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BY: Jamie Bonisteel

NAVAL OCEANOGRAPHIC OFFICE
Stennis Space Center, Mississippi

Data Processing Report,

Territory of American Samoa

Vessel: CHARTS Aircraft
Detachment: CHARTS Team
Dates of Survey: 05-07 May 2006
Technical Specification: None provided
Archive Number: 06H3A04
Hydrographic Area: Pago Pago Harbor
Topographic Areas: Pago Pago International Airport

SURVOP	SURVOP Dates	Senior NAVOCEANO Representative	Data Manager	N4 Lead
ALH-0-06	05-07 May 2006	Micah Tinkler	Jamie Bonisteel	Jamie Bonisteel

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1. Introduction

An airborne hydrographic and topographic survey was conducted in the Territory of American Samoa 05-07 May 2006. This survey was conducted using Kinematic GPS positioning, therefore all hydrographic and topographic data was collected with respect to the WGS84 ellipsoid. Reduction of the data to chart and map datum was accomplished following work by the Geospatial Products Branch (NP432). Complete details of the hydrographic survey can be found in the American Samoa Report of Survey.

2. Geodesy

No new geodetic work was done in Samoa. The kinematic GPS base station was established over a previously installed NGS benchmark (see Appendix A for bench mark datasheets).

The aircraft was initially positioned in the field using the published Special Team Royal Engineers (STRE) Publication GGAD-94-1509 for SATELLITE TRIANG STATION 022 (STN-022). Once in the office this base station was discovered on the NGS website as PID AA3709. From the NGS coordinates the station was then updated and transformed.

The base station coordinates were at NAD 83 (2002) at epoch 2002.00 then transformed to WGS 84 (G1150) at epoch 2006.3466. The NGS program HTDP was used, with velocities taken from the datasheet for the nearby CORS station ASPA.

The final Samoan base station position used for data processing is:

S 14° 19' 54.34443"
W 170° 42' 51.23461"
WGS84 ellipsoid height: 37.658 meters

3. Tides

Tide measurements were not required for this survey.

4. Reduction to Chart Datum

Tidal datums previously established by NOAA for tide gage 1770000, located Pago Pago Harbor, were used for this survey.

Chart datum for NOAA chart 83484 is Mean Low Water (MLW). The GPS base station was established over the Coast and Geodetic Survey (CGS) monument STN-022. The benchmark ellipsoid height is 37.658 meters. The separation between the benchmark and MLW is 33.452 meters (as related to the Pago Pago tide gage). The data was initially collected with respect to the benchmark ellipsoid height, and a datum reduction value is calculated by subtracting the elevation of the bench mark above chart datum from the benchmark's ellipsoid height:

(BM ellipsoid height)	–	(BM height above chart datum)	=	datum reduction value
(37.658 m)	–	(4.206 m)	=	33.452 m

Reduction of soundings to chart datum was accomplished by subtracting 33.452 meters from every raw lidar sounding. (See Figure 4.1 Samoa datum reduction).

