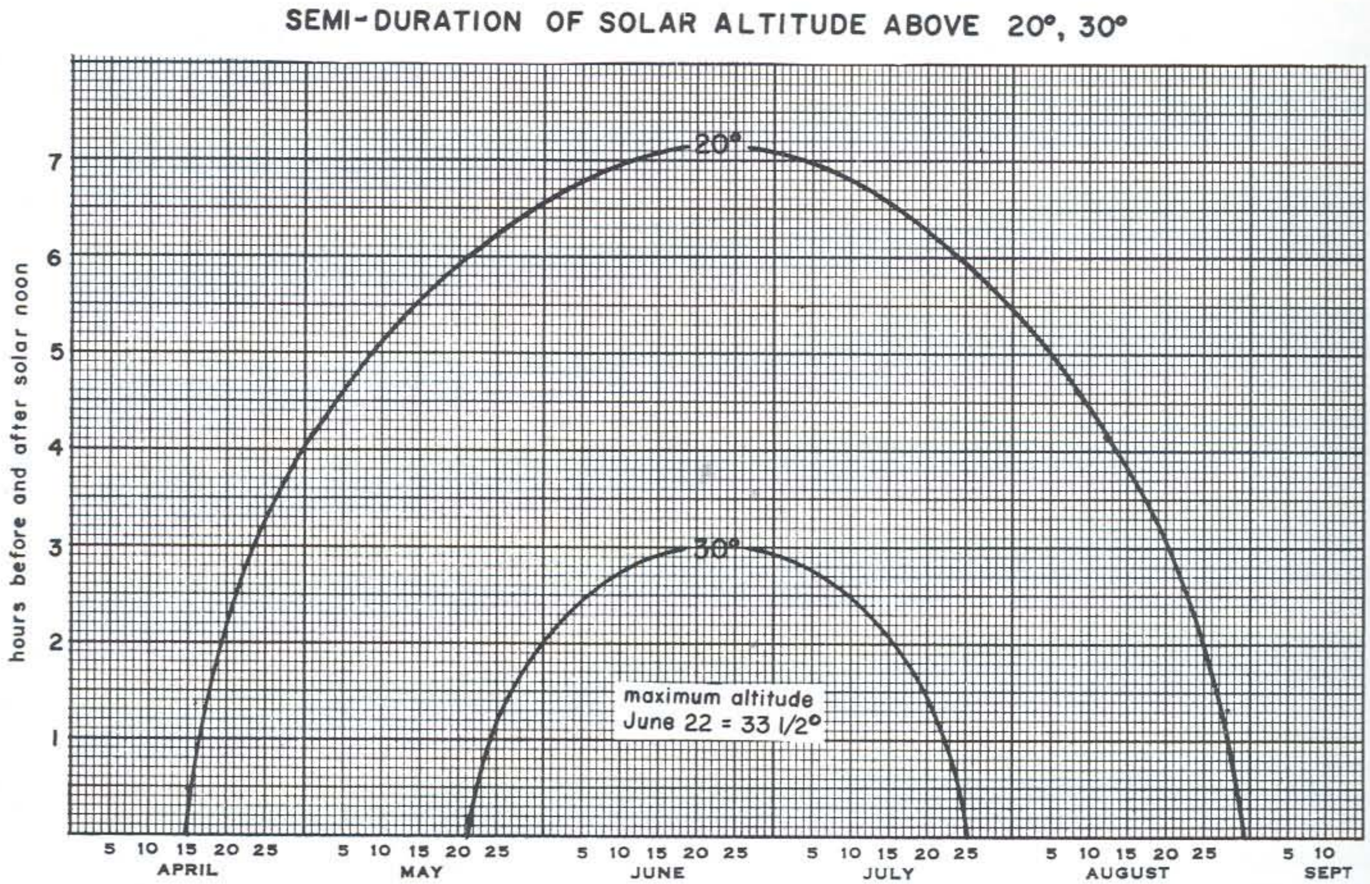



FIGURE 2.2.11–*80° North Latitude.*—Since neither the "hot spot" nor the "sun spot" is of serious significance at this latitude the form of the graph has been changed to give only the hours of photographic light before and after local solar noon. *90° North Latitutde.*—The solar altitude is above 20° for 24 hours a day from May 21 to July 24.

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# ATTACHMENT AG

# MARK RECOVERY INSTRUCTIONS (NEW)

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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November 18, 2009

ATTACHMENT AG - MARK RECOVERY INSTRUCTIONS (New)

1. DATASHEET - Obtain and study the mark's most recent datasheet (description), including all recovery notes, and highlight key points (such as: the number of reference marks, the distance from the edge of a road, etc.) and any flag any discrepancies found. U.S. Coast & Geodetic Survey (USC&GS) and National Geodetic Survey (NGS) marks and some others are included in the NGS database at: http://www.ngs.noaa.gov/cgi-bin/datasheet.prl . For a sample NGS datasheet, with explanations, see: http://www.ngs.noaa.gov/cgi-bin/dsformat.prl . Also, recent recoveries and photos of many marks can be found on the Geocaching.com web site. Note, the Geocaching web site is not a government web site and is not maintained by NGS. Visiting the Geocaching site will direct the user off the NGS web site.

2. DATABASE SEARCH - Perform a NGS database search for other nearby survey marks (radial search at: http://www.ngs.noaa.gov/cgi-bin/ds_radius.prl . This information may be helpful in finding the intended mark and may help avoid confusion between marks at the site.

