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## **1. - Introduction.**

The present report has as its objective to respond to requirements of a technical assignment formulated by the designers from the company CCOA, which is a Contracting Company of works that has to do with Aviation, in the accomplishment of a topographic study that would be used in the projection and execution of the Argyle International Airport in Saint Vincent and the Grenadines.

## **2. - General Information of the Project.**

Beginning Date:

Completion Date:

Scale for the Surveys: 1: 2000

System of coordinates:

Height System: Referred to the mean sea level.

Area Surveyed: 140 Ha.

## **3. - Description of the Works done.**

3.1- Densification.

3.2- Leveling.

3.3- Layout

3.4- Tachymetric Surveying.

3.5- Longitudinal profile

3.6- Cross Sections.

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### **3.1. – Densification.**

For the advancement of the topographic studies, a group of actions were done directed to the densification of the work area with support points that permitted the execution of the same. The method used to determine the coordinates of the support points was that of polygonometry.



Two main polygonals were done and other smaller secondary polygonals were being done as the densification of the ample area of study became necessary, likewise the determination of several isolated polygonal points by the polar method.

The technical characteristics of the two main polygonal are described next.

### **Polygonal # 1**

Polygonal of connection of 4.444 km. of length, it begins at the base formed by points Versus 158 with national coordinates  $X=491858.50$  and  $Y=1456250.70$ , located in an elevation, approximately 0.68 km. to the left of station 275+0.00 of the center line of the runway to be projected and with an orientation to the point V4 with coordinates  $X=490273.20$  and  $Y=1455571.10$  located on an elevation at approximately 1.6 km. from the area of the future airport and whose coordinates were given by the investors of Saint Vincent and the Grenadines.

From these points coordinates were given to vertices that were being placed in a convenient manner in the area proposed by the technical team of the project, as position of the air field, locating a total of 13 points in the areas of greatest visibility like roofs of houses, elevations and lands with little vegetation, until closing in point Versus 159, with national coordinates  $X=492335.70$  and  $Y=1454293.00$ , located in an elevation to 0.48 km. to the right of station 127+1.76 of the center line of the proposed runway.

The perimeter of the polygonal of connection was of 4444.71 ms, the linear error obtained in the measurements was 0.253 m, product of an error in semi axis X of  $E_x=0.177$  m and in Y axis of  $E_y=0.181$  m, the precision obtained was superior to 1: 17000.

See annex 1.

### **Polygonal # 2**

This polygonal was done starting from points situated with the polygonal # 1 and its objective was the densification of the work area with support points to the topographical survey, to locate them on the center line of the runway, that would have been initially decided by the technical team of project, in such a way that it allowed the marking of the study areas.

We started off from points A and B, and we closed in point I, during its development the planimetric positioning of 32 points of the polygonal was determined, of them 28 points in center line of the runway, the same reached a perimeter of 3565.729 m, obtaining a precision in the measurements of 1: 18000, see annex 2.

Both polygonal achieved precisions superior to 1:10000, precision required for this type of work.



During the development of the topographic study other works were done concerning the densification, by means of small closed polygonal and by the polar method, with the purpose of locating points of support in places of little visibility due to the irregularities of the land and the locally existing objects.

Equipments used

- Electronic Tachymeter (Total Station) Leica TCR 405
- Electronic Tachymeter (Total Station) TOPCON GTS-233W
- Prisms.

### **3.2. - Trigonometric leveling.**

Taking into consideration the topographic characteristics of land, the location of the initial data provided by the investors and the precision required for the first stage of the project, we decided to use the method of trigonometric leveling.

We started off from point Versus 158, with an elevation of 121.005 referred to the NMM, from which point a number of levels were done, jointly with the initial polygonal, determining the elevation of each support point that constitutes it until the closing point in Vs159 with elevation 81.686 above sea level.

The leveling was done in 2 directions, direct and inverse, and the precision achieved was superior to  $40\text{ mm}\sqrt{k}$ , considering that there was only a difference in elevation of 0.081m, in a length of 4444.71. Along the route several points with stable height were placed, located outside the work area and that will serve as support to future works of leveling while they carry out the ground works.

The description, horizontal control and elevation of the same are found in annex # 3, and they are also located in the topographic plane.

From the points established during establishments of the levels, the heights of the rest of support points for the surveying were determined.

Equipments Used.

- Electronic Tachymeter (Total Station) Leica TCR 405
- Electronic Tachymeter (Total Station) TOPCON GTS-233W
- Prisms.

### **3.3. - Layout.**



The layout had two fundamental stages. First was the location of the initial proposal of the center line by the investors, locating in the area stakes at intervals of 100 m that defined the center line of the projected runway. This stage was done by the layout method using coordinates, for this, the rectangular flat coordinates of the center line of the runway was introduced in total station and with the help of the initial polygonal, they were to located in land, resulting in a perfect matching with the layout done previously by the commissions of national studies.

In the second stage, the layout of the definitive center line, decided between the designers and the investors, was done locating stakes at intervals of 100 m with an azimuth of  $20^{\circ} 43' 53.85''$ .

The centerline of the runway and the data that will be used to later outline it, once earthworks begin, is documented in a tabulated form in annex # 4, and can be replaced as much as it is necessary to do so, using the references located with this aim, outside of the work area.

The recommended layout method should be that of coordinates, with use of total station.

Equipments used.

- Electronic Tachymeter (Total Station) TOPCON GTS-233W
- Prism.

### **3.4. - Tachymetric Surveying.**

The tachymetric surveying was done in the entire area defined by the designers that which was increased according to their necessities, reaching an area of approximately 120 Ha. With the strip having a width that varies from 200 to 300 m on either side of proposed center line, and greater in all the area of the airport facilities, in a length greater than 3 km.

With this work all locally existing objects within the area was located planimetrically and topographically, as is, communications networks, electrical networks, houses, constructions, drainage facilities, rivers and channels, in addition to which the configurations of the land and its notable points were determined, by means of the measurement of more than 10000 points on land, that which (the relief) is presented as contour lines with an equidistance of 1 m displayed at a scale of 1:2000, so as to give greater graphical information to the designers, and is also given as a soft copy for its in the project, thus responding to the requirements of the technical assignment.

Equipments used.

- Electronic Tachymeter (Total Station) TOPCON GTS-233W
- Prisms.



### **3.5. - Longitudinal Profile.**

A longitudinal profile was done of the center line of the proposed runway that was outlined in field, it was done in a trigonometric form and the height of the points of the land determined at intervals 100 m on the center line. The profile started at point A with a height of 17.301 m, and during its development, verifications were made with the existing points along the alignment, until closing in point I with elevation 42.639 attaining a precision of  $30\text{mm}\sqrt{k}$ , product of a difference in height of -0.489 m in a length of 3565.729 m.

Equipments used.

- Electronic Tachymeter (Total Station) TOPCON GTS-233W
- Prism.

### **3.6. - Cross Sections.**

The sections were done in precise form in the existing areas of interest considered as hydraulic obstacles by the designers, like rivers and gorges, and by their request doing sections along these obstacles with strips of 40 m in width on either side of the central axis and with a precise progression indicated by the hydraulic designer.

Equipments used.

- Electronic Tachymeter (Total Station) TOPCON GTS-233W
- Prism.

### **3.7. - References.**

Given the characteristics of land and structure to be constructed, the location of reference points was necessary along the layout and located outside the area of the earth movement. These references will allow the quick and effective reestablishment of proposed center line, and they are constituted by monuments embedded in the land or reinforced nails embedded in roofs of constructions, all of which are properly identified (labeled), protected in the ground and represented in the map that was handed over.

The references were given X, Y, and Z coordinates and has indivisibility among them.



The monographs for access to these references, along with its sketch and general data are presented in annex 3 of this report.

