FIG WORKING WEEK 2025
AND Locate25 THE NATIONAL GEOSPATIAL CONFERENCE
Collaboration, Innovation and Resilience: Championing a Digital Generation
FIG Geospatial Council of Australia
Brisbane, Australia 6–10 April

Fiji Geodetic Datum Surveys, Data Handling and Compilation

Andrick Lal
Pacific Community (SPC)
Pacific Geospatial & Surveying Council (PGSC) Partnership Desk
Email: andrickl@spc.int

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Acknowledgement

Ministry of Lands and Mineral Resources of the Government of Fiji would like to acknowledge the good support and kind assistance provided by the Climate and Oceans Support Program in the Pacific (COSPPac) supported by Government of Australia and Geoscience Australia to complete the geodetic surveys of the islands in Fiji, from November 2019 to February 2020 and the compilation of data and information for the modernisation of the Fiji Geodetic Datum from March to December 2021.

This activity of “Geodetic Data Compilation” was generously successful through the COSPPac program staff; the Geodetic Unit, based in the Oceans and Maritime programme at the Geoscience, Energy and Maritime Division of the Pacific Community (SPC). Since there was COVID-19 lock down, this activity was well executed during this time frame.

The survey equipment donated by Geoscience Australia, to the SPC PGSC Partnership Desk, enabled the project survey activities and the capacity for surveyors.

The COSPPac program has been supporting the Pacific Geospatial & Surveying Council (PGSC) since November 2014. SPC has established the PGSC Partnership Desk to provide support and assistance in the geospatial and surveying activities in the region

