



**GOVERNMENT OF THE
COMMONWEALTH OF DOMINICA**

MINISTRY OF PUBLIC WORKS, ENERGY AND PORTS

**DRAFT REPORT ON THE IMPACT OF HEAVY RAINS
ON 17-18 September 2011 and 27-28 November 2011**



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Introduction

The passage of several low level trough systems during the last quarter of 2011 between the months of September and December, triggered major slope instability and flooding events primarily along the North, East and South Eastern part of the island of Dominica. These above average rainfall intensities resulted in damage to critical and essential transportation assets (roads, crossings, drainage systems), other related infrastructural assets and private properties. This has negatively affected the overall national economic growth prospects as guided by the Growth and Social Protection Strategy (GSPS) with specific impact on the agricultural, tourism and fishing sectors.

Background

Due to the nature of the island's rugged topography, a substantial amount of the road infrastructure lies either along the coast or along high cliffs or smaller embankments. In many instances, the proximity and of this road infrastructure make them quite vulnerable to land slippages emanating from increase rainfall. The central and eastern parts of the island are heavy rainfall areas and the soils are usually saturated. An increase rainfall more often leads to instability of these cliffs or embankment causing land slippages and negatively impacting on the road infrastructure.

The islands terrain has posed a major challenge to the Ministry of Public Works, Energy and Ports (MPWEP) in responding to hazards particularly during the hurricane season, which runs from June 1 to November 30 of every calendar year. Notwithstanding these challenges, the Ministry has been able to reinstate road accesses within a considerable period of time, following land slippages along existing transportation routes.

An established relationship with local equipment operators working in collaboration with the Public Works Corporation is being strengthened to improve response. In light of the events which occurred within the last quarter of 2011, in excess of one hundred and fifty (150) land slippages (major to medium) were cleared at an estimated cost of over EC\$3 million dollars.

The responses and expenditure from local utility companies (underground and aerial infrastructure) and other private property owners (housing, businesses) amount for increase expenditure in the aftermath of these events. Financial resources for payment to service provides can be challenging as these are unforeseen hazards. It is therefore recommended that a minimal budgetary allocation say US\$1 million be appropriated to the MPWEP to facilitate emergency responses on an annual basis.

Notwithstanding these challenges, the Ministry has over the years been able to collaborate and will continue to do so with local service providers, to respond in the most timely and efficient manner as possible.

ASSESSMENTS

The process of assessing the impact of the events is done in three (stages) and comprises of:

1. Rapid Assessment

The main objective of this Rapid Assessment is to provide a description of the levels and nature of the sustained damage and an initial estimate of rehabilitation measures. The estimated duration and cost of clean-up operation, preliminary cost of damage and rehabilitation costs, and forms the basis for request of emergency funds by the Ministry of Finance from donor institutions. Private ventures are not necessarily included. This is done within 24 to 48 hours of the event. This assessment is to rapidly provide a description of the impact of the event on the road infrastructure, to determine areas critically affected and, to propose a response (short and longer term).

2. Detailed Assessment

The main objective of this detailed assessment is to provide a more informed and detailed description of the levels and nature of the sustained damage and a revised estimate of rehabilitation measures to be undertaken. The cost of the damage is also assessed. This refers to the actual cost of the asset when it was destroyed. The cost of rehabilitation in most cases would be more than the cost of the damage. This is normally provided within two (2) weeks of the event based on the magnitude of the incurred damages. The assessment at that stage can also be used to sensitize donors on the possibility of assistance to respond effectively to the event. This is normally an intermediate stage of assessment that is fine-tuned during the final assessment.

3. Final Assessment

The main objective of this final assessment is to provide the MPWEP with a comprehensive assessment which includes revised estimates for Rehabilitation (short and long term) based on actual engineering designs inclusive of site conditions, design options, works scheduling etc. This could take between one (1) and three (3) months, again based on the location and magnitude of the incurred damage. This instrument is also used to solicit financial external support given the magnitude of the event.

RAINFALL DATA

The Ministry of Public Works Energy and Ports receives rainfall data from the Meteorological Services Department which provides data from Canefield and Melville Hall Airports Over the period September to November these two stations recorded above average rainfall which impacted negatively on the already saturated soils within the affected areas. provides detail of these data results.

This report will seek to highlight two main aspects of the areas affected. This will include:

- 1. *Rapid Assessment;***
- 2. *Detailed Final Assessment***

Key findings

The rapid assessment undertaken during the aftermath of the event (September to November 2011) indicated extensive land slippage and overflowing of several ravine/rivers impacting negatively on the existing roadway and properties. Of major significance were two (2) extremely large land slippages in the Petite Soufriere area which took approximately four (4) days to be cleared to allow for motor vehicular traffic. This along with a number of land slippages, failure of culverts, retaining structures and flooding events which caused damages to existing roadways, characterized this two day event.

