5.7.4 Methodology

The basic approach to prepare the management plan comprises the following parts:

(1) Reviews of the mitigation plan.

(2) Discussions with engineering staff engaged on the design phase of the Project.

(3) Experience gained through past relevant environmental monitoring activity.

5.7.5 Environmental Management Plan (EMP)

Within the EMP, the engineer's role is to monitor the activities of the contractors and to take action under the terms of the Contract to prevent and minimize the environmental damage. Basically, there are three factors to be considered in order to have an organized and efficient EMP; i.e., (1) the contractors' organization, (2) the resident engineer's organization, and (3) the liaison, coordination and reporting among each section of the Project.

(1) Contractors' Organization.

The tender documents should require the contractor to state his/or her environmental policy clearly. The clear specification of the responsibility for the environmental protection within the contractor's organization is a critical factor for the achievement of good environmental control. It is therefore necessary to ask contractors of submission for their proposals for the environmental management. Basically, this proposal must contain the following items:

a) Clear statement of their environmental policy.

b) Their own organizational framework, in particular, the assignment of an engineer to take overall responsibility, to manage environmental control facilities on a daily basis and to liaise with the resident engineer's monitoring team.

c) Principal pollution control facilities, including procedures of the construction wastes disposal, and of contingency plans in the event of facility failures.

d) Proposed environmental monitoring procedures in order to ensure that facilities are operating satisfactorily and problems are being dealt with promptly.

e) Environmental awareness training programme for the workforce.

(2) Resident Engineer's Organization (REO)

The following arrangement may be necessary when the staffing structure for the Project is finalized. The ultimate responsibility for environmental matters within the REO will rest with the Project Manager (PM), and with the Chief Resident Engineer (CRE) being responsible for daily direction and management. It will be necessary to have an Environmental Monitor (EM) who will be able to make occasional visits to sites, and a full-time local Assistant Environmental Monitor (Assistant EM) who will be responsible for daily monitoring of the Projects. The Environmental Monitor (EM) should have suitable experience in environmental management.

The followings are the brief description of the responsibilities of each team member.

a) Environmental Monitor (EM)

The EM has to act on two different levels. Firstly, he/or she has to give overall advice and define the general procedures which will include environmental reports. Secondly, he/or she will be involved in the establishment of the daily monitoring procedures. The followings are major tasks for the EM, and first three (a – c) belong to the first level, and remaining tasks (d – p) to the second level.

a. To review and make him/or herself familiar with the EMP, including advice on:
   - The environmental management framework.
   - Reporting and liaison requirements.
   - Key environmental issues.
   - Monitoring strategy.
   - Data management.
   - Environmental control measure.

b. To carry out periodic environmental audits of the Project in order to:
   - Identify any deficiencies in environmental performance and advise how to to address these.
   - Assess the degree of compliance with the EMP achieved on site.
   - Review the continuing relevance of the EMP in the light of experience, and instigate changes where appropriate.
   - Review the organization and administrative frameworks for the environmental management.
   - Review environmental monitoring data and its management.
   - Review environmental problems which have arisen and how these have been dealt with.
   - Propose changes to the environmental management procedures and framework and identify the need for additional measures to control environmental degradation.

c. To provide ad-hoc advice on environmental issues to the PM, CRE and Assistant EM.

d. To establish an effective environmental monitoring, sampling and analysis programme.

e. To establish routine management, liaison and reporting systems, including the establishment of the environmental database.

f. To evaluate the results of the monitoring programme and to advise the REs of the required action.

g. To prepare routine management reports.

h. To advise the CRE/PM on the contractors' proposals for site establishments in terms of landscape, drainage, erosion control, liquid and solid hazardous waste management, fuel and chemical storage and site restoration.

i. To review the contractors' proposals for pollution control facilities and to advise on its adequacy.

j. To study the mitigation measures proposed by the contractors and to recommend safeguards.

k. To co-ordinate the sampling and analysis programme with a nominated laboratory.

l. To liaise and report on a routine basis with the Mangochi DCs, the Ministry of Works and Supplies (MOWS), and with the Ministry of Research and Environmental Affairs (MOREA).

m. To train and support the Assistant EM.

n. To recommend the procurement of the equipment required for the environmental monitoring.
o. To advise on the need for expert assistance.

b) Assistant Environmental Monitor

The followings are the fundamental routine tasks for the Assistant EM:

a. To undertake environmental monitoring through site inspections on a daily basis and to notify the EM/or the REs of any problems.
b. To conduct the routine sampling and analysis programmes, and to take ad-hoc samples when necessary.
c. To look after the environmental monitoring equipment and to advise the EM or REs of defects, problems or replacement/or additional requirements.
d. To assist the EM in the analysis of results, preparation of reports and with other duties as required.
e. To be responsible for the daily management of the database system to be established.
f. To liaise with the local communities and to act as a channel for their concerns.

Occasionaly, the Assistant EM has to take over the tasks f, g, k and l of the EM's, summarized earlier.

(3) Liaison, Co-ordination and Reporting

a) Liaison with the Contractors

The Assistant EM will attend a weekly site meeting with the relevant contractors' staff and address environmental shortcomings arising there. From the contractor's side, the attendance of the senior manager and the engineer responsible at the environmental protection would be preferable for this meeting. From the consultant's side, the EM or Assistant EM and the RE/or CRE will attend. These meetings should be minuted.

b) Liaison with Central Government.

As mentioned above, the Assistant EM will prepare a short monthly report for submission to the relevant ministries such as the MOWS and

the MOREA, and will be available to attend progress meetings when required.

c) Liaison with the Local Community

Liaison with the local community will be important during the construction period in order to ensure that their views are being taken into account and that problems and nuisances such as noise and dust are reduced to the minimum. All complaints must be recorded, and also, these records should show what action was taken, and when, and what monitoring is necessary.

d) Consultant's Internal Co-ordination and Reporting

The Environmental Monitoring Team will prepare a monthly report, which should not be lengthy, but will summarize issues carried over from the previous report, stating whether they have been resolved or are on-going, and new issues arising. This should be included in a general monthly progress report to be submitted to the MOWS. It is not envisaged that formal meetings will be required for the internal management of the environmental programme, and that ad-hoc meeting would be adequate.

(4) Environmental Management and Audit Programme

The first several months of the construction phase will be important for the EMP establishment. It is anticipated that the Programme should be audited annually, but that the first audit should be carried out after six months in order to review the establishment of the management systems and procedures. The processes of environmental management should be continuously evolving and improving as the Project proceeds.

5.8 Environmental Monitoring

5.8.1 Introduction

The main objectives of the environmental monitoring are to provide a continuous feedback on Project implementation to identify actual or potential successes/or problems at an early stage, and to implement timely adjustments to the whole Project management works. Monitoring is a continuous assessment of Project

implementation and must be an integrated part of good management by the engineer during the construction.

5.8.2 Objectives

The objective of the monitoring system is to assist the Project management through:

(1) Defining requirements and procedures for the environmental monitoring (type of equipment to be used, monitoring schedule, parameters to be monitored and so on).

(2) Identifying targets and objectives for the Project implementation.

(3) Keeping environmental records for the Project evaluation.

(4) Identifying problems arising from the Project, and figuring out procedures for the environmental remedies in the event of pollution or similar incidents.

(5) Providing readily available results of related environmental analysis for decision making.

5.8.3 Scope of the Monitoring Plan

The scope of the monitoring plan is:

(1) To identify the monitoring tasks to be undertaken by the EM during the construction phase.