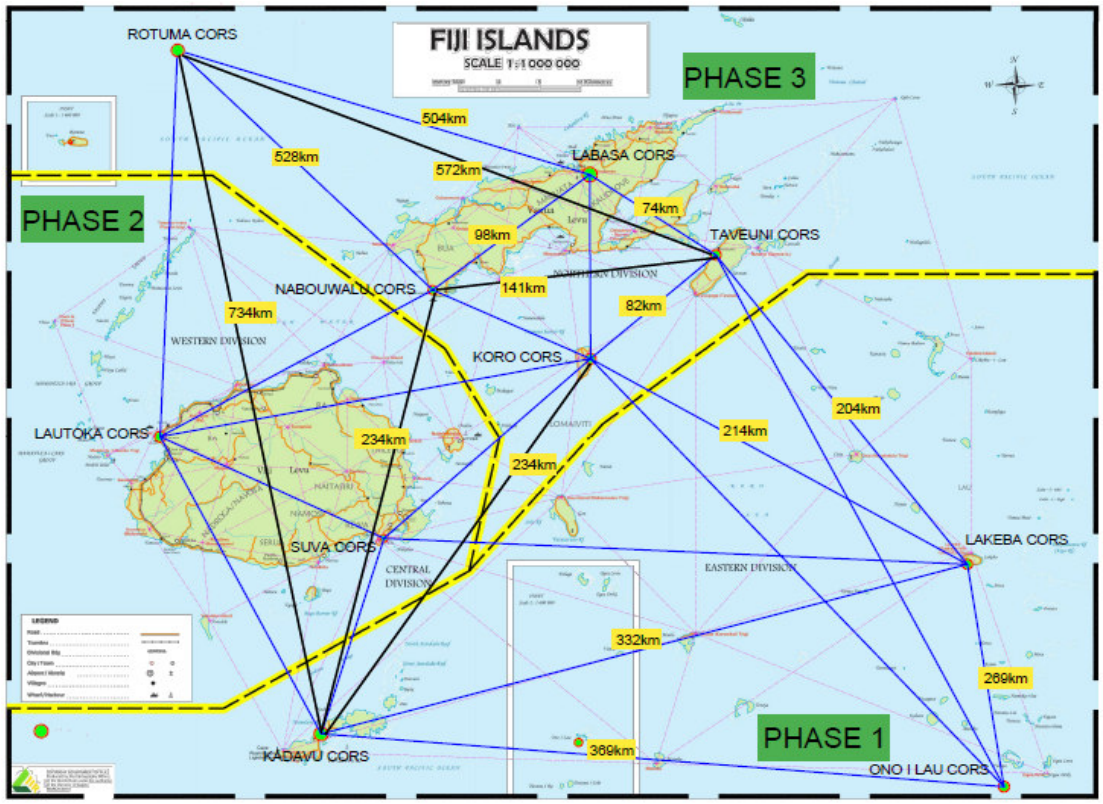
Introduction

Fiji moved the motion at the United Nations General Assembly 2015 for a global geodetic reference frame for sustainable development, the Resolution (A/RES/69/266) “A Global Geodetic Reference Frame for Sustainable Development” was adopted by the United Nations General Assembly in its 80th plenary meeting held on 26th February 2015. This reference framework has already been used by many developed countries including Australia and New Zealand in defining their new geodetic datum based on ITRS, with Fiji, to adopt, align and modernize its geodetic datum and following the ten-year regional strategy (2017 -2027), for the Pacific Geospatial and Surveying Council Strategy Goal 2; Countries across the pacific region to adopt the Global Geodetic Reference Frame (GGRF) and improve technology underpinning geospatial systems and applications.

A cabinet memorandum – “Modernizing Fiji’s Geodetic Datum” (CP (15)169) dated 29th August 2015, by the Minister for Lands and Mineral Resources was accepted and endorsed by cabinet via decision no. 207. An approved budget of FJ $2,546,560 for three years, enabled the Ministry to embark on this very important project and with approval from the cabinet, the Control Section was able to implement the activities for the Global Geodetic Reference Frame.

To modernise the Fiji Geodetic Datum, the Control Section of Lands & Survey Department of Fiji, has developed its geodetic infrastructure, with the establishment of the GNSS CORS network and to reinforce the geodetic survey network, established geodetic survey benchmarks were occupied during the survey campaign.

Fiji GNSS Geodetic Survey Network



Pacific Community
Communauté du Pacifique

PGSC
Pacific Geospatial and Surveying Council

Activities

The activities towards data compilation, manipulation, and delivery of all the survey data and information; in detail, the following tasks were completed for data handling: -

- Download all the GNSS survey data from the survey campaigns and the GNSS CORS
- Download all the UAV data from the field surveys for the survey campaign (Phase 1)
- Check, verify and validate GNSS survey datasets and make correctness for occupation time, antenna height, file format, file type, file structure and point ID of all the individual geodetic stations.
- Convert all the GNSS raw survey data (Leica, Hi-Target and Trimble) of the survey campaigns in RINEX format using the converter utility tool
- Complete the locality diagram pages and the field occupation sheet for as per individual geodetic stations
- Collect and complete the metadata table of the geodetic stations as per type, original coordinates, origin of survey, geodetic datum
- Complete the occupation summary report of all geodetic stations
- Complete the RINEX data summary report as per individual geodetic stations
- Record all the geodetic survey data sets accordingly for post processing and analysis
- Upload all the RINEX data for all the individual geodetic stations on AUSPOS
- Assess and provide options for good data handling, data accessibility, data storage and archive, data management of all the GNSS survey data and GNSS CORS

