4.2.2 VIRGIN GORDA

Virgin Gorda is situated to the East of Tortola, at approximately 18º 29' North latitude and 64º 24' West longitude. It has a rectangular central block, with two branches. The first extends westwards and the second southwards. Spanish Town is located in the latter. The central block is dominated by the Virgin Gorda peak (1359 feet). This peak imposes a radial drainage system, with the typical BVI steep slopes and short distances. The eastern branch is elongated and hilly, with low elevations. Both the central block and the eastern branch are typical of the steep BVI physiography, with an extremely efficient surface runoff system. The southern branch, in contrast, presents a rather flat physiography, producing a slower runoff condition. This island presents flatter areas than other BVI islands, and the average slope of the larger watersheds is about 20 %, which, in spite of being high, is smaller than the slopes found in other islands. The main ghut water courses are shown in **Table 4.6 and Map 4.2.**

TABLE 4.6: VIRGIN GORDA GHUT CHARACTERISTICS

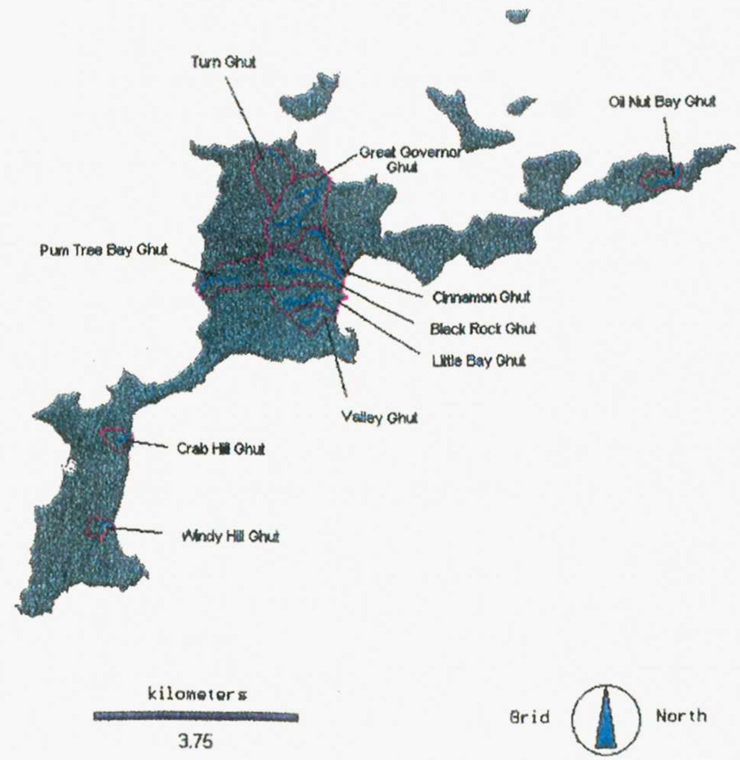
GHUT NAME	ORIENTATION	LENGTH (feet)	ELEVATION (feet)	SLOPE (%)
WINDY HILL	WE	1600	251	16
CRAB HILL	WE	2400	175	7
PLUM TREE BAY	EW	4800	1348	28
TURN GHUT	SN	2800	725	26
GREAT GOVERNOR	SN	5600	1359	24
CINNAMON GHUT	NS	4000	825	21
BLACK ROCK GHUT	WE	4800	1250	26
LITTLE BAY GHUT	WE	5200	1050	20
VALLEY GHUT	WE	2800	750	27
OIL NUT BAY	WE	2800	225	8
AVERAGE		3680	796	20

DRAINAGE DENSITY

36800/9 = 4089 (ft/m^2)

Map 4.2

VIRGIN GORDA WATERSHED MAIN CHARACTERISTICS



The more developed area of this island is Spanish Town. This town has very favorable drainage conditions:

- The population is not densely concentrated.

- The slopes are moderate, facilitating a quick runoff disposal without high energy levels.

- The watersheds are very small in the town.

- Runoff is divided into two components: the eastern side of the town drains towards St. Thomas Bay, and the western side towards Taylor's Bay.

- Elevations in the Spanish Town area are low (maximum 448 feet in the Cow Hill), so that precipitation is expected to be low, having a very small orographic effect. This conclusion is supported by the presence of low vegetation, typical of arid climates, like cactus.

Drainage problems in this area should not be serious, and are caused by insufficient capacity of drainage works, and debris blockage of ghuts and bridges.

