NATIONAL ROAD OPERATING AND CONSTRUCTION COMPANY

ATTACHMENTS ADDRESSING THE COMMENTS FROM THE NATIONAL ENVIRONMENT PLANNING AGENCY REGARDING THE CAYMANS TO LINSTEAD HIGHWAY DEVELOPMENT PROJECT

JANUARY 31 2013

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Attachment 1 NEPA Letter December x 2012

Our Ref: 2012/EM/12/092

2012 December 11

The Chief Executive Officer
National Environment & Planning Agency
10 Caledonia Avenue
Kingston 5

Attention: Miss Frances Blair

RE: **Application for permit under Section 9 of the Natural Resources Conservation Authority (NRCA) Act, 1991 in respect Highway Construction (Spanish Town to Linstead) and Moneague to Ocho Rios**

We herewith submit for your information (only) a copy of the structures survey for the sections of the highway captioned above. These documents are used by primarily by NROCC in the acquisition of land for the right-of-way for the Highway and **NOT** for circulation to the general public.

Should you have any query regarding the reports feel free to contact me.

Yours truly

Carol Mackey
Environmental Manager

Copy: Mr. Ivan Anderson, Managing Director, NROCC

ttachment 2NEPA Letter December 17, 2012

Ref: 2012/rb/2A/12/05

December 17, 2012

The Chief Executive Officer
National Environmental and Planning Agency
10 & 11 Caledonia Ave
Kingston 5

Dear Sir,

RE: NORTH SOUTH HIGHWAY – SECTION 1 – CAYMANAS AREA TO LIENSTEAD (CAYMANAS STATE)

In response to some questions raised at the meeting held on November 10th, 2012 regarding the coordination of the proposed highways with UDC and the appropriate drainage management at the Caymanas area, NROCC has been and will continue working with UDC very closely.

Attached you will find a Master Development Plan of the Caymanas Estate that was shared with NROCC by UDC as confidential information for planning purposes. The proposed highway shall/will provide and accommodate drainage structures (culverts) along strategic locations under the highway at the Caymanas area as shown in the attached exhibit to minimize any disruption and impact to the existing drainage conditions. These drainage structures will be sized to convey the 100-yr storm peak flows as stated in the Impact Environmental Assessment report.

Yours sincerely,

Raul Brito, P.E.
Grantor's Technical Representative

Attachments

cc. Ivan Anderson – NROCC
Errol Morley NROCC

NROCC
NATIONAL ROAD OPERATING & CONSTRUCTING COMPANY LTD

Development Bank of Jamaica Building, 4th Floor, 11A-15 Oxford Road, Kingston 5, Jamaica, W.I.
Tel: (876) 929 1561, (876) 926 [illegible] 4800 Fax: (876) 929 9281. Email: info@h2kjamaica.com

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Attachment 3 Generalised Guidelines for the Treatment of Sinkholes

General Subject: Treatment of Sinkholes

Design Considerations.

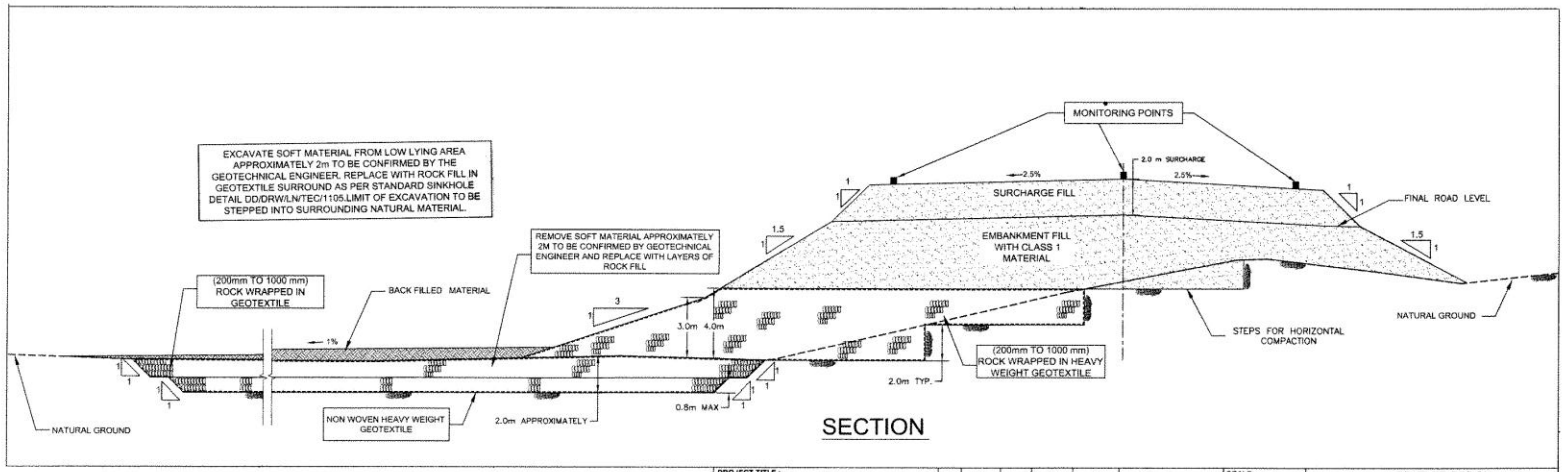
The following design considerations will be followed during the design and construction of the North South Highway in areas where sinkholes are present:

- Avoidance. Determine if there are any feasible alternatives that would avoid construction in the area of the sinkhole. Where the sinkhole is the natural outfall for the stormwater runoff from the roadway area, determine if the stormwater runoff can be diverted away from the sinkhole to an adequate surface water channel.
- Minimization of Impacts from Direct Discharges. If avoidance is not possible, drainage outfalls from the highway should include natural buffer zones between the outlet of the highway drainage structure and the sinkhole in order to provide for a natural filtering process and to improve runoff water quality by filtration and absorption of contaminants.
  If stormwater runoff from the highway project is directed to the sinkhole, the drainage design for the project should reflect how the sinkhole is anticipated to function after completion of the construction activities. The project should be designed to avoid any flood damages resulting from potential blockage and ponding in the sinkhole area.

General Treatment of Sinkholes.

The mitigation and treatment of any sinkhole affected by the construction of the highway will be in general terms as follows (see Figures 1 and 2 attached):

1. Excavation of soft material to a depth specified by the geotechnical engineer. Enlarge the sinkhole, as necessary, to allow for installation of the filter material.
2. Placement of non-woven geotextile at the bottom of excavated material and placement of boulders (100/300 mm rip-rap).
3. Specific detail design information will be developed during the design of the project.


EXCAVATE SOFT MATERIAL FROM LOW LYING AREA APPROXIMATELY 2m TO BE CONFIRMED BY THE GEOTECHNICAL ENGINEER. REPLACE WITH ROCK FILL IN GEOTEXTILE SURROUND AS PER STANDARD SINKHOLE DETAIL DD/DRW/LN/TEC/1105.LIMIT OF EXCAVATION TO BE STEPPED INTO SURROUNDING NATURAL MATERIAL.
REMOVE SOFT MATERIAL APPROXIMATELY 2M TO BE CONFIRMED BY GEOTECHNICAL ENGINEER AND REPLACE WITH LAYERS OF ROCK FILL
MONITORING POINTS
2.0 m SURCHARGE
2.5%
2.5%
SURCHARGE FILL
FINAL ROAD LEVEL
EMBANKMENT FILL WITH CLASS 1 MATERIAL
(200mm TO 1000 mm) ROCK WRAPPED IN GEOTEXTILE
BACK FILLED MATERIAL
1%
3.0m
4.0m
STEPS FOR HORIZONTAL COMPACTION
NATURAL GROUND
(200mm TO 1000 mm) ROCK WRAPPED IN HEAVY WEIGHT GEOTEXTILE
2.0m TYP.
NATURAL GROUND
NON WOVEN HEAVY WEIGHT GEOTEXTILE
2.0m APPROXIMATELY
0.8m MAX
SECTION
PROJECT TITLE :
HIGHWAY 2000
HIGHWAY 2000
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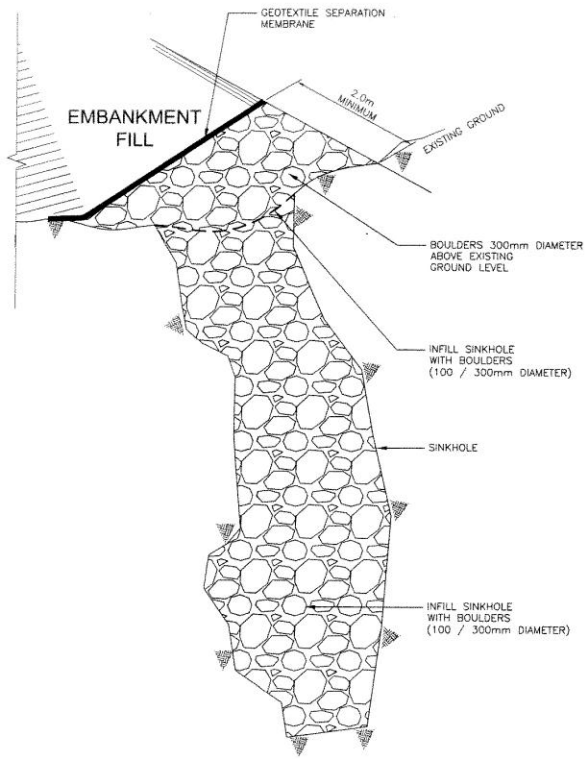
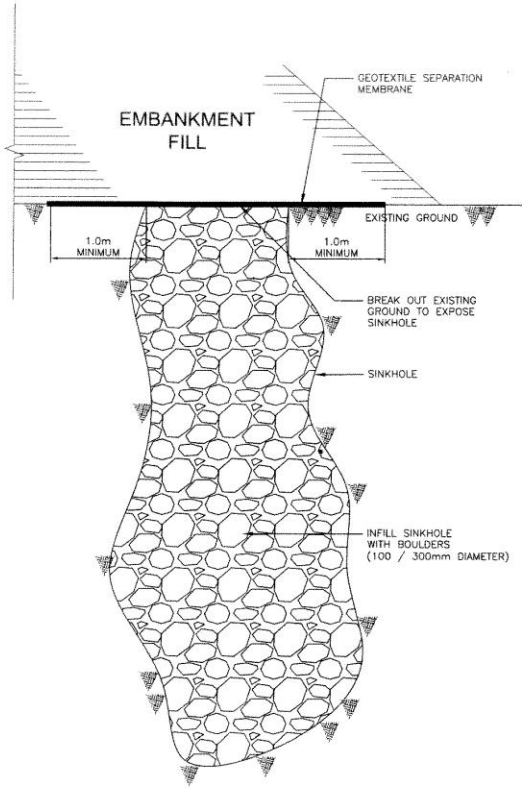


EXISTING GROUND SLOPES TOWARDS SINK HOLE



EXISTING GROUND FLAT

PROJECT TITLE :
HIGHWAY 2000

HIGHWAY 2000

SCALE:-
N.T.S.

SHEET SIZE:-

DETAIL DESIGN

STANDARD DETAILS
TREATMENT OF SINKHOLES

Attachment 4 Treatment of Sinkholes

General Subject: Treatment of Sinkholes

Design Considerations.

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2. Placement of non-woven geotextile at the bottom of excavated material and placement of boulders (100/300 mm rip-rap).
3. Specific detail design information will be developed during the design of the project.

Attachment 5 Additional Faunal Surveys

BOG WALK HILLSIDE FAUNAL SURVEY

SUMMARY

Twenty eight species of bird were identified in the woodland and seven from the agricultural and residential areas. Twenty three species of insects were recorded from the woodland and thirty eight from the agricultural and residential areas. There were also three species of Amphibians, eight reptiles and seventeen land snails were recorded from the area. Since these populations of all species listed are widespread no special protective measures are needed at this area.

RESULT OF THE FAUNAL SURVEY

Avifaunal Composition

Woodland

Twenty eight species of bird were identified in the woodland. The bird species composition was typical of a dry limestone forest in Jamaica. This included three Columbids (Common Ground Dove, Caribbean Dove and White-crowned Pigeon); Olive throated Parakeet, Jamaica Oriole, Jamaica Vireo and Warblers.
Only eleven of the islands twenty nine endemic birds were identified. Only five of the forest dependent endemic birds were seen. Although the survey was carried out in the month of February, where some of the migrant warblers were expected to be present, only a few were observed during the survey.

Table 1. Birds observed in forested areas

Proper Name	**Code Used**	***Scientific Name***	Status	**DAF OR**
American Redstart	AMRE	*Setophaga ruticilla*	Migrant	R
Antillean Palm Swift	APSW	*Tachornis phoenicobia*	Resident	R
Bananaquit	BANA	*Coereba flaveola*	Resident	A
Black-Whiskered Vireo	BWVI	*Vireo altiloquus*	(Summer) Migrant	R
Caribbean Dove	CADO	*Leptotila jamaicensis*	Resident	R
Common Ground Dove	COGD	*Columbina passerina*	Resident	O
Greater Antillean Bullfinch	GABU	*Loxigilla violacea*	Resident	R
Greater Antillean Grackle	GAGR	*Quiscalus niger*	Resident	O
Jamaica Tody	**JATO**	***Todus todus***	**Endemic**	**R**
Jamaican Elania	**JAEL**	***Myiopagis cotta***	**Endemic**	**R**
Jamaican Euphonia	**JAEU**	***Euphonia Jamaica***	**Endemic**	**F**
Jamaican Lizard-cuckoo	**JALC**	***Saurothera vetula***	**Endemic**	**R**

Proper Name	**Code Used**	***Scientific Name***	Status	**DAFOR**
Jamaican Oriole	**JAOR**	***Icterus leucopteryx***	**Endemic**	**O**
Jamaican Pewee	**JAPE**	***Contopus pallidus***	**Endemic**	**R**
Jamaican Vireo	**JAVI**	***Vireo modestus***	**Endemic**	**O**
Jamaican Woodpecker	**JAWO**	***Melanerpes radiolatus***	**Endemic**	**O**
Loggerhead Kingbird	LOKI	*Tyrannus caudifasciatus*	Resident	F
Northern Mockingbird	NOMO	*Mimus polyglottos*	Resident	F
Olive-throated Parakeet	OTPA	*Aratinga nana*	Endemic sub-species	O
Red-billed Streamertail	**RBST**	***Trochilus polytmus***	**Endemic**	**O**
Sad Flycatcher	**SAFL**	***Myiarchus barbirostris***	**Endemic**	**R**
Turkey Vulture	TUVU	*Carthartes aura*	Resident	F
Vervain Hummingbird	VEHU	*Mellisuga minima*	Resident	O
White Crowned Pigeon	WCPI	*Columba leucocephala*	Resident	F
White-chinned Thrush	**WCTH**	***Turdus aurantius***	**Endemic**	**R**
White-Winged Dove	WWDO	*Zenaida asiatica*	Resident	O
Yellow-faced Grassquit	YEFC	*Tiaris olivacea*	Resident	F
Zenaida Dove	ZEDO	*Zenaida aurita*	Resident	R

Canfields

The bird diversity and numbers within the cane fields were very low. This is as a result of the monoculture nature of the cane fields, where there are few or no other trees present. A few ground feeding birds such as the Common Ground Dove and Zenaida Dove were seen foraging on the cane roads. The yellow face grassquits were seen in the cane fields and the grasses along the road. There are several wetlands birds that are associated with water logged cane fields. However the fields were not waterlogged.

Table 2. Birds observed in the cane field

Proper Name	**Code Used**	***Scientific Name***	**Status**	**DAFOR**
Cattle Egret	CAEG	*Bubulcus ibis*	Resident	F
Great Egret	GREG	*Casmerodius albus*	Resident / Migrant	R
Common Ground Dove	COGD	*Columbina passerina*	Resident	O
Northern Mockingbird	NOMO	*Mimus polyglottos*	Resident	O
Turkey Vulture	TUVU	*Carthartes aura*	Resident	O
Yellow-faced Grassquit	YEFC	*Tiaris olivacea*	Resident	0
Zenaida Dove	ZEDO	*Zenaida aurita*	Resident	R

Amphibians and Reptiles

The areas searched include several micro-habitats which include small bromeliads, log piles, stone piles, shrubs, trees, debris piles and dry river beds. Charcoal burners and farmers were interviewed and this gave insight to species that are rarely seen and to the areas in which they can be found.

Table 3. Amphibians found in the regions surrounding the proposed highway

Species	IUCN Red List Status	DAFOR scale	Habitat type
Rhinella marina	Least Concern	Occasional	Terrestrial
Eleutherodactylus gossei gossei	Least Concern	Occasional	Terrestrial
Eleutherodactylus johnstonei	Least Concern	Occasional	Terrestrial

Table 4. Reptiles found in the regions surrounding the propose highway

Species	IUCN Red List Status	DAFOR scale	Habitat type
Celestus crusculus cundalli	Not Assessed	Occasional	Terrestrial
Typhlops jamaicensis	Not Assessed	Occasional	Terrestrial
Hemidactylus mabouia	Not Assessed	Occasional	Arboreal
Anolis garmani	Not Assessed	Occasional	Arboreal
Anolis grahami grahami	Not Assessed	Abundant	Arboreal
Anolis lineatopus ssp.	Not Assessed	Dominant	Arboreal
Anolis opalinus	Not Assessed	Frequent	Arboreal
Anolis sagrei	Not Assessed	Occasional	Terrestrial

Amphibians

Three of Jamaica's 26 Amphibians were recorded.

The amphibians are mostly terrestrial; the terrestrial frogs are found in log piles, leaf litter, stones piles and under old termite mounds. The arboreal frogs which are known mostly from arboreal bromeliads were distinctly missing.

Reptiles

Eight species of Jamaica's 55 reptiles were recorded, none of which are presently protected species. Their distributions are widespread although a number of localized morphs have been recorded. Since these populations are generally widespread no special protective measures are needed at this area.

Terrestrial invertebrate fauna

The invertebrate fauna varied with habitat type. Twenty three species of insects, from 8 orders were recorded from the forest, and thirty eight species from 7orders from the residential and agricultural areas (Tables 3 & 4). Details of the fauna are given in Appendices 1& 2.

The land snails were also very diverse; 17 species were recorded from both the forests and the developed areas (see Appendix 1). No land snails were recorded in the cane fields. The level of endemism was 88% in these developed areas; these levels of endemism are not unusual for Jamaican habitats. The absence of land snails in the cane fields is a result of the regular intense disturbance of the habitat due to agricultural practices.

Table 5. Summary of insect fauna forested area (Appendix 1)

ORDER	NO. FAMILIES	NO. SPECIES
Lepidoptera (butterflies & moths)	9	15
Hemiptera (true bugs)	1	1
Homoptera (plant bugs)	5	11
Diptera (flies)	2	2
Isoptera (termites)	1	1
Coleoptera (beetles)	2	2
Hymenoptera (ants, wasps & bees)	1	1
Odonata	1	1

Table 6. Summary of insect fauna Agricultural and Residential areas (Appendix 1)

ORDER	NO. FAMILIES	NO. SPECIES
Lepidoptera (butterflies & moths)	7	18
Hemiptera (true bugs)	3	5
Homoptera (plant bugs)	2	4
Diptera (flies)	3	3
Isoptera (termites)	1	1
Coleoptera (beetles)	5	5
Hymenoptera (ants, wasps & bees)	2	2

An interesting find was a colony of the Onychophoran, *Peripatus*. This colony was discovered beneath a pile of rubble at the edge of a small banana plot. Onychophorans are of tremendous interest biologically, and they are generally rare. The group is widespread on Jamaica, occurring in a wide variety of habitats and therefore not recorded as in need of special protection.

APPENDIX 1

INVERTEBRATE FAUNA OF THE FORESTED HILLSIDE

ORDER & FAMILY	GENUS & SPECIES	COMMON NAME	DAFOR RATING	COMMENTS
LEPIDOPTERA Heliconiidae	*Heliconius charitonius* simulator	The Jamaican Zebra	F	Endemic subspecies
	Dryas iulia delila	Julia	O	Endemic subspecies; common on the island
	Dione (Agraulis) vanilla insularis	The Tropical Silverspot		Occurs in Cuba, Jamaica and Bahamas
Pieridae	*Eurema nise nise*	Cramer's Little Sulphur, Jamaican Sulphur	O	Endemic subspecies, Central America and Cuba
	Phoebis sennae sennae	The Cloudless Sulphur	O	West Indian
	Appias drusilla jacksoni	The Jamaican Albatross	O	Endemic subspecies, occurs in dry areas
Nymphalidae	*Junonia (Precis) evarete zonalis*	The West Indian Buckeye	O	Widespread subspecies, American mainland, Caribbean
	Adelpha abyla		R	
	Colobura dirce		R	
	Histois odius	Orion	R	
Apaturidae	*Anaea troglodyta*		R	
Satyridae	*Calisto zangis*	The Jamaican Satyr	F	Endemic
Hesperiidae	*Chioides catillus churchi*		R	1 specimen
Papilionidae	*Papilio andraemon*	Citrus swallowtail	R	
HEMIPTERA Lygaeidae	*Oncopeltus sandara*		A	Locally common;
ODONATA	Little blue damselfly		R	
DIPTERA Sarcophagidae	*Hystricocnema plinthopyga*		R	
Muscidae	1 sp.		O	
HYMENOPTERA Vespidae	*Polistes crinitus*	Paper wasp	O	
COLEOPTERA Coccinellidae	*Brachyacantha bistripustula*		R	
Carabidae			R	
Class: DIPLOPODA				
MILLIPEDES	Rhino....			Widespread
PHYLUM: ONYCOPHORA	*Peripatus* sp.			Rare, wide distribution

LAND SNAILS RECORDED FROM FORESTED AREAS

PHYLUM: MOLLUSCA
CLASS : GASTROPODA

FAMILY	**GENUS & SPECIES**	**COMMON NAME**	**DAFOR RATING**	**COMMENTS**
Pleurodontidae	*Pleurodonte aspera*		D	Endemic
	Dentellaria valida		A	Endemic
Camenidae	*Thelidomus aspera*		O	Endemic
	Zachrysia provisoria		F	Introduced by humans
Neocyclotidae	*Cyclochittya chttyi*		O	Endemic
Helicinia	*Lucidella aureola*		O	Endemic
	Helicinia neritella		R	Endemic
Sagdidae	*Sagda spei*		O	Endemic
Urocoptidae	*Urocoptis brevis*		R	Endemic
	Urocoptis aspersa		R	Endemic
	Geoscala seminuda		R	Endemic
Annularidae	*Annularia mitis*		R	Endemic
	Parachrondia sp.			
Orthalicidae	*Orthalicus undatus jamaicensis*		R	Endemic subspecies
Bulimulidae	*Drymaeus immaculatus*		R	Endemic
Subulinidae	*Lamellaxis sp.*			
Xanthonycidae	*Dialeuca nemoraloides*		R	Endemic

APPENDIX 2

INVERTEBRATE FAUNA OF THE AGRICULTURAL AND RESIDENTIAL AREAS

Phylum: Arthropoda Class: Insecta

Order & Family	Genus & Species	Common Name	DAFOR Rating	Comments
LEPIDOPTERA Heliconiidae	*Heliconius charitonius simulator*	The Jamaican Zebra	F	Endemic subspecies
	Dione (Agraulis) vanilla insularis	The Tropical Silverspot	O	Occurs in Cuba, Jamaica and Bahamas
	Dryas iulia delia	Julia	O	
Pieridae	*Eurema nise nise*	Cramer's little sulphur	F	
	Eurema daira palmira	Poey's Barred Sulphur	F	
	Phoebis sennae sennae	The Cloudless Sulphur	O	West Indian
	Ascia monuste eubotea	Antillean great white, Cabbage White Butterfly	O	Non-endemic
Hesperiidae	*Wallengrenia otho vesuria*		O	
	Pyrgus oileus	Syrichtus	A	
Nymphalidae	*Mestra dorcas*	Jamaican Mestra, Dorcas	O	Endemic subspecies
	Phyciodes frisia frisia	Cuban crescent Spot	D	
	Euptoieta hegesia	Mexican fritillary	R	
	Anartia jatrophae	The Jamaican white Peacock	O	Endemic subspecies
	Precis evarete zonalis		A	
Satyridae	*Calisto zangis*	The Jamaican Satyr	O	
Papilionidae	*Papilio andraemon*		O	
	Papilio demoleus		A	
Danaidae	*Danaus gilippus jamaicensis*	The Jamaica Queen	R	Endemic subspecies

Phylum: Arthropoda Class: Insecta

Order & Family	**Genus & Species**	**Common Name**	**DAFOR Rating**	**Comments**
HEMIPTERA Coreidae	*Zicca taeniola*		F	
	Niesthrea pictipes		F	
Pyrrhocoridae	*Dysdercus mimulus*		F	
Pentatomidae	*Mermidea pictiventris*		R	
Anthocoridae	1 sp.	Minute Pirate Bug	F	
HOMOPTERA Cicadellidae	*Tylozygus fasciatus*		A	
	Hortensia similis		D	
Cixiidae	1 sp. Blk/brwn		O	
Cicadidae	Unknown sp.			
DIPTERA Syrphidae	*Palpada vinetorum*		F	
Otitidae	Chaetopsis sp.		A	
Drosophlidae	Drosophila sp.		F	
ISOPTERA	*Insicitermes nigriceps*			
COLEOPTERA Chrysomelidae	*Leptinotarsa undecemlineata*	False Potato Beetle	O	
Curculionidae	*Exophthalmus vittatus*		O	
Coccinellidae	*Scymnus roseicollis*		R	
	Brachyacantha bistripustulata		O	
Chrysomelidae	*Disonycha leptolineata*		R	
Bruchidae	1 sp.	Pea weevil	F	
HYMENOPTERA Chalcididae	*Brachymeria novata*		O	
	Spilochalsis sp.		O	
Apidae	*Apis mellifera*		A	

Land snails recorded from residential areas

Phylum : Mollusca Class: Gastropoda

FAMILY	**GENUS & SPECIES**	**COMMON NAME**	**DAFOR RATING**	**COMMENTS**
Camenidae	*Thelidomus*		A	Endemic
	Zachrysia provisoria		A	Introduced by humans
Pleurodontidae	*Pleurodonte 1 tooth*		D	Endemic
	Pleurodonte 2 teeth		R	Endemic
	Dentellaria valida		A	Endemic
Neocyclotidae	*Cyclochittya chittyi*		F	endemic
Helicinidae	*Lucidella*		A	endemic
	Lucidella aureola		R	endemic
	Eutrochatella pulchella		F	endemic
Sagdidae	*Sagda spei*		O	endemic
Urocoptidae	*Urocptis aspera*		R	endemic
Annularidae	*Annularia fimbricata*		R	endemic
Neocyclotidae	*Cyclochittya chittyi*		A	endemic
Camaenidae	*Zachrysia provisoria*		F	Introduced by humans
	Dentellaria valida		R	endemic
	Dentellaria invalida		R	endemic
Helicinidae	*Helicinia neritella*		R	endemic

Fig 1. Top: The blind snake *Thpylops jamaicensis*
Bottom: The common skink *Celestus crusculus*

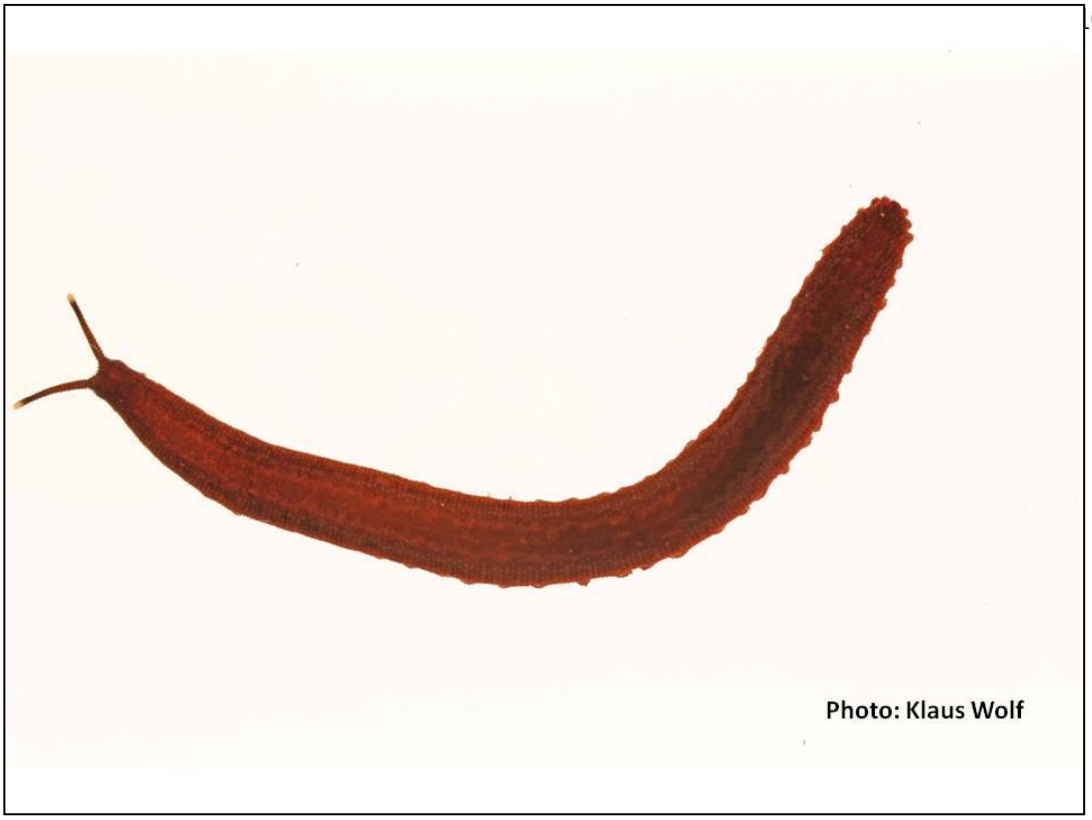


Fig 2. Top: The Onychophoran *Peripatus* sp.
Bottom: Colony of *Peripatus*

Fig 3. *Peripatus* were found in under a rubble heap on a small farm.

CAYAMANAS TO BOG WALK ALIGNMENT-FAUNAL SURVEY

SUMMARY

The Avifauna and Invertebrate were studied at five sites, covering all major habitat types. The Herpetofauna was also studied at 5 sites but an additional site was examined. Thirty- five species of birds were identified in the Gully forest while 41 were observed in the Cayamanas Hills; the other sites had much lower diversity. A number of endemic species were forest dependent, however they do not require primary forests and do thrive even is secondary forests.

The only amphibian observed was *Rhinella marina.* Ten species of Reptiles, belonging to 5 genera were recorded. These populations appear to be extensions of populations recorded for the adjoining Red Hills area. The Arthropod fauna is also improvised, with a maximum of 13 land snails and 10 arthropod species recorded for any area.

Since none of the species recorded are known to be endangered or need any special conservation measures, standard good environmental practices should be adequate to conserve these species.

STUDY SITES

The area is dominated by dry limestone forest. Additionally there were sections which may be described as Gully Forests; as the name suggests these occurred in narrow, sometimes deep valleys, where the moisture level was distinctly higher than the open areas. The forest in the area has been the subject of significant amount of human activity and there were significant cane plantations. The study sites that were used (Figure 1).were representative of the major habitat types.

The habitat types were placed in three categories:

1. Gully forest
    a. Transect 1
2. Dry limestone forest
    a. Transect 2 – secondary forest
    b. Transect 3 (below St Jago Heights) – disturbed forest
    c. Transect 4 (Caymanas Hills) – disturbed forest
3. Canefields
    a. Transect 5 - Caymanas

Figure 1: Location of the transects used in the avian study

Methods

Avifauna

The line transect method was selected for the avifauna assessment since there were a number of accessible foot paths, trails and roads in the vegetation. The line transect method entailed walking slowly for a given distance or time period along selected routes, noting all the birds seen or heard in the area (Wunderle 1994).

Herpetofauna

The macro habitats were first identified and pictures taken. The micro-habitats were then identified and pictures taken when necessary. Active specimen collection and identification were then conducted and pictures were taken where necessary; specimens were then generally released.

Invertebrate fauna

At each sampling site transects were established. All butterflies and spiders etc. observed within a belt of ± 5 m along the transect line were recorded. Litter and rotting logs were searched along the transect.. A 40 cm sweep net with cotton bag was swept from side through the shrub and herb layers while the researcher walked along the transect. The species were later identified and counted. Sampling for land snails was done by a combination of hand search of soil surface and trees. All snail specimens were identified using the features of their shells.

Identification

Some of the species detected were identified in the field; in other cases specimens were collected for verification or identification in the laboratory. Some material were readily identified; in other cases identification was done using available literature, and by comparison with specimens at the Entomology museum at the Department of Life Sciences, University of the West Indies, or the Museum of the Natural History Division of the Institute of Jamaica. It was not always possible to identify some material to the level of species. In such cases classification was done to the nearest taxon.

Results

THE AVIFAUNA

The data from the three major habitat types, Gully forest, Dry limestone forest/Woodland, and cane fields are presented separately.

Birds of the Gully forest

Thirty five species of birds were identified during the assessment. The species diversity in the gullies was higher than the adjacent dry limestone forest. The gully forest is located in an old river bed or gully which is usually between the limestone hills. The vegetation in the gully consists of plants typical of the dry limestone forest along with several introduced species. The gullies have higher moisture content than the open forest as a consequence; the trees here are taller and have a larger DBH than those in the open forest. In addition, several fruit trees which are not seen in the dry limestone forest are usually present in the gully. This provides habitat for dry limestone bird species and other species which would be seen in moist forests. For example birds such as the Greater Antillean Pewee, Greater Antillean Elaenia, Yellow-shouldered Grass quit, which are usually found at higher altitudes and cooler areas were seen in the gully forest.

Thirteen of the 35 bird species identified are endemic to Jamaica. Only six of the endemic species are forest dependent. Only one migrant warbler was observed during the assessment, although the survey was carried in the month of February, where some of the migrant

warblers were expected to be present. The Chestnut Mannikin, an introduced species was observed during the assessment.

Birds of the Dry limestone forest/ woodland

The avian fauna distribution from the three transects varied in the dry limestone forest. However, bird species that are typical of a dry limestone forest (Downer 1990) were represented in the three transects. These birds include Caribbean Dove, Parakeets, Hummingbirds, Jamaican Woodpeckers, Orioles and Warblers.

Forty one species of birds were observed in the Caymanas Hills. Twelve of the islands 29 endemic birds were identified in the area. However, only 8 of the 12 endemics were forest dependent. The dry limestone forest in Caymanas Hills was the least disturbed forest of the three areas surveyed.

The other two transects in disturbed limestone forest yielded fewer species compared to Caymanas Hills. There were also fewer endemic bird species (n=3 and n=4). It should also be noted that none of the endemic birds were forest specialist.

The high number of endemic forest specialist in the Caymanas Hills suggests that the forest is in good health. Interestingly, although the survey was carried out in the month of February, when some of the migrant warblers were expected to be present, only a few were observed.

Birds of the Canfields

Seventeen bird species were observed in the cane fields; this was lower than the dry limestone forest in Caymanas Hills. This is the result of the monoculture nature of the cane fields, where there are few or no other trees present. Several ground feeding birds such as the Common Ground Dove and Zenaida Dove were seen foraging on the cane roads. The yellow face grass quits were seen in the cane fields and the grasses along the road. No water birds that are usually associated with irrigation canals were observed because the fields were mature and were no longer waterlogged. One endemic bird, the Jamaican Euphonia was seen in the cane fields, however it utilizes a wide variety of habitats. No migrant warbler was observed in the field. Of note is that one recently introduced species, the Orange Bishop, was observed in the cane fields.

HERPETOFAUNA

The only amphibian observed was *Rhinella marina*. Specimens of genus *Eleutherodactylus* were expected as the species are not rare and have a wider range. The relatively dry habitats and absence of microhabitats such as bromeliads may have contributed to their absence.

Ten species of Reptiles, belonging to 5 genera were recorded. All the *Anolis* spp. that were expected in this type of habitat were recorded. Of interest was *Anolis lineatopus lineatopus* as there were several different colourations. The *lineatopus* ??species group is one of a few reptiles that has several subspecies and it is not clear what was the significance of the different colourations recorded here.

Table 1. Amphibians and Reptiles recorded in study area

Genus	species	Area 1		Area 2		Area 3		Area 4		Area 5		Area 6	
		Seen	DAFOR Scale	Seen	DAFOR Scale	Seen	DAFOR Scale	Seen	DAFOR Scale	Seen	DAFOR Scale	Seen	DAFOR Scale
AMPHIBIANS													
Rhinella	marina	Y	O	Y	O	Y	O	-	-	-	-	Y	O
REPTILES													
Celestus	crusculus cundalli	Y	O	Y	O	-	-	-	-	Y	O	Y	O
Aristelliger	praesignis	Y	O	Y	O	Y	F	Y	F	Y	F	Y	F
Hemidactylus	mabouia	Y	O	Y	O	Y	O	Y	O	-	-	Y	O
Sphaerodactylus	argus henriquesi	Y	O	Y	O	-	-	-	-	-	-	-	-
Sphaerodactylus	parkeri	-	-	-	-	-	-	-	-	-	-	Y	O
Anolis	grahami grahami	Y	F	Y	F	Y	F	Y	F	Y	F	Y	F
Anolis	lineatopus lineatopus	Y	F	Y	F	Y	F	Y	F	Y	F	Y	F
Anolis	opalinus	Y	F	Y	F	Y	F	Y	F	Y	F	Y	F
Anolis	sagrei	-	-	-	-	Y	F	-	-	-	-	-	-
Anolis	valencienni	-	-	-	-	-	-	Y	O	-	-	-	-

The study area is sandwiched between two known reptilian population centres, Hellshire Hills area the Red Hills Area. The species from the Hellshire Hills are only known from that region and Portland Ridge Areas are mostly rare, endangered species and are currently protected. The species from the Red Hills area are widespread, not listed as endangered, and have been recorded before and after the introduction of human settlements to that area. However, these two populations have been kept apart by the geographical layout of the area with the Rio Cobre River dividing them.

No endangered species were recorded during this study; the population is akin to the Red Hills population, although a number of expected species were not recorded.

Since the of amphibians and reptiles are not listed as endangered and have been recorded before and after the introduction of human settlements to that area, and since the populations

mirror those of Red Hills, there is no need for special conservation measures targeting the groups.