(2) To identify the nature and the schedule of the monitoring.

(3) To identify samples to be taken for analysis and parameters to be measured.

5.8.4 Methodology

The basic approach to prepare the monitoring plan has comprised:

(1) Reviews of the mitigation plan discussed in the previous chapter, and in particular, of the monitoring requirements identified for the construction phase of the Project.

(2) Discussions with engineering staff engaged in the Project design and planning.

(3) Consideration of the environmental monitoring experience.

5.8.5 Environmental Monitoring

The aim of the monitoring plan is to develop a cost-effective approach to monitor the contractors' environmental performance. Certain parameters (e.g., water quality and so on) can be monitored through measurements, and others can only be monitored through observation (e.g., cutting of trees). Careful observations made through this monitoring work, established by a forward planning, is a key part for a successful environmental management to prevent problems (or at least to limit their effects).

Baseline data to be summarized in this Project will help to define the requirements for the site restoration and provide a basis for the comparison of effects during the construction. A post Project audit should be carried out to examine the success of the site restoration and to evaluate the effectiveness of the mitigation measures adopted.

5.8.6 Monitoring Requirements

The monitoring requirements of the Monitoring Programme were identified in the Mitigation Plan. The engineer should be responsible for the monitoring of the activities of the contractor, and the EM and the Assistant EM should assist the engineer in the monitoring which requires measurements, based on the responsibilities listed in previous chapter.

The monitoring activities can be divided into the following two groups; one which can be carried out through measurement, and one which will be carried out through observation. Figure 5.1 shows the suggested relationship between the Client, the engineer and the contractor's teams.

Table 5.10 provides more detailed descriptions of the activities to be undertaken for each of the monitoring requirements. It is strongly recommended that corresponding clauses should be developed for inclusion in the bid documents. The monitoring requirements for the water quality, noise and dust etc, will be the responsibility of the EM.

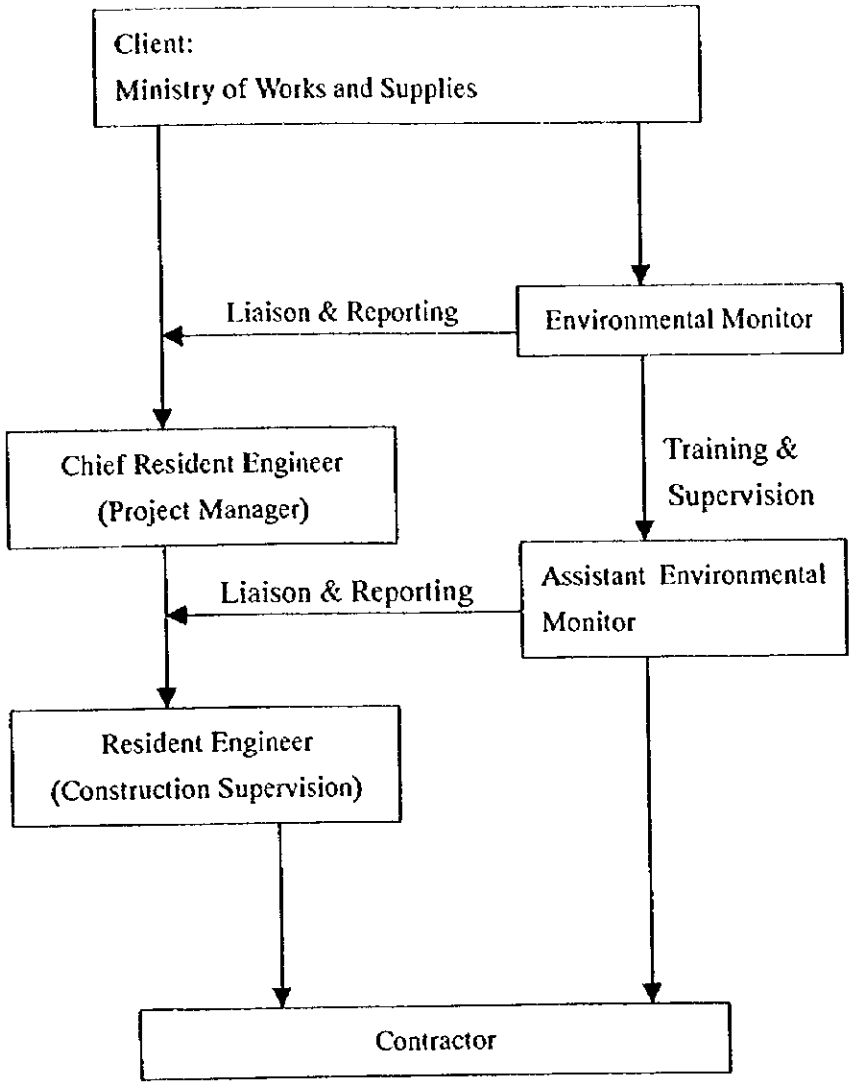

Figure 5.1 Relationship among the Client, the Engineer, Environmental Monitor and the Contractor

Table 5.10 Monitoring Activities and Indicators

Monitoring Issue	**Monitoring Method**	**Positive Indicator**
Soils	The engineer should make a daily inspection of earth works, and ensure that slopes are suitably graded. Once earthworks are complete, the engineer should monitor restoration measures implemented by the contractor, such as revegetation or use of geotextiles.	Absence of rills, gullies or other erosion features.
Vegetation	The engineer should ensure that excessive clearance of vegetation is avoided. Contractor must seek approval of engineer prior to clearance.	Area of vegetation to be cleared minimized.
Animals	The engineer should carry out regular inspections of animal intrusion evidence onto the site. If animal intrusion onto the site becomes a significant problem, consultation should be carried out with the National Park and Wildlife Department.	Animal damage to site to be reduced to a minimum.
Birds	No monitoring required.	
Fish	The engineer should monitor the contractor's procedures for preventing polluted water from flowing into the Shire River. The Environmental Monitor shall take water samples from the Shire River.	No dead fish found at riverbanks, and maintenance of the river water quality.
River Morphology	The engineer should monitor the generation of lagoons or sand-bars, and measure the riverbed elevation at the up/down-streamside of the new bridge route for safe bigger of larger sized ships.	Generation of new lagoons or sand bars. Secure safe navigation route and make local water flowing smooth flowing.
Land Take	The engineer shall ensure the contractor gives advance warning of any land take or demolition. The Ministry of Works and Supplies shall arrange compensation for land loss where necessary. New houses shall be built prior to demolition.	Land take and demolition minimized.
Health	The engineer must ensure that the contractor has liaised with relevant government bodies and that the education and awareness campaigns are implemented.	Reduction of Bilharzia and malaria diseases recorded at hospital and medical clinic.
Education	The Ministry of Works and Supplies should liaise with the relevant government departments to ensure that additional funds and teaching staff are available prior to the commencement of the works.	Construction work force children to receive education.
Road Safety	The engineer should monitor the condition of trucks arriving at the site and keep a record of night driving.	No road accidents related with Project. Night driving kept to minimum.
Fisheries	The engineer should monitor the procedures of the contractor and ensure that pollution (sediment or chemicals) does not enter the Shire River. The Environmental Monitor shall take water samples.	Water quality in river maintained, and no complaints from local fisheries.