A very interesting situation occurs in the South Sound flat. This is an attractive site, with an area of about 0.2 mi^2 (0.5 km^2), with practically no development at all. There are a few similar situations in the BVI, such as the Paraquita Bay flat, where development could be safer, from the surface drainage and stability points of view. In fact, in South Sound, slopes are moderate, nor very low nor very steep, and four different small watersheds are identified, so that runoff is not concentrated. There are no meteorological measurements in this island. Low and semiarid vegetation, such as scrubs, predominate. This is an indicator of lower levels of precipitation in comparison with the precipitation recorded in the central part of Tortola.

4.2.3 JOST VAN DYKE

Jost van Dyke island is situated to the West of Tortola, at approximately 18º 27' North latitude and 64º 45' West longitude. The island has a West-East elongated shape and is dominated by two summits: Mahonny Hill (1054 ft) and Roach Hill (1026 ft). Like the rest of the BVI islands, Jost van Dyke is very hilly, with steep slopes and a few small coastal flats. The average slope of the more important watersheds is about 36 %, which is very high. This island presents only one significant developed area: the Great Harbour flat. The watersheds are steep but small. Development has occurred at the seashore, with a road and bridges that makes the surface runoff more difficult.

There is also some development at the foot of the hills. A mangrove wetland is located in the center of the flat, preventing development in this area. A great deal of the runoff from the watersheds is not channelized directly into the ocean, but spreads out into the mangrove wetland. There are no meteorological measurements in this island. Low and semiarid vegetation, and relatively low mountain elevations, of just above 1000 feet, are indicators of a more reduced precipitation, as compared to the Tortola precipitation record. The principal watercourses are presented in **Table 4.7 and Map 4.3**.

Map 4.3

JOST VAN DYKE WATERSHED MAIN CHARACTERISTICS

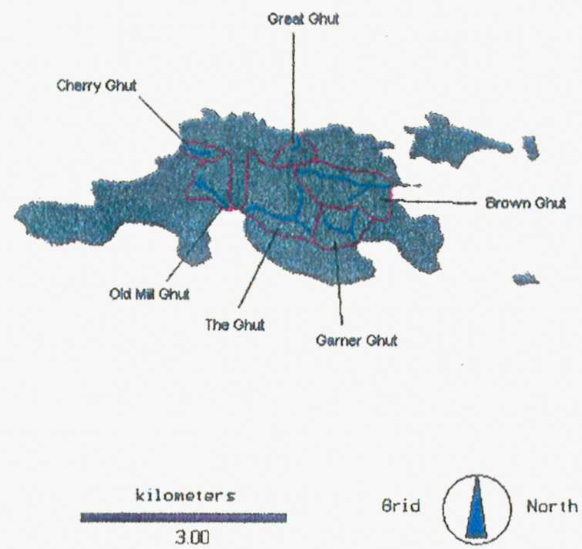


TABLE 4.7: JOST VAN DYKE WATERCOURSE CHARACTERISTICS

GHUT NAME	ORIENTATION	LENGTH (feet)	·ELEVATION (feet)	SLOPE (%)
Old Mill Round Ghut	WE	2160	596	28
Cherry Ghut	WE	2240	1054	47
Brown Ghut	EW	4800	950	20
The Ghut	WE	4000	1026	25
Great Ghut	SN	1600	950	59
Garner Bay	NS	2400	1026	43
Spring Hill	NS	2400	800	33
AVERAGE		2800	914	36
DRAINAGE DENSITY 19600/3.2 = 6125 ft/mi^2				