INVERTEBRATE FAUNA

The invertebrate fauna was relatively low in diversity (Tables 2 & 3). The Mollusca was most diverse with 13 of Jamaica's 500 species being present. While the area has a lot of limestone, it is quite dry and this is likely to be the major factor affecting the land snail populations. Not surprisingly land snails were absent from the highly disturbed habitat of the cane fields.

The Arthropod fauna was also very improvised. The cane fields (Site 5) with a large amount of rapidly growing herbs (weeds) and limited irrigation water was the most diverse.

The invertebrate fauna is characteristic of areas with high levels of human disturbance. Species which are generally widespread in distribution and which can tolerate a wide variety of habitats (generalists) dominate the fauna. Such species do not need any special conservation measures

Table 2 Summary of Land Snail fauna of the area (details in Appendix 2)

HABITAT	NO. FAMILIES	NO. SPECIES	NO. OF ENDEMICS	NO. OF INTRODUCED
Site 1	4	5	3	1
Site 2	9	13	9	
Site 3	6	9	3	
Site 4	7	8	5	
Site 5	0	0		

Table 3 Summary of Arthropod fauna of the area (details in Appendix 2)

	Site 1	**Site 2**	**Site 3**	**Site 4**	**Site 5**
No. Families	**8**	**5**	**4**	**7**	**10**
No. Species	**10**	**5**	**4**	**8**	**12**

CONCLUSIONS

This area has been the subject of significant human activity, very intense in many cases, consequently all the species observed are generalist capable of surviving in a wide variety of habitats. The species diversity is comparatively low. There were no species requiring specific conservation efforts and proper environmental management should suffice to conserve these species**.**

APPENDIX 1

AVIFAUNA

DAFOR scale used to categorize the birds identified in the study.

DAFOR scale	Total number of birds observed during the survey (2 days)
Dominant	≥ 20
Abundant	15 – 19
Frequent	10 – 14
Odd	5- 9
Rare	< 4

Birds observed from the transects for the proposed highway during the assessment.

Common Name	**Scientific Name**	**Status**	**Tran 1**	**Tran 2**	**Tran 3**	**Tran 4**	**Tran 5**
American Kestrel	*Falco sparverius*	*Resident*	R			R	
American Redstart	*Setophaga ruticilla*	*Migrant*		O	R	O	
Antillean Palm Swift	*Tachornis phoenicobia*	*Resident*	O				
Arrow-headed Warbler	*Dendroica pharetra*	*Endemic*				R	
Bananaquit	*Coereba flaveola*	*Resident*	A			A	R
Barn Swallow	*Hirundo*	*Migrant*				R	
Black and White Warbler	*Mniotilta varia*	*Migrant*	R	R		R	
Black-faced Grassquit	Tiaris bicolor	*Resident*	R			R	O
Black-Whiskered Vireo	*Vireo altiloquus*	*Resident*	O		O	O	R
Caribbean Dove	*Leptotila jamaicensis*	*Resident*	O		O	O	
Cattle Egret	Bubulcus ibis	*Resident*				O	D
Cave Swallow	*Petrochelidon fulva*	*Resident*			O	F	F
Chestnut Mannikin	*Lonchura atricapilla*	*Resident*				R	
Common Ground Dove	*Columbina passerina*	*Introduce*	O		R	A	A
Glossy Ibis	*Plegadis falcinellus*	*Resident*					F
Greater Antillean Bullfinch	*Loxigilla violacea*	*Resident*	R			R	
Greater Antillean Grackle	*Quiscalus niger*	*Resident*	O			F	A
Jamaica Tody	*Todus todus*	*Endemic*	O	O	R	R	
Jamaican Elania	*Myiopagis cotta*	*Endemic*	R				
Jamaican Euphonia	*Euphonia Jamaica*	*Endemic*	F			R	R

Common Name	**Scientific Name**	**Status**	**Tran 1**	**Tran 2**	**Tran 3**	**Tran 4**	**Tran 5**
Jamaican Lizard-cuckoo	*Saurothera vetula*	*Endemic*	O		R	O	
Jamaican Mango	*Anthracothorax mango*	*Endemic*	O			R	
Jamaican Oriole	*Icterus leucopteryx*	*Endemic*	O	R	R	R	
Jamaican Pewee	*Contopus pallidus*	*Endemic*	R	O			
Jamaican Vireo	*Vireo modestus*	*Endemic*	R	R		O	
Jamaican Woodpecker	*Melanerpes radiolatus*	*Endemic*	O			O	
Loggerhead Kingbird	*Tyrannus caudifasciatus*	*Resident*	R		O	D	D
Mangrove Cuckoo	*Coccyzus minor*	*Resident*	R			R	
Nothern Mockingbird	*Mimus polyglottos*	*Resident*		O	O	A	
Olive-throated Parakeet	*Aratinga nana*	*Resident*	F	O	O	O	
Orange Bishop	*Euplectes franciscanus*	*Introduced*					F
Ovenbird	*Seiurus aurocapillus*	*Resident*	R				
Prairie Warbler	*Dendroica discolor*	*Migrant*				R	
Red-billed Streamertail	*Trochilus polytmus*	*Endemic*	O			R	
Red-tailed Hawk	*Buteo jamaicensis*	*Resident*				R	
Sad Flycatcher	*Myiarchus barbirostris*	*Endemic*	R			R	
Saffron Finch	*Sicalis flaveola*	*Resident*					R
Smooth-billed Ani	Crotophaga ani	Resident	F			A	A
Stolid Flycacther	*Myiarchus stolidus*	*Resident*	R			R	
Turkey Vulture	*Carthartes aura*	*Resident*	O		O	O	O
Vervain Hummingbird	*Mellisuga minima*	*Resident*	O	R		F	O
White Crowned Pigeon	*Columba leucocephala*	*Resident*	O			A	
White-chinned Thrush	*Turdus aurantius*	*Endemic*	R		R	R	
White-Collared Swift	*Streptoprocene zonaris*	*Resident*				O	
White-Winged Dove	*Zenaida asiatica*	*Resident*	O			F	
Yellow-faced Grassquit	*Tiaris olivacea*	*Resident*	O	O	O	A	D
Yellow-shouldered	*Loxipasser anoxanthus*	*Endemic*	R			O	

Common Name	**Scientific Name**	**Status**	**Tran 1**	**Tran 2**	**Tran 3**	**Tran 4**	**Tran 5**
Grassquit							
Zenaida Dove	*Zenaida aurita*	*Resident*				F	A

APPENDIX 2

INVERTEBRATE FAUNA

Site 1.

Phylum: Mollusca

FAMILY	GENUS & SPECIES	DAFOR RATING	COMMENTS
Pleurodontidae	*Pleurodonte sp*.	D	Pulmonate, endemic
Sagdidae	*Sagda spei*	O	Pulmonate, endemic
Neocyclotidae	*Cyclochittya chittyi*	O	Operculate,endemic
Camenidae	*Zachrysia provisoria*	O	Introduced by humans
	Annularia mitis	O	Operculate

Phylum: Arthropoda
Class : INSECTA

ORDER & FAMILY	GENUS & SPECIES	COMMON NAME	DAFOR RATING
LEPIDOPTERA Nymphalidae	*Mestra dorcas*	Dorcas	R
Heliconiidae	*Dryas iulia delia*	Julia	O
Satyridae	*Calisto zangis*	The Jamaican Satyr	O
Pieridae	*Eurema messalina messalina*	Fabricius's Small White Sulphur	O
	Phoebis sennae	Cloudless sulphur	
Hesperidae	*Urbanus proteus*		
HYMENOPTERA	*Polisties crinitus*	Red wasps, paper wasps	O
	Apis melifera	Honey bee	O
ISOPTERA	*Nasutitermes nigriceps*	Termites, duck ants	O

INVERTEBRATE FAUNA

Site 2.

Phylum : Mollusca

FAMILY	GENUS & SPECIES	DAFOR RATING	COMMENTS
Orthalicidae	*Orthalicus undatus jamaicensis*	O/R	Endemic subspecies
Pleurodontidae	*Pleurodonte sp.*	D	Pulmonate,
	Dentellaria invalida	O	??
Sagdidae	*Sagda spei*	F	Pulmonate, endemic
	Hyalosagda arboreioides	O	Pulmonate, endemic
Urocoptidae	**Urocoptis aspera*	A	Pulmonate,endemic
Neocyclotidae	*Cyclochittya chittyi*	O	Operculate,
Helicinidae	*Eutrochatella pulchella*	O	Operculate, endemic
Annularidae	*Annularia* sp.	O	Operculate
	Parachondria fecunda	O	Operculate, endemic
	Lucidella aureola	O	Operculate, endemic
Helicinidae	*Helicinia neritella neritella*	R	Operculate, endemic
Oleacinidae	*Varicella dominicensis*	R	Pulmonate, endemic

* Live specimens seen

Phylum: Arthropoda
Class : INSECTA

ORDER & FAMILY	GENUS & SPECIES	COMMON NAME	DAFOR RATING
LEPIDOPTERA			
Heliconiidae	*Dryas iulia delia*	Julia	O
Hesperidae	*Urbanus proteus*		
HYMENOPTERA	*Polisties crinitus*	Red wasps, paper wasps	O
	Apis melifera	Honey bee	O
ISOPTERA	*Nasutitermes nigriceps*	Termites, duck ants	O
ODONATA			

INVERTEBRATE FAUNA

Site 3.

Phylum: Mollusca

FAMILY	GENUS & SPECIES	DAFOR RATING	COMMENTS
	Zachrysia provisoria	D	Introduced by humans
Camaenidae	*Dentellaria invalida*	O	
Pleurodontidae	*Pleurodonte lucerna*	A	Pulmonate (2 teeth)
	Pleurodonte sp.	R	Pulmonate , *1 tooth,*

			large shell, old
	Cyclochittya chittyi	R	Operculate
Urocoptidae	*Urocoptis brevis*	R	Pulmonate, endemic
Helicinidae	*Helicinia neritella*	R	Operculate, endemic
Bulimulidae	*Drymaeus immaculatus*	R	Pulmonate, endemic
Subulinidae	*Lamellaxis sp.*	R	Pulmonate

INVERTEBRATE FAUNA
Site 3. ctd.

Phylum: Arthropoda
Class: Hexapoda

ORDER & FAMILY	GENUS & SPECIES	COMMON NAME	DAFOR RATINGS
LEPIDOPTERA			
Papilionidae	*Papilio thersites*	Thersites Swallowtail	O
Peridae	*Phoebis sennae*	Cloudless sulphur	
Nymphalidae	*Mestra dorcas*	Dorcas	O
Heliconidae	*Dryas iulia delia*	Julia	O

INVERTEBRATE FAUNA
Site 4
Phylum: Mollusca

FAMILY	GENUS & SPECIES	DAFOR RATING	COMMENTS
Orthalicidae	*Ortahlicus undatus jamaicensis*	R	Pulmonate; Endemic subspecies
Pleurodontidae	*Pleurodonte* sp.	D	Pulmonate; 2 teeth;
Camenidae	*Zachrysia provisoria*	F	Introduced by human
	Dentellaria valida	A	
Sagdidae	*Sagda spei*	R	Pulmonate, endemic
Urocoptidae	*Urocoptis aspera*	O	Pulmonate, endemic
Neocyclotidae	*Cyclochittya chittyi*	O	Operculate, endemic
Helicinidae	*Lucidella aureola*	F	Operculate, endemic

INVERTEBRATE FAUNA

Site 4 ctd.

Phylum: Arthropoda
Class: Hexapoda

ORDER & FAMILY	GENUS & SPECIES	COMMON NAME	DAFOR RATINGS
COLEOPTERA Cerambycidae	*Eburia tetrastalcata*		R
LEPIDOPTERA			

Hesperiidae	*Agura asander*		R
Papilionidae	*Papilio thersites*	The Thersites Swallowtail	O
Peridae	*Phoebissennae*	Cloudless sulphur	
Nymphalidae	*Mestra dorcas*	Dorcas	O
Heliconidae	*Dryas iulia delia*	Julia	O
DIPTERA Bombilidae	*Poecilanthrax lucifer*		R

Class: Arachnida
Order: Scorpiones : one large of scorpion,unidentfied

INVERTEBRATE FAUNA
Site 5 Cane fields

Phylum: Arthropoda Class: Insecta

ORDER & FAMILY	**GENUS & SPECIES**	COMMON NAME	**DAFOR RATING**
LEPIDOPTERA			
Pieridae	*Eurema nise nise*	Cramer's Little Sulphur	F
	Ascia monuste	Cabbage White	F
	Phoebis sennae sennae	Cloudless sulphur	F
Nymphalidae	*Junonia (Precis) evarete*		O
Heliconiidae	*Dione vanillae*		O
Lycaenidae	*Leptotes perkinsae*		F
COLEOPTERA Coccinellidae	*Brachyacantha*		O
Curculionidae	*Cosmopolites sordidus*	Banana Root weevil	R
HYMENOPTERA Sphecidae	*Sceliphron assimile*	Mud wasp	R
Vespidae	*Poliste crinitus*	Paper wasp	O
Apidae	*Apis melifera*	Honey bee	
ODONATA			
	Erythemis plebja	Dragon fly	F/A
HEMIPTERA			
Pentatomidae	*Euschistus sp.*		O
DIPTERA			
Syrphidae	*Toxomerus pulchellus*		R

DAM HEAD TO LINSTEAD FAUNAL SURVEY

SUMMARY

Fifty two bird species were observed during the survey. The avifauna composition consist of 29 resident of which 6 were wetland birds, 17 endemics, 2 migrants and 2 introduced species. Of the seventeen endemics ten were forest dependent. No migrant warblers were observed during the assessment as a result of the time of year the assessment was carried out. Only sixteen species were observed, in which 6 were wetlands birds and 10 were terrestrial; all these species are highly adapted to human disturbance. The proposed development will not have a major negative effect on the bird community in the area. The birds which are going to be displaced during the development will migrate to the adjacent vegetation outside of the property. The cane field and the residential area have already been modified and the species found in cane field and the residential areas will continue to coexist with the humans.

All potential bat roosting sites identified were inspected, however no bats were encountered. Interviews with locals suggested the presence of the Jamaican Hutia, however, no animals or their droppings were observed. However, hunters were encountered with wild pigs.

Six of Jamaica's 26 Amphibians were recorded, one of which (*Eleutherodactylus jamaicensis)* is listed as endangered. *E. jamaicensis* is known mostly from arboreal bromeliads; only a few such bromeliads occur in this area of the island. The amphibians are mostly terrestrial and are found in log piles, leaf litter, stones piles and under old termite mounds and have adapted to human activity.

Nine species of Jamaica's 55 reptiles were recorded, none of which are presently a protected species. Their distributions are widespread although a number of localized morphs have been recorded. Since these populations are generally widespread no special protective measures are needed at this area.

Three main fresh water systems were surveyed Thomas River, Rio Cobre North of Bog Walk and a number of canals. Twenty eight species were recorded from Thomas River, including 2 crustaceans, 12 insects and 3 fishes (2 introduced). Twenty eight species were also recoded form the Rio Cobre, including 2 crustaceans, 16 insects and 4 fishes (introduced). Twenty

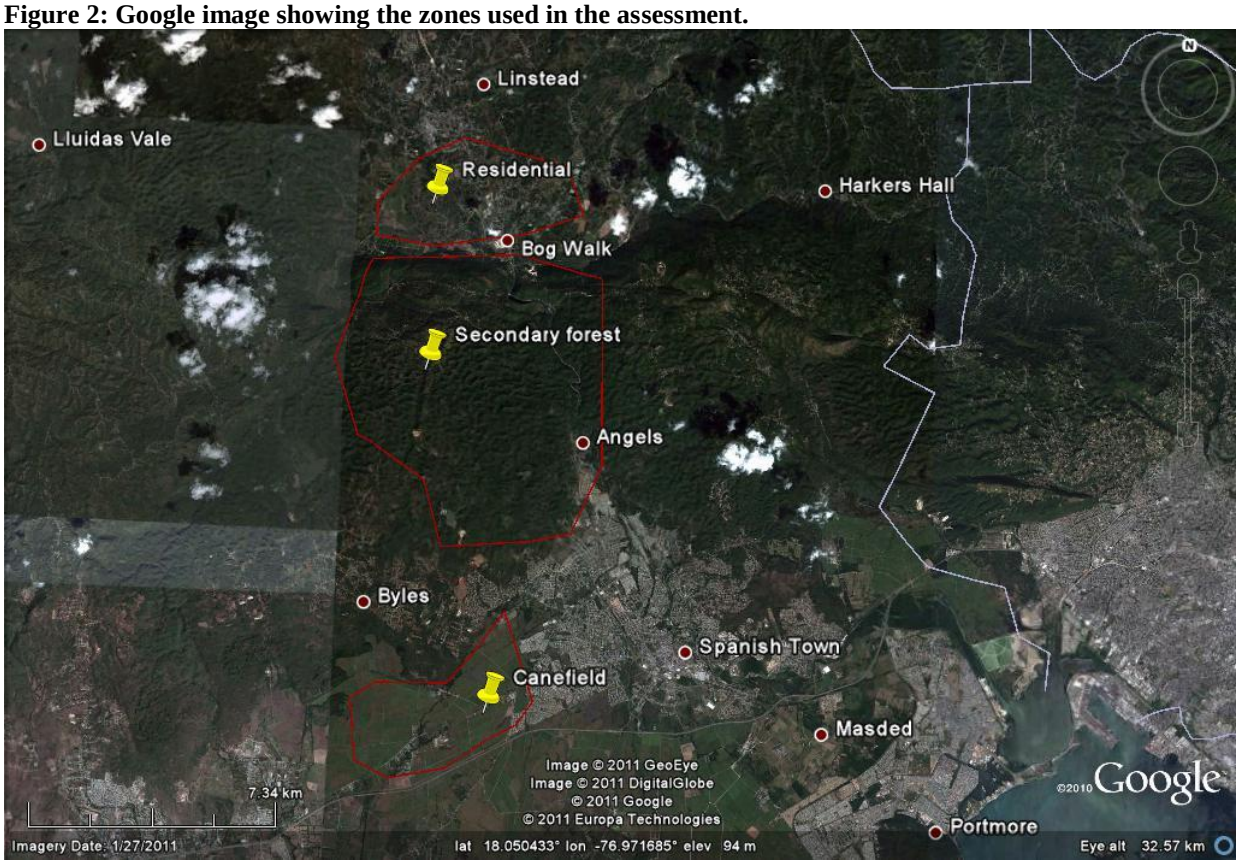
three species were recorded from the canals including 12 insects and 4 fishes. Based on the composition of the fauna at the three locations listed above, it is fair to say that while all three support reasonably healthy communities, there is no evidence to suggest that the community at any of the three locations has unique components. Provided reasonable precautions are taken to minimize contamination, to stabilize construction, and to minimize increased sediment loading due to bankside erosion while attempting to minimize removal of vegetation cover at these locations, it is fully expected that the community will return to its current composition within a few months of the cessation of construction activities.

The invertebrate fauna varied with habitat type. Fifty six species of insects, from 5 orders were recorded from the forest, sixty eight species from 6 orders from the developed areas, and fifty species from 5 orders from the cane fields and other agricultural areas. Details of the fauna are given in Appendix 6 - 8. The land snails were also very diverse; 18 species were recorded from the forests and 20 from the developed areas. No land snails were recorded in the cane fields. The level of land snail endemism was 90% in the forest and 93% in the developed areas; these levels of endemism are not unusual for Jamaican habitats. The absence of land snails in the cane fields is a result of the regular intense disturbance of the habitat due to agricultural practices

1. The Study Site

For the purpose of this study the area was zoned as residential, secondary forest/woodland and cane field according to the current land use (Figure 2).

Figure 2: Google image showing the zones used in the assessment.



Residential/ Commercial

The proposed highway will run along sections of the Bag Walk main road and sections of the Bog Walk community (Figure 2). The area the proposed road will pass-through is zoned as a residential and farming area. In the residential areas there are several trees, including fruit trees and shade trees.

The main food crop in Bog Walk is citrus and there are several orchards, both large and small. The major commercial entities in the area are "Tru-Juice" plant and "Nestle" dairy product plant.

Cane fields

The cane crops were at different stage of maturity, from fields presently being replanted to mature crops ready to be reaped (Figure 2). There are a few large trees along the periphery of the field. There are several irrigation canals and drains throughout the fields. Several sections of the cane fields were flooded for replanting.

Woodland/ Secondary forest

The vegetation type varies in the area from overgrown woodland to secondary forest (Figure 2). Currently there is an old parochial road linking Spanish Town via Dam head, Dignam to Bog Walk. There are several foot paths and gullies within the area.

The forest vegetation, closer to Spanish Town, the has characteristics of a dry limestone forest, while the vegetation closer to Bog Walk is intermediate between dry and wet limestone forest as a result of an increase in rainfall. There are several small cash crop farmers and coal burners in the area. In addition, there are a few wild pig hunters in the area.

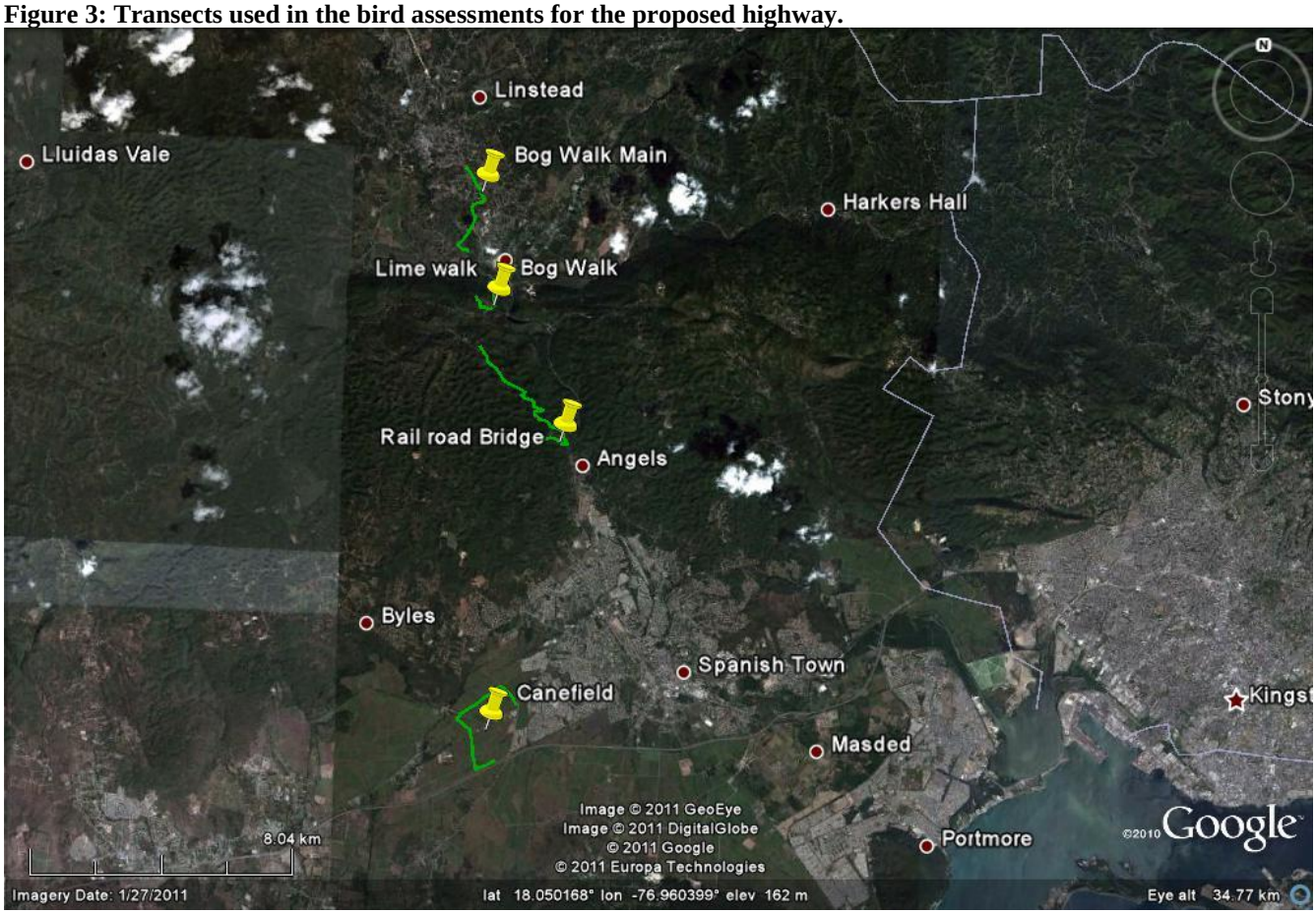
2. Methods

Avifaunal survey

The bird surveys were carried out along the path (where possible), of the proposed leg of the highway from Linstead to Spanish Town. In some cases the path of the proposed highway was not easily accessible, in such cases adjoining areas of similar structure were explored.

Line transects were selected for the assessment of the avifaunal community, since there were vast networks of old roads, footpaths and trails within the proposed area. The line transect survey was conducted from sunrise to noon along four major trails (Figure 3). Additional bird species which were encountered were recorded.

Figure 3: Transects used in the bird assessments for the proposed highway.



Herpetology Survey

The areas searched include several micro-habitats such as small bromeliads, log piles, stone piles, shrubs, trees, debris piles and dry river beds. Charcoal burners and farmers are encountered frequently in the area; these people give insight to species that are rarely seen and to the areas that they can be found in.

Arthropod survey

Larger specimens such as butterflies and spiders were recorded directly. Flight nets, sweep nets, light trap, beating tray, and direct search of were used to sample other groups.

Specimens collected were taken back to the laboratory for identification. Material was identified using appropriate literature or the collections at the University of the West Indies and the Institute of Jamaica. A DAFOR rating was established for all recorded species.

Fresh water survey
Kick samples and Dip nets were the key method utilized.
Kick sampling involves kicking an area of about $0.15m^2$ of substrate in a designated riffle for 1.5 minutes. Dip net pulls under bank side vegetation and along the bank were used. The open water of the large ponds were sampled using plankton nets, and fish trawls.

For identification a representative number of individuals of all taxa will be stored in 70% ethanol for subsequent examination in the laboratory.

3. RESULT OF THE FAUNAL SURVEY

Avifaunal Composition

Fifty two bird species were observed during the survey (Appendix 2). The avifauna composition consist of 29 resident of which 6 were wetland birds, 17 endemics, 2 migrants and 2 introduced species.

Table 1. Endemic birds observed in the woodland/ secondary forest during the assessment.

Proper Name	**Code Used**	***Scientific Name***	**Forest dependent**
Arrow-headed Warbler	AHWA	*Dendroica pharetra*	Yes
Jamaica Crow	JACR	*Corvus jamaicensis*	Yes
Jamaica Tody	JATO	*Todus todus*	Yes
Jamaican Elania	JAEL	*Myiopagis cotta*	Yes
Jamaican Euphonia	JAEU	*Euphonia Jamaica*	No
Jamaican Lizard-cuckoo	JALC	*Saurothera vetula*	Yes
Jamaican Mango	JAMH	*Anthracothorax mango*	No
Jamaican Oriole	JAOR	*Icterus leucopteryx*	No
Jamaican Owl	JAOW	Pseudoscops grammicus	No
Jamaican Pewee	JAPE	*Contopus pallidus*	Yes
Jamaican Vireo	JAVI	*Vireo modestus*	Yes
Jamaican Woodpecker	JAWO	*Melanerpes radiolatus*	No
Red-billed Streamertail	RBST	*Trochilus polytmus*	No
Sad Flycatcher	SAFL	*Myiarchus barbirostris*	Yes
White-chinned Thrush	WCTH	*Turdus aurantius*	Yes
Yellow-shouldered Grassquit	YSGR	*Loxipasser anoxanthus*	No
White-eyed Thrush	WETH	*Turdus Jamaicensis*	Yes

Note: Ten of the endemics observed are forest dependent species.

Table 2. Wetland birds observed during the assessment of the area for the proposed highway from Linstead to Spanish Town.

Proper Name	Code Used	*Scientific Name*	Status
Cattle Egret	CAEG	*Bubulcus ibis*	Resident
Glossy Ibis	GLIB	*Plegadis falcinellus*	Resident
Great Blue Heron	GBHE	*Ardea herodias*	Migrant
Great Egret	GREG	*Casmerodius albus*	Resident / Migrant
Killdeer	KIER	*Charadrius vociferus*	Resident
Yellow-Crowned Night Heron	YCNH	*Nycticorax violaceus*	Resident

Discussion on the Avian Fauna

The bird species distribution varied as a result the of vegetation type.

Woodland/ secondary limestone forest (Rail Road Bridge and Lime Walk)

Fifty two bird species were observed during the assessment and the majority encountered were terrestrial species (Appendix 1). Seventeen of the 29 endemic birds on the island were observed during the assessment and 10 were forest dependent. The endemics were not seen in great numbers. In addition, the forest dependent/endemic numbers increased as the forest became more pristine. The detectability of birds such as the Arrow-headed Warbler increased as the forest was less disturbed.

No migrant warblers were observed during the assessment as a result of the time of year the assessment was carried out. Migrant warblers are known to arrive on the island as early as September. Hence, the bird species diversity will increase in the forested areas as a result of the arrival of the migrant warblers.

Cane fields

The bird species diversity within the cane field was very low compared to the forested areas. Only sixteen species were observed, in which 6 were wetlands birds and 10 were terrestrial. It should be noted that no endemic birds were encountered in the cane fields. The low species diversity is as a result of the homogenous nature of cane fields.

The majority of the terrestrial species observed were eaters. A small flock of Orange Bishop, an introduced species were observed foraging during the assessment. These birds are common in cane fields on the island.
Barn swallows, Antillean Night hawk and swifts were also seen foraging on insects in the cane field.

Several wetland birds were seen in the cane field because sections of the fields were flooded for the replanting process, providing a habitat for these birds. The wetland bird diversity in the flooded areas will increase in the winter months, as a result of the migrant waterfowl, which arrives on the island as early as October to escape the North America winter.

Residential

The bird diversity in the residential area was not as high as in the forest. The birds typical of Town and residential areas such as the Grey King Bird, Northern Mocking Bird, Great Antillean Grackle, Logger-head King Bird and a few Columbids were seen. The European starling was the only introduced bird species encountered in the area. These birds are seen regularly in cow pastures and there were several cow pastures within the area.

Only 4 endemic birds were encountered in the area and only 1 the Jamaican Crow was forest dependent. Although the area is residential, it is surrounded by forest and several forest dependent species such as the Jamaican Crow will forage in the residential area.

Effect of the proposed development on avifauna

The proposed development will not have a major negative effect on the bird community in the area. The birds which are going to be displaced during the development will migrate to the adjacent vegetation outside of the property. The cane field and the residential area have already been modified and the species found in cane field and the residential areas will continue to coexist with the human activity.

The construction of the road creates a potential for a negative impact on the forest. The road might create easy access to sections of the forest which was not accessible. This will cause degradation of the forest, which will have an indirect effect on forest specialist. However, there is a significant amount of forest in the area and forest specialists can migrate to the

adjoining forest. It should be noted that the construction of a highway in a forest will usually have a great impact on flightless birds, but none occur in Jamaica.

Conclusion

The construction of the highway will not have great impact on the bird population because the birds can migrate to other forest habitats, while the other species are already co-habiting with human activity. In addition, the construction of a highway does not require large acreage of lands such as a housing development, which will have negative impacts on the bird's habitat.

Amphibians and Reptiles

The areas searched include several micro-habitats which include small bromeliads, log piles, stone piles, shrubs, trees, debris piles and dry river beds. Charcoal burners and farmers are encountered frequently in the area. These people give insight to species that are rarely seen and to the areas that they can be found in.

Table 3. Amphibians found in the regions surrounding the propose highway

Species	IUCN Red List Status	DAFOR scale	Habitat type
Rhinella marina	Least Concern	Occasional	Terrestrial
Eleutherodactylus gossei gossei	Least Concern	Occasional	Terrestrial
Eleutherodactylus jamaicensis	Endangered	Rare	Arboreal
Eleutherodactylus johnstonei	Least Concern	Occasional	Terrestrial
Eleutherdactylus pantoni	Near Threatened	Rare	Terrestrial
Osteopilus ocellatus	Least Concern	Rare	Arboreal

Table 4. Reptiles found in the regions surrounding the propose highway

Species	IUCN Red List Status	DAFOR scale	Habitat type
Celestus barbouri	Not Assessed	Rare	Terrestrial
Celestus crusculus cundalli	Not Assessed	Occasional	Terrestrial
Hemidactylus mabouia	Not Assessed	Occasional	Arboreal
Anolis garmani	Not Assessed	Occasional	Arboreal
Anolis grahami grahami	Not Assessed	Abundant	Arboreal

Anolis lineatopus ssp.	Not Assessed	Dominant	Arboreal
Anolis opalinus	Not Assessed	Frequent	Arboreal
Anolis sagrei	Not Assessed	Occasional	Terrestrial
Anolis valencienni ssp.	Not Assessed	Rare	Arboreal

Amphibians
Six of Jamaica's 26 Amphibians were recorded, one of which (*Eleutherodactylus jamaicensis)* is listed as endangered.

The amphibians are mostly terrestrial with the exception of the *O. ocellatus* and *E. jamaicensis* which are known mostly from arboreal bromeliads. The bromeliads are rare and the larger bromeliads are only found in the most rural locations. The terrestrial frogs are found in log piles, leaf litter, stones piles and under old termite mounds. The Eleutherodactyls have adapted to human activity and become silent upon approach.

Reptiles
Nine species of Jamaica's 55 reptiles were recorded, none of which are presently protected species. Their distributions are widespread although a number of localized morphs have been recorded. Three such variations are recorded here, *Anolis lineatopus, Anolis grahami,* and *Anolis valencienni*. Both *Anolis lineatopus* and *Anolis grahami* actually form species groups with several subspecies and unspecified populations across the island. The *A. lineatopus* spp. found in the research area does not mirror the description of *A. l. lineatopus* or *A. l. neckeri* that are known from neighbouring areas. *The A. grahami* spp. does not match the description of the *A. g. grahami* that is known from surrounded areas. However the *A. grahami* population has not been separated into subspecies even though there are several descriptions that are specific to particular areas across the country.

Anolis valencienni was captured in the area and is considerably smaller than average size of full grown adults. It also differs in colouration as the *A. valencienni* in the southern region of the island tend to have a gray tinge instead of white in the light phase, the specimens captured were white, not grey.

None of the recent revisions have separated these morphs into subspecies, and so here they are treated as variations within a larger Jamaican population. Since these populations are generally widespread no special protective measures are needed at this area.

Fresh water fauna

Background. The area where the proposed development will take place is located firmly in the catchment of the upper Rio Cobre, the principal river basin in the parish of St. Catherine Jamaica. The Rio Cobre is one of the largest rivers in Jamaica and is also one of the most heavily contaminated. Notwithstanding that fact, the water quality is variable throughout the

basin and is affected mainly by point sources of pollution. Some of these, particularly in the upper basin, are as follows: bauxite/alumina waste, inorganic fertilizer and pesticide contamination organic contamination from domestic sewage and industrial effluent.

Specific freshwater locations affected by the proposed development.
In the upper Rio Cobre, two areas are likely to be affected. These are:

1) the Rio D'Oro which is a major tributary from the eastern part of the basin to the main Rio Cobre channel located on the outskirts of Linstead town
2) the main Rio Cobre channel north of Bog Walk.

3) Thomas river which is also a major tributary of the Rio Cobre entering from the west with a confluence at Bog Walk.

In the middle section the proposed road will run through the elevated region parallel to the existing road through the Rio Cobre gorge. There are no significant freshwater bodies located here, other than some first order streams which feed into the main river channel.

In the lower section of the proposed road the main freshwater bodies affected are again a few lower order streams and the Portmore branch of the canal which emanates from the Rio Cobre dam at the foot of the gorge. There is also a small reservoir associated with the race course in this area.

Likely impacts to freshwater bodies in the area from the proposed development.
Freshwater habitats are particularly sensitive to contamination from development work occurring in the immediate vicinity. While by no means exhaustive, the list below indicates the primary factors emanating from a development of the proposed type, which are likely to have a negative impact on freshwater bodies:

1) Increased sedimentation due to construction /earth moving creating the potential for soil erosion.
2) Inorganic contamination due to increased run-off resulting from vegetation removal /soil instability.
3) Increased temperature due to removal of shade vegetation.
4) Hydrocarbon contamination due to vehicle /plant operation in the area of development.

1) and 2) listed above are likely to be the most serious sources of contamination.

Conditions in the main freshwater bodies affected

1. Rio D'Oro. This river enters the main basin from the east. For much of the lower section the flow is subsurface and surface water only appears in the lower channel when rainfall is above normal. At this time, the river may develop a series of standing pools. These are ephemeral and rarely persist for more than a few days. The lower section of the river, which is where the proposed development is located, rarely supports significant amounts of freshwater flora and fauna. In this location much of the bankside vegetation is Bamboo and there is little natural vegetation remaining.

2. Section of Rio Cobre north of Bog Walk located in United Estates property. There are two freshwater bodies located in this vicinity. One, the main Rio Cobre channel which runs through the United Estates fruit orchards at this point and is contaminated to an extent by agricultural runoff from the surrounding land and also receives organic waste from the adjacent factories. The second, a small dammed area which was constructed to supply water presumably for processing of fruit. It is not known whether this facility is currently still in use. The Rio Cobre at this point is channelized to an extent and shows a fairly uniform flow pattern, not typical of a natural river channel. There is frequently enhanced grow of *Elodea canadensis* and *Potamogeton*, indicative of nutrient enhancement

   Listed in Appendix 3 are the faunal components of the Rio Cobre at this point.

3. Thomas River. This tributary to the main Rio Cobre enters from the west. It is a medium sized river and has good habitat subdivision in that it shows alternation of riffles and pools. The Thomas River forms a confluence with the main Rio Cobre and the eastern Rio Pedro at this point. The lower sections of both of these last two are fairly eutrophic due to agricultural input. The flow pattern of the Thomas River is conducive to reasonably high dissolved oxygen levels.

   Appendix 4 lists the main components of the fauna of the Thomas River at this point. Most of these are fairly typical of other similar rivers in the area and indicate that the river is in reasonable condition and the water quality, while not optimal, is certainly acceptable for such a water body in this area. There is no component of the fauna that is unique to this location, indeed several of the species are invasive.

