# LIDAR FINAL REPORT

## April 3, 2006 Revision



## AK0301 - Shishmaref

Dates of LIDAR Data Acquisition
July 9–August 12, 2004

AEROMAP U.S.
YOUR GEOSPATIAL DATA SOLUTION
AN AERO-METRIC COMPANY

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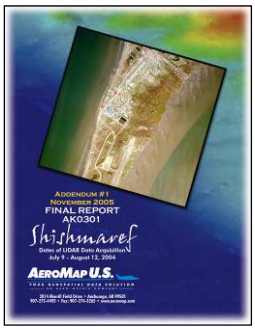
**AK0301 REVISED LIDAR DATA SET**

# EXECUTIVE SUMMARY

This report replaces previous AeroMap U.S. reports to NOAA for the AK0301 Area including the towns of Shishmaref and Wales. Those reports are titled as follows:

- Final Report AK0301 Shishmaref – Dates of LIDAR Acquisition July 9-Aug 12, 2004
- Addendum #1 November 2005 – Final Report AK0301 Shishmaref – Dates of LIDAR Acquisition July 9-August 12, 2004




The above reports should be destroyed as they contain erroneous information that has been corrected with this revised report and the submission of a reprocessed LIDAR data set for the AK0301 area to ellipsoid heights.

## Reasons for Resubmitted Data and Report

There are two primary reasons for the resubmission of data and reports

Reason #1: Confusion in data processing between Derived NAVD88 datum and ellipsoid data requested by NOAA January 3, 2005, and subsequent questions by NOAA which have been documented and clarified in this Executive Summary and Final Report. See Narrative starting below, and continued on page v, for more detailed information on Reason #1.

Reason #2: Erroneous data being generated by a bug in the Optech proprietary REALM processing software. This bug, here to fore not seen or documented by Optech or any of their users, causes false high points which show up as a halo effect around certain shoal and sandbar areas. This halo effect was first found in late January 2006 by AERO-METRIC, Inc of Sheboygan, WI, while working on a similar NOAA Shoreline Mapping Contract (Area NOAA-NY0401). For additional detail on Reason #2, see narrative, which begins on, page vi of this Executive Summary.

Reason #1 - Narrative: During various phases of LIDAR data processing, there was some confusion between “Derived NAVD88” and ellipsoid heights that resulted in data processing errors. The original Scope of Work required the LIDAR data be submitted in a “Derived NAVD88” datum and AeroMap did submit that data set in December 2004.

On January 3, 2005 NOAA asked if the “original raw ellipsoidal data” could be provided. In a series of messages from January 7 –25, this data set was better defined and it was agreed that the data would be provided.

AeroMap adjusted the original "Derived NAVD88" data set to ellipsoid heights using the Geoid99-Alaska model, and submitted the data in March 2005. This was followed by "Final Report AK0301 Shishmaref – Dates of LIDAR Acquisition July 9 – Aug 12, 2004" submitted in May 2005

This was followed on September 20, 2005 by a series of questions from NOAA, which resulted in the submission of "Addendum #1 November 2005 – Final Report AK0301 Shishmaref – Dates of LIDAR Acquisition July 9-August 12, 2004". The Addendum was shipped to Aero-Metric on December 1, 2005

In the course of analyzing the data and writing the Addendum #1 in response to the 20 September 2005 questions, it became apparent that there were some discrepancies with the LIDAR data in some areas relative to John Oswald and Associates (JOA) LIDAR checkpoint data. Not knowing at the time the reason or extent of the discrepancy problem, AeroMap submitted the Addendum #1 along with a cover letter acknowledging the discrepancies and stating that AeroMap was beginning an investigation into the cause of the discrepancies.

AeroMap began investigations by conferring with JOA and eliminating all potential problems (e.g., incorrect antenna height, incorrect control values) in the LIDAR check point survey. When no errors were found in the JOA survey data, AeroMap began concentrating on the LIDAR data processing.

At about this same time, NOAA sent a second set of questions on 16 December 2005 related to Addendum #1.

## NOAA Questions from September 20, 2005

The comments and questions that required a response from AeroMap are as follows (Items #1 and 4 are omitted as they need no reply from AeroMap):

> *2. …Please explain the 3 airport accuracy reports. Were there known points at these airports, or is the software just comparing a pulse to other pulses in the same area on the ground? See #3 below.*
> **ANSWER OR ACTION: Please see Section 12.3 TerraMatch Results on Kotzebue, Shishmaref and Wales Runways - for detailed explanation of the TerraMatch information, which compares LIDAR information against itself as a check for system calibration. See also Section 12.4 - TerraScan Output Control Reports - Wales & Shishmaref Runways for analysis of LIDAR data on runway ground truth data provided by JOA.**
>
> *3. Where is the information about the 30 LIDAR check points? Were these done? Was any comparison done to these points? Is this the information in the airport Accuracy Report on pages 150-152? See also #5 below.*
> **ANSWER OR ACTION: Please see Sections 12-5 through 12.7 for detailed narrative, maps and statistical comparison tests on the JOA provided LIDAR check points (34 points in AK0301 and 31 points in AK0302).**

*5. LIDAR CHECK Points - In the maps included with the report, we did not find a map showing the LIDAR check points. Also, neither paragraph I A "Purpose" nor paragraph II "LOCATION" mention surveying the LIDAR check points. The two LIDAR reports, "Final Report AK0302 Kivalina" and "...Shishmaref" also don't seem to mention the survey of the LIDAR check points. The 30 LIDAR check points were required by the document "LIDAR Requirements", Section 3.4A and also mentioned in section 3.4 of the Project Instructions. Were these points surveyed? Did we agree at some point to drop these and add the Beach Profiles? JOA's Technical Proposal mentions that the 60 LIDAR check points would be done in 2004. ACTION - Explain.*
**ANSWER OR ACTION: Please see Sections 12-5 through 12.7 for detailed narrative, maps and statistical comparison tests on the 34 JOA provided LIDAR check points.**

## NOAA Comments & Questions from December 16, 2005

On December 16, 2005 clarification was requested for several items within the November 2005 Addendum #1 to the Final Report. Clarification as requested are incorporated in this revised Final Report, the Addendum has been deleted. The relevant comments and questions are included here (Item 2 is omitted as it required no reply from AeroMap):

1. *"… the last paragraph refers to an NGS person by name and the fact that he is familiar with certain software. ACTION - Please modify the report to eliminate Jason's name. The brief explanation of Terrasolid in your report is adequate."*
**ANSWER OR ACTION: The NGS name reference has been removed from this report.**

3. *In the Tables (Output Control Reports – Wales & Shishmaref runways and Output Control Reports – JOA LIDAR check points) the UTM zone is not listed and the units are not listed. ACTION - for each table identify the Horizontal datum, the UTM zone, and the units used.*
**ANSWER OR ACTION: In all tables generated from TerraScan Output Control Reports (OCR) contained in this report (Sections 12.4 and 12.7), descriptive headers have been added to identify the horizontal datum, the UTM zone, and the units used, as well as other mission information.**

4. *In the same Tables, the statement is made, "Only the first and last 15 points and results are shown." That's fine, but how many ground control points are there? Also, the "Laser Z" values are all the same number (for the first x points) and the "Known Z" values change. Shouldn't it be the other way around? I think the 30 points shown are LIDAR values as compared to the same ground control point. Is that correct? How many ground control points were there, how were they surveyed, to what accuracy and by whom? Are these points in addition to the 66 points surveyed by JOA (66 according to the LIDAR Check Point Report)? In other words, what is being compared to what in these Tables? ACTION - Please explain.*
**ANSWER OR ACTION: All runway ground truth data and LIDAR check point data were surveyed by JOA. The LIDAR check points (See Sections 12.5 through 12.7) were surveyed with static GPS sessions and should be accurate horizontally to +/- 1 cm + 1 ppm of the distance from the reference base station, and vertically 2 cm + 1 ppm of the distance from the reference base station. All**

**runway ground truth data points were collected in kinematic mode, and they should be accurate to horizontally to +/- 3 cm + 1 ppm of the distance from the reference base station, and vertically 5 cm + 1 ppm of the distance from the reference base station. In the original report, some photo ID and base station points were mistakenly included. As noted in Section 12.5, only points with Station Type 4 are actual LIDAR check points. There are 34 LIDAR check points in Area AK0301, and 31 LIDAR check points in AK0302. Section 12.4 - TerraScan Output Control Reports contains a narrative on how the runway ground truth points were checked and evaluated. As noted in Section 12.4 -, the Dz value shown in the right column is the computed LIDAR data minus the known ground point value. The runway data was edited before the OCR process to delete numerous points at the start and end of the PPK survey where the receiver was not moving because of static observations, or moving so slowly that the values of the ground points are the same or nearly the same. The listing in this report only shows short relevant sample sections of these long listings along with the statistics for brevity and clarity sake. The full data set is contained in a digital file on CD that accompanies this report.**

5. *In several of the tables (Output Control Reports – Wales & Shishmaref runways and Output Control Reports – JOA LIDAR check points) in the "Z" column the word "outside" is entered rather than a value. ACTION - Please explain what "outside" means.*
   **ANSWER OR ACTION: See Section 12.4 - TerraScan Output Control Reports for explanation of what "outside" means.**

6. *In several Tables (Output Control Reports – Wales & Shishmaref runways and Output Control Reports – JOA LIDAR check points), the "Dz" values are large. We assume this is the discrepancy you mentioned in an email? ACTION - Explain discrepancy and resolution.*
   **ANSWER OR ACTION: As noted in the first part of this Executive Summary, and also in Section 14 - Results and Problems, the discrepancies found were traced back to confusion between "Derived NAVD88" and ellipsoid heights that resulted in data processing errors. As stated in the section REMEDY at the end of this Executive Summary, AeroMap has reprocessed all the LIDAR data from the raw data stage holding ellipsoid heights throughout, and is resubmitting a new ellipsoid height data set and this report to replace the previous ellipsoid data set and prior reports and Addendums.**

7. *(Table 12.5.2 NGS Project AK0301 Final Values from JOA) lists JOA's LIDAR check points. Was the LIDAR data compared to these points? If so, where? ACTION - Please explain.*
   **ANSWER OR ACTION: Please see Sections 12-5 through 12.7 for detailed narrative, maps and statistical comparison tests on the 34 JOA provided LIDAR check points.**

8. *The last paragraph...again states that "these check points were thought lost..." Which points were thought lost, I'm confused. The points on the airport, JOA's points or something else? ACTION - Please explain.*

**ANSWER OR ACTION: Please see Section 12.2 Software and Processes Used To Compute Accuracy Reports, which explains what happended to the "lost" data, and why it is not a problem area that needs correction.**

9. *In Tables (Section 12.7), I do not understand what is being compare to what. There are 79 points here. JOA did 66 points, total, in AK0301and AK0302. Are these 79 points in addition to JOA's points? We note that the first 3 columns of these tables are the same in both reports. Does "outside" mean that that point is in the other project? Some of the points have "outside" in both reports? ACTION - Please explain the Tables, what is compared to what. Also, explain how many sets of ground control points there were.*

   **ANSWER OR ACTION: In the original report, some photo ID and base station points were mistakenly included. As noted in Section 12.5, only points with Station Type 4 are actual LIDAR check points. There are 34 LIDAR check points in Area AK0301, and 31 LIDAR check points in AK0302. In addition, there are 3 sets of runway ground truth data (Wales and Shishmaref in Area AK0301 and Kivalina in Area AK0302). The ground truth and LIDAR check points are separate from the JOA GPS Base Station control reported in Section 10 – Ground Control Report.**

## Narrative on AeroMap LIDAR
## Data Processing Errors to Ellipsoidal Heights

The basis of the JOA "Derived NAVD88" control survey for the base stations for this project are the NGS NAVD88 control values for monuments 2BAD and 8756K (at Nome) and WTK-A (at Noatak). From the JOA base station survey in 2004, JOA established "Derived NAVD88" values on the following stations:

- Point Hope Base Station
- Kivalina Base Station
- Kotzebue Base Station 3
- Kotzebue Base Station 5
- Kotzebue Base Station 6
- Shishmaref Base Station
- Wales Base Station

There is a difference of approximately 1.54 meters between "Derived NAVD88" and orthometric heights as would be determined by Geoid99-Alaska. The data processing approach to establish "Derived NAVD88" heights for the airborne trajectory and subsequent LIDAR data was as follows:

1. Compute a project specific or "pseudo" ellipsoid height for the base stations used at the airport in Kotzebue (KOT5 and KOT6), where the airplane was based, and all airborne missions began and ended. This incorporated the approximately 1.54 meters difference between "Derived NAVD88" and Geoid99-Alaska orthometric heights.
2. Compute the GPS and inertial airborne trajectory using the "pseudo" ellipsoid height.

3. Check the airborne trajectory from Kotzebue with the base stations within the mission area, and use the best trajectory.
4. Apply Geoid99-Alaska to the airborne trajectory, to bring the data to the desired "Derived NAVD88" orthometric surface.
5. Process all the LIDAR points using the "Derived NAVD88" trajectory. At this point, all the LIDAR data is in "Derived NAVD88". The LIDAR data never had original ellipsoid heights.

NOAA requested a second LIDAR dataset processed to ellipsoid heights in January 2005. Several approaches to deliver the new ellipsoid data set were discussed by email with NOAA, and it was agreed that instead starting from the beginning with the actual raw data as it is collected in the air, and reprocessing all of the data all over again, that the previously delivered "Derived NAVD88" would be adjusted by a combination of a shift from "Derived NAVD88" to orthometric heights, then using the Geoid99-Alaska model to bring all the LIDAR data to the ellipsoid reference.

All of the data for both Areas AK0301 and AK0302 were reprocessed by the end of January 2006, and the data and Final Report were ready for delivery to NOAA, when AERO-METRIC found the problem with occasional erroneous data being generated by the Optech REALM software. AeroMap began an investigation into the data to see if at certain types of terrain, these erroneous data points were being generated in the AK0301 or AK0302 areas. The investigation revealed that in some conditions of shoal water and sandbars, these erroneous data points were being generated in the AK0301 and AK0302 areas. More detail on this problem and the remedy can be found in the following section.

**Reason #2 – Erroneous Data Narrative:** In late January 2006, AERO-METRIC, under a similar shoreline mapping contract with NOAA (Area NOAA-NY0401), found that under certain conditions along shoal areas and areas of sandbars, the Optech REALM data processing software was generating erroneous high points which produced a halo pattern along parts of the shoal or sandbar area. AeroMap investigated the data sets for both the AK0301 and AK0302 areas, and found some areas where the same types of erroneous high points were being generated.
An example of this type of this "halo" effect of erroneous high points can be seen in the following Figure 1 (below).

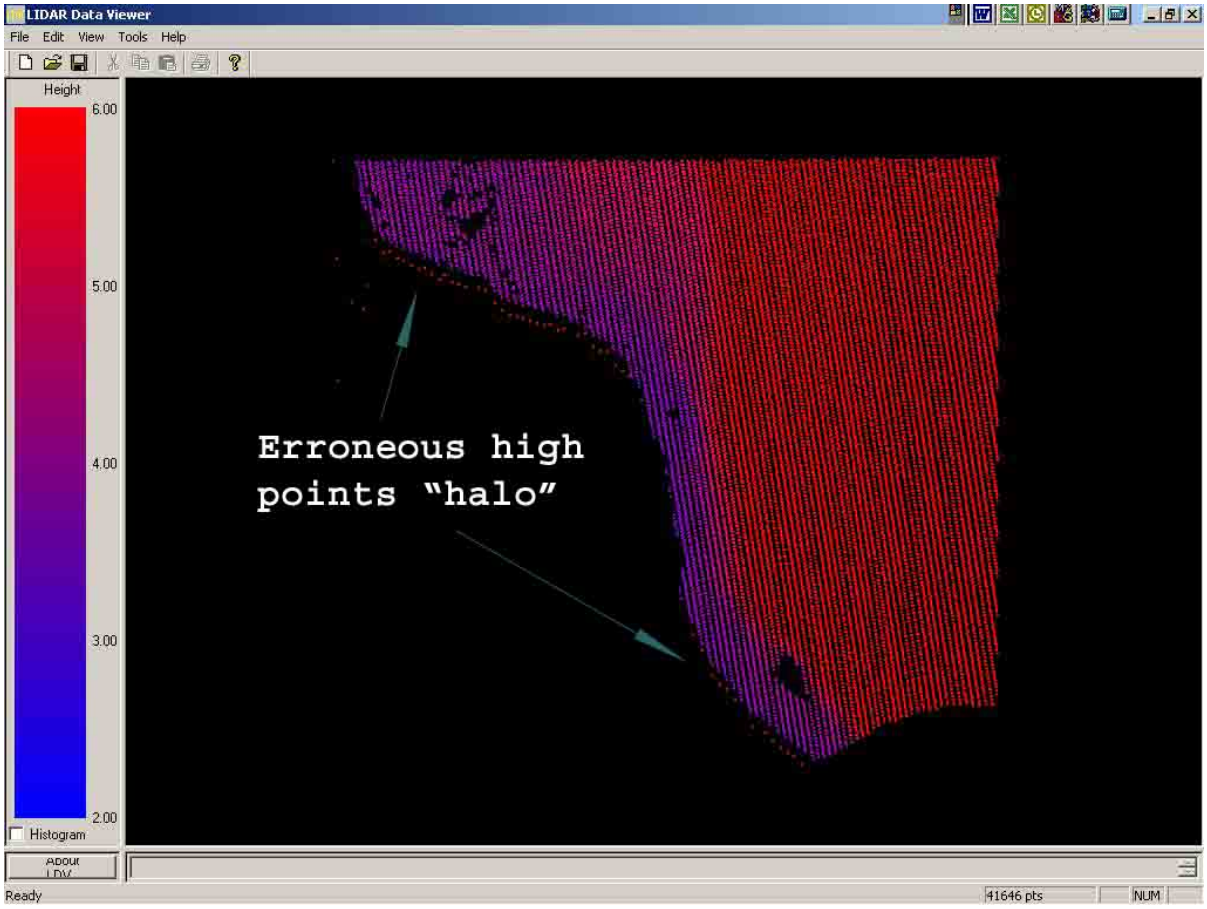



**Figure 1 – Erroneous high points in "halo" effect**

## Conclusion on Data Processing Errors

After the submittal of the Final Report and Addendum #1, and subsequent questions by NOAA on LIDAR check points, the AeroMap review of the ellipsoid data delivered to NOAA has revealed that not all missions had the correct adjustments applied to bring the "Derived NAVD88" data to true ellipsoid values.

In addition to the error in data processing, a blunder was identified in the AK0302 data set. An incorrect GPS trajectory was inadvertently used in REALM processing.

The erroneous high point "halo" effect was found in early February 2006, and required a software fix by the manufacturer, Optech, Inc. of Toronto, Canada.

## Remedy

In order to assure that the data delivered in this resubmission to NOAA does not have any of the above described errors and blunders, AeroMap decided in January 2006 to start from the initial point where the airborne trajectories are computed, and reprocess all of the data, holding only ellipsoid values, throughout to the final LIDAR values.

This ellipsoid reprocessing was just being completed when the erroneous high point "halo" effect was found in some of the data for both the AK0301 and AK0302 areas. Any plans to

submit revised data to NOAA were put on hold pending a resolution by Optech of their software bug in the Optech proprietary REALM processing software. The software fix from Optech under a new version of REALM software (Version 3.5.4), took until the middle of March 2006, before it was delivered to AeroMap, and thoroughly tested.

Once again to ensure that none of the previous problems would affect this final data deliverable and this report, all original LIDAR range data were reprocessed again, holding ellipsoid heights throughout. All areas where the erroneous high point "halo" effect were first noted were checked to make sure that the revised Optech software fixed these problems, and had not created any new anomalies. This reprocessing and subsequent Quality Control checks was completed in late March 2006.

This revised data set represents a minimally adjusted data set. This means that no additional post processing (e.g., TerraMatch) has been performed on these data. Checks have been completed on all missions where there is any ground truth data (e.g., LIDAR check points, or runway data), and the results have been tabulated within this report. All missions where LIDAR check point data were present have shown to all be within the 0.30 meter RMSE accuracy specification for the project.

This revised Final LIDAR Report of April 3, 2006 incorporates new sections for the airport surveys, the checkpoint surveys, and a discussion of the check points relative to the ellipsoid LIDAR data set. All questions or comments, from either the September or December 2005 NOAA e-mails concerning Addendum 1 have been addressed within this revised Final LIDAR Report of April 3, 2006.

The December 2004 LIDAR 'ellipsoid' data set, the May 2005 Final Report and the December Addendum 1 should be discarded.

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# 1. WORK PERFORMED SUMMARY

This report is submitted February 3, 2006, to replace a previous Report and Addendum titled:

- Final Report AK0301 Shishmaref –
  Dates of LIDAR Acquisition July 9 – Aug 12, 2004
- Addendum #1 November 2005 – Final Report AK0301 Shishmaref –
  Dates of LIDAR Acquisition July 9-August 12, 2004

The reason for this resubmitted report is to address changes in the final ellipsoid data set as a result of reprocessing the data. The reasons for the reprocessing are fully detailed in the Executive Summary that is a preface to this report.

## Overview

In July and August of 2004, AeroMap U.S (a subsidiary of AERO-METRIC, Inc.) acquired LIDAR data for shoreline mapping in North West Alaska for NOAA task order AK0301-Shishmaref, and NOAA task order AK0302-Kivalina. All the Area 301 project areas were located south of Kotzebue and covered the communities of Wales and Shishmaref. This report focuses on the Area 301 Task Order, but because both Areas 301 and 302 were flown as part of one mobilization, and sometimes missions for both areas were flown on the same day, there will be many references to Area 302. All of the Area 302 project areas were located north of Kotzebue, and covered the communities of Kivalina and Point Hope. All of the targeted coastal areas were covered with LIDAR data flown at an altitude of 2000 meters Above Ground Level (AGL) with an average LIDAR data posting density of 2 meters. In addition there were missions flown at the communities of Shishmaref and Kivalina at a lower AGL altitude of 1200 meters with an average LIDAR data posting density of 1 meter.

The missions were all to be tide coordinated for tides below Mean Lower Low Water (MLLW). Because of the small tide range in the area, and the difficulties coordinating airborne missions with the complex conditions that influence tides in that region (e.g., atmospheric pressure, winds and currents), the requirement for all data acquisition to be performed at MLLW or below were relaxed by NOAA, first to Mean High Water, then in August to any tide window so that all the targeted shoreline areas could be covered. The base of operations was Kotzebue, Alaska.

The basis for the LIDAR survey and ground truth information was an extensive GPS survey carried out by the firm John Oswald and Associates (JOA), under a sub-contract to AeroMap. The complete report of this survey can be found in Section 10 (Ground Control Report). As part of this sub-contract survey, JOA established base stations sites KOT5 and KOT6 at the Kotzebue airport. These GPS base station sites were used throughout the project by the AeroMap crew for many of the missions. In addition to the stations at the Kotzebue airport, there were other base GPS sites manned by JOA and used as controlling base stations for some of the missions at locations in Shishmaref and Wales in Area 301, and Kivalina and Point Hope in Area 302.

JOA also monitored tides and suitable tide windows during the project. While this information was relayed by satellite to an Internet web site, the lag time from when the tide window

data was available to when it was posted on the Internet meant that LIDAR mission coordination was handled by phone communications with JOA staff.

In Section 4 (Flight Line Maps and Coverage), there is an Excel spreadsheet that contains all of the key details of every mission flown. This spreadsheet should be used as the initial starting point for any information sought for any mission. In this section there are also the maps of the LIDAR coverage for each mission, and the flight logs.

## Equipment Used

The list below provides the details of the major components used in the LIDAR data acquisition.

- **Aircraft:** Cessna Model 320 – Registration Number N3443Q
- **LIDAR System:** Optech Model 30/70 Airborne Laser Terrain Mapper (ALTM). Sensor Serial Number 03SEN145, and Control Console Serial Number 03CON152
- **GPS Base Station Receivers:** Trimble 4000 Ssi – Serial Numbers 3508A09934 and 3508A09849 were deployed at Kotzebue on a per mission basis by the flight crew. An additional four GPS receivers were operating full time at Wales, Shishmaref, Kivalina and Point Hope. The details of the personnel, equipment and their GPS logs are contained within the report entitled "GPS Base Station Report" located in Section 10 (Ground Control Report).

## Personnel:

AeroMap personnel on the project consisted of 2 pilots, Dale Roark and Jay Hoogstra, and one LIDAR operator, David Rider. The JOA personnel manning the base station are detailed in the report entitled "GPS Base Station Report" located in Section 10 (Ground Control Report).

## Report Content

As outlined in the Table of Contents, the other sections of this report will cover:

2. Planning
3. Weather
4. Flight Line Maps and Coverage
5. Equipment Calibration
6. Airborne Positioning
7. Aircraft Navigation
8. Tide Coordination
9. GPS Report
10. Ground Control Report
11. Product Creation
12. Accuracy report
13. QA_QC
14. Results - Problems

# 2. PLANNING

AeroMap U.S. performed extensive planning of the areas targeted by NOAA. Key aspects in the planning process are:

1. Areas to be covered
2. Type of Terrain
3. Accuracy requirement for the survey (e.g. 0.15 meter RMSE)
4. Data density, or average posting of data points (e.g., 1 meter and 2 meter)
5. Basis of Horizontal and Vertical Control for the Survey (NAD83 and NAVD88)
6. Datum and Projection for Final Data
7. Specialized Data Processing Requirements (e.g., bare earth)
8. Data format of deliverables (e.g., DEM suitable for 2 foot contour)

Once all the basic parameters of the survey were defined, AeroMap designed the LIDAR missions. The project areas were outlined using Delorme Xmap as the preliminary planning tool. This allowed initial flight line design with the USGS topographic map series. General project planning guidelines were then followed. These guidelines included:

- Confirmation of the location of the project areas
- Locations of ground reference GPS base stations (no more than 100 km from the project area), and any geodetic survey ties that must be made
- Planned location of calibration check site
- Planned locations of QC ground surveys
- Any unusual flight requirements (e.g., restricted flight zones).

The terrain was analyzed for the most efficient direction of flight lines, and areas noted where higher density data may be required (e.g., densely forested areas). If the terrain dictated that the flight lines must be flown in a “stair step” mode to achieve adequate coverage in steeply rising terrain, those areas were defined.

A sample of part of one of the Xmap flight line layout maps is included on the following page.

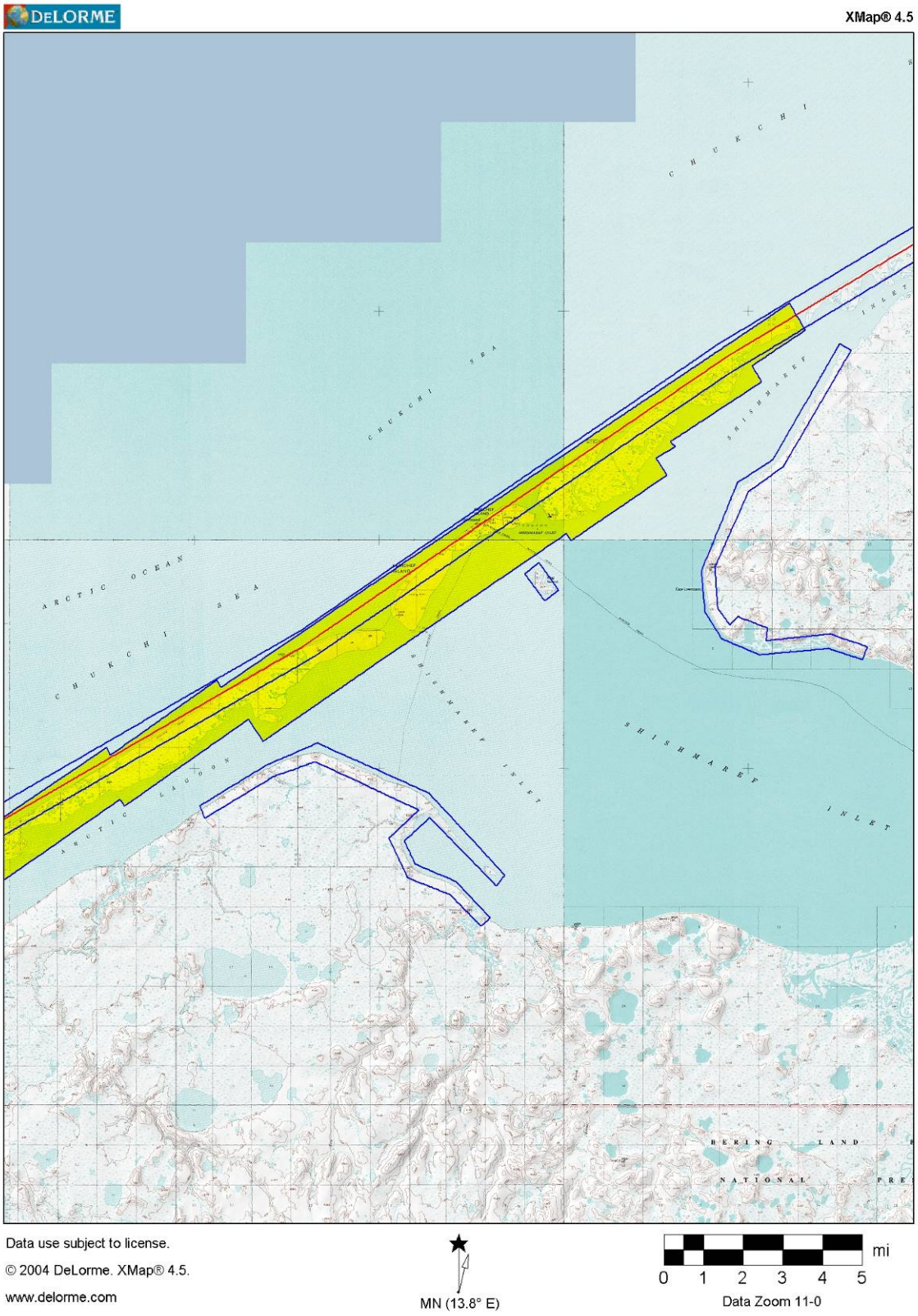



*Figure 2.1 XMap Flight Lines – 2 meter plan solid red line – 1 meter area is yellow polygon*

When the preliminary planning was completed, then the relevant project boundaries were exported to Optech's proprietary planning software (ALTM-NAV Planner).

The ALTM-NAV Planner software is a combined project design tool, and automatic flight line parameter setup for the in-flight missions of the ALTM.

Project boundaries were brought in to ALTM-NAV Planner as well as background maps or imagery. Flight lines can be designed as polygons, corridors, or fixed line surveys. The ALTM LIDAR parameters that could be set for the project included:

- Flying height (AGL)
- Ground Speed
- Flight line sidelap (normally 30 to 60 percent)
- Pulse Repetition Frequency (PRF) from 33 to 70 KHz (number of pulses per second to the ground)
- Scan Angle (the angle of the sweep) from 0 to 25 degrees on both sides of nadir (total angle up to 50 degrees)
- Scan Rate – the number of times per second the scanning mirror oscillates per second (0 to 70 Hz)

The project was broken up into a number of polygons for the 1 meter areas, and fixed line plans for the 2 meter areas.

All settings for each flight segment were then saved as an ALTM-NAV plan file, which was then used in the airborne missions to control the ALTM system.

A sample of an ALTM-NAV Planner screen is shown on the next page.

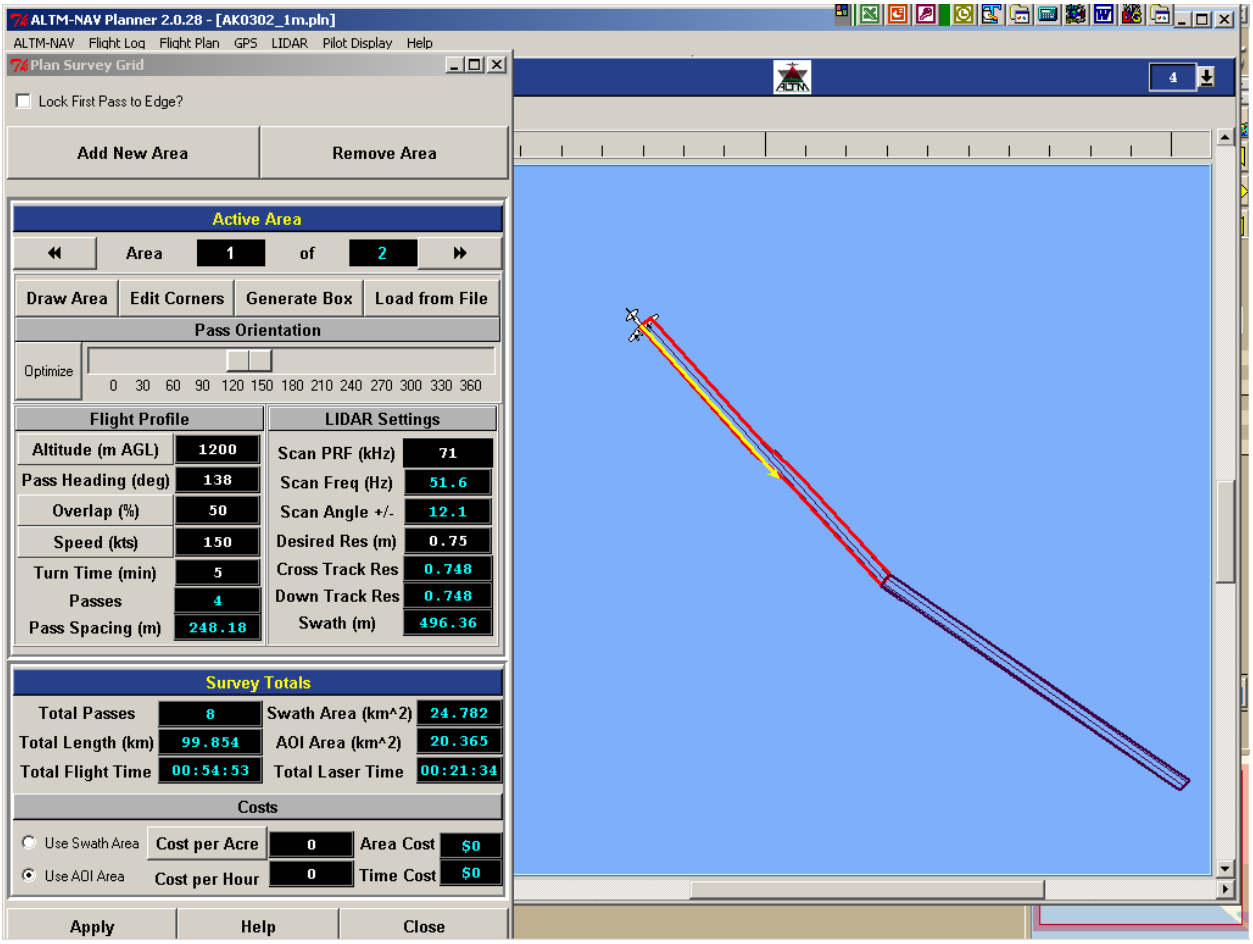



*Figure 2.2 Sample ALTM-NAV Flight Plan*

One last step involved proper GPS planning. Predictions were run on the GPS satellite geometry in the project areas at the estimated time the data would be acquired. For surveys suitable for two-foot contour DEM generation, missions were designed to avoid times when the GPS satellite Position Dilution Of Precision (PDOP) factor was above a value of 4. This insured that there would be good geometry of GPS satellites to compute an accurate GPS trajectory. This was checked again just prior to actual data acquisition.

# 3. WEATHER

The Optech 30/70 ALTM system can be operated in any condition where there is not precipitation, fog, or haze below the planned flying altitude. The system can even be flown at night. Because of the Summer time of year and the Arctic location of the project, there was not much in the way of conditions that could be classified as night. Because of the requirement to meet tide windows, there were some missions that were flown at times that had reduced daylight conditions.

The weather conditions for all missions are detailed in a column labeled Wx within the Excel spreadsheet that resides Section 4 – Flight Line Maps and Coverage. This spreadsheet contains all pertinent details of every mission.

# 4. FLIGHT LINE MAPS AND COVERAGE

This section contains all the pertinent information on the missions flown. The most important document which summarizes all the key information for each mission is the Excel spreadsheet which has the details for each mission including:

- Date
- Aircraft Number
- Pilot and Operator
- Starting Location
- Ending Location
- Start and Stop Engine Times
- Total Time for the Mission
- Weather
- Mission Number
- Area (e.g., Area 301 or Area 302, Calibration or Ground Truth Check Missions)
- Planned Altitude
- Start and Stop Times of the LIDAR Mission
- Strip or Line Number
- Altitude Flown
- PDOP as measured by the AeroMap Optech 30/70 ALTM
- Number of SV (satellites) observed by the AeroMap Optech 30/70 ALTM
- LIDAR settings (e.g., Pulse Rate, Scan Frequency, Scan Angle)
- Mission Notes (which contain the location of the base stations used to control the LIDAR Mission)

In addition, there are flight line coverage maps of each mission flown in this project area.

At the end are the actual electronic Flight Logs as completed by the operator during the mission.

NOAA Areas 301 and 302 LIDAR Flight Line Worksheet

301 Area
302 Area

All Times UTC

| Date | A/C | Pilot/Operator | Start Location | Stop Location | Hobbs Start | Hobbs Stop | Hobbs Total | Wx | Mission Number | Area | Planned Altitude | Start | Stop | Strip | Altitude Flown | Heading | PDOP | SVs | LIDAR Setting PRF | LIDAR Setting Freq. | LIDAR Setting Scan < | Notes |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 7/9/04 | 43Q | Hoogstra/Rider | PAMR | PAOT | 1014.7 | 1018.2 | 3.5 | | | | | | | | | | | | | | | Ferry Flight to Kotzebue |
| 7/11/04 | 43Q | Hoogstra/Rider | PAOT | PAOT | 1018.2 | 1020.8 | 2.6 | CLR | 43Q19304A | PAOT RW Cal | | 20:55:55 | 20:56:15 | 9 | 2041 | 114 | 1.7 | 11 | 50 | 25.8 | 18.7 | Laser Test |
| 7/11/04 | 43Q | Hoogstra/Rider | PAOT | PAOT | | | | CLR | 43Q19304A | PAOT RW Cal | | 20:56:22 | 20:56:45 | 9 | 2046 | 114 | 1.6 | 11 | 50 | 25.8 | 18.7 | Laser Test |
| 7/11/04 | 43Q | Hoogstra/Rider | PAOT | PAOT | | | | CLR | 43Q19304A | PAOT RW Cal | | 21:02:06 | 21:02:23 | 11 | 2063 | 294 | 1.6 | 10 | 50 | 25.8 | 18.7 | Missed Target areas. This was mainly a practice and orientation flight for Dale Roark and Jay Hoogstra. |
| 7/11/04 | 43Q | Hoogstra/Rider | PAOT | PAOT | | | | CLR | 43Q19304A | PAOT RW Cal | | 21:07:11 | 21:09:26 | 11 | 2071 | 294 | 2.0 | 9 | 50 | 25.8 | 18.7 | Refly later with Tmatch. |
| 7/11/04 | 43Q | Hoogstra/Rider | PAOT | PAOT | | | | CLR | 43Q19304A | PAOT RW Cal | | 21:13:15 | 21:14:45 | 11 | 2057 | 294 | 1.9 | 9 | 50 | 25.8 | 18.7 | Refly later with Tmatch. |
| 7/11/04 | 43Q | Hoogstra/Rider | PAOT | PAOT | | | | CLR | 43Q19304A | PAOT RW Cal | | 21:20:32 | 21:22:06 | 47 | 1553 | 114 | 1.5 | 10 | 50 | 30 | 19.0 | Refly later with Tmatch. |
| 7/11/04 | 43Q | Hoogstra/Rider | PAOT | PAOT | | | | CLR | 43Q19304A | PAOT RW Cal | | 21:25:35 | 21:27:53 | 47 | 1559 | 114 | 1.5 | 10 | 50 | 30 | 19.0 | Refly later with Tmatch. |
| 7/11/04 | 43Q | Hoogstra/Rider | PAOT | PAOT | 1020.8 | 1022.6 | 1.8 | | | | | | | | | | | | | | | Engine run on ground to test and troubleshoot backup laptop computer. |
| 7/19/04 | 43Q | Hoogstra/Rider | PAOT | PAOT | 1022.6 | 1024.6 | 2.0 | CLR | 43Q20104A | PAOT_Tmatch | 700 | 2:39:45 | 2:40:11 | 1 | 601 | 101 | 2.0 | 11 | 70 | 0 | 0.0 | Laser Test |
| 7/19/04 | 43Q | Hoogstra/Rider | PAOT | PAOT | | | | CLR | 43Q20104A | PAOT_Tmatch | 700 | 2:40:31 | 2:40:53 | 1 | 767 | 101 | 2.0 | 11 | 70 | 0 | 0.0 | Laser Test |
| 7/19/04 | 43Q | Hoogstra/Rider | PAOT | PAOT | | | | CLR | 43Q20104A | PAOT_Tmatch | 700 | 2:51:00 | 2:52:41 | 1 | 732 | 101 | 2.0 | 11 | 70 | 0 | 0.0 | |
| 7/19/04 | 43Q | Hoogstra/Rider | PAOT | PAOT | | | | CLR | 43Q20104A | PAOT_Tmatch | 700 | 3:00:59 | 3:02:36 | 1 | 723 | 281 | 1.9 | 11 | 70 | 0 | 0.0 | Off line. Need to Refly. |
| 7/19/04 | 43Q | Hoogstra/Rider | PAOT | PAOT | | | | CLR | 43Q20104A | PAOT_Tmatch | 700 | 3:11:23 | 3:13:02 | 1 | 725 | 101 | 1.8 | 11 | 70 | 0 | 0.0 | |
| 7/19/04 | 43Q | Hoogstra/Rider | PAOT | PAOT | | | | CLR | 43Q20104A | PAOT_Tmatch | 700 | 3:22:52 | 3:24:26 | 2 | 729 | 281 | 1.4 | 12 | 70 | 61 | 13.0 | |
| 7/19/04 | 43Q | Hoogstra/Rider | PAOT | PAOT | | | | CLR | 43Q20104A | PAOT_Tmatch | 700 | 3:35:06 | 3:36:25 | 2 | 724 | 101 | 1.4 | 11 | 70 | 61 | 13.0 | |
| 7/19/04 | 43Q | Hoogstra/Rider | PAOT | PAOT | | | | CLR | 43Q20104A | PAOT_Tmatch | 2000 | 3:48:14 | 3:49:41 | 3 | 2053 | 192 | 1.5 | 11 | 50 | 21 | 25.0 | |
| 7/19/04 | 43Q | Hoogstra/Rider | PAOT | PAOT | | | | CLR | 43Q20104A | PAOT_Tmatch | 2000 | 3:58:19 | 3:59:38 | 3 | 2062 | 12 | 1.9 | 10 | 50 | 21 | 25.0 | |
| 7/21/04 | 43Q | Hoogstra/Rider | PAOT | PAOT | 1024.6 | 1027.2 | 2.6 | CLR | 43Q20304B | 302_2m | | 17:21:34 | 17:22:03 | 1 | 8 | 138 | 2.0 | 9 | 70 | 51.6 | 12.1 | Laser Test |
| 7/21/04 | 43Q | Hoogstra/Rider | PAOT | PAOT | | | | CLR | 43Q20304B | 302_2m | | 17:22:12 | 17:22:54 | 1 | 7 | 138 | 2.0 | 9 | 70 | 51.6 | 12.1 | Laser Test |
| 7/21/04 | 43Q | Hoogstra/Rider | PAOT | PAOT | | | | CLR | 43Q20304B | 302_2m | | 17:45:08 | 17:45:31 | 43 | 701 | 293 | 1.9 | 9 | 50 | 25.8 | 18.7 | Laser Test |
| 7/21/04 | 43Q | Hoogstra/Rider | PAOT | PAOT | | | | CLR | 43Q20304B | 302_2m | | 17:45:44 | 17:46:01 | 43 | 911 | 293 | 1.9 | 9 | 50 | 25.8 | 18.7 | Laser Test |
| 7/21/04 | 43Q | Hoogstra/Rider | PAOT | PAOT | | | | CLR | 43Q20304B | 302_2m | 2000 | 17:52:03 | 17:53:24 | 43 | 2016 | 293 | 1.9 | 9 | 50 | 25.8 | 18.7 | |
| 7/21/04 | 43Q | Hoogstra/Rider | PAOT | PAOT | | | | CLR | 43Q20304B | 302_2m | 2000 | 17:53:34 | 17:53:52 | 41 | 2012 | 296 | 1.9 | 9 | 50 | 25.8 | 18.7 | Off line. Need to refly. |
| 7/21/04 | 43Q | Hoogstra/Rider | PAOT | PAOT | | | | CLR | 43Q20304B | 302_2m | 2000 | 17:55:21 | 17:56:45 | 39 | 2020 | 293 | 1.9 | 9 | 50 | 25.8 | 18.7 | |
| 7/21/04 | 43Q | Hoogstra/Rider | PAOT | PAOT | | | | CLR | 43Q20304B | 302_2m | 2000 | 17:56:55 | 17:58:57 | 37 | 2018 | 287 | 1.9 | 9 | 50 | 25.8 | 18.7 | |
| 7/21/04 | 43Q | Hoogstra/Rider | PAOT | PAOT | | | | CLR | 43Q20304B | 302_2m | 2000 | 18:01:21 | 18:01:50 | 34 | 1962 | 296 | 1.9 | 9 | 50 | 25.8 | 18.7 | Off line. Need to refly. |
| 7/21/04 | 43Q | Hoogstra/Rider | PAOT | PAOT | | | | CLR | 43Q20304B | 302_2m | 2000 | 18:06:08 | 18:09:45 | 35 | 2039 | 102 | 1.9 | 9 | 50 | 25.8 | 18.7 | |
| 7/21/04 | 43Q | Hoogstra/Rider | PAOT | PAOT | | | | CLR | 43Q20304B | 302_2m | 2000 | 18:13:32 | 18:15:23 | 41 | 2039 | 116 | 1.8 | 9 | 50 | 25.8 | 18.7 | |
| 7/21/04 | 43Q | Hoogstra/Rider | PAOT | PAOT | | | | CLR | 43Q20304B | 302_2m | 2000 | 18:23:25 | 18:24:44 | 44 | 2039 | 71 | 1.7 | 9 | 50 | 25.8 | 18.7 | |
| 7/21/04 | 43Q | Hoogstra/Rider | PAOT | PAOT | 1027.2 | 1030.8 | 3.6 | CLR | 43Q20304C | 301_2m | | 4:33:31 | 4:33:52 | 6 | 841 | 266 | 1.9 | 12 | 50 | 25.8 | 18.7 | Laser Test |
| 7/21/04 | 43Q | Hoogstra/Rider | PAOT | PAOT | | | | CLR | 43Q20304C | 301_2m | | 4:34:03 | 4:34:24 | 6 | 988 | 266 | 1.9 | 12 | 50 | 25.8 | 18.7 | Laser Test |
| 7/21/04 | 43Q | Hoogstra/Rider | PAOT | PAOT | | | | CLR | 43Q20304C | 301_2m | 2000 | 4:48:51 | 4:53:18 | 6 | 2058 | 266 | 2.8 | 9 | 50 | 25.8 | 18.7 | **Mission 43Q20304B used KOT5 & KOT6 as base stations** |
| 7/21/04 | 43Q | Hoogstra/Rider | PAOT | PAOT | | | | CLR | 43Q20304C | 301_2m | 2000 | 4:55:45 | 5:01:56 | 4 | 2057 | 248 | 2.9 | 9 | 50 | 25.8 | 18.7 | |
| 7/21/04 | 43Q | Hoogstra/Rider | PAOT | PAOT | | | | CLR | 43Q20304C | 301_2m | 2000 | 5:04:36 | 5:09:38 | 2 | 2060 | 239 | 2.8 | 9 | 50 | 25.8 | 18.7 | |
| 7/21/04 | 43Q | Hoogstra/Rider | PAOT | PAOT | | | | CLR | 43Q20304C | 301_2m | 2000 | 5:13:37 | 5:17:57 | 38 | 2056 | 240 | 2.5 | 9 | 50 | 25.8 | 18.7 | |
| 7/21/04 | 43Q | Hoogstra/Rider | PAOT | PAOT | | | | CLR | 43Q20304C | 301_2m | 2000 | 5:23:26 | 5:32:57 | 37 | 2054 | 232 | 2.0 | 10 | 50 | 25.8 | 18.7 | |
| 7/21/04 | 43Q | Hoogstra/Rider | PAOT | PAOT | | | | CLR | 43Q20304C | 301_2m | 2000 | 5:39:34 | 6:04:06 | 21 | 2055 | 52 | 1.7 | 11 | 50 | 25.8 | 18.7 | Strip 21 includes lines 20, 19, 18, and 17. Flown as one continuous line without turning off Laser. **Mission 43Q20304C used Station SHIS as the base station. Stations KOT5 & KOT6 were used for blunder checks.** |
| 7/21/04 | 43Q | Hoogstra/Rider | PAOT | PAOT | | | | CLR | 43Q20304C | 301_2m | 2000 | 6:07:38 | 6:12:18 | 3 | 2055 | 243 | 1.7 | 9 | 50 | 25.8 | 18.7 | |
| 7/21/04 | 43Q | Hoogstra/Rider | PAOT | PAOT | | | | CLR | 43Q20304C | 301_2m | 2000 | 6:15:20 | 6:21:01 | 1 | 2087 | 236 | 2.5 | 8 | 50 | 25.8 | 18.7 | |
| 7/21/04 | 43Q | Hoogstra/Rider | PAOT | PAOT | | | | CLR | 43Q20304C | SHF_Tmatch | 2000 | 6:28:24 | 6:30:13 | 3 | 2054 | 192 | 2.3 | 8 | 50 | 21 | 25.0 | |
| 7/21/04 | 43Q | Hoogstra/Rider | PAOT | PAOT | | | | CLR | 43Q20304C | SHF_Tmatch | 2000 | 6:36:05 | 6:38:07 | 4 | 2005 | 90 | 2.2 | 8 | 50 | 21 | 25.0 | |
| 7/21/04 | 43Q | Hoogstra/Rider | PAOT | PAOT | | | | CLR | 43Q20304C | SHF_Tmatch | 700 | 6:42:50 | 6:45:17 | 2 | 705 | 101 | 1.7 | 8 | 70 | 61 | 13.0 | |
| 7/21/04 | 43Q | Hoogstra/Rider | PAOT | PAOT | | | | CLR | 43Q20304C | SHF_Tmatch | 700 | 6:49:29 | 6:51:02 | 2 | 684 | 101 | 1.7 | 8 | 70 | 61 | 13.0 | |
| 7/21/04 | 43Q | Hoogstra/Rider | PAOT | PAOT | | | | CLR | 43Q20304C | SHF_Tmatch | 700 | 6:54:29 | 6:56:24 | 1 | 724 | 101 | 2.0 | 7 | 70 | 0 | 0.0 | |
| 7/21/04 | 43Q | Hoogstra/Rider | PAOT | PAOT | | | | CLR | 43Q20304C | SHF_Tmatch | 700 | 6:58:17 | 6:59:53 | 1 | 736 | 101 | 2.1 | 7 | 70 | 0 | 0.0 | |
| 7/22/04 | 43Q | Hoogstra/Rider | PAOT | PAOT | 1030.8 | 1034.9 | 4.1 | CLR | 43Q20404A | 301_1m | 1200 | 17:05:23 | 17:05:48 | 3 | 1342 | 236 | 2.1 | 10 | 70 | 51.6 | 12.1 | Laser Test |
| 7/22/04 | 43Q | Hoogstra/Rider | PAOT | PAOT | | | | CLR | 43Q20404A | 301_1m | 1200 | 17:05:57 | 17:06:21 | 3 | 1345 | 236 | 2.1 | 10 | 70 | 51.6 | 12.1 | Laser Test |
| 7/22/04 | 43Q | Hoogstra/Rider | PAOT | PAOT | | | | CLR | 43Q20404A | 301_1m | 1200 | 17:22:54 | 17:35:46 | 3 | 1200 | 236 | 1.9 | 9 | 70 | 51.6 | 12.1 | **Mission 43Q20404A used stations KOT6 & SHIS as base stations** |

NOAA Areas 301 and 302 LIDAR Flight Line Worksheet

301 Area
302 Area

All Times UTC

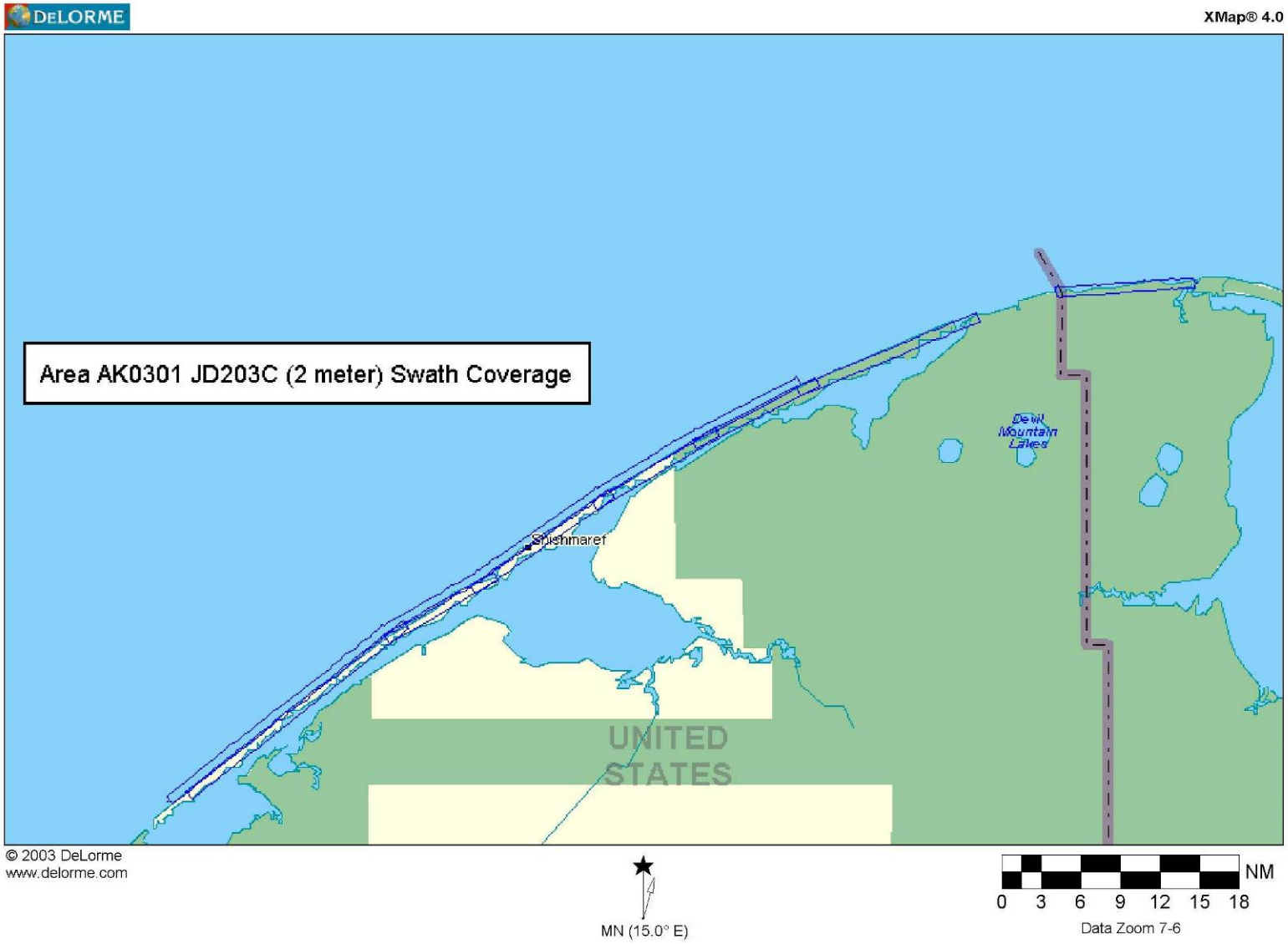
| Date | A/C | Pilot/Operator | Start Location | Stop Location | Hobbs Start | Hobbs Stop | Hobbs Total | Wx | Mission Number | Area | Planned Altitude | Start | Stop | Strip | Altitude Flown | Heading | PDOP | SVs | LIDAR Setting PRF | LIDAR Setting Freq. | LIDAR Setting Scan < | Notes |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 7/22/04 | 43Q | Hoogstra/Rider | PAOT | PAOT | | | | CLR | 43Q20404A | 301_1m | 1200 | 17:40:49 | 17:46:37 | 2 | 1199 | 56 | 1.9 | 9 | 70 | 51.6 | 12.1 | |
| 7/22/04 | 43Q | Hoogstra/Rider | PAOT | PAOT | | | | CLR | 43Q20404A | 301_1m | 1200 | 17:52:19 | 17:57:08 | 1 | 1198 | 236 | 1.9 | 9 | 70 | 51.6 | 12.1 | |
| 7/22/04 | 43Q | Hoogstra/Rider | PAOT | PAOT | | | | CLR | 43Q20404A | 301_1m | 1200 | 18:03:54 | 18:16:55 | 4 | 1212 | 56 | 1.8 | 9 | 70 | 51.6 | 12.1 | |
| 7/22/04 | 43Q | Hoogstra/Rider | PAOT | PAOT | | | | CLR | 43Q20404A | 301_1m | 1200 | 18:22:04 | 18:34:57 | 5 | 1204 | 236 | 1.6 | 9 | 70 | 51.6 | 12.1 | |
| 7/22/04 | 43Q | Hoogstra/Rider | PAOT | PAOT | | | | CLR | 43Q20404A | 301_1m | 1200 | 18:39:04 | 18:51:51 | 6 | 1197 | 56 | 3.0 | 7 | 70 | 51.6 | 12.1 | |
| 7/22/04 | 43Q | Hoogstra/Rider | PAOT | PAOT | | | | CLR | 43Q20404A | 301_2m | 2000 | 18:57:47 | 19:07:50 | 16 | 1998 | 68 | 2.3 | 7 | 50 | 25.8 | 18.7 | Strip 16 includes line 15. Flown as one line. |
| 7/22/04 | 43Q | Hoogstra/Rider | PAOT | PAOT | | | | CLR | 43Q20404A | 301_2m | 2000 | 19:10:41 | 19:13:37 | 13 | 2041 | 90 | 1.8 | 9 | 50 | 25.8 | 18.7 | |
| 7/22/04 | 43Q | Hoogstra/Rider | PAOT | PAOT | | | | CLR | 43Q20404A | 301_2m | 2000 | 19:20:50 | 19:25:08 | 5 | 2042 | 252 | 2.0 | 9 | 50 | 25.8 | 18.7 | |
| 7/22/04 | 43Q | Hoogstra/Rider | PAOT | PAOT | | | | CLR | 43Q20404A | 301_2m | 2000 | 19:30:14 | 19:34:16 | 14 | 2029 | 86 | 1.9 | 10 | 50 | 25.8 | 18.7 | |
| 7/22/04 | 43Q | Hoogstra/Rider | PAOT | PAOT | | | | CLR | 43Q20404A | 301_2m | 2000 | 19:35:21 | 19:37:59 | 12 | 1999 | 98 | 2.0 | 10 | 50 | 25.8 | 18.7 | |
| 7/22/04 | 43Q | Hoogstra/Rider | PAOT | PAOT | | | | CLR | 43Q20404A | 301_2m | 2000 | 19:42:06 | 19:44:21 | 8 | 2044 | 278 | 2.2 | 10 | 50 | 25.8 | 18.7 | |
| 7/22/04 | 43Q | Hoogstra/Rider | PAOT | PAOT | | | | CLR | 43Q20404A | 301_2m | 2000 | 19:49:00 | 19:52:05 | 7 | 2011 | 90 | 2.1 | 11 | 50 | 25.8 | 18.7 | |
| 7/22/04 | 43Q | Hoogstra/Rider | PAOT | PAOT | | | | CLR | 43Q20404A | 301_2m | 2000 | 19:52:32 | 19:53:33 | 9 | 2065 | 114 | 2.1 | 11 | 50 | 25.8 | 18.7 | Off line. Need to refly. |
| 7/22/04 | 43Q | Hoogstra/Rider | PAOT | PAOT | | | | CLR | 43Q20404A | 301_2m | 2000 | 20:01:12 | 20:03:50 | 9 | 2068 | 114 | 2.0 | 11 | 50 | 25.8 | 18.7 | |
| 7/22/04 | 43Q | Hoogstra/Rider | PAOT | PAOT | | | | CLR | 43Q20404A | 301_2m | 2000 | 20:07:03 | 20:09:46 | 11 | 2002 | 294 | 1.9 | 11 | 50 | 25.8 | 18.7 | |
| 7/24/04 | 43Q | Roark/Rider | PAOT | PAUN | 1034.8 | 1036.2 | 1.4 | | | | | | | | | | | | | | | Flew to Unalakleet to provide 16Q with base stations. |
| 7/24/04 | 43Q | Roark/Rider | PAUN | PAOT | 1036.2 | 1038.7 | 2.5 | | | | | | | | | | | | | | | Landed at Wales and Shishmaref on return trip to check base stations. |
| 7/25/04 | 43Q | Roark/Rider | PAOT | PAOT | 1038.7 | 1040.7 | 2.0 | | | | | | | | | | | | | | | Flew to Point Hope to Check base station. |
| 8/1/04 | 43Q | Roark/Rider | PAOT | PAOT | 1040.7 | 1043.2 | 2.5 | CLR | 43Q21404A | 302_1m | | 2:52:31 | 2:52:54 | 7 | 7 | 305 | 1.4 | 11 | 70 | 51.6 | 12.1 | Laser Test |
| 8/1/04 | 43Q | Roark/Rider | PAOT | PAOT | | | | CLR | 43Q21404A | 302_1m | | 3:02:58 | 3:03:22 | 7 | 1214 | 305 | 1.5 | 11 | 70 | 51.6 | 12.1 | Laser Test |
| 8/1/04 | 43Q | Roark/Rider | PAOT | PAOT | | | | CLR | 43Q21404A | 302_1m | | 3:03:29 | 3:03:48 | 7 | 1278 | 305 | 1.5 | 11 | 70 | 51.6 | 12.1 | Laser Test |
| 8/1/04 | 43Q | Roark/Rider | PAOT | PAOT | | | | CLR | 43Q21404A | 302_1m | 1200 | 3:20:12 | 3:24:43 | 7 | 1189 | 305 | 1.6 | 11 | 70 | 51.6 | 12.1 | **Mission 43Q21404A used stations KIVI & PTHP as base stations.** |
| 8/1/04 | 43Q | Roark/Rider | PAOT | PAOT | | | | CLR | 43Q21404A | 302_1m | 1200 | 3:29:40 | 3:33:53 | 2 | 1206 | 318 | 1.8 | 11 | 70 | 51.6 | 12.1 | |
| 8/1/04 | 43Q | Roark/Rider | PAOT | PAOT | | | | CLR | 43Q21404A | 302_1m | 1200 | 3:38:47 | 3:41:38 | 1 | 1194 | 138 | 1.9 | 12 | 70 | 51.6 | 12.1 | |
| 8/1/04 | 43Q | Roark/Rider | PAOT | PAOT | | | | CLR | 43Q21404A | 302_1m | 1200 | 3:42:29 | 3:43:16 | 8 | 1191 | 125 | 1.9 | 12 | 70 | 51.6 | 12.1 | May need to refly. |
| 8/1/04 | 43Q | Roark/Rider | PAOT | PAOT | | | | CLR | 43Q21404A | 302_1m | 1200 | 3:49:09 | 3:53:24 | 6 | 1228 | 125 | 2.0 | 12 | 70 | 51.6 | 12.1 | |
| 8/1/04 | 43Q | Roark/Rider | PAOT | PAOT | | | | CLR | 43Q21404A | 302_1m | 1200 | 3:58:49 | 4:03:23 | 5 | 1192 | 305 | 2.8 | 9 | 70 | 51.6 | 12.1 | |
| 8/1/04 | 43Q | Roark/Rider | PAOT | PAOT | | | | CLR | 43Q21404A | 302_1m | 1200 | 4:09:32 | 4:12:02 | 4 | 1191 | 318 | 3.0 | 9 | 70 | 51.6 | 12.1 | |
| 8/1/04 | 43Q | Roark/Rider | PAOT | PAOT | | | | CLR | 43Q21404A | 302_1m | 1200 | 4:17:51 | 4:22:10 | 3 | 1170 | 138 | 2.9 | 9 | 70 | 51.6 | 12.1 | |
| 8/1/04 | 43Q | Roark/Rider | PAOT | PAOT | | | | CLR | 43Q21404A | 302_2m | 2000 | 4:36:58 | 4:38:17 | 26 | 2009 | 157 | 1.9 | 10 | 50 | 25.8 | 18.7 | Need to refly. Laser off due to clouds. |
| 8/1/04 | 43Q | Roark/Rider | PAOT | PAOT | | | | CLR | 43Q21404A | 302_2m | 2000 | 4:40:54 | 4:44:21 | 27 | 2026 | 163 | 1.9 | 10 | 50 | 25.8 | 18.7 | |
| 8/5/04 | 43Q | Roark/Rider | PAOT | PAOT | 1043.2 | 1044.9 | 1.7 | OC/LT RN | 43Q21804A | 302_2m | | 17:13:42 | 17:14:01 | 37 | 11 | 287 | 1.8 | 9 | 50 | 25.8 | 18.7 | Laser Test |
| 8/5/04 | 43Q | Roark/Rider | PAOT | PAOT | | | | OC/LT RN | 43Q21804A | 302_2m | | 17:39:36 | 17:39:57 | 26 | 2030 | 337 | 1.7 | 8 | 50 | 25.8 | 18.7 | Laser Test |
| 8/5/04 | 43Q | Roark/Rider | PAOT | PAOT | | | | OC/LT RN | 43Q21804A | 302_2m | | 17:40:02 | 17:40:17 | 26 | 2018 | 337 | 1.7 | 8 | 50 | 25.8 | 18.7 | Laser Test |
| 8/5/04 | 43Q | Roark/Rider | PAOT | PAOT | | | | OC/LT RN | 43Q21804A | 302_2m | 2000 | 17:40:26 | 17:44:57 | 26 | 2022 | 337 | 1.7 | 8 | 50 | 25.8 | 18.7 | **Mission 43Q21804A used stations KOT6 and KIVI as base stations.** |
| 8/5/04 | 43Q | Roark/Rider | PAOT | PAOT | | | | OC/LT RN | 43Q21804A | 302_2m | 2000 | 17:45:50 | 17:47:36 | 24 | 1977 | 315 | 1.7 | 8 | 50 | 25.8 | 18.7 | |
| 8/5/04 | 43Q | Roark/Rider | PAOT | PAOT | | | | OC/LT RN | 43Q21804A | 302_2m | 2000 | 17:51:06 | 17:55:37 | 22 | 2021 | 317 | 2.2 | 7 | 50 | 25.8 | 18.7 | Need to refly at least north half of this line due to clouds. |
| 8/5/04 | 43Q | Roark/Rider | PAOT | PAOT | | | | OC/LT RN | 43Q21804A | 302_2m | 2000 | 18:00:16 | 18:05:26 | 23 | 2025 | 124 | 2.1 | 8 | 50 | 25.8 | 18.7 | |
| 8/5/04 | 43Q | Roark/Rider | PAOT | PAOT | | | | OC/LT RN | 43Q21804A | 302_2m | 2000 | 18:10:58 | 18:13:37 | 25 | 2024 | 146 | 2.5 | 8 | 50 | 25.8 | 18.7 | |
| 8/5/04 | 43Q | Roark/Rider | PAOT | PAOT | | | | OC/LT RN | 43Q21804A | 302_2m | 2000 | 18:18:20 | 18:20:20 | 28 | 2034 | 166 | 2.0 | 9 | 50 | 25.8 | 18.7 | North half of line complete. Refly South end due to clouds. |
| 8/5/04 | 43Q | Roark/Rider | PAOT | PAOT | | | | OC/LT RN | 43Q21804A | 302_2m | 2000 | 18:27:27 | 18:29:04 | 36 | 2041 | 112 | 2.2 | 9 | 50 | 25.8 | 18.7 | |
| 8/5/04 | 43Q | Roark/Rider | PAOT | PAOT | 1044.9 | 1048.3 | 3.4 | CLR | 43Q21804B | 302_2m | | 4:37:26 | 4:37:44 | 1 | 2031 | 70 | 1.7 | 11 | 50 | 25.8 | 18.7 | Laser Test |
| 8/5/04 | 43Q | Roark/Rider | PAOT | PAOT | | | | CLR | 43Q21804B | 302_2m | | 4:37:51 | 4:38:07 | 1 | 2029 | 70 | 1.7 | 11 | 50 | 25.8 | 18.7 | Laser Test |
| 8/5/04 | 43Q | Roark/Rider | PAOT | PAOT | | | | CLR | 43Q21804B | 302_2m | 2000 | 4:58:58 | 5:01:11 | 20 | 1989 | 314 | 1.7 | 10 | 50 | 25.8 | 18.7 | Part of line complete. Will refly. |
| 8/5/04 | 43Q | Roark/Rider | PAOT | PAOT | | | | CLR | 43Q21804B | 302_2m | 2000 | 5:06:44 | 5:11:16 | 20 | 2035 | 134 | 1.7 | 9 | 50 | 25.8 | 18.7 | Strip 20 includes line 21. |
| 8/5/04 | 43Q | Roark/Rider | PAOT | PAOT | | | | CLR | 43Q21804B | 302_2m | 2000 | 5:15:58 | 5:18:07 | 19 | 2028 | 308 | 2.4 | 8 | 50 | 25.8 | 18.7 | **Mission 43Q21804B used stations KOT6 and KIVI as base stations.** |
| 8/5/04 | 43Q | Roark/Rider | PAOT | PAOT | | | | CLR | 43Q21804B | 302_2m | 2000 | 5:23:16 | 5:24:37 | 18 | 2024 | 315 | 2.3 | 8 | 50 | 25.8 | 18.7 | |
| 8/5/04 | 43Q | Roark/Rider | PAOT | PAOT | | | | CLR | 43Q21804B | 302_2m | 2000 | 5:29:50 | 5:31:09 | 17 | 2009 | 327 | 2.2 | 8 | 50 | 25.8 | 18.7 | |
| 8/5/04 | 43Q | Roark/Rider | PAOT | PAOT | | | | CLR | 43Q21804B | 302_2m | 2000 | 5:37:14 | 5:40:08 | 16 | 2002 | 314 | 2.3 | 8 | 50 | 25.8 | 18.7 | Strip 16 includes line 15. |
| 8/5/04 | 43Q | Roark/Rider | PAOT | PAOT | | | | CLR | 43Q21804B | 302_2m | 2000 | 5:45:41 | 5:50:13 | 14 | 2018 | 299 | 1.6 | 9 | 50 | 25.8 | 18.7 | Strip 14 includes line 13. |
| 8/5/04 | 43Q | Roark/Rider | PAOT | PAOT | | | | CLR | 43Q21804B | 302_2m | 2000 | 5:51:20 | 5:52:06 | 10 | 2003 | 311 | 2.0 | 7 | 50 | 25.8 | 18.7 | Off line. Will refly. |
| 8/5/04 | 43Q | Roark/Rider | PAOT | PAOT | | | | CLR | 43Q21804B | 302_2m | 2000 | 5:53:19 | 5:54:57 | 8 | 1991 | 328 | 2.1 | 7 | 50 | 25.8 | 18.7 | |

