UNDP

Infrastructure Rehabilitation

Short to Medium Term Plan

First Draft

June 2005

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Issue and Revision Record

Rev	Date	Originator	Checker	Approver	Description
01	June2005	Andrew Kirby	Bob Goodyear	Richard Cullen	First Draft

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1 Introduction

During January 2005 extremely heavy and prolonged rainfall in the coastal regions of Guyana, particularly in Regions 3, 4 (including Georgetown) and 5 led to widespread flooding. The government declared these areas to be disaster areas. In Region 3, 41 % of the population was severely affected in Region 4, 71 % of the population was severely affected, this amounted to over 270,000 people severely affected and a further 354,000 secondarily affected [15]. Accounts of the events of January 2005 have been described elsewhere and do not need re-iteration here. Suffice to say the floods of January 2005 were the worst on record and will be remembered by those affected for a long time to come.

The emergency galvanised the government and international donors to mobilise funds for emergency works. The emergency works sought to repair damaged drainage infrastructure and to carry out as much rehabilitation of key drainage infrastructure as possible within the time and funds available before the next rainy season. A Task Force for Infrastructure Rehabilitation (TFIR) was set up, tasked with managing and procuring the Emergency Works.

A time limit of 15 July 2005 was set by government for undertaking Emergency Works and for the work of the Task Force. The majority of the G$ 800 M originally allocated for Emergency Works and a further G$ 130 M subsequently approved for Immediate Works is currently being expended carrying out emergency works. The scale of Works achieved in a very limited time and their successful management means that the implementation of the Emergency Works is considered by government, donors and the Task Force to have been a success. The model of co-operation and organisation used is being held up as good practice.

However, there remain many high priority works which could not be undertaken due to the limited time and budget. In addition flood control and drainage systems continue to be in a state of serious disrepair requiring a coherent and targeted rehabilitation strategy. Hence this report has been prepared to consider rehabilitation needs in the short, medium and long term and to set out a rehabilitation programme.

2 The Need for Infrastructure Rehabilitation

There has been a gradual deterioration in the drainage systems along the coast over many years along with only limited capital works to improve their condition. Key drainage structures such as pump stations and outfall sluice have reached the end of their life and significant rehabilitation and replacement is required. Inadequacies in the drainage system are evident at macro scale – in terms of main drains and outfall structures and at a micro-drainage scale in communities. Without investment in a medium term programme of rehabilitation there will be a continued cycle of deterioration. The situation will worsen and flooding will become more frequent and more extensive.

Serious defects in the condition of the East Demerara Water conservancy Dam (EDWC) have been known about for over 40 years [5] and have been confirmed by inspections in 2005 [2]. Defects also exist in the Boerasirie Water conservancy dam, albeit to lesser degree. The consequences of failure are very significant: the risk of loss of life and considerable economic damage. The UNDAC report [14] graphically highlighted the consequences by noting that release of the water stored in the conservancy would cover the whole area between Georgetown and the Mahaica River to a depth of 2 feet. Failure of the dams in January 2005 was only avoided by extreme good fortune and the hard work of emergency workers and volunteers. Unless works are carried out to remedy these defects in the medium term Guyana may not be so lucky next time.

Georgetown has expanded significantly over the last 20 years or more. However there has not been an associated expansion in its drainage capacity. Instead there has been a deterioration in its capacity. During January 2005 it was estimated to be functioning at only 60 % capacity [13]. Key drainage structures such as pump stations and outfall sluice have reached the end of their life and significant rehabilitation and replacement is required. Inadequacies in Georgetown's drainage system are evident at macro scale – in terms of its main drains and outfall structures and at a micro-drainage scale in street and alleyside drains. Without investment in Georgetown's Drainage System as part of the medium term programme of rehabilitation there will be a continued cycle of deterioration. The situation will worsen and flooding will become more frequent and more extensive.

3 Aims and Objectives

The aim of the rehabilitation programme is to reduce the risk and consequences of fluvial flooding in Guyana in order to reduce the risk of loss of life, to reduce the impact on people's health, to alleviate poverty, to reduce financial loss to people and businesses and to reduce economic loss to the country.

The specific objectives of the rehabilitation programme are:

a) Improve the safety of the East Demerara Conservancy Dam to a standard (10,000 year) commensurate with the risk of loss of life and major economic consequences were it to fail

b) Improve the safety of the Boerasirie Conservancy Dam to a standard (10,000 year) commensurate with the risk of loss of life and major economic consequences were it to fail

c) Improve the drainage systems in the coastal areas of Regions 2, 3, 4, 5 and 6 to an acceptable minimum standard

d) Improve the drainage in Georgetown to an acceptable minimum standard appropriate to its position as the business, financial and administrative centre of the country

4 The Benefits

There are at least three main types of benefit arising from improved drainage – economic, social and health. These benefits can be summarised as:

- reduced risk of loss of life to people and livestock
- reduced risk of flood damage to agricultural land
- reduced risk of flood damage to infrastructure (roads, D&I systems, power, telephone, sewage, hospitals, schools
- reduced risk of flood damage to residential property and contents
- reduced risk of damage to businesses
- reduced risk of health problems arising from flooding
- poverty alleviation
- increased confidence to live, work and enjoy life
- increased confidence to invest in the country

Studies of the impact of flooding elsewhere in the world have generally recognised that flooding affects the poor to a greater extent than the rest of the population, and there is no reason to believe that Guyana is any different. The reasons are varied but include: the poor tend to live on lower quality land which is more flood-prone, the poor have fewer resources available to reduce the impact of flood damage, fewer resources to cope afterwards to recover from flooding, are more likely to suffer flood induced ill health and have less access to healthcare. One of the long term benefits of improved drainage will therefore be poverty reduction which ties in with Guyana's Poverty Reduction Strategy as well as the focus of donor objectives. The recent Poverty Reduction Strategy Progress Report [10] noted the risks that Guyana's fragile infrastructure posed to long-term sustainable growth and the need for the lessons of January 2005 to be learnt by ensuring medium term investment is carried out with an emphasis on drainage systems and conservancy dams.

ECLA reported that that 34 lives were lost directly from flooding (7 drowned and 27 due to illness)[15] in the January 2005 flood. Studies of the health impact of flooding elsewhere in the world show that such statistics are just the tip of the iceberg in terms of the adverse impact on the health of those affected. Worsening of existing clinical conditions, contracting of new conditions, increase in stress and mental health problems and greater risk of early death in vulnerable groups have all been noted.

Economic loss due to flooding is difficult to predict and often under-estimated. Local information collected by the IDB Mission [8] suggested that direct losses in agriculture alone were US$ 47.5 M, rising to $65M when both direct and indirect losses are taken into account (10.4 % of GDP). Losses in other sectors of the economy are likely to considerably increase the total amount of flood loss. ECLAC reported a total of G$ 83.6 Billion (US$ 418 M) in direct losses and a further G$ 9.3 Billion (US$ 46.5 M) in indirect losses.

The scale of loss experienced in the January 2005 flood indicates the potential benefits of the medium term rehabilitation programme in reducing and limiting such losses. Without the medium term rehabilitation programme the scale of loss for a given flood probability will increase year on year as the risk of conservancy dam failure increases and as the drainage systems in Georgetown and the Regions deteriorate further.

5 Short and Medium Term Rehabilitation Programme

The Short and Medium Term Programme has been divided up into 15 packages: 9 Works Packages, 5 Services Packages and 1 Goods Package. Each package comprises a number of elements of work or sub-projects. The rehabilitation packages cover Regions 2, 3, 4, 5 and 6, Georgetown, the Boerasirie Water Conservancy and the East Demerara Water Conservancy. The fifteen packages are:

Table 5.1: Works Packages

Works Packages	
1	Boerasirie Water Conservancy Flood Relief Works
2	East Demerara Water Conservancy Improvement Works
3	Georgetown Urban Drainage Improvement Works
4	Region 2 Drainage Improvement Works
5	Region 3 Drainage Improvement Works
6	Region 4 Drainage Improvement Works
7	Region 5 Drainage Improvement Works
8	Region 6 Drainage Improvement Works
9	Conservancy Maintenance Equipment Contract
Services Packages	
10	Infrastructure Rehabilitation Unit
11	Boerasirie Water Conservancy Dam and Flood Relief Design & Supervision
12	East Demerara Water Conservancy Dam and Flood Relief Design & Supervision
13	Georgetown Urban Drainage Design & Supervision
14	Regions 2 to 6 Drainage Rehabilitation Design & Supervision
Goods Packages	
15	Equipment for Water Conservancy Monitoring and Management

The programme has been developed from consultation, from information arising during the implementation of the Emergency Works, from the recommendations of specialists investigating the situation following the January 2005 flood: UNDAC, ECLAC, USACE, Dr Wardlaw (flood modelling), Mr Wagner (dams) and from previous studies.

The table below summarises the total cost of Works, Services and Goods in the Short, Medium and Long Term.

	Cost (G$ M)		
Type	**Short Term**	**Medium Term**	**Long Term**
Works	476	5794	7370
Services	281	620	590
Goods	0	16	0
Total	757	6430	7959

The packages and their estimated cost are set out in the following tables. Details of the technical scope of each package is given in Appendix A.

Summary of Short and Medium Term Programme in Guyanese Dollars

	Package	Cost (M G$)		
		Short Term	Medium Term	Long Term
Works				
1	Boerasirie Water Conservancy Flood Relief Works	76	824	
2	East Demerara Water Conservancy Improvement Works	0	2,440	
3	Georgetown Urban Drainage Improvement Works	150	980	1,130
4	Region 2 Drainage Improvement Works	50	250	801
5	Region 3 Drainage Improvement Works	50	400	1,297
6	Region 4 Drainage Improvement Works	50	250	1,616
7	Region 5 Drainage Improvement Works	50	250	1,108
8	Region 6 Drainage Improvement Works	50	250	1,418
9	Conservancy Maintenance Equipment Contract		150	
	sub-total	476	5,794	7,370
Services				
10	Infrastructure Rehabilitation Unit	72	217	0
11	Boerasirie Conservancy Dam and Flood Relief Design & Supervision	38	45	0
12	East Demerara Conservancy Dam and Flood Relief Design & Supervision	54	157	0
13	Georgetown Urban Drainage Design & Supervision	46	72	90
14	Regions 2 to 6 Drainage Rehabilitation Design & Supervision	70	129	499
	sub-total	281	620	590
Goods				
15	Equipment for Water Conservancy Monitoring and Management		16	
	sub-total		16	
	Grand Total	757	6,430	7,959

Summary of Short and Medium Term Programme in US Dollars

	Package	Cost (US$)		
		Short Term	Medium Term	Long Term
Works				
1	Boerasirie Water Conservancy Flood Relief Works	380,000	4,120,000	
2	East Demerara Water Conservancy Improvement Works		12,200,000	
3	Georgetown Urban Drainage Improvement Works	750,000	4,900,000	5,650,000
4	Region 2 Drainage Improvement Works	250,000	1,250,000	4,003,100
5	Region 3 Drainage Improvement Works	250,000	2,000,000	6,484,900
6	Region 4 Drainage Improvement Works	250,000	1,250,000	8,082,400
7	Region 5 Drainage Improvement Works	250,000	1,250,000	5,539,900
8	Region 6 Drainage Improvement Works	250,000	1,250,000	7,088,000
9	Conservancy Maintenance Equipment Contract		750,907	
	sub-total	2,380,000	28,970,907	36,848,300
Services				
10	Infrastructure Rehabilitation Unit	361,790	1,085,370	
11	Boerasirie Conservancy Dam and Flood Relief Design & Supervision	192,000	225,000	
12	East Demerara Conservancy Dam and Flood Relief Design & Supervision	270,500	785,000	
13	Georgetown Urban Drainage Design & Supervision	230,000	357,500	452,000
14	Regions 2 to 6 Drainage Rehabilitation Design & Supervision	350,000	645,000	2,495,864
	sub-total	1,404,290	3,097,870	2,947,864
Goods				
15	Equipment for Water Conservancy Monitoring and Management		80,000	
	sub-total		80,000	
	Grand Total	3,784,290	32,148,777	39,796,164

Short and Medium Term Programme

Works

Nr	1	Boerasirie Water Conservancy Flood Relief Works				Location :Region 3
		Elements	**Cost (US$)**	**Timescale (months)**	**Programme**	**Procurement**
	1.1	Raising low dam crest	50,000	2	Short Term	Competitive tendering by local contractors
	1.2	Clearing internal waterways Naamryck to Waramia	300,000	4	Short Term	Competitive tendering by local contractors
	1.3	Repair of Naamryck Tail Sluice	30,000	2	Short Term	Tender by local contractors with international fabrication
	1.4	Excavation internal waterways Naamryck to Waramia	2,600,000	12	Medium Term	Competitive tendering by local
	1.5	Flood relief improvements: one or more of:	1,520,000	18	Medium Term	Competitive tendering by local/international contractors depending on scope of works
	1.5a	*Clearing and excavation at 8,000 ft weir*				
	1.5b	*Concrete lining at 8,000 ft weir*				
	1.5c	*Over-toppable embankments*				
	1.5d	*New relief structure*				
	1.5e	*Modification of existing structures*				
		Total	**4,500,000**	6 + 18		

Summary: Implementation of flood relief measures to improve flood control on the Boerasirie Conservancy to an acceptable standard. Works will include: widening the waterway between Naamryck and Waramia; b) raising of low sections of embankment c) repair of Naamryck Relief Tail Sluice. Works may also include a combination of some of the following: d) improving the hydraulic conditions at the 8,000 ft weir; e) construction of over-toppable embankment sections; e) construction of an additional relief structure; f) modification of other existing structures and channels for relief e.g. the use of Salem, Hubu or Maripa Main Drains or the abandoned sluice at Potosi.

Short and Medium Term Programme

Nr	2	East Demerara Water Conservancy Improvement Works				Location :Region 4
		Elements	**Cost (US$)**	**Timescale (months)**	**Programme**	**Procurement**
	2.1	New Dam: Non Pareil to Flagstaff	10,900,000	24	Medium Term	Competitive tendering by international contractors
	2.2	Dam rehabilitation: Nancy to Non Pareil, Flagstaff to Madu	500,000	12	Medium Term	Include within Package 2.1
	2.3	*Construction of MMA Stage III*	*35,000,000*	*36*	*Long Term*	*Potential alternative to Package 2.1 and 2.2 - to be investigated by feasibility study*
	2.4	Reconstruct head regulators	250,000	6	Medium Term	Tender by local contractors with international fabrication
	2.5	New relief structure	550,000	12	Medium Term	Include within Package 2.1
		Total	**11,950,000**	24		

Summary: Implementation of dam improvements and flood relief measures to improve flood control on the East Demerara Conservancy to an acceptable standard commensurate with the risk of loss of life and major economic consequences were it to fail. Works will include: a) replacement of the dam between Non Pareil and Flagstaff; b) construction of additional flood relief structure; c) improvements to other section of the dam where its condition and stability is less than acceptable.

Short and Medium Term Programme

Nr	3	Georgetown Urban Drainage Improvement Works				Location :Georgetown
		Elements	**Cost (US$)**	**Timescale (months)**	**Programme**	**Procurement**
	3.1	Short Term Rehabilitation	750,000	6	Short Term	Competitive tendering by local contractors
	3.2	Medium Term Rehabilitation	4,900,000	18	Medium Term	Competitive tendering by local/international contractors depending on scope of works
	3.3	Long Term Improvement Works	5,650,000	36	Long Term	Competitive tendering by local/international contractors depending on scope of works
		Total	**11,300,000**	60		

Summary: Short and Medium Term Works to rehabilitate the Georgetown drainage system to as far as possible its original capacity. Long Term works to undertake drainage improvements to reflect the increased loading on the system. Short and Medium Term Works concentrate on cleaning and de-silting main drains and road/alleyway drains, replacement of culverts and rehabilitation of outfall sluices and pump stations

Short and Medium Term Programme

Nr	4	Region 2 Drainage Improvement Works				Location : Region 2
		Elements	**Cost (US$)**	**Timescale (months)**	**Programme**	**Procurement**
	4.1	Short Term Rehabilitation	250,000	9	Short Term	Competitive tendering by local contractors
	4.2	Medium Term Rehabilitation	1,250,000	18	Medium Term	Competitive tendering by local/international contractors depending on scope of works
	4.3	Long Term Improvement Works	4,003,100	36	Long Term	Competitive tendering by local/international contractors depending on scope of works
		Total	**5,503,100**	24 + 36		

Summary: Improvement of the drainage system in Region 2 by planned and targeted interventions of priority works. Works will focus on public good drainage: rehabilitation of main drains, outfall sluices and pump stations. Implementation of new works where current system inappropriate e.g façade or collector drains, supplementary outfall sluices. Two phases: short term (clear and urgent needs) and medium term (after feasibility assessment) works

Short and Medium Term Programme

Nr	5	Region 3 Drainage Improvement Works				Location : Region 3
		Elements	**Cost (US$)**	**Timescale (months)**	**Programme**	**Procurement**
	5.1	Short Term Rehabilitation	250,000	9	Short Term	Competitive tendering by local contractors
	5.2	Medium Term Rehabilitation	2,000,000	18	Medium Term	Competitive tendering by local/international contractors depending on scope of works
	5.3	Long Term Improvement Works	6,484,900	36	Long Term	Competitive tendering by local/international contractors depending on scope of works
		Total	**8,734,900**	24 + 36		

Summary: Improvement of the drainage system in Region 3 by planned and targeted interventions of priority works. Works will focus on public good drainage: rehabilitation of main drains, outfall sluices and pump stations. Implementation of new works where current system inappropriate e.g façade or collector drains, supplementary outfall sluices. Two phases: short term (clear and urgent needs) and medium term (after feasibility assessment) works