4. Canal from Rio Cobre dam carrying water to Portmore. This runs from behind the Rio Cobre dam at the foot of the Rio Cobre gorge. There are two branches of the canal; one which enters Spanish town and a second which carries water to Portmore for treatment. The latter is in the path of the proposed development and is likely to be affected by it. The canal is man-made concrete lined construction. It is therefore stable and of relatively uniform depth and flow pattern. In parts the water in the canal is heavily utilized for domestic purposes: washing of cars, bathing and laundry. The water temperature in the canal tends to be higher than it would be in a natural water body of similar dimensions. This is an effect of the man-made construction.

   Details of the fauna are shown in Appendix 5. Some additional elements associated more with non-flowing water are located in the canal due to the uniform low flow pattern.

Conclusion. Based on the composition of the fauna at the three locations listed above, it is fair to say that while all three support reasonably healthy communities, there is no evidence to suggest that the community at any of the three locations has unique components. Provided reasonable precautions are taken to minimize contamination and to stabilize construction to minimize increased sediment loading due to bankside erosion, while attempting to minimize removal of vegetation cover at these locations, it is fully expected that the community will

return to its current composition within a few months of the cessation of construction activities.

Terrestrial invertebrate fauna

The invertebrate fauna varied with habitat type. Fifty six species of insects, from 5 orders were recorded from the forest, sixty eight species from 6 orders from the developed areas, and 50 species from 5 orders from the cane fields and other agricultural areas. Details of the fauna are given in Appendix 6 - 8.
The land snails were also very diverse; 18 species were recorded from the forests and 20 from the developed areas. No land snails were recorded in the cane fields. The level of endemism was 90% in the forest and 93% in the developed areas; these levels of endemism are not unusual for Jamaican habitats. The absence of land snails in the cane fields is a result of the regular intense disturbance of the habitat due to agricultural practices.

Table 5 Invertebrate fauna of Residential areas (Appendix 6-8)

ORDER	NO. FAMILIES	NO. SPECIES
Lepidoptera (butterflies & moths)	9	21
Hemiptera (true bugs)	9	13
Homoptera (plant bugs)	5	10
Diptera (flies)	6	6
Isoptera (termites)	1	1
Coleoptera (beetles)	6	12
Hymenoptera (ants, wasps & bees)	2	5

Table 6 .Summary of Invertebrate fauna of the Cane fields (Appendix 6-8)

ORDER	NO. FAMILIES	NO. SPECIES
Lepidoptera (butterflies & moths)	5	12
Hemiptera (true bugs)	3	5
Homoptera (plant bugs)	5	11
Diptera (flies)	2	2
Isoptera (termites)		
Coleoptera (beetles)	5	7
Hymenoptera (ants, wasps & bees)	6	9
Odonata	1	4

Table 7 Invertebrate fauna of the forested areas

ORDER	NO. FAMILIES	NO. SPECIES
Lepidoptera (butterflies & moths)	7	22
Hemiptera (true bugs)	3	5
Homoptera (plant bugs)	3	8

Diptera (flies)	6	10
Isoptera (termites)		
Coleoptera (beetles)	4	6
Hymenoptera (ants, wasps & bees)	2	5

Table 8 Summary of Land Snail fauna of the area (details in Appndix 6-8)

HABITAT	NO. FAMILIES	NO. SPECIES	NO. AND % ENDEMICS	NO. AND % INTRODUCED
BogWalk	10	20	18	2
Cane fields	0	0		
Forests	9	15	14	1

APPENDICIES

APPENXIX 1

DAFOR scale used to rank the birds on the property

(D= dominant, A = abundant, F= frequent, O= occasional, R= rare).

	Number of bird seen along the transect
D	≥ 20
A	15 – 19
F	10 – 14
O	5- 9
R	< 4

APPENXIX 2

List of bird species observed during the assessment.

Proper Name	**Scientific Name**	**Status**	**Residential**	**Forest/woodland**		**Cane field**
			Bogwalk main	**Lime Walk**	**Railway Bridge**	
American Kestrel	*Falco sparverius*	*Resident*	R			R
Antillean Nighthawk	*Chordeiles gundlachii*	*Resident*			O	F
Arrow-headed Warbler	*Dendroica pharetra*	*Endemic*			R	
Bananaquit	*Coereba flaveola*	*Resident*	O	O	F	
Barn Owl	*Tyto Alba*	*Resident*	R		R	
Barn Swallow	*Hirundo*	*Migrant*				A
Black-faced Grassquit	Tiaris bicolor	*Resident*	R	R		
Black-Whiskered Vireo	*Vireo altiloquus*	*Resident*	O	O	O	
Caribbean Dove	*Leptotila jamaicensis*	*Resident*		O		
Cattle Egret	Bubulcus ibis	*Resident*	O			F
Common Ground Dove	*Columbina passerine*	*Resident*	O			O
European Starling	*Sturnus vulgaris*	*Introduced*	R			
Glossy Ibis	Plegadis falcinellus	*Resident*				F

Gray Kingbird	*Tyrannus dominicensis*	*Migrant*	O			
Great Blue Heron	Ardea herodias	*Resident*				O
Great Egret	Casmerodius albus	*Resident*				O
Greater Antillean Bullfinch	*Loxigilla violacea*	*Resident*			R	
Greater Antillean Grackle	*Quiscalus niger*	*Resident*	O	R		R
Jamaica Crow	*Corvus jamaicensis*	*Endemic*	R	O		
Jamaica Tody	*Todus todus*	*Endemic*			R	
Jamaican Elania	*Myiopagis cotta*	*Endemic*			R	
Jamaican Euphonia	*Euphonia Jamaica*	*Endemic*	R		O	
Jamaican Lizard-cuckoo	*Saurothera vetula*	*Endemic*		R	R	
Jamaican Mango	*Anthracothorax mango*	*Endemic*	R	R		
Jamaican Oriole	*Icterus leucopteryx*	*Endemic*	R	R	R	
Jamaican Owl	*Pseudoscops grammicus*	*Endemic*			R	
Jamaican Pewee	*Contopus pallidus*	*Endemic*			R	
Jamaican Vireo	*Vireo modestus*	*Endemic*			O	
Jamaican Woodpecker	*Melanerpes radiolatus*	*Endemic*	R	O	R	
Killdeer	Charadrius vociferous	*Resident*				R
Little Blue Heron	Egretta caerulea	*Resident*				
Loggerhead Kingbird	*Tyrannus caudifasciatus*	*Resident*	F	O	O	
Northern Waterthrush	*Seiurus noveboracensis*	*Resident*			R	
Olive-throated Parakeet	*Aratinga nana*	*Resident*	O	O	R	
Orange Bishop	*Euplectes franciscanus*	*Introduced*				R
Ovenbird	*Seiurus aurocapillus*	*Resident*	R	R		
Red-billed Streamertail	*Trochilus polytmus*	*Endemic*	O	R	O	
Red-tailed Hawk	*Buteo jamaicensis*	*Resident*				
Ruddy Quail Dove	*Geotrygon montana*	*Resident*		R		
Sad Flycatcher	*Myiarchus barbirostris*	*Endemic*			R	

Smooth-billed Ani	Crotophaga ani	*Resident*	O	F		O
Turkey Vulture	*Carthartes aura*	*Resident*	O	O	O	O
Vervain Hummingbird	*Mellisuga minima*	*Resident*	O	O	R	
White Crowned Pigeon	*Columba leucocephala*	*Resident*	O	O	F	O
White-chinned Thrush	*Turdus aurantius*	*Endemic*		R	R	
White-eyed Thrush	*Turdus Jamaicensis*	*Endemic*		O		
White-Winged Dove	*Zenaida asiatica*	*Resident*	R	O	O	
Yellow-Crowned Night Heron	Nycticorax violaceus	*Resident*				O
Yellow-faced Grassquit	*Tiaris olivacea*	*Resident*	F	O	O	F
Yellow-shouldered Grassquit	*Loxipasser anoxanthus*	*Endemic*		R	R	
Zenaida Dove	*Zenaida aurita*	*Resident*	O	O		R

APPENDIX 3

Composition of Fauna from the Rio Cobre, north of Bog Walk, St. Catherine, Jamaica.

Invertebrata
Turbellaria
Dugesidae (Flatworms)
Girardia sp.

Hirudinea
Glossiphonidae (Leeches)
Helobdella sp.

Crustacea
Palaemonidae (Shrimps)
Macrobrachium sp.
Parastacidae (Red Claw shrimps)
*Cherax quadricarinatus**

Ostracoda

Insecta

Lepidoptera
Pyralidae (Aquatic Caterpillars**)** *Paraponyx*

Ephemeroptera(Mayflies**)**
Baetidae *Baetis* sp.
Caenidae *Caenis* sp.

Trichoptera (Caddis Flies)
Hydropsychidae *Smicridea jamaicensis*
Hydroptilidae *Ochrotrichia* sp.

Odonata:Anisoptera
Libellulidae(Dragonflies) *Scapanea frontalis*
Aesnidae(Dragonflies) *Anax junius*

Odonata:Zygoptera
Coenagrionidae (Damsel flies)
Enallagma coeceum

Coleoptera (Beetles)
Elminthidae (Water Beetles) *Elmis filiformis*
Gyrinidae (Whirlygig Beetles) *Dineutius longimanus*

Hemiptera (Water bugs)
Gerridae (Water striders) *Rhagovelia tayloriella*

Diptera (Flies)
Simulidae (Black flies) *Prosimulium* sp.
Chironomidae (Non-biting midges) *Tanytarus* sp.
Dolichiopodidae *Dolichopus* sp.
Ceratopogonidae (Biting midges) *Beezia* sp.

Gastropoda (Snails)
Thiaridae *Thiara granifera**
Physidae *Physa jamaicensis*
Ancylidae *Ferrissia hendersoni*

Vertebrata
Pisces (Fishes)
Poecilidae (Livebearing fishes)
Gambusia puncticulata
Xiphiphorous helleri (Swordtail)*
Cichlidae (Tilapias)
Oreochromis mossambica (Perch)*
Loricariidae (Suckermouth Catfishes)
*Pterygoplichthyes paradalis**

* = introduced, non-native species

APPENDIX 4

Composition of Fauna from the Thomas River, near Bog Walk, St. Catherine, Jamaica

Invertebrata
Turbellaria
Dugesidae (Flatworms)
Girardia sp.

Oligochaeta
Tubificidae(Worms)
species1
Tubifex sp.

Hirudinea
Glossiphonidae (Leeches)
Helobdella sp.

Crustacea
Palaemonidae (Shrimps)
Macrobrachium sp.
Ostracoda

Insecta

Lepidoptera
Pyralidae (Aquatic Caterpillars**)** *Paraponyx*

Ephemeroptera
Baetidae (Mayflies**)** *Baetis* sp.

Trichoptera (Caddis Flies)
Hydropsychidae *Smicridea jamaicensis*
Hydroptilidae *Ochrotrichia* sp.

Odonata:Anisoptera
Libellulidae(Dragonflies) *Scapanea frontalis*

Coleoptera
Elminthidae (Water Beetles) *Elmis filiformis*
Gyrinidae (Whirlygig Beetles) *Dineutius longimanus*

Hemiptera
Gerridae (Water striders) *Rhagovelia tayloriella*

Diptera
Simulidae (Black flies) *Prosimulium* sp.

Chironomidae (Non-biting midges) *Tanytarus* sp.
Ceratopogonidae (Biting midges) *Beezia* sp.
Culicidae (Mosquitoes) *Culex* sp.
Gastropoda (Snails)
Thiaridae *Thiara granifera**
Physidae *Physa jamaicensis*
Amnicolidae *Spilochamys* sp.
Ancylidae *Ferrissia hendersonii*

Vertebrata
Pisces (Fishes)
Poecilidae (Livebearing fishes)
Gambusia puncticulata
Xiphiphorous helleri (Swordtail)*
Cichlidae (Tilapias)
Oreochromis mossambica (Perch)*

* = introduced, non-native species

APPENDIX 5

Fauna from Portmore Canal

Oligochaeta(Worms)
Naididae
Dero sp.
Tubificidae
Tubifex sp.

Crustacea
Palaemonidae (Shrimps)
Macrobrachium sp.
Parastacidae (Red Claw shrimps)
*Cherax quadricarinatus**
Ostracoda

Insecta

Lepidoptera
Pyralidae (Aquatic Caterpillars**)** *Paraponyx*

Odonata:Anisoptera
Aesnidae(Dragon flies)
Anax junius

Odonata:Zygoptera
Coenagrionidae (Damsel flies)
Enallagma coeceum

Coleoptera
Gyrinidae (Whirlygig Beetles) *Dineutius longimanus*
Hydrophilidae *Tropisternus lateralis*

Hemiptera
Gerridae (Water striders) *Rhagovelia tayloriella*
Belostomatidae (Giant water bugs) *Belostoma* sp.
Hydrometridae (Water measurers) *Hydrometra* sp.

Diptera (Flies)
Chironomidae (Non-biting midges) *Chironomus* sp.
Culicidae (Mosquitoes) *Culex* sp.

Gastropoda (Snails)
Thiaridae *Thiara granifera**
Physidae *Physa jamaicensis*
Ampullaridae *Pomacea diffusa**

Vertebrata
Pisces (Fishes)

Poecilidae (Livebearing fishes)
Gambusia puncticulata
Xiphiphorous helleri (Swordtail)*
Cichlidae (Tilapias)
Oreochromis mossambica (Perch)*
Red hybrid Tilapia*
* = introduced, non-native species

APPENDIX 6

Invertebrate fauna of the Forested Areas

Phylum: Mollusca Class: Gastropoda

FAMILY	Genus & SPECIES	COMMON NAME	DAFOR RATING	COMMENTS
Helicinidae	*Lucidella aureola*		O	endemic
	Lucidella (Perenna) lineata		O	endemic
	Helicinia neritella neritella		O	endemic
	Eutrochatella pulchella		F	
Urocoptidae	*Urocoptis aspera*		O	endemic
	Urocoptis brevis		F	endemic
	Geoscala seminuda		R	endemic
	Apoma agnesianum		R	endemic
Sagdidae	*Sagda spei*		D	endemic
Orthalicidae	*Orthalicus undatus jamaicensis*		R	endemic
Neocyclotidae	*Cyclochittya chittyi*		F	endemic
Xanthonychidae	*Dialeuca nemiroloides*		O	endemic
Pleurodontidae/Camaenidae?	*Pleurodonte sp. 1 tooth*		D	endemic
Camaenidae	*Thelidomus aspera*		O	endemic
Annulariidae	*Annularia fimbricata*		A	endemic

Phylum: Arthropoda Class: Insecta

Order & Family	**Genus & Species**	**Common Name**	**DAFOR Rating**	**Comments**
LEPIDOPTERA		Fabricius's White		Occurs in

Pieridae	*Eurema messalina messalina*	Small Sulphur	O	Cuba, Caymans, Jamaica and Bahamas
	Eurema daira palmira	Poey's Barred Sulphur	O	Non-endemic?
	Eurema dina parvumbra	Kaye's Little Sulphur	F	Endemic subspecies
	Eurema nise nise			
	Phoebis sennae sennae	The Cloudless Sulphur	O	West Indian
	Appias Drusilla jacksoni	The Jamaican Albtross	R?	Jamaica and CaymanBrac and Little Cayman
	Ascia monuste	Antillean great white, Cabbage White Butterfly	O	
Nymphalidae	*Mestra dorcas*		F	endemic
	Siproeta stelenes stelenes	The Antillean Malachite	O	Greater Antilles?
	Anaea troglodyta	The Troglodyte	F/O	
	Anartia jatrophae jamaicensis	The Jamaican White Peacock	O	Endemic subspecies
	Dynamine egaea egaea	The Bronze Wing	O	Endemic subspecies, females seen
Heliconiidae	*Heliconius charitonius simulator*	The Zebra	F	Endemic subspecies
	Dryas iulia delia	Julia	O	
	Dione vanilla vanillae		O	
Papilionidae	*Papilio andraemon*		O	
Satyridae	*Calisto zangis*		F	Endemic?
Hesperiidae	*Chioides catillus churchi*		F	
	Urbanus proteus		O	
	Wallengrenia otho vesuria		O	
	Pyrgus oileus		A	
Apaturidae	*Anaea troglodyta*			

Order & Family	**Genus & Species**	Common Name	**DAFOR Rating**	**Comments**
HEMIPTERA Coreidae	*Niesthrea pictipes*		R	
	Zicca taeniola		D	

Pentatomidae	*Oebalus pugnax*		O	
	1 uk. sp.		R	
Alydidae	*Megalotomus jamaicensis*		R	
HOMOPTERA Cicadellidae	Hortensia similis		O	
	Tylozygus fasciatus		R	
	4 uk. spp.		O/R	
Cixiidae	1 uk sp.		R	
Issidae	1 uk sp.		R	
COLEOPTERA Coccinellidae	*Scymnus roseicollis*		R	
	Brachyacantha bistriputulata		R	
Chrysomelidae	*Ceratoma ruficornis*		O	
	Chalepus sanguinicollis		R	
Scolytidae	*Hypothenemus hampei*		R	
Mantidae	1 sp.		R	
DIPTERA Drosophilidae	1 sp	Pomace Fly	O	
Tachinidae	1 sp.		O	
Tephritidae	1 sp.		R	
Calliphoridae	1 sp.		R	
Dolicopodidae??	1 sp.		R	
Asilidae	1 sp.		O	
Syrphidae	*Toxomerus pulchellus*		O	
	Toxomerus sp. large		O	
Syrphidae	*Orinida obesa*		O	
Culicidae	1 sp.		F	
HYMENOPTERA Vespidae	*Polistes crinitus*	Paper wasp	R	
Chalcididae	*Spilochalsis sp.1*		R	
	1 sp.		R	
	Brachymeria sp.		R	
MILLIPEDES	1 sp.		O	

APPENDIX 7

Invertebrate fauna of the Residential areas

Phylum: Arthropoda Class: Insecta

Order & Family	Genus & Species	Common Name	DAFOR Rating	Comments
LEPIDOPTERA Heliconiidae	*Heliconius charitonius simulator*	The Jamaican Zebra	F	Endemic subspecies
	Dione (Agraulis) vanilla insularis	The Tropical Silverspot	O	Occurs in Cuba, Jamaica and Bahamas
	Dryas iulia delia	Julia	O	
Pieridae	*Eurema nise nise*	Cramer's little sulphur	F	
	Eurema daira palmira	Poey's Barred Sulphur	F	
	Phoebis sennae sennae	The Cloudless Sulphur	O	West Indian
	Ascia monuste eubotea	Antillean great white, Cabbage White Butterfly	O	Non-endemic
Hesperiidae	*Synapte malitiosa malitiosa*		O	
	Wallengrenia otho vesuria		O	
	Pyrgus oileus	Syrichtus	A	
Nymphalidae	*Mestra dorcas*	Jamaican Mestra, Dorcas	O	Endemic subspecies
	Phyciodes frisia frisia	Cuban crescent Spot	D	
	Euptoieta hegesia	Mexican fritillary	R	
	Anartia jatrophae	The Jamaican white Peacock	O	Endemic subspecies
	Precis evarete zonalis		A	
Satyridae	*Calisto zangis*	The Jamaican Satyr	O	
Apaturidae	*Anaea troglodyte portia*		A	
Pyralidae	*Diaphania hyalinata*		O	
Papilionidae	*Papilio andraemon*		O	
	Papilio demoleus		A	
Danaidae	*Danaus gilippus*	The Jamaica Queen		Endemic

	jamaicensis		R	subspecies

Phylum: Arthropoda Class: Insecta

Order & Family	Genus & Species	Common Name	DAFOR Rating	Comments
HEMIPTERA Coreidae	*Zicca taeniola*		F	
	1 unknown sp.		R	
	Niesthrea pictipes		F	
Pyrrhocoridae	*Dysdercus mimulus*		F	
Pentatomidae	*Mermidea pictiventris*		R	
Reduviidae	1 brown sp.		O	
	1 sp. Emesinae		R	
Scutelleridae	1 sp.		R	
	1 sp. dark		R	
Miridae	1 sp.		R	
Tingidae	1 sp.		R	
Anthocoridae	1 sp.	Minute Pirate Bug	F	
Corimelaenidae	1 sp.		R	
HOMOPTERA Cicadellidae	*Tylozygus fasciatus*		A	
	Hortensia similis		D	
	1 sp. brown		R	
	1 sp. p. green		O	
	1 sp. Green/yell		O	
	1 sp. p. brown		R	
	1 sp. p. brown		R	
Issidae	1 sp.		R	
Cixiidae	1 sp. Blk/brwn		O	
Kinnaridae	1 sp.		R	
Cicadidae	Unknown sp.			
DIPTERA Syrphidae	*Palpada vinetorum*		R	
Otitidae	1 sp.		R	
Otitidae	Chaetopsis sp.?		A	
Tephritidae	1 sp.		F	
Drosophlidae	Drosophila sp.		F	
Bombyliidae	1 sp.			

Order & Family	**Genus & Species**	**Common Name**	**DAFOR Rating**	**Comments**
ISOPTERA	Unknown sp. Black winged			
COLEOPTERA Chrysomelidae	*Leptinotarsa undecemlineata*	False Potato Beetle	O	
Curculionidae	*Exophthalmus vittatus*		O	
COLEOPTERA Curculionidae: Apioninae	1sp.		R	
Order & Family	**Genus & Species**	**Common Names**	**DAFOR Rating**	**Comments**
Coccinellidae	1 sp.		R	
	Scymnus roseicollis		R	
	Brachyacantha bistripustulata		O	
Chrysomelidae	*Disonycha leptolineata*		R	
	1 sp. Blue bod/orange head		R	
	1 sp.		R	
	Lema sp.		R	
Dermestidae	1 sp.		R	
Bruchidae	1 sp.	Pea weevil	R	
HYMENOPTERA Chalcididae	*Brachymeria novata*		O	
	Spilochalsis sp.		O	
	1 sp. unidentified		R	
	1 sp.		O	
Apidae	Apis mellifera		A	

Phylum : Mollusca Class: Gastropoda

FAMILY	**GENUS & SPECIES**	**COMMON NAME**	**DAFOR RATING**	**COMMENTS**
Camenidae	*Thelidomus*		A	Endemic
	Zachrysia provisoria		A	Introduced by humans
Pleurodontidae	*Pleurodonte 1 tooth*		D	Endemic
	Pleurodonte 2 teeth		R	Endemic
	Dentellaria valida		A	Endemic
Neocyclotidae	*Cyclochittya chittyi*		F	endemic
Helicinidae	*Lucidella*		A	endemic
	Lucidella aureola		R	endemic

	Eutrochatella pulchella		F	endemic
Sagdidae	*Sagda spei*		O	endemic
Urocoptidae	*Urocptis aspera*		R	endemic
	Urocoptis brevis		R	endemic
Annularidae	*Annularia fimbricata*		R	endemic
Neocyclotidae	*Cyclochittya chittyi*		A	endemic
Camaenidae	*Zachrysia provisoria*		F	Introduced by humans
	Dentellaria valida		R	endemic
	Dentellaria invalida		R	endemic
Helicinidae	*Helicinia neritella*		R	endemic
	Unknown sp. 1		R	
	Unknown sp.1		R	

APPENDIX 8

Invertebrate fauna of the Cane Fields

Phylum: Arthropoda Class: Insecta

Order & Family	**Genus & Species**	Common Name	**DAFOR Rating**	**Comments**
LEPIDOPTERA Pieridae	*Eurema nise nise*	Cramer's Little Sulphur	F	Non-endemic
	Eurema messalina messalina	Fabricius's White Small Sulphur	O	
	Ascia monuste	Antillean great white, Cabbage White Butterfly	F	
	Phoebis sennae sennae	The Cloudless sulphur	F	West Indian
	Phoebis argante comstocki?	Argante	O	Endemic subspecies
	Phoebis agarithe antillia?	The Cloudless Orange	O	Greater Antilles
Nymphalidae	*Junonia (Precis) evarete*		O	
	Anartia jatrophae jamaicensis		F	
	Euptoita hegesia hegesia		F	
Heliconiidae	*Dione vanillae*		O	
Apaturidae	*Anaea troglodyta*		R	
Lycaenidae	*Leptotes perkinsae*		F	
COLEOPTERA Coccinellidae	*Brachyacantha bistripustulata*		O	
	Brachyacantha bistriputulata		R	
	1 sp. Tiny 2.5 mm black and beige beetle		R	**NEW SPECIES??**
Scutelleridae	*1 sp.*		R	
Chrysomelidae	*Cerotoma ruficornis*		F	
	1 sp		R	
Curculionidae	*Cosmopolites*	Banana Root	R	

Order & Family	**Genus & Species**	Common Name	**DAFOR Rating**	**Comments**
		weevil		
Gyrinidae		Whirligig Beetle	O	
HYMENOPTERA Sphecidae	*Sceliphron assimile*		R	
	Trypoxylon jamaicensis		R	
Ichneumonidae	*Ichnemonus sp.*		R	
Megachilidae	*Megachile concinna*		F	
Vespidae	*Poliste crinitus*		O	
???	*Stenodynerus baccus saussure*		F	
Apidae	*1 sp.*		O	
Ichneumonidae	*1 sp.*		R	
	1 sp.		R	
ODONATA	*1 sp.*		O	
	Erythemis plebja		F/A	
	Tramea binotata		F	
	1 sp.		O	
HEMIPTERA Pentatomidae	*2 uk. spp.*		O	
	Euschistus sp.		O	
Coreidae	*Catorhinta sp.*		O	
Alydidae	*Megalotomus jamaicensis*		O	
Homoptera Cicadelliade	*Hortensia similis*		F	
	1 sp. Orange on head and prothorax		R	
	6 uk. spp.		F/O	
Membracidae	*1 sp.*		O	
Issidae	*1 sp. large*		R	
Delphacidae	*Texananus excultus*		R	Smaller than specimen in collection
Cixiidae	*1 sp*		F	
DIPTERA Dolicopodidae	*1 sp.*		R	
Syrphidae	*Toxomerus pulchellus*		R	

HIGH WAY -- CAYMANAS TO LINSTEAD FAUNAL SURVEY SUMMARY

SUMMARY

The faunal survey was conducted in three sections: Caymanas to Dam Head, Damhead to Linstead, Bog Walk steep hillside.

Cayamanas to Dam Head

The Avifauna and invertebrate was studies at five sites, covering all major habitat types. The Herpetofauna was also studied at 5 sites but an additional site was examined. Thirty five species of birds were identified in the Gully forest while 41 was observed in the Cayamanas Hills; the other sites had much lower diversity. A number of endemic species were forest dependent, however they do not require primary forests and do thrive even is secondary forests.

The only amphibian observed was *Rhinella marina.* Ten species of Reptiles, belonging to 5 genera were recorded. These populations here appear to be an extension of the population recorded for the adjoining Red Hill area. The Arthropod fauna is also improvised, with a maximum of 13 land snails and 10 arthropod species recorded for any area. Since none of the species recorded are known to be endangered or needing any special conservation measures, standard good environmental practice should be adequate to conserve these species.

Dam Head to Linstead

Fifty two bird species were observed during the survey. The avifauna composition consist of 29 resident of which 6 wetland birds, 17 endemics, 2 migrants and 2 introduced species. Of the seventeen endemics ten were forest dependent. No migrant warblers were observed during the assessment as a result of the time of year the assessment was carried out. Only sixteen species were observed, in which 6 were wetlands birds and 10 were terrestrial; all these species are highly adaptive to human disturbance. The proposed development will not have a major negative effect on the bird community in the area. The birds which are going to be displaced during the development will migrate to the adjacent vegetation outside of the property. The cane field and the residential area have already been modified and the species found in cane field and the residential areas will continue to coexist with the human activity.

All potential bat roosting sites identified were inspected, however no bats were encountered. Interviews with locals suggested the presence of the Jamaican Hutia, however, no specimens or their droppings were observed. However, hunters were encountered with wild pigs.

Six of Jamaica's 26 Amphibians were recorded, one of which (*Eleutherodactylus jamaicensis)* is listed as endangered. *E. jamaicensis* is known mostly from arboreal bromeliads; only few such bromeliads occur in this area of the island. The amphibians are mostly terrestrial are found in log piles, leaf litter, stones piles and under old termite mounds and have adapted to human activity.

Nine species of Jamaica's 55 reptiles were recorded, none of which are presently a protected species. Their distributions are widespread although a number of localized morphs have been recorded. Since these populations are generally widespread no special protective measures are needed at this area.

Three main fresh water systems were survey, Thomas River, Rio Cobre North of Bog Walk and a number of canals. Twenty eight species were recorded from Thomas River, including 2 crustaceans, 12 insects and 3 fishes (2 introduced). Twenty eight species were also recoded form the Rio Cobre, including 2 crustaceans, 16 insects and 4 fishes (2 introduced). Twenty three species were recorded from the canals including 12 insects and 4 fishes.
Based on the composition of the fauna at the three locations listed above, it is fair to say that while all three support reasonably healthy communities, there is no evidence to suggest that the community at any of the three locations has unique components. Provided reasonable precautions are taken to minimize contamination and to stabilize construction to minimize increased sediment loading due to bankside erosion, while attempting to minimize removal of vegetation cover at these locations, it is fully expected that the community will return to its current composition within a few months of the cessation of construction activities.

The invertebrate fauna varied with habitat type. Fifty six species of insects, from 5 orders were recorded from the forest, sixty eight species from 6 orders from the developed areas, and 50 species from 5 orders from the cane fields and other agricultural areas. Details of the fauna are given in Appendix 6 - 8. The land snails were also very diverse; 18 species were recorded from the forests and 20 from the developed areas. No land snails were recorded in the cane fields. The level of land snail endemism was 90% in the forest and 93% in the developed areas; these levels of endemism are not unusual for Jamaican habitats. The absence of land snails in the cane fields is a result of the regular intense disturbance of the habitat due to agricultural practices.

Bog Walk Steep Hillside
Twenty eight species of bird were identified in the woodland and seven from the agricultural and residential areas. Twenty three species of insects were recorded from the woodland and thirty eight from the agricultural and residential areas. There were also three species of Amphibians, eight reptiles and seventeen land snails were recorded from the area. Since the populations of all species listed are widespread no special protective measures are needed at this area.

Attachment 6 Forestry Management Draft Management Plan

Local Forest Management Plan

For

Tulloch Estate and Hampton Forest Management Areas

2012

Presented by:

_____

Ms. Marilyn Headley
CEO and Conservator of Forests

Approved by:

_____

Mr. Robert Pickersgill
Minister of Water, Land, Environment and Climate Change

Table of Contents

Chapter 1

Introduction

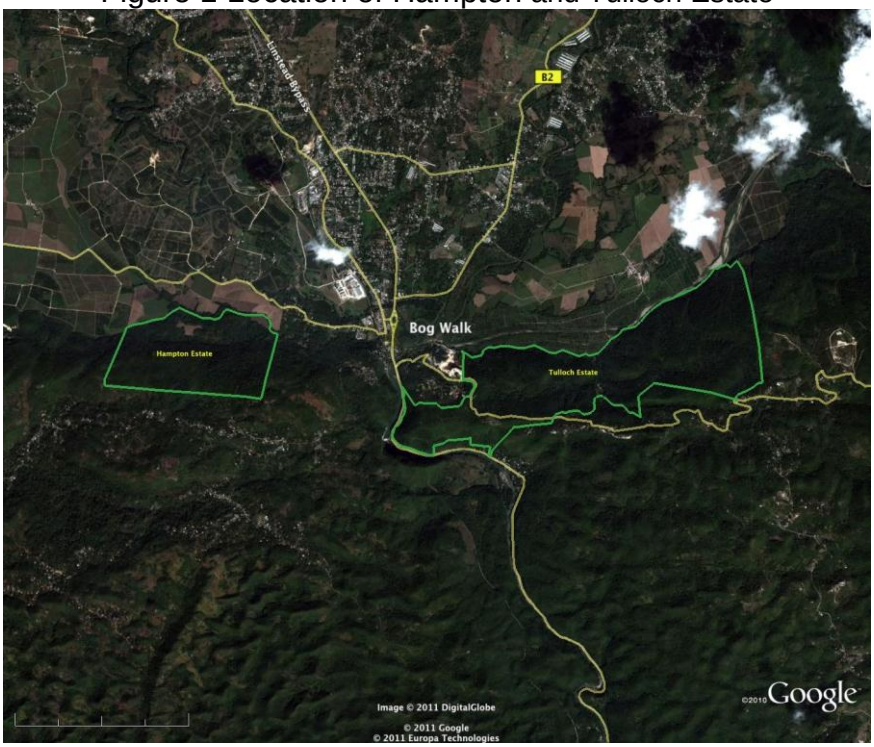
The Tulloch Estate and Hampton Forest Management Areas (hereinafter referenced as the FMAs) were established by the Tulloch Estate Forest Management Declaration Order of 2005 and the Hampton Forest Management Declaration Order of 2005 respectively. The establishment of the FMAs was in accordance with Section 5 of the Forest Act, 1996 and is consistent with the other applicable provisions found in the Forest Act, Forest Regulations, Forest Policy and the Strategic Forest Management Plan.

The FMAs were primarily established to allow for the continued conservation of the water, wildlife and forest resources on the designated properties, through the facilitation of a public-private partnership between the landowner and the Department in relation to the maintenance of these values. To fulfill the statutory requirements under Sections 46 and 47 of the Forest Regulations, 2001 which stipulates that any private lands so declared, “shall be managed in accordance with a management plan”, the following Plan to manage the FMAs has been developed.

Location Description

The FMAs cumulatively cover 1000 acres of lands which is broken up in to two parcels of land, namely, Hampton and Tulloch Estate. This land is situated near Bog Walk in the parish of St. Catherine and belongs to Tulloch Estates Limited. The surveyed location plans are found in the Declaration Order and are outlined on the map in Figure 1.

Figure 1 Location of Hampton and Tulloch Estate



Land Use History

This FMA has been utilized by Mr. Roger Turner's family for five generations. The area is heavily forested with the exception of approximately 60 acres of pastureland with a relatively light forest canopy. These lands are comprised of even-faced slopes (up to 40%) with ridges, shallow valleys and depressions. This secondary forest over limestone is characterized by a diversity of vegetative species and age classes as well as a variety of terrestrial wildlife species. Approximately 70% of the FMA is densely forested with the majority of the trees being approximately 100 years of age. Prior to 1910, these lands were used for cattle grazing and fuelwood harvest to support sugar cane production. The remaining 30% of the FMA is also densely forested with the majority of trees being approximately 50 year of age. Prior to 1960, these lands were also used to support grazing and fuelwood harvest. All of these lands followed a similar pattern of cutting timber, burning, planting guinea grass (non-native grass species), and grazing cattle. Some cedar and mahoe were planted and remain today.

Existing Conditions

The following categories define the primary uses of the FMA. The existing condition (a description of what currently exists) for these uses/resources is described below in alphabetical order and not by order of importance. All acres are approximate and may change as mapping techniques and inventory methods improve and/or are refined.

Ecotourism Existing Condition

- None at this time.

Forest Cover Existing Condition

- 1000 acres of wooded lands primarily comprised of:
    - Closed Broadleaf Forest comprising of Cedar, broadleaf, cotton, breadnut, fiddlewood, mahoe, logwood and bullet tree species; representing a variety of age and size classes;
    - Shrub and grass species.
- Invasive species are minimal and include bamboo, guinea grass and rubber which are prolific in some areas such as glades and on the periphery of the property.
- Sixty acres is pasture lands with a relatively light forest canopy of immature volunteer native tree species.
- Evidence of infringement by goats, ganja farmers, native herbal tree drink collectors, and fuelwood (charcoal) collectors.
- Provides/contributes to: carbon sink, wildlife habitat, healthy water supply and soil stability.

Forest Products Existing Condition

- Incidental tree harvest, primarily of trees damaged by natural events such as windstorms. Tree harvest contributes to the niche market for large, native woods as well as for residential use.

Infrastructure Existing Condition

- Road(s) 8-10 foot (width), approximately 12 miles in length, accessing remote parts of FMA, are closed by locked gates.
- Six miles of maintained 4 foot trails (width) throughout the forest.
- Licensed marl quarry for residential use.
- National Water Commission water well.
- Digicel and Cable & Wireless electronic cellular tower.
- Abandoned GoTel electronic tower.
- Fenced boundaries to main roads.

Lands and Inventory Existing Condition

- Some large seed trees identified.
- Jamaican Public Service (JPS) easements – 8 foot, see Plan (need specifics as to type and longevity of easements).

Revenue Stream Existing Condition

- Tax remission on property tax
- Limited harvest - less than 10 mature trees/year of large damaged trees for niche market of 12”-24” lumber.
- Income from electronic cellular tower

Soils Existing Condition

- Upper elevation soils are generally stony and unstable in areas with pockets of bauxite soils.
- Lower elevation soils consist of calcareous clays and alluvial deposits.

Watershed Existing Condition

- Watershed of the Rio Pedro River, a major tributary of the Rio Cobre.
- Catchment basins comprised of limestone formations, which feed the Rio Pedro with spring water.
- Source for the Tulloch Springs water supply, providing water for:
    - Sligoville community by means of a surface well, and for the city of Kingston, Jamaica (water is piped to western Kingston).

Wildlife Existing Condition

- Terrestrial vertebrate species include: doves, red tail buzzard, quits, owls, woodpeckers, lizard cuckoo, orioles, Jamaican becard, and hummingbird

Threats

The following threats (activities that affect the environment in an undesirable way) are derived primarily from discussion with the landowner. The list is organized in alphabetical order and not by order of importance. Threats include:

- Invasion/Spread of Non-native Species;
- Goat grazing;
- Ganja production;
- Illegal charcoal production;

- Native herbal tree drink collectors.

Desired Conditions

The following conditions are *desired* conditions that may exist now and/or are desired in the future. These conditions are displayed in alphabetical order and not by order of importance. The desired conditions are consistent with the categories identified for the existing conditions discussed above. Budget constraints and shifting priorities may impact the movement towards desired conditions.

Action items to move towards the desired conditions over the life of the plan are included as part of the desired conditons.

Ecotourism Desired Condition

- Public tours of area providing background of the area's land use history and land use practices.

Action items include:

- Explore potential eco-tourism opportunities

Forest Cover Desired Condition

Maintenance of the existing condition with the following additions:

- Reduce/prevent invasive species such as bamboo and rubber trees from becoming prolific.
- Reduce/prevent infringement by goats, ganja farmers, native herbal tree drink and fuelwood (charcoal) collectors.
- Restock pasture lands with tree species.
- Interplant the forest canopy with native tree species (i.e. cedar and mahogany), depending on the soils and canopy. For example, interplant cedar tree species in openings along existing roads and trails.
- Maintain for potential carbon sink, generating revenue from Credits factored through Government of Jamaica tax programs.
- Retain mature trees as seed sources and GPS trees.
- Explore opportunity to provide for potential licensing of high value "villas."
- Explore ecotourism opportunities.