NOAA Areas 301 and 302 LIDAR Flight Line Worksheet

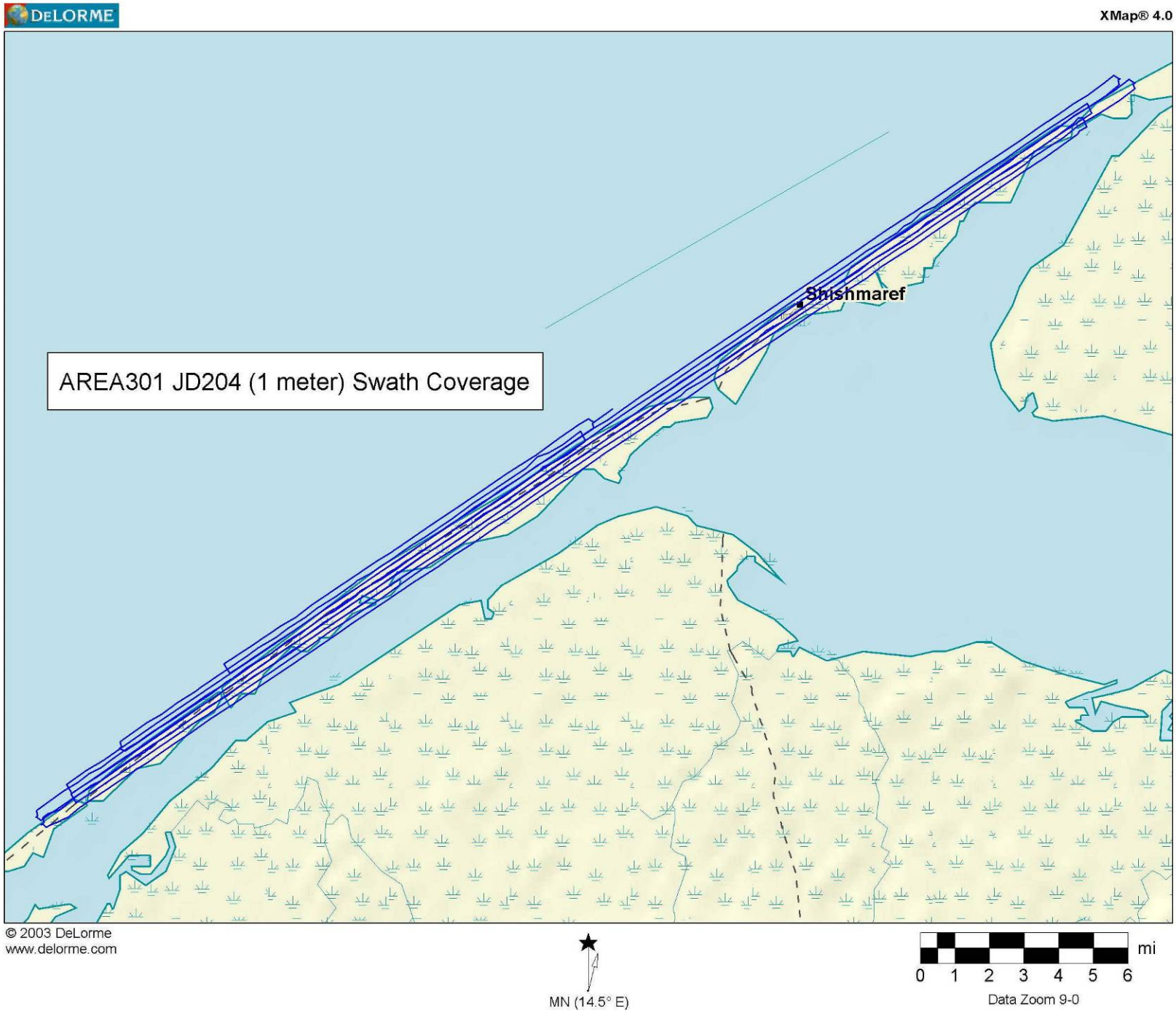
301 Area
302 Area

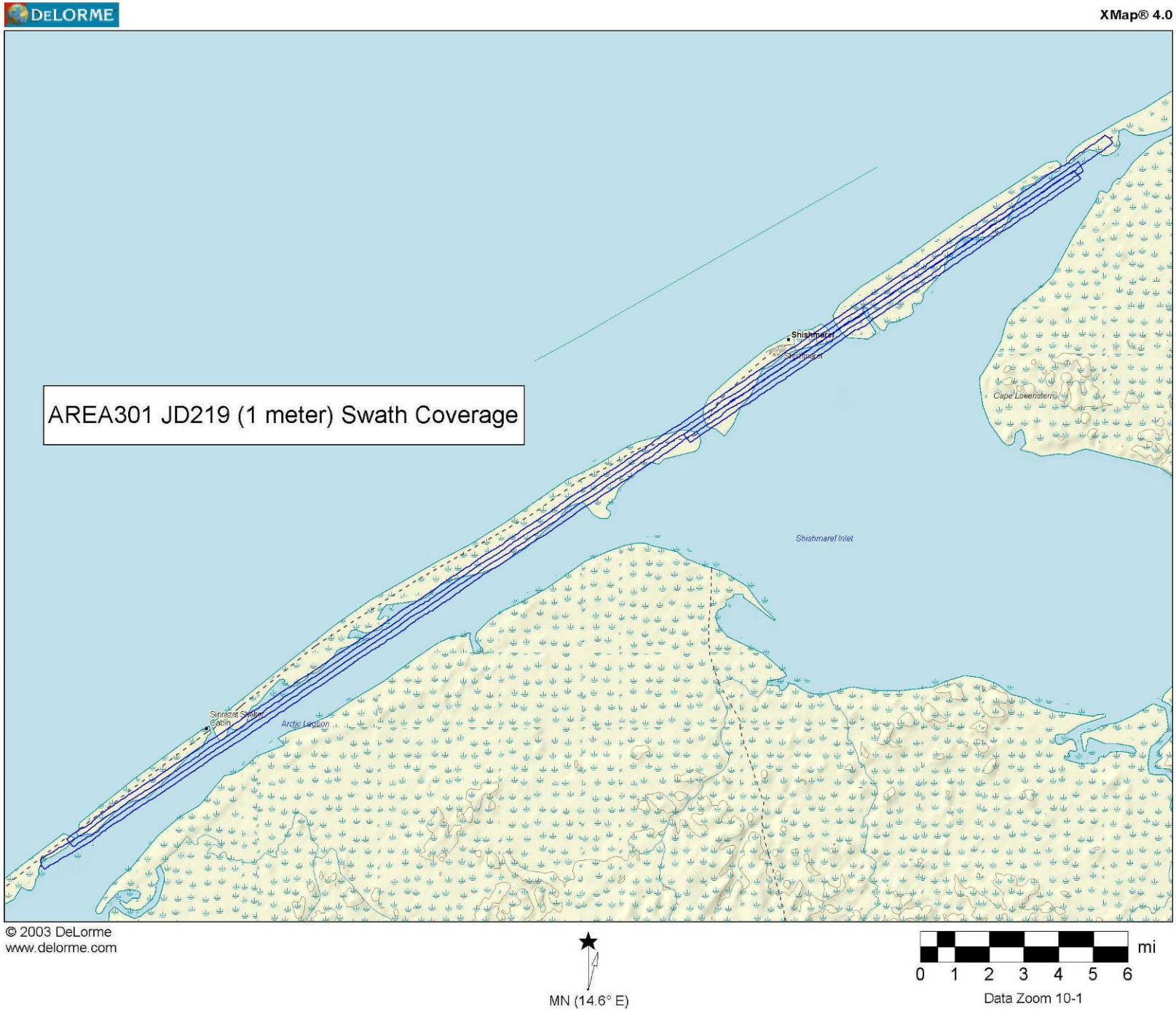
All Times UTC

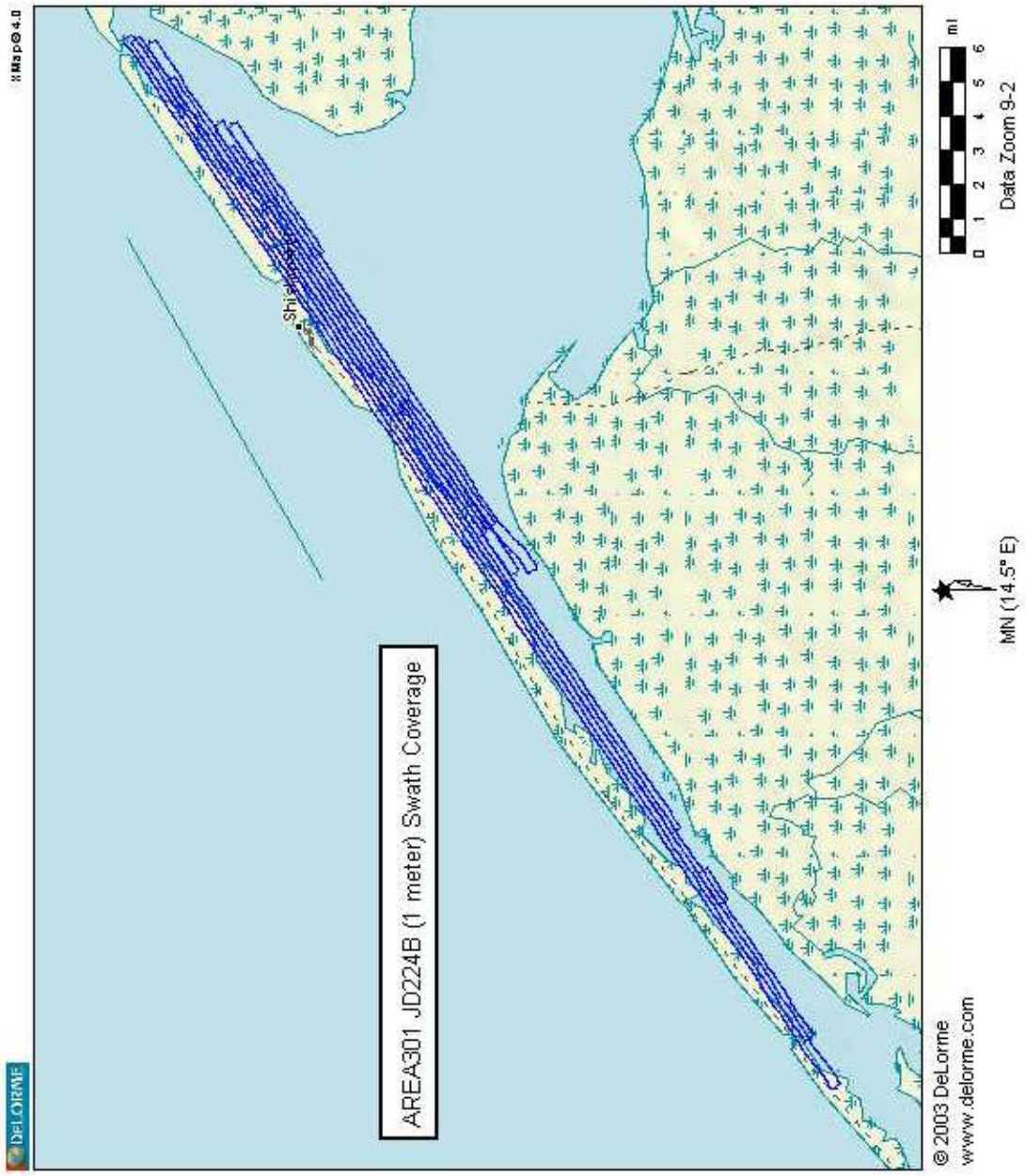
| Date | A/C | Pilot/Operator | Start Location | Stop Location | Hobbs Start | Hobbs Stop | Hobbs Total | Wx | Mission Number | Area | Planned Altitude | Start | Stop | Strip | Altitude Flown | Heading | PDOP | SVs | LIDAR Setting PRF | LIDAR Setting Freq. | LIDAR Setting Scan < | Notes |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 8/5/04 | 43Q | Roark/Rider | PAOT | PAOT | | | | CLR | 43Q21804B | 302_2m | 2000 | 5:58:02 | 6:00:02 | 9 | 2022 | 160 | 2.2 | 7 | 50 | 25.8 | 18.7 | |
| 8/5/04 | 43Q | Roark/Rider | PAOT | PAOT | | | | CLR | 43Q21804B | 302_2m | 2000 | 6:00:34 | 6:02:11 | 11 | 2072 | 111 | 2.2 | 7 | 50 | 25.8 | 18.7 | |
| 8/5/04 | 43Q | Roark/Rider | PAOT | PAOT | | | | CLR | 43Q21804B | 302_2m | 2000 | 6:06:36 | 6:08:33 | 12 | 2014 | 284 | 2.2 | 8 | 50 | 25.8 | 18.7 | |
| 8/5/04 | 43Q | Roark/Rider | PAOT | PAOT | | | | CLR | 43Q21804B | 302_2m | 2000 | 6:08:45 | 6:08:59 | 10 | 2010 | 311 | 2.3 | 8 | 50 | 25.8 | 18.7 | Off line. Will refly. |
| 8/5/04 | 43Q | Roark/Rider | PAOT | PAOT | | | | CLR | 43Q21804B | 302_2m | 2000 | 6:14:22 | 6:16:23 | 10 | 2001 | 311 | 2.6 | 8 | 50 | 25.8 | 18.7 | |
| | | | | | | | | | | | | | | | | | | | | | | |
| 8/6/04 | 43Q | Roark/Rider | PAOT | PAOT | 1048.3 | 1049.6 | 1.3 | | | | | | | | | | | | | | | Terminated flight due to rain. |
| | | | | | | | | | | | | | | | | | | | | | | |
| 8/6/04 | 43Q | Roark/Rider | PAOT | PAOT | 1049.6 | 1052.6 | 3.0 | OC/LT RN | 43Q21904A | Shish_Tmatch | | 4:27:14 | 4:27:34 | 1 | 1395 | 243 | 1.7 | 11 | 70 | 0 | 0.0 | Laser Test |
| 8/6/04 | 43Q | Roark/Rider | PAOT | PAOT | | | | OC/LT RN | 43Q21904A | Shish_Tmatch | | 4:28:06 | 4:28:21 | 1 | 1211 | 243 | 1.7 | 11 | 70 | 0 | 0.0 | Laser Test |
| 8/6/04 | 43Q | Roark/Rider | PAOT | PAOT | | | | OC/LT RN | 43Q21904A | Shish_Tmatch | 700 | 4:38:05 | 4:39:24 | 1 | 725 | 243 | 1.7 | 11 | 70 | 0 | 0.0 | |
| 8/6/04 | 43Q | Roark/Rider | PAOT | PAOT | | | | OC/LT RN | 43Q21904A | Shish_Tmatch | 700 | 4:44:40 | 4:45:52 | -18 | 679 | 63 | 1.6 | 11 | 70 | 0 | 0.0 | |
| | | | | | | | | | | | | | | | | | | | | | | **Mission 43Q21904A used station SHIS as the base station, with station KOT5 used for a blunder check.** |
| 8/6/04 | 43Q | Roark/Rider | PAOT | PAOT | | | | OC/LT RN | 43Q21904A | 301_1m | 1200 | 4:54:07 | 5:06:55 | 7 | 1194 | 236 | 1.7 | 10 | 70 | 51.6 | 12.1 | |
| 8/6/04 | 43Q | Roark/Rider | PAOT | PAOT | | | | OC/LT RN | 43Q21904A | 301_1m | 1200 | 5:11:41 | 5:24:38 | 8 | 1158 | 56 | 2.4 | 8 | 70 | 51.6 | 12.1 | |
| 8/6/04 | 43Q | Roark/Rider | PAOT | PAOT | | | | OC/LT RN | 43Q21904A | 301_1m | 1200 | 5:29:06 | 5:34:07 | 9 | 1204 | 236 | 2.3 | 8 | 70 | 51.6 | 12.1 | Terminated flight due to rain. |
| | | | | | | | | | | | | | | | | | | | | | | |
| 8/10/04 | 43Q | Roark/Rider | PAOT | PAOT | 1052.6 | 1053.9 | 1.3 | | | | | | | | | | | | | | | Terminated flight due to rain. |
| | | | | | | | | | | | | | | | | | | | | | | |
| 8/11/04 | 43Q | Roark/Rider | PAOT | PAOT | 1053.9 | 1057.0 | 3.1 | CLR | 43Q22404A | 302_2m | | 16:15:00 | 16:15:22 | 42 | 826 | 308 | 2.0 | 9 | 50 | 25.8 | 18.7 | Laser Test |
| 8/11/04 | 43Q | Roark/Rider | PAOT | PAOT | | | | CLR | 43Q22404A | 302_2m | | 16:15:29 | 16:15:48 | 42 | 962 | 308 | 2.0 | 9 | 50 | 25.8 | 18.7 | Laser Test |
| | | | | | | | | | | | | | | | | | | | | | | **Mission 43Q22404A used stations KIVI & KOT5** |
| 8/11/04 | 43Q | Roark/Rider | PAOT | PAOT | | | | CLR | 43Q22404A | 302_2m | 2000 | 16:22:47 | 16:24:31 | 42 | 2024 | 308 | 2.0 | 9 | 50 | 25.8 | 18.7 | **as base stations.** |
| 8/11/04 | 43Q | Roark/Rider | PAOT | PAOT | | | | CLR | 43Q22404A | 302_2m | 2000 | 16:27:48 | 16:29:44 | 40 | 2019 | 283 | 2.0 | 9 | 50 | 25.8 | 18.7 | |
| 8/11/04 | 43Q | Roark/Rider | PAOT | PAOT | | | | CLR | 43Q22404A | 302_2m | 2000 | 16:35:11 | 16:37:10 | 38 | 2004 | 284 | 2.0 | 9 | 50 | 25.8 | 18.7 | |
| 8/11/04 | 43Q | Roark/Rider | PAOT | PAOT | | | | CLR | 43Q22404A | 302_2m | 2000 | 16:40:16 | 16:41:30 | 34 | 2031 | 296 | 1.9 | 9 | 50 | 25.8 | 18.7 | |
| 8/11/04 | 43Q | Roark/Rider | PAOT | PAOT | | | | CLR | 43Q22404A | 302_2m | 2000 | 16:47:06 | 16:48:44 | 33 | 2056 | 308 | 1.8 | 9 | 50 | 25.8 | 18.7 | |
| 8/11/04 | 43Q | Roark/Rider | PAOT | PAOT | | | | CLR | 43Q22404A | 302_2m | 2000 | 16:54:35 | 16:55:36 | 32 | 2024 | 324 | 1.7 | 9 | 50 | 25.8 | 18.7 | |
| 8/11/04 | 43Q | Roark/Rider | PAOT | PAOT | | | | CLR | 43Q22404A | 302_2m | 2000 | 16:57:00 | 17:02:04 | 29 | 1983 | 351 | 1.7 | 9 | 50 | 25.8 | 18.7 | Strip 29 includes line 28. Flown as one line. |
| 8/11/04 | 43Q | Roark/Rider | PAOT | PAOT | | | | CLR | 43Q22404A | 302_2m | 2000 | 17:09:22 | 17:12:28 | 30 | 2018 | 177 | 1.6 | 9 | 50 | 25.8 | 18.7 | Strip 30 includes line 31. Flown as one line. |
| 8/11/04 | 43Q | Roark/Rider | PAOT | PAOT | | | | CLR | 43Q22404A | 302_2m | 2000 | 17:27:14 | 17:31:55 | 22 | 2018 | 317 | 2.3 | 7 | 50 | 25.8 | 18.7 | |
| 8/11/04 | 43Q | Roark/Rider | PAOT | PAOT | | | | CLR | 43Q22404A | 302_2m | 2000 | 17:44:20 | 17:46:33 | 7 | 2021 | 317 | 2.5 | 8 | 50 | 25.8 | 18.7 | |
| 8/11/04 | 43Q | Roark/Rider | PAOT | PAOT | | | | CLR | 43Q22404A | 302_2m | 2000 | 17:47:02 | 17:49:17 | 5 | 2010 | 298 | 2.6 | 8 | 50 | 25.8 | 18.7 | |
| 8/11/04 | 43Q | Roark/Rider | PAOT | PAOT | | | | CLR | 43Q22404A | 302_2m | 2000 | 17:49:43 | 17:52:10 | 3 | 1998 | 284 | 1.9 | 9 | 50 | 25.8 | 18.7 | |
| 8/11/04 | 43Q | Roark/Rider | PAOT | PAOT | | | | CLR | 43Q22404A | 302_2m | 2000 | 17:58:56 | 18:00:46 | 2 | 1996 | 271 | 2.1 | 9 | 50 | 25.8 | 18.7 | |
| 8/11/04 | 43Q | Roark/Rider | PAOT | PAOT | | | | CLR | 43Q22404A | 302_2m | 2000 | 18:05:26 | 18:06:57 | 1 | 2024 | 70 | 1.8 | 10 | 50 | 25.8 | 18.7 | |
| 8/11/04 | 43Q | Roark/Rider | PAOT | PAOT | | | | CLR | 43Q22404A | 302_2m | 2000 | 18:08:22 | 18:11:00 | 4 | 2003 | 111 | 1.9 | 10 | 50 | 25.8 | 18.7 | |
| 8/11/04 | 43Q | Roark/Rider | PAOT | PAOT | | | | CLR | 43Q22404A | 302_2m | 2000 | 18:11:46 | 18:14:12 | 6 | 2000 | 128 | 2.0 | 10 | 50 | 25.8 | 18.7 | |
| | | | | | | | | | | | | | | | | | | | | | | |
| 8/11/04 | 43Q | Roark/Rider | PAOT | PAOT | 1057.0 | 1062.0 | 5.0 | SCT CLD | 43Q22404B | 301_2m_s_rev | | 20:10:33 | 20:10:51 | 1 | 2038 | 229 | 3.0 | 8 | 50 | 25.8 | 18.7 | Laser Test |
| 8/11/04 | 43Q | Roark/Rider | PAOT | PAOT | | | | SCT CLD | 43Q22404B | 301_2m_s_rev | | 20:11:07 | 20:11:29 | 1 | 2007 | 229 | 3.0 | 8 | 50 | 25.8 | 18.7 | Laser Test |
| | | | | | | | | | | | | | | | | | | | | | | **Mission 43Q22404B use stations SHIS & KOT5** |
| 8/11/04 | 43Q | Roark/Rider | PAOT | PAOT | | | | SCT CLD | 43Q22404B | 301_2m_s_rev | 2000 | 20:24:37 | 20:27:26 | 1 | 2003 | 229 | 3.1 | 8 | 50 | 25.8 | 18.7 | **as base stations.** |
| 8/11/04 | 43Q | Roark/Rider | PAOT | PAOT | | | | SCT CLD | 43Q22404B | 301_2m_s_rev | 2000 | 20:37:47 | 20:39:16 | 7 | 2009 | 202 | 2.1 | 9 | 50 | 25.8 | 18.7 | |
| 8/11/04 | 43Q | Roark/Rider | PAOT | PAOT | | | | SCT CLD | 43Q22404B | 301_2m_s_rev | 2000 | 20:43:45 | 20:45:21 | 8 | 1991 | 6 | 2.2 | 9 | 50 | 25.8 | 18.7 | |
| 8/11/04 | 43Q | Roark/Rider | PAOT | PAOT | | | | SCT CLD | 43Q22404B | 301_2m_s_rev | 2000 | 20:49:36 | 20:51:37 | 9 | 1982 | 155 | 2.3 | 9 | 50 | 25.8 | 18.7 | |
| 8/11/04 | 43Q | Roark/Rider | PAOT | PAOT | | | | SCT CLD | 43Q22404B | IWK_Tmatch | 1200 | 21:02:15 | 21:03:28 | 3 | 1198 | 278 | 1.5 | 11 | 70 | 37 | 20.0 | |
| 8/11/04 | 43Q | Roark/Rider | PAOT | PAOT | | | | SCT CLD | 43Q22404B | IWK_Tmatch | 1200 | 21:07:51 | 21:09:25 | 3 | 1194 | 98 | 1.5 | 11 | 70 | 37 | 20.0 | |
| 8/11/04 | 43Q | Roark/Rider | PAOT | PAOT | | | | SCT CLD | 43Q22404B | IWK_Tmatch | 700 | 21:15:00 | 21:16:30 | 2 | 704 | 188 | 1.6 | 10 | 70 | 61 | 13.0 | |
| 8/11/04 | 43Q | Roark/Rider | PAOT | PAOT | | | | SCT CLD | 43Q22404B | IWK_Tmatch | 700 | 21:22:10 | 21:23:29 | 2 | 711 | 8 | 1.7 | 10 | 70 | 61 | 13.0 | |
| 8/11/04 | 43Q | Roark/Rider | PAOT | PAOT | | | | SCT CLD | 43Q22404B | IWK_Tmatch | 700 | 21:28:03 | 21:29:31 | 1 | 708 | 188 | 1.5 | 11 | 70 | 0 | 0.0 | |
| 8/11/04 | 43Q | Roark/Rider | PAOT | PAOT | | | | SCT CLD | 43Q22404B | IWK_Tmatch | 700 | 21:33:42 | 21:35:04 | 2 | 708 | 8 | 1.5 | 11 | 70 | 0 | 0.0 | |
| | | | | | | | | | | | | | | | | | | | | | | Strip 6 includes lines 5. 4. 3. and 2. Flown as one |
| 8/11/04 | 43Q | Roark/Rider | PAOT | PAOT | | | | SCT CLD | 43Q22404B | 301_2m_s_rev | 2000 | 21:43:18 | 21:54:54 | 6 | 2039 | 51 | 1.9 | 10 | 50 | 25.8 | 18.7 | line. |
| 8/11/04 | 43Q | Roark/Rider | PAOT | PAOT | | | | SCT CLD | 43Q22404B | 301_1m | 1200 | 21:59:05 | 22:12:16 | 8 | 1176 | 56 | 1.9 | 10 | 70 | 51.6 | 12.1 | |
| 8/11/04 | 43Q | Roark/Rider | PAOT | PAOT | | | | SCT CLD | 43Q22404B | 301_1m | 1201 | 22:16:18 | 22:28:48 | 9 | 1212 | 236 | 1.8 | 10 | 70 | 51.6 | 12.1 | |
| 8/11/04 | 43Q | Roark/Rider | PAOT | PAOT | | | | SCT CLD | 43Q22404B | 301_1m | 1202 | 22:34:11 | 22:43:33 | 10 | 1199 | 56 | 1.7 | 10 | 70 | 51.6 | 12.1 | |
| 8/11/04 | 43Q | Roark/Rider | PAOT | PAOT | | | | SCT CLD | 43Q22404B | 301_1m | 1203 | 22:48:05 | 22:54:17 | 11 | 1208 | 236 | 2.0 | 9 | 70 | 51.6 | 12.1 | |
| 8/11/04 | 43Q | Roark/Rider | PAOT | PAOT | | | | SCT CLD | 43Q22404B | 301_1m | 1204 | 22:58:30 | 23:03:50 | 12 | 1194 | 56 | 1.8 | 9 | 70 | 51.6 | 12.1 | |
| 8/11/04 | 43Q | Roark/Rider | PAOT | PAOT | | | | SCT CLD | 43Q22404B | 301_1m | 1205 | 23:07:56 | 23:13:04 | 13 | 1198 | 236 | 2.5 | 7 | 70 | 51.6 | 12.1 | |
| 8/11/04 | 43Q | Roark/Rider | PAOT | PAOT | | | | SCT CLD | 43Q22404B | 301_1m | 1206 | 23:16:37 | 23:21:48 | 14 | 1192 | 56 | 2.1 | 8 | 70 | 51.6 | 12.1 | |
| 8/11/04 | 43Q | Roark/Rider | PAOT | PAOT | | | | SCT CLD | 43Q22404B | 301_1m | 1207 | 23:26:10 | 23:27:58 | 15 | 1189 | 236 | 1.7 | 10 | 70 | 51.6 | 12.1 | |

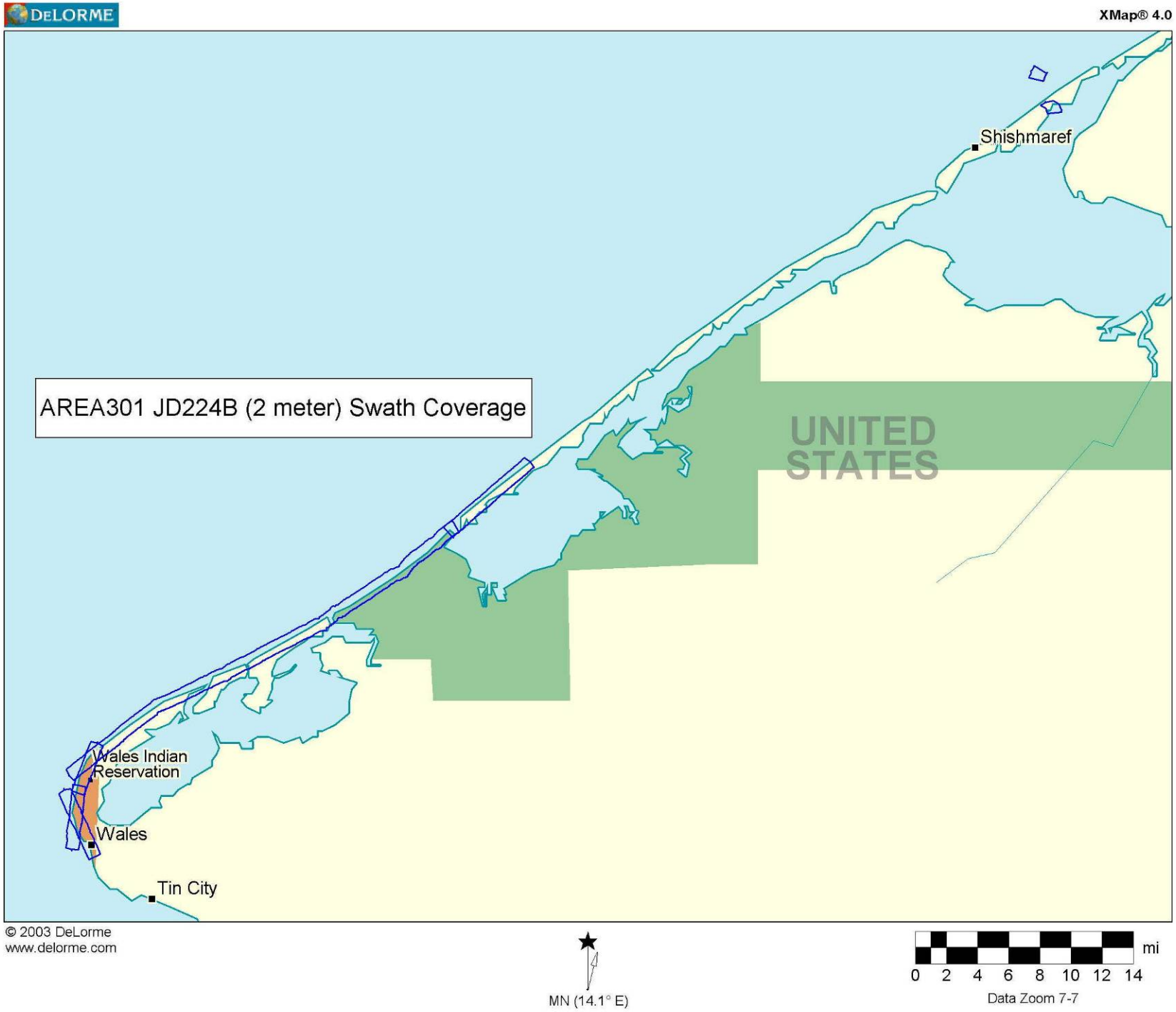

DeLORME
XMap® 4.0
Area AK0301 JD203C (2 meter) Swath Coverage
Devil Mountain Lakes
Shishmaref
UNITED STATES
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MN (15.0° E)
NM
0 3 6 9 12 15 18
Data Zoom 7-6


DeLORME
XMap® 4.0
Area AK0301 JD 204A (2 meter) Swath Coverage
Kivalina
Singeak
Espenberg
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MN (15.8° E)
NM
0 2 4 6 8 10
Data Zoom 8-6


DeLORME
XMap® 4.0
Shishmaref
AREA301 JD204 (1 meter) Swath Coverage
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MN (14.5° E)
0 1 2 3 4 5 6
mi
Data Zoom 9-0


DELORME
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AREA301 JD219 (1 meter) Swath Coverage
Shishmaref
Cape Lowenstern
Shishmaref Inlet
Sinrazat Shelter Cabin
Arctic Lagoon
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MN (14.6° E)
0 1 2 3 4 5 6
mi
Data Zoom 10-1


AREA301 JD224B (1 meter) Swath Coverage
Shishmaref
MN (14.5° E)
Data Zoom 9-2
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AREA301 JD224B (2 meter) Swath Coverage
Shishmaref
UNITED STATES
Wales Indian Reservation
Wales
Tin City
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MN (14.1° E)
0 2 4 6 8 10 12 14
mi
Data Zoom 7-7

Flight Log

---

Project Number: 6030810
S/N : 03SEN152
Operator : Rider
Pilot(s) : Hoogstra
Aircraft : 43Q
Airport : PAOT
Mission : NOAA 301 (2met), TMatch Cal flight over Shishmaref
Wheels Up : ???
Flight Length : 3.6
HOBBS Start : 1027.2
HOBBS End : 1030.8

Weather

---

Date : July 21, 2004
Julian Day : 203
Temperature : 15C on ground, 8C at altitude
Visibility : ???
Clouds : ???
Precipitation : ???
Wind Dir : ???
Wind Speed : ???
Pressure : 29.96

Statistics

---

Laser Time : 01:13:55

| Start | Stop | Strip | Alt(m) | Hdg | PDOP | SVs | PRF | Freq | Angle | Plan |
|---|---|---|---|---|---|---|---|---|---|---|
| 04:33:31 | 04:33:52 | 6 | 841 | 266.04 | 1.9 | 12 | 50.0 | 25.8 | 18.7 | C:/Program Files/ALTM-NAV/Plans/NOAA 301/AK0301_2m.pln |
| 04:34:03 | 04:34:24 | 6 | 988 | 266.04 | 1.9 | 12 | 50.0 | 25.8 | 18.7 | C:/Program Files/ALTM-NAV/Plans/NOAA 301/AK0301_2m.pln |
| 04:48:51 | 04:53:18 | 6 | 2058 | 266.04 | 2.8 | 9 | 50.0 | 25.8 | 18.7 | C:/Program Files/ALTM-NAV/Plans/NOAA 301/AK0301_2m.pln |
| 04:55:45 | 05:01:56 | 4 | 2057 | 247.86 | 2.9 | 9 | 50.0 | 25.8 | 18.7 | C:/Program Files/ALTM-NAV/Plans/NOAA 301/AK0301_2m.pln |
| 05:04:36 | 05:09:38 | 2 | 2060 | 239.00 | 2.8 | 9 | 50.0 | 25.8 | 18.7 | C:/Program Files/ALTM-NAV/Plans/NOAA 301/AK0301_2m.pln |
| 05:13:37 | 05:17:57 | 38 | 2056 | 240.11 | 2.5 | 9 | 50.0 | 25.8 | 18.7 | C:/Program Files/ALTM-NAV/Plans/NOAA 301/AK0301_2m.pln |
| 05:23:26 | 05:32:57 | 37 | 2054 | 231.97 | 2.0 | 10 | 50.0 | 25.8 | 18.7 | C:/Program Files/ALTM-NAV/Plans/NOAA 301/AK0301_2m.pln |
| 05:39:34 | 06:04:06 | 21 | 2055 | 51.96 | 1.7 | 11 | 50.0 | 25.8 | 18.7 | C:/Program Files/ALTM-NAV/Plans/NOAA 301/AK0301_2m.pln |

Note: Strip 21 above includes lines 21, 20, 19, 18, and 17. Lines were flown as a corridor flight plan without turning off laser between lines.

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 06:07:38 | 06:12:18 | 3 | 2055 | 243.08 | 1.7 | 9 | 50.0 | 25.8 | 18.7 | C:/Program Files/ALTM-NAV/Plans/NOAA 301/AK0301_2m.pln |
| 06:15:20 | 06:21:01 | 1 | 2087 | 235.72 | 2.5 | 8 | 50.0 | 25.8 | 18.7 | C:/Program Files/ALTM-NAV/Plans/NOAA 301/AK0301_2m.pln |
| 06:28:24 | 06:30:13 | 3 | 2054 | 192.12 | 2.3 | 8 | 50.0 | 21.0 | 25.0 | C:/Program Files/ALTM-NAV/Plans/NOAA Cal/SHF_TMatch.pln |
| 06:36:05 | 06:38:07 | 4 | 2005 | 90.00 | 2.2 | 8 | 50.0 | 21.0 | 25.0 | C:/Program Files/ALTM-NAV/Plans/NOAA Cal/SHF_TMatch.pln |
| 06:42:50 | 06:45:17 | 2 | 705 | 101.09 | 1.7 | 8 | 70.0 | 61.0 | 13.0 | C:/Program Files/ALTM-NAV/Plans/NOAA Cal/SHF_TMatch.pln |
| 06:49:29 | 06:51:02 | 2 | 684 | 101.09 | 1.7 | 8 | 70.0 | 61.0 | 13.0 | C:/Program Files/ALTM-NAV/Plans/NOAA Cal/SHF_TMatch.pln |
| 06:54:29 | 06:56:24 | 1 | 724 | 101.09 | 2.0 | 7 | 70.0 | 0.0 | 0.0 | C:/Program Files/ALTM-NAV/Plans/NOAA Cal/SHF_TMatch.pln |
| 06:58:17 | 06:59:53 | 1 | 736 | 101.09 | 2.1 | 7 | 70.0 | 0.0 | 0.0 | C:/Program Files/ALTM-NAV/Plans/NOAA Cal/SHF_TMatch.pln |

---

Comments

---

04:20:58 GMT : Start Static.
04:22:17 GMT : Alt 29.96, Temp 15C on ground.
04:34:55 GMT : Two test strips complete. End of survey marker added.
04:40:15 GMT : Temp at alt 8C. Alt 29.96 at Shishmaref.
04:53:31 GMT : Line 6 complete.
05:02:30 GMT : Line 4 complete.
05:11:10 GMT : Line 2 complete.
05:18:21 GMT : Line 38 complete.
05:36:06 GMT : Line 37 complete.
05:49:05 GMT : Line 21 complete.
06:06:09 GMT : Line 21, 20, 19, 18, and 17 flown without turning off laser. All lines are recorded under line 21.
06:13:09 GMT : Line 3 complete.
06:22:04 GMT : Line 1 complete. End of survey marker added.
06:31:23 GMT : First line perpendicular to Shishmaref runway complete at 6600ft.
06:39:00 GMT : Second line perpendicular to runway complete.
06:46:40 GMT : First parallel scan line line down runway complete at 2300ft.
06:52:10 GMT : Second scan line parallel to runway complete.
07:01:13 GMT : Two profile lines down runway complete.
07:01:35 GMT : End of survey marker added.
07:33:51 GMT : Start Static.

Flight Log

---

Project Number: 6030810
S/N : 03SEN152
Operator : Rider
Pilot(s) : Hoogstra
Aircraft : 43Q
Airport : PAOT
Mission : NOAA 301 (1met, 2met)
Wheels Up : ???
Flight Length : 4.1
HOBBS Start : 1030.8
HOBBS End : 1034.9

Weather

---

Date : July 22, 2004
Julian Day : 204
Temperature : 13C on ground, 10C at 3900ft
Visibility : ???
Clouds : ???
Precipitation : ???
Wind Dir : ???
Wind Speed : ???
Pressure : 29.94

Statistics

---

Laser Time : 01:35:33

| Start | Stop | Strip | Alt(m) | Hdg | PDOP | SVs | PRF | Freq | Angle | Plan |
|---|---|---|---|---|---|---|---|---|---|---|
| 17:05:23 | 17:05:48 | 3 | 1342 | 236.00 | 2.1 | 10 | 70.0 | 51.6 | 12.1 | C:/Program Files/ALTM-NAV/Plans/NOAA 301/AK0301_1m.pln |
| 17:05:57 | 17:06:21 | 3 | 1345 | 236.00 | 2.1 | 10 | 70.0 | 51.6 | 12.1 | C:/Program Files/ALTM-NAV/Plans/NOAA 301/AK0301_1m.pln |
| 17:22:54 | 17:35:46 | 3 | 1200 | 236.00 | 1.9 | 9 | 70.0 | 51.6 | 12.1 | C:/Program Files/ALTM-NAV/Plans/NOAA 301/AK0301_1m.pln |
| 17:40:49 | 17:46:37 | 2 | 1199 | 56.00 | 1.9 | 9 | 70.0 | 51.6 | 12.1 | C:/Program Files/ALTM-NAV/Plans/NOAA 301/AK0301_1m.pln |
| 17:52:19 | 17:57:08 | 1 | 1198 | 236.00 | 1.9 | 9 | 70.0 | 51.6 | 12.1 | C:/Program Files/ALTM-NAV/Plans/NOAA 301/AK0301_1m.pln |
| 18:03:54 | 18:16:55 | 4 | 1212 | 56.00 | 1.8 | 9 | 70.0 | 51.6 | 12.1 | C:/Program Files/ALTM-NAV/Plans/NOAA 301/AK0301_1m.pln |
| 18:22:04 | 18:34:57 | 5 | 1204 | 236.00 | 1.6 | 9 | 70.0 | 51.6 | 12.1 | C:/Program Files/ALTM-NAV/Plans/NOAA 301/AK0301_1m.pln |
| 18:39:04 | 18:51:51 | 6 | 1197 | 56.00 | 3.0 | 7 | 70.0 | 51.6 | 12.1 | C:/Program Files/ALTM-NAV/Plans/NOAA 301/AK0301_1m.pln |
| 18:57:47 | 19:07:50 | 16 | 1998 | 67.80 | 2.3 | 7 | 50.0 | 25.8 | 18.7 | C:/Program Files/ALTM-NAV/Plans/NOAA 301/AK0301_2m.pln |

Note: Strip 16 above includes line 15. These lines flown as a corridor without turning laser off between lines.

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 19:10:41 | 19:13:37 | 13 | 2041 | 89.55 | 1.8 | 9 | 50.0 | 25.8 | 18.7 | C:/Program Files/ALTM-NAV/Plans/NOAA 301/AK0301_2m.pln |
| 19:20:50 | 19:25:08 | 5 | 2042 | 251.55 | 2.0 | 9 | 50.0 | 25.8 | 18.7 | C:/Program Files/ALTM-NAV/Plans/NOAA 301/AK0301_2m.pln |
| 19:30:14 | 19:34:16 | 14 | 2029 | 85.86 | 1.9 | 10 | 50.0 | 25.8 | 18.7 | C:/Program Files/ALTM-NAV/Plans/NOAA 301/AK0301_2m.pln |
| 19:35:21 | 19:37:59 | 12 | 1999 | 98.23 | 2.0 | 10 | 50.0 | 25.8 | 18.7 | C:/Program Files/ALTM-NAV/Plans/NOAA 301/AK0301_2m.pln |
| 19:42:06 | 19:44:21 | 8 | 2044 | 278.36 | 2.2 | 10 | 50.0 | 25.8 | 18.7 | C:/Program Files/ALTM-NAV/Plans/NOAA 301/AK0301_2m.pln |
| 19:49:00 | 19:52:05 | 7 | 2011 | 89.63 | 2.1 | 11 | 50.0 | 25.8 | 18.7 | C:/Program Files/ALTM-NAV/Plans/NOAA 301/AK0301_2m.pln |
| 19:52:32 | 19:53:33 | 9 | 2065 | 113.89 | 2.1 | 11 | 50.0 | 25.8 | 18.7 | C:/Program Files/ALTM-NAV/Plans/NOAA 301/AK0301_2m.pln |
| 20:01:12 | 20:03:50 | 9 | 2068 | 113.89 | 2.0 | 11 | 50.0 | 25.8 | 18.7 | C:/Program Files/ALTM-NAV/Plans/NOAA 301/AK0301_2m.pln |
| 20:07:03 | 20:09:46 | 11 | 2002 | 293.52 | 1.9 | 11 | 50.0 | 25.8 | 18.7 | C:/Program Files/ALTM-NAV/Plans/NOAA 301/AK0301_2m.pln |

---

Comments

---

16:44:47 GMT : Start Static. Temp 13C, Alt 29.94.
17:07:01 GMT : Two test lines complete. End of survey marker added.
17:07:20 GMT : 10C temp at 3900ft.
17:36:27 GMT : Line 3 complete.
17:47:17 GMT : Line 2 complete.
17:58:00 GMT : Line 1 complete.
18:20:03 GMT : Line 4 complete.
18:36:32 GMT : Line 5 complete.
18:53:40 GMT : Line 6 complete. End of survey marker added.
19:04:51 GMT : Line 16 complete.
19:08:51 GMT : Line 15 complete.
19:13:50 GMT : Line 13 complete.
19:26:12 GMT : Line 5 complete.
19:34:27 GMT : Line 14 complete.
19:39:12 GMT : Line 12 complete.
19:45:26 GMT : Line 8 complete.
19:52:10 GMT : Line 7 complete.
19:54:00 GMT : Tried to fly line line but could not turn fast enough.
20:04:37 GMT : Line 9 complete.
20:10:49 GMT : Line 11 complete.
20:25:59 GMT : Start Static.

Flight Log

---

Project Number: 6030810
S/N : 03SEN152
Operator : Rider
Pilot(s) : Roark
Aircraft : 43Q
Airport : PAOT
Mission : NOAA 301 (1met), Shishmaref Tmatch Profiles
Wheels Up : ???
Flight Length : 3.0
HOBBS Start : 1049.6
HOBBS End : 1052.6

Weather

---

Date : August 06, 2004
Julian Day : 219
Temperature : ???
Visibility : ???
Clouds : ???
Precipitation : 20C on ground, 10C at 3900ft
Wind Dir : ???
Wind Speed : ???
Pressure : 29.92

Statistics

---

Laser Time : 00:32:44

| Start | Stop | Strip | Alt(m) | Hdg | PDOP | SVs | PRF | Freq | Angle | Plan |
|---|---|---|---|---|---|---|---|---|---|---|
| 04:27:14 | 04:27:34 | 1 | 1395 | 243.26 | 1.7 | 11 | 70.0 | 0.0 | 0.0 | C:/Program Files/ALTM-NAV/Plans/NOAA Cal/Shishmaref_TMatch.pln |
| 04:28:06 | 04:28:21 | 1 | 1211 | 243.26 | 1.7 | 11 | 70.0 | 0.0 | 0.0 | C:/Program Files/ALTM-NAV/Plans/NOAA Cal/Shishmaref_TMatch.pln |
| 04:38:05 | 04:39:24 | 1 | 725 | 243.26 | 1.7 | 11 | 70.0 | 0.0 | 0.0 | C:/Program Files/ALTM-NAV/Plans/NOAA Cal/Shishmaref_TMatch.pln |
| 04:44:40 | 04:45:52 | -18 | 679 | 63.26 | 1.6 | 11 | 70.0 | 0.0 | 0.0 | C:/Program Files/ALTM-NAV/Plans/NOAA Cal/Shishmaref_TMatch.pln |
| 04:54:07 | 05:06:55 | 7 | 1194 | 236.00 | 1.7 | 10 | 70.0 | 51.6 | 12.1 | C:/Program Files/ALTM-NAV/Plans/NOAA 301/AK0301_1m.pln |
| 05:11:41 | 05:24:38 | 8 | 1158 | 56.00 | 2.4 | 8 | 70.0 | 51.6 | 12.1 | C:/Program Files/ALTM-NAV/Plans/NOAA 301/AK0301_1m.pln |
| 05:29:06 | 05:34:07 | 9 | 1204 | 236.00 | 2.3 | 8 | 70.0 | 51.6 | 12.1 | C:/Program Files/ALTM-NAV/Plans/NOAA 301/AK0301_1m.pln |

---

Comments

---

03:54:45 GMT : Start Static.
03:55:21 GMT : Alt 29.92, Temp 20C on ground.
04:28:52 GMT : Two test lines complete. End of survey marker added.
04:41:33 GMT : First proflile line down runway at Shishmaref complete.
04:46:31 GMT : Second profile line complete. End of survey marker added.
05:07:22 GMT : Line 7 complete.
05:07:38 GMT : Temp 10C at 3900 ft.
05:16:06 GMT : Have a few rain drops on line 8.
05:26:36 GMT : Line 8 complete.
05:34:55 GMT : Terminated line 9 due to rain.
05:37:11 GMT : End of survey marker added at end of line 9.
06:20:35 GMT : End of survey marker added.
06:35:51 GMT : Start Static.

Flight Log

---

Project Number: 6030810
S/N : 03SEN152
Operator : Rider
Pilot(s) : Roark
Aircraft : 43Q
Airport : PAOT
Mission : NOAA 301 (2met), Wales TMatch, 301 (1met)
Wheels Up : ???
Flight Length : 5.0
HOBBS Start : 1057.0
HOBBS End : 1062.0

Weather

---

Date : August 11, 2004
Julian Day : 224
Temperature : 11C on ground, 4C at 6600ft
Visibility : ???
Clouds : ???
Precipitation : ???
Wind Dir : ???
Wind Speed : ???
Pressure : 30.00

Statistics

---

Laser Time : 01:23:51

| Start | Stop | Strip | Alt(m) | Hdg | PDOP | SVs | PRF | Freq | Angle | Plan |
|---|---|---|---|---|---|---|---|---|---|---|
| 20:10:33 | 20:10:51 | 1 | 2038 | 229.31 | 3.0 | 8 | 50.0 | 25.8 | 18.7 | C:/Program Files/ALTM-NAV/Plans/NOAA 301/301_2m_S_rev072304.pln |
| 20:11:07 | 20:11:29 | 1 | 2007 | 229.31 | 3.0 | 8 | 50.0 | 25.8 | 18.7 | C:/Program Files/ALTM-NAV/Plans/NOAA 301/301_2m_S_rev072304.pln |
| 20:24:37 | 20:27:26 | 1 | 2003 | 229.31 | 3.1 | 8 | 50.0 | 25.8 | 18.7 | C:/Program Files/ALTM-NAV/Plans/NOAA 301/301_2m_S_rev072304.pln |
| 20:37:47 | 20:39:16 | 7 | 2009 | 201.85 | 2.1 | 9 | 50.0 | 25.8 | 18.7 | C:/Program Files/ALTM-NAV/Plans/NOAA 301/301_2m_S_rev072304.pln |
| 20:43:45 | 20:45:21 | 8 | 1991 | 5.82 | 2.2 | 9 | 50.0 | 25.8 | 18.7 | C:/Program Files/ALTM-NAV/Plans/NOAA 301/301_2m_S_rev072304.pln |
| 20:49:36 | 20:51:37 | 9 | 1982 | 155.19 | 2.3 | 9 | 50.0 | 25.8 | 18.7 | C:/Program Files/ALTM-NAV/Plans/NOAA 301/301_2m_S_rev072304.pln |
| 21:02:15 | 21:03:28 | 3 | 1198 | 278.11 | 1.5 | 11 | 70.0 | 37.0 | 20.0 | C:/Program Files/ALTM-NAV/Plans/NOAA Cal/IWK_TMatch.pln |
| 21:07:51 | 21:09:25 | 3 | 1194 | 98.11 | 1.5 | 11 | 70.0 | 37.0 | 20.0 | C:/Program Files/ALTM-NAV/Plans/NOAA Cal/IWK_TMatch.pln |
| 21:15:00 | 21:16:30 | 2 | 704 | 188.24 | 1.6 | 10 | 70.0 | 61.0 | 13.0 | C:/Program Files/ALTM-NAV/Plans/NOAA Cal/IWK_TMatch.pln |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 21:22:10 | 21:23:29 | 2 | 711 | 8.24 | 1.7 | 10 | 70.0 | 61.0 | 13.0 | C:/Program Files/ALTM-NAV/Plans/NOAA Cal/IWK_TMatch.pln |
| 21:28:03 | 21:29:31 | 1 | 708 | 188.23 | 1.5 | 11 | 70.0 | 0.0 | 0.0 | C:/Program Files/ALTM-NAV/Plans/NOAA Cal/IWK_TMatch.pln |
| 21:33:42 | 21:35:04 | 2 | 708 | 8.24 | 1.5 | 11 | 70.0 | 0.0 | 0.0 | C:/Program Files/ALTM-NAV/Plans/NOAA Cal/IWK_TMatch.pln |
| 21:43:18 | 21:54:54 | 6 | 2039 | 51.22 | 1.9 | 10 | 50.0 | 25.8 | 18.7 | C:/Program Files/ALTM-NAV/Plans/NOAA 301/301_2m_S_rev072304.pln |
| 21:59:05 | 22:12:16 | 8 | 1176 | 56.00 | 1.9 | 10 | 70.0 | 51.6 | 12.1 | C:/Program Files/ALTM-NAV/Plans/NOAA 301/AK0301_1m.pln |
| 22:16:18 | 22:28:48 | 9 | 1212 | 236.00 | 1.8 | 10 | 70.0 | 51.6 | 12.1 | C:/Program Files/ALTM-NAV/Plans/NOAA 301/AK0301_1m.pln |
| 22:34:11 | 22:43:33 | 10 | 1199 | 56.00 | 1.7 | 10 | 70.0 | 51.6 | 12.1 | C:/Program Files/ALTM-NAV/Plans/NOAA 301/AK0301_1m.pln |
| 22:48:05 | 22:54:17 | 11 | 1208 | 236.00 | 2.0 | 9 | 70.0 | 51.6 | 12.1 | C:/Program Files/ALTM-NAV/Plans/NOAA 301/AK0301_1m.pln |
| 22:58:30 | 23:03:50 | 12 | 1194 | 56.00 | 1.8 | 9 | 70.0 | 51.6 | 12.1 | C:/Program Files/ALTM-NAV/Plans/NOAA 301/AK0301_1m.pln |
| 23:07:56 | 23:13:04 | 13 | 1198 | 236.00 | 2.5 | 7 | 70.0 | 51.6 | 12.1 | C:/Program Files/ALTM-NAV/Plans/NOAA 301/AK0301_1m.pln |
| 23:16:37 | 23:21:48 | 14 | 1192 | 56.00 | 2.1 | 8 | 70.0 | 51.6 | 12.1 | C:/Program Files/ALTM-NAV/Plans/NOAA 301/AK0301_1m.pln |
| 23:26:10 | 23:27:58 | 15 | 1189 | 236.00 | 1.7 | 10 | 70.0 | 51.6 | 12.1 | C:/Program Files/ALTM-NAV/Plans/NOAA 301/AK0301_1m.pln |

---

Comments

---

19:30:16 GMT : Start Static.
20:12:11 GMT : Two test lines complete. End of survey marker added. Temp 4C at 6600ft.
20:30:20 GMT : Line 1 of 301 2 met complete.
20:31:16 GMT : End of survey marker added after line 1.
20:40:35 GMT : Line 7 complete.
20:42:34 GMT : A few clouds off shore on line 7. A couple small clouds over shoreline.
20:46:26 GMT : Line 8 complete.
20:52:12 GMT : Line 9 complete. End of survey marker added.
21:11:24 GMT : Two scan lines perpendicular to Wales runway complete.
21:23:42 GMT : Two scan lines parallel down runway complete.
21:35:36 GMT : Two profile lines parallel to Wales runway complete.
21:35:46 GMT : End of survey marker added.
21:47:12 GMT : Line 7 section has a few clouds over shore.
21:56:13 GMT : Lines 6 through 2 complete. All are under line 6 above. Several lines have scattered clouds.
22:13:18 GMT : Line 8 (1met) complete.
22:29:18 GMT : Line 9 complete.
22:35:41 GMT : Laser shut off for eyesafety at start of line 10. Probably due to clouds.
22:44:34 GMT : Line 10 complete except for very start on south end of line.
22:54:34 GMT : Line 11 complete.
23:04:13 GMT : Line 12 complete.
23:13:27 GMT : Line 13 complete.
23:22:11 GMT : Line 14 complete.
23:28:31 GMT : Line 15 complete.
23:36:05 GMT : End of survey marker added after line 15.
00:20:17 GMT : Start Static.

# 5. EQUIPMENT AND CALIBRATION

The LIDAR system used on this project is an Optech 30/70 Airborne Laser Terrain Mapper (ALTM) owned by AeroMap U.S. The system is capable of providing absolute elevation accuracy ranges from 0.15 meter to 0.35 meter RMSE depending on the operating altitudes which range from 400 meters to 3,000 meters Above Ground Level (AGL). The 2 meter areas were flown at an altitude of 2,000 meters AGL with a pulse rate of 50,000 pulses per second. The 1 meter areas were flown at an altitude of 1,200 meters AGL with a pulse rate of 70,000 pulses per second. Each pulse is capable of providing up to 4 separate returns - 1st, 2nd, 3rd, and last return. The system includes a real-time flight planning, flight tracking, navigation, and acquisition system, with built-in QA/QC.

There are detailed calibration reports in this section from the manufacturer of the 30/70 ALTM (Optech) as it was delivered from the factory early in 2004. Detailed specifications of the system can be found in these reports. Also contained in this section is the system log book showing all maintenance and installation procedures since the system was acquired in January 2004 through the duration of this project.

