

3.0 BASELINE ENVIRONMENTAL STATUS

Existing environmental set-up of the study area (area of influence around the project site) in general, and within the project site in particular, has been studied as described in subsequent sections.

3.1 TOPOGRAPHY & GEOLOGY

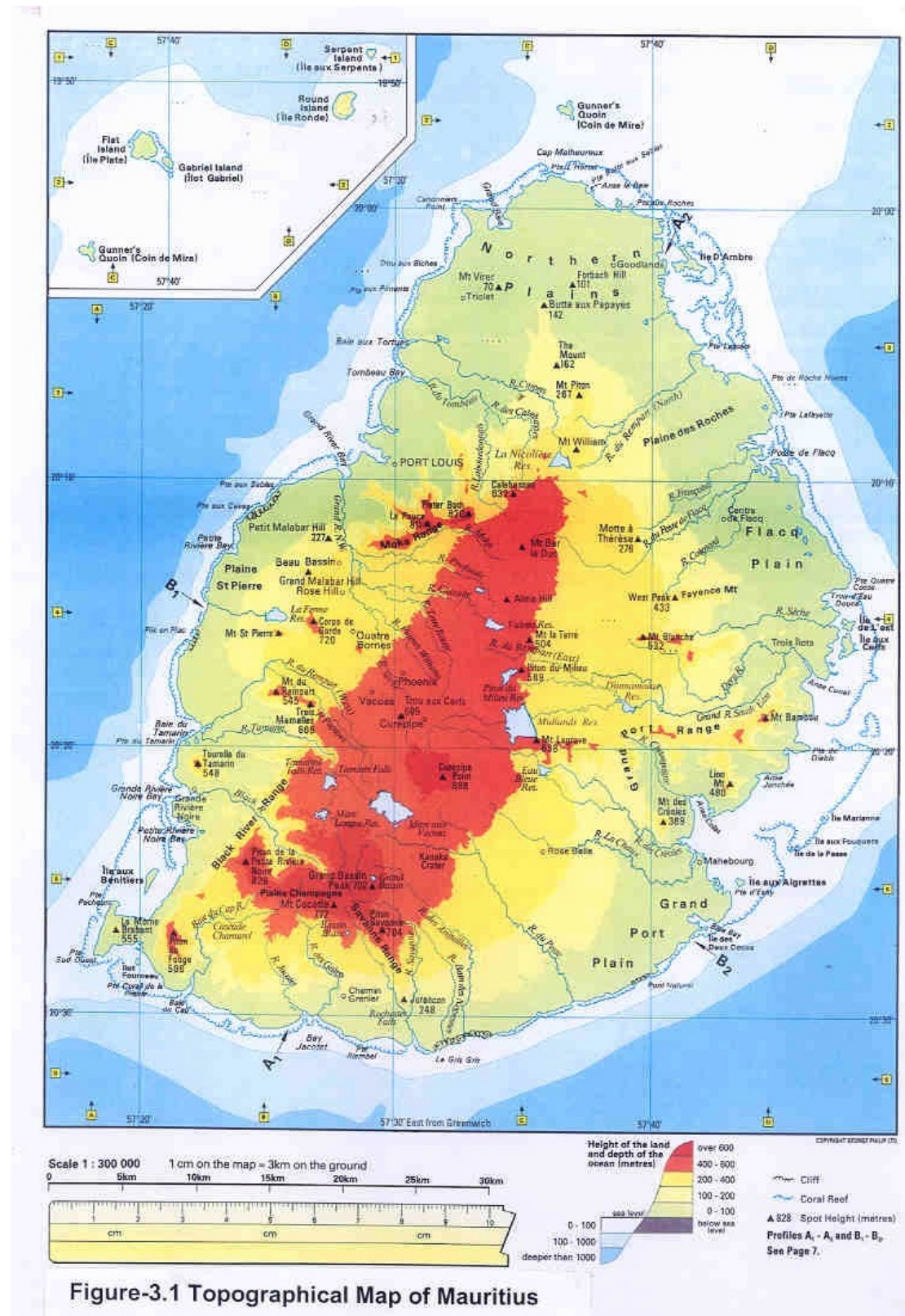
3.1.1 Topography

It is evident from the topographical map of Mauritius (**Figure-3.1**) that the Deux Bras site is located within a height varying between 178m and 200m AMSL. The general slope of the site is towards the South-East and South direction.

3.1.2 Geology

The island of Mauritius is entirely volcanic in origin, except for deposits of coral sands along the coast and deposits from alluvial erosion of the hard rocks. The hard rocks are volcanic deposits composed essentially of basaltic lava flows with some inclusions of pyroclastics.

Mauritius Island has been formed by a succession of volcanic episodes that began in the middle of the Miocene. The island emerged about 10 million years ago following a volcanic phase, mainly explosive and then intersected with periods of quiescence during which erosion modeled the relief. Except for some consolidated coral and shell debris in isolated remnant raised beaches, and the coral reefs and beach and sand dunes around most of the coast, Mauritius is entirely volcanic: an Older Volcanic Series and a Younger Volcanic series between which there was a long period of erosion (**Table-3.1 & Figure-3.2**). The Younger Series was subdivided into the Early and Late Lavas.