Monitoring Issue	Monitoring Method	Positive Indicator
Historical/ Cultural/ Archaeological	The engineer should inspect all excavations or earthworks around historical monuments, and where archaeological remains are found work must stop until the engineer gives the all clear to proceed. The engineer should contact the National Antiquities Department in the event of the relocation of *the Gun from HMS Guendolin* or in the event of a significant archaeological find.	Historical monuments not disturbed. Archaeological remains not excavated or disturbed.
Quarry	The engineer should inspect borrow pits to ensure that they have been properly filled/graded/or restored after excavation.	Pits left so that water cannot accumulate.
Energy	The engineer must inspect the provisions made by the contractor to supply energy to the workforce, and ensure that fuelwood is not being collected illegally.	Energy supplied by electric generator or other suitable source.
Noise	Noise measurement should be carried out at the center and the boundaries of the work site, and at the nearest sensitive receiver.	Noise levels at the nearest sensitive receiver should not exceed the level suggested in Appendix E.
Air Pollution	Observations should be made on the level of dust generated during the construction activities. Damping down should be carried out if levels are unacceptable. Further details on the method to be used are provided in the following sections.	Deposition of dust on surfaces should decrease with increased dampening.
Water Resources	The engineer should inspect provisions made by the contractor to provide the construction workforce and local residents with drinking water during the construction period. The water intake works should be moved upstream from the proposed bridge.	Clean water supply shall maintained throughout construction period.
Landscape	The engineer should make a visual inspection of earthworks to ensure that excessive excavation is not being carried out. Temporary screening may be appropriate in some cases.	Landscape alteration to be reduced to a minimum.
Complaints	The engineer should inspect the record of complaints made by local residents, (to be kept by the contractor), and should check that action is taken quickly and that the number of complaints does not rise significantly.	Number of complaints decreases.

(1) Water Quality

It is essential to have regular water quality tests during the construction phase of the Project in order to check the water quality pumped from excavations and discharges from the construction sites, and to monitor the effects of any localized pollution due to human activities and spills.

Monitoring of the ambient water quality will determine whether there are likely to be problems for downstream users, whereas monitoring of the

effluents will help to identify the source of the problem and the appropriate remedial action to be taken. Parameters to be monitored should reflect the type of contaminants likely to be detected. For example, contamination caused by the concrete may be detected through increased pH levels.

Ad-hoc water sampling shall be taken during the course of the construction as required. Some parameters can be directly measured on site whereas others will need to be sent to the laboratory for analysis. Arrangements should be made with the laboratory to ensure that correct bottles and preservatives are used. Direct reading instruments are available for field measurement (e.g., pH, temperature, conductivity and dissolved oxygen). Sometime, calibration procedures may be necessary prior to testing, and it is recommended to purchase multiple sets of instruments of same type for the quality assurance, and for the back-up in the event of equipment failure.

Portable incubating equipment should be used in the event of sample collection for microbiological analysis for fecal coliforms determination. This apparatus can aiso be used for oil and grease measurements. Samples should be taken in flowing water as far from the riverbank as possible.

(2) Noise

The purpose of noise monitoring is to limit the nuisance to the local residents and the workforce, and the noise should be measured frequently during the construction. Potential sources of noise include heavy construction plant and vehicles. An ad-hoc approach should be taken, depending on the type of activities in progress and their location on site in relation to the sensitivity receivers. Background noise level must be measured before the Project commencement.

(3) Dust

The objective of dust monitoring is once again to control the nuisance to both local residents and the workforce on site. Monitoring at site should be located in areas where there are sensitive receivers. Generally, the dust generation is most severe along unpaved access roads and at areas where loose materials are handled (e.g., industrial waste sites, stockpiles etc). Based on these facts, the monitoring station sites should be determined.

The parameter to be monitored is the weight of the dust accumulated within a specific time period (one week – 1 month). The background dust level must

be measured before the Project commencement, and remedial measures shall be taken where more than a 50 % increase in the background dust level occurs.

(4) River Bed

Due to the enlargement of the river cross-sectional area caused by the removal of the east-side embankment, the effect of the scouring observed under the present conditions will be lessened and sedimentation will occur to some extent. Based on this fact, a long-term riverbed monitoring survey around the preferred route option should be done regularly, and as well checks on the regional riverbed variation .

5.8.7 Manpower and Budgeting

It is envisaged that the engineer will carry out the construction environmental monitoring programme as a part of the Contract. The EM will be employed on a full-time basis. The Assistant EM will be full-time, and will report to the engineer, and the EM. The cost of implementing the monitoring plan will include the full-time salary of the EM and the Assistant EM. It may be necessary to employ an international environmental expert for the initial training of EMs and for him/her to subsequently attend at audit time. The estimated cost of this monitoring plan implementation will be summarized as the environmental protection cost in the next section.

5.9 Environmental Protection Costs

Environmental protection costs are of two types: components of the bridge construction works (e.g., drains, vegetation), and technical support. Generally, the cost of direct environmental protection measures such as drainage works is included in the estimation of the direct construction cost. Here, the cost for the later item is summarized.

The environmental technical support for the Project consists of the following five components: (1) hiring environmental personnel, (2) local consultation, (3) training and co-ordination meetings, and (4) facilitation.

The local consultation consists of developing and implementing a briefing for contractor personnel, and preparation/or implementation of workshops for local officials. The estimated cost of this item is 354,000 Malawi Kwacha.

The training and meeting coordination involve workshops, and quarterly gatherings for exchanging information and compatible decision-making by officials and expert in different departments. These costs are estimated at 156,000 Malawi Kwacha.

An additional 100,000 Malawi Kwacha is recommended for facilitating activities miscellaneous activities, and diverging Project activities, which include environmental monitoring.

The total cost of the environmental technical support for this new Mangochi Bridge project, including a 10 percent contingency allocation is estimated at 671,000 Malawi Kwacha.

Table 5.11 Cost Estimates of the Environmental Program for the New Mangochi Bridge Project

Item	Unit Price [MK]	Q'ty	Amount [MK]
Hiring Environmental Staff			
Environmental Monitor	50,000	1 person/yr×2 yrs	100,000
Assistant EM	40,000	1 person/yr×2 yrs	80,000
Short-Term Consultation Services			
Contractor Crew Briefing on-site		L.S.	30,000
Workshop Preparation/Implementation	36,000	4	144,000
Training and Meeting Co-ordination			
Workshop Participants	1,500	20 persons, 4 meetings	120,000
Coordination Meetings	600	15 persons, 4 meetings	36,000
Facilitation (L.S.)		L.S.	100,000
Base Technical Support and Assistance	*	*	610,000
Physical Contingency (10 percent).	*	*	61,000
Total	*	*	671,000

Note: Unit price of "training and meeting coordination" is taken from the technical report, entitled "Selected Rural Roads Development Project, Republic of Malawi, 1996".

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CHAPTER 6 CONSTRUCTION PLAN AND COST ESTIMATES

6.1 Construction Conditions

6.1.1 Construction Materials

The main materials necessary for the Project at the Mangochi Bridge are cement, coarse and fine aggregate for concrete, structural steel, reinforcement bar and prestressing cable. Such materials appear to be good in quality and adequate in quantity except for the steel products.

(1) Fine Aggregate for Concrete

The source of river sand to be used for concrete will be the river bed at the Nakundu river located 40 Km from the construction site.

(2) Coarse Aggregate for Concrete

The source of coarse aggregate to be used for concrete will be rock from the Chius Hill at the Chingo village located about 4.0 Km from the construction site. This rock will necessitate blasting and crushing to create a suitable aggregate.