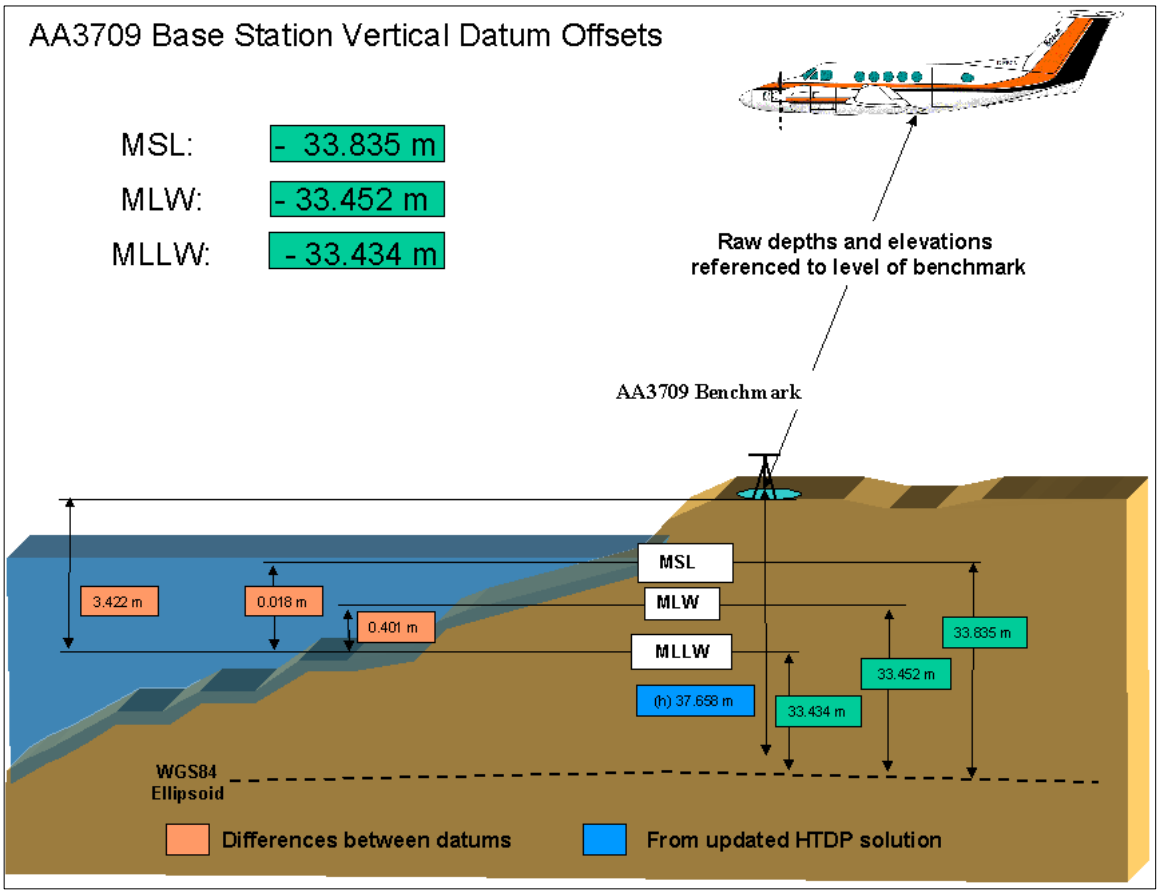


Figure 4.1. Samoa datum reduction.

5. Reduction to Map Datum

Topographic elevations for all areas are referred to Mean Sea Level (MSL) (i.e. map datum is MSL). The aircraft was positioned initially with respect to the benchmark elevation (i.e. the benchmark elevation is initially "0"). Since the CHARTS system is primarily oriented towards hydrography, elevations are negative in the upwards direction.

The topographic survey of Samoa was positioned using the base station established near the airport STN-022. Since the survey area of Samoa was within 20 km of the base station a single value was used to reduce the elevations of the airport to map datum. The benchmark elevation of AA3709 was 37.658 m above the WGS84 ellipsoid, and at the benchmark MSL it is 0.383 meters above MLW.

Reduction of elevations to map datum was accomplished by subtracting 33.835 meters from every raw lidar elevation. (See Figure 4.1. above).

(BM ellipsoid height) – (BM height above map datum) = datum reduction value

(37.658 m) – (3.823 m) = 33.835 m

6. Hardware and Software

6.1. Fugro-Pelagos Hardware and Software

Manufacturers: Opetch / Dell
Models: Optech in-house / Dell Dimension
Operating system: Microsoft Windows XP Professional
Description: Ground Control System (GCS)
Software: Fledermaus V6.1.4b
Optech GCS V 6.01

6.2. NAVOCEANO Hardware and Software

Manufacturer: Pogolinux
Model: Storageware S316
Operating system: Linux Fedora Core 2
Description: 3 terabyte RAID 5
Software: Area Based Editor V 1.06

7. Hydrographic Data Processing

Data processing was done by both Fugro-Pelagos (FP) and NAVOCEANO employees. FP employees performed processing that could only be done using Optech's proprietary software (detailed below). The data was checked by a second FP employee before being turned over to NAVOCEANO. NAVOCEANO employees performed additional processing and noise elimination (detailed below). The data was checked by a second NAVOCEANO employee.