Alternate method, this with graphics; download program DSWORLD from: http://www.ngs.noaa.gov/PC_PROD/PARTNERS/index.shtml , and then click on "Stations", select your area of interest, the type of mark and the mark stability. The program will plot the marks in the selected area on a Google Earth background, with different symbols for different types of marks. This program provides a link to the station's Datasheet in the NGS database, a link to the on-line NGS Mark Recovery Entry page, and driving directions. This software allows the submission of: ".gpx" files of station positions, individual positions of stations, and photographs of stations.

Second alternate method, also with graphics; go to: http://benchmarks.scaredycatfilms.com/index.html , and click on the U.S. State of interest. Then scroll and zoom as necessary to display the area of interest. Markers of various colors and with various letters representing the type and condition of the mark will show the location of all the NGS database marks within the selected area. Various backgrounds are available. By clicking on one of the markers, links are provided to NGS data sheets, and to recent photographs and recovery notes on the Geocaching web site.

Note, the two alternate methods above are not maintained by NGS. Both methods will direct the user off the NGS web site.

3. MAPS - Obtain maps, aerial imagery and/or satellite imagery of the area (paper or digital).

4. COMPUTE POSITIONS - Recommend computing the positions of Reference Marks (RMs) and any other nearby marks, and consider computing the distances between RMs and any other marks. The "box score" on the datasheet lists the directions and distances to RMs and any other

nearby marks, and the “Forward” on-line software at: http://www.ngs.noaa.gov/TOOLS/Inv_Fwd/Inv_Fwd.html can be used to do the computation. Also, the “Inverse” software can be used to compute the distance between known points. Be careful to use the same distance units for all computations. Consider converting all distances to the same units for ease of use in the field. It is also helpful to convert true bearings to magnetic bearings to save time and work in the field.

5. PLOT - Recommend plotting all marks on the map and/or imagery at a scale to show surrounding features. Check features in the imagery against the facts stated in the description (near a road, on a hill top, etc.), and then attempt to resolve any discrepancies and contradictions.

6. EQUIPMENT - Gather recovery equipment including: mark description, map, magnetic compass, 100 – 300 ft tape, shovel, long screwdriver (to hold one end of tape; and open logo caps over rod marks), whisk broom, camera, Global Positioning System receiver (GPSr), scientific calculator, and, optionally, tile probe, metal detector, lopper, vegetable brush, survey flagging, distance wheel. Also, a yellow crayon or white powder (baby powder, corn starch, etc.) can improve the photos by highlighting the stampings.

7. TRAVEL - To travel to the mark the original and “hard-core” way, travel to the beginning of the description’s “To Reach” and follow the “To Reach” using the vehicle’s odometer, and left and right turns as listed in the description. Otherwise, enter the position into the GPSr and follow the GPSr’s directions (making sure to use the North American Datum of 1983 (NAD 83) or the World Geodetic System of 1984 (WGS 84) datum).

8. PERMISSION - Request property owner permission as necessary.

9. COMPLETE TRAVEL - Continue travel to the immediate vicinity of the mark and do a visual search for:
9.1. REFERENCE OBJECTS - Reference objects mentioned in the description (edge of roads, bridges, buildings, fence-lines, telephone poles, etc.),
9.2. WITNESS POSTS – Wooden, metal, or plastic posts with or without signs,
9.3 REMAINS - Remains from previous occupations (wood, wire, slight depression, etc.)
9.4 SURVEY MARKS – Disks, marks in stone, etc.

10. FIND - Use distances, angles, and other information from the description to narrow the search, (e.g., the distance from a road or fence, witness post, reference mark, etc., the type of mark: concrete monument, disk in bedrock, etc.). If not found, review the datasheet for additional clues.

11. MEASURE - Once some of the objects and/or marks are found, use a magnetic compass to determine the approximate directions and measure the distances by pacing or taping from the witness post, Reference Marks (RM), and other reference objects. Mark the arc of each distance and intersect the distance arcs, as required. Use any vertical information provided, such as distance above or below road or railroad track. When using a magnetic compass be sure to correct for the magnetic declination (difference between true north and magnetic north). The value can be obtained from: http://www.ngdc.noaa.gov/geomagmodels/Declination.jsp . If the main station is found first, use a compass, and pacing or taping to locate the RMs. If an RM is found first, use the direction of the RM's arrow and the distance stated on the Datasheet to help find the main station. Also, the "Back Azimuth" from the "Forward" computation for that RM will provide the azimuth from the RM back to the Triangulation Station.

12. GPS - Remember when searching using GPS that most vertical control points have only scaled positions with a 6 arc-second error tolerance (about 600 ft); the description may get you much closer to the mark than a GPSr with the scaled coordinates. Combine GPS results with other clues. Most horizontal control points have coordinates that are much better than a hand-held GPS receiver (GPSr). A hand-held GPSr may only be accurate to 6-8 meters, perhaps 1-2 meters if equipped with the Wide Area Augmentation System (WAAS) and if the WAAS signal is available. Thick trees are a definite challenge for a GPSr. The Wide Area Augmentation System is operated by the Federal Aviation Administration (FAA.)

13. CHECK DESCRIPTION - For all marks found, check the description elements such as: (1) the name of the agency cast into the disk or logo cap, (2) the type of disk (RM, Azimuth Mark, etc.) cast into the disk, (3) the exact name and date stamped, and (4) the type of setting (bedrock, concrete, etc.). Check all information on the survey disk against what is stated on the Datasheet. Avoid false recoveries. Also avoid false "destroyed" notices. Do not report a mark as destroyed unless you are sending the disk itself or its photo showing it destroyed, to NGS. Note, and ideally resolve, any discrepancies. In the Recovery Note, list significant changes and discrepancies.