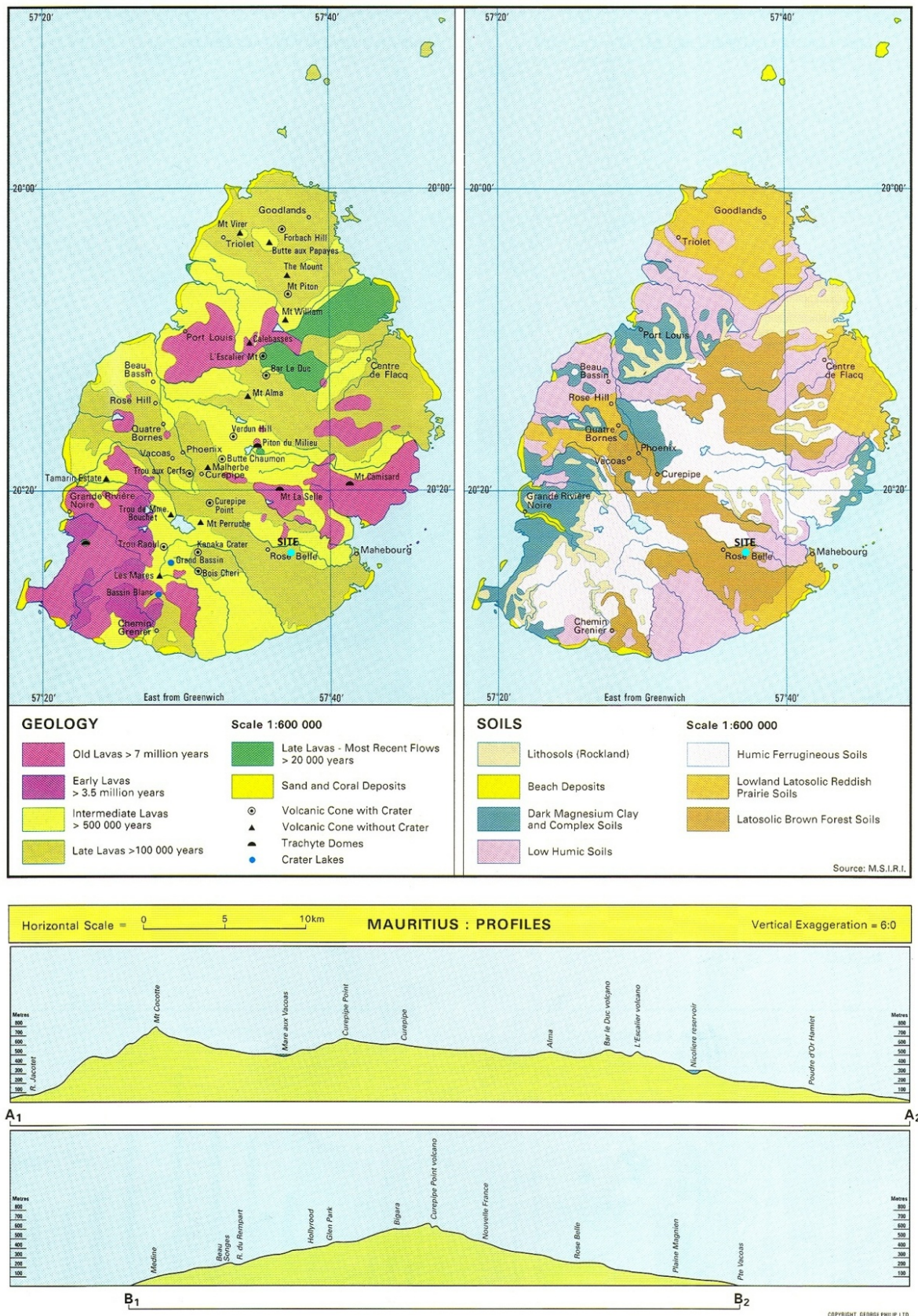


Figure 3.2: Geological and Soil Map of Mauritius

Table-3.1 Geological Formations of Mauritius

Older Volcanic Series	Old Lavas		
Younger Volcanic Series	Early Lavas		
	Intermediate Lavas		
	Late Lavas	Earlier Flows	
		Main Flows	Deux Bras site
		Recent Flows	
Non-volcanic Formations	Raised reefs, beaches and old dunes		

The Intermediate and Late Lavas cover the 70% of the island but in comparison with the earlier volcanism their volume is relative small. They comprise a whole series of flows from about 1 to 8 m thick, of generally highly vesicular olivine basalt, often with coarse grained doleritic textures and usually light grayish in colour. Scoriaceous zones are common at the top and base of flows and these appear to be more abundant in the Late Lavas.

Basalts: It is an irregular piling of basaltic flows whose cumulated thickness can exceed one hundred metres. Healthy flows alternate with flows transformed by weathering, which is a sign that emissions of lavas, far from being continuous, have occurred intermittently. When the flow is important and when the slope is sufficient, lava tunnels exist generally at the exit of ancient topographic breaches for example visible at the surface where the roof has collapsed. At outcrops, these are massive basalts, vesicular and micro fissured that we find as slabs well cleaned by agents of erosion. The base of these flows indicates signs of progression. They are scoriaceous and their thickness can vary from one metre to ten metres.

3.2 SOIL

Weathering processes have altered the layers of basalt and pyroclastics. The pattern of weathering has been varying on account of the vesicular and fractured nature of the basalt. The pyroclastics weather faster than basalt. The resulting soils are also varied in nature.

As per the soil map of Mauritius (**Figure-3.2**) the soils of the project site are as under (**Table-3.2**):

Table-3.2 Soil Types of the Project Site

Project Site	Soil Group	Families	Special Phase
Deux Bras	Latosolic BrownForest Soils	Rose Belle	Rocky

Source: Soil Map of Mauritius (Provisional Classification) (Scale 1:100,000) published by Directorate of Overseas Surveys 1957

Latosolic BrownForest Soils:

Although these series have been developed on Late Lavas, moderate to strong weathering has occurred on account of the higher rainfall (>2000 mm). Base depletion has produced acidic to strongly acidic soils with varying amounts of concretionary iron oxide nodules in the solum. The A horizon is dark brown in color, high in organic matter and grades into a lighter coloured B horizon over parent rock often at shallow depths. The texture varies from clay loam to silty clay or clay. The clay fraction contains moderate to little kaolinite and rather more gibbsite than goethite. Two families have been mapped on the basis of intensity of weathering- the Rose Belle family occurring at lower elevations within the rainfall zone 2000-4000 mm and the Bois Cheri family which receives over 3000 mm of rainfall.

