



**GOVERNMENT OF THE
COMMONWEALTH OF DOMINICA**

MINISTRY OF PUBLIC WORKS, ENERGY AND PORTS

Disaster Vulnerability Reduction Project

**Proposed Rehabilitation Of Roads And Drainage Structures
In The Eastern Part Of Dominica**



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1. Introduction/Background

The island of Dominica, like many of its Caribbean sister islands, is particularly vulnerable to the effects of natural hazards such as hurricanes, earthquakes, floods and landslides. Over the past several years, such disasters have not only impacted the physical environment but have had particularly major negative impacts on the county's economy.

The Government of Dominica is collaborating with the World Bank to develop a disaster vulnerability reduction project (DVRP) with the aim of reducing the vulnerability to natural hazards and the adverse impacts of climate change in Dominica. In particular, sections of the main road in the eastern parts of the island has shown to be particularly vulnerable under conditions of heavy rainfall.

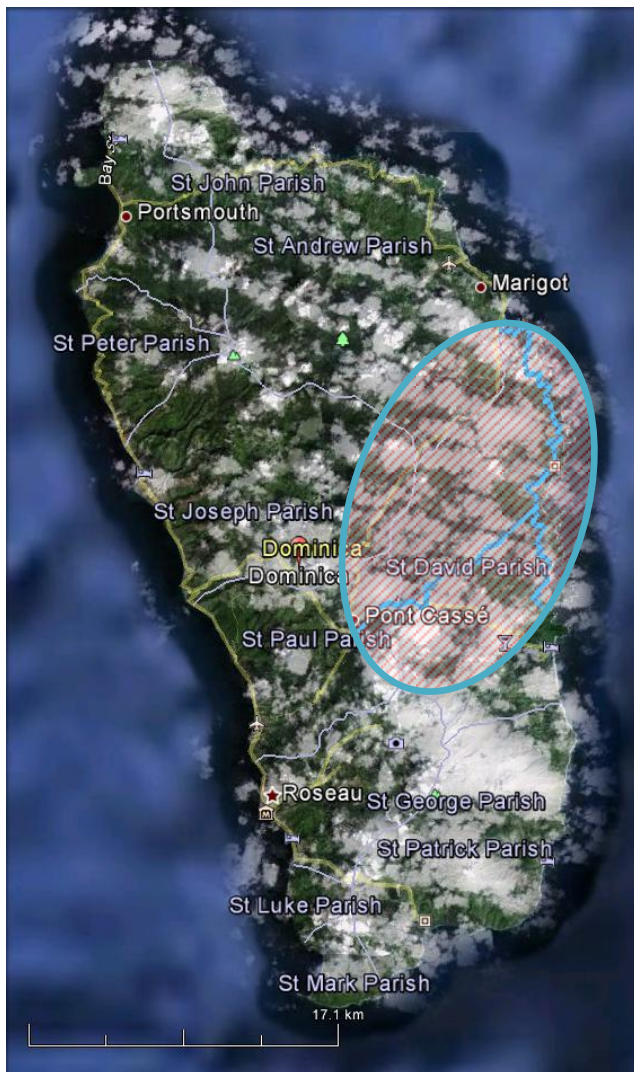


Figure 1 – Map of Dominica and showing vulnerable area under consideration for project

The sections of road (43.3km) as highlighted in Figure 1 above comprise four (4) major road links as follows:

Link Number	Description	Length of Link (km)
31104	Pond Casse - Bois Diable	4.5
31201	Bois Diable - Castle Bruce	9.5
31202	Castle Bruce - Petite Soufriere	8.8
31301	Castle Bruce - Hatton Garden (through the Carib Territory)	20.5

Figure 2 – Roads for consideration under DVRP

The indicated sections of road have shown to be particularly susceptible to flooding and landslides.