Additionally, the September 17-18, 2011 event appeared to serve as a catalyst for the November 27-28, 2011 event resulting in weakening of the already saturated soils and in so doing triggering increase soil instability. The findings of both the Rapid Assessment and the Detailed Assessment identified impacts of a greater magnitude in the Eastern and South Eastern communities and of a lesser magnitude in the North-East and Southern communities. The areas affected were as follows:

- **North Eastern Communities:**
 - ✓ Carib Territory
 - ✓ Marigot
 - ✓ Calibishie
 - ✓ Blenheim
 - ✓ Veille Casse
 - ✓ Penville
 - ✓ Guillet
 - ✓ Bourne

- **Eastern Communities:**
 - ✓ Castle Bruce
 - ✓ San Sauveur
 - ✓ Petite Souffriere
 - ✓ Bois Diable to Rosalie
 - ✓ Grandfond
 - ✓ Reviere Cyrique to La Plaine
 - ✓ Petite Savanne

- **South-Eastern Communities:**
 - ✓ Delices
 - ✓ Petite Savanne
 - ✓ Bagatelle
 - ✓ Stowe
 - ✓ Dubique
 - ✓ Grandbay

- **Southern Communities:**
 - ✓ Soufriere
 - ✓ Gallion
 - ✓ Scotts Head

RAPID ASSESSMENTS OF SEPT 17-18, 2011

Following the passage of these two (2) events, the Roads Engineering Department of the Ministry of Public Works, Energy and Ports mobilized engineers to undertake the Rapid Assessment Report.

Rapid Assessment- Primarily Eastern Communities

Following heavy rains which occurred from the night of the 17th and during the 18th of September, a number of landslides were reported to have occurred in the Castle Bruce, Good Hope, San Sauveur and Petite Soufriere communities. This report will provide an assessment of the overall damage arising as a result of this above average rainfall event.

The damage in the various communities is detailed as follows:

Castle Bruce: Jalousie Road

Three (3) landslides were recorded in the Jalousie area. Two (2) were of notable proportions and the exposed slope faces were particularly vulnerable because of the loose nature of the native soil. These slides would require slope stabilization to protect residential property immediately above the landslide and to prevent loss of use of the existing road.

The first landslide opposite the Bannis Residence in Jalousie took place at an observed area of slope instability of length approximately 160 feet (49m) and a maximum height 25ft (7.6m). The existing earth drain is in need of cleaning and should ideally be replaced by concrete box drains. Grey water and "run-off" from homes above the slope, flows along the slope, contributing to water saturation of the soil therefore increasing the likelihood of slope failure. An immediate measure to channel this water through an impervious drainage channel (concrete box drains or similar) to the earth drain below should be adopted.

The second slide which brought down soil debris and a large tree left an exposed failure plane of width 50ft (15m) and height 30ft (9m). It is recommended that the large trees remaining on the property above this slope should be cut down to the trunks to relieve some of the weight on the slope, the roots however contribute to trapping the soil and should be left in place.

A gabion/ reinforced earth retaining wall may be more cost effective in both instances than a conventional reinforced concrete wall, because of the expanse and height of the failures.

Estimated cost \$420,000



Figure 1: *First Landslide on Jalousie Road*



Figure 2: *Second Landslide on Jalousie Road*

Castle Bruce: Wind Blow road

Failure of a 3 foot (1m) pre-cast concrete culvert has cause the collapse of a culvert crossing. The existing earth drain appears to carry a high volume of water during heavy rains and consequently the invert of the drainage channel has been considerably scoured leading to the deepening of the channel and undermining of culvert structures. It is recommended that concrete box drains should be installed along the entire length of the channel, with the first 70m being the most critical section of the channel. The collapsed culvert should be replaced with a box culvert structure to accommodate high discharges and periodic cleaning. Shoulder-bladding and ditch clearing have been recommended for upper wind blow road to alleviate flooding in that area. **Estimated cost EC\$ 139, 000**



Figure 3: *Culvert Failure and Drain Sourcing at Wind Blow Road*

Good Hope: Cochrane Road

Land slippage near the home of Churchill Darroux of Cochrane Road, Good Hope is currently affecting the course of a small river running adjacent to this residential property. Previous landslides have diverted the course of the river which undermines the property particularly during heavy rainfall. Excavation of the debris in the river is recommended to re-establish the river course further away from the property. A river wall of maximum height 6ft (1.8m) above the river bed by width 10 ft is recommended to prevent further undermining of the property.