14. GROUND CHECK - For all marks found, visually check them to see if they appear disturbed. Then check them by taping the distances between the marks and any other usable references, and compare them to published and computed values. Note the direction (to at least the nearest 45 degrees--NE, NW, etc.) from the main Triangulation Station to each RM. Note any significant differences from what is on the datasheet. A good check on distance measurements is to first tape in metric units, then tape in English units, and then to use a calculator to convert and compare. There are 3.280833333 U.S. Survey Feet in one meter.

15. PHOTOS - Clean the marks off completely and photograph the marks. Ensure adequate and even lighting. Close-up photos should be in sharp focus, and clearly and legibly show ALL the information cast into, and stamped onto, the disks. Also take photo(s) showing the surrounding area and including the mark. See Attachment R for more specifications.

16. TIPS

16.1. INFORMATION - Ask local residents for information, and permission, as necessary.

16.2. LIKELY LOCATION - Once close to the triangulation station, go to the location where you would set a mark, where it would make sense (highest point, point with best view, exposed bedrock, etc.).

16.3. SKY VISIBILITY - Marks originally positioned with GPS can be anywhere with good access and good sky visibility.

16.4. REFERENCE MARKS - RMs are usually within 30 meters of the Triangulation Station, about the same elevation when possible, numbered clockwise from north, and about 90 degrees apart (around the Triangulation Station).

16.5. OLDER BENCH MARKS - Older Bench Marks (vertical control points) are usually along a road or railroad, often set in a rock outcrop or bridge abutment. Newer, rod-type marks may be near the right-of-way fence along a road.

16.6. REMAINS - There may be signs of a previous survey, like old wooden boards or wire. In the Western U.S. some intact 4-foot wooden stands have been found that are many years old.

16.7. DATUM - Ensure that the coordinates, map, and imagery are on the same datum (use NAD 83).

16.8. AZIMUTH MARK - From the Description, determine if the Azimuth Mark is along the route to the main mark, and while enroute to the main station, watch for the mark and a possible Witness Post.

16.9. METAL DETECTOR - If the marks are still not found, consider using a metal detector and/or steel tile probe (long rod with handle).

16.10. CONSTRUCTION CHANGES - Also consider construction in the area which may have destroyed the mark, or at least changed its setting considerably. Also consider that roads are sometimes rerouted and the mark may be adjacent to the old roadbed and some distance from the new road.

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# 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

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## ATTACHMENT AH - NGS REQUIREMENTS FOR TIDE GAUGE STATIONS

### 1.0 GENERAL COMMENTS

1.1 DOCUMENT PRECEDENCE – In order of precedence:

A. PROJECT INSTRUCTIONS

B. THIS DOCUMENT

C. COASTAL MAPPING PROGRAM (CMP) SCOPE OF WORK (SOW)

D. "WATER LEVEL STATION SPECIFICATIONS AND DELIVERABLES FOR SHORELINE MAPPING PROJECTS", May 2009, on-line at: http://tidesandcurrents.noaa.gov/publications/Water_Level_Station_Specifications_and_Deliverables_for_Shoreline_Mapping_Projects,_Updated_May_2009.pdf and other Center for Operational Oceanographic Products and Services (CO-OPS) documents.

1.2 CORRECT NAME – For survey marks and tide stations, 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 (BM) 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.

1.3 UPPER CASE – Survey mark names are always recorded using upper case letters.

1.4 STAMPING – Record the stamping exactly as on the disk or logo cap. Note, most stampings include the year set, but most station designations (names) do not include the year. Never modify the stamping on a disk or logo cap.

1.5 OTHER SPECIFICATIONS – Do not use the Height Modernization specifications in publication NOS NGS 58, "Guidelines for Establishing GPS-Derived Ellipsoid Heights" for Global Positioning System (GPS) observations on tidal BM, unless specifically directed in the Project Instructions. Use the specifications listed in Section 1.1, above.

1.6 RESPONSIBILITIES – For a listing of CO-OPS versus Contractor responsibilities, see Reference D (Specs. and Deliverables, 2009), Section 1.1.1, Scope.

### 2.0 NUMBER OF TIDAL BENCH MARKS

2.1 FIVE MARKS REQUIRED - Five BM are required at each tertiary tidal station (a tide gauge that will be in place between 1 month and 1 year), see Reference D (Specs. and Deliverables, 2009) and CO-OPS document "USER'S GUIDE FOR THE

INSTALLATION OF BENCH MARKS AND LEVELING REQUIREMENTS FOR WATER LEVEL STATIONS", (USERS GUIDE FOR BM) dated October 1987, Section 2.3.2 at: http://tidesandcurrents.noaa.gov/publications/users_guide_for_installation_of_Bench_Mark.pdf . These five may include existing tidal BM, existing NGS geodetic BM, and existing marks of other organizations that meet NOAA standards or any combination of the above. All five BM should be within about one mile of the tide station, see USERS GUIDE FOR BM, page 5.

2.2 ADDING MARKS - 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. Any additional BM set shall not be set in the same structure as an existing BM to avoid simultaneous destruction of multiple BM.

## 3.0 MARK SETTING

3.1 SITE SELECTION – See guidance in SOW, Attachment W; Reference D (Specs. and Deliverables, 2009) and USERS GUIDE FOR BM, Section 2.8.