Before the system was sent to Kotzebue for this project a calibration check flight was performed in Anchorage. A calibration mission requires a forward and reverse flight of two orthogonal directions (a total of four flight lines). One pair of flight lines must be at a lower altitude than the other. For this project requiring 0.15 meter RMSE accuracy, the lower flight lines are at 700 meters over a runway with thousands of ground truth points acquired with Post Processed Kinematic (PPK) GPS profiles. The cross flight is at the standard flying height for this survey at 1,200 meters or 3,900 feet AGL. The data from these flights were processed as a normal data acquisition mission, then run through a calibration module in the Terrasolid suite of software, described in more detail in Data Processing. This process yields the relevant system calibration parameters for the ALTM. These parameters are checked, and the calibration process repeated if calibration factors exceed predetermined limits.

When the system was mobilized to Kotzebue on July 9, 2004, it was again checked for calibration on July 11.

The results from that mission are shown below:

| | |
|---|---|
| Trajectories:<br>H:\6030810_NOAA\Kotzebue_TMatch\trj\<br>No known points<br>Observe every 1th point<br>Intensity not used<br>Solution for whole data set<br>Starting average dz: 0.0388<br>Final average dz: 0.0390<br>Standard error of unit 0.0174<br>Execution time: 17.6 sec<br>Number of iterations: 2<br>Points 749300<br>Roll shift +0.0003 Std dev 0.0000<br>Pitch shift -0.0002 Std dev 0.0002<br>Scale +0.00012 | <br><br><br><br><br><br>Should not exceed 10 cm<br><br><br><br><br><br>Should not exceed 0.005 degrees<br>Should not exceed 0.005 degrees<br>Should not exceed 0.0005 |

| | |
|---|---|
| Check Points<br>Average magnitude: 0.0533<br><br>Flightline Points Magnitude Dz<br>7 296003 0.0320 -0.0138<br>8 329629 0.0306 -0.0131<br>10 432919 0.0690 +0.0233<br>11 360800 0.0727 -0.0248 | Should not exceed 0.10 meter |

There were additional calibration check flights flown at Shishmaref and Wales airports using ground truth data provided by John Oswald and Associates. These are detailed in Section 12 – Accuracy Report.

**Production Missions**

Each production mission consisting of a takeoff, data acquisition and landing is called a lift. At the beginning and end of each lift, the aircraft/system observes at least five minutes of static GPS observation time. This allows for precision GPS trajectories to be computed in both a forward and reverse mode. The aircrew, consisting of the pilot and operator, fly the designed flight lines. The pilot navigates the flight lines with a pilot display that gives him the necessary information to stay on line, at the proper altitude, and proper airspeed to meet the design groundspeed. The operator has a real time display in a laptop computer attached to the ALTM that shows the controls and status of the system. The ALTM system parameters are automatically selected from the designed flight line. The operator also has a real time display of the progress of the survey, and the LIDAR swath is painted over the flight line. This allows the operator an immediate Quality Control check to see any problems in a mission such as being off line or gaps between flight lines. If this occurs, the operator has the flexibility to add fill-in flight lines as needed, so at the end of a lift, he has assurance that the area to be surveyed has been fully covered. During each lift, two or more ground based GPS stations on known project control are operating through the full cycle of static observation, takeoff, data acquisition, landing and final static observation. These data are used in the differential post processing of the GPS trajectory. Missions can be flown day or night as long as there are no clouds, fog or precipitation below the aircraft in the survey area. As part of the Quality Control for surveys suitable for this project two-foot contours, missions are not flown when the GPS Position Dilution of Precision (PDOP) factor is above 4. In all but one of the flight lines flown for this project, the PDOP did not exceed 3.0 except for August 11, when there was one flight line at PDOP 3.1.







# Optech ALTM

# Conformance Report

**Contract Number: 03SEN145-03CON145**

**Prepared For:**
Aero Map

**Prepared By:**
Optech Incorporated
Terrestrial Survey Division
100 Wildcat Road
Toronto, Ontario
Canada M3J 2Z9

| | |
|---|---|
| Prepared By: Patrick Spence | Date: Jan. 08 /2004 |
| Approved By: TBD | Date: |
| Released By: TBD | Date: |

Document No. 0000000/Rev A.0

January 2004

## Revision History

| Revision | Date | Description |
|---|---|---|
| A | Jan 2004 | Original release |

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# 1 ALTM CONFORMANCE REPORT

## 1.1 ALTM System Specifications

| Specifications | |
|---|---|
| Serial numbers | Sensor Head 03SEN145<br>Control Rack 03CON145 |
| Operating altitude | 80 – 3000 m nominal |
| Horizontal accuracy | 1/2000 x altitude; 1 σ |
| Elevation accuracy | < 15 cm @ 1200 m; 1 σ<br>< 25 cm @ 2000 m; 1 σ<br>< 35 cm @ 3000 m; 1 σ |
| Range resolution | 1 cm |
| Range capture | 4 range measurements for each pulse including last |
| Intensity capture | 12 bit dynamic range for each measurement |
| Scan frequency | Variable; maximum 70 Hz |
| Scan angle | Variable from 0 to ± 25°, in increments of ±1° |
| Scanner Product | Scan Angle x Scan Frequency ≤ 1000 |
| Roll compensation | Nominal ± 4°, depending on scan setting (e.g. ± 20° allows ± 4° compensation; ± 15° allows ± 9° compensation) |
| Swath width | Variable; 0 to 0.93 x altitude m |
| Position Orientation System | Applanix – Optech custom POS including internal 12 channel dual frequency 2 Hz GPS receiver |
| Laser repetition rate | 33 kHz (maximum AGL 3 km)<br>50 kHz (maximum AGL 2 km)<br>70 kHz (maximum AGL 1.5 km) |
| Data storage hard drive | Ruggedized removable hard drive |
| Beam divergence | Dual 0.31 mrad (1/e) or 0.78mrad (1/e) |
| Eye safe range | 80 - wide, unaided<br>400 - wide, aided and narrow unaided<br>500 - narrow profiling unaided<br>1300 - narrow aided. |
| Laser classification | Class IV (FDA CFR 21) |
| Power requirements | 28 V, 35 A |
| Internal ambient operating temperatures | Control rack: 10 – 35° C<br>Sensor head: 0 – 35° C |
| Humidity | 1 – 95% non-condensing |


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## 1.2 Reference Information

### 1.2.1 Sensor Head Constants

| Reference to IMU Misalignment (PosAV) | |
|---|---|
| X | 0.000 |
| Y | 0.000 |
| Z | 0.000 |
| Reference to IMU Lever Arm (PosAV) | |
| X | -0.090 |
| Y | -0.008 |
| Z | -0.096 |
| Reference to Reference Point | |
| X | -0.051 |
| Y | -0.029 |
| Z | -0.487 |

### 1.2.2 GPS Eccentricity Values

| Reference Point to GPS Antenna (REALM) | |
|---|---|
| X | 0.368 |
| Y | 0.038 |
| Z | -0.916 |
| Reference to GPS Antenna (PosAV) | |
| X | 0.317 |
| Y | 0.009 |
| Z | -1.403 |

### 1.2.3 IP Addresses

| Reference to GPS Antenna (PosAV) | |
|---|---|
| POS version | 4.0 (TCP) |
| Laptop IP address | 192.9.202.99 |
| Laptop Subnet Mask | 255.255.255.0 |
| POS IP Address | 192.9.202.40 |


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### 1.2.4 Firmware Version Numbers

| | Firmware | | AeroMap |
|---|---|---|---|
| | Type | Part Number | 5101 |
| Receiver Logic | cpld | 0022330 | A |
| | micro | N/A | N/A |
| Intensity | cpld | 0022170 | C |
| | micro | 0022171 | A |
| TIM | cpld | 0022328 | A |
| Range finder Interface | fpga | 0022164 | B |
| Scanner Microcontroller | micro | 0022865 | B |
| Sensor Microcontroller 1 | micro | 0022873 | B |
| Sensor Microcontroller 2 | micro | 0023880 | N/A |
| Input Power Meter | micro | 0022867 | A |
| CPCI dc/dc | micro | 0022871 | A |
| Range Finder Buffer | fpga | 0022161 | B |
| | plx | 0022162 | A |
| POS A/V | N/A | N/A | 2.13B (2.15 installed on site) |
| ALTM Computer | mcp | TBD | 7.1.53 |

### 1.2.5 Operational Software Version Numbers

| Software | Hardware Fingerprint | Version Number |
|---|---|---|
| ALTM Nav. | 996B-ABFF | 2.0.18 |
| OI Server | N/A | N/A |
| PosAV | N/A | 1.2.1 (1.5 installed on site) |

### 1.2.6 Post-Processing Software Version Numbers

| Software | Version Number | Description |
|---|---|---|
| Acalib | 1.2 | ALTM Auto-calibration software |
| Disk_2K | 4.0.0.64 | ALTM disk extractor for WIN 2000 and XP |
| Disk_NT | 4.0.0.40 | ALTM disk extractor for WIN NT |
| ALTMdecode | 3.2.0.9 | External disk decode |
| Decode32 | 3.0.0.1 | Range file strip extractor |
| BintoAscW | 1.0 | Binary to ascii convertor for decoded range files |
| Realm Survey Suite | 3.3 | ALTM data post-processing software |
| TDDiag | 1.3.0.1 | ALTM raw data analyser |


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## 1.3 Conformance Test Results

### 1.3.1 Production Team

| Test | Description | New build | Customer Support |
|---|---|---|---|
| Beam divergence | Flip in lens alignment | Pass | - |
| Beam attenuator | Test beam attenuator alignment | Pass | - |
| Receiver alignment | Test receiver alignment | Pass | - |


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### 1.3.2 Terrestrial Field Operations Lab Tests

| Test | Description | New build | Customer Support |
|---|---|---|---|
| ALTM-NAV alerts | Confirm ALTM system alerts reported in ALTM-NAV. | Pass | - |
| ALTM system defaults | ALTM parameters are correct and consistent on system start-up. | Pass | - |
| Rx Tx shutters alerts | Verify ALTM-NAV recognizes and reports transmit/receiver shutters open or closed. | Pass | - |
| ALTM rejects parameters | Test settings rejected & laser not triggered when system limits exceeded for; scanner frequency, angle & product. | Pass | - |
| ALTM PRF setting | Confirm three Pulse Rate Frequencies (33, 50, 70 kHz) are accepted and laser triggers. | Pass | - |
| Ranked Alert pop-up | Test ranked alert pop-up text warning appears when system violation occurs. | Pass | - |
| Eye safety shutoff | Confirm laser shuts off with short range violation for each of three PRF. | Pass | - |
| Beam divergence | Laser return intensity decreases between narrow and wide beam divergence. | Pass | - |
| Roll compensation | Verify roll compensation reported on/off in ALTM-NAV & evident in data. | Pass | - |
| ALTM system communication | Confirm ALTM-NAV is communicating and monitoring all ALTM systems and subsystems. | Pass | - |
| ALTM rejects changes with laser on | Verify changes in parameters are not sent while laser is on and scanner does not stop. | Pass | - |
| Hard drive function | Confirm hard drive is identification and data is writing. | Pass | - |
| Hard drive processes | Verify hard drive can be formatted and survey markers and comments can be written to drive. | Pass | - |
| Short-cut keys | Confirm short-cut keys perform the anticipated function. | Pass | - |
| Flight plans | Verify flight plans can be loaded during operation. | Pass | - |
| Auto increment | Test auto increment of flight lines using a polygon flight plan. Increments up or down depending on setting. | N/A | - |
| Multi-plan flight plan | Verify "multi-plan" flight plans function according to settings. | Pass | - |
| Multi-plan auto increment | Test auto increment of flight lines using a multi-plan flight plan. Increments up or down depending on setting. | N/A | - |
| Swath painting | Verify a swath is painted during operation in the Plan Progress window or ALTM-NAV. | Pass | - |
| Video display | Confirm presence of video signal and time stamp annotation. | Fail | - |
| POS computer settings/configuration | Verify POS settings are present and can be changed, saved and re-loaded. | Pass | - |
| POS computer function | Confirm there are no GPS/IMU data gaps or alert messages. | Pass | - |


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### 1.3.3 Terrestrial Field Operations Shakedown Flight Tests

| Test | Description | New build | Customer Support |
|---|---|---|---|
| POS/IMU | Check settings saved, data gaps and IMU health. | Pass | - |
| Laser data gaps | Confirm there are no gaps in laser data. | Pass | - |
| Scanner temperature | Confirm laser operates in normal temperature range. | Pass | - |
| Laser dropouts | Verify there are a limited number of laser dropouts. | Pass | - |
| Intensity banding | Confirm intensity banding is > 20%. | Pass | - |
| Transmitted versus received pulses | Verify the number of emitted pulses approximately equals the number of returned pulses. | Pass | - |
| Roll compensation | Verify roll compensation reported on/off in ALTM-NAV & evident in data. | Pass | - |
| Video annotation | Confirm video annotation functions and all fields are updating properly. | Fail | - |
| | | | |
| Eye safety shut off | Confirm laser shuts off when eye safe limits are violated. | Pass | - |
| ALTM system communication | Confirm ALTM-NAV is communicating and monitoring all ALTM systems and subsystems. | Pass | - |
| ALTM PRF setting | Confirm three Pulse Rate Frequencies (33, 50, 70 kHz) are functioning. | Pass | - |

### 1.3.4 Terrestrial Field Operations Calibration Flight Tests

| Test | Description | New build | Customer Support |
|---|---|---|---|
| IMU alignment calibration – narrow beam divergence | Confirm flight-to-flight variation in IMU to laser range finder alignment is consistent within specified limits for pitch and roll for narrow beam divergence. | Pass | - |
| IMU alignment calibration – wide beam divergence | Confirm flight-to-flight variation in IMU to laser range finder alignment is consistent within specified limits for pitch and roll for wide beam divergence. | Pass | - |
| Laser scanner calibration | Verify scanner offset and scale are consistent flight-to-flight to specification. | Pass | - |
| Laser range finder calibration | Confirm specified accuracy for laser range finder. | Pass | - |
| | | | |
| | | | |
| | | | |


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## 1.4 Lab Calibration Information

| Parameter | Lab Calibration | Optech Flight Calibration |
|---|---|---|
| **TIM** | | |
| Pulse Offset (meters) | -1.45 | -1.60 |
| | | |
| **Elevation Block Adjustment** | 0.00 | 0.00 |
| | | |
| **IMU Alignment Calibration** | | |
| Pitch | 0.000 | -0.053 |
| Roll | 0.000 | 0.094 |
| Heading | 0.000 | 0.600 |
| | | |
| **Scanner Calibration** | | |
| Offset | 0.000 | 0.007 |
| Scale | 1.0000 | 1.1087 |
| Lag (msec) | 0.000001 | 0.00009 |


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# Airborne Laser Terrain Mapper
# (ALTM)
# Delivery Performance Report: Addendum

**Prepared For:**
Aeromap U.S.
International Photogrammetric Consultants
2014 Merrill Field Drive
Anchorage, AK
U.S.A 99501-4116

**Prepared By:**
Optech Incorporated
Terrestrial Survey Division
100 Wildcat Road
Toronto, Ontario
Canada M3J 2Z9

**ALTM Type:** ALTM 30/70

**Serial Number:** 03SEN145; 03CON145

**Testing Period:** Jan. 20, 2004

**Optech Delivery Team:** Michael Sitar
William Kalbfleisch
Matthew Slater

## Restriction Notice

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## Addendum Summary

The following is an addendum to the Delivery Performance Report submitted to Aeromap U.S. on January 20, 2004. Data collected at 2000m and 3000m has been added to complete the requirements of system acceptance at the accuracy specification ranges specified for this unit. In all cases the original tables have been expanded to include the additional tests. Table numbers correspond to those contained within the original Delivery Performance Summery for ease of reference.

## 1.1 Absolute Vertical Accuracy Analysis

The vertical accuracy of the system was confirmed through a series of flights over a hard, flat surface with unobstructed ground control points. Approximately 4281 points surveyed along the Birchwood Airport runway were used for validation.

Data passes flown over the runway were collected over several days from altitudes of 1000m, 2000m agl and 3000m agl. To quantify the vertical accuracy of the system, a TIN surface was generated within Terrascan from the laser points and differences determined from the ground control points. Last pulse returns were used in the analysis.

**Table 1: Vertical Accuracy Results from Calibration Flights**

| Flight | Flight Altitude (m AGL) | Strip | Laser Freq. (kHz) | Mean Difference (m) | Std Dev. (m) | RMS (m) | Sample Size (# of Points) | FOV (± degree) | Accuracy (% within 1 δ) |
|---|---|---|---|---|---|---|---|---|---|
| **00804** | 1000 | 98 | 70 | -0.043 | 0.095 | 0.104 | 3387 | 25 | 88.16 |
| | | 99 | | -0.060 | 0.065 | 0.089 | 3402 | | 90.77 |
| | | | | | | | | | |
| **01104** | 1000 | 81 | 70 | 0.074 | 0.109 | 0.132 | 3403 | 25 | 68.15 |
| | | 82 | | 0.062 | 0.073 | 0.096 | 3614 | | 90.62 |
| | | | | | | | | | |
| **01304** | 1000 | 146 | 70 | 0.006 | 0.047 | 0.047 | 3619 | 25 | 98.51 |
| | | 147 | | -0.010 | 0.075 | 0.075 | 3652 | | 94.41 |
| | 2000 | 157 | 50 | -0.033 | 0.060 | 0.068 | 4281 | | 99.72 |
| | | 158 | | -0.003 | 0.078 | 0.078 | 4271 | | 99.13 |
| | | | | | | | | | |
| **02004** | 3000 | 123 | 33 | 0.068 | 0.140 | 0.156 | 3834 | 25 | 84.06 |
| | | 124 | | 0.094 | 0.118 | 0.151 | 4267 | | 85.52 |

***Note***: Data sets collected on Julian day 01104 were observed to have been collected when snow had not yet been removed from the underlying control surface. Snow depths were observed to range from 10-15cm via a single sampling profile across the runway approximately midway.

**Table 2: Overall Vertical Accuracy for All Calibration Flights**

| Attribute | Average Altitude (m) | Specification (m 1 δ) | Average Accuracy (m) |
|---|---|---|---|
| Z | 1000 | ±0.150 | **-0.027** |
| | 2000 | ±0.250 | **-0.018** |
| | 3000 | ±0.350 | **0.081** |

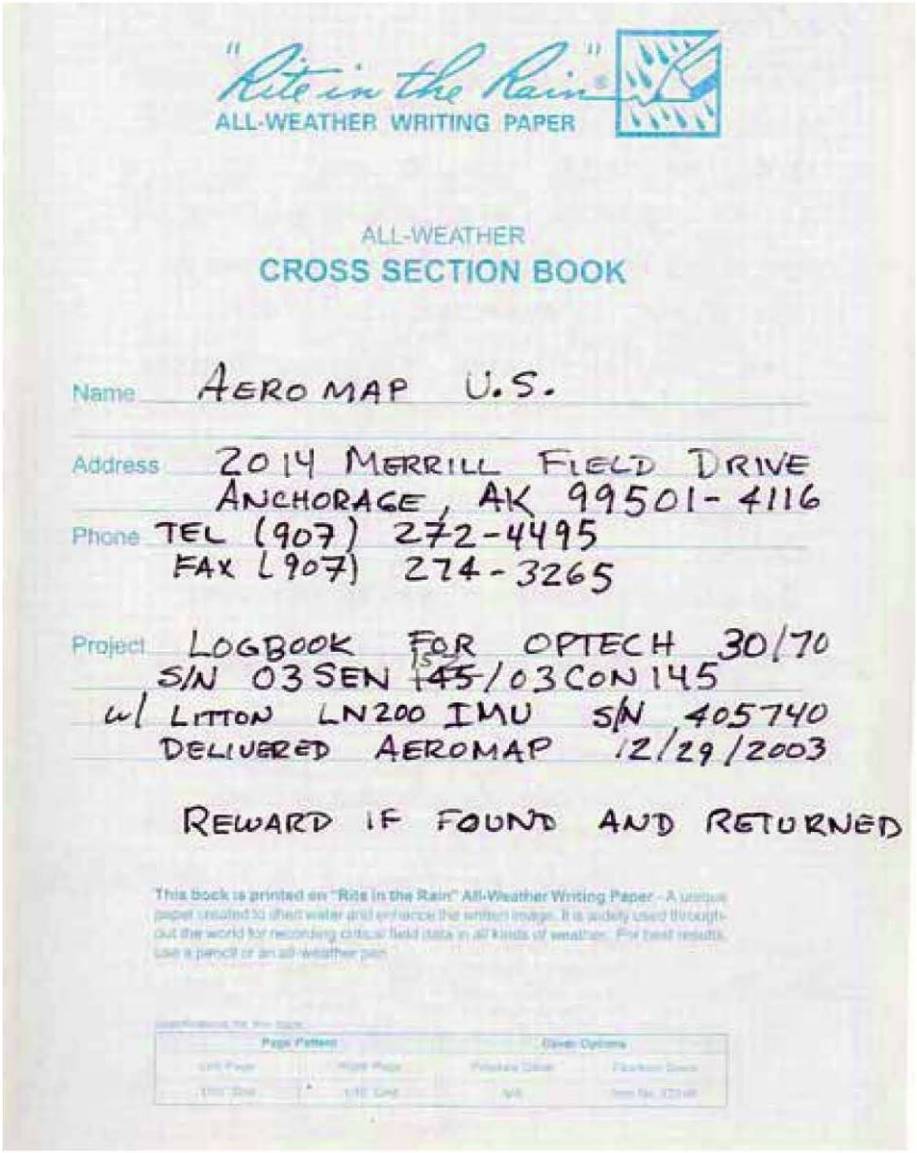
## 1.2 Altitude Dependent Ranging Capabilities / Laser Power

Tests performed over the runway revealed average dropout rates of less than 2% at 3000m, whereby dropouts are a function of the lack of a return signal for the outgoing pulse (Table 8). Expected average dropout rates are 0-1% at 1000m, 0-5% at 2000m, and 0-10% at 3000m.

**Table 3: ALTM Dropout Rates from Varying Altitudes**

| Flight | Strip ID | Aircraft Height (agl) | Dropouts (%) |
|---|---|---|---|
| 00804 | 97 | 1000 | 0.005 |
| | 100 | | 0.006 |
| 01004 | 101 | 1000 | 0.056 |
| 02004 | 9 | 2000 | 0.206 |
| | 10 | 3000 | 1.154 |

***Note***: Data sets collected on Julian day 01304 were not included as they were collected over water and do not represent a true test of the system ranging capabilities at altitude.



"Rite in the Rain"
ALL-WEATHER WRITING PAPER

ALL-WEATHER
CROSS SECTION BOOK

Name AERO MAP U.S.

Address 2014 MERRILL FIELD DRIVE
ANCHORAGE, AK 99501-4116

Phone TEL (907) 272-4495
FAX (907) 274-3265

Project LOGBOOK FOR OPTECH 30/70
S/N 03SEN ~~145~~ 15/03CON145
w/ LITTON LN200 IMU S/N 405740
DELIVERED AEROMAP 12/29/2003

REWARD IF FOUND AND RETURNED

This book is printed on "Rite in the Rain" All-Weather Writing Paper - A unique paper created to shed water and enhance the written image. It is widely used throughout the world for recording critical field data in all kinds of weather. For best results, use a pencil or an all-weather pen.

| Page Pattern | | Cover Options | |
|---|---|---|---|
| | | | |
| | | | |

1/05/04

Examine power cable as shipped with system - It is 3 pin and A/C N3443Q is 2 pin called Optech (Eric Liberty) and he & Mike Sitar are bringing a 2 pin connector solution

Joe Gallant also orders some connectors to make a conversion table.

SAJ

1/07/04

Optech acceptance team arrives

13:00 begin check off list (delivery)

14:00 begin installation

Sensor head mounting bolts w/ Spherical Washer Should be torqued to 10-12 ft/lbs

Sensor head insulating gasket shipped without foam insert to cushion sensor head

Receive initial training on fibre-optic install & removal procedures.

Request initial data set of unit from Toronto flight tests for Calibration comparison.

Install GPS antenna that came with 30/70

Discuss S/n issues

03CON145 Control Rack S/N

~~512~~ 8

Antenna Novatel 512C-7151

1/08/04 Finish install of System including pilot display and power hookup

Airplane power is creating dirty, causing system to shut down voltage is less than 22 Volts. Shut down alternator & run on battery only to startup.

** Airplane power issue unresolved at this point

1/05/04

Examine power cable as shipped with system - It is 3 pin and A/C N3443Q is 2 pin called Optech (Eric Liberty) and he & Mike Sitar are bringing a 2 pin connector solution

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03CON145 Control Rack S/N

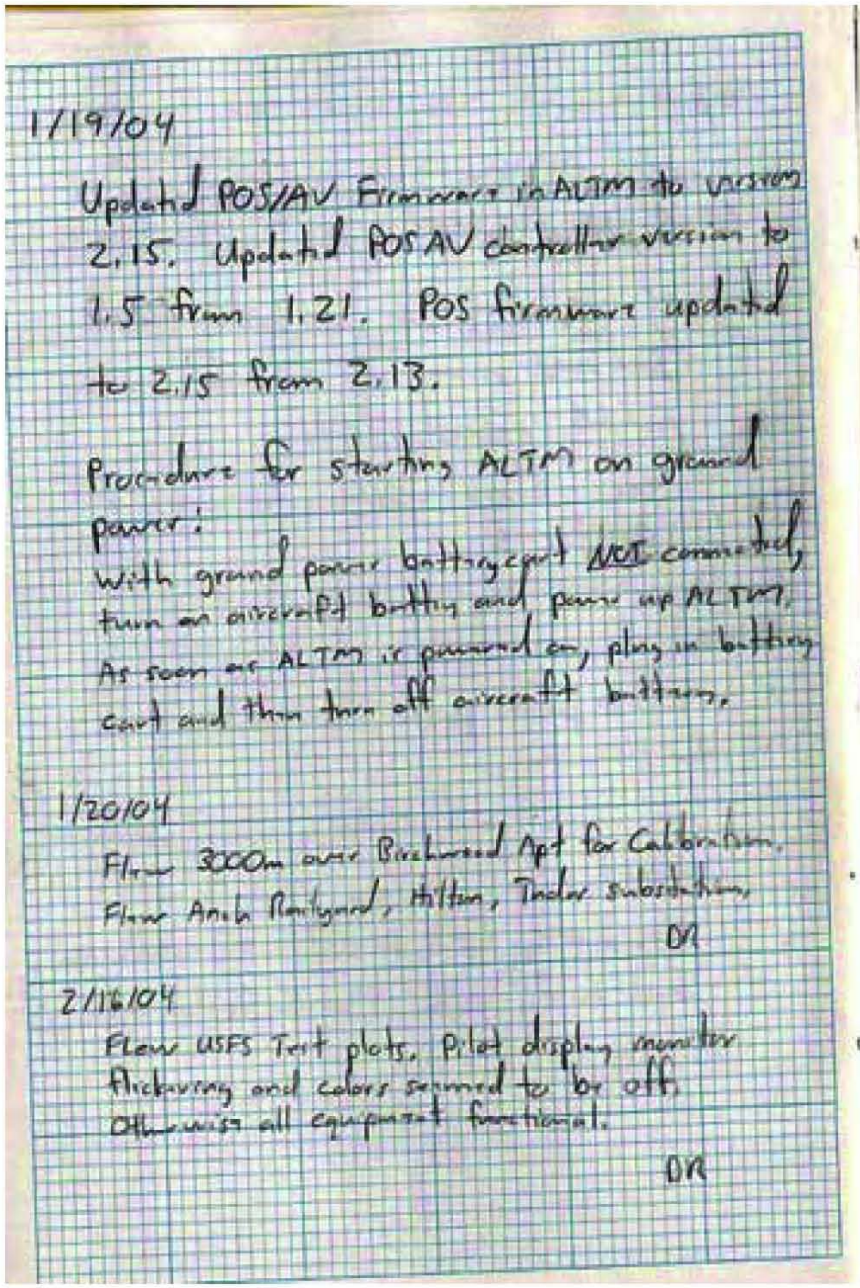
~~512~~ 8

Antenna Novatel 512C-7151

1/08/04 Finish install of System including pilot display and power hookup

Airplane power is creating dirty, causing system to shut down voltage is less than 22 Volts. Shut down alternator & run on battery only to startup.

** Airplane power issue unresolved at this point



1/19/04

Updated POS/AV Firmware in ALTM to version 2.15. Updated POS AV controller version to 1.5 from 1.21. POS firmware updated to 2.15 from 2.13.

Procedure for starting ALTM on ground power:
With ground power battery pack NOT connected, turn on aircraft battery and power up ALTM. As soon as ALTM is powered on, plug in battery cart and then turn off aircraft battery.

1/20/04

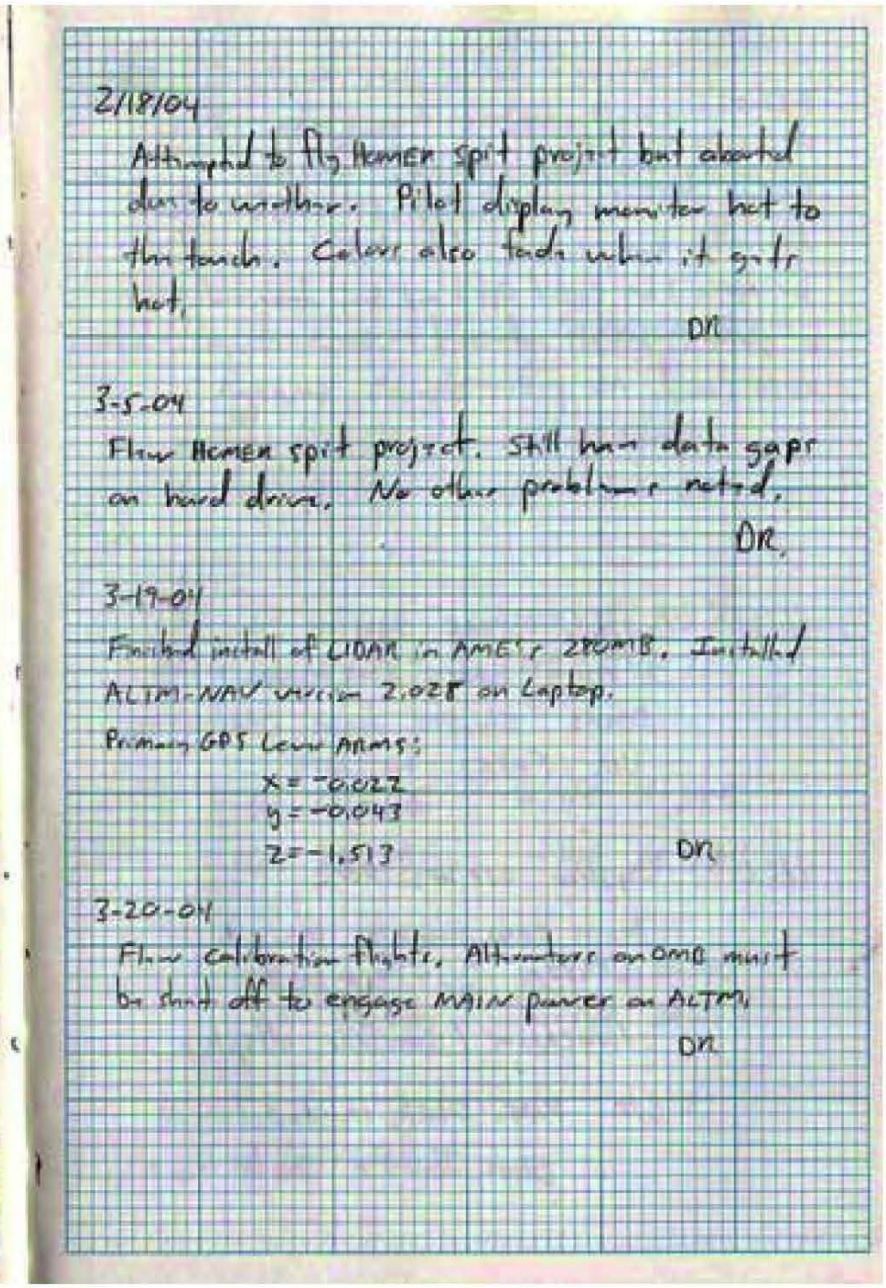
Flew 3000m over Birchwood Apt for Calibration. Flew Anoka Railyard, Hilton, Tinder substation.

DR

2/16/04

Flew USFS Test plots. Pilot display monitor flickering and colors seemed to be off. Otherwise all equipment functional.

DR



2/18/04

Attempted to fly Hemer split project but aborted due to weather. Pilot display monitor hot to the touch. Color also fades when it gets hot.

DR

3-5-04

Flew Hemer split project. Still have data gaps on hard drive. No other problems noted.

DR

3-19-04

Finished install of LIDAR in AMES 280MB. Installed ALTM-NAV version 2.028 on Laptop.

Primary GPS Lever Arms:

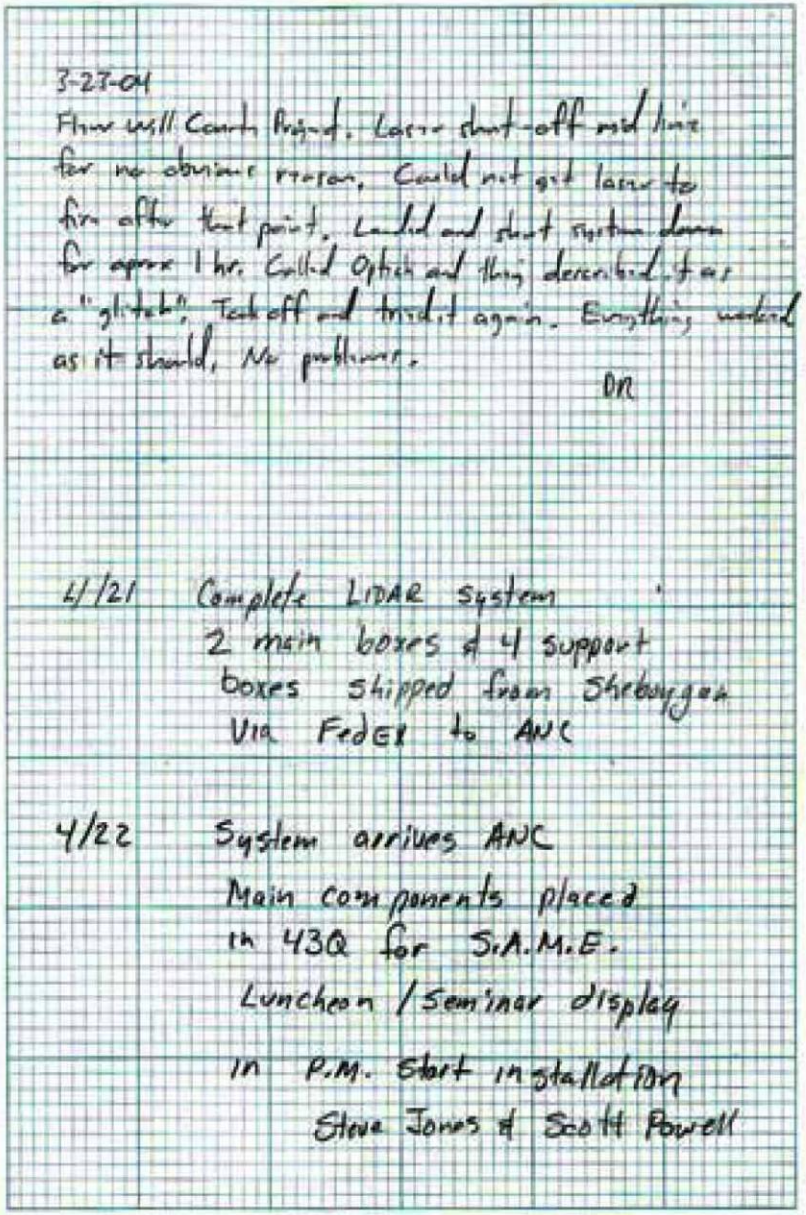
X = -0.022
Y = -0.043
Z = -1.513

DR

3-20-04

Flew calibration flights. Altimeter on OMC must be shut off to engage MAIN power on ALTM.

DR

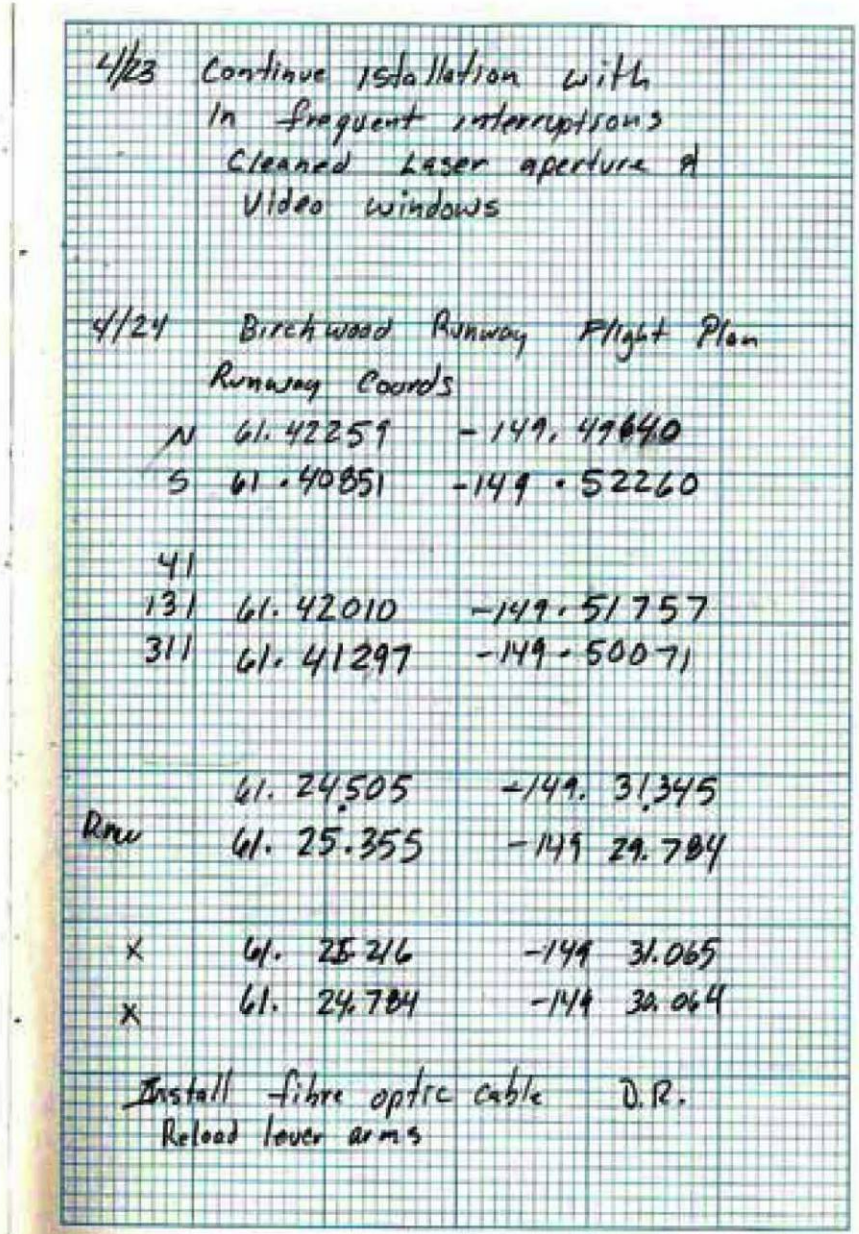


3-27-04
Flew will County Proj-d. Laser shut-off mid line for no obvious reason. Could not get laser to fire after that point. Landed and shut system down for approx 1 hr. Called Optech and they described it as a "glitch". Took off and tried it again. Everything worked as it should. No problems.

DR

4/21 Complete LIDAR system
2 main boxes & 4 support boxes shipped from Sheboygan Via FedEx to ANC

4/22 System arrives ANC
Main components placed in 430 for S.A.M.E. Luncheon / Seminar display
In P.M. Start installation
Steve Jones & Scott Powell



4/23 Continue installation with
In frequent interruptions
Cleaned Laser aperture & Video windows

4/24 Birchwood Runway Flight Plan
Runway Coords

| | | |
|---|---|---|
| N | 61.42259 | -149.49640 |
| S | 61.40851 | -149.52260 |
| 41 | | |
| 131 | 61.42010 | -149.51757 |
| 311 | 61.41297 | -149.50071 |
| | 61.24505 | -149.31345 |
| Rnw | 61.25.355 | -149 29.784 |
| X | 61.25.216 | -149 31.065 |
| X | 61.24.784 | -149 30.064 |

Install fibre optic cable D.R.
Reload lever arms

4/30/02

Prepare to fly USFS test plots but have two problems

1. ALTM-NAV line problems
   └ Resolved
2. laptop can not connect to MADS

April 30, Network Settings on Ghost Drive

Broadcom 570x is N/W driver for Pos/AV

TCP/IP only checked

Props/General

Use Following:

192.9.202.99

255.255.255.0

◉ Use Following DNS Server

- Null
- Null

/Advanced

IP Settings

IP

199.9.202.99 255 255 255 0

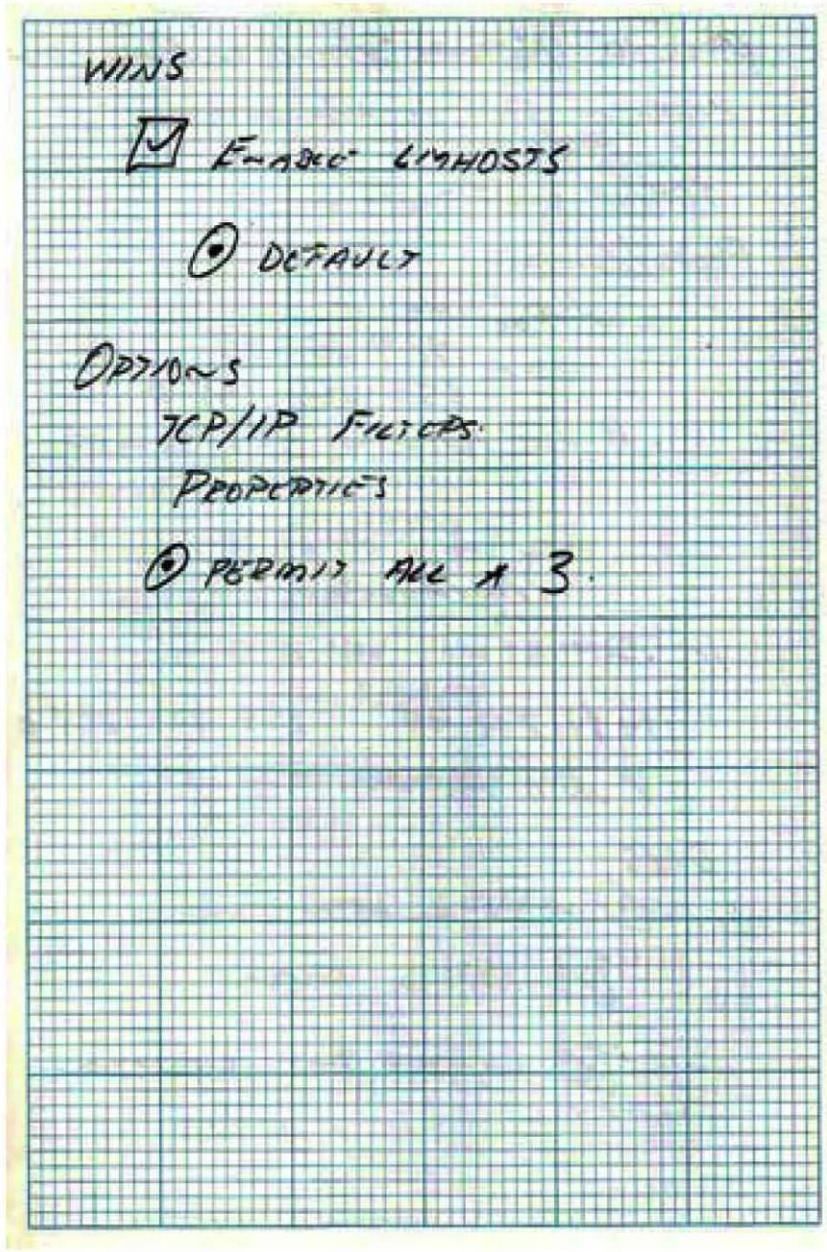
✓ Auto Metric

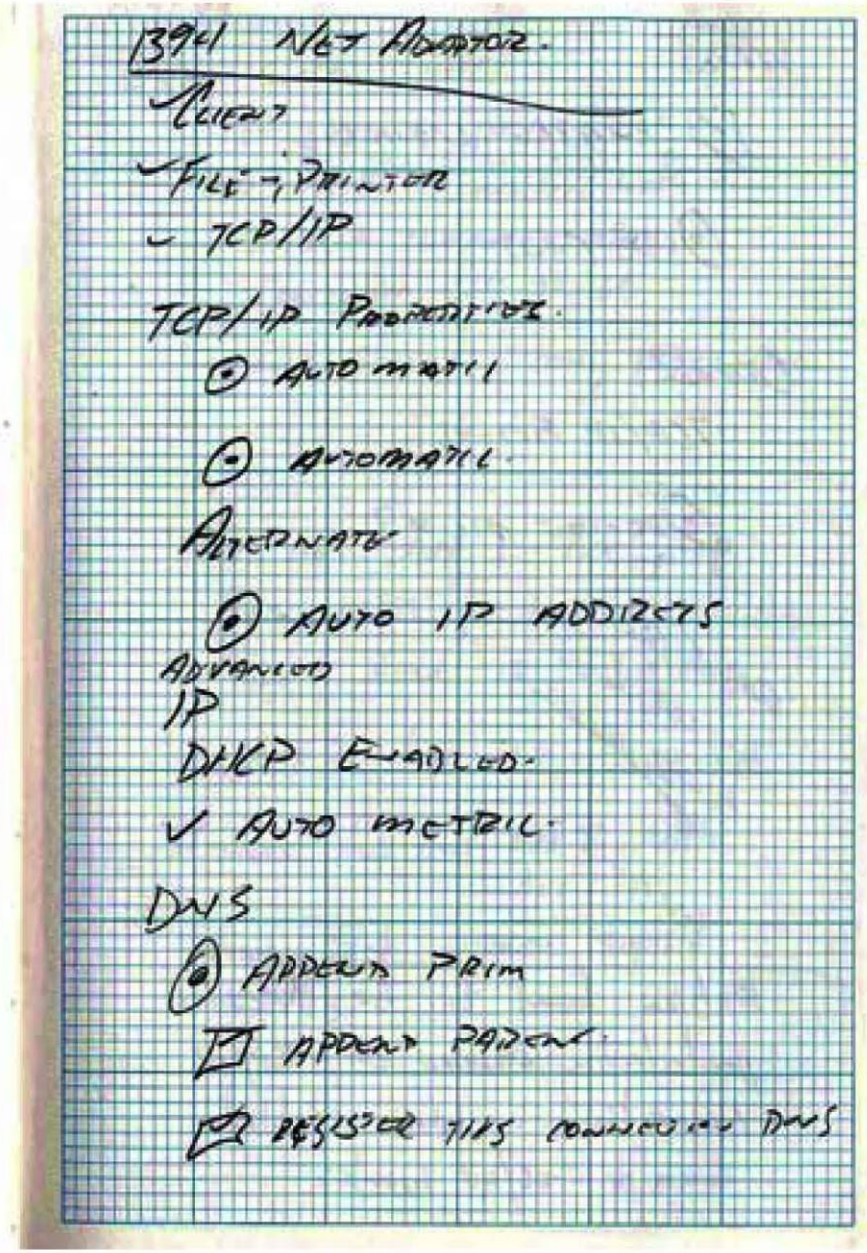
DNS

◉ Append prim

☑ Append parent

☑ Register this connection


WINS
ENABLE LMHOSTS
DEFAULT
OPTIONS
TCP/IP FILTERS
PROPERTIES
PERMIT ALL # 3.


3941 NET MONITOR.
CLIENT
FILE + PRINTER
TCP/IP
TCP/IP PROPERTIES.
AUTOMATIC
AUTOMATIC
ALTERNATE
AUTO IP ADDRESS
ADVANCED
IP
DHCP ENABLED.
AUTO METRIC.
DNS
APPEND PRIM
APPEND PARENT
REGISTER THIS CONNECTION DNS

WINDOWS

☐ ENABLE LMHOSTS

◉ DEFAULT

OPTIONS

TCP/IP FILTERS

◉ PERMIT ALL #3

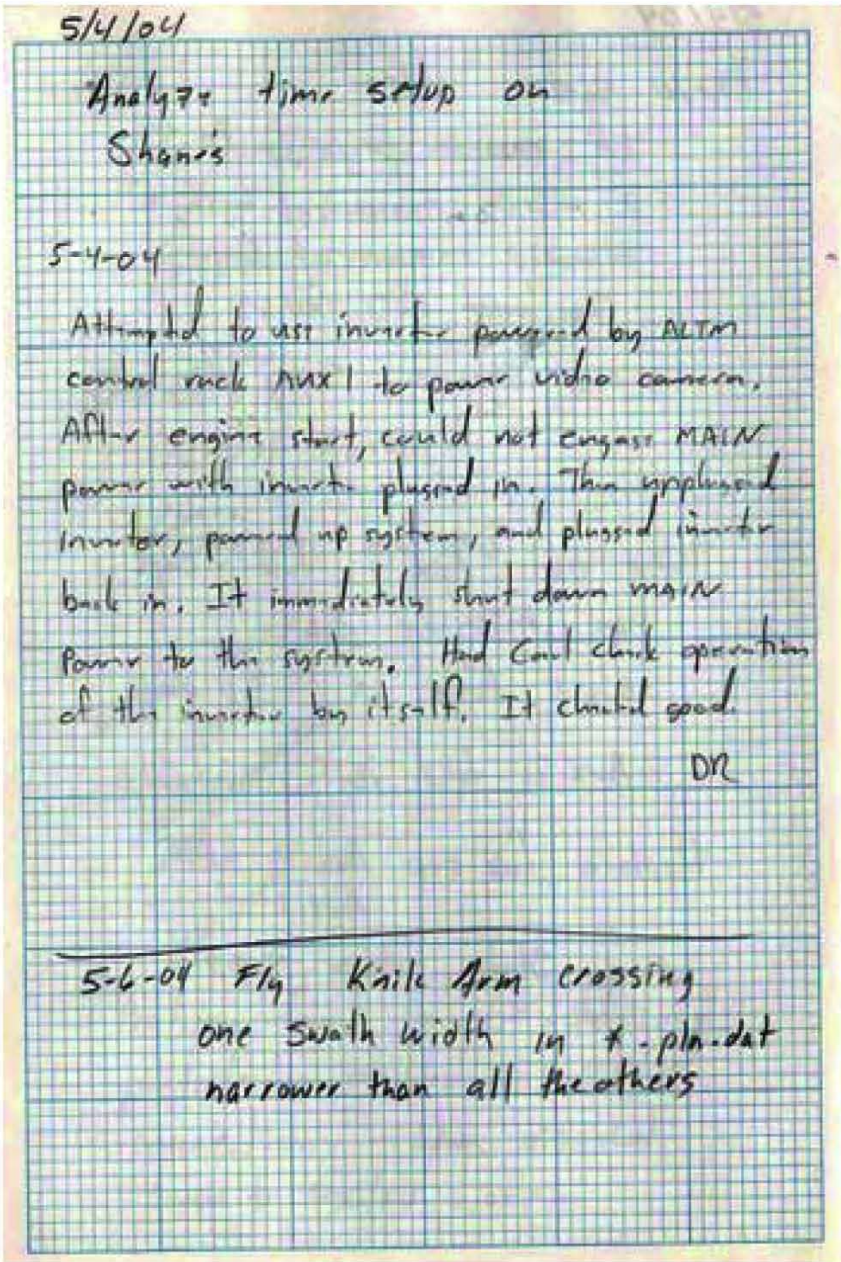
SPUD Comm
AND LOAD with
Default Profile
WP Current

Problem found to be firewall protection enabled on TCP/IP connection. When disabled Comm to POS/AV works.

5/4/04

Check System video
It records properly to a HI-8- Camcorder (both a standard commercial Sony Camcorder CCD-TRV65 and Shanes Sony CCD-VX3-

Take out Aux 1 fuse cap has missing dog
Aux 1 fuse is 3.0 amp
Aux 2 fuse is 10.0 amp
Replace fuse cap Aux 2 with Aux 1
and Stat power supply works



5/4/04

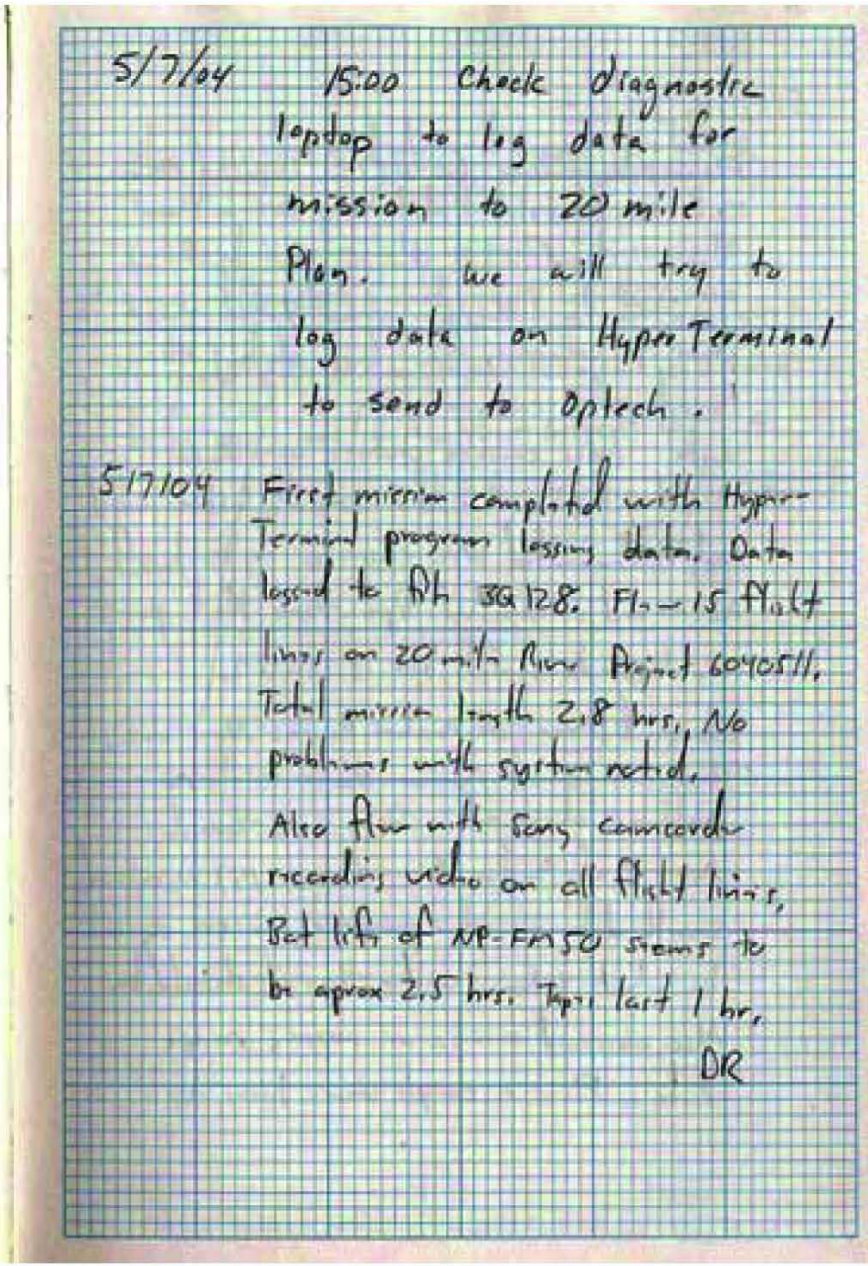
Analyze time setup on Shanni's

5-4-04

Attempted to use inverter powered by ACTM control rack MUX 1 to power video camera. After engine start, could not engage MAIN power with inverter plugged in. Then unplugged inverter, powered up system, and plugged inverter back in. It immediately shut down MAIN Power to the system. Had Carl check operation of the inverter by itself. It checked good.

DR

5-6-04 Fly Knik Arm crossing one Swath width in *.pln.dat narrower than all the others



5/7/04 15:00 Check diagnostic laptop to log data for mission to 20 mile Plan. We will try to log data on HyperTerminal to send to Optech.

5/7/04 First mission completed with HyperTerminal program logging data. Data logged to file 3Q128. Flt-15 flight lines on 20 mile Run Project 6040511. Total mission length 2.8 hrs, No problems with system noted. Also flew with Sony camcorder recording video on all flight lines, But lift of NP-FM50 seems to be aprox 2.5 hrs. Trip last 1 hr.

DR

5/8/04 JD 129

Flew Kenai River 6040517. Dispatched MRI with no status but did have POS in "Fine alignment". Flew one line over Kenai River area. Started Hyper terminal diagnostic computer prior to collecting first laser data. Also started video camera prior to first laser data. Video camera picture initially cut in and out on camcorder screen. Disconnected and reconnected BNC connector on back of ALTM and it worked fine from that point on. Hyper terminal file is 3d129.

Completed Area 1 of Anchor River, Ninilchik, then area 2 of Anchor River with no problems observed. Past many through Area 3 of Anchor River (Lines 14) observed swath data on plan progress screen to be about 4 times wider than it should be. Also observed erratic or missing range data. Flew a couple more lines to check system and observed same problems. Turned laser power off and back on again but had same result after turning laser on again after that. Observed a difference in data collected on Hyper terminal. Seemed to be more missing with a lot of 0's. Flew one alignment over Anchor River area and returned home.

DR

May 11 2004. By Semon Chea

May 10 - Visual inspection of ALTM control rack found one washer for RFI data cable missing (Sensor head end).
- Replaced SCSI cable, add a washer to the RFI data connector.
- Visual inspection, three stripes ground test.
- 6 - Data collected was sent to Optech for processing.
- Optech recommended a flight test to be done to verify the real working condition of the ALTM.

MAY 11.
- 2ND RISER INSTALLED TO ALLOW LENS COVER TO BE INSTALLED TO PROTECT SENSOR HEAD.

May 13th, 204

After flying about 24 flight lines, the laser suddenly shut off about half way down a line. I received the "Range Missing" and "Invalid Prism" error messages highlighted in red. I then attempted to turn the laser control back with no success. Every time I tried to turn it I received the same two error messages. There were no error messages on the laser power supply LCD screen. I believe the diod. temp was around 21. I did not try cleaning from receiver to verify divergence. I did not observe the laser firing indicators came on.

I did try cleaning, and then switching back on, the shutter the interlock key and the laser power supply switch. None of this worked, with POS/AV still up and running, I also tried closing out of and relanding the flight plan. This also did not work.

We then landed and shut the entire system down. About 30 minutes later we started it back up and went for a test flight. The laser fired just like it was supposed to, and everything seemed to work normally from that point on. DR

5-14-04

Flew Grouse Creek and Takotna/Donlin Lakes project out of Juneau. No problems noted with system operations during flight. Only thing slightly out of the ordinary was that we had to reroute to O'Dea to the high mountain ridges around the ends of the flight lines.

After hard drive 3-2 was downloaded, it was noted that there were no data files for the Takotna project and files were missing from Donlin Lake as well. Several lines showed 0's for amount of data collected. Problem still to be determined.

OR

5-27-04

Optech engineers Hepeter Cardinell, Jason Chaney and Alex Kuzvoetsligkaar installed new ALTM control rack with all new components.

OR

5-24-04

Tried the fly wahlmart Calibration. Laser would not fire. Every time we attempted to fire the laser, the red light for Calibrat "on" would come on for about 5 seconds. There was no range data. Then laser would shut down and a "range warning" error message would pop up. Returned to MRI. Optech engineers were able to fire laser on ground. They determined problem to be too much moisture in the air. We did have light rain and precipitation at the time.

OR

5-25-04

Flew Walnut calibration. No problems noted. No longer need to turn alternators off to start control rack Main Power. Also no longer need to press Main Power button switch twice to power up unit.

OR

5-26-04

Changed Z-level arm setting from -1.286 to -1.136 to compensate for second riser.

OR

7-20-04

Procedure to register a copy of ALTM CFlight Version):

1. Optech will need the hardware fingerprint of your computer:
   a) open DOS command prompt
   b) change directory to C:\Programs files\altm-new
   c) type altm-new.exe register (Enter) Fingerprint for machine: 4779-812E
2. After Optech has this code, they can email you the name and key code. Cut and paste into this window.
3. Entered a temporary code from Optech good for the next 30 days into laptop computer.

7-21-04

Attempted to fly NOAA 6030810. Laser would not fire. Got "Range Missing" error message even when laser turned on. Tried changing divergence and other flight plan settings. Finally had to land and shut system down. Turned it back on and had laser turn on ground with shutter closed. It worked fine at this point. Departed and flew project with no further problems.

May have moisture/condensation in scanner head. Plane has been parked outside for past 2 weeks and not flown for 2 days. Will try putting on cheap light and dehumidifier in cockpit at night to reduce moisture level.

DR

8-5-04

Flew 14 lines on NOAA 303 (2 mod). Laser shut off due to "Range Missing" error message. Landed and shut down ALTM control rack power. Restarted and system worked fine from that point on.

DR

8-15-04
Removed LIDAR System from 430 for shipment to Walker Associates. No problems noted.
DR

8-25-04
Installed LIDAR system in Walker and Associates 210 Aircraft 9WA. Built and installed mount with vertical riser and mount with riser at 20° angle. Applied power to system for initial test and everything seemed to work fine. Noted some vibration on vertical mount when aircraft engine running. Built braces on risers to hold rigid.

8-26-04
Leroy Signori used Total Station to obtain new lever arm settings for both mounts.
20° Forward angled mount; (WALKER 210 - 9WA)
X = -0.091
y = -0.116
Z = -1.441

Vertical Riser (Walker 210 - 9WA)
X = 0.103
y = -0.112
Z = -1.360

Flew calibration test mission with vertical mount over Rainier Apt. All seemed to work.

8-27-04
Installed 20° mount and changed lever arm settings in POS/AV.

9-5-04
Completed Granite Pass OR project. Only problem to note is that the ALTM-NAV program got hung up during flight a couple times. Program froze. Had to exit out and restart. Happened 3 times during on flight.
DR

9-6-04
Hard drive 3-2 froze up and stopped in the middle of disk extraction download process. Had to exit out of disk 2k and restart. Download also seemed slower than normal.
DR

# 6. AIRBORNE POSITIONING ORIENTATION

This section contains information on how the raw LIDAR, GPS, and inertial data is post-processed to obtain first the kinematic GPS trajectory of the ALTM system in the aircraft, how that 1 Hz GPS trajectory information is combined with the on-board 200 Hz inertial data for a final Smoothed Best Estimate Trajectory (SBET), then how it is combined with the laser information to generate final laser information for each pulse and return. This final laser information is distilled down to a laser output file in the industry standard .las format. These .las formatted files have a number of fields of information, but the critical ones that are passed onto the LIDAR Product Creation Post Processing (see Section 11 – Product Creation), are GPS time, UTM x,y,z coordinates, and intensity information for each pulse and return.

This Airborne Positioning Orientation process is carried out in an Optech proprietary software suite called REALM.

*What is REALM?*
REALM (Results of Airborne Laser Mapping) is a modular, tab-based survey software suite for processing raw data derived from Optech's ALTM (Airborne Laser Terrain Mapper). The processed data files can then be brought into an off-the-shelf visualization software package such as TerraModel or TerraScan to output graphic representations of the ALTM's 3D point data.

*The Basic Concept*
In general, the REALM Survey Suite software produces three-dimensional (3D) point data acquired by an Airborne Laser Terrain Mapper (ALTM). This data is processed from various inputs including: laser ranges, intensity values, scan angles, Differential Global Positioning System (DGPS) data, Inertial Navigation System (INS) data and system calibration data.

Integrated classification and output algorithms allow for the structured output of the 3D point data into various types, such as ground or vegetation only, time sequential, flightline, patches (input for DEM generation), buildings (3D city modeling), power lines, etc. REALM's graphical user interface presents a well organized tool box (e.g., Geodetic Tools, GPS Positioning Tools, INS Tools, ALS Tools) in a modular, tab-oriented structure. A common front-end user interface connects the various tools with each other to ensure an optimally controlled process flow.

