

**“Using Google Maps”**  
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**Abstract**

“Google Maps” [<http://maps.google.com>] is a publicly available Geographic Information System (GIS) Base Map from Google Inc. (the de-facto search engine for the internet) comprising traditional Mapping (roads, buildings, rivers, lakes, forests, coastline etc.) with satellite imagery and aerial photography perfectly registered so that the image can be viewed in-place on top of the map. The system was established in 2005 by Google which allows public internet access to the system and not internal intranets. The system is free for use without a license from Google providing the website using the map gets less than 25,000 hits a day for 90 consecutive days. The GIS is programmable via Google’s APIv3 (Application Programming Interface version 3.0). Therefore programmers can put in their own information on Google Maps in the form of Markers which are graphical symbols at specific locations on the map. When clicked by users, each Marker is a gateway to Database Information about the specific location: photos, addresses, services and links to other websites for additional information.

**2.0 Google Maps Data Input / Output**

Google Maps can be used to (1) Get Basic Location Information but more importantly (2) Put Geographic Information for access via the internet.

**2.1 Getting Information**

A significant amount of information is inherently built into Google Maps: In “Map” mode there are Roads, Rivers, Lakes, Coastline and many (but not all) place and street names. In “Satellite” mode the near-perfect registration of aerial photography, though dated at present, has a lot of value especially for things that have not changed since the time of the photography like buildings, roads etc.

**2.2 Geodetic Co-ordinates**

The default Geodetic Co-ordinates or Google maps are on the WGS84 ellipsoid and are given in decimal degrees to six decimal places which is equivalent to about 0.1m but some basic testing between Google Maps and the Lands & Surveys Digital mapping shows a difference of about ±5m. Latitude is given North of the equator (10.0° to 11.4° for T&T) and Longitude is given East of the Prime Meridian therefore values for Trinidad & Tobago are negative (-60.4° to -62.0°).

**2.3 Converting Between WGS84 and Naparima 1955 UTM Co-ordinates**

Naparima 1955 UTM		WGS84 UTM			
E	N	E	N	Delta E	Delta N
615000.00	1109000.00	615169.60	1109183.56	169.60	183.56
774000.00	1253000.00	774170.62	1253184.77	170.62	184.77
			<b>Range</b>	1.02	1.21

**Table 1**

[Table 1] shows the UTM co-ordinates for two points, the first just SW of Cedros in Trinidad and the second just NE of St. Giles Island in Tobago. The first set of co-ordinates is on the Naparima 1955 (International 1924) Datum and the second set is on the WGS84 datum. The mean differences between the Eastings & Northings are approximately 170m E and 184m N with a range of 1.02m and 1.21m respectively. Therefore when converting from Naparima 1955 to WGS84 and working  $\pm 5m$ , it is appropriate to simply +170m E and +184m N while applying the negative for the reverse conversion without getting into more formal conversion formulæ.

## 2.4 Converting Between WGS84 and Naparima 1955 Geodetic Co-ordinates

For converting between Geodetic Co-ordinates the method is slightly more complex:

Primary ellipsoid parameters		
Parameter Name	Symbol	Description
semi-major axis	a	Length of the semi-major axis of the ellipsoid, the radius of the equator.
semi-minor axis	b	Length of the semi-minor axis of the ellipsoid, the distance along the ellipsoid axis between equator and pole.
inverse flattening	1/f	= a/(a - b)
Derived ellipsoid parameters		
Parameter Name	Symbol	Description
eccentricity	e	= $\sqrt{2f - f^2}$
flattening	f	= 1 / (1/f)
radius of curvature in the meridian	$R_M$	radius of curvature of the ellipsoid in the plane of the meridian at latitude $\phi$ , where $\rho = a(1 - e^2)/(1 - e^2 \sin^2 \phi)^{3/2}$
radius of curvature in the prime vertical	$R_N$	radius of curvature of the ellipsoid perpendicular to the meridian at latitude $\phi$ , where $v = a / (1 - e^2 \sin^2 \phi)^{1/2}$
second eccentricity	e'	= $\sqrt{[e^2 / (1 - e^2)]}$

**Molodensky Transformation**

$$\Delta\phi'' = \{ -\Delta X \sin \phi \cos \lambda - \Delta Y \sin \phi \sin \lambda + \Delta Z \cos \phi + (a\Delta f + \Delta a f) \sin 2\phi \} / [R_M \sin 1'']$$

$$\Delta\lambda'' = \{ -\Delta X \sin \lambda + \Delta Y \cos \lambda \} / [R_N \cos \phi \sin 1'']$$

[Table 2] shows the 3-parameter Molodensky Transformation originally developed by Mikhail Sergeevich Molodensky (1909–1991), a Russian geodesist. The 3 parameters for WGS84 to Naparima 1955 (Trinidad) are  $\Delta x = 0.216m$  ;  $\Delta y = -372.252m$  ;  $\Delta z = -172.231m$  (Dr. Keith Miller). Once geodetic co-ordinates are obtained on the International 1924 Datum, the standard UTM direct formulæ can be applied to obtain plane co-ordinates (*Map Projections Used by the U.S. Geological Survey* - J.P. Snyder).