(3) Cement

Production capacity of the cement factory ("The Portland Cement Company (1974) Limited") at Blantyre, located about 180 Km from the construction site is 120,000 tonnes per year, its to be used mostly for substructures concrete.

Cement for the superstructure concrete will be imported and will be Rapid Hardening Portland Cement.

(4) Steel Products

Steel materials such as reinforcing bar, prestressing cable, structural steels and steel pipe pile will be imported.

6.1.2 Conditions for Construction on the Works

(1) Climate

The weather patterns of Malawi are divided into the dry season, between May

and October and the wet season with rain being intermittent during the remaining months. Most of the rainfall occurs between December and March.

The Following is a summary of meteorological date measurements at the Mangochi Meteorological Station.

1) Mean temperature 25℃

Max, monthly mean	30 – 34℃	in September – December
Min, monthly mean	14 – 17℃	in May – August

2) Mean rainfall

1-5 mm in May – September
10 –15 mm in October
40 – 60 mm in April and November
150 – 220 mm in December – March

3) Wind: Wind directions are influenced by the course of the Shire River, and are generally from south and north. The strongest winds occur in mid year.

January; prevailing winds from S.N. up to 8 knots
July; prevailing winds from S, SE, SW. up to 12 knots
October; prevailing winds from S.N. up to 10 knots.

(2) Workable Day

In the case of construction works, non-working days caused by rough winds and rainfall are based on verbal information given by the local contractors. Non-working days are generally the days with over 20 knots of wind velocity or 25mm rainfall per day. The total number of workable days per year is approximately 320 days.

In Malawi, the fiscal year is set from April to March, and holidays for the construction works are set as follows;

Sunday	48 days
Public Holidays	12 days
Total	60 days

Besides non-working days due to the weather conditions, 60 extra days are subtracted for Sunday and public holidays, and the net workable days are assumed to be 260 days per year or 21 days per month.

(3) Contractors Registered in Malawi

The registered contractors are classified into three main categories according to the capability of the contractor. The classification of contractors are as follows:

- The K2.0 million Category

  These are small contractors who can only handle works amounting below K2.0 million. Their capabilities are small and their work is limited to maintenance of buildings and other small infrastructures. In most cases, these contractor are local indigenous Malawians.

- The K5.0 million Category

  This category is composed of contractors capable of performing jobs in value ranging up to K5.0 million. In most cases, these contractors are foreign owned, usually by local foreign residents.

- The Unlimited Category

  These contractors can handle any job inclusive of small and medium works. They are composed of locally based firms owned by expatriates or are subsidiaries of foreign owned companies.

All together there are 55 contractors registered, 27 of which are in the K2.0 million category, 2 in the K5.0 million category and 25 registered in the unlimited category. Of all the registered contractors, 16 were Malawian nationals, 23 local foreign residents and 16 were international companies.

Almost all of the registered contractors, operate in the buildings sector. With Large civil works are presently carried out by international companies.

6.1.3 Construction Method

The Mangochi Bridge will be a pre-stressed concrete bridge with a single box girder. The Structure is to be constructed in the following manner;

(1) Foundation and Substructure

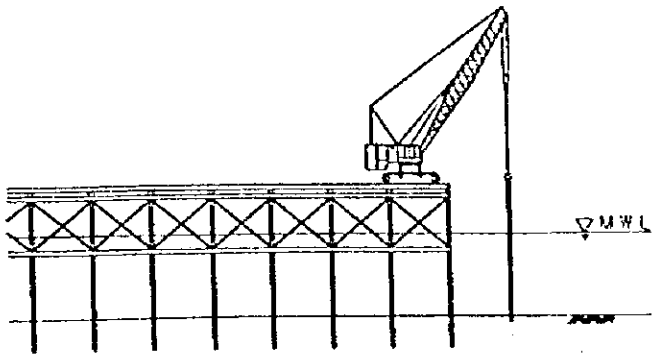
Prior to construction of the substructure a temporary landing stage composed of a combination of H type piles will be erected with a crawler crane in order to approach the pier position and to install a coffer dam using double H type sheet. Next, the working chamber of the open caisson will be set, and the open caisson will be forced to sink gradually to the required depth using a pulling jack. After completion of the foundation, the pier body will be constructed.

(2) Superstructure

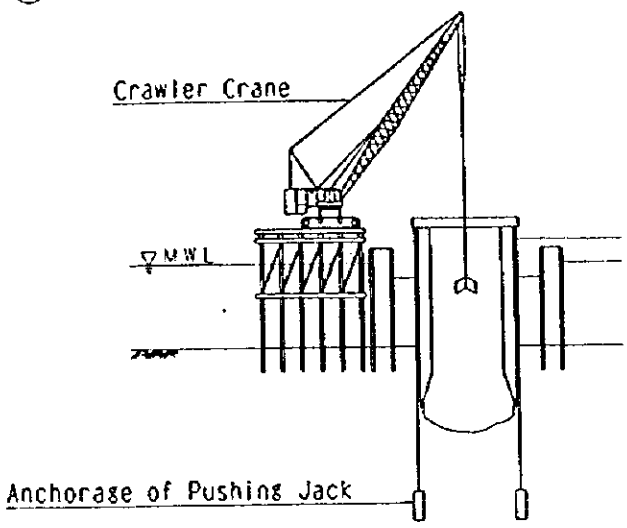
The superstructure is to be erected by the balanced cantilever erection method, in which travelling form work will be used in building each segment of the box girder. After construction of the cantilever superstructure will be extended from each pier, the key segment of the center portion will be subsequently cast in sites to rigidly connect both extended cantilever.

These construction stagse are illustrated in Figure 6.1 and 6.2.