4. -

# ***ANNEXES***



**ANNEX 1**

POLYGONAL # 1

<i>Vertex</i>	<i>Azimuth</i>	<i>Distance</i>	<i>Coordinates</i>
VS158	(Starting Point)		X = 491858.500 Y = 1456250.700
A	148-51-53	944.890m	X = 492347.067 Y = 1455441.924
B	234-10-10	352.763m	X = 492061.064 Y = 1455235.420
C	205-03-04	224.938m	X = 491965.819 Y = 1455031.642
D	206-44-30	245.129m	X = 491855.518 Y = 1454812.731
E	197-09-01	414.152m	X = 491733.394 Y = 1454416.994
F	157-40-28	244.194m	X = 491826.155 Y = 1454191.104
G	209-35-24	372.553m	X = 491642.192 Y = 1453867.139
H	167-42-18	121.138m	X = 491667.988 Y = 1453748.779
I	189-50-49	168.040m	X = 491639.250 Y = 1453583.215
J	65-36-39	307.092m	X = 491918.938 Y = 1453710.023



<i>K</i>	<i>20-48-05</i>	<i>315.555m</i>	<i>X = 492031.000</i>	<i>Y = 1454005.010</i>
<i>L</i>	<i>335-32-03</i>	<i>273.332m</i>	<i>X = 491917.799</i>	<i>Y = 1454253.799</i>
<i>M</i>	<i>41-07-42</i>	<i>115.913m</i>	<i>X = 491994.040</i>	<i>Y = 1454341.109</i>
<i>VS159</i>	<i>98-00-54</i>	<i>345.030m</i>	<i>X = 492335.700</i>	<i>Y = 1454293.000</i>

*Perimeter of the polygonal 4444.71 m*

*Lineal error 0.253 m*

*Error in X = 0.177 m*

*Error in Y= 0.181 m*

*Measurement Precision 1: 17000*



**ANNEX 2**

POLYGONAL # 2

<i>Vertex</i>	<i>Azimuth</i>	<i>Distance</i>	<i>Coordinates</i>
<hr style="border-top: 1px dashed black;"/>			
A	(Starting Point)		X = 492347.067 Y = 1455441.924
LA	07-24-27	328.542m	X = 492389.424 Y = 1455767.724
274+3.00	13-13-49	73.348m	X = 492406.211 Y = 1455839.126
270+0.00	200-43-54	43.001m	X = 492390.989 Y = 1455798.910
260+0.00	200-43-54	100.000m	X = 492355.590 Y = 1455705.385
250+0.00	200-43-54	100.000m	X = 492320.191 Y = 1455611.860
240+0.00	200-43-54	100.000m	X = 492284.792 Y = 1455518.335
230+0.00	200-43-54	100.000m	X = 492249.393 Y = 1455424.810
220+0.00	200-43-54	100.000m	X = 492213.994 Y = 1455331.285
210+0.00	200-43-54	100.000m	X = 492178.595 Y = 1455237.760



200+0.00	200-43-54	100.000m	X = 492143.195 Y = 1455144.235
190+0.00	200-43-54	100.000m	X = 492107.796 Y = 1455050.711
180+0.00	200-43-54	100.000m	X = 492072.397 Y = 1454957.186
170+0.00	200-43-54	100.000m	X = 492036.998 Y = 1454863.661
160+0.00	200-43-54	100.000m	X = 492001.599 Y = 1454770.136
150+0.00	200-43-54	100.000m	X = 491966.200 Y = 1454676.611
140+0.00	200-43-54	100.000m	X = 491930.801 Y = 1454583.086
130+0.00	200-43-54	100.000m	X = 491895.402 Y = 1454489.561
120+0.00	200-43-54	100.000m	X = 491860.003 Y = 1454396.036
110+0.00	200-43-54	100.000m	X = 491824.604 Y = 1454302.511
100+0.00	200-43-54	100.000m	X = 491789.205 Y = 1454208.987
90+0.00	200-43-54	100.000m	X = 491753.805 Y = 1454115.462
80+0.00	200-43-54	100.000m	X = 491718.406 Y = 1454021.937
70+0.00	200-43-54	100.000m	X = 491683.007 Y = 1453928.412
60+0.00	200-43-54	100.000m	X = 491647.608 Y = 1453834.887



50+0.00	200-43-54	100.000m	X = 491612.209 Y = 1453741.362
40+0.00	200-43-54	100.000m	X = 491576.810 Y = 1453647.837
30+0.00	200-43-54	100.000m	X = 491541.411 Y = 1453554.312
20+0.00	200-43-54	100.000m	X = 491506.012 Y = 1453460.788
10+0.00	200-43-54	100.000m	X = 491470.613 Y = 1453367.263
0+0.00	200-43-54	100.000m	X = 491435.214 Y = 1453273.738
SV1	97-01-41	75.251m	X = 491509.899 Y = 1453264.530
SV2	18-53-48	260.433m	X = 491594.243 Y = 1453510.927
I	31-54-24	85.154m	X = 491639.250 Y = 1453583.215

*Perimeter of the polygon 3565.729 m*

*Error lineal 0.190 m*

*Error in X = 0.141 m*

*Error in Y= 0.124 m*

*Measurement Precision 1: 18000*



### ANNEX 3

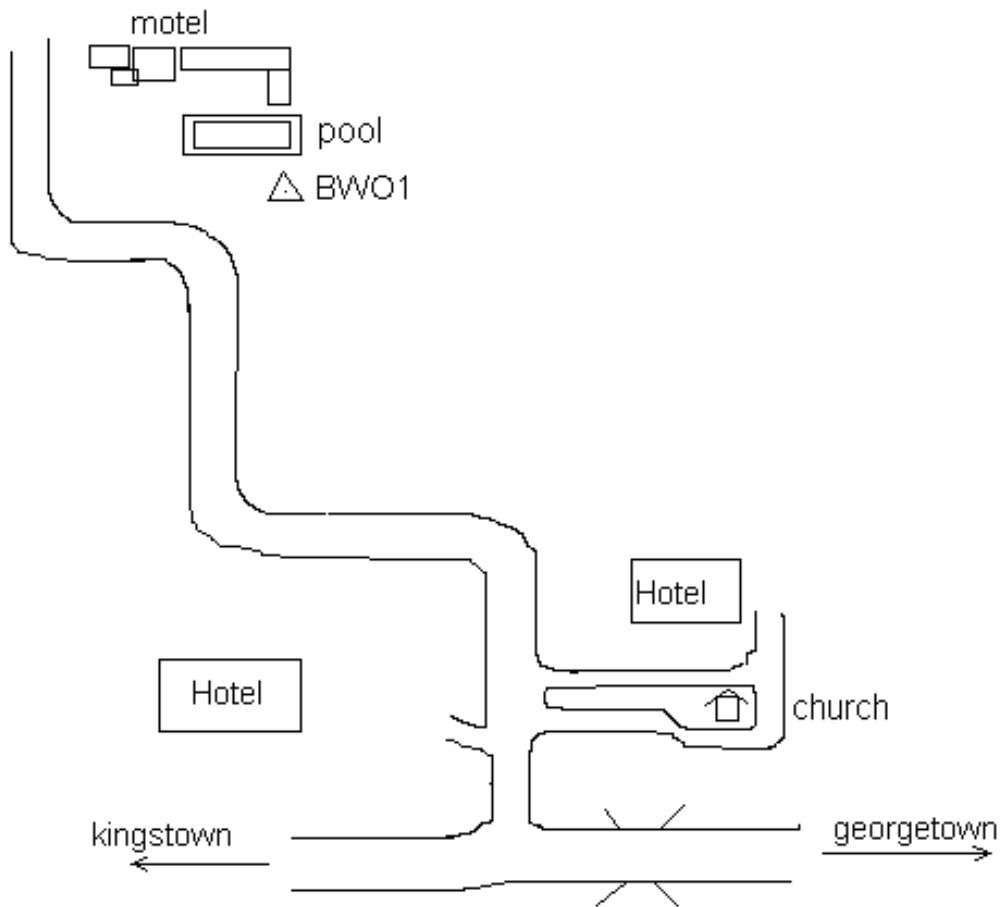
**Sketch**

**BWO-1**

$X=492046.057$

$Y=1455676.615$

$Z=42.384$



*When you are in Argyle arriving by the Kingston-Georgetown highway and you get to the junction with entrance to the catholic church, advance on this same cross road about 529.00m until you get to the point where on your right there is a motel, enter and go to the swimming pool area and about 4.00 m approximately towards the east of the swimming pool you will find the point. It is a concrete monument.*