Estimated Cost EC\$ 40, 000



Figure 4: Landslide on Cochrane Road, Goodhope

Fie Road: Deux Branch (Derrier Morne)

Damaged wing-walls and blocked culverts at this location have allowed water to wash away culvert backfill material leading to a large area of subsidence in the road directly above the culvert structure (3 ft bore). Re-establishing failed section of the wing walls, cleaning of the culvert and backfill with tarrish to the road level will be required to repair this collapsed section of road. **Estimated Cost EC \$ 160, 000.**



Figure 5: Subsidence above culvert on Fie Road



Figure 6: Hole in Culvert Wing Walls on Fie Road

San Sauveur to Petite Soufriere Main Road

A large volume of water carrying rocks and debris has caused damaged two locations with blocked culverts along this main road, immediate remedial measures should include clearing of these culverts. Based on the observed size of the catchment areas for these culverts, it is believed that the discharge capacity of the existing culverts is insufficient and the culvert bore limits the ease of periodic cleaning and removal of obstructive debris. In the long term, the installation of box culverts is recommended for these two areas. **Estimated Cost EC\$ 295,000**



Figure 7: Culvert Blockage and complete cover of inlet on San Sauveur to Petite Soufriere Road

Petite Soufriere: Morne Z'orange (Orange Hill)

A landslide in this area and slope instability adjacent to the house of Theresa Mourillon (occupant) requires immediate attention, as the occupant of the house is elderly and with limited mobility. Furthermore the slide and slope cannot be accessed by heavy equipment and can only be cleared manually. The Village Council has already identified an area for the relocation of the occupant. Further action by the Ministry of Housing is urgently required in this instance.

Petite Soufriere: Upper Fond Bleu (road below Government School)

An extensive landslide along the edge of the existing concrete road has threatened the stability of approximately 10m of road edge. The most viable option, considering that the slope material from the road edge to a depth of about 80ft (24m) appears unstable and unconsolidated, is to re-align the road away from the area of slope failure.

Another landslide in this area has affected a communal footpath to several houses. The slope in this area appears very unstable and working in this area may prove difficult and precarious for heavy equipment. It is expected that more material from this slope will slide to the road below, which has already been cleared of debris coming from the slide. An alternative footpath of 75m length has been identified and will require widening and possible pavement. **Estimated Cost EC\$ 90, 000.**



Figure 8: Landslide on upper part of hill at Fond Bleu

Table 1: Summary of cost for rehabilitation due to damage caused by storm

| Location | Damage Cost EC \$ |
|---|--------------------|
| Jalousie Road, Castle Bruce | \$ 420,000 |
| Windblow Road, Castle Bruce | \$ 139,000 |
| Cochrane Road, Goodhope | \$ 40,000 |
| Fie Road | \$ 160,000 |
| San Sauveur to Petite Soufriere Main Road | \$ 295,000 |
| Upper Fond Bleu Road, Petite Soufriere | \$ 90,000 |
| TOTAL | \$1,144,000 |

RAPID ASSESSMENTS OF NOVEMBER 27-28, 2011 EVENT

The North-Eastern section of Dominica is historically known to have among the highest volumes of rainfall on the island. The area impacted on runs from the north eastern village of Guillet (further North) to the Carib- Territory (further East).

Based on the initial site inspection and observations made by the Road Engineers most of the damage resulting from heavy incidence of landslides and road edge failures were largely localized in the eastern part and to a lesser extent the north-eastern and southern section of the island.

During the said adverse weather conditions, a total of eighty-eight (88) landslides occurred throughout the affected region, cutting off vehicular access and communication amongst a number of rural communities, with the worst hit being the section between Hatton Garden to Castle Bruce where there were two (2) massive landslides, completely blocking the road way as well as another five (5) moderate size landslides which also restricted the free movement of people and motor vehicles.

Similarly, affected is the section from Rosalie to Delices where a total of thirteen (13) slides occurred of which six (6) completely cut off the roadway from motorable traffic. The road section leading to Grand Fond village was also totally blocked by two (2) major landslides as well as the Castle Bruce to Petite Soufriere roads which was impassable due to the occurrence of seven (7) major landslides. Mention should also be made of the Blenheim to Vieille Case Section where a number of significant slides blocked the roadway and restricted communication in that respect.

The severity of the impact of the large-scale landslides on the road network in the mentioned region can be appreciated by the total number of machine hours (heavy-duty excavators and backhoe) which is required for clearing the slides and reinstating the drainage and traffic capacity of the damaged sections.

According to preliminary figures a total of 1,440 machine hours plus 2,190 hours of transportation service is the minimum required to get the roadway back into serviceable form. The initial estimated cost for clearing slides and reinstating of the drainage along the affected region is \$891,020.00 (See Appendix 2).

The cost for repairing the broken road edges, damaged pavement, drainage, side slopes and road embankments as well as other rehabilitative cost for fully reinstating the road network in the damaged region will be very significant. The actual scope of works, engineering designs and costing is currently being undertaken by the Technical Services Division of the Ministry of Public Works Energy and Ports which will form part of the final report to be presented subsequently.