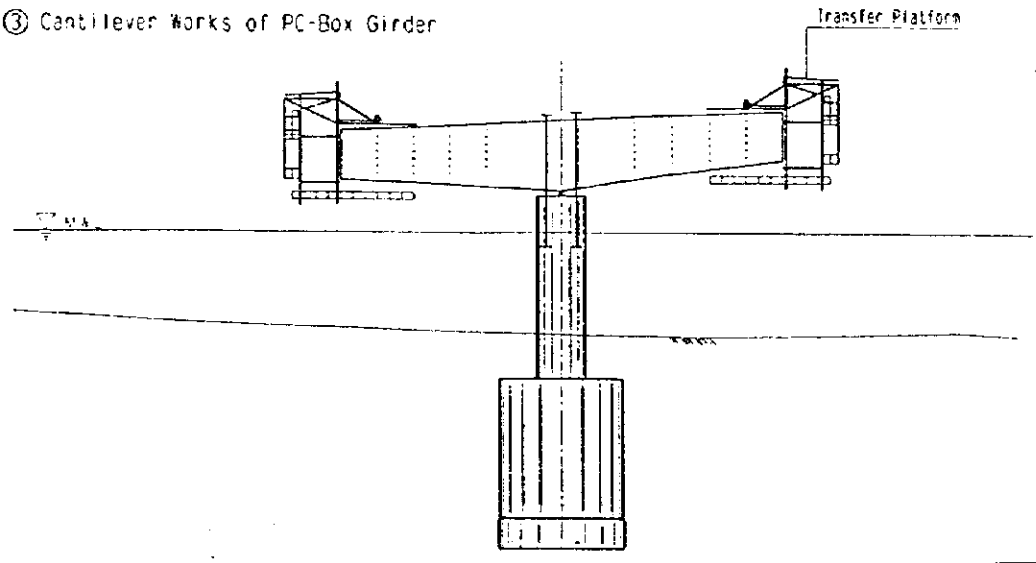
① Temporary Landing Stage Works



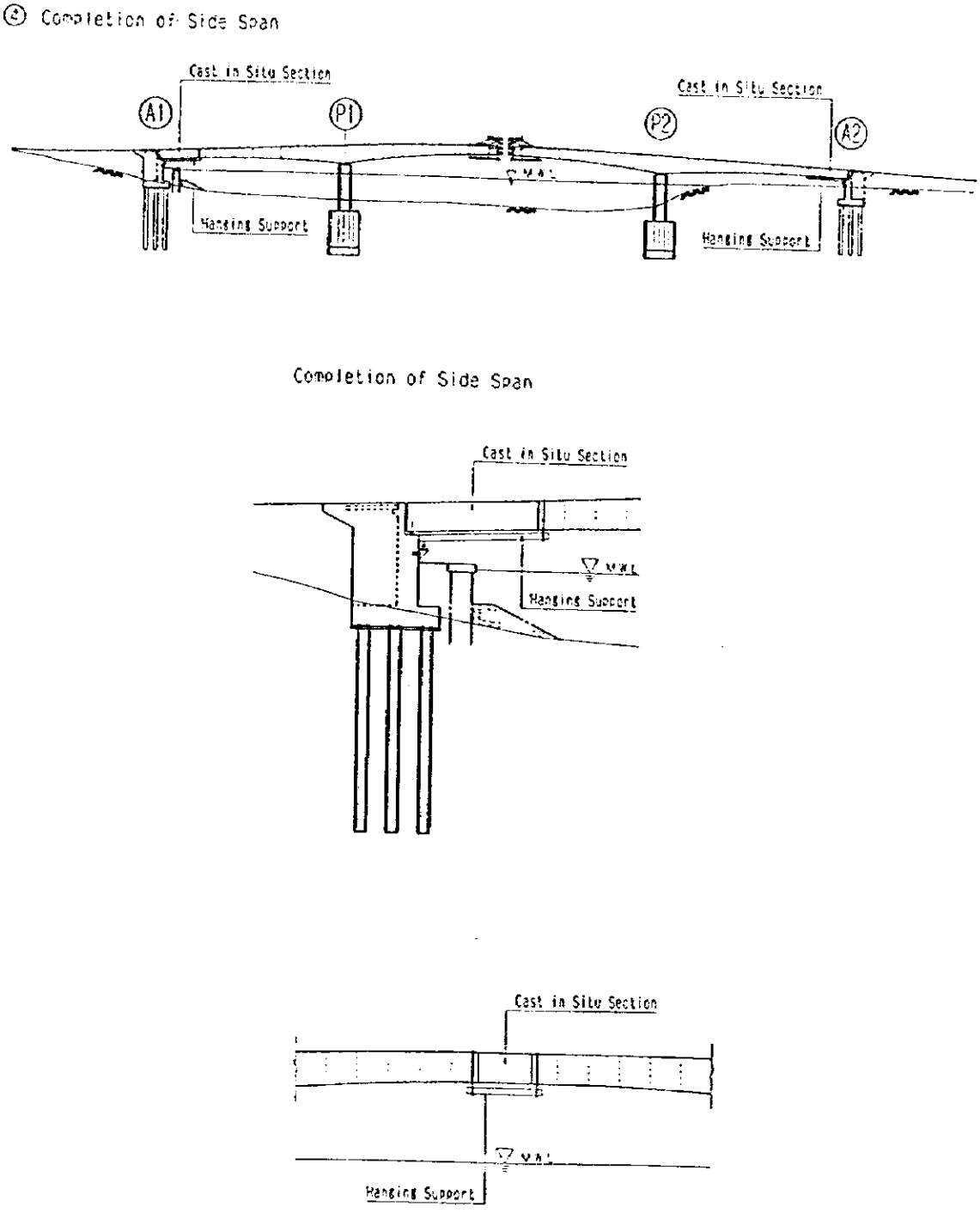
② Open Caisson Works



③ Cantilever Works of PC-Box Girder



The Feasibility Study on the Reconstruction of Mangochi Road Bridge in Republic of Malawi	Figure 6.1 Construction Method of Mangochi Bridge



The Feasibility Study on the Reconstruction of Mangochi Road Bridge in Republic of Malawi	Figure 6.2 Construction Method of Mangochi Bridge

6.2 Cost Estimates

6.2.1 General

The Project cost estimate consists of the construction cost, the detailed design and supervision cost, the non-eligible costs (land acquisition and compensation costs, taxes, duties, and MOWS's administration cost), and contingencies. The basic components of the Project cost estimate are shown in Figure 6.3, considering the following assumptions.

(1) The cost estimate is calculated at the price level as of the end of March 1998.

(2) The foreign currency exchange rates are assumed to be ;

US$1.0=Yen 128.70
Malawi Kwach=Yen5.27

(3) Materials and equipment, which cannot be procured in Malawi, will be generally to be imported from South Africa and Japan.

(4) It is assumed that the Project construction will be undertaken by an international contractor selected in a competitive tender under the supervision of an international consultant.