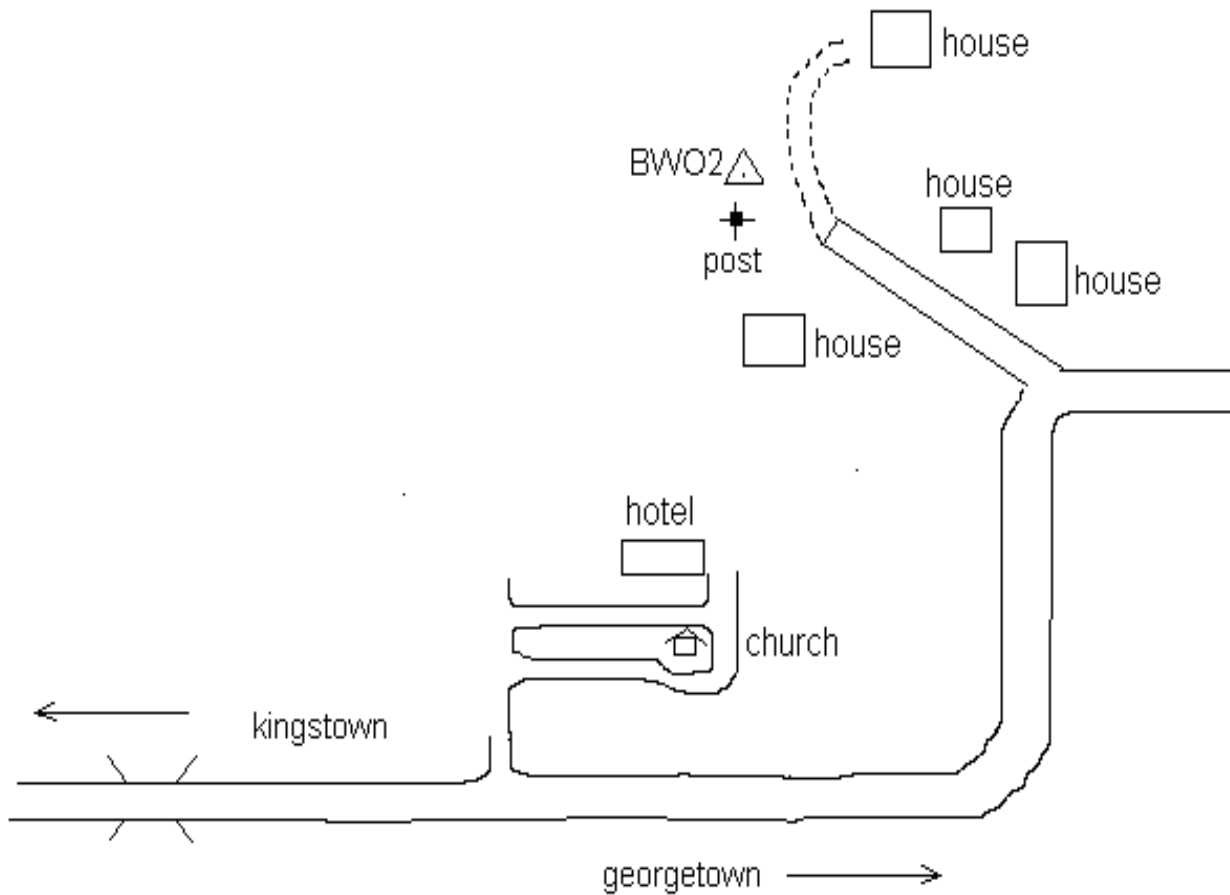
**Sketch**

**BWO-2**

X=492242.318

Y=1455864.738

Z=34.864



*Arriving at Argyle using the Kingstown - Georgetown highway, pass the bridge over the yamboo river, continue on the highway, pass the church, take a curve and before taking the other curve enter the concrete access on the left, pass two houses to the right, continue and pass another one on the left where there is an electrical post, a few meters to the west of the post is the monument with the point*

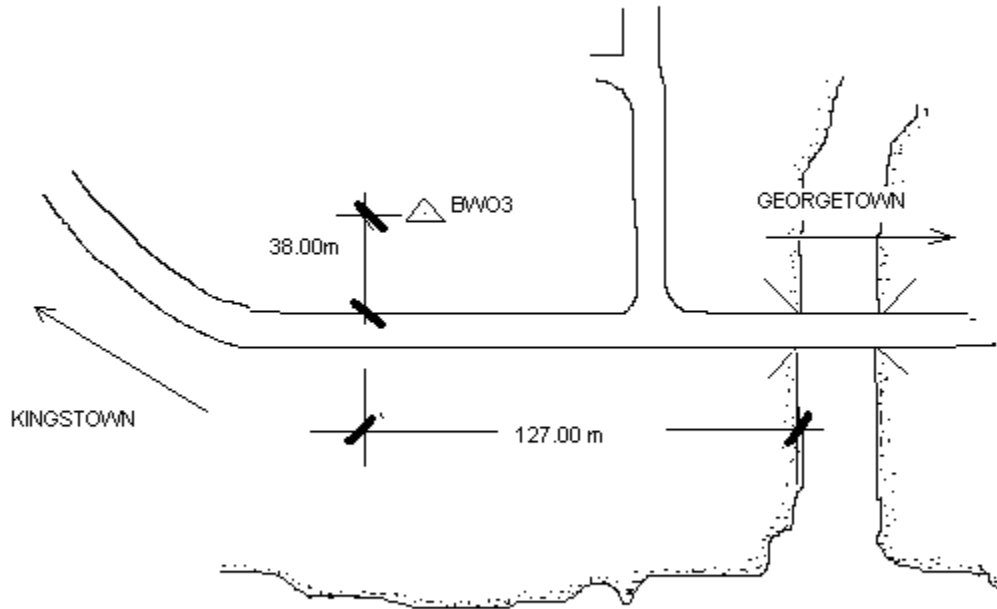
**Sketch**

**BWO-3**

X=492400.164

Y=1454893.437

Z=11.678



*Take the highway Kingstown - Georgetown, when arrive at the bridge of the Yamboo river in Argyle, go back 127.00m, climb a small hill to the right of the highway and 38.00m in an open spot on the hill you find the point. Concrete monument*

