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EDM Height Traversing Levelling Survey Report

Honiara, Solomon Islands, March 2012

S. J. K. Yates, A. Lal

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GEOSCIENCE AUSTRALIA
RECORD 2014/26

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Australian Government
Geoscience Australia

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Contents

1 Introduction

This report outlines the high precision level survey completed between the Sea Level Fine Resolution Acoustic Measuring Equipment (SEAFRAME) tide gauge and the Continuous Global Navigation Satellite System (CGNSS) station in Honiara, Solomon Islands from 27 March to 4 April 2012.

Personnel involved in the survey were Steve Yates, Surveyor, Geoscience Australia and Andrick Lal, Surveyor, Secretariat of the Pacific Community (SPC).

The Electronic Distance Measurement (EDM) height traversing levelling technique was employed to observe differences in height between the deep bench mark arrays in Honiara, which runs approximately 2 km from the tide gauge sensor to the CGNSS antenna. Previous levelling surveys have been conducted along the route using this technique in 2007 and 2010.

In addition, precise differential levelling surveys were performed along the deep bench mark (BM) array from 1994 to 1999 by the National Tidal Centre Australia (NTCA). This report contains a comparison between the 2012 and 2010 EDM height traversing results as well as a combined comparison since the first levelling survey in 1994.

2 The Survey

The EDM height traversing levelling survey was carried out between the SEAFRAME tide gauge sensor, CGNSS station and the deep driven bench marks:

SOLOBM – GPS Benchmark

SOL103 – SEAFRAME Project Bench Mark

SOL18 – SEAFRAME Project Sensor Bench Mark

FBM1 – DESTROYED

FBM3 – Deep Driven BM

FBM4 – Deep Driven BM

FBM8 – Deep Driven BM

FBM9 – Deep Driven BM

Most of the deep bench marks were located and found in good order and undisturbed, FBM2 was unable to be located and FBM1 (a local Lands and Survey mark) was found to be inaccessible and probably will be destroyed with the construction activity in the area. Also included in the survey were temporary holding marks SOL103, SOL106, SOL107, SOL108, SOL110, SOL111, SOL112, SOL113 and SOL114.

The EDM height traversing levelling technique was performed to the Class L2A specifications (ICSM, Standards and Practices for Control Surveys). After reduction an internal precision of $1mm\sqrt{K}$ or better was achieved (zero order); well within the specifications of the project which is $2\sqrt{K}$ where K is the distance in kilometres. A table of results and comparisons and the 2012 reduced levels are detailed later in this report.

2.1 Bench Mark Locality Diagram

2.2 The Solomon Islands Datum

The adopted reference point for this survey is FBM4. Reduction of the data was calculated holding FBM4 fixed at 3.61966 metres. The height of FBM4 was derived NTC in 1994.

2.3 Equipment

- Leica total station model TM30 (Serial No: 361441)
- Leica precision prisms GPH1P (2).
- Leica rigid tripod.
- Stainless steel target poles supported by Leica telescopic bi-poles (2).
- Shortened stainless steel target pole for the SEAFRAME sensor BM connection.
- Leica cast iron change plates (2).
- Kestral 4000 pocket weather tracker

2.4 Method

The “Leap-Frog” EDM height traversing technique was employed for the Honiara tide gauge levelling survey. This technique involves setting up a total station (TCA1800L) midway between two target/reflectors (on reflector rods with struts). The targets remain at a particular change point for the back-sight and fore-sight observations. The instrument measures slope distances (±1mm) and vertical angle (1”) to derive height differences (between the instrument’s trunnion axis and the reflectors). In support of the slope distance observations, the ambient temperature, pressure and humidity are recorded (Kestral 4000 pocket weather tracker) and input into the instrument to apply the first velocity correction to the observed distances (Rüeger & Brunner, 1982). Four rounds of observations are taken to the back-sight and fore-sight targets from each instrument setup. All levelling runs started and finished with the same reflector and reflector rod, i.e. an even number of setups when the two reflector rod configuration was used. This eliminates any reflector rod zero error. This technique can also be performed using a single set-up / single rod configuration which is particularly useful when levelling between bench marks which are close together e.g. between the CGNSS RMs.

Reduction of the digital data was computed by the Geoscience Australia levelling program “leveling1.exe”. This program computes the height difference between the two reflectors.

2.5 Survey Support

The survey team very much appreciated the assistance from Solomon Islands Meteorological Service, especially the field assistance from Mr. David Tapiei. All the staff from the Solomon Islands Meteorological Service have developed a keen interest in the SPSLCMP project and are always eager to provide assistance when required.

2.6 Issues

Prior approvals needs to be taken to access the following deep benchmarks; -

Tide Gauge Station and Deep Driven Bench Mark, FBM8 – Police Patrol Base

FBM4 is now within a locked compound and due to the heavy traffic, the level run to SOL106 across the road is best attempted early on a Sunday.

CGNSS Station – Meteorological Department

As a matter of courtesy, prior approval should be made for access to the survey array from deep driven bench mark FBM9 to FBM3. This survey array runs across the parliament complex building compounds.

3 Comparisons

3.1 Comparisons between 2012 and 2010 EDM Surveys

Table 3.1 Honiara, Solomon Islands 2010 EDM Height Traversing Levelling & Comparison 2012 - 2010. FBM4 - adopted fixed height of 3.6197 m

From	To	Levelled Ht. Diff.	RL 2012	Misclose (mm)	Dist. (km)	1mm√k	RL 2010	Difference (mm) 2012 - 2010
FBM4			3.6197				3.6197	
SOL106	SOL106	-0.4139	3.2058	0.19	0.098	0.313	3.2064	-0.64
FBM8	FBM8	-1.2440	1.9618	0.11	0.134	0.366	1.9620	-0.24
SOL103	SOL103	0.3444	2.3062	0.16	0.124	0.352	2.3078	-1.61
SOL18	SOL18	1.2630	3.5691	-0.02	0.009	0.095	3.5707	-1.56
FBM4			3.6197					
SOL107	SOL107	1.3794	4.9991	0.20	0.116	0.341	4.9987	0.35
FBM9	FBM9	-0.2494	4.7496	0.13	0.148	0.385	4.7500	-0.39
SOL112	SOL112	1.4691	6.2187	0.01	0.040	0.200	6.2219	-3.20
SOL113	SOL113	25.0907	31.3094	-0.06	0.099	0.315	31.3039	5.51
SOL114	SOL114	14.3966	45.7060	0.19	0.086	0.293	45.6886	17.42
SOL108	SOL108	4.6018	50.3078	0.03	0.059	0.243	50.3052	2.57
	FBM3	3.7402	54.0479	-0.04	0.069	0.263	54.0467	1.22
SOL114			45.7060					
SOL110	SOL110	8.3816	54.0876	0.31	0.016	0.128	54.0794	8.16
	SOLOBM	0.2237	54.3113	-0.02	0.035	0.187	54.3032	8.08
			Misclose for all bays levelled =	1.19	1.033	1.017		
SOLOBM			54.3113					
	RM1	-0.0688	54.2425	0.05	0.027	0.164	54.23470	7.78
SOLOBM			54.3113					
	RM2	-1.2951	53.0162	-0.04	0.014	0.118	53.00790	8.30
SOLOBM			54.3113					
	RM3	-0.5575	53.7538	0.00	0.028	0.167	53.74580	7.96