3.2 STABILITY – At least one of the tidal BM should be NGS stability A or B

3.3 SETTING SPECIFICATIONS - Use NGS mark setting specifications for all marks that will be submitted to the NGS database, including the Online Positioning User Service-Data Base (OPUS-DB). For marks being submitted to only the CO-OPS database, use CO-OPS mark setting specifications, if different.

A. TYPES OF MARKS

i. Disks in Concrete, see SOW, Attachment T.

ii. Disks in Bedrock, see SOW, Attachment U.

iii. Stainless Steel Rods, see SOW, Attachment V.

B. MARK MATERIALS

i. Disks - For tidal BM, use only brass disks with factory inscription including "NATIONAL OCEAN SERVICE BENCH MARK"

ii. Rod Marks - For rod marks use aluminum logo caps with factory inscription including "TIDAL BENCH MARK NATIONAL OCEAN SERVICE"

iii. Witness Posts – For Witness Posts use those with sticker containing the NOAA logo and printed text including "FOR INFO WRITE TO THE DIRECTOR, NATIONAL OCEAN SERVICE DEPT. OF COMMERCE

WASH., D.C."   Witness posts should be set unless the property owner objects, the post cannot be driven, or the mark should not be made easily visible because of a high risk of vandalism.

C.  NGS SUPPLIED MATERIALS - NGS will supply these items upon request. All other mark setting supplies and equipment are the responsibility of the contractor.

## 4.0  MARK NAMING

Follow CO-OPS specifications for naming tidal BM.  See Reference D (Specs. and Deliverables, 2009) and  "USER'S GUIDE FOR THE INSTALLATION OF BENCH MARKS AND LEVELING REQUIREMENTS FOR WATER LEVEL STATIONS," Section 2.7.

## 5.0  MARK DESCRIPTIONS & RECOVERY NOTES

5.1  GENERAL - Descriptions are required for all new marks set and recovery notes are required for all existing marks searched for.

A.  NGS DATABASE MARKS - Any marks existing in the NGS database require an NGS format recovery note.  Any new mark or existing tidal BM being connected to the National Spatial Reference System (NSRS) (leveling and/or GPS) requires an NGS format description.

B. TIDAL BENCH MARKS - Any marks existing in the CO-OPS database require a separate, CO-OPS format recovery note.  Portions of the text may be the same as the NGS note.  New marks set as tidal BM which will only have leveling conducted between them, other tidal BM, and the tide gauge itself,  require CO-OPS format descriptions, but not NGS format.

C. BENCH MARKS CONNECTED TO THE NSRS AND THE TIDE STATION Tidal BM that will have leveling connections and/or GPS ties to the NSRS, require descriptions or recovery notes in both formats.

5.2  DESCRIPTIONS

A.  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 BM description and save the files as MS Word files and PDF files.  Save these separately 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", January, 2002, Page 1, second paragraph, see: http://tidesandcurrents.noaa.gov/publications/bmguide5.pdf .

B. CASE 2 – DESCRIPTIONS FOR ENTRY INTO NGS DATABASE ONLY – Create and submit digital descriptions using WINDESC.

C. 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.

5.3 RECOVERY NOTES

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. 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.

As in Section 5.2 above, marks in (or going into) both NGS and CO-OPS databases require two recovery notes. Marks in only one of the databases, require only a recovery note for that database. As above, the text may be very similar, the formats are just different.

5.4 LIST OF DESCRIPTIONS AND RECOVERY NOTES

Submit a list of all marks described and recovered and which format was used for each.

**6.0 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 DVD separate from other deliverables. In addition, for work at tide gauge stations, follow CO-OPS requirements for photographs: four photos of each bench mark and photos of tide gauge equipment, see Reference D (Specs. and Deliverables, 2009), page 40.

## 7.0 SELECTION OF EXISTING BM FOR GPS TIES

7.1 PRIMARY BENCH MARK – Use the mark designated by CO-OPS as the Primary BM, if it meets requirements, especially visibility and stability.

7.2 VISIBILITY – An antenna set up over the mark must be able to receive satellite signals, see CMP SOW, Attachment P, Section 4, and Attachment Q, Form Q12. Ideally there should be clear sky above 15 degrees all around the horizon.

7.3 STABILITY – Marks occupied with GPS should be Stability "A" or "B", see CMP SOW, Attachment W.

## 8.0 LEVELING TIES

8.1 BETWEEN TIDAL BENCH MARKS – Follow CO-OPS specifications for spirit level ties between tidal BM at a tide station, see Reference D (Specs. and Deliverables, 2009) and "USER'S GUILD FOR THE INSTALLATION OF BENCH MARKS AND LEVELING REQURIEMENTS FOR WATER LEVEL STATIONS".

8.2 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.

8.3 LEVELING ACCURACY STANDARD – Third-Order permitted, see Reference D (Specs. and Deliverables, 2009), Section 1.2.5.3.

## 9.0 GPS HORIZONTAL TIE SPECIFICATIONS

9.1 MARKS TO OBSERVE – Make static GPS observations on one tidal BM, the primary BM if possible (meets stability, visibility, etc. requirements).

9.2 EQUIPMENT - Use geodetic quality GPS receivers (dual frequency), fixed height poles, and GPS antennas that have had their phase center calibrated by NGS. See CMP SOW for additional details.

9.3 SESSION LENGTH – At least 4 hours, longer as possible, because high accuracy data is desired.

9.4 NUMBER OF SESSIONS – One required, two or more recommended.

9.5  DATA PROCESSING – Submit data to OPUS-DB for processing and entry into the OPUS Database.

**10.0  GPS POSITIONING OF OTHER TIDAL BENCH MARKS**

Determine horizontal positions for all other tidal BM 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.