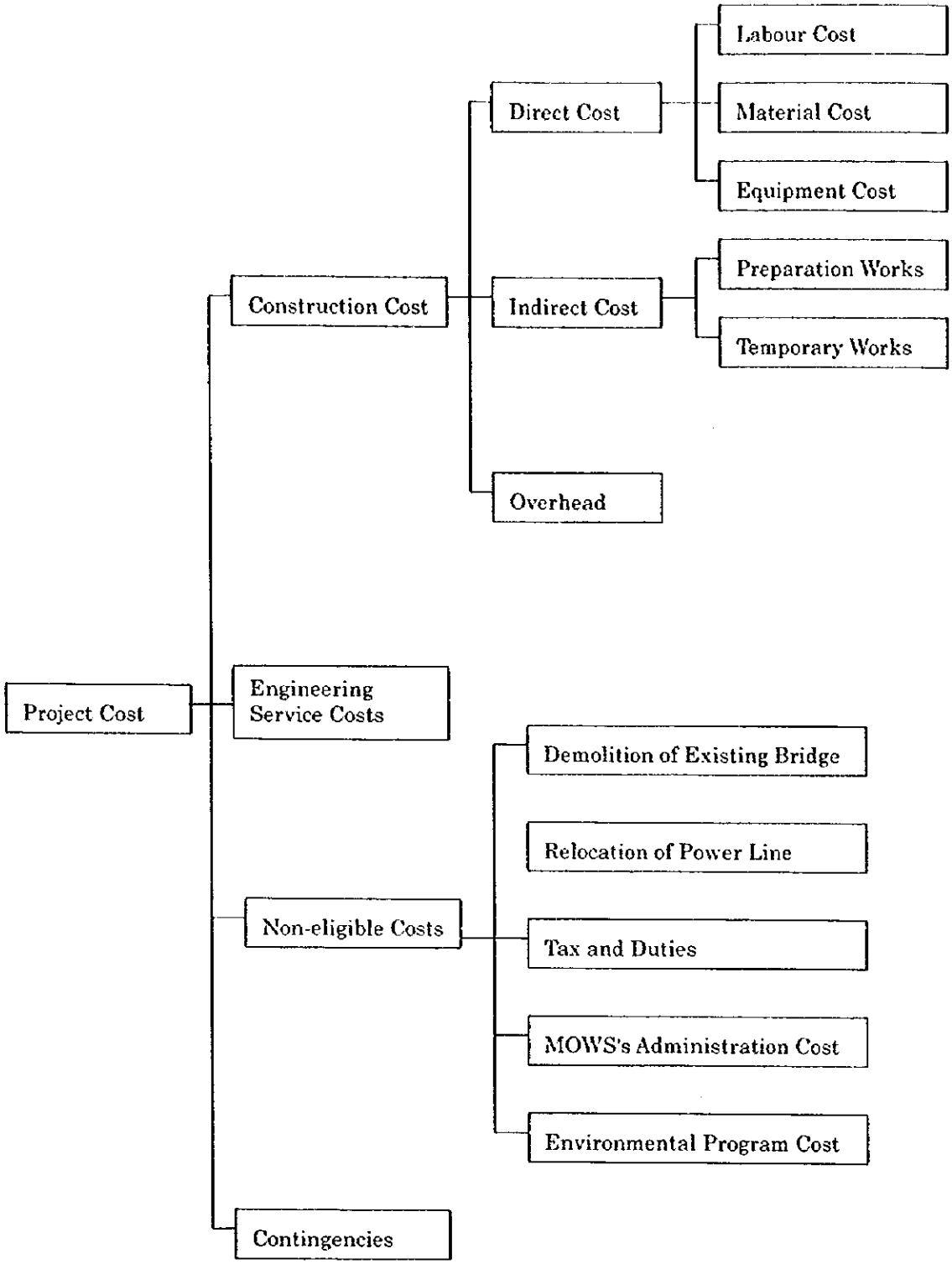
6.2.2 Construction Cost

The construction cost is estimated based on the basic design philosophy studied in 4.4.

The construction cost consists of direct cost, indirect cost, and overhead as described bellow :

(1) Direct Cost

The direct cost consists of labour, materials and equipment costs. Labour will be recruited in Malawi and supervised and trained by foreign experts. The wages of labour per day are used as those of contractors who carry out the bridge and road works for MOWS.



The Feasibility Study on the Reconstruction of Mangochi Road Bridge in the Republic of Malawi	Figure 6.3 Basic System of Project Cost Estimation

Equipment costs are estimated based on a depreciation rate during the workable days per year at the site. Life year, depreciation ratio, maintenance ratio and management ratio for each piece of equipment are as per the relevant Japanese standard.

Materials, that are not produced locally or are of insufficient quality are likely to be imported from South Africa or Japan.

(2) Indirect Cost

The indirect cost consists of the preparatory works and temporary works. The estimated cost of the preparatory works is obtained from a summation of the development of yards including reclamation and roads in the site, provision of the site facilities for the contractor and the resident engineer's staff, and transportation costs.

(3) Overhead

The overhead costs consist of the contractor's supervision, general overhead, profit for headquarters, and insurance, including indemnification of the principal against property damage and public risk. The overhead cost is assumed as 10% of the direct cost.

6.2.3 Engineering Service Costs

The engineering service costs consist of the detailed design and supervision costs undertaken by a engineering consultant.

6.2.4 Non-Eligible Cost

The non-eligible cost consists of the demolition of the existing bridge, relocation of the power line near the existing bridge, taxes and duties and MOWS's administration cost which will be provided by the Malawi Government.

(1) Demolition of the Existing Bridge

After completion of the new Mangochi Bridge, the existing bridge should be demolished with a view to reducing the river flow disturbance caused by the substructure of this bridge. This will lessen the influence of scour at downstream location of the new bridge. As an intake facility for water is installed on the first pier of the old bridge at the Mangochi city side, it is expected that the first span of the old bridge together with the first pier will

remain. The demolition of the old bridge is expected to be undertaken by the Malawi Government.

Table 6.1 Demolition Cost of the Existing Bridge

Description	Number of Structure	Cost (US$)
Superstructure	5 set	12,000
Substructure	4 set	16,000
Total		28,000

(2) Relocation of the Power Line

The alignment of the new bridge is located just downstream of the existing bridge on which a power line is installed. It is necessary therefore that the Malawi Government relocate this facility before commencement of the new bridge construction works.

Table 6.2 Relocation Cost of the Power Line

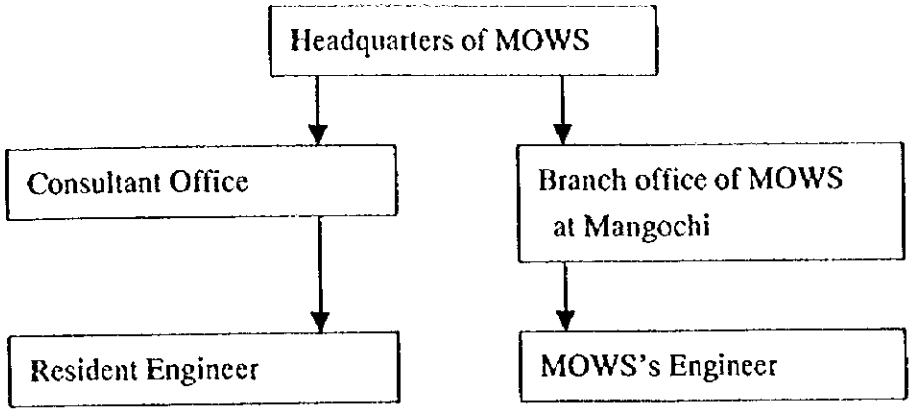
Description	Number of Structure	Cost (US$)
Power Line	1 set	6,000

(3) Tax and Duties

Import taxes of construction materials and equipment are levies on the CIF (Cost, Insurance & Freight) prices when the materials and equipment are imported to Malawi, provided always that if the materials and equipment be sent back from Malawi after completion of the Project, the taxes will be exempt. Tax ratios of the construction materials and equipment will be levied, based on the tables of "Customs and Excise Act" in Malawi.

(4) MOWS's Administration Cost

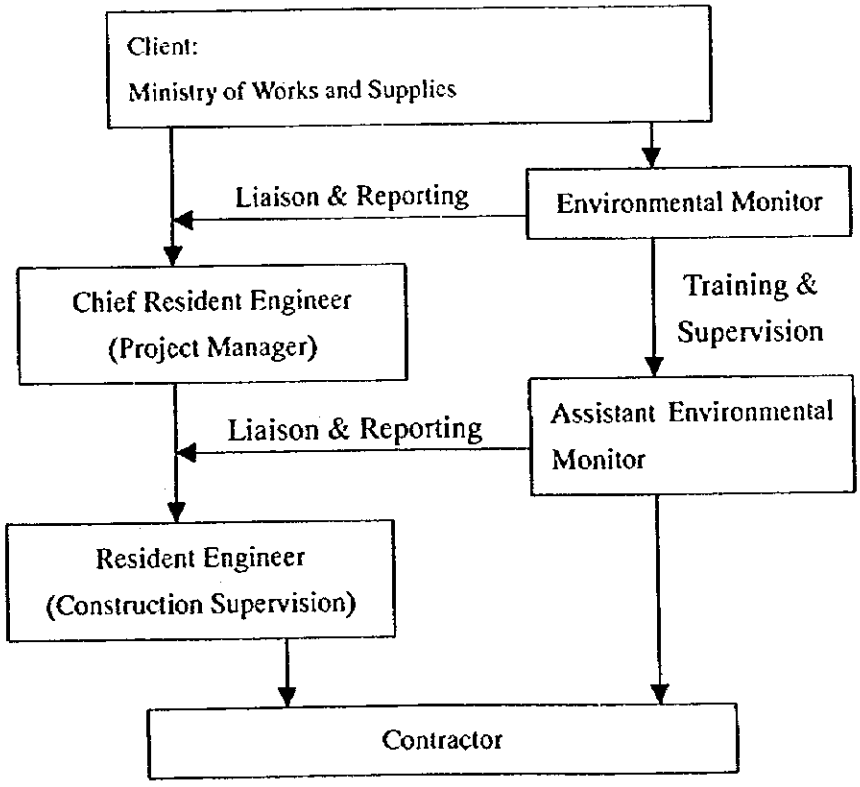
The MOWS will provide staff who have the responsibility for the coordination of the various national input and the management of the Project as the Client. It is assumed that the MOWS's administration cost will be three percent of the engineering service cost in this stage.