North-Eastern District

i. Castle Bruce - Petite Soufriere:



Figure 9: Flooding of crossing within Castle Bruce Village



Figure 10: Flooding of Farm Lands close to Carluxe Bridge (CB)



Figure 11: Road edge and drainage failure at San Sauveur



Figure 12: Road edge Failure and Drainage at San Sauveur



Figure 13: Land Slippage approaching GoodHope Village



Figure 14: Flooding of culvert structure at Petite Soufriere



Figure 15: Land Slippage at Petite Souffriere.

- A total of seven (8) landslides, along with fallen rocks and trees, made this road impassable to vehicular traffic along several sections. The road has been critically undermined in the San Sauveur area as a result of water run-off and several culverts have been blocked. Backhoe excavators along with other heavy duty machinery were deployed make the road passable at least to one lane width.

Follow-up

- Maintain and deploy additional equipment, along with tipper trucks, to clear the carriageway, shoulder and drains of all slides, rocks and fallen trees. A labour crew to clear the fallen trees along this section of roadway.

ii. Castle Bruce - Hatton Garden:



Figure 16: Major land slippage along Carib Territory Rd Figure 17: Extent of slide along Carib Territory Road (Rd)



Figure 18: Major road settlement at Mahaut River



Figure 19: Culvert failure along Carib Territory Road

Immediate Response

- Two major landslides made vehicular traffic impossible at two sections of the Carib Territory while there were several smaller ones reducing the carriageway to one-lane capacity. Two large excavators, trucks and manual labour mobilized to assist in clearing operation.

iii. Castle Bruce Bois Diable:



Figure 20: Clearing of mud slide along Bois Diable/Castle Bruce Road

Immediate Response

- Machinery deployed to cleared off the carriageway, road shoulder and drains as a result of several slides which occurred rendering roadway impassable.
- A labour crew dispatched to clear the fallen trees along this section of roadway with the use of chainsaws.

South-Eastern District.

iv. Bois Diable - Rosalie



Figure 21: Land Slippage close to Rosalie



Figure 22: Road /drainage failure at Aux Delices



Figure 23: Road Failure at Aux Delices due to flooding.



Figure 24: Edge and culvert failure at Aux Delices



Figure 25: Road edge Failure at Aux Delices

Immediate Response

- The road was blocked by major landslides at Terre Femme, Rosalie and Grand Fond. There were also several other slides which reduced the roadway to one-lane capacity. Several large to medium size machines, trucks and manual labour deployed to assist in clearing roadway.

v. White River - Loubiere:

Immediate Response

- Several major landslides encountered along this road. The section of roadway at Dubique was made impassable to vehicular traffic. Backhoe and labour crew deployed to clear roadway.

Southern District.

vi. Pointe Michel - Soufriere:

Immediate Response

- Two major landslides encountered along this road. There was also considerable rock fall and a huge boulder made the roadway temporarily impassable. There were also several minor slides to road shoulder and drains. One backhoe and one excavator employed to clear roadway.

Northern District.

vii. Portsmouth - Vielle Casse:

- A total of sixteen slides encountered along this section. Roadway made impassable from Blenheim to Aux Pac (Vielle Casse). The Aux Pac culvert crossing was flooded with the eastern pavement approach receiving some damage. An excavator and a bobcat (Fast Company) along with a labour crew deployed to reinstate this section of roadway to one-lane capacity.

viii. Blenheim - Hatton Garden:

- Roadway hasn't been made impassable but several minor slides occurred challenging the normal free movement of traffic. The road was reduced to one-lane capacity in several areas. A labour crew is to be dispatched to clear the fallen trees along this section of roadway with the use of chainsaws and backhoe to clear blocked drainage.

ix. Guillete - Penville:

- A total of eight slides encountered along this section. Roadway made impassable at Lod Bor River. Excavator and labour crew deployed to clear slides.



Figure 26: Road edge and Culvert Failure

x. Rosalie to White River

- In excess of 20 slides occurred along this route and disrupting vehicular access in many areas. Excavator and Labour crew deployed to clear slides.



Figure 27: Rockfall Rosalie to White River



Figure 28: Slope failure at Morne Jaune/Riviere Cyrique



Figure 29: Road edge failure Grand Fond village



Figure 30: Edge failure Fueyal



Figure 31: Flooding destroyed road edge and drainage system.



Figure 32: Road edge failure and drainage system

FINAL DESIGNS AND ESTIMATES

The Final Report comprises of the preliminary cost of the required intervention to not only address the cost of infrastructure rehabilitation, but to make these interventions much more robust to withstand future events.

The damages considered were primarily that of road, drainage and issues of slope stability. The ravines/streams which flooded during this event were also inspected to get an appreciation of the status of these rivers.

The report seeks to highlight and quantify the damages caused and to make recommendation for the implementation of appropriate and effective management infrastructural solutions for the mitigation of flood and soil stability events and the strengthening of community based disaster mitigation and management procedures.