7.1. Fugro-Pelagos

Fugro-Pelagos employees performed the initial hydrographic data processing using the computers and software of the Ground Control System (GCS), both in the field and at the Joint Lidar Bathymetry Technical Center of Expertise (JALBTCX). Tasks included reverse-processing flight lines flown in "land-to-water" directions and reprocessing very shallow (<1.0 m) water areas using special depth selection algorithms. At this time any obvious noise was removed as well. Each sheet was processed by an FP employee and quality-checked by a second FP employee before being released to NAVOCEANO.

7.2. NAVOCEANO

NAVOCEANO employees performed the final data processing. Using Area Based Editor software the waveforms (time/intensity graphs) of questionable soundings were examined. Processing included “Second Depth Swaps” (SDS) and noise elimination. When a laser pulse passes through a relatively turbid layer of water the reflection off the layer can result in a false bottom detection. When these false bottoms are detected the sounding can be reprocessed to select the more appropriate “Second Depth”. Obvious noise in the data was removed as well.

7.2.1 NAVOCEANO Target Investigations.

A list of Aids to Navigation (ATON) was downloaded from NGA's website (see 06H3A04, AS Report of Survey). A point file was also created from this list and imported into the PFM file structure. Soundings in the vicinity of the ATON were carefully investigated, and the floating ATONs showed up as anomalously shoal soundings. Digital down-look images for these soundings were also examined for the presence of the ATON. The results of these investigations are shown in AS_aton_obstructions.xls: verified (listed position correct), not verified (not seen in the digital down-look imagery or in the lidar data) or observed (seen in down-look imagery but not positioned with lidar data).

Additional targets were identified and tagged in an .XML format using ABE. Target information includes target type, position, least depth, orientation, description and digital down-look image if available. A spreadsheet of the results are shown in

8. Topographic Processing

Pago Pago International Airport was surveyed in topographic mode. Noise elimination was the primary task during topographic lidar processing. FP employees cleaned the data using the computers and software of the GCS before turning it over to NAVOCEANO.

8.1. Fugro-Pelagos

Fugro-Pelagos employees performed the initial topographic data processing using the computers and software of the Ground Control System (GCS), both in the field and at the Joint Lidar Bathymetry Technical Center of Expertise (JALBTCX). Tasks included checking for GPS errors, water elimination and removal of any obvious noise. The data was processed by an FP employee and quality-checked by a second FP employee before being released to NAVOCEANO.

8.2. NAVOCEANO

NAVOCEANO employees performed the final data processing. Using Area Based Editor software to eliminate obvious noise in the data.

Appendix A. Datasheet for KGPS base station location

A.1 National Coast and Geodetic Survey (NCG) STN-022 (AA3709) Datasheet

The benchmark STN-022 was used for the all survey missions on American Samoa. The GPS base station can be found in 512 STRE: Publication GGAD-94-1509 and also on the NGS website. The pertinent information is reproduced below.

DESCRIPTION (WITH BRIEF "TO REACH")

The station is located close to the U. S. Weather Station near the Pago Pago International (Tafuna) Airport on Tutuila Island, American Samoa.