Geodetic Survey Campaign Data

```
     3.02           OBSERVATION DATA    M: MIXED            RINEX VERSION / TYPE
LEICA GEO OFFICE 8.4                    20210329 221704 UTC PGM / RUN BY / DATE
VANT                                                        MARKER NAME
VANT                                                        MARKER NUMBER
GEODETIC                                                    MARKER TYPE
Control             Survey-FJ                               OBSERVER / AGENCY
3707722             LEICA GS16          8.00                REC # / TYPE / VERS
                    LEIGS16                                 ANT # / TYPE
 -6063994.3539   159513.6132 -1964444.5071                  APPROX POSITION XYZ
        1.6450        0.0000        0.0000                  ANTENNA: DELTA H/E/N
  L1    0.0000        0.0000        0.0887                  ANTENNA: PHASECENTER
  L2    0.0000        0.0000        0.0887                  ANTENNA: PHASECENTER
G   12 C1C L1C D1C S1C C2W L2W D2W S2W C5Q L5Q D5Q S5Q      SYS / # / OBS TYPES
R    8 C1C L1C D1C S1C C2P L2P D2P S2P                      SYS / # / OBS TYPES
DBHZ                                                        SIGNAL STRENGTH UNIT
    30.000                                                  INTERVAL
  2019    12    10    23    10   30.0000000     GPS         TIME OF FIRST OBS
  2019    12    11    05    13    0.0000000     GPS         TIME OF LAST OBS
     0                                                      RCV CLOCK OFFS APPL
G                                                           SYS / PHASE SHIFT
R                                                           SYS / PHASE SHIFT
E                                                           SYS / PHASE SHIFT
                                                            END OF HEADER
> 2019 12 10 23 10 30.0000000  0 16
G01  23778627.820   124957531.11917     -2916.145          45.400    23778630.960    97369513.58216     -2272.323          38.250
G03
G06  21955013.940   115374377.02318      2912.435          49.150    21955017.440    89902120.66717      2269.430          42.950
G07  22815077.580   119894038.08118     -3097.857          48.200    22815078.180    93423925.09516     -2413.923          37.100
G11  24733025.500   129972922.42516     -3185.299          41.250    24733024.540   101277615.48415     -2482.049          35.150
G13  23889301.160   125539123.71717      -579.053          46.250    23889302.200    97822693.33915      -451.208          32.450
G17  20945999.020   110071967.65119      -389.286          53.900    20945998.440    85770359.98917      -303.340          43.400
G19  21788405.740   114498844.87318        96.593          49.100    21788403.640    89219867.86917        75.268          42.200
G22  24865290.680   130667986.03116        65.336          38.200    24865292.680   101819216.35416        50.909          37.300
G28  20804085.620   109326206.60818       870.145          49.700    20804084.520    85189247.36516       678.035          38.850
G30  20667682.980   108609406.51418     -1464.509          52.600    20667684.700    84630708.96017     -1141.176          44.300
R12  23297241.260   124449685.59717     -3373.314          45.900    23297251.620    96794231.95016     -2623.686          36.350
R13  19737650.260   105397949.85418      -648.081          49.650    19737654.200    81976196.52517      -504.064          41.900
R14  20403280.000   108760962.25518      2828.159          50.350    20403283.380    84591871.99016      2199.678          37.800
R17  20291907.160   108586092.16118      1345.448          52.700    20291910.540    84455861.71817      1046.460          46.250
R23  22419655.440   119930039.50117     -3748.992          43.400    22419661.240    93278934.36415     -2915.888          32.450
> 2019 12 10 23 11  0.0000000  0 16
G01  23795298.120   125045134.12107     -2924.312          46.050    23795301.240    97437775.62506     -2278.683          36.650
G03
```

Geodetic Survey Capacity

A total of forty (40) survey operators attended the training held at the Geodetic Survey Office, the training went on, from setting up to powering the equipment and measuring – tracking satellites and storing the raw data on the equipment. Also, in addition to this all operators were required to fill the log sheets accordingly. As part of the GNSS geodetic operations workshop, attachment with SPC (GEM division) on data management, processing and online training (training with GA on CORS operation), with the COVID-19 lockdown, the survey personnel were able to build capacity in the following: -

- GNSS CORS infrastructure, geodetic survey campaign data and metadata
- Maintenance and operationalisation of the GNSS COR station
- Handling and management of GNSS CORS data, geodetic survey campaign data and metadata
- Project scope, necessary requirements and documentation of the geodetic survey campaign
- Capacity in field survey procedure
- Raw data conversion to RINEX format
- Online data processing - AUSPOS data submission and requirements
- GNSS equipment operations – ability to use different GNSS survey equipment
- Proper data manipulation (slicing, combining and decimate, etc)

Geodetic Survey Capacity

- Use of different converter utility tools and software: -
  - TEQC (UNAVCO)
  - Trimble RINEX converter
  - Leica Geo Office
  - Trimble Business Centre
  - Hi-Target Geo Office
- Online resources
  - Antenna calibrations (https://geodesy.noaa.gov/ANTCAL/)
  - Four-character point ID checks (http://sopac.ucsd.edu/checkSiteID.shtml)
  - RINEX data formatting (point ID, antenna type, antenna height, antenna code, version)
- Next steps for the GNSS CORS and the geodetic survey data management