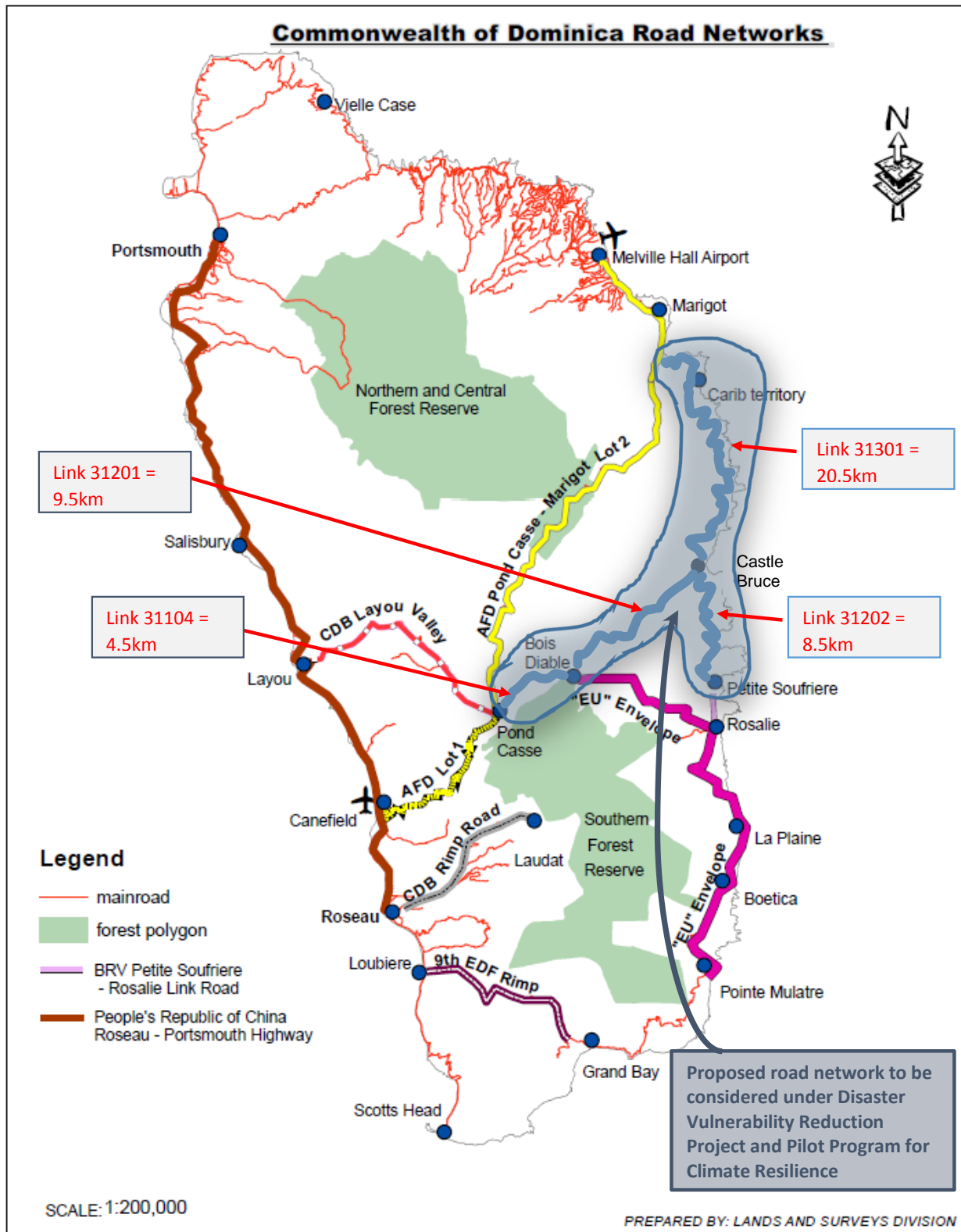


Figure 3 – Map showing further detail of project

2. General Objective of the Project

The main objective of the project is the rehabilitation of infrastructure taking into account the effects of climate change and adopting a design and construction methodology to build in sufficient robustness/resilience to help such structures function under extreme environmental forces.