All levelling was performed within the project specifications of 2√k

3.2 Combined Comparisons 1994 to 2012

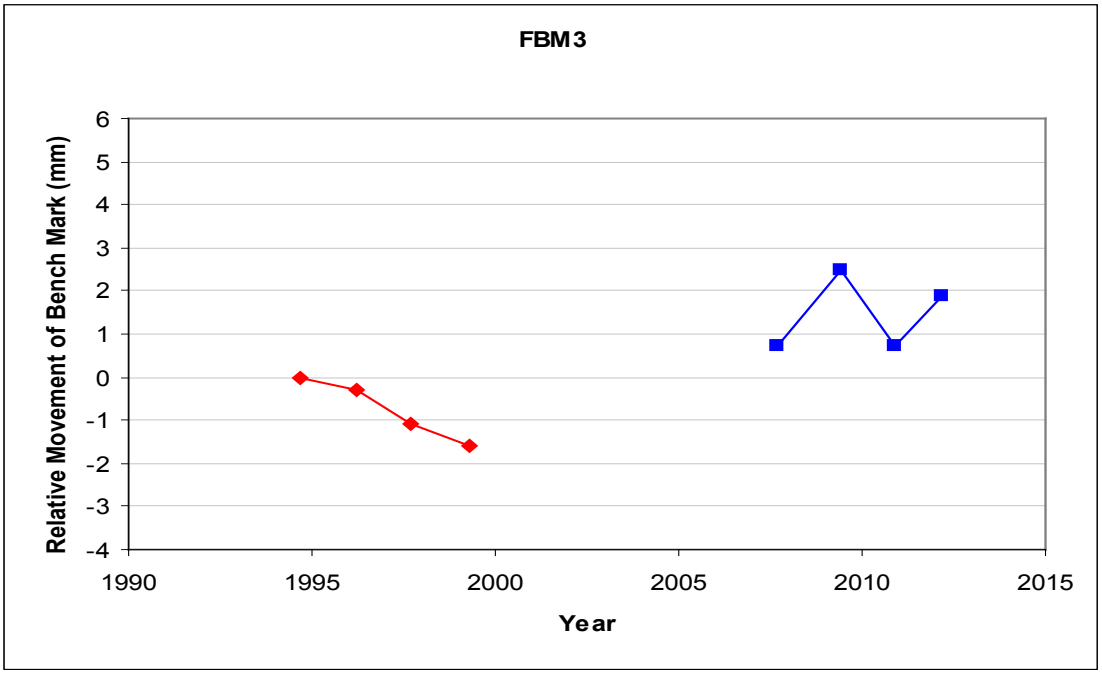
Table 3.2 Honiara, Solomon Islands - Comparison of the RL's for Precise Differential Levelling (1994-1999) and EDM Height Traversing (2007 - 2012).

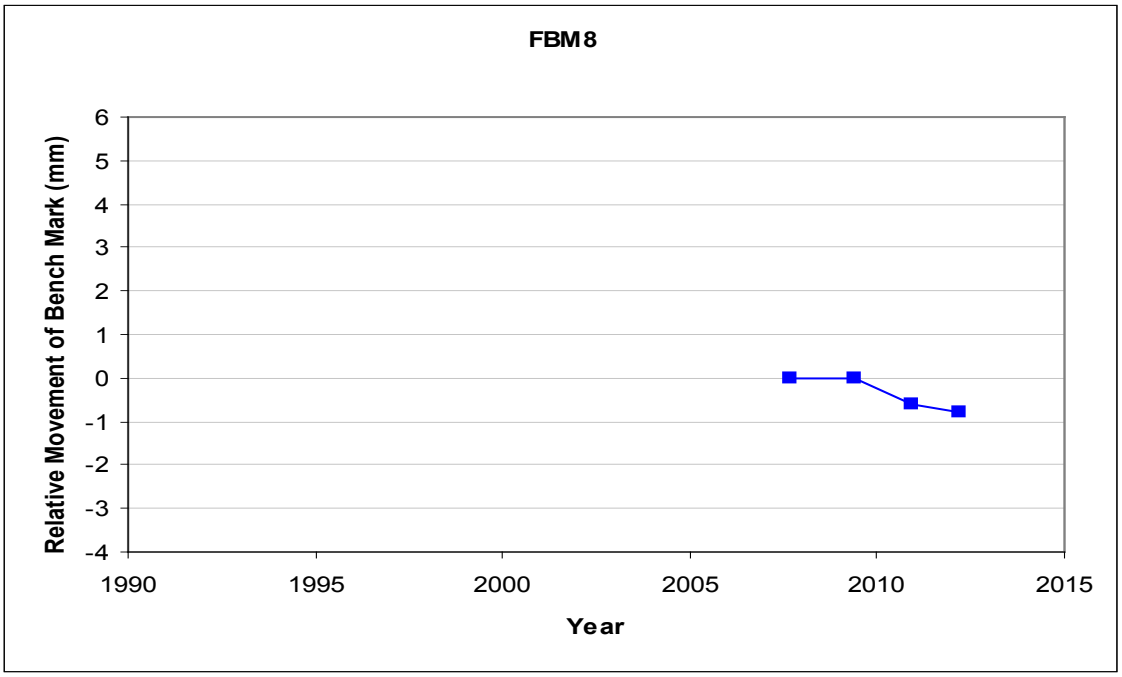
Year	1994.7	1996.2	1997.7	1999.3	2007.7	2009.4	2010.9	2012.2
FBM1	6.3860	6.3848	6.3857	6.3856	6.3866	6.3863	6.3868	
FBM2	3.3171	3.3175	3.3182	3.3161	3.3177			
FBM3	54.0460	54.0457	54.0449	54.0444	54.0467	54.0485	54.0467	54.0479
FBM4	3.6197	3.6197	3.6197	3.6197	3.6197	3.6197	3.6197	3.6197
SOL18	3.5755	3.5758	3.5741	3.5742	3.5720	3.5718	3.5707	3.5691
SOL103					2.3093	2.3085	2.3078	2.3062
FBM8					1.9626	1.9626	1.9620	1.9618
FBM9					4.7500	4.7502	4.7500	4.7496
SOLOBM					54.3111	54.3134	54.3032	54.3113
SOLO					55.7756	55.7801	55.7678	55.7759

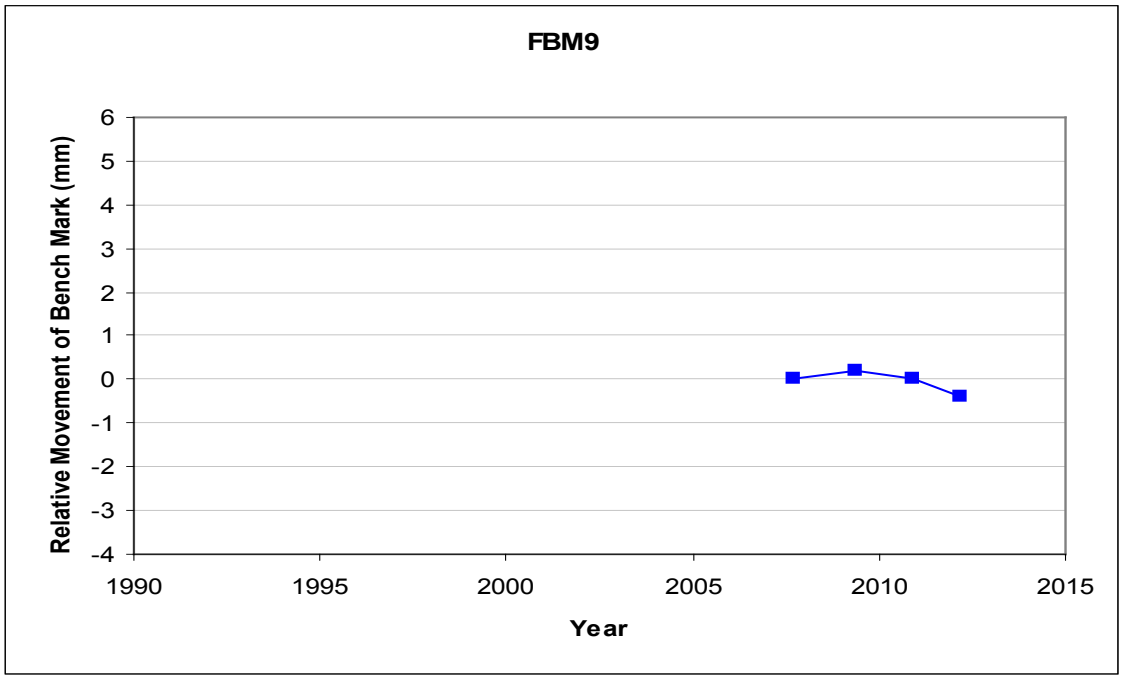
The ARP (SOLO) was not levelled to during the 2012 survey. The 2012 RL of SOLO was adjusted to the same height difference surveyed for 2012 RL of SOLOBM.