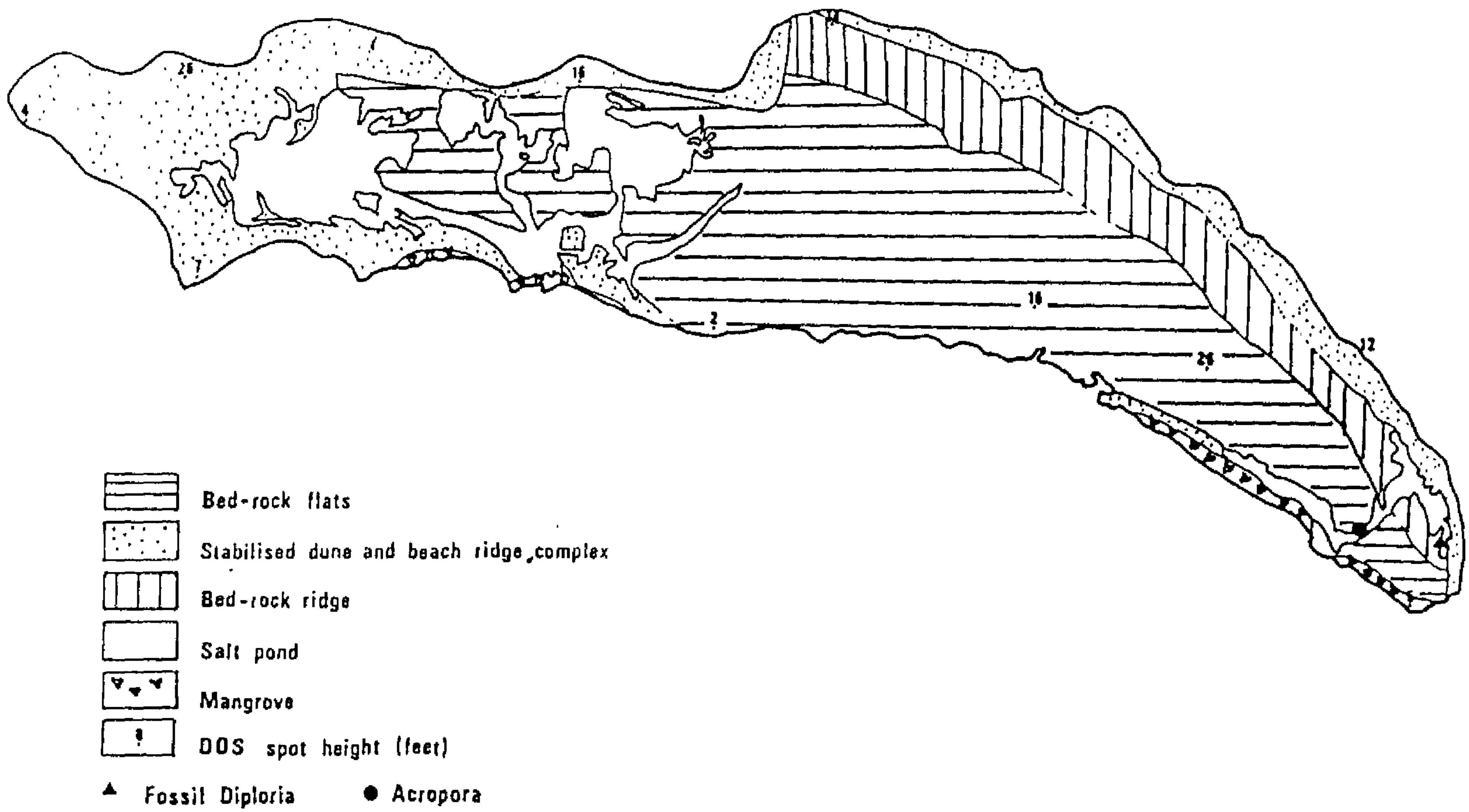
it can be observed from **Table 4.7** that the average length of the ghut courses is very small, in contrast with the elevation, resulting into an extremely high average slope.

4.2.4 ANEGADA

Anegada is a very low and flat limestone island, formed by the elevation of a coral reef. The island is entirely composed of limestone. Bedrock is exposed over 60 % of the island, and typically is characterized by a modified karst topography.

Anegada can be divided into five physiographic subdivisions: 1. Bedrock Ridge, 2. Bedrock Flat, 3. Stabilized Dune and Beach Ridge Complex, 4. Salt Ponds and 5. Mangrove Marsh. **(Map 4.4)**. Sands are common in the West, and in the East upraised coral limestone predominates, with rock outcrops.

Map 4.4



ANEGADA

Physiographic subdivisions (after Howard, 1970)

Climate in Anegada must be significantly drier, with rainfall estimated to be about 40 in per year, due to its flat topography. Vegetation is very low and typically semiarid (cactus, century, low bushes). In fact, localized clouds tend to pass over the island without precipitation, in the absence of cooling effect from forested high mountains. Limestone rocks have an heterogeneous infiltration behavior, with a general tendency to low infiltration rates but, isolated sink holes, where infiltration is very high. The amount of precipitation, however, is so small, and the topography so flat, that concentrated surface runoff should be limited.