As a general summary and from proceeding discussion, the following direct impacts from the events of September to November 2011 are assessed as follows:

- | | |
|---------------------------------|-----------------|
| 1. Clearing/Cleanup costs | - EC\$891,020 |
| 2. Damage/Rehabilitations costs | - EC\$1,144,000 |

Total - EC\$2,350,020

Further to the above, the condition of key and strategic sections has been assessed with the objective of establishing a global/ball park figure for rehabilitation of critical infrastructure. As indicated, a sum of at least EC\$265,465,286 would be required to bring the majority of the island's road network, key drainage systems and coastal defence requirement to an effective climate resilient status (See Appendix 3).

As a way forward, the design of such critical infrastructure requires proper and adequate engineering data. With a general observation of a lack of such data, we recommend the acquisition of instrumentation for data gathering. Further, training of staff in the use of such equipment and processing of captured information is important.

APPENDIX 1

RAINFALL MEASUREMENTS

Main hour rainfall totals at Canefield Airport for September 2011.

27 September, 2011 From 8pm on the 26th to 8am on the 27th = 13.9mm (12 hrs)

27th 8am to 2pm = 3.3mm (6hrs)

2pm to 8pm = 6.8mm (6hrs)

28 September, 2011 From 8pm on the 27th to 8am on the 28th = 59.1mm (12hrs)

28th from 8am to 2pm = 90.9mm (3.58 inches in 6hrs)

From 2pm to 6pm **58.3mm (4hrs, non-standard check)**

29 September, 2011 From 6pm on the 28th to 8am on the 29th = 8.2

The 18 hour total from 2pm on the 28th to 8am on the 29th = (58.3+ 8.2) = 66.5mm

Main hour rainfall totals at Melville Hall Airport for September 2011.

27 September, 2011 From 8pm on the 26th to 8am on the 27th = nil (12 hrs)

27th 8am to 2pm = nil (6hrs)

2pm to 8pm = 0.4mm (6hrs)

28 September, 2011 From 8pm on the 27th to 8am on the 28th = 29.8mm (12hrs)

28th from 8am to 2pm = 1.1mm (6 hrs)