**11.0  METEORLOGICAL DATA** – Not required.

**12.0  TIDE GAUGE INSTALLATION, SERVICING, REMOVAL –** See Reference D (Specs. and Deliverables, 2009), especially Sections:

1.2.3.1 – Installation,
1.2.3.2 – Monitoring,
1.2.3.2 – Removal,
1.2.5.4 - Leveling Frequency,
1.2.6 - Water Level Station Documentation, and
1.5 - Data Submission (and Section 14, below).

**13.0  TIDE DATA PROCESSING –** See  Reference D (Specs. and Deliverables, 2009)

**14.0  DATA SUBMISSION** – Submit all reports and data to NGS.  NGS will review and forward to CO-OPS.  For long term stations submit water level data every 6 months till the gauge is removed unless the data are transmitted via satellite.  After the gauge is removed, submit the final data package.

**15.0  TIMELINE FOR DATA SUBMISSION -**  15 days

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# ATTACHMENT AI (NEW)
# TASK ORDER MANAGEMENT AND INFORMATION SYSTEM (TOMIS) 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 AND ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE

**ATTACHMENT AI: <u>TASK ORDER MANAGEMENT AND INFORMATION SYSTEM</u> (TOMIS) INSTRUCTIONS**

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**ATTACHMENT AI: TASK ORDER MANAGEMENT AND INFORMATION SYSTEM (TOMIS) INSTRUCTIONS**

1. INTRODUCTION - 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 Officials to track the status of Deliverables, Task Orders, and Contracts. TOMIS sends Officials emails when the status of Deliverables changes. TOMIS allows Government Contractors to submit and track Deliverables, as well as monitor Deliverables that are upcoming or delinquent. E-mail notifications remind Contractors and government officials when actions are required. Contractors will be evaluated on their performance at the completion of all Task Orders. The TOMIS system is located at: https://secure.csc.noaa.gov/TOMIS/index2.jsp . Use Internet Explorer to access TOMIS.

2. SUBMITTING DELIVERABLES - The Contractor shall submit all Task Order Deliverables (size and type permitting) and Weekly Status Reports to NGS using the TOMIS system. All Weekly Status Reports shall be submitted directly to TOMIS by 2:00 pm Eastern Standard Time every Monday. All Deliverables smaller than 10 Mega Bytes (MB) in size shall be submitted to TOMIS as an attachment. Larger files may be compressed and then submitted to TOMIS. If the Deliverable is still too large, or hardcopy, DVD, etc. the Contractor shall submit an entry to TOMIS expressly stating what the Deliverable is and how the Deliverable is being delivered, i.e. via FedEx, FTP, etc. The Contractor shall submit the data shipment report to TOMIS the same day that the hard copy Deliverable is sent and ensure that the Deliverable name in TOMIS and the Deliverable name on the item are the same. Use a Transmittal Letter (TL) for all shipments outside of TOMIS. Once the Deliverable is received by NGS, NGS will mark it as received in TOMIS and TOMIS will send an e-mail to the Contractor confirming receipt of the Deliverable.

All Deliverables shall be submitted by the Prime Contractor to NGS via TOMIS, 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 Prime Contractor shall enter into TOMIS that the film has been shipped to NGS' film processing Contractor.

3. NGS SHIPMENTS - TOMIS does not currently support items that NGS ships to the Contractors, so TL shall continue to be used for this. The Contractor shall inventory the items upon receipt, sign the TL, and FAX it back to NGS. The TL will list all items sent, each individually. See Attachment AC for details and an example.

4. TOMIS SPREADSHEET - The Contractors shall complete a Deliverable Tracking Spreadsheet in TOMIS format, and submit it with their Technical Proposal, see attached sample. This shall be submitted as part of the Technical Proposal and NGS will use it to add the project to TOMIS. The spreadsheet will be used as a tool for tracking and for determining payment based on the percentage of the project completed. The due dates for all Deliverables on the

TOMIS Spreadsheet shall be on or before the final project due date in the Project Instructions. After its receipt by NGS, the spreadsheet will be reviewed and approved by the Contracting Officer's Representative (COR) before being entered into TOMIS. The Contractor shall ensure that the list of Deliverables on the spreadsheet includes, at least, the list of Deliverables in the SOW and Project Instructions. The format of the spreadsheet must be exactly as provided or TOMIS will not accept it. The Contractor shall complete the columns headed: Deliverables, "% of Task Order" and "Due Date". Comments may be added in the fourth column. The "% of Task Order" value must be a realistic portion of the overall project. Invoices may be submitted monthly (or at longer intervals) and shall be based on the work complete. The last 10% of payment shall be assigned to the shipment of the Government Supplied Materials back to the government.

5. PAYMENT - The Government will not pay an invoice until the percent of work invoiced has actually been completed and accepted by NGS. The last 10% will be approved for payment once all Deliverables have been received and approved by NGS.