In the affected region, the main areas of concern and our observation of structures most impacted include:

1. High embankments immediately adjacent to the existing roads – Increased frequency of landslides
2. Hydraulic structures/Pipe culverts – High failure of structures due to construction method and in cases, lack of sufficient discharge capacity
3. Bridges – Many of the existing structures show signs of severe scour at the piers/abutments and also suffer the effects of a general lack of regular maintenance
4. Road infrastructure – Road pavement has deteriorated due to insufficient drainage and the effects of increased traffic

3. Preliminary Assessment of Existing Site Conditions

Using the area of the Pond Casse roundabout as a reference, the following locations have been highlighted.

3.1 Link 31104 – Pond Casse Roundabout to Bois Diable

Failure of hydraulic/culvert structure at chainage 1.6km – Following heavy rains from 17 – 19 April 2013, a section of the main road 25m long by 15m deep was washed away.

Proposal – Replace by a new rectangular reinforced concrete hydraulic box structure and retaining wall.
Cost – EC\$1.2M (US\$0.45M)



Figure 4 – Resulting gap in road caused by failure of culvert

Chainage 1.6km - New reinforced concrete drainage structure					
Item No.	Description	Quantity	Unit	Rate (EC\$)	Amount (EC\$)
1	General items	1	sum	235,130	235,130
2	Demolition/Site clearance	1	sum	6,125	6,125
3	Retaining walls/Box culvert	1	sum	900,000	900,000
4	Road surfacing/Guard rails	1	sum	74,340	74,340
					1,215,595

Further to the above, there are fifty one (51) circular concrete pipe culverts (See Figure 20) along that road link which were constructed about the same time (1950's and 1960's) and using the same construction methodology as the failed structure. A recent inspection has shown a high level of deterioration (separation between pipe joints, scouring near inlet causing ingress of water into the fill, etc.) for the main structures. Thus, an urgent and detailed inspection regime is proposed.

3.2 Link 31201 – Bois Diable to Castle Bruce

- i) Landslide at chainage 5.2km – Approximate size of landslide is 25m long by 20m high.



Figure 5 – Landslide being cleared

Proposal – Embankment stabilization, drainage, road and safety measures.
 Cost – EC\$0.25M (US\$0.1M)

Chainage 5.2km - Typical landslide mitigation measures					
Item No.	Description	Quantity	Unit	Rate (EC\$)	Amount (EC\$)
1	Clearing and grubbing of site	1	ha	20,000	20,000
2	Excavation for stabilisation of embankment, incl disposal	2,500	m3	50	125,000
3	Drainage; concrete section 1mx1m	50	m	500	25,000
4	Base/Subbsae	100	m3	100	10,000
5	Wearing course; 50mm asphalt surfacing	325	m2	110	35,750
6	Grassing/Seeding - Replanting of slopes	1,500	m2	10	15,000
7	Guard rails - Provision of safety measures	50	m	300	15,000
					245,750

- ii) Subsidence in road pavement as a result of culvert failure – The observed failure can be linked to a failure in the culvert structure



Figure 6 – Subsidence in road showing direction of movement

Proposal – Replace existing culvert structure with new. Overall cost for new structures is provided in Figure 19.

- iii) Bridge at chainage 8.2km – Scour along abutments and missing safety railings. Single lane bridge 18m span by 5m wide and of typical composite construction. Recommended for replacement.



Figure 7 – Missing railings to narrow single lane bridge



Figure 8 – Scour to bridge abutments due to high flows of river

Proposal – Existing bridge is of an aged construction and replacement is recommended. Overall cost for new structures is approximately EC\$1.5M (US\$0.55M).