Short and Medium Term Programme

Nr	6	Region 4 Drainage Improvement Works				Location : Region 4
		Elements	**Cost (US$)**	**Timescale (months)**	**Programme**	**Procurement**
	6.1	Short Term Rehabilitation	250,000	9	Short Term	Competitive tendering by local contractors
	6.2	Medium Term Rehabilitation	1,250,000	18	Medium Term	Competitive tendering by local/international contractors depending on scope of works
	6.3	Long Term Improvement Works	8,082,400	36	Long Term	Competitive tendering by local/international contractors depending on scope of works
		Total	**9,582,400**	24 + 36		

Summary: Improvement of the drainage system in Region 4 by planned and targeted interventions of priority works. Works will focus on public good drainage: rehabilitation of main drains, outfall sluices and pump stations. Implementation of new works where current system inappropriate e.g façade or collector drains, supplementary outfall sluices. Two phases: short term (clear and urgent needs) and medium term (after feasibility assessment) works

Short and Medium Term Programme

Nr	7	Region 5 Drainage Improvement Works				Location : Region 5
		Elements	**Cost (US$)**	**Timescale (months)**	**Programme**	**Procurement**
	7.1	Short Term Rehabilitation	250,000	9	Short Term	Competitive tendering by local contractors
	7.2	Medium Term Rehabilitation	1,250,000	18	Medium Term	Competitive tendering by local/international contractors depending on scope of works
	7.3	Long Term Improvement Works	5,539,900	36	Long Term	Competitive tendering by local/international contractors depending on scope of works
		Total	**7,039,900**	24 + 36		

Summary: Improvement of the drainage system in Region 5 by planned and targeted interventions of priority works. Works will focus on public good drainage: rehabilitation of main drains, outfall sluices and pump stations. Implementation of new works where current system inappropriate e.g façade or collector drains, supplementary outfall sluices. Two phases: short term (clear and urgent needs) and medium term (after feasibility assessment) works

Short and Medium Term Programme

Nr	8	Region 6 Drainage Improvement Works				Location : Region 6
		Elements	**Cost (US$)**	**Timescale (months)**	**Programme**	**Procurement**
	8.1	Short Term Rehabilitation	250,000	9	Short Term	Competitive tendering by local contractors
	8.2	Medium Term Rehabilitation	1,250,000	18	Medium Term	Competitive tendering by local/international contractors depending on scope of works
	8.3	Long Term Improvement Works	7,088,000	36	Long Term	Competitive tendering by local/international contractors depending on scope of works
		Total	**8,588,000**	24 + 36		

Summary: Improvement of the drainage system in Region 6 by planned and targeted interventions of priority works. Works will focus on public good drainage: rehabilitation of main drains, outfall sluices and pump stations. Implementation of new works where current system inappropriate e.g façade or collector drains, supplementary outfall sluices. Two phases: short term (clear and urgent needs) and medium term (after feasibility assessment) works

Short and Medium Term Programme

Nr	9	Conservancy Maintenance Equipment Contract				Location : Region 3 & 4
		Elements	**Cost (US$)**	**Timescale (months)**	**Programme**	**Procurement**
	9.1	Equipment for maintenance over 5 year contract	750,907	60	Medium Term	Competitive tendering by local/international contractors depending on scope of works
	9.2					
	9.3					
		Total	**750,907**	60		

Summary: Provision and operation of maintenance equipment (weed cutters and pontoon mounted excavators/draglines) for the East Demerara and Boerasirie Conservancy under a 5 year maintenance contract

Short and Medium Term Programme

Services

Nr	10	Infrastructure Rehabilitation Unit	Location :All

	Elements	Cost (US$)	Timescale (months)	Programme	Procurement
10.1	Staff salaries local - Short Term	148,200	6	Short Term	Direct appointment
10.2	Staff salaries International Short Term	163,590	6	Short Term	Direct appointment
10.3	Running Costs Short Term	50,000	6	Short Term	Local shopping
10.4	Staff salaries local - Medium Term	444,600	18	Medium Term	Direct appointment
10.5	Staff salaries International Medium Term	490,770	18	Medium Term	Direct appointment
10.6	Running Costs Medium Term	150,000	18	Medium Term	Local shopping
	Total	**1,447,160**	6 + 18		

Summary: establishment and operation of a unit to manage and procure the short and medium term programme. Includes staffing the IRU committee, project manager, management team, accountant, clerical staff, office and transport

Short and Medium Term Programme

Nr	11	Boerasirie Conservancy Dam and Flood Relief Design & Supervision				Location :Region 4
		Elements	**Cost (US$)**	**Timescale (months)**	**Programme**	**Procurement**
	11.1	Topographic Survey	6,000	2	Short Term	Competitive tendering by local surveyors or direct appointment of Land & Surveys Commission (LSC)
	11.2	Hydrographic Survey	21,000	2	Short Term	Ground survey: tender by local surveyors; echo sounding: Sea Defence
	11.3	Flood Modelling	25,000	2	Short Term	Direct appointment of Emergency Works Modelling Team
	11.4	Design and Tender Documents	140,000	4	Short Term	Competitive tendering - international/local consultant partnerships
	11.5	Supervision of Works	225,000	12	Medium Term	Competitive tendering - international/local consultant partnerships
		Total	**417,000**	7 + 12		

Summary: Analysis and design of flood relief measures to improve flood control on the Boerasirie Conservancy to an acceptable standard. Includes: a) topographic survey of the conservancy dam crest level to identify low areas; b) hydrographic survey of the conservancy and its waterways as data for flood management assessment; c) flood modelling - comprising hydraulic modelling to identify deficiencies in the existing system and to aid design of improver works; d) design of improved flood control measures, comprising design of basic dam raising/strengthening measures, design of new flood relief sluice or overtopping embankments, design of internal waterways; e) preparation of tender documents for the above works f) supervision of the works

Short and Medium Term Programme

Nr	12	East Demerara Conservancy Dam and Flood Relief Design & Supervision				Location :Region 4
		Elements	**Cost (US$)**	**Timescale (months)**	**Programme**	**Procurement**
	12.1	Topographic Survey	19,000	4	Short Term	Competitive tendering by local surveyors
	12.2	Hydrographic Survey	29,000	4	Short Term	Ground survey: tender by local surveyors; echo sounding: Sea Defence
	12.3	Site Investigation	60,000	4	Short Term	Competitive tendering by local SI contractors
	12.4	Feasibility Study	100,000	4	Short Term	Competitive tendering - international/local consultant partnerships plus direct appointments - Dams Specialist & Modelling Team
	12.5	Design and Tender Documents	250,000	4	Short/Medium Term	Competitive tendering - international/local consultant partnerships plus direct appointment of Dams Specialist
	12.6	Supervision of Works	597,500	24	Medium Term	Competitive tendering - international/local consultant partnerships
		Total	**1,055,500**	9 + 24		

Summary: Investigations design and supervision of dam improvements and flood relief measures to improve flood control on the East Demerara Conservancy to an acceptable standard. Services will include: a) topographic survey; b) site investigation; c) hydrographic survey; d) flood modelling; e) feasibility study of options; f) detailed design and supervision

Short and Medium Term Programme

Nr	13	Georgetown Urban Drainage Design & Supervision				Location : Georgetown
		Elements	**Cost (US$)**	**Timescale (months)**	**Programme**	**Procurement**
	13.1	Condition inspections and survey	30,000	2	Short Term	Competitive tendering - international/local consultant partnerships
	13.2	Prepare short and medium term strategy	50,000	3	Short Term	Include within Package 13.1
	13.3	Feasibility study of long term improvements	75,000	4	Short Term	Include within Package 13.1
	13.4	Design and Tender Documents Short/Medium Term	75,000	4	Short Term	Include within Package 13.1
	13.5	Supervision of Short/Medium Term Works	282,500	24	Medium Term	Competitive tendering - international/local consultant partnerships
	13.6	Institutional strengthening	75,000	24	Medium Term	Include within Package 13.1
	13.7	Design & Supervision of Long Term Improvements	452,000	36	Long Term	Competitive tendering - international/local consultant partnerships
		Total	**1,039,500**	24 + 36		

Summary: Phased programme of survey, design and supervision for rehabilitation of the Georgetown Drainage system. Includes: a) condition inspections and surveys b) review of needs and preparation of coherent strategy for short & medium term; c) feasibility study for long term improvements; d) preparation of designs and tender docs for short and medium term works; e) institutional strengthening/public awareness programme; f) supervision

Short and Medium Term Programme

Nr	14	Regions 2 to 6 Drainage Rehabilitation Design & Supervision				Regions 2, 3, 4 ,5, 6
		Elements	**Cost (US$)**	**Timescale (months)**	**Programme**	**Procurement**
	14.1	Inspections	50,000	9	Short Term	Competitive tendering - international/ocal consultant partnerships
	14.2	Prepare short and medium term strategy	250,000	3	Short Term	Include within Package 14.1
	14.3	Design and Tender Documents Short Term Works	50,000	3	Short Term	Include within Package 14.1
	14.4	Design and Tender Documents Medium Term Works	150,000	9	Medium Term	Include within Package 14.1
	14.5	Supervision of Short/Medium Term Works	495,000	24	Medium Term	Competitive tendering - international/ocal consultant partnerships
	14.6	Design & Supervision of Long Term Improvements	2,495,864	36+	Long Term	Competitive tendering - international/ocal consultant partnerships
		Total	**3,490,864**	24 + 36+		

Summary: Phased programme of survey, design and supervision for rehabilitation of the drainage systems in Regions 2, 3, 4, 5, and 6. Includes: a) inspections b) review of needs and preparation of coherent, consistent strategy for short & medium term; c) preparation of designs and tender documents for short and medium term works; e) supervision of works

Short and Medium Term Programme

Goods

Nr	15	Equipment for Water Conservancy Monitoring and Management				Location :Regions 3 & 4
		Elements	**Cost (US$)**	**Timescale (months)**	**Programme**	**Procurement**
	15.1	Automatic water level monitoring equipment	40,000		Medium Term	International shopping
	15.2	Associated equipment	40,000		Medium Term	Local/International shopping
		Total	**80,000**			

Summary: Supply and installation of automatic water level monitoring equipment and other monitroring support equipment for HYDROMET to monitor the East Demerara and Boerasirie Conservancies as a management and Flood Warning tool for Emergency response

6 Institutional Arrangements

Construction of the Immediate Works will not be complete before the dissolution of the Task Force on 15 July 2005. The immediate Works are expected to be complete within 4-6 weeks by mid-August. Without some form of management in place after that time it will not be possible to procure, manage and complete those Immediate Works. It is therefore necessary to have some interim management in place until commencement of the Short Term programme. It is recommended that NDIB take on this role and some of the NDIB engineers that have been working with the Task Force can take up this role. To support them it is recommended that those local consultants who have performed well supervising the Emergency Works are employed to complete the supervision and the role of Special Advisor is extended for a further four weeks to ensure the proper completion and sign off of those works. The local consultant's supervisory role should be expanded to include the contract management role that the international engineers supporting the Special Advisor were undertaking. Further part-time inputs by members of the Task Force should be allowed for to provide continuity in the completion of these works. Funds remain unallocated for consultancy which could be utilised. Unallocated funds are understood to be in excess of US$ 100,000. The estimated cost of supervision by local consultants is about G$20 M (US$ 100,000). Funds for extension of the Special Advisor role would be available within unspent funds for that contract.

The organisational approach adopted for the Emergency Works worked well. The lessons learnt on this "model" have been used to put forward an approach for managing and implementing the Medium Term Plan. The overall organisation proposed is shown in Figure 6.1.

The Task Force would be replaced by an Infrastructure Rehabilitation Unit (IRU) which would have a number of similarities to the organisation of the Task Force. Its duties would be to monitor, manage and procure the Works, Services and Goods required under the Short and Medium Term Programme. The IRU would be composed of a Committee or Board and a Management Team for day to day implementation. The Committee would be made up of a number of members who have the trust and respect of the government and other stakeholders. The Committee would include a representative from a government ministry, probably from NDIB and the Project Manager, who would perform a similar role to the Task Force Special Advisor and would act as the Donor's Representative. The Committee would convene as the IRU Tender Committee for tender evaluation. The Committee would be full time employed and paid accordingly. The IRU would act as "Engineer" under the contracts. It is envisaged that the IRU would have a time-bound remit and that it would be dissolved at the end of the Medium Term. However long term integration into NDIA as its project execution unit should be considered.

The Project Manager would be supported by a management team of international engineers and local engineers drawn from ministries and local consultants. The size of the team would vary with workload. The team would be supported by an accountant and clerical support. The IRU would need office and transport. The proposed organisation of the IRU is shown in Figure 6.2.

An example of the success of the Emergency Works has been the excellent co-operation achieved between donors and between donors, the Task Force and government to expedite allocation of funds, reduce bureaucracy and to continuously engage with the Task Force to monitor progress throughout the period. The special nature of the emergency situation encouraged such an approach and as the programme moves into the Medium Term some procedures will inevitably return to standard rules and approach. Nevertheless the management of the medium term programme aims to build on the good relationships developed and a Donor Pool is proposed for co-ordination, overview and fund allocation. However there is a real concern that the different procurement rules, different forms of contract, constraints and priorities of different donors will seriously slow the progress of approvals. It is recommended that the donors discuss whether it is possible to work together to adopt a common form of procedure that satisfies the financial control and oversight rules of each donor along with a common form of Works, Services and goods contract such as the FIDIC suite of contract documents.

Some Packages are for drainage systems within Georgetown which fall within the responsibility of the City Council rather than NDIB. To ensure a consistent approach to implementation of the programme it is recommended that these packages are nevertheless procured and managed by the IRU but that a senior representative of the City Engineer's department is co-opted onto the IRU Committee for dealing with these packages. Similarly staff of the City Engineer's department would be part of the management team for day to day implementation of those packages.

Delays were encountered during the procurement of the Emergency Works owing to the government procurement structure and the limited staff resources available. To overcome these problems it is recommended that a special Contract Award Committee should be formed consisting of the Chairman of the Central Tender Board, and representatives from the Office of the President and the Auditor General's Office. The Tender Evaluation report of the IRU Tender Committee can then be emailed to all three members with hard copies being hand delivered. The Committee should then meet with the IRU Committe within one week to discuss, agree, with any necessary modifications, and issue the Contract Award letter.

Works and Goods within the Short Term programme will be procured by competitive tendering by local contractors and local shopping respectively. Works in the Medium Term will be procured by competitive tendering by local or international contractors depending on the size of contract. Works to the East Demerara Conservancy Dam would be procured through international competitive tendering. Local competitive tendering should follow a prequalification stage with pass/fail criteria followed by lowest price bidding for those passing the prequalification stage. This reduces the subjective nature of the tender evaluation and allows more rapid evaluation and agreement of the preferred bidder.

Consultants for design and supervision would generally by procured by international tendering using local/international consultancy partnerships, though some elements of work e.g. modelling and specialist dam expertise should be by direct appointment as they are a continuation of services carried out under the emergency response.