**Sketch**

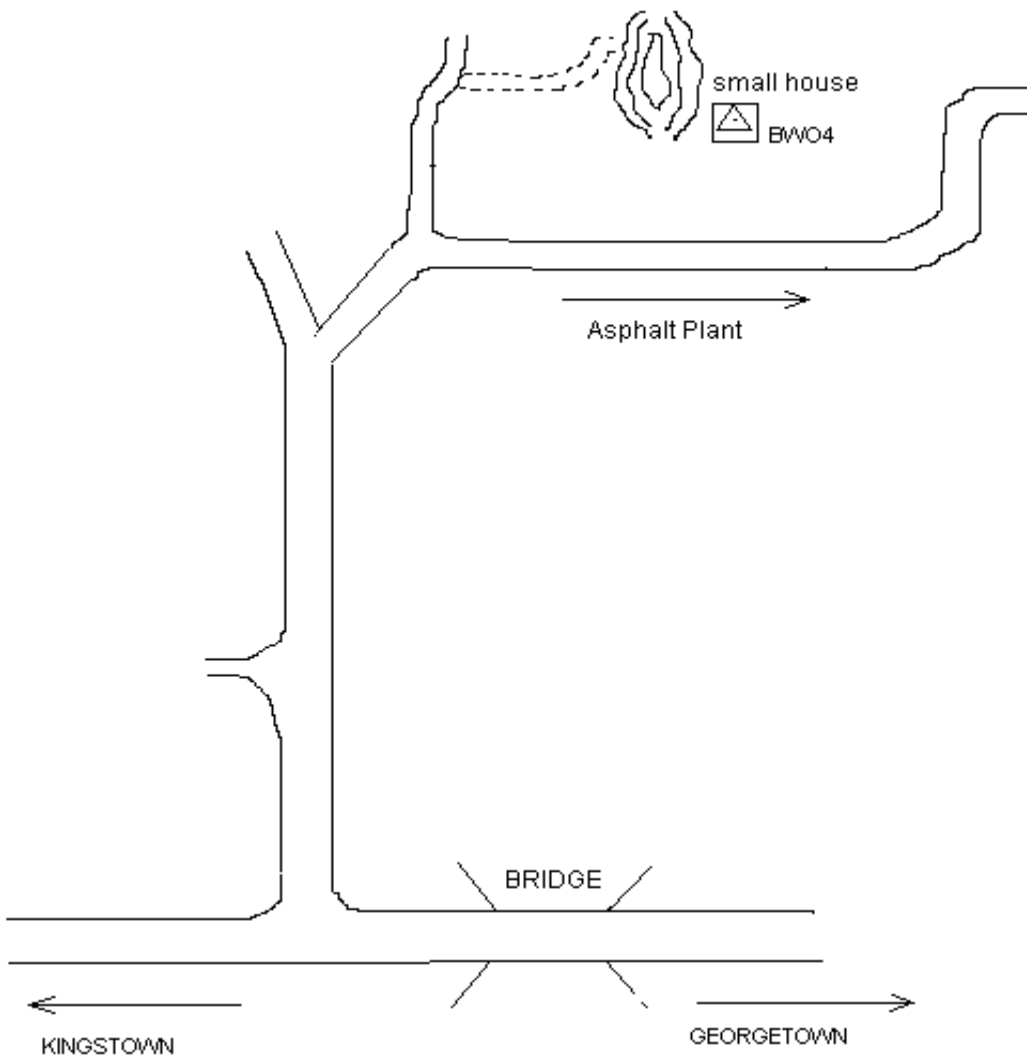
**BWO-4**

X=491978.879

Y=1455289.116



Z=54.239



*Arrive at the yamboo river bridge in Argyle by means of the Kingstown-Georgetown highway, before passing turn to the left, take this route until you arrive at a junction, turn right (this route takes you to the asphalt plant) pass a little bridge and continue straight ahead until you get to a hill (concrete road), advance approximately 150 m and to the right there is an embankment that goes all the way to the top of the hill, when you get to the end of it turn right and walk about 50 m, there you will find small house with a concrete roof (a shed in somebody's land), on top of the roof is the point.*

**Sketch**

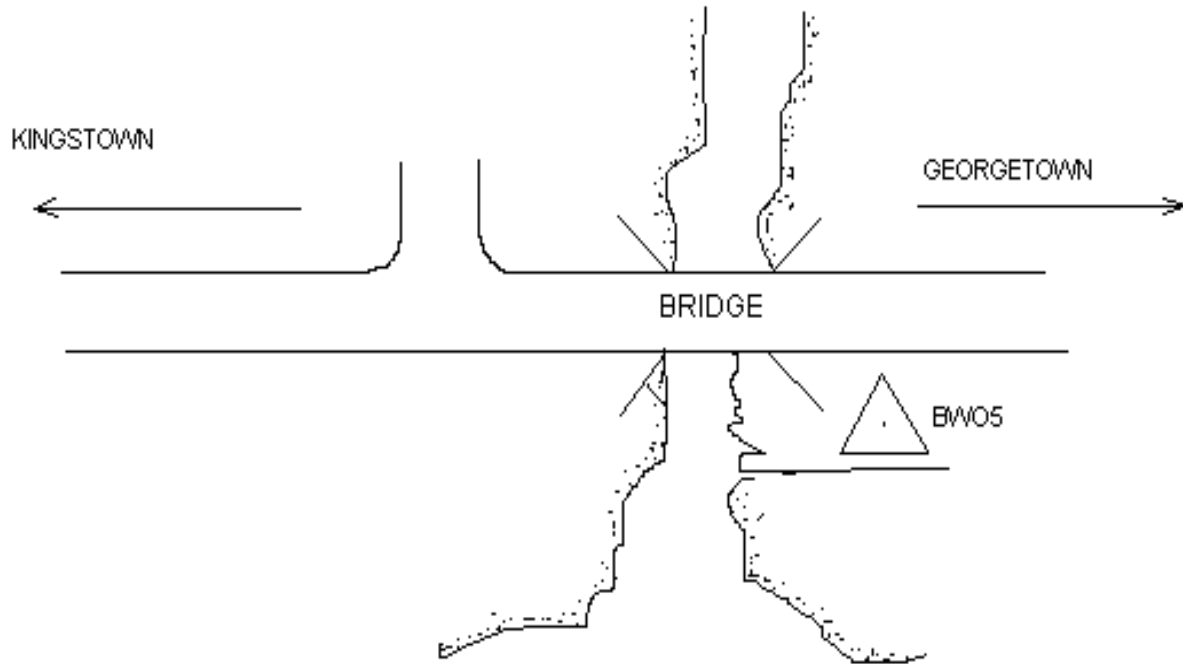
**BWO-5**

X=492430.082

Y=1455054.039



Z=4.547



*Taking the Kingstown – Georgetown highway, arrive at the Yamboo river bridge in Argyle, pass the bridge, there you find the remains of the bridge that was previously there, in a corner of what's left of the bridge is the point.*