The posted MOWS's engineer is to conduct the supervision of the construction works under supervision on assistance by the residence engineer of the consultant to acquire the technical experience at the stage of implementation of the works.

(5) Environmental Program

The monitoring requirements of the Monitoring Program were identified in the Mitigation Plan. The resident engineer should be responsible for the monitoring of the activities of the contractor, and the engineering monitor and the assistant engineering monitor should assist the resident engineer in the monitoring which requires measurements, based on the responsibilities listed in previous chapter.



6.2.5 Contingencies

This cost estimate is prepared based on information available at the Feasible Study stage. It is assumed that the bridge construction will commence in about one year hence. Consequently, an allowance must be considered for the following unknown factors :

1) Economic changes (exchange rate, inflation, etc) in Malawi, Japan and other countries;

2) Changes in the geological condition of the river and work quantities which may occur during the detailed design stage; and

3) Changes in assumptions regarding procurement of materials and equipment.

From an assessment of the above factors involved, the contingency amount is assumed to be a maximum of 10% of the construction cost.

6.2.6 Total Project Cost

The total Project cost was estimated by the procedure described in the subsections 6.2.2 and 6.2.3. The total Project cost is estimated at US$14,668,959(US$9,604,681 for the foreign portion and US$5,064,278 for the local portion) and is summarized in Table 6.3. The detailed breakdown of the construction cost is given in Appendix 8.5.

Table 6.3 Summary of the Project Cost

No	Work Item	Foreign (US$)	Local (US$)	Total (US$)
1)	Construction Cost			
A)	Preparation Works	43,966	698,160	742,126
B)	Temporary Works	349,425	94,220	443,645
C)	Bridge	5,072,424	2,446,138	7,518,562
D)	Approach Road	106,936	497,570	604,506
	Total(1)	5,572,751	3,736,088	9,308,839
2)	Engineering Fee	1,312,209	68,243	1,380,452
3)	Non-Eligible Cost			
3.1	Demolition of the Existing Bridge	0	28,000	28,000
3.2	Relocation of the Power Line	0	6,000	6,000
3.3	Taxes and Duties	1,807,199	736,712	2,543,911
3.4	MOWS's Administration Cost	39,366	2,047	41,413
3.5	Environmental Program	0	26,800	26,800
	Total 3)	1,846,565	799,599	2,646,125
4)	Contingencies	873,153	460,389	1,333,542
5)	Project Cost (1+2+3+4)	9,604,681	5,064,278	14,668,959

6.2.7 Maintenance Cost

Although a continuous PC Box Girder Bridge is almost free from maintenance over the anticipated life of the structure, a minimum of maintenance is required. The maintenance items and interval of maintenance are preliminary adopted as shown in Table 6.4.

Table 6.4 Maintenance Costs

Item	Maintenance Interval	Maintenance Cost (US$)
1. Bridge, Approach road and bank protection	Annual	6140

(1) Relevant Maintenance System in Malawi

Once Maintenance works of roads and bridge used to be conducted by force account of the Ministry of Works & Supplies. However, the maintenance works have been undertaken with contracts existing between the MOWS and

private companies since the 1996/1997 fiscal year. The majority of Malawi engineers and technicians have moved to private companies from MOWS since the change of policy on maintenance.

Many construction equipment is controlled exclusively by VHO(Vehicle Hiring Organization) Plant belonging to the MOWS. Private construction companies now carrying out contracted works, are forced to hire equipment from the VHO.

The maintenance budget in the last three years in Malawi is as follows.

Unit : Kwacha

Fiscal year	Southern Region	Central	Northern Region	Headquarters Region
1994/1995	22,828,163	21,686,755	18,262,530	661,768
1995/1996	19,321,775	18,355,686	15,457,420	14.881,598
1996/1997	31,472,698	29,899,063	25,178,158	24,803.160

Source : Ministry of Works and Supplies

(2) Estimate of the Maintenance Cost of the new Mangochi Bridge

After completion of the new Mangochi Bridge including the adjoining approach road, periodical inspection and cleaning works of this facility will be required even though the bridge type requires a minimum of maintenance works.

The following Maintenance works are expected to be done by the MOWS.

Work Items	Frequency (per year)
Inspection of Expansion Joints	2 times
Inspection of Bridge Shoes	2 times
Inspection of Scour around the Bridge Substructure	1 time
Cleaning Works on the Bridge Surface and Road	6 times
Inspection and Cleaning Works on revetment	2 times

For these works it is estimated that 150,000 kwacha or (US$6140) per year is required.

CHAPTER 7 IMPLEMENTATION PROGRAM

7.1 General

In examining the implementation program for the new Mangochi Bridge, several crucial subjects should be clarified. Among these subjects, financial and organizational arrangements and time of commencement of the Project would be the most significant items. In this chapter these important subjects are assumed to be fixed for the purpose of developing the construction schedule.

Prior to the commencement of the construction works, it is necessary to complete many preparatory works such as the geological survey, detailed design, arrangement of adjoining roads, environmental assessment, arrangement for tender, land acquisition and compensation and relocation of the existing facilities.

7.2 Implementation Schedule

Before the commencement of the construction works, particular engineering activities should be carried out, as described bellow.

The detailed design works including an additional geological survey is essential to cover further detailed aspects of the design, and also to fix the total quantities to be used for cost estimates in which up-dated relevant material cost, labor cost and so on will be reflected. In addition, general and technical specifications will be covered in accordance with the contents of the detailed design. This work is estimated to take 6 months.

Tender works include the pre-qualification, tender evaluation and the approval by the Project implementation body. This work is estimated to take 2 months.

The following items will be undertaken by the Government of Malawi, namely the required environmental assessment, arrangement of the adjoining road project, land acquisition and compensation, and relocation of existing facilities. This will ensure the smooth and initial development of the construction works without any delay. It is expected that these works be carried out immediately after the Project is officially approved.

It is estimated that the total construction period, which comprises the mobilization and preparatory works, construction of substructures and superstructures, and the relevant road, be twenty six (26) months, on the condition that above mentioned works undertaken by the Government of Malawi are completed in the appropriate

time.

The implementation schedule is shown in Figure 7.1.