Figure 6.1: Organisation for the Medium Term

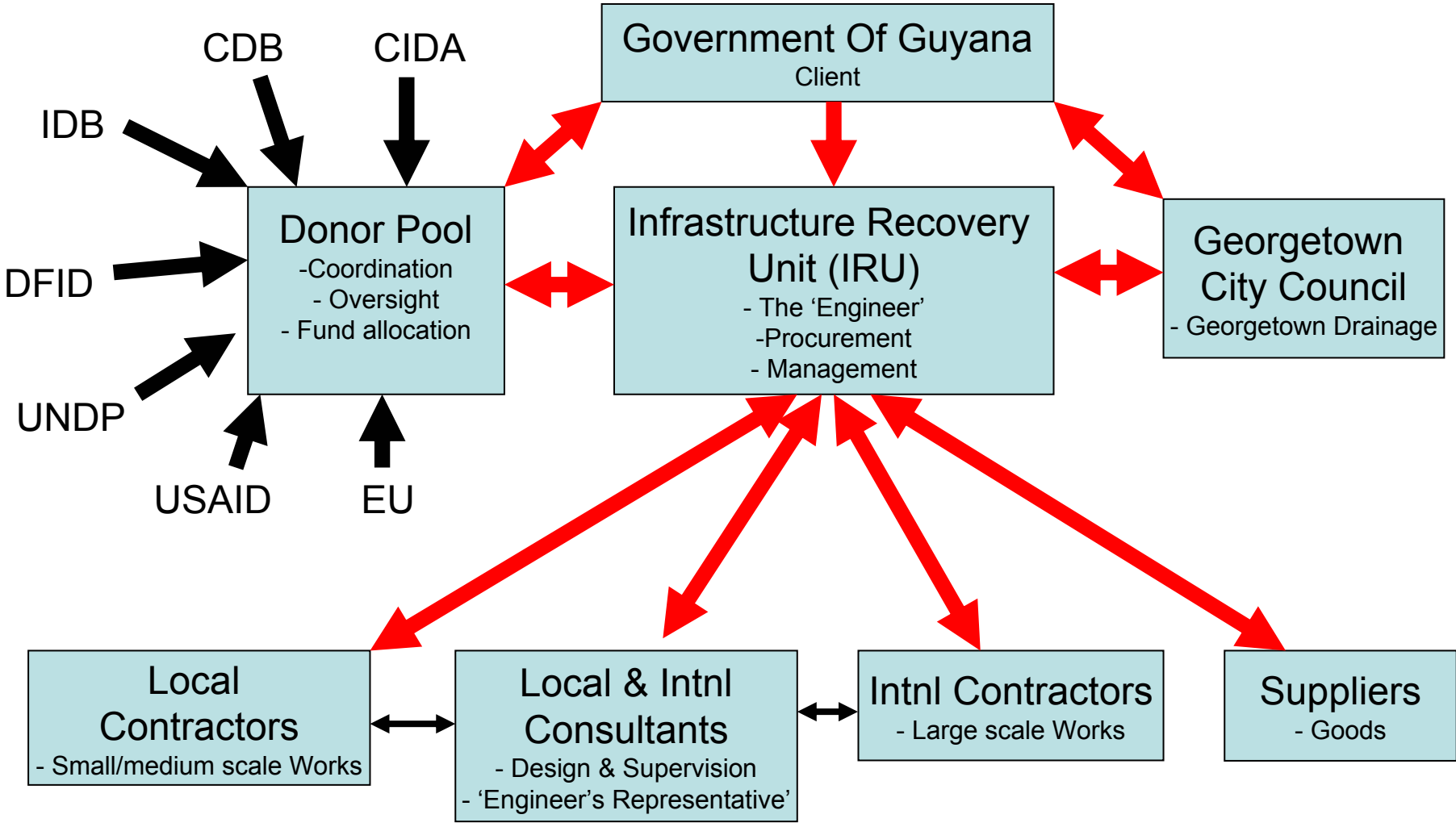
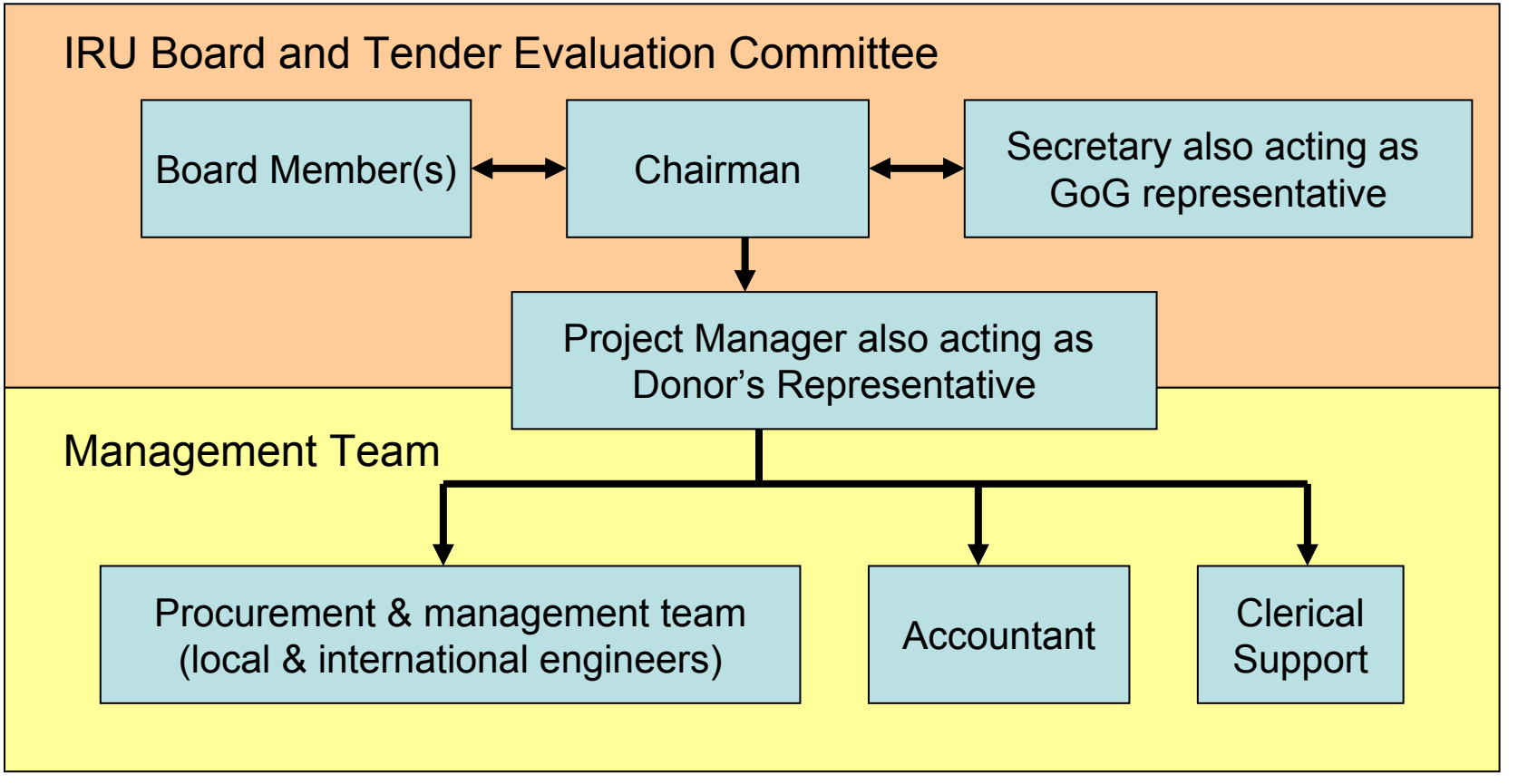


Figure 6.2 Infrastructure Rehabilitation Unit (IRU) Organisation



7 Programme

The rehabilitation programme has been divided into three phases to give an overall programme duration of 5 years:

a) **Short Term**: next 8 months leading up to and into the next rainy season (July 2005 to February 2006)
b) **Medium Term**: the subsequent 22 months leading up to the December 2007 rainy season (March 2006 to December 2007)
c) **Long Term**: a period of 2 ½ years following on from the Medium Term (January 2008 to June 2010)

This report concentrates on the Short and Medium Term. A programme detailing the timescale for each element of the rehabilitation packages has been prepared and is shown in Figure 7.1.

The Short Term will focus on three aspects, firstly the establishment and operation of the Infrastructure Rehabilitation Unit (IRU) to manage and procure Works, Services and Goods; secondly the procurement, implementation and supervision of urgent construction works that have already been identified during the Emergency Works as a high priority and thirdly the undertaking of investigations, planning and designs for Medium Term Works that are required before implementation can take place.

The Medium Term will focus on the procurement, implementation and supervision of construction Works. There will of course be some overlap in activities between the Short and Medium Term and between the Medium and Long Term.

A challenging but achievable programme has been set out in Figure 7.1. To meet such a programme will require high level strategic planning and agreement at each phase. In progressing the Short and Medium Term programme there will be some key strategic decisions to be made about the future of the drainage systems in Guyana that will require government approval. These decisions and the probable milestones by when decisions need to be made are indicated below:

Table 7.1 Decision Milestones

Decision	Date of Milestone
Decision on the long term future of the East Demerara Conservancy: whether to pursue for the long term the MMA Stage III (and also Stage II) projects or whether to re-construct the EDWC dam. If the latter a decision on the alignment required.	31 January 2006
Decision on whether to pursue long term improvements to Georgetown Drainage system	31 March 2006
Decision on the priorities for drainage improvement of the coastal areas in Regions 2, 3, 4, 5 and 6: which areas have highest priority, whether agricultural or settlement drainage has highest priority, what standard of drainage should be the target	31 December 2005
Decision on whether and how to fund adequate maintenance of the improved systems to avoid wasting the investment	31 December 2005

A timetable of strategic planning activities and milestones required to be carried out by GoG to achieve the programme is set out in Figure 7.2.

Figure 7.1
Short and Medium Term Programme

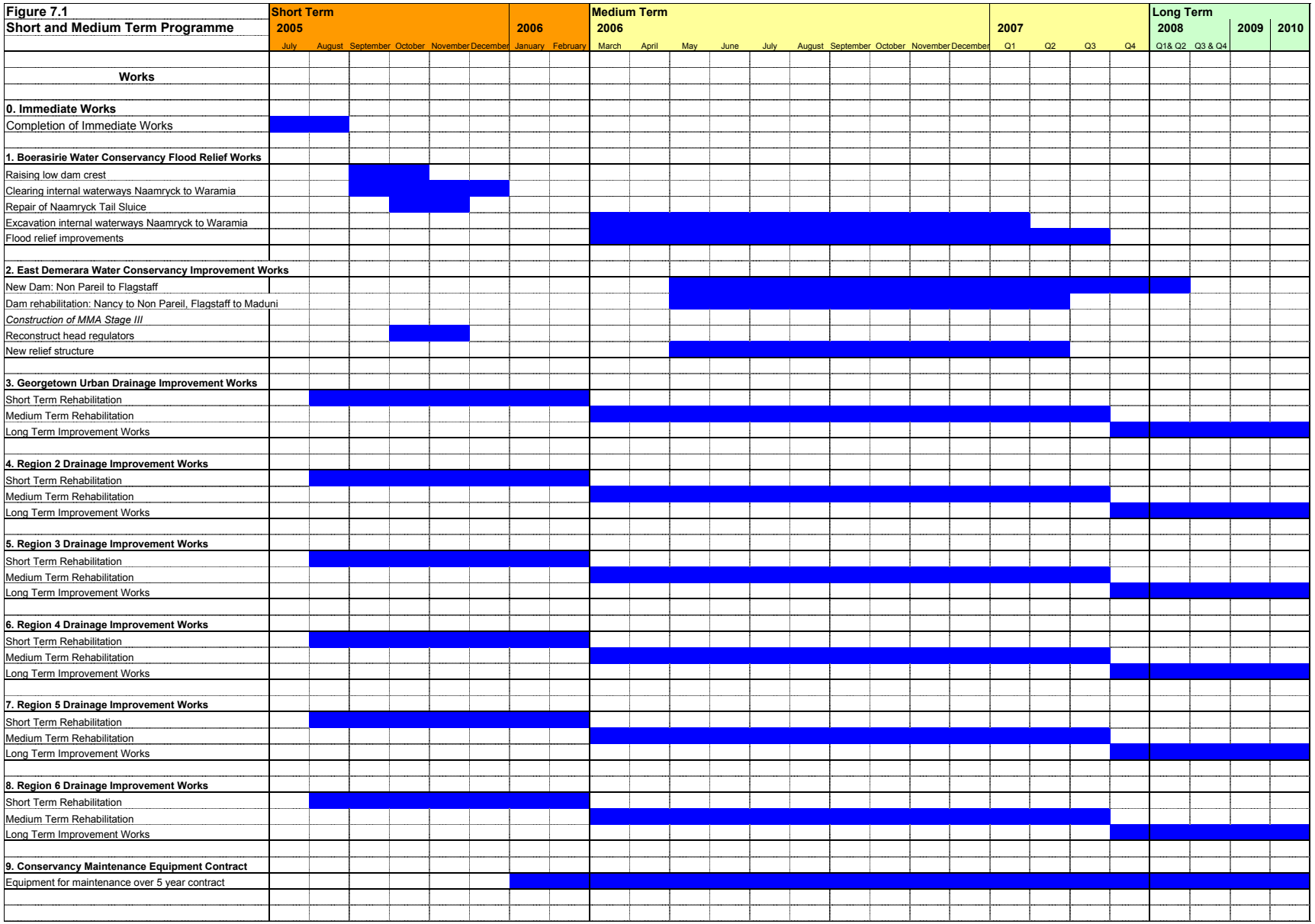


Figure 7.1
Short and Medium Term Programme

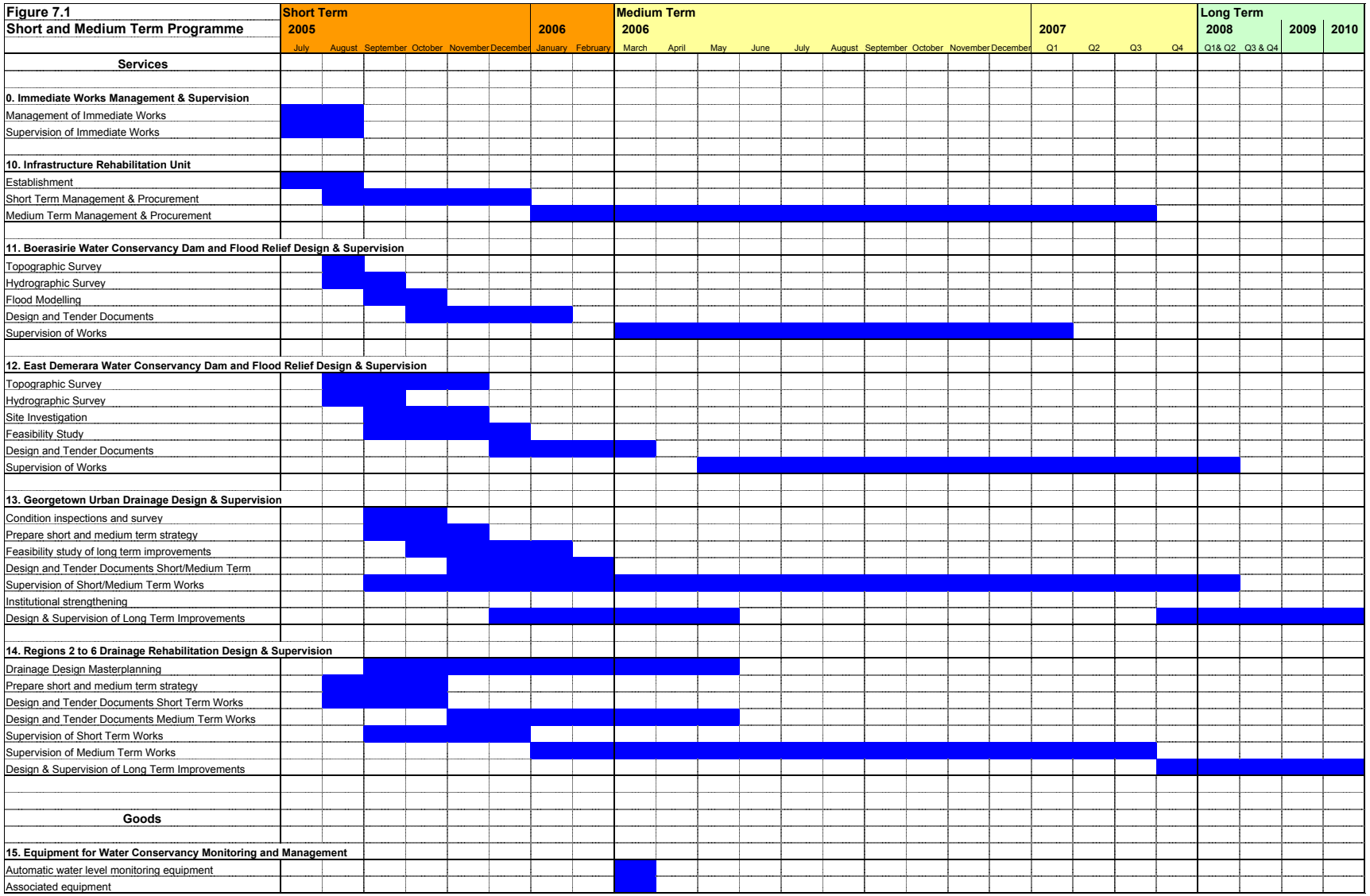
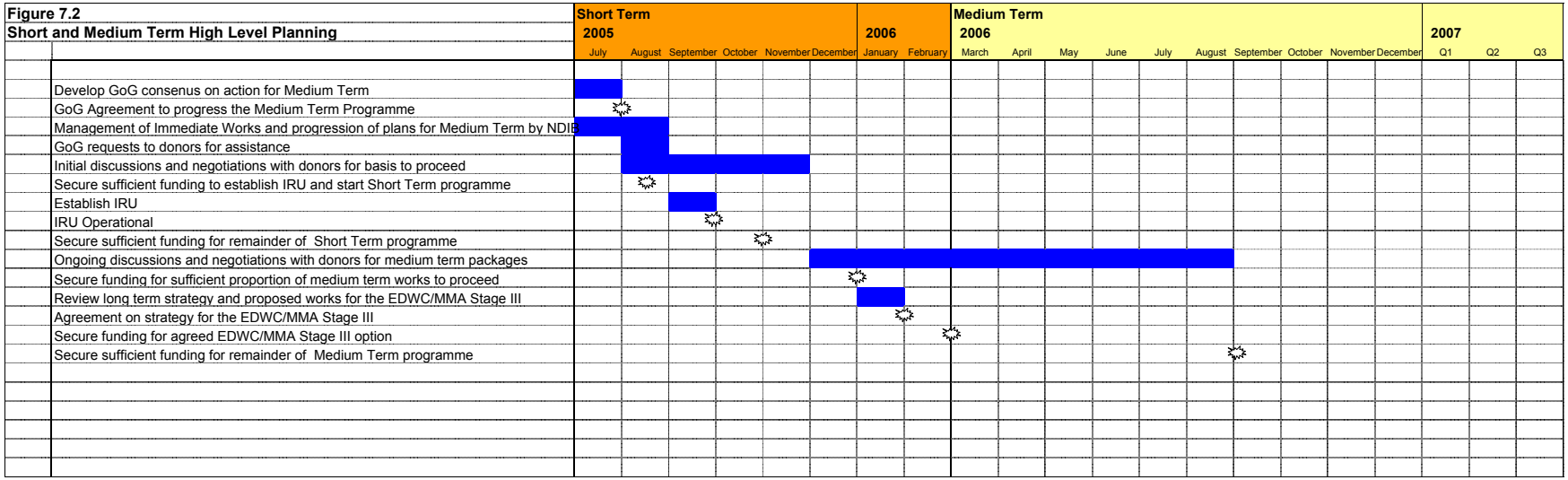


Figure 7.2
Short and Medium Term High Level Planning



Q4

8 Funding

The government has a unique window of opportunity to access aid funding for flood control and drainage rehabilitation. Donor interest has been mobilised by the emergency situation and donors are waiting for coherent proposals from government. It is recommended that the GoG act rapidly by requesting assistance on the basis of this Medium Term Plan, to seize that opportunity.