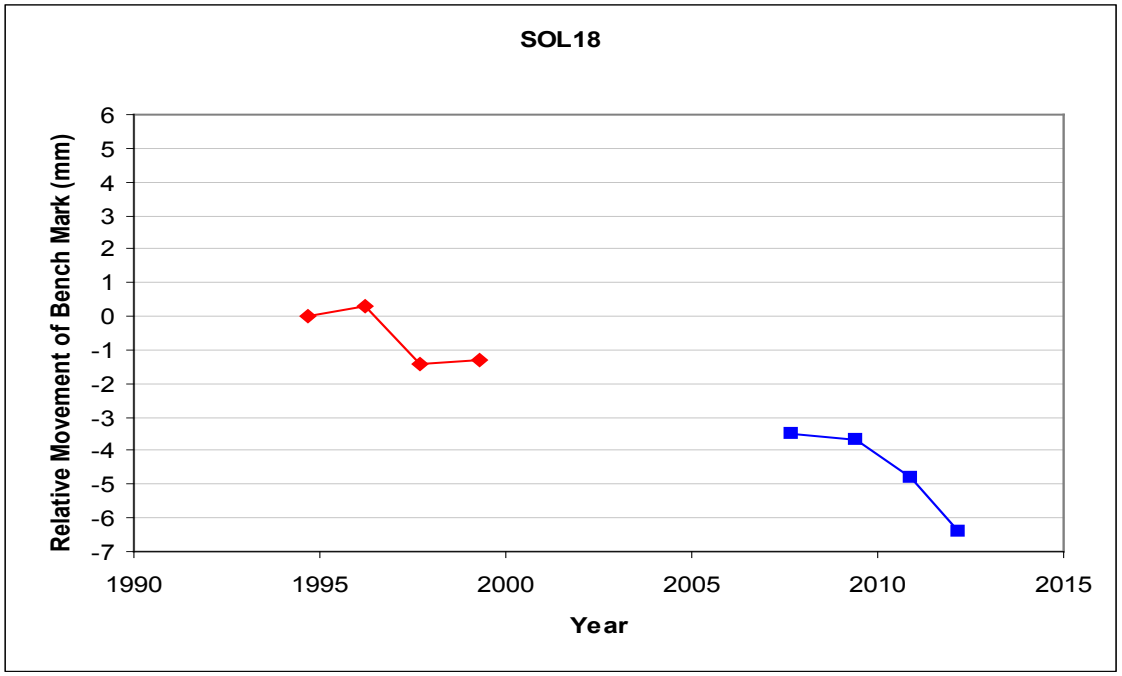
3.3 Time Series of Bench Mark Movement

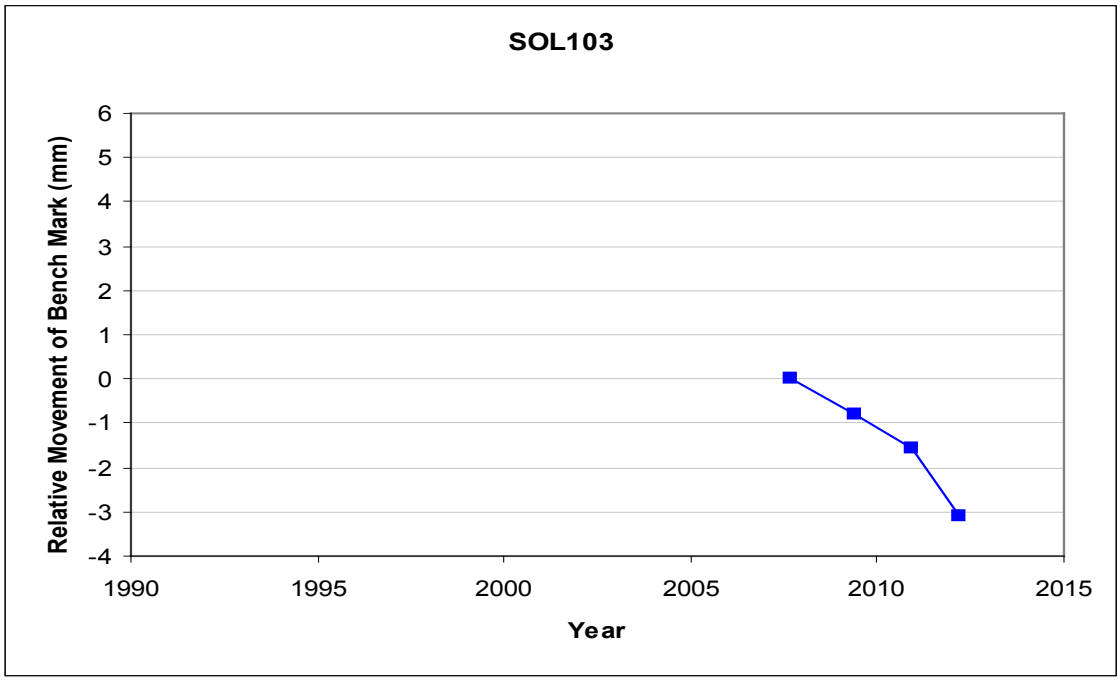
The purpose of this survey is two folds: firstly, to provide accurate changes in land height to be used in computations of absolute sea level rise and secondly to provide accurate assessments of relative sea level changes due to localised deformation.