Action Items include:

- 10 acres of bamboo and rubber trees will be reduced on an annual basis.
- Limited harvesting of damaged trees, estimate <10 per year.
- Planting gaps that occur along the roads, trails, an in the forest as they occur annually.
- As funds become available, plant sixty acres of pasture lands with species such as Jamaican Cedar, Mahogany, Mahoe and Bullet.

Forest Products Desired Condition

Maintenance of the existing condition is the desired condition.

Action items include:

- Removing limited fence post material for use on Tulloch's lands for pastures and boundaries.

Infrastructure Desired Condition
Maintenance of the existing condition is the desired condition with the following additions:

- Extend power and water distribution based on need from ecotourism and villas.
- Remove limited fence post material for use on Tulloch's lands – pastures and boundaries.
- Maintain tracks and road.

Action Item includes:

- Maintain 6 miles of tracks and 12 miles of road with a 6 person crew for 3 weeks every 5 years.

Lands and Inventory Desired Condition
Maintenance of the existing condition with the following addition:

- Some large seed trees identified need to be marked through Global Positioning System (GPS).
- Increase the number and type of tree species identified using GPS, targeting large trees.

Action items include:

- Work with Forestry Department to GPS and map large trees.

Revenue Stream Desired Condition
Maintenance of the existing condition with the following addition:

- Carbon sequestration approved by Designated National Authority (DNA),
- High-end home site licensing,
- Eco-tourism,
- Provide annual income (revenue) stream,
- Limited quarrying of limestone from marl pit

Action items include:

- Tax remission;
- Timber harvesting and utilization of niche market for 12"-24' inch boards;
- Revenue generation for carbon sequestration approved by DNA)
- License high-end home sites on 40-60 acres parcels, work with Forestry Department to:
  - Develop a framework for acceptable practices;
  - Building codes;
  - Maintain conservation and diversity of area.

Soils Desired Condition
Maintenance of the existing condition.

Watershed Desired Condition
Maintenance of the existing condition.

Wildlife Desired Condition
Maintenance of the existing condition

Desired Condition Summary
The aforementioned desired conditions reflect that for the most part, the existing condition is the desired condition; thus, maintaining the existing condition through sustainable management practices is the desired condition. In summary, the desired condition for the FMA is to continue to provide for a sustainable variety of uses (e.g. domestic water source), values (e.g. clean water), benefits (e.g. economic), and opportunities (e.g. ecotourism, carbon sinks) now and into the future.

Monitoring

The Forestry Department will conduct an annual site visit to the area. The purpose of the site visit is to monitor activities that have taken place, determine if activities are maintaining or moving towards the desired conditions, and whether there are any changes to the desired conditions that should be incorporated into the Plan.

Glossary

Desired Conditions (DCs): Descriptions of the ecological, economic, and social attributes that characterize or exemplify the desired outcome of land management. Desired conditions can be the maintenance of existing conditions or specific descriptions of the condition of the landscape in the future (future can be defined- e.g. 5 years, 10 years, or longer).

- Short-term Desired Condition- 5 years or less
- Long-term Desired Condition- 5 years or greater

Existing Condition: A description of what currently prevails/exists. Existing conditions include the current ecological, economic, and social attributes of the Plan area.

Monitoring: The monitoring program is considered an important element of planning. It includes analyzing action and data; learning and changing from results, and sharing findings. Monitoring is key to discovering what Plan components (e.g. desired condition) may need to be changed in the future.

Sustainability: Meeting the needs of present generations without compromising the ability of future generations to meet their needs.

Threats: Threats are human or natural activities that affect the environment in manner that is undesirable. Human threats can be activities like bauxite mining, invasive species, bird hunting, animals, agriculture practices/activities, squatting, fish poisoning, illegal harvest of forest products, etc.). Natural threats can be natural events on the environment such as hurricanes, animals, etc.

Values: Positive attributes/means of assessing resource worth/perceived benefit defined by a group of persons and are specific to a resource and/or plan area.

References

Acronyms

FD Forestry Department
FMA Forest Management Area
GPS Geoglobal Positioning System

Appendices

Local Forest Management Plan

For

Tulloch Estate and Hampton Forest Management Areas

2012

Presented by:

_____

Ms. Marilyn Headley
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Approved by:

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Minister of Water, Land, Environment and Climate Change

Attachment 7 General Drainage Guidelines

NORTH SOUTH HIGHWAY (CAYMANAS TO OCHO RIOS) PROJECT

GENERAL DRAINAGE GUILINES

1. INTRODUCTION

1.1 PURPOSE

The purpose of this document is to provide general guidance on drainage for the implementation of drainage designs. It is intended that the drainage studies, plans, design reports, construction drawings etc. are prepared in accordance with sound engineering and best management practices to meet the requirements of the local governing regulations and the Concession Agreement. These guidelines are intended to reduce or eliminate any negative impacts resulting from the proposed development, to improve existing drainage conditions where possible and to enhance public safety.

1.2 DISCLAIMER

NROCC and NWA will review the drainage reports and plans for construction for conformance with drainage regulations. This notwithstanding, NROCC assume no liability for insufficient design or improper construction. Review and approval does not absolve the developer, design engineer, or contractor of liability for inadequate design or poor construction. The Developer's design engineer has the responsibility to design drainage facilities that meet standards of practice for the industry and promote public safety.

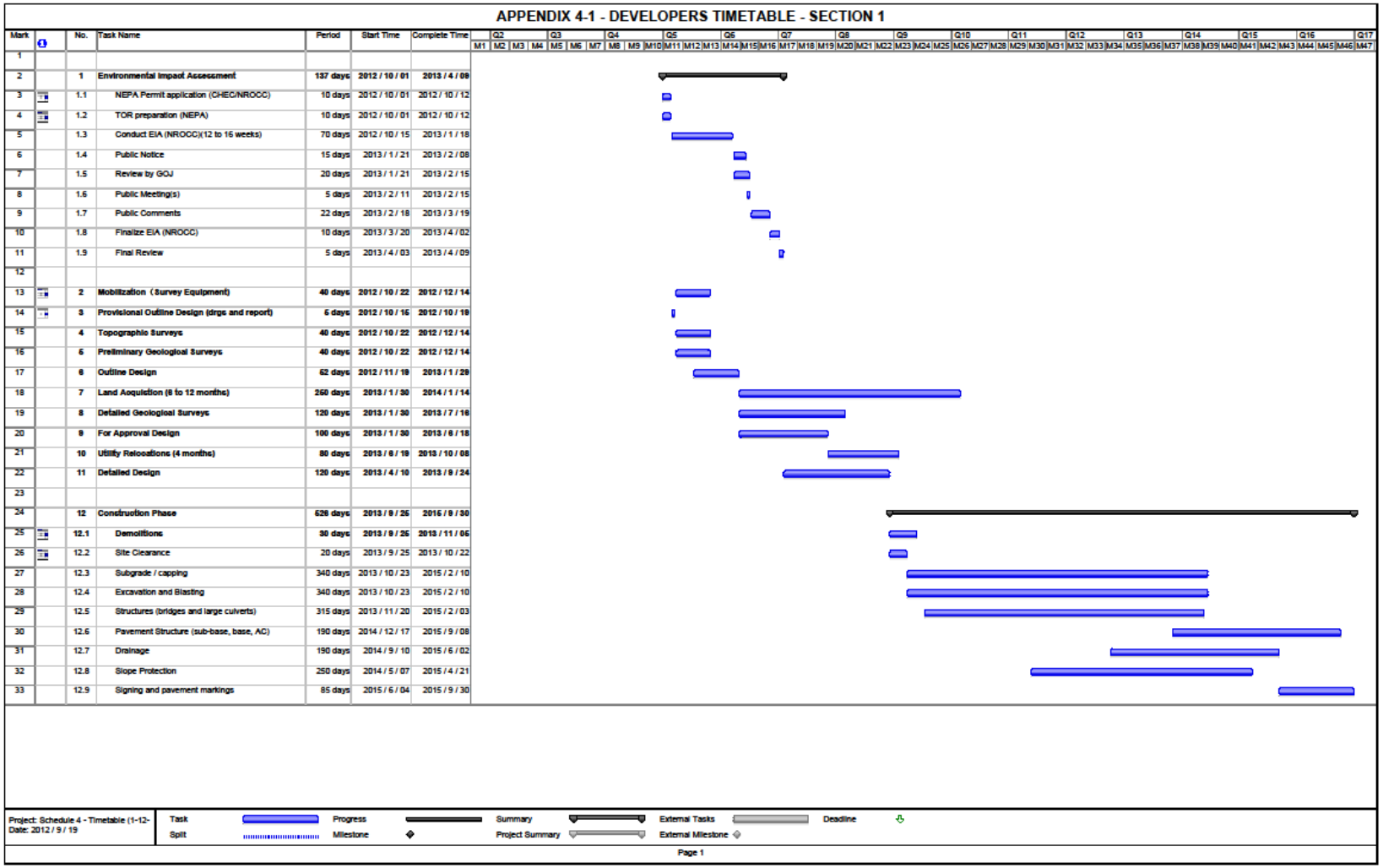
2. DRAINAGE PLANNING

2.1 PURPOSE

The purpose of proper Drainage Planning is to encourage thoughtful and careful consideration of drainage issues when preparing to impose change on a natural system by the proposed highway facility to benefit upstream, downstream, and adjacent properties. The purpose for applying proper drainage planning is to minimize or eliminate adverse impacts and to achieve the many benefits, including the following:

1. Minimum disturbance to the existing conditions.
2. Increased public safety.
3. Reduced costs, including the cost to repair property damaged by flooding, erosion and deposition of sediment, and the cost of drainage infrastructure and maintenance.
4. Continuity of stormwater flow through the site to maintain existing conditions to minimize and to prevent impacting adjacent, upstream, and downstream properties.
5. Improved stormwater quality.

Attachment 8 Preliminary Project Schedule



Attachment 9 Letter addressing the acquisition of Hampton Estate lands

-----Original Message-----
From: Glenton Rose [mailto:GlentonRose@h2kjamaica.com]
Sent: Friday, December 21, 2012 8:41 AM
To: 'Ivan Anderson'; 'Errol Mortley'
Subject: FW: Hampton Property

Gentlemen,

Please see response from Mr. Turner

GLENTON

-----Original Message-----
From: Roger & Claire Turner [mailto:tullochestates@cwjamaica.com]
Sent: Tuesday, December 18, 2012 6:04 PM
To: Rose, Glenton
Cc: Oliphant, Rainee; Headley, Marilyn
Subject: Fw: Hampton Property

Dear Mr. Rose,

Thank you for your letter of December 18th 2012.

I have no objection to the current alignment of the Highway 2000 across Hampton Property, as discussed in our meeting at Tulloch on December 7th 2012.
I have copied this reply to the Forestry Dept - Ms Headley & Ms Oliphant for their consideration to furnish you with the current draft of the Tulloch Forest Management Area Plan; my copy on file is May 2012 (attached).

I hope you find this in order,

Sincerely,

Roger Turner

----- Original Message -----
From: <xerox@h2kjamaica.com>
To: <tullochestates@cwjamaica.com>
Cc: <maureenhendricks@h2kjamaica.com>
Sent: Tuesday, December 18, 2012 3:32 PM
Subject: Hampton Property

> Please open the attached document. It was scanned and sent to you
> using a

> Xerox WorkCentre.
>
> Attachment File Type: PDF
>
> WorkCentre Location: machine location not set Device Name:
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Attachment 10 Flood and Disaster control management plan for Caymans Estates

A Research Report on Flood Disaster Control Program of Caymanas Economic and Technological Development Zone

Prepared by: Yu Hongan
Reviewed by: Han Lei
Approved by: Cha Minggao

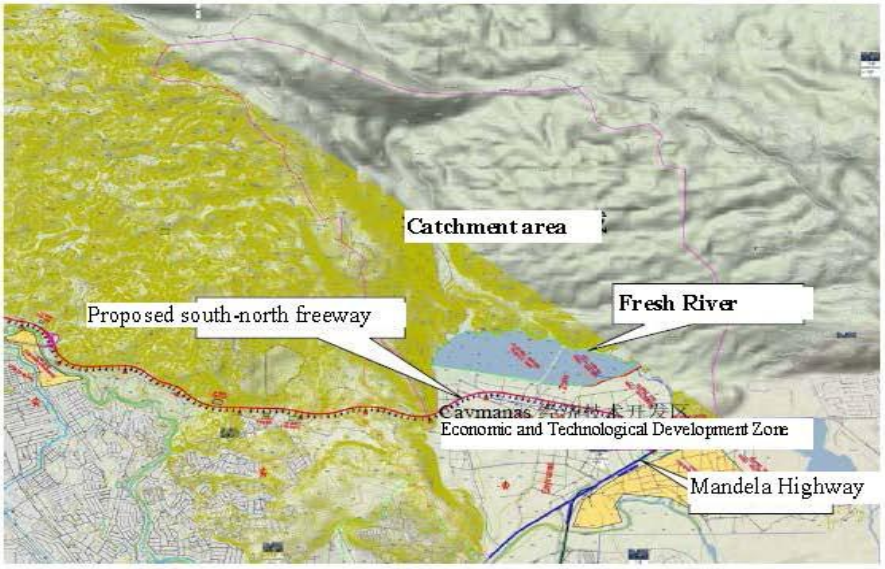
CCCC Second Highway Consultants Co.,Ltd
August, 2012

Research Report on Flood Disaster Control Program of

Caymanas Economic and Technological Development Zone

1 Project Overview

Located in the west of Kingston, Capital city of Jamaica, and to the north of Mandela Highway, Caymanas Economic and Technological Development Zone is a key project planned by Jamaica Government , with a planned land area of 15.0 km^2. Topographically, it falls into pre-mountain pluvial alluvial plain, with gentle terrain, and is close to mountains on its three sides- the east, west and north. It is quite high in topography, with a ground elevation of 4.0-9.5m. It is closed to the sea on its south, where the terrain is quite low and the ground elevation ranges from 0.5 to 2.0m. (For more information ,refer to the geological location map of Caymanas Economic and Technological Development
Zone)



There is river called Fresh River within the planned land of Caymanas Economic and Technological Development Zone. Such river, flowing in north-south direction and located on the eastern edge of the land, with a width of approximately 5.0-12.0m and a depth of approximately 1.5-2.0m, is an major drainage outlet of Caymanas Economic and Technological Development Zone, at which a 1-9.0m small bridge is provided over the Fresh River for Mandela Highway to its south, and except which, no other drainage outlet exist, making Caymanas Economic and Technological Development Zone an enclosed area, where flood disaster can easily occur in the flood period, even the Mandela Highway to its south can be flooded.

2 Analysis of Flood Disaster Causes

Located in the middle of Caribbean Sea,Jamaica falls into the area of tropical rain-forest climate, with plenty of rainfall, and the annual precipitation is about 2000 mm. There are two rainy seasons, from May to June and from September to November. Hurricane occurs frequently from June to October. The Hurricane "Gilbert" in 1988, "Ivan "in 2004 and "Gustav" in 2008, along with the rainstorms, brought about great economic losses to Jamaica. The following is the information about the precipitation intensity in such area:

Period (Year)	Precipitation intensity (i.p.h or mm/hour)	
	T>60 min	T>60 min
2	$i = 2.6125\ P \times t^{-0.4814}$	$i = 5.9487\ P \times t^{-0.6822}$
5	$i = 2.5444\ P \times t^{-0.5119}$	$i = 4.2020\ P \times t^{-0.6344}$
10	$i = 2.4944\ P \times t^{-0.5218}$	$i = 3.6597\ P \times t^{-0.6154}$
25	$i = 2.4556\ P \times t^{-0.5300}$	$i = 3.2696\ P \times t^{-0.5999}$
50	$i = 2.4377\ P \times t^{-0.5343}$	$i = 3.0870\ P \times t^{-0.59}$
100	$i = 2.4230\ P \times t^{-0.5375}$	$i = 2.9552\ P \times t^{-0.5860}$

There is a big catchment area in the planned land of Caymanas Economic and Technological Development Zone, which is about 3551.2 hectares. An enclosed area is formed due to impact of Mandela Highway upon the drainage outlet in its south, where the drainage is achieved only through the 1-9.0m fresh river bridge, whose drainage capacity can not meet the flood drainage demand. This is the major cause of the occurrence of flood disaster in the land of Caymanas Economic and Technological Development Zone.

The Caymanas Economic and Technological Zone is close to the sea in its south, where there is a low terrain and the exclusive flood discharging river Fresh River is seriously silted up, especially downstream the bridge of Fresh River, the terrain is very gentle and the rainwater runoff speed is very slow, providing a poor flood carrying capacity.

3 Related Hydrological Calculations

In this hydrological calculation, calculation is made for the small bridge of Mandela Highway over the Fresh River based on the flood standard with a-hundred-year return period. The calculation process and results are given as follows:

Drainage area (in hectare) **A=3.5512E7 m^2=3551.2ha**

Longest length of riverway (in m) **L=6784m**

Water head difference (in m) **H=606m**

Runoff curve parameter **CN=82**

Concentration time $Tc = \left[\frac{4.7815L^3(\frac{101.4-CN_\lambda)^2}{70}}{H}\right]^{0.234} = 86.5$ (min)

The calculation formula on precipitation intensity with a-hundred-year return period in the table below is used:

Period (year)	Precipitation intensity (i.p.h or mm/hours)	
	T>60 min	T>60 min
2	$i = 2.6125\ P \times t^{-0.4814}$	$i = 5.9487\ P \times t^{-0.6822}$
5	$i = 2.5444\ P \times t^{-0.5119}$	$i = 4.2020\ P \times t^{-0.6344}$
10	$i = 2.4944\ P \times t^{-0.5218}$	$i = 3.6597\ P \times t^{-0.6154}$
25	$i = 2.4556\ P \times t^{-0.5300}$	$i = 3.2696\ P \times t^{-0.5999}$
50	$i = 2.4377\ P \times t^{-0.5343}$	$i = 3.0870\ P \times t^{-0.59}$
100	$i = 2.4230\ P \times t^{-0.5375}$	$i = 2.9552\ P \times t^{-0.5860}$

Where, i——Precipitation intensity per hour (in inch/hour or mm/hour)

P——Precipitation per 24 hours (in inch or mm)

T——Precipitation period (in min)

The maximum characteristic precipitation of Fresh River per 24 hours with a-hundred-year return period is 379mm.

Then the precipitation intensity is:

$P = i \times t/60 = 2.9552 \times 379 \times t^{-0.5860}/60$(mm/min)

The runoff thickness is:

$$R = \frac{[(CN \times p) - 50.8(100 - CN)]^2}{CN[(CN \times p) + 203.2(100 - CN)]} = \frac{[82p - 914.4]^2}{[82 \times [82p + 3657.6]}(mm)$$

The peak discharge

$$Q_p = \frac{0.505AR}{1.6467Tc + t}\ (m^3/s),$$

Where, t is the rainfall period, in min.

The calculation indicates that, when t= 143 mins, the maximum value of Q_p is 412.78 m3/s.

The bridge span required is (m) $B = 4.9Q_p^{0.42} = 61.5$ (m).

Conclusion: The existing 1-9.0m small bridge of Mandela Highway over Fresh River is far

from meeting the flood drainage demand of Caymanas Economic and Technological Development Zone.

4 Flood Disaster Control Program

The major disposal measures are proposed as follows. For specific implementation measures, refer to Flood Disaster Control Design Drawing of Caymanas Economic and Technological Development Zone.

1) Reconstruct the road section of the small bridge of Mandela Highway over Fresh River for a length of 400 to lift the existing upgrade to 3.53 m above the flood level and increase the span of the bridge to more than 61.5m, thus enhancing the flood carrying capacity of Fresh River.

2) Dredge the Fresh River to increase the flood carrying capacity of Fresh River.

3) Add one earth-rock dam on the existing marshland to build an artificial lake to collect the flood, based on the plan map of Caymanas Economic and Technological Development Zone.

4)Establish an independent drainage system to the west of the proposed south-north freeway to reduce the flood carrying pressure of Fresh River.

5 Project Scale

1) The reconstruction length of Mandela Highway will be about 400m and the subgrade design elevation will be lifted to more than 3.53m. Besides, the 1-9.0m small bridge over Fresh River will be dismantled and a 3 x 20m new medium bridge will be built.

2) Dredge the Fresh River to obtain a riverway width of 25 x 2m.

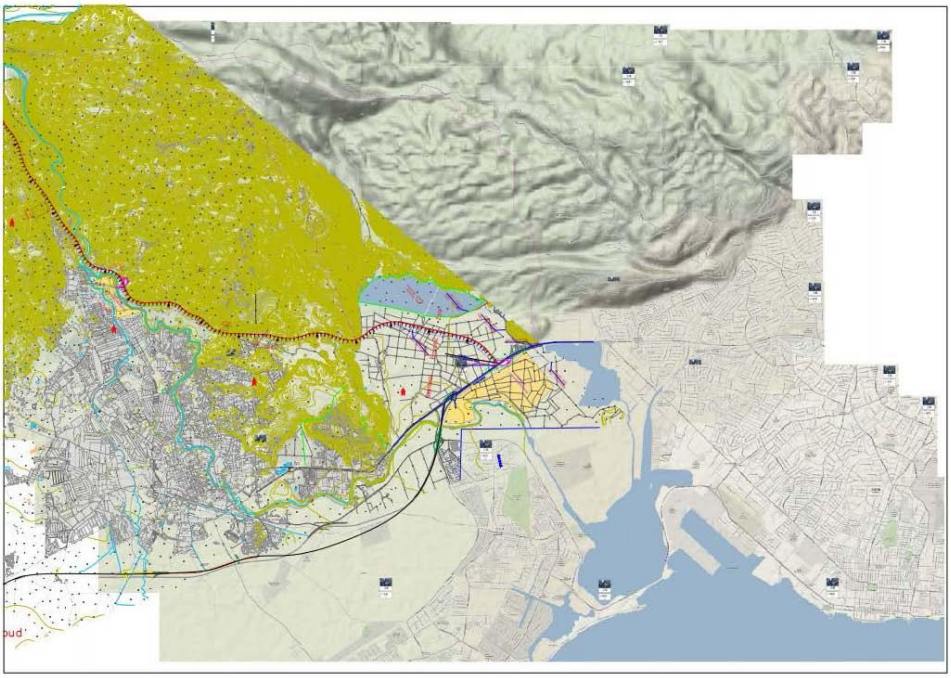
3) Add one earth-rock dam on the existing marshland to build an artificial lake. For the earth-rock dam, the crest elevation will be about 7.0m , the top width will be 3.0m and the bottom width will be 7.0m.

4) Add one 4 x 2.2m culvert at the interchange of the start point of north-south freeway at Caymanas, provide a 4 x 2.0m drainage ditch on the left side of the freeway.

6 Problems and Suggestions

The formation of flood disaster in Caymanas Economic and Technological Development Zone is mainly due to the small bridge of Mandela Highway over Fresh River with a small opening and low clearance. To completely settle the flood disaster issue of such area, it is required to actively discuss with the related highway authorities.

It is recommended that the flood disaster control program shall be combined with the planning of Caymanas Economic and Technological Development Zone.



Attachment 11 Storm Water Management Statement

1

CONTRACTOR	***CHINA HARBOUR ENGINEERING COMPANY***		
(A) PROJECT	***NORTH-SOUTH LINK OF HIGHWAY 2000***		
(B) METHOD STATEMENT #	***SWM003***		
(C) ENVIRONMENTAL ASPECT	***SRORM WATER MANAGEMENT***		
(D) METHOD STATEMENT	***MEASURES TO BE USED TO MANAGE STORM WATER RUN-OFF DURING THE CONSTRUCTION AND OPERATION OF HIGHWAY.***		
Prepared by :	China Harbour Engineering Company	**Reviewed by:**	23/1/2013
Approved by:	23/1/2013		
Presented to:	**National Road Operation and Construction Company (NROCC)**		

JANUARY 2013

2

METHOD STATEMENT FOR THE MANAGEMENT OF STORM WATER RUN-OFF DURING THE CONSTRUCTION AND OPERATION OF HIGHWAY.

APPROACH AND METHODOLOGY

1. The road design drawings and the EIA will be carefully perused.
2. All flood prone areas will be mapped. Special attention will be given to these areas during construction.
3. Drains will be constructed according to approved drainage plan.
4. Bridges, culverts and drainage will be designed to accommodate a 100 year flood event.
5. Runoff from the hydrophobic surfaces of the high way will be concentrated in roadside swales, channels, and ditches. These drainage systems will empty concentrated flow into natural drains.
6. All natural watercourses/drains will be preserved, and if needs be, will be improved, to match the proposed increase flow rate of storm water-runoff.
7. Flow direction of all natural drains will be preserved.
8. Natural water courses will not be impeded.
9. Where needs be, check dams; filter rocks; and/or fabric checks will be used to reduce velocity of run-off in drain ways, swales, ditches, and channels.
10. For sheet flows over slopes, filter rocks will be used to reduce run-off velocity and increase infiltration.
11. All sinkholes in proximity to the road foot print will be carefully managed according to proposed Sinkhole Management Method Statement. EVERY EFFORT WILL BE MADE TO PRESERVE ALL SINKHOLES.
12. Where road traverses drain with high flow volume, box culvert will be constructed; for smaller flow volume, pipe culvert will be used. It will be ensured that all culverts have the appropriate size hydraulic inlet, as per drainage plan.

13. It will be ensured that drains and culverts are maintained, during construction and operating of the highway, to mitigate flooding.
14. Drain and culvert inlet will be protected from scouring using riprap.
15. Dirt drains will be armoured to reduce the velocity of storm water flow.
16. Gabion works, retaining wall etc. will be used to stabilize embankments of watercourses where earthworks have caused embankments to be prone to erosion.
17. Catch basins will be protected from blockage using appropriate inlet protection.
18. For channels with extreme flow, gabions and gabion mattresses will be used to dissipate the high energy of storm water run-off.
19. It will be ensured that drainage onto and between any wetland area adjacent to the road construction activities is established and maintained, using appropriately sized culverts to maintain existing water flow regimes.
20. Slopes will be revegetated to reduce the flow velocity of storm water run-off, and hence erosion. As for steep slopes, diversions, using swales will be used to shorten slope and minimize run-off down the slope and/or stones will be used to construct barriers along contour of slope to convert concentrated flow to sheet flow.
21. Slope drains will be used as follows: on slopes before permanent storm water drainage structure are installed, where diversion measures are being used to concentrate flow, and where storm water from uphill areas/down slope runs straight into receiving streams or rivers. Slope drains will be designed to carry peak discharge from storm water event.
22. Impact and mitigation monitoring will be done by CHEC's Environmental Engineer, assigned to the project.
23. CHEC will be obliged to modify this mitigation approach to satisfy the concerns and recommendations articulated, at any time, by the National Environmental and Planning Agency (NEPA).

4

PERSONNEL AND MATERIALS

To deal with storm water management during the construction and operation of the highway, the following personnel, materials and equipment will be made available at site, at all times.

Personnel

a. Environmental Engineer
b. Site Engineer
c. Surveyors
d. Site Supervisor
e. Labourers

MATERIALS AND EQUIPMENT

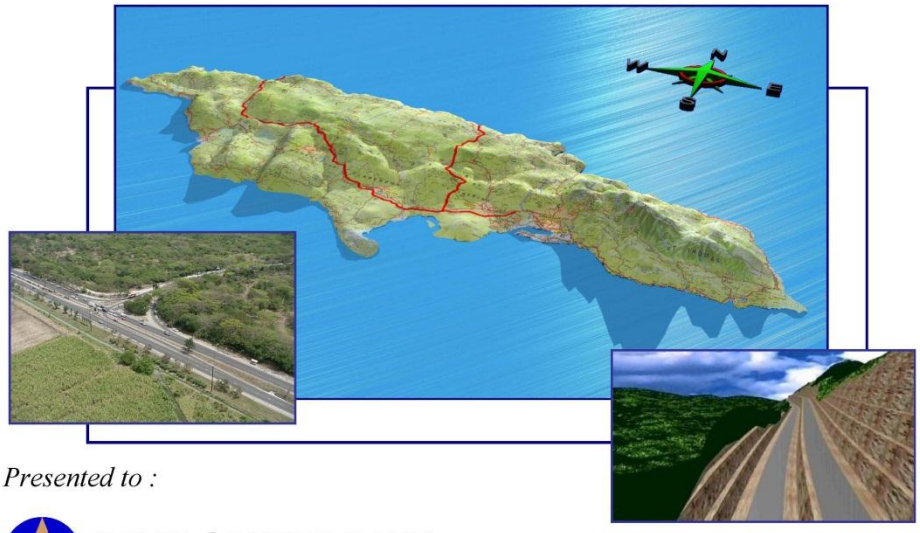
a. EIA documents
b. Environmental and Mitigation Plan
c. Map of flood prone areas
d. Design drawing of drainage plan
e. Construction materials for construction of storm water drains, riprap, slope drains, ditches, swales, bridges, culverts et al.
f. Construction equipment.

Attachment 12 Highway 2000, Preliminary Design Phase;- Project Economic Cost-Benefit Analysis

JAMAICA

HIGHWAY 2000 PROJECT
Preliminary Design Phase

ECONOMIC COST-BENEFIT ANALYSIS



Presented to :

DEVELOPMENT BANK OF JAMAICA LIMITED

By :

DESSAU SOPRIN INTERNATIONAL INC., Canada

O/Ref : 40052-241

JULY 2000

Development Bank of Jamaica Limited

HIGHWAY 2000 PROJECT
PRELIMINARY DESIGN PHASE

ECONOMIC COST-BENEFIT ANALYSIS

Prepared by : Jeff Plant, P. Eng.

Gilles Joubert
ADEC Consultants Inc.

Approved by :

Imants Hausmanis, P. Eng.
Project Director

DESSAU SOPRIN INTERNATIONAL INC., Canada

HIGHWAY 2000 Technical Services

July 2000
O/Ref. : 40052-241

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EXECUTIVE SUMMARY

A conventional economic cost-benefit analysis (ECBA) has been undertaken to determine the economic profitability to Jamaica of proceeding with the development of Highway 2000.

Highway 2000 is planned as a 4-lane high speed limited access motorway that will connect Kingston to Montego Bay and Ocho Rios. The project is to be constructed in two phases: Phase 1 includes upgrading of the Portmore Causeway and completion of the Highway between Kingston and Mandeville (85 km in total); Phase 2 includes completion of the Highway between Mandeville and Montego Bay[1] and completion of the Highway between Old Harbour and Ocho Rios (148 km in total).

Costs used for the ECBA are based upon a Class "C" estimate[2] prepared by Dessau Soprin International using the alignment and technical requirements described in the Functional Planning Report[3]. Capital Costs are summarised below in Year 2000 Constant Dollars:

Construction – Phase 1	US$235,000,000
Construction – Phase 2	US$523,000,000
Grantor Development Costs[4]	US$20,000,000
Concessionaire Development Costs[5]	US$45,000,000
Total Capital Costs	US$823,000,000

Annual operating, maintenance and rehabilitation costs are assumed to be 1.17% of the Construction Costs in Year 2000 Constant Dollars.

1. Although a decision has been made to include construction of the Montego Bay By-pass in Phase 2 of the concession project, the economic costs and benefits are not included in the calculations. The estimated capital cost of the Montego Bay By-pass works is US$35,000,000.
2. A Class "C" cost estimate is based upon conceptual plans and a limited amount of field information. Class "C" cost estimates are generally considered to be accurate to plus or minus 25%, 19 times out of 20.
3. Highway 2000 Functional Planning Report, prepared by Dessau Soprin International for the Development Bank of Jamaica, May 2000
4. Grantor costs include preliminary design studies and land transfer costs.
5. Concessionaire Development Costs including planning, design, approvals, QA/QC and engineering during construction.

It is estimated that 36% of the total construction cost will be spent on Jamaican goods and services and 64% on foreign goods and services.

For analysis purposes, it has been assumed that construction of Phase 1 will start in 2002 and Phase 2 in 2003. A 2 year construction period has been assumed for Phase 1 and 3 years for Phase 2. The costs and benefits are compared to the status quo condition (no Highway 2000) over a 50 year period.

The Present Value (PV) of the costs of Highway 2000 have been calculated using a 10% discount rate as follows:

Phase 1 Cost (PV) =	US$227,837,114
Phase 2 Cost (PV) =	US$278,681,155
Total Cost (PV) =	US$501,415,018

Construction of Highway 2000 will provide significant benefits to the Jamaican travelling public. The benefits have been assessed in terms of travel time savings, vehicle operating cost savings, public safety savings (reduced accident costs), rehabilitation and maintenance cost savings on the existing highway network and savings related to other externalities (primarily air pollution related).

The Present Value (PV) of the benefits of Highway 2000 have been calculated using a 10% discount rate in a range[6] as follows:

	Low Range	High Range
Phase 1 Benefits (PV) =	US$472,201,797	US$666,373,720
Phase 2 Benefits (PV) =	US$194,068,865	US$237,611,329
Total Benefits (PV) =	US$608,791,006	US$855,911,690

A comparison of the benefits to costs at a 10% discount rate produces the following Benefit/Cost (BCR) ratios:

6. The difference is solely related to differences in the estimated value of time from J$79.45 to J$125.00 per hour for work-related travel, J$57.22 to J$107.50 per hour for work-related commuting and J$15.93 to J$75.00 for leisure-related travel. (J$40 = US$1)

	Phase 1	Phase 2	Total
BCR Low Range	2.07	0.70	1.21
BCR High Range	2.92	0.85	1.71

Another method of assessing the attractiveness of public sector projects is to estimate their Internal Rate of Return (IRR). The IRR is equivalent to the discount rate at which the NPV of the stream of benefits is exactly equal to the NPV of the stream of costs. The following is a summary of the IRR calculations for Highway 2000:

	Phase 1	Phase 2	Total
IRR Low Range	16.05%	7.76%	11.41%
IRR High Range	19.92%	9.00%	14.15%

A project is clearly worthwhile when the BCR is greater than 1.0 and becomes increasingly beneficial as the value of BCR grows. On the other hand, a project for which the BCR is less than 1.0 would only proceed if it was considered that there would be substantial secondary benefits not fully captured by the analysis or if that project was a component of a larger scheme that had an overall BCR greater than 1.0.

In the case of Highway 2000, there are many indirect benefits that are not captured in a traditional ECBA. These include the development of collateral opportunities that could not proceed unless the Highway is constructed. In addition, the stimulative effect of a major infrastructure project such as Highway 2000 can not be overlooked within the context of the Jamaican economy. The Planning Institute of Jamaica has undertaken parallel analyses which support the positive impact which Highway 2000 will have on the overall economy.

It is concluded that both the direct and indirect benefits of Highway 2000 are greater than the associated costs of proceeding with the project. In economic terms, Highway 2000 will certainly benefit the Jamaican economy when it is constructed.

1 ECONOMIC ANALYSIS

1.1 CONTEXT

The Government of Jamaica is planning a major new highway to link the Cities of Kingston, Spanish Town, Mandeville, Montego Bay and Ocho Rios.

A Pre-Feasibility Study[7] undertaken in 1996 by Dessau International of Canada concluded that the project was technically feasible and should be considered further, perhaps on the basis of a public-private toll-based concession. In September of 1999, the Government of Jamaica announced its intentions to proceed with Highway 2000 as a concession project.

Dessau Soprin International was retained to complete a Functional Planning Study; to recommend a preferred alignment within the broad corridor that had been previously identified; to undertake supplementary technical, environmental and socio-economic investigations; and to prepare an Illustrative Solution and technical specifications for Concessionaire bidding purposes.

This report summarises aspects of the socio-economic investigations and provides an update to the economic cost-benefit analysis that was undertaken in 1996.

1.2 METHODOLOGY

Cost-benefit analysis techniques have been used to structure and analyse available information to estimate the efficiency and socio-economic profitability of Highway 2000 and thus determine the extent to which society in general will benefit from it.

A five-step work program was undertaken :

1. review of existing information and preparation of a detailed methodology;
2. identification of economic parameters;
3. data collection;

7 "Highway 2000 Project, Final Report of a Pre-feasibility Study" for National Investment Bank of Jamaica, Dessau International Ltd. January 1997

4. calculation of costs and benefits;
5. conclusions and final economic report.

The project is divided into four sections (**Table 1.1**) for analysis.

Table 1.1 Sections of Highway 2000

Section	Km
Kingston - Bushy Park	34
Bushy Park - Mandeville	51
Mandeville - Montego Bay	85
Bushy Park - Ocho Rios	63
Total	233

It is expected that construction of Highway 2000 will also improve travel conditions on the existing road network as traffic is drawn to the new highway. The basis for the economic cost-benefit analysis is a comparison of two scenarios describing the impact on the road network: the first assuming that the highway is built; the second assuming nothing is done (the status quo).

A key objective is to compare the investment required to build the highway and maintain it to a level that will generate the expected benefits on a net present value (NPV) basis and to provide an opinion on its economic viability.

The analysis relies on :

- traffic modelling and forecasts prepared by Steer Davies Gleave [SDG][8];
- Class "C" cost estimates prepared by Dessau-Soprin.

An economic cost-benefit analysis for Highway 2000 requires : i) an understanding of the dynamics of travelling in Jamaica and the role that the new highway could play in the

8 Highway 2000 Traffic and Revenue Forecasts, May, 31 2000

future, ii) the identification and evaluation of the discounted[9] costs and benefits resulting from the situation in which the highway is built, and finally, iii) a comparison of potential benefits against potential costs in order to determine if the project is socially viable.

The challenge is to evaluate the full range of benefits and costs of this project and determine if there is a social case to justify the highway; and to examine, determine and report on the potential impact that the project would have.

9 Discounted refers to costs (or benefits) whose future values have been discounted, using an annual discount rate over the project's economic life, to reflect their present values (PV) in constant J$.

2 ECONOMIC COST-BENEFIT ANALYSIS

The Economic Cost-Benefit Analysis (ECBA) approach is a well-known and recognised procedure used to structure and analyse available information in the evaluation of public infrastructure projects to address the efficiency issue and the economic growth such projects may generate. Facilitating choice among projects and allocation of public resources are the two main objectives of the ECBA. This requires setting-up a base case and comparing other scenarios against it.

The technique is recommended for the appraisal of partially or fully publicly financed investment projects in order to allocate resources in a way most profitable to society.