Figure 7.1 Implementation Schedule

Implementation Schedule and Disbursement

Item \ Month	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	FC	LC
Detailed Design																																				
Arrangement of adjoining Road Project																																				
Preparation of Tender																																				
Tender																																				
Contract																																				
Environmental Assessment																																				
Land Acquisition etc																																				
Construction Stage									1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26		
Mobilization/Preparation																																				
A1 Abutment																																				
P1 Pier																																				
P2 Pier																																				
A2 Abutment																																				
Tempory Piers																																				
Revetment (A1)																																				
Revetment (A2)																																				
Superstructure (P1)																																				
Superstructure(P2)																																				
Surface Work of the Bridge																																				
Approach Road																																				
Remaining Work																																				
Total Construction Period																																				

Fund Requirement						FC	LC
						Unit: 1,000$	
1) Construction Works	FC		1954.3	2879.3	739.1	5572.8	
	LC		1798.1	1390.0	547.9		3736.1
2) Engineering Cost	FC	206.1	448.4	415.4	242.3	1312.2	
inclusive of the detailed design work	LC	3.1	19.8	28.7	16.7		68.2
3) Non-Eligible Cost							
3.1) Demolition Cost of the Existing Brid	FC						
	LC		28.0				28.0
3.2) Relocation Cost of the Power Line	FC						
	LC		6.0				6.0
3.3) Tax and Duties	FC	54.1	630.7	864.8	257.6	1807.2	
	LC	0.6	352.0	274.7	109.3		736.7
3.4) MOWS's administration Cost	FC	6.2	13.5	12.5	7.3	39.4	
	LC	0.1	0.6	0.9	0.5		2.0
3.5) Environmental Program	FC						
	LC		8.9	8.9	9.0		26.8
Sub Total(Non-Eligible Cost)	FC	60.3	644.1	877.3	264.9	1846.6	
	LC	0.7	395.5	284.5	118.8		799.6
4) Contigency	FC	26.6	304.7	417.2	124.6	873.2	
	LC	0.4	221.3	170.3	68.3		460.4
Total Cost	FC	293.0	3351.6	4589.2	1370.9	9604.7	
	LC	4.1	2434.8	1873.5	751.8		5064.3
						14669.0	

CHAPTER 8 CONCLUSIONS AND RECOMMENDATIONS

The Feasibility Study on the Construction of the Mangochi Bridge in the Republic of Malawi presents the results of many types of economic and engineering studies (e.g., traffic surveys, topographic surveys, geological surveys, river hydrological studies, environmental examination, bridge design plan studies, design calculations, and cost estimates) ,and the following conclusions and recommendations are made:

(1) Existing Mangochi Bridge

As far as the substructure of the existing bridge is concerned, no major signs of deterioration has been detected except for erosion of ground nearby the abutments. However some symptoms of deterioration were found at the end strut, pin joint, and timber deck in the superstructure. In consideration of the future increased traffic volume and the future heavy weight of vehicles the existing bridge is unlikely to remain structurally sound in the future due to (a) being a one lane bridges, (b) increased traffic demand and (c) insufficient load bearing capacity.

(2) Role of the existing Mangochi Bridge

For international trade, Malawi heavily depends on the external ports of Nacala, Beira, Durban and Dar-es-Salaam. Among these the Nacala port in Mozambique has a significance role in Malawi's international trade because this transportation route is the shortest. The total quantities of commodities to and from Malawi dealt with at Nacala port has dominated recently those of other ports as a result of the settlement of Mozambique's political situation. The Mangochi Bridge is located on national road No.3 connecting Nacala to Lilongwe or Blantyre fulfilling an important road transportation system as well as the railway system connecting Nacala and Blantyre.

(3) Road Rehabilitation Plan neighboring Mangochi Bridge

Road rehabilitation works at both sides of the Mangochi Bridge is scheduled to be implemented along Route No.3 within Malawi and furthermore along the extended net work in Mozambique (Route No.8)

where bridge rehabilitation works are in progress under Japanese Grant Aid. In this context the rehabilitation of the Mangochi Bridge is required as an integral part of the rehabilitation scheme of the road network.

(4) Result of Traffic Survey and Traffic Demand

The traffic survey conducted in March 1998 on the existing bridge observed a traffic count result as follows:

24-Hour Traffic Counts

Pedestrian	Bicycle	Motorcycle	Motorized vehicle
4,362	2,154	54	398

Future traffic demands are estimated as follows:

Traffic Assignment Results, Vehicles per Day

	Without New Bridge	With New Bridge
Total Traffic (2005 year)	931	1,026
Total Traffic (2022 year)	2,500	3,060

While current daily traffic volume counts 398 vehicles in terms of motorized vehicles, 931 and 1,026 vehicles are estimated respectively in the years 2005 and 2022 in the case of "without new bridge". On the other hand, 2,500 and 3,060 vehicles have been estimated to use the bridge in the case of "with new bridge" based on the assumption that the adjacent road rehabilitation Project is carried out.

(5) Expected Benefits to emerge from completion of new the Mangochi Bridge

a) Direct Benefits

The direct economic benefit of the Project is composed of savings in distance and time-related vehicle operating cost. These economic benefits vary year by year, increasing from an initial US $ 135,385 in 2002 to US $ 174,231 in 2005 and US $ 1,450,375 in 2022.

b) Indirect Benefits

Indirect benefits can be identified in two categories: transport effects and regional development effects.

i) Transportation Effects:

- Improvement of traffic safety and reduction of risk and uncertainty
- Strengthening of Malawi's international road network
- Strengthening of Mozambique's international and domestic traffic through Malawi
- Improvement of accessibility to remote area
- Reduced transport tariffs and increased tax revenue

ii) Regional Development Effects

- Promotion of a market-oriented economy
- Upgrading of living standards in the rural areas
- Modernization of agriculture
- Promotion of agro-industries and fish-processing industries
- Promotion of resource development
- Tourism development
- Balanced development of the region
- Technology transfer

(6) Basic Design of the Bridge

Based on the preparatory design of the bridge in which the selection of bridge type together with span arrangement and location of the bridge were studied, a pre-stressed concrete bridge 220m long was adopted for the new Mangochi Bridge and will be located 30m downstream of the existing bridge. The following are the main parameters of the new bridge.

Navigational Clearance	:	4.40m from high water level
Bridge Width	:	10.50m
Number of Lane	:	two lane (3.65mx2)

Side Walk	:	1.30m both side
Span Arrangement	:	60m-100m-60m
Bridge Type	:	Cast-in-situ Pre-stressed concrete single box girder

(7) Environmental Impact Assessment

Although the Shire River is regarded as the migratory path of chambo fish and the historical monument of Queen Victoria clock tower exists, any predicated negative impacts are of minor significance during the construction of the new bridge and can be reduced or avoided by the utilization of the recommended mitigation measures.

(8) Construction Plan

The total construction period is estimated to be 26 months. For the construction of the foundations of both piers, an open caisson is to be used utilizing the jack down method for sinking. The superstructure of pre-stressed concrete will be constructed by the balanced cantilever method.

(9) Total Project Cost

The total Project cost is estimated to be US$14,668,959 of which the foreign currency portion and local portion are US $ 9,604,681 and US $ 5,064,278 respectively.

(10) Economic Evaluation

EIRR is estimated to be 7.0%. As the indirect benefits of the Project outlined in (5) above are substantial, the Study Team considers that these indirect factors remove any doubt concerning the economic viability of the Project.

(11) Expected Works to be undertaken by the Government of Malawi

The following works are expected to be undertaken by the Government of Malawi:

- Adjustment of plans between this Project and the adjoining road project
- Relocation of the power line and other necessary facilities
- Demolition of the existing bridge
- Land acquisition and compensation
- Environmental Impact Assessment and monitoring

In conclusion the Study Team considers that the construction of the new Mangochi Bridge is technically and economically feasible under proper finance and accordingly recommends that it be immediately implemented.