REALM's basic processing steps can be seen in Figure 6.1. The flow among the modules is illustrated in Figure 6.2. (see next page).

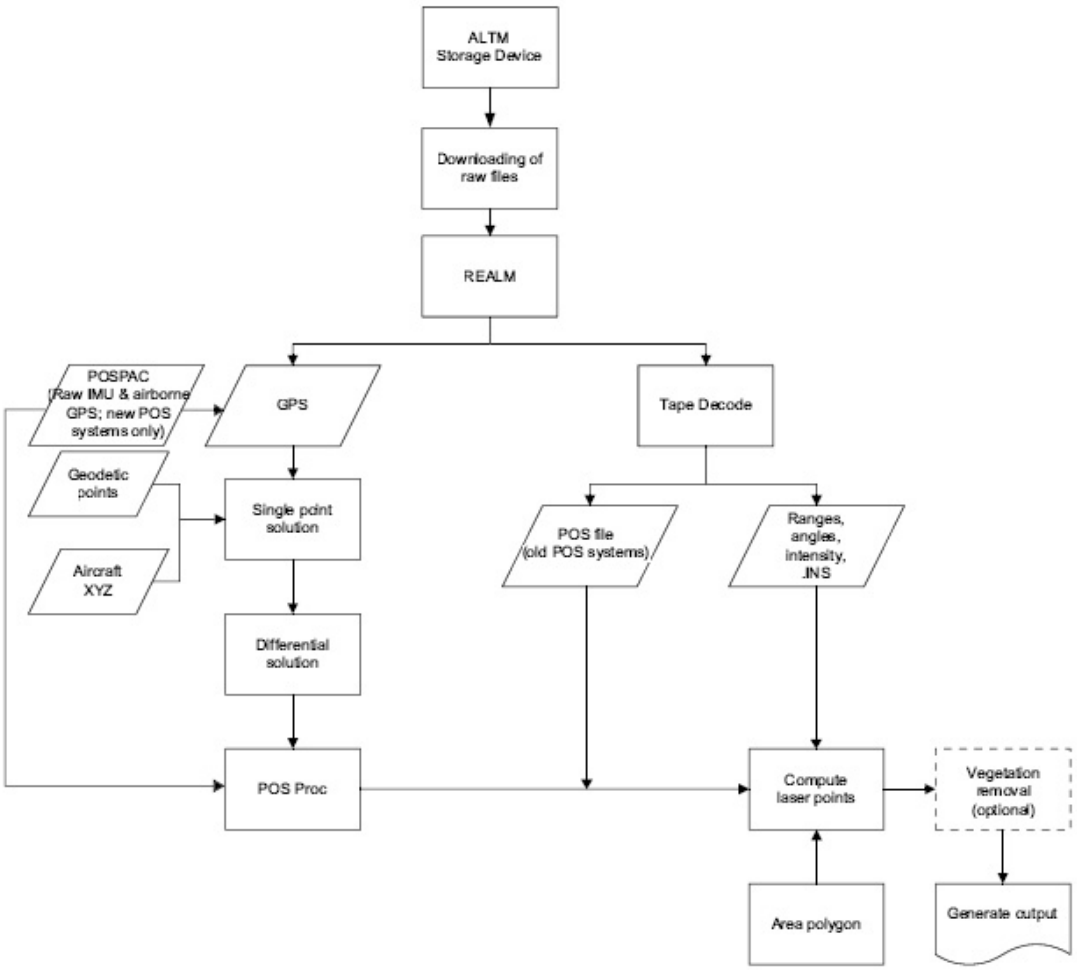



*Figure 6.1 REALM Processing Flow*

# 7. AIRCRAFT NAVIGATION

The Optech 30/70 ALTM provides aircraft navigation from the ALTM-NAV program running as the operators main system controller interface on a laptop in the airplane. The ALTM-NAV program takes GPS information from the Novatel GPS receiver that is located in the main system console, and then feeds it to a pilot display for aircraft navigation. The ALTM-NAV program uses flight plans earlier generated in the planning stage with the ALTM-NAV Planner program.




*Figure 7.1 Optech 30/70 ALTM System Components*

## Pilot Display

ALTM-NAV manages a separate video display to assist the pilot in flying the survey lines accurately (see photo on next page).

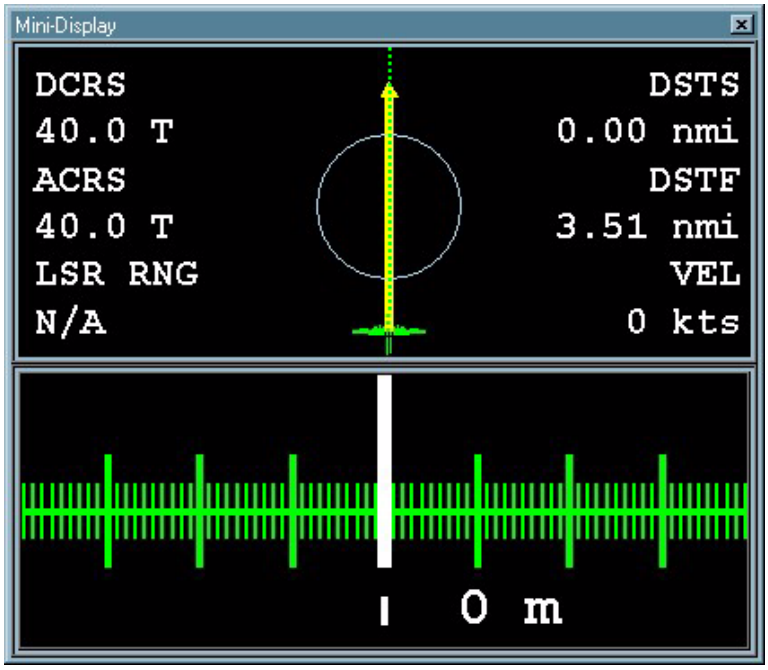



*Figure 7-2: Course Direction Indicator (CDI) Display*

The CDI display indicates the perpendicular distance from the survey track to the aircraft's current position. It always uses the current survey track as selected in the ALTM-NAV control panel. The ticks on this display occur every 100 yd (91 m), with larger ticks occurring every 1000 yd (914 m). It has three automated zoom resolutions: 400 yd (366 m), 1000 yd (914 m), and 5000 yd (4572 m). The zoom level is set automatically and switches instantaneously as the aircraft's distance from the flight line passes each threshold.

The CDI operates in fly-to mode. If the aircraft indicator is to the left of center, the aircraft must be steered to the left to get back on line. At the top of the pilot's display is a mini-map indicating the position of the aircraft with respect to its desired paths.

Along the top sides are numerical readouts of the Desired Course (**DCRS**), Actual Course (**ACRS**), Laser Range (**LSR RNG**), Distance to Start (**DSTS**), Distance to Finish (**DSTF**) and Velocity (**VEL**). The **LSR RNG** field shows a sample (in meters) of the laser ranges returned from the ALTM.

# 8. TIDE COORDINATION

The missions were all to be tide coordinated for tides below Mean Lower Low Water (MLLW). Because of the small tide range in the area, and the difficulties coordinating airborne missions with the complex conditions that influence tides in that region (e.g., atmospheric pressure, winds and currents), the requirement for all data acquisition to be performed at MLLW or below were relaxed by NOAA, first to Mean High Water, then in August to any tide window so that all the targeted shoreline areas could be covered.

In Section 4 – Flight Line Maps and Coverage, there is an Excel spreadsheet that has extensive mission detail, including the UTC time for the start and stop of all flight lines for coordinating with the NOAA precise tide information.

# 9. GPS REPORT

This section contains mostly GPS observation logs and station recovery notes.

For the detailed GPS control report, see Section 10 – Ground Control Report. This control survey and the report "GPS Base Station Report" were performed by John Oswald and Associates (JOA) under sub-contract to AeroMap for GPS base station control values, ground truth surveys, and GPS base station support throughout the duration of the project.

Much of the "GPS Base Station Report" of 2004 had a foundation in earlier work performed in 2003 by JOA in support of the aerial photography and LIDAR missions for Areas 301 and 302 in the year 2004. This 2003 project entitled "Ground Surveys Report – GPS Survey in Support of Coastal Mapping Program – Chukchi Sea, Alaska – NGS Project Nos. AK301, 302". This report has been previously submitted to NOAA on July 12, 2004.

# GPS OBSERVATION LOG

Station ID KOT 5
Project No. 6030810
Project Name NOAA
Rcvr. Type 4CCC
Rcvr. S/N 9849
Antenna Type Com L1/L2 NC GP
Antenna S/N C14056

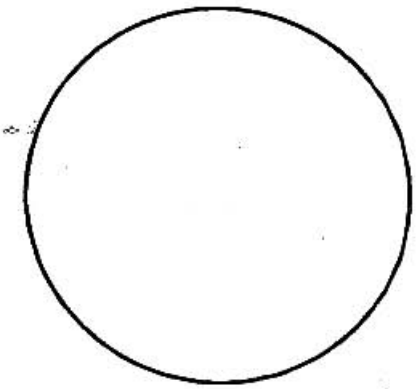
Date 8/11/04
Julian Date 223
Start Time 15:48: :
Stop Time 00:47: :
Rcvr.File Name KOT5223C
Observer DN
New or Existing Mon. ☐ New ☐ Existing
Photo Taken: ☐ Yes ☐ No

Slant height:
(Top of Monument to Bottom of Ground Plane)

Start 1.485 M. 4.88 Ft.
1.486 M. Radius ____ Cm.
(Ctr. Antenna to Outer Edge)
1.486 M.
Mean ____ M.

Stop ____ M. 4.88 Ft.
____ M. Radius ____ Cm.
(Ctr. Antenna to Outer Edge)
____ M.
Mean ____ M.

Position: LAT. ° ' "
LONG. ° ' "
Elevation ____ M.



Monument Sketch

Monument Type: ____
Spike ☐ PK Nail ☒
Flagging ☐ AM Washer ☒
Other ____

Monument ht: -2.0 Cm.
(Ground to top of monument)

Notes:

**- If new location, draw sight map on back -**

# GPS OBSERVATION LOG

Station ID KAT 6

Project No. 6030810

Project Name NOAA

Rcvr. Type 4000

Rcvr. S/N 9934

Antenna Type Com 4112 NO GP

Antenna S/N 014056

Date 7/19/04

Julian Date 201

Start Time 01:30: :

Stop Time 04:50: :

Rcvr.File Name KAT6201A

Observer DN

New or Existing Mon. ☒ New ☐ Existing

Photo Taken: ☐ Yes ☐ No

Slant height:
(Top of Monument to Bottom of Ground Plane)

Start 1.304 M. 4.28 Ft.

1.305 M. Radius _____ Cm.
(Ctr. Antenna to Outer Edge)

1.307 M.

Mean _____ M.

Stop _____ M. 4.28 Ft.

_____ M. Radius _____ Cm.
(Ctr. Antenna to Outer Edge)

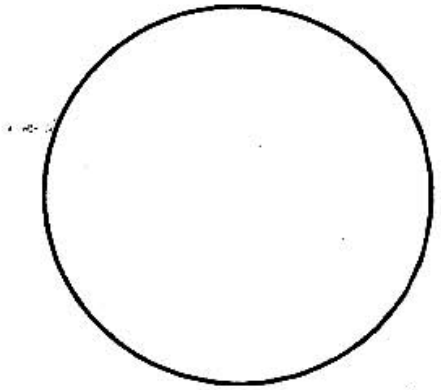
_____ M.

Mean _____ M.

Position: LAT. _____ ° ' "

LONG. _____ ° ' "

Elevation _____ M.



Monument Sketch

Monument Type: _____

Spike ☐ PK Nail ☐

Flagging ☐ AM Washer ☐

Other BOLT HEAD

Monument ht: Ø Cm.
(Ground to top of monument)

Notes:

**- If new location, draw sight map on back -**

# GPS OBSERVATION LOG

Station ID KCT 5
Project No. 6030810
Project Name NOAA
Rcvr. Type 4000
Rcvr. S/N 9849
Antenna Type Com L1/L2 NC GP
Antenna S/N 014404

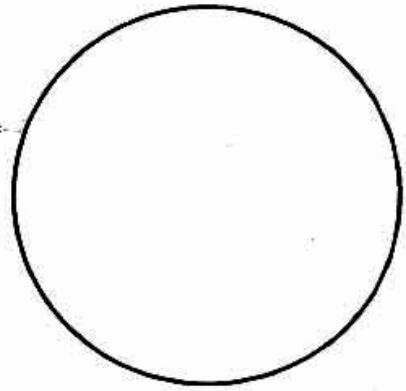
Date 7/19/04
Julian Date 201
Start Time 02 : 00 : :
Stop Time 04 : 41 : :
Rcvr. File Name K 0 I 5 1 2 0 1 1 - 0
Observer DM
New or Existing Mon. ☒ New ☐ Existing
Photo Taken: ☐ Yes ☐ No

Slant height:
(Top of Monument to Bottom of Ground Plane)

Start 1.585 M. 5.20 Ft.
1.585 M. Radius ____ Cm.
(Ctr. Antenna to Outer Edge)
1.585 M.
Mean ____ M.

Stop ____ M. 5.20 Ft.
____ M. Radius ____ Cm.
(Ctr. Antenna to Outer Edge)
____ M.
Mean ____ M.

Position: LAT. ____ ° ' "
LONG. ____ ° ' "
Elevation ____ M.



Monument Sketch

Monument Type: ____
Spike ☐ PK Nail ☒
Flagging ☐ AM Washer ☒
Other ____

Monument ht: -2.0 Cm.
(Ground to top of monument)

Notes:

**- If new location, draw sight map on back -**

## GPS OBSERVATION LOG

Station ID KOT 5
Project No. 6030810
Project Name NOAA
Rcvr. Type 4000
Rcvr. S/N 9849
Antenna Type COM L1/L2 NO GP
Antenna S/N 014404

Date 07/21/04
Julian Date 203
Start Time 02:02: :
Stop Time 08 10 : :
Rcvr.File Name KOT5203-1
Observer DN
New or Existing Mon. ☒ New ☐ Existing
Photo Taken: ☐ Yes ☐ No

Slant height:
(Top of Monument to Bottom of Ground Plane)

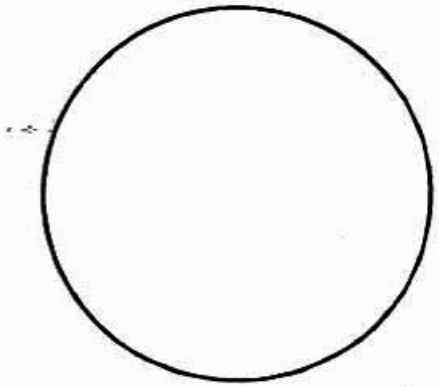
Start 1.585 M. 5.20 Ft.
1.585 M. Radius ____ Cm.
(Ctr. Antenna to Outer Edge)
1.584 M.

Mean ____ M.

Stop ____ M. 5.20 Ft.
____ M. Radius ____ Cm.
(Ctr. Antenna to Outer Edge)
____ M.

Mean ____ M.

Position: LAT. ____ • ' "
LONG. ____ • ' "
Elevation ____ M.



Monument Sketch

Monument Type: ____
Spike ☐ PK Nail ☒
Flagging ☐ AM Washer ☒
Other ____

Monument ht: -2.0 Cm.
(Ground to top of monument)

Notes:

**- If new location, draw sight map on back -**

## GPS OBSERVATION LOG

Station ID KOT 6
Project No. 6030810
Project Name NOAA
Rcvr. Type 4000
Rcvr. S/N 9934
Antenna Type com L1/L2 NO GP
Antenna S/N 014056

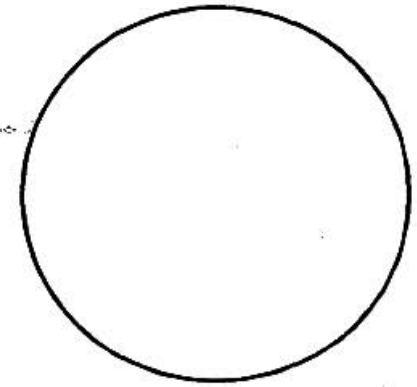
Date 07/21/04
Julian Date 203
Start Time 01:52: :
Stop Time 08:00: :
Rcvr.File Name KOI61203I-1
Observer DN
New or Existing Mon. ☒ New ☐ Existing
Photo Taken: ☐ Yes ☐ No

Slant height:
(Top of Monument to Bottom of Ground Plane)

Start 1.305 M. 4.28 Ft.
1.305 M. Radius ____ Cm.
(Ctr. Antenna to Outer Edge)
1.305 M.
Mean ____ M.

Stop ____ M. 4.28 Ft.
____ M. Radius ____ Cm.
(Ctr. Antenna to Outer Edge)
____ M.
Mean ____ M.

Position: LAT. ____ • ' "
LONG. ____ • ' "
Elevation ____ M.



Monument Sketch

Monument Type: ____
Spike ☐ PK Nail ☐
Flagging ☐ AM Washer ☐
Other Bolt N.G.S.M

Monument ht: 0 Cm.
(Ground to top of monument)

Notes:

**- If new location, draw sight map on back -**

# GPS OBSERVATION LOG

Station ID KOT 5
Project No. 6030810
Project Name NOAA
Rcvr. Type 4000
Rcvr. S/N 9849
Antenna Type Com C1/L2 NO GP
Antenna S/N 014404

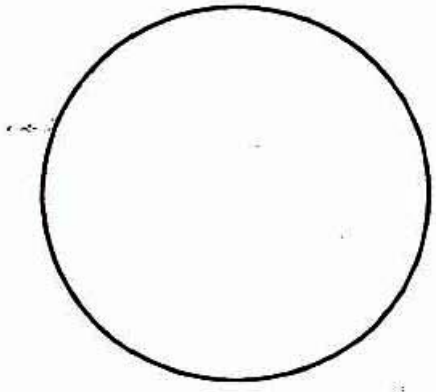
Date 7/21/04
Julian Date 203
Start Time 15:06:
Stop Time 19:01:
Rcvr.File Name KOT5203I.O
Observer DR
New or Existing Mon. ☒ New ☐ Existing
Photo Taken: ☐ Yes ☐ No

Slant height:
(Top of Monument to Bottom of Ground Plane)

Start 1.585 M. 5.20 Ft.
1.585 M. Radius ____ Cm.
(Ctr. Antenna to Outer Edge)
1.585 M.
Mean ____ M.

Stop ____ M. 5.20 Ft.
____ M. Radius ____ Cm.
(Ctr. Antenna to Outer Edge)
____ M.
Mean ____ M.

Position: LAT. ____ ° ' "
LONG. ____ ° ' "
Elevation ____ M.



Monument Sketch

Monument Type: ____
Spike ☐ PK Nail ☒
Flagging ☐ AM Washer ☒
Other ____

Monument ht: 2.0 Cm.
(Ground to top of monument)

Notes:

**- If new location, draw sight map on back -**

# GPS OBSERVATION LOG

Station ID KOT 6
Project No. 603810
Project Name NOAA
Rcvr. Type 4000
Rcvr. S/N 9984
Antenna Type Com L1/L2 NO GP
Antenna S/N 014056

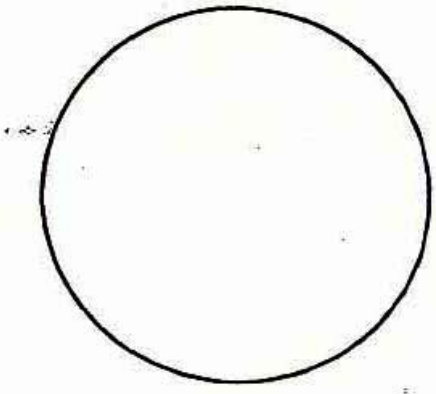
Date 7/21/04
Julian Date 203
Start Time 14:52: :
Stop Time 18:57: :
Rcvr. File Name KeI61203I-0
Observer DN
New or Existing Mon. ☒ New ☐ Existing
Photo Taken: ☐ Yes ☐ No

Slant height:
(Top of Monument to Bottom of Ground Plane)

Start 1.305 M. 4.28 Ft.
1.304 M. Radius ____ Cm.
(Ctr. Antenna to Outer Edge)
1.306 M.
Mean ____ M.

Stop ____ M. 4.28 Ft.
____ M. Radius ____ Cm.
(Ctr. Antenna to Outer Edge)
____ M.
Mean ____ M.

Position: LAT. ° ' "
LONG. ° ' "
Elevation ____ M.



Monument Sketch

Monument Type: ____
Spike ☐ PK Nail ☐
Flagging ☐ AM Washer ☐
Other BOLT HEAD

Monument ht: 0 Cm.
(Ground to top of monument)

Notes:

**- If new location, draw sight map on back -**

# GPS OBSERVATION LOG

Station ID KCT 6
Project No. 6030810
Project Name NOAA
Rcvr. Type 4000
Rcvr. S/N 9934
Antenna Type COM L1/L2 NO GP
Antenna S/N 014056

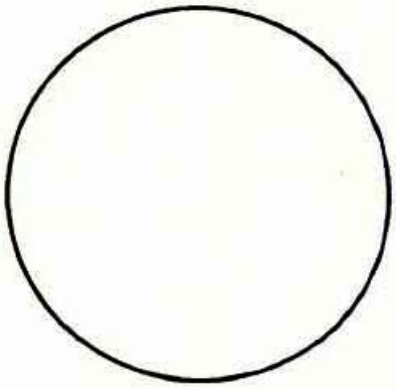
Date 7/22/04
Julian Date 204
Start Time 16 : 23 : :
Stop Time 20 : 59 : :
Rcvr. File Name KCT6204F0
Observer DN
New or Existing Mon. ☒ New ☐ Existing
Photo Taken: ☐ Yes ☐ No

Slant height:
(Top of Monument to Bottom of Ground Plane)

Start 1.305 M. 4.28 Ft.
1.304 M. Radius ____ Cm.
(Ctr. Antenna to Outer Edge)
1.305 M.
Mean ____ M.

Stop ____ M. 4.28 Ft.
____ M. Radius ____ Cm.
(Ctr. Antenna to Outer Edge)
____ M.
Mean ____ M.

Position: LAT. ° ' "
LONG. ° ' "
Elevation ____ M.



Monument Sketch

Monument Type: ____
Spike ☐ PK Nail ☐
Flagging ☐ AM Washer ☐
Other BOLT HEAD

Monument ht: Ø Cm.
(Ground to top of monument)

Notes:

**- If new location, draw sight map on back -**

# GPS OBSERVATION LOG

Station ID KCT 5
Project No. 6030810
Project Name NOAA
Rcvr. Type 4000
Rcvr. S/N 014404
Antenna Type Com 4/12 AOGP
Antenna S/N 9849

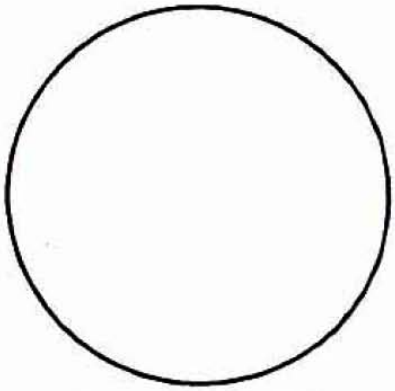
Date 7/22/04
Julian Date 204
Start Time 16:11: :
Stop Time 20:50: :
Rcvr.File Name KCT5204I=0
Observer DN
New or Existing Mon. ☒ New ☐ Existing
Photo Taken: ☐ Yes ☐ No

Slant height:
(Top of Monument to Bottom of Ground Plane)

Start 1.585 M. 5.20 Ft.
1.585 M. Radius ____ Cm.
(Ctr. Antenna to Outer Edge)
1.585 M.
Mean ____ M.

Stop ____ M. 5.20 Ft.
____ M. Radius ____ Cm.
(Ctr. Antenna to Outer Edge)
____ M.
Mean ____ M.

Position: LAT. ____ • ' "
LONG. ____ • ' "
Elevation ____ M.



Monument Sketch

Monument Type: ____
Spike ☐ PK Nail ☒
Flagging ☐ AM Washer ☒
Other ____

Monument ht: -2.0 Cm.
(Ground to top of monument)

Notes:

**- If new location, draw sight map on back -**

## GPS OBSERVATION LOG

Station ID KOT 6
Project No. 6030810
Project Name NOAA
Rcvr. Type 4000
Rcvr. S/N 9934
Antenna Type COM L1/L2 NO GP
Antenna S/N 014056

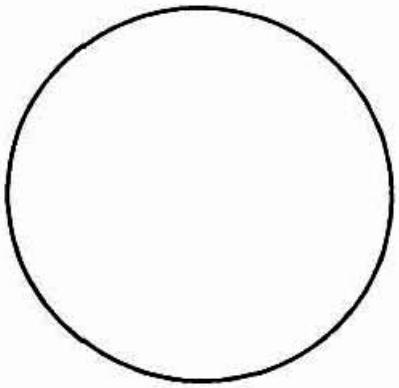
Date 8/1/04
Julian Date 214
Start Time 01 : 44 : :
Stop Time 05 :38 : :
Rcvr.File Name KOT6214C
Observer DM
New or Existing Mon. ☒ New ☐ Existing
Photo Taken: ☐ Yes ☐ No

Slant height:
(Top of Monument to Bottom of Ground Plane)

Start 1.455 M. 4.78 Ft.
1.455 M. Radius ____ Cm.
(Ctr. Antenna to Outer Edge)
1.456 M.
Mean ____ M.

Stop ____ M. 4.78 Ft.
____ M. Radius ____ Cm.
(Ctr. Antenna to Outer Edge)
____ M.
Mean ____ M.

Position: LAT. ____ ° ' "
LONG. ____ ° ' "
Elevation ____ M.



Monument Sketch

Monument Type: ____
Spike ☐ PK Nail ☐
Flagging ☐ AM Washer ☐
Other Bolt Head

Monument ht: Ø Cm.
(Ground to top of monument)

Notes:

**- If new location, draw sight map on back -**

# GPS OBSERVATION LOG

Station ID KOT 5
Project No. 030810
Project Name NOAA
Rcvr. Type 4000
Rcvr. S/N 9849
Antenna Type Com L1/L2 NOAP
Antenna S/N 014404

Date 8/1/04
Julian Date 214
Start Time 01:51: :
Stop Time 05:31: :
Rcvr. File Name KOT5214C
Observer DN
New or Existing Mon. ☒ New ☐ Existing
Photo Taken: ☐ Yes ☐ No

Slant height:
(Top of Monument to Bottom of Ground Plane)

Start 1.486 M. 4.87 Ft.
1.486 M. Radius ____ Cm.
(Ctr. Antenna to Outer Edge)
1.487 M.
Mean ____ M.

Stop ____ M. 4.87 Ft.
____ M. Radius ____ Cm.
(Ctr. Antenna to Outer Edge)
____ M.
Mean ____ M.

Position: LAT. ° ' "
LONG. ° ' "
Elevation ____ M.

Monument Sketch

Monument Type: ____
Spike ☐ PK Nail ☒
Flagging ☐ AM Washer ☒
Other ____

Monument ht: -2.0 Cm.
(Ground to top of monument)

Notes:

**- If new location, draw sight map on back -**

## GPS OBSERVATION LOG

Station ID KCT 6
Project No. 603081C
Project Name NOAA
Rcvr. Type 4000
Rcvr. S/N 9849
Antenna Type Com L1/L2 NGGP
Antenna S/N C14404

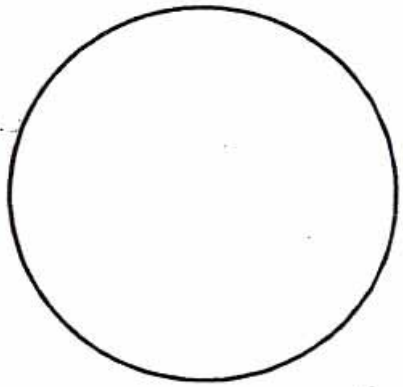
Date 8/5/04
Julian Date 218
Start Time 04:00:
Stop Time 07:49:
Rcvr.File Name KCT6218I-2
Observer DH
New or Existing Mon. ☒ New ☐ Existing
Photo Taken: ☐ Yes ☐ No

Slant height:
(Top of Monument to Bottom of Ground Plane)

Start 1.456 M. 4.78 Ft.
1.456 M. Radius ____ Cm.
(Ctr. Antenna to Outer Edge)
1.455 M.
Mean ____ M.

Stop ____ M. 4.78 Ft.
____ M. Radius ____ Cm.
(Ctr. Antenna to Outer Edge)
____ M.
Mean ____ M.

Position: LAT. ____ ° ' "
LONG. ____ ° ' "
Elevation ____ M.



Monument Sketch

Monument Type: ____
Spike ☐ PK Nail ☐
Flagging ☐ AM Washer ☐
Other BOLT HEAD

Monument ht: Ø Cm.
(Ground to top of monument)

Notes:

**- If new location, draw sight map on back -**

## GPS OBSERVATION LOG

Station ID KCT 6
Project No. 6030810
Project Name NOAA
Rcvr. Type 4000
Rcvr. S/N 9849
Antenna Type CORM 4/L2 NO GP
Antenna S/N 014404

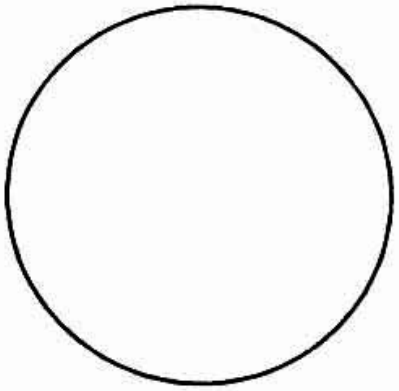
Date 8/15/04
Julian Date 218
Start Time 01 : 47 : :
Stop Time 07 : 49 : :
Rcvr.File Name KCT6218-1 KCT6218-2
Observer DM
New or Existing Mon. ☒ New ☐ Existing
Photo Taken: ☐ Yes ☒ No

Slant height:
(Top of Monument to Bottom of Ground Plane)

Start 1.456 M. 4.78 Ft.
1.455 M. Radius ____ Cm.
(Ctr. Antenna to Outer Edge)
1.456 M.
Mean ____ M.

Stop ____ M. 4.78 Ft.
____ M. Radius ____ Cm.
(Ctr. Antenna to Outer Edge)
____ M.
Mean ____ M.

Position: LAT. ____ ° ' "
LONG. ____ ° ' "
Elevation ____ M.



Monument Sketch

Monument Type: ____
Spike ☐ PK Nail ☐
Flagging ☐ AM Washer ☐
Other BOLT HEAD

Monument ht: Ø Cm.
(Ground to top of monument)

Notes: Receiver shut down for battery change around 04:00 prior to 43Q218048 mission, KCT6218-1 probably not needed for anything. KCT6218-2 is the data associated with mission 43Q218048.

**- If new location, draw sight map on back -**

## GPS OBSERVATION LOG

Station ID KOT 6

Project No. 603081C

Project Name NOAA

Rcvr. Type 4000

Rcvr. S/N 9849

Antenna Type Com L1/L2 NO GP

Antenna S/N 014404

Date 08/05/04

Julian Date 218

Start Time 14 :47: :

Stop Time 20 :52: :

Rcvr.File Name KeI6121 81=0

Observer DN

New or Existing Mon. ☐ New ☐ Existing

Photo Taken: ☐ Yes ☐ No

Slant height:
(Top of Monument to Bottom of Ground Plane)

Start 1.456 M. 4.78 Ft.

1.456 M. Radius _____ Cm.
(Ctr. Antenna to Outer Edge)

1.456 M.

Mean _____ M.

Stop _____ M. 4.78 Ft.

_____ M. Radius _____ Cm.
(Ctr. Antenna to Outer Edge)

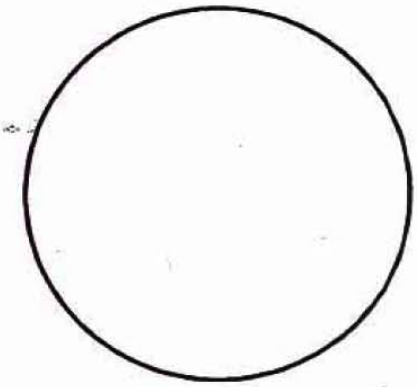
_____ M.

Mean _____ M.

Position: LAT. _____ ° ' "

LONG. _____ ° ' "

Elevation _____ M.



Monument Sketch

Monument Type: _____

Spike ☐ PK Nail ☐

Flagging ☐ AM Washer ☐

Other BOLT HEAD

Monument ht: Ø Cm.
(Ground to top of monument)

Notes:

**- If new location, draw sight map on back -**

## GPS OBSERVATION LOG

Station ID KOT5

Project No. 6030810

Project Name NOAA

Rcvr. Type 4000

Rcvr. S/N 9849

Antenna Type CORM 4/L2 NOGP

Antenna S/N 01440 4

Date 08/06/04

Julian Date 219

Start Time 03:39: :

Stop Time 06:54: :

Rcvr.File Name KOI5219I=O

Observer DN

New or Existing Mon. ☒ New ☐ Existing

Photo Taken: ☐ Yes ☐ No

Slant height:
(Top of Monument to Bottom of Ground Plane)

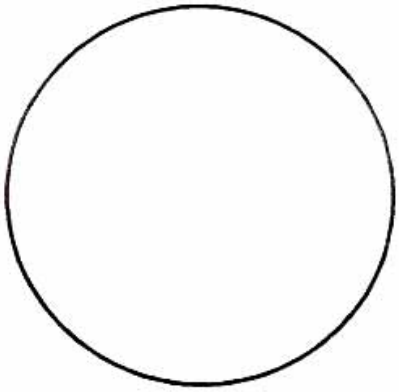
Start 1.485 M. 4.88 Ft.
1.486 M. Radius ____ Cm.
(Ctr. Antenna to Outer Edge)
1.486 M.

Mean ____ M.

Stop ____ M. 4.88 Ft.
____ M. Radius ____ Cm.
(Ctr. Antenna to Outer Edge)
____ M.

Mean ____ M.

Position: LAT. ° ' "
LONG. ° ' "
Elevation ____ M.



Monument Sketch

Monument Type: ____

Spike ☐ PK Nail ☒

Flagging ☐ AM Washer ☒

Other ____

Monument ht: -2.0 Cm.
(Ground to top of monument)

Notes:

**- If new location, draw sight map on back -**

NOAA GPS STATION OBSERVATION LOG (15-Apr-2003)

| | | | |
|---|---|---|---|
| Station Designation: (circle applicable: FBN / CBN / PAC / SAC / BM) KOT 6 | | Station PID, if any: | Date (UTC): 7-22-04 |
| General Location: KOTZEBUE AIRPORT | Airport ID, if any: PACT | Station 4-Character ID: KOT 6 | Day of Year: 204 |
| Project Name: NOAA COASTAL MAPPING | Project Number: AK 301 / GPS- AK302 | Station Serial # (SSN): | Session ID:(A,B,C etc) |

| | | | |
|---|---|---|---|
| NAD83 Latitude: 66° 53' 24.57" | NAD83 Longitude: 162° 36' 11.54" | NAD83 Ellipsoidal Height: meters<br>NAVD88 Orthometric Ht.: meters<br>GEOID99 Geoid Height: meters | Agency Full Name: AEROMAP US<br>Operator Full Name: DAVID RIDER<br>Phone #: (907) 339-1988<br>e-mail address: drider@aeromap.com |
| Observation Session Times (UTC): Sched. Start ____ Stop ____ Epoch Interval= 1 Seconds<br>Actual Start 16:23 Stop 20:59 Elevation Mask = 10 Degrees | | | |

**GPS Receiver:**
Manufacturer & Model: TRIM 4000 SSI
P/N: 24840-01
S/N: 3509A09934
Firmware Version:
☐ CamCorder Battery, ☒ 12V DC, ☐ 110V AC, ☐ Other

**GPS Antenna:**
Manufacturer & Model, & NGS antenna code*: TRIM COMPACT L1/L2
P/N: 22020-00
S/N: 0220014056
Cable Length, meters: 10
Vehicle is Parked MA meters ____(direction) from antenna.

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

**Tripod or Ant. Mount:** Check one: ☐ Fixed-Height Tripod, ☒ Slip-Leg Tripod, ☐ Fixed Mount
Manufacturer & Model:
P/N: NONE
S/N:
Last Calibration date:

**Tribrach:** Check one: ☐ None, ☐ Wild GDF 22, ☐ Topcon, ☒ Other (describe)
Last Calibration date: SOKKIA

**** ANTENNA HEIGHT ****
(see back of form for measurement illustration)

| | Before Session Begins: measure and record both Meters | AND Feet | After Session Ends: measure and record both Meters | AND Feet |
|---|---|---|---|---|
| A= Datum point to Top of Tripod (Tripod Height) | | | | |
| B=Additional offset to ARP if any (Tribrach/Spacer) | | | | |
| H= Antenna Height = A + B = Datum Point to Antenna Reference Point (ARP) | 1.305 | 4.28 | 1.305 | 4.28 |

Note: Meters = Feet X (0.3048)
Height Entered Into Receiver = 1.305 meters.
Please note &/or sketch ANY unusual conditions. Be Very Explicit as to where and how Measured!

**Barometer:**
Manufacturer & Model:
P/N:
S/N:
Last Calibration or check Date:

**Psychrometer:**
Manufacturer & Model:
S/N:

| Weather DATA | Time (UTC) | Dry-Bulb Temp Fahrenheit | Dry-Bulb Temp Celsius | WetBulb Temp Fahrenheit | WetBulb Temp Celsius | Rel. % Humidity | Atm. Pressure inches Hg | Atm. Pressure millibar | Weather Codes * |
|---|---|---|---|---|---|---|---|---|---|
| Before | | | | | | | | | 00000 |
| Middle | | | | | | | | | |
| After | | | | | | | | | 00000 |
| Average of Readings | | | | | | | | | * See back of form for codes |

**Remarks, Comments on Problems, Sketches, Pencil Rubbing, etc:**

Note: Entries are Required in all Unshaded areas.
* Antenna code is provided by NGS coordinator in the ant_info file.

| | | |
|---|---|---|
| Data File Name(s):<br>(Standard NGS Format = aaaaddds.xxx)<br>where aaaa=4-Character ID, ddd=Day of Year, s=Session ID, xxx=file dependant extension | Updated Station Description: ☐ Attached ☐ Submitted earlier<br>Visibility Obstruction Form: ☐ Attached ☐ Submitted earlier<br>Photographs of Station: ☐ Attached ☐ Submitted earlier<br>Pencil Rubbing of Mark: ☐ Attached | LOG CHECKED BY: |

**NOAA GPS STATION OBSERVATION LOG** (15-Apr-2003)

| | | | |
|---|---|---|---|
| Station Designation: (circle applicable: FBN / CBN / PAC / SAC / BM) KCT 5 | | Station PID, if any: | Date (UTC): 8-6-04 |
| General Location: KOTZEBUE AIRPORT | Airport ID, if any: | Station 4-Character ID: KCT 5 | Day of Year: 219 |
| Project Name: NOAA COASTAL MAPPING | Project Number: GPS- AK301 / AK302 | Station Serial # (SSN): | Session ID:(A,B,C etc) |

| | | | |
|---|---|---|---|
| NAD83 Latitude: 66° 53' 24.21" | NAD83 Longitude: 162° 35' 40.57" | NAD83 Ellipsoidal Height: meters | Agency Full Name: Aeromap US |
| Observation Session Times (UTC): Sched. Start ____ Stop ____ | Epoch Interval= 1 Seconds | NAVD88 Orthometric Ht. meters | Operator Full Name: DAVID RIDEN |
| Actual Start 03:39 Stop 06:54 | Elevation Mask = 10 Degrees | GEOID99 Geoid Height meters | Phone #: (907) 339-1988 |
| | | | e-mail address: dridr@aeromap.com |

**GPS Receiver:**
Manufacturer & Model: TRIM 4000 SSI
P/N: 24840-01
S/N: 3508A09849
Firmware Version:
☐ CamCorder Battery, ☒ 12V DC, ☐ 110V AC, ☐ Other

**GPS Antenna:**
Manufacturer & Model, & NGS antenna code*: TRM COMPACT L1/L2
P/N: 22020-00
S/N: 014404
Cable Length, meters: 10
Vehicle is Parked N/A meters ____(direction) from antenna.

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

**Tripod or Ant. Mount:** Check one:
☐ Fixed-Height Tripod, ☒ Slip-Leg Tripod, ☐ Fixed Mount
Manufacturer & Model:
P/N: NONE
S/N:
Last Calibration date:

**Tribrach:** Check one:
☐ None, ☐ Wild GDF 22, ☐ Topcon, ☒ Other (describe)
Last Calibration date: SOKKIA

**** ANTENNA HEIGHT ****
(see back of form for measurement illustration)

| | Before Session Begins: measure and record both Meters | AND Feet | After Session Ends: measure and record both Meters | AND Feet |
|---|---|---|---|---|
| **A=** Datum point to Top of Tripod (Tripod Height) | | | | |
| **B=** Additional offset to ARP if any (Tribrach/Spacer) | | | | |
| **H=** Antenna Height **= A + B** = Datum Point to Antenna Reference Point (ARP) | 1.486 | 4.88 | 1.486 | 4.88 |

Note: Meters = Feet X (0.3048)
Height Entered Into Receiver = 1.486 meters.
Please note &/or sketch **ANY** unusual conditions. Be **Very Explicit** as to where and how Measured!

**Barometer:**
Manufacturer & Model:
P/N:
S/N:
Last Calibration or check Date:

**Psychrometer:**
Manufacturer & Model:
S/N:

| Weather DATA | Time (UTC) | Dry-Bulb Temp Fahrenheit | Dry-Bulb Temp Celsius | WetBulb Temp Fahrenheit | WetBulb Temp Celsius | Rel. % Humidity | Atm. Pressure inches Hg | Atm. Pressure millibar | Weather Codes * |
|---|---|---|---|---|---|---|---|---|---|
| Before | | | | | | | | | CCCCC |
| Middle | | | | | | | | | |
| After | | | | | | | | | CCCCC |
| Average of Readings | | | | | | | | | * See back of form for codes |

**Remarks, Comments on Problems, Sketches, Pencil Rubbing, etc:**

Note: Entries are Required in all Unshaded areas.
* Antenna code is provided by NGS coordinator in the ant_info file.

**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:

NOAA GPS STATION OBSERVATION LOG (15-Apr-2003)

| | | | |
|---|---|---|---|
| Station Designation: KOT 6 (circle applicable: FBN / CBN / PAC / SAC / BM) | | Station PID, if any: | Date (UTC): 8-5-04 |
| General Location: KOTZEBUE AIRPORT | Airport ID, if any: PAOT | Station 4-Character ID: KOT6 | Day of Year: 218 |
| Project Name: NOAA COASTAL MAPPING | Project Number: GPS- AK301 AK302 | Station Serial # (SSN): | Session ID:(A,B,C etc) |

| | | | |
|---|---|---|---|
| NAD83 Latitude: 66° 53' 24.57" | NAD83 Longitude: 162° 36' 11.54" | NAD83 Ellipsoidal Height: meters<br>NAVD88 Orthometric Ht.: meters<br>GEOID99 Geoid Height: meters | Agency Full Name: Aeromap US<br>Operator Full Name: David Ridlon<br>Phone #: (907) 339-1988<br>e-mail address: dridlon@aeromap.com |
| Observation Session Times (UTC): Sched. Start ____ Stop ____ Actual Start 14:47 Stop 20:52 | Epoch Interval= 1 Seconds; Elevation Mask = 10 Degrees | | |

**GPS Receiver:**
Manufacturer & Model: TRIM 4000 SSI
P/N: 24840-01
S/N: 3508A09849
Firmware Version:
☐ CamCorder Battery, ☒ 12V DC, ☐ 110V AC, ☐ Other

**GPS Antenna:**
Manufacturer & Model, & NGS antenna code*: TRIM COMPACT L1/L2
P/N: 22020-00
S/N: 014404
Cable Length, meters: 10
Vehicle is Parked N/A meters ___(direction) from antenna.

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

**Tripod or Ant. Mount:** Check one:
☐ Fixed-Height Tripod, ☒ Slip-Leg Tripod, ☐ Fixed Mount
Manufacturer & Model:
P/N: NONE
S/N:
Last Calibration date:

**Tribrach:** Check one:
☐ None, ☐ Wild GDF 22, ☐ Topcon, ☒ Other (describe)
Last Calibration date: SOKKIA

**** ANTENNA HEIGHT ****
(see back of form for measurement illustration)

| | Before Session Begins: measure and record both Meters | AND Feet | After Session Ends: measure and record both Meters | AND Feet |
|---|---|---|---|---|
| A= Datum point to Top of Tripod (Tripod Height) | | | | |
| B=Additional offset to ARP if any (Tribrach/Spacer) | | | | |
| H= Antenna Height = A + B = Datum Point to Antenna Reference Point (ARP) | 1.456 | 4.78 | 1.456 | 4.78 |

Note: Meters = Feet X (0.3048)
Height Entered Into Receiver = 1.456 meters.
Please note &/or sketch **ANY** unusual conditions. Be **Very Explicit** as to where and how Measured!

**Barometer:**
Manufacturer & Model:
P/N:
S/N:
Last Calibration or check Date:

**Psychrometer:**
Manufacturer & Model:
S/N:

| Weather DATA | Time (UTC) | Dry-Bulb Temp Fahrenheit | Dry-Bulb Temp Celsius | WetBulb Temp Fahrenheit | WetBulb Temp Celsius | Rel. % Humidity | Atm. Pressure inches Hg | Atm. Pressure millibar | Weather Codes * |
|---|---|---|---|---|---|---|---|---|---|
| Before | | | | | | | | | ccccc |
| Middle | | | | | | | | | |
| After | | | | | | | | | ccccc |
| Average of Readings | | | | | | | | | * See back of form for codes |

**Remarks, Comments on Problems, Sketches, Pencil Rubbing, etc:**

Note: Entries are Required in all Unshaded areas.
* Antenna code is provided by NGS coordinator in the ant_info file.

**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:

NOAA GPS STATION OBSERVATION LOG (15-Apr-2003)

| Station Designation: (circle applicable: FBN / CBN / PAC / SAC / BM) | Station PID, if any: | Date (UTC): |
|---|---|---|
| KOT 6 | | 8-5-04 |
| **General Location:** / **Airport ID, if any:** | **Station 4-Character ID:** | **Day of Year:** |
| KOTZEBUE AIRPORT / PAOT | KOT 6 | 218 |
| **Project Name:** / **Project Number: GPS-** | **Station Serial # (SSN):** | **Session ID:(A,B,C etc)** |
| NOAA COASTAL MAPPING / AK 301 / AK 302 | | |

| NAD83 Latitude | NAD83 Longitude | NAD83 Ellipsoidal Height | Agency Full Name: |
|---|---|---|---|
| 66° 53' 24.57" | 162° 36' 11.54" | meters | Aeromap US |
| | | NAVD88 Orthometric Ht. meters | Operator Full Name: David Ridyr |
| Observation Session Times (UTC): Sched. Start ____ Stop ____ | Epoch Interval= 1 Seconds | GEOID99 Geoid Height meters | Phone #: (907) 339-1988 |
| Actual Start ~~01:47~~ 04:00 Stop 07:49 | Elevation Mask = 10 Degrees | | e-mail address: dridyr@aeromap.com |

## GPS Receiver:
Manufacturer & Model: TRIM 4000 SSI
P/N: 24840-01
S/N: 3508AC9849
Firmware Version:
☐ CamCorder Battery, ☐ 12V DC, ☐ 110V AC, ☐ Other

## GPS Antenna:
Manufacturer & Model, & NGS antenna code*: TRIM COMPACT L1/L2
P/N: 22020-00
S/N: 014464
Cable Length, meters: 10
Vehicle is Parked N/A meters ____(direction) from antenna.

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

## Tripod or Ant. Mount: Check one:
☐ Fixed-Height Tripod, ☒ Slip-Leg Tripod, ☐ Fixed Mount
Manufacturer & Model:
P/N: NONE
S/N:
Last Calibration date:

## Tribrach: Check one:
☐ None, ☐ Wild GDF 22, ☐ Topcon, ☒ Other (describe)
Last Calibration date: SOKKIA

## ** ANTENNA HEIGHT **
(see back of form for measurement illustration)

| | Before Session Begins: measure and record both Meters AND Feet | | After Session Ends: measure and record both Meters AND Feet | |
|---|---|---|---|---|
| **A=** Datum point to Top of Tripod (Tripod Height) | | | | |
| **B=** Additional offset to ARP if any (Tribrach/Spacer) | | | | |
| **H=** Antenna Height **= A + B** = Datum Point to Antenna Reference Point (ARP) | 1.456 | 4.78 | 1.456 | 4.78 |

Note: Meters = Feet X (0.3048)
Height Entered Into Receiver = 1.456 meters.
Please note &/or sketch **ANY** unusual conditions. Be **Very Explicit** as to where and how Measured!

## Barometer:
Manufacturer & Model:
P/N:
S/N:
Last Calibration or check Date:

## Psychrometer:
Manufacturer & Model:
S/N:

| Weather DATA | Time (UTC) | Dry-Bulb Temp Fahrenheit | Dry-Bulb Temp Celsius | WetBulb Temp Fahrenheit | WetBulb Temp Celsius | Rel. % Humidity | Atm. Pressure inches Hg | Atm. Pressure millibar | Weather Codes * |
|---|---|---|---|---|---|---|---|---|---|
| Before | | | | | | | | | ccccc |
| Middle | | | | | | | | | |
| After | | | | | | | | | ccccc |
| Average of Readings | | | | | | | | | * See back of form for codes |

## Remarks, Comments on Problems, Sketches, Pencil Rubbing, etc:

Note: Entries are Required in all Unshaded areas.
* Antenna code is provided by NGS coordinator in the ant_info file.

**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 | LOG CHECKED BY: |
| Visibility Obstruction Form: | ☐ Attached | ☐ Submitted earlier | |
| Photographs of Station: | ☐ Attached | ☐ Submitted earlier | |
| Pencil Rubbing of Mark: | ☐ Attached | | |

NOAA GPS STATION OBSERVATION LOG (15-Apr-2003)

| | | | |
|---|---|---|---|
| Station Designation: (circle applicable: FBN / CBN / PAC / SAC / BM) KOT 5 | | Station PID, if any: | Date (UTC): 8-1-04 |
| General Location: KOTZEBUE AIRPORT | Airport ID, if any: PAOT | Station 4-Character ID: KOT5 | Day of Year: 214 |
| Project Name: NOAA COASTAL MAPPING | Project Number: AK 301 / GPS- AK302 | Station Serial # (SSN): | Session ID:(A,B,C etc) |

| | | | |
|---|---|---|---|
| NAD83 Latitude: 66° 53' 24.21" | NAD83 Longitude: 162° 35' 40.57" | NAD83 Ellipsoidal Height: meters | Agency Full Name: AEROMAP US |
| Observation Session Times (UTC): Sched. Start ____ Stop ____ | Epoch Interval= 1 Seconds | NAVD88 Orthometric Ht.: meters | Operator Full Name: DAVID RIDEN |
| Actual Start 01:51 Stop 05:31 | Elevation Mask = 10 Degrees | GEOID99 Geoid Height: meters | Phone #: (907) 339-1988 |
| | | | e-mail address: driderearthmap.com |

**GPS Receiver:**
Manufacturer & Model: TRIM 4000 SSI
P/N: 24840-01
S/N: 3508A09849
Firmware Version:
☐ CamCorder Battery. ☒ 12V DC. ☐ 110V AC. ☐ Other

**GPS Antenna:**
Manufacturer & Model, & NGS antenna code*: TRIM COMPACT L1/L2
P/N: 22020-CC
S/N: 014404
Cable Length, meters: 10
Vehicle is Parked N/A meters ___(direction) from antenna.

| | |
|---|---|
| Antenna plumb before session? | (Y) N |
| Antenna plumb after session? | (Y) N |
| Antenna oriented to true North? | (Y) N |
| Weather observed at antenna ht. | Y (N) |
| Antenna ground plane used? | Y (N) |
| Antenna radome used? | Y (N) |
| Eccentric occupation (>0.5 mm)? | Y (N) |
| Any obstructions above 10°? | Y (N) |
| Radio interference source nearby | Y (N) |

Circle Yes or No -If no, explain * If yes, describe. Use Vis. form

**Tripod or Ant. Mount:** Check one: ☐ Fixed-Height Tripod, ☒ Slip-Leg Tripod, ☐ Fixed Mount
Manufacturer & Model:
P/N: NONE
S/N:
Last Calibration date:

**Tribrach:** Check one: ☐ None, ☐ Wild GDF 22, ☐ Topcon, ☒ Other (describe)
Last Calibration date: SOKKIA

**** ANTENNA HEIGHT ****
(see back of form for measurement illustration)

| | Before Session Begins: measure and record both Meters | AND Feet | After Session Ends: measure and record both Meters | AND Feet |
|---|---|---|---|---|
| A= Datum point to Top of Tripod (Tripod Height) | | | | |
| B=Additional offset to ARP if any (Tribrach/Spacer) | | | | |
| H= Antenna Height = A + B = Datum Point to Antenna Reference Point (ARP) | 1.486 | 4.87 | 1.486 | 4.87 |

Note: Meters = Feet X (0.3048)
Height Entered Into Receiver = 1.486 meters.

Please note &/or sketch **ANY** unusual conditions. Be **Very Explicit** as to where and how Measured!

**Barometer:** Manufacturer & Model:
P/N:
S/N:
Last Calibration or check Date:

**Psychrometer:** Manufacturer & Model:
S/N:

| Weather DATA | Time (UTC) | Dry-Bulb Temp Fahrenheit | Dry-Bulb Temp Celsius | WetBulb Temp Fahrenheit | WetBulb Temp Celsius | Rel. % Humidity | Atm. Pressure inches Hg | Atm. Pressure millibar | Weather Codes * |
|---|---|---|---|---|---|---|---|---|---|
| Before | | | | | | | | | CCCCC |
| Middle | | | | | | | | | |
| After | | | | | | | | | CCCCC |
| Average of Readings | | | | | | | | | * See back of form for codes |

**Remarks, Comments on Problems, Sketches, Pencil Rubbing, etc:**

Note: Entries are Required in all Unshaded areas.

* Antenna code is provided by NGS coordinator in the ant_info file.

**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:

NOAA GPS STATION OBSERVATION LOG (15-Apr-2003)

Station Designation: KOT 6 (circle applicable: FBN / CBN / PAC / SAC / BM)

Station PID, if any:

Date (UTC): 8-1-04

General Location: KOTZEBUE AIRPORT

Airport ID, if any: PAOT

Station 4-Character ID: KOT 6

Day of Year: 214

Project Name: NOAA COASTAL MAPPING

Project Number: AIC 301 / GPS- AK307

Station Serial # (SSN):

Session ID:(A,B,C etc)

NAD83 Latitude: 66° 53' 24,57"

NAD83 Longitude: 162° 36' 11,54"

NAD83 Ellipsoidal Height: meters

NAVD88 Orthometric Ht.: meters

GEOID99 Geoid Height: meters

Agency Full Name: AEROMAP US

Operator Full Name: DAVID RIDER

Phone #: (907) 339-1988

e-mail address: drider@aeromap.com

Observation Session Times (UTC): Sched. Start _____ Stop _____

Actual Start 01:44 Stop 05:38

Epoch Interval= 1 Seconds

Elevation Mask = 10 Degrees

## GPS Receiver:

Manufacturer & Model: TRIM 4000 SSI

P/N: 24840-01

S/N: 3509A09934

Firmware Version:

☐ CamCorder Battery, ☒ 12V DC, ☐ 110V AC, ☐ Other

## GPS Antenna:

Manufacturer & Model, & NGS antenna code*: TRIM COMPACT L1/L2

P/N: 22020-00

S/N: 022001405L

Cable Length, meters: 10

Vehicle is Parked N/A meters ____(direction) from antenna.

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

## Tripod or Ant. Mount: Check one:

☐ Fixed-Height Tripod, ☒ Slip-Leg Tripod, ☐ Fixed Mount

Manufacturer & Model:

P/N: NONE

S/N:

Last Calibration date:

## Tribrach: Check one:

☐ None, ☐ Wild GDF 22, ☐ Topcon, ☒ Other (describe)

Last Calibration date: SOKKIA

## ** ANTENNA HEIGHT **

(see back of form for measurement illustration)

| | Before Session Begins: measure and record both Meters | AND Feet | After Session Ends: measure and record both Meters | AND Feet |
|---|---|---|---|---|
| A= Datum point to Top of Tripod (Tripod Height) | | | | |
| B=Additional offset to ARP if any (Tribrach/Spacer) | | | | |
| H= Antenna Height = A + B = Datum Point to Antenna Reference Point (ARP) | 1,455 | 4.78 | 1.455 | 4.78 |

Note: Meters = Feet X (0.3048)

Height Entered Into Receiver = 1,455 meters.

Please note &/or sketch **ANY** unusual conditions. Be **Very Explicit** as to where and how Measured!

## Barometer:

Manufacturer & Model:

P/N:

S/N:

Last Calibration or check Date:

## Psychrometer:

Manufacturer & Model:

S/N:

| Weather DATA | Time (UTC) | Dry-Bulb Temp Fahrenheit | Dry-Bulb Temp Celsius | WetBulb Temp Fahrenheit | WetBulb Temp Celsius | Rel. % Humidity | Atm. Pressure inches Hg | Atm. Pressure millibar | Weather Codes * |
|---|---|---|---|---|---|---|---|---|---|
| Before | | | | | | | | | 00000 |
| Middle | | | | | | | | | |
| After | | | | | | | | | 00000 |
| Average of Readings | | | | | | | | | * See back of form for codes |

## Remarks, Comments on Problems, Sketches, Pencil Rubbing, etc:

Note: Entries are Required in all Unshaded areas.

* Antenna code is provided by NGS coordinator in the ant_info file.

**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:

NOAA GPS STATION OBSERVATION LOG (15-Apr-2003)

| | | | |
|---|---|---|---|
| Station Designation: (circle applicable: FBN / CBN / PAC / SAC / BM) KOT 6 | | Station PID, if any: | Date (UTC): 7-21-04 |
| General Location: KOTZEBUE AIRPORT | Airport ID, if any: PAOT | Station 4-Character ID: KOT 6 | Day of Year: 2003 |
| Project Name: NOAA COASTAL MAPPING | Project Number: GPS- AK301/AK302 | Station Serial # (SSN): | Session ID:(A,B,C etc) |

| | | | |
|---|---|---|---|
| NAD83 Latitude: 66° 53' 24.57" | NAD83 Longitude: 162° 36' 11.54" | NAD83 Ellipsoidal Height: meters<br>NAVD88 Orthometric Ht.: meters<br>GEOID99 Geoid Height: meters | Agency Full Name: AEROMAP US<br>Operator Full Name: DAVID RIDER<br>Phone #: (907) 339-1988<br>e-mail address: drider@aeromap.com |
| Observation Session Times (UTC):<br>Sched. Start _____ Stop _____<br>Actual Start 01:52 Stop 08:00 | Epoch Interval= 1 Seconds<br>Elevation Mask = 10 Degrees | | |

**GPS Receiver:**
Manufacturer & Model: TRIMBLE 4000 SSI
P/N: 24840-01
S/N: 3509T09934
Firmware Version:
☐ CamCorder Battery, ☒ 12V DC, ☐ 110V AC, ☐ Other

**GPS Antenna:**
Manufacturer & Model, & NGS antenna code*: TRIMBLE 4000 ZIPZ
P/N: 22020-00
S/N: 02200140S6
Cable Length, meters: 10
Vehicle is Parked N/A meters ____(direction) from antenna.

| | |
|---|---|
| Antenna plumb before session? | (Y) N) |
| Antenna plumb after session? | (Y) N) |
| Antenna oriented to true North? | (Y) N) |
| Weather observed at antenna ht. | (Y (N) |
| Antenna ground plane used? | (Y (N) |
| Antenna radome used? | (Y (N) |
| Eccentric occupation (>0.5 mm)? | (Y / N) |
| Any obstructions above 10°? | (Y (N) |
| Radio interference source nearby | (Y (N) |

Circle Yes or No -If no, explain *
If yes, describe. Use Vis. form

**Tripod or Ant. Mount:** Check one:
☐ Fixed-Height Tripod, ☒ Slip-Leg Tripod, ☐ Fixed Mount
Manufacturer & Model:
P/N: NONE
S/N:
Last Calibration date:

**Tribrach:** Check one:
☐ None, ☐ Wild GDF 22, ☐ Topcon, ☒ Other (describe)
Last Calibration date: SOKKIA

**** ANTENNA HEIGHT ****
(see back of form for measurement illustration)

| | Before Session Begins: measure and record both Meters AND Feet | | After Session Ends: measure and record both Meters AND Feet | |
|---|---|---|---|---|
| A= Datum point to Top of Tripod (Tripod Height) | | | | |
| B=Additional offset to ARP if any (Tribrach/Spacer) | | | | |
| H= Antenna Height = A + B = Datum Point to Antenna Reference Point (ARP) | 1.305 | 4.28 | 1.305 | 4.28 |

Note: Meters = Feet X (0.3048)
Height Entered Into Receiver = 1.305 meters.
Please note &/or sketch ANY unusual conditions. Be Very Explicit as to where and how Measured!

**Barometer:**
Manufacturer & Model:
P/N:
S/N:
Last Calibration or check Date:

**Psychrometer:**
Manufacturer & Model:
S/N:

| Weather DATA | Time (UTC) | Dry-Bulb Temp Fahrenheit | Dry-Bulb Temp Celsius | WetBulb Temp Fahrenheit | WetBulb Temp Celsius | Rel. % Humidity | Atm. Pressure inches Hg | Atm. Pressure millibar | Weather Codes * |
|---|---|---|---|---|---|---|---|---|---|
| Before | | | | | | | | | 0000 |
| Middle | | | | | | | | | |
| After | | | | | | | | | 0000 |
| Average of Readings | | | | | | | | | * See back of form for codes |

**Remarks, Comments on Problems, Sketches, Pencil Rubbing, etc:**

Note: Entries are Required in all Unshaded areas.
* Antenna code is provided by NGS coordinator in the ant_info file.

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:

NOAA GPS STATION OBSERVATION LOG (15-Apr-2003)

| | | | |
|---|---|---|---|
| Station Designation: KCT 6 (circle applicable: FBN / CBN / PAC / SAC / BM) | | Station PID, if any: | Date (UTC): 7-21-04 |
| General Location: KOTZEBUE AIRPORT | Airport ID, if any: PACT | Station 4-Character ID: KCT 6 | Day of Year: 203 |
| Project Name: NOAA COASTAL MAPPING | Project Number: GPS- AK301/AK302 | Station Serial # (SSN): | Session ID:(A,B,C etc) |

| | | | |
|---|---|---|---|
| NAD83 Latitude: 66° 53' 24.57" | NAD83 Longitude: 162° 36' 11.54" | NAD83 Ellipsoidal Height: meters | Agency Full Name: AEROMAP US |
| Observation Session Times (UTC): Sched. Start ____ Stop ____ | Epoch Interval= 1 Seconds | NAVD88 Orthometric Ht.: meters | Operator Full Name: DAVID RIDER |
| Actual Start 14:52 Stop 18:57 | Elevation Mask = 10 Degrees | GEOID99 Geoid Height: meters | Phone #: (907) 339-1988 |
| | | | e-mail address: drider@aeromap.com |

**GPS Receiver:**
Manufacturer & Model: TRIM 4000 SSI
P/N: 24840-01
S/N: 3509A09934
Firmware Version:
☐ CamCorder Battery, ☐ 12V DC, ☐ 110V AC, ☐ Other

**GPS Antenna:**
Manufacturer & Model, & NGS antenna code*: TRIM COMPACT L1/L2
P/N: 22020-00
S/N: 02200146056
Cable Length, meters: 10
Vehicle is Parked N/A meters ___ (direction) from antenna.