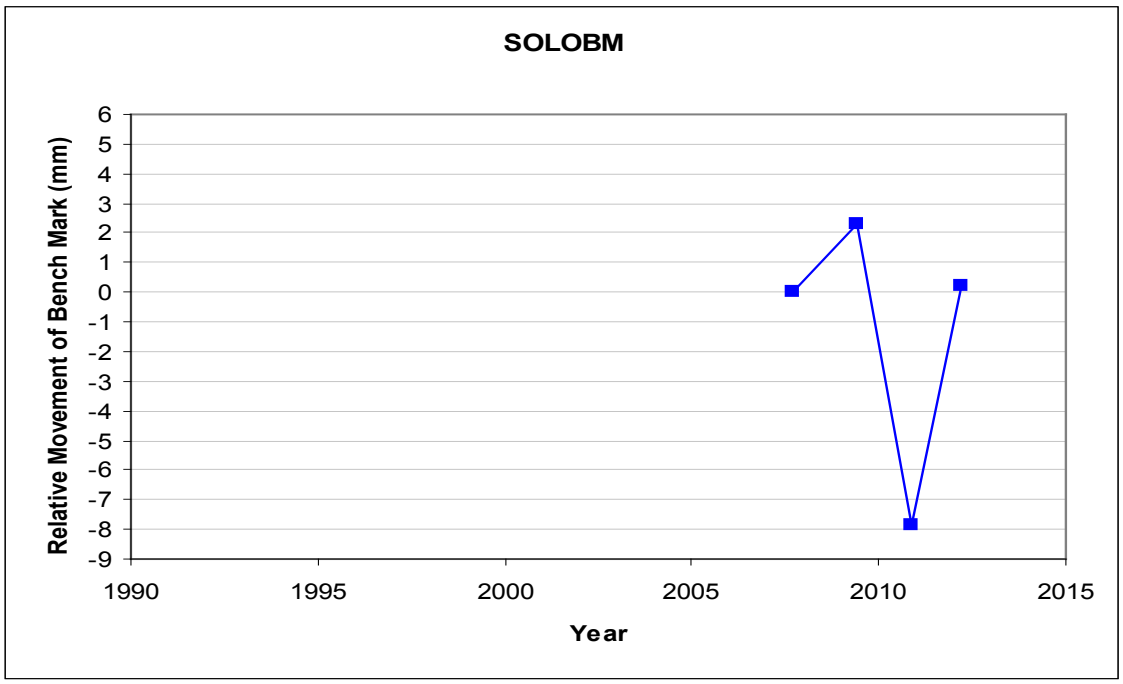


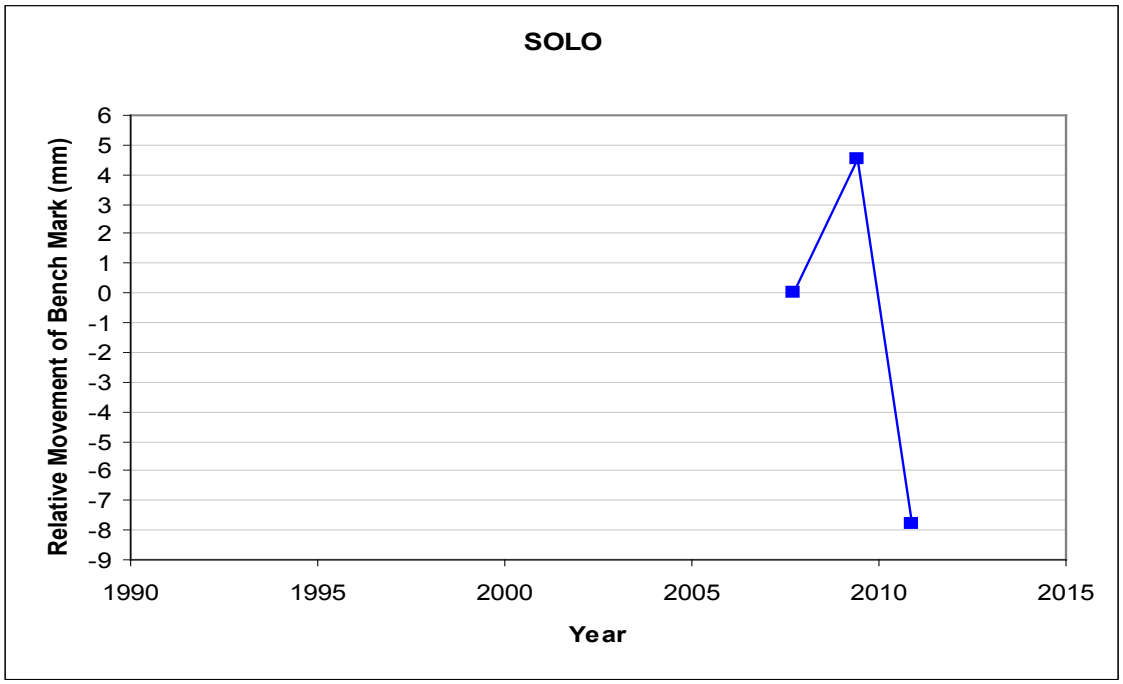



FBM9
Relative Movement of Bench Mark (mm)
6
5
4
3
2
1
0
-1
-2
-3
-4
1990
1995
2000
2005
2010
2015
Year


SOL18
Relative Movement of Bench Mark (mm)
6
5
4
3
2
1
0
-1
-2
-3
-4
-5
-6
-7
1990
1995
2000
2005
2010
2015
Year


SOL103
Relative Movement of Bench Mark (mm)
6
5
4
3
2
1
0
-1
-2
-3
-4
1990
1995
2000
2005
2010
2015
Year


SOLOBM
Relative Movement of Bench Mark (mm)
6
5
4
3
2
1
0
-1
-2
-3
-4
-5
-6
-7
-8
-9
1990
1995
2000
2005
2010
2015
Year


SOLO
Relative Movement of Bench Mark (mm)
6
5
4
3
2
1
0
-1
-2
-3
-4
-5
-6
-7
-8
-9
1990
1995
2000
2005
2010
2015
Year

4 Deep Bench Mark Locality Diagrams

SOUTH PACIFIC SEA LEVEL
&
CLIMATE MONITORING PROJECT

Survey Bench Mark Record

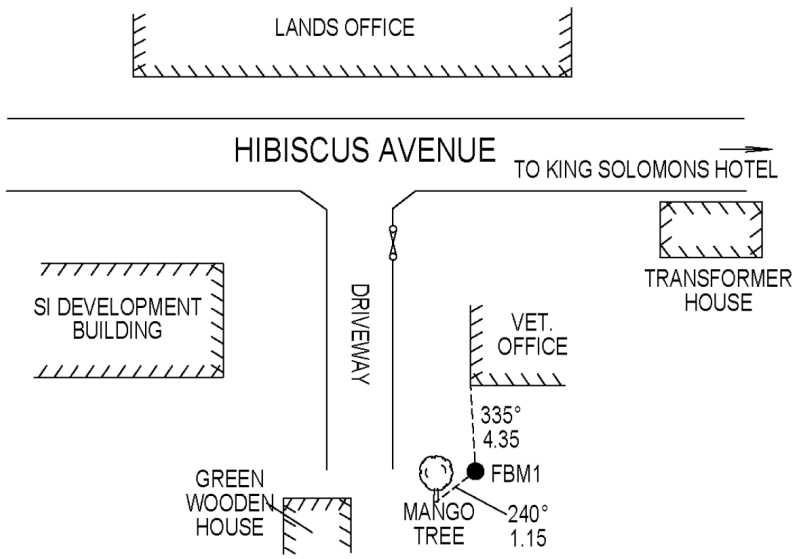
Bench Mark Number: FBM1

Bench Mark Established by: National Tidal Centre Australia, Oceanographic Services, Bureau of Meteorology, 25 College Rd, Kent Town, SA. — *Date*: Unknown
Existing Bench Mark Established by: — *Date*:
Notes / References: Department of Lands & Surveys BM register - FBM (Honiara) This survey mark is not in a good locality for GPS occupation.
Country: Solomon Islands *Island*: Guadalcanal — *City: Honiara*

Marking and locality sketch

Bench Mark: Brass bolt in the centre of a concrete pillar 35cm diameter and approx. 70cm above ground level

Locality sketch: Mark approximately 750m from the tide gauge station.



Not to scale — Distances in Metres — Magnetic bearings

Approved by: Geoscience Australia / SOPAC — Date: Dec 2007

c:\users\andrick\spslcmp\localitydiagrams\solomons

SOUTH PACIFIC SEA LEVEL
&
CLIMATE MONITORING PROJECT

Survey Bench Mark Record

Bench Mark Number: FBM3

Original Bench Mark Established by:
National Tidal Centre Australia, Oceanographic Services,
Bureau of Meteorology, 25 College Rd, Kent Town, SA.

Date: 28-10-91

Existing Bench Mark Established by:

Date:

Notes / References: Deep Benchmark
This survey mark is in a good locality for GPS occupation.

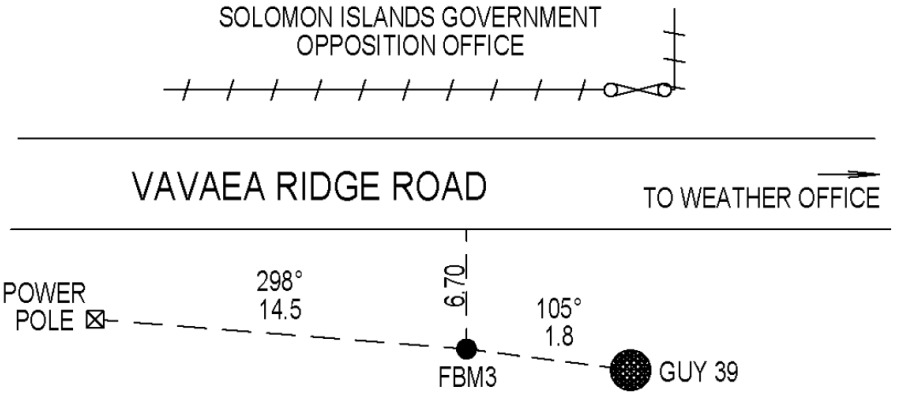
Country: Solomon Islands
Island: Guadalcanal

City: Honiara

Marking and locality sketch

Bench Mark: 6.0m of 19mm diameter stainless steel capped rod driven to refusal. Rod sheathed with 50mm diameter PVC tube for top 2.0m. Top of mark 0.25m below ground level

Locality sketch: Mark approximately 2200m from the tide gauge station.