Geodetic Survey Data and Information

The following survey datasets and information packages that was checked, verified, reviewed and validated by the Control Section and Geodetic Unit of SPC and will be further post processed and analysed: -

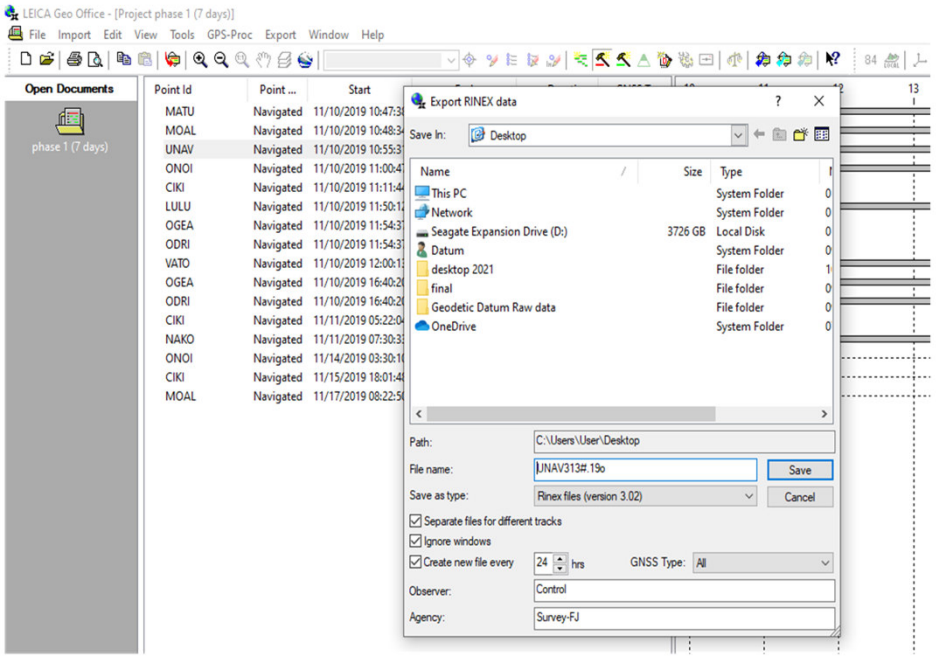
- ❑ RINEX Data for the geodetic stations and GNSS CORS.
- ❑ Field Sheets
- ❑ Locality Diagram Pages
- ❑ Geodetic Survey Station metadata (station coordinates, source files, occupation summary)
- ❑ Historical Survey Information
- ❑ AUSPOS Reports