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

**Tripod or Ant. Mount:** Check one: ☐ Fixed-Height Tripod, ☒ Slip-Leg Tripod, ☐ Fixed Mount
Manufacturer & Model:
P/N: NONE
S/N:
Last Calibration date:

**Tribrach:** Check one: ☐ None, ☐ Wild GDF 22, ☐ Topcon, ☒ Other (describe)
Last Calibration date: SOKKIA

**** ANTENNA HEIGHT **** (see back of form for measurement illustration)

| | Before Session Begins: measure and record both Meters | AND Feet | After Session Ends: measure and record both Meters | AND Feet |
|---|---|---|---|---|
| A= Datum point to Top of Tripod (Tripod Height) | | | | |
| B=Additional offset to ARP if any (Tribrach/Spacer) | | | | |
| H= Antenna Height = A + B = Datum Point to Antenna Reference Point (ARP) | 1.305 | 4.28 | 1.305 | 4.28 |

Note: Meters = Feet X (0.3048)
Height Entered Into Receiver = 1.305 meters.
Please note &/or sketch **ANY** unusual conditions. Be **Very Explicit** as to where and how Measured!

**Barometer:**
Manufacturer & Model:
P/N:
S/N:
Last Calibration or check Date:

**Psychrometer:**
Manufacturer & Model:
S/N:

| Weather DATA | Time (UTC) | Dry-Bulb Temp Fahrenheit | Dry-Bulb Temp Celsius | WetBulb Temp Fahrenheit | WetBulb Temp Celsius | Rel. % Humidity | Atm. Pressure inches Hg | Atm. Pressure millibar | Weather Codes * |
|---|---|---|---|---|---|---|---|---|---|
| Before | | | | | | | | | CCCC |
| Middle | | | | | | | | | |
| After | | | | | | | | | CCCC |
| Average of Readings | | | | | | | | | * See back of form for codes |

**Remarks, Comments on Problems, Sketches, Pencil Rubbing, etc:**

Note: Entries are Required in all Unshaded areas.
* Antenna code is provided by NGS coordinator in the ant_info file.

**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:

NOAA GPS STATION OBSERVATION LOG (15-Apr-2003)

| | | | |
|---|---|---|---|
| Station Designation: KOT 5 (circle applicable: FBN / CBN / PAC / SAC / BM) | | Station PID, if any: | Date (UTC): 7-21-04 |
| General Location: KOTZEBUE AIRPORT | Airport ID, if any: PAOT | Station 4-Character ID: KOT 5 | Day of Year: 203 |
| Project Name: NOAA COASTAL MAPPING | Project Number: AK301 GPS- AK302 | Station Serial # (SSN): | Session ID:(A,B,C etc) |

| | | | |
|---|---|---|---|
| NAD83 Latitude: 66° 53' 24.21" | NAD83 Longitude: 162° 35' 40.57" | NAD83 Ellipsoidal Height: meters<br>NAVD88 Orthometric Ht.: meters<br>GEOID99 Geoid Height: meters | Agency Full Name: AEROMAP US<br>Operator Full Name: DAVID RIDEN<br>Phone #: (907) 339-1988<br>e-mail address: driden@aeromap.com |
| Observation Session Times (UTC): Sched. Start ____ Stop ____<br>Actual Start 15:06 Stop 19:01 | Epoch Interval= 1 Seconds<br>Elevation Mask = 10 Degrees | | |

**GPS Receiver:**
Manufacturer & Model: TRIM 4000 SSI
P/N: 24840-01
S/N: 3508AC9849
Firmware Version:
☐ CamCorder Battery. ☐ 12V DC. ☐ 110V AC. ☐ Other

**GPS Antenna:**
Manufacturer & Model, & NGS antenna code*: TRIM COMPACT L1/L2
P/N: 022020-00
S/N: 014404
Cable Length, meters: 10
Vehicle is Parked N/A meters ____(direction) from antenna.

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

**Tripod or Ant. Mount:** Check one:
☐ Fixed-Height Tripod, ☒ Slip-Leg Tripod, ☐ Fixed Mount
Manufacturer & Model:
P/N: NONE
S/N:
Last Calibration date:

**Tribrach:** Check one:
☐ None, ☐ Wild GDF 22, ☐ Topcon, ☒ Other (describe)
Last Calibration date: SOKKIA

**** ANTENNA HEIGHT ****
(see back of form for measurement illustration)

| | Before Session Begins: measure and record both Meters | AND Feet | After Session Ends: measure and record both Meters | AND Feet |
|---|---|---|---|---|
| A= Datum point to Top of Tripod (Tripod Height) | | | | |
| B=Additional offset to ARP if any (Tribrach/Spacer) | | | | |
| H= Antenna Height = A + B = Datum Point to Antenna Reference Point (ARP) | 1.585 | 5.20 | 1.585 | 5.20 |

Note: Meters = Feet X (0.3048)
Height Entered Into Receiver = 1.585 meters.
Please note &/or sketch **ANY** unusual conditions. Be **Very Explicit** as to where and how Measured!

**Barometer:**
Manufacturer & Model:
P/N:
S/N:
Last Calibration or check Date:

**Psychrometer:**
Manufacturer & Model:
S/N:

| Weather DATA | Time (UTC) | Dry-Bulb Temp Fahrenheit | Dry-Bulb Temp Celsius | WetBulb Temp Fahrenheit | WetBulb Temp Celsius | Rel. % Humidity | Atm. Pressure inches Hg | Atm. Pressure millibar | Weather Codes * |
|---|---|---|---|---|---|---|---|---|---|
| Before | | | | | | | | | 00000 |
| Middle | | | | | | | | | |
| After | | | | | | | | | 00000 |
| Average of Readings | | | | | | | | | * See back of form for codes |

**Remarks, Comments on Problems, Sketches, Pencil Rubbing, etc:**

Note: Entries are Required in all Unshaded areas.

* Antenna code is provided by NGS coordinator in the ant_info file.

| | | |
|---|---|---|
| Data File Name(s):<br>(Standard NGS Format = aaaaddds.xxx)<br>where aaaa=4-Character ID, ddd=Day of Year, s=Session ID, xxx=file dependant extension | Updated Station Description: ☐ Attached ☐ Submitted earlier<br>Visibility Obstruction Form: ☐ Attached ☐ Submitted earlier<br>Photographs of Station: ☐ Attached ☐ Submitted earlier<br>Pencil Rubbing of Mark: ☐ Attached | LOG CHECKED BY: |

# GPS STATION OBSERVATION LOG

(15-Apr-2003)

| | | | |
|---|---|---|---|
| Station Designation: (circle applicable: FBN / CBN / PAC / SAC / BM) KOT 5 | | Station PID, if any: | Date (UTC): 7-21-04 |
| General Location: KOTZEBUE AIRPORT | Airport ID, if any: PACT | Station 4-Character ID: KOT 5 | Day of Year: 203 |
| Project Name: NOAA COASTAL MAPPING | Project Number: GPS- | Station Serial # (SSN): | Session ID:(A,B,C etc) |

| | | |
|---|---|---|
| NAD83 Latitude: 66° 53' 24.21" | NAD83 Longitude: 162° 35' 40.57" | NAD83 Ellipsoidal Height: meters<br>NAVD88 Orthometric Ht.: meters<br>GEOID99 Geoid Height: meters |
| Observation Session Times (UTC): Sched. Start ____ Stop ____ Actual Start 02:02 Stop 08:10 | Epoch Interval= 1 Seconds<br>Elevation Mask = 10 Degrees | Agency Full Name: AEROMAP US<br>Operator Full Name: DAVID RIDEN<br>Phone #: (907) 339-1988<br>e-mail address: driden@aeromap.com |

## GPS Receiver:

Manufacturer & Model: TRIM 4000 SSI
P/N: 24840-01
S/N: 3508A09849
Firmware Version:

☐ CamCorder Battery. ☐ 12V DC. ☐ 110V AC. ☐ Other

## GPS Antenna:

Manufacturer & Model, & NGS antenna code*: TRIM COMPACT L1/L2
P/N: 22020-00
S/N: 014404
Cable Length, meters: 10

Vehicle is Parked N/A meters ____ (direction) from antenna.

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

## Tripod or Ant. Mount: Check one:

☐ Fixed-Height Tripod, ☒ Slip-Leg Tripod, ☐ Fixed Mount
Manufacturer & Model:
P/N: NONE
S/N:
Last Calibration date:

## Tribrach: Check one:

☐ None, ☐ Wild GDF 22, ☐ Topcon, ☒ Other (describe)
Last Calibration date: SOKKIA

## ** ANTENNA HEIGHT **

(see back of form for measurement illustration)

| | Before Session Begins: measure and record both Meters AND Feet | | After Session Ends: measure and record both Meters AND Feet | |
|---|---|---|---|---|
| A= Datum point to Top of Tripod (Tripod Height) | | | | |
| B=Additional offset to ARP if any (Tribrach/Spacer) | | | | |
| H= Antenna Height = A + B = Datum Point to Antenna Reference Point (ARP) | 1.585 | 5.20 | 1.585 | 5.20 |

Note: Meters = Feet X (0.3048)
Height Entered Into Receiver = 1.585 meters.

Please note &/or sketch ANY unusual conditions. Be Very Explicit as to where and how Measured!

## Barometer:

Manufacturer & Model:
P/N:
S/N:
Last Calibration or check Date:

## Psychrometer:

Manufacturer & Model:
S/N:

| Weather DATA | Time (UTC) | Dry-Bulb Temp Fahrenheit | Dry-Bulb Temp Celsius | WetBulb Temp Fahrenheit | WetBulb Temp Celsius | Rel. % Humidity | Atm. Pressure inches Hg | Atm. Pressure millibar | Weather Codes * |
|---|---|---|---|---|---|---|---|---|---|
| Before | | | | | | | | | 00000 |
| Middle | | | | | | | | | |
| After | | | | | | | | | 00000 |
| Average of Readings | | | | | | | | | |

* See back of form for codes

## Remarks, Comments on Problems, Sketches, Pencil Rubbing, etc:

Note: Entries are Required in all Unshaded areas.

* Antenna code is provided by NGS coordinator in the ant_info file.

| | | |
|---|---|---|
| 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<br>Visibility Obstruction Form: ☐ Attached ☐ Submitted earlier<br>Photographs of Station: ☐ Attached ☐ Submitted earlier<br>Pencil Rubbing of Mark: ☐ Attached | LOG CHECKED BY: |

NOAA GPS STATION OBSERVATION LOG (15-Apr-2003)

| | | | |
|---|---|---|---|
| Station Designation: (circle applicable: FBN / CBN / PAC / SAC / BM) KOT 6 | | Station PID, if any: | Date (UTC): 7-19-04 |
| General Location: KOTZEBUE AIRPORT | Airport ID, if any: PAOT | Station 4-Character ID: KOT 6 | Day of Year: 201 |
| Project Name: NOAA COASTAL MAPPING | Project Number: AK 301 / GPS- AK302 | Station Serial # (SSN): | Session ID:(A,B,C etc) |

| | | | |
|---|---|---|---|
| NAD83 Latitude: 66° 53' 24.57" | NAD83 Longitude: 162° 36' 11.54" | NAD83 Ellipsoidal Height: meters | Agency Full Name: AEROMAP US |
| Observation Session Times (UTC): Sched. Start ____ Stop ____ Actual Start 01:50 Stop 04:50 | Epoch Interval= 1 Seconds; Elevation Mask = 10 Degrees | NAVD88 Orthometric Ht. meters; GEOID99 Geoid Height meters | Operator Full Name: DAVID RIDER; Phone #: (907) 339-1988; e-mail address: drider@aeromap.com |

**GPS Receiver:**
Manufacturer & Model: TRIM 4000 SSI
P/N: 24840-01
S/N: 3509A09934
Firmware Version:
☐ CamCorder Battery. ☒ 12V DC. ☐ 110V AC. ☐ Other

**GPS Antenna:**
Manufacturer & Model, & NGS antenna code*: TRIM COMPACT L1/L2
P/N: 22020-00
S/N: 022001 4056
Cable Length, meters: 10
Vehicle is Parked NA meters ____(direction) from antenna.

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

**Tripod or Ant. Mount:** Check one: ☐ Fixed-Height Tripod, ☒ Slip-Leg Tripod, ☐ Fixed Mount
Manufacturer & Model:
P/N: NONE
S/N:
Last Calibration date:

**Tribrach:** Check one: ☐ None, ☐ Wild GDF 22, ☐ Topcon, ☒ Other (describe)
Last Calibration date: SOKKIA

**** ANTENNA HEIGHT **** (see back of form for measurement illustration)

| | Before Session Begins: measure and record both Meters | AND Feet | After Session Ends: measure and record both Meters | AND Feet |
|---|---|---|---|---|
| A= Datum point to Top of Tripod (Tripod Height) | | | | |
| B= Additional offset to ARP if any (Tribrach/Spacer) | | | | |
| H= Antenna Height = A + B = Datum Point to Antenna Reference Point (ARP) | 1.305 | 4.28 | 1.305 | 4.28 |

Note: Meters = Feet X (0.3048)
Height Entered Into Receiver = 1.305 meters.
Please note &/or sketch ANY unusual conditions. Be Very Explicit as to where and how Measured!

**Barometer:**
Manufacturer & Model:
P/N:
S/N:
Last Calibration or check Date:

**Psychrometer:**
Manufacturer & Model:
S/N:

| Weather DATA | Time (UTC) | Dry-Bulb Temp Fahrenheit | Dry-Bulb Temp Celsius | WetBulb Temp Fahrenheit | WetBulb Temp Celsius | Rel. % Humidity | Atm. Pressure inches Hg | Atm. Pressure millibar | Weather Codes * |
|---|---|---|---|---|---|---|---|---|---|
| Before | | | | | | | | | 00000 |
| Middle | | | | | | | | | |
| After | | | | | | | | | 00000 |
| Average of Readings | | | | | | | | | * See back of form for codes |

**Remarks, Comments on Problems, Sketches, Pencil Rubbing, etc:**

Note: Entries are Required in all Unshaded areas.
* Antenna code is provided by NGS coordinator in the ant_info file.

| | | |
|---|---|---|
| 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: |

NOAA GPS STATION OBSERVATION LOG (15-Apr-2003)

| | | | |
|---|---|---|---|
| Station Designation: KOT 5 (circle applicable: FBN / CBN / PAC / SAC / BM) | | Station PID, if any: | Date (UTC): 7-19-04 |
| General Location: KOTZEBUE AIRPORT | Airport ID, if any: PACT | Station 4-Character ID: KOT 5 | Day of Year: 201 |
| Project Name: NOAA COASTAL MAPPING | Project Number: AK301 / GPS- AK302 | Station Serial # (SSN): | Session ID:(A,B,C etc) |

| | | |
|---|---|---|
| NAD83 Latitude: 66° 53' 24.21" | NAD83 Longitude: 162° 35' 40.57" | NAD83 Ellipsoidal Height: meters |
| Observation Session Times (UTC): Sched. Start ____ Stop ____ Actual Start 02:00 Stop 04:41 | Epoch Interval= 1 Seconds; Elevation Mask = 10 Degrees | NAVD88 Orthometric Ht. meters; GEOID99 Geoid Height meters |

Agency Full Name: AEROMAP US
Operator Full Name: DAVID RIDEN
Phone #: (907) 339-1988
e-mail address: driden@aeromapus.com

**GPS Receiver:**
Manufacturer & Model: TRIM 4000SSI
P/N: 24840-01
S/N: 3508A09849
Firmware Version:
☐ CamCorder Battery. (12V DC) ☐ 110V AC. ☐ Other

**GPS Antenna:**
Manufacturer & Model, & NGS antenna code*: TRIM COMPACT L1/L2
P/N: 22020-00
S/N: 014404
Cable Length, meters: 10
Vehicle is Parked N/A meters ____ (direction) from antenna.

| | Circle |
|---|---|
| Antenna plumb before session? (Y N) | Yes or No |
| Antenna plumb after session? (Y N) | -If no, |
| Antenna oriented to true North? (Y N) | explain |
| Weather observed at antenna ht. (Y N) | * |
| 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 Ant. Mount:** Check one:
☐ Fixed-Height Tripod, ☒ Slip-Leg Tripod, ☐ Fixed Mount
Manufacturer & Model:
P/N:
S/N: NONE
Last Calibration date:

**Tribrach:** Check one:
☐ None, ☐ Wild GDF 22, ☐ Topcon, ☒ Other (describe)
Last Calibration date: SOKKIA

**** ANTENNA HEIGHT ****
(see back of form for measurement illustration)

| | Before Session Begins: measure and record both Meters | AND Feet | After Session Ends: measure and record both Meters | AND Feet |
|---|---|---|---|---|
| A= Datum point to Top of Tripod (Tripod Height) | | | | |
| B=Additional offset to ARP if any (Tribrach/Spacer) | | | | |
| H= Antenna Height = A + B = Datum Point to Antenna Reference Point (ARP) | 1.585 | 5.20 | 1.585 | 5.20 |

Note: Meters = Feet X (0.3048)
Height Entered Into Receiver = 1.585 meters.
Please note &/or sketch ANY unusual conditions. Be Very Explicit as to where and how Measured!

**Barometer:**
Manufacturer & Model:
P/N:
S/N:
Last Calibration or check Date:

**Psychrometer:**
Manufacturer & Model:
S/N:

| Weather DATA | Time (UTC) | Dry-Bulb Temp Fahrenheit | Dry-Bulb Temp Celsius | WetBulb Temp Fahrenheit | WetBulb Temp Celsius | Rel. % Humidity | Atm. Pressure inches Hg | Atm. Pressure millibar | Weather Codes * |
|---|---|---|---|---|---|---|---|---|---|
| Before | | | | | | | | | 00000 |
| Middle | | | | | | | | | |
| After | | | | | | | | | 00000 |
| Average of Readings | | | | | | | | | * See back of form for codes |

**Remarks, Comments on Problems, Sketches, Pencil Rubbing, etc:**

Note: Entries are Required in all Unshaded areas.
* Antenna code is provided by NGS coordinator in the ant_info file.

| | | |
|---|---|---|
| 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: |

NOAA GPS STATION OBSERVATION LOG (15-Apr-2003)

| | | | |
|---|---|---|---|
| Station Designation: KOT 5 (circle applicable: FBN / CBN / PAC / SAC / BM) | | Station PID, if any: | Date (UTC): 7-22-04 |
| General Location: KOTZEBUE AIRPORT | Airport ID, if any: PAOT | Station 4-Character ID: KOT | Day of Year: 204 |
| Project Name: NOAA COASTAL MAPPING | Project Number: AK301 / GPS- AK302 | Station Serial # (SSN): | Session ID:(A,B,C etc) |

| | | |
|---|---|---|
| NAD83 Latitude: 66° 53' 24,21" | NAD83 Longitude: 162° 35' 40,57" | NAD83 Ellipsoidal Height: meters<br>NAVD88 Orthometric Ht.: meters<br>GEOID99 Geoid Height: meters |
| Observation Session Times (UTC): Sched. Start ____ Stop ____ Epoch Interval= 1 Seconds<br>Actual Start 16:11 Stop 20:50 Elevation Mask = 10 Degrees | | Agency Full Name: AEROMAP US<br>Operator Full Name: DAVID RIDEN<br>Phone #: (907) 339-1988<br>e-mail address: driden@aeromap.com |

**GPS Receiver:**
Manufacturer & Model: TRIM 4000 SSI
P/N: 24840-01
S/N: 3508AC9849
Firmware Version:
☐ CamCorder Battery, (☐ 12V DC, ☐ 110V AC, ☐ Other

**GPS Antenna:**
Manufacturer & Model, & NGS antenna code*: TRM COMPACT L1/L2
P/N: 22020-00
S/N: 014404
Cable Length, meters: 10
Vehicle is Parked N/A meters ___(direction) from antenna.

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

**Tripod or Ant. Mount:** Check one:
☐ Fixed-Height Tripod, ☒ Slip-Leg Tripod, ☐ Fixed Mount
Manufacturer & Model:
P/N: NONE
S/N:
Last Calibration date:

**Tribrach:** Check one:
☐ None, ☐ Wild GDF 22, ☐ Topcon, ☒ Other (describe)
Last Calibration date: SOKKIA

**** ANTENNA HEIGHT ****
(see back of form for measurement illustration)

| | Before Session Begins: measure and record both Meters AND Feet | | After Session Ends: measure and record both Meters AND Feet | |
|---|---|---|---|---|
| A= Datum point to Top of Tripod (Tripod Height) | | | | |
| B=Additional offset to ARP if any (Tribrach/Spacer) | | | | |
| H= Antenna Height = A + B = Datum Point to Antenna Reference Point (ARP) | 1,585 | 5,20 | 1,585 | 5,20 |

Note: Meters = Feet X (0.3048)
Height Entered Into Receiver = 1,585 meters.
Please note &/or sketch **ANY** unusual conditions. Be **Very Explicit** as to where and how Measured!

**Barometer:**
Manufacturer & Model:
P/N:
S/N:
Last Calibration or check Date:

**Psychrometer:**
Manufacturer & Model:
S/N:

| Weather DATA | Time (UTC) | Dry-Bulb Temp Fahrenheit | Dry-Bulb Temp Celsius | WetBulb Temp Fahrenheit | WetBulb Temp Celsius | Rel. % Humidity | Atm. Pressure inches Hg | Atm. Pressure millibar | Weather Codes * |
|---|---|---|---|---|---|---|---|---|---|
| Before | | | | | | | | | 00000 |
| Middle | | | | | | | | | |
| After | | | | | | | | | 00000 |
| Average of Readings | | | | | | | | | * See back of form for codes |

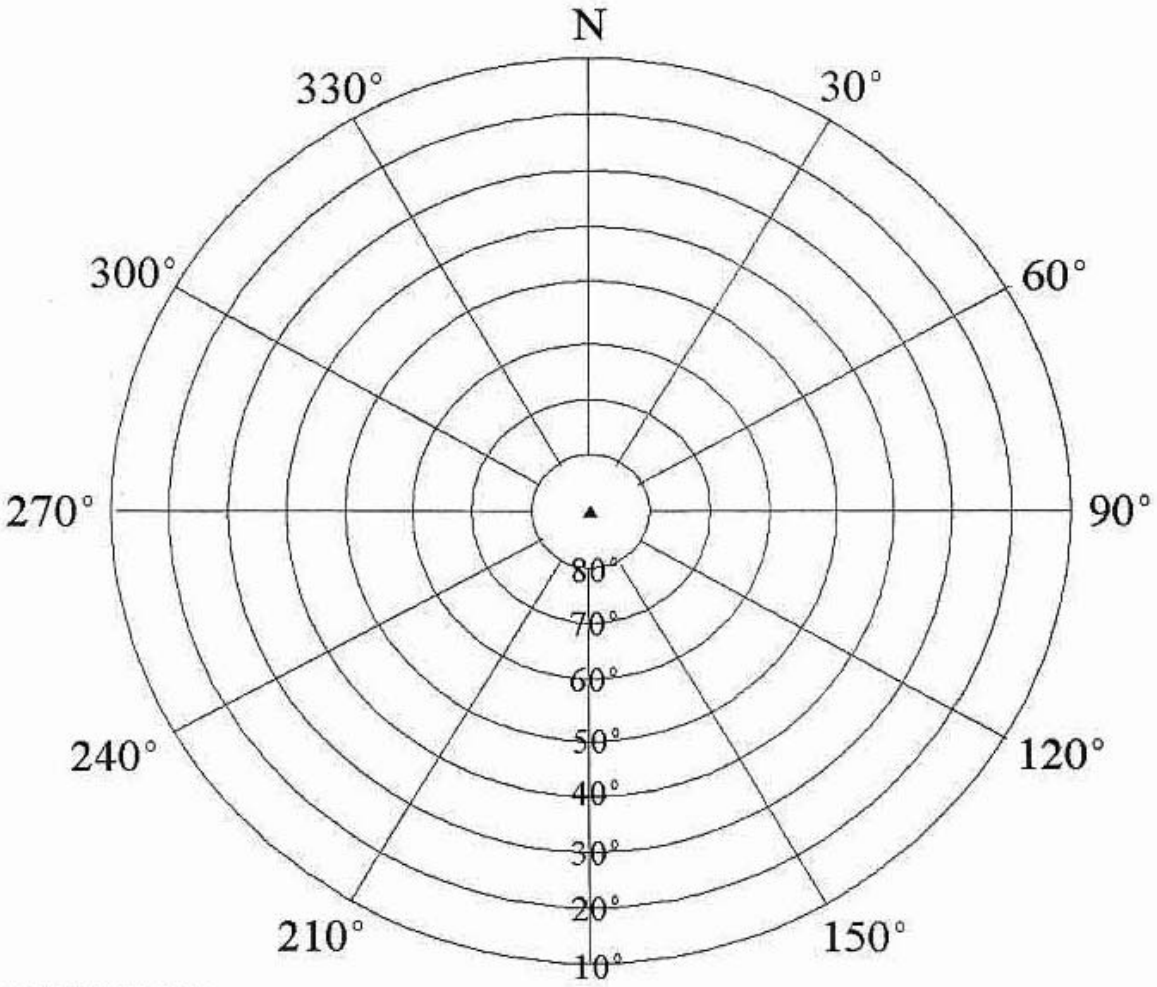
**Remarks, Comments on Problems, Sketches, Pencil Rubbing, etc:**

Note: Entries are Required in all Unshaded areas.

* Antenna code is provided by NGS coordinator in the ant_info file.

| | | |
|---|---|---|
| **Data File Name(s):**<br>(Standard NGS Format = aaaaddds.xxx)<br>where aaaa=4-Character ID, ddd=Day of Year, s=Session ID, xxx=file dependant extension | Updated Station Description: ☐ Attached ☐ Submitted earlier<br>Visibility Obstruction Form: ☐ Attached ☐ Submitted earlier<br>Photographs of Station: ☐ Attached ☐ Submitted earlier<br>Pencil Rubbing of Mark: ☐ Attached | LOG CHECKED BY: |

## 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: KOT 5 Designation: _____

PID: _____ Location: KOTZEBUE AIRPORT, AK

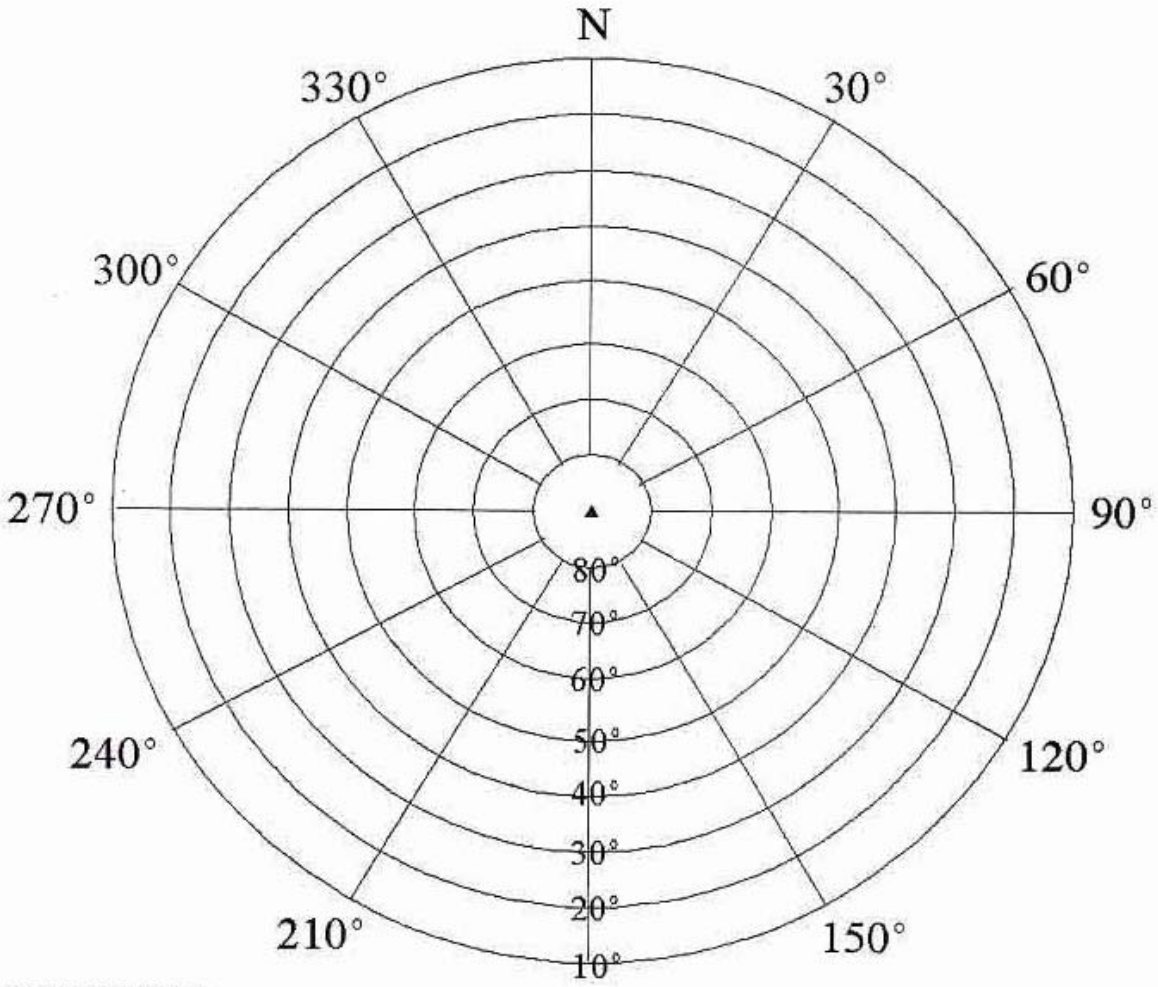
County: _____ Reconnaissance By: DAVID RIDER

Height above mark, meters: _____ Agency/Company: AEROMAP U.S.

Phone: ( 907 ) 339-1988 Date: 7-14-04

Check if no obstructions above 10 degrees X

## 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: KOT 6 Designation: _____

PID: _____ Location: KOTZEBUE AIRPORT, AK

County: _____ Reconnaissance By: DAVID RIDER

Height above mark, meters: _____ Agency/Company: AEROMAP U.S.

Phone: ( 907 ) 339-1988 Date: 7-14-04

Check if no obstructions above 10 degrees ☒

## NATIONAL GEODETIC SURVEY STATION DESCRIPTION / RECOVERY FORM

4-char ID: KOT 5 Designation: KOT 5

PID: _____ Alias: _____

Country: (USA / ) State: AK County: _____

Latitude: N 66 ° 53 · 24 " Longitude: W 162 ° 35 · 40 " 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: 7-14-04 Chief of Party (initials): DN | |

| 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:)) PK NAIL | |
| Setting Type: (Bedrock / Concrete / (Other:)) PAVEMENT | |
| Y / (N) / ? | Monument contains magnetic material? |

| | |
|---|---|
| Stamping: NONE | |
| Agency Inscription: (NGS / CGS / Other:) | |
| Rod Depth: (m/ft) | Sleeve Depth: (m/ft) |
| Monument is: (flush / projecting / (recessed)) 2.0 (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 KOTZEBUE AIRPORT - ADJACENT TO CITY OF KOTZEBUE, AK

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

**Ownership:** STATE OF ALASKA – AIRPORT MANAGER (907) 442-3147

(name, address, phone of landowner)

**To Reach Narrative:** To reach the station from the intersection of PROCEED ALONG SOUTH EDGE OF MAIN AIRCRAFT PARKING RAMP, NORTH OF RUNWAY 8-26, UNTIL JUST WEST OF ALASKA AIRLINES HANGER AND EAST OF THE TWO DRAINAGE PIPES THAT FEED INTO THE POND.

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

**Monument Description and Measurements:** The station is STATION IS THE CENTER OF A BOLT HEAD ON AN ELECTRICAL JUNCTION BOX MARKED "LIGHTING." STATION IS THE NORTHERN-MOST BOLT HEAD CLOSEST TO THE SOUTH EDGE OF THE TAXIWAY / RAMP AND 23.0 FT FROM THE EDGE OF PAVEMENT. STATION IS 17.8 FT EAST OF THE OUTER EDGE OF THE EASTERN-MOST DRAIN PIPE.

(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: DAVID RINER Phone: (907) 339-1988 e-mail: driner@aeromap.com

## NATIONAL GEODETIC SURVEY STATION DESCRIPTION / RECOVERY FORM

4-char ID: KOT 6 Designation: KOT 6

PID: _____ Alias: _____

Country: (USA / ) State: AK County: _____

Latitude: N 66 ° 53 ' 24 " Longitude: W 162 ° 36 ' 11 " 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: 7-14-04 Chief of Party (initials): DH | |

| 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:) BOLT HEAD | |
| Setting Type: (Bedrock / Concrete / (Other:) | |
| Y / (N) ? | Monument contains magnetic material? |

| | |
|---|---|
| Stamping: NONE | |
| 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 KOTZEBUE AIRPORT – ADJACENT TO CITY OF KOTZEBUE, AK

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

**Ownership:** STATE OF ALASKA – AIRPORT MANAGER (907) 442-3147

(name, address, phone of landowner)

**To Reach Narrative:** To reach the station from the intersection of PROCEED TO FAR EAST EDGE OF THE AIRCRAFT PARKING RAMP APROXIMATELY HALF-WAY BETWEEN THE NORTHWESTERN AVIATION HANGER AND TAXIWAY E.

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

**Monument Description and Measurements:** The station is STATION IS A 1.5 IN PK NAIL WITH AN ORANGE COLORED WASHER UNDER THE NAIL HEAD. THE POINT IS AT THE BASE OF A GOUGED OUT SECTION OF PAVEMENT AND SITS ABOUT 2.0 CM BELOW THE SURFACE OF THE SURROUNDING PAVEMENT. THE POINT IS 14 CM FROM THE EDGE OF PAVEMENT CENTERED IN THE YELLOW STRIPE CLOSEST TO THE PAVEMENT EDGE.

(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: DAVID RIDER Phone: (907) 339-1988 e-mail: drider@aeromap.com

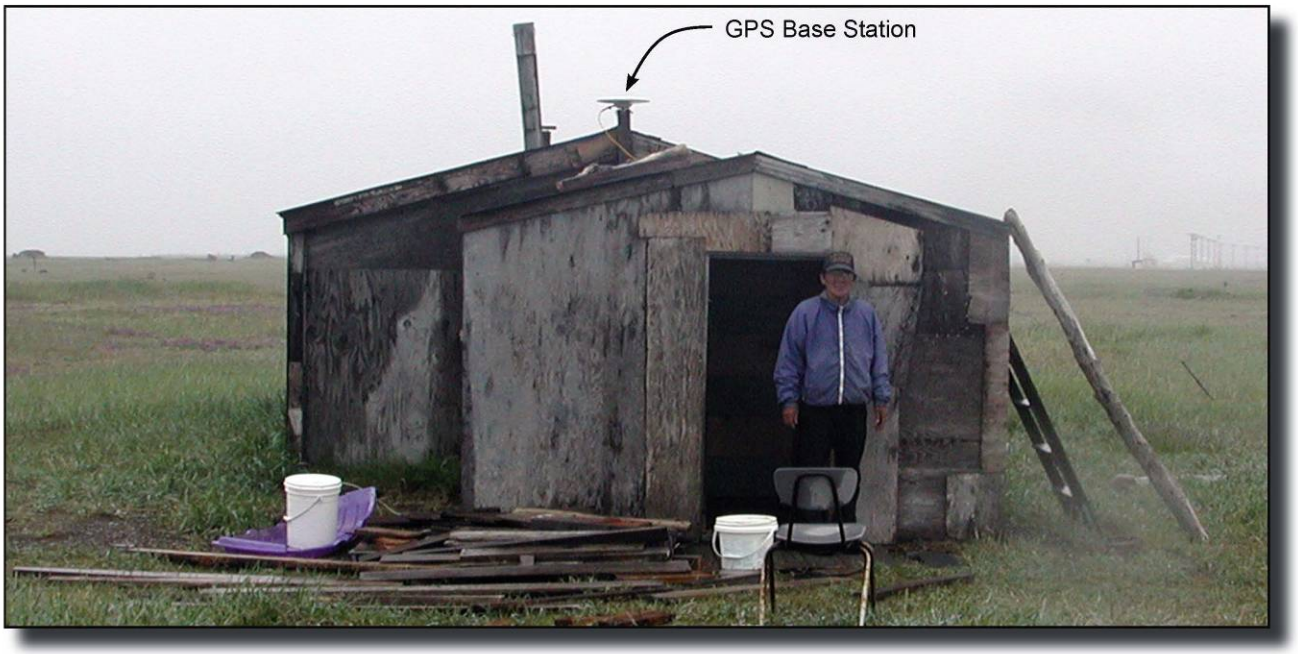
# 10. GROUND CONTROL REPORT

This section contains the report from John Oswald and Associates (JOA) on the survey to establish final coordinates for the ground GPS base stations used in both Areas 301 and 302 for the airborne LIDAR data acquisition.

JOA was the designated sub-contractor for AeroMap for this work, and as well provided tide gauge surveys, and communicated with the AeroMap LIDAR team at Kotzebue, AK on a daily basis on the conditions of tide windows for airborne LIDAR data acquisition for this project.

# GPS Base Stations Report
## NGS Projects AK0301 & AK0302

**Shoreline Mapping, Alaska**




View of Pete Lisbourne's house and the GPS base station in Point Hope, just west of the Point Hope Airport (July 5, 2004).

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Date: September 22, 2004

# Final GPS Base Station Coordinates 2004

## AeroMap US Shoreline Mapping - Chukchi Sea

## NGS Project AK0301 & AK0302

*in meters*

| | Year of Survey | Latitude | Longitude | Ellipsoid Height | Separation | Derived NAVD 88 |
|---|---|---|---|---|---|---|
| Point Hope Base Station | 2004 | **68 20 44.3936** | **166 48 50.7171** | **6.767** | **0.035** | **6.802** |
| Kivalina Base Station | 2004 | **67 43 38.9469** | **164 32 15.9203** | **8.787** | **-0.309** | **8.478** |
| Kotzebue Base Station 3 | 2003 | **66 53 24.1908** | **162 36 14.1141** | **4.876** | **-2.545** | **2.331** |
| Kotzebue Base Station 5 | 2004 | **66 53 24.2630** | **162 35 40.6119** | **5.275** | **-2.545** | **2.730** |
| Kotzebue Base Station 6 | 2004 | **66 53 24.5495** | **162 36 11.5172** | **4.688** | **-2.545** | **2.143** |
| Shishmaref Base Station | 2004 | **66 15 18.9742** | **166 04 11.3248** | **12.086** | **-3.096** | **8.990** |
| Wales Base Station | 2004 | **65 36 59.2838** | **168 05 36.9814** | **17.176** | **-3.553** | **13.623** |

1) Datum: NAD83(CORS96)(EPOCH:2003.0000)
2) All elevations are to the antenna ARP, except for Kotzebue 3, 5 and 6 which are to the top of the monument.
3) Derived NAVD 88 based on the separation determined for the 2003 GPS network performed by JOA and documented in the GPS report dated 7/12/04. The NAVD 88 height is based on GPS ties in 2003 to NGS published NAVD 88 elevations in Nome and Noatak.

# Point Hope GPS Base Station Survey

**Procedure:** The Point Hope GPS base station was installed on July 10, 2004 and removed on August 4, 2004. The base station consisted of an AeroMap US provided Trimble 5700 receiver (S/N #0220310616) with a JOA provided 512MB flash card and a Trimble Zephyr Geodetic antenna (S/N #12469585). The antenna was mounted on an all-thread rod which was attached to a board fastened to the peak of the roof on Pete Lisbourne's house. The receiver collected 1 second epoch data.

The final coordinate for this GPS base station refers to the ARP of the antenna. The coordinate was determined by averaging OPUS solutions of 5 separate GPS sessions that were 24 hours long and had been decimated to a 30 second epoch interval. Two OPUS solutions were obtained for each GPS session. One solution was derived using the default CORS chosen by OPUS (TLKA, EDOC and PBOC) and a second solution was determined using CORS chosen by the user (FAIR, BAY1 and TSEA or ACCU). It was believed that the user chosen stations would provide a check on the original OPUS solution. No solutions were rejected and the final coordinate is the average of all 10 solutions.

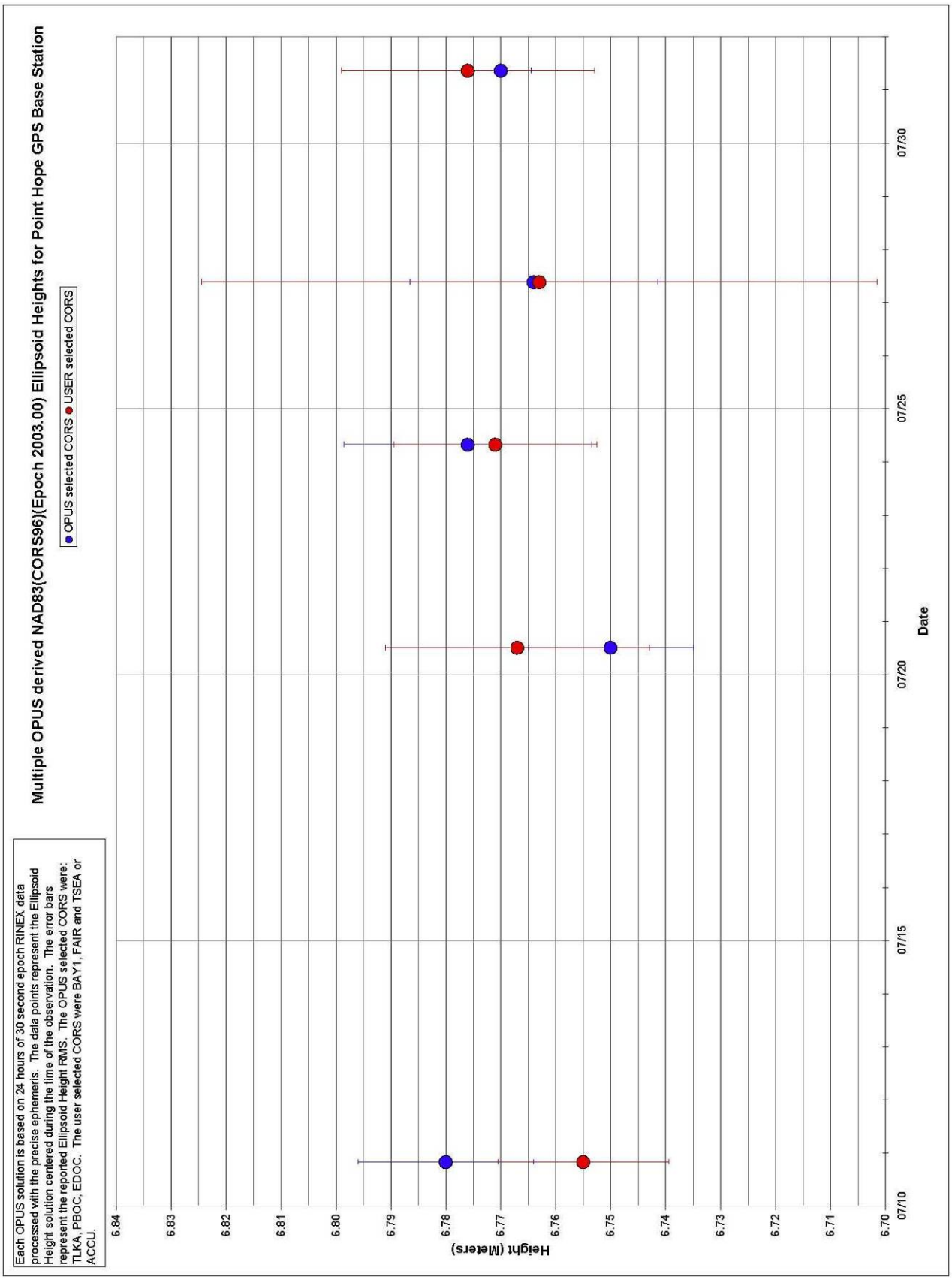
## Final Coordinate for 2004 Point Hope GPS Base Station

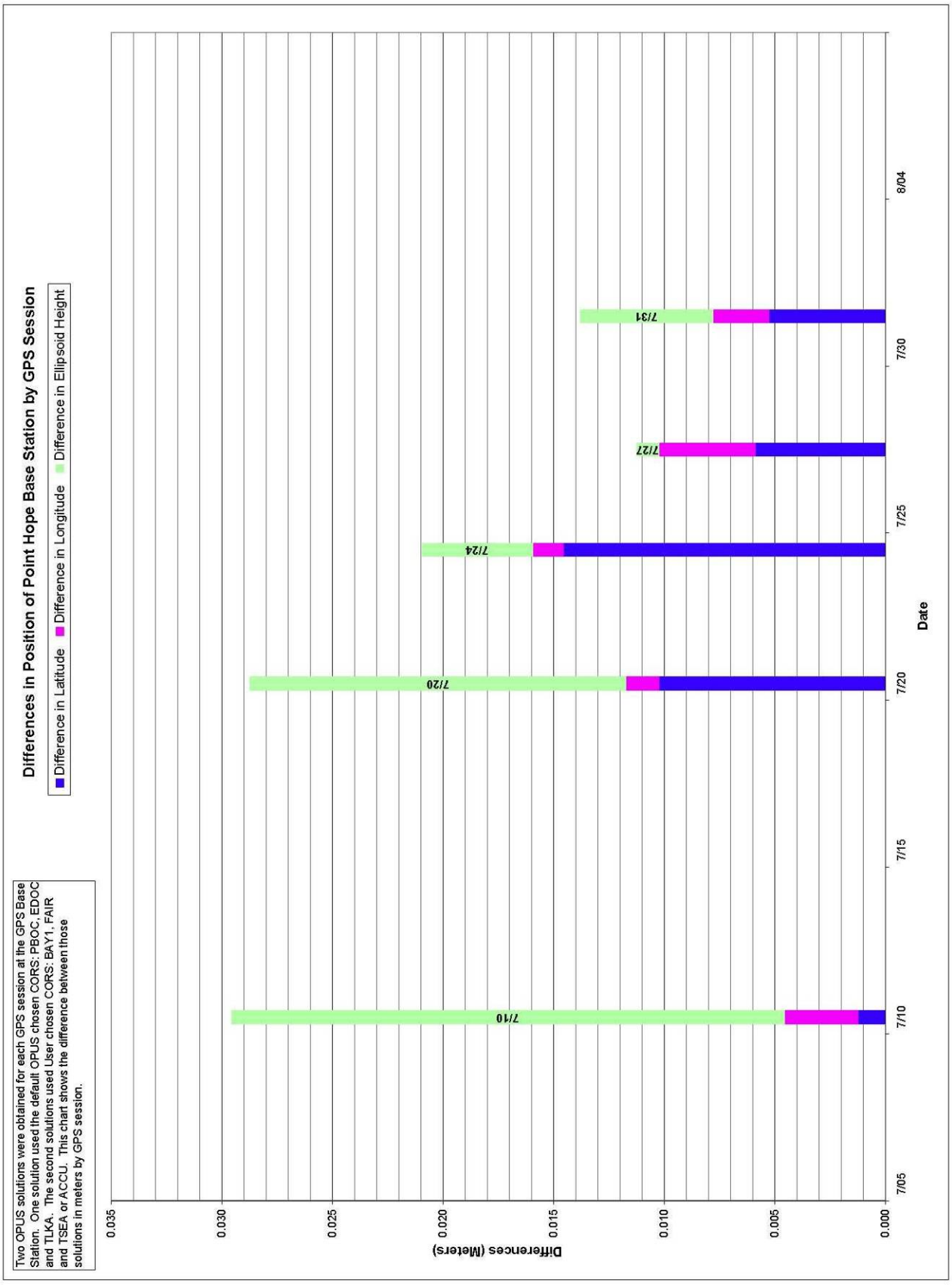
NAD83(CORS96)(EPOCH:2003.0000)

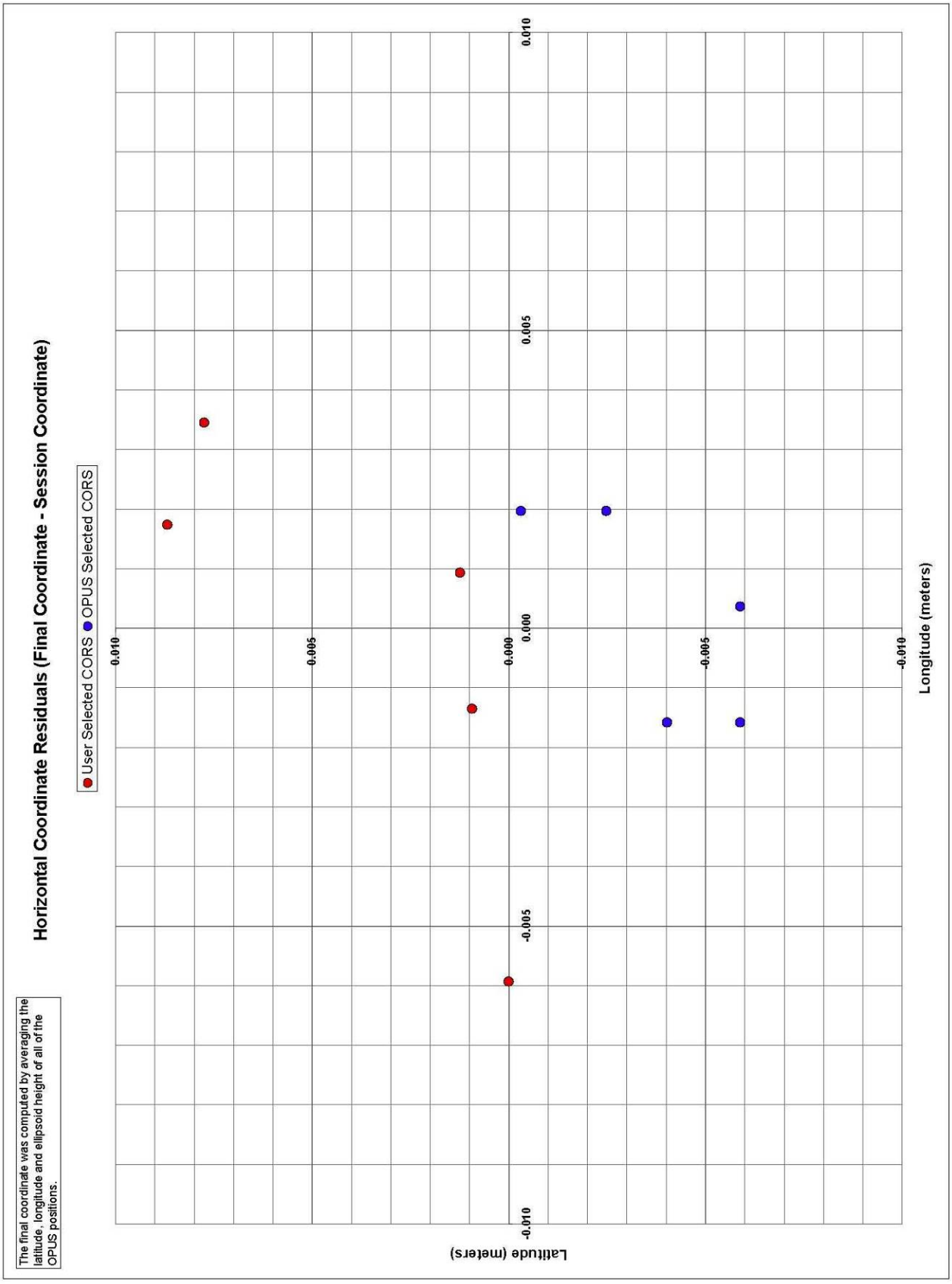
| | | RMS (m) |
|---|---|---|
| Latitude: | **68 20 44.3936 N** | 0.005 |
| Longitude: | **166 48 50.7171 W** | 0.003 |
| Ellipsoid Height: | **6.767 m** | 0.009 |
| Ellipsoid to NAVD 88 | **0.035 m** (from 2003 survey) | |
| Derived NAVD88: | **6.802 m** | |

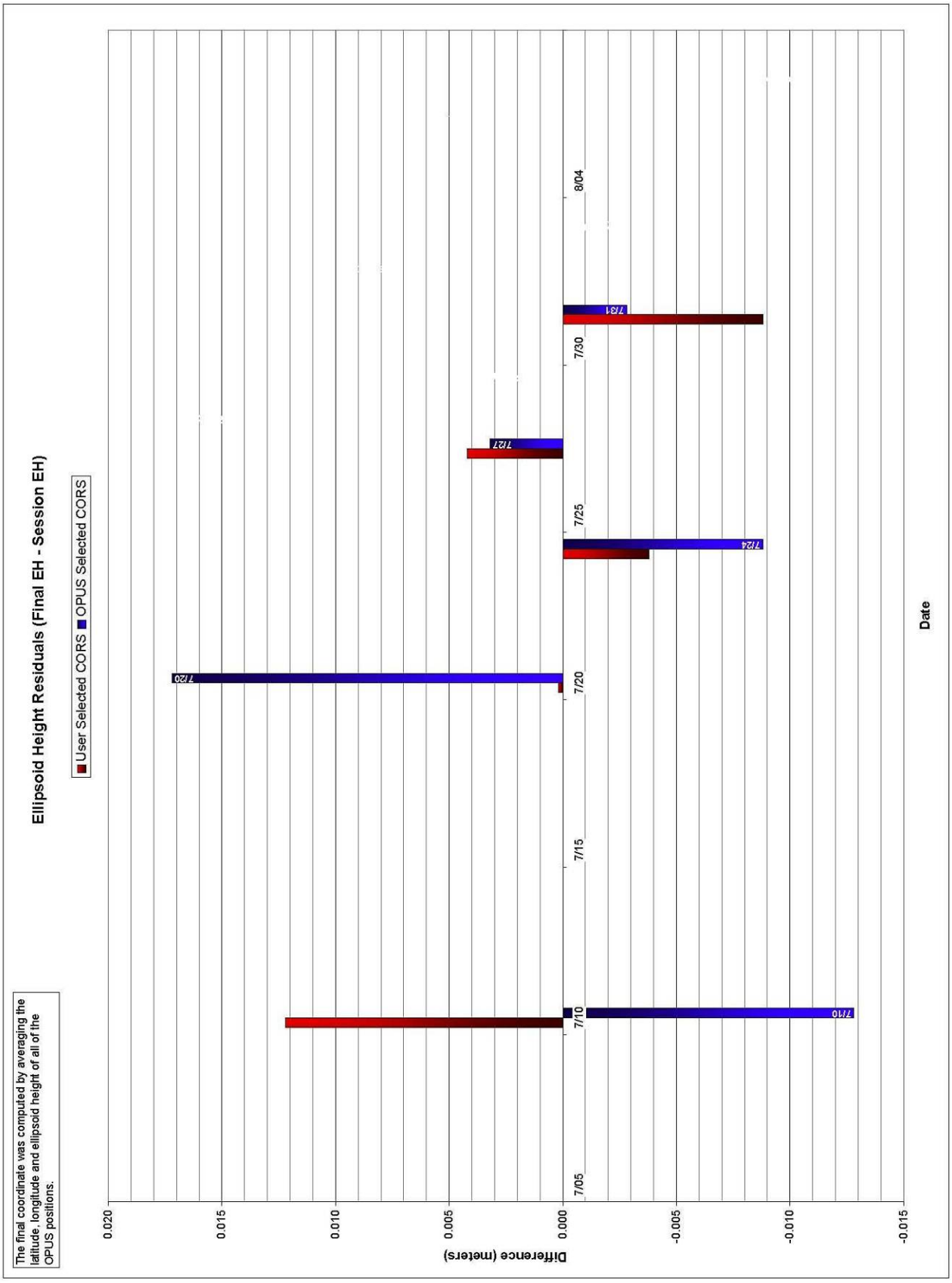
## Table of Individual GPS Session Solutions

| | | NAD83(CORS96)(EPOCH:2003.0000) | | | | | Residuals (Final - Each Session) | | |
|---|---|---|---|---|---|---|---|---|---|
| CORS | Date | Latitude | Longitude | Ellipsoid Height | EH RMS | Used in Final Position | Latitude (m) | Longitude (m) | Ellipsoid Height (m) |
| BAY1, FAIR, TSEA | July 10 | 68 20 44.39355 | 166 48 50.71726 | 6.755 | 0.031 | Accepted | 0.001 | -0.001 | 0.012 |
| BAY1, FAIR, TSEA | July 20 | 68 20 44.39333 | 166 48 50.71684 | 6.767 | 0.048 | Accepted | 0.008 | 0.003 | 0.000 |
| BAY1, FAIR, TSEA | July 24 | 68 20 44.39330 | 166 48 50.71699 | 6.771 | 0.037 | Accepted | 0.009 | 0.002 | -0.004 |
| BAY1, FAIR, TSEA | July 27 | 68 20 44.39358 | 166 48 50.71766 | 6.763 | 0.123 | Accepted | 0.000 | -0.006 | 0.004 |
| BAY1, FAIR, ACCU | July 31 | 68 20 44.39354 | 166 48 50.71706 | 6.776 | 0.046 | Accepted | 0.001 | 0.001 | -0.009 |
| TLKA, PBOC, EDOC | July 10 | 68 20 44.39359 | 166 48 50.71697 | 6.780 | 0.032 | Accepted | 0.000 | 0.002 | -0.013 |
| TLKA, PBOC, EDOC | July 20 | 68 20 44.39366 | 166 48 50.71697 | 6.750 | 0.030 | Accepted | -0.002 | 0.002 | 0.017 |
| TLKA, PBOC, EDOC | July 24 | 68 20 44.39377 | 166 48 50.71711 | 6.776 | 0.045 | Accepted | -0.006 | 0.000 | -0.009 |
| TLKA, PBOC, EDOC | July 27 | 68 20 44.39377 | 166 48 50.71728 | 6.764 | 0.045 | Accepted | -0.006 | -0.002 | 0.003 |
| TLKA, PBOC, EDOC | July 31 | 68 20 44.39371 | 166 48 50.71728 | 6.770 | 0.011 | Accepted | -0.004 | -0.002 | -0.003 |

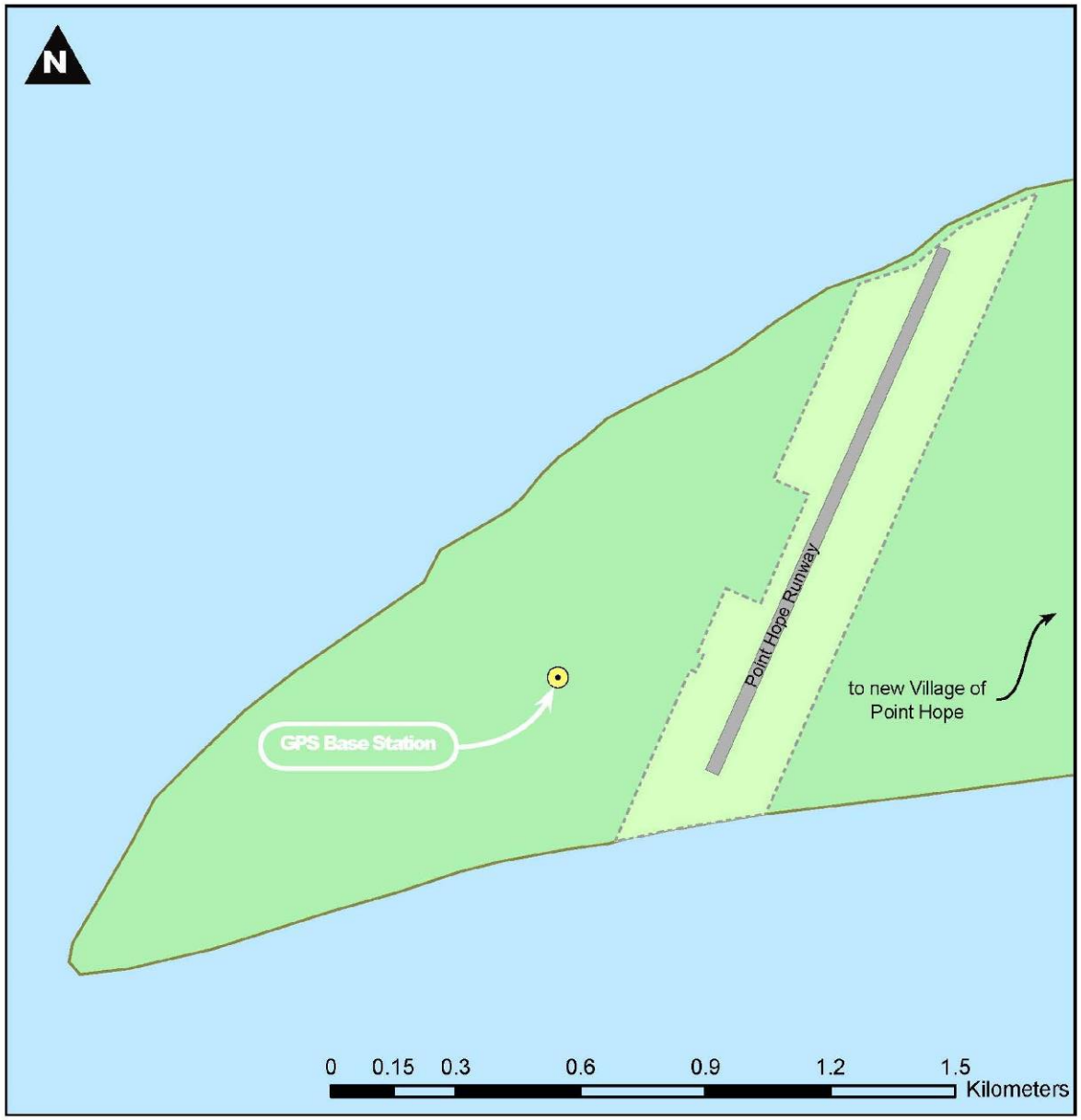

Multiple OPUS derived NAD83(CORS96)(Epoch 2003.00) Ellipsoid Heights for Point Hope GPS Base Station
OPUS selected CORS
USER selected CORS
Each OPUS solution is based on 24 hours of 30 second epoch RINEX data processed with the precise ephemeris. The data points represent the Ellipsoid Height solution centered during the time of the observation. The error bars represent the reported Ellipsoid Height RMS. The OPUS selected CORS were: TLKA, PBOC, EDOC. The user selected CORS were BAY1, FAIR and TSEA or ACCU.
Height (Meters)
6.84
6.83
6.82
6.81
6.80
6.79
6.78
6.77
6.76
6.75
6.74
6.73
6.72
6.71
6.70
07/10
07/15
07/20
07/25
07/30
Date


Differences in Position of Point Hope Base Station by GPS Session
Difference in Latitude
Difference in Longitude
Difference in Ellipsoid Height
Two OPUS solutions were obtained for each GPS session at the GPS Base Station. One solution used the default OPUS chosen CORS: PBOC, EDOC and TLKA. The second solutions used User chosen CORS: BAY1, FAIR and TSEA or ACCU. This chart shows the difference between those solutions in meters by GPS session.
Differences (Meters)
0.035
0.030
0.025
0.020
0.015
0.010
0.005
0.000
7/10
7/20
7/24
7/27
7/31
7/05
7/10
7/15
7/20
7/25
7/30
8/04
Date

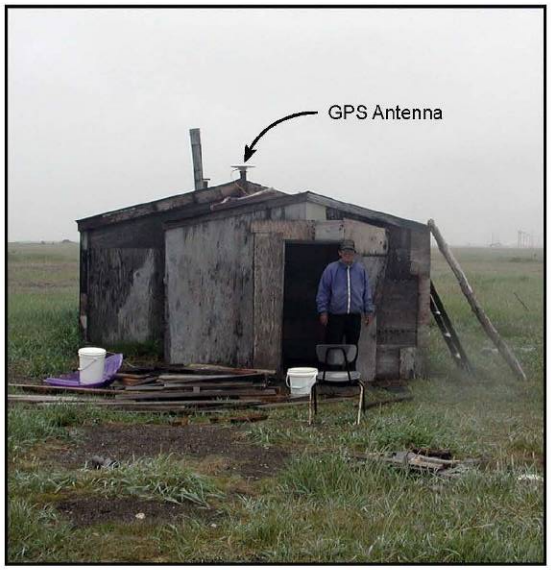

Horizontal Coordinate Residuals (Final Coordinate - Session Coordinate)
User Selected CORS
OPUS Selected CORS
The final coordinate was computed by averaging the latitude, longitude and ellipsoid height of all of the OPUS positions.
0.010
0.005
0.000
-0.005
-0.010
Latitude (meters)
Longitude (meters)


Ellipsoid Height Residuals (Final EH - Session EH)
User Selected CORS
OPUS Selected CORS
The final coordinate was computed by averaging the latitude, longitude and ellipsoid height of all of the OPUS positions.
Difference (meters)
0.020
0.015
0.010
0.005
0.000
-0.005
-0.010
-0.015
7/05
7/10
7/15
7/20
7/25
7/30
8/04
Date
7/10
7/20
7/27
7/24
7/31

# Point Hope GPS Base Station 2004




Map of general location of GPS base station in Point Hope, Alaska. The GPS base station was located on the roof of Pete Lisbourne's house, approximately 0.5km west of the Point Hope runway.