Not to scale Distances in Metres Magnetic bearings

Approved by: Geoscience Australia / SOPAC

Date: Dec 2007

c:\users\andrick\spslcmp\localitydiagrams\solomons

SOUTH PACIFIC SEA LEVEL
&
CLIMATE MONITORING PROJECT

Survey Bench Mark Record

Bench Mark Number: FBM4

Original Bench Mark Established by: *Date*: 30-07-94
National Tidal Centre Australia, Oceanographic Services,
Bureau of Meteorology, 25 College Rd, Kent Town, SA.

Existing Bench Mark Established by: *Date*:

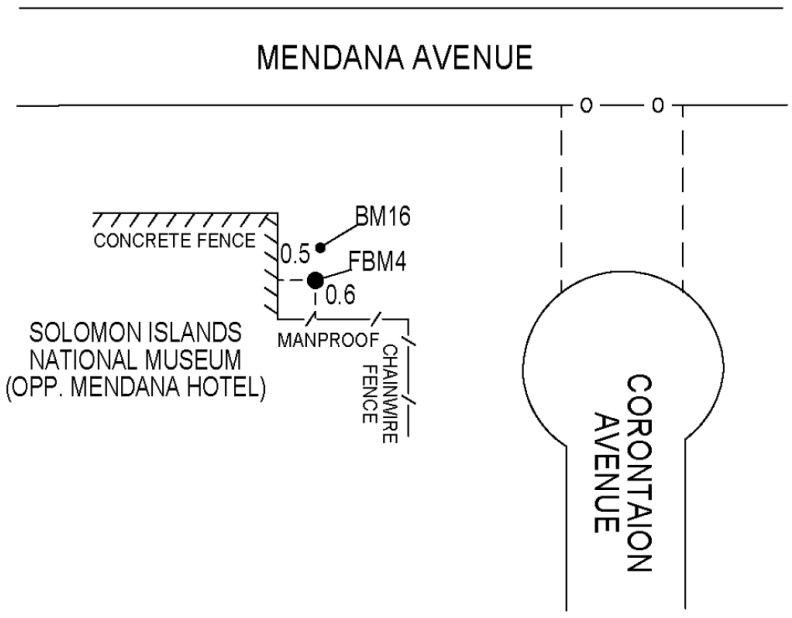
Notes / References: Deep Benchmark
This survey mark is not in a good locality for GPS occupation.

Country: Solomon Islands
Island: Guadalcanal *City: Honiara*

Marking and locality sketch

Bench Mark: 1.8m of 19mm diameter stainless steel capped rod driven to refusal. Rod sheathed with 50mm diameter PVC tube for top 0.3m. Top of mark 0.3m below ground level

Locality sketch: Mark approximately 370m from the tide gauge station.



Not to scale Distances in Metres Magnetic bearings

Approved by: Geoscience Australia / SOPAC Date: Dec 2007
c:\users\andrick\spslcmp\localitydiagrams\solomons

SOUTH PACIFIC SEA LEVEL
&
CLIMATE MONITORING PROJECT

Survey Bench Mark Record

Bench Mark Number: FBM8

Original Bench Mark Established by: *Date*: 20-08-07
National Geospatial Reference Systems, Geospatial & Earth Monitoring Division (GEMD), Geoscience Australia.

Existing Bench Mark Established by: *Date*:

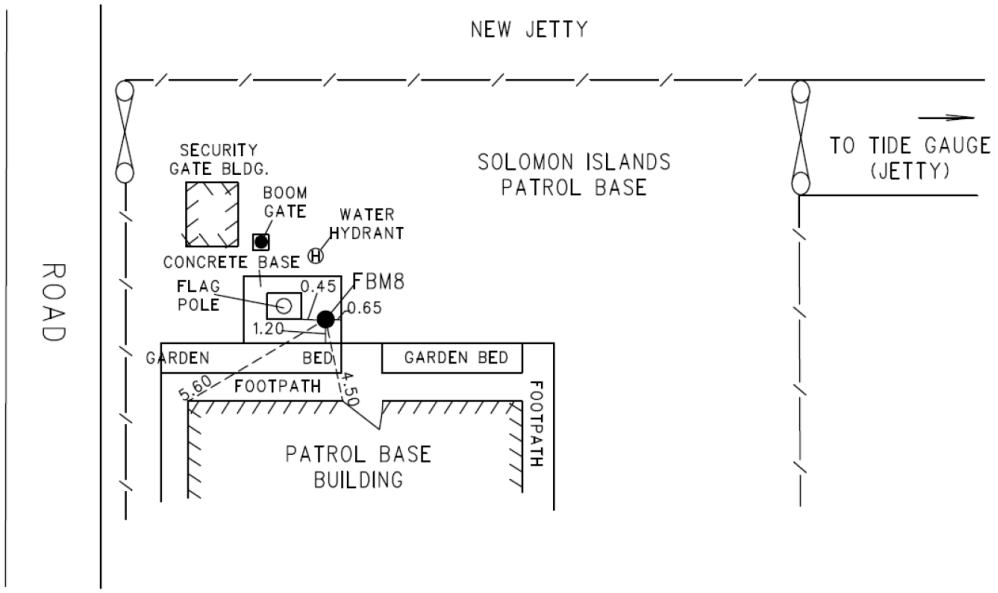
Notes / References: Deep Benchmark
This survey mark is in a good locality for GPS occupation.

Country: Solomon Islands
Island: Guadalcanal *City: Honiara*

Marking and locality sketch

Bench Mark: 3.0m of 19mm diameter stainless steel capped rod driven to refusal. Rod sheathed with 50mm diameter PVC tube for top 0.3m. Top of mark 0.2m below ground level

Locality sketch: Mark approximately 125m from the tide gauge station.



Not to scale Distances in Metres Magnetic bearings

Approved by: Geoscience Australia / SOPAC Date: Dec 2007
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SOUTH PACIFIC SEA LEVEL
&
CLIMATE MONITORING PROJECT

Survey Bench Mark Record

Bench Mark Number: FBM9

Original Bench Mark Established by: *Date*: 20-08-07
National Geospatial Reference Systems, Geospatial & Earth Monitoring Division (GEMD), Geoscience Australia.

Existing Bench Mark Established by: *Date*:

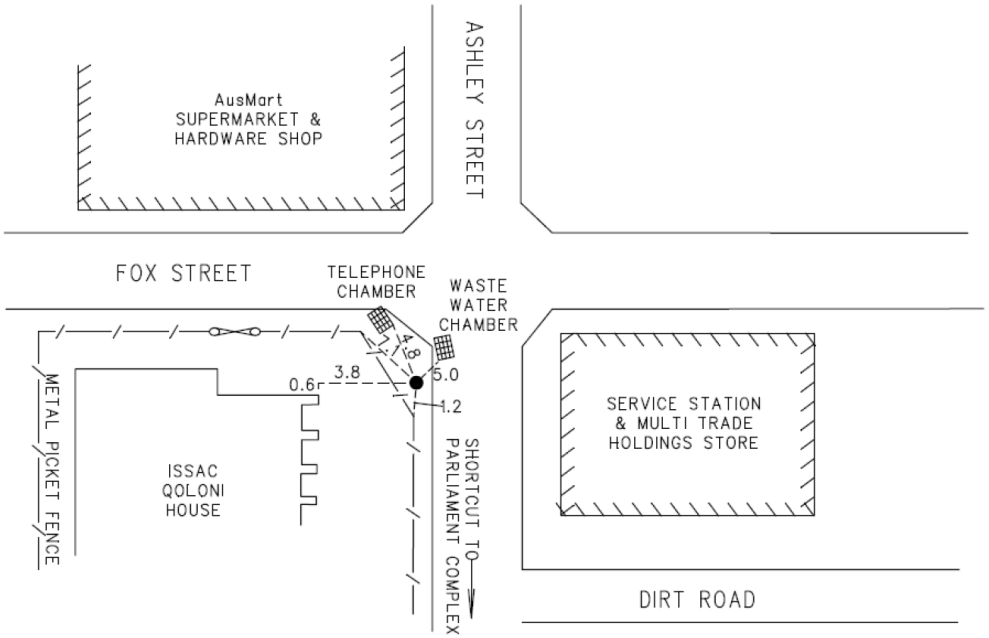
Notes / References: Deep Benchmark
This survey mark is in a good locality for GPS occupation.