One of the loans that has many synergies with the Medium Term programme is the IDB funded Agricultural Sector Support Programme (ASSP). This loan for US$ 24M was approved in 2004 and the Ministry of Agriculture was beginning to implement when the January 2005 floods diverted staff resources and focus away from it. It includes components on institutional strengthening, crop diversification, rice improvement and drainage and irrigation infrastructure improvement. The latter component comprises of some $ 16 M of Works in nine selected areas covering Regions 3, 4 and 6. It should be noted that some of the Works proposed under the ASSP have already been carried out under the Emergency Works. The table below summarises these works which total about G$ 120 M (US$ 600,000).

Table 8.1: Works within the ASSP carried out under the Emergency Works

Description	Area	Approximate Value (G$ M)
Region 3		
Parika Outfall	Verenoegen/Bonasika	6.8
Vergenoegen revetment	Verenoegen/Bonasika	2.7
Barnwell Box	Verenoegen/Bonasika	1.9
Steel Door at Naamryck	Verenoegen/Bonasika	1.0
Desilting Canal No 2	Canals Polder	4.9
A Line Drain	Canals Polder	2.4
Centreline head regulator gate	Canals Polder	0.2
B Line Tail Wall	Canals Polder	0.6
Region 4		
Golden Grove East Drain	Golden Grove/Victoria	1.3
Victoria Sluice	Golden Grove/Victoria	8.6
Golden Grove Sluice	Golden Grove/Victoria	9.0
Golden Grove Middlewalk	Golden Grove/Victoria	2.5
Nabaclis Middlewalk	Golden Grove/Victoria	1.7
Jetting Outfalls	Golden Grove/Victoria	2.0
Craig Milne Drainage Canal	Golden Grove/Victoria	8.9
Cane Grove Pump Stations[1]	Cane Grove	64.0
Region 6		
Grading Dams	Black Bush	2.0
	Total	**120.5**

[1]includes estimated cost of pumpset which was donated

A formulated plan is required from government to request donors for allocation of funds. Until that is done it is somewhat premature to speculate on what funds could be made available and the timescale for agreement. It is understood from initial discussions that the following potential funding streams should be investigated:

Table 8.2 Potential Funding Streams

Donor	**Funding**	**Comments**
IDB	US$ 2.4 M plus possible reallocation from the $16 M Works under the ASSP including $600,000 of ASSP work already carried out	For Emergency Assistance within 9 months of the emergency. Discussion required with IDB on whether synergies with the ASSP loan could result in re-prioritisation of D&I works to the Medium Term Works
EU	Euro 20 M	Potential, lead in time perhaps 1 -2 years ?
UNDP	US$ 100,000 or more	For Consultancy Services only. Unallocated from existing funding of Task Force – utilise to complete Immediate Works management and supervision
CIDA	Not known	
DfID	Not known	
USAID	Not known	
CDB	US$ 3 M	Potential, proposed for Works in Regions 2 and 5 as Emergency Works in these areas was limited
Others	Not known	
Total	Not known	

It is understood that the G$ 480 M (US$ 2.4 M) for emergency works offered by IDB needs to have contracts awarded within 9 months of the emergency. This indicates that by the end of October 2005 contracts should be awarded. The Short Term Works suitable for award within this timescale include:

Table 8.3: Options for Scope of Works for funding under IDB Emergency Response

Option A	**Cost (G$ M)**	**Comments**
Package 1 Boerasirie Water Conservancy Flood Relief Works		
1.1 Raising low dam crest	10	Tender documents straightforward to prepare as continuation of works carried out under the Emergency Works
1.2 Clearing Internal waterways Naamryck to Waramia	60	Tender documents straightforward to prepare
1.4 Excavation of internal waterways Naamryck to Waramia – 80 %	410	Tender documents straightforward to prepare, 80 % of estimated scope of Works could be completed
Total	480	

Option B	**Cost (G$ M)**	**Comments**
Package 1 Boerasirie Water Conservancy Flood Relief Works		
1.1 Raising low dam crest	10	Tender documents straightforward to prepare as continuation of works carried out under the Emergency Works
1.2 Clearing Internal waterways Naamryck to Waramia	60	Tender documents straightforward to prepare
1.4 Excavation of internal waterways Naamryck to Waramia – 40 %	205	Tender documents straightforward to prepare, 40 % of estimated scope of Works could be completed
Package 3 Georgetown Urban Drainage Improvement Works		
3.1 Short Term rehabilitation of Georgetown Drainage System (50 %)	205	Little work carried out so far under the emergency situation. About 50 % of proposed Short Term Works could be carried out
Total	480	

9 Risks and Constraints

The success of the medium term programme will rely on the continued cooperation of stakeholders: donors, OoP, NDIB, MoA, RDCs, NDCs, Central Tender Board, City council, consultants, contractors and others. The political will to drive this programme forward will be needed to ensure that action does not become bogged down in bureaucracy and conflicting priorities and agendas.

The extent of funding that government and donors are willing to make available will dictate the extent to which the programme can be fully implemented. A realistic programme has been developed which as far as possible reflects the urgent needs of flood control and drainage and is not simply "a wish list". The constraints and conditions that may be imposed prior to approval of implementation are unclear and may affect the timing of the programme.

The biggest long term risk is the sustainability of the improved systems and the main risk to their sustainability is lack of funding for maintenance. It cannot be over-emphasised that without commitment from government on this then there is a serious risk that the investment will be wasted. With the passing of the recent D&I Act the legal framework exists for the management, operation and maintenance of the public good drainage system on a nationwide scale under the NDIA and the management, operation and maintenance of private good drainage systems through Water User Associations and probably NDCs. The words of 40 year's ago still unfortunately ring true today:

"The fundamental need for the adequate maintenance and supervision of completed projects, the levying and collection of rates and proper land tenure, is diminished neither by the longevity of these problems nor by their platitudinarian nature"[5]

Memories can be short and there is a risk that the memory of the events of January 2005 will be taken over by more recent issues and concerns. It is therefore essential to avoid the risk that the momentum gained so far peters out. This will require rapid action to ensure continuity between the Emergency Works that are coming to an end and the establishment of the IRU and the subsequent start of the Short Term programme.

10 Recommendations

The detailed recommendations for the Short and Medium Term are contained in Appendix A – Implementation Packages. It is recommended that the following is carried out as a matter of urgency:

- Internal GoG discussions to gain consensus that the Medium Term Plan should be implemented

- In order that the Immediate Works can be completed the role of managing the contracts should be passed to NDIB when the Task Force is dissolved. It should be supported by those local consultants who have performed well supervising the Emergency Works. The local consultants will supervise the works and contract manage the works assisted by further part-time inputs by Task Force members to ensure continuity. The role of Special Advisor should be extended for one month using unspent funds within the contract for the Special Advisor. The UNDP should be requested to allocate funds that remain in the existing consultancy budgets to achieve this.

- GoG should make requests for assistance and hold discussions leading to agreement in principle with donors and government to secure funding for the Short Term programme. In particular GoG should hold discussions with IDB on a) the US$ 2.4 M that has been offered for emergency assistance but needs to be allocated to approved emergency works within 9 months of the emergency (the proposed work packages for utilisation of those funds are given in this report in Chapter 8) and b) refunding of US$ 600,000 of ASSP works that have been carried out under the Emergency Works.

- Establish the Infrastructure Rehabilitation Unit to manage the programme and if necessary assist with completing the procurement/management of the Immediate Works.

The near-completion of the Emergency Works programme should not be seen as “the beginning of the end” of the country’s response to the January 2005 floods but just “the end of the beginning”.

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6. Final Report on a Study of Drainage Outfalls, Ministry of Public Works in association with Halcrow, January 1973

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15. Macro socio-economic assessment of the Damages and Losses caused by the January-February 2005 Flooding, ECLAC, 2005

Appendix A Programme Packages

Package Nr 01: Boerasirie Conservancy Improved Flood Control Measures

Background

The Boeraisire Conservancy in Region 3 was constructed in the 1950s to provide flood protection and water supply to the coastal area of Region 3. It has a total catchment of 436 km^2, the conservancy itself covers a vast area of about 254 km^2 at the elevation of its main spillway crest. The conservancy dam runs for some 41 miles. It provides flood protection to an area of some XX km^2 (acres) and a population of about XX.

In the January 2005 floods the conservancy dam was not breached. However overtopping to a shallow depth did occur primarily along low areas of the north east dam between Leonora and Naamryck and it is a matter of extreme good fortune that such overtopping did not result in a major breach. These areas are known to be low and have experienced overtopping during floods in recent years. As in 2005, this overtopping fortunately did not cause breaching. Temporary repairs using timber had been carried out following those floods. Part of the low area have subsequently been built up using clay bags under the Emergency Works however sections of the dam remain low. At its lowest point the dam crest is reported to be only 60 mm above the level of the 8,000 foot weir crest and at its highest point only 214 mm above the weir crest. Such a small freeboard means that there is no real margin of safety.

The January 2005 flood highlighted the need for rehabilitation of the conservancy dam to an acceptable minimum standard.

Other than its low crest level the Boerasirie Conserancy dam is generally acknowledged to be in a reasonable structural condition. This is confirmed by inspections carried out by Mr Chris Wagner, Dams Specialist to the TFIR [2] and also by Mr Andrew Kirby in 2003/2004 under the Agricultural Sector Programme (ASP).

Dr Robin Wardlaw carried out hydrological and water resource analysis of the conservancy under the ASP [3] and subsequently undertook preliminary modelling of the conservancy for the TFIR, the latter being described in the Report on Conservancy Flood Management Modelling [1]. Analysis of water level records from the January 2005 flood showed that water levels in much of the conservancy (from Naamryck round to Potosi) were considerably higher than water levels at the western end of the conservancy (Waramia) where the major flood relief structures are located. This suggests that internal conservancy waterways between the two are constricting flow and that the conservancy is not getting the full benefit of the western relief structures (Waramai Relief Sluice and the 8,000 ft weir). The modelling showed that the conservancy does not act as a level pool of water. The Report also highlighted the fact that the 8,000 ft weir is not acting at its design capacity due to vegetation growth. This, along with the restricted waterways led to the situation identified in the report that “were the weir functioning properly the Boerasirie Conservancy would have been able to accommodate the January 2005 flood without overtopping”.

Aims and Objectives of the Intervention

The aim of the intervention is to raise the standard of the conservancy’s dam and flood relief structures up to an acceptable minimum standard

The objective of the intervention is to implement a number of flood control works to meet the above aim. These works will include:

- raising of low areas of crest along the dam
- widening internal waterways between Naamryck and Waramia

The findings of the conservancy modelling and design will determine which of the following may also be required:

- improving the hydraulic conditions at the 8,000 ft weir
- construction of over-toppable embankment sections
- construction of an additional relief structure
- modification of other existing structures and channels for relief e.g. the use of Salem, Hubu or Maripa Main Drains or the abandoned sluice at Potosi.

Benefits of the Intervention

This intervention will result in improved flood control on the Boerasirie Conservancy. The benefits of improved flood control on the Boerasirie Conservancy arise from the reduction in the risk of dam breaching and overtopping leading to the following benefits:

- reduced the risk of loss of life to people in Region 3
- reduced risk of flood damage to agricultural land
- reduced risk of flood damage to infrastructure in Region 3 (roads, D&I systems, power, telephone, sewage, hospitals, schools
- reduced risk of flood damage to residential property and contents
- reduced risk of damage to businesses
- reduced risk of health problems arising from flooding
- confidence to live, work and enjoy life
- confidence to invest in the Region

Quantification of the direct and indirect economic benefits of the intervention is beyond the scope of this plan however these benefits will affect XX people over an area of XX acres.

The reduction in risk that can be achieved by relatively straightforward measures is considerable. Currently overtopping occurs for relatively modest floods (a 100 year flood will result in overtopping by as much as 60 mm [3]) and a number of overtopping events have occurred in the last ten years. For the relatively modest investment proposed below the risks can be reduced so that overtopping will not occur in a 1,000 year flood or potentially even a 10,000 year flood. The latter being a typical level of acceptable risk, internationally, in situations where considerable damage and the risk of loss of life exists.

Potential Works

Raising of low areas of crest

Raising of low areas of the crest is fundamental to improving the standard of the conservancy dam. The dam is only as strong as its weakest link. Identifying the weaknesses and bringing them up the general standard of the rest of the dam is a straightforward measure for improving flood control with clear benefits.

A survey of the crest of the dam is not available, except between Leonora and Naamryck and has been recommended under Package Nr 11. Only an initial assessment of the extent of dam raising can therefore be made at this stage. Raising of some of the lowest areas of the dam with clay bagwork formed part of the Emergency Works. Some G$ 9 M of works was undertaken to raise the dam over about a 5,800 m section between Leonora and Naamryck. It is estimated that an allowance should be made for raising the dam over a further 4,000 m to complete the section between Leonora and Naamryck. The rest of the dam is generally at a higher level, though this needs to be confirmed by the topographic survey. A nominal allowance of a further 1,000 m of raising has been assumed for local low spots outside the Leonora to Naamryck section.

The works undertaken as Emergency Works raised the dam to a crest level of 19.2 mGD (63.0 ftGD) which is approximately the peak flood level in the conservancy during the January 2005 floods. Initial modelling [1] suggests that if the internal waterways are opened up and the 8,000 ft weir is operating at its design capacity (or alternative relief measures are constructed to give an equivalent discharge) then water levels during the January 2005 flood would have been around 18.8 m GD (61.7 ftGD). Thus undertaking the dam raising and carrying out the relief structure improvements would result in a dam with a freeboard of about 0.4 m (1.3 ft) during an extreme flood (January 2005 equivalent, approximately 10,000 year flood). With wave action in the conservancy known to be limited this size of freeboard is probably at the minimum adequate to give confidence of the dam's safety. A crest level of 19.2 mGD (63.0 ftGD) has therefore been assumed when estimating the cost of raising works. A crest width of 3.65 m (12 feet) has been assumed.

The cost of raising works is estimated at G$ 10 M (US$ 50,000).

Widening internal waterways

Preliminary modelling and water level records from the January 2005 floods have shown that there is a constriction in flow between Naamryck and the main relief structures: Waramia Sluice and the 8,000 foot weir. The modelling indicated that removing this constriction and improving hydraulic conditions at the weir would have reduced water levels in the conservancy by about 0.4 m (from about 19.2 mGD to about 18.8 mGD) during the January 2005 floods [1]. This is clearly a considerable benefit for flood control at a low cost when compared with say raising the whole conservancy dam by 0.4 m.

The further modelling recommended in Package Nr 11 will identify the required waterway width to prevent constriction of flow to the relief structures. Works to widen the waterways can be considered as two elements: clearing of vegetation to reduce the hydraulic roughness of the existing channels and excavation to widen the channels to provide additional conveyance.

Tender documents were prepared during the Emergency Works for both clearing and excavation of the two sections of waterways within the conservancy that are likely to be restricting flow: one between Naamryck and Waramia and the other between Spillway and Potosi. The length of these sections of waterway are 20,100 m and 4,900 m respectively. Tender documents were prepared on the basis that channels should be excavated to a 75 ft (22.9 m) bed width, 1:2 side slopes and 10 ft (3.0 m) deep. Engineer's estimates for these works were prepared:

Works	Cost (MG$)
Naamryck to Waramia	
Clearing	46.2
Clearing and Excavation	460.2
Spillway and Potosi	
Clearing	13.0
Clearing and Excavation	118.2

Clearing alone would only give a low cost short term improvement in hydraulic conditions. It was considered as an option during the Emergency Works as funds were limited. Clearing and excavation of the channel to the required design width is an appropriate medium term solution. The total costs are G$ 59.2 M (US$ 296,000) for clearing and G$ 578.4 M (US$ 2.89 M) for full excavation.

Repair of Naamryck Relief Tail Sluice

At the Essequibo end of the Naamryck Relief Channel is a tail sluice comprising three radial gates. It appears to perform a number of potential functions – to prevent water (and possibly saline) ingress from the Essequibo, to maintain water levels in the channels upstream for irrigation and to prevent the Naamryck Relief Sluice accidentally draining the conservancy in the event of a gate failure.

It's current condition is very poor and some gates cannot be raised. This means that it blocks the relif channel and thus the relief sluice cannot be opened to its full capacity without risking causing flooding in the Naamryck and Lookout areas.

Designs and cost estimates for replacement of the gates were prepared under the ASP for implementation in the ASSP[4]. The cost of gate replacement is estimated to be G$ 6 M (US$ 30,000).

Improving hydraulic conditions at the 8,000 foot weir

The 8,000 foot weir is the major flood relief structure on the Conservancy in terms of discharge capacity at high water levels. However it cannot currently discharge to its full capacity due to poor hydraulic conditions. In front of the weir is a bank of vegetation at least 15 m wide which restricts flow as well as vegetation downstream of the weir which could restrict its performance at high discharges. Conventional clearing of the vegetation prior to rainy seasons is only a short term measure as re-growth occurs in a matter of a few weeks.

A more permanent measure to overcome the problem would be to excavate an approach channel along the length of the weir to give deepwater in front of the weir which would restrict vegetation growth. A similar channel could be excavated on the downstream side. Periodic re-excavation and clearance would still be required as the channel silted up but would be considerably less than required at present. However details of the design of the weir have not been found and therefore it is not known whether this would risk undermining the foundations of the structure. Another alternative would be to line the approach to the weir with concrete which would restrict vegetation growth. Silt would gradually be deposited over the concrete which would result in vegetation growth. Periodic removal of this silt would be required but maintenance would be considerably less than is required at present. The cost of concrete lining such a long length would be considerable. The most cost effective method of construction may be to use grout filled mattresses. These are large geotextile mattresses which are pumped with concrete grout to form a lining. A combination of the two options may be possible if excavation of a channel right to the edge of the weir crest would undermine its foundations.