*View to the East* *July 4, 2004*
Trimble Zephyr Geodetic antenna above the roof of Pete Lisbourne's house. Pete is standing at the front door.




*View to the NE* *July 4, 2004*
Another view of the Trimble Zephyr Geodetic antenna above the roof of Pete Lisbourne's house.

# Kivalina GPS Base Station Survey

**Procedure:** The Kivalina GPS base station was installed on July 8, 2004 and removed on August 6, 2004. The base station consisted of an AeroMap US provided Trimble 5700 receiver (S/N # 0220310564) with a JOA provided 512MB flash card and a Trimble Zephyr Geodetic antenna (S/N #12200506). The antenna was mounted on an all-thread rod attached to a board that was fastened to the peak of Joe Swan, Jr.'s house. The receiver collected 1 second epoch data.

The final coordinate for this GPS base station refers to the ARP of the antenna. The coordinate was determined by averaging OPUS solutions of 5 separate GPS sessions that were 24 hours long and had been decimated to a 30 second epoch interval. Two OPUS solutions were obtained for each GPS session. One solution was derived using the default CORS chosen by OPUS (TLKA, EDOC and PBOC) and a second solution was determined using CORS chosen by the user (FAIR, BAY1 and TSEA or ACCU). It was believed that the user chosen stations would provide a check on the original OPUS solution. No solutions were rejected and the final coordinate is the average of all 10 solutions.

## Final Coordinate for 2004 Kivalina GPS Base Station

NAD83(CORS96)(EPOCH:2003.0000)

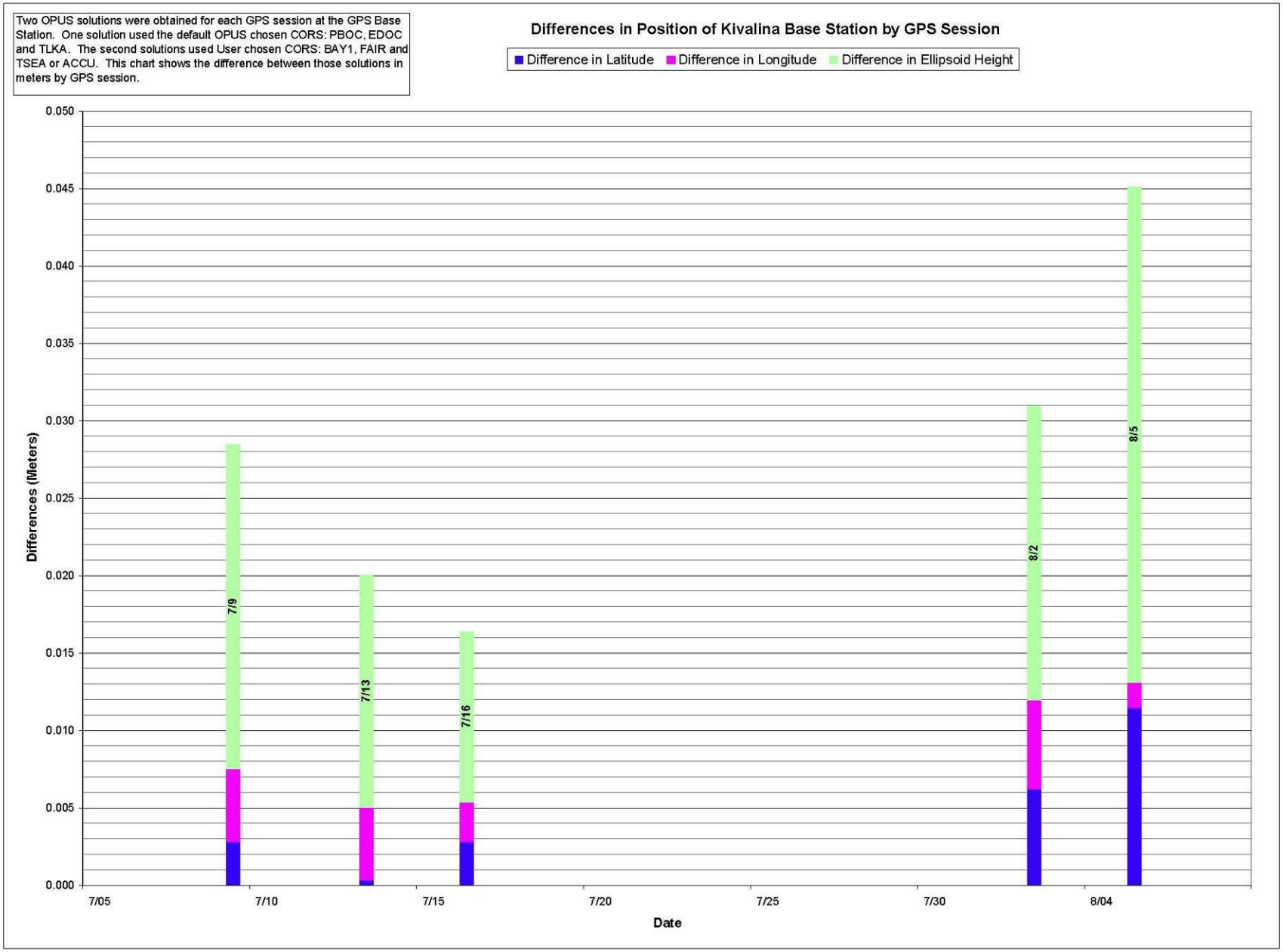
| | | RMS (m) |
|---|---|---|
| Latitude: | **67 43 38.9469 N** | 0.003 |
| Longitude: | **164 32 15.9203 W** | 0.002 |
| Ellipsoid Height: | **8.787 m** | 0.013 |
| Ellipsoid to NAVD 88 | **-0.309 m** (from 2003 survey) | |
| Derived NAVD88: | **8.478 m** | |

## Table of Individual GPS Session Solutions

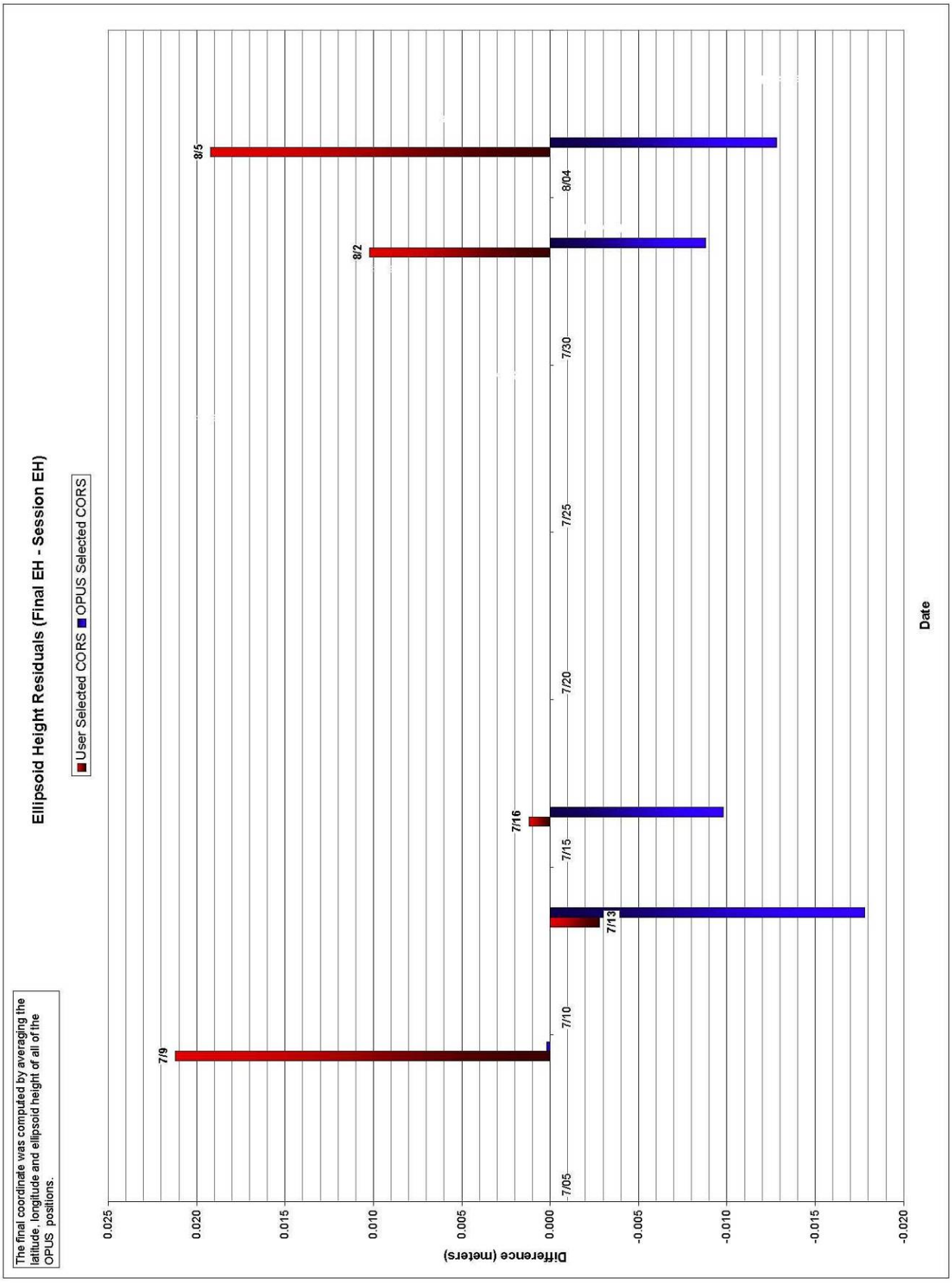
| | | NAD83(CORS96)(EPOCH:2003.0000) | | | | | Residuals (Final - Each Session) | | |
|---|---|---|---|---|---|---|---|---|---|
| CORS | Date | Latitude | Longitude | Ellipsoid Height | EH RMS | Used in Final Position | Latitude (m) | Longitude (m) | Ellipsoid Height (m) |
| BAY1, TSEA, FAIR | July 09 | 67 43 38.94684 | 164 32 15.92057 | 8.766 | 0.020 | Accepted | 0.000 | -0.003 | 0.021 |
| BAY1, ACCU, FAIR | July 13 | 67 43 38.94682 | 164 32 15.92053 | 8.790 | 0.004 | Accepted | 0.001 | -0.003 | -0.003 |
| BAY1, ACCU, FAIR | July 16 | 67 43 38.94687 | 164 32 15.92046 | 8.786 | 0.010 | Accepted | 0.000 | -0.002 | 0.001 |
| BAY1, ACCU, FAIR | August 02 | 67 43 38.94669 | 164 32 15.92051 | 8.777 | 0.025 | Accepted | 0.005 | -0.002 | 0.010 |
| BAY1, TSEA, FAIR | August 05 | 67 43 38.94668 | 164 32 15.92025 | 8.768 | 0.026 | Accepted | 0.005 | 0.001 | 0.019 |
| TLKA, PBOC, EDOC | July 09 | 67 43 38.94693 | 164 32 15.92017 | 8.787 | 0.052 | Accepted | -0.002 | 0.002 | 0.000 |
| TLKA, PBOC, EDOC | July 13 | 67 43 38.94683 | 164 32 15.92013 | 8.805 | 0.050 | Accepted | 0.001 | 0.002 | -0.018 |
| TLKA, PBOC, EDOC | July 16 | 67 43 38.94696 | 164 32 15.92024 | 8.797 | 0.058 | Accepted | -0.003 | 0.001 | -0.010 |
| TLKA, PBOC, EDOC | August 02 | 67 43 38.94689 | 164 32 15.92002 | 8.796 | 0.032 | Accepted | -0.001 | 0.003 | -0.009 |
| TLKA, PBOC, EDOC | August 05 | 67 43 38.94705 | 164 32 15.92011 | 8.800 | 0.039 | Accepted | -0.006 | 0.002 | -0.013 |

Multiple OPUS derived NAD83(CORS96)(Epoch 2003.00) Ellipsoid Heights for Kivalina GPS Base Station
OPUS selected CORS
USER selected CORS
Each OPUS solution is based on 24 hours of 30 second epoch RINEX data processed with the precise ephemeris. The data points represent the Ellipsoid Height solution centered during the time of the observation. The error bars represent the reported Ellipsoid Height RMS. The OPUS selected CORS were: TLKA, PBOC, EDOC. The user selected CORS were BAY1, FAIR and TSEA or ACCU.
Height (Meters)
8.84
8.83
8.82
8.81
8.80
8.79
8.78
8.77
8.76
8.75
07/05
07/10
07/15
07/20
07/25
07/30
08/04
08/09
Date

Two OPUS solutions were obtained for each GPS session at the GPS Base Station. One solution used the default OPUS chosen CORS: PBOC, EDOC and TLKA. The second solutions used User chosen CORS: BAY1, FAIR and TSEA or ACCU. This chart shows the difference between those solutions in meters by GPS session.



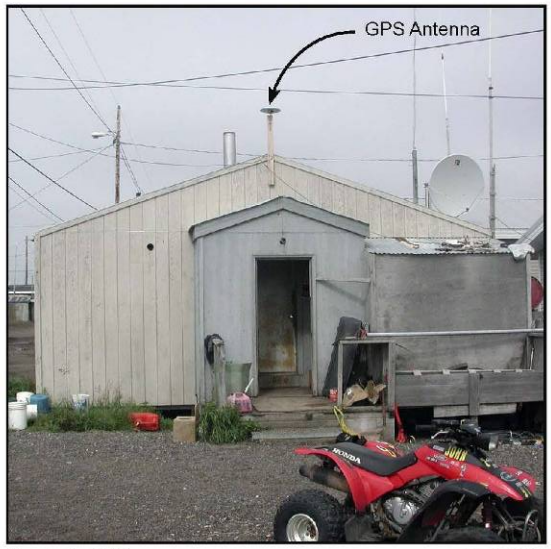
Horizontal Coordinate Residuals (Final Coordinate - Session Coordinate)
User Selected CORS
OPUS Selected CORS
The final coordinate was computed by averaging the latitude, longitude and ellipsoid height of all of the OPUS positions.
Latitude (meters)
Longitude (meters)
0.010
0.005
0.000
-0.005
-0.010


Ellipsoid Height Residuals (Final EH - Session EH)
User Selected CORS
OPUS Selected CORS
The final coordinate was computed by averaging the latitude, longitude and ellipsoid height of all of the OPUS positions.
Difference (meters)
0.025
0.020
0.015
0.010
0.005
0.000
-0.005
-0.010
-0.015
-0.020
7/05
7/10
7/15
7/20
7/25
7/30
8/04
Date
7/9
7/13
7/16
8/2
8/5

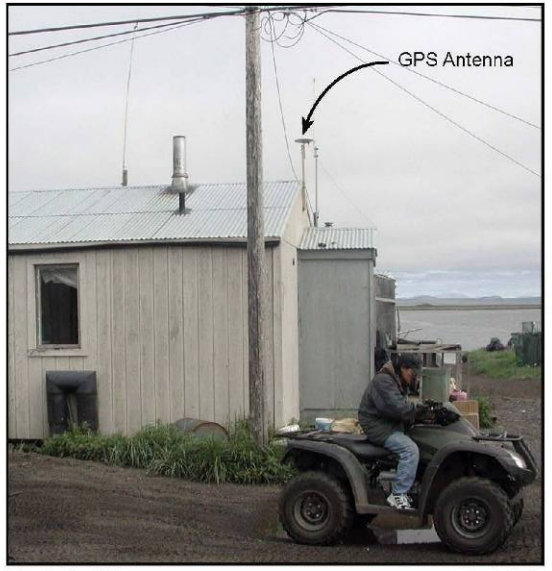
# Kivalina GPS Base Station 2004




Aerial view of Kivalina, Alaska from the DCED Community Profile Map. The GPS base station was located on the roof of Joe Swan, Jr.'s house, approximately 0.5km SE of the Kivalina runway.




*View to the NW* *July 8, 2004*
Trimble Zephyr Geodetic antenna above the peak of Joe Swan, Jr.'s house.




*View to the NE* *July 8, 2004*
Another view of the Trimble Zephyr Geodetic antenna above the peak of Joe Swan, Jr.'s house.

# KOT6 GPS Base Station Survey

**Procedure:** The KOT6 GPS base station was located on the Kotzebue Airport and was used intermitantly during July and August of 2004. The station was operated by the Aeromap flight crew. The base station consisted of a Trimble 4000SSi receiver and a Trimble Compact L1/L2 antenna without a groundplane. The antenna was set up on a tripod over the temporary monument, which is the head of a bolt. The HI was measured as a slant height from the top of the monument to the bottom of the notch on the antenna. This was converted to a vertical height using the antenna radius of 0.0914m and subtacting an offset of 0.0556m to the ARP.

The final coordinate for this GPS base station refers to the monument. The coordinate was determined by averaging OPUS solutions of 5 separate GPS sessions that varied in length from 4 to 7 hours long and had been decimated to a 30 second epoch interval. Two OPUS solutions were obtained for each GPS session. One solution was derived using the default CORS chosen by OPUS (KOD1, EDOC and POT3) and a second solution was determined using CORS chosen by the user (BAY1, KEN1 and FAIR). The user chosen stations provided a check on the default OPUS solution. No solutions were rejected and the final coordinate is the average of all 10 solutions.

Another check was performed by using Trimble Geomatics Office v1.62 to process the GPS baseline that was 1.5 hours in length between KOT3, a tidal bench mark with coordinates from the 2003 GPS survey, and KOT6. The position for KOT6 derived from this baseline was within a few centimeters of the final average position. The difference was attributed to the different control stations used between 2003 (NGS survey monuments) and 2004 (CORS only).

## Final Coordinate for 2004 KOT6 GPS Base Station

NAD83(CORS96)(EPOCH:2003.0000)

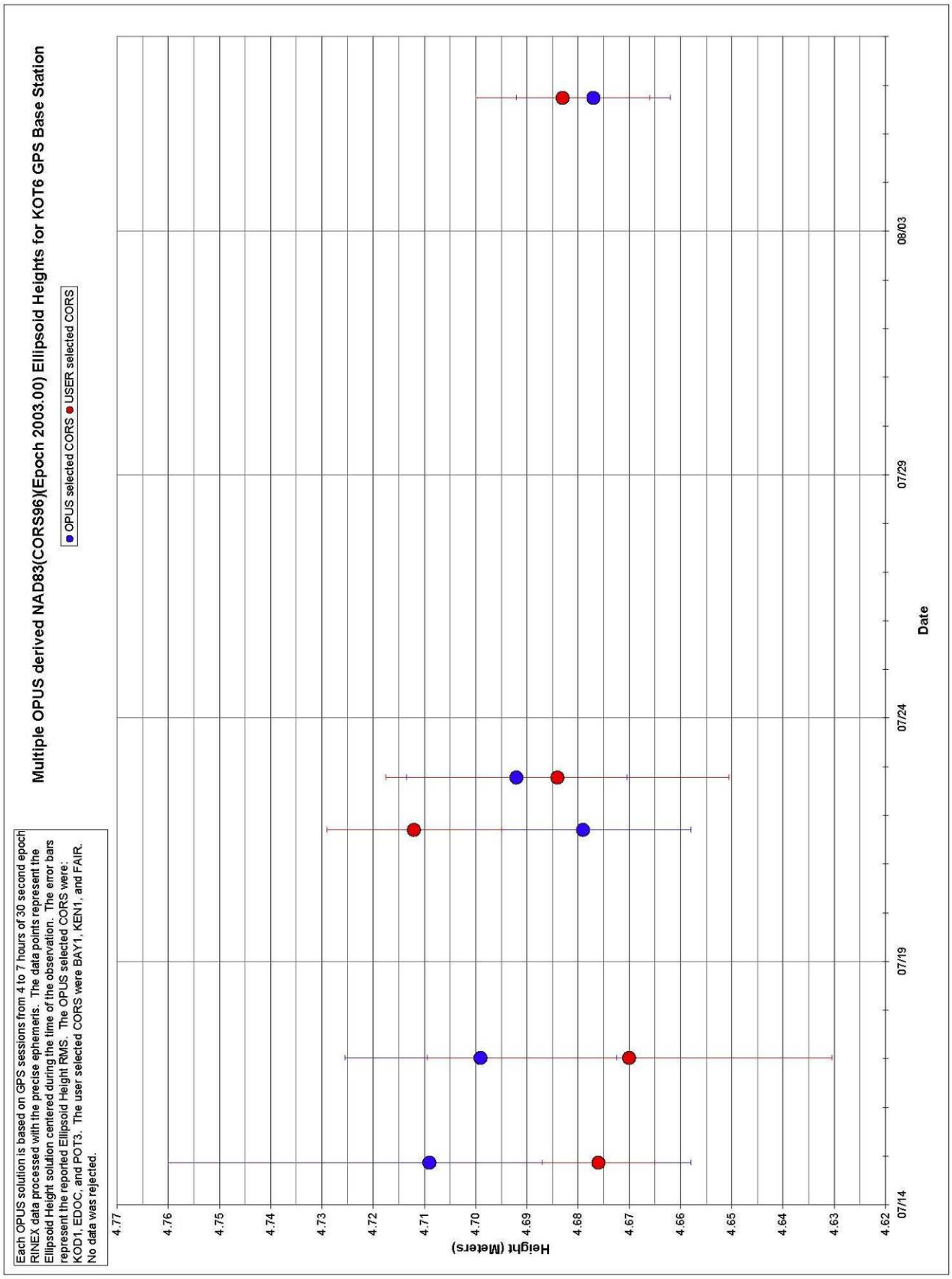
| | | RMS (m) |
|---|---|---|
| Latitude: | **66 53 24.5495 N** | 0.006 |
| Longitude: | **162 36 11.5172 W** | 0.014 |
| Ellipsoid Height: | **4.688 m** | 0.014 |
| Ellipsoid to NAVD88 | **-2.545 m** (from 2003 survey) | |
| Derived NAVD88: | **2.143 m** | |

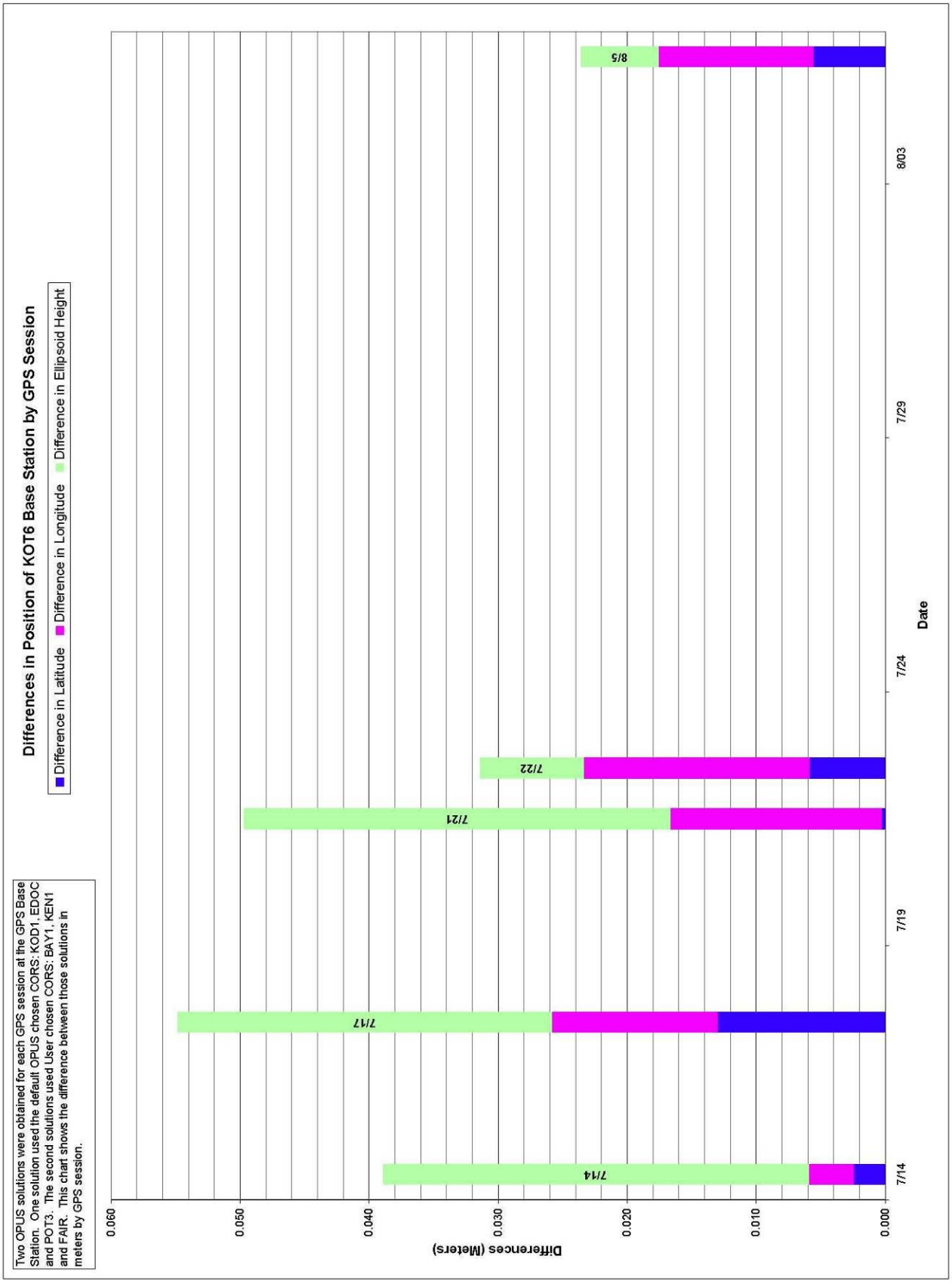
## Table of Individual GPS Session Solutions

| | | NAD83(CORS96)(EPOCH:2003.0000) | | | | | Residuals (Final - Each Session) | | |
|---|---|---|---|---|---|---|---|---|---|
| CORS | Date | Latitude | Longitude | Ellipsoid Height | EH RMS | Used in Final Position | Latitude (m) | Longitude (m) | Ellipsoid Height (m) |
| BAY1, KEN1, FAIR | July 14 | 66 53 24.54966 | 162 36 11.51674 | 4.676 | 0.022 | Accepted | -0.004 | 0.006 | 0.012 |
| BAY1, KEN1, FAIR | July 17 | 66 53 24.54986 | 162 36 11.51808 | 4.670 | 0.079 | Accepted | -0.010 | -0.010 | 0.018 |
| BAY1, KEN1, FAIR | July 21 | 66 53 24.54966 | 162 36 11.51641 | 4.712 | 0.034 | Accepted | -0.004 | 0.009 | -0.024 |
| BAY1, KEN1, FAIR | July 22 | 66 53 24.54937 | 162 36 11.51816 | 4.684 | 0.067 | Accepted | 0.005 | -0.011 | 0.004 |
| BAY1, KEN1, FAIR | August 05 | 66 53 24.54916 | 162 36 11.51950 | 4.683 | 0.034 | Accepted | 0.011 | -0.026 | 0.005 |
| KOD1, EDOC, POT3 | July 14 | 66 53 24.54958 | 162 36 11.51644 | 4.709 | 0.102 | Accepted | -0.002 | 0.009 | -0.021 |
| KOD1, EDOC, POT3 | July 17 | 66 53 24.54944 | 162 36 11.51696 | 4.699 | 0.053 | Accepted | 0.003 | 0.003 | -0.011 |
| KOD1, EDOC, POT3 | July 21 | 66 53 24.54965 | 162 36 11.51498 | 4.679 | 0.042 | Accepted | -0.004 | 0.026 | 0.009 |
| KOD1, EDOC, POT3 | July 22 | 66 53 24.54956 | 162 36 11.51663 | 4.692 | 0.043 | Accepted | -0.001 | 0.007 | -0.004 |
| KOD1, EDOC, POT3 | August 05 | 66 53 24.54934 | 162 36 11.51845 | 4.677 | 0.030 | Accepted | 0.006 | -0.014 | 0.011 |

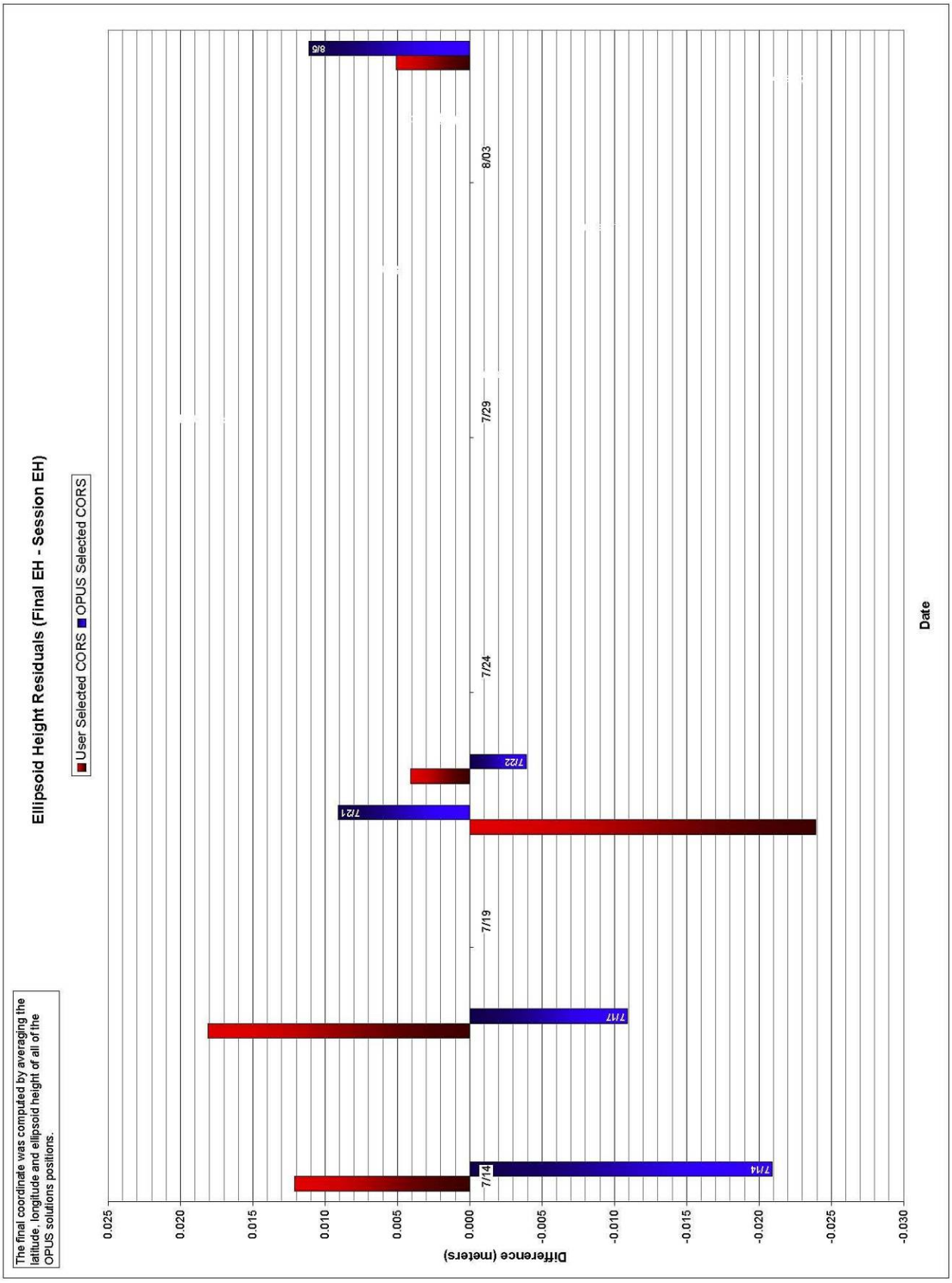
## GPS Solution Holding 2003 Coordinates

| | | NAD83(CORS96)(EPOCH:2003.0000) | | | | | Residuals (Final - Holding KOT3 2003 Coordinate) | | |
|---|---|---|---|---|---|---|---|---|---|
| Control Station | Date | Latitude | Longitude | Ellipsoid Height | EH RMS | Used in Final Position | Latitude (m) | Longitude (m) | Ellipsoid Height (m) |
| KOT3 | August 12 | 66 53 24.54862 | 162 36 11.51501 | 4.688 | 0.006 | QC Only | 0.028 | 0.025 | 0.000 |


Multiple OPUS derived NAD83(CORS96)(Epoch 2003.00) Ellipsoid Heights for KOT6 GPS Base Station
OPUS selected CORS
USER selected CORS
Each OPUS solution is based on GPS sessions from 4 to 7 hours of 30 second epoch RINEX data processed with the precise ephemeris. The data points represent the Ellipsoid Height solution centered during the time of the observation. The error bars represent the reported Ellipsoid Height RMS. The OPUS selected CORS were: KOD1, EDOC, and POT3. The user selected CORS were BAY1, KEN1, and FAIR. No data was rejected.
Height (Meters)
4.77
4.76
4.75
4.74
4.73
4.72
4.71
4.70
4.69
4.68
4.67
4.66
4.65
4.64
4.63
4.62
07/14
07/19
07/24
07/29
08/03
Date


Differences in Position of KOT6 Base Station by GPS Session
Difference in Latitude
Difference in Longitude
Difference in Ellipsoid Height
Two OPUS solutions were obtained for each GPS session at the GPS Base Station. One solution used the default OPUS chosen CORS: KOD1, EDOC and POT3. The second solutions used User chosen CORS: BAY1, KEN1 and FAIR. This chart shows the difference between those solutions in meters by GPS session.
Differences (Meters)
0.060
0.050
0.040
0.030
0.020
0.010
0.000
7/14
7/17
7/19
7/21
7/22
7/24
7/29
8/3
8/5
Date

Horizontal Coordinate Residuals (Final Coordinate - Session Coordinate)
The final coordinate was computed by averaging the latitude, longitude and ellipsoid height of all of the OPUS positions.
User Selected CORS
OPUS Selected CORS
Holding KOT3 2003
Latitude (meters)
Longitude (meters)
0.035
0.030
0.025
0.020
0.015
0.010
0.005
0.000
-0.005
-0.010
-0.015
-0.020
-0.025
-0.030
-0.045


Ellipsoid Height Residuals (Final EH - Session EH)
User Selected CORS
OPUS Selected CORS
The final coordinate was computed by averaging the latitude, longitude and ellipsoid height of all of the OPUS solutions positions.
Difference (meters)
0.025
0.020
0.015
0.010
0.005
0.000
-0.005
-0.010
-0.015
-0.020
-0.025
-0.030
7/14
7/19
7/21
7/22
7/24
7/29
8/03
8/5
7/17
Date

# KOT5 GPS Base Station Survey

**Procedure:** The KOT5 GPS base station was located on the Kotzebue Airport and was used intermitantly during July and August of 2004. The station was operated by the Aeromap flight crew. The base station consisted of a Trimble 4000SSi receiver and a Trimble Compact L1/L2 antenna without a groundplane. The antenna was set up on a tripod over the temporary monument, which is a PK nail with washer. The HI was measured as a slant height from the top of the monument to the bottom of the notch on the antenna. The slant height was converted to a vertical height by using the radius for the antenna of 0.0914m and subtracting an offset to the ARP of 0.0556m.

The final coordinate for this GPS base station refers to the monument. The coordinate was determined by averaging OPUS solutions of 5 separate GPS sessions that varied in length from 4 to 9 hours long and had been decimated to a 30 second epoch interval. Two OPUS solutions were obtained for each GPS session. One solution was derived using the default CORS chosen by OPUS (TLKA, PBOC and EDOC) and a second solution was determined using CORS chosen by the user (BAY1, FAIR, and TSEA or ACCU). The user chosen stations provided a check on the default OPUS solution. No solutions were rejected and the final coordinate is the average of all 10 solutions.

Another check was performed by processing the GPS baseline that was 1.5 hours in length between KOT3, a monument with coordinates from the 2003 GPS survey, and KOT5. The position for KOT5 derived from this baseline was within a few centimeters of the final average position from OPUS. The difference was attributed to the different control stations used between 2003 (NGS survey monuments) and 2004 (CORS only).

## Final Coordinate for 2004 KOT5 GPS Base Station

NAD83(CORS96)(EPOCH:2003.0000)

| | | RMS (m) |
|---|---|---|
| Latitude: | **66 53 24.2630 N** | 0.008 |
| Longitude: | **162 35 40.6119 W** | 0.015 |
| Ellipsoid Height: | **5.275 m** | 0.012 |
| Ellisoid to NAVD88 | **-2.545 m** (from 2003 survey) | |
| Derived NAVD88: | **2.730 m** | |

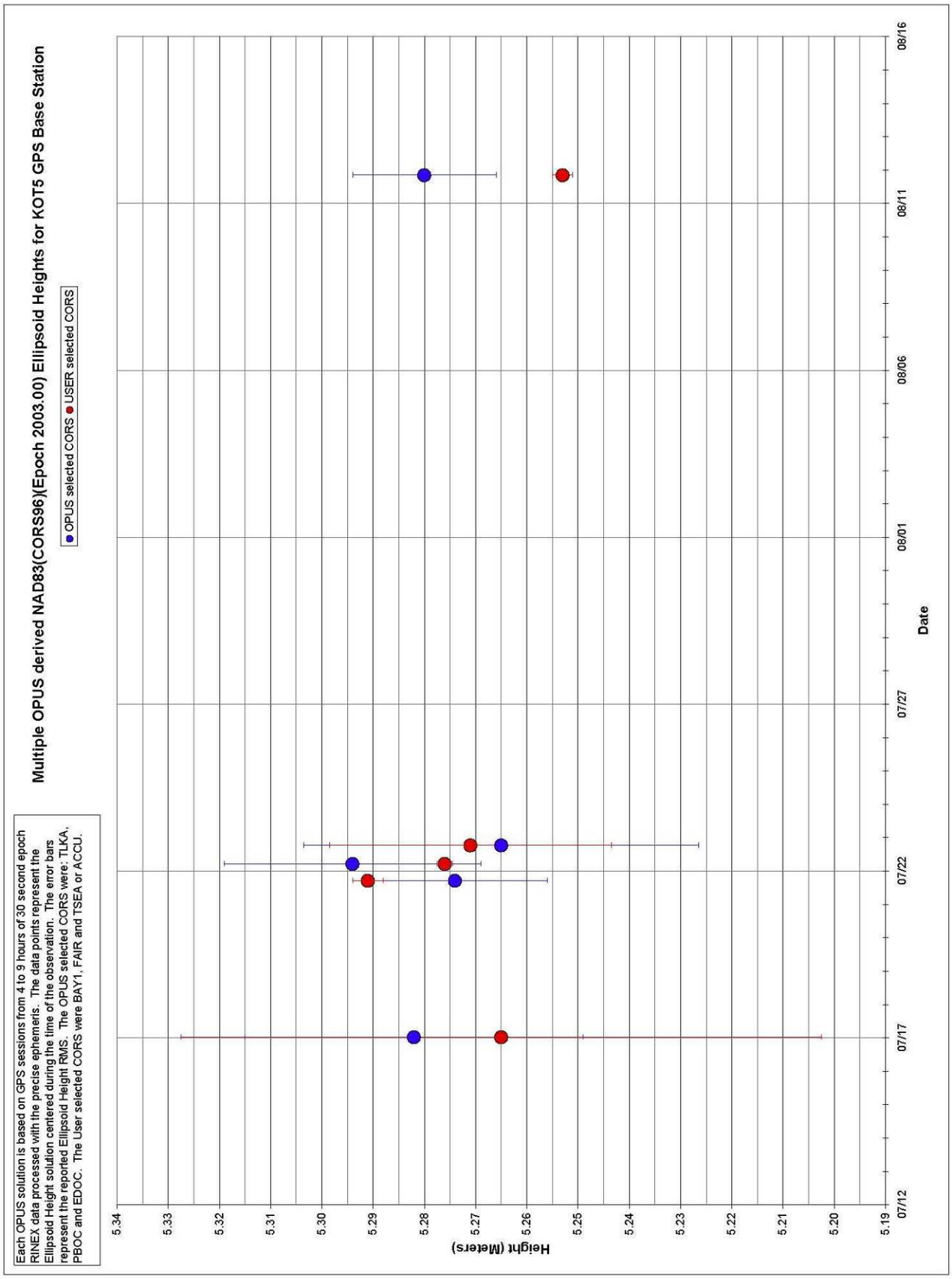
## Table of Individual GPS Session Solutions

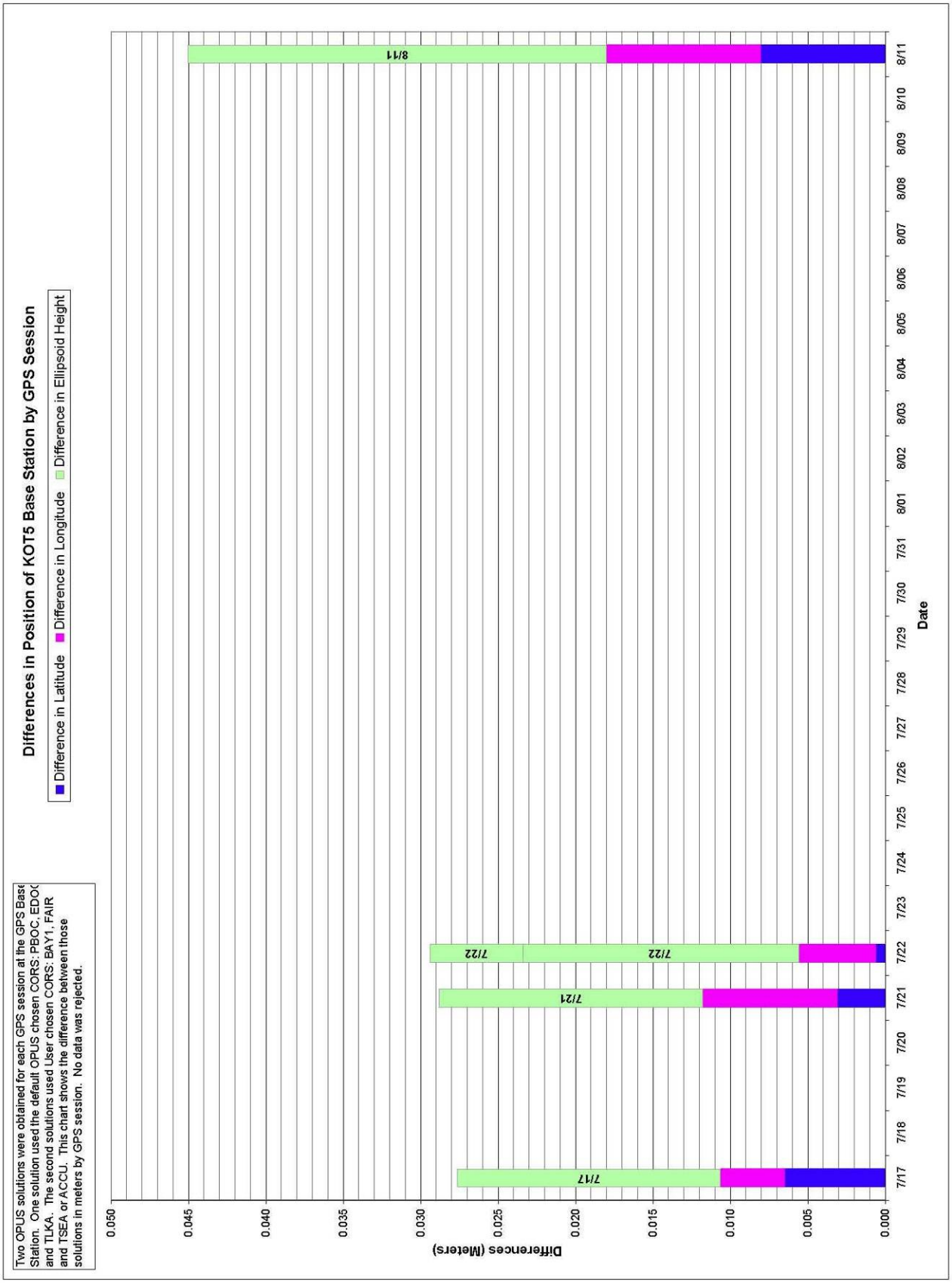
Rejected Solutions are Bold and Gray

| | | NAD83(CORS96)(EPOCH:2003.0000) | | | | | Residuals (Final - Each Session) | | |
|---|---|---|---|---|---|---|---|---|---|
| CORS | Date | Latitude | Longitude | Ellipsoid Height | EH RMS | Used in Final Position | Latitude (m) | Longitude (m) | Ellipsoid Height (m) |
| BAY1, ACCU, FAIR | July 17 | 66 53 24.26340 | 162 35 40.61318 | 5.265 | 0.125 | Accepted | -0.012 | -0.014 | 0.010 |
| BAY1, TSEA, FAIR | July 21 | 66 53 24.26323 | 162 35 40.61134 | 5.291 | 0.006 | Accepted | -0.007 | 0.007 | -0.016 |
| BAY1, TSEA, FAIR | July 22 | 66 53 24.26307 | 162 35 40.61233 | 5.276 | 0.003 | Accepted | -0.002 | -0.005 | -0.001 |
| BAY1, TSEA, FAIR | July 22 | 66 53 24.26279 | 162 35 40.61344 | 5.271 | 0.055 | Accepted | 0.007 | -0.017 | 0.004 |
| BAY1, TSEA, FAIR | August 11 | 66 53 24.26266 | 162 35 40.60999 | 5.253 | 0.004 | Accepted | 0.011 | 0.022 | 0.022 |
| TLKA, PBOC, EDOC | July 17 | 66 53 24.26319 | 162 35 40.61282 | 5.282 | 0.066 | Accepted | -0.006 | -0.010 | -0.007 |
| TLKA, PBOC, EDOC | July 21 | 66 53 24.26313 | 162 35 40.61210 | 5.274 | 0.036 | Accepted | -0.004 | -0.002 | 0.001 |
| TLKA, PBOC, EDOC | July 22 | 66 53 24.26309 | 162 35 40.61276 | 5.294 | 0.050 | Accepted | -0.003 | -0.010 | -0.019 |
| TLKA, PBOC, EDOC | July 22 | 66 53 24.26253 | 162 35 40.61210 | 5.265 | 0.077 | Accepted | 0.015 | -0.002 | 0.010 |
| TLKA, PBOC, EDOC | August 11 | 66 53 24.26292 | 162 35 40.60912 | 5.280 | 0.028 | Accepted | 0.003 | 0.032 | -0.005 |

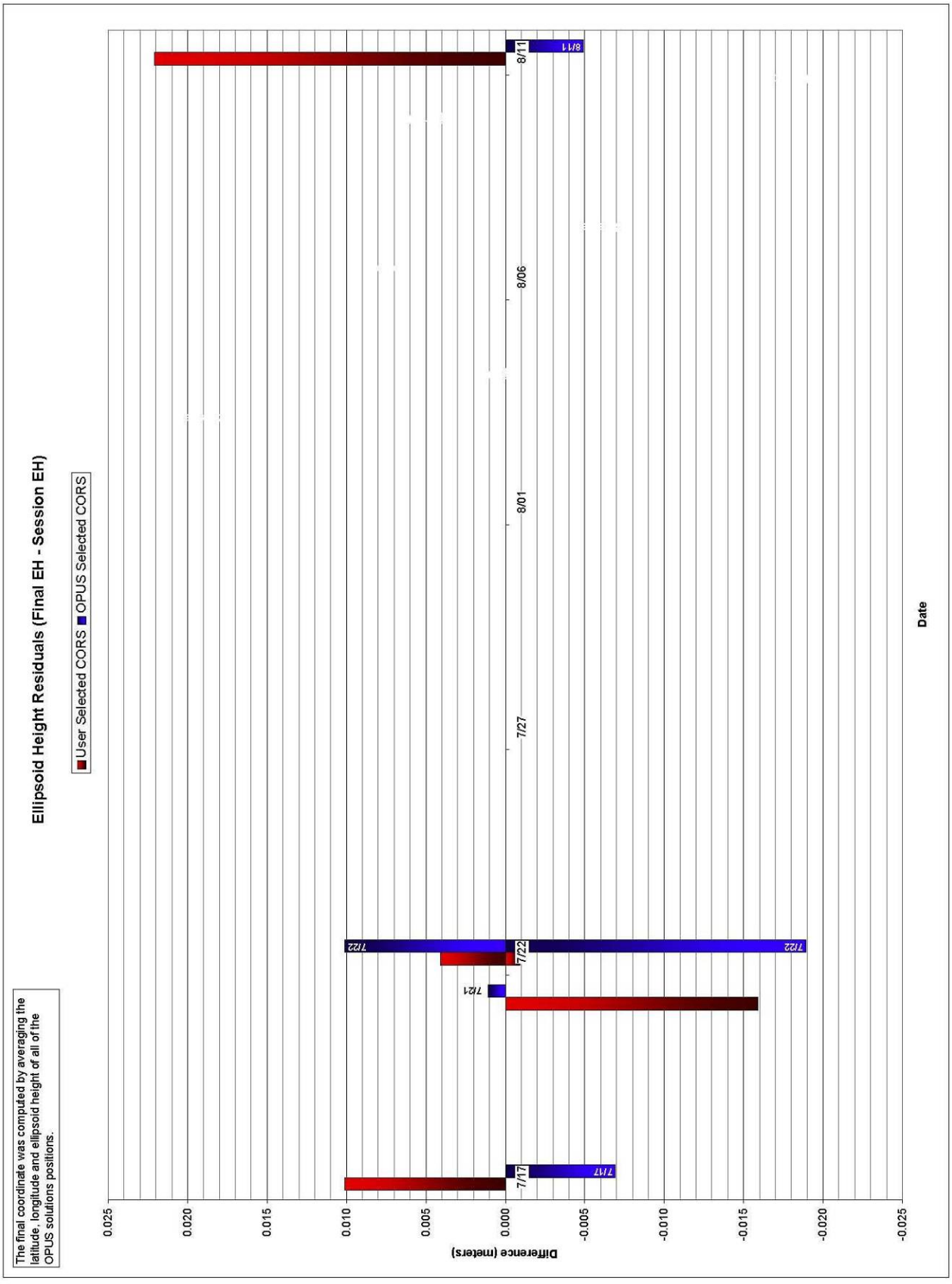
## GPS Solution Holding 2003 Coordinates

| | | NAD83(CORS96)(EPOCH:2003.0000) | | | | | Residuals (Final - Each Session) | | |
|---|---|---|---|---|---|---|---|---|---|
| Control Station | Date | Latitude | Longitude | Ellipsoid Height | EH RMS | Used in Final Position | Latitude (m) | Longitude (m) | Ellipsoid Height (m) |
| KOT3 | August 12 | 66 53 24.26187 | 162 35 40.60814 | 5.272 | 0.006 | QC Only | 0.035 | 0.043 | 0.003 |


Multiple OPUS derived NAD83(CORS96)(Epoch 2003.00) Ellipsoid Heights for KOT5 GPS Base Station
OPUS selected CORS
USER selected CORS
Each OPUS solution is based on GPS sessions from 4 to 9 hours of 30 second epoch RINEX data processed with the precise ephemeris. The data points represent the Ellipsoid Height solution centered during the time of the observation. The error bars represent the reported Ellipsoid Height RMS. The OPUS selected CORS were: TLKA, PBOC and EDOC. The User selected CORS were BAY1, FAIR and TSEA or ACCU.
Height (Meters)
5.34
5.33
5.32
5.31
5.30
5.29
5.28
5.27
5.26
5.25
5.24
5.23
5.22
5.21
5.20
5.19
07/12
07/17
07/22
07/27
08/01
08/06
08/11
08/16
Date


Differences in Position of KOT5 Base Station by GPS Session
Difference in Latitude
Difference in Longitude
Difference in Ellipsoid Height
Two OPUS solutions were obtained for each GPS session at the GPS Base Station. One solution used the default OPUS chosen CORS: PBOC, EDOC and TLKA. The second solutions used User chosen CORS: BAY1, FAIR and TSEA or ACCU. This chart shows the difference between those solutions in meters by GPS session. No data was rejected.
Differences (Meters)
0.050
0.045
0.040
0.035
0.030
0.025
0.020
0.015
0.010
0.005
0.000
7/17
7/22
7/22
7/24
8/11
7/17
7/18
7/19
7/20
7/21
7/22
7/23
7/24
7/25
7/26
7/27
7/28
7/29
7/30
7/31
8/01
8/02
8/03
8/04
8/05
8/06
8/07
8/08
8/09
8/10
8/11
Date

Horizontal Coordinate Residuals (Final Coordinate - Session Coordinate)
The final coordinate was computed by averaging the latitude, longitude and ellipsoid height of all of the OPUS solutions positions. No data was rejected.
User Selected CORS
OPUS Selected CORS
Holding KOT3 2003
Latitude (meters)
Longitude (meters)
0.040
0.035
0.030
0.025
0.020
0.015
0.010
0.005
0.000
-0.005
-0.010
-0.015
-0.020
-0.025
0.050
0.045
0.040
0.035
0.030
0.025
0.020
0.015
0.010
0.005
0.000
-0.005
-0.010
-0.015


Ellipsoid Height Residuals (Final EH - Session EH)
User Selected CORS
OPUS Selected CORS
The final coordinate was computed by averaging the latitude, longitude and ellipsoid height of all of the OPUS solutions positions.
Difference (meters)
0.025
0.020
0.015
0.010
0.005
0.000
-0.005
-0.010
-0.015
-0.020
-0.025
7/17
7/21
7/22
8/11
7/27
8/01
8/06
8/11
Date

# Kotzebue GPS Base Stations 2004: KOT3, KOT5, KOT6

# Shishmaref GPS Base Station Survey

**Procedure:** The Shishmaref GPS base station was installed on June 29th, 2004 and removed on August 13th, 2004. The base station consisted of an AeroMap US provided dual frequency Trimble 5700 receiver (S/N #0220298055) with JOA provided 512MB flash card and a Trimble Zephyr Geodetic antenna (S/N # 12560739). The antenna was mounted on an all-thread rod which was hose-clamped to a metal pole on the roof of Gene Snell's house in Shishmaref. The receiver collected 1 second epoch data.

The final coordinate for this GPS base station refers to the ARP of the antenna. The coordinate was determined by averaging 18 OPUS solutions of 9 separate GPS sessions varying in length from 17 to 24 hours and decimated to a 30 second epoch interval. Two OPUS solutions were obtained for each GPS session. One solution was derived using the default CORS chosen by OPUS (TLKA, EDOC and PBOC) and a second solution was determined using CORS chosen by the user (FAIR, TSEA and BAY1). It was believed that the user chosen stations would provide a check on the original OPUS solution. The OPUS solutions from twelve GPS sessions were originally considered, however the solutions from three sessions were rejected due to large RMS in the Ellipsoid Height, large deviation in the Ellipsoid Height from the average, or large deviation in the horizontal position from the average.

Another check was performed by using Trimble Geomatics Office v 1.62 to process two GPS baselines that were 7 hours in length between tidal bench mark 9854 B 2003, a monument with coordinates from the 2003 GPS survey, and the Shishmaref GPS Base Station. The position for the Shishmaref GPS Base Station that was derived from this baseline was within a couple of centimeters of the final average position from OPUS. The difference was attributed to the different control stations used between 2003 (NGS survey monuments) and 2004 (CORS only).