### 3.0 Putting Information on Google Maps

Through the API and the in-built JavaScript Programming Language found in all major web browsers, it is possible for anyone, not just professional programmers, to put their own data on Google Maps on their own website. The data would be ephemeral, emanating from the user's website without affecting the origination GIS base map from Google. It would easier to say what cannot be plotted on Google Maps rather than what can be plotted. Essentially anything with a location can be plotted: control points, roads, traverses, topos, cadastral plans etc.

The author has thus far implemented three Google Maps applications, which will be discussed briefly below.

#### 3.1 Cadastral Info Map Locator

**SurvPlan.com**  
hakeeb\_nandalal@yahoo.com  
Navigation Help

Type a Location in T&T  
[Input Field] GO

WGS84 Geodetic	
Latitude N	Longitude W
10° 39' 06"	61° 30' 54"

WGS84 U.T.M.	
Eastings	Northings
662403	1177880

Naparima 1955 Geodetic	
Latitude N	Longitude W
10° 39' 00"	61° 31' 01"

Naparima 1955 U.T.M.	
Eastings	Northings
662233	1177696

Plot a GPS Point on the Map  
 Naparima     WGS84  
 Eastings: [000000]    Northings: [0000000]  
 Plot    Clear

APPS: SOLAR  
 S  
 METRIC: M  
 ARP: A  
 R TO P: R  
 TRAV: T

County of St. George	
City of Port-of-Spain	
Sheet	23A
Section	2/b/1
Date	03-09-12
TT Time	07:55:50
Sun's Dec.	+7:17:41

Map Labels: Sackville St, London St, Dock Rd, Wightson Rd, Ajax St, Crowne Plaza, Hyatt Regency Trinidad

Fig. 1

<http://www.survtools.com/tools/gmaps/gmaps.htm>

[Fig. 1] shows a push-pin marker, moveable by the user, on the map while two tables show a myriad of data represented by the push-pin's location. The WGS84 geodetic co-ordinates are obtained directly from Google Maps in decimal degrees but were converted to DMS using JavaScript. Next are the WGS84 UTM co-ordinates which were computed using the UTM direct formulæ from Snyder then the Naparima geodetic co-ordinates are obtained using Molodensky's Transformation (Section 2.4). UTM plane co-ordinates are obtained by the UTM inverse formulæ from Snyder.

The second table shows the County and Ward/Borough/City in which the point falls. This is achieved by importing polygons for each Ward/Borough/City and performing a "point-in-polygon" test. These polygons were supplied to the author by Mr. Paul Williams in the form of AutoCAD dwg files in Naparima UTM. In order to import them into Google Maps the polygons had to be deconstructed point-by-point using AutoLISP, exported as text files, converted to Naparima geodetic, transformed to WGS84 geodetic and finally written out in decimal degrees format. There are 4600 polygon points for the wards of Trinidad and 3800 points for Tobago's parishes.

Computing the Ward Sheet/Section is a purely mathematical exercise since sheet edges follow a regular grid pattern. Note that this only possible for Trinidad. The author was unable to obtain *printed* UTM map sheets for Tobago in order to develop a corresponding algorithm.

### 3.2 Trinidad's Triangulation Stations

1031	Brigand Hill * 3
1032	15 mm Blanchisseuse Road
1033	17 1/4 mm Blanchisseuse Road
1034	21 mm Blanchisseuse Road
1035	St. Barb's Road
1036	Matelot Island
1036A	Matelot Rest House
1037	El Quemado * 2
1038	Goodrich Bay
1039	Milton * 2
1040	Phoenix Park
1041	Tortuga Church * 2
1042	TTT Television Mast
1043	Hybernia
1044	Soledad * 2
1045	Munro Buck * 2
1046	Cotton Hill * 2

**Trigonometrical Station Data**  
**U.T.M. Naparima 1955**

Number	1036
Name	Matelot Island
Eastings	704642.42
Northings	1196869.53
Latitude	10° 49' 16.927"
Longitude	61° 07' 41.670"

**Radial Search for Trigs**

Eastings	<input type="text" value="691380"/>
Northings	<input type="text" value="1155513"/>
Radius (m)	<input type="text" value="5000"/>

JavaScript Code © 2012 H.A. Nandalal



Fig. 2

<http://www.survplan.com/trigsgm/trigsgm.htm>

[Fig. 2] shows a second application for Google Maps: plotting control points. In this case it is the Triangulation Stations fixed in Trinidad and computed in the mid-sixties. Some additional control points obtained from the Hydrographic Unit are also on this map. In total there are 655 Trig Stations. The tables show for each station the Trig Number, Name and the Plane/Geodetic co-ordinates. Interestingly the original printed Trig Tables gave the geodetic co-ordinates to two decimal places which translate to a linear precision of 0.3m but the plane co-ordinates are given to the nearest centimetre. In the Google Maps table the author *computes* the geodetic co-ordinates from the plane co-ordinates using Snyder's (Section 2.4) UTM inverse formulæ and displays them safely to three decimal places (0.03m precision).