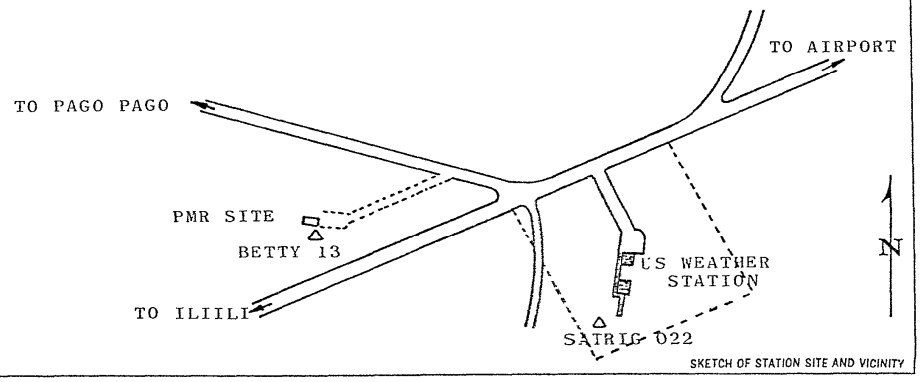
To reach the station from the airport terminal, go 180 yards west on the paved road to the Weather Station drive. The station is approximately 195 yards south of this intersection.

The station is a C&GS triangulation station disk stamped "SATELLITE TRIANG STATION 022, 1966" and set in the center of a 14 feet square concrete pad. The mark is in a hole 1 foot in diameter in the center of the pad and 6½ inches below the pad surface. It is 185 feet southwest of the southwest corner of the Weather Station's power generator building and 181 feet west of a metal wind gauge pole. No underground mark was set.

Reference mark 1 is a C&GS disk stamped "SAT TRIANG STATION 022 NO 1 1966" and set in a drill hole at the south end of a north-south concrete walkway at the Weather Station. It is 157.3 feet south of the main building at the Weather Station and 127.3 feet west of the metal wind gauge pole.

Reference mark 2 is a C&GS disk stamped "SAT TRIANG STATION 022 NO 2 1966" and set in an outcrop of lava rock which projects 1 inch above the ground. It is 166.7 feet south of a 40 foot wooden antenna pole and 77.1 feet southwest of a theodolite stand next to RM 1.

Reference mark 3 is a C&GS disk stamped "SAT TRIANG STATION 022 NO 3 1966" and set in the center of an 18-inch circular concrete monument flush with the ground. Four anchor bolts are embedded in the monument 7 inches from the disk for the purpose of securing a BC-4 camera pedestal. An underground mark was set in a drill hole 21 inches below ground level. The underground mark is a 3½ inch plain bronze disk stamped "INTERNATIONAL SATELLITE TRIANGULATION STATION 022, 022 RESET 1970". It is 127.3 feet south of the southwest corner of the power generator building and 84.4 feet west of the theodolite stand.



SKETCH OF STATION SITE AND VICINITY

Publication GGAD-94-1509: 512 STRE - GPS Survey; Hawaiian and Pacific Islands 1993

SUMMARY OF SATELLITE-OBSERVED STATION

STATION NAME/LOCAL NUMBER	LOCATION	GPS NUMBER
SATELLITE TRIANGULATION STN 022	AMERICAN SAMOA	100330

STAMPING ON MARK	
NOT REPORTED	

AGENCY (CAST IN MARK)	TYPE OF STATION MARK

SATELLITE OBSERVATION

EQUIPMENT TYPE/SERIAL NO.	HEIGHT OF TRACKING EQUIPMENT REFERENCE POINT ABOVE STATION MARK	TRACKING EQUIPMENT REFERENCE POINT
TRIMBLE	1.772 m	ELECTRICAL CENTER OF ANTENNA

OBSERVED BY (AGENCY)	SV'S OBSERVED	PERIOD OF OCCUPATION
512 STRE	All in view except 19	93237-93240 (3 sessions)

SATELLITE-DERIVED COORDINATES REFERRED TO STATION MARK

MIN DATA POINTS	COLLECTION INTERVAL	RESIDUAL RMS	STATION SET	GRAVITY MODEL	ELLIPSOID	ELEVATION CUTOFF ANGLE
6563	30 sec	7.10 cm		WGS 84	WGS 84	10DG