3.3 LAND USE

Major part of the island of Mauritius is devoted to sugarcane. Next in rank for covering the land surface are the forests consisting of some plantations and the rest nature reserves.

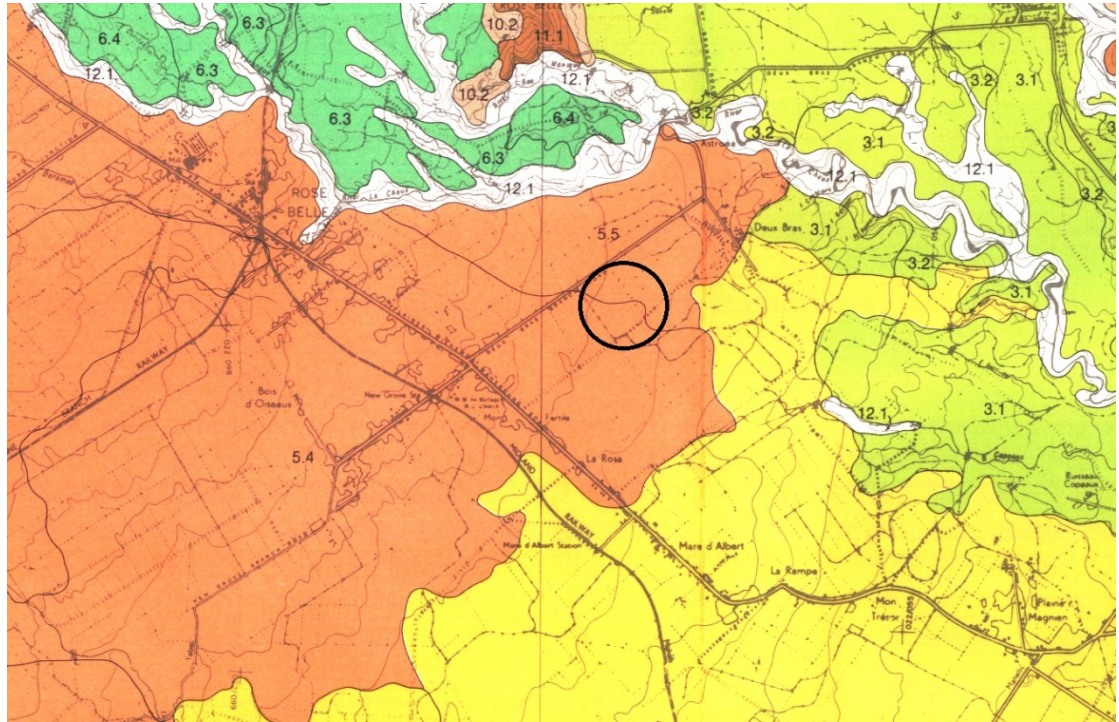


Figure 3.3: FAO/MSIRI map

As per the Land Resources and Agricultural Maps (1:50000) of Mauritius, 1973 published by Food and Agricultural Organization (FAO) of the United Nations and Mauritius Sugar Industry Research Institute (MSIRI), the land features of the project site (refer to **Figure 3.3**) are summarized in **Table-3.3**:

Table-3.3 Land Features of the Project Site

Project Site	Item	Description	Description
Deux Bras	Land complex	Central Lava Plateau	Central Lava Plateau
	Land unit	5.4	5.5
	Landforms	Almost flat to sloping and undulating; smooth hummocks	sloping and undulating; frequent low hummocks

Project Site	Item	Description	Description
	Soil type	Latosolic Brown Forest (LBF) soils; shallow to moderately shallow, gravelly, dark brown silty clay loams; few to bedrock exposures and rock heaps	Latosolic Brown Forest (LBF) soils; very shallow to shallow, gravelly, dark brown silty clay loam; frequent bedrock exposures and rock heaps
	Agricultural suitability	S2 - tea, limited mixed cropping S3 - sugarcane	S2 - tea, sugar cane, limited mixed cropping
	% of total land	3.5% of total land mass in Mauritius	1.5% of total land mass in Mauritius

Source: Land Resources and Agricultural Maps (1:50000) of Mauritius, 1973 published by Food and Agricultural Organization (FAO) of the United Nations and Mauritius Sugar Industry Research Institute (MSIRI)

S1: Highly Suitable

S2: Moderately Suitable

S3: Marginally Suitable

S4: Suitable

Deux Bras: The FAO and the MSIRI identifies the site area as forming part of the Younger Volcanic series. FAO and MSIRI map classifies the different regions into Land Units. The site comprises Land Units 5.4 and 5.5. The site consists of mild sloping and undulating land. Hummocks are offrequent smooth and low frequency form resulting in resulting from the moderate degree of weathering on either Late Lavas of intermediate age or more readily weathered scoriaceous basalts extruded in these flows. The soils on some part are shallow to moderately shallow and at other places very shallow to shallow Latasolic Brown Forest soils. At the other extreme they become quite stony or boulder.

Existing Land Use at Project Site:

The project site is presently under sugarcane cultivation to its full extent. It does not accommodate any flora and fauna that are of any ecological interest. The site does not fall in environmentally and ecologically sensitive areas such as river reserve, wetlands, or springs.

3.4 DRAINAGE

The natural drainage path of the existing topography is converging towards the south-east of the project site. In order to cater for the drainage of the “morcellement” development and the concerned catchment areas, a storm water drainage network will be provided to discharge into a retention pond and only the overflow will be diverted into an existing drainage path in the area. The site drainage design philosophy is discussed in detail in section 2.6.2 of this report.