6. DUE DATES - 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 and justify an extension prior to the due date.

7. SAMPLE SPREADSHEET

7. SAMPLE TOMIS SPREADSHEET (Add or remove Deliverables as required for specific project.)

| PROJECT NAME | YY1234 | | |
|---|---|---|---|
| Deliverable Description | Percent of Task Order | Due Date | Comments |
| | | | |
| Ground Photo Control Data & Digital Report | | | |
| Ground Photo Control Report - Paper | | | (Submit paper copy after digital version is approved.) |
| Aerial Imagery Exposure Test(s) | | | |
| Flight Line Maps | | | |
| Roll A: Tabulation of Aerial Photography | | | (Repeat for several rolls, NGS will add more as needed.) |
| Roll A: Photographic Flight Report (PFR) | | | |
| Roll A: Raw Navigation File | | | |
| Roll A: Electronic Exposure Data File (EED) | | | |
| Roll A: Film | | | |
| Airborne Positioning & Orient. Report | | | |
| Camera Calibration Report | | | |
| Camera Maintenance Log | | | |
| Camera Window Information | | | |
| Photo Final Report | | | |
| Aerotriangulation Data & Report | | | |
| Other Remotely Sensed Data & Report(s) | | | (See list of Deliverables in appropriate Attachment.) |
| Sub-Area A: Pilot Area Shapefiles | | | (Repeat as needed for each subsequent sub-area.) |
| Sub-Area A: Interim Shapefiles | | | |
| Sub-Area A: Final Shapefiles | | | |
| Sub-Area A: Chart Evaluation File | | | |
| Sub-Area A: Project Completion Report | | | |
| Tidal Data: Transmittal Letter | | | (Submit with every submission) |
| Tidal Data: Tide Station Report/E-Site Report, Xpert Site report | | | (Submit documentation package after: installation, bracketing levels every 6 months, gauge maintenance/repair, and removal) |
| Tidal Data: NOAA Chartlet, or Google Map showing station location with NOAA chart | | | (Submit with Installation Package) |
| Tidal Data: USGS Quad Map Name and Scale (Name of the 15 minute x 15 Minute Quad Maps) | | | (Submit with Installation Package) |
| Tidal Data: Sensor Test Worksheet | | | (Submit whenever sensor is changed, if appplicable) |
| Tidal Data: Sensor Elevvation Drawing | | | (Submit with Installation Package) |
| Tidal Data: Bench Mark Sketch | | | (Submit with Installation Package) |
| Tidal Data: Bench Mark Descriptions with GPS | | | (Submit with Installation Package) |
| Tidal Data: Digital Photos | | | (Submit with Installation Package) |
| Tidal Data: Levels | | | (Run levels every six months & submit leveling data.) |
| Tidal Data: Abstract of Precise Leveling | | | (Submit whenever levels are run) |
| Tidal Data: Datum Offset Comp. (Worksheet, applicable for acoustic sensors) | | | (Submit every 6 months or whenever levels are run) |
| Tidal Data: Staff to Gauge Observations | | | (Submit every 6 months with data, but perform observation weekly as required.) |
| Tidal Data: Leveling Rod Calibration Certs. | | | (Submit every 6 months.) |
| Tidal Data: Sensor Calibration Records | | | (submit when new sensors are installed) |
| Tidal Data: Installation Agreements | | | (Submit with Installation package,if applicable) |
| Tidal Data: Water Level Data | | | (Submit every 6 months.) |
| Tidal Data: GPS Data (OPUS DB datasheet) | | | (Submit only once every 5 years - GPS observations on a single tidal bench mark and submit to OPUS DB) |
| Hourly Hts, High/Low, Monthly Means, & Datums | | | (Submit every 6 months.) |
| Government Property (Portable Hard Drive, etc.) | | | (Portable hard drives that are shipped back and forth.) |
| Government Supplied Items | | | (Items supplied at project start-up; .) |

Notes:
1. Do not include:
   Weekly Status Reports
   Monthly Graphic (of Progress)
2. Complete & submit this Spreadsheet with the Technical & Cost Proposals.
3. Each Deliverable shall be assigned a % of the total project that Deliverable represents.
4. The total percents shall add to 100%.
5. Each Deliverable shall be assigned a due date.
6. The notes in the right column may be removed and your notes added.

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Version 14A
October 2010

# ATTACHMENT AK (New)
# REPORT OF GOVERNMENT PROPERTY IN POSSESSION OF CONTRACTOR

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 AK - REPORT OF GOVERNMENT PROPERTY IN POSSESSION OF CONTRACTOR

1. INTRODUCTION – The "Report of Government Property in Possession of Contractor" is a document required to be confirmed, signed, and returned to NGS by the contractor when possession of Federal Government property occurs.

2. RECEIPT OF PROPERTY

2.1 PROCEDURES – Included in any shipment of Government property from NGS to the contractor will be the document "Report of Government Property in Possession of Contractor". Upon receipt of the Government property, the contractor shall check to confirm the items described on the form are included in the shipment and sign the document. At time of shipment, NGS will add a deliverable field for the applicable project within the Task Order Management Information System (TOMIS) titled "Government Property Report". Once verification of the property has taken place and the document signed, the contractor shall submit that document through the associated deliverable field within TOMIS.

2.2 DISCREPANCIES – In the case of a discrepancy being discovered between the Government property and the associated description of the property on the report, the contractor shall notify the COR within three (3) days of receipt.

2.3 EXCLUSIONS – Film products ordered from the NGS film processing contract laboratory and paper products are exempt from this requirement.

2.4 YEARLY REQUIREMENT – Should the contractor maintain possession of the property for more than one (1) year, the contractor shall submit an additional completed document through TOMIS on the anniversary date of receipt. NGS will have created this provisionary TOMIS deliverable slot at the time the contractor originally received the property. This yearly requirement remains in effect for the duration of time the property is in possession of the contractor.

2.5 DOCUMENT LOCATION – Along with the version that will accompany any shipment of Government property to the contractor, this document can be located online, see: http://www.pps.noaa.gov/New_menu/cd281fll.pdf

3.0 RETURN OF PROPERTY – At the conclusion of the project, or any time at the Government's request, the contractor shall return the property to the COR in the same condition as it was received.