- iv) Bridge at chainage 8.2km at Castle Bruce – The structure as shown in Figures 9 and 10 indicates a compromised structure. In particular, the channel under the 34m span and 5m wide structure has suffered significant siltation. The clearance between the bridge soffit and river is only 1m.



Figure 9 – Damaged safety rails to bridge



Figure 10 – Heavily silted river channel

Proposal – Existing bridge is of an aged construction and replacement is recommended. In addition, significant upstream/downstream dredging and river training measures are required. Overall cost for new structures is approximately EC\$2.5M (US\$0.92M).

3.3 Link 31202 – Castle Bruce to Petite Soufriere

- i) Causeway at Castle Bruce – Existing structure at chainage 14.1km with twelve (12) 0.9m diameter culvert pipes are frequently blocked with debris. Consideration to be given to the provision of an adequate structure across the affected location. In addition, the road level may need raising.



Figure 11 – Causeway at Castle Bruce

Proposal – Given the frequency of overtopping due to obstruction with debris, the construction of a wide span crossing structure/bridge is recommended. In addition, consideration must be given to raising the existing road by at least 1m (for 50m before and after crossing structure) to obtain sufficient clearance between the stream and soffit of the proposed structure. Overall cost for new structures is approximately EC\$1.0M (US\$0.37M).

- ii) Bridge at chainage 14.5km – Calixte bridge 24m span by 4.5m wide structures at Castle Bruce in good condition but abutment walls require attention to mitigate the effects of adverse river flows.



Figure 12 – Single lane bridge



Figure 13 – Both upstream and downstream abutments flanked/scoured

Proposal – Abutment walls need to be extended to mitigate the effects of flanking. If not addressed, sustained high river flows may cause undermining and thus, compromise the main structure. The bridge is also narrow and may need widening to accommodate two (2) lane traffic. Overall cost for new structures is approximately EC\$1.0M (US\$0.37M)

- iii) Landslide location – Situation at chainage 16.5km at Castle Bruce after heavy rains in 2012. Affected section approximately 20m high by at least 500m long. Slope stabilisation required.



Figure 14 – Unstable slopes after landslide at Castle Bruce

Proposal – Embankment stabilization, drainage, road and safety measures.
Cost – EC\$0.25M (US\$0.1M)

Chainage 16.5km - Typical landslide mitigation measures (Castle Bruce; Dipax, Tranto)					
Item No.	Description	Quantity	Unit	Rate (EC\$)	Amount (EC\$)
1	Clearing and grubbing of site	1	ha	20,000	10,000
2	Excavation for stabilisation of embankment, incl disposal	3,000	m3	50	150,000
3	Drainage; concrete section 1mx1m	50	m	500	25,000
4	Base/Subbsae	100	m3	100	10,000
5	Wearing course; 50mm asphalt surfacing	350	m2	110	38,500
6	Grassing/Seeding - Replanting of slopes	2,000	m2	10	20,000
					253,500

- iv) Hydraulic structure at chainage 19.2km – Two (2) streams flow into existing structures. The capacity of that structure appears inadequate for the levels of discharge and replacement advised.

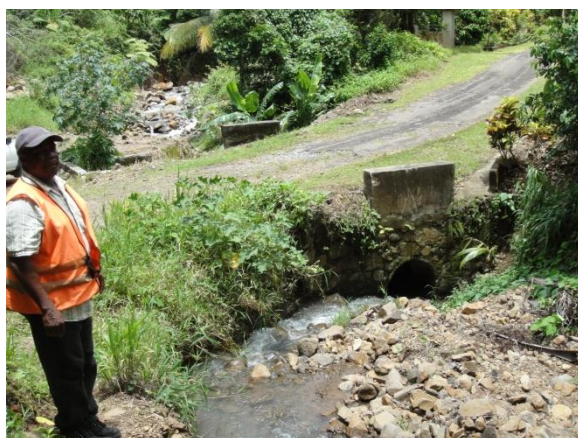


Figure 15 – Culvert structure with compromised

Proposal – Replace existing culvert structure with new. Overall cost for new structures is provided in Figure 20.