3.5 WATER RESOURCES

Mauritius can be considered as a well-watered island. Even the sub-humid coastal regions can be regarded as having adequate water. The island has a radial surface drainage pattern of major drainage areas with perennial streams and minor drainage areas lying between the major ones. The riverless zones of the Late Lavas are important groundwater storage basins. Surface storage of water is mostly confined to natural basins in the central table-land. About 52% of all the water distributed for consumption is sourced from underground water beds; the remaining consists of surface water collected in reservoirs.

On account of the shallow nature of the lithomerge with relatively high clay and silt fractions lying over hard impervious basalt, this island is generally not bestowed with any rich ground water resources. Seepage rate is also small. As a result, at the bottom of basins with low gradient soggy marshy soil tends to develop. Immediately after rains, soil in any given part of this island feels soggy. However, an exception to this rule is found in the terrain traversed by Segments 7 to 10, where the fractured nature of the

surface geology, seepage rate is high, contributing to availability of rather rich ground water resource above the underlying impervious massive lava layers.

Groundwater is compartmentalized in aquifers by structures of ancient volcanic formations. There are five principal aquifers in Mauritius but they are exploited differently. As per the aquifer map of Mauritius (**Figure 3.4**), the Rose Belle site falls in the Aquifer-III. Aquifer-III is the Aquifer of Nouvelle France-Rose Belle-Plaisance.

This aquifer comprises:

- the eastern part of the intracalderic reservoir centered on Arnaud – Curepipe Point,
- the median reservoir of Cluny / Eau Bleue – UnionPark, limited to the southwest by the ancient basalt ascent to the east of the crater of Montagne Perruche, and to the north-east by southwest buttresses of the Montagne Bambous,
- the coastal reservoir of Plaisance.

This aquifer has to be extended in its eastern part up to the ancient mountains of Savanne. Groundwater recharge to this part is ensured by the fractured area of Rivière des Anguilles that exist at the south rim of the caldera. This multiplayer aquifer has a different hydraulic behaviour in different sectors. Static water level fluctuations recorded to this day show variations in the order of 5 to 10 metres at Nouvelle France, 10 to 20 metres in the region of Cluny – Eau Bleue and 20 to 30 metres in the sector of Mare Tabac. These fluctuations are conditioned by the presence of old basalt thresholds (Montagne Pauline, Vernon Hill) sometimes covered by intermediate basalts (Gros Billot) that have channelled basaltic flows and subsequently groundwater flows. The distribution and natural flows of groundwater are conditioned by the structures of the different calderas and the corresponding importance of the intermediate and of the recent basaltic formations, more or less weathered. Fractures connect groundwater of the different formations juxtaposed and superposed. This arrangement conditions the existence of the principal multilayer aquifers.