Country: Solomon Islands
Island: Guadalcanal *City: Honiara*

Marking and locality sketch

Bench Mark: 2.0m of 19mm diameter stainless steel capped rod driven to refusal. Rod sheathed with 50mm diameter PVC tube for top 0.3m. Top of mark 0.2m below ground level

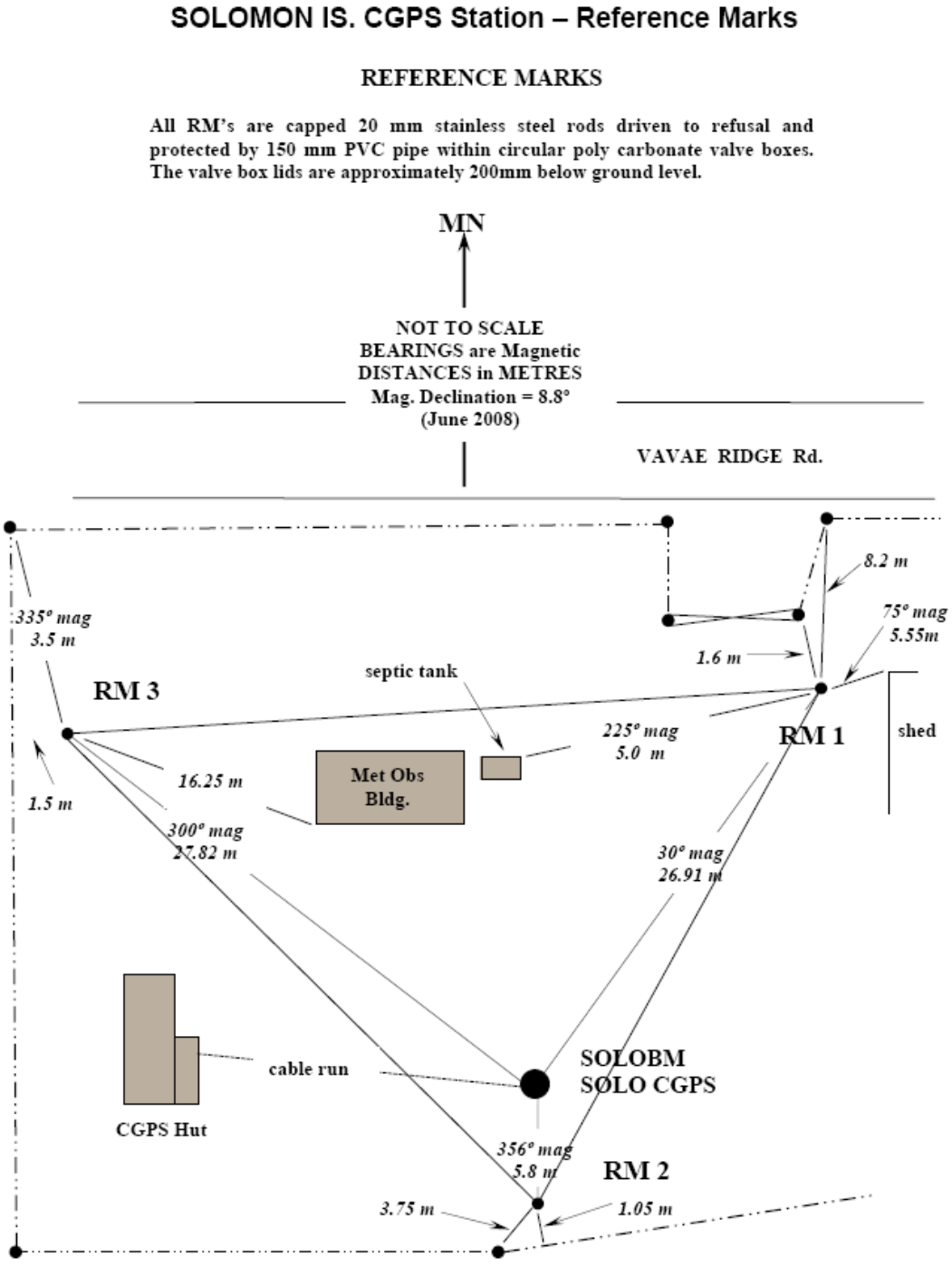
Locality sketch: Mark approximately 125m from the tide gauge station.



Not to scale Distances in Metres Magnetic bearings

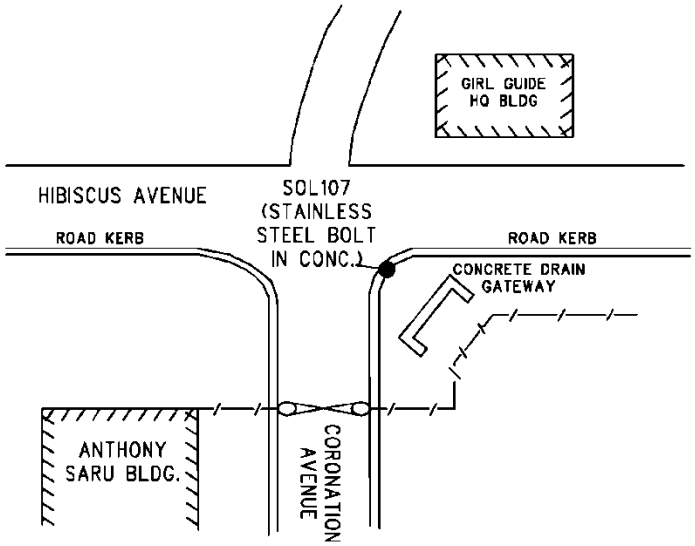
Approved by: Geoscience Australia / SOPAC Date: Dec 2007
c:\users\andrick\spslcmp\localitydiagrams\solomons