Fiji Geodetic Survey Stations – GNSS CORS

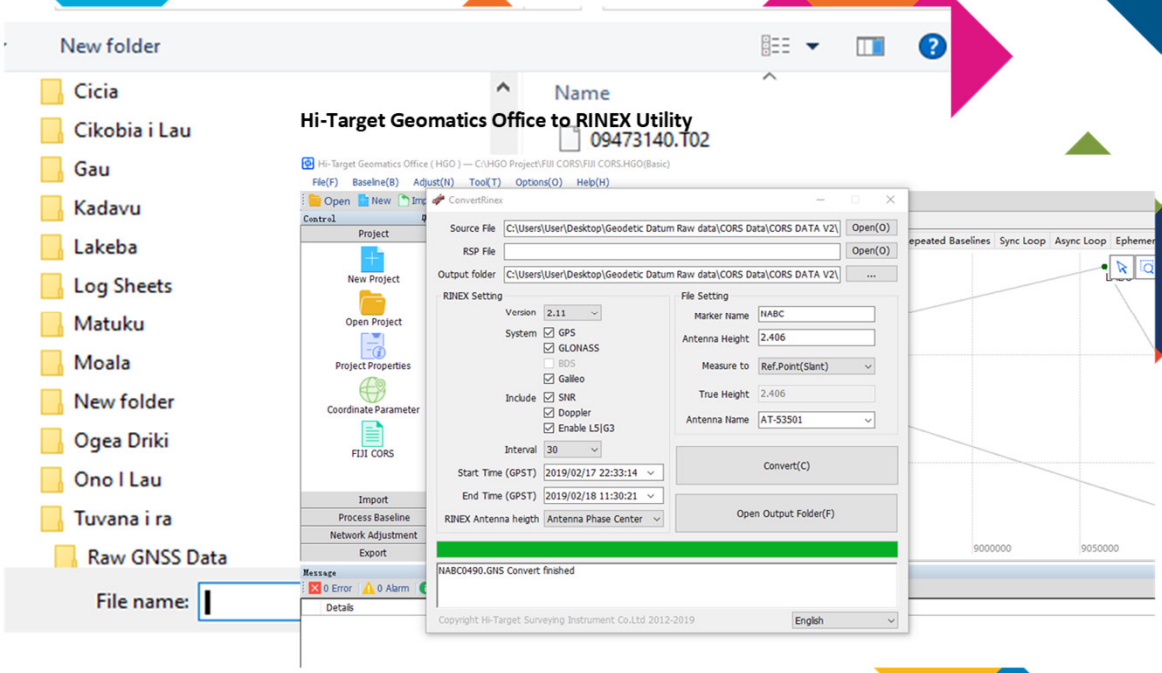
Station ID	Location	Station Type	Source	Establish By	Year
LAUT	Drasa Ave, Lautoka, Viti Levu	GNSS CORS	PSLGMP	PSLGMP	2002
SUV1	Suva, Viti Levu	GNSS CORS	SPC	SPC	2018
LABC	Labasa, Vanua Levu	GNSS CORS	LANDS	Control Office	2018
NABC	Nabouwalu, Vanua Levu	GNSS CORS	LANDS	Control Office	2018
TAVC	Taveuni, Vanua Levu	GNSS CORS	LANDS	Control Office	2018
KORC	Koro Island	GNSS CORS	LANDS	Control Office	2018
LAKC	Lakeba, Island	GNSS CORS	LANDS	Control Office	2018

GNSS Survey Data Conversion

Leica Geo Office Export Utility



Trimble Convert to RINEX Utility



Fiji Geodetic Survey Occupation Summary

Station ID	Start time	Duration	File Name	RINEX Version	Receiver Type	Antenna Height	Antenna Method	ARP Height	Antenna Type
CEVA	10/11/19 1200hrs UTC	7days	16633153.19o 16633133.19o 16633140.19o 16633201.19o	3.02	Trimble R10	1.642	BQR	1.692	TRMR10
KADV	10/11/19 1200hrs UTC	7days	42703140.19o 42703150.19o 42703160.19o 42703170.19o 42703180.19o 42703190.19o 42703200.19o	3.02	Trimble Net R9	1.978	BON	1.934	TRIMBLE ZEPHYR MODEL 2
NAKO	10/11/19 1200hrs UTC	7days	NAKO3140.19o NAKO3140.19o NAKO3150.19o NAKO3160.19o NAKO3170.19o NAKO3180.19o NAKO3190.19o NAKO3200.19o	3.02	Leica GS10	1.265	Hook Height	1.625	LEIAS10

Geodetic Survey Station Coordinates

GNSS CORS

Station ID	Latitude	Longitude	Ellipsoidal Ht.	Source
LAUT	S 17 36 31.71375	E 177 26 47.69618	89.655	AUSPOS # 8548
SUV1	S 18 06 55.94150	E 178 27 14.89659	102.169	AUSPOS # 8548
LABC	S 16 26 08.61637	E 179 24 36.67287	124.801	AUSPOS # 8548
NABC	S 16 59 35.06579	E 178 41 25.97184	112.152	AUSPOS # 6729
TAVC	S 16 47 54.41640	W 179 59 44.63888	140.275	AUSPOS # 8548
KADC	S 19 02 47.62361	E 178 09 57.05379	104.950	AUSPOS # 8548
ROTC	S 12 29 57.73022	E 177 02 46.26410	75.197	AUSPOS # 8548

NEW Survey Stations

Station ID	Easting	Northing	Zone	Ht. above Geoid	Source
TUVR	307989.620	7673224.618	1	4.046	AUSPOS # 8970
C111	253330.661	8036782.110	1	160.5142	AUSPOS # 7732
CIJ1	252765.206	8038903.104	1	2.955	AUSPOS # 5935
CP02	252813.696	8038550.954	1	26.685	AUSPOS # 4475