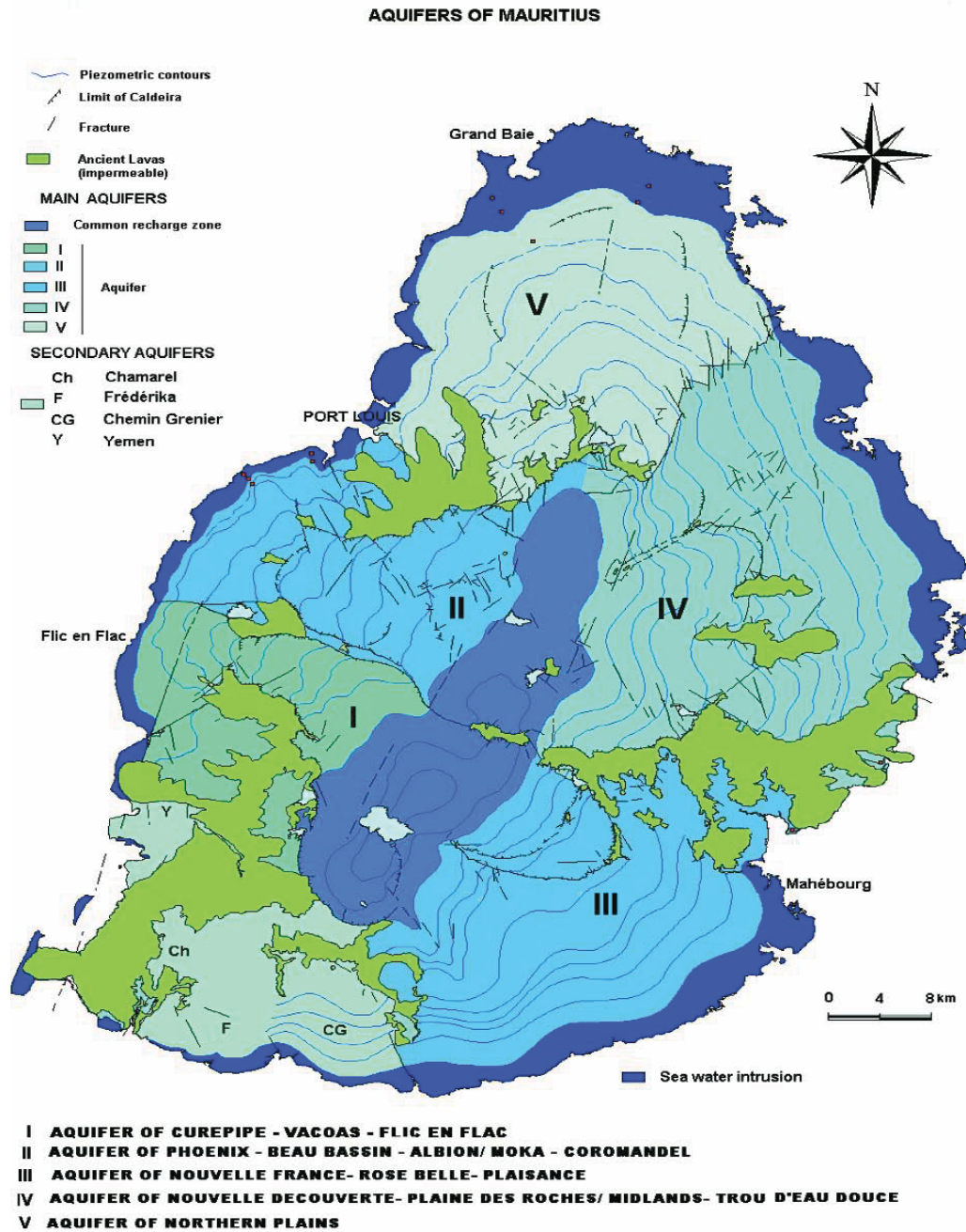


Figure 3.4: Aquifer map of Mauritius

3.6 CLIMATE AND METEOROLOGY

The climate is equable maritime sub-tropical humid. Rain comes in all months although the weather never remains the same for more than a few days at a stretch. It is frequently affected by disturbances of both temperate and tropical types. The direction of wind is generally from the East, although the cyclones hit the island from the West.

The topography of the island is such that the mid-summer temperature at the Central Plateau and the mid-winter temperature at the coast are similar.

In general, climate can be considered as comprising two seasons: a winter from May to October during which the island experiences a cool and comparatively dry season under the predominant influence of steady southeasterly trade winds, and the summer from November to April, which is a warm and wet season often affected by tropical cyclones. July is the coldest month with mean temperatures of 21.9°C and 20.7°C at sea level in the leeward and windward exposures respectively, and 16.4°C in the central tableland at an elevation of about 600 m. February is the warmest month with corresponding mean temperatures of 27.8°C, 26.1°C and 22.3°C. The difference in mean temperature between the two months of July and February is only 5.5°C.

During the hot season that is between December and March, when the South East Trade Wind is mild but the cyclonic activity is high, torrential rains of high intensity occur.

On the other hand, during the cool months of June to September, the south East Trade Wind will be strong, rainfall will be very frequent but not with high precipitation (less than 100 mm per month). October and November may be drier still.

The months of most frequent cyclones are from December to March. The incidence of tropical cyclones is of considerable importance to agriculture and economy. There are, on average, 2 to 3 intense cyclones (with an indicated wind speed > 65 knots (~120 kph)) in the southwest Indian Ocean in a year. During the passage of the very destructive cyclone Carol in 1960, a wind gust of 159 mph (~ 256 kph) was recorded.

Mauritius Trade Winds, land and sea breezes

Trade winds are southeasterly surface winds that generally blow from the subtropical high pressure zone. The south-east trade winds have a direct effect on the climate of Mauritius. There is a light breeze from south-eastern direction the whole year through.

Mare Chicose Landfill is around 2.0 km in a north-west direction from the project site. Therefore, the SE trade wind will not carry any pungent smell from the landfill towards the project site. Besides, a poultry farm, found 375m at the north-west direction from

the project site, is not a nuisance problem as the poultry farm is located downwind from the subject site and is hidden within a sugarcane field on the other side of Deux Bras Cent Gaulettes Road. (Refer to Context Plan in **Annex 2**)

Local wind is affected by the sea and land breeze effects and will show change of direction with time of day. On calm nights, places on the eastern slope may experience a land-breeze blowing towards the sea, and therefore with a pronounced westward component. The project site is way outside this wind path especially from Mare Chicose landfill and nearest poultry perspectives.

Cyclonic Winds

The south-western Indian Ocean is a region known for its cyclonic activity. Cyclones are very low-pressure regions, which have very high wind speeds that increase in magnitude in the direction of the centre of the cyclone. Tropical cyclones usually occur during the months of December to May. February is the most active month in terms of cyclonic formation; this is based on the data collected by the National Meteorological Services at Vacoas. **Table 3.4** indicates the monthly occurrences of observed cyclones.

Table 3.4 Monthly Percentage Occurrences of observed Cyclones

MONTH	Dec.	Jan.	Feb.	Mar.	Apr.	May.	Total
%	18.1	20.8	30.6	18.1	9.7	2.8	100

From the observation of cyclonic wind speeds during the same period, the National Meteorological Service has also established that the average for the wind velocities is 140 km/h (75 knots).

Mauritius is subject to occasional tropical cyclones characterized by low pressure, high wind systems which typically occur in the months of December through March. Over the period, 39% of cyclones have been classified as 'weak' (gust speeds <48 km/hr), 42% as 'moderate' (gust speeds between 48-80 km/hr) and 19% as 'strong' with gust speeds >80 km/hr).

Table 3.5 gives the maximum gust speed of major cyclones of 100 km/h or more, which has affected Mauritius during last 10 years.

The Inter-Tropical Zone of convergence gets located much further to the north of the equator in the months of May to September than during November to April, when it is

located close to Mauritius. Seasonal shifts of this zone produce tropical cyclones, visiting Mauritius in the summer months.

Table 3.5: Major Cyclones in and around Mauritius

Cyclone	Month - year	Highest Gust Speed (km/hr)
Not Named	Apr-1892	240
Not Named	Mar-1931	180
Not Named	Jan-1945	157
Alix	Jan-1960	200
Carol	Feb-1960	256
Jenny	Feb-1962	235
Danielle	Mar-1964	219
Gervaise	Feb-1975	280
Claudette	Dec-1979	221
Laure	Mar-1980	201
Bakoly	Dec-1983	198
Firinga	Jan-1989	190
Hollanda	Feb-1994	216
Dina	Jan-2002	228

The strongest gusts recorded instrumentally at Mauritius have been of **280 km/h**, (Gervaise at Mon Desert, February 1975) and records of gusts of 250 km/h have been made in earlier cyclones, (e.g. Carol, 1960). **Figure 3.5** shows the past major cyclone tracks on Mauritius.