5 Solomon Island Reference Mark Locality Diagram

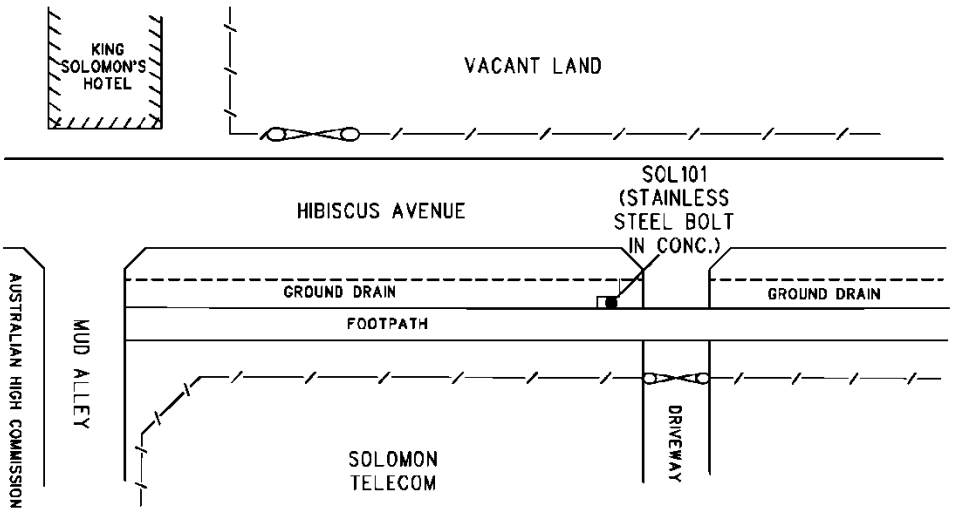


6 Temporary Holding Mark Locality Diagrams

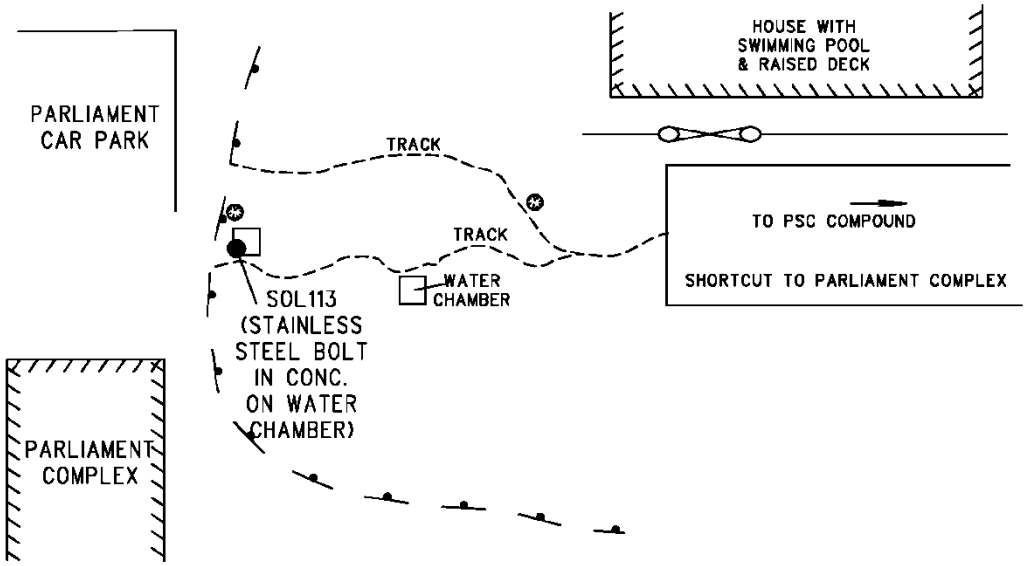
COUNTRY: Solomon Is	ISLAND: Guadalcanal CITY: Honiara	L. D. P. 886 POINT NO. SOL107
PROJECT: SPSLCMP	SURVEYOR: A. Lal & M. Deo	DATE: 19-05-09



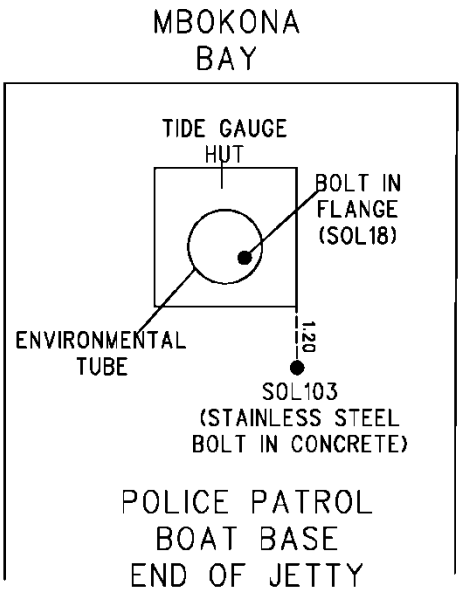
COUNTRY: Solomon Is	ISLAND: Guadalcanal CITY: Honiara	L. D. P. 820 POINT NO. SOL101
PROJECT: SPSLCMP	SURVEYOR: A.Lal & M. Deo	DATE: 25-08-07



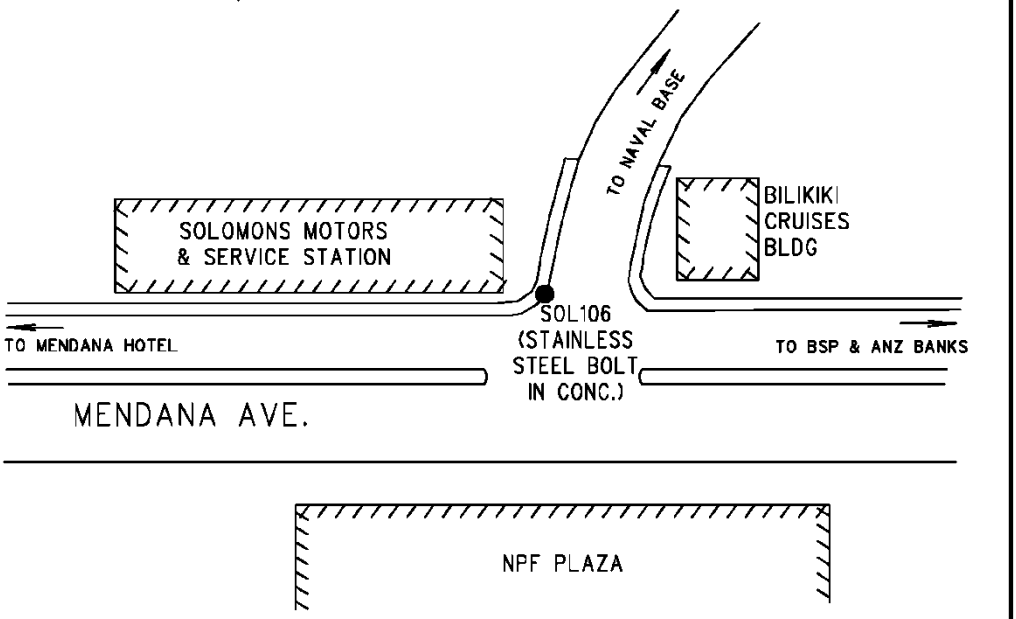
COUNTRY: Solomon Is	ISLAND: Guadalcanal CITY: Honiara	L. D. P. 821 POINT NO. SOL113
PROJECT: SPSLCMP	SURVEYOR: A. Lal & G. Hu	DATE: 25-11-10



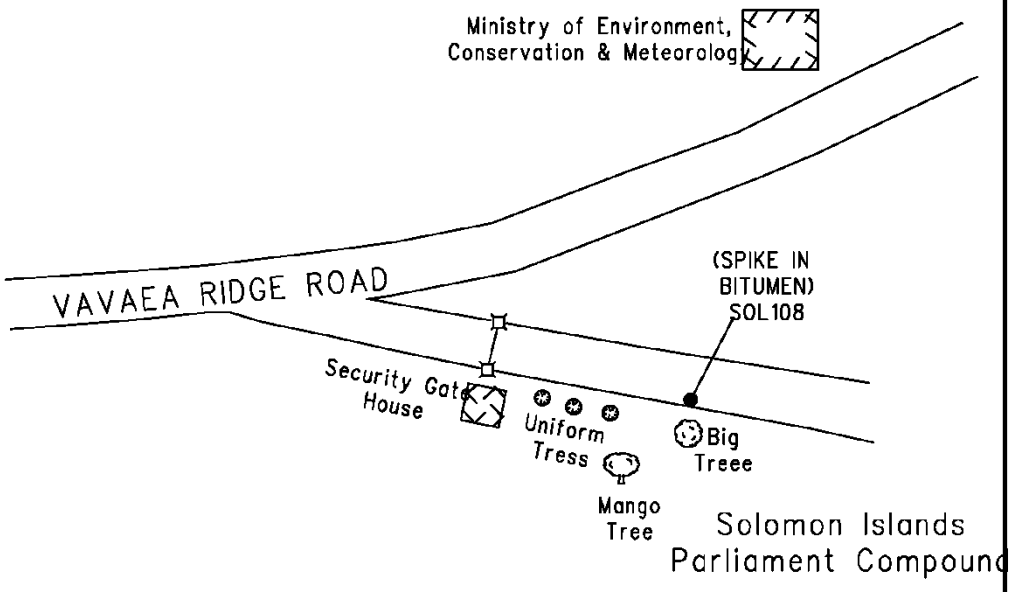
COUNTRY: Solomon Is	ISLAND: Guadalcanal CITY: Honiara	L. D. P. 822 POINT NO. SOL103
PROJECT: SPSLCMP	SURVEYOR: A.Lal & M. Deo	DATE: 25-08-07



COUNTRY: Solomon Is	ISLAND: Guadalcanal CITY: Honiara	L. D. P. 887 POINT NO. SOL106
PROJECT: SPSLCMP	SURVEYOR: A. Lal & M. Deo	DATE: 19-05-09



COUNTRY: Solomon Is	ISLAND: Guadalcanal CITY: Honiara	L. D. P. 888 POINT NO. SOL108
PROJECT: SPSLCMP	SURVEYOR: A.Lal & M. Deo	DATE: 19-05-09