						ACCURACY of Φ, λ, and h 1m, 1m, 1m, 1 SIGMA
Φ	14 19 54.363 S	λ	189 17 08.807 E	h	37.133 m	
X	-6,099,948.09 m	Y	-997,350.33 m	Z	-1,568,581.78 m	

COORDINATES OF STATION USED AS REFERENCE

STATION	DATUM	SOURCE	ACCURACY
Φ	λ	h	
X	Y	Z	DATE OF CONTROL

GROUND SURVEY COORDINATES OF STATION MARK

Φ	λ	DATUM (HORIZONTAL)	ELLIPSOID

DATE OF ADJUSTMENT	ORDER	SURVEY BY (AGENCY	DATE	LOCATION OF SURVEY DATA

ELEVATION (H)	DATUM (VERTICAL)	GEOID HEIGHT (N)	ELLIPSOID HEIGHT (h)

ORDER (ELEV)	ESTABLISHED BY (AGENCY)	DATE	SOURCE OF (N)

CONNECTION TO LOCAL CONTROL

FROM	TO	( ) AZ FROM NORTH	DISTANCE

REMARKS m=meters

OTHER RELATED DATA FOR THIS STATION		
DATA	AVAILABLE	LOCATION
STATION OCCUPATION REPORT	X	DMAAC/GGC
GEODETIC INFORMATION REPORT		
STATION DESCRIPTION		
SURVEY DIAGRAM		
STATION SITE SKETCH		
PHOTO IDENTIFICATION		
ASTRONOMIC COORDINATES		
STATION PHOTOS		
OTHER: SPECIFY		

PREPARED BY/DATE	CHECKED BY/DATE	REVISED BY/DATE	CHECKED BY/DATE
DMAAC/GGAD JRB MAY94	DMAAC/GGAD DJB MAY94		

DMA FORM 8290-R APR 93 REPRODUCED ON MACINTOSH

DATABASE = Sybase ,PROGRAM = datasheet, VERSION = 7.36
1 National Geodetic Survey, Retrieval Date = MAY 11, 2006
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DESIGNATION - SATELLITE TRIANG STATION 022
PID - AA3709
STATE/COUNTY- AS/AMERICAN SAMOA
USGS QUAD - TUTUILA ISLAND (1989)

*CURRENT SURVEY CONTROL

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* NAD 83(2002)- 14 19 54.38461(S) 170 42 51.13897(W) ADJUSTED
* ASVD02 - 3.823 (meters) 12.54 (feet) ADJUSTED

EPOCH DATE - 2002.00
X - -6,099,947.702 (meters) COMP
Y - -997,351.900 (meters) COMP
Z - -1,568,582.435 (meters) COMP
ELLIP HEIGHT- 37.17 (meters) (02/05/03) GPS OBS
GEOID HEIGHT- 31.19 (meters) EGM96

HORZ ORDER - A
VERT ORDER - FIRST CLASS II
ELLP ORDER - THIRD CLASS I

.This is a reference station for the AMERICAN SAMOA
.National Continuously Operating Reference Station (ASPA).

.The horizontal coordinates were established by GPS observations
.and adjusted by the National Geodetic Survey in February 2003..
.This is a SPECIAL STATUS position. See SPECIAL STATUS under the
.DATUM ITEM on the data sheet items page.
.The horizontal coordinates are valid at the epoch date displayed above.
.The epoch date for horizontal control is a decimal equivalence
.of Year/Month/Day.

.The orthometric height was determined by differential leveling
.and adjusted by the National Geodetic Survey in April 2003..
.No vertical observational check was made to the station.

.The X, Y, and Z were computed from the position and the ellipsoidal ht.

.The ellipsoidal height was determined by GPS observations
.and is referenced to NAD 83.

.The geoid height was determined by EARTH GRAVITY MODEL 96.
.The EGM96 model is referenced to the WGS84 ellipsoid.