The objective is to set a monetary value for the benefits and economic costs of the project when compared to the base case. All elements of cost and benefit must be detailed and the appropriate monetary value attributed to them. **Table 2.1** summarises the costs and benefits that are generally considered, while **Table 2.2** lists the quantifiable factors that are generally considered.

In an ECBA, it is also recognised that the market prices of goods and factors of production do not necessarily reflect their social value and costs respectively. Corrections to market prices are therefore made.

Table 2.1: General Diagram of a ECBA

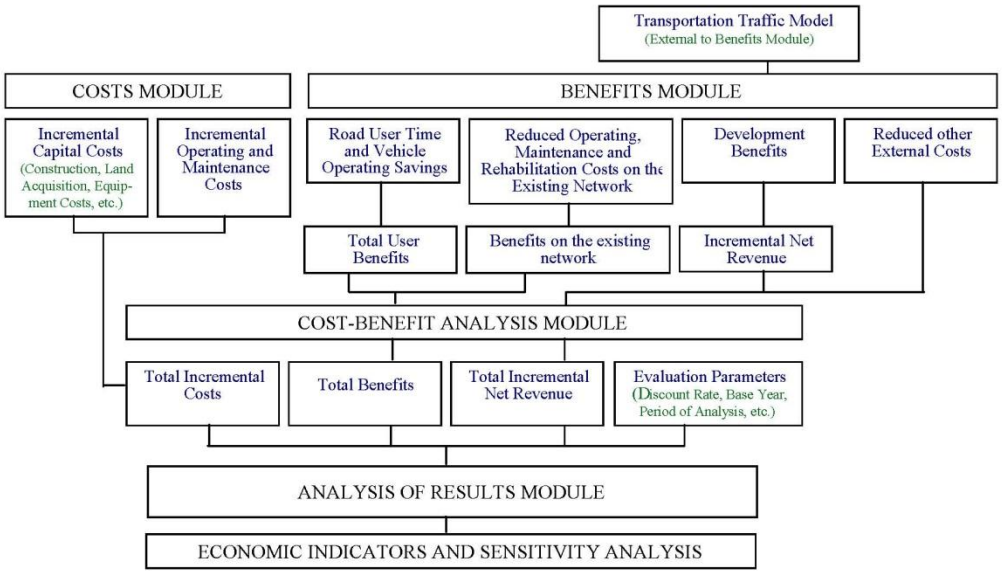

Table 2.2 : Benefits and Costs Items

Affecting Users
• Travel time savings;
• Vehicle operation cost savings;
• Security related savings (life and injuries, damage to property).
Affecting Owners and Operators of the Road Network
• Highway construction costs;
• Land acquisition;
• Maintenance costs;
• Network operating costs;
• Savings related to postponement of maintenance costs on other roads (*ex.* existing road).
Affecting Non-users
• Travel time savings or costs from changes in traffic on other roads or modes;
• Costs and benefits related to air quality;
• Costs and benefits related to energy consumption of different transportation modes;
• Other externalities.

Traditional cost-benefit analysis of highway projects concentrates on savings in vehicle operating cost, maintenance cost and time savings. It is true that road projects create benefits that come in the form of savings of costs. They do not create revenues per se. In road projects, externalities are the major source of benefits and the challenge is to internalise these externalities and thus give a measure and a value of the effects on vehicle operating costs, people's time, people's lives, environment, etc. As well, it is recognised that investment in transportation infrastructure can generate substantial secondary benefits by reducing costs for existing productive activities, providing access to new areas with economic development potential and triggering investment activities. These secondary

benefits are usually translated in generated traffic, and are generally captured in the forecast activity.

The economic evaluation of public projects does not ask a different sort of question to those posed by private enterprise in pondering the wisdom of a proposed capital investment. While a financial analyst may ask whether its company owners will be made better-off by the proposed investment, the public sector analyst asks whether society as a whole will be made better-off by undertaking the project rather than not undertaking it, or by undertaking an alternative project instead.

Simply stated, public and private sector (in this case the concessionaire) analyses differ in the nature and the range of benefits and costs taken into consideration. The financial analyst must examine the earning power of a prospective investment for its shareholders. In so doing, only those costs and benefits that are internal to company operations are considered.

A concessionaire for instance will be interested only in users costs savings like time, vehicle operating and security. The concessionaire will set tolls in order to capture the savings made or perceived by these users.

In the public sector, on the other hand, the project analyst must consider the earning power of an investment not just from the owners' point of view but from the national viewpoint. In the case of highway investment, improved labour productivity that stems from passenger time savings and energy conservation from the reduction in truck, mini-bus and private vehicle fuel consumption, all of which can result from new road capacity, are just as significant as the efficiency gains that an owner might achieve as a result of investment.

3 PROJECT DEFINITION AND DATA

3.1 THE PROJECT

Highway 2000 consists of building 233 km of toll highway linking the main towns and some of the major tourist areas in Jamaica. It will improve ground transportation and be a catalyst for economic activity along its corridor. Split in four sections of different lengths, their individual lengths and construction and maintenance costs are given in Table 3.1.

Table 3.1: Construction and Maintenance Costs by Road Sections

Section	Length	Lanes	Construction	Annual Maintenance
Kingston–Bushy Park	34 km	4	US$235,000,000	US$2,750,000
Bushy Park-Mandeville	51 km	4		
Mandeville–Montego Bay	85 km	4	US$523,000,000	US$6,120,000
Old Harbour–Ocho Rios	63 km	4		
Total	233 km		US$758,000,000	US$8,870,0000

Source : Dessau-Soprin May 2000

For the purpose of this cost-benefit analysis, two road sections will be evaluated. Phase 1 includes Kingston to Mandeville and Phase 2, Mandeville to Montego Bay and Old Harbour to Ocho Rios.

3.2 TRAVELLING PRICES AND THE VEHICLE FLEET

In the 1996 pre-feasibility study, the out-of-pocket savings were estimated at 0.049 US$/veh-km from running on the future highway between Kingston to Montego Bay as compared to the existing road, representing a 27.8% savings on present costs. For trucks the savings were estimated to be 20.00 US$ for a 10 ton load, a saving of 32.2% on actual costs. In 1996, the costs of travelling between Kingston and Montego Bay were estimated at US$31.96. With the new road this price would decline to a level of US$22.78 for a total saving of 9.18 US$.

In 1998, 163,575 motor cars passed the fitness registration (the best proxy available of the vehicle fleet). Since about 70% of the vehicle fleet is captured in one year according to the Island Traffic Authority, the total 2000 fleet is estimated to be around 230,000 cars. In Table 3.2, the average rate of growth over the last 37 years is shown as 5% for cars and 6% for trucks. Compared with the population in Jamaica estimated at 2.55 million at this time, there is a ratio of 0.09 cars per person. Compared with the USA ratio of 0.48 or Canada at 0.46 this is fairly low. Trucks account for an additional 85,000 vehicles or roughly 37% of the fleet. The following observations are made about the vehicle fleet :

- The quantity and the quality of vehicles have changed substantially since the 70s and, in particular, since 1993. Jamaica placed or restrictions on imports of cars between the mid-1980s and 1993. In 1993, restrictions on the importation of used cars were relaxed, resulting in a flood of cars from Japan. Since then, rules have been tightened by only allowing the importation of cars less than five years old and by imposing an increased import levy.
- The figures on licensing statistics are appreciably higher than those obtained from inspection statistics. This is due to the fact that licenses may be taken for a minimum of three months at a time and many owners renew their licenses more than once a year, resulting in appreciable double counting. The fact that people can renew their license on a new car without their actual license or an old car explains the overstated number.
- In Jamaica, it is mandatory to obtain an inspection certificate to operate a vehicle on public road. New vehicles have to be inspected after 18 months, and defective vehicles may be inspected more than once a year.
- While the statistics on vehicles inspection are not a true measure of the vehicle fleet, they are the best available estimates. **Table 3.2** shows the number of inspections carried out island-wide since 1961. The same statistics are also available by Parish. According to officials of the Island Traffic Authority, they capture between 60 and 70 % of all vehicles in one year (from April to March of the following year). Thus the numbers in **Table 3.2** are adjusted to take this factor into account.

Table 3.2 : Number of Fitness Registration per Year - per Vehicle Type

Fleet Indicators Vehicle Types	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970
Fitness Registrations	41 677	48 633	51 024	54 830	57 194	57 571	63 204	67 354	64 910	64 982
Motors Cars	28 999	34 452	35 851	38 434	40 477	40 110	44 325	47 924	46 615	45 864
Trucks and Tractors	8 485	9 180	9 690	10 297	10 400	10 554	12 080	12 279	11 636	12 026
Motorcycles	2 414	3 265	3 683	4 275	4 478	5 175	5 277	5 521	5 126	5 716
Trailers	1 779	1 736	1 800	1 824	1 839	1 732	1 522	1 630	1 533	1 376
Annual Growth		17%	5%	7%	4%	1%	10%	7%	-4%	0%
As % of Total Fleet										
Motors Cars	70%	71%	70%	70%	71%	70%	70%	71%	72%	71%
Trucks and Tractors	20%	19%	19%	19%	18%	18%	19%	18%	18%	19%
Motorcycles	6%	7%	7%	8%	8%	9%	8%	8%	8%	9%
Trailers	4%	4%	4%	3%	3%	3%	2%	2%	2%	2%

Fleet Indicators Vehicle Types	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
Fitness Registrations	72 521	72 778	71 092	77 080	88 801	84 646	72 072	60 242	60 505	53 327
Motors Cars	51 544	50 759	48 890	51 147	58 671	55 969	48 001	39 446	40 174	34 036
Trucks and Tractors	13 015	13 464	13 040	14 971	17 340	17 093	13 946	12 336	13 282	13 805
Motorcycles	6 631	7 294	8 082	10 225	11 958	10 510	9 263	7 578	6 355	4 876
Trailers	1 331	1 261	1 080	737	832	1 074	862	882	694	610
Annual Growth	12%	0%	-2%	8%	15%	-5%	-15%	-16%	0%	-12%
As % of Total Fleet										
Motors Cars	71%	70%	69%	66%	66%	66%	67%	65%	66%	64%
Trucks and Tractors	18%	19%	18%	19%	20%	20%	19%	20%	22%	26%
Motorcycles	9%	10%	11%	13%	13%	12%	13%	13%	11%	9%
Trailers	2%	2%	2%	1%	1%	1%	1%	1%	1%	1%

Fleet Indicators Vehicle Types	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Fitness Registrations	63 812	65 534	56 752	70 406	74 982	71 742	82 881	98 856	111 858	115 995
Motors Cars	41 163	40 271	35 024	42 037	42 888	44 457	52 886	63 125	72 881	69 616
Trucks and Tractors	17 394	20 167	17 392	23 154	26 060	20 737	23 032	26 885	29 793	37 481
Motorcycles	4 828	4 554	3 859	4 770	5 608	6 032	6 347	8 181	8 397	7 732
Trailers	427	542	477	445	426	516	616	665	787	1 166
Annual Growth	20%	3%	-13%	24%	6%	-4%	16%	19%	13%	4%
As % of Total Fleet										
Motors Cars	65%	61%	62%	60%	57%	62%	64%	64%	65%	60%
Trucks and Tractors	27%	31%	31%	33%	35%	29%	28%	27%	27%	32%
Motorcycles	8%	7%	7%	7%	7%	8%	8%	8%	8%	7%
Trailers	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%

Fleet Indicators Vehicle Types	1991	1992	1993	1994	1995	1996	1997	1998	Average annual growth
Fitness Registrations	117 398	109 828	125 121	135 059	160 096	180 290	223 610	227 779	5 030
Motors Cars	77 840	73 865	81 116	86 791	103 996	120 743	156 751	163 575	3 637
Trucks and Tractors	29 771	27 048	36 157	41 312	49 095	52 833	61 482	59 373	1 375
Motorcycles	8 675	8 239	7 150	6 155	6 363	5 783	4 345	3 782	37
Trailers	1 112	676	698	801	642	931	1 032	1 049	-20
Annual Growth	1%	-6%	14%	8%	19%	13%	24%	2%	5%
As % of Total Fleet									
Motors Cars	66%	67%	65%	64%	65%	67%	70%	72%	67%
Trucks and Tractors	25%	25%	29%	31%	31%	29%	27%	26%	24%
Motorcycles	7%	8%	6%	5%	4%	3%	2%	2%	8%
Trailers	1%	1%	1%	1%	0%	1%	0%	0%	1%

source: ISLAND TRAFFIC AUTHORITY
Determination of Traffic Growth, No. Fitness Registration Issues, by Year and Category of Vehicle, 1960-1998.

None of these fleet owners pay directly for the road network they now use; they contribute indirectly through income taxes, license fees and consumption taxes. But, some of their passengers do pay if they use travel services. From a small survey conducted at the end of January 2000, a number of transport services companies were asked what they charge for transporting people from Kingston to Montego Bay, for example. The survey results indicate that the average fare for taxis is J$1,300 (US$30.95) and for buses J$500 (US$11.90) (See Table 3.3).

Table 3.3 : Taxi and Buses Service Charges from Kingston to Montego Bay

Taxi Service
from: Kingston to Montego Bay.

Company	Fare (J$)	Passengers	Trip type	Address	Telephone
Apollo Tours & Taxi Serv	5 000	4	1-way trip	30E C Spring Rd (10)	901-9512
Safe Travel Taxi	4 500	4	1-way trip	Shop 16 27A Seaward Dr (20)	901-5510
Candy Cab Ltd	5 000	4	1-way trip	189 Mountain View Ave	978-8090
Central Taxi Services Ltd	5 500	4	1-way trip	Shop 1 30 Red Hills Rd (10)	926-8470
Checkers Cabs	6 000	4	1-way trip	19 Connolley Av (4)	922-1777
AVERAGE FARE:	**5 200**			**AVERAGE FARE PER PASSENGER:**	**1300 J$**
				AVERAGE FARE PER KILOMETRE:	6,95 J$
					0.17 US$

Souce: Telephone Survey, Wed Jan 26 2000, Kingston, Jamaica.

Buses - Charter & Rental Service
from: Kingston to Montego Bay.

Company	Fare (J$)	Max. load	Trip type	Address	Telephone
Bloomfield Ja Ltd	14 000	30	round trip	53 Hope Rd (6)	927-3484
Clough Cars & Buses	18 000	32	round trip	20 Bentley Cres (20)	933-5436
Neville's Transport	15 000	30	round trip	14 Maxfield Av (13)	923-4399
Danobal Transport Servs Ltd	18 000	40	round trip	5 Melwood (8)	924-0644
GB Transport	15 000	30	round trip	Shop 12 176 Spanish Town (11)	937-4476
AVERAGE FARE:	**16 000**			**AVERAGE FARE PER PASSENGER:**	**500 J$**
				AVERAGE FARE PER KILOMETRE:	2,67 J$
					0,07 US$

Souce: Telephone Survey, Wed Jan 27-28 2000, Kingston, Jamaica.

Charging for use of Highway 2000 as part of a resource-based tax shift would offset, or internalise, some of the costs that driving imposes on society. These costs include both common perceptions of costs, time, energy, material, health, as well as other subsidies which artificially reduce the price of driving. If drivers do not bear the full costs, they are

receiving a subsidy even if government is not paying them anything. In the USA, for example, a recent study evaluated this subsidy at US$184 billion a year (private costs US$59 billion and social costs US$125 billion)[10].

3.3 THE BASE CASE: THE PRESENT SITUATION

The existing road network is recognised to be unable to provide an adequate contribution to mobility and thus can not adequately support economic activities and development. Measures to optimise the existing road network are not considered to form the base case against which major investment options are subsequently evaluated. The base case for this evaluation is the existing condition of the road network.

The base case will certainly bring some benefits to society but will also use available resources that could otherwise be used for other purpose. Therefore all further savings and costs will be additional ones when compared to the base case situation.

In a recent paper by Todd Litman[11], all travel costs were detailed and weighted against each other.

Figure 3.1 and **Figure 3.2** contain excerpts from Litman's paper where the magnitude and distribution of costs for an average north-American automobile-owner are presented. Normalisation to the Jamaican case should be made, however, the unadjusted figures give a good understanding of the total automobile costs that society in general has to deal with. Thus there are potential savings on these costs.

A number of other recent studies examine the full costs of motor vehicle travel[12]. Some transport costs are already commonly measured, such as vehicle operating expenses, transportation facility costs, and the value that people place on travel time, safety and

10 *The roads aren't free: estimating the full social costs of driving and the effects of accurate pricing*, by Clifford W.Cobb.

11 Todd Litman, *Socially Optimal Transport Prices and Markets: Principles, Strategies and Impacts*, VTPI (www.vtpi.org), November 1999, p.11-14.

12 More than two dozen such studies have been performed during the last decade. Bibliographies are available in Mark Delucchi, *Review of Some of The Literature on the Social Cost of Motor-Vehicle Use, Report # 3 in the Series: Annualized Social Cost of Motor-Vehicle Use in the U.S., 1990-1991*, Institute of Transportation Studies (Davis), UCD-ITS-RR-96-3, April 1996; Todd Litman, *Transportation Cost Analysis; Techniques, Estimates and Implications*, VTPI (www.vtpi.org), 1998; Chapter 2; K.T. Analytics, *Review of Cost of Driving Studies*, Metropolitan Washington Council of Governments (Washington DC), 1997; David Bray and Peter Tisato, "Broadening the Debate on Road Pricing," *Road & Transport Research*, Vol. 7, No. 4, Dec. 1998, pp. 34-45.

comfort under various conditions. Other costs, such as environmental impacts and social costs from road crash injuries and deaths, are more difficult to quantify, but recent studies have estimated them using various analysis techniques. **Table 3.4** defines these costs.

Table 3.4 : Costs that Can Result from Motor Vehicles[11]

Cost	Definition	Categories
User Travel Time	Time spent travelling.	Internal-Variable
Internal Accident	Vehicle accident costs borne by users.	Internal-Variable
Vehicle Operation	User expenses that are proportional to travel.	Internal-Variable
Internal Parking	Parking costs borne by users.	Internal-Fixed
Vehicle Ownership	Fixed vehicle expenses.	Internal-Fixed
External Accident	Vehicle accident costs not borne by users.	External
Operating Subsidies	Vehicle expenses not paid by the user.	External
External Parking	Parking costs not borne by users.	External
Congestion	Delay each vehicle imposes on other road users.	External
Road Facilities	Road expenses not paid by user fees.	External
Roadway Land Value	Opportunity cost of land used for roads.	External
Municipal Services	Public services devoted to vehicle traffic.	External
Equity & Option Value	Reduced travel choices, especially for disadvantaged people.	External
Air Pollution	Costs of motor vehicle emissions.	External
Noise	Costs of motor vehicle noise.	External
Resource Consumption	External costs from consumption of natural resources.	External
Barrier Effect	The dis-amenity motor traffic imposes on pedestrians and bicyclists. Also called "severance."	External
Land Use Impacts	Economic, social and environmental costs resulting from increased pavement and low density, auto oriented land use.	External
Water Pollution	Water pollution and hydrologic impacts of vehicles & roads.	External
Waste Disposal	External costs from motor vehicle waste disposal.	External

These costs can be categorised according to how they impact consumers transport decisions:

- *Internal variable* costs are users' short-term costs that vary with the amount of travel. This includes out-of-pocket expenses, travel time and accident risk borne by the traveller. These directly affect trip decisions and are those that a concessionaire will consider in a toll-pricing policy.
- *Internal fixed* costs are not perceived as being significantly affected by vehicle use. These include vehicle depreciation, insurance, registration, and residential or leased parking. These tend to affect consumers' vehicle purchase decisions, but once a vehicle is purchased and put on the road, have little impact on its use[13].
- *External costs* are not directly borne by individual users (although everybody, including vehicle users, bears them in aggregate). These include costs of roadway and parking facilities not charged directly to users, congestion impacts on other road users, accident risk borne by others, and environmental damages. These costs do not directly affect individual consumers' travel decisions, although they may affect a community's long-term transport policies.

13 Vehicle depreciation and insurance costs are actually partly variable, so true marginal costs average about twice what most drivers perceive when evaluating their marginal cost for a particular trip.

Figure 3.1 illustrates the estimated magnitude of these costs. The largest costs are internal and the most frequently used in transportation evaluation: time, vehicle operating costs and accidents. External costs are smaller, but more numerous.

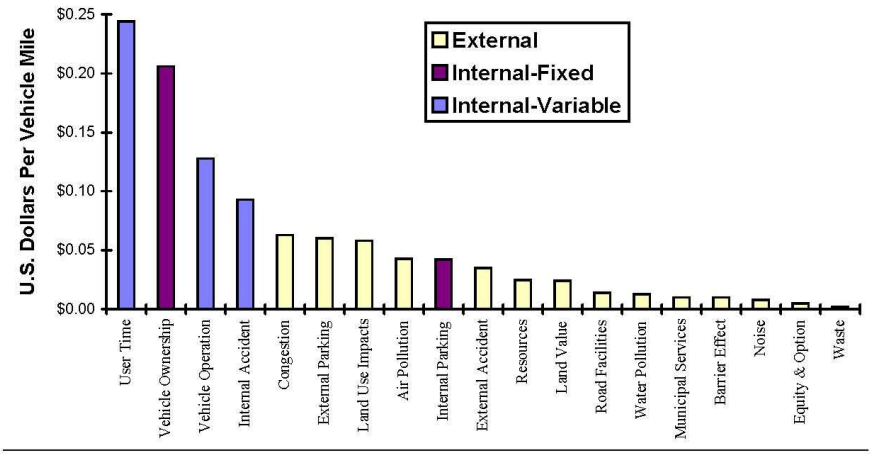

Figure 3.1: Magnitude and distribution of costs for an average automobile in North-America[11]

Figure 3.2 illustrates the distribution of automobile costs. It shows that internal-variable costs, the "price" that affects individual trip decisions in the short run, constitute 45 % of all costs. Almost a third (32 %) of costs are external according to this figure. These figures also show that user charges would have to increase significantly to internalise all costs. In addition, almost a quarter of total costs are perceived as internal but are fixed generally speaking. Once users pay these costs they do not affect vehicle use but they are certainly affected by road improvement.

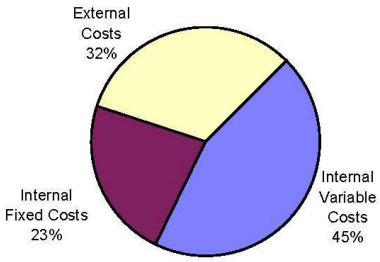

Figure 3.2 : Distribution of automobile costs[11].

Figure 3.3 compares the estimated magnitude and distribution of costs per passenger kilometre for eleven different modes. Most motorised forms of transport impose significant external costs. The exception is a rideshare passenger (an additional vehicle passenger using an otherwise empty seat), which has the lowest cost of all modes. Fuel efficient and electric cars reduce some external costs, such as air pollution, but not others, such as congestion, parking and accidents. Transit has relatively high external costs per passenger kilometre, due to operating subsidies where they exist, but because transit riders tend to travel less than automobile users, their annual external costs are typically lower than that of drivers.

All of these modes are not necessarily present in Jamaica but most of them are so that categories or mode categories should be used to properly reflect the Jamaican context.

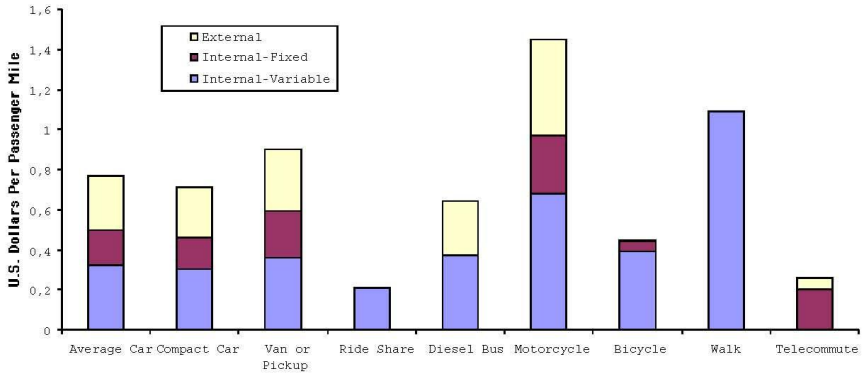

Figure 3.3 : Cost distribution for nine modes[11].

3.4 HIGHWAY STRATEGY

The Highway 2000 strategy is evaluated in an incremental fashion in relation to the base case. For each cost item the base case figure is compared to the highway case on a net basis (incremental).

Five major groups of benefits have been identified and each one of them is desegregated and detailed as much as possible. The categories are the following:

- travel time savings;
- vehicle operating cost savings;
- security related savings;
- maintenance and rehabilitation costs savings;
- savings related to other externalities.

3.4.1 Travel Time Savings

When roadway capacity is expanded, the following is generally observed : i) improved productivity as a result of reductions in travel time for business travellers and ii) social benefits as a result of savings in leisure time for non-business travellers.

These savings have economic value by virtue of users' willingness to pay to reduce the amount of time spent travelling.

The building of a new highway increases the capacity of the network. More vehicles travelling from one point to another more rapidly means that less time is spent on transportation and more time becomes available for other activities. These savings have economic value by virtue of user's willingness to pay to reduce the amount of time spent in travel. These benefits fall into specific categories in the *ECBA* tables as the value of time differs between modes and between motives.

SDG have estimated time saving between major cities and towns and for the road sections under study. Table 2 from the SDG report is reproduced here to illustrate this point (see Table 3.5). For more details, see Appendix A where estimated total time savings in hours per year are given.

Table 3.5 : Time Savings in Minutes by Light Vehicle

From	To	Existing Time	New Time	Saving
Kingston	Spanish Town	63	15	48
	Old Harbour	81	17	64
	May Pen	106	29	77
	Mandeville	151	42	109
	Montego Bay	242	104	138
	Ocho Rios	139	58	81
Mandeville	Ocho Rios	176	73	103

Road users travel for either business purposes or leisure activities. Daily commuting to and from the workplace, transporting people or freight, collecting or making payments and meeting clients or colleagues are all considered travel for business purposes. Travel for

leisure purposes include all other motives for road use. The next step is to attribute monetary values for the time spent or saved on the road *i.e.* value of time, for these categories of road users.

Since a person travelling for business purposes is prevented from simultaneously working at the usual workplace, society forgoes (or loses) the equivalent of the person's salary in production. Therefore, the monetary value of one hour spent on the road network is equivalent to that person's gross hourly wage.

3.4.1.1 Truckers and Motorists -- for Business Purposes (Work Motive)

The data in **Table 3.6** and **Table 3.7** enables to calculate the values of time for truck drivers and motorists. These numbers along with the procedure described in the next section allows two estimates to be calculated based on different sources of information.

By taking the weekly average salary of a driver (heavy duty) in the manufacturing sector in 1999, which from **Table 3.6** is J$5,507 /week, and dividing it by the hours worked per week in the land transportation sector in 1998, which from **Table 3.7** is 40.10 hrs/week, the average hourly wage of a truck driver is obtained. In 2000, this represents J$140.85/hr.

An alternative is to take the basic hourly rate in land transportation from **Table 3.7**, which was J$57.70/hr in 1998, and assume that all workers in that sector are truck drivers. The estimate of the average hourly wage of a truck driver becomes then J$63.95 /hr in 2000.

Table 3.6 : Weekly Salary Ranges (1997) for Drivers (J$)

Weekly Salary Ranges Type	Maximum	Minimum	Average	Median	Number[1]	Standard Deviation	Upper Quartile	Lower Quartile
Driver[2] (MB or MV)	6 831	1 711	3 672	3 339	31	1 198	2 705	4 389
Driver (Heavy Duty)	6 951	2 500	4 147	3 778	9	1 574	3 221	4 059
Driver (MB or MV)	1 085	2 846	5 022	4 805	21	1 941	5 569	3 738
Driver (Heavy Duty)	4 180	1 709	3 321	3 313	8	739	3 651	3 017
Manufacturing Sector								
Driver (Heavy Duty)	11 610	2 019	5 507	5 124	9	2 836	3 529	6 514

source: BRYAN, G. (1999), Wage, Salary and Benefits: Supervisory, Clerical and Hourly-Rated Employees, Jamaica Employers' Federation, 1999.

Table Service Summary: Salary Ranges - Clerical Staff - Driver (MV or MB), 1997, p. 17.

Table Service Summary: Salary Ranges - Hourly Rated/Weekly Paid Staff - Driver (Heavy Duty), 1997, p. 19.

Table Manufacturing Summary: Salary Ranges - Clerical Staff - Driver (MV or MB), 1997, p. 25.

Table Manufacturing Summary: Salary Ranges - Hourly Rated/Weekly Paid Staff - Driver (Heavy Duty), 1997, p. 27.

note: [1] Number is the Number of Companies that Supplied Data for that Particular Position.
[2] Drives Motor Vehicle (Car, Van, etc.) for the Transport of Passenger or Freight by Road or for Collection of moneys for the Establishments.
In 1997, 63 companies were surveyed and in 1999, 61 companies were surveyed.
MB = Mini-Bus;
MV = Mini-Van.

In the case of motorists, the average hourly wage is obtained from the all-sector basic hourly rate for 1998 in **Table 3.7**. The value used for 2000 is J$79.53 /hr which is considered a high estimate.

Table 3.7 : Hours Worked per Week and Basic Hourly Rates in Selected Sectors

All Sectors Indicators Industry	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Hours Worked Per Week	**38.50**	**39.74**	**39.46**	**39.48**	**39.42**	**39.74**	**39.86**	**40.51**	**40.54**	**40.52**	**41.87**
Construction	40.49	39.96	39.45	39.65	37.98	40.34	39.85	41.35	41.16	45.40	46.19
Land Transport	38.77	41.39	40.62	40.25	40.93	39.93	39.98	39.72	37.74	38.93	40.10
Services Incidental to Transport	38.55	40.25	39.47	39.50	39.22	41.49	42.68	42.07	43.55	40.46	39.68
Basic Hourly Rate	**6.59**	**7.56**	**9.15**	**11.57**	**16.51**	**26.91**	**38.12**	**47.27**	**56.86**	**68.69**	**72.93**
Construction	6.68	8.00	8.61	10.73	16.08	25.64	39.42	42.23	57.63	63.27	57.63
Land Transport	4.71	4.88	5.80	8.21	10.70	15.30	24.40	25.92	31.29	47.42	57.70
Services Incidental to Transport	6.65	9.10	10.44	12.56	23.75	24.48	30.09	50.84	59.49	77.56	74.71
Average Earnings Per Week	**253.72**	**300.43**	**361.06**	**456.78**	**650.82**	**1069.40**	**1519.46**	**1914.91**	**2305.10**	**2783.32**	**3050.66**
Construction	270.47	319.68	339.66	425.41	610.72	1034.32	1570.89	1746.21	2373.20	2872.46	2662.02
Land Transport	182.61	201.96	235.60	330.45	437.95	610.93	975.51	1029.54	1180.88	1846.06	2318.90
Services Incidental to Transport	256.36	366.28	412.07	496.12	931.48	1015.68	1284.24	2138.84	2590.79	3138.08	2964.22

source: THE STATISTICAL INSTITUTE OF JAMAICA, Employment, Earnings and Hours Worked in Large Establishments, Kingston, Jamaica, 1988-1997.
Table A8. Quarterly Estimates of Average Standard Time Hours Worked Per Week by Hourly Rated Wage Earners in Large Establishments, by Major Industry Groups, 1992-1995 (Excluding Agriculture, Government and Free Zones), p. 47-49.
Table A9. Quarterly Estimates of Basic Hourly Rate of Hourly Rated Wage Earners in Large Establishments, by Major Industry Groups, 1992-1995 (Excluding Agriculture, Government and Free Zones), p. 50-52.

3.4.1.2 Motorists - for Leisure Activities (Non-Work Motive)

Another calculation method can be used to derive a value for work, commute and leisure time for motorists[14] as described in **Table 3.8**. It gives an average hourly value of time of J$15.93/hr in 2000 for motorists travelling by road for leisure purposes. Work time value would be J$79.45 and the all motives time value would be J$57.22.

We believe that this method underestimates the value of leisure time in Jamaica for the following reasons. As indicated earlier, car ownership is relatively low in Jamaica. The weekly average salary of car owners and of car users is probably much higher than the one used in the calculations.

14 F. Juneau and J.M. Salvador (1995), Guide pour analyse avantages-coûts à l'intention des organismes publics de transport, MTQ, Montreal, December 1995, p. 37-38. (Appendix 2: Value of Time Travel, p.37.)

Table 3.8 : Value of Time Calculation Method for Traveller's

1) Work time	
A) Weekly average salary in Jamaica in 1998 [1]	3 326.78 J$
B) Average hours per week	
Number of hours worked [1]	41.87 hrs
C) Value of time during a trip for "work motive" (A / B)	**79.45J$**
2) Non-work time	
D) Disposable income per capita [2]	100 355.90 J$
E) Hours not-worked per year	
Hours in a year (24 hours X 7 days X 52 weeks)	8 736.00 hrs
Hours worked per year (D X 52 weeks)	2 437.41 hrs
Difference	6 298.59 hrs
F) Value of time during a trip for "non-work motive" (F / G)	**15.93J$**
3) All-motive time [3]	
G) Proportion of trips for work motive	65%
H) Proportion of trips for non-work motive	35%
I) Value of time during a trip for "all-motive" (G X C + H X F)	**57.22J$**

[1] THE STATISTICAL INSTITUTE OF JAMAICA, Employment, Earnings and Hours Worked in Large Establishments, Kingston, Jamaica, 1988-1998.

[2] THE STATISTICAL INSTITUTE OF JAMAICA, National Income and Product 1998 (Preliminary Report), Kingston, Jamaica, 1999, 43 p.

[3] Assumption.

Note also that this method generates another estimate of the motorists' value of time for work-related trips. A value of J$79.45 /hr is estimated to be the low-wage for the average hourly wage of motorists but is very close to the estimate with the first method.

As another reference, in a recent study[15], passenger time value were given in the following way :

	Car	Pickup	M bus	L bus	Truck
Passenger time value J$ financial/hr	175	100	70	70	60
Passenger time value J$ economic/hr	122.5	70	49	49	42

In the SDG report, the values of time were estimated from a stated preference survey. Values are quite different from those that have been estimated using analytical techniques. In Table 3.9 a comparison between SDG's empirical data and the analytical data is presented.

Table 3.9 : Value of Time J$

	Method 1 Average hourly salary	Method 2	Method 3 Technical Enterprises Limited	SDG willingness to pay
Truck driver Manufacturing	J$ 140.85			J$ 156.00
Truck driver Land transportation	J$ 63.95		J$ 42.00	
Motorists Business	J$ 79.53	J$ 79.45	J$ 122.50	J$ 156.00
Leisure		J$ 15.93		J$ 103.00
Commute		J$ 57.22		J$ 107.00

15 TECHNICAL ENTERPRISES LIMITED. July 1999. *Clarendon Park to Williamsfield Highway : Feasibility Study.* Kingston (Jamaica):Government of Jamaica, Ministry of Transport and Works.

The empirical values may overstate the economic value of travel time of average Jamaicans, as the sample was biased towards determining the value of time of those who would be likely to pay a toll to use the highway. Those values refer to what people believe are their values while analytical values refer to what the market gives them in reality.

For economic analysis purposes, two assumptions will be used : high range values of time of J$125/hr and J$75/hr are assumed for work and leisure time respectively, while commuting would be J$107.5; and low range : J$79.45, J$57.22 and J$15.93.

3.4.2 Vehicle Operating Cost Savings

A smoother surface and a smoother ride contribute to lower fuel consumption and the wear and tear by road vehicles. H2K will provide both through a smoother surface, limited access and full highway configuration as opposed to the stop-and-go semi-urban configuration of most of the existing network.

These savings are compiled per category of vehicle and on a per unit of distance basis. These savings represent lower costs resulting from the implementation of the new infrastructure versus the existing one.

Actual costs of moving vehicles on the existing origin-destinations pairs were taken from the prefeasibility study and updated to year 2000 by taking the general inflation rate.

	%
1997	9.7
1998	8.6
1999	8.0 estimate
2000	8.0 estimate

Costs of moving vehicles in year 2000 on the new highway are calculated on the basis of the physical characteristics of the new road (pavement roughness, the rise and fall, the speed, the horizontal alignment, the traffic, etc.). In 1996, references to HDM-III model were used for these calculations and correction factors for two types of vehicle and various road classes and topographies were calculated.

Price adjustment to vehicle operating costs were made as follows :

1996 Basic VOC (economic)		
Cars	J$ 5.95/veh-km	(including the value of person times and excluding taxes and duties)
Trucks	J$ 22.69/veh-km	(including the value of person times and excluding taxes and duties)
1996 Savings		
Cars	J$ 1.71/veh-km	(including the value of person times and excluding taxes and duties)
Trucks	J$ 9.73/veh-km	(including the value of person times and excluding taxes and duties)
2000 Savings (updated according to inflation)		
Cars	J$ 2.38/veh-km	(including the value of person times and excluding taxes and duties)
Trucks	J$ 9.73/veh-km	(including the value of person times and excluding taxes and duties)

Since the time saving and the vehicle operating cost savings can be distinguished, the proportion of time savings in total VOC can be calculated as follows:

For cars

Average kilometer/year :	30,000
Average speed :	40 km/hour
Hours spent travelling :	750 hours

Time spent travelling by purpose and value of time by purpose

		Hours	Unit Value	Total Value
Business	15 %	112.5	J$ 125.00	14,062.50
Commuting	52 %	390	J$ 107.50	41,925.00
Leisure	33 %	247.5	J$ 75.00	18,562.50
				74,550.00

Average value of time in cars :	J$ 74,550 / 30,000 km =	J$ 2.49
Total 1996 VOC (economic) for cars :		J$ 5.95
Inflated to 2000 :		J$ 8.27

Proportion :

$$\frac{\text{Value of time}}{\text{VOC}} = \frac{\text{J\$ 2.49}}{\text{J\$ 8.27}} = 30\ \%$$

For trucks

Average kilometer/year :	60,000
Average speed :	30 km/hour
Time spent travelling :	2,000 hours

Cost per hour for a driver :	J$ 63.95	
Total cost :	J$ 127,900	
Cost per kilometer :	J$ 127,900	= J$ 2.13/km
	60,000 km	

Total 1996 VOC economic value :			J$ 22.69
Inflated to 2000 :			J$ 31.53
Proportion :			
Value of time	=	J$ 2.13	= 7 %
VOC		J$ 31.53	

Vehicle operation cost savings:

Cars $J :	2.38 X .7	=	J$ 1.67
Trucks $J :	9.73 X .93	=	J$ 9.05

These costs can be compared with North American cost structures. Litman (1999) presents private vehicle operating costs in US$ per mile so that these numbers will have to be converted into corrected J$ per kilometre. This exercise yields the following results:

Table 3.10 : Vehicle Operating Costs in North-America

Vehicle Operating Costs per pass-km
category

(units)	*(US$/pas.-mile)*	*(J$/pass-km)*	*(J$/veh-km)*
Total Automobile	**1.08**	**70.89**	**107.05**
Internal-Variable	**0.46**	**30.19**	**45.59**
User Time	0.24	15.75	23.79
Vehicle Operation	0.13	8.53	12.89
Internal Accident	0.09	5.91	8.92
Internal-Fixed	**0.25**	**16.41**	**24.78**
External	**0.37**	**24.29**	**36.67**

source: Todd Litman, Socially Optimal Transport Prices and Markets: Principles, Strategies and Impacts,VTPI (www.vtpi.org), November 1999, p. 11-14.