**Sketch**

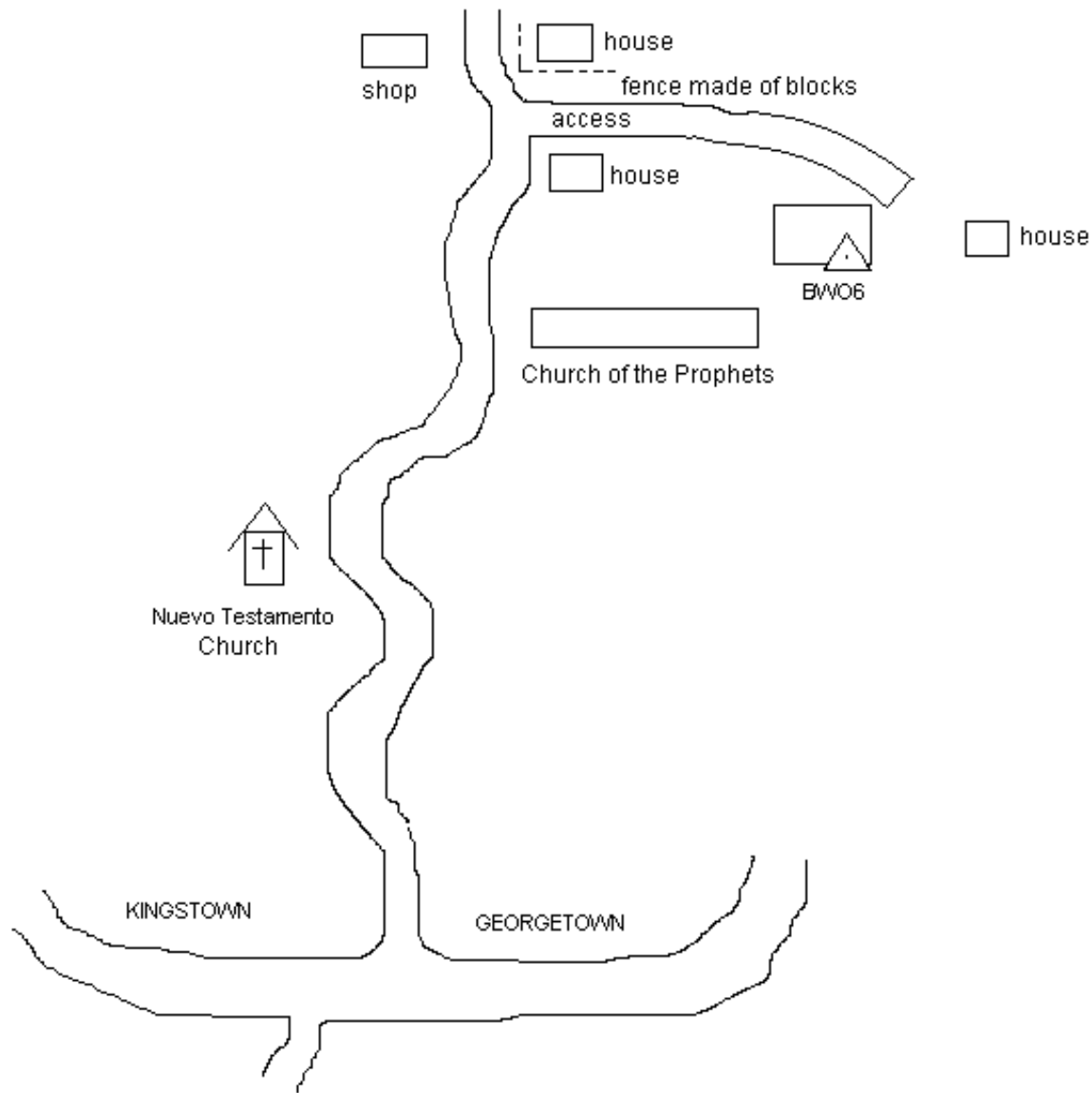
**BWO-6**

X=491036.247

Y=1454652.153



Z=126.087



*Using the Kingstown-Georgetown highway, arrive at the junction with the road that leads to Calder, turn into this road, pass a church named “ New Testament ” continue and pass a church or school named “ School of the Prophets ”, continue and to arrive at the top, where there is an access to the right and a fence made of blocks surrounding a house, take this access and go down until you get to the end of it, here to the right there is a house with a concrete roof at the same level of the land, in the East corner you can find the point.*

**Sketch**

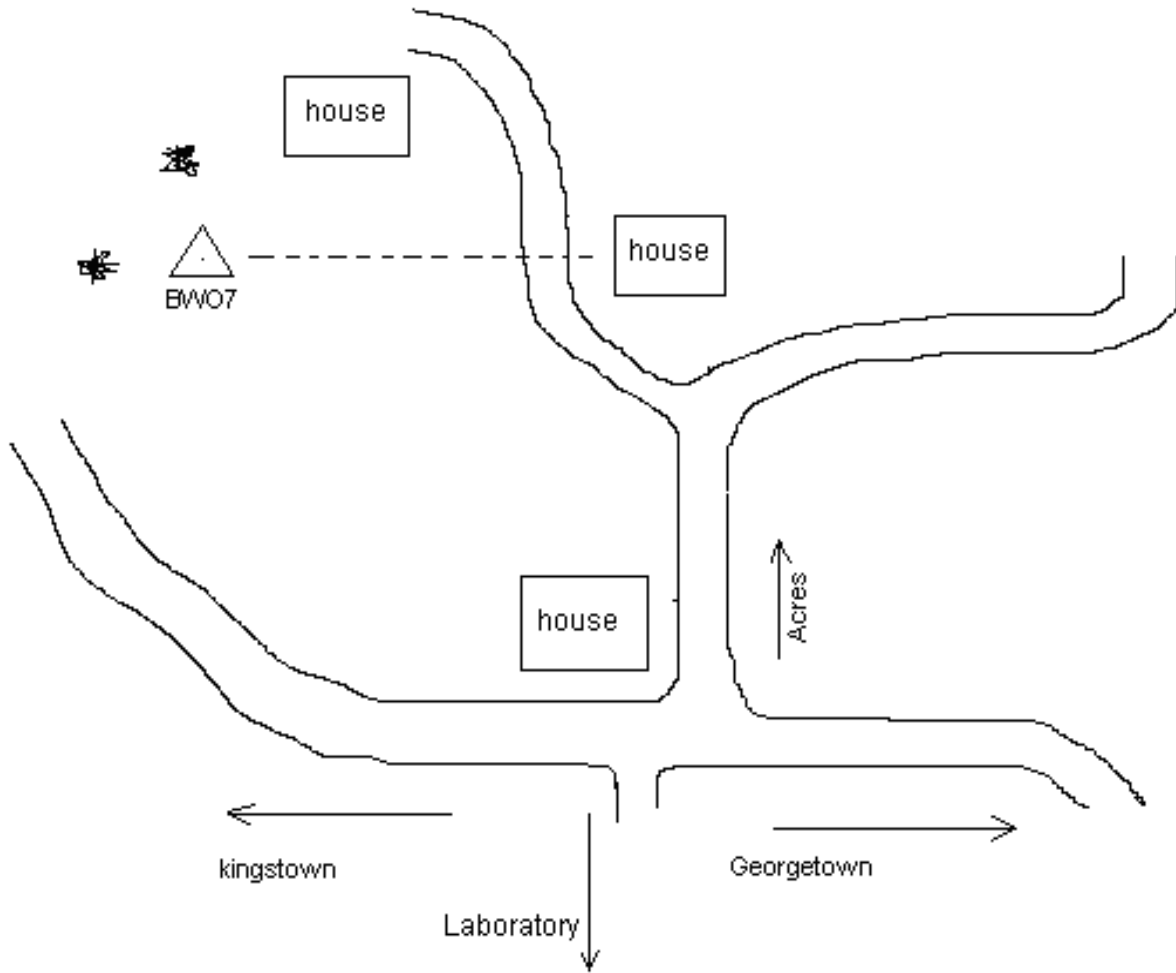
**BWO-7**

X=491608.398

Y=1454303.493



Z=69.977



*Traveling on the Kingstown - Georgetown highway, you arrive at the junction with Acres road, take this the Acres road, advance 80.00m and you find an access to the left that leads to two houses, take this access route for about 40.00m and in front of the first house climb the hill, with a direction of 90 degrees with respect to the house and 66.00m in an open field with some mango trees you will find the point, which is a concrete monument.*