; North East Units Scale Factor Converg.
;UTM 02 - 8,415,561.660 530,818.516 MT 0.99961175 +0 04 14.7

! - Elev Factor x Scale Factor = Combined Factor
!UTM 02 - 0.99999416 x 0.99961175 = 0.99960591

: Primary Azimuth Mark Grid Az
:UTM 02 - PPG ARP 054 24 55.6

|---|
| PID Reference Object Distance Geod. Az |
| dddmmss.s |
| AA4462 PPG ARP 450.709 METERS 0542910.3 |
| AJ2252 SAT TRIANG STA 022 RM 1 17.732 METERS 17445 |
| AI9463 BETTY 13 ECC ET 203.139 METERS 30553 |
AI9968 TAU MTN OBSTRUCTION LIGHT APPROX. 2.6 KM 3222356.9

SUPERSEDED SURVEY CONTROL

NAD 83(1993)- 14 19 54.37534(S) 170 42 51.13727(W) AD(1993.62) 1
ELLIP H (11/30/94) 37.62 (m) GP(1993.62) 5 1
ASD 62 - 14 20 12.21614(S) 170 42 46.75786(W) AD( ) 2

.Superseded values are not recommended for survey control.
.NGS no longer adjusts projects to the AS datum.
.See file dsdata.txt <http://www.ngs.noaa.gov/cgi-bin/ds_lookup.prl?Item=HOW_SUP_DET>to determine how the superseded data were derived.

_U.S. NATIONAL GRID SPATIAL ADDRESS: 2LNK3081915562(NAD 83)
_MARKER: DB = BENCH MARK DISK
_SETTING: 7 = SET IN TOP OF CONCRETE MONUMENT
_SP_SET: CONCRETE POST
_STAMPING: SATELLITE TRIANG STATION 022 1966
_MARK LOGO: CGS
_MAGNETIC: N = NO MAGNETIC MATERIAL
_STABILITY: C = MAY HOLD, BUT OF TYPE COMMONLY SUBJECT TO
+STABILITY: SURFACE MOTION
_SATELLITE: THE SITE LOCATION WAS REPORTED AS SUITABLE FOR
+SATELLITE: SATELLITE OBSERVATIONS - August 04, 1993

HISTORY - Date Condition Report By
HISTORY - 1966 MONUMENTED CGS
HISTORY - 1968 GOOD CGS
HISTORY - 19930804 GOOD NOS
HISTORY - 20020822 GOOD NGS

STATION DESCRIPTION

'DESCRIBED BY COAST AND GEODETIC SURVEY 1968 (CND)