Savings from reduction in VOC arise from the following improvement of traffic conditions:

- Reduction of travel distances;
- Improvement of the road geometry and/or surface conditions;
- Reduction of traffic congestion.

3.4.3 Security Related Savings

Safety is a major issue in road transport. Building the highway will likely reduce the frequency of accidents as it will reduce the amount of traffic sharing road space with pedestrians and separate the lanes in which traffic flows in opposite directions. From accident statistics, most fatal or serious accidents involve pedestrians being hit by cars or careless overtaking, often as a result of driver inexperience or misjudgement.

By improving travelling conditions and designing a safer highway, it is expected that accident costs will be reduced.

Table 3.11 presents the statistics on accidents for Jamaica.

Table 3.11 : Motor Vehicle Accidents

Motor Vehicle Accidents Indicator	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**Average**
Accidents	**6320**	**6608**	**7276**	**7861**	**8045**	**8247**	**8574**	**7379**	**6868**	**8660**	**8086**	**7629**
Fatal	308	363	367	389	394	380	342	318	303	336	312	347
Injuries	1987	1987	2083	2227	2301	2106	2013	1992	1885	2336	2215	2103
Property Damage	4025	4258	4826	5245	5350	5761	6219	5069	4680	5988	5559	5180
Casualties	**3525**	**3437**	**3589**	**3935**	**4101**	**3687**	**3440**	**3411**	**3373**	**4009**	**3737**	**3659**
Persons Killed	343	400	393	444	428	434	385	367	342	372	356	388
Persons Injured	3182	3037	3196	3491	3673	3253	3055	3044	3031	3637	3381	3271
Major Causes	**6320**	**6608**	**7276**	**7861**	**8045**	**8247**	**8574**	**7379**	**6868**	**8660**	**8086**	**%**
Error of Judgement/Negligence	758	574	765	1381	926	985	1124	1394	915	2187	1822	15%
Improper Overtaking	944	1054	693	494	700	748	593	605	459	679	415	9%
Following Too Closely	394	500	677	687	673	563	653	518	722	1101	647	9%
Turning without Due Care	530	849	587	389	591	468	541	643	840	971	587	8%
Crossing Heedlessly	557	368	583	788	713	604	703	324	839	315	560	8%
Fail to Keep to Near Side	398	561	628	479	676	621	557	621	471	627	479	7%
Losing Control	126	268	586	726	619	655	735	700	418	715	544	7%
Excessive Speed	1031	556	624	487	634	583	693	382	212	324	478	7%
Misjudging Clearance/Distance	450	363	609	671	662	538	598	485	411	621	564	7%
Improper Change of Lane	301	290	568	721	603	673	697	549	363	290	379	6%
Disobeying Stop Sign	370	229	402	368	587	503	523	314	245	125	346	5%
Disobeying Traffic Light	189	178	293	324	367	382	408	193	325	94	269	4%
Defective Vehicle	96	119	79	184	97	353	408	171	144	220	248	3%
Skidding	90	251	88	63	80	256	158	222	115	128	270	2%
Road Bad/Not Maintained	61	104	58	34	67	157	102	75	43	38	126	1%
Under the Influence of Liquor	8	29	14	27	18	41	22	23	280	180	192	1%
Other Factors	14	211	14	26	18	58	33	131	40	23	116	1%
Disobeying Pedestrian Crossing	3	104	8	12	14	59	26	29	26	22	44	0%

source : POLICE DEPARTMENT - TRAFFIC HEADQUARTERS, Accidents and Major Causes.

Precarious road conditions are the cause of many accidents. Improvements to the geometry itself can significantly reduce the frequency and severity of accidents (refer to Table 3.12).

Table 3.12 : Statistics on Accident Reduction

Type of intervention	Reduction in accidents	Source
Slope smoothening, profile correction	40% - 50%	Ogden (1996)
Increasing the visibility of traffic signals	20% - 60% of all accidents	Malo (1967), Craven (1985), Bhesania (1991), Lalani (1991), Hamilton (1998)
Profile and curve correction	10% - 60%	Persaud (1994), Ogden (1996)
Road delimitation and access management	6% of all accidents (based on 1959 data)	FHWA, Vol.1, p4-2
Speed limit reduction to 50km/h	10% - 25%	Ogden (1996)
Widening to 4 lanes (rural setting)	30% - 50% of all accidents	Ogden (1996)
Widening to 4 lanes (urban setting)	20% - 35% on all accidents 22% fatal accidents and with injuries	Fisher (1977), Hauer (1996)
Shoulder paving	20% - 65%	Heimback (1974), Armour (1984)

Source: Dessau pre-feasibility study.

3.4.3.1 Cost of Death, Injuries and Material Losses

Accidents can be grouped in three major categories: fatal accidents, accidents involving injuries and accidents that result in property damage only. Two methods of computing these costs are commonly used and are presented here: the human capital method, and the willingness to pay method. Accident claims and settlements may represent the true costs of accidents. However, the payments received for a person killed is more a question of equity than a question of lost of production. Unfortunately, when someone dies, that person's net contribution to society fails. That is why the approach using the human capital method is so controversial. The willingness to pay approach is the one used more frequently.

Examples of average cost per accident in Canada showin are the following:

Table 3.13 : Average Accident Cost in Canada (Can$)

Accident Type	Fatal	With Serious Injuries	With Light Injuries	Property Damage
Using the human capital method				
- Cost per accident	461,404	115,762	12,424	6,995
- Multiple factor	66	17	2	1
Using the willingness to pay method				
- Cost per accident	3,529,563	121,709	121,709	7,303
- Multiple factor	483	17	1.1	1

Source: Quebec's Ministry of Transport, 1999

Unfortunately, such data is not yet available in Jamaica although efforts to obtain it date back to 1984[16]. Nonetheless, other available sources of information and some assumptions will allow the costs of motor vehicle accidents to be estimated. Since prices are not comparable between Canada and Jamaica and in the absence of purchasing power parity, proportioning is required. It is assumed that elements comprising accidents costs such as: health care costs, lost production, etc. are comparably weighted in Jamaica and in Canada.

Accidents with property damage are used to provide the base unit. Hence, each accident-type cost can be represented as a multiple of the cost of property damage. In both suggested methods, property damage and serious injuries (where a serious injury is 17-times more costly than a property damage) are comparable but major divergences arise when comparing fatal accidents. Roughly speaking, the willingness to pay method sets fatal accidents 10-times higher than does the human capital method.

Some statistics have been found in Jamaican sources but calculations and numeric transformations are required to present the data in the fatal accident, serious injury, light injury, and property damage form. Here are some examples :

16 WORLD HEALTH ORGANIZATION (1984), *Joint HQ/PAHO on the Prevention and Care of Motor Vehicle Injuries in the Caribbean*, Bridgetown, Barbados, June 1984,

- From Dr Ward's[17] numbers, motor vehicle accidents account for 34.35% of all accidents and injuries that were estimated at J$419 million in 1996[17]. This represents J$144 million. The property damage is therefore J$3,875 for 1996 and the other values are presented below in **Table 3.14** :

Table 3.14 : Ward's Cost of Accidents (J$)

Accident Type	Fatal	With Serious Injuries	With Light Injuries	Property Damage
Using the human capital method	255,635	64,136	6,883	3,875
Using the willingness to pay method	411,766	14,199	14,199	852

- Gordon *et al.* (1999)[18] cite the National Road Safety Board's estimation of motor vehicle accidents at US$39 million in 1999. The average cost of a property damage type accident is therefore J$8,546 for 1999 and the other values are presented below in **Table 3.15** :

Table 3.15 : Gordon's Cost of an Accident (J$)

Accident Type	Fatal	With Serious Injuries	With Light Injuries	Property Damage
Using the human capital method	2,564,283	643,355	69,047	38,875
Using the willingness to pay method	4,130,444	156,468	142,429	8,546

17 WARD, E. (1996), *A Review of Hospital Care: Outlining Morbidity & Mortality Patterns, Costs of Care and Resource Inputs*, Jamaica 1996, Epidemiology Unit, Ministry of Health, Jamaica, 1996.

18 GORDON, G., DURANT, T., WARD, E., LEWIS-BELL, K. AND D. ASHLEY (1999), *Understanding the state of Accidental and Violence-Related Injuries in Jamaica*, August 19, 1999, 51 p.

- In SweRoad's report to the Ministry of Construction[19] in 1993, the total cost of motor vehicle accidents is J$1 billion for 1992. In 2000 prices this number increases to J$1.6 billion (**Table 3.16**). This comes out to J$5,934 /property damage in 2000 by using the highway capacity method.

Table 3.16 : SweRoad's Cost of an Accident (J$)

Accident Type	Fatal	With Serious Injuries	With Light Injuries	Property Damage
Using the human capital method	1,803,641	452,517	48,566	27,344
Using the willingness to pay method	2,867,819	98,890	98,890	5,934

- Finally, following a brief telephone survey to insurance companies, the following information was collected as shown in **Table 3.17** :

Table 3.17 : Insurance Claims by Accident (J$)

Average insurance claim type		Number of claims	1998	1999
Company 1		**---**	**83 470**	**79 878**
Company 2		**---**	**---**	**90 000**
Company 3			**---**	**91 313**
private	3rd party	7 993	---	106 373
	PD			80 078
commercial	3rd party	4 116	---	107 615
	PD			67 582
Survey average insurance claim (J$)			**83 470**	**87 064**
Survey average property damage (J$)			**---**	**75 830**

19 GOVERNMENT OF JAMAICA – MINISTRY OF CONSTRUCTION (WORKS), *Road Safety Report, Final report, Phase 1*, Kingston, Jamaica, December 1993.

By using the property damage obtained this way, J$75,830 for 2000, the highest estimates of accident costs are clearly generated as can be seen in the following **Table 3.18** :

Table 3.18 : Jamaican Estimate of the Costs of Accidents (J$)

Accident Type	Fatal	With Serious Injuries	With Light Injuries	Property Damage
Using the human capital method	5,001,926	1,254,937	134,684	75,830
Using the willingness to pay method	36,649,098	1,263,761	1,263,761	75,830

The following **Table 3.19** summarises the different accident costs sources and assumptions.

Table 3.19 : Summary Table of the Cost of Accidents

Accident type	Fatal	with Serious Injuries	with Light Injuries	Property Damage
using the human capital method in J$/acc.				
Ward (1996)	255635	64136	6883	3875
Gordon *et al.* (1999)	2564283	643355	69047	38875
World Health Organization (1984)	71059	17828	1913	1077
Average insurance claim (2000)	5001926	1254937	134684	75830
GOJ - Ministry of Construction (1993)	1803641	452517	48566	27344
using the willingness to pay method in J$/acc.				
Ward (1996)	411766	14199	14199	852
Gordon *et al.* (1999)	4130444	142429	142429	8546
World Health Organization (1984)	114459	3947	3947	237
Average insurance claim (2000)	36649098	1263761	1263761	75830
GOJ - Ministry of Construction (1993)	2867819	98890	98890	5934

3.4.3.2 Reduction in the Number of Accidents

Savings from increased safety are assessed with reliability with supporting data on accidents and the economic costs of accidents.

Presently, the best estimate of avoided accidents is based on the numbers in section 3.4.3. Highway 2000 is considered to be synonymous with "widening to 4 lanes". The corresponding rural setting/urban setting ratio is therefore 1. Traffic data obtained from the traffic consultant on trips for all origin-destination pairs versus trips for highway origin-destination pairs can be used to obtain the percentage of reported accidents that most likely occurred in the Highway 2000 corridor. Finally, the appropriate reduction percentages are applied to obtain "reduction in accidents" estimates.

In Table 3.20 an evaluation of accident savings is provided using two approaches. With these assumptions, the savings will come close to US$1.2 million in 1998. If fatal cost estimates are subtracted, the reduction would be US$673,500.

Table 3.20 : Jamaica : Benefits Related to Reduction in the Costs of Accidents

	Numbers in 1998	Average kms/year	Total veh-km/year			
Motor Cars: cars taxis	163 575	25 000	4 089 375 000	53%		
Buses, trucks, tractors, trailers	59 373	60 000	3 562 380 000	46%		
Motercycles	3 782	25 000	94 550 000	1%		
			7 746 305 000	100%		
					Gordon's	
Accident costs	Numbers in 1998	Costs/accident :	human capital		Costs/accidents :	willingness
Killed	356	$2 564 283	$912 884 748		$4 130 444	$1 470 438 064
Serious injuries	1 328	$643 355	$854 375 440		$142 429	$189 145 712
Minor injuries	2 053	$69 047	$141 753 491		$142 429	$292 406 737
Damage	5 559	$3 875	$21 541 125		$8 546	$47 507 214
Total			$1 930 554 804			$1 999 497 727
US$			$48 263 870			$49 987 443
					Swe Road's	
Accident costs	Numbers in 1998	Costs/accident :	human capital		Costs/accidents :	willingness
Killed	356	$1 803 641	$642 096 196		$2 867 819	$1 020 943 564
Serious injuries	1 328	$452 517	$600 942 576		$98 890	$131 325 920
Minor injuries	2 053	$48 566	$99 705 998		$98 890	$203 021 170
Damage	5 559	$27 344	$152 005 296		$5 934	$32 987 106
			$1 494 750 066			$1 388 277 760
US$			$37 368 752			$34 706 944
Reduction in accident costs				Reduction of accident in %		
Total veh-km travelled on the highway/year		246 119 500		50%	50%	25%
Total veh-km travelled on the existing road/year		246 119 500		50%	20%	10%
Total		492 239 000				
Proportion of national travelled kilometers		6.35%				
Proportion of the costs of accidents		$3 376 019		35%		
US$		$1 181 607				
Less killed (US$)		$673 516				

As a rule of thumb, it is recognised that road accidents represent about 1 % of GNP. If this number is applied to Jamaica, the cost of accidents would be US$68 million which is higher than the analytical data (GNP J$272 billions in 1999). A US$1.2 million reduction in accident costs related to Highway 2000 would represent a 1.76% overall reduction in accident costs for the country.

3.5 REHABILITATION AND MAINTENANCE COSTS SAVINGS

Maintenance requirements on roads is proportional to the design characteristics and the traffic that the pavement has to support. Since a fraction of the traffic is assumed to shift from existing roads to the new highway, less traffic on the existing network means both the need for less maintenance and of the opportunity to defer scheduled rehabilitation works.

Table 3.21 summarises investments made on the existing road network for the past ten years. Since traffic is the heaviest along the roads from which H2K is to draw traffic, it is assumed that this is also where most of the rehabilitative road work is being done and most of the resources are being spent. Therefore, 70% of the total budget intended for capital expenditure on roads is assumed to be expended on roads that will be affected by Highway 2000. The budget grew almost nine-fold during the last 10 years, from J$225 million to almost J$2,035 billion as can be seen in **Table 3.21**.

Table 3.21 : Recurrent and Capital expenditures on roads, in current Millions J$

	88-89	89-90	90-91	91-92	92-93	93-94	94-95	95-96	96-97	97-98	98-99	99-00
Recurrent	16.3	13	14.3	9.6	52	39.1	82.8	146.1	146.5	149.3	123.8	133.7
Capital	225.6	168.5	248.5	329.2	547.3	1062.2	1 360.9	2 401.5	2 408.0	2 454.2	2 035.7	2 198.6
Total	241.9	181.5	262.8	338.8	599.3	1101.3	1 443.7	2 547.6	2 554.5	2 603.5	2 159.5	2 332.3
Proportion	6.7%	7.2%	5.4%	2.8%	8.7%	3.6%						
Average						5.7%						
Exchange rate				20.91	22.2	32.7	33.28	39.8	37.02	35.58	36.68	

The following assumptions are proposed to calculate the reduction of rehabilitation and maintenance costs as a consequence of the implementation of Highway 2000.

- H2K corridor proportion : 70 % X 2332 = $1632.6 million
- US equivalent : J$ 1632 / US$40 = US$40.81 million
- Proportion of :

- capital	95 %	= US$ 38.5 million
- maintenance	5 %	= US$ 2.3 million

- Costs reduction :

- capital	10 %	= US$ 3.8 million
- maintenance	20 %	= US$ 0.5 million
- Total		US$ 4.3 million

3.6 SAVINGS RELATED TO OTHER EXTERNALITIES

Highway trips pollute less and generate less noise (on a per vehicle basis) than do trips in density populated areas. Access to high quality transportation will cause changes in real estate patterns over time and result in escalation of property values in certain areas.

It should be noted that user-based, owner/operator-based and non-user-based benefits represent the total value of productivity and output gains that occur throughout the economy as a result of a public investment -- users thus "transmit" such benefits to the economy at-large and are not necessarily the final beneficiaries (hence the expression user-based benefits).

For example, improved time for business travellers and a reduction in existing network operating and maintenance costs, to the extent that they are passed on to a given industry, permit greater output for a given call on labour and transportation resources. Depending upon the strength of market forces in the industry in question, consumers would gain from lower prices. Since this study does not examine these distributional implications of

productivity and output gains as a result of alternative highway investment strategies, the value of user benefits may be regarded as the aggregate value of such gains.

Externalities such as pollution, land use, etc., are often calculated on a per vehicle-km basis. The relationship between the two is an increasing one in the sense that when total vehicle-km increases, so do the externalities in terms of volumes and costs.

3.6.1 Unit Price of Externalities

Evaluating the environmental impacts of transportation projects and policies is relatively new science. Accounting for these impacts in transportation decisions, involves integrating what are called externalities in the economic calculation.

The main form of pollution caused by vehicles is air pollution.

The main pollutants released into the atmosphere by the majority of vehicles circulating in our cities and towns are: carbon dioxide (CO_2), carbon monoxide (CO), hydrocarbons (HC), and nitrous oxide (NO), sulphur oxide (SO) and particulates (PM).

Since the early 1980s, many evaluation methods have been suggested to evaluate the monetary costs of these externalities generated by motorised vehicles. Many operational studies in European countries now serve as benchmarks when recommendations on unit cost measurement of atmospheric and noise disturbances are needed. In this study, the prices for different pollutants are obtained from those studies.[20 21 22 23]

Table 3.22 shows a preliminary comparison of atmospheric emissions of pollutants by vehicles circulating on Jamaica's road network along with the costs brought up by each type. The data provided so far finds three categories of road users: personal vehicles, minibuses and trucks. Pollution costs are attributed to these categories by associating them with the categories in **Table 3.22** in the following way:

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20 Todd Litman, Transportation Cost Analysis: Techniques, Estimates and Implications, VTPI (www.vtpi.org), 1998, p. 3.10-5.

21 Massachusetts Department of Public Utilities, *Hearing on environmental externality values*, 1992.

22 Miller, P. and J, Moffet, *The price of mobility*, Natural Resources Defense Council, Washington, DC, 1993.

23 Convergence Research, *Valuing emissions from Hermiston generating project*, Seattle, Wa., 1994.

Table 3.22 : Atmospheric Pollutants

Atmospheric pollutants released vehicle	CO2	CO	HC	NO	SO	PM	Occupants per
Released quantities (g/km)							
Gasoline automobile	204	14.73	1.97	1.19	0.04	0.06	1.1
car pool		6.14	0.82	0.50	0.02	0.03	2.6
van pool		3.39	0.45	0.28	0.01	0.01	5.4
Diesel bus	1346	0.94	0.07	0.42	0.06	0.11	22.8
Articulated diesel bus	1724	1.03	0.08	0.46	0.06	0.12	26.5
methanol bus		0.01	0.01	0.31	0.00	0.00	22.8
Median cost of pollutant (J$/ton)	**40**	**1814**	**6600**	**8418**	**3586**	**4992**	**---**
Cost of pollutant (J$/km)							**Total**
Gasoline automobile	0.008	0.027	0.013	0.010	0.000	0.000	0.058
car pool		0.011	0.005	0.004	0.000	0.000	0.021
van pool		0.006	0.003	0.002	0.000	0.000	0.012
Diesel bus	0.054	0.002	0.000	0.004	0.000	0.001	0.060
Articulated diesel bus	0.069	0.002	0.000	0.004	0.000	0,001	0.076
methanol bus		0.000	0.000	0.003	0.000	0.000	0.003
(J$/pass-km)							
Gasoline automobile	0.006	0.025	0.012	0.010	0.000	0.000	0.054
car pool		0.004	0.002	0.002	0.000	0.000	0.008
van pool		0.001	0.001	0.000	0.000	0.000	0.002
Diesel bus	0.003	0.000	0.000	0.000	0.000	0.000	0.003
Articulated diesel bus	0.003	0.000	0.000	0.000	0.000	0.000	0.003
methanol bus		0.000	0.000	0.000	0.000	0.000	0.000

source : Todd Litman, Transportation Cost Analysis: Techniques, Estimates and Implications, VTPI (www.vtpi.org),

3.7 CONSTRUCTION

Costs are incurred in the construction and acquisition of new infrastructure, land and equipment. Capital costs are treated as lump-sum outlays in the years they occur. Depreciation is thus not taken into account as it would mean double-counting capital expenses.

The construction of the highway requires heavy investment in the first 4 years of the project's life. After that, periodic investments are scheduled to maintain the infrastructure. The life-span of each element is crucial in setting its residual value in year end of evaluation.

Table 3.23 shows the estimated construction costs by Phase.

Table 3.23 : Construction and Maintenance Costs by Road Sections

1) Construction Costs Breakdown

Phase 1	$235 000 000
Phase 2	$523 000 000
Total	$758 000 000
Grantor development costs	$20 000 000
Concessionnaire development costs	$45 000 000

2) Construction Costs Per Year

Year	Kingston-Williamsfield	Williamsfield-MoBay-OchoRios	TOTAL	Salvage value
2002	$112 800 000		$112 800 000	$90 240 000
2003	$122 200 000	$120 300 000	$242 500 000	$194 000 000
2004		$230 100 000	$230 100 000	$184 080 000
2005		$172 600 000	$172 600 000	$138 080 000
Total	$235 000 000	$523 000 000	$758 000 000	$606 400 000

3) Construction Costs: Local and Foreign Content

Kingston-Williamsfield	Local	Foreign	Total	Local	Foreign
labour	$36 100 000	$37 200 000	$73 300 000	49%	51%
material	$26 400 000	$66 900 000	$93 300 000	28%	72%
equipment	$6 600 000	$61 800 000	$68 400 000	10%	90%
total	$69 100 000	$165 900 000	$235 000 000	29%	71%
Williamsfield-MoBay-Orios					
labour	$124 400 000	$55 800 000	$180 200 000	69%	31%
material	$35 200 000	$96 600 000	$131 800 000	27%	73%
equipment	$40 800 000	$170 200 000	$211 000 000	19%	81%
total	$200 400 000	$322 600 000	$523 000 000	38%	62%
Total					
labour	$160 500 000	$93 000 000	$253 500 000	63%	37%
material	$61 600 000	$163 500 000	$225 100 000	27%	73%
equipment	$47 400 000	$232 000 000	$279 400 000	17%	83%
total	$269 500 000	$488 500 000	$758 000 000	36%	64%

3.7.1 Land Acquisition, Relocation of Services (Utilities) and Costs of Externalities

These costs are considered construction costs but the distinction is that they do not have a residual value at the end of the period of analysis. They are sunk costs but are inevitable in order to make space, in an environmentally-appropriate way, for the highway.

Opportunity costs of land are not considered since the Government of Jamaica intends to swap existing land holdings for land required along the corridor. Only the transaction costs are recognised. These are estimated as follows:

Legal Survey (5,000 parcels plus corridor)	US$5,000,000
Conveyancing	US$5,000,000
Resettlement Assistance	US$10,000,000
Sub-total	US$20,000,000

These costs are included in the grantor development costs.

3.7.2 Maintenance and Operating Costs

Once the installations are in place and the highway is opened for traffic, operation and maintenance of this new facility will involve recurrent expenditures.

These costs are estimated to be 1.17% annually of the total construction costs. The costs do not include any costs related to operation or maintenance of the tolling facilities.

3.7.3 Cost Evaluations

In the economic CBA, the monetary values of the costs elements must reflect real costs *i.e.* the actual amounts of resources that have to be sacrificed in order to purchase them. As such, taxes and duties and market inefficiencies must be identified and corrected for. Market prices of goods, services and factors of production may not reflect their economic value to society.

The following sub-sections identify the elements that can misrepresent the actual prices of goods and correction factors are proposed for them.

Since taxes and duties are a simple redistribution of wealth, they must be eliminated from economic calculations in order to accurately evaluate the costs or benefits of a project.

The shadow price is a real price to society paid for goods or services. Market inefficiencies result from monopolies, government-subsidised industries, price controls, currency devaluation, etc. Labour and imports are the most frequent sectors of the economy where shadow prices exist, and therefore have to be corrected in order to accurately calculate the costs of a project.

For labour for instance, through union contracts, unsteady rates of unemployment and level of non-salary income, wages might be artificially high (or low) so that they do not reflect the real cost of labour. When market clear, economic theory dictates the following relationship between a worker's wage (W) and his/her marginal productivity (MP): $W=MP$. In cases where this relationship does not hold, wages must be multiplied by a correction factor >1 (if $W<MP$) or <1 (if $W>MP$). More generally, we can say that labour of different types may be regarded as having a value greater (or less) than the actual price paid.

Imported goods require foreign currencies in order to be purchased and inefficiencies in the foreign exchange market can maintain their prices at an artificial level. Since the highway project involves capital and other resources imported from foreign sources, prices paid for these might be corrected in order to reflect their true values.

An analysis of studies conducted for Jamaica has revealed the following data. The conversion factors for several sectors of the Jamaican economy were derived from the runs of the input-output model[24]. The conversion factors give the ratio between the price to be used in evaluating the project, the shadow prices, and the price used to evaluate their costs, the market prices.

For non-traded sectors of the economy, the conversion factors applied will be :

- Construction ⇒ 0.57
- land transportation ⇒ 0.72
- aggregated ⇒ 0.70

24 National Economic Parameters and Economic Analysis for the Public Sector Investment Program in Jamaica. Prepared for the Planning Institute of Jamaica by John Weiss, University of Bradford U.K. July 1999.

These conversion factors will be applied respectively to :

- construction costs
- operation and maintenance costs

Since we know from the project cost estimate the proportions of labour, foreign exchange and capital involved we can estimate the specific conversion factor in the following way.

Conversion factor for construction

0.81	=	0.21 x 0.27	+ 0.65 x1	+0.14 x .7	+ 0.0 x 1.0
		Labour	Foreign Exchange	Material & Equipment	Transfers

Conversion factor for maintenance & operation

0.47	=	0.6 x 0.27	+ 0.10 x 1	+ 0.3 x 0.7	+ 0.0 x 1.0
		Labour	Foreign Exchange	Material & Equipment	Transfers

4 EVALUATION PARAMETERS

The following parameters must be established to compare different streams of benefits and costs over time :

- discount rate;
- period of analysis;
- base year of comparison;
- salvage values of the investments made.

4.1 DISCOUNT RATE (*DR*)

The economic analysis assumes a 10% discount rate.

4.2 PERIOD OF ANALYSIS

The period of analysis is set at 50 years. Considering that construction is to begin in 2002, the streams of net benefits will be analysed until 2052. All infrastructure investments are expected to be functional through out the period and the sequence of investments (incl. minor maintenance investments) covers this period.

4.3 BASE YEAR

The base year is set to be 2002. All costs and benefits presently observed are evaluated in constant 2000 prices.

4.4 SALVAGE VALUES OF THE INVESTMENTS

The operation and maintenance expenditures over the life of the project are designed to ensure that the project is sustainable and has a substantial salvage value. For modelling purposes, the salvage value is assumed to be 80% of the initial capital cost.

This percentage of salvage value should be based on normal service life of the various components of the construction (50 years for design and structures, 30 years for earthworks, 15 years for pavement and drainage, etc.). It has been assumed that the level of operations, maintenance and rehabilitation expenditures will ensure that the investment has a substantial salvage value.

5 COMPUTATION

It is important to note that in a project such as Highway 2000, the costs and benefits are not contained in a static framework but rather in a dynamic framework corresponding to the life of the project. For example, operation and maintenance costs along with environmental consequences are spaced out over several years. Therefore, in order to establish a common basis for comparison of the project's costs and benefits, it is necessary that all monetary amounts be converted into their present value. In fact, all annually evaluated sums (costs and benefits) must be brought back to reflect their present value via the discount rate so that the different alternatives of the project can be compared *ex aequo* with the present situation. This discounting process will in turn allow the decision-makers to choose the alternative that maximises economic welfare.

The core of an *ECBA* lies in the discounting process where evaluating the present value of a future stream of cash-flows is obtained by calculating its present value (*PV*). The present for each category of cost or benefit, *pv*, is calculated as follows:

$$pv = \sum_{i=1}^{n} \frac{\text{cashflow}_i}{(1+DR)_i}$$

where, n = period of analysis in years;
$i = 1...n$;
DR =discount rate.

5.1 NET PRESENT VALUE (*NPV*)

This indicator is simply the value of the whole project (over the entire period of analysis) today. The *NPV* is calculated as follows:

$$NPV = \text{discounted benefits} + \text{discounted salvage value} - \text{discounted costs}$$

A project is profitable when $NPV>0$ and becomes more so as the value of *NPV* grows positively. On the other hand, a project for which $NPV=0$ would not normally proceed.

5.2 INTERNAL RATE OF RETURN (*IRR*)

The Internal Rate of Return is the discount rate at which the Present Value of the Costs is equal to the Benefits. A project with a positive IRR is expected to generate positive benefits to society.

In **Figure 5.1**, an actual net benefits curve is drawn and superimposed with the estimated curve using the IRR iterations-procedure briefly described above. seethe graph reflects that heavy investment takes place in the first two years (net benefits are negative) and the rest of the period of analysis is marked by positive and increasing net benefits.

Intuitively, a positive slope means a positive *IRR* and in this case, it is around 7%. Another way to see it is that the net benefits curve yields the same interest payments as an investment with a 7% annual yield. Detailed calculations and an economic model are included in **Appendix "A"**.

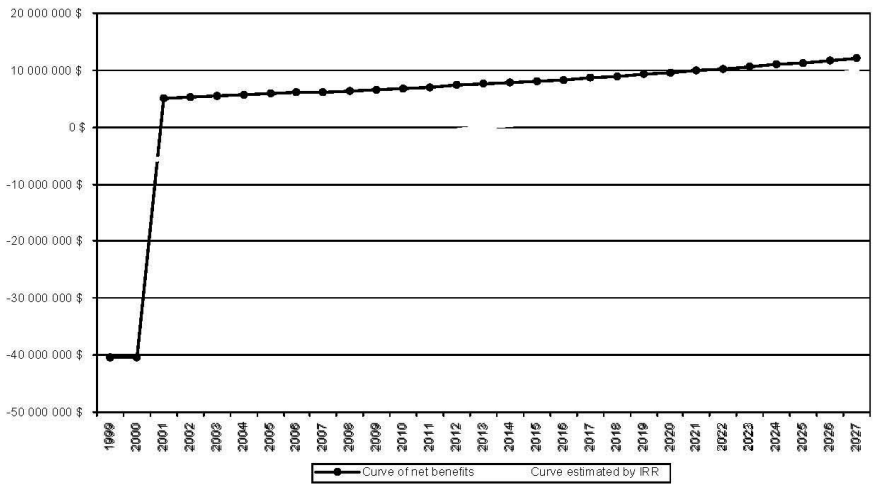

Figure 5.1: Iterations-estimation of the internal rate of return (*IRR*).

The relationship between the *IRR* and the *PV* is the following :

$$PV = \sum_{i=1}^{n} \frac{\text{cashflow}_i}{(1 + IRR)_i} = 0$$

where, n = period of analysis in years;
$i = 1...n$.

5.3 BENEFIT-COST RATIO (*BCR*)

This indicator is simply the ratio of benefits over costs (incl. salvage value) of the whole project over its entire life-span. The *BCR* is calculated as follows:

$$BCR = \frac{\text{(discounted benefits + discounted salvage value)}}{\text{discounted costs}}$$

A project is clearly worthwhile when $BCR>1$ and becomes more and more beneficial as the value of *BCR* grows positively. On the other hand, a project for which $BCR<1$ would only proceed if it was considered that there would be substantial secondary benefits not fully captured by the analysis or if that project was a component of a larger scheme that had an overall BCR greater than 1.

6 RESULTS, CONCLUSIONS AND RECOMMENDATION

Two scenarios have been evaluated; the only differences between scenario 1 and 2 are the values of time. See **Table 6.1**.

Table 6.1 : Evaluation Scenarios

	Scenario 1	Scenario 2
Vehicle operating costs savings		
1.Cars	J$ 1.67/km	J$1.67/km
2.Trucks	J$ 9.05/km	J$ 9.05/km
Time values		
• Work	J$ 125/h	J$ 79.45/h
• Commute	J$ 107.5/h	J$ 57.22/h
• Leisure	J$ 75/h	J$ 15.93/h
Pollutant savings	J$ 0.05/veh-km	J$ 0.05/veh-km
Maintenance savings	J$ 172 M/pa	J$ 172 M/pa
Accident savings	J$ 47 M/pa	J$ 47 M/pa

It is considered that time savings are proportionate to vehicle kilometres travelled on the highway.

With these assumptions the results are as follows:

Scenario 1

	Phase 1	Phase 2	Total
Internal rate of return at a 10% discount rate	19.92 %	9 %	14.15 %
Benefits to costs ratio	2.92	0.85	1.71
Net present value	US$ 440,668,186	US$ (36,325,926)	US$ 361,372,152

Scenario 2

	Total
Internal rate of return at a 10% discount rate	11.41 %
Benefits to costs ratio	1.21
Net present value	US$ 114,251,467

Based on the best estimates of benefits and costs, Phase 1 of the Highway 2000 project is economically justified with a benefit to cost ratio greater than 2.0. Although Phase 2 would not be economically justified as a stand-alone project (BCR < 1.0), the entire project (Phases 1 and 2) is economically justified (BCR >1.0) as currently planned.

Travel time savings and vehicle operation costs savings represent nearly 90% of total projected benefits.

A project that is economically justified is not necessarily financially feasible. The decision of a government to commit financial resources to a project should be made in the context of the economic aspects of other competing projects and on the broader development policies of the country.

The economics of the Highway 2000 project could most directly be improved by reducing the costs. The most likely opportunities for cost savings that do not generate a coincident reduction in benefits will be found in Phase 2. It is recommended that some consideration be given to the optimisation of Phase 2 if financial resources are scarce.

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APPENDIX A

Evaluation of the net present value(NPV) and of the internal rate of return(IRR)

ADEC Inc.