From 2pm to 8pm = 3.5 mm

29 September, 2011 From 8pm on the 28th to 8am on the 29th = 0.2mm

APPENDIX 2

**ESTIMATES OF CLEANUP AS A RESULT OF
HEAVY RAINS**

FROM 27 – 28 NOVEMBER, 2011

| Rapid Assessment Report: 28th November, 2011 | | | | | | | | | | | | | | | |
|--|----------|---------------------------------|---|-------------------|--|-----------|-----|------|--------------|----------------|-----------|---------------------|--------------|---------------------|----------------|
| Projected Expenditure | | | | | | | | | | | | | | | |
| No. | District | Location | Observations | No. of Landslides | Projected Duration of Clean-up Activities (Days) | Equipment | | | | | Transport | | | | Projected Cost |
| | | | | | | Type | No. | Hrs | Rate (EC \$) | Amount (EC \$) | No. | Hrs | Rate (EC \$) | Amount (EC \$) | |
| 1 | Northern | Portsmouth -Vielle Casse | • A total of 16 slides encountered along this road. •Road impassable at Blenheim and Aux pax | 16 | 6 | Excavator | 3 | 180 | 320 | 57,600 | 6 | 360 | 200 | 72,000 | \$129,600.00 |
| 2 | Northern | Guillete - Penville | • A total of 8 slides encountered along this road. •Road impassable at Lodbor River | 8 | 3 | Excavator | 1 | 30 | 320 | 9,600 | 2 | 40 | 200 | 8,000 | \$17,600.00 |
| 3 | Northern | Blenheim - Hatton Garden | •Roadway hasn't been made impassable but several minor landslides to be cleared off road shoulder and drains | 10 | 5 | Backhoe | 1 | 50 | 140 | 7,000 | 3 | 150 | 60 | 9,000 | \$16,000.00 |
| 4 | Eastern | Hatton Garden - Castle Bruce | • Two major slides in the Carib Territory has made the road impassable. Five (5) moderate-size slides to be cleared as well. Significant section of pavement failure (sunken leg) in Mahaut River | 7 | 6 | Excavator | 2 | 120 | 320 | 46,800 | 2 | 120 | 200 | 31,200 | \$78,000.00 |
| | | | | | | Backhoe | 1 | 60 | 140 | | 2 | 120 | 60 | | |
| 5 | Eastern | Castle Bruce - Petite Soufriere | • A total of 7 slides encountered along this road; two of which are major. •Road impassable at Mopo | 10 | 10 | Excavator | 1 | 80 | 320 | 44,800 | 3 | 210 | 200 | 54,600 | \$99,400.00 |
| | | | | | | Backhoe | 2 | 160 | 120 | | 3 | 210 | 60 | | |
| 6 | Eastern | Castle Bruce - Bois Diable | •Roadway hasn't been made impassable but several minor landslides to be cleared off road shoulder and drains | 6 | 3 | Excavator | 1 | 30 | 320 | 9,600 | 2 | 60 | 200 | 12,000 | \$21,600.00 |
| 7 | Eastern | Bois Diable -Rosalie | • Road Impassable at Terre Femme (3 major ones), Rosalie and Grand Fond. •Three (3) minor slides to be cleared as well. | 6 | 7 | Excavator | 1 | 70 | 320 | 32,200 | 2 | 120 | 200 | 27,600 | \$59,800.00 |
| | | | | | | Backhoe | 1 | 70 | 140 | | 2 | 60 | 60 | | |
| | Eastern | Rosalie - Grand Fond | Two (2) major and one (1) minor landslides and a number of road edge failures | 3 | 8 | Excavator | 2 | 160 | 300 | 60,000 | 3 | 240 | 200 | 48,000 | \$108,000.00 |
| | | | | | | Backhoe | 1 | 80 | 150 | | | | | | |
| 8 | Eastern | Rosalie - White River | •Six (6) major and seven (7) minor landslides encountered along this road. | 13 | 5 | Excavator | 2 | 100 | 300 | 45,000 | 3 | 240 | 200 | 48,000 | \$93,000.00 |
| | | | | | | Backhoe | 2 | 100 | 150 | | | | | | |
| 9 | Southern | White River - Loubiere | •Four (4) major landslides encountered along this road. •Road impassable at Dubique | 4 | 5 | Excavator | 1 | 50 | 320 | 23,000 | 2 | 120 | 200 | 26,400 | \$49,400.00 |
| | | | | | | Backhoe | 1 | 50 | 140 | | 2 | 40 | 60 | | |
| 10 | Southern | Pointe Michel - Soufriere | •2 major landslides, considerable rock fall and a huge boulder all contributed to the inhibition of vehicular traffic along this route. | 2 | 2 | Backhoe | 1 | 20 | 140 | 2,800 | 2 | 40 | 60 | 2,400 | \$5,200.00 |
| 11 | Southern | Soufriere - Galleon | •Roadway hasn't been made impassable but three (3) minor landslides to be cleared off road shoulder and drains | 3 | 3 | Backhoe | 1 | 30 | 140 | 4,200 | 2 | 60 | 60 | 3,600 | \$7,800.00 |
| | | | | 88 | | | | 1440 | | 342,600 | | 2190 | | 342,800 | \$685,400.00 |
| | | | | | | | | | | | | Contingencies (30%) | | \$205,620.00 | |
| | | | | | | | | | | | | Total | | \$891,020.00 | |

APPENDIX 3

PRELIMINARY GLOBAL ESTIMATE FOR THE REHABILITATION OF THE ROAD NETWORKS AND IMPORTANT COASTAL/DRAINAGE STRUCTURES

| Preliminary Estimated Cost (Road/Drainage/Stability) improvement. | | | | | | |
|--|----------|--------------------------------------|--|-----------------------|---|--|
| No. | District | Location | Works | Estimated Cost (EC\$) | Solution | Comment |
| Retaining Structures and Culvert Crossings | | | | | | |
| 1 | East | St. Cyr (Carib Territory) | Construction of Retaining Wall (L=5.5m H= 3m) Drainage Improvement (1 No. New 1.2m dia. Circular culvert) Road Re-instatement | 40,947.25 | Slope Stabilization and drainage improvement. | Works are Urgent |
| 2 | East | Mahaut River (Carib Territory) | Construction of single span concrete box culvert (2.4m x 3.0m) and road re-instatement | 135,967.03 | Drainage and road settlement improvement | Detailed geotechnical analysis required. Substantial settlement has occurred along with failure of Armco culverts. |
| 3 | East | Castle Bruce (Jalousie Road) | Construction of Retaining walls (Wing Wall) L=12m; H=3m | 424,761.70 | Slope Stability Improvement Drainage Improvement Pedestrian movement improvement. | |
| 4 | East | Good Hope (Sickwi Road) | Construction of single span concrete box culvert (2.4m x 3.0m) and road re-instatement. Construction of Retaining (Wing) Wall: L=13m; H=3m River Control Measures | 109,934.59 | Drainage Improvement Slope Stability Improvement | Regular maintenance of river channel i.e. key |
| 5 | East | Good Hope (Bayside) | Construction of single span concrete box culvert (2.4m x 3.0m) and road re-instatement. Construction of Retaining (Wing) Wall: L=13m; H=3m River Control Measures | 82,873.72 | Drainage Improvement Slope Stability Improvement | Regular maintenance of river channel i.e. key |
| 6 | East | Good Hope (Upper Good Hope) | Construction of damaged river crossing L=6m;W=1.2m | 13,614.40 | Improve access to Recreational facility. | |
| 7 | East | San Sauveur | Construction of Retaining wall: L= 30m; H=4.1 Installation of new pipe culvert | 157,527.91 | Improve slope stability Improve drainage system contain road infrastructure | |
| 8 | East | Petite Soufriere (River Louis) | Construction of single span box culvert: L= 7m; H= 2.4m Construction of Retaining wall: L=12m; H= 3.8m | 108,134.67 | | |
| 9 | East | Petite Soufriere (Shaw Shaw River) | Construction of Retaining wall: L=7m; H=2.7m Installation of new pipe culvert | 25,571.29 | | Regular maintenance of river channel i.e. key |