'STATION MARK AND 3 REFERENCE MARKS WERE ALL RECOVERED AND FOUND IN
'GOOD CONDITION. ORIGINAL DESCRIPTION NOT AVAILABLE, SO A COMPLETE NEW
'DESCRIPTION IS AS FOLLOWS. STATION IS LOCATED IN THE SOUTHWEST CORNER
'OF THE WEATHER BUREAU STATION GROUNDS IN TAFUNA, ABOUT 0.2 MILE
'SOUTHWEST OF THE TAFUNA AIRPORT TERMINAL BUILDING. -PAGO PAGO
'INTERNATIONAL AIRPORT-. TO REACH FROM THE AIRPORT TERMINAL BUILDING,
'GO WESTERLY ON PAVED ROAD FOR 0.1 MILE TO A SIDE ROAD LEFT. -ENTRANCE
'TO WEATHER BUREAU SITE-. TURN LEFT AND GO SOUTH FOR 0.1 MILE,
'-PASSING TO THE RIGHT OF THE WEATHER BUREAU BUILDINGS-, TO THE STATION
'AS DESCRIBED. STATION IS A STANDARD DISK, SET IN THE TOP OF A 3 FOOT
'DIAMETER CONCRETE POST, WHICH IS 2 INCHES BELOW SURFACE OF THE GROUND.
'IT IS 52 FEET WEST OF A 6X6 FOOT CONCRETE PAD, 2.5 FEET SOUTH OF A
'METAL WITNESS SIGN, WHICH IS ATTACHED TO A 4X4 INCH WOODEN POST. THE
'DISK IS STAMPED---SATELLITE TRIANG. STATION 022 1966---. REFERENCE
'MARK NO. 1 IS A STANDARD DISK, CEMENTED FLUSH IN A DRILL HOLE IN THE
'NORTHEAST CORNER OF A 6X6 FOOT CONCRETE PAD. IT IS 57 FEET EAST OF A
'METAL WITNESS SIGN, WHICH IS ATTACHED TO A 4X4 INCH WOODEN POST. THE
'DISK IS STAMPED---SAT TRIANG STATION NO 022 NO 1 1966---. REFERENCE
'MARK NO. 2 IS A STANDARD DISK, CEMENTED FLUSH IN A DRILL HOLE IN
'BEDROCK. IT IS 73 FEET SOUTHWEST OF A 6X6 FOOT CONCRETE PAD, 37 FEET
'SOUTH OF A METAL WITNESS SIGN, WHICH IS ATTACHED TO A 4X4 INCH WOODEN
'POST. THE DISK IS STAMPED---SAT TRIANG STATION NO 022 NO 2 1966---.
'REFERENCE MARK NO. 3 IS A STANDARD DISK, CEMENTED FLUSH IN A DRILL
'HOLE IN BEDROCK. IT IS 82 FEET NORTHWEST OF A 6X6 FOOT CONCRETE PAD,
'68 FEET SOUTH-SOUTHEAST OF A POWER POLE, 68 FEET NORTH-NORTHWEST OF A
'METAL WITNESS SIGN, WHICH IS ATTACHED TO A 4X4 INCH WOODEN POST. THE
'DISK IS STAMPED---SAT TRIANG STATION NO 022 NO 3 1966. THERE IS NO
'AZIMUTH MARK SET TO THIS STATION. STATION BETTY 13 ECC ET -USGS- 1962
'CAN BE USED.

STATION RECOVERY (1993)

'RECOVERY NOTE BY NATIONAL OCEAN SERVICE 1993 (JGF)
'RECOVERED AS DESCRIBED.

STATION RECOVERY (2002)

'RECOVERY NOTE BY NATIONAL GEODETIC SURVEY 2002 (EEC)
'RECOVERED AS DESCRIBED.

See http://tidesandcurrents.noaa.gov/data_menu.shtml?stn=1770000%20Pago%20Pago,%20AMERICAN%20SAMOA&type=Bench%20Mark%20Sheets for more information on tidal benchmarks for Pago Pago Harbor.

T I D A L D A T U M S

Tidal datums at PAGO PAGO, AMERICAN SAMOA based on:

LENGTH OF SERIES: 19 Years
TIME PERIOD: January 1983 - December 2001
TIDAL EPOCH: 1983-2001
CONTROL TIDE STATION:

Elevations of tidal datums referred to Mean Lower Low Water (MLLW), in METERS:

HIGHEST OBSERVED WATER LEVEL (09/04/1960)	=	1.250
MEAN HIGHER HIGH WATER (MHHW)	=	0.827
MEAN HIGH WATER (MHW)	=	0.783
MEAN TIDE LEVEL (MTL)	=	0.401
MEAN SEA LEVEL (MSL) = ASVD02	=	0.401
MEAN LOW WATER (MLW)	=	0.018
MEAN LOWER LOW WATER (MLLW)	=	0.000
LOWEST OBSERVED WATER LEVEL (02/06/1966)	=	-0.518

National Geodetic Vertical Datum (NGVD 29)

Bench Mark Elevation Information In METERS above:

Stamping or Designation	MLLW	MHW
0000 S 1993	1.765	0.982
NO 10 1963	2.463	1.680
0000 M 1983	3.252	2.469
0000 N 1983	3.509	2.725
0000 P 1987	2.719	1.935
0000 Q 1991	4.772	3.989
0000 R 1993	2.427	1.643
0000 T 1993	2.803	2.020
0000 U 1993	2.062	1.278
0000 V 1993	1.924	1.141