- v) Bridge at chainage 20km – Existing single lane 12.5m by 4m bridge at San Sauveur has severely scoured/undermined. Replacement of structure recommended.



Figure 16 – Small bridge at San Sauveur near shoreline

Proposal – Existing bridge is of an aged construction and replacement is recommended. In addition, the structure is near an aggressive marine environment. Overall cost for new structures is approximately EC\$0.8M (US\$0.3M).

- vi) Unstable slopes at chainage 21km – San Sauveur slopes. Stabilisation measures recommended.



Figure 17 – Unstable slopes at San Sauveur

Proposal – Embankment stabilization, drainage, road and safety measures.
Cost – EC\$1.9M (US\$0.7M)

Chainage 21.0km - Typical landslide mitigation measures (San Sauveur)					
Item No.	Description	Quantity	Unit	Rate (EC\$)	Amount (EC\$)
1	Clearing and grubbing of site	1	ha	20,000	20,000
2	Excavation for stabilisation of embankment, incl disposal	20,000	m3	50	1,000,000
3	Drainage; concrete section 1mx1m	600	m	500	300,000
4	Base/Subbsae	1,200	m3	100	120,000
5	Wearing course; 50mm asphalt surfacing	3,900	m2	110	429,000
6	Grassing/Seeding - Replanting of slopes	2,500	m2	10	25,000
					1,894,000

3.4 Link 31301 – Castle Bruce to Hatton Garden (through the Carib Territory)

Like the rest of region, that 20.5km section of road has suffered from many landslides. However, the scale of such occurrences are less severe but must be considered for investigation.

In addition, there are at least two (2) areas where slow creeping landslips have been observed. At one location, the main road has been traversed by the slip and in another, a school building is at risk.

There are strong suspicions that such occurrences are related to subsurface water. In that regard, there is strong recommendation for geotechnical investigation across the entire region. Further, preliminary assessments have shown that many of the existing culverts/hydraulic structures (100 nos. crossing structures) are showing signs of a structural failure. As such their integrity and discharge capacity are compromised.

As a result, there is the need to carry out detailed assessments on all the structures, with a view to complete replacement, if necessary.

The existing road has also deteriorated rapidly and considerably due to increased traffic from Pond Casse to Marigot, as a result of heavy construction works on the Airport Road Upgrade Project (Seen in figure 3 as the AFD Pond Casse – Marigot

Lot2). Some rehabilitation is recommended in order to maintain satisfactory performance of that road.

Further, at the end of that road link, chainage 20km, is the Hatton Garden Bridge. The steel girders of that composite structure (2 spans of 12m) are severely corroded due to exposure to the marine climate.



Figure 18 – Hatton Garden Bridge at chainage 20km



Figure 19 – Corrosion to steel girders of bridge

Proposal – Rehabilitation and widening of existing bridge is recommended. Overall cost for rehabilitated structure is approximately EC\$2.0M (US\$0.74M).

3.6 Proposal for the replacement of culverts

The following figures (20 – 22) summarize the replacement costs for culvert structures in the affected 43km region.

Link Nº	Link Name	Length (km)	Av. Width (m)	Details			Replacement cost per structure (EC\$)	Total cost (EC\$)
				Type	Diameter/Height (m)	Nº		
31104	Pond Casse - Bois Diable	4.5	5.6	Concrete Pipe	0.6	1	15,000	15,000
				Concrete Pipe	0.9	32	20,640	660,480
				Concrete Pipe	1.2	15	27,338	410,070
				Concrete Box	3.0	2	250,000	500,000
				Concrete Box	4.0	1	400,000	400,000
Total number of culvert structures in link						51	Total	1,985,550