Only very rough costs of the works can be estimated at this stage based on visual inspections of the weir. It is estimated that of the order of 160,00 cubic yards (120,000 m^3) of material would require excavation to clear the upstream and downstream approaches to the weir. The material would need to be disposed of away from the weir which would introduce additional costs. The overall cost is estimated to be about G$ 41 M (US$ 205,000). Lining of the bed immediately upstream and downstream of the weir and excavation of a channel to the end of the lining is estimated to cost about G$ 365 M (US$ 1.8 M). The nature of the lining works means that specialist contractor input would be required from an international contractor.

Construction of overtoppable embankment sections

If the modelling of the conservancy identifies the need for additional flood relief an alternative to constructing new flood relief structures, put forward by Mr Wagner the Dams Specialist, was the construction of overtoppable dam sections. These would be sections of the existing conservancy dam which would be constructed with a slightly lower crest level than the rest of the dam and whose crest and downsteam face would be protected to resist erosion due to overtopping without failure. At high flood levels these would overtop before the rest of the dam and act as a safety valve. They would need to be constructed in locations where the release of water would not cause significant damage. This suggests that they would either need to be located on the western side of the conservancy around Waramia or on its eastern flank around Potosi.

The length and crest level of such sections would need to be assessed as part of the conservancy modelling. In order to make an initial guess of their length and hence cost it has been assumed that they would be designed to overtop at the same level as the 8,000 ft weir, i.e. they would have a crest level of 18.684 m GD (61.3 ft). It has been assumed that they would be designed to provide a discharge of 68 m^3/s at a conservancy water level of 18.898 mGD (62.0 ft GD), which is nominally the highest crest level of the conservancy dam. Such a discharge is the same as that provided by Waramia Sluice. Under these conditions a 600 m length of overtoppable embankment would be required. The flow velocities on the rear embankment slope resulting from such a design would be about 3-4 m/s, assuming a slope gradient of about 1 in 4. Such velocities would require reinforcement of the embankment surface to prevent erosion. Reinforcement with a three-dimensional geotextile grid should be sufficient with such flow velocities rather than the use of say concrete blocks. The geotextile grid would reinforce the vegetative layer. The cost of such an embankment is estimated to be of the order of G$ 117 M (US$ 590,000).

Construction of additional flood relief structure

The additional modelling of the conservancy may identify the need for additional flood relief structures. Currently, it is only at very high water levels, at water levels that threatens the dam safety, that significant flood relief discharge is possible. Additional flood relief discharge at lower conservancy water levels could therefore significantly improve safety. Such flood relief would need to be provided by a gated structure of a similar type to the Naamryck Relief or the Waramia Relief Sluice. The structure would need an adequate outfall channel to discharge flood water safely. It may be possible to site such a structure adjacent to an existing relief structure and combine their discharges into an enlarged existing channel. In order to come up with a budget cost for such works the following assumptions have been made:

- it would be twice the width of Naamryck or Potosi sluices
- it would be located at Potosi
- a new relief channel would be excavated

The cost of an additional relief structure is estimated at about G$ 67 M (US$ 340,000).

Modification of existing structures

The Hubu, Maripa and Salem main drains run between the conservancy and the Essequibo and are used to drain agricultural land between the two. Modification of these channels for flood relief of the Conservancy may be possible. However the impact on drainage of using these for conservancy flood relief would have to be investigated to avoid the risk of discharges from the conservancy causing flooding downstream. It would require new relief structures on the conservancy and probably enlargement of the existing drains. At this stage it is not possible to develop the option further but should be considered as an option if additional flood relief is shown to be required. It appears likely that the cost of such an option would be of a similar magnitude to a new relief structure and a cost of G$ 67 M (US$ 340,000) has been assumed.

Assumed Works Required

In order to budget for construction works it is necessary to assess the combination of measures that are likely to be recommended in the short and medium term. Four possible situations have been considered in the table below:

1. Short Term to Medium Term Works – for some quick wins to improve safety before the next rainy season
2. Medium Term to Long Term Works A – a possible mix of medium term works – additional relief rather than improvements to the 8,000 ft weir
3. Medium Term to Long Term Works B – a possible mix of medium term works – improvements to existing relief structures, particularly the 8,000 ft weir
4. Upper estimate – likely upper estimate on works that may be recommended

The two medium term options have similar magnitudes of cost (between G$ 810 and 1000 M) and therefore a cost of Medium Term/Long Term Works of G$ 900 M (US$ 4.5 M) has been adopted.

Potential Works	Range of Potential Options			
	Low cost/short term	Best estimate A - medium term	Best estimate B - medium term	Upper estimate
raising of low areas of crest along the dam	9.7	9.7	9.7	9.7
widening internal waterways between Naamryck and Waramia	59.2 (clearing only)	578.4 (clearing and excavation)	578.4 (clearing and excavation)	578.4 (clearing and excavation)
Repair of Naamryck Tail Sluice	5.8	5.8	5.8	5.8
improving the hydraulic conditions at the 8,000 ft weir	41(excavation only)	41 (excavation only)	406 (excavation and concrete lining)	406 (excavation and concrete lining)
construction of over-toppable embankment sections	Not carried out	117	Not carried out	117
construction of an additional relief structure	Not carried out	67	Not carried out	67
modification of other existing structures and channels for relief	Not carried out	Same-cost alternative to new structure	Same-cost alternative to new structure	Same-cost alternative to new structure
Total	115.7	818.9	999.9	1183.9

Package Nr 02: East Demerara Conservancy Improvements

Background

The East Demerara Conservancy in Region 4 was constructed in the 1880's to provide flood protection and water supply to the coastal area of Region 4. It has a total catchment of 582 km^2, the conservancy itself covers an area of about 335 km^2 at a typical water elevation of 17.53 mGD (57.51 ftGD). The conservancy dam runs for some 42 miles. It provides flood protection to an area of some XX km^2 (acres) and a population of about XX.

In the January 2005 floods the conservancy dam was not breached. However significant overtopping did occur. Comparison of flood levels with a crest level survey undertaken by the Land and Surveys Commisison in 2005 suggests that 10 % of the length of the dam was overtopped [1]. It is a matter of extreme good fortune that such overtopping did not result in a major breach. The January 2005 flood highlighted the need for rehabilitation of the conservancy dam to an acceptable minimum standard.

Other than its low crest level the East Demerara Conservancy dam is known to be in a very poor structural condition. This is confirmed by inspections carried out by Mr Chris Wagner, Dams Specialist to the TFIR [2] and recent inspections have confirmed significant longitudinal cracking, slumps and slippages. Its poor condition has been known for many years, e.g. from the 1960's:"flood control of the EDWC continues to be an anxiety", "obsolescent Conservancy", [5] Raising of the dam at that time was considered but rejected as one of "doubtful technical and economic feasibility".

The dam currently has little or no freeboard during floods and has insufficient capacity during droughts. In summary:

"The present Conservancy dam does not meet internationally recognised standards with respect to safety of impounding reservoirs….the risks they pose in the event of failure are considerable…potential risk to life, major economic disruption and loss of primary existing source of domestic water supply" [2]

Aims and Objectives of the Intervention

The aim of the intervention is to raise the standard of the conservancy's dam and flood relief structures up to an acceptable minimum standard

The objective of the intervention is to implement a number of flood control works to meet the above aim. These works will include a combination of the following:

- Re-construction of the dam between Non Pareil and Flagstaff on a new alignment either immediately downstream or along the crown dam
- Rehabilitation of sections of the dam between Nancy Stop Off and Non Pareil and between Flagstaff and Maduni if their stability is found from analysis to be less than satisfactory
- Construction of MMA Stage III to improve flood control and water supply in the EDWC to obviate the need for re-construction of the EDWC dam.

- Construction of an additional flood relief structure subject to confirmation from modelling and feasibility design

- Other flood relief works e.g. clearing of internal waterways, identified during modelling and feasibility design

Benefits of the Intervention

This intervention will result in improved flood control on the East Demerara Conservancy. The benefits of improved flood control on the East Demerara Conservancy arise from the reduction in the risk of dam breaching and overtopping leading to the following benefits:

- reduced the risk of loss of life to people in Region 4

- reduced risk of flood damage to agricultural land

- reduced risk of flood damage to infrastructure in Region 4 (roads, D&I systems, power, telephone, sewage, hospitals, schools

- reduced risk of flood damage to residential property and contents

- reduced risk of damage to businesses

- reduced risk of health problems arising from flooding

- confidence to live, work and enjoy life

- confidence to invest in the Region

Quantification of the direct and indirect economic benefits of the intervention is beyond the scope of this plan however these benefits will affect XX people over an area of XX acres.

Potential Works

New Dam Between Non Pareil and Flagstaff

The March 2005 Inspection identified the EDC dam between Non Pareil and Falgstaff a distance of 8-9 miles (14 km) as being in a very poor condition. It was considered that the existing dam was so severely damaged by historic slips, poor maintenance and deep excavations directly at the downstream toe, that remedial works to this structure would be costly and difficult, with the view that an entirely new dam downstream would be more appropriate.

The existing dam is narrow, re-construction of the dam on the same alignment as the existing dam is constrained by a deep (10 feet or more in places) borrow trench on the downstream side and perimeter channel of the conservancy on the upstream side. Re-construction would therefore require considerable filling out on one or both sides. In addition the dam is founded on weak pegasse soils and has suffered extensive cracking and slippages. Hence the conclusion that a new dam is preferred to re-construction.

Construction of a new dam a short distance downstream could be constructed to current water impoundment dam standards. However it would still be founded on pegasse. Thus an alternative, construction along the crown dam should be considered. A new dam would require construction of new head regulators along that section of dam.

It is understood that the crown dam pre-dates the conservancy and is really a series of dams each the upstream polder dam of a plantation. The dams still have some function, providing a secondary small conservancy for each village, used particularly in times of drought. The borrow trenches running upstream of the dams also act as the irrigation distribution system from a head regulator on the EDWC to each villages' middlewalk (canal). The crown dam is in a variable condition and does not exist in some places. Re-construction of part of the crown dam has been carried out in 2005 over about a 5.8 km section. The land between is mainly savannah and used in many places for cattle grazing.

Construction of a new dam along the crown dam would require the construction of flank embankments back to the rest of the conservancy dam, a distance of about 1.5 km. It would also require the construction of a significant number of new head regulators, generally one for each village. To avoid too many head regulators passing through the main dam an irrigation distributary system would probably be needed downstream of the main dam to distribute irrigation water to each village (in a similar manner to the current situation). The material excavated to create this new canal system could be used for borrow for the main dam.

Possible pros and cons of the alternatives, along with MMA Stage III (which is described later in this section) include:

Pro/ Con	**Replacement North-East Dam**	**Crown Dam alternative**	**MMA Stage III New Conservancy**
Advantages	No agricultural land lost downstream	Easier to build (on clay)	No agricultural land lost downstream
	No change in operating regime?	Probably cheaper overall	Improves reliability of water supply as well as flood control
		Increase in water storage upstream	
		Possibly quicker to build	
Disadvantages	Probable foundation on pegasse	Loss of agricultural land	More expensive
		Added cost of wing embankments and new head regulators	Probably slower to secure funding and implement

The cost of a new dam is difficult to estimate as it is strongly dependent on a number of highly ill defined and uncertain factors in particular ground levels along the alignment, soil conditions and the precise scope of works required.

Nevertheless two budget estimate has been prepared based on two sets of slightly different gross assumptions:

Conservative best estimate:

- typical ground levels along the dam alignment are at 15.85 mGD (52.0 ft GD)
- the crest level is at 18.3 mGD (60.0 ft GD)
- the crest width is 4.6 m (15 ft) and the side slopes are at 1:2.5
- structural geotextile would be used at base level and mid-height to provide strength over the weak foundation soils

Optimistic Best Estimate – as above except:

- typical ground levels along the dam alignment range from 15.85 to 16.76 mGD (52.0 to 55.0 ft GD) in accordance with the ground levels indicated on maps in reference [6]
- structural geotextile would be used at base level only

The broadbrush cost estimate based on these assumptions ranges from G$ 1,827 to 2,536 M (US$ 9.1 to 12.7 M). The average of these two figures G$ 2182 M (US$ 10.9 M) has been adopted.

Rehabilitation of sections of the dam between Nancy Stop Off and Non Pareil and between Flagstaff and Maduni

Though the dam between Nancy Stop Off and Non Pareil and between Flagstaff and Maduni is in a better condition than Non Pareil and Flagstaff there are nevertheless doubts about its stability. Stability analysis is required to determine whether its stability is less than required for an impounding dam of such significance in terms of economic loss and risk of loss of life. If stability is found to be inadequate remedial works will be required. Such works could include strengthening by construction of a downstream berm, re-grading slopes to a shallower gradient by widening the embankment.

The scope of these works is not known at this stage. It is considered prudent to allow a contingency of G$ 100 M (US$ 500,000) for these works until they can be better quantified.

Construction of MMA Stage III

Construction of MMA Stage III represents an alternative to construction of a new EDWC dam with potential agricultural benefits beyond flood control. The scheme is described in reference [7]. Its principal features comprise:

- a new conservancy dam across the Mahaica River, approximately 23 km (14 miles) long to an average height of 3.7 m (12 ft) and a top level of 22.5 mGD (14 ftGD).
- The Mahaica Control Sluice with a design capacity of about 2000 cusecs (57.1 m3/s)
- The Mahaica Flood Relief and Irrigation Supply Regulator for irrigation supply to the EDWC area, with a design capacity of 1.750 cusecs (50.0 m3/s)

- An additional flood escape sluice to the Demerara river with a design capacity of 4,000 cusecs (115.0 m3/s) at a flood water level of 57.5 ftGD (17.52 mGD)

- An enlarged flood relief channel from the Mahaica Dam to the Demerara river channel (17.5 miles (28 km) long within

A preliminary estimate of the cost of works is given in reference [7] as G$ 3,800.6 M (US$ 27.1 M) at 1997 prices. To obtain a very rough non-rigorous approximation of current prices a local annual price increase of 5 % was assumed giving a price increase multiplier of 1.4 and then adjusted by the change in G$:US$ exchange rate (140 to 200) giving a cost of G$ 7,449 M (US$ 37M) at 2005 prices. A check using the US consumer price index for the period gives a 1.21 uplift for US consumer prices (albeit this is not directly applicable) giving a cost of US$ 32.5 M (G$ 6500 M) at 2005 prices. This suggests that a current price of around G$ 7,000 M (US$ 35 M) should be assumed for MMA III.

Construction of additional flood relief structures/improvements to existing relief structures and facilities

Modelling of the conservancy [1] indicates even following Emergency Works to open up Kofi and Cunha Reliefs that an additional 30 m wide flood relief structure is required to pass the 10,000 year flood without encroaching on dam freeboard. NB The modelling indicated that a 1,000 year flood could be passed. Further modelling is proposed (Package 12) to confirm this. This size of structure is similar to the size of the Land of Canaan sluice.

A detailed breakdown of the cost of such a structure has not been made. However, based on engineering judgement, a budget of G$ 80 M ($400,000) should be allowed for the structure and G$ 30 M (US$ 150,000) for its relief channel, giving a total cost of G$ 130 M (US$ 550,000).

Reconstruction of head regulators

Some of the head regulators along the conservancy dam are in a poor state of repair resulting in leakage which exacerbates flooding. In addition the head regulators represent a weak spot in the dam. Repairs and replacement of a nominal number of five head regulators along the dam is proposed at a cost of G$ 50 M ((US$ 250,000).

Package Nr 03: Georgetown Urban Drainage Improvements

Background

Georgetown suffers from flooding annually. The January 2005 floods caused widespread flooding to Georgetown with many properties flooded, roads were under water, many government offices and businesses were forced to close and many residents had to leave their houses. The depth of flooding was reported [8] to be less than elsewhere in Region 4, of the order of 1 to 2 feet, and of a shorter duration. However with about half the population of Guyana living in and around Georgetown and with the high concentration of businesses, services and infrastructure in the area flooding of Georgetown will have inevitably a significant economic and social impact.

Deficiencies in the drainage system have been known for many years and are evident from a walk along the streets of Georgetown. Georgetown has expanded considerably over the last 50 years but without little corresponding increase in capacity of the drainage system, exceptions being construction of the Kitty pump station in 1968 and the East Georgetown Flood Alleviation Scheme in 1978 [9].

The condition of the drainage system is in a state of disrepair. Outfall sluices are in a poor condition or inoperable, drains are overgrown, silted and obstructed with refuse, culverts are blocked, drains have been filled in, reserves along drains have been occupied making access for cleaning impossible, etc.

The condition of the drainage system was examined as part of a masterplan in 1995 [9]. Since then the overall condition is unlikely to have significantly changed, though particular problems may have changed.

There is no doubt that significant works are required to bring the drainage system back to its design capacity and beyond that there is a clear need to invest significantly in improving the system in the medium to long term to cope with the increased drainage needs of Georgetown. For such infrastructure improvement to be worthwhile will require institutional strengthening of the Engineer's department; commitment by the Government to adequately fund management, operation and maintenance of the system; education of the population of the need to keep drains clear.

Aims and Objectives

The aims of this Package are:

- To increase existing storm capacity from its current les than 1 year standard to its practical maximum of 2 yr standard
- To plan and implement long term improvements to the drainage system to cope with its expansion

The objectives of this package are:

- To undertake a strategic programme of rehabilitation and improvement works in the short, medium and long term focussing on drain cleaning, removal of bottlenecks in the system , rehabilitation of sluices and pump stations and long term improvement works

Benefits

The benefits of the Package will be reduced incidence and severity of flooding in Georgetown giving rise to the benefits described in Chapter 4.