**Sketch**

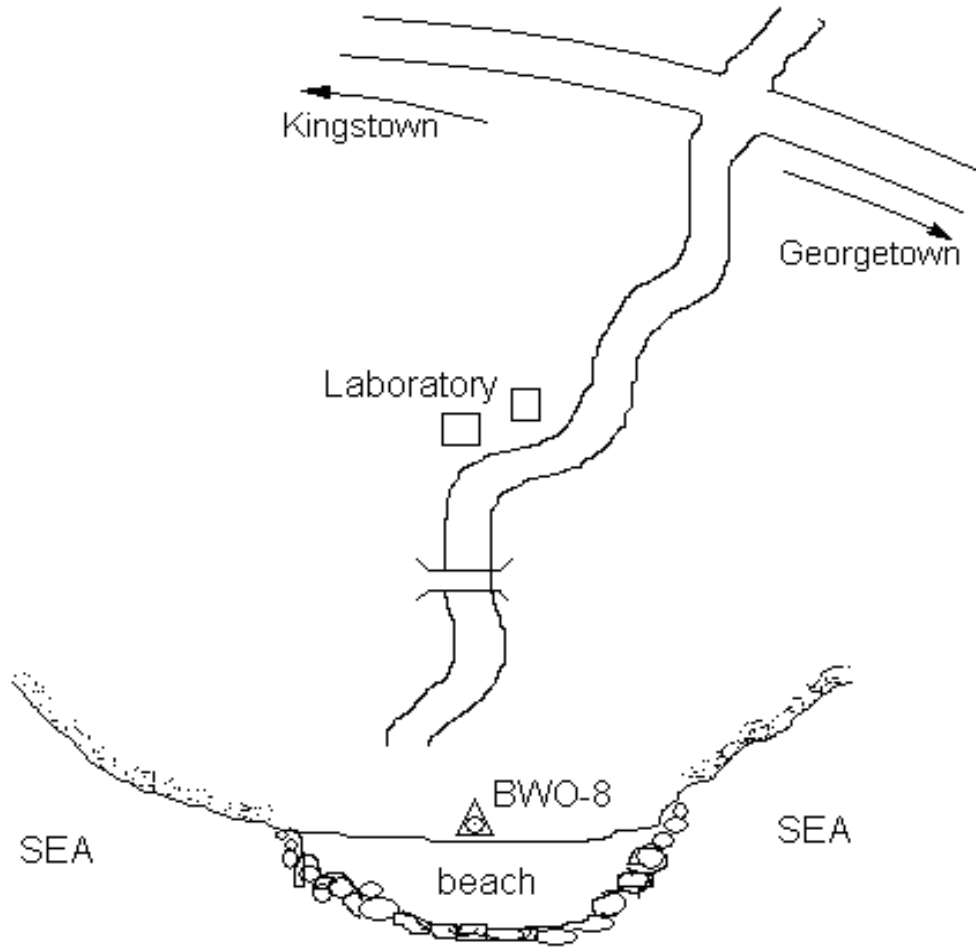
**BWO-8**

X=492136.986

Y=1453480.122



Z=8.286



*By means of the Kingston-Argyle highway arrive at the Acres junction, double to the right and go pass the laboratory belonging to the Airport project (IADC), follow this route all the way to the coast down to the Rawacou beach, on the coastline of this beach there is a small elevation where on which you can find the point in the form of a concrete monument.*

**Sketch**

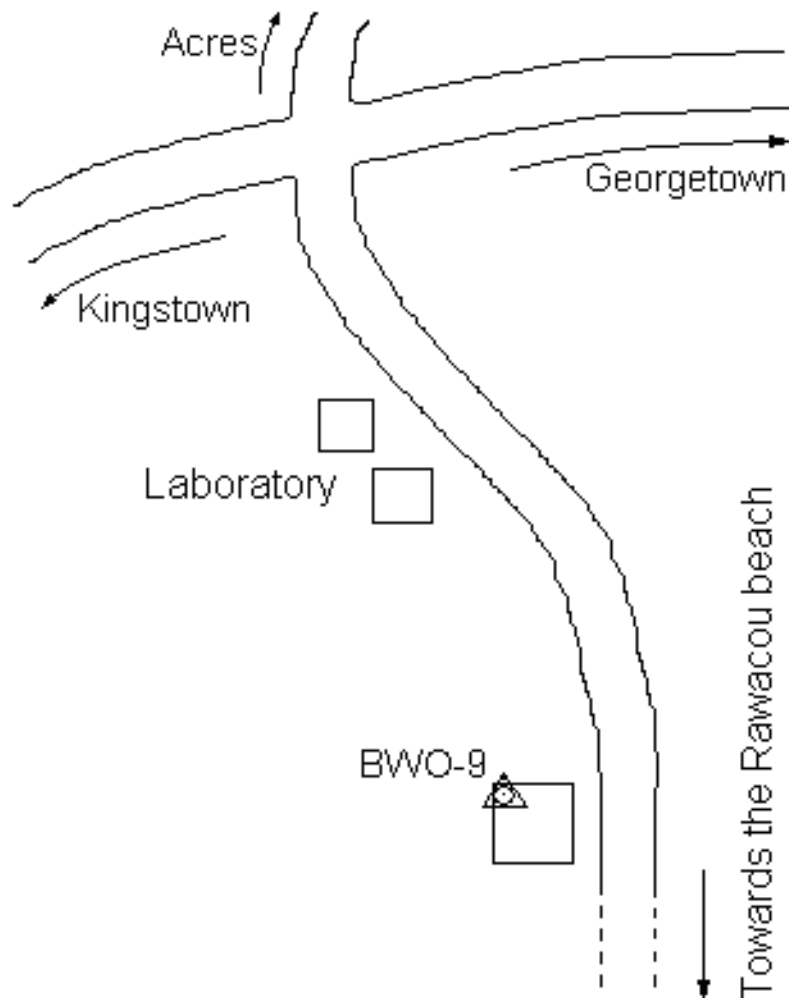
**BWO-9**

X=492031.000

Y=1454005.010



Z=33.285



*Taking the Kingston – Argyle highway you arrive at the Acres junction, turn right to enter this access route that leads you to the Airport laboratory (IADC) and in the next house after you pass the laboratory, to the right of the route, on the concreted roof of this house in the west corner you find the point. It is a reinforced nail (concrete nail) embedded in the roof.*