## Final Coordinate for 2004 Shishmaref GPS Base Station

NAD83(CORS96)(EPOCH:2003.0000)

| | | RMS (m) |
|---|---|---|
| Latitude: | 66 15 18.9742 N | 0.004 |
| Longitude: | 166 4 11.3248 W | 0.003 |
| Ellipsoid Height: | 12.086 m | 0.013 |
| Ellipsoid to NAVD88: | -3.096 m (from 2003 survey) | |
| Derived NAVD88: | 8.990 m | |

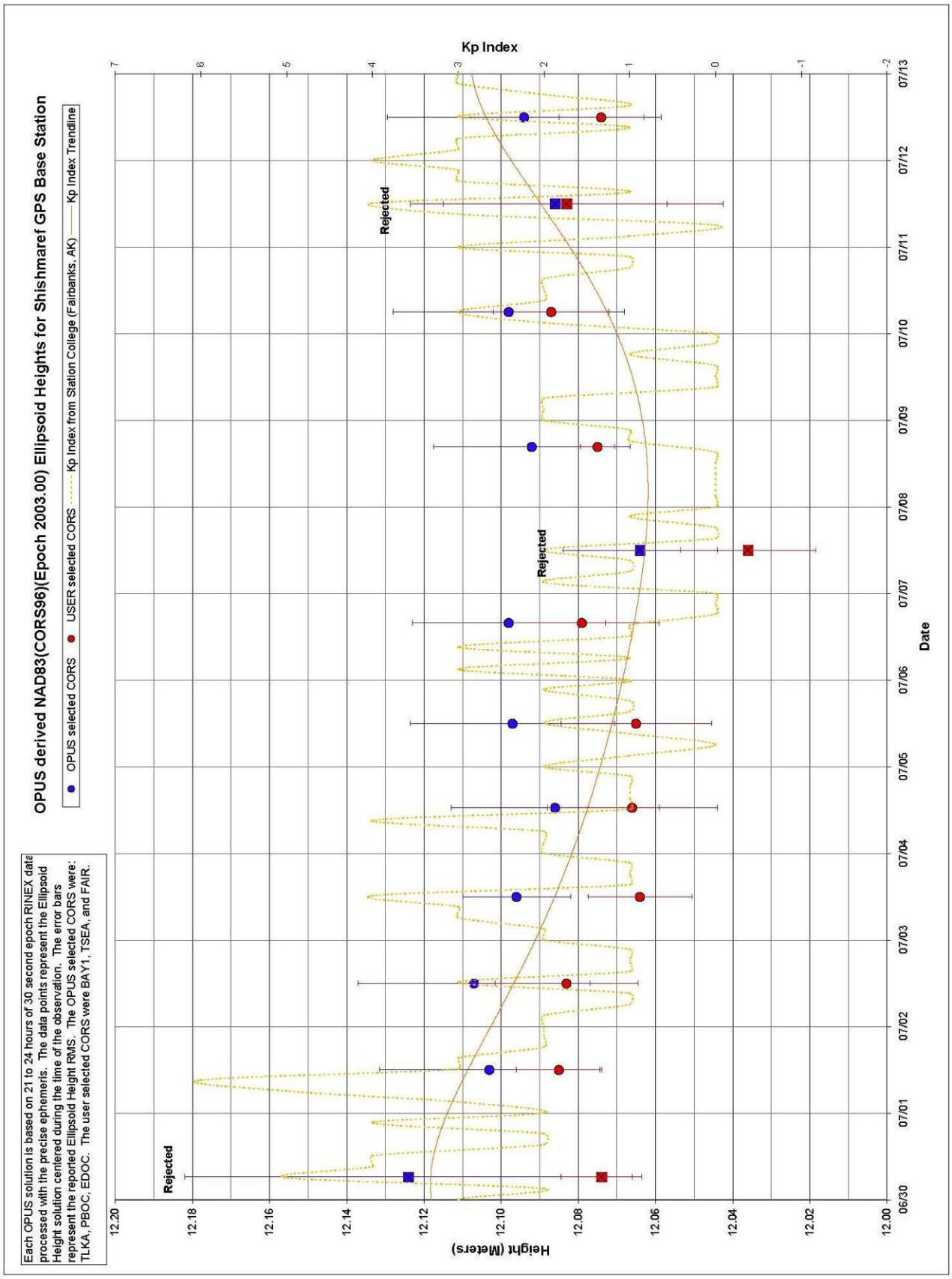
## Table of Individual GPS Session Solutions

Rejected Solutions are Bold and Gray

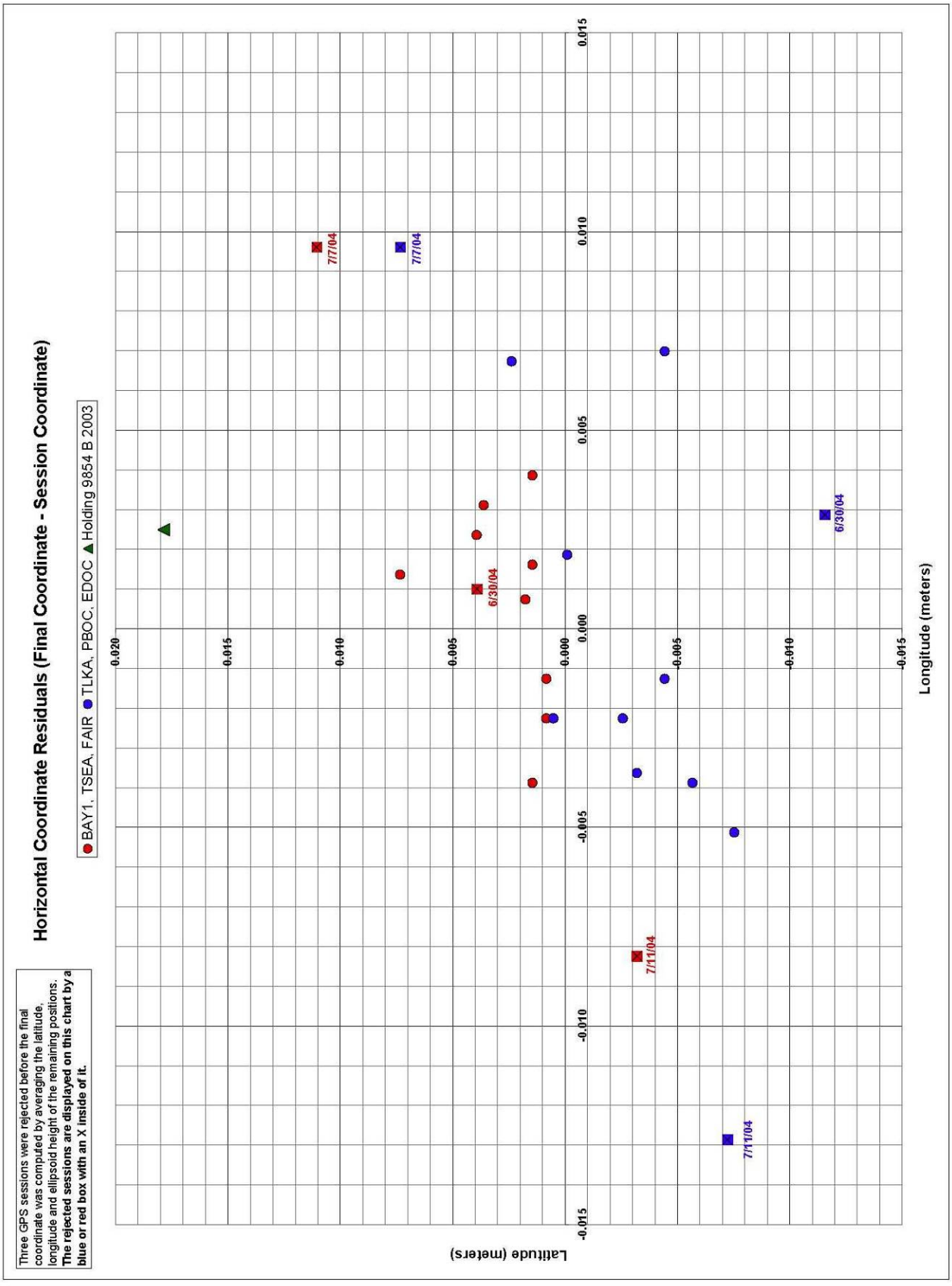
| | | NAD83(CORS96)(EPOCH:2003.0000) | | | | | Residuals (Final - Each Session) | | |
|---|---|---|---|---|---|---|---|---|---|
| CORS | Date | Latitude | Longitude | Ellipsoid Height | EH RMS | Used in Final Position | Latitude (m) | Longitude (m) | Ellipsoid Height (m) |
| **BAY1, TSEA, FAIR** | **June 30** | **66 15 18.97418** | **166 4 11.32451** | **12.074** | **0.021** | **Rejected** | **0.001** | **0.004** | **0.012** |
| BAY1, TSEA, FAIR | July 01 | 66 15 18.97420 | 166 4 11.32500 | 12.085 | 0.022 | Accepted | 0.001 | -0.002 | 0.001 |
| BAY1, TSEA, FAIR | July 02 | 66 15 18.97410 | 166 4 11.32463 | 12.083 | 0.037 | Accepted | 0.004 | 0.002 | 0.003 |
| BAY1, TSEA, FAIR | July 03 | 66 15 18.97417 | 166 4 11.32476 | 12.064 | 0.027 | Accepted | 0.002 | 0.001 | 0.022 |
| BAY1, TSEA, FAIR | July 04 | 66 15 18.97411 | 166 4 11.32457 | 12.066 | 0.044 | Accepted | 0.004 | 0.003 | 0.020 |
| BAY1, TSEA, FAIR | July 05 | 66 15 18.97420 | 166 4 11.32492 | 12.065 | 0.039 | Accepted | 0.001 | -0.001 | 0.021 |
| BAY1, TSEA, FAIR | July 06 | 66 15 18.97418 | 166 4 11.32513 | 12.079 | 0.040 | Accepted | 0.001 | -0.004 | 0.007 |
| **BAY1, TSEA, FAIR** | **July 07** | **66 15 18.97387** | **166 4 11.32405** | **12.036** | **0.035** | **Rejected** | **0.011** | **0.010** | **0.050** |
| BAY1, TSEA, FAIR | July 08 | 66 15 18.97418 | 166 4 11.32469 | 12.075 | 0.009 | Accepted | 0.001 | 0.002 | 0.011 |
| BAY1, TSEA, FAIR | July 10 | 66 15 18.97410 | 166 4 11.32474 | 12.087 | 0.030 | Accepted | 0.004 | 0.001 | -0.001 |
| **BAY1, TSEA, FAIR** | **July 11** | **66 15 18.97433** | **166 4 11.32548** | **12.083** | **0.081** | **Rejected** | **-0.003** | **-0.008** | **0.003** |
| BAY1, TSEA, FAIR | July 12 | 66 15 18.97399 | 166 4 11.32471 | 12.074 | 0.022 | Accepted | 0.007 | 0.001 | 0.012 |
| **TLKA, PBOC, EDOC** | **June 30** | **66 15 18.97460** | **166 4 11.32459** | **12.124** | **0.116** | **Rejected** | **-0.012** | **0.003** | **-0.038** |
| TLKA, PBOC, EDOC | July 01 | 66 15 18.97431 | 166 4 11.32500 | 12.103 | 0.057 | Accepted | -0.003 | -0.002 | -0.017 |
| TLKA, PBOC, EDOC | July 02 | 66 15 18.97437 | 166 4 11.32426 | 12.107 | 0.060 | Accepted | -0.004 | 0.007 | -0.021 |
| TLKA, PBOC, EDOC | July 03 | 66 15 18.97441 | 166 4 11.32513 | 12.096 | 0.028 | Accepted | -0.006 | -0.004 | -0.010 |
| TLKA, PBOC, EDOC | July 04 | 66 15 18.97421 | 166 4 11.32500 | 12.086 | 0.054 | Accepted | 0.001 | -0.002 | 0.000 |
| TLKA, PBOC, EDOC | July 05 | 66 15 18.97423 | 166 4 11.32467 | 12.097 | 0.053 | Accepted | 0.000 | 0.002 | -0.011 |
| TLKA, PBOC, EDOC | July 06 | 66 15 18.97437 | 166 4 11.32492 | 12.098 | 0.050 | Accepted | -0.004 | -0.001 | -0.012 |
| **TLKA, PBOC, EDOC** | **July 07** | **66 15 18.97399** | **166 4 11.32405** | **12.064** | **0.040** | **Rejected** | **0.007** | **0.010** | **0.022** |
| TLKA, PBOC, EDOC | July 08 | 66 15 18.97447 | 166 4 11.32523 | 12.092 | 0.051 | Accepted | -0.008 | -0.005 | -0.006 |
| TLKA, PBOC, EDOC | July 10 | 66 15 18.97433 | 166 4 11.32511 | 12.098 | 0.060 | Accepted | -0.003 | -0.004 | -0.012 |
| **TLKA, PBOC, EDOC** | **July 11** | **66 15 18.97446** | **166 4 11.32585** | **12.086** | **0.058** | **Rejected** | **-0.007** | **-0.013** | **0.000** |
| TLKA, PBOC, EDOC | July 12 | 66 15 18.97415 | 166 4 11.32428 | 12.094 | 0.071 | Accepted | 0.002 | 0.007 | -0.008 |

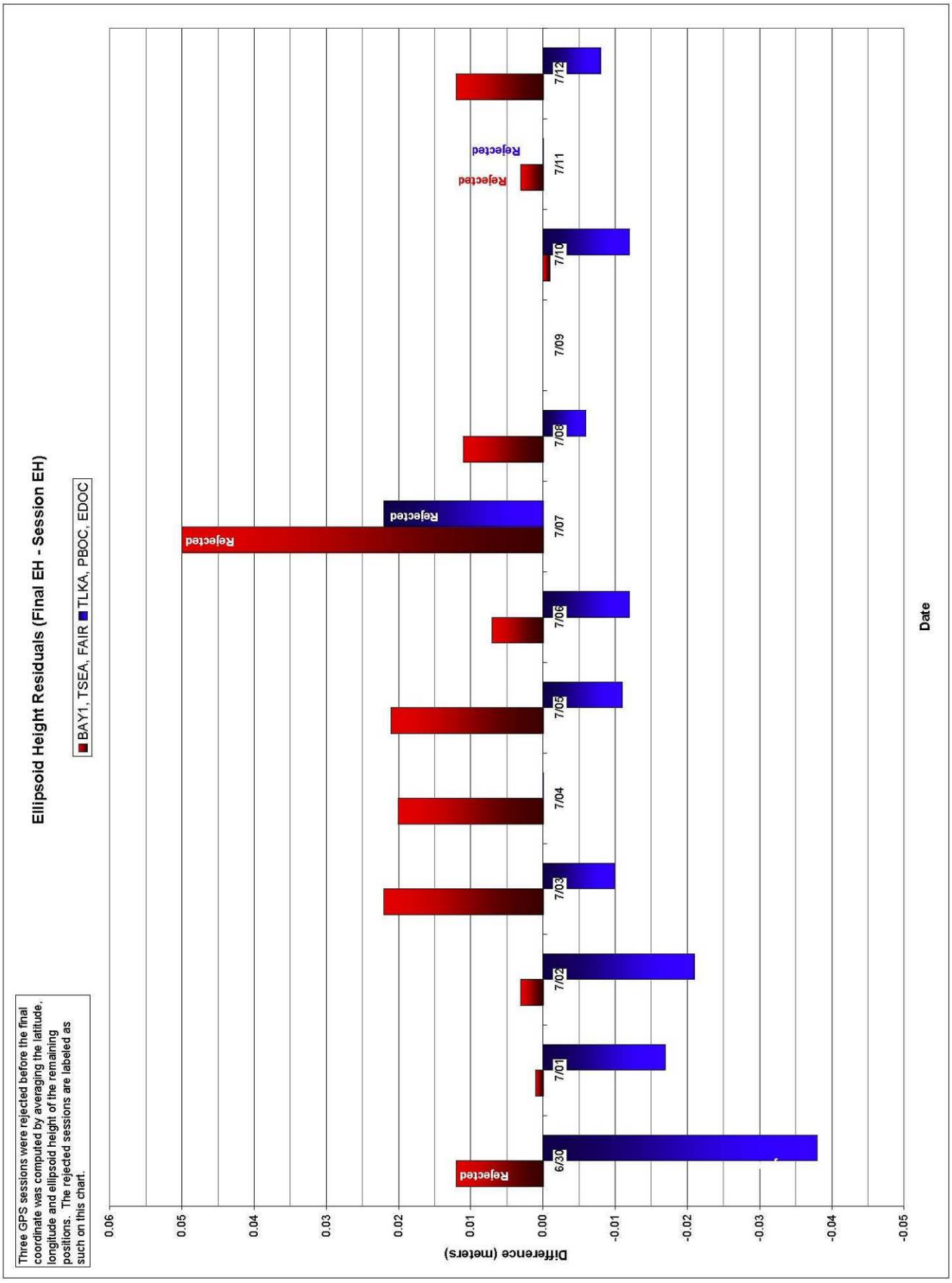
## GPS Solution Holding 2003 Coordinates

| | | NAD83(CORS96)(EPOCH:2003.0000) | | | | | Residuals (Final - Each Session) | | |
|---|---|---|---|---|---|---|---|---|---|
| Control Station | Date | Latitude | Longitude | Ellipsoid Height | EH RMS | Used in Final Position | Latitude (m) | Longitude (m) | Ellipsoid Height (m) |
| 9854 B 2003 | July 04 | 66 15 18.97365 | 166 04 11.32462 | 12.096 | 0.005 | QC Only | 0.018 | 0.002 | -0.010 |


OPUS derived NAD83(CORS96)(Epoch 2003.00) Ellipsoid Heights for Shishmaref GPS Base Station
OPUS selected CORS
USER selected CORS
Kp Index from Station College (Fairbanks, AK)
Kp Index Trendline
Each OPUS solution is based on 21 to 24 hours of 30 second epoch RINEX data processed with the precise ephemeris. The data points represent the Ellipsoid Height solution centered during the time of the observation. The error bars represent the reported Ellipsoid Height RMS. The OPUS selected CORS were: TLKA, PBOC, EDOC. The user selected CORS were BAY1, TSEA, and FAIR.
Rejected
Rejected
Rejected
Kp Index
Height (Meters)
Date
12.20
12.18
12.16
12.14
12.12
12.10
12.08
12.06
12.04
12.02
12.00
7
6
5
4
3
2
1
0
-1
-2
06/30
07/01
07/02
07/03
07/04
07/05
07/06
07/07
07/08
07/09
07/10
07/11
07/12
07/13


Differences in Position of Shishmaref Base Station by GPS Session
Difference in Latitude
Difference in Longitude
Difference in Ellipsoid Height
Two OPUS solutions were obtained for each GPS session at the Shishmaref Base Station. One solution used the default OPUS chosen CORS: PBOC, EDOC and TLKA. The second solutions used User chosen CORS: BAY1, TSEA and FAIR. This chart shows the difference between those solutions in meters by GPS session.
Differences (Meters)
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
Rejected
Rejected
Rejected
6/30
7/01
7/02
7/03
7/04
7/05
7/06
7/07
7/08
7/09
7/10
7/11
7/12
Date

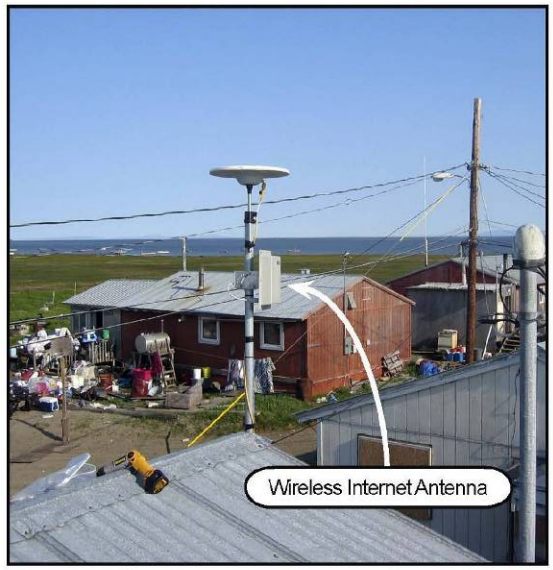

Three GPS sessions were rejected before the final coordinate was computed by averaging the latitude, longitude and ellipsoid height of the remaining positions. The rejected sessions are displayed on this chart by a blue or red box with an X inside of it.
Horizontal Coordinate Residuals (Final Coordinate - Session Coordinate)
BAY1, TSEA, FAIR TLKA, PBOC, EDOC Holding 9854 B 2003
0.020
0.015
0.010
0.005
0.000
-0.005
-0.010
-0.015
Latitude (meters)
0.015
0.010
0.005
0.000
-0.005
-0.010
-0.015
Longitude (meters)
7/7/04
7/7/04
6/30/04
7/11/04
7/11/04
6/30/04


Ellipsoid Height Residuals (Final EH - Session EH)
BAY1, TSEA, FAIR
TLKA, PBOC, EDOC
Three GPS sessions were rejected before the final coordinate was computed by averaging the latitude, longitude and ellipsoid height of the remaining positions. The rejected sessions are labeled as such on this chart.
Difference (meters)
0.06
0.05
0.04
0.03
0.02
0.01
0.00
-0.01
-0.02
-0.03
-0.04
-0.05
Date
6/30
7/01
7/02
7/03
7/04
7/05
7/06
7/07
7/08
7/09
7/10
7/11
7/12
Rejected

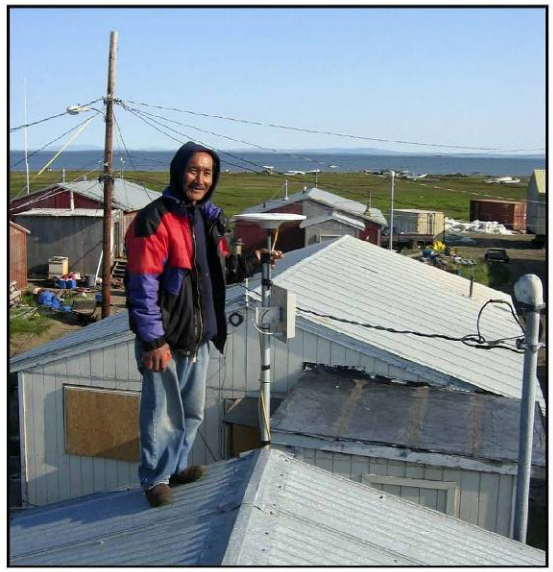
# Shishmaref GPS Base Station 2004




Aerial view of Shishmaref, Alaska. The GPS base station was located on the roof of Gene Snell's house, approximately 0.5km ENE of the Shishmaref runway.




*View to the SW* *June 29, 2004*
Trimble Zephyr Geodetic antenna on pole on south roof peak of house.



*View to the South* *June 29, 2004*
Gene Snell next to the Trimble Zephyr Geodetic antenna.

# Wales GPS Base Station Survey

**Procedure:** The Wales GPS base station was installed on July 1st, 2004 and removed on August 14th, 2004. The base station consisted of an AeroMap US provided Trimble 5700 dual frequency receiver (S/N #4805) with JOA provided 512MB flash card and a Trimble Zephyr Geodetic antenna (S/N #12545665). The antenna was mounted on an all-thread rod which was clamped to a 2 x 3 board screwed onto the wood support for the ladder at the peak of the roof on the AK DOTPF building on the apron of the Wales Airport. The receiver collected 1 second epoch data.

The final coordinate for this GPS base station refers to the ARP of the antenna. The coordinate was determined by averaging OPUS solutions of 5 separate GPS sessions varying in length from 13 to 24 hours and decimated to a 30 second epoch interval. Two OPUS solutions were obtained for each GPS session. One solution was derived using the default CORS chosen by OPUS (TLKA, EDOC and PBOC) and a second solution was determined using CORS chosen by the user (FAIR, TSEA and BAY1). It was believed that the user chosen stations would provide a check on the original OPUS solution. The OPUS solutions from eight GPS sessions were originally considered, however the solutions from three sessions were rejected due to large RMS in the Ellipsoid Height, large deviation in the Ellipsoid Height from the average, or large deviation in the horizontal position from the average.

Another check was performed by processing with Trimble Geomatics Office v1.62 the GPS baseline that was 11.5 hours in length between tidal bench mark 9460 A 2003, a monument with coordinates from the 2003 GPS survey, and the Wales GPS Base Station. The position for the Wales GPS Base Station that was derived from this baseline was within a couple of centimeters of the final average position from OPUS. The difference was attributed to the different control stations used between 2003 (NGS survey monuments) and 2004 (CORS only).

## Final Coordinate for 2004 Wales GPS Base Station

NAD83(CORS96)(EPOCH:2003.0000)

| | | RMS (m) |
|---|---|---|
| Latitude: | **65 36 59.2838 N** | 0.002 |
| Longitude: | **168 5 36.9814 W** | 0.003 |
| Ellipsoid Height: | **17.176 m** | 0.010 |
| Ellipsoid to NAVD88: | **-3.553 m** (from 2003 survey) | |
| Derived NAVD88: | **13.630 m** | |

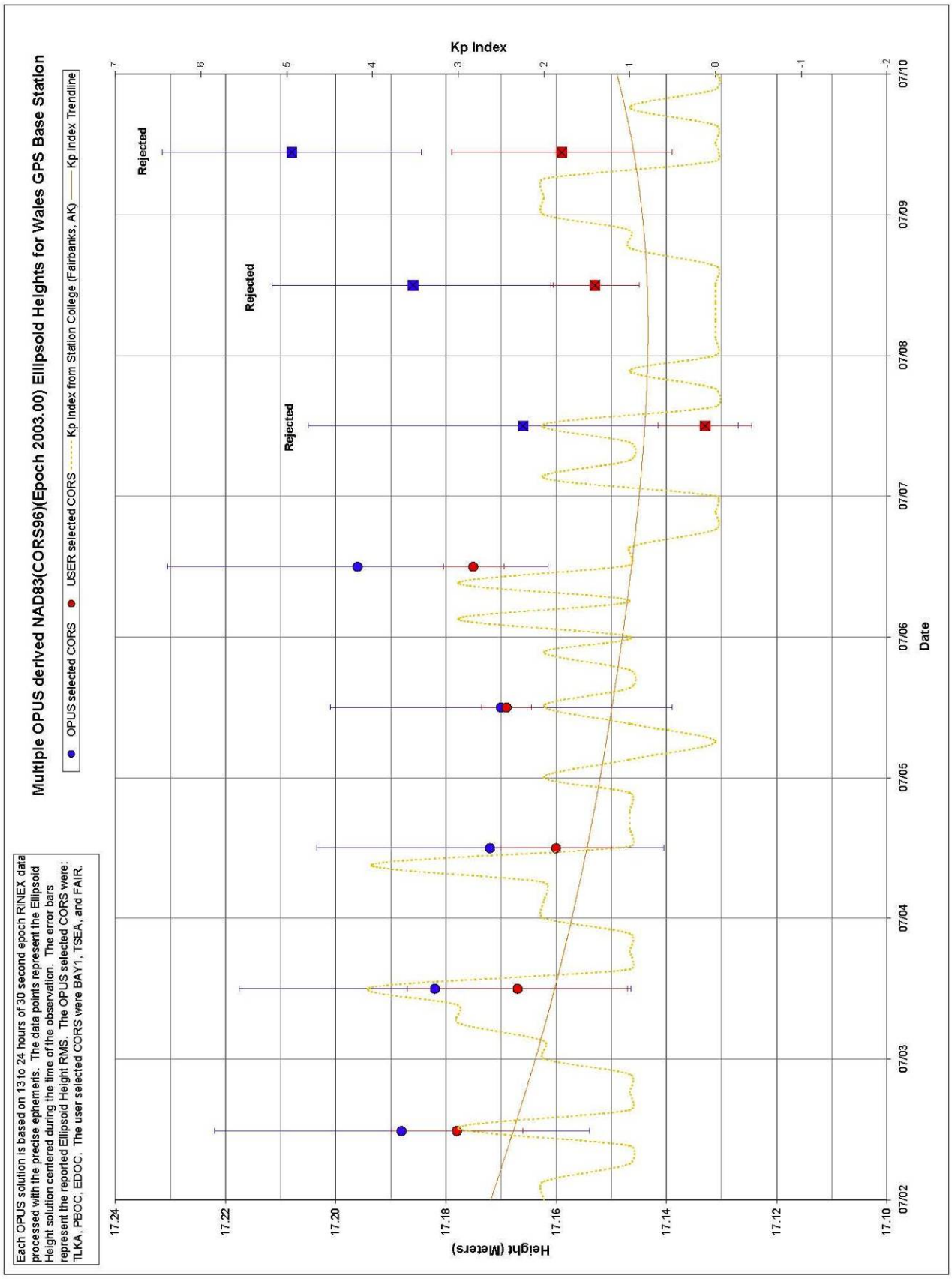
## Table of Individual GPS Session Solutions

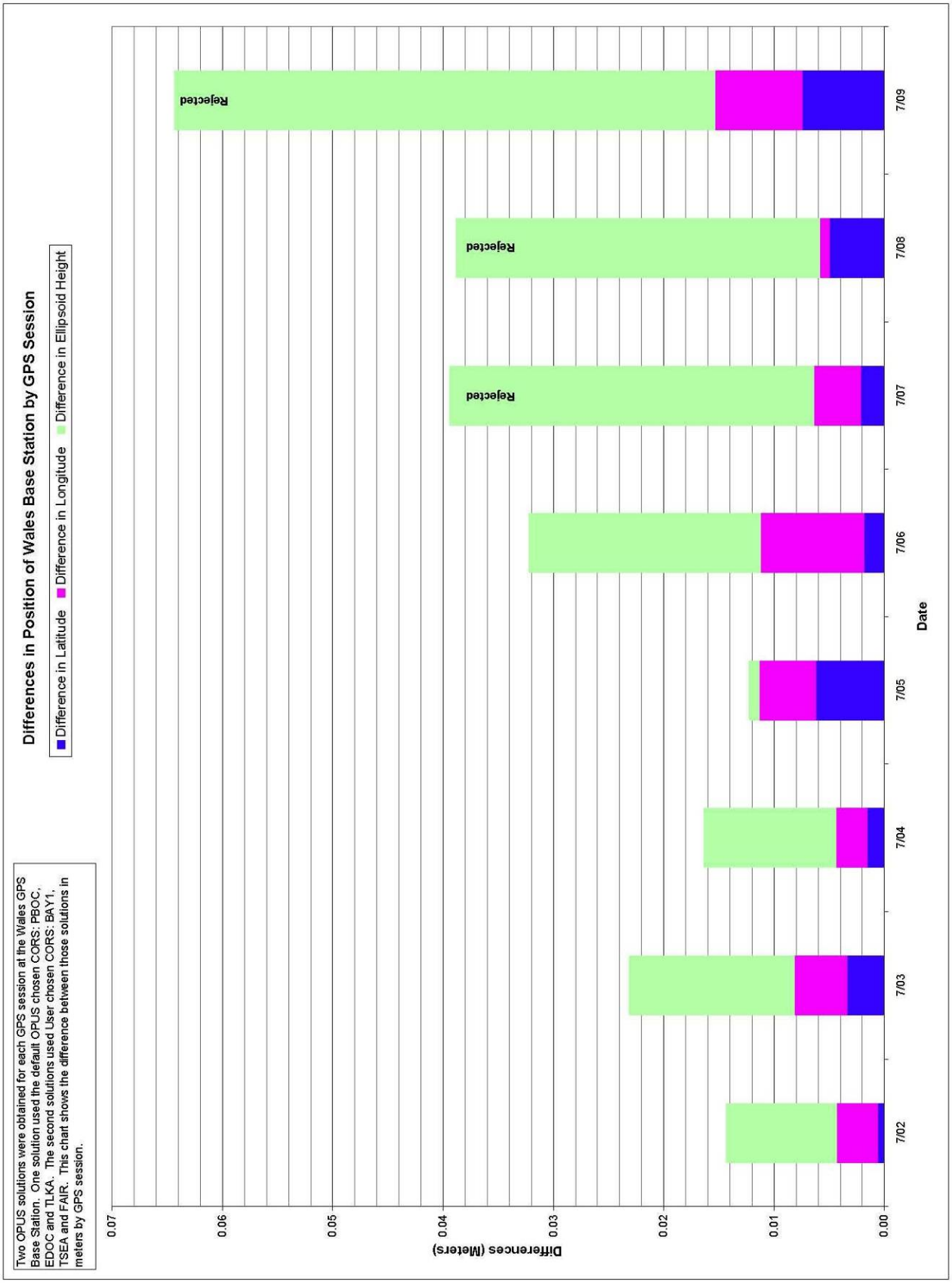
Rejected Solutions are Bold and Gray

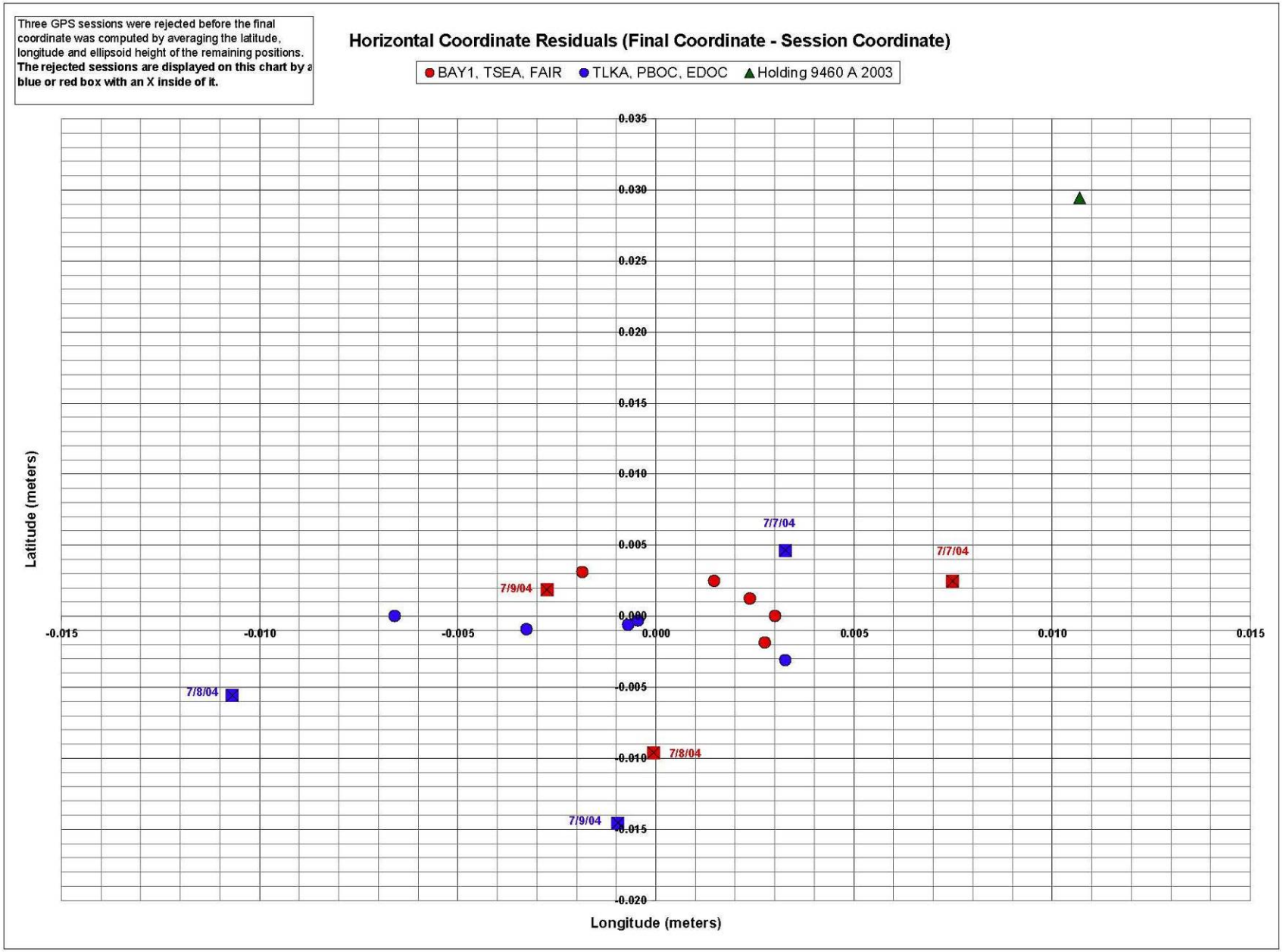
| | | NAD83(CORS96)(EPOCH:2003.0000) | | | | | Residuals (Final - Each Session) | | |
|---|---|---|---|---|---|---|---|---|---|
| CORS | Date | Latitude | Longitude | Ellipsoid Height | EH RMS | Used in Final Position | Latitude (m) | Longitude (m) | Ellipsoid Height (m) |
| BAY1, TSEA, FAIR | July 02 | 65 36 59.28375 | 168 5 36.98111 | 17.178 | 0.024 | Accepted | 0.000 | 0.003 | -0.002 |
| BAY1, TSEA, FAIR | July 03 | 65 36 59.28367 | 168 5 36.98123 | 17.167 | 0.040 | Accepted | 0.002 | 0.001 | 0.009 |
| BAY1, TSEA, FAIR | July 04 | 65 36 59.28371 | 168 5 36.98116 | 17.160 | 0.020 | Accepted | 0.001 | 0.002 | 0.016 |
| BAY1, TSEA, FAIR | July 05 | 65 36 59.28365 | 168 5 36.98149 | 17.169 | 0.009 | Accepted | 0.003 | -0.002 | 0.007 |
| BAY1, TSEA, FAIR | July 06 | 65 36 59.28381 | 168 5 36.98113 | 17.175 | 0.011 | Accepted | -0.002 | 0.003 | 0.001 |
| **BAY1, TSEA, FAIR** | **July 07** | **65 36 59.28367** | **168 5 36.98076** | **17.133** | **0.017** | **Rejected** | **0.002** | **0.007** | **0.043** |
| **BAY1, TSEA, FAIR** | **July 08** | **65 36 59.28406** | **168 5 36.98135** | **17.153** | **0.016** | **Rejected** | **-0.010** | **0.000** | **0.023** |
| **BAY1, TSEA, FAIR** | **July 09** | **65 36 59.28369** | **168 5 36.98156** | **17.159** | **0.040** | **Rejected** | **0.002** | **-0.003** | **0.017** |
| TLKA, PBOC, EDOC | July 02 | 65 36 59.28377 | 168 5 36.98140 | 17.188 | 0.068 | Accepted | -0.001 | -0.001 | -0.012 |
| TLKA, PBOC, EDOC | July 03 | 65 36 59.28378 | 168 5 36.98160 | 17.182 | 0.071 | Accepted | -0.001 | -0.003 | -0.006 |
| TLKA, PBOC, EDOC | July 04 | 65 36 59.28376 | 168 5 36.98138 | 17.172 | 0.063 | Accepted | 0.000 | 0.000 | 0.004 |
| TLKA, PBOC, EDOC | July 05 | 65 36 59.28385 | 168 5 36.98109 | 17.170 | 0.062 | Accepted | -0.003 | 0.003 | 0.006 |
| TLKA, PBOC, EDOC | July 06 | 65 36 59.28375 | 168 5 36.98186 | 17.196 | 0.069 | Accepted | 0.000 | -0.007 | -0.020 |
| **TLKA, PBOC, EDOC** | **July 07** | **65 36 59.28360** | **168 5 36.98109** | **17.166** | **0.078** | **Rejected** | **0.005** | **0.003** | **0.010** |
| **TLKA, PBOC, EDOC** | **July 08** | **65 36 59.28422** | **168 5 36.98142** | **17.186** | **0.051** | **Rejected** | **-0.015** | **-0.001** | **-0.010** |
| **TLKA, PBOC, EDOC** | **July 09** | **65 36 59.28393** | **168 5 36.98218** | **17.208** | **0.047** | **Rejected** | **-0.006** | **-0.011** | **-0.032** |

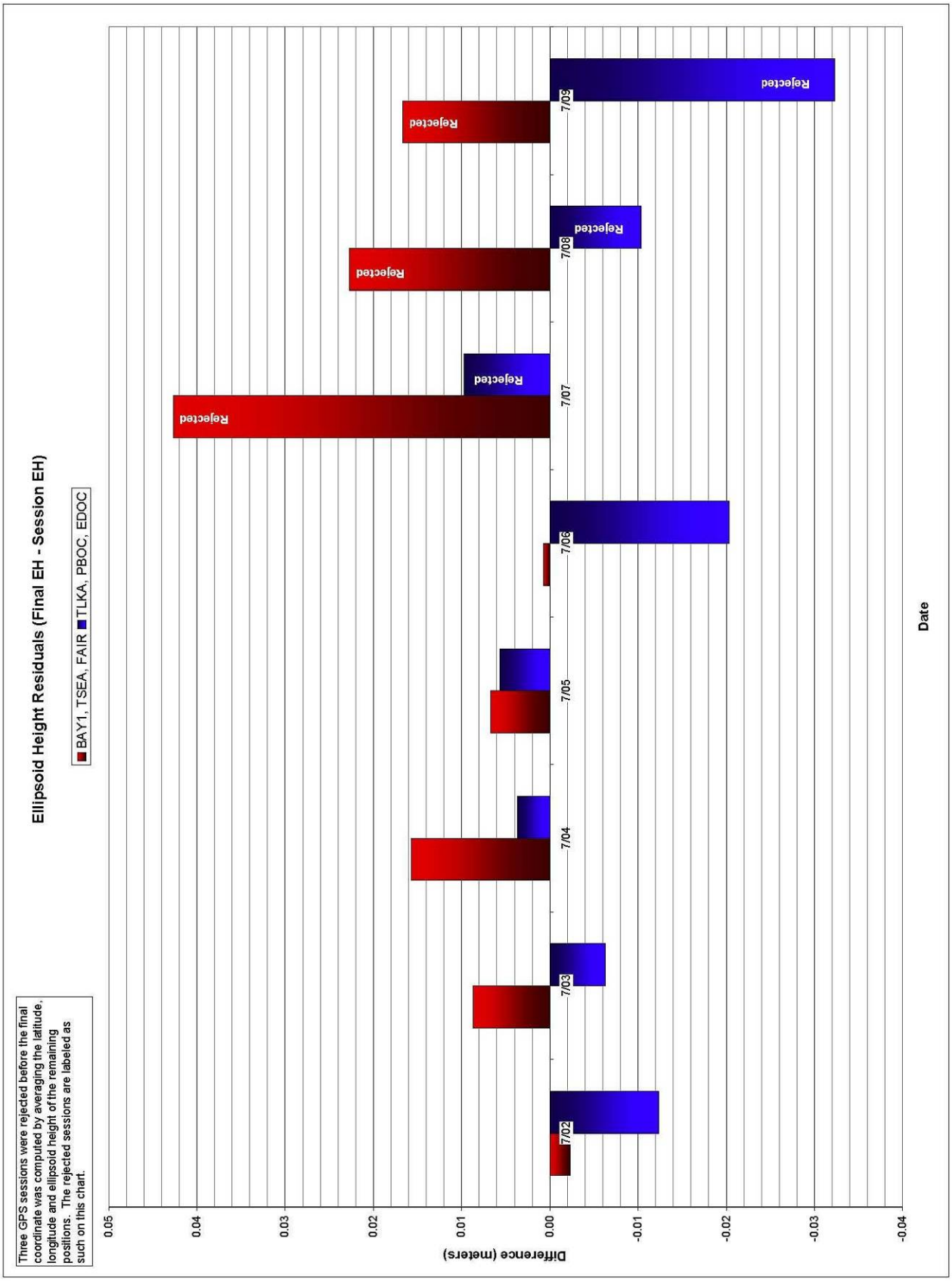
## GPS Solution Holding 2003 Coordinates

| | | NAD83(CORS96)(EPOCH:2003.0000) | | | | | Residuals (Final - Each Session) | | |
|---|---|---|---|---|---|---|---|---|---|
| Control Station | Date | Latitude | Longitude | Ellipsoid Height | EH RMS | Used in Final Position | Latitude (m) | Longitude (m) | Ellipsoid Height (m) |
| 9460 A 2003 | July 02 | 65 36 59.28280 | 168 05 36.98051 | 17.190 | 0.006 | QC Only | 0.029 | 0.011 | -0.014 |

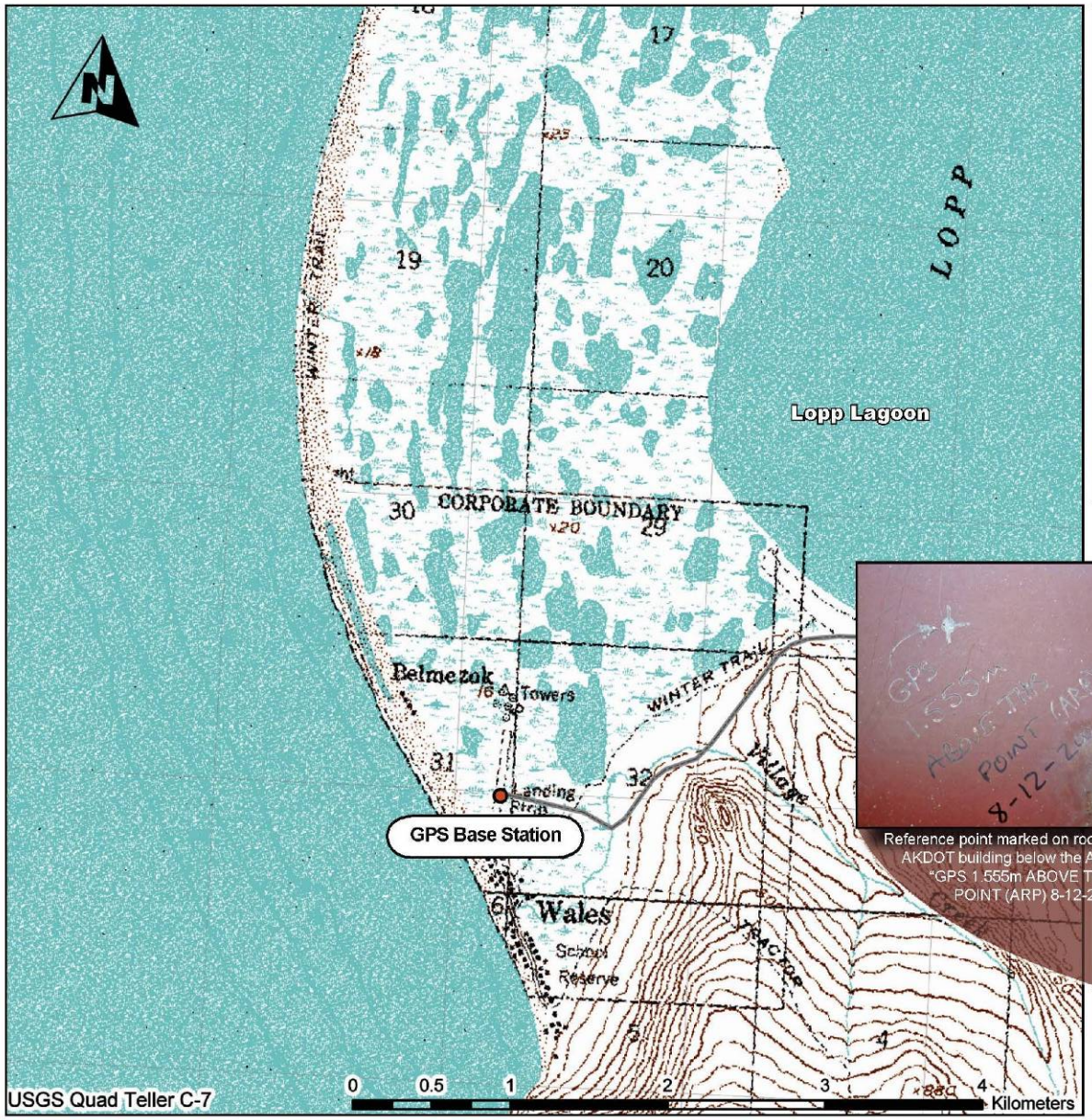

Multiple OPUS derived NAD83(CORS96)(Epoch 2003.00) Ellipsoid Heights for Wales GPS Base Station
OPUS selected CORS
USER selected CORS
Kp Index from Station College (Fairbanks, AK)
Kp Index Trendline
Each OPUS solution is based on 13 to 24 hours of 30 second epoch RINEX data processed with the precise ephemeris. The data points represent the Ellipsoid Height solution centered during the time of the observation. The error bars represent the reported Ellipsoid Height RMS. The OPUS selected CORS were: TLKA, PBOC, EDOC. The user selected CORS were BAY1, TSEA, and FAIR.
Rejected
Rejected
Rejected
Kp Index
Height (Meters)
Date
17.24
17.22
17.20
17.18
17.16
17.14
17.12
17.10
07/02
07/03
07/04
07/05
07/06
07/07
07/08
07/09
07/10
7
6
5
4
3
2
1
0
-1
-2


Differences in Position of Wales Base Station by GPS Session
Difference in Latitude
Difference in Longitude
Difference in Ellipsoid Height
Two OPUS solutions were obtained for each GPS session at the Wales GPS Base Station. One solution used the default OPUS chosen CORS: PBOC, EDOC and TLKA. The second solutions used User chosen CORS: BAY1, TSEA and FAIR. This chart shows the difference between those solutions in meters by GPS session.
Differences (Meters)
0.00
0.01
0.02
0.03
0.04
0.05
0.06
0.07
Rejected
Rejected
Rejected
7/02
7/03
7/04
7/05
7/06
7/07
7/08
7/09
Date

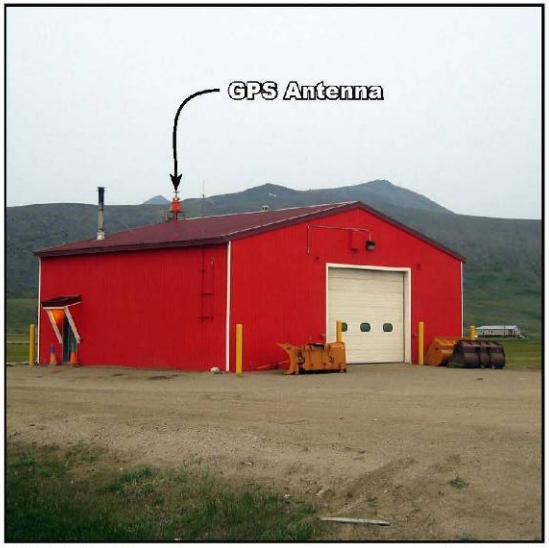

Three GPS sessions were rejected before the final coordinate was computed by averaging the latitude, longitude and ellipsoid height of the remaining positions. The rejected sessions are displayed on this chart by a blue or red box with an X inside of it.
Horizontal Coordinate Residuals (Final Coordinate - Session Coordinate)
BAY1, TSEA, FAIR
TLKA, PBOC, EDOC
Holding 9460 A 2003
Latitude (meters)
Longitude (meters)
0.035
0.030
0.025
0.020
0.015
0.010
0.005
0.000
-0.005
-0.010
-0.015
-0.020
-0.015
-0.010
-0.005
0.000
0.005
0.010
0.015
7/7/04
7/7/04
7/9/04
7/8/04
7/8/04
7/9/04


Ellipsoid Height Residuals (Final EH - Session EH)
BAY1, TSEA, FAIR
TLKA, PBOC, EDOC
Three GPS sessions were rejected before the final coordinate was computed by averaging the latitude, longitude and ellipsoid height of the remaining positions. The rejected sessions are labeled as such on this chart.
Difference (meters)
0.05
0.04
0.03
0.02
0.01
0.00
-0.01
-0.02
-0.03
-0.04
7/02
7/03
7/04
7/05
7/06
7/07
7/08
7/09
Rejected
Date

# Wales GPS Base Station 2004




Map of Wales, Alaska. The GPS base station was located on the above the peak of the roof of the AKDOT building on the apron of the Wales Airport.,




*View to the SW* *July 1, 2004*
AKDOT building on the apron of the Wales Airport.




Reference point marked on roof of AKDOT building below the ARP: "GPS 1.555m ABOVE THIS POINT (ARP) 8-12-2004"



*View to the North* *July 1, 2004*
Trimble Zephyr Geodetic antenna mounted on board on AKDOT building.

# 11. PRODUCT CREATION

This section details how the final products were generated for this project from the raw LIDAR data. Also included in this section is a copy of the metadata for the project in plain text format. The metadata has more detailed information on Product Creation. This document is meant to provide an overview of the Product Creation. A copy in .xml format of the metadata was included with the data deliverables to NOAA.

**Project Datum and Projection:**
As specified by NOAA the basic control for the project was in NAD83 (CORS96) (EPOCH:2003.000) and NAVD88. The NAVD88 heights were derived by GPS means by John Oswald and Associates (see their report in Section 10 – Ground Control "GPS Base Station Reports"). This derived elevation for the base stations at Kotzebue, Wales, Shishmaref, Kivalina and Point Hope are based on NGS control stations at Nome and Noatak that have NAVD88 heights. Because of the distance of the project base stations from Nome and Noatak, the derived NAVD88 heights for the project base stations is somewhat in question. AeroMap suggested early on in negotiations with NOAA on this project that perhaps ellipsoidal heights may be a better solution for this project, but NOAA decided to stay with the derived NAVD88 heights. At a later date, under a separate task order, AeroMap delivered all the LIDAR data in ellipsoid heights to NOAA.

The projection for this project is UTM meters Zone 3.

**Data Processing**
LIDAR data processing is divided into three main categories:

- "Point Cloud" Processing
- Classification
- Specialized Processing

The process for each of these categories is summarized below:

1. *"Point Cloud" Processing* – This step involves downloading the data, computing the trajectory, then deriving the "Point Cloud" of LIDAR data. The raw data for a mission are stored onboard on a removable disk drive in an Optech proprietary format. These data were downloaded either in the field or in the AeroMap Anchorage office. Here follows the steps processing to a "Point Cloud".
    a. Download data using Optech proprietary download program
    b. Separate data into strips representing each flight line
    c. Import data into Optech's proprietary main processing program "REALM"
    d. Compute GPS trajectory
    e. Compute blended GPS/inertial trajectory
    f. Process LIDAR points into "Point Cloud" in ASPRS standard .las format

    This "Point Cloud" data processing normally requires approximately 6 hours for each lift if there are no complications in the data acquisition.

2. *Classification* – The classification data processing involves importing the .las files into the Terrasolid suite of software for project setup, tiling, and initial classification. The main Terrasolid module used for classification is TerraScan that runs in the Bentley MicroStation environment. TerraScan is a very flexible package that allows the data processor to set up macro processes to classify the data into first return, bare earth, and vegetation/building classes based on the different types of terrain and ground cover. The data is visualized with a separate software application called QT Viewer that allows for viewing the data from many perspectives in different classes. As part of the automated classification process, the LIDAR data goes through a Quality Control check to insure that the LIDAR data meets the project requirements for accuracy by using the QC surveys performed earlier. When the automated classification is complete, the data tiles are then sent to the manual editing phase. For the manual editing phase, AeroMap firmly believes that LIDAR data is best interpreted and edited by people who have had extensive experience working with photogrammetric data. These trained people are familiar with looking at various types of terrain, and they are best suited to making sure that the LIDAR data is classified properly in this manual edit phase.
3. *Specialized Processing* – Once the data was classified to bare earth and manually edited, then the data deliverables were generated and written to a portable external USB 2.0 disk drive that was delivered to NOAA.

## 11.1 LIDAR Metadata

```
Identification_Information:
  Citation:
    Citation_Information:
      Originator: AeroMap U.S.
      Publication_Date: 20060322
      Title: LIDAR-NOAA-AK0301 & AK0302 JOB #6030810
      Edition: 1.0
      Geospatial_Data_Presentation_Form: Digital Point Data
      Publication_Information:
        Publication_Place: Anchorage, Alaska
        Publisher: AeroMap U.S.
  Description:
    Abstract:
      The data sets are generated using the OPTECH ALTM 70 kHz LIDAR sys-
tem mounted onboard AeroMap's twin-engine Cessna 320 aircraft. Classified
data sets such as this one may have varying posting due to some LIDAR
pulses not reaching the ground caused by data anomalies. Accuracy state-
ments are based on areas of moderate terrain.  Diminished accuracies are
to be expected in areas of extreme terrain and dense vegetation. The accu-
racy of each point is expected to meet the vertical accuracy standard,
however, derived products may be less accurate in extreme terrain and
dense vegetation due to a lesser number of points defining the bare-earth
in these areas.

      These data were classified using TerraSolid's TerraScan (Version
6.04) software from the originally acquired 4 return LIDAR data.

      1st_return data sets contain the points that were identified as the
"First return" from each laser pulse, back to the aircraft.  This means
that the data represent the first surface the beam encountered, frequently
buildings and vegetation in addition to those areas where both first and
last return are on the ground.  As such these data may not represent the
actual surface of the earth, but features that exist on the ground and
above the earth's surface.

      2nd_return data sets contain the points that were identified as the
"Second return" from each laser pulse, back to the aircraft. This means
that the data represent the second surface the beam encountered, fre-
quently buildings and vegetation. As such these data may not represent the
actual surface of the earth, but features that exist on the ground and
above the earth's surface.

      3rd_return data sets contain the points that were identified as the
"Third return" from each laser pulse, back to the aircraft. This means
that the data represent the third surface the beam encountered, frequently
buildings and vegetation . As such these data may not represent the actual
surface of the earth, but features that exist on the ground and above the
earth's surface.

      Last_return data sets contain the points that were identified as the
"Last_return" from each laser pulse, back to the aircraft. This means that
the data represent the last surface the beam encountered. This data is the
last return returned to the aircraft. It is from these data that the
Bare_earth is classified.
    Purpose:
```

The purpose of this data set is to provide a source for current and accurate digital elevation models (DEM) with vertical accuracy's of 30cm root mean square error (RMSE) or better.

These data were acquired at flying heights of 1200 and 2000 meters Above Mean Terrain (AMT) with post spacing planned for 1 and 2 meters. This data is not recommended for design mapping or engineering. A DEM is used as a fundamental layer of information in Geographic Information Systems (GIS). A number of the priority layers of spatial information recognized by the National Spatial Data Infrastructure may be derived from LIDAR DEMs, including elevation, hydrography, slope, aspect, and shoreline delineation.

```
  Time_Period_of_Content:
    Time_Period_Information:
      Multiple_Dates/Times:
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          Calendar_Date: 20040721
        Single_Date/Time:
          Calendar_Date: 20040722
        Single_Date/Time:
          Calendar_Date: 20040801
        Single_Date/Time:
          Calendar_Date: 20040805
        Single_Date/Time:
          Calendar_Date: 20040806
        Single_Date/Time:
          Calendar_Date: 20040811
    Currentness_Reference: ground condition
  Status:
    Progress: Complete
    Maintenance_and_Update_Frequency: Unknown
  Spatial_Domain:
    Bounding_Coordinates:
      West_Bounding_Coordinate: -168.530215
      East_Bounding_Coordinate: -162.633189
      North_Bounding_Coordinate: 68.359970
      South_Bounding_Coordinate: 65.594656
  Keywords:
    Theme:
      Theme_Keyword_Thesaurus: None
      Theme_Keyword: Elevation
      Theme_Keyword: Cartography
      Theme_Keyword: Geodesy
      Theme_Keyword: Geography
      Theme_Keyword: Hydrography
      Theme_Keyword: Mapping
      Theme_Keyword: Photogrammetry
      Theme_Keyword: Stereophotogrammetry
      Theme_Keyword: Topography
      Theme_Keyword: Radar
      Theme_Keyword: Interferometric
      Theme_Keyword: Remote
      Theme_Keyword: Sensing
      Theme_Keyword: LIDAR
      Theme_Keyword: Laser
      Theme_Keyword: DEM
      Theme_Keyword: DTM
      Theme_Keyword: DSM
```

```
      Theme_Keyword: Terrain
      Theme_Keyword: Height
    Place:
      Place_Keyword_Thesaurus: None
      Place_Keyword: USA
      Place_Keyword: Alaska
      Place_Keyword: Seward Peninsula
      Place_Keyword: Wales
      Place_Keyword: Shishmaref
      Place_Keyword: Cape Espenburg
      Place_Keyword: Kotzebue
      Place_Keyword: Cape Krusenstern
      Place_Keyword: Kivilina
      Place_Keyword: Cape Seppings
      Place_Keyword: Cape Thompson
      Place_Keyword: Point Hope
    Stratum:
      Stratum_Keyword_Thesaurus: None
      Stratum_Keyword: Terrain
      Stratum_Keyword: Earth
      Stratum_Keyword: Surface
      Stratum_Keyword: Bald
      Stratum_Keyword: Ground
      Stratum_Keyword: First
    Temporal:
      Temporal_Keyword_Thesaurus: None
      Temporal_Keyword: July
      Temporal_Keyword: August
      Temporal_Keyword: 2004
  Access_Constraints: Purchase
  Use_Constraints: License Agreement
  Point_of_Contact:
    Contact_Information:
      Contact_Organization_Primary:
        Contact_Organization: AeroMap U.S.
        Contact_Person: Robert T. Thomason Jr.
      Contact_Position: LIDAR Production Manager
      Contact_Address:
        Address_Type: mailing and physical address
        Address: 2014 Merrill Field Drive
        City: Anchorage
        State_or_Province: Alaska
        Postal_Code: 99501-4116
        Country: USA
      Contact_Voice_Telephone: 907-677-9635
      Contact_Facsimile_Telephone: 907-274-3265
      Contact_Electronic_Mail_Address: thomason@aeromap.com
      Hours_of_Service: 8:00 am to 5:00 pm Alaska Time
  Native_Data_Set_Environment: Microsoft Windows 2000 Version 5.0 (Build
2195) Service Pack 3; ESRI ArcCatalog 8.3.0.800
Data_Quality_Information:
  Attribute_Accuracy:
  Completeness_Report: Complete
  Positional_Accuracy:
    Horizontal_Positional_Accuracy:
      Horizontal_Positional_Accuracy_Report: All data products were proc-
essed to meet 0.6 & 1.0 meters  RMSE or better in horizontal accuracy.
    Vertical_Positional_Accuracy:
```

```
      Vertical_Positional_Accuracy_Report: All data products were proc-
essed to meet 30cm root mean square error (RMSE) or better in vertical
accuracy. We recommend a ground quality control check of the data set.
This data is not recommended for design grade mapping or engineering.
  Lineage:
    Process_Step:
      Process_Description:
        The raw points for the point cloud data product were captured us-
ing AeroMap U.S.'s twin-engine Cessna equipped with our OPTECH ALTM 70 kHz
LIDAR data acquisition system. The system includes differential GPS and
inertial measurement systems to provide superior accuracy. The flying
height is 1200 & 2000 meters  Above Mean Terrain (AMT).

        These data were post-processed utilizing Optech's REALM (Version
3.5.4) software, which applies AeroMap U.S.'s Applanix Inertial Measure-
ment Unit (IMU) values to the acquired Airborne Global Positioning Systems
(ABGPS) data. These results are then applied to the acquired LIDAR data
points and output to a LIDAR accuracy standard (LAS) format in a WGS 84,
Universal Transverse Mercator (UTM), Zone 3, Meters coordinate system.

        Using Bentley's Microstation V8  LIDAR these data were imported in
LAS format. Using TerraSolid's TerraScan (Version 6.04) software,  these
data were imported into a TerraScan project file (PRJ) and converted (on
import) to binary files,  no data were classified, all original "point
cloud" data as output from REALM. These data were then output to the de-
liverable ASCII, space delimited, CTIXYZ format, (see attribute section
for explanation of ASCII file syntax).
      Process_Date: 20060324
      Process_Contact:
        Contact_Information:
          Contact_Person_Primary:
            Contact_Person: Robert T. Thomason Jr.
            Contact_Organization: AeroMap U.S.
          Contact_Position: LIDAR Production Manager
          Contact_Address:
            Address_Type: mailing and physical address
            Address: 2014 Merrill Field Drive
            City: Anchorage
            State_or_Province: Alaska
            Postal_Code: 99501-4116
            Country: USA
          Contact_Voice_Telephone: 907-677-9635
          Contact_Facsimile_Telephone: 907-274-3265
          Contact_Electronic_Mail_Address: thomason@aeromap.com
          Hours_of_Service: 8:00 am to 5:00 pm Alaska Time
  Cloud_Cover: none
Spatial_Data_Organization_Information:
  Direct_Spatial_Reference_Method: Point
  Point_and_Vector_Object_Information:
    SDTS_Terms_Description:
      SDTS_Point_and_Vector_Object_Type: Entity point
      Point_and_Vector_Object_Count: 1,605,257,945
Spatial_Reference_Information:
  Horizontal_Coordinate_System_Definition:
    Planar:
      Grid_Coordinate_System:
        Grid_Coordinate_System_Name: Universal Transverse Mercator
        Universal_Transverse_Mercator:
```

```
            UTM_Zone_Number: 3
            Transverse_Mercator:
              Scale_Factor_at_Central_Meridian: 0.999600
              Longitude_of_Central_Meridian: -165.000000
              Latitude_of_Projection_Origin: 0.000000
              False_Easting: 500000.000000
              False_Northing: 0.000000
          Planar_Coordinate_Information:
            Planar_Coordinate_Encoding_Method: coordinate pair
            Coordinate_Representation:
              Abscissa_Resolution: 0.000512
              Ordinate_Resolution: 0.000512
            Planar_Distance_Units: meters
        Geodetic_Model:
          Horizontal_Datum_Name: North American Datum of 1983
          Ellipsoid_Name: Geodetic Reference System 80
          Semi-major_Axis: 6378137.000000
          Denominator_of_Flattening_Ratio: 298.257222
      Vertical_Coordinate_System_Definition:
        Altitude_System_Definition:
          Altitude_Datum_Name: Ellipsoidal Heights
          Altitude_Resolution: .01
          Altitude_Distance_Units: meters
          Altitude_Encoding_Method: Attribute values
        Depth_System_Definition:
    Entity_and_Attribute_Information:
      Detailed_Description:
        Entity_Type:
          Entity_Type_Label: *.xyz
          Entity_Type_Definition: ASCII text data fields
          Entity_Type_Definition_Source: Software Generated
      Detailed_Description:
        Entity_Type:
          Entity_Type_Label: C
          Entity_Type_Definition: LIDAR "Class" of data point
          Entity_Type_Definition_Source: Software generated
      Detailed_Description:
        Entity_Type:
          Entity_Type_Label: T
          Entity_Type_Definition: LIDAR GPS Timestamp number
          Entity_Type_Definition_Source: Software generated
      Detailed_Description:
        Entity_Type:
          Entity_Type_Label: I
          Entity_Type_Definition: LIDAR "Intensity" value of data point
          Entity_Type_Definition_Source: Software Generated
      Detailed_Description:
        Entity_Type:
          Entity_Type_Label: X
          Entity_Type_Definition: Horizontal easting location of data point
          Entity_Type_Definition_Source: Software Generated
      Detailed_Description:
        Entity_Type:
          Entity_Type_Label: Y
          Entity_Type_Definition: Horizontal northing of data point
          Entity_Type_Definition_Source: Software Generated
      Detailed_Description:
        Entity_Type:
```

```
      Entity_Type_Label: Z
      Entity_Type_Definition: Vertical elevation of data point
      Entity_Type_Definition_Source: Software Generated
  Overview_Description:
Distribution_Information:
  Distributor:
    Contact_Information:
      Contact_Organization_Primary:
        Contact_Organization: AeroMap U.S.
        Contact_Person: Robert T. Thomason Jr.
      Contact_Position: LIDAR Production Manager
      Contact_Address:
        Address_Type: mailing and physical address
        Address: 2014 Merrill Field Drive
        City: Anchorage
        State_or_Province: Alaska
        Postal_Code: 99501-4116
        Country: USA
      Contact_Voice_Telephone: 907-677-9635
      Contact_Facsimile_Telephone: 907-274-3265
      Contact_Electronic_Mail_Address: thomason@aeromap.com
      Hours_of_Service: 8:00 am to 5:00 pm Alaska Time
  Resource_Description: LIDAR- AK0301 & AK0302
  Distribution_Liability:
    AeroMap U.S. assumes no liability for the data
    being used for purposes other than stated in this document.
  Standard_Order_Process:
    Digital_Form:
      Digital_Transfer_Information:
        Transfer_Size: 0.041
  Available_Time_Period:
    Time_Period_Information:
      Single_Date/Time:
        Calendar_Date: unknown
Metadata_Reference_Information:
  Metadata_Date: 20060324
  Metadata_Contact:
    Contact_Information:
      Contact_Organization_Primary:
        Contact_Organization: AeroMap U.S.
        Contact_Person: Robert T. Thomason Jr.
      Contact_Position: LIDAR Production Manager
      Contact_Address:
        Address_Type: mailing and physical address
        Address: 2014 Merrill Field Drive
        City: Anchorage
        State_or_Province: Alaska
        Postal_Code: 99501-4116
      Contact_Voice_Telephone: 907-677-9635
      Contact_Facsimile_Telephone: (907) 274-3265
      Contact_Electronic_Mail_Address: thomason@aeromap.com
  Metadata_Standard_Name: FGDC Content Standards for Digital Geospatial
Metadata
  Metadata_Standard_Version: FGDC-STD-001-1998
  Metadata_Time_Convention: local time
```

# 12. ACCURACY REPORT

Both Areas 301 and 302 had two different flight plans for data acquisition. All of the coastal areas were covered with a higher altitude - 2,000 meters Above Ground Level (AGL), flight plan designed to provide 2 meter average data postings, and to meet the required vertical accuracy of 0.30 meter RMSE. The areas near the communities of Shishmaref (Area 301), and Kivalina (Area 302), had areas where higher accuracy was required and there were additional flight plans designed at 1,200 metes AGL with average data postings of 1 meter. These lower altitude flight lines were also designed to meet a vertical accuracy requirement of 0.30 meter RMSE.

In all cases, the horizontal accuracy was to be the published manufacturer's specification of better than 1:2000 of the flying height. This meant that the horizontal accuracy of the LIDAR data points in the 2,000 meter AGL flight plans could vary up to 1.0 meter, and up to 0.6 meter for the 1,200 meter AGL flight plans.

See Section 2 – Planning, for more detail on flight plan design.

## Fundamental Vertical Accuracy Statements

The LIDAR data for the 2,000 meter flight plans have been compiled to meet a Fundamental Vertical Accuracy of 0.30 meter RMSE.

The LIDAR data for the 1,200 meter flight plans have been compiled to meet a Fundamental Vertical Accuracy of 0.30 meter RMSE.

Fundamental Vertical Accuracy is defined as the value by which vertical accuracy can be equitably assessed and compared among datasets. The fundamental Vertical Accuracy of a dataset must be determined by check points located only in open flat terrain where there is a very high probability that the sensor will have detected the ground.

## 12.1 - Airport Accuracy Reports

This following section describes the process used to determine how the LIDAR data compares to the required project specifications. This section also includes supporting documentation and maps organize in the following sub-sections:

- 12.2 Software and processes used to compute accuracy reports
- 12.3 TerraMatch results - Kotzebue, Shishmaref & Wales runways
- 12.4 TerraScan Output Control Reports - Wales & Shishmaref runways
- 12.5 JOA LIDAR Check Points
- 12.6 Maps of LIDAR QC Check points
- 12.7 TerraScan Output Control Reports - JOA LIDAR Check Points

## 12.2 - Software and Processes Used To Compute Accuracy Reports

AeroMap uses the software suite called Terrasolid from Finland (http://www.terrasolid.fi/). This software has become the de facto standard for LIDAR data processing for Optech ALTM systems. The accuracy reports in sections 12.3, 12.4 and 12.7 have been compiled from output reports from a Terrasolid software module called TerraScan and TerraMatch, which analyze both the quality of data upon itself, quality of data when compared to ground control, and any suggested calibration changes in pitch, roll, scale, and Dz or vertical consistency and bias.

During the autumn of 2004, some of the intermediate data files and accuracy reports were thought lost because of an unusual double failure of a RAID server, and a corrupted backup tape. These files were subsequently reconstructed, however this is no longer an issue as new intermediate files and reports have been created from the reprocessed raw data for this report.

## 12.3 - TerraMatch Results on Kotzebue, Shishmaref and Wales Runways

The following tables show the results from flights designed for checking system calibration with the TerraMatch module from Terrasolid. These reports show how well the LIDAR data checks on itself, and confirms that system calibration has not drifted or been jarred out of specified limits from the system's last calibration flight in Anchorage. These tables show a check of the LIDAR data without the inclusion of check points.