| No. | District | Location | Works | Estimated Cost (EC\$) | Solution | Comment |
|---|----------|--|--|-----------------------|---|---------|
| 10 | East | Petite Savanne | Construction of 5 Nos. Retaining walls L= 10 to 18m; H=3m | 463,650.62 | Improve Slope Stability and Contain road section | |
| 11 | East | Delices | Construction of Retaining wall L=22m; H= 4m | 171,764.46 | Improve Slope Stability and Contain road section | |
| 12 | East | Casgory/La Rond Area | Construction of Composite Gabion Wall and Retaining wall section. L=25m; H= 7m with toe section. | 323,606.49 | Improve Slope Stability and Contain road section | |
| 13 | East | Fueyal | Construction of retaining wall: L=10m; H=4.5m | 83,559.00 | Improve Slope Stability and Contain road section | |
| 14 | East | Reviere Cyrique | Construction of retaining wall: L=10m; H=4.5m | 270,000.00 | Improve Slope Stability and Contain road section | |
| 15 | East | Rosalie to Bois Diable Aux Delices Area | Construction of Retaining walls 4Nos along the Aux Delices section of Road. L=8 to 15m; H= 3.8 to 4.8m | 232,128.57 | Improve Slope Stability and Contain road section | |
| 16 | East | Rosalie to Bois Diable Aux Delices Area | Construction of 3Nos. Culvert crossing | 261,694.74 | Drainage Improvement | |
| 17 | East | Rosalie to Bois Diable Aux Delices Area | Construction of rectangular and slipper drains | 74,925.95 | Drainage Improvement | |
| | | | Sub-Total | 2,980,662.39 | | |
| Major Slope Stabilization > 40 meters | | | | | | |
| 18 | East | Castle Bruce to Petite Soufriere | Slope Stabilization, Drainage Improvement: L=400m | 12,004,519.50 | Improve Slope Stability | |
| 19 | East | Hatton Garden to Castle Bruce | Slope Stabilization, Drainage Improvement: L=300m | 8,003,013.00 | Improve Slope Stability | |
| 20 | East | Bois Diable to Castle Bruce | Slope Stabilization, Drainage Improvement: L=300m | 4,001,506.50 | Improve Slope Stability | |
| 21 | East | Bois Diable to Rosalie | Slope Stabilization, Drainage Improvement: L=550m | 14,672,190.50 | Improve Slope Stability | |
| 22 | East | Grand Fond Road | Slope Stabilization, Drainage Improvement: L=300m | 8,003,013.00 | Improve Slope Stability | |
| 23 | East | Rosalie to White River | Slope Stabilization, Drainage Improvement: L=500m | 13,338,355.00 | Improve Slope Stability | |
| 24 | South | White River to Stowe | Slope Stabilization, Drainage Improvement: L=100m | 2,667,671.00 | Improve Slope Stability | |
| 25 | South | Stowe to Dubique | Slope Stabilization, Drainage Improvement: L=720m | 19,207,231.20 | Improve Slope Stability | |
| 26 | South | Grandbay to Loubiere | Slope Stabilization, Drainage Improvement: L=250m | 6,669,177.50 | Improve Slope Stability | |
| | | | Sub-Total | 88,566,677.20 | | |