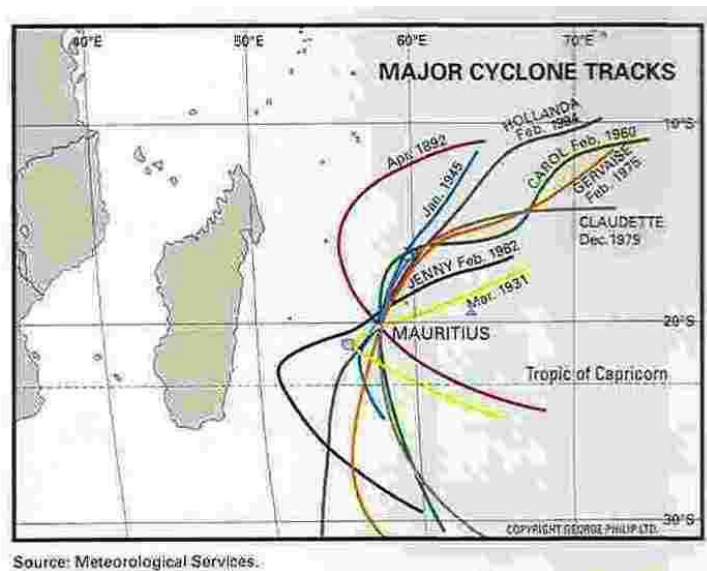


Figure 3.5: Major cyclone tracks on Mauritius

Relative Humidity

Mean monthly relative humidity varies from 86% in March to 80% in October in Vacoas (Central Plateau). Corresponding figures for Plaisance (Coastal) are 85% and 78%. So, we can deduce that the relative humidity at Deux Bras is being within the same range.

Rainfall Intensity

Mean annual rainfall ranges from a minimum of 800 mm on the west coast to over 3,600 mm in the central tableland, giving an increase of more than 2,800 mm over a distance of about 20 km. During winter from May to October, rainfall expressed in as a percentage of annual rainfall, varies between 30% and 35% in locations exposed to trade winds, and between 10% and 30% in the western leeward areas.

The mean annual average rainfall over Mauritius as a whole is about 2,100mm. Two-thirds of this total falls in the summer months of November to April. The driest month is October with only 74mm or 3.5% of the total. November is taken as the first wet month, as it receives an average 4.7% of the total, but it is noted that rainfall in November is more variable than on other months, depending to some extent on whether early warm season depressions affect the island or not in any particular year.

Figure 3.6 gives the 30-year average annual rainfall (the 1951-1980 normal rainfall) over Mauritius in the form of isohyets.