Geodetic Survey Station Coordinates

Station ID	Latitude	Longitude	Ellipsoidal Ht.	Source
CEVA	N 21 44 10.55364	E 174 37 57.47920	63.5479	GA Record2008/04, SO6450
KADV	S 19 07 05.31825	E 177 59 17.45239	860.5357	GA Record2008/04
NAKO	S 17 56 49.7928	E 179 17 55.0587	142.0013	EEZ Report - Northern
UNAV	S 18 11 14.3492	W 178 46 47.5921	112.6458	EEZ Report - Northern
CIKI	S 17 17 0.1427	W 178 47 33.4089	208.6234	EEZ Report - Northern

Station ID	Easting	Northing	Orthometric Ht.	Source
KADV	1919868.03	3765411.97	805.3	TD88
NAKO	2058096.05	3895100.72	89.62	SO 4274
OALA	2124627.20	3825511.38	302.53	SO 4274
UNAV	2261331.88	3866850.50	59.77	SO 4347

Geodetic Survey Campaign Metadata

Fiji Geodetic Stations Survey Campaign Metadata

Station ID	Station Name	Occupation Period	Interval	Receiver Type	Antenna Type	Rinex Version	Vertical Ht (m)	Rinex Height	Antenna Method	Firmware	Checked By	Field Operators
LAUT	Lautoka	Continuous	1sec	SEPT POLARX5	JAVRINGANT_DM	5.2.0			ARP			GA
SUV1	Suva	Continuous	1sec	Trimble NetR5	TRM55971.00	4.19			ARP			SPC
LABC	Labasa	Continuous	1sec	VNET10T-D	HI-TARGET AT-53501	3.02			ARP	CJ00		CONTROL
NABC	Nabouwalu	Continuous	1sec	HI-TARGET VNET10T-D	HITAT53501(HITS)	3.02			ARP	CJ00		CONTROL
TAVC	Taveuni	Continuous	1sec	HI-TARGET VNET10T-D	HITAT53501(HITS)	3.02			ARP	CJ00		CONTROL
KORC	Koro	Continuous	1sec	Leica GR50	Leica AR20	3.02			ARP	4.11.606		CONTROL
LAKC	Lakeba	Continuous	1sec	Leica GR50	Leica AR20	3.02			ARP	4.11.606		CONTROL
ONOC	Ono-i-Lau	Continuous	1sec	Leica GR50	Leica AR20	3.02			ARP	4.11.606		CONTROL
KADC	Kadavu	Continuous	1sec	Leica GR50	Leica AR20	3.02			ARP	4.11.606		CONTROL
ROTC	Rotuma	Continuous	1sec	Leica GR51	Leica AR21	3.02			ARP	4.11.606		CONTROL
CEVA	Ceva-i-ra	7 DAYS	1sec	TRIMBLE R10	TRMR10	3.02	1.642	1.692	Bottom of Notch	4.81	MT&MR	Poate
BUKE	Delainabukelevu (Kadavu)	7 DAYS	30sec	TRIMBLE NET R9	TRM557971.0	3.02	1.978	1.934	Bottom of Notch	5.37	MT&MR	Sakumeni
NAKO	Nakorowaro (Gau)	7 DAYS	30sec	LEICA GS10	LEIAS10	3.02	1.265	1.625	Hook height	5.05	MT&MR	Sisa
OALA	Korokoli (Moala)	7 DAYS	10sec	LEICA GPS 1200	LEIAX1202	2.11	1.404	1.764	Hook height	4.0	MT&MR	Navitalai
UNAV	Lakeba(GPS - Yadrana)	7 DAYS	1sec	LEICA GS16	LEIGS16	3.02	1.38	1.740	Hook height	8.0	MT&MR	Jesoni
CIKI	Cikobia-i-lau	7 DAYS	15sec	LEICA GS10	LEIAS10	3.02	1.333	1.693	Hook height	5.05	MT&MR	Gabiriele
LULU	Cokalulu (Cicia)	7 DAYS	10sec	TRIMBLE NET R9	TRM557971.0	3.02	1.751	1.707	Bottom of Notch	4.85	MT&MR	Daniel
MTKU	Matuku	7 DAYS	30sec	LEICA GPS 1200	LEIAX1202	2.11	1.263	1.623	Hook height	4.0	MT&MR	William C
OGEA	Ogea Driki	7 DAYS	30sec	LEICA GPS 1200	LEIAX1202	2.11	1.185	1.545	Hook height	4.0	MT&MR	Livi
VATO	Vatoa	7 DAYS	30sec	LEICA GPS 1200	LEIAX1202	2.11	1.272	1.632	Hook height	4.0	MT&MR	Niko