Figure 20 – Link 31104 Pond Casse to Bois Diable

Link Nº	Link Name	Length (km)	Av. Width (m)	Details			Replacement cost per structure (EC\$)	Total cost (EC\$)
				Type	Diameter/Height (m)	Nº		
31201	Bois Diable - Castle Bruce	9.5	5.3	Concrete Pipe	0.6	22	15,000	330,000
				Concrete Pipe	0.9	34	20,640	701,760
				Concrete Pipe	1.2	14	27,338	382,732
				Concrete Box	2.4	1	150,000	150,000
				Concrete Box	3.0	2	250,000	500,000
				Concrete Box	5.0	2	500,000	1,000,000
Total number of culvert structures in link						75	Total	3,064,492

Figure 21 – Link 31201 Bois Diable - Castle Bruce

Link Nº	Link Name	Length (km)	Av. Width (m)	Details			Replacement cost per structure (EC\$)	Total cost (EC\$)
				Type	Diameter/Height (m)	Nº		
31202	Castle Bruce - Petite Soufriere	8.8	4.5	Concrete Pipe	0.6	15	15,000	225,000
				Concrete Pipe	0.9	20	20,640	412,800
				Concrete Pipe	1.2	5	27,338	136,690
				Concrete Box	4.0	2	400,000	800,000
Total number of culvert structures in link						42	Total	1,574,490

Figure 22 – Link 31202 Castle Bruce - Petite Soufriere

Link Nº	Link Name	Length (km)	Av. Width (m)	Details			Replacement cost per structure (EC\$)	Total cost (EC\$)
				Type	Diameter/Height (m)	Nº		
31301	Castle Bruce - Hatton Garden (through the Carib Territory)	20.5	5.1	Concrete Pipe	0.4	3	15,000	45,000
				Concrete Pipe	0.6	38	15,000	570,000
				Concrete Pipe	0.9	25	20,640	516,000
				Concrete Box	1.2	20	27,338	546,760
				Metal (Armco) Pipe	1.2	12	27,338	328,056
				Metal (Armco) Pipe	1.8	1	40,000	40,000
				Concrete Box	2.0	1	45,000	45,000
Total number of culvert structures in link						100	Total	2,090,816

Figure 23 – Link 31301 Castle Bruce - Hatton Garden (through the Carib Territory)

From the above, the total replacement cost of the culvert structures (figures 21 to 23) is estimated at EC\$8.7M (US\$3.2M).

3.7 Summary of other infrastructure costs

The following figure 24 summarizes the cost of infrastructure for consideration.

Considered are:

- ✓ Stabilisation of slopes affected by landslides
- ✓ Upgrade of bridges

Item No.	Description	Cost (EC\$M)
<i>Link 31104 – Pond Casse Roundabout to Bois Diable</i>		
1	Hydraulic/culvert structure at chainage 1.6km	1,215,595
2	Landslide at chainage 5.2km	245,750
3	Bridge at chainage 8.2km	1,500,000
4	Bridge at chainage 8.2km at Castle Bruce	2,500,000
Total in link		5,461,345
<i>Link 31201 – Bois Diable to Castle Bruce</i>		
1	Landslide at chainage 5.2km	245,750
2	Bridge at chainage 8.2km	1,500,000
3	Bridge at chainage 8.2km at Castle Bruce	2,500,000
Total in link		4,245,750
<i>Link 31202 – Castle Bruce to Petite Soufriere</i>		
1	Causeway at Castle Bruce	1,000,000
2	Bridge at chainage 14.5km	1,000,000
3	Landslide at chainage 16.5km - Dipax	253,500
4	Bridge at chainage 20km - San Sauveur	800,000
5	Unstable slopes at chainage 21km – San Sauveur	1,894,000
Total in link		4,947,500
<i>Link 31301 – Castle Bruce - Hatton Garden (through the Carib Territory)</i>		
1	Bridge at chainage 20km	2,000,000
Total in link		2,000,000
Total infrastructure cost		16,654,595

Figure 24 – Summary of infrastructure upgrade costs

3.9 Roads and safety

Worthy for consideration are the sections of roads listed in the following figures. Considerable damage was done by the action of overflowing rivers and streams.