Scope of Works

The Engineer's Department provided a list of priority works to the TFIR in May 2005 with a total value of G$ 397.5 M (US$ 1.99 M), see table below. Some of these works were being started using the Council's limited resources. These works covered about G$ 60.5 M of the total works. Information provided by the Council in May on ongoing and recently completed projects suggested that about G$ 36.2 M of contracts had been let, with about G$ 10.5 M expended so far. The works proposed are focussed on emergency rehabilitation – primarily cleaning and desilting main and secondary drains, repairs to sluices and pump stations and replacement of culverts.

The Drainage Masterplan [9] indicated that the potential capacity of the existing system if rehabilitated could cope with a storm of 2 year return period (defined as 88 mm in 12 hours) though its capacity at the time of the masterplan (1995) was considerably less than that. To increase its capacity beyond a storm of 2 year return period would require new infrastructure.

The rehabilitation works proposed in the Masterplan comprise:

- Excavation of outfall channels
- Excavation of primary drains to design cross sections
- Concrete lining of channels at particular locations
- Construction of culverts to link adjacent drainage basins
- Rehabilitation of existing pump stations and outfall sluices

The cost of rehabilitating the main drainage system to a 2 year return period storm standard was estimated in the Masterplan [9] at G$320 M (US$ 2.56 M) at 1995 prices. To obtain a very rough non-rigorous approximation of current prices a local annual price increase of 5 % was assumed giving a price increase multiplier of 1.6 and then adjusted by the change in G$:US$ exchange rate (125 to 200) giving a cost of G$ 819 M (US$ 4.1M) at 2005 prices. A check using the US consumer price index for the period gives a 1.28 uplift for US consumer prices (albeit this is not directly applicable) giving a cost of US$ 3.3 M (G$ 660 M) at 2005 prices. This suggests that a current price of around G$ 750 M (US$ 3.75 M) should be assumed for rehabilitation of the existing main drainage system. This is about 190 % of the cost of the priority works identified by the Council and thus seems of the right order of magnitude.

Whilst the details of which particular locations in the drainage system require rehabilitation may have changed it is expected that the current scale of rehabilitation required will be similar (if not more).

The cost of rehabilitating the secondary system is not known, so a proportion of the cost of the primary system has been assumed. In the ASP D&I Rehabilitation Feasibility Study the primary system rehabilitation costs were on average around 25 % of the total costs. However use of this proportion is not considered appropriate as that project concentrated on agricultural land where the primary system was in a fair condition but the secondary system was in a very poor condition. It is judged that at this stage rehabilitation of the secondary system should be assumed to be 50 % of the cost of primary system rehabilitation. This gives a cost for secondary rehabilitation of around G$ 325 M (US$ 1.9 M). Thus rehabilitation of both the primary and secondary system is estimated to cost around G$ 1,075 M (US$ 5.65 M). The implementation of these works has been divided between the Short and Medium Term to give a realistic, achievable work programme for the short term of G$ 150 M (US$ 750,000).

As a comparison, the report by Muntz et al [13] suggested costs for rehabilitation of Can $ 3M (US$ 2.4 M) for the Primary System, Can $ 2.5 M (US$ 2.0 M) for the secondary System and Can $ 2 (US$ 1.6 M) for the Tertiary System giving a total of G$ 1,200 (US$ 6 M). Which compares well with the above estimate.

The cost of long term works to expand the capacity of the existing system cannot be determined at this stage. Work to assess the feasibility of options is required (Package 13). It is not unreasonable to assume that a similar amount is required in the long term for improvements to that allowed in the medium term for system rehabilitation. Therefore a further G$ 1,075 M (US$ 5.65 M) has been assumed for long term improvements to Georgetown drainage.

Georgetown Municipality
Works Identified for Emergency, Short and Medium Term

Nr	Description	Cost (G$M)	Priority	Procurement
1	Cleaning of alley drains and roadside drains in Lacytown/Bourda	14	Ongoing	
3	Cleaning of alley drains and roadside drains in Queenstown	4	Ongoing	
4	Cleaning of alley drains and roadside drains in Charlestown	8	Ongoing	
6	Rehabilitation of mobile Hydraflow pump	3	Ongoing	
8	Maintenance of Cummings Canal (Downer Canal to Dem. River	6	Ongoing	
9	Desilting of Church Street Canal	6	Ongoing	
13	Cleaning and desilting of street drains and alleyway drains, North East La Penitence	4	Ongoing	
22	Cleaning of alley drains and roadside drains in Charlestown	8	Ongoing	
25	Clean and repair storm water sewer between Lamaha and Church Streets	6	Ongoing	
33	Cleaning and desilting of street drains and alleyway drains, Robbtown, and Ave of the Republic	1.5	Ongoing	
	sub-total	**60.5**		
10	Desilting street drains and alleway drains, Kitty	18	short	Contractor
15	Cleaning and desilting of street drains and alleyway drains, Werk en Rust	11	short	Contractor
16	Cleaning and desilting of street drains and alleyway drains, South Ruimveldt Gardens	9	short	Contractor
17	Cleaning and desilting of street drains and alleyway drains, Campbellville	20	short	Contractor
18	Cleaning and desilting of street drains and alleyway drains, Wortmanville, Bel Ar park, Atlantic Ville & Bourda	10.5	short	Contractor
19	Maintenance of Main Canals (Cummings, Downer, North Road, South Road, Cane View, North Ruimveldt sideline, L	20	short	Contractor
26	Clean and desilt old clogged 40 ' façade drain parallel to railway and public road, betweenDowner Canal & Industry	18	short	Contractor
32	Cleaning and desilting of street drains and alleyway drains, Mc Doom	2	short	Contractor
36	Cleaning and desilting of street drains and alleyway drains, Lamaha Gardens	6	short	Contractor
37	Cleaning and desilting of street drains and alleyway drains, Preshad Nagar	8	short	Contractor
41	Maintenance works	5	short	Engineer's dept.
42	provision of culverts (100)	40	short	Council work force &Contractor
43	Public Awareness programme	10	short	Contractor
	sub-total	**177.5**		
2	Cleaning of alley drains and roadside drains in North & South Cummingsburg	5	medium	
5	Replacing culverts to improve drainage of Main Street	4	medium	
7	Cleaning and maintenance of Sussex St Canal (Mandela Ave to Dem. River)	6	medium	
11	Desilting of alleyway drains, Kingston	7	medium	
12	Cleaning and desilting of street drains and alleyway drains, North Ruimveldt	14	medium	
14	Cleaning and desilting of street drains and alleyway drains, Stabroek	7	medium	
20	Rehabilitation of Kitty Pump Station	20	medium	
21	Rehabilitation of Sussex St. sluice	10.5	medium	
23	Replacing defective culverts & bridges, East la penitence, Lodge Housing scheme, Tucville	6	medium	
24	Cleaning and desilting of street drains and alleyway drains, Ave of the Republic, Tiger Bay, Atlantic ville, Cummings	15	medium	
27	Cleaning and desilting of street drains and alleyway drains, Werk en Rust -Newburg Wards	7	medium	
28	Cleaning and desilting of street drains and alleyway drains, Lodge (between Vlissingen Rd and Mandela Ave, Hadfie	6.5	medium	
29	Cleaning and desilting of street drains and alleyway drains, meadow Brook Gardens, Lodge Housing Scheme	7	medium	
30	Clean and desilt street and roadside drains in Tucville	13	medium	
31	Cleaning and desilting of street drains and alleyway drains, Festival City	10	medium	
34	Cleaning and desilting of street drains and alleyway drains, West La Penitence	12	medium	
35	Cleaning and desilting of street drains and alleyway drains, Kitty	10	medium	
38	Cleaning and desilting of street drains and alleyway drains, Bel Air Gardens & Bel Air Spring	4	medium	
39	Cleaning and desilting of street drains and alleyway drains, Subrayanville	3	medium	
40	Cleaning and desilting of street drains and alleyway drains, Alexander Village	2.5	medium	
	sub-total	**169.5**		
	Grand Total	**407.5**		

Packages Nr 4 to 8: Regions 2,3,4,5 and 6 Drainage Improvement Project

Background

Regions 3, 4 and 5 experienced the worst of the flooding in the coastal areas with Regions 2 and 6 being more fortunate that rainfall was significantly lower in those parts of Guyana. In all Regions drainage infrastructure is in need of rehabilitation following years of neglect to varying degrees with Region 2 generally acknowledged to have the better maintained of the Region's systems. The degree of rehabilitation required will depend heavily on the strategy adopted for rehabilitation – in particular the areas chosen for rehabilitation, the priorities between agricultural and settlement drainage and the extent of rehabilitation proposed. Hence only very broad brush cost estimates can be considered based on previous studies and the likely scale of potential investment possible in the short and medium term.

In 2000 a D&I Masterplan was prepared [11] which carried out rapid-reconnasiance inspections of the D&I infrastructure and developed outline costs for their rehabilitation and proposals for a phased programme of rehabilitation. This led under the Agricultural Sector Programme (ASP) to the development of feasibility studies, designs and tender documents for nine areas in Regions 3, 4 and 6 covering over 100,000 acres, references [3] and [4] being just two of a suite of documents produced. The cost of this rehabilitation work was estimated to be about US$ 17.1 M (Engineer's Estimate). The intention is that these works will be carried out using funds from the IDB loan for the Agricultural Sector Support Programme (ASSP).

Aims and Objectives

The aims of this Package are:

- To improve drainage to agricultural land and settlements in the coastal area
- To implement long term improvements to the drainage system

The objectives of this package are:

- To undertake a strategic programme of rehabilitation and improvement works in the short, medium and long term focussing on drain cleaning, removal of bottlenecks in the system , rehabilitation of sluices and pump stations and long term improvement works

Benefits

The benefits of the Package will be reduced incidence and severity of flooding in the Regions giving rise to the benefits described in Chapter 4.

Scope of Works

Overall Scope

The scale of potential rehabilitation and modernisation set out in Masterplan for the D&I Declared Areas was US$ 47.56 M at 2000 prices, about US$ 54 M at current prices. The costs were evenly spread between Regions 3, 4, 5 and 6 but with the rehabilitation for Region 2 comprising about 2/3 of the cost of other Regions. The table below summarises the investments proposed in the Masterplan.

Masterplan
Declared Areas

Region	Earthworks	Structures	Pump Stations	Total	%
2	1.86	1.61	1.4	4.87	14
3	3.08	4.25	0.4	7.73	22
4	3.1	3.48	1.9	8.48	24
5	4.66	0.97	0.6	6.23	18
6	5.2	1.25	1.15	7.6	22
			sub-total	34.91	100
			Less already being done under other projects	-3.5	
			sub-total	31.41	

Modernisation

4	2.58	1.45		4.03
5				1
6	4.29		3.51	7.8
			sub-total	12.83
			Design & Supervision	4.32
			Total	48.56

The proportions of the above costs between irrigation and drainage works is not known. Old water control legislation set out the following proportions for setting rates: Flood Control: Primary Irrigation: Secondary Irrigation: Primary Drainage : Secondary Drainage in the ratios 1:2:4:4:6 / 17 suggesting the drainage accounted for about 60 % of the total D&I cost needs. Experience in development of designs for the ASSP confirm this approximate proportion. This suggests that an investment in drainage of over US $ 30 M is required.

However it is clear that before detailed works proposals can be developed an overall drainage and flood control strategy needs to be developed for a consistent approach across the five Regions building on the Masterplan and the ASP work.

Region 2

About G$ 20 M (US$ 100,000) of works is planned in Region 2 under the Immediate Works. A further G$ 275.9 M (US$ 1.38 M) has been identified as priority works by engineers in the RDC, though the basis of these proposals has not been reviewed. The works proposed by the RDC are set out below

Programme of Works Proposed by RDC	**Cost (G$M)**
South Head, Itribisi Conservancy	4.5
Onderneeming Outfall- timber revetment	7.3
Unu Creek Relief - embankment raising	1.8
La Union - reactivate relief structure	1.4
Capoey - timber revetment	4.5
Capoey Relief Creek - raising of embankment	2.5
Mainstay Relief - desilitng drain and raising embankment	2.5
Huis't Dieren - drain excavation, embankment raising	0.22
Huis't Dieren - embankment raising	1.04
Huis't Dieren - desilting relief drain	0.109
Crozier Pump Station replacement and rehabilitation of outfall channel	200
Rehabilitation of Itribisi embankment	50
Total	**275.9**

The scale of works would require them to be carried out under both the Short and Medium Term.

The details of proposed works would need to be developed as part of the strategy proposed for Package 14. At this stage the costs of rehabilitation set out in the Masterplan (excluding modernisation) have been assumed uplifted by 1.13 to current prices. Thus the total rehabilitation cost for Region 2 is estimated to be G$ 1100 M (US$ 5.5 M), with G$ 300 M (US$ 1.5 M) being carried out in the Short and Medium Term.

Region 3

Significant works were carried out under the Emergency Works. The details of proposed works would need to be developed as part of the strategy proposed for Package 14. At this stage the costs of rehabilitation set out in the Masterplan (excluding modernisation) have been assumed uplifted by 1.13 to current prices. Thus the total rehabilitation cost for Region 3 is estimated to be G$ 1740 M (US$ 8.7 M), with G$ 450 M (US$ 2.25 M) being carried out in the Short and Medium Term.

Region 4

Significant works were carried out under the Emergency Works. A further G$ 207 M (US$ 1.04 M) has been identified as priority works by engineers in the RDC, though the basis of these proposals has not been reviewed. The works proposed by the RDC are set out below:

Programme of Works Proposed by RDC Region 4

RDC Project No.	Village Name	Total Contract Length (rods)	Total Contract Value
5.2.3	Annandale	200	1,000,000
5.2.23	Anns Grove	2,200	7,000,000
5.2.29	Anns Grove	2,200	7,000,000
5.3.11	Anns Grove	-	7,000,000
5.3.13	Anns Grove	100	500,000
5.2.40	Arcadia	370	1,000,000
5.2.9	Bachelor's Adventure	1,000	3,000,000
5.1.17	Bee Hive	2,000	272,000
5.2.1	Beterverwagting	800	3,000,000
5.2.17	Beterverwagting	1,000	4,500,000
5.2.41	Better Hope	1,400	4,300,000
5.1.12	Buxton	2,198	6,594,000
5.2.11	Cove & John	2,364	7,400,000
5.2.34	Craig	100	400,000
5.2.12	Craig Milne	2,200	8,950,000
5.2.13	Craig Milne	-	1,200,000
5.2.24	Crown dam	-	9,000,000
5.2.25	Douch Four	2,200	8,600,000
5.3.14	Douch Four	0	0
5.2.32	Eccles	335	600,000
5.2.20	Enmore	-	4,500,000
5.2.21	Enmore	-	8,000,000

5.3.21	Enterprise	164	328,000
5.3.6	Friendship	-	1,500,000
5.3.5	Friendship Backlands	-	200,000
5.3.9	Golden Grove		
5.3.15	Golden Grove	2,364	7,400,000
5.2.16	Greenfield	-	8,900,000
5.3.12	Greenfield	-	900,000
5.2.30	Herstelling	206	700,000
5.2.31	Herstelling	110	400,000
5.3.4	IMAX	1,800	900,000
5.2.42	La Bonne Intention	1,400	4,300,000
5.2.43	LBI to Success	600	2,000,000
5.2.19	Lusignan to Annandale	1,000	300,000
5.3.20	Melanie	215	430,000
5.3.22	Melanie	150	300,000
5.2.38	Mocha	470	1,050,000
5.2.39	Mocha	940	3,500,000
5.3.1	Nabaclis	2,364	7,400,000
5.3.17	Nabaclis	2,364	7,400,000
5.3.19	Non Pariel	442	884,000
5.2.22	Nootenzuil	250	900,000
5.2.26	Nootenzuil	300	1,200,000
5.2.28	Nootenzuil	250	800,000
5.1.9	Paradise	-	900,000
5.2.5	Paradise	3,000	8,900,000
5.2.37	Pearl	750	3,250,000
5.2.33	Providence	500	1,500,000
5.2.2	Triumph	2,200	8,000,000
5.2.18	Triumph	1,000	4,500,000
5.3.10	Unity	1,583	5,749,000
5.1.18	Victoria	650	884,000
5.2.14	Victoria	2,000	7,400,000
5.2.27	Victoria	1,800	6,900,000
5.3.8	Victoria	26,095	5,219,000
5.3.18	Victoria		8,700,000
	TOTAL		**207,410,000**

In addition it has been proposed that Friendship is another area for consideration in the Short Term. Works there have been estimated to be of the order of G$ 100 M (US$ 500,000).

The details of proposed works would need to be developed as part of the strategy proposed for Package 14. At this stage the costs of rehabilitation set out in the Masterplan (excluding modernisation) have been assumed uplifted by 1.13 to current prices. Thus the total rehabilitation cost for Region 4 is estimated to be G$ 1920 M (US$ 9.6 M), with G$ 300 M (US$ 1.5 M) being carried out in the Short and Medium Term.