Geospatial Data Management

FIJI GEODETIC DATUM 2019 - 2020 GNSS OCCUPATION REPORT

STATION NAME: NAKOROWARO
4 CHARACTER ID: NAKO
LOCATION: VIONE, GAU, LOMAIVITI
COUNTRY: FIJI
TYPE OF SURVEY MARK: BRASS PLAQUE IN CONCRETE
ORTHOMETRIC HEIGHT OF SURVEY MARK: (MEAN SEA LEVEL DATUM)
OBSERVATION START DATE/DAY: 10/11/2019
UTC TIME: 1931hrs
OBSERVATION END DATE/DAY: 17/11/2019
UTC TIME: 0001hrs
GNSS RECEIVER TYPE: LEICA
MODEL: LEICA GS10
SERIAL NUMBER: 1532578
FIRMWARE VERSION: 5.05
GNSS ANTENNA TYPE: LEICA
MODEL: LEIAS10
SERIAL NUMBER: 667126
HEIGHT OF GNSS ANTENNA ABOVE STATION MARK: 1.265m (VERTICAL MEASUREMENT)
DESCRIPTION OF THE POINT ON THE GNSS ANTENNA
THAT THE ANTENNA HEIGHT REFERS TO:

HOOK HEIGHT

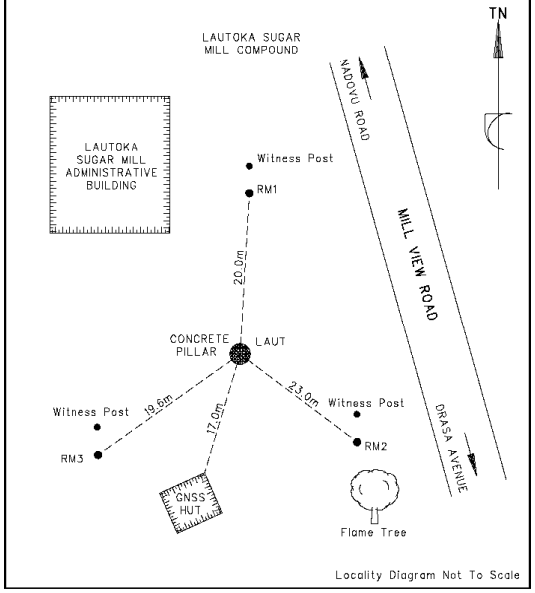
ANTENNA HEIGHT TO ARP - 1.625m

ATTACH ADDITIONAL INFORMATION AND DIAGRAMS THAT MAY BE USEFUL FOR PERSONS PROCESSING THE DATA AND ANALYSING THE RESULTS.

ISLAND: VITI LEVU PROVINCE: BA DATE: 14-11-19	MINISTRY OF LANDS & MINERAL RESOURCES CONTROL SECTION	POINT ID: LAUT STATION NAME: LAUTOKA

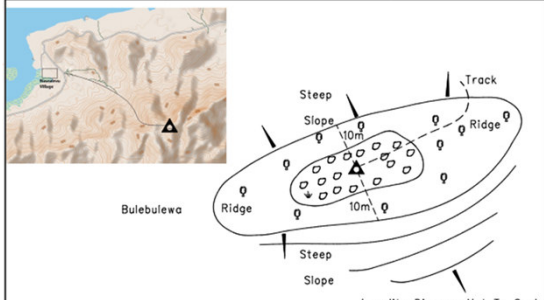
GNSS COR STATION

The GNSS COR station is a concrete pillar of 400mm in diameter and is of 1.5 metres above the ground level. The concrete pillar sits on a concrete base of 1.96m² in area and 3.5m in depth.