One can make the argument that by putting control on Google Maps with the aerial photography overlay, the need for location diagrams may be obsolete. The author would like to see all national control points put on Google Maps for all Surveyors to easily access and use for all types of Surveys especially Cadastral Surveys.

### 3.3 Recent Submitted (Un-Indexed) Cadastral Plans on Google Maps

Cadastral Plan Data U.T.M. Naparima 1955	
Plan Number	33F-4d-0001
Eastings	673322
Northings	1155623
Surveyor #	64
Plan Type	OLD LAW
Submitted	2012-06
Radial Search for Plans	
<input type="button" value="Get Centre-Point From Map"/>	
Eastings	<input type="text" value="710000"/>
Northings	<input type="text" value="1188000"/>
Radius (m)	<input type="text" value="5000"/>
<input type="button" value="Search"/>	
OLD LAW	<input checked="" type="radio"/>
RPO	<input type="radio"/>
TO-BE-BROUGHT	<input type="radio"/>
STATE LEASE	<input type="radio"/>
ACQUISITION	<input type="radio"/>

Fig. 3

[Figs. 3&4] show a third application for Google Maps: plotting the recently submitted and most importantly, *un-indexed*, cadastral plans as *searchable* location markers.

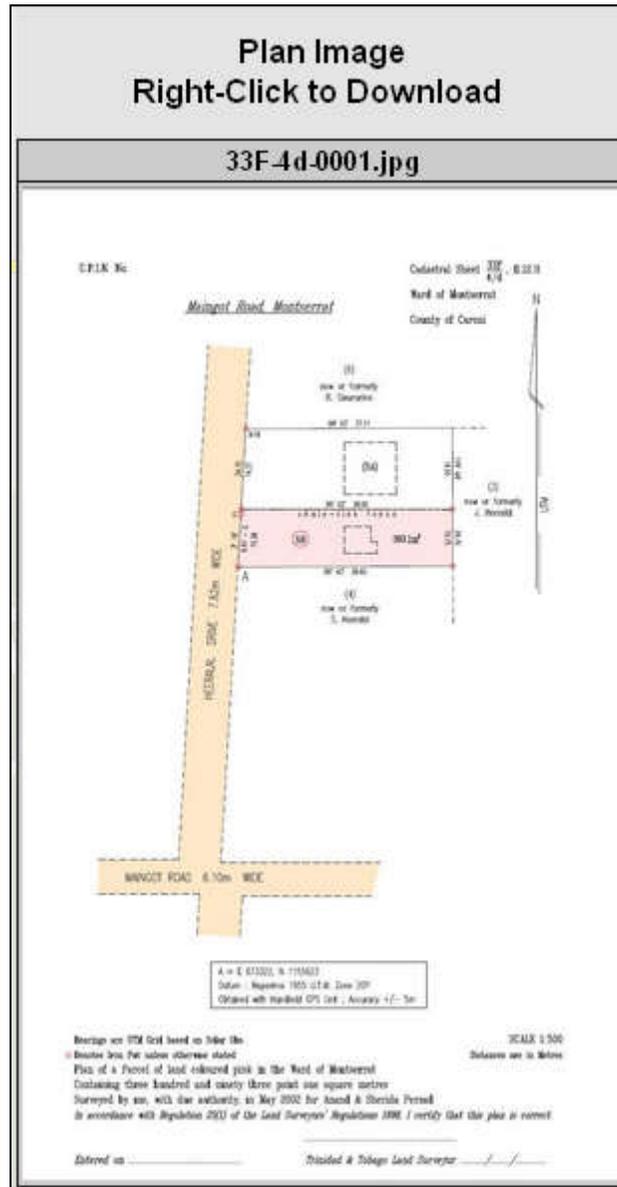


Fig. 4

<http://www.survplan.com/boxfile/boxfile.htm>

Rather than waiting to create an index map before plans can be indexed, the fact all new plans have at least one co-ordinated point in Napparia or WGS84 make them suitable for plotting as point positions which are searchable by centre and search radius. Strictly speaking, this can be done without any map, Google or otherwise. Thus far thanks to the contribution of a handful of Surveyors the author has created a database of 60 cadastral plans to demonstrate the principle. The concept can be taken one step further: go back to all the old Survey Books and using different techniques, assign one pair of co-ordinates to all the cadastral plans and put them on Google Maps to be graphically searchable. ■