Region 5

Significant works were carried out under the Emergency Works. A further G$ 200 M (US$ 1.0 M) has been identified as priority works by engineers in the RDC, though the basis of these proposals has not been reviewed. The works proposed by the RDC are set out below:

Programme of Works Proposed by RDC Region 5	**Cost (G$M)**
Biaboo Creek to Grass Hook - rehabilitation of flood embankment	8
Grass Hook to Bara Bara - construction of flood embankment	20
Rehabilitation of Bara Bara Canal from mahaicony River to First Depth	8
Excavation of Bara bara Canal from First Depth Mahicony to Mahiaca River	118
Construct head regulator at Bara Bara Vanal : Mahaicony River intersection	10
Construct head regulator at Bara Bara Vanal : Mahaica River intersection	10
Construct head regulator at Bara Bara Vanal : Perth Baiboo River intersection	10
Construct head regulator at Baiboo Creek : Mahaica River intersection	8
Construct head regulator at Perth Baiboo Canal : Washclothes Canal intersection	8
Total	**200**

The details of proposed works would need to be developed as part of the strategy proposed for Package 14. At this stage the costs of rehabilitation set out in the Masterplan (excluding modernisation) have been assumed uplifted by 1.13 to current prices. Thus the total rehabilitation cost for Region 5 is estimated to be G$ 1400 M (US$ 7.0 M), with G$ 300 M (US$ 1.5 M)being carried out in the Short and Medium Term.

Region 6

Only about G$ 16 M (US$ 80,000) of works is planned in Region 6 under the Immediate Works.

The details of proposed works would need to be developed as part of the strategy proposed for Package 14. At this stage the costs of rehabilitation set out in the Masterplan (excluding modernisation) have been assumed uplifted by 1.13 to current prices. Thus the total rehabilitation cost for Region 6 is estimated to be G$ 1980 M (US$ 9.9 M), with G$ 300 M (US$ 1.5 M) being carried out in the Short and Medium Term.

Package Nr 9: Conservancy Maintenance Equipment Contract

XX Details to follow

Package Nr 10: Infrastructure Rehabilitation Unit

Background

To plan, manage and procure the programme of works, services and goods will require a competent dedicated organisation. It is not considered that there is sufficient capacity within existing government organisations to take on that role as well as carrying out their normal duties. Hence the establishment of an Infrastructure Rehabilitation Unit for that specific purpose is essential. It is proposed to be run along similar lines to the Task Force for Infrastructure Rehabilitation. Further details of its composition is contained in Chapter 6.

Scope of Services

The services will comprise the employment of staff to run the IRU in the short and medium term along with administrative support staff, transport, office accommodation and running costs. The size of the IRU will vary as workload varies. It is intended that some staff on the Management Team will be drawn from government ministries – NDIB and City Engineer's department, others will be independent consultants such as some committee members whilst others could be drawn from local and international consultants.

The cost of establishing and running the IRU is estimated at G$ 72 M (US$ 360,000) for the Short Term and G$ 217 M (US$ 1.08 M) in the Medium Term.

Package Nr 11: Boerasirie Water Conservancy Dam and Flood Relief Design & Supervision

Background

The Boeraisire Conservancy in Region 3 was constructed in the late 19th century and extended to its current design in the 1950s to provide flood protection and water supply to the coastal area of Region 3. It has a total catchment of 436 km^2, the conservancy itself covers a vast area of about 254 km^2 at the elevation of its main spillway crest. The conservancy dam runs for some 41 miles. It provides flood protection to an area of some XX km^2 (acres) and a population of about XX.

In the January 2005 floods the conservancy dam was not breached. However overtopping to a shallow depth did occur primarily along low areas of the north east dam between Leonora and Naamryck and it is a matter of extreme good fortune that such overtopping did not result in a major breach. These areas are known to be low and have experienced overtopping during floods in recent years. As in 2005, this overtopping fortunately did not cause breaching. Temporary repairs using timber had been carried out following those floods. Part of the low area have subsequently been built up using clay bags under the Emergency Works however sections of the dam remain low. A crest level survey of the dam is not available to identify the extent of raising required.

The January 2005 flood emphasised the need for effective management of the conservancy and to do so requires a better understanding of its hydraulic response to rainfall events. It also highlighted the need for rehabilitation of the conservancy dam to an acceptable minimum standard.

Other than its low crest level the Boerasirie Conserancy dam is generally acknowledged to be in a reasonable structural condition. This is confirmed by inspections carried out by Mr Chris Wagner, Dams Specialist to the TFIR [2] and also by Mr Andrew Kirby in 2003/2004 under the Agricultural Sector Programme (ASP).

Dr Robin Wardlaw carried out hydrological and water resource analysis of the conservancy under the ASP [3] and subsequently undertook preliminary modelling of the conservancy for the TFIR, the latter being described in the Report on Conservancy Flood Management Modelling [1]. Analysis of water level records from the January 2005 flood showed that water levels in much of the conservancy (from Naamryck round to Potosi) were considerably higher than water levels at the western end of the conservancy (Waramia) where the major flood relief structures are located. This suggests that internal conservancy waterways between the two are constricting flow and that the conservancy is not getting the full benefit of the western relief structures (Waramai Relief Sluice and the 8,000 ft weir). The modelling showed that the conservancy does not act as a level pool of water. The Report also highlighted the fact that the 8,000 ft weir is not acting at its design capacity due to vegetation growth. This, along with the restricted waterways led to the situation identified in the report that “were the weir functioning properly the Boerasirie Conservancy would have been able to accommodate the January 2005 flood without overtopping”.

The Report on Conservancy Flood Management Modelling [1] recommended pseudo-2 dimensional modelling of the conservancy in order to determine the size of internal waterways required to pass flow to the relief structures. This would require data on the conservancy from hydrographic survey. The modelling would also allow determination of the need for additional or modified relief structures. The report also recommended an assessment of whether it is feasible to adequately maintain the 8,000 foot weir to its design discharge or whether additional flood relief capacity is required.

Aims and Objectives of the Intervention

The aims of the intervention are twofold:

- to allow better water level management of the conservancy by the BWCB
- for the Government of Guyana to be in a position to procure the works required to raise the standard of the conservancy's dam and flood relief structures up to an acceptable minimum standard

The objectives of the intervention are:

- to have sufficient hydrographic survey data to undertake reliable modelling of the conservancy
- to determine the required design cross section of internal waterways to evacuate flood water to the relief structures
- to determine the requirements for adequate flood relief
- to have sufficient crest level data to allow the design of dam raising works
- to prepare designs for dam raising
- to prepare designs for excavation of internal waterways
- to prepare designs for modifications to existing relief structures or the design of new structures (if required)
- to prepare tender documents for the works identified

Benefits of the Intervention

The benefit of the intervention will arise from the sound technical assessment of flood control in the conservancy. This will allow investment in flood control to be prioritised and targeted at the highest need and greatest benefit. It will avoid the construction of unsuitable or inadequate works and avoid the waste of investment in works that are not needed or are of low priority.

These Services are required to achieve the benefits of improved flood control on the Boerasirie Conservancy (see Package Nr 1). The benefits of improved flood control on the Boerasirie Conservancy arise from the reduction in the risk of dam breaching and overtopping which would lead to significant risk of loss of life and extensive economic loss. Overall benefits are those described in Chapter 4.

Quantification of the direct and indirect economic benefits of the intervention is beyond the scope of this plan however these benefits will affect XX people over an area of XX acres.

Services Required

Topographic Survey

Topographic survey along the crest of the dam is required to determine which sections of the dam require raising and by how much. A survey on the East Demerara Conservancy by Lands and Surveys is partially complete. The EDC survey comprised spot levels on the crest at 300 ft (100m) intervals with the level of temporary bagwork walls also identified. A similar survey for the Boerasirie Conservancy is proposed.

The total length of the dam is approximately 56 km (35 miles). The section of dam between Leonora and Naamryck (9,900 m, 32,400 ft) has already been surveyed at 100 foot intervals prior to construction of dam raising works along that section. The length of the dam to be surveyed is therefore approximately 46 km. Some section of the dams, particularly the western flank (Leonora to Waramia) and the eastern end (Spilllway to Potosi) are quite heavily bushed and there progress will be slower than elsewhere. The cost of survey is estimated to be G$ 1.2 M (US$ 6,000). The survey could be procured by the IRU on a lump sum basis from local surveyors or consultants. An alternative would be a direct appointment negotiated with the Land and Surveys Commission as was carried out under the Emergency Works.

Hydrographic Survey

Hydrographic survey is required within the conservancy to provide data for conservancy modelling. Two types of survey would be carried out.

Conventional surveying would comprise taking a series of sections through the conservancy to determine general ground levels. To obtain a representative ground profile about 8 sections totalling some 80 km in length would be required. This would be carried out across swampy terrain with significant bush cutting required for sight lines. It may be possible to survey parts of the conservancy using GPS though the degree of tree cover in many parts of the conservancy would prevent its use throughout. However it is also understood that there may be no GPS equipment in Guyana at present. Handheld GPS may be a low accuracy option. Other ground surveying techniques such as low level laser (LIDAR) survey which can be carried out from small planes and cover large areas such as the conservancy is unlikely to be appropriate as its signal would be interrupted by vegetation cover and give false elevation readings. The cost of survey is estimated to be G$ 3.2 M (US$ 16,000).

Hydrographic surveying would survey the main internal waterways of the conservancy so their hydraulic behaviour can be modelled. This could be carried out by conventional soundings of the waterways to obtain representative cross sections at say 2 km intervals. An alternative would be to use echo sounding which would provide much more data and would be quicker to achieve. Sea Defence's echo sounder and boat has been used during the Emergency Works to survey parts of the waterways in the East Demerara Conservancy and it is recommended that this is used on the Boerasirie. It is estimated that up to about 60 km of waterways would be surveyed. The cost would need to be agreed with Sea Defence. The cost for provision of vehicle, boat, equipment, survey team and fuel is estimated to be of the order of G$ 1.0 M (US$ 5,000).

Flood Modelling

Flood modelling would require the construction of a computational model of the conservancy. This would use data from the hydrographic survey and would be combined with the preliminary modelling carried out by Dr Wardlaw. It is envisaged that the model would be pseudo-2 dimensional comprising the internal waterways modelled as channels interlinked with each other by storage cells which would represent low ground in the conservancy between the channels with water spilling into and out of the storage cells from the waterways and rainfall within the conservancy represented by inflows into the storage cells. The hydraulic performance of the relief structures and boundary conditions have already been developed [1]. A model of the existing situation would be developed and calibrated against the January 2005 floods. Options for improvements would then be modelled to determine: the impact of improving flow conditions at the 8,000 ft weir, the required width of waterway between Naamryck and Waramia, required dimensions of an additional relief structure, required dimensions of an overtoppable embankment as well as combinations of the above options.

The flood modelling could be carried out independently of the design of the improved flood control measures however it would be better if it were integrated into the design process as the development of designs will be an iterative process.

During the Emergency Works NDIB engineers and engineers of some local consultants were trained by Dr Wardlaw and Mr Anthony Badcock in hydraulic modelling using the software program HYDRO-1D. The East Demerara Conservancy has been modelled using this software as has the initial modelling of the Boerasisire Conservancy so for continuity it is recommended that this initial work is built upon. It is recommended that the modelling is carried out by Dr Wardlaw in collaboration with the local engineers already trained. It is recommended that they are also involved in preparing the specification for the hydrographic survey to ensure adequate but not excessive data is collected.

The cost of flood modelling is estimated to be G$ 5.0 M (US$ 25,000)

Design and Tender Documents for Improved Flood Control Measures

The design of improved flood control measures would focus on the following options:

- improving the hydraulic conditions at the 8,000 ft weir
- widening the waterway between Naamryck and Waramia
- construction of over-toppable embankment sections
- construction of an additional relief structure
- modification of other existing structures and channels for relief e.g. the use of Salem, Hubu or Maripa Main Drains or the abandoned sluice at Potosi.
- raising of low sections of embankment

A combination of options may present the most cost effective solution. An outline design and budget cost for each option would be developed along with an assessment of its benefits for flood control. This would lead to the agreement of a preferred option which would be developed into a detailed design. Tender documents would be prepared for the preferred option.

It is recommended that these services are procured by competitive bidding by international consultants working in association with local consultants. The cost of design services is estimated to be G$ 28 M (US$ 140,000).

Package Nr 12: Design of East Demerara Conservancy Improvements

Background

The northern part of Guyana suffered exceptionally unusual very heavy rainfall in January and February of 2005. This rainfall was considered to have a return period of in excess of 1000 years and led to significant flooding in areas in and around the capital Georgetown. The extreme rainfall also led to concerns about the risks of overtopping of the East Demerara Water Conservancy Dam (EDWC), resulting in its potential failure. Subsequent assessment of these dams by an expert from UNDP indicated that, irrespective of the risks of overtopping, lengths of these dams were poorly constructed or due to lack of maintenance over time had questionable integrity.

The rehabilitation of the conservancy dams was at the initial assessment stage envisaged to be undertaken in three phases:

- Emergency Works up to the end of May/June to ensure that the conservancy dams would not be at risk of overtopping, leading to possible failure, in the coming (2005) wet season;
- Medium Term Works, targeting those aspects and lengths of the dams which were considered to be at most risk of potential failure due to overtopping or slope instability;
- Long Term Works to ensure the long term integrity of the conservancy dams.

As part of the study of the Emergency Works, a dams specialist undertook an inspection of the conservancy dams [2]. A plan showing the location of the conservancy dams is given in Appendix B. This inspection indicated that lengths of the conservancy dams may or was likely to have marginal stability. The most critical conservancy dam was considered to be the North-East Dam, with a length of about 8 miles between Non-Pareil and Flagstaff. Previous large slope failures had occured in specific locations along this dam and deep excavations at the downstream toe of this dam also raised considerable concerns about its integrity.

In addition, due to previous slips, there were also doubts about the integrity of both the North Dam between Nancy Stop-off and Non-Pareil, and the East Dam between Flagstaff and Maduni Relief Sluice.

The concern with respect to these conservancy dams relates to the major consequences in the event of a failure of any length of the dams. These consequences are the potential loss of life and major economic consequences in terms of downstream flooding and loss of water both for irrigation and the main source of Georgetown's domestic water supply. In this context the March 2005 Inspection [2] indicated that the dams did not meet recognised international standards in relation to both their importance and also risk to life.

Aims and Objectives of the Intervention

The aims of the intervention are twofold:

- to allow better water level management of the conservancy by the BWCB

- for the Government of Guyana to be in a position to procure the works required to raise the standard of the conservancy's dam and flood relief structures up to an acceptable minimum standard

The objectives of the intervention are:

- to have sufficient hydrographic survey data to update the preliminary modelling of the conservancy
- to determine the requirements for adequate flood relief either in terms of new/rehabilitated structures or additional excavation of internal waterways to evacuate flood water to the relief structures
- to have sufficient site investigation data to undertake a reliable assessment of the stability of the conservancy dam
- to assess the feasibility of dam reconstruction between Non Pareil and Flagstaff along different alignments
- to broadly assess the likelihood and feasibility of implementing the Mahaica-Mahaicony-Abary (MMA) Project Phase III, to obviate the need for dam re-alignment
- to have sufficient site investigation data to undertake the feasibility assessment of dam re-alignment
- to prepare designs for improving the stability of the existing dam (if required)
- to prepare designs for excavation of internal waterways, for modifications to existing relief structures or the design of new structures (if required)
- to prepare tender documents for the works identified

Benefits of the Intervention

The benefit of the intervention will arise from the sound technical assessment of flood control in the conservancy. This will allow investment in flood control to be prioritised and targeted at the highest need and greatest benefit. It will avoid the construction of unsuitable or inadequate works and avoid the waste of investment in works that are not needed or are of low priority.

This intervention is required to achieve the benefits of improved flood control on the East Demerara Conservancy (see Package Nr 2). The benefits of improved flood control on the East Demerara Conservancy arise from the reduction in the risk of dam breaching and overtopping leading to the following benefits:

- reduced the risk of loss of life to people in Region 4
- reduced risk of flood damage to agricultural land
- reduced risk of flood damage to infrastructure in Region 4 (roads, D&I systems, power, telephone, sewage, hospitals, schools

- reduced risk of flood damage to residential property and contents
- reduced risk of damage to businesses
- reduced risk of health problems arising from flooding
- confidence to live, work and enjoy life
- confidence to invest in the Region

Quantification of the direct and indirect economic benefits of the intervention is beyond the scope of this plan however these benefits will affect XX people over an area of XX acres.

Scope of Services

General

The Short Term Works should be considered as a first stage of the Medium to Long Term rehabilitation of the conservancy dams and any proposed works for the Short and Medium Term should link into any Long Term measures. As a result the studies and designs to be carried out should include sufficient examination of the most favourable long term options to the extent to ensure that there is no reciprocation or later redundant structures. In this context Medium to Long Term solutions identified to date include:

- Construction of replacement new dam downstream of existing dam, Non Pareil to Flagstaff;
- Reducing the storage requirements, and hence the water loadings on the dams, by the development of the Mahaica-Mahaicony-Abary Stage II & III Project involving new storage to the south-east of the existing conservancy.
- Rehabilitation or reconstruction of all the conservancy dams as may be appropriate dependent on stability analyses;
- Improving flood relief

These solutions are inter-related and to develop the most appropriate combination of solutions will require the collection of data, assessment of the feasibility of the solutions and preparation of designs. It is therefore proposed to divide the services into the following items/phases:

- Topographic survey
- Site investigation
- Feasibility study
- Detailed design and tender documents

Topographic Survey

Topographic survey of the dam crest level has been undertaken by the Lands and Surveys Commission.

Cross –section survey of the existing dam between Non Pareil and Falgstaff is required to provide data to establish the extent of the existing slips and excavations at the downstream toe and thus the detailed extent of dam that needs to be replaced. This would comprise cross sections at every 300 ft intervals. This interval should reduce where known significant slips have occurred or where there are deep excavations at the downstream toe. The cross section surveys should extend for 60 ft downstream of the existing downstream toe of the dam.

A similar topographical survey should be undertaken of the Crown dam between Non Pareil and Falgstaff as data for feasibility and design of a replacement embankment. The survey should also include the alignments of the required wing embankments to tie into the existing conservancy dam.