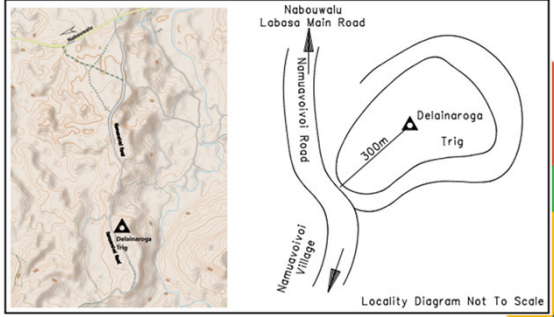
Locality Diagram Not To Scale

COUNTRY: FIJI ISLAND: VANUA LEVU PROVINCE: MACUATA	MINISTRY OF LANDS & MINERAL RESOURCE CONTROL SECTION	POINT ID: BULE DATE: 26-01-20 LDP: FJ133



Locality Diagram Not To Scale

COUNTRY: FIJI ISLAND: VANUA LEVU PROVINCE:BUA	MINISTRY OF LANDS & MINERAL RESOURCE CONTROL SECTION	POINT ID: ROGA DATE: 26-01-20 LDP: FJ134



Locality Diagram Not To Scale

Challenges

- Data downloading and backup – GNSS CORS data was not downloaded immediately after the completion of each phase, also backup copies were not stored in a remote location; it was still in the server, which collapsed.
- GNSS CORS setup was not configured to IGS Standards and Guidelines.
- Missing information from field survey sheets e.g., heights, equipment type, photos, etc
- Timely and accurate compilation of geodetic survey data
- Data Gaps due to disruptions of GNSS COR station failure from natural disasters and internet connectivity
- Capacity – limited knowledge in conversion of GNSS Raw data to RINEX of Leica, Hi-Target and Trimble.
- Internet connectivity during data processing (difficulty in upload AUSPOS)
- GNSS COR stations - data handling, data access, data storage, and data management
- Capacity on operations and management of GNSS CORS
- Timely provision of data after geodetic survey campaign
- Lack of IT support – importance of GNSS CORS data
- Software and firmware issue for - Vnet platform for GNSS CORS, LGO for multiple users, upgrade LISCAD license

Lessons Learnt

- Better management and maintenance of the GNSS CORS
- Capacity building in geodetic survey data handling and management
- Consultations with all relevant stakeholders
- Better communications within teams
- Project ownership and commitment from project staff
- Proper planning for fieldwork
- Importance of documenting relevant and accurate information on field sheets, localities.
- Visibility for future projects

Work in Progress

- Geodetic survey data processing, analysis and network adjustment using AUSPOS, TBC, LGO, DynAdjust and Bernese.
- Capacity building in geodetic survey data processing, analysis, and network adjustment.
- Technical Reports – Geodetic Surveys
- Definition of transformation parameters and develop tools for transformations
- Transformation and alignment of all the geospatial data, information and products (survey plans and topographic maps) from the Fiji Map Grid 1986 to the new datum.
- Awareness and visibility of the new Fiji Geodetic Datum 2020
- Installation of the Tide Gauges, to be co-located with the GNSS CORS
- Develop and establish the vertical reference frame with pole to gauge calibrations
- Develop and establish reference marks at the GNSS CORS sites, for monitoring surveys
- Precision levelling surveys from the GNSS CORS to the Tide Gauge Stations

Work in Progress

- Maintenance plan for the GNSS CORS and site
- Capacity building needs in ICT and electronics of the GNSS CORS
- GNSS CORS data management plan and strategy for handling, accessibility, sharing.
- Solutions and results of the GNSS CORS to analysis for land velocity
- Inclusion of GNSS CORS to be part of the APREF and IGS network
- Upgrade the GNSS CORS for Network RTK capability
- Develop and maintain archive data sets for all the GPS/GNSS observations in the past, current and in future
- Seek opportunity to establish and develop Fiji's geoid model.
- Geospatial Policy, incorporating the Fiji's Geodetic Reference Frame
- Fiji Geodetic Reference Frame Database incorporated into VanuaGIS (Online GIS Portal)

The most relevant SDGs related to the presentation and theme of this session

SUSTAINABLE DEVELOPMENT GOALS

International Federation of Surveyors supports the Sustainable Development Goals