Scenario 1

Projet:	9908 - JAMAICA HYW 2000	Base year:	2000	Net present value (NPV) :	361372152	Ratio Benefits/Costs :	1.71	Rate of exchange	46J$/US$
Length	total 233kms	Discount rate	10.00%	Internal rate of return :	14.15%	Salvage value :	606400000		

	BENEFITS									COSTS			DIFFERENCES		
	Benefits related to cars			Benefits related to trucks			Reduction	Reduction	Total	Construction	Operation &	Total Costs	Savings	Salvage	Savings
YEAR	Savings in VOC : ***Total***	Time savings ***Total***	Savings in Pollutants ***Total***	Savings in VOC	Time savings ***Total***	Pollutants Savings	in operation & Maintenance Costs	of Accident costs	Benefits	Costs Economic costs	Maintenance Costs Economic costs	Economic costs	- Costs	Value	Costs +Salvage value
	Cars / Trucks	*Cars*	*Cars / Trucks*		*Trucks*										
2000							0	0	0	$47,500,000	$0	$47,500,000	-$47,500,000	$0	-$47,500,000
2001							0	0	0	$47,500,000	$0	$47,500,000	-$47,500,000	$0	-$47,500,000
2002							0	0	0	$91,368,000	$0	$91,368,000	-$91,368,000	$0	-$91,368,000
2003							0		0	$196,668,000	$615,888	$197,283,888	-$197,283,888	$0	-$197,283,888
2004							0		0	$186,381,000	$1,953,795	$188,334,795	-$188,334,795	$0	-$188,334,795
2005							0		0	$139,806,000	$3,216,915	$143,022,915	-$143,022,915	$0	-$143,022,915
2006	$29,590,640	$41,799,713	$815,285		$2,056,643		$4,300,000	$1,181,607	$79,743,888		$3,216,915	$3,216,915	$76,526,973	$0	$76,526,973
2007	$33,984,487	$47,815,036	$896,814		$2,204,065		$4,300,000	$1,228,871	$90,429,243		$3,216,915	$3,216,915	$87,212,328	$0	$87,212,328
2008	$38,875,111	$54,595,242	$986,495		$2,363,900		$4,300,000	$1,278,026	$102,308,773		$3,216,915	$3,216,915	$99,091,858	$0	$99,091,858
2009	$41,077,510	$57,561,351	$1,035,820		$2,471,596		$4,300,000	$1,329,147	$107,775,423		$3,216,915	$3,216,915	$104,558,508	$0	$104,558,508
2010	$43,400,375	$60,783,500	$1,087,611		$2,584,256		$4,300,000	$1,382,313	$113,538,055		$3,216,915	$3,216,915	$110,321,140	$0	$110,321,140
2011	$45,850,142	$64,180,519	$1,141,991		$2,702,113		$4,300,000	$1,437,606	$119,612,372		$3,216,915	$3,216,915	$116,395,457	$0	$116,395,457
2012	$48,433,588	$67,761,704	$1,199,091		$2,825,409		$4,300,000	$1,495,110	$126,014,902		$3,216,915	$3,216,915	$122,797,987	$0	$122,797,987
2013	$51,157,844	$71,536,834	$1,259,045		$2,954,397		$4,300,000	$1,554,914	$132,763,034		$3,216,915	$3,216,915	$129,546,119	$0	$129,546,119
2014	$54,030,416	$75,516,202	$1,321,998		$3,089,343		$4,300,000	$1,617,111	$139,875,068		$3,216,915	$3,216,915	$136,658,154	$0	$136,658,154
2015	$57,059,203	$79,710,639	$1,388,097		$3,230,525		$4,300,000	$1,681,795	$147,370,261		$3,216,915	$3,216,915	$144,153,346	$0	$144,153,346
2016	$59,941,572	$82,099,065	$1,443,621		$3,359,746		$4,300,000	$1,749,067	$153,093,071		$3,216,915	$3,216,915	$149,876,156	$0	$149,876,156
2017	$61,715,234	$86,215,027	$1,501,366		$3,494,136		$4,300,000	$1,819,030	$159,044,794		$3,216,915	$3,216,915	$155,827,879	$0	$155,827,879
2018	$64,183,844	$89,663,629	$1,561,421		$3,633,901		$4,300,000	$1,891,791	$165,234,586		$3,216,915	$3,216,915	$162,017,671	$0	$162,017,671
2019	$66,751,198	$93,250,174	$1,623,878		$3,779,258		$4,300,000	$1,967,463	$171,671,969		$3,216,915	$3,216,915	$168,455,054	$0	$168,455,054
2020	$69,421,245	$96,980,181	$1,688,833		$3,930,428		$4,300,000	$2,046,161	$178,366,848		$3,216,915	$3,216,915	$175,149,933	$0	$175,149,933
2021	$72,198,095	$100,859,388	$1,756,386		$4,087,645		$4,300,000	$2,128,007	$185,329,522		$3,216,915	$3,216,915	$182,112,607	$0	$182,112,607
2022	$75,086,019	$104,893,763	$1,826,642		$4,251,151		$4,300,000	$2,213,128	$192,570,703		$3,216,915	$3,216,915	$189,353,788	$0	$189,353,788
2023	$78,089,460	$109,089,514	$1,899,707		$4,421,197		$4,300,000	$2,301,653	$200,101,531		$3,216,915	$3,216,915	$196,884,616	$0	$196,884,616
2024	$81,213,038	$113,453,094	$1,975,695		$4,598,045		$4,300,000	$2,393,719	$207,933,592		$3,216,915	$3,216,915	$204,716,677	$0	$204,716,677
2025	$84,461,560	$117,991,218	$2,054,723		$4,781,966		$4,300,000	$2,489,468	$216,078,936		$3,216,915	$3,216,915	$212,862,021	$0	$212,862,021
2026	$87,840,022	$122,710,867	$2,136,912		$4,973,245		$4,300,000	$2,589,046	$224,550,093		$3,216,915	$3,216,915	$221,333,178	$0	$221,333,178
2027	$91,353,623	$127,619,302	$2,222,389		$5,172,175		$4,300,000	$2,692,608	$233,360,097		$3,216,915	$3,216,915	$230,143,182	$0	$230,143,182
2028	$95,007,768	$132,724,074	$2,311,284		$5,379,062		$4,300,000	$2,800,313	$242,522,501		$3,216,915	$3,216,915	$239,305,586	$0	$239,305,586
2029	$98,808,079	$138,033,037	$2,403,736		$5,594,224		$4,300,000	$2,912,325	$252,051,401		$3,216,915	$3,216,915	$248,834,486	$0	$248,834,486
2030	$102,760,402	$143,554,358	$2,499,885		$5,817,993		$4,300,000	$3,028,818	$261,961,457		$3,216,915	$3,216,915	$258,744,542	$0	$258,744,542
2031	$106,870,818	$149,296,532	$2,599,880		$6,050,713		$4,300,000	$3,149,971	$272,267,915		$3,216,915	$3,216,915	$269,051,000	$0	$269,051,000
2032	$111,145,651	$155,268,394	$2,703,876		$6,292,742		$4,300,000	$3,275,970	$282,986,631		$3,216,915	$3,216,915	$279,769,716	$0	$279,769,716
2033	$115,591,477	$161,479,130	$2,812,031		$6,544,451		$4,300,000	$3,407,009	$294,134,097		$3,216,915	$3,216,915	$290,917,182	$0	$290,917,182
2034	$120,215,136	$167,938,295	$2,924,512		$6,806,229		$4,300,000	$3,543,289	$305,727,461		$3,216,915	$3,216,915	$302,510,546	$0	$302,510,546
2035	$125,023,741	$174,655,826	$3,041,492		$7,078,478		$4,300,000	$3,685,020	$317,784,559		$3,216,915	$3,216,915	$314,567,644	$0	$314,567,644
2036	$130,024,691	$181,642,060	$3,163,152		$7,361,618		$4,300,000	$3,832,421	$330,323,941		$3,216,915	$3,216,915	$327,107,026	$0	$327,107,026
2037	$135,225,678	$188,907,742	$3,289,678		$7,656,082		$4,300,000	$3,985,718	$343,364,899		$3,216,915	$3,216,915	$340,147,984	$0	$340,147,984
2038	$140,634,706	$196,464,052	$3,421,265		$7,962,326		$4,300,000	$4,145,147	$356,927,495		$3,216,915	$3,216,915	$353,710,580	$0	$353,710,580
2039	$146,260,094	$204,322,614	$3,558,116		$8,280,819		$4,300,000	$4,310,953	$371,032,595		$3,216,915	$3,216,915	$367,815,680	$0	$367,815,680
2040	$152,110,498	$212,495,518	$3,700,441		$8,612,051		$4,300,000	$4,483,391	$385,701,099		$3,216,915	$3,216,915	$382,484,984	$0	$382,484,984
2041	$158,194,918	$220,995,339	$3,848,458		$8,956,533		$4,300,000	$4,662,726	$400,957,974		$3,216,915	$3,216,915	$397,741,059	$0	$397,741,059
2042	$164,522,714	$229,835,152	$4,002,397		$9,314,795		$4,300,000	$4,849,235	$416,824,293		$3,216,915	$3,216,915	$413,607,378	$0	$413,607,378
2043	$171,103,623	$239,028,559	$4,162,492		$9,687,387		$4,300,000	$5,043,205	$433,325,265		$3,216,915	$3,216,915	$430,108,350	$0	$430,108,350
2044	$177,947,768	$248,589,701	$4,328,992		$10,074,882		$4,300,000	$5,244,933	$450,486,276		$3,216,915	$3,216,915	$447,269,361	$0	$447,269,361
2045	$185,065,678	$258,533,289	$4,502,152		$10,477,877		$4,300,000	$5,454,730	$468,333,727		$3,216,915	$3,216,915	$465,116,812	$0	$465,116,812
2046	$192,468,306	$268,874,621	$4,682,238		$10,896,992		$4,300,000	$5,672,920	$486,895,076		$3,216,915	$3,216,915	$483,678,161	$0	$483,678,161
2047	$200,167,038	$279,629,605	$4,869,527		$11,332,872		$4,300,000	$5,899,836	$506,198,879		$3,216,915	$3,216,915	$502,981,964	$0	$502,981,964
2048	$208,173,719	$290,814,790	$5,064,308		$11,786,187		$4,300,000	$6,135,830	$526,274,834		$3,216,915	$3,216,915	$523,057,919	$0	$523,057,919
2049	$216,500,668	$302,447,381	$5,266,881		$12,257,634		$4,300,000	$6,381,263	$547,153,827		$3,216,915	$3,216,915	$543,936,912	$0	$543,936,912
2050	$225,160,695	$314,545,276	$5,477,556		$12,747,949		$4,300,000	$6,636,514	$568,867,981		$3,216,915	$3,216,915	$565,651,066	$606,400,000	$1,172,051,066

Present value of salvage	$6,875,479.48	Present values of savings:	$ 855,911,690	Present values of costs:	$501,415,018	Total in present values:	$359,192,717

11/07/2000

Evaluation of the net present value(NPV) and of the internal rate of return(IRR)

AD*EC* Inc.

Scenario 1.1

Project:	9908 - JAMAICA HYW 2000	Base year:	2000	Net present value (NPV) :	440668186	Ratio Benefits/Costs :	2.92	Rate of exchange	40J$/US$
Length:	total: 85kms	Discount rate:	10.00%	Internal rate of return :	19.92%	Salvage value :	188000000		

	BENEFITS									COSTS			DIFFERENCES		
	Benefits related to cars			Benefits related to trucks			Reduction	Reduction	Total	Construction	Operation &	Total Costs	Savings	Salvage	Savings
YEAR	Savings in VOC *Section 1*	Time savings *Section 1*	Savings in Pollutants *Section 1*	Savings in VOC	Time savings *Section 1*	Pollutants Savings	in operation & Maintenance Costs	of Accident costs	Benefits	Costs Economic costs	Maintenance Costs Economic costs	Economic costs	- Costs	Value	- Costs +Salvage value
	Cars / Trucks	*Cars*	*Cars / Trucks*		*Trucks*										
2000							$0	$0	$0	$47,500,000	$0	$47,500,000	-$47,500,000	$0	-$47,500,000
2001							$0	$0	$0	$47,500,000	$0	$47,500,000	-$47,500,000	$0	-$47,500,000
2002							$0	$0	$0	$91,368,000	$0	$91,368,000	-$91,368,000	$0	-$91,368,000
2003							$0		$0	$98,982,000	$615,888	$99,597,888	-$99,597,888	$0	-$99,597,888
2004	$13,595,749	$25,321,868	$131,814		$1,521,226		$1,548,000	$756,228	$42,118,657		$1,292,265	$1,292,265	$40,826,392	$0	$40,826,392
2005	$15,771,804	$29,216,196	$474,348		$1,628,991		$1,548,000	$786,478	$48,638,540		$1,292,265	$1,292,265	$47,346,275	$0	$47,346,275
2006	$18,196,483	$33,554,443	$521,782		$1,745,759		$1,548,000	$817,937	$56,384,405		$1,292,265	$1,292,265	$55,092,140	$0	$55,092,140
2007	$20,898,445	$38,383,180	$573,961		$1,872,358		$1,548,000	$850,654	$64,126,599		$1,292,265	$1,292,265	$62,834,334	$0	$62,834,334
2008	$23,905,896	$43,753,723	$631,357		$2,009,698		$1,548,000	$884,680	$72,733,354		$1,292,265	$1,292,265	$71,441,089	$0	$71,441,089
2009	$25,260,243	$46,206,994	$662,925		$2,101,534		$1,548,000	$920,068	$76,699,764		$1,292,265	$1,292,265	$75,407,499	$0	$75,407,499
2010	$26,688,668	$48,793,553	$696,071		$2,197,617		$1,548,000	$956,870	$80,880,779		$1,292,265	$1,292,265	$79,588,514	$0	$79,588,514
2011	$28,195,132	$51,520,488	$730,874		$2,298,143		$1,548,000	$995,145	$85,287,783		$1,292,265	$1,292,265	$83,995,518	$0	$83,995,518
2012	$29,783,801	$54,395,260	$767,418		$2,403,322		$1,548,000	$1,034,951	$89,932,751		$1,292,265	$1,292,265	$88,640,486	$0	$88,640,486
2013	$31,459,059	$57,425,721	$805,789		$2,513,370		$1,548,000	$1,076,349	$94,828,287		$1,292,265	$1,292,265	$93,536,022	$0	$93,536,022
2014	$33,225,522	$60,620,132	$846,078		$2,628,516		$1,548,000	$1,119,403	$99,967,652		$1,292,265	$1,292,265	$98,695,387	$0	$98,695,387
2015	$35,088,050	$63,987,189	$888,382		$2,748,999		$1,548,000	$1,164,179	$105,434,799		$1,292,265	$1,292,265	$104,132,534	$0	$104,132,534
2016	$36,491,572	$66,546,677	$923,918		$2,858,959		$1,548,000	$1,210,746	$109,579,871		$1,292,265	$1,292,265	$108,287,606	$0	$108,287,606
2017	$37,951,235	$69,208,544	$960,874		$2,973,317		$1,548,000	$1,259,176	$113,901,146		$1,292,265	$1,292,265	$112,608,881	$0	$112,608,881
2018	$39,469,284	$71,976,886	$999,309		$3,092,250		$1,548,000	$1,309,543	$118,395,272		$1,292,265	$1,292,265	$117,103,007	$0	$117,103,007
2019	$41,048,055	$74,855,961	$1,039,282		$3,215,940		$1,548,000	$1,361,925	$123,069,163		$1,292,265	$1,292,265	$121,776,898	$0	$121,776,898
2020	$42,689,978	$77,850,200	$1,080,853		$3,344,577		$1,548,000	$1,416,402	$127,930,009		$1,292,265	$1,292,265	$126,637,744	$0	$126,637,744
2021	$44,397,577	$80,964,207	$1,124,087		$3,478,361		$1,548,000	$1,473,058	$132,985,290		$1,292,265	$1,292,265	$131,693,025	$0	$131,693,025
2022	$46,173,480	$84,202,776	$1,169,051		$3,617,495		$1,548,000	$1,531,980	$138,242,781		$1,292,265	$1,292,265	$136,950,516	$0	$136,950,516
2023	$48,020,419	$87,570,887	$1,215,813		$3,762,195		$1,548,000	$1,593,259	$143,710,572		$1,292,265	$1,292,265	$142,418,307	$0	$142,418,307
2024	$49,941,236	$91,073,722	$1,264,445		$3,912,683		$1,548,000	$1,656,990	$149,397,075		$1,292,265	$1,292,265	$148,104,810	$0	$148,104,810
2025	$51,938,885	$94,716,671	$1,315,023		$4,069,190		$1,548,000	$1,723,269	$155,311,038		$1,292,265	$1,292,265	$154,018,773	$0	$154,018,773
2026	$54,016,441	$98,505,338	$1,367,624		$4,231,957		$1,548,000	$1,792,200	$161,461,560		$1,292,265	$1,292,265	$160,169,295	$0	$160,169,295
2027	$56,177,098	$102,445,552	$1,422,329		$4,401,236		$1,548,000	$1,863,888	$167,858,102		$1,292,265	$1,292,265	$166,565,837	$0	$166,565,837
2028	$58,424,182	$106,543,374	$1,479,222		$4,577,285		$1,548,000	$1,938,444	$174,510,506		$1,292,265	$1,292,265	$173,218,241	$0	$173,218,241
2029	$60,761,149	$110,805,109	$1,538,391		$4,760,377		$1,548,000	$2,015,981	$181,429,007		$1,292,265	$1,292,265	$180,136,742	$0	$180,136,742
2030	$63,191,595	$115,237,313	$1,599,926		$4,950,792		$1,548,000	$2,096,621	$188,624,247		$1,292,265	$1,292,265	$187,331,982	$0	$187,331,982
2031	$65,719,259	$119,846,805	$1,663,923		$5,148,823		$1,548,000	$2,180,485	$196,107,297		$1,292,265	$1,292,265	$194,815,032	$0	$194,815,032
2032	$68,348,030	$124,640,678	$1,730,480		$5,354,776		$1,548,000	$2,267,705	$203,889,669		$1,292,265	$1,292,265	$202,597,404	$0	$202,597,404
2033	$71,081,951	$129,626,305	$1,799,700		$5,568,967		$1,548,000	$2,358,413	$211,980,335		$1,292,265	$1,292,265	$210,691,070	$0	$210,691,070
2034	$73,925,229	$134,811,357	$1,871,688		$5,791,726		$1,548,000	$2,452,750	$220,400,749		$1,292,265	$1,292,265	$219,108,484	$0	$219,108,484
2035	$76,882,238	$140,203,811	$1,946,555		$6,023,395		$1,548,000	$2,550,860	$229,154,859		$1,292,265	$1,292,265	$227,862,594	$0	$227,862,594
2036	$79,957,527	$145,811,964	$2,024,417		$6,264,331		$1,548,000	$2,652,894	$238,299,133		$1,292,265	$1,292,265	$236,966,868	$0	$236,966,868
2037	$83,155,829	$151,644,442	$2,105,394		$6,514,904		$1,548,000	$2,759,010	$247,727,578		$1,292,265	$1,292,265	$246,435,313	$0	$246,435,313
2038	$86,482,062	$157,710,220	$2,189,610		$6,775,500		$1,548,000	$2,869,370	$257,574,762		$1,292,265	$1,292,265	$256,282,497	$0	$256,282,497
2039	$89,941,344	$164,018,629	$2,277,194		$7,046,520		$1,548,000	$2,984,145	$267,815,832		$1,292,265	$1,292,265	$266,523,567	$0	$266,523,567
2040	$93,538,998	$170,579,374	$2,368,282		$7,328,381		$1,548,000	$3,103,511	$278,466,545		$1,292,265	$1,292,265	$277,174,280	$0	$277,174,280
2041	$97,280,558	$177,402,549	$2,463,013		$7,621,516		$1,548,000	$3,227,651	$289,543,287		$1,292,265	$1,292,265	$288,251,022	$0	$288,251,022
2042	$101,171,780	$184,498,651	$2,561,534		$7,926,377		$1,548,000	$3,356,757	$301,063,099		$1,292,265	$1,292,265	$299,770,834	$0	$299,770,834
2043	$105,218,651	$191,878,597	$2,663,995		$8,243,432		$1,548,000	$3,491,027	$313,043,703		$1,292,265	$1,292,265	$311,751,438	$0	$311,751,438
2044	$109,427,397	$199,553,741	$2,770,555		$8,573,169		$1,548,000	$3,630,669	$325,503,531		$1,292,265	$1,292,265	$324,211,266	$0	$324,211,266
2045	$113,804,493	$207,535,890	$2,881,377		$8,916,096		$1,548,000	$3,775,895	$338,461,752		$1,292,265	$1,292,265	$337,169,487	$0	$337,169,487
2046	$118,356,673	$215,837,326	$2,996,632		$9,272,740		$1,548,000	$3,926,931	$351,938,302		$1,292,265	$1,292,265	$350,646,037	$0	$350,646,037
2047	$123,090,940	$224,470,819	$3,116,497		$9,643,649		$1,548,000	$4,084,008	$365,953,914		$1,292,265	$1,292,265	$364,661,649	$0	$364,661,649
2048	$128,014,578	$233,449,652	$3,241,157		$10,029,395		$1,548,000	$4,247,369	$380,530,151		$1,292,265	$1,292,265	$379,237,886	$0	$379,237,886
2049	$133,135,161	$242,787,638	$3,370,804		$10,430,571		$1,548,000	$4,417,263	$395,689,437		$1,292,265	$1,292,265	$394,397,172	$0	$394,397,172
2050	$138,460,567	$252,499,143	$3,505,636		$10,847,794		$1,548,000	$4,593,954	$411,455,094		$1,292,265	$1,292,265	$410,162,829	$188,000,000	$598,162,829

Present value of salvage	$2,131,580.05	Present values of savings:	$666,373,720	Present values of costs:	$227,837,114	Total in present values:	$439,992,504

11/07/2000

Evaluation of the net present value(NPV) and of the internal rate of return(IRR)

AD*EC* Inc.

Scenario 1.2

Project:	9908 - JAMAICA HYW 2000	Base year:	2000	Net present value (NPV) :	-36325926	Ratio Benefits/Costs :	0.85	Rate of exchange	40J$/US$
Length:	total: 148kms	Discount rate:	10.00%	Internal rate of return :	9.00%	Salvage value :	41840000		

	BENEFITS									COSTS			DIFFERENCES		
	Benefits related to cars			Benefits related to trucks			Reduction in operation & Maintenance Costs	Reduction of Accident costs	Total Benefits	Construction Costs Economic costs	Operation & Maintenance Costs Economic costs	Total Costs Economic costs	Savings - Costs	Salvage Value	Savings - Costs +Salvage value
YEAR	Savings in VOC: ***Section 2***	Time savings ***Section 2***	Savings in Pollutants: ***Section 2***	Savings in VOC	Time savings ***Section 2***	Pollutants Savings									
	Cars / Trucks	*Cars*	*Cars / Trucks*		*Trucks*										
2000							$ -	$ -	$ -		$ -	$ -	$ -	$ -	$ -
2001							$ -	$ -	$ -		$ -	$ -	$ -	$ -	$ -
2002							$ -	$ -	$ -		$ -	$ -	$ -	$ -	$ -
2003							$ -		$ -	$ 97,443,000		$ 97,443,000	$ (97,443,000)	$ -	$ (97,443,000)
2004							$ -		$ -	$ 186,381,000	$ 615,888	$ 186,996,888	$ (186,996,888)	$ -	$ (186,996,888)
2005							$ -		$ -	$ 139,806,000	$ 1,926,850	$ 141,732,850	$ (141,732,850)	$ -	$ (141,732,850)
2006	$ 11,368,987	$ 7,602,804	$ 293,503		$ 362,492		$ 2,752,000	$ 425,379	$ 22,805,164		$ 2,875,977	$ 2,875,977	$ 19,929,187	$ -	$ 19,929,187
2007	$ 13,057,143	$ 8,731,727	$ 322,853		$ 398,476		$ 2,752,000	$ 442,394	$ 25,694,592		$ 2,875,977	$ 2,875,977	$ 22,818,615	$ -	$ 22,818,615
2008	$ 14,936,164	$ 9,988,288	$ 355,138		$ 416,647		$ 2,752,000	$ 460,089	$ 28,908,327		$ 2,875,977	$ 2,875,977	$ 26,032,350	$ -	$ 26,032,350
2009	$ 15,782,345	$ 10,554,157	$ 372,895		$ 435,629		$ 2,752,000	$ 478,493	$ 30,375,519		$ 2,875,977	$ 2,875,977	$ 27,499,542	$ -	$ 27,499,542
2010	$ 16,674,810	$ 11,150,977	$ 391,540		$ 455,486		$ 2,752,000	$ 497,633	$ 31,922,446		$ 2,875,977	$ 2,875,977	$ 29,046,469	$ -	$ 29,046,469
2011	$ 17,616,033	$ 11,780,402	$ 411,117		$ 476,259		$ 2,752,000	$ 517,538	$ 33,553,349		$ 2,875,977	$ 2,875,977	$ 30,677,372	$ -	$ 30,677,372
2012	$ 18,608,616	$ 12,444,174	$ 431,673		$ 497,990		$ 2,752,000	$ 538,240	$ 35,272,692		$ 2,875,977	$ 2,875,977	$ 32,396,715	$ -	$ 32,396,715
2013	$ 19,655,299	$ 13,144,125	$ 453,256		$ 520,725		$ 2,752,000	$ 559,769	$ 37,085,174		$ 2,875,977	$ 2,875,977	$ 34,209,197	$ -	$ 34,209,197
2014	$ 20,758,967	$ 13,882,182	$ 475,919		$ 544,510		$ 2,752,000	$ 582,160	$ 38,995,738		$ 2,875,977	$ 2,875,977	$ 36,119,761	$ -	$ 36,119,761
2015	$ 21,922,654	$ 14,660,377	$ 499,715		$ 569,394		$ 2,752,000	$ 605,446	$ 41,009,586		$ 2,875,977	$ 2,875,977	$ 38,133,609	$ -	$ 38,133,609
2016	$ 22,799,560	$ 15,246,792	$ 519,704		$ 592,169		$ 2,752,000	$ 629,664	$ 42,539,889		$ 2,875,977	$ 2,875,977	$ 39,663,912	$ -	$ 39,663,912
2017	$ 23,711,543	$ 15,856,664	$ 540,492		$ 615,856		$ 2,752,000	$ 654,851	$ 44,131,405		$ 2,875,977	$ 2,875,977	$ 41,255,428	$ -	$ 41,255,428
2018	$ 24,660,004	$ 16,490,930	$ 562,111		$ 640,490		$ 2,752,000	$ 681,045	$ 45,786,581		$ 2,875,977	$ 2,875,977	$ 42,910,604	$ -	$ 42,910,604
2019	$ 25,646,404	$ 17,150,567	$ 584,596		$ 666,110		$ 2,752,000	$ 708,287	$ 47,507,964		$ 2,875,977	$ 2,875,977	$ 44,631,987	$ -	$ 44,631,987
2020	$ 26,672,261	$ 17,836,590	$ 607,980		$ 692,754		$ 2,752,000	$ 736,618	$ 49,298,203		$ 2,875,977	$ 2,875,977	$ 46,422,226	$ -	$ 46,422,226
2021	$ 27,739,151	$ 18,550,054	$ 632,299		$ 720,465		$ 2,752,000	$ 766,083	$ 51,160,051		$ 2,875,977	$ 2,875,977	$ 48,284,074	$ -	$ 48,284,074
2022	$ 28,848,717	$ 19,292,056	$ 657,591		$ 749,283		$ 2,752,000	$ 796,726	$ 53,096,373		$ 2,875,977	$ 2,875,977	$ 50,220,396	$ -	$ 50,220,396
2023	$ 30,002,666	$ 20,063,738	$ 683,895		$ 779,254		$ 2,752,000	$ 828,595	$ 55,110,148		$ 2,875,977	$ 2,875,977	$ 52,234,171	$ -	$ 52,234,171
2024	$ 31,202,772	$ 20,866,288	$ 711,250		$ 810,425		$ 2,752,000	$ 861,739	$ 57,204,474		$ 2,875,977	$ 2,875,977	$ 54,328,497	$ -	$ 54,328,497
2025	$ 32,450,883	$ 21,700,939	$ 739,700		$ 842,842		$ 2,752,000	$ 896,208	$ 59,382,573		$ 2,875,977	$ 2,875,977	$ 56,506,596	$ -	$ 56,506,596
2026	$ 33,748,919	$ 22,568,977	$ 769,288		$ 876,555		$ 2,752,000	$ 932,057	$ 61,647,796		$ 2,875,977	$ 2,875,977	$ 58,771,819	$ -	$ 58,771,819
2027	$ 35,098,875	$ 23,471,736	$ 800,060		$ 911,617		$ 2,752,000	$ 969,339	$ 64,003,628		$ 2,875,977	$ 2,875,977	$ 61,127,651	$ -	$ 61,127,651
2028	$ 36,502,830	$ 24,410,605	$ 832,062		$ 948,082		$ 2,752,000	$ 1,008,113	$ 66,453,693		$ 2,875,977	$ 2,875,977	$ 63,577,716	$ -	$ 63,577,716
2029	$ 37,962,944	$ 25,387,030	$ 865,345		$ 986,005		$ 2,752,000	$ 1,048,437	$ 69,001,760		$ 2,875,977	$ 2,875,977	$ 66,125,783	$ -	$ 66,125,783
2030	$ 39,481,461	$ 26,402,511	$ 899,959		$ 1,025,446		$ 2,752,000	$ 1,090,375	$ 71,651,751		$ 2,875,977	$ 2,875,977	$ 68,775,774	$ -	$ 68,775,774
2031	$ 41,060,720	$ 27,458,611	$ 935,957		$ 1,066,464		$ 2,752,000	$ 1,133,990	$ 74,407,741		$ 2,875,977	$ 2,875,977	$ 71,531,764	$ -	$ 71,531,764
2032	$ 42,703,149	$ 28,556,956	$ 973,395		$ 1,109,122		$ 2,752,000	$ 1,179,349	$ 77,273,970		$ 2,875,977	$ 2,875,977	$ 74,397,993	$ -	$ 74,397,993
2033	$ 44,411,274	$ 29,699,234	$ 1,012,331		$ 1,153,487		$ 2,752,000	$ 1,226,523	$ 80,254,849		$ 2,875,977	$ 2,875,977	$ 77,378,872	$ -	$ 77,378,872
2034	$ 46,187,725	$ 30,887,203	$ 1,052,824		$ 1,199,626		$ 2,752,000	$ 1,275,584	$ 83,354,963		$ 2,875,977	$ 2,875,977	$ 80,478,986	$ -	$ 80,478,986
2035	$ 48,035,234	$ 32,122,691	$ 1,094,937		$ 1,247,611		$ 2,752,000	$ 1,326,607	$ 86,579,082		$ 2,875,977	$ 2,875,977	$ 83,703,105	$ -	$ 83,703,105
2036	$ 49,956,644	$ 33,407,599	$ 1,138,735		$ 1,297,516		$ 2,752,000	$ 1,379,672	$ 89,932,165		$ 2,875,977	$ 2,875,977	$ 87,056,188	$ -	$ 87,056,188
2037	$ 51,954,910	$ 34,743,903	$ 1,184,284		$ 1,349,417		$ 2,752,000	$ 1,434,858	$ 93,419,372		$ 2,875,977	$ 2,875,977	$ 90,543,395	$ -	$ 90,543,395
2038	$ 54,033,106	$ 36,133,659	$ 1,231,656		$ 1,403,393		$ 2,752,000	$ 1,492,253	$ 97,046,067		$ 2,875,977	$ 2,875,977	$ 94,170,090	$ -	$ 94,170,090
2039	$ 56,194,430	$ 37,579,005	$ 1,280,922		$ 1,459,529		$ 2,752,000	$ 1,551,943	$ 100,817,829		$ 2,875,977	$ 2,875,977	$ 97,941,852	$ -	$ 97,941,852
2040	$ 58,442,207	$ 39,082,166	$ 1,332,159		$ 1,517,910		$ 2,752,000	$ 1,614,021	$ 104,740,462		$ 2,875,977	$ 2,875,977	$ 101,864,485	$ -	$ 101,864,485
2041	$ 60,779,896	$ 40,645,452	$ 1,385,445		$ 1,578,627		$ 2,752,000	$ 1,678,581	$ 108,820,001		$ 2,875,977	$ 2,875,977	$ 105,944,024	$ -	$ 105,944,024
2042	$ 63,211,092	$ 42,271,270	$ 1,440,863		$ 1,641,772		$ 2,752,000	$ 1,745,725	$ 113,062,721		$ 2,875,977	$ 2,875,977	$ 110,186,744	$ -	$ 110,186,744
2043	$ 65,739,535	$ 43,962,121	$ 1,498,497		$ 1,707,442		$ 2,752,000	$ 1,815,554	$ 117,475,150		$ 2,875,977	$ 2,875,977	$ 114,599,173	$ -	$ 114,599,173
2044	$ 68,369,117	$ 45,720,606	$ 1,558,437		$ 1,775,740		$ 2,752,000	$ 1,888,176	$ 122,064,076		$ 2,875,977	$ 2,875,977	$ 119,188,099	$ -	$ 119,188,099
2045	$ 71,103,881	$ 47,549,430	$ 1,620,775		$ 1,846,770		$ 2,752,000	$ 1,963,703	$ 126,836,559		$ 2,875,977	$ 2,875,977	$ 123,960,582	$ -	$ 123,960,582
2046	$ 73,948,036	$ 49,451,407	$ 1,685,606		$ 1,920,641		$ 2,752,000	$ 2,042,251	$ 131,799,941		$ 2,875,977	$ 2,875,977	$ 128,923,964	$ -	$ 128,923,964
2047	$ 76,905,958	$ 51,429,464	$ 1,753,030		$ 1,997,466		$ 2,752,000	$ 2,123,941	$ 136,961,859		$ 2,875,977	$ 2,875,977	$ 134,085,882	$ -	$ 134,085,882
2048	$ 79,982,196	$ 53,486,642	$ 1,823,151		$ 2,077,365		$ 2,752,000	$ 2,208,899	$ 142,330,253		$ 2,875,977	$ 2,875,977	$ 139,454,276	$ -	$ 139,454,276
2049	$ 83,181,484	$ 55,626,108	$ 1,896,077		$ 2,160,459		$ 2,752,000	$ 2,297,255	$ 147,913,383		$ 2,875,977	$ 2,875,977	$ 145,037,406	$ -	$ 145,037,406
2050	$ 86,508,743	$ 57,851,152	$ 1,971,920		$ 2,246,878		$ 2,752,000	$ 2,389,145	$ 153,719,839		$ 2,875,977	$ 2,875,977	$ 150,843,862	$ 418,400,000	$ 569,243,862

Present value of salvage:	$ 4,743,899	Present values of savings:	$237,611,329	Present values of costs:	$278,681,155	Total in present values:	$ (37,829,678)

11/07/2000

Evaluation of the net present value(NPV) and of the internal rate of return(IRR)

AD*EC* Inc.

Scenario 2

Projet:	9908 - JAMAICA HYW 2000	Base year:	2000	Net present value (NPV) :	114251467	Ratio Benefits/Costs :	1.21	Rate of exchange	40J$/US$
Length:	total : 233kms	Discount rate:	10.00%	Internal rate of return :	11.41%	Salvage value :	606400000		