A similar topographical survey of the dam between Nancy stop off and Non Pareil and between Flagstaff and Maduni should also be carried out as data for assessment of the stability of these dams. Cross sections at 600 ft intervals, except at known locations of slips or movement where a closer spacing should be adopted.

The cost of the above topographic surveys of the dam is estimated at G$ 3.8 M (US$ 19,000).

Hydrographic survey of the EDWC will also be required to provide data for conservancy modelling. Two types of survey would be carried out.

Conventional surveying would comprise taking a series of sections through the conservancy to determine general ground levels. To obtain a representative ground profile about 8 sections totalling some 80 km in length would be required. This would be carried out across swampy terrain with significant bush cutting required for sight lines. It may be possible to survey parts of the conservancy using GPS though the degree of tree cover in many parts of the conservancy would prevent its use throughout. However it is also understood that there may be no GPS equipment in Guyana at present. Handheld GPS may be a low accuracy option. Other ground surveying techniques such as low level laser (LIDAR) survey which can be carried out from small planes and cover large areas such as the conservancy is unlikely to be appropriate as its signal would be interrupted by vegetation cover and give false elevation readings. The cost of survey is estimated to be G$ 4.4 M (US$ 22,000).

Hydrographic surveying would survey the main internal waterways of the conservancy so their hydraulic behaviour can be modelled. This could be carried out by conventional soundings of the waterways to obtain representative cross sections at say 2 km intervals. An alternative would be to use echo sounding which would provide much more data and would be quicker to achieve. Sea Defence's echo sounder and boat has already been used during the Emergency Works to survey parts of the waterways in the East Demerara Conservancy and it is recommended that as part of the Short Term Measures that the survey is extended within the Conservancy. It is estimated that up to about XX km of waterways would be surveyed. The cost would need to be agreed with Sea Defence. The cost for provision of vehicle, boat, equipment, survey team and fuel is estimated to be of the order of G$ 1.4 M (US$ 7,000).

All the above topographic survey works should be carried out for the feasibility study. Additional topographic survey would be required during detailed design but provisional amounts for this have been included within the costs for detailed design.

Site Investigation

A comprehensive programme of hand augering along the potential dam alignment is required for the feasibility study as part of the assessment of the new dam alignment to avoid or minimise the presence of pegasse (peat) in the dam foundation. Tender documents for this work have already been prepared under the Emergency Works. The cost of this Works is estimated at G$ 6 M (US$ 30,000).

Site investigation is also required for the feasibility study to establish soil strata and strengths in order to undertake an assessment of the stability of the existing dam. A programme of boreholes in the crest and downstream toe followed by laboratory testing is proposed. Tender documents for this work have already been prepared under the Emergency Works. The cost of this Works is estimated at G$ 6 M (US$ 30,000).

During detailed design further site investigation may be required to supplement the information obtained. Provisional amounts for this have been included within the costs for detailed design

Feasibility Study

The feasibility study would cover the following four aspects:

- Assessment of the options for replacement of the EDCW dam between Non Pareil and Flagstaff
- Assessment of the stability of the dam between Nancy stop off and Non Pareil and between Flagstaff and Maduni
- Assessment of the need for additional flood relief
- Supervision of the topographic and site investigation

Leading from the first three aspects would be the identification of a costed programme for the rehabilitation/improvement of the EDWC.

The cost of the feasibility study is estimated to be G$ 20M (US$ 100,000)

Options for Replacement of Dam (Non Pareil to Flagstaff)

The March 2005 Inspection identified the EDC dam between Non Pareil and Falgstaff as being in a very poor condition. It was considered that the existing dam was so severely damaged by historic slips, poor maintenance and deep excavations directly at the downstream toe, that remedial works to this structure would be costly and difficult, with the view that an entirely new dam downstream would be more appropriate.

However the new dam may not need to extend over the full length between Non-Pareil and Flagstaff depending on the extent of the existing slips and downstream excavations. This will need be established using data from the topographical surveys.

The most appropriate alignment for a new dam would be established based on the topographic survey of the existing dam and the crown dam and the proposed hand augering.

Since the March 2005 inspection it has been suggested that there might be considerable benefit in aligning the replacement for the existing North-East conservancy dam further downstream along or close to the line of the existing Crown Dam, (which is understood to be mainly founded on clays without the problems of pegasse) and tying this into the existing EDWC embankments system with long wing embankments.

In addition a third option has been raised which is to reduce the water loading on the EDWC dam by construction of a new conservancy upstream. The new conservancy would provide increased storage of water for irrigation and would thus allow water levels in the EDWC to be held at a lower level than at present. This would go a long way to alleviating the two problems of the EDWC: unreliable irrigation supply in dry years and a low standard of flood control in wet years. The concept was proposed at least as far back as the 1950s and 1960s as the third stage of the Mahaica-Mahaicony-Abary Water Control Project [5], known as MMA Stage III. The other two phases are primarily agricultural expansion projects. Stage I, control of the Abary River to develop land between the Mahaicony and Berbice Rivers was completed in the 1980s. It should be noted that Stage III does not depend on the prior implementation of Stage II. The Stage II and III proposals were reviewed and updated in the 1990's as a project profile report to the Inter-American Development Bank [7] but have not received funding .

Thus there are three broad alternatives to be considered: the selection of the final alignment will depend on a combination of technical considerations (costs, foundation requirements, ease of construction, speed), operational and associated flood risk aspects and environmental impacts (loss of agricultural land). The mechanism for making the necessary decisions needs to be established.

This stage of the services will include:

- Assess the technical feasibility of (1) a new embankment downstream of the North-East Dam; and (2) an alternative dam and associated wing embankments involving the downstream Crown Dam, based on the results of initial hand auger exploration work and the topographic survey work. This study will also take into account the loss of farming land, as the location is moved further downstream from the existing North-East Dam.

- Broadly review and establish whether MMA Stage III is a feasible long term alternative to a new dam, identify the risks and timescale for implementation and carry out a qualitative comparison with the other two options

- Cost the three alternatives, including the alternative arrangements for linking into this new dam to the adjacent conservancy dams, including any future storage to the south-east.

- Evaluate the three alternatives in terms of technical, construction, costs and operational considerations (including any loss of agricultural land) and recommend an alignment on technical grounds. Evaluation of MMA III should be primarily on the basis of existing information rather than further assessment or design.

Stability Assessment of EDWC Dam

This would comprise the investigation of the present stability of the North Dam between Nancy Stop-off and Non-Pareil, and the East Dam between Flagstaff and Maduni Relief Sluice. This would be based on site investigations and laboratory testing described in the above section on site investigation. It would entail appropriate slope stability analyses and outline design and costing of remedial measures if required.

Additional Flood Relief Assessment

Dr Wardlaw [1] strongly recommended that an additional outlet structure should be provided on the EDWC to permit evacuation of the 10,000 year flood. Proper design of such a structure would need the development of the existing conservancy model to assess options.

An assessment of requirements for additional flood relief would require the relatively straightforward modification of the existing computational hydraulic model of the conservancy. This would use data from the hydrographic survey described above and would use the preliminary conservancy model developed by Dr Wardlaw in association with NDIB and local consultants. It is envisaged that the modified model would be pseudo-2 dimensional comprising the internal waterways modelled as channels interlinked with each other by storage cells which would represent low ground in the conservancy between the channels with water spilling into and out of the storage cells from the waterways and rainfall within the conservancy represented by inflows into the storage cells.

The hydraulic performance of the relief structures and boundary conditions have already been developed [1]. A model of the conservancy in its condition during the January 2005 floods would be developed from the initial model to calibrate the modified model.

The impact of the Emergency Works can then be modelled - rehabilitation of the Kofi and Cunha sluices and outfall channels and the clearing of waterways within the conservancy and an assessment can then be made whether further flood relief works are required to ensure the safety of the dam.

The flood modelling could be carried out independently of the design of the dam and any flood relief improvements arising from the modelling however it would be better if it were integrated into the design process as the development of designs will be an iterative process.

Relatively modest inputs are required to undertake this modelling and it can be undertaken by local engineers from NDIB and local consultants who have already been trained in hydraulic modelling during the emergency works in collaboration with Dr Wardlaw. Economies of scale could be achived by combining this element of modelling with the proposed additional modelling of the Boerasirie Conservancy (Package Nr 11).

From this work outline designs and costs for any flood relief works could be developed. In conjunction with the other elements of the feasibility study it will then be possible to define the required crest level of the conservancy dam.

Supervision of the Topographic and Site Investigation

This would involve:

- Review the site investigation programme in terms of specification and scope of work and amend accordingly;

- Supervise the site investigation fieldwork and initiate the required laboratory testing;
- Supervise the topographic survey

Detailed Design and Tender Documents

The scope, extent and cost of detailed design will depend on the findings of the feasibility study, in general it can be assumed to comprise:

- Finalise the detailed locations of the site investigation boreholes and any remaining topographic survey requirements, and then supervise them.
- Undertake detailed slope stability analyses for the new embankment based on the laboratory testing and design accordingly.
- Design strengthening works for lengths of the North and East dams (provisional).
- Design additional relief structure
- Prepare tender documents including drawings, specifications and bill of quantities. This will be 'provisional' work in the case of any strengthening of the North and East dams depending on the results of slope stability analyses.

Assuming the magnitude of construction works is of the order of G$ 2,400 M (US $12 M), such as a new dam and a relief structure, the cost of detailed design is likely to be of the order of G$ 50 M (US$ 250,000).

Package Nr 13: Design of Georgetown Urban Drainage Improvements

Background

This package of Services provides the necessary strategy, designs and supervision to plan and implement the Georgetown Urban Drainage Improvement Works (Package 3).

The improvement Works Package is divided into Short, Medium and Long Term Works. The Short Term Works will require investigation and inspection of the Council Engineering Department's list of proposed works to confirm that works are the most urgent and that there is joined-up thinking in what is being rehabilitated to ensure that the benefits of carrying out the works are not negated by the neglection of other bottlenecks in the system. In a similar way the Medium Term requires the development of a coherent strategy of rehabilitation to ensure appropriate levels of rehabilitation thoroughout all levels of the system and in order to plan for overcoming the non-technical, socio-political problems associated with drainage in Georgetown. The Long Term Works require feasibility study to examine the options for expansion and improvement of the drainage system

Aims and Objectives of the Intervention

The aims of the intervention are twofold:

- for the Government of Guyana to be in a position to procure a strategic programme of rehabilitation works in Georgetown for the Short and medium Term
- to identify the most feasible option for long-term improvements of the Georgetown drainage system for strategic planning

The objectives of the intervention are:

- to have carried out sufficient inspection and survey of the drainage system to provide the data for development of a plan for short and medium term works
- to develop a well-thought through programme of short and medium term works
- to determine the feasibility of long-term improvements and identify the preferred option
- to prepare designs for rehabilitation of the drainage system in the short and medium term
- to prepare tender documents for the works identified
- to supervise the works to achieve the required standard of technical quality, programme and budgetary control

Benefits of the Intervention

The benefit of the intervention will arise from the sound technical assessment of drainage in Georgetown. Only by such assessment will it be possible for drainage rehabilitation to be prioritised and targeted at the highest need and greatest benefit. It will avoid the construction of unsuitable or inadequate works and avoid the waste of investment in works that are not needed or are of low priority.

This intervention is required to achieve the benefits of the Georgetown Urban Drainage Improvement Works (Package 3). The benefits of which are described in that Package.

Scope of Services

Condition Inspection and Surveys

The Masterplan [9] carried out a condition inspection of the drainage system. This should be updated using rapid appraisal techniques to determine the current state of the system with the primary objectives of confirming the location of bottlenecks, to confirm the layout and general hydraulics of the system and to identify constraints on rehabilitation e.g. location of squatters. The cost of this is estimated at G$ 6 M (US$ 30,000).

Strategy for Short/Medium Term

Using the data from the inspections a basic drainage assessment and design should be carried out to determine the available hydraulic capacity of the primary system post-rehabilitation. A strategy will then be developed for rehabilitating the system to its capacity with the assistance of the City Engineer's department. The strategy will focus on identifying rehabilitation priorities and ensuring that works "join-up" into a complete rehabilitation. The cost of this is estimated at G$ 10 M (US$ 50,000).

Feasibility Study for Long-Term Improvements

A feasibility study will be undertaken to determine the options for long-term improvements to the drainage system. This will focus on the areas known to experience the most severe flooding and those areas where drainage has not kept pace with urban expansion. The cost of this is estimated at G$ 15 M (US$ 75,000).

Institutional Strengthening

Disposal of solid waste into the drainage system is acknowledged to be a problem at a macro-drainage level and to some degree at main drainage level e.g. clogging of pump weed screens with plastic. The City Engineer's department has proposed a public education program. A budget of G$ 15 M (US$ 75,000) ahs provisionally been allowed for this and other similar measures, the details of which would be developed under the Strategy for the Short/Medium Term.

Designs, Tender Documents and Supervision

The scope, extent and cost of detailed design will depend to some extent on the Strategy for the Short/Medium Term. However the design work required is fairly well defined and is likely to include:

- design of drain cleaning
- design of drainage structures (culverts)
- designs for repairs and replacement of outfall sluices
- designs for rehabilitation of pump stations

The cost is estimated to be G$ 15 M ($ 75,000) for the design of short and medium term works, G$ 56.5 M (US$ 282,500) for the supervision of short and medium term works. A nominal amount of 10 % of the cost of the long term works has been allowed for the design and supervision of those works.

Package Nr 14: Regions 2 to 6 Drainage Rehabilitation Design & Supervision

Background

This package of Services provides the necessary strategy, designs and supervision to plan and implement the Drainage Rehabilitation Works in Regions 2 to 6 (Packages 4 to 8).

The improvement Works Packages are divided into Short, Medium and Long Term Works. The Short Term Works will require investigation and inspection to review the high priority proposals put forward by RDC Engineers to confirm that works are the most urgent and that there is joined-up thinking in what is being rehabilitated to ensure that the benefits of carrying out the works are not negated by the neglection of other bottlenecks in the system. In a similar way the Medium Term requires the development of a coherent strategy focussing on drainage including settlement drainage to ensure appropriate levels of rehabilitation is carried out throughout all levels of the system. This needs to go beyond just looking at what infrastructure has deteriorated and requires rehabilitation to assessing long term needs and improvements to the system e.g. linking of façade trenches, increased use of cut-off drains upstream of settlements, outfall sluice and pump station constraints. This work will have a lot of synergies with the D&I Masterplan and the feasibility and detailed designs of the nine areas under the ASSP. However we believe it will be one of the most difficult elements of the services packages to complete adequately owing to the large areas of land involved and the complex drainage system in each village or area. Achieving a systematic and consistent approach based on sound engineering principles will be difficult.

Prior to the start of this package it is essential that the IRU in discussions with GoG and donors establish and agree the boundaries of this package in terms of which areas within the Regions are being considered, what drainage priorities there are e.g. settlement versus agricultural, and the extent to which drainage rehabilitation can be de-coupled from irrigation rehabilitation and agricultural development. Cross-over and co-ordination with the ASSP will be important.

Aims and Objectives

The aim of the intervention is:

- for the Government of Guyana to be in a position to procure a strategic programme of rehabilitation works in Regions 2 to 6 for the Short and medium Term and into the Long Term

The objectives of the intervention are:

- to have carried out sufficient inspection and survey of the drainage system to provide the data for development of a strategy for short and medium term works
- to develop a well-thought through programme of short and medium term works
- to determine the feasibility of long-term improvements
- to prepare designs for rehabilitation of the drainage system in the short and medium term
- to prepare tender documents for the works identified

- to supervise the works to achieve the required standard of technical quality, programme and budgetary control

Benefits of the Intervention

The benefit of the intervention will arise from the sound technical assessment of drainage in the Regions. Only by such assessment will it be possible for drainage rehabilitation to be prioritised and targeted at the highest need and greatest benefit. It will avoid the construction of unsuitable or inadequate works and avoid the waste of investment in works that are not needed or are of low priority.

This intervention is required to achieve the benefits of the Drainage Improvement Works for Regions 2, 3, 4, 5, and 6 (Packages 4 to 8). The benefits of which are described in those Packages.

Scope of Works

Condition Inspection and Initial data Collection

The D&I Masterplan [11] carried out condition inspections of the drainage system. The designs for the nine areas for the ASSP contains detailed information on drainage rehabilitation needs. Regional Engineers have also put forward proposals for rehabilitation. These need to be collated, critically reviewed and inspected to confirm the scope of works, assess the need and to understand the current state of the system. The cost of this is estimated at G$ 10 M (US$ 50,000).

Strategy for Short/Medium Term

Using the data from the inspections a basic drainage assessment and design should be carried out to determine the available hydraulic capacity of the system with the primary objectives of confirming the location of bottlenecks, to confirm the layout and general hydraulics of the system and to identify constraints on rehabilitation. A strategy will then be developed for rehabilitating the systems to target investment at greatest. The strategy will focus on identifying rehabilitation priorities and ensuring that works “join-up” into a complete rehabilitation. The cost of this is estimated at G$ 50 M (US$ 250,000).

Designs, Tender Documents and Supervision

The scope, extent and cost of detailed design will depend to some extent on the Strategy for the Short/Medium Term. However the design work required is fairly well defined and is likely to include:

- design of drain cleaning
- design of drainage structures (culverts)
- designs for repairs and replacement of outfall sluices
- designs for rehabilitation of pump stations

The cost is estimated to be G$ 50 M ($ 250,000) for the design of short and medium term works, G$ 99 M (US$ 495,000) for the supervision of short and medium term works. A nominal amount of 8 % of the cost of the long term works has been allowed for the design and supervision of those works.

Package Nr 15: Equipment for Water conservancy Monitoring and Management

XX Details to follow

Appendix B Location Plans

XX To follow