The sandy areas of the West and North coasts present higher rates of infiltration. In the areas of limestone outcrops, there is so little infiltration and so small slopes, that water tends to accumulate in topographic shallow depressions forming ponds and puddles that can last for several weeks. Some large ponds are permanent and are predominantly brackish, but fresh water ponds are also found. When rainfall is very heavy some localised ponding will occur, with low depths, and very slow rate of flow, not presenting a real danger to the communities. However, this is a nuisance and can lead to mosquito related health problems.

The extensive salt pond system has only one outlet to the sea, in the place called The Creek, in the Point Peter pond. Unfortunately, a bridge was built there with very small culverts that can be easily obstructed by debris and sand bars. The culverts should be substituted by a bridge with a higher hydraulic capacity.

In Anegada, it is not possible to define any watershed. Water flows in a disperse way to the sea, where the slope favors this option, or accumulates in ponds or puddles, and in this case water extraction is mainly due to evaporation.

There is an important contrast in the flood problems of the mountainous BVI islands, and Anegada. Runoff in the mountainous islands is concentrated, with high energy, in very small valleys and flats and can be very destructive. On the contrary, in Anegada, topography does not favor runoff concentration, water flows everywhere, with little energy, and, as a consequence, is much less damaging.

4.3 HYDROLOGIC MODELING

4.3.1 INTRODUCTION

In order to determine the flood potential of natural channels, detailed investigation of the watersheds which drain through these channels is required. Because of the limitations of time, the project investigated the three main watersheds and associated ghuts which run through Road Town, which are the Huntums, Long Bush and Johnson Ghut watersheds. These watersheds were selected because they are located at the most populated and important area of the BVI, and have traditionally presented flooding problems. These studies would then serve to develop a methodology which could be used to assess other watersheds in the BVI if required.

The main aim of the hydrological modeling process is to determine the nature of flow or discharge through the drainage channels. This requires a detailed analysis of the nature of precipitation, the configuration and surface covering of the watersheds and other features. The actual modeling process involved using these parameters as inputs in the HEC-1 hydrologic modeling software.

Because of the absence of stream flow records in the BVI and the lack of data on extreme precipitation events in the BVI, the hydrologic modeling of the Road Town watersheds involved using some data from similar watersheds in the US Virgin Islands. Details of the modeling process are presented in the final report. The important findings are summarised below.

4.3.3.1 PRECIPITATION

An important part of the hydrologic study relating to flood hazard is to establish the overall pattern of precipitation but more importantly to estimate the magnitude of extreme events and the frequency of occurrence. Data from the US Virgin Islands was used extensively to obtain these estimates for the BVI. The close proximity and similarity in size geomorphology and watershed conditions in the BVI and USVI makes it possible to derive crucial data to characterize the BVI watersheds. The estimates of 24 hour precipitation and their return periods produced by this analysis is summarised in **Table 4.11**. The details of the precipitation analysis are available in the final report.

TABLE 4.11: 24 HR. RAINFALL ESTIMATES FOR DIFFERENT RETURN PERIODS IN TORTOLA

RETURN PERIOD (years)	PRECIPITATION (in)
2	5.6
5	7.9
10	9.4
25	11.4
50	13.4
100	15.0

4.3.4 HUNTUMS GHUT HYDROLOGIC MODELING RESULTS

The Huntums Ghut and Long Bush Ghut are modeled in the same process, taking into account that these ghuts were artificially joined and can be seen to represent two adjacent sub-watersheds, **(Map 4.5)**. The Huntums Ghut sub-watershed characteristics are presented in **Table 4.12.**

TABLE 4.12: HUNTUMS GHUT SUB-WATERSHED CHARACTERISTICS

SUB-WATERSHED	AREA (mi^2)	MAX. ELEV. (ft)	MIN. ELEV. (ft)	LENGTH (ft)	LAG TIME (hr)
EVA TOWN	0.16	721.93	0.00	3116.0	0.11
LONG BUSH1	0.47	1310.69	0.00	7708.0	0.25
LONG BUSH2	0.02	2.95	0.00	656.0	0.15
BOTANIC GARDEN	0.14	49.00	0.00	8134.4	0.95
PICKERING	0.12	1228.00	49.20	2788.0	0.08
GORDON	0.67	1155.00	85.28	5018.4	0.16

The HEC-1 output files provide the maximum discharges for the different reaches of the Huntums and Long Bush Ghuts. The main results, which will be used for the HEC-2 hydraulic modeling are presented in **Table 4.13**.

MAP 4.5

ROADTOWN WATERSHEDS FOR HEC-1 MODELLING