3.1 PROCEDURES – At the time the contractor receives the Government property, NGS will also add a deliverable slot in TOMIS for a Transmittal Letter for each item of property. When the contractor ships each item of property back to the COR, the contractor shall submit a copy of the Transmittal Letter to this slot. Upon receipt and inspection of the property, NGS will accept the Transmittal Letter deliverable, verifying return of the Government property.

3.2 PROPERTY CONDITION – The contractor is responsible for the property being returned in the same condition as it was at time of receipt, less normal wear and tear. The contractor is responsible for proper shipment of the property during return. All damages, repairs, and replacement of the property from time of contractor receipt to time of COR acknowledgment of its return are the contractor’s responsibility.

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December 14, 2009

# ATTACHMENT AL (New)
# ORTHOPHOTOGRAPHY 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

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ATTACHMENT AL: ORTHOPHOTOGRAPHY REQUIREMENTS PAGE

# ATTACHMENT AL:  ORTHOPHOTOGRAPHY REQUIREMENTS

## ORTHOPHOTOGRAPHY

1. GENERAL – The contractor shall provide natural color orthorectified mosaic digital images (hereafter referred to as “orthos” or “orthomosaics”) using all the color imagery that was included in the aerotriangulation for the original acquisition/compilation project, including any partial (or incomplete) tiles.  The non-image area of partial tiles shall be black (RGB=0,0,0).  Along the edges of the photo coverage the contractor should attempt to include as much of the actual image data as practical in the orthomosaic, without including any non-image data (fiducial marks, etc.)  The same digital scan files of the color photography for use in performing shoreline compilation shall be used to produce the orthos.  Orthos shall not be created using the infrared (IR) imagery that was acquired for this project.

2. AEROTRIANGULATION – If an acceptable aerotriangulation (AT) of the project photography has already been completed in order to support feature compilation, this same AT solution shall be used for the orthorectification of the imagery.  If the project requirements include multiple sets of imagery (Color, Mean High Water-IR, Mean Lower Low Water-IR) then the AT should include all sets of imagery adjusted together.  It is important for the georeferencing to be consistent in both the orthos and the compiled features.  If the contractor should wish to begin ortho production prior to all imagery being collected and a combined AT solution being accepted, the contractor shall request approval for this change from NGS in writing.  If all of the color imagery has been collected NGS may approve the request.  If this is approved the AT may be performed using only the complete set of color images and the results used to produce the orthos.  Furthermore, when the IR imagery is subsequently collected, and additional AT is performed, the contractor shall hold the previously adjusted images in the color block fixed, and points measured from this block shall be used to control the IR images, as a means of tying all sets of imagery together.  The color images shall not be readjusted.

3. DIGITAL ELEVATION MODEL – A “bare earth” Digital Elevation Model (DEM) shall be used in the production of the orthos to correct for terrain displacements.  The contractor shall use the most current version of a United States Geologic Survey (USGS) 10-meter DEM, if available. If not, the contractor shall use another equivalent DEM of the same or better spatial resolution. If no DEM coverage is available, the contractor shall create a 10 meter resolution DEM from the original color stereo imagery that is of equivalent quality or better than a standard USGS 10-meter DEM.  The contractor shall include in their Technical Proposal which DEM they propose to use.

4. DIGITAL ORTHORECTIFIED MOSAIC IMAGES – The orthomosaic images shall meet the following requirements:

4.1 The orthomosaic images shall have a nominal spatial resolution of one (1) meter.

4.2 The orthomosaic image files shall be in 8-bit Georeferenced Tagged Image File Format (GeoTIFF) format with embedded pyramid layers.

4.3 The orthomosaic shall be divided into tiles. Each tile shall represent a ground distance of 2.5 km by 2.5 km. There shall be a ten meter buffer (overlap) around all four edges of the tile.

4.4 The orthomosaic shall be color and tone balanced to provide a consistent and uniform image quality. The final product shall maintain as much of the original color and appearance as practical.

4.5 As stated above, the orthos shall include correction for terrain displacement, but they shall not be corrected for building lean or for other displacements caused by structures elevated above the land.

4.6 When mosaicking the images, the placement of seam lines shall be chosen to minimize specular reflections and extreme tonal variations in adjacent image areas. Seam lines should go around, and avoid cutting through, elevated structures in the images, especially those structures (such as bridges) that cross over navigable water. The ortho images shall not contain any non-image data, such as artifacts, fiducial marks, film titling, or frame borders.

<u>5. COORDINATE SYSTEM</u> – The final digital ortho image files shall be projected in the Universal Transverse Mercator (UTM) coordinate system, in meters, and referenced to the North American Datum of 1983 (NAD 83). Should the project extend beyond a single UTM zone, all image tiles shall use the coordinate system of the zone that contains the majority of the project.

<u>6. HORIZONTAL ACCURACY</u> – The horizontal accuracy of points tested in the final orthos shall be five meters or better at the 95% confidence level.

<u>7. TILE FILE NAMING</u> – Tiles shall be named using the UTM easting and northing coordinate (rounded to the nearest meter) of the upper left corner of the upper left pixel of the 2.5 x 2.5 km tile (not the buffer pixel coordinate). The tile image files shall conform to the following naming convention:

CZZeEEEEEEnNNNNNNN.tif
where:
C = refers to the images being color negative images
ZZ = UTM zone
e = start of easting
EEEEEE = easting coordinate
n = start of northing
NNNNNNN = northing coordinate

Example: C17e560000n6627500.tif

8. PREPRODUCTION SAMPLE – The contractor shall submit a single, color and tone balanced, orthorectified sample image as soon as possible after initiation of this phase, for Government review. The sample shall be in GeoTIFF format, UTM (NAD 83) coordinates. NGS will make every attempt to evaluate and approve or disapprove the sample with comments no later than 3 business days after receipt. Additional sample images may be submitted for review if approved by the COR.