| Major Drainage Improvement to Upgrade Storm Drains Capacity. | | | | | | |
|--|------------|--|--|-----------------------|-------------------------------|---------|
| No. | District | Location | Works | Estimated Cost (EC\$) | Solution | Comment |
| 27 | East | Castle Bruce to Petite Soufriere | Construction of Major Storm Drains L= 5km | 3,000,000.00 | Improve Drainage/Protect Road | |
| 28 | East | Pond Casse to Bois Diable | Construction of Major Storm Drains L= 4km | 2,400,000.00 | Improve Drainage/Protect Road | |
| 29 | East | Hatton Garden to Castle Bruce | Construction of Major Storm Drains L= 10km | 6,000,000.00 | Improve Drainage/Protect Road | |
| 30 | East | Bois Diable to Castle Bruce | Construction of Major Storm Drains L= 5km | 3,000,000.00 | Improve Drainage/Protect Road | |
| 31 | East | Bois Diable to Rosalie | Construction of Major Storm Drains L=8km | 4,800,000.00 | Improve Drainage/Protect Road | |
| 32 | East | Grand Fond Road | Construction of Major Storm Drains L= 2km | 1,200,000.00 | Improve Drainage/Protect Road | |
| 33 | East | Rosalie to White River | Construction of Major Storm Drains L= 10km | 6,000,000.00 | Improve Drainage/Protect Road | |
| 34 | East | Morne Jaune/Reviere Cyrique Communities | Construction of Major Storm Drains L= 4km | 2,400,000.00 | Improve Drainage/Protect Road | |
| 35 | East/South | White River to Stowe | Construction of Major Storm Drains L= 3km | 1,800,000.00 | Improve Drainage/Protect Road | |
| 36 | South | Stowe to Dubique | Construction of Major Storm Drains L= 1.5km | 900,000.00 | Improve Drainage/Protect Road | |
| 37 | South | Grandbay to Loubiere | Construction of Major Storm Drains L= 3km | 1,800,000.00 | Improve Drainage/Protect Road | |
| Sub-Total | | | | 30,300,000.00 | | |

| Major Road Rehabilitation | | | | | | |
|---------------------------|------------|----------------------------------|--|-----------------------|------------------------|---------|
| No. | District | Location | Works | Estimated Cost (EC\$) | Solution | Comment |
| 38 | East | Castle Bruce to Petite Soufriere | Road Formation Improvement to include: Base/Sub-base repairs; lined drains; alignment improvement; pavement replacement. | 6,617,888.00 | Improve Road Condition | |
| 39 | East | Hatton Garden to Castle Bruce | Road Formation Improvement to include: Base/Sub-base repairs; lined drains; alignment improvement; pavement replacement. | 14,981,078.75 | Improve Road Condition | |
| 40 | East | Pond Casse to Bois Diable | Road Formation Improvement to include: Base/Sub-base repairs; lined drains; alignment improvement; pavement replacement. | 3,837,554.60 | Improve Road Condition | |
| 41 | East | Bois Diable to Castle Bruce | Road Formation Improvement to include: Base/Sub-base repairs; lined drains; alignment improvement; pavement replacement. | 7,941,467.60 | Improve Road Condition | |
| 42 | East | Bois Diable to Rosalie | Road Formation Improvement to include: Base/Sub-base repairs; lined drains; alignment improvement; pavement replacement. | 6,275,348.75 | Improve Road Condition | |
| 43 | East | Grand Fond Road | Road Formation Improvement to include: Base/Sub-base repairs; lined drains; alignment improvement; pavement replacement. | 654,472.00 | Improve Road Condition | |
| 44 | East | Rosalie to White River | Road Formation Improvement to include: Base/Sub-base repairs; lined drains; alignment improvement; pavement replacement. | 14,890,248.00 | Improve Road Condition | |
| 45 | East/South | White River to Stowe | Road Formation Improvement to include: Base/Sub-base repairs; lined drains; alignment improvement; pavement replacement. | 8,272,360.00 | Improve Road Condition | |
| 46 | South | Stowe to Dubique | Road Formation Improvement to include: Base/Sub-base repairs; lined drains; alignment improvement; pavement replacement. | 654,472.00 | Improve Road Condition | |
| Sub-Total | | | | 64,124,889.70 | | |

| No. | District | Location | Works | Estimated Cost (EC\$) | Solution | Comment |
|--|------------|------------------------|---|---|---|-------------------------|
| Coastal Protection Works | | | | | | |
| 47 | South | Stowe/Dubique | Construction of Sea Defence Wall to include Sea Defence wall and Rock Revetment. L=840m | 12,900,000.00 | Protect Road Infrastructure | |
| | | | | Sub-Total | 12,900,000.00 | |
| Bridges/Crossings Rehabilitation/Reconstruction | | | | | | |
| 48 | South/East | Boetica River Crossing | Repairs to damage culvert pipes and slope failures | 9,000,000.00 | Ensure continued access along road infrastructure | |
| 49 | South/East | White River Bridge | Replacement of Bridge Structure | 4,000,000.00 | Ensure continued access along road infrastructure | |
| 50 | South/East | Michum River crossing | Rehabilitation of culvert crossing | 500,000.00 | Ensure continued access along road infrastructure | |
| | | | | Sub-Total | 13,500,000.00 | |
| | | | | Accumulative Sub-Totals | 212,372,229.29 | |
| | | | | | | |
| | | | | 15% Contingency | 31,855,834.39 | |
| | | | | Project Design, Implementation , Preliminaries (10%) | 21,237,222.93 | |
| | | | | TOTAL | 265,465,286.61 | (US\$96 Million) |