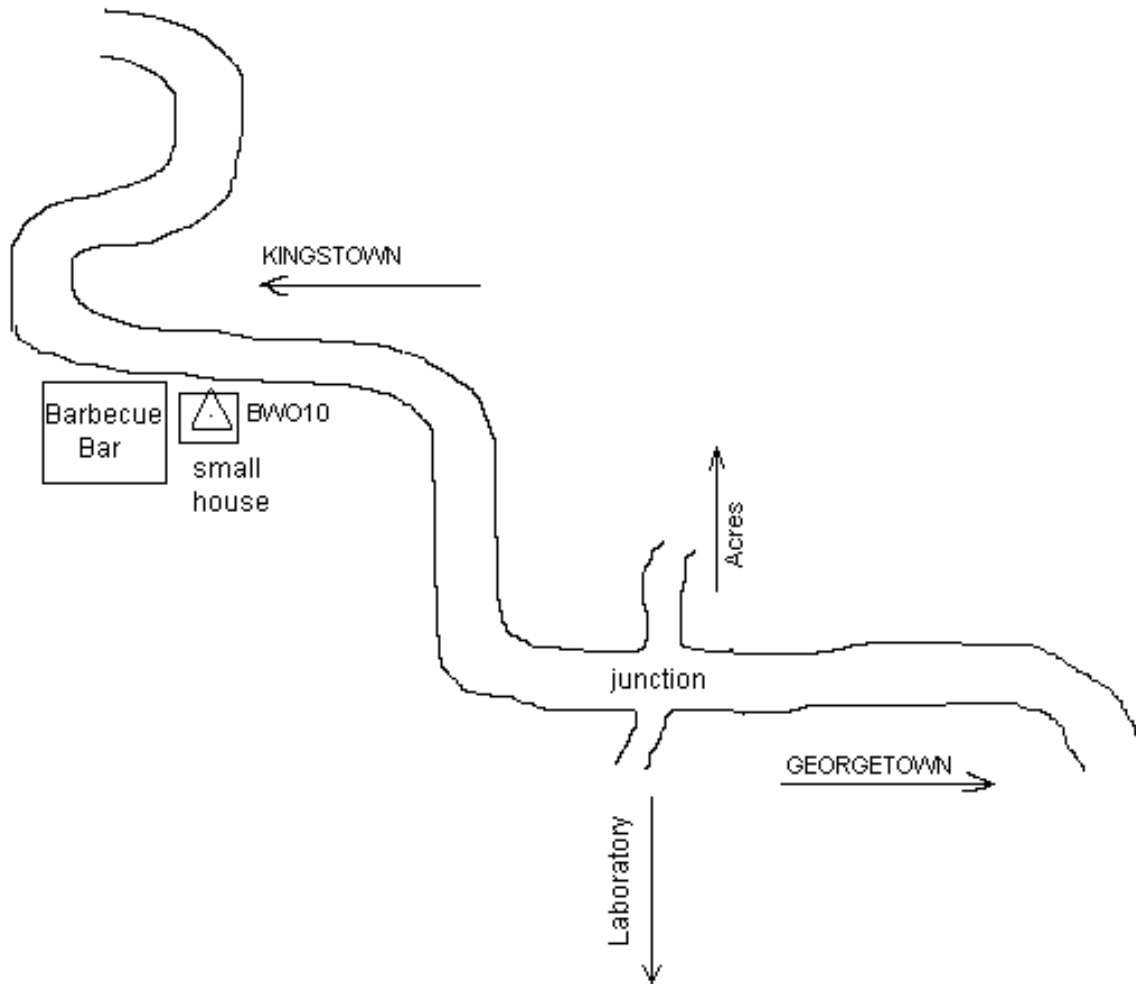
**Sketch**

**BWO-10**

X=491416.291



Y=1454128.204  
Z=70.291



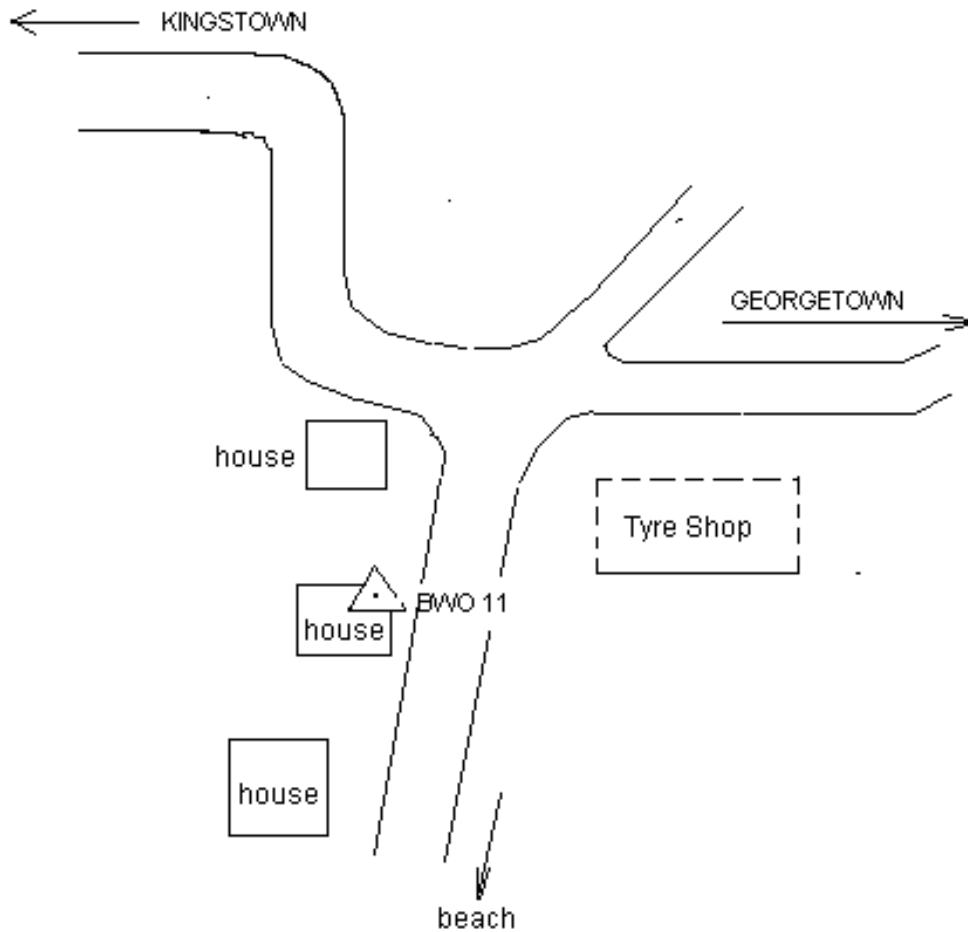
*Transiting the highway going from Georgetown to Kingstown, arrive at the Acres junction and from there advance 372.00m the windward highway in the direction of Kingstown, at this distance and the left border of the highway there is a bar where they sell barbecue, in the lateral north there is a small house with a concrete roof and the point is upon this roof, which is a reinforced nail embedded roof.*

**Sketch**

**BWO-11**  
X=491371.662



Y=1453626.351  
Z=78.178



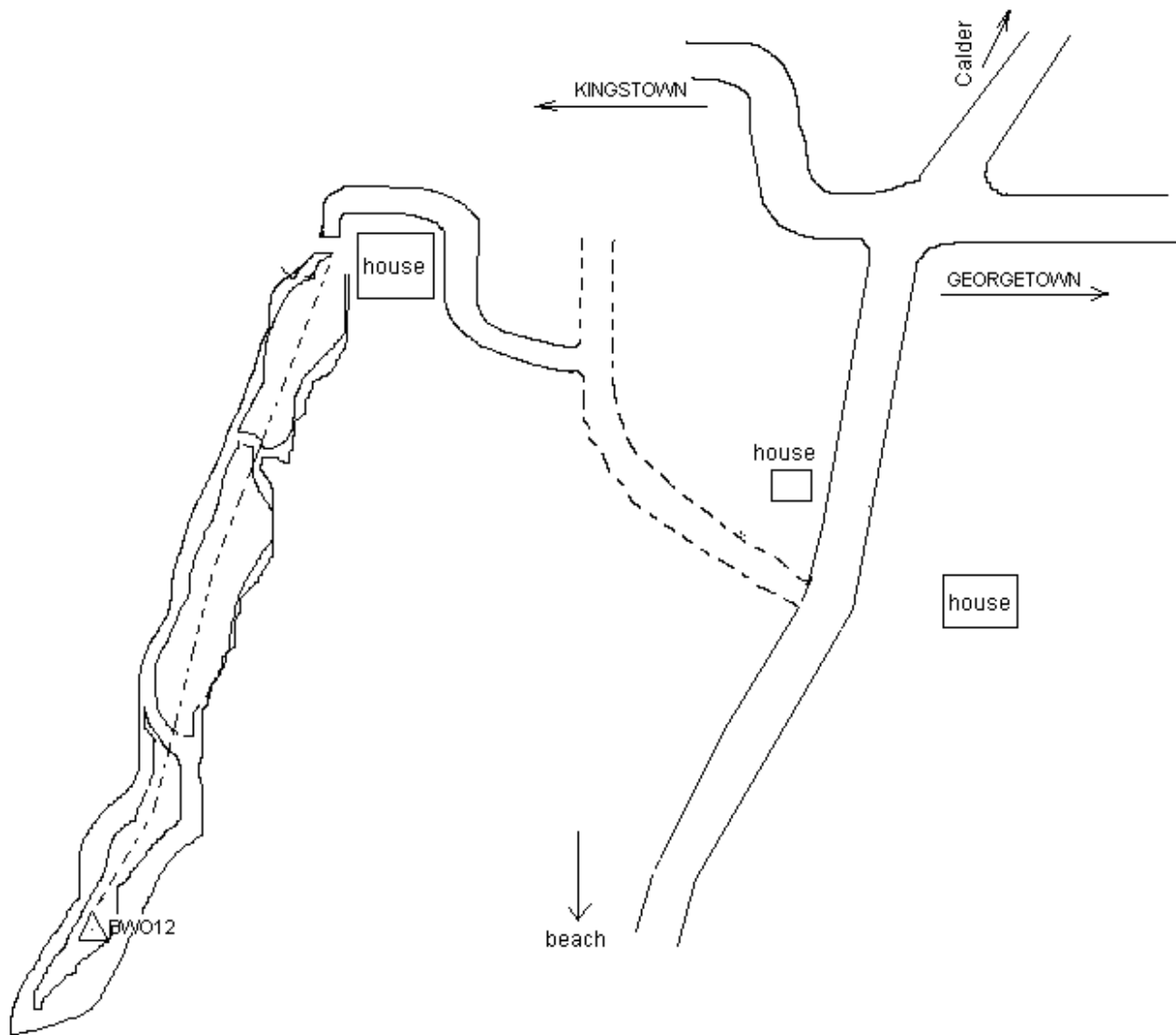
*Coming from Kingstown heading towards Argyle, arrive at the Calder junction (gap), enter an access to the right of the windward highway in this area (this route goes down to Rawacou beach), and pass the first house on the right of the route, in the second house also to the right of the route on the roof in the North end you find the point, which is in the form of an embedded nail.*