Item No.	Description	Quantity	Unit	Rate (EC\$)	Amount (EC\$)
<i>Link 31202 – Castle Bruce to Petite Soufriere</i>					
1	Drainage; small rectangular concrete section	5,000	m	300	1,500,000
2	Base/Subbsae	9,000	m3	100	900,000
3	Wearing course; 50mm asphalt surfacing	30,000	m2	110	3,300,000
4	Guard rails - Provision of safety measures	5,000	m	300	1,500,000
					7,200,000

Figure 25 – Proposal for the upgrade of 5km of affected road

Item No.	Description	Quantity	Unit	Rate (EC\$)	Amount (EC\$)
<i>Link 31301 – Castle Bruce - Hatton Garden (through the Carib Territory)</i>					
1	Drainage; small rectangular concrete section	5,000	m	300	1,500,000
2	Base/Subbsae	20,000	m3	100	2,000,000
3	Wearing course; 50mm asphalt surfacing	75,000	m2	110	8,250,000
4	Guard rails - Provision of safety measures	10,000	m	300	3,000,000
					14,750,000

Figure 26 – Proposal for the upgrade of 15km of affected road

From figures 22 and 23, at least EC\$21.9M is required for the noted upgrade.

3.10 General summary of costs

As a general summary, a sum of at least EC\$47.3M (US\$17.5) is required to address the issues related to infrastructure of deficient standard, with a view to improving the integrity and long term performance.

Item No.	Description	Cost (EC\$M)
1	Rehabilitation of culverts	8.7
2	Other infrastructure; Landslide stabilisation/bridges	16.7
3	Roads and safety	22.0
	Total	47.3

Figure 27 – Total cost of rehabilitation of infrastructure

APPENDIX 1

SUMMARY OF CULVERT INVENTORY IN AFFECTED REGION

Link N°	Link Name	Length (km)	Av. Width (m)	Details		
				Type	Diameter/Height (m)	N°
31104	Pond Casse - Bois Diable	4.5	5.6	Concrete Pipe	0.6	1
				Concrete Pipe	0.9	32
				Concrete Pipe	1.2	15
				Concrete Box	3.0	2
				Concrete Box	4.0	1
Total number of culvert structures in link						51

Link №	Link Name	Length (km)	Av. Width (m)	Details		
				Type	Diameter/Height (m)	№
31201	Bois Diable - Castle Bruce	9.5	5.3	Concrete Pipe	0.6	22
				Concrete Pipe	0.9	34
				Concrete Pipe	1.2	14
				Concrete Box	2.4	1
				Concrete Box	3.0	2
				Concrete Box	5.0	2
Total number of culvert structures in link						75

Link N°	Link Name	Length (km)	Av. Width (m)	Details		
				Type	Diameter/Height (m)	N°
31202	Castle Bruce - Petite Soufriere	8.8	4.5	Concrete Pipe	0.6	15
				Concrete Pipe	0.9	20
				Concrete Pipe	1.2	5
				Concrete Box	4.0	2
Total number of culvert structures in link						42

Link №	Link Name	Length (km)	Av. Width (m)	Details		
				Type	Diameter/Height (m)	№
31301	Castle Bruce - Hatton Garden (through the Carib Territory)	20.5	5.1	Concrete Pipe	0.4	3
				Concrete Pipe	0.6	38
				Concrete Pipe	0.9	25
				Concrete Box	1.2	20
				Metal (Armco) Pipe	1.2	12
				Metal (Armco) Pipe	1.8	1
				Concrete Box	2.0	1
Total number of culvert structures in link						100

Total number of culverts in region (43.3km) = 268