	BENEFITS									COSTS			DIFFERENCES		
	Benefits related to cars			Benefits related to trucks			Reduction	Reduction	Total	Construction	Operation &	Total Costs	Savings	Salvage	Savings
YEAR	Savings in VOC: ***Total***	Time savings (Value 2) ***Total***	Savings in Pollutants: ***Total***	Savings in VOC	Time savings (Value 2) ***Total***	Pollutants Savings	in operation & Maintenance Costs	of Accident costs	Benefits	Costs Economic costs	Maintenance Costs Economic costs	Economic costs	- Costs	Value	- Costs +Salvage value
	Cars / Trucks	*Cars*	*Cars / Trucks*		*Trucks*										
2000							$ -	$ -	$ -	$ 47,500,000	$ -	$ 47,500,000	$ (47,500,000)	$ -	$ (47,500,000)
2001							$ -	$ -	$ -	$ 47,500,000	$ -	$ 47,500,000	$ (47,500,000)	$ -	$ (47,500,000)
2002							$ -	$ -	$ -	$ 91,368,000	$ -	$ 91,368,000	$ (91,368,000)	$ -	$ (91,368,000)
2003							$ -		$ -	$ 196,668,000	$ 615,888	$ 197,283,888	$(197,283,888)	$ -	$ (197,283,888)
2004							$ -		$ -	$ 186,381,000	$ 1,953,795	$ 188,334,795	$(188,334,795)	$ -	$ (188,334,795)
2005							$ -		$ -	$ 139,806,000	$ 3,216,915	$ 143,022,915	$(143,022,915)	$ -	$ (143,022,915)
2006	$ 29,590,640	$ 19,441,193	$ 815,285		$ 2,119,293		$ 4,300,000	$ 1,181,607	$ 57,448,018		$ 3,216,915	$ 3,216,915	$ 54,231,103	$ -	$ 54,231,103
2007	$ 33,984,487	$ 22,238,927	$ 896,814		$ 2,272,981		$ 4,300,000	$ 1,228,871	$ 64,922,079		$ 3,216,915	$ 3,216,915	$ 61,705,164	$ -	$ 61,705,164
2008	$ 38,875,111	$ 25,350,579	$ 986,495		$ 2,439,707		$ 4,300,000	$ 1,278,026	$ 73,229,917		$ 3,216,915	$ 3,216,915	$ 70,013,002	$ -	$ 70,013,002
2009	$ 41,977,510	$ 26,771,986	$ 1,035,820		$ 2,551,193		$ 4,300,000	$ 1,329,147	$ 77,065,655		$ 3,216,915	$ 3,216,915	$ 73,848,740	$ -	$ 73,848,740
2010	$ 43,400,375	$ 28,270,618	$ 1,087,611		$ 2,667,833		$ 4,300,000	$ 1,382,313	$ 81,108,750		$ 3,216,915	$ 3,216,915	$ 77,891,835	$ -	$ 77,891,835
2011	$ 45,850,142	$ 29,950,594	$ 1,141,991		$ 2,789,869		$ 4,300,000	$ 1,437,606	$ 85,570,192		$ 3,216,915	$ 3,216,915	$ 82,153,277	$ -	$ 82,153,277
2012	$ 48,433,588	$ 31,516,205	$ 1,199,091		$ 2,917,553		$ 4,300,000	$ 1,495,110	$ 89,861,547		$ 3,216,915	$ 3,216,915	$ 86,644,632	$ -	$ 86,644,632
2013	$ 51,157,844	$ 33,272,032	$ 1,259,045		$ 3,051,148		$ 4,300,000	$ 1,554,914	$ 94,594,983		$ 3,216,915	$ 3,216,915	$ 91,378,068	$ -	$ 91,378,068
2014	$ 54,030,416	$ 35,122,850	$ 1,321,998		$ 3,190,931		$ 4,300,000	$ 1,617,111	$ 99,583,305		$ 3,216,915	$ 3,216,915	$ 96,366,390	$ -	$ 96,366,390
2015	$ 57,059,203	$ 37,073,697	$ 1,388,097		$ 3,337,193		$ 4,300,000	$ 1,681,795	$ 104,839,986		$ 3,216,915	$ 3,216,915	$ 101,623,071	$ -	$ 101,623,071
2016	$ 59,941,572	$ 38,556,645	$ 1,443,621		$ 3,470,681		$ 4,300,000	$ 1,749,067	$ 109,861,586		$ 3,216,915	$ 3,216,915	$ 105,644,671	$ -	$ 105,644,671
2017	$ 61,715,234	$ 40,098,911	$ 1,501,366		$ 3,609,508		$ 4,300,000	$ 1,819,030	$ 113,044,049		$ 3,216,915	$ 3,216,915	$ 109,827,134	$ -	$ 109,827,134
2018	$ 64,183,844	$ 41,702,867	$ 1,561,421		$ 3,753,888		$ 4,300,000	$ 1,891,791	$ 117,393,811		$ 3,216,915	$ 3,216,915	$ 114,176,896	$ -	$ 114,176,896
2019	$ 66,751,198	$ 43,370,982	$ 1,623,878		$ 3,904,044		$ 4,300,000	$ 1,967,463	$ 121,917,564		$ 3,216,915	$ 3,216,915	$ 118,700,649	$ -	$ 118,700,649
2020	$ 69,421,245	$ 45,105,821	$ 1,688,833		$ 4,060,206		$ 4,300,000	$ 2,046,161	$ 126,622,266		$ 3,216,915	$ 3,216,915	$ 123,405,351	$ -	$ 123,405,351
2021	$ 72,198,095	$ 46,910,054	$ 1,756,386		$ 4,222,614		$ 4,300,000	$ 2,128,007	$ 131,515,157		$ 3,216,915	$ 3,216,915	$ 128,298,242	$ -	$ 128,298,242
2022	$ 75,086,019	$ 48,786,456	$ 1,826,642		$ 4,391,518		$ 4,300,000	$ 2,213,128	$ 136,603,763		$ 3,216,915	$ 3,216,915	$ 133,386,848	$ -	$ 133,386,848
2023	$ 78,089,460	$ 50,737,915	$ 1,899,707		$ 4,567,179		$ 4,300,000	$ 2,301,653	$ 141,895,914		$ 3,216,915	$ 3,216,915	$ 138,678,999	$ -	$ 138,678,999
2024	$ 81,213,038	$ 52,767,431	$ 1,975,695		$ 4,749,866		$ 4,300,000	$ 2,393,719	$ 147,399,750		$ 3,216,915	$ 3,216,915	$ 144,182,835	$ -	$ 144,182,835
2025	$ 84,461,560	$ 54,878,128	$ 2,054,723		$ 4,939,861		$ 4,300,000	$ 2,489,468	$ 153,123,740		$ 3,216,915	$ 3,216,915	$ 149,906,825	$ -	$ 149,906,825
2026	$ 87,840,022	$ 57,073,254	$ 2,136,912		$ 5,137,455		$ 4,300,000	$ 2,589,046	$ 159,076,690		$ 3,216,915	$ 3,216,915	$ 155,859,775	$ -	$ 155,859,775
2027	$ 91,353,623	$ 59,356,184	$ 2,222,389		$ 5,342,954		$ 4,300,000	$ 2,692,608	$ 165,267,757		$ 3,216,915	$ 3,216,915	$ 162,050,842	$ -	$ 162,050,842
2028	$ 95,007,768	$ 61,730,431	$ 2,311,284		$ 5,556,672		$ 4,300,000	$ 2,800,313	$ 171,706,468		$ 3,216,915	$ 3,216,915	$ 168,489,553	$ -	$ 168,489,553
2029	$ 98,808,079	$ 64,199,648	$ 2,403,736		$ 5,778,939		$ 4,300,000	$ 2,912,326	$ 178,402,726		$ 3,216,915	$ 3,216,915	$ 175,185,811	$ -	$ 175,185,811
2030	$ 102,760,402	$ 66,767,634	$ 2,499,885		$ 6,010,096		$ 4,300,000	$ 3,028,818	$ 185,366,836		$ 3,216,915	$ 3,216,915	$ 182,149,921	$ -	$ 182,149,921
2031	$ 106,870,818	$ 69,438,340	$ 2,599,880		$ 6,250,500		$ 4,300,000	$ 3,149,971	$ 192,609,509		$ 3,216,915	$ 3,216,915	$ 189,392,594	$ -	$ 189,392,594
2032	$ 111,145,651	$ 72,215,873	$ 2,703,876		$ 6,500,520		$ 4,300,000	$ 3,275,970	$ 200,141,889		$ 3,216,915	$ 3,216,915	$ 196,924,974	$ -	$ 196,924,974
2033	$ 115,591,477	$ 75,104,508	$ 2,812,031		$ 6,760,541		$ 4,300,000	$ 3,407,008	$ 207,975,565		$ 3,216,915	$ 3,216,915	$ 204,758,650	$ -	$ 204,758,650
2034	$ 120,215,136	$ 78,108,688	$ 2,924,512		$ 7,030,963		$ 4,300,000	$ 3,543,289	$ 216,122,587		$ 3,216,915	$ 3,216,915	$ 212,905,672	$ -	$ 212,905,672
2035	$ 125,023,741	$ 81,233,036	$ 3,041,492		$ 7,312,201		$ 4,300,000	$ 3,685,020	$ 224,595,491		$ 3,216,915	$ 3,216,915	$ 221,378,576	$ -	$ 221,378,576
2036	$ 130,024,691	$ 84,482,357	$ 3,163,152		$ 7,604,689		$ 4,300,000	$ 3,832,421	$ 233,407,311		$ 3,216,915	$ 3,216,915	$ 230,190,396	$ -	$ 230,190,396
2037	$ 135,225,678	$ 87,861,652	$ 3,289,678		$ 7,908,877		$ 4,300,000	$ 3,985,718	$ 242,571,603		$ 3,216,915	$ 3,216,915	$ 239,354,688	$ -	$ 239,354,688
2038	$ 140,634,706	$ 91,376,118	$ 3,421,265		$ 8,225,232		$ 4,300,000	$ 4,145,147	$ 252,102,467		$ 3,216,915	$ 3,216,915	$ 248,885,552	$ -	$ 248,885,552
2039	$ 146,260,094	$ 95,031,162	$ 3,558,116		$ 8,554,241		$ 4,300,000	$ 4,310,953	$ 262,014,566		$ 3,216,915	$ 3,216,915	$ 258,797,651	$ -	$ 258,797,651
2040	$ 152,110,498	$ 98,832,409	$ 3,700,441		$ 8,896,411		$ 4,300,000	$ 4,483,391	$ 272,323,148		$ 3,216,915	$ 3,216,915	$ 269,106,233	$ -	$ 269,106,233
2041	$ 158,194,918	$ 102,785,705	$ 3,848,458		$ 9,252,267		$ 4,300,000	$ 4,662,726	$ 283,044,074		$ 3,216,915	$ 3,216,915	$ 279,827,159	$ -	$ 279,827,159
2042	$ 164,522,714	$ 106,897,133	$ 4,002,397		$ 9,622,358		$ 4,300,000	$ 4,849,235	$ 294,193,837		$ 3,216,915	$ 3,216,915	$ 290,976,922	$ -	$ 290,976,922
2043	$ 171,103,623	$ 111,173,019	$ 4,162,492		$ 10,007,252		$ 4,300,000	$ 5,043,205	$ 305,789,591		$ 3,216,915	$ 3,216,915	$ 302,572,676	$ -	$ 302,572,676
2044	$ 177,947,768	$ 115,619,940	$ 4,328,992		$ 10,407,542		$ 4,300,000	$ 5,244,933	$ 317,849,175		$ 3,216,915	$ 3,216,915	$ 314,632,260	$ -	$ 314,632,260
2045	$ 185,065,678	$ 120,244,737	$ 4,502,152		$ 10,823,844		$ 4,300,000	$ 5,454,730	$ 330,391,142		$ 3,216,915	$ 3,216,915	$ 327,174,227	$ -	$ 327,174,227
2046	$ 192,468,306	$ 125,054,527	$ 4,682,238		$ 11,256,798		$ 4,300,000	$ 5,672,920	$ 343,434,787		$ 3,216,915	$ 3,216,915	$ 340,217,872	$ -	$ 340,217,872
2047	$ 200,167,038	$ 130,056,708	$ 4,869,527		$ 11,707,069		$ 4,300,000	$ 5,899,836	$ 357,000,179		$ 3,216,915	$ 3,216,915	$ 353,783,264	$ -	$ 353,783,264
2048	$ 208,173,719	$ 135,258,976	$ 5,064,308		$ 12,175,352		$ 4,300,000	$ 6,135,830	$ 371,108,186		$ 3,216,915	$ 3,216,915	$ 367,891,271	$ -	$ 367,891,271
2049	$ 216,500,668	$ 140,669,335	$ 5,266,881		$ 12,662,366		$ 4,300,000	$ 6,381,263	$ 385,780,513		$ 3,216,915	$ 3,216,915	$ 382,563,598	$ -	$ 382,563,598
2050	$ 225,160,695	$ 146,296,108	$ 5,477,556		$ 13,168,861		$ 4,300,000	$ 6,636,514	$ 401,039,734		$ 3,216,915	$ 3,216,915	$ 397,822,819	$ 606,400,000	$ 1,004,222,819

Present value of salvage:	$ 6,875,479	Present values of savings:	$608,791,006	Present values of costs: $501,415,018	Total in present values: $112,072,032

11/07/2000

Evaluation of the net present value(NPV) and of the internal rate of return(IRR)

ADEC Inc.

Scenario 2.1

Project:	9908 - JAMAICA HYW 2000	Base year:	2000	Net present value (NPV) :	246496263	Ratio Benefits/Costs :	2.07	Rate of exchange	40J$/US$
Length:	total: 85kms	Discount rate:	10.00%	Internal rate of return :	16.05%	Salvage value :	188000000		

	BENEFITS									COSTS			DIFFERENCES		
	Benefits related to cars			Benefits related to trucks			Reduction	Reduction	Total	Construction	Operation &	Total Costs	Savings	Salvage	Savings
YEAR	Savings in VOC **Section 1**	Time savings **Section 1**	Savings in Pollutants **Section 1**	Savings in VOC	Time savings **Section 1**	Pollutants Savings	in operation & Maintenance Costs	of Accident costs	Benefits	Costs Economic costs	Maintenance Costs Economic costs	Economic costs	- Costs	Value	- Costs +Salvage value
	Cars / Trucks	*Cars*	*Cars / Trucks*		*Trucks*										
2000							$0	$0	$0	$47,500,000	$0	$47,500,000	-$47,500,000	$0	-$47,500,000
2001							$0	$0	$0	$47,500,000	$0	$47,500,000	-$47,500,000	$0	-$47,500,000
2002							$0	$0	$0	$91,368,000	$0	$91,368,000	-$91,368,000	$0	-$91,368,000
2003							$0		$0	$98,982,000	$615,888	$99,597,888	-$99,597,888	$0	-$99,597,888
2004	$13,595,749	$13,526,778	$131,814		$1,521,226		$1,548,000	$756,228	$30,323,567		$1,292,265	$1,292,265	$29,031,302	$0	$29,031,302
2005	$15,771,804	$15,480,914	$474,348		$1,628,991		$1,548,000	$786,478	$34,903,258		$1,292,265	$1,292,265	$33,610,993	$0	$33,610,993
2006	$18,196,483	$17,654,523	$521,782		$1,745,759		$1,548,000	$817,937	$40,484,484		$1,292,265	$1,292,265	$39,192,219	$0	$39,192,219
2007	$20,898,445	$20,070,513	$573,961		$1,872,358		$1,548,000	$850,654	$45,813,931		$1,292,265	$1,292,265	$44,521,666	$0	$44,521,666
2008	$23,905,896	$22,754,123	$631,357		$2,009,698		$1,548,000	$884,680	$51,733,754		$1,292,265	$1,292,265	$50,441,489	$0	$50,441,489
2009	$25,260,243	$24,009,099	$662,925		$2,101,534		$1,548,000	$920,068	$54,501,869		$1,292,265	$1,292,265	$53,209,604	$0	$53,209,604
2010	$26,688,668	$25,331,515	$696,071		$2,197,617		$1,548,000	$956,870	$57,418,742		$1,292,265	$1,292,265	$56,126,477	$0	$56,126,477
2011	$28,195,132	$26,724,931	$730,874		$2,298,143		$1,548,000	$995,145	$60,492,226		$1,292,265	$1,292,265	$59,199,961	$0	$59,199,961
2012	$29,783,801	$28,193,090	$767,418		$2,403,322		$1,548,000	$1,034,951	$63,730,582		$1,292,265	$1,292,265	$62,438,317	$0	$62,438,317
2013	$31,459,059	$29,739,935	$805,789		$2,513,370		$1,548,000	$1,076,349	$67,142,501		$1,292,265	$1,292,265	$65,850,236	$0	$65,850,236
2014	$33,225,522	$31,369,608	$846,078		$2,628,516		$1,548,000	$1,119,403	$70,737,129		$1,292,265	$1,292,265	$69,444,863	$0	$69,444,863
2015	$35,088,050	$33,086,473	$888,382		$2,748,999		$1,548,000	$1,164,179	$74,524,083		$1,292,265	$1,292,265	$73,231,818	$0	$73,231,818
2016	$36,491,572	$34,409,932	$923,918		$2,858,959		$1,548,000	$1,210,746	$77,443,126		$1,292,265	$1,292,265	$76,150,861	$0	$76,150,861
2017	$37,951,235	$35,786,329	$960,874		$2,973,317		$1,548,000	$1,259,176	$80,478,932		$1,292,265	$1,292,265	$79,186,667	$0	$79,186,667
2018	$39,469,284	$37,217,783	$999,309		$3,092,250		$1,548,000	$1,309,543	$83,636,169		$1,292,265	$1,292,265	$82,343,904	$0	$82,343,904
2019	$41,048,055	$38,706,494	$1,039,282		$3,215,940		$1,548,000	$1,361,925	$86,919,696		$1,292,265	$1,292,265	$85,627,431	$0	$85,627,431
2020	$42,689,978	$40,254,754	$1,080,853		$3,344,577		$1,548,000	$1,416,402	$90,334,563		$1,292,265	$1,292,265	$89,042,298	$0	$89,042,298
2021	$44,397,577	$41,864,944	$1,124,087		$3,478,361		$1,548,000	$1,473,058	$93,886,026		$1,292,265	$1,292,265	$92,593,761	$0	$92,593,761
2022	$46,173,480	$43,539,541	$1,169,051		$3,617,495		$1,548,000	$1,531,980	$97,579,547		$1,292,265	$1,292,265	$96,287,282	$0	$96,287,282
2023	$48,020,419	$45,281,123	$1,215,813		$3,762,195		$1,548,000	$1,593,259	$101,420,809		$1,292,265	$1,292,265	$100,128,544	$0	$100,128,544
2024	$49,941,236	$47,092,368	$1,264,445		$3,912,683		$1,548,000	$1,656,990	$105,415,721		$1,292,265	$1,292,265	$104,123,456	$0	$104,123,456
2025	$51,938,885	$48,976,063	$1,315,023		$4,069,190		$1,548,000	$1,723,269	$109,570,430		$1,292,265	$1,292,265	$108,278,165	$0	$108,278,165
2026	$54,016,441	$50,935,105	$1,367,624		$4,231,957		$1,548,000	$1,792,200	$113,891,327		$1,292,265	$1,292,265	$112,599,062	$0	$112,599,062
2027	$56,177,098	$52,972,510	$1,422,329		$4,401,236		$1,548,000	$1,863,888	$118,385,060		$1,292,265	$1,292,265	$117,092,795	$0	$117,092,795
2028	$58,424,182	$55,091,410	$1,479,222		$4,577,285		$1,548,000	$1,938,444	$123,059,543		$1,292,265	$1,292,265	$121,766,278	$0	$121,766,278
2029	$60,761,149	$57,295,066	$1,538,391		$4,760,377		$1,548,000	$2,015,981	$127,918,964		$1,292,265	$1,292,265	$126,626,699	$0	$126,626,699
2030	$63,191,595	$59,586,869	$1,599,926		$4,950,792		$1,548,000	$2,096,621	$132,973,803		$1,292,265	$1,292,265	$131,681,538	$0	$131,681,538
2031	$65,719,259	$61,970,344	$1,663,923		$5,148,823		$1,548,000	$2,180,485	$138,230,935		$1,292,265	$1,292,265	$136,938,670	$0	$136,938,670
2032	$68,348,030	$64,449,157	$1,730,480		$5,354,776		$1,548,000	$2,267,705	$143,696,148		$1,292,265	$1,292,265	$142,405,883	$0	$142,405,883
2033	$71,081,951	$67,027,124	$1,799,700		$5,568,967		$1,548,000	$2,358,413	$149,394,154		$1,292,265	$1,292,265	$148,091,889	$0	$148,091,889
2034	$73,925,229	$69,708,209	$1,871,688		$5,791,726		$1,548,000	$2,452,750	$155,297,601		$1,292,265	$1,292,265	$154,005,336	$0	$154,005,336
2035	$76,882,238	$72,496,537	$1,946,555		$6,023,395		$1,548,000	$2,550,860	$161,447,585		$1,292,265	$1,292,265	$160,155,320	$0	$160,155,320
2036	$79,957,527	$75,396,399	$2,024,417		$6,264,331		$1,548,000	$2,652,894	$167,843,568		$1,292,265	$1,292,265	$166,551,303	$0	$166,551,303
2037	$83,155,828	$78,412,254	$2,105,394		$6,514,904		$1,548,000	$2,759,010	$174,495,391		$1,292,265	$1,292,265	$173,203,126	$0	$173,203,126
2038	$86,482,062	$81,548,745	$2,189,610		$6,775,500		$1,548,000	$2,869,370	$181,413,286		$1,292,265	$1,292,265	$180,121,021	$0	$180,121,021
2039	$89,941,344	$84,810,694	$2,277,194		$7,046,520		$1,548,000	$2,984,145	$188,607,898		$1,292,265	$1,292,265	$187,315,633	$0	$187,315,633
2040	$93,538,998	$88,203,122	$2,368,282		$7,328,381		$1,548,000	$3,103,511	$196,090,294		$1,292,265	$1,292,265	$194,798,029	$0	$194,798,029
2041	$97,280,558	$91,731,247	$2,463,013		$7,621,516		$1,548,000	$3,227,651	$203,871,985		$1,292,265	$1,292,265	$202,579,720	$0	$202,579,720
2042	$101,171,780	$95,400,497	$2,561,534		$7,926,377		$1,548,000	$3,356,757	$211,964,945		$1,292,265	$1,292,265	$210,672,680	$0	$210,672,680
2043	$105,218,651	$99,216,517	$2,663,995		$8,243,432		$1,548,000	$3,491,027	$220,381,623		$1,292,265	$1,292,265	$219,089,358	$0	$219,089,358
2044	$109,427,397	$103,185,178	$2,770,555		$8,573,169		$1,548,000	$3,630,669	$229,134,969		$1,292,265	$1,292,265	$227,842,703	$0	$227,842,703
2045	$113,804,493	$107,312,585	$2,881,377		$8,916,096		$1,548,000	$3,775,895	$238,238,446		$1,292,265	$1,292,265	$236,946,181	$0	$236,946,181
2046	$118,356,673	$111,605,088	$2,996,632		$9,272,740		$1,548,000	$3,926,931	$247,706,064		$1,292,265	$1,292,265	$246,413,799	$0	$246,413,799
2047	$123,090,940	$116,069,292	$3,116,497		$9,643,649		$1,548,000	$4,084,008	$257,552,387		$1,292,265	$1,292,265	$256,260,122	$0	$256,260,122
2048	$128,014,578	$120,712,063	$3,241,157		$10,029,395		$1,548,000	$4,247,369	$267,792,562		$1,292,265	$1,292,265	$266,500,297	$0	$266,500,297
2049	$133,135,161	$125,540,546	$3,370,804		$10,430,571		$1,548,000	$4,417,263	$278,442,345		$1,292,265	$1,292,265	$277,150,080	$0	$277,150,080
2050	$138,460,567	$130,562,168	$3,505,636		$10,847,794		$1,548,000	$4,593,954	$289,518,118		$1,292,265	$1,292,265	$288,225,853	$188,000,000	$476,225,853

Present value of salvage	$ 2,131,580	Present values of savings:	$472,201,797	Present values of costs:	$227,837,114	Total in present values:	$245,820,581

11/07/2000

Evaluation of the net present value(NPV) and of the internal rate of return(IRR)

AD*EC* Inc.

Scenario 2.2

Project:	9908 - JAMAICA HYW 2000	Base year:	2000	Net present value (NPV) :	-79868390	Ratio Benefits/Costs :	0.70	Rate of exchange	40J$/US$
Length:	total: 148kms	Discount rate:	10.00%	Internal rate of return :	7.76%	Salvage value :	41840000		

	BENEFITS									COSTS			DIFFERENCES		
	Benefits related to cars			Benefits related to trucks			Reduction	Reduction	Total	Construction	Operation &	Total Costs	Savings	Salvage	Savings
YEAR	Savings in VOC: ***Section 2***	Time savings ***Section 2***	Savings in Pollutants: ***Section 2***	Savings in VOC	Time savings ***Section 2***	Pollutants Savings	in operation & Maintenance Costs	of Accident costs	Benefits	Costs Economic costs	Maintenance Costs Economic costs	Economic costs	- Costs	Value	- Costs +Salvage value
	Cars / Trucks	*Cars*	*Cars / Trucks*		*Trucks*										
2000							$ -	$ -	$ -		$ -	$ -	$ -	$ -	$ -
2001							$ -	$ -	$ -		$ -	$ -	$ -	$ -	$ -
2002							$ -	$ -	$ -		$ -	$ -	$ -	$ -	$ -
2003							$ -		$ -	$ 97,443,000		$ 97,443,000	$ (97,443,000)	$ -	$ (97,443,000)
2004							$ -		$ -	$ 186,381,000	$ 615,888	$ 186,996,888	$(186,996,888)	$ -	$ (186,996,888)
2005							$ -		$ -	$ 139,806,000	$ 1,926,850	$ 141,732,850	$(141,732,850)	$ -	$ (141,732,850)
2006	$ 11,368,987	$ 3,478,325	$ 293,503		$ 362,492		$ 2,752,000	$ 425,379	$ 18,680,685		$ 2,875,977	$ 2,875,977	$ 15,804,708	$ -	$ 15,804,708
2007	$ 13,057,143	$ 3,995,187	$ 322,853		$ 398,476		$ 2,752,000	$ 442,394	$ 20,948,052		$ 2,875,977	$ 2,875,977	$ 18,072,075	$ -	$ 18,072,075
2008	$ 14,936,164	$ 4,549,097	$ 355,138		$ 416,647		$ 2,752,000	$ 460,089	$ 23,469,135		$ 2,875,977	$ 2,875,977	$ 20,593,158	$ -	$ 20,593,158
2009	$ 15,782,345	$ 5,176,013	$ 372,895		$ 435,629		$ 2,752,000	$ 478,493	$ 24,997,375		$ 2,875,977	$ 2,875,977	$ 22,121,398	$ -	$ 22,121,398
2010	$ 16,674,810	$ 5,464,628	$ 391,540		$ 455,486		$ 2,752,000	$ 497,633	$ 26,236,097		$ 2,875,977	$ 2,875,977	$ 23,360,120	$ -	$ 23,360,120
2011	$ 17,616,033	$ 5,768,866	$ 411,117		$ 476,259		$ 2,752,000	$ 517,538	$ 27,541,813		$ 2,875,977	$ 2,875,977	$ 24,665,836	$ -	$ 24,665,836
2012	$ 18,608,616	$ 6,089,857	$ 431,673		$ 497,990		$ 2,752,000	$ 538,240	$ 28,918,076		$ 2,875,977	$ 2,875,977	$ 26,042,098	$ -	$ 26,042,098
2013	$ 19,655,299	$ 6,427,572	$ 453,256		$ 520,725		$ 2,752,000	$ 559,769	$ 30,368,622		$ 2,875,977	$ 2,875,977	$ 27,492,645	$ -	$ 27,492,645
2014	$ 20,758,967	$ 6,783,830	$ 475,919		$ 544,510		$ 2,752,000	$ 582,160	$ 31,897,385		$ 2,875,977	$ 2,875,977	$ 29,021,408	$ -	$ 29,021,408
2015	$ 21,922,654	$ 7,159,295	$ 499,715		$ 569,394		$ 2,752,000	$ 605,446	$ 33,508,504		$ 2,875,977	$ 2,875,977	$ 30,632,527	$ -	$ 30,632,527
2016	$ 22,799,560	$ 7,554,984	$ 519,704		$ 592,169		$ 2,752,000	$ 629,664	$ 34,848,082		$ 2,875,977	$ 2,875,977	$ 31,972,105	$ -	$ 31,972,105
2017	$ 23,711,543	$ 7,857,184	$ 540,492		$ 615,856		$ 2,752,000	$ 654,851	$ 36,131,925		$ 2,875,977	$ 2,875,977	$ 33,255,948	$ -	$ 33,255,948
2018	$ 24,660,004	$ 8,171,471	$ 562,111		$ 640,490		$ 2,752,000	$ 681,045	$ 37,467,122		$ 2,875,977	$ 2,875,977	$ 34,591,145	$ -	$ 34,591,145
2019	$ 25,646,404	$ 8,498,330	$ 584,596		$ 666,110		$ 2,752,000	$ 708,287	$ 38,855,727		$ 2,875,977	$ 2,875,977	$ 35,979,750	$ -	$ 35,979,750
2020	$ 26,672,261	$ 8,838,263	$ 607,980		$ 692,754		$ 2,752,000	$ 736,618	$ 40,299,876		$ 2,875,977	$ 2,875,977	$ 37,423,899	$ -	$ 37,423,899
2021	$ 27,739,151	$ 9,191,794	$ 632,299		$ 720,465		$ 2,752,000	$ 766,083	$ 41,801,791		$ 2,875,977	$ 2,875,977	$ 38,925,814	$ -	$ 38,925,814
2022	$ 28,848,717	$ 9,559,465	$ 657,591		$ 749,283		$ 2,752,000	$ 796,726	$ 43,363,783		$ 2,875,977	$ 2,875,977	$ 40,487,806	$ -	$ 40,487,806
2023	$ 30,002,666	$ 9,941,844	$ 683,895		$ 779,254		$ 2,752,000	$ 828,595	$ 44,988,254		$ 2,875,977	$ 2,875,977	$ 42,112,277	$ -	$ 42,112,277
2024	$ 31,202,772	$ 10,339,518	$ 711,250		$ 810,425		$ 2,752,000	$ 861,739	$ 46,677,704		$ 2,875,977	$ 2,875,977	$ 43,801,727	$ -	$ 43,801,727
2025	$ 32,450,883	$ 10,753,099	$ 739,700		$ 842,842		$ 2,752,000	$ 896,208	$ 48,434,732		$ 2,875,977	$ 2,875,977	$ 45,558,755	$ -	$ 45,558,755
2026	$ 33,748,919	$ 11,183,222	$ 769,288		$ 876,555		$ 2,752,000	$ 932,057	$ 50,262,041		$ 2,875,977	$ 2,875,977	$ 47,386,064	$ -	$ 47,386,064
2027	$ 35,098,875	$ 11,630,551	$ 800,060		$ 911,617		$ 2,752,000	$ 969,339	$ 52,162,443		$ 2,875,977	$ 2,875,977	$ 49,286,466	$ -	$ 49,286,466
2028	$ 36,502,830	$ 12,095,773	$ 832,062		$ 948,082		$ 2,752,000	$ 1,008,113	$ 54,138,861		$ 2,875,977	$ 2,875,977	$ 51,262,884	$ -	$ 51,262,884
2029	$ 37,962,944	$ 12,579,604	$ 865,345		$ 986,005		$ 2,752,000	$ 1,048,437	$ 56,194,335		$ 2,875,977	$ 2,875,977	$ 53,318,358	$ -	$ 53,318,358
2030	$ 39,481,461	$ 13,082,789	$ 899,959		$ 1,025,446		$ 2,752,000	$ 1,090,375	$ 58,332,029		$ 2,875,977	$ 2,875,977	$ 55,456,052	$ -	$ 55,456,052
2031	$ 41,060,720	$ 13,606,100	$ 935,957		$ 1,066,464		$ 2,752,000	$ 1,133,990	$ 60,555,230		$ 2,875,977	$ 2,875,977	$ 57,679,253	$ -	$ 57,679,253
2032	$ 42,703,149	$ 14,150,344	$ 973,395		$ 1,109,122		$ 2,752,000	$ 1,179,349	$ 62,867,359		$ 2,875,977	$ 2,875,977	$ 59,991,382	$ -	$ 59,991,382
2033	$ 44,411,274	$ 14,716,358	$ 1,012,331		$ 1,153,487		$ 2,752,000	$ 1,226,523	$ 65,271,973		$ 2,875,977	$ 2,875,977	$ 62,395,996	$ -	$ 62,395,996
2034	$ 46,187,725	$ 15,305,012	$ 1,052,824		$ 1,199,626		$ 2,752,000	$ 1,275,584	$ 67,772,772		$ 2,875,977	$ 2,875,977	$ 64,896,795	$ -	$ 64,896,795
2035	$ 48,035,234	$ 15,917,213	$ 1,094,937		$ 1,247,611		$ 2,752,000	$ 1,326,607	$ 70,373,603		$ 2,875,977	$ 2,875,977	$ 67,497,626	$ -	$ 67,497,626
2036	$ 49,956,644	$ 16,553,901	$ 1,138,735		$ 1,297,516		$ 2,752,000	$ 1,379,672	$ 73,078,467		$ 2,875,977	$ 2,875,977	$ 70,202,490	$ -	$ 70,202,490
2037	$ 51,954,910	$ 17,216,057	$ 1,184,284		$ 1,349,417		$ 2,752,000	$ 1,434,858	$ 75,891,526		$ 2,875,977	$ 2,875,977	$ 73,015,549	$ -	$ 73,015,549
2038	$ 54,033,106	$ 17,904,700	$ 1,231,656		$ 1,403,393		$ 2,752,000	$ 1,492,253	$ 78,817,107		$ 2,875,977	$ 2,875,977	$ 75,941,130	$ -	$ 75,941,130
2039	$ 56,194,430	$ 18,620,887	$ 1,280,922		$ 1,459,529		$ 2,752,000	$ 1,551,943	$ 81,859,711		$ 2,875,977	$ 2,875,977	$ 78,983,734	$ -	$ 78,983,734
2040	$ 58,442,207	$ 19,365,723	$ 1,332,159		$ 1,517,910		$ 2,752,000	$ 1,614,021	$ 85,024,020		$ 2,875,977	$ 2,875,977	$ 82,148,043	$ -	$ 82,148,043
2041	$ 60,779,896	$ 20,140,352	$ 1,385,445		$ 1,578,627		$ 2,752,000	$ 1,678,581	$ 88,314,901		$ 2,875,977	$ 2,875,977	$ 85,438,924	$ -	$ 85,438,924
2042	$ 63,211,092	$ 20,945,966	$ 1,440,863		$ 1,641,772		$ 2,752,000	$ 1,745,725	$ 91,737,417		$ 2,875,977	$ 2,875,977	$ 88,861,440	$ -	$ 88,861,440
2043	$ 65,739,535	$ 21,783,805	$ 1,498,497		$ 1,707,442		$ 2,752,000	$ 1,815,554	$ 95,296,833		$ 2,875,977	$ 2,875,977	$ 92,420,856	$ -	$ 92,420,856
2044	$ 68,369,117	$ 22,655,157	$ 1,558,437		$ 1,775,740		$ 2,752,000	$ 1,888,176	$ 99,098,627		$ 2,875,977	$ 2,875,977	$ 96,122,650	$ -	$ 96,122,650
2045	$ 71,103,881	$ 23,561,363	$ 1,620,775		$ 1,846,770		$ 2,752,000	$ 1,963,703	$ 102,848,492		$ 2,875,977	$ 2,875,977	$ 99,972,515	$ -	$ 99,972,515
2046	$ 73,948,036	$ 24,503,818	$ 1,685,606		$ 1,920,641		$ 2,752,000	$ 2,042,251	$ 106,852,351		$ 2,875,977	$ 2,875,977	$ 103,976,374	$ -	$ 103,976,374
2047	$ 76,905,958	$ 25,483,970	$ 1,753,030		$ 1,997,466		$ 2,752,000	$ 2,123,941	$ 111,016,365		$ 2,875,977	$ 2,875,977	$ 108,140,388	$ -	$ 108,140,388
2048	$ 79,982,196	$ 26,503,329	$ 1,823,151		$ 2,077,365		$ 2,752,000	$ 2,208,899	$ 115,346,940		$ 2,875,977	$ 2,875,977	$ 112,470,963	$ -	$ 112,470,963
2049	$ 83,181,484	$ 27,563,462	$ 1,896,077		$ 2,160,459		$ 2,752,000	$ 2,297,255	$ 119,850,738		$ 2,875,977	$ 2,875,977	$ 116,974,761	$ -	$ 116,974,761
2050	$ 86,508,743	$ 28,666,001	$ 1,971,920		$ 2,246,878		$ 2,752,000	$ 2,389,145	$ 124,534,687		$ 2,875,977	$ 2,875,977	$ 121,658,710	$ 418,400,000	$ 540,058,710

Present value of salvage:	$ 4,743,899	Present values of savings:	$194,068,865	Present values of costs:	$278,681,155	Total in present values:	$ (81,372,143)

11/07/2000

Attachment 13 Sediment Management Plan

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CONTRACTOR	CHINA HARBOUR ENGINEERING COMPANY		
(A) PROJECT		***NORTH-SOUTH LINK OF HIGHWAY 2000***	
(B) METHOD STATEMENT #		***EC/SM002***	
(C) ENVIRONMENTAL ASPECT		***EROSION CONTROL/SEDIMENT MANAGEMENT***	
(D) METHOD STATEMENT		***MEASURES TO BE USED TO CONTROL EROSION AND SEDIMENT LOAD OF STORM WATER RUN-OFF & STREAM FLOW DURING THE CONSTRUCTION OF THE HIGHWAY.***	
Prepared by :	China Harbour Engineering Company	**Reviewed by:**	23/11/2013
Approved by:	23/11/2013		
Presented to:	**National Road Operation and Construction Company (NROCC)**		

JANUARY 2013

METHOD STATEMENT FOR THE CONTROL OF EROSION AND SEDIMENT LOAD OF STORM WATER RUN-OFF AND STREAM FLOW DURING THE CONSTRUCTION OF THE HIGHWAY.

APPROACH AND METHODOLOGY

1. The road design drawings and the EIA will be carefully perused.
2. All erosion prone areas will be mapped.
3. Construction fence (preferably orange colour) will be used to highly critically erodible areas.
4. All rivers (mainly the perennial and the intermittent ones) that are intimate with the road alignment will be mapped.
5. Turbidity baseline data for these rivers will be collected prior to the start of the project. The sampling location, weather condition and time of day that measurements were done will be documented.
6. For sediment load management of surface water, both compliance and impact monitoring will be done at all locations where construction activities are intimate with surface water bodies (rivers, streams, rivulets, or gullies). Water samples will be appropriately collected and turbidity measurement taken on a weekly basis, or where visual inspection commands such.
7. Turbidity data will then be compared with that of the baseline, and where the baseline data are exceeded in any significant way, construction activities will be immediately stopped until surface water has regained its integrity.
8. For erosion, impact and mitigation monitoring will be done; inspection of construction sites will be done, during and after construction, for the following parameters: siltation of run-off, sediment deposit in culverts, sediment load of surface water bodies, unearthing or exposure of structures after rainfall, and sign of rill erosion and accelerated erosion. This will be done along the high way segments, quarries, and borrow pits, particularly after heavy and/ or prolong rainfall.
9. Monitoring will be done by CHEC's Environmental Engineer, assigned to the project.

10. CHEC will be obliged to modify this mitigation approach to satisfy the concerns and recommendations articulated, at any time, by the National Environmental and Planning Agency (NEPA).
11. The following **MITIGATION APPROACHES (proposed)** will be employed:

a) Avoidance:

i. All geologically challenging areas with respect to susceptibility to landslides and erosion will be avoided e.g. area where geological fault lines are located.
ii. Major earth clearing and excavation activity will not be undertaken in the wet season, or whenever there is a forecast of inclement weather.
iii. Environmentally sustainable technology will be used to avoid any major land-slippage, mass wasting (soil creep, debris slides, and rock fall), or erosion during and after construction. For instance, steep embankments will be benched or gabions will be used to stabilize soil.
iv. Temporary erosion prevention and sediment control measures will be applied at all construction sites, such as slopes, roadside earth ditches etc., where soil is exposed to the element of erosion. One or a combination of the following measures will be considered:
    a. The use of erosion control blanket in earth ditches, channels, swales, and not so steep slopes to protect embankments from erosion prior to establishment of vegetation.
    b. The hydraulic application of cellulose fiber and tackifiers mixture on not so steep slope to prevent erosion and enhance vegetation establishment.
    c. The hydraulic application of bonded fiber matrix to steep slopes those are difficult to access by equipment. This will provide soil stabilization and will be applied within 24 hours of seeding.
    d. Applying straw or hay mulch over seeded exposed soil and then mechanically pressed into soil's surface. The straw will

protect the soil's surface: reducing runoff velocity, promoting infiltration and vegetation establishment and reducing erosion.

e. Using hydraulic seeding and mulching on slopes to reduce erosion and enhance vegetation establishment. This will be done by applying seeds and fertilizer first follows by cellulose fiber mulch together with a green dye. The dye will show where mulch is applied.

v. Erosion control measures – gabions, retaining walls, and paving roadside ditches – will be employed were needs be. Example the use of gabion and gabion mattresses as transition structure for culverts to prevent scour, the use of gabions at high velocity discharge points; at channel bends; at channel narrows such as bridge crossing etc.

vi. Using of riprap erosion control measure at discharge outlets, as ditch channel lining, as lining for downstream channel etc.

vii. Using a soil binder e.g. Polyacrylamides (which is biodegradable) where large area of exposed soil exists to improve erosion control or as dust control.

viii. No extraction of river stones, gravel, sand or any other construction material will be done from any watercourse.

ix. Silt fence and trash screens will be used where construction site boarders watercourse so as to prevent sediment particles and debris from the construction site from getting into water channel.

x. Where silt fence cannot be employed, stilling ponds (sedimentation ponds) will be constructed to prevent the exportation of sediments etc. to watercourse.

xi. Earth and construction materials (marl etc.) will be stored within berms to prevent silting and increase sediments load of storm water run-off.

xii. Surplus and waste materials will not be deposited on the road side, open lots, or in any watercourse or wetland. A designated area will be used for this which will be carefully managed and close out.

xiii. Frequent fording of rivers and streams with construction equipment will not be permitted.

xiv. The use of floating silt mats during bridge construction so as to collect debris and waste that might fall directly in the water.

b) Abatement/Reduction:

i. Clearing of vegetative stands will be done on a phase or sequential basis to reduce the amount of area exposed to the element of water erosion. Sequencing will be done in coordination with the general contractor, and the installation of erosion and sediment control measures.

ii. Contour shape embankments to slow the rate of water run-off and subsequently reduce siltation of run-off and erosion of landscape.

iii. For excavation of river channel during the construction of bridges and culverts, the following measures will be employed to reduce the siltation of fluvial flow:

   a) Stream flow will be diverted from the excavation area.
   b) Sand and gravel bags will be used to create barrier between excavation zone and stream flow.
   c) Where embankments of watercourse will be impacted, large boulders will be used to stabilize same.

c) Rectification:

i. Area of disturbance will be replanting with plant species native to the immediate area so as to stabilize the soil from the effect of erosion.

ii. Embankments along the highway will be hydro-seeded to have these exposed areas cover with grass in a short time.

iii. For gently sloping or flat borrow areas with no top soil, top soil will be used to spread over these areas followed by hydro – seeding.

iv. Where rock fall is imminent, a mesh will be attached to this area to catch pieces of rock before falling.

PERSONNEL AND MATERIALS

Dealing with erosion control and sediment management during the construction of the highway, the following personnel, materials and equipment will be made available at site, at all times.

Personnel

a. Environmental Engineer
b. Site Engineer
c. Site Supervisor
d. Labourers.

MATERIALS AND EQUIPMENT

a. EIA documents
b. Environmental and Mitigation Plan
c. Design drawings
d. Map of erosion prone areas
e. Turbidity meter
f. Construction fence (orange in colour)
g. Sampling bottles
h. Igloo
i. Ice
j. Radio, preferably a transistor one.
k. Construction equipment – backhoe, excavator etc.
l. Boulders
m. Galvanized mesh wires
n. Steel pegs
o. Geotextile and other erosion and turbidity prevention and control materials and equipment.