**Sketch**

**BWO-12**  
X=491549.509



Y=1453077.081  
Z=56.759



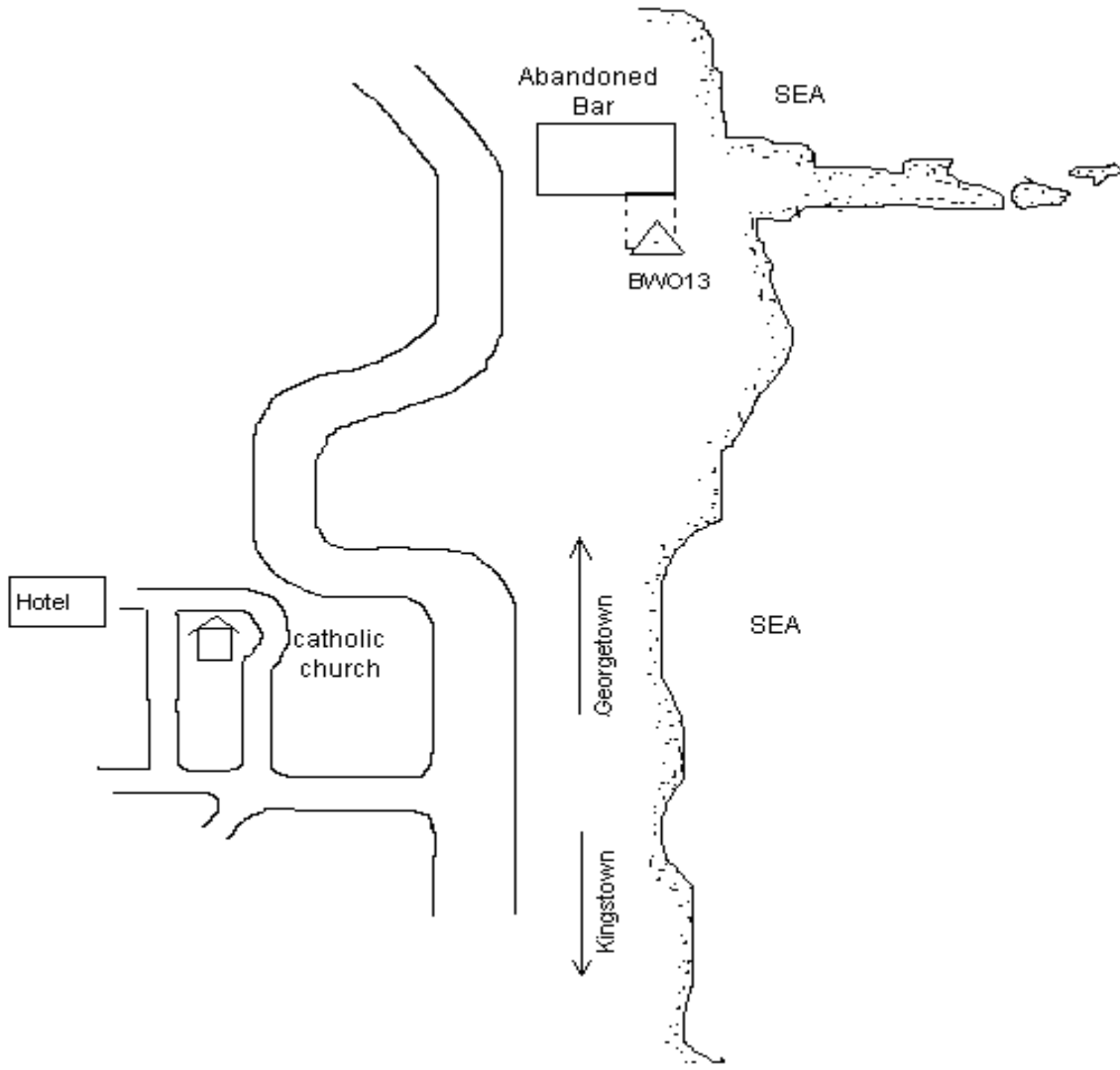
*Coming from Kingstown heading to Argyle, arrive at the Calder gap, turn right into the access route that leads you to the Rawacou beach, continue until you get to a gap, in this gap if you turn left you go towards a house and right takes you along a dirt road, take the dirt road approximately 242.00m and you arrive at another access to the left of the route, this route is concreted and leads to a house on the hill, take this route until you get to the end of it (behind the house) from there walk on the ridge of the hill in direction to the sea that is towards the east, about 315.00m and about 80.00m from the coast, in the same ridge you find the point. A concrete monument.*

**Sketch**

**BWO-13**  
X=492530.922



Y=1456320.006  
Z=25.856



*Take the Kingstown- Georgetown highway pass the catholic church at the top of a hill in Argyle, continue on this highway and go pass a house and a primary school on the left side. Continue on the windward highway until you get to the top of the hill, here you find an abandoned bar to the right of the road, in the South side of the bar there is a concrete platform, close to the sea, where the point is located. This point is represented by a reinforced nail embedded in the platform.*

#### **ANNEX 4**



INFO FOR THE LAYOUT OF THE CENTERLINE OF THE RUNWAY

<i>Vertex</i>	<i>Azimuth</i>	<i>Distance</i>	<i>Coordinates</i>	
0+00			X = 491435.214	Y = 1453273.738
10+00	20-43-54	100.000m	X = 491470.613	Y = 1453367.263
20+00	20-43-54	100.000m	X = 491506.012	Y = 1453460.788
30+00	20-43-54	100.000m	X = 491541.411	Y = 1453554.312
40+00	20-43-54	100.000m	X = 491576.810	Y = 1453647.837
50+00	20-43-54	100.000m	X = 491612.209	Y = 1453741.362
60+00	20-43-54	100.000m	X = 491647.613	Y = 1453834.887
70+00	20-43-54	100.000m	X = 491683.007	Y = 1453928.412
80+00	20-43-54	100.000m	X = 491718.406	Y = 1454021.937
90+00	20-43-54	100.000m	X = 491753.805	Y = 1454115.462
100+00	20-43-54	100.000m	X = 491789.205	Y = 1454208.987
110+00	20-43-54	100.000m	X = 491824.604	Y = 1454302.511
120+00	20-43-54	100.000m	X = 491860.003	Y = 1454396.036
130+00	20-43-54	100.000m	X = 491895.402	Y = 1454489.561
140+00	20-43-54	100.000m	X = 491930.801	Y = 1454583.086
150+00	20-43-54	100.000m	X = 491966.200	Y = 1454676.611
160+00	20-43-54	100.000m	X = 492001.599	Y = 1454770.136
170+00	20-43-54	100.000m	X = 492036.998	Y = 1454863.661
180+00	20-43-54	100.000m	X = 492072.397	Y = 1454957.186
190+00	20-43-54	100.000m	X = 492107.796	Y = 1455050.711



200+00	20-43-54	100.000m	X = 492143.195	Y = 1455144.235
210+00	20-43-54	100.000m	X = 492178.595	Y = 1455237.760
220+00	20-43-54	100.000m	X = 492213.994	Y = 1455331.285
230+00	20-43-54	100.000m	X = 492249.393	Y = 1455424.810
240+00	20-43-54	100.000m	X = 492284.792	Y = 1455518.335
250+00	20-43-54	100.000m	X = 492320.191	Y = 1455611.860
260+00	20-43-54	100.000m	X = 492355.590	Y = 1455705.385
270+00	20-43-54	100.000m	X = 492390.989	Y = 1455798.910
274+3.0	20-43-54	43.001m	X = 492406.211	Y = 1455839.126