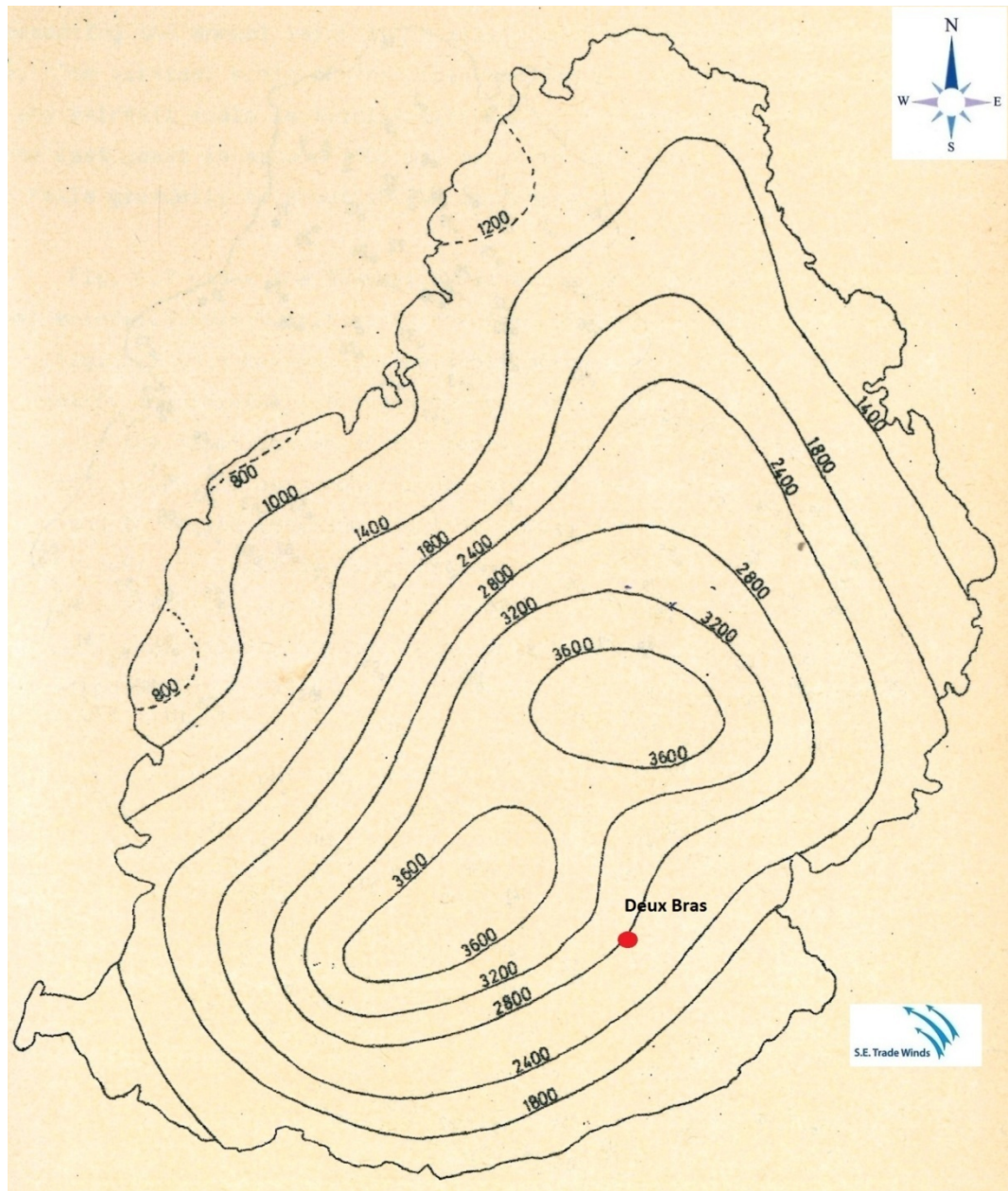


Figure 3.6: Mauritius Rainfall Normals 1951-1980 (Padya, 1984)

The South-East of Mauritius receives the oceanic air with its moisture content and benefits from the forced uplift resulting from its passage over sloping lands and hills. The annual areal normal for the Deux Bras is around 2755mm (**Table 3.6**), of which 65% is received in the period November to April. The winter months thus receives a fair amount of rain and can be considered only relatively dry. The driest month is October with only 94mm or 3.4% of the yearly total.

Table 3.6: Monthly and annual normals in millimeters, 1951-1980

Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Deux Bras	370	352	400	295	230	183	185	155	104	94	131	256	2755
% of Year	13.4	12.8	15	11	8.3	6.6	6.7	5.6	3.8	3.4	4.8	9.2	100

Source: Padya (1984)

High intensity rainstorms are common and rainfalls of the order of 375 mm in 24 hours have been recorded, particularly influenced by low pressure troughs, weak depressions and tropical cyclones.

The above noted features of rainfall demand longitudinal and cross drains along the roads. The capacities of the drains are normally designed by local run-off characteristics in relation to intensity of rainfall for 10-year return period.

Past meteorological data of the project area have been collected from the Meteorological Services. The climatologic features are summarized in **Table-3.7**.

Table-3.7 Climatologic Features of the Project Site

Project Site	Range of Mean Monthly Temperature (°C)	Range of Monthly Total Rainfall (mm)	Total Annual Rainfall (mm)
Deux Bras	18 (July) - 26 (Jan)	94 (Oct) –400 (Mar)	2755

Reference: PADYA B.M. (1984). *The Climate Of Mauritius*. Mauritius: Published by meteorological office.

Figure 3.7 below shows the mean summer and winter temperature variation in Mauritius.

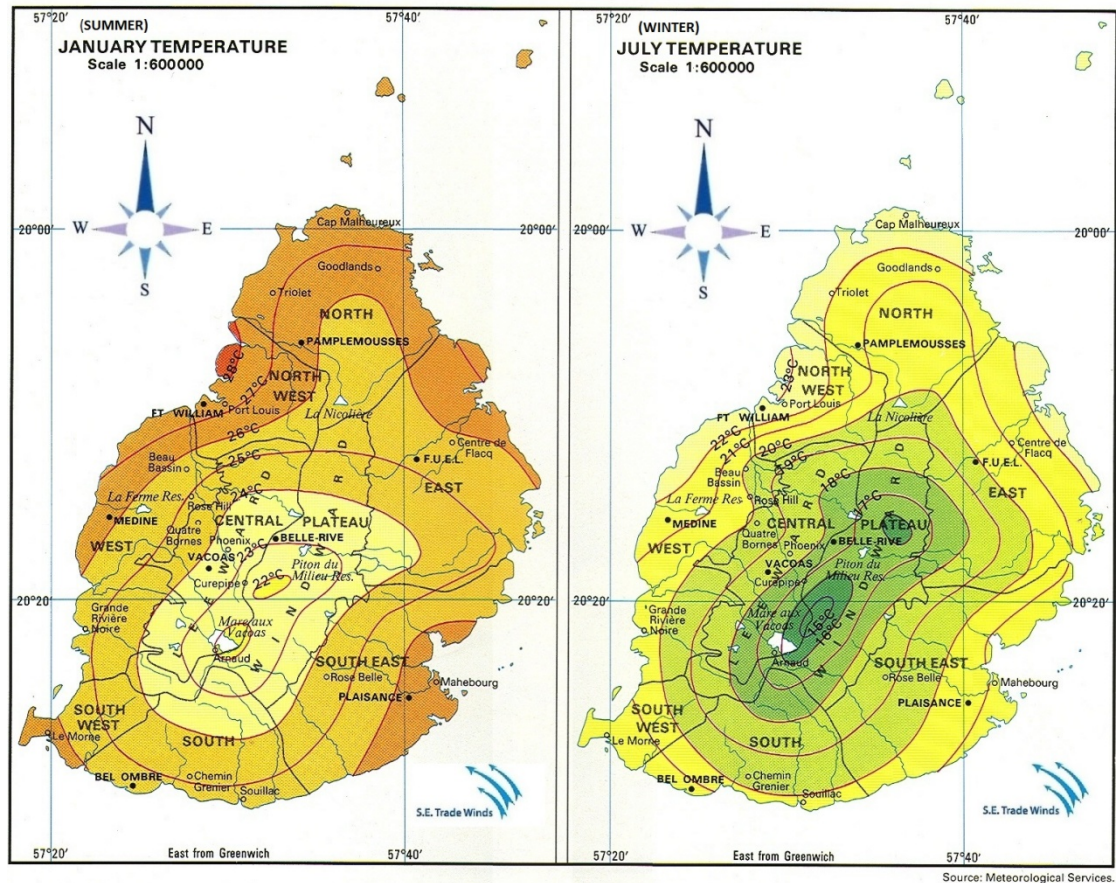


Figure 3.7: Seasonal Temperature Variation in Mauritius

3.7 FLORA and FAUNA

3.7.1 Flora

The flora of the Island of Mauritius has been impacted upon over many centuries through man induced processes. The pristine forest was cleared and brought under cultivation between 1772 and 1810. So there is almost no indigenous vegetation left on the site. The river reserves below the 150 m contour were de-reserved by law in 1965, re-reserved by law in 1971. This has resulted in a complete modification of the flora

along the river reserves. However, the River Reserves are now protected under the Forest and Reserves Act No. 41 of 1983.