**Table 12.3.1 - Kotzebue Airport TerraMatch Flight Results July 19, 2004 JD 201**

| | |
|---|---|
| Trajectories: | |
| H:\6030810_NOAA\Kotzebue_TMatch\trj\ | |
| No known points | |
| Observe every 1th point | |
| Intensity not used | |
| Solution for whole data set | |
| Starting average dz: 0.0388 m | |
| Final average dz: 0.0390 m | Should not exceed 10 cm |
| Standard error of unit 0.0174 m | |
| Execution time: 17.6 sec | |
| Number of iterations: 2 | |
| Points 749300 | |
| Roll shift +0.0003 Std dev 0.0000 | Should not exceed 0.005 degrees |
| Pitch shift -0.0002 Std dev 0.0002 | Should not exceed 0.005 degrees |
| Scale +0.00012 | Should not exceed 0.0005 |

| | |
|---|---|
| Check Points | |
| Average magnitude: 0.0533 m | Should not exceed 0.10 meter |
| | |
| Flightline Points Magnitude Dz | |
| 7 296003 0.0320 -0.0138 | |
| 8 329629 0.0306 -0.0131 | |
| 10 432919 0.0690 +0.0233 | |
| 11 360800 0.0727 -0.0248 | |

**Table 12.3.2 - Shishmaref Airport TerraMatch Flight Results August 6, 2004 JD 219**

| | |
|---|---|
| Trajectories:<br>h:\6030810_noaa\Shishmaref_TMatch\203\TRJ\<br>No known points<br>Observe every 1th point<br>Intensity not used<br>Solution for whole data set<br><br>Starting average dz: 0.0480 m<br>Final average dz: 0.0486 m<br>Standard error of unit 0.0217 m<br><br>Execution time: 31.4 sec<br>Number of iterations: 2<br><br>Points 1189850<br>R shift -0.0004 Std dev 0.0000<br>P shift -0.0004 Std dev 0.0001<br>Scale +0.00007 | Should not exceed 10 cm<br><br>Should not exceed 0.005 degrees<br>Should not exceed 0.005 degrees<br>Should not exceed 0.0005 |

| | |
|---|---|
| Used loaded points<br>Average magnitude: 0.0721 m<br><br>Flightline Points Magnitude Dz<br>7 729986 0.1009 -0.0001<br>8 842153 0.0786 +0.0472<br>10 488704 0.0416 -0.0265<br>11 378646 0.0413 -0.0237 | Should not exceed 0.10 meter |

**Table 12.3.3 - Wales Airport TerraMatch Flight Results August 11, 2004 JD 224**

| | |
|---|---|
| Trajectories:<br>h:\6030810_noaa\Wales_TMatch\TRJ\<br>No known points<br>Observe every 1th point<br>Intensity not used<br>Solution for whole data set<br><br>Starting average dz: 0.0371 m<br>Final average dz: 0.0371 m<br>Standard error of unit 0.0166 m<br><br>Execution time: 8.9 sec<br>Number of iterations: 1<br><br>Points 364410<br>R shift +0.0000 Std dev 0.0000<br>P shift -0.0002 Std dev 0.0000<br>Scale +0.00000 | Should not exceed 10 cm<br><br>Should not exceed 0.005 degrees<br>Should not exceed 0.005 degrees<br>Should not exceed 0.0005 |

| | |
|---|---|
| Used loaded points<br>Average magnitude: 0.0408<br><br>Flightline Points Magnitude Dz<br>8 120860 0.0390 -0.0084<br>9 125147 0.0372 -0.0161<br>11 73619 0.0459 -0.0335<br>12 64777 0.0451 -0.0189 | Should not exceed 0.10 meter |

## 12.4 - TerraScan Output Control Reports - Wales & Shishmaref Runways

The following tables show the results from flights designed for checking system calibration using many check points on the runway surface. JOA established many hundreds of points collected by Post Processed Kinematic methods. A GPS antenna and receiver was mounted on a "4 wheeler" All Terrain Vehicle (ATV), and a series of profiles were run up and down the runways. The average spacing of points along the profiles was approximately 1 meter (depending on the speed of the ATV). These runway check points were provided to AeroMap by JOA, and a module within TerraScan called "Output Control Report" (OCR) was run to compare the LIDAR data to the numerous runway points. This module develops a Triangulated Irregular Network (TIN) of the LIDAR data and then computes what the value of the LIDAR data would be at the known ground point. The Dz value shown in the right column is the computed LIDAR data minus the known ground point value. The runway data was edited before the OCR process to delete numerous points at the start and end of the PPK survey where the receiver was not moving because of static observations, or moving so slowly that the values of the ground points are nearly the same. The listing in this report only shows the start and end of the listing along with the statistics for brevity and clarity sake. The full data set is contained in a digital file on CD which accompanies this report.

When a point is in the listings has a notation of "outside", it means that the control point does not fall within a valid LIDAR surface model triangle. This may be caused by:

- The control point being outside the area covered by LIDAR data OR,
- The control point is inside a triangle longer than given maximum triangle length. See Figure 12.1 below. For this project, the maximum triangle size for the TerraScan Output Control Reports is 15 meters

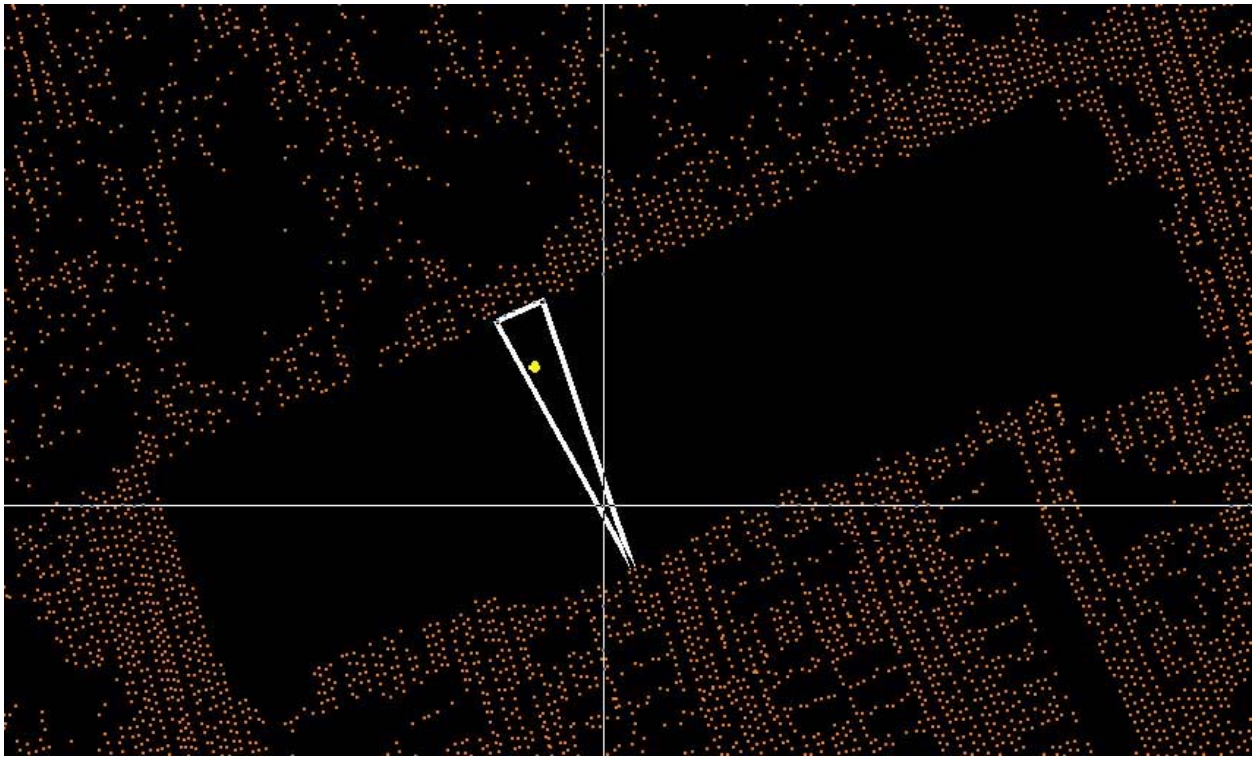


*Figure 12.1 - Example of check point marked "outside" when triangle size is exceeded*

**Table 12.4.1 - Wales Runway Ground Truth Survey**

Area: AK0301 (2 meter)
Mission Number: 43Q22404B
Date: August 11, 2004 (JD 224)

Output Control Report using Wales Runway Ground Truth Points

Projection: UTM Meters Zone 3
Vertical Datum: GRS80 Ellipsoid Heights

C:\WORK_DIRECTORY\NEW_NOAA\QAQC\Wales Runway Point List Static Removed.txt

| Number | Easting | Northing | Known Z | Laser Z | Dz |
|---|---|---|---|---|---|
| 1 | 357599.396 | 7281891.118 | 9.394 | outside | * |
| 2 | 357599.537 | 7281891.860 | 9.390 | outside | * |
| 3 | 357599.672 | 7281892.604 | 9.393 | outside | * |
| ----------Removed data for brevity---------- | | | | | |
| 2536 | 357405.385 | 7280694.355 | 8.868 | 8.820 | -0.048 |
| 2537 | 357404.738 | 7280694.464 | 8.864 | 8.800 | -0.064 |
| 2538 | 357404.082 | 7280694.602 | 8.860 | 8.770 | -0.090 |
| 2539 | 357403.447 | 7280694.749 | 8.863 | 8.780 | -0.083 |
| 2540 | 357402.815 | 7280694.910 | 8.858 | 8.820 | -0.038 |
| ----------Removed data for brevity---------- | | | | | |
| 15363 | 357535.548 | 7281571.096 | 10.077 | 9.320 | -0.757 |
| 15364 | 357535.689 | 7281571.883 | 10.060 | 9.240 | -0.820 |
| 15365 | 357535.844 | 7281572.677 | 10.067 | 9.320 | -0.747 |
| 15366 | 357535.981 | 7281573.470 | 10.050 | 9.280 | -0.770 |
| 15367 | 357536.136 | 7281574.261 | 10.061 | 9.290 | -0.771 |
| ----------Removed data for brevity---------- | | | | | |
| 15770 | 357598.970 | 7281888.859 | 9.387 | outside | * |
| 15771 | 357599.110 | 7281889.620 | 9.391 | outside | * |
| 15772 | 357599.256 | 7281890.365 | 9.400 | outside | * |

| | |
|---|---|
| Average dz | -0.299 |
| Minimum dz | -1.028 |
| Maximum dz | +0.049 |
| Average magnitude | 0.300 |
| Root mean square | 0.366 |
| Std deviation | 0.210 |
| Number of Points | 8046 |

* Outside means that the control point does not fall within a valid LIDAR surface model triangle. This may be caused by: The control point being outside the area covered by LIDAR data OR, the control point is inside a triangle longer than given maximum triangle length.

The listing in this report only shows portions of the complete listing along with the statistics for brevity and clarity sake. The full data set is contained in a digital file on CD that accompanies this report.

**Table 12.4.2 - Shishmaref Runway Ground Truth Survey**

Area: AK0301 (1 meter)
Mission Number: 43Q20404A
Date: July 22, 2004 (JD 204)

Output Control Report using Shishmaref Runway Ground Truth Points

Projection: UTM Meters Zone 3
Vertical Datum: GRS80 Ellipsoid Heights

C:\WORK_DIRECTORY\NEW_NOAA\QAQC\Shishmarif_Runway_UTM_QAQC.txt

| Number | Easting | Northing | Known Z | Laser Z | Dz |
|---|---|---|---|---|---|
| 1 | 451514.607 | 7348506.171 | 5.740 | 5.610 | -0.130 |
| 2 | 451514.613 | 7348506.171 | 5.736 | 5.610 | -0.126 |
| 3 | 451514.610 | 7348506.171 | 5.734 | 5.610 | -0.124 |
| 4 | 451514.613 | 7348506.171 | 5.733 | 5.610 | -0.123 |
| 5 | 451514.609 | 7348506.171 | 5.739 | 5.610 | -0.129 |
| 6 | 451514.611 | 7348506.170 | 5.739 | 5.610 | -0.129 |
| 7 | 451514.608 | 7348506.172 | 5.740 | 5.610 | -0.130 |
| 8 | 451514.612 | 7348506.173 | 5.733 | 5.610 | -0.123 |
| 9 | 451514.610 | 7348506.171 | 5.744 | 5.610 | -0.134 |
| 10 | 451514.611 | 7348506.171 | 5.736 | 5.610 | -0.126 |
| ----------Removed data for brevity---------- | | | | | |
| 2320 | 451514.543 | 7348507.428 | 5.732 | 5.750 | +0.018 |
| 2321 | 451514.538 | 7348507.426 | 5.746 | 5.750 | +0.004 |
| 2322 | 451514.542 | 7348507.429 | 5.738 | 5.750 | +0.012 |
| 2323 | 451514.541 | 7348507.425 | 5.743 | 5.750 | +0.007 |
| 2324 | 451514.544 | 7348507.424 | 5.734 | 5.750 | +0.016 |
| 2325 | 451514.539 | 7348507.431 | 5.751 | 5.750 | -0.001 |
| 2326 | 451514.541 | 7348507.427 | 5.738 | 5.750 | +0.012 |
| 2327 | 451514.537 | 7348507.431 | 5.756 | 5.750 | -0.006 |
| 2328 | 451514.538 | 7348507.428 | 5.742 | 5.750 | +0.008 |
| 2329 | 451509.966 | 7348505.769 | 5.839 | 5.860 | +0.021 |

| | |
|---|---|
| Average dz | -0.051 |
| Minimum dz | -0.347 |
| Maximum dz | +0.168 |
| Average magnitude | 0.070 |
| Root mean square | 0.088 |
| Std deviation | 0.072 |
| Number of Points | 2329 |

* Outside means that the control point does not fall within a valid LIDAR surface model triangle. This may be caused by: The control point being outside the area covered by LIDAR data OR, the control point is inside a triangle longer than given maximum triangle length.

The listing in this report only shows portions of the complete listing along with the statistics for brevity and clarity sake. The full data set is contained in a digital file on CD that accompanies this report.

## 12.5 - JOA LIDAR Check Points

Thirty-four LIDAR check points were surveyed on the ground by John Oswald and Associates and sent to NOAA along with his report in December 2004. The following checkpoint list (Table 12.5.2) for AK0301 are from that report, only 'Station Type 4' points are check points. Maps showing the location of these LIDAR check points are listed in Section 12.6. These LIDAR check points were used in developing "Output Control Reports" (OCR) from the TerraScan software to compare the LIDAR data to the check points. This OCR process is described in more detail at the beginning of Section 12.4.

There were 6 missions flown in the AK0301 Area, however only four of the missions had LIDAR check points in the LIDAR swath data. These OCR listings are tabulated below in Table 12.5.1, and are contained in Section 12.7 TerraScan Output Control Reports - JOA LIDAR check points.

**Table 12.5.1 - Missions and OCR Tables**

| Julian Day and Mission Number | Planned Spacing (m) | OCR Com-plete Check Pts (Y/N) | Number of QC Pts in OCR (Check Points) | OCR List-ing (Table Reference) |
|---|---|---|---|---|
| 203C | 2 | Y | 17 | 12.7.1 |
| 204A | 2 | Y | 9 | 12.7.2 |
| 224B | 2 | Y | 10 | 12.7.3 |
| 204A | 1 | Y | 11 | 12.7.4 |
| 219A | 1 | NO CHK PTS | - | N/A |
| 224B | 1 | NO CHK PTS | - | N/A |

**Table 12.5.2 - NGS Project AK0301 Final Values From JOA**

| Location | Check point | Latitude (N) | Longitude (W) | Ellipsoid Height (meters) | Station Type |
|---|---|---|---|---|---|
| Wales, AK<br>Control Station:<br>Wales Base Station | CP1A | 65° 37' 22.827" | 168° 06' 00.154" | 9.04 | 4 |
| | CP1B | 65° 37' 00.556" | 168° 05' 41.617" | 8.79 | 4 |
| | CP1C | 65° 38' 11.862" | 168° 07' 11.202" | 5.69 | 4 |
| | CP1D | 65° 38' 50.967" | 168° 07' 09.846" | 5.9 | 4 |
| | CP1E | 65° 39' 05.255" | 168° 07' 06.134" | 5.78 | 4 |
| | CP1F | 65° 37' 42.650" | 168° 05' 34.444" | 9.23 | 4 |
| | **460 A** | **65° 37' 28.983"** | **168° 01' 33.332"** | **7.45** | **3** |
| | **WALE** | **65° 36' 59.284"** | **168°0 5' 36.981"** | **17.18** | **5** |
| Ikpek, AK<br>Control Stations:<br>Wales & Shishmaref<br>Base Stations | CP2A | 65° 53' 42.620" | 167° 16' 33.723" | 7.3 | 4 |
| | CP2B | 65° 53' 44.563" | 167° 16' 25.472" | 7.1 | 4 |
| | CP2C | 65° 53' 53.243" | 167° 16' 08.292" | 6.58 | 4 |
| | CP2D | 65° 53' 39.296" | 167° 17' 04.288" | 6.89 | 4 |
| | CP2E | 65° 53' 33.672" | 167° 17' 20.012" | 6.79 | 4 |
| | **IKPE** | **65° 53' 37.512"** | **167°16'44.483"** | **10.97** | **3** |
| | **WALE** | **65° 36' 59.284"** | **168° 05' 36.981"** | **17.18** | **5** |
| | **SHIS** | **66° 15' 18.974"** | **166° 04' 11.325"** | **12.09** | **5** |

| | | | | | |
|---|---|---|---|---|---|
| SW of Shishmaref<br>Control Station:<br>Shishmaref Base Station | CP3A | 66° 12' 34.156" | 166° 14' 17.233" | 4.62 | 4 |
| | CP3B | 66° 11' 20.220" | 166° 19' 16.286" | 4.46 | 4 |
| | CP3C | 66° 11' 15.280" | 166° 19' 39.438" | 4.82 | 4 |
| | CP3D | 66° 11' 11.682" | 166° 19' 48.843" | 5.06 | 4 |
| | CP3E | 66° 11' 08.056" | 166° 20' 03.977" | 4.74 | 4 |
| | CP3F | 66° 12' 33.013" | 166° 14' 13.962" | 4.43 | 4 |
| | **854B** | **66° 15' 50.900"** | **166° 01' 14.700"** | **5.18** | **3** |
| | **SHIS** | **66° 15' 18.974"** | **166° 04' 11.325"** | **12.09** | **5** |
| NE of Shishmaref<br>Control Station:<br>Shishmaref Base Station | CP4A | 66° 19' 06.288" | 165° 50' 26.803" | 4.46 | 4 |
| | CP4B | 66° 19' 01.064" | 165° 50' 38.103" | 4.62 | 4 |
| | CP4C | 66° 18' 58.781" | 165° 50' 47.622" | 4.74 | 4 |
| | CP4D | 66° 18' 58.215" | 165° 51' 02.054" | 4.62 | 4 |
| | CP4E | 66° 18' 52.871" | 165° 51' 19.669" | 4.48 | 4 |
| | **854B** | **66° 15' 50.900"** | **166° 01' 14.700"** | **5.18** | **3** |
| | **SHIS** | **66° 15' 18.974"** | **166° 04' 11.325"** | **12.09** | **5** |
| Lagoon at 165W<br>Control Station:<br>Shishmaref Base Station | CP5A | 66° 31' 36.006" | 164° 47' 50.460" | 5.58 | 4 |
| | CP5B | 66° 31' 33.576" | 164° 48' 04.056" | 5.32 | 4 |
| | CP5C | 66° 31' 28.598" | 164° 48' 44.612" | 4.33 | 4 |
| | CP5D | 66° 31' 24.216" | 164° 49' 05.268" | 4.36 | 4 |
| | CP5E | 66° 31' 15.503" | 164° 49' 28.696" | 4.43 | 4 |
| | CP5F | 66° 31' 21.702" | 164° 49' 10.180" | 4.45 | 4 |
| | **SHIS** | **66° 15' 18.974"** | **166° 4' 11.325"** | **12.09** | **5** |
| Espenberg<br>Control Station:<br>Shishmaref Base Station | CP6A | 66° 35' 32.927" | 163° 57' 28.741" | 8.79 | 4 |
| | CP6B | 66° 35' 32.391" | 163° 56' 58.510" | 7.54 | 4 |
| | CP6C | 66° 35' 37.763" | 163° 56' 18.158" | 4.46 | 4 |
| | CP6D | 66° 35' 29.311" | 163° 55' 56.697" | 8.85 | 4 |
| | CP6E | 66° 35' 29.134" | 163° 55' 46.970" | 9.16 | 4 |
| | CP6F | 66° 35' 31.994" | 163° 58' 02.226" | 4.75 | 4 |
| | **KGRK** | **66° 35' 34.908"** | **163° 57' 02.175"** | **15.94** | **1** |
| | **KGAZ** | **66° 35' 27.056"** | **163° 58' 12.684"** | **10.27** | **4** |
| | **SHIS** | **66° 15' 18.974"** | **166° 04' 11.325"** | **12.07** | **5** |

Note 1) Datum NAD83(CORS96)(EPOCH:2003.0000).

Note 2) Bold points were used in the processing and adjustment of the check points, even though they are not LIDAR check points.

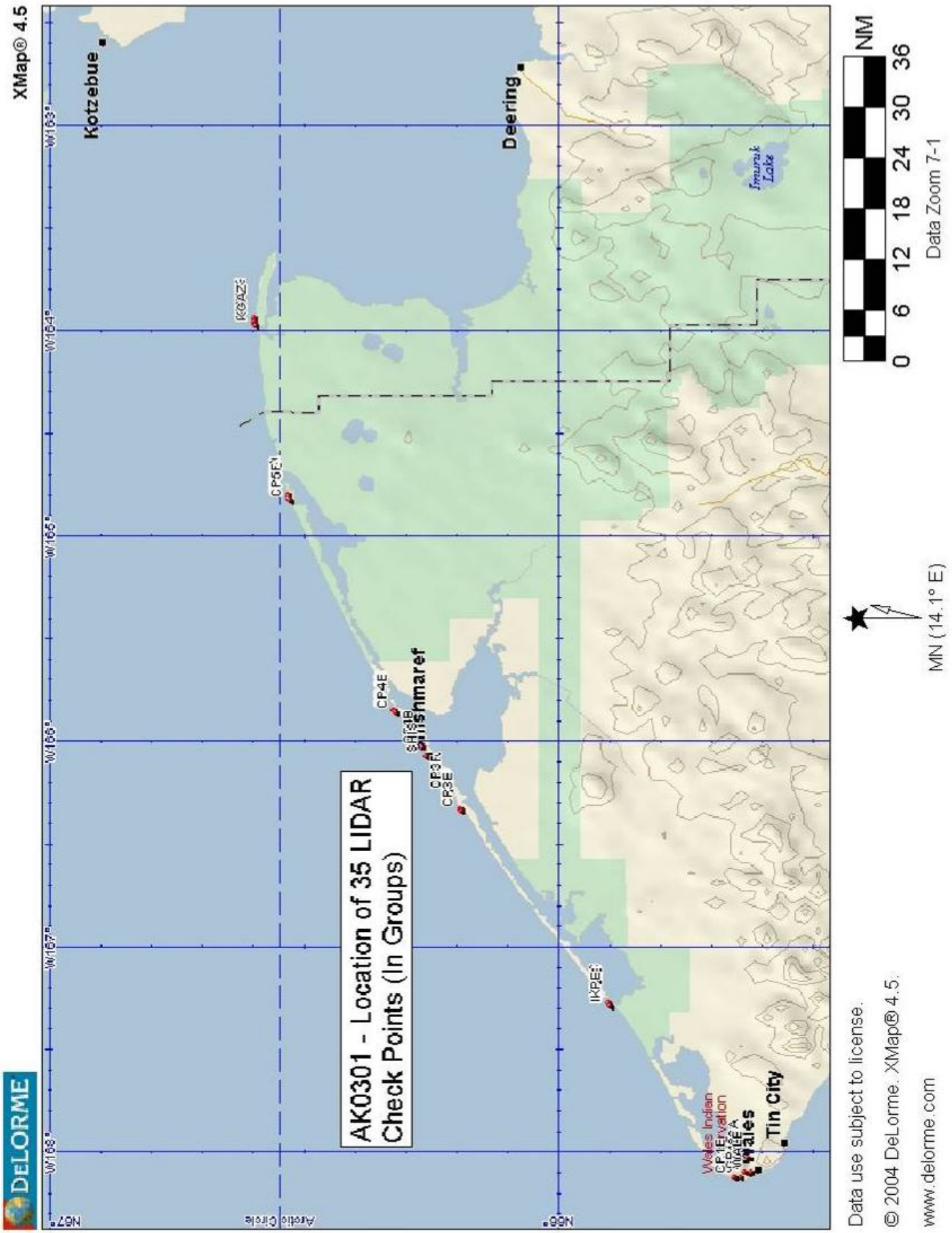
Note 3) Precise ephemeris from IGS used for each solution.

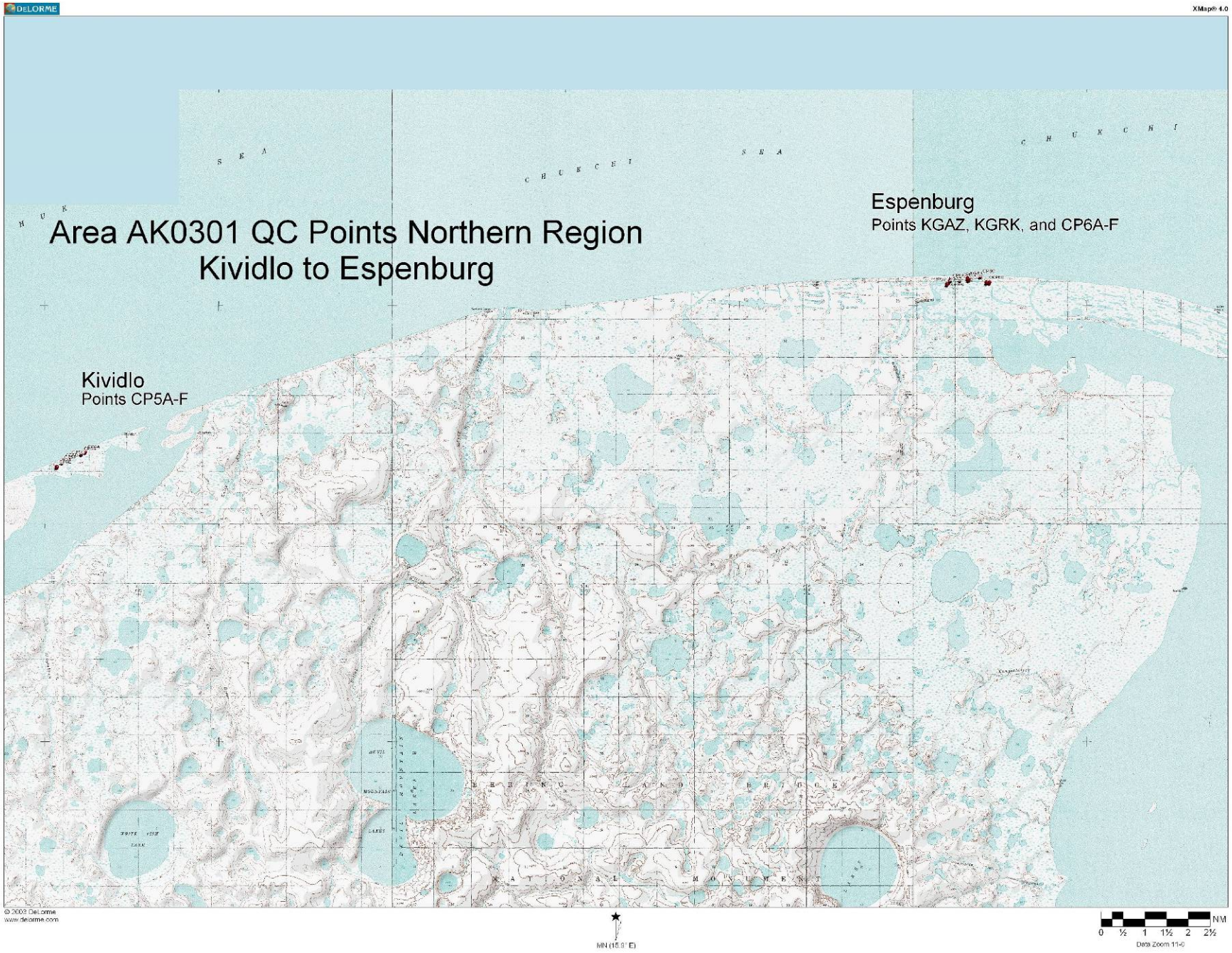
Note 4) The coordinate for KGRK in this table was derived by JOA, which differs from the published coordinates in section VI B.

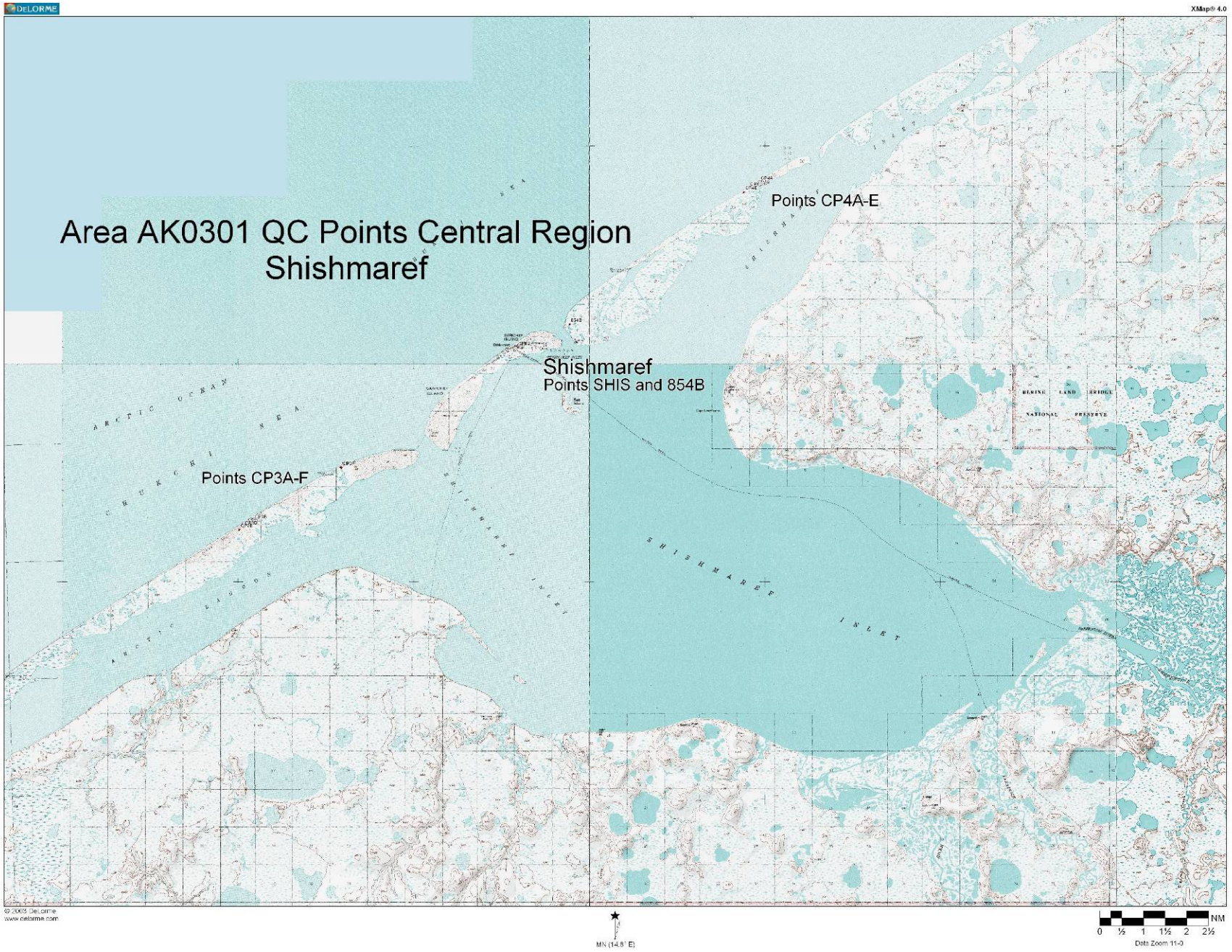
Note 5) Station type: 1 - Existing NSRS horizontal stations
3 - Existing horz. & vert. stations
4 - Check points surveyed
5 - GPS base station, survey described in "GPS Base Station Report: NGS Projects AK0301 & AK0302" by JOA and submitted to AeroMap on September 22, 2004

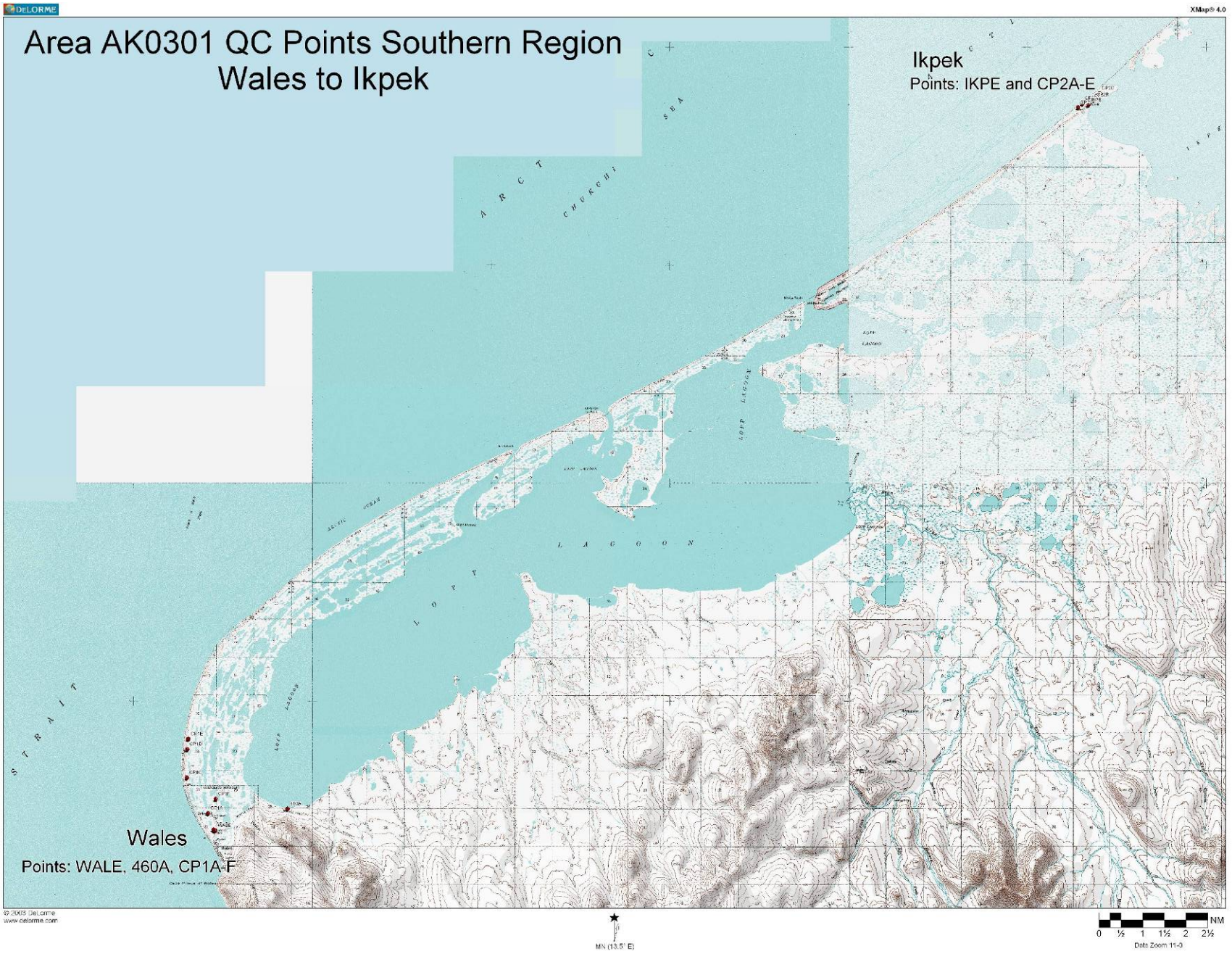
## 12.6 - Maps of LIDAR QC Check Points

The following pages have maps of the AK0301 Area and the location of the check points, both as an overview and by inset areas.




DELORME
XMap® 4.0
Area AK0301 QC Points Northern Region
Kividlo to Espenburg
Kividlo
Points CP5A-F
Espenburg
Points KGAZ, KGRK, and CP6A-F
S E A
C H U K C H I
B E R I N G L A N D
N A T I O N A L M O N U M E N T
© 2009 DeLorme
www.delorme.com
MN (15.9° E)
NM
0 ½ 1 1½ 2 2½
Data Zoom 11-0


DeLorme
XMap® 4.0
Area AK0301 QC Points Central Region
Shishmaref
Points CP4A-E
Shishmaref
Points SHIS and 854B
Points CP3A-F
BERING LAND BRIDGE
NATIONAL PRESERVE
SHISHMAREF INLET
ARCTIC OCEAN
CHUKCHI SEA
ARCTIC LAGOON
© 2005 DeLorme
www.delorme.com
MN (14.8° E)
0 ½ 1 1½ 2 2½ NM
Data Zoom 11-0


DeLORME
XMap® 4.0
Area AK0301 QC Points Southern Region
Wales to Ikpek
Ikpek
Points: IKPE and CP2A-E
Wales
Points: WALE, 460A, CP1A-F
ARCTIC OCEAN
CHUKCHI SEA
LOPP LAGOON
STRAIT
© 2005 DeLorme
www.delorme.com
MN (13.5° E)
NM
0 ½ 1 1½ 2 2½
Data Zoom 11-0

## 12.7 - TerraScan Output Control Reports - JOA LIDAR Check Points

See Sections 12.4 and 12.5 for narrative of how the following tables were developed. See Section 4 - Flight Line Maps and Coverage which relate to these tables by Julian Day. See Section 14 Results and Problems for a discussion and summary of these tables.

### Table 12.7.1 - Area: AK0301 (2 meter)

Mission Number: 43Q20304C Date: July 21, 2004 (JD 203)
Output Control Report using LIDAR QC Check Points
Projection: UTM Meters Zone 3 Vertical Datum: GRS80 Ellipsoid Heights

E:\WORK_DIRECTORY\6030810_Last_NOAA\QAQC\AK301_QC_CheckpointsOnly_UTM3_ENh.txt

| Number | Sta_Name | Easting | Northing | Known Z | Laser Z | Dz |
|---|---|---|---|---|---|---|
| 1 | CP1A | 357271.731 | 7281408.578 | 9.040 | outside | * |
| 2 | CP1B | 357474.726 | 7280708.046 | 8.790 | outside | * |
| 3 | CP1C | 356438.981 | 7282970.174 | 5.690 | outside | * |
| 4 | CP1D | 356516.352 | 7284178.837 | 5.900 | outside | * |
| 5 | CP1E | 356585.683 | 7284618.415 | 5.780 | outside | * |
| 6 | CP1F | 357630.505 | 7282005.525 | 9.230 | outside | * |
| 7 | CP2A | 396292.949 | 7310106.279 | 7.300 | outside | * |
| 8 | CP2B | 396399.524 | 7310162.620 | 7.100 | outside | * |
| 9 | CP2C | 396626.604 | 7310423.355 | 6.580 | outside | * |
| 10 | CP2D | 395902.482 | 7310017.474 | 6.890 | outside | * |
| 11 | CP2E | 395697.179 | 7309850.691 | 6.790 | outside | * |
| 12 | CP3A | 444270.232 | 7343811.469 | 4.620 | 4.730 | +0.110 |
| 13 | CP3B | 440483.240 | 7341599.039 | 4.460 | 4.680 | +0.220 |
| 14 | CP3C | 440190.325 | 7341452.238 | 4.820 | 5.070 | +0.250 |
| 15 | CP3D | 440070.279 | 7341343.352 | 5.060 | 4.990 | -0.070 |
| 16 | CP3E | 439878.516 | 7341235.131 | 4.740 | 4.970 | +0.230 |
| 17 | CP3F | 444310.426 | 7343775.275 | 4.430 | 4.690 | +0.260 |
| 18 | CP4A | 462317.241 | 7355655.244 | 4.460 | 4.580 | +0.120 |
| 19 | CP4B | 462174.385 | 7355495.399 | 4.620 | 4.780 | +0.160 |
| 20 | CP4C | 462054.919 | 7355426.316 | 4.740 | 4.940 | +0.200 |
| 21 | CP4D | 461875.001 | 7355411.230 | 4.620 | 4.750 | +0.130 |
| 22 | CP4E | 461653.429 | 7355248.765 | 4.480 | 4.620 | +0.140 |
| 23 | CP5A | 509007.503 | 7378630.616 | 5.580 | 5.670 | +0.090 |
| 24 | CP5B | 508839.876 | 7378554.834 | 5.320 | 5.350 | +0.030 |
| 25 | CP5C | 508339.588 | 7378399.147 | 4.330 | 4.450 | +0.120 |
| 26 | CP5D | 508084.927 | 7378262.709 | 4.360 | 4.490 | +0.130 |
| 27 | CP5E | 507796.385 | 7377992.093 | 4.430 | 4.590 | +0.160 |
| 28 | CP5F | 508024.496 | 7378184.689 | 4.450 | 4.610 | +0.160 |
| 29 | CP6A | 546192.057 | 7386337.546 | 8.790 | outside | * |
| 30 | CP6B | 546564.564 | 7386327.190 | 7.540 | outside | * |
| 31 | CP6C | 547058.584 | 7386501.915 | 4.460 | outside | * |
| 32 | CP6D | 547327.289 | 7386244.742 | 8.850 | outside | * |
| 33 | CP6E | 547447.154 | 7386241.313 | 9.160 | outside | * |
| 34 | CP6F | 545780.239 | 7386301.809 | 4.750 | outside | * |

| | |
|---|---|
| Average dz | +0.144 |
| Minimum dz | -0.070 |
| Maximum dz | +0.260 |
| Average magnitude | 0.152 |
| Root mean square | 0.164 |
| Std deviation | 0.081 |
| Number of Pts | 17 |

* Outside means that the control point does not fall within a valid LIDAR surface model triangle. This may be caused by: The control point being outside the area covered by LIDAR data OR, the control point is inside a triangle longer than given maximum triangle length.

## Table 12.7.2 - Area: AK0301 (2 meter)

Mission Number: 43Q20404A
Date: July 22, 2004 (JD 204)

Output Control Report using LIDAR QC Check Points

Projection: UTM Meters Zone 3
Vertical Datum: GRS80 Ellipsoid Heights

E:\WORK_DIRECTORY\6030810_Last_NOAA\QAQC\AK301_QC_CheckpointsOnly_UTM3_ENh.txt

| Number | Sta_Name | sting | Northing | Known Z | Laser Z | Dz |
|---|---|---|---|---|---|---|
| 1 | CP1A | 357271.731 | 7281408.578 | 9.040 | outside | * |
| 2 | CP1B | 357474.726 | 7280708.046 | 8.790 | outside | * |
| 3 | CP1C | 356438.981 | 7282970.174 | 5.690 | outside | * |
| 4 | CP1D | 356516.352 | 7284178.837 | 5.900 | outside | * |
| 5 | CP1E | 356585.683 | 7284618.415 | 5.780 | outside | * |
| 6 | CP1F | 357630.505 | 7282005.525 | 9.230 | outside | * |
| 7 | CP2A | 396292.949 | 7310106.279 | 7.300 | outside | * |
| 8 | CP2B | 396399.524 | 7310162.620 | 7.100 | outside | * |
| 9 | CP2C | 396626.604 | 7310423.355 | 6.580 | outside | * |
| 10 | CP2D | 395902.482 | 7310017.474 | 6.890 | outside | * |
| 11 | CP2E | 395697.179 | 7309850.691 | 6.790 | outside | * |
| 12 | CP3A | 444270.232 | 7343811.469 | 4.620 | outside | * |
| 13 | CP3B | 440483.240 | 7341599.039 | 4.460 | outside | * |
| 14 | CP3C | 440190.325 | 7341452.238 | 4.820 | outside | * |
| 15 | CP3D | 440070.279 | 7341343.352 | 5.060 | outside | * |
| 16 | CP3E | 439878.516 | 7341235.131 | 4.740 | outside | * |
| 17 | CP3F | 444310.426 | 7343775.275 | 4.430 | outside | * |
| 18 | CP4A | 462317.241 | 7355655.244 | 4.460 | outside | * |
| 19 | CP4B | 462174.385 | 7355495.399 | 4.620 | outside | * |
| 20 | CP4C | 462054.919 | 7355426.316 | 4.740 | outside | * |
| 21 | CP4D | 461875.001 | 7355411.230 | 4.620 | outside | * |
| 22 | CP4E | 461653.429 | 7355248.765 | 4.480 | outside | * |
| 23 | CP5A | 509007.503 | 7378630.616 | 5.580 | outside | * |
| 24 | CP5B | 508839.876 | 7378554.834 | 5.320 | outside | * |
| 25 | CP5C | 508339.588 | 7378399.147 | 4.330 | 4.100 | -0.230 |
| 26 | CP5D | 508084.927 | 7378262.709 | 4.360 | 4.050 | -0.310 |
| 27 | CP5E | 507796.385 | 7377992.093 | 4.430 | outside | * |
| 28 | CP5F | 508024.496 | 7378184.689 | 4.450 | 4.030 | -0.420 |
| 29 | CP6A | 546192.057 | 7386337.546 | 8.790 | 8.840 | +0.050 |
| 30 | CP6B | 546564.564 | 7386327.190 | 7.540 | 7.810 | +0.270 |
| 31 | CP6C | 547058.584 | 7386501.915 | 4.460 | 4.580 | +0.120 |
| 32 | CP6D | 547327.289 | 7386244.742 | 8.850 | 9.090 | +0.240 |
| 33 | CP6E | 547447.154 | 7386241.313 | 9.160 | 9.300 | +0.140 |
| 34 | CP6F | 545780.239 | 7386301.809 | 4.750 | 4.880 | +0.130 |

| | |
|---|---|
| Average dz | -0.001 |
| Minimum dz | -0.420 |
| Maximum dz | +0.270 |
| Average magnitude | 0.212 |
| Root mean square | 0.238 |
| Std deviation | 0.252 |
| Number of Pts | 9 |

* Outside means that the control point does not fall within a valid LIDAR surface model triangle. This may be caused by: The control point being outside the area covered by LIDAR data OR, the control point is inside a triangle longer than given maximum triangle length.

## Table 12.7.3 - Area: AK0301 (2 meter)

Mission Number: 43Q22404B
Date: August 11, 2004 (JD 224)

Output Control Report using LIDAR QC Check Points

Projection: UTM Meters Zone 3
Vertical Datum: GRS80 Ellipsoid Heights

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| Number | Sta_Name | Easting | Northing | Known Z | Laser Z | Dz |
|---|---|---|---|---|---|---|
| 1 | CP1A | 357271.731 | 7281408.578 | 9.040 | 8.880 | -0.160 |
| 2 | CP1B | 357474.726 | 7280708.046 | 8.790 | 8.680 | -0.110 |
| 3 | CP1C | 356438.981 | 7282970.174 | 5.690 | 5.840 | +0.150 |
| 4 | CP1D | 356516.352 | 7284178.837 | 5.900 | 6.100 | +0.200 |
| 5 | CP1E | 356585.683 | 7284618.415 | 5.780 | 5.990 | +0.210 |
| 6 | CP1F | 357630.505 | 7282005.525 | 9.230 | outside | * |
| 7 | CP2A | 396292.949 | 7310106.279 | 7.300 | 7.730 | +0.430 |
| 8 | CP2B | 396399.524 | 7310162.620 | 7.100 | 7.550 | +0.450 |
| 9 | CP2C | 396626.604 | 7310423.355 | 6.580 | 6.670 | +0.090 |
| 10 | CP2D | 395902.482 | 7310017.474 | 6.890 | 7.190 | +0.300 |
| 11 | CP2E | 395697.179 | 7309850.691 | 6.790 | 7.110 | +0.320 |
| 12 | CP3A | 444270.232 | 7343811.469 | 4.620 | outside | * |
| 13 | CP3B | 440483.240 | 7341599.039 | 4.460 | outside | * |
| 14 | CP3C | 440190.325 | 7341452.238 | 4.820 | outside | * |
| 15 | CP3D | 440070.279 | 7341343.352 | 5.060 | outside | * |
| 16 | CP3E | 439878.516 | 7341235.131 | 4.740 | outside | * |
| 17 | CP3F | 444310.426 | 7343775.275 | 4.430 | outside | * |
| 18 | CP4A | 462317.241 | 7355655.244 | 4.460 | outside | * |
| 19 | CP4B | 462174.385 | 7355495.399 | 4.620 | outside | * |
| 20 | CP4C | 462054.919 | 7355426.316 | 4.740 | outside | * |
| 21 | CP4D | 461875.001 | 7355411.230 | 4.620 | outside | * |
| 22 | CP4E | 461653.429 | 7355248.765 | 4.480 | outside | * |
| 23 | CP5A | 509007.503 | 7378630.616 | 5.580 | outside | * |
| 24 | CP5B | 508839.876 | 7378554.834 | 5.320 | outside | * |
| 25 | CP5C | 508339.588 | 7378399.147 | 4.330 | outside | * |
| 26 | CP5D | 508084.927 | 7378262.709 | 4.360 | outside | * |
| 27 | CP5E | 507796.385 | 7377992.093 | 4.430 | outside | * |
| 28 | CP5F | 508024.496 | 7378184.689 | 4.450 | outside | * |
| 29 | CP6A | 546192.057 | 7386337.546 | 8.790 | outside | * |
| 30 | CP6B | 546564.564 | 7386327.190 | 7.540 | outside | * |
| 31 | CP6C | 547058.584 | 7386501.915 | 4.460 | outside | * |
| 32 | CP6D | 547327.289 | 7386244.742 | 8.850 | outside | * |
| 33 | CP6E | 547447.154 | 7386241.313 | 9.160 | outside | * |
| 34 | CP6F | 545780.239 | 7386301.809 | 4.750 | outside | * |

| | |
|---|---|
| Average dz | +0.188 |
| Minimum dz | -0.160 |
| Maximum dz | +0.450 |
| Average magnitude | 0.242 |
| Root mean square | 0.271 |
| Std deviation | 0.205 |
| Number of Pts | 10 |

* Outside means that the control point does not fall within a valid LIDAR surface model triangle. This may be caused by: The control point being outside the area covered by LIDAR data OR, the control point is inside a triangle longer than given maximum triangle length.

## Table 12.7.3 - Area: AK0301 (1 meter)

Mission Number: 43Q20404A
Date: July 22, 2004 (JD 204)

Output Control Report using LIDAR QC Check Points

Projection: UTM Meters Zone 3
Vertical Datum: GRS80 Ellipsoid Heights

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| Number | Sta_Name | Easting | Northing | Known Z | Laser Z | Dz |
|---|---|---|---|---|---|---|
| 1 | CP1A | 357271.731 | 7281408.578 | 9.040 | outside | * |
| 2 | CP1B | 357474.726 | 7280708.046 | 8.790 | outside | * |
| 3 | CP1C | 356438.981 | 7282970.174 | 5.690 | outside | * |
| 4 | CP1D | 356516.352 | 7284178.837 | 5.900 | outside | * |
| 5 | CP1E | 356585.683 | 7284618.415 | 5.780 | outside | * |
| 6 | CP1F | 357630.505 | 7282005.525 | 9.230 | outside | * |
| 7 | CP2A | 396292.949 | 7310106.279 | 7.300 | outside | * |
| 8 | CP2B | 396399.524 | 7310162.620 | 7.100 | outside | * |
| 9 | CP2C | 396626.604 | 7310423.355 | 6.580 | outside | * |
| 10 | CP2D | 395902.482 | 7310017.474 | 6.890 | outside | * |
| 11 | CP2E | 395697.179 | 7309850.691 | 6.790 | outside | * |
| 12 | CP3A | 444270.232 | 7343811.469 | 4.620 | 4.430 | -0.190 |
| 13 | CP3B | 440483.240 | 7341599.039 | 4.460 | 4.480 | +0.020 |
| 14 | CP3C | 440190.325 | 7341452.238 | 4.820 | 4.860 | +0.040 |
| 15 | CP3D | 440070.279 | 7341343.352 | 5.060 | 5.120 | +0.060 |
| 16 | CP3E | 439878.516 | 7341235.131 | 4.740 | 4.740 | +0.000 |
| 17 | CP3F | 444310.426 | 7343775.275 | 4.430 | 4.360 | -0.070 |
| 18 | CP4A | 462317.241 | 7355655.244 | 4.460 | 4.490 | +0.030 |
| 19 | CP4B | 462174.385 | 7355495.399 | 4.620 | 4.570 | -0.050 |
| 20 | CP4C | 462054.919 | 7355426.316 | 4.740 | 4.730 | -0.010 |
| 21 | CP4D | 461875.001 | 7355411.230 | 4.620 | 4.610 | -0.010 |
| 22 | CP4E | 461653.429 | 7355248.765 | 4.480 | 4.470 | -0.010 |
| 23 | CP5A | 509007.503 | 7378630.616 | 5.580 | outside | * |
| 24 | CP5B | 508839.876 | 7378554.834 | 5.320 | outside | * |
| 25 | CP5C | 508339.588 | 7378399.147 | 4.330 | outside | * |
| 26 | CP5D | 508084.927 | 7378262.709 | 4.360 | outside | * |
| 27 | CP5E | 507796.385 | 7377992.093 | 4.430 | outside | * |
| 28 | CP5F | 508024.496 | 7378184.689 | 4.450 | outside | * |
| 29 | CP6A | 546192.057 | 7386337.546 | 8.790 | outside | * |
| 30 | CP6B | 546564.564 | 7386327.190 | 7.540 | outside | * |
| 31 | CP6C | 547058.584 | 7386501.915 | 4.460 | outside | * |
| 32 | CP6D | 547327.289 | 7386244.742 | 8.850 | outside | * |
| 33 | CP6E | 547447.154 | 7386241.313 | 9.160 | outside | * |
| 34 | CP6F | 545780.239 | 7386301.809 | 4.750 | outside | * |

| | |
|---|---|
| Average dz | -0.017 |
| Minimum dz | -0.190 |
| Maximum dz | +0.060 |
| Average magnitude | 0.045 |
| Root mean square | 0.068 |
| Std deviation | 0.069 |
| Number of Points | 11 |

* Outside means that the control point does not fall within a valid LIDAR surface model triangle. This may be caused by: The control point being outside the area covered by LIDAR data OR, the control point is inside a triangle longer than given maximum triangle length.

# 13. QUALITY ASSURANCE/QUALITY CONTROL (QA/QC)

Quality Assurance/Quality Control is an integral part of all aspects of any AeroMap LIDAR project. This begins at the mission planning stages, and continues through the field operations and data processing/data delivery in the office. Here below are the steps AeroMap uses for Quality Control and Quality Assurance for LIDAR projects.

1. *Proposal/Mission Planning* – AeroMap uses a series of checklists for most aspects of the Quality Assurance/Quality Control. This is true in the proposal/mission planning stage. The checklists insure that we have a clear understanding of the Scope of Work, Schedule, and Deliverables for the project. Mission planning checklists insure that the optimum plan is designed to cover the survey area with flight lines to meet the survey accuracy requirement for each specialized area of terrain and building/vegetation cover. Proposal checklists are used to insure that all technical phases of the project are properly described.
2. *Field Operations* – Checklists and procedures cover all critical phases of field operations. These include:
    a. Geodetic Survey, Calibration and Quality Control Surveys – These types of GPS surveys have industry/government guidelines established to insure that the accuracy required is met. In addition, AeroMap has checklists for observations and operations. Whenever the Optech ALTM LIDAR system is installed in a different aircraft, a rigorous survey is performed to accurately define the location of the GPS antenna and ALTM system reference in the aircraft. This is checked in the office by allowing the post processing software to calculate the lever arms directly from the GPS information.
    b. Airborne Data Acquisition – Both manufacturer and AeroMap defined checklists cover all phases of the airborne data acquisition. The pilot and operator get instant feedback in a Plan/Progress display that the survey area is being properly covered. Should there be any gaps that appear in the data coverage, the operator has procedures to easily add additional flight lines as needed. Other system parameters like ranging, drop out percentage, and GPS status are constantly monitored in the aircraft. Rigorous eye-safety procedures are followed, and the Optech ALTM has several layers of interlocks to prevent any operations of the system that may even remotely pose an eye safety concern. Before each day's missions, the GPS planning is checked to insure that there are an adequate number of satellites in view, and their geometry is such that the PDOP factor is less than 4. In northern climes, space weather is checked daily to assess whether solar activity may cause conditions for unsuitable GPS data collection.
    c. Calibration and Ground Truth Checks – AeroMap has a policy of checking system calibration on the project site. For this project, these checks were performed at the airports of Kotzebue, Shishmaref and Wales. See Section 5 – Equipment Calibration, and Section 13 – Quality Assurance/Quality Control for more information on the check surveys.

3. *Data Processing/Data Delivery* – The checklists used in data processing have been developed both by the manufacturers of the system and the data processing software, and by AeroMap for specialized data processing operations. Each of these checklists has parameters that must be met in order to insure LIDAR data accuracy meets defined project standards. The Quality Control ground surveys are used to verify that the LIDAR data meets Fundamental Vertical Accuracy guidelines. AeroMap LIDAR data processors have a previous photogrammetric background, which adds an additional check on LIDAR data classification and interpretation. Before final data is delivered to the customer, the Project Manager reviews the data products as a final QC step.

# 14. RESULTS AND PROBLEMS

**Results**
All areas planned for data acquisition were covered by LIDAR data acquisition flights. See Problems section below for discussion on tide coordination. All data was acquired during one mobilization to Kotzebue, which spanned the period of July 9 through August 11, 2004.

There were no special problems in the initial data processing, and final "Derived NAVD88" data deliverables were sent to NOAA on a portable USB 2.0 disk drive on November 29, 2004.

At the request of NOAA on 3 January 2005, AeroMap processed the LIDAR data to ellipsoid heights and delivered that data set to NOAA on 18 March, 2005. As outlined both in the Executive Summary that prefaces this report, and the subsection below – Problems, AeroMap found errors in the data processing of the ellipsoid data set. In order to remedy those errors, AeroMap has reprocessed all the LIDAR data from the raw data stage, maintaining ellipsoid heights throughout, and is submitting this Revised Final Report along with the data. The LIDAR data has been processed using TerraScan software from Terrasolid. No further adjustments to the data have been performed.

**Accuracies**
The accuracies specified by NOAA from the Project Instructions dated 14 August 2003 for this project are:

"*The data collection parameters shall be such that the horizontal accuracy shall be 1 meter and the vertical accuracy 0.3 meter.*"

Horizontal accuracies are difficult to assess, but TerraMatch flights performed July 19, August 6, and August 11 (see Section 12 – Accuracy Report) to check system calibration indicate that the system is operating within calibration specifications.

From the Output Control Reports (Section 12), all missions which had within them LIDAR Check Points provided by JOA, had an RMSE of less than 0.30 meter.

**Problems**
Ellipsoid Data – Data Processing Problems and Remedy:
On 3 January 2005 a NOAA Task Order was issued to provide the LIDAR data in ellipsoidal heights instead of the original "Derived NAVD88" elevations. The ellipsoidal height data set was sent to NOAA on March 18, 2005. This was followed by "Final Report AK0301 Shishmaref – Dates of LIDAR Acquisition July 9 – Aug 12, 2004" submitted in May 2005. As described in the Executive Summary, NOAA responded with several questions on 20 September 2005. This resulted in the submission of "Addendum #1 November 2005 – Final Report AK0301 Shishmaref – Dates of LIDAR Acquisition July 9-August 12, 2004". The Addendum was shipped to Aero-Metric on December 1, 2005, and then on to NOAA.

In the course of analyzing the data and writing the Addendum #1 in response to the 20 September 2005 questions, it became apparent that there were some discrepancies with the LIDAR data in some areas relative to John Oswald and Associates (JOA) LIDAR checkpoint data. Not know-

ing at the time the reason or extent of the discrepancy problem, AeroMap submitted the Addendum #1 along with a cover letter acknowledging the discrepancies and stating that AeroMap was beginning an investigation into the cause of the discrepancies.

AeroMap began investigations by conferring with JOA and eliminating all potential problems (e.g., incorrect antenna height, incorrect control values) in the LIDAR check point survey. When no errors were found in the JOA survey data, AeroMap began concentrating on the LIDAR data processing.

At about this same time, NOAA sent a second set of questions on 16 December 2005 related to Addendum #1.

After the subsequent questions by NOAA, the AeroMap review of the ellipsoid data delivered to NOAA revealed that not all missions had the correct adjustments applied to bring the "Derived NAVD88" data to true ellipsoid values.

To remedy this problem and answer all the NOAA questions from 20 September and 16 December 2005, AeroMap decided in January 2006 to start from the initial point where the airborne trajectories are computed, and reprocess all of the data, holding only ellipsoid values, throughout to the final LIDAR values.

Just when this reprocessing effort was complete in late January, AeroMap learned from AERO-METRIC, Inc., that a similar NOAA Shoreline Mapping Project (Area NOAA-NY0401), performed with the same system, had erroneous high points being generated by a bug in the Optech proprietary REALM processing software. The erroneous high points, which formed a "halo" effect around certain types of shoal and sandbar terrain, were also found in several areas of the AK0301 and AK0302 projects. The remedy for this required a number of weeks of waiting for and then testing new versions of Optech's REALM software to eliminate the erroneous high points. That final version of REALM (Version 3.5.4) was not delivered and thoroughly tested until the middle of March 2006. At that time, Aeromap once again reprocessed all the LIDAR data for both the AK0301 and AK0302 project areas. This problem and remedy procedures are defined in more detail in the Executive Summary that prefaces this report.

Checks have been completed on all missions wherein there are any LIDAR check points as provided by John Oswald and Associates (JOA). All these LIDAR missions with JOA LIDAR Check Points meet the project specification of vertical accuracy (0.30 meter RMSE). The results have been tabulated within this report.

This revised Final LIDAR Report of April 3, 2006 incorporates new sections for the airport surveys, the checkpoint surveys, and a discussion of the check points relative to the ellipsoid LIDAR data set All questions or comments, from either the September or December 2005 NOAA e-mails concerning Addendum 1 have been addressed within this revised Final LIDAR Report of April 3, 2006, and the locations of the answers are outlined in the Executive Summary.

**Other Problems**

There were three areas where we encountered problems related to the project:

- Operational/Data Acquisition
- System Performance/Maintenance

- Report Generation

*Operational/Data Acquisition – Tide Coordination*
The missions were all to be tide coordinated for tides below Mean Lower Low Water (MLLW). This state of tides in the project area was almost never met due to the small tide range in the area and the difficulties coordinating airborne missions with the complex conditions that influence tides in that region (e.g., atmospheric pressure, winds and currents). As a result of continuing conversations with NOAA, the requirement for all data acquisition to be performed at MLLW or below was relaxed, first to Mean High Water, then in August to any tide window so that all the targeted shoreline areas could be covered.

*System Performance/Maintenance*
The Optech ALTM system performed extremely well throughout the course of the project. There were two occasions where the laser shutdown on July 21 and August 5, 2004 because of a "Range Missing" error. This is an occasional software glitch in the ALTM system, and the manufacturer (Optech), said these errors occasionally happen. In each case, the aircraft landed to complete the GPS mission, and the system was restarted and data acquisition continued.

*Report Generation*
This report has taken an unusually long time to generate. Shortly after the final "Derived NAVD88" data deliverables were sent to NOAA on November 29, 2004 – AeroMap suffered a catastrophic failure of its main RAID LIDAR server. In an unfortunate coincidence of having two RAID drives fail at the same time and having a problem with a corrupted back-up tape, a significant amount of data for this project was lost. Because of AeroMap's policy of having multiple back-ups and archives of the original raw data and final data deliverables, all those files were quickly recovered. However, many interim files and supporting documentation for the project were lost. After many weeks of sorting through file fragments left from the RAID server failure, most of the supporting documentation for this report was re-created, but at the cost of a long delay in finalizing the initial reports. For this report and data submission, all new interim data processing files and documentation have been created from the raw data. AeroMap has instituted changes in the management of LIDAR data to improve data backup and archiving.

*Project Management*
This project was managed by a joint team with some members located in Sheboygan WI and some in Anchorage AK. The Alaska based project manager retired and left the company before the project was completed with insufficient project hand off. The technician initially in charge of the REALM LIDAR data processing suffered a debilitating illness which led to long term disability. These situations led to miscommunications and delays. The steps that AeroMap has taken to remedy these Project Management problem areas are:

1) For large projects such as this AeroMap will assign a Project Management Team so that more than one person has a full understanding of the project,
2) AeroMap has hired additional technical staff and has cross trained them in data processing procedures so that more than one person can handle any particular phase of data processing.