9. ORTHOMOSAIC TILE INDEX – The contractor shall submit an index of the orthomosaic tiles in the form of polygon shapefiles that delineate the area of each tile, not including the buffer zone around each. The shapefiles for the index shall use NAD 83 geographic coordinates.

10. ORTHOMOSAIC METADATA – Prior to the start of work the Government will furnish to the contractor a text (.txt) file containing a template which will define the Federal Geographic Data Committee (FGDC) compliant metadata elements required. The contractor shall create an FGDC compliant metadata file using the Government provided template for each orthomosaic tile generated.

11. ORTHOMOSAIC REPORT – The contractor shall submit a report describing the work performed to produce the orthos. This report shall include at least the following information:

11.1 A summary of the aerotriangulation procedures performed, and the quality of the results

11.2 What DEM was used, including its source, date, resolution, and accuracy

11.3 A summary of the processes used to produce the orthos

11.4 A summary of the Quality Control/Quality Assurance (QC/QA) procedures followed to validate the accuracy and quality of the orthos, and the results of that validation.

If the AeroTriangulation (AT), and the accompanying AT Report, have already been completed, then this Orthomosaic Report shall be submitted as a separate document. Otherwise, if the AT Report has not yet been written, the above information may be included as a section in the AT Report called “ORTHOMOSAIC PRODUCTION”.

12. DVD LABELING – Media, Digital Video Disk (DVD), containing the final orthomosaic tiles, index, and report deliverables shall be uniquely labeled with the following identifying elements:

| ELEMENT | EXAMPLE |
|---|---|
| Disk Number | DVD 1 of 1 |
| Company Name (with optional logo) | Acme Company |
| Project ID | MD0803 |
| Brief Description of Contents | Orthomosaic Tiles, Index, Metadata, and Report |
| Creation Date | February 10, 2009 |
| Coordinate System and Zone | UTM Zone 17 |

See Main Text, Section 9.4 for further details about the use of DVDs.

13. QUALITY CONTROL – Quality control shall be exercised by the contractor continuously throughout all phases of the project. Procedures shall be established to assure that all contract materials are delivered in accordance with the required level of accuracy and quality. Any products delivered by the contractor which do not meet the minimum requirements described in the SOW and in the sections above may be rejected.

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October 2, 2012

# ATTACHMENT AM
# GRAVITY FOR THE REDEFINITION OF THE AMERICAN VERTICAL DATUM (GRAV-D) GOVERNMENT FURNISHED PROPERTY

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 AM - GRAVITY FOR THE REDEFINITION OF THE AMERICAN VERTICAL DATUM (GRAV-D) GOVERNMENT FURNISHED PROPERTY

1. GOVERNMENT FURNISHED PROPERTY NOTIFICATION

Government furnished property will be specified within individual task orders.

2. GOVERNMENT FURNISHED PROPERTY AVAILABLE

2.1. Turnkey Airborne Gravimetry System (TAGS) Air III gravity meter, either S-137 or S-161, manufactured by Micro-g LaCoste (http://www.microglacoste.com/tags.php).

A) Quantity – 2 Each

B) Property ID: CD0001723983 and CD0004084915

C) Unit acquisition cost - $800,000 each

D) Equipment will be supplied in an "As is" condition. Gravimeter will come with an aluminum base plate for mounting to seat tracks that can be modified to fit various aircraft.

2.2. NovAtel SPAN GNSS Inertial Systems including a SPAN-SE-RT2-G-S-J receiver (http://www.novatel.com/products/span-gnss-inertial-systems/span-receivers/span-enclosures/span-se/) and a Honeywell LASEREF V Micro-IRS SM inertial measurement unit (https://commerce.honeywell.com/webapp/wcs/stores/servlet/eSystemDisplay?catalogId=10251&storeId=10651&categoryId=14183&langId=-1)

A) Quantity – 2 Each

B) Property ID: CD0001723982 and CD0004084916

C) Unit acquisition cost - $125,000 each

D) Equipment will be supplied in an "As is" condition.

3. SPECIAL INSTRUCTIONS FOR CONTRACTOR SUPPLIED AIRCRAFT

3.1. The contractor will provide an aircraft that meets the following minimum requirements to utilize GRAV-D Government Furnished Property:

A) Pressurized and capable of operation at 20,000 ft

B) Able to fly at 200-250 kts ground speed

C) Sufficient payload capability to carry the 420 lbs of the GRAV-D instrument suite plus two pilots and an operator

D) Capable of at least 4 hours endurance given the payload

E) Can deliver 700W max of 60 Hz, 110VAC power to the gravity instruments

F) Equipped with an autopilot in good working condition that is capable of maintaining straight and level with minimal variance and is capable of being coupled with the aircraft flight management system (FMS).

G) Equipped with a NovAtel ANT-A72GLA-TW-N antenna, 33 db with TNC connector, or equivalent with antenna feed into the cabin (http://www.novatel.com/products/gnss-antennas/compactgnss-antennas/)

H) Able to accept AC ground power via an extension cord for 24 hours a day, 7 days a week power supplied to the aircraft while parked

I) Equipped with a satellite telephone system that performs and is compatible with the area of operations