In the first instance, the natural vegetative covers on nearly all land with relatively gentle slopes have been largely removed to make room for plantations of sugarcane. Then, many exotic species of vegetation were introduced into this island, which have turned invaders to suppress many of the indigenous species of vegetation. In most forest plantations, preference has been given to the exotic species. About one third of the area of this island has a cover of uncultivated vegetation, of which a major part is under shrubs.

The project site is presently cultivated for sugarcane to its full extent. It does not accommodate any endemic/endangered species, any rare flora or fauna that are protected by law.

3.7.2 Fauna

No endangered animal species was noticed during field survey nor was any reported by the local people. All the mammals found on the common exotic ones. A few of them are the Black Rat and the Ship Rat, the Mongoose and hare.

All the birds that have been recorded in the region are exotic ones except for the ubiquitous endemic *Zosterops borbonica*, which is common all over the island. Among the exotic birds are the barred ground dove (*Geopelia striata*), the House sparrow (*Passer domesticus*), the Indian francolin (*Francolinus pondicerianus*), the Madagascar red fody (*Foudia madagascariensis*), the Mynah (*Acridotheres tristis*), the Red whiskered bulbul (*Pycnonotus jocosus*), the Spotted dove (*Streptopelia chinensis*), the Waxbill (*Estrilda astrild*), and the Weaver bird (*Ploceus cucullatus*).

3.8 SOCIAL ENVIRONMENT

Social environment can be conveniently described in terms of population, features of urbanization, occupational pattern, ethnic features, objects of religion, etc.

3.8.1 Population

From the population statistics it is evident that the population in the island of Mauritius is growing steadily. Between 2000 and 2010 the annual average population growth rate was 0.87%. This growth is taking place across all the districts of the island. A glimpse on this feature of the society in Mauritius in general and of the project area in particular can be obtained from **Table-3.8**.

Table 3.8 Growth of Population

Regions	2000		2010		Annual Growth Rate (%) 2000-2010
	Population	Density per sq. km	Population	Density per sq. km	
Island of Mauritius	1,143,069	613	1,243,084	667	0.87
District of Plaines of Wilhems	358,182	1762	384,434	1891	0.73
District of Grand Port	106,665	410	115,377	559	0.82
District of Savanne	66,356	271	70,430	288	0.61

Source: Annual Digest of Statistics 2001 & 2010, Central Statistics Office

3.8.2 Patterns of Urbanization

The above mentioned growth of population is reflected in an asymmetric order in terms of urban and rural components of the society. The rate has been faster for the rural population. This is reflected in **Table 3.9**.

It is worth mentioning that the largest settlement of the Republic of Mauritius is the capital City of Port Louis. It is also important to note that practically the entire urban population of this island is found within the two neighbouring districts of Port Louis and Plaines Wilhems. This feature of regional concentration of urban population is arising from the fact that the five settlements of Port Louis, Beau Bassin-Rose Hill, Quatre Bornes, Vacoas-Phoenix and Curepipe are the only designated urban places. Between these urban centers, the growth rate has not been the same. For being away from Port Louis, the rate of growth has been higher. This suggests that area spread of urban functions is a continuing process in this island.

Table 3.9 Growth of Urban and Rural Population in the Island of Mauritius

Categories	Population		Annual Growth Rate (%) between 2000-2010
	2000	2010	
<i>Rural Population</i>	640,024	711,125	1.11
<i>Urban Population</i>	503,045	534,163	0.62
• Port Louis	144,303	148,416	0.29
• Beau Bassin/Rose Hill	103,872	110,866	0.67
• Quatre Bornes	75,884	81,899	0.79
• Vacoas/Phoenix	100,066	108,347	0.83
• Curepipe	78,920	84,635	0.72

Source: Annual Digest of Statistics 2001 & 2010, Central Statistics Office

3.8.3 Occupational Pattern

The society is experiencing the impacts of economic transformation. This is reflected in the shifts in the pattern of employment. From the limited data that is available in this regard, **Table-3.10** has been constructed. Although the data is somewhat dated, one can easily see that the processes of economic transformation have been operating over a long time.

This table clearly shows that the shift has been in favour of service industry. This is another sign of transformation towards increasing urbanization. The features of the more recent period have been discussed under economic environment in a subsequent section of this chapter.

Table 3.10 Shift in Sectoral Employment between 2009 & 2011

Sector	% Shift in 2011 over 2009
Agriculture, forestry & fishing	(-) 0.5
Mining & Quarrying	(+) 0.0
Manufacturing Industry	(-) 3.5
Electricity, gas & water	(+) 0.2
Construction	(+) 2.6
Wholesale & retail trade	(+) 4.3

Hotels & Restaurants	(+) 2.2
Transport, Storage & Communications	(+) 0.2
Financial Intermediation	(+) 0.9
Real Estate, renting and business activities	(+) 3.4
Public administration and defense; compulsory social security	(-) 0.5
Education	(+) 1.0
Health and social work	(+) 2.8
Other services	(+) 0.8
TOTAL	(+) 13.9

Source: Ministry of Economic Planning & Development (2011)

3.8.4 Ethnic Features

There are no ethnic features currently on the site that would require preservation or would be disturbed by the construction works.