COUNTRY: Solomon Is	ISLAND: Guadalcanal CITY: Honiara	L. D. P. 889 POINT NO. SOL114
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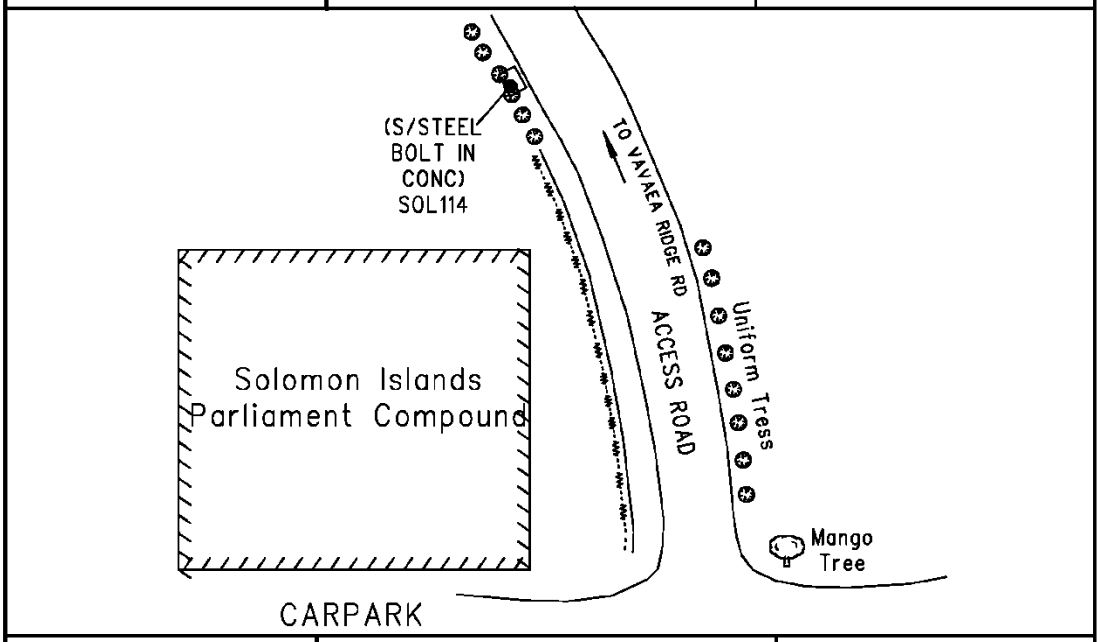

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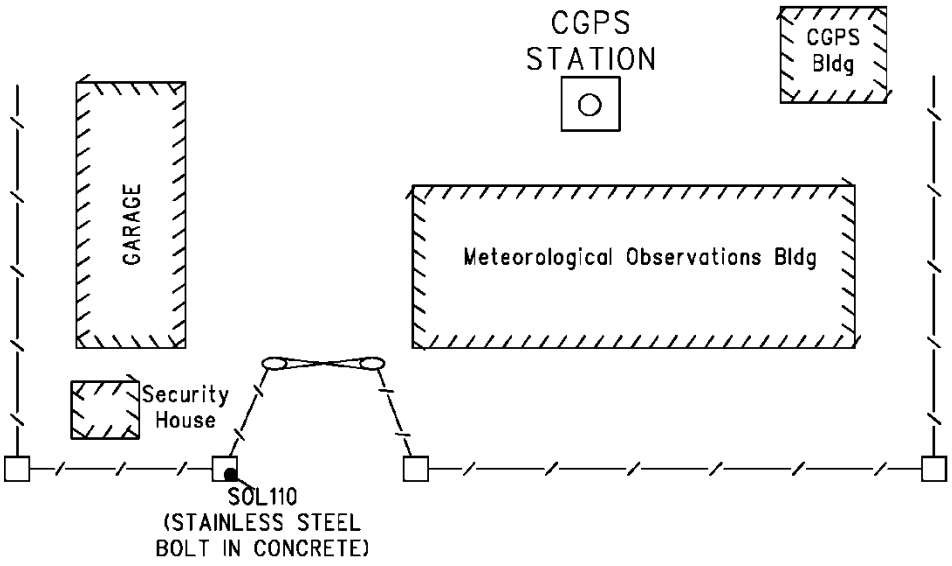
PROJECT: SPSLCMP	SURVEYOR: A.Lal & M. Deo	DATE: 19-05-09



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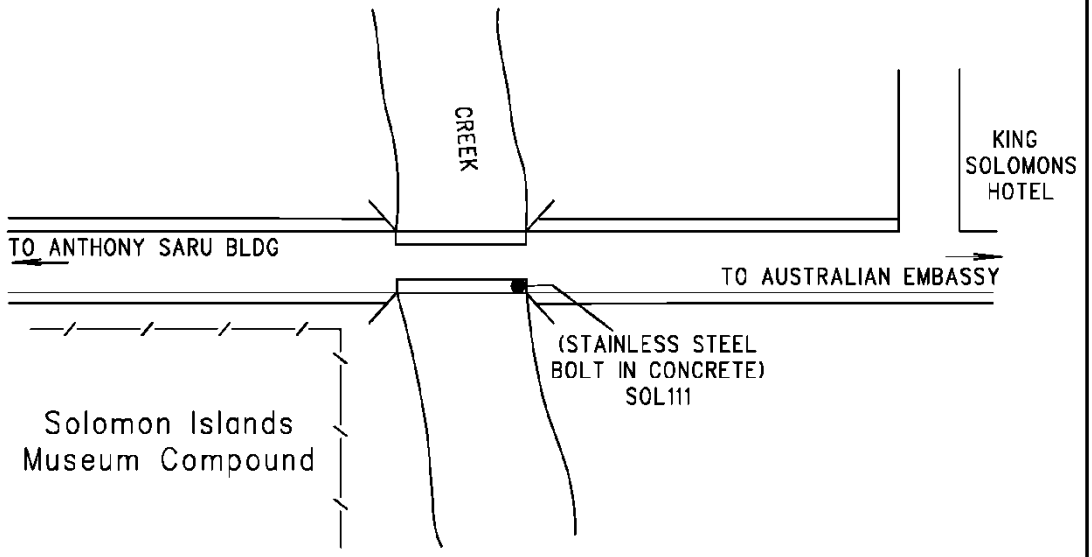
PROJECT: SPSLCMP	SURVEYOR: A. Lal & M. Deo	DATE: 19-05-09



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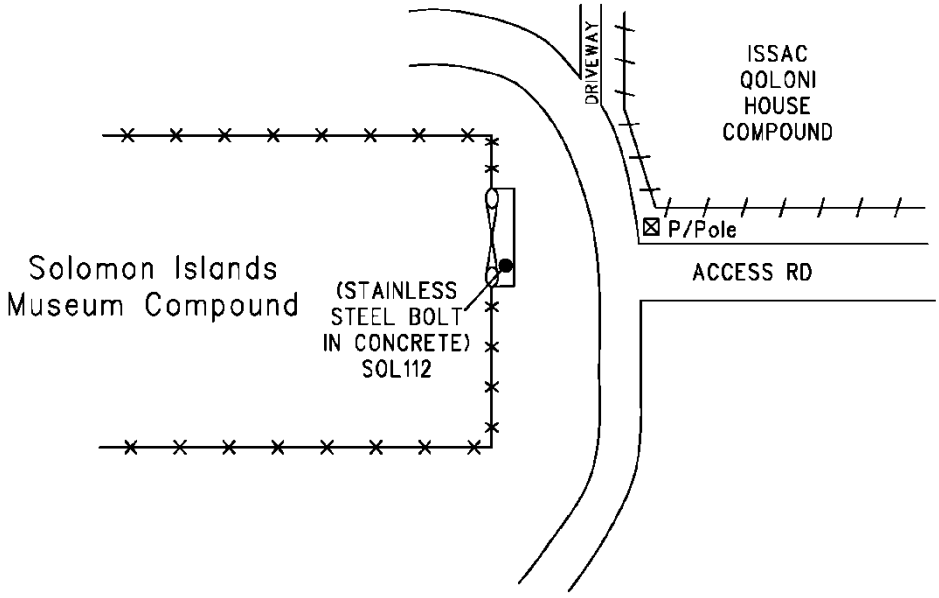

7 References

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