DEMOCRATIC SOCIALIST REPUBLIC OF
SRI LANKA

MINISTRY OF TRANSPORT AND HIGHWAYS
MINISTRY OF FINANCE AND PLANING

COLOMBO-KATUNAYAKE EXPRESSWAY PROJECT

DESIGN BUILD & TURNKEY

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Environmental Impact Assessment (EIA) of Colombo – Katunayake Expressway Project

Road Development Authority- 1997

BETWEEN
ROAD DEVELOPMENT AUTHORITY OF SRI LANKA

AND
DAEWOO – KEANGNAM JOINT VENTURE
REPUBLIC OF SOUTH KOREA

DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA

MINISTRY OF TRANSPORT AND HIGHWAYS

COLOMBO KATUNAYAKE EXPRESSWAY

ENVIRONMENTAL IMPACT ASSESSMENT REPORT

Road Development Authority
"Sethsiripaya",Battaramulla
SRI LANKA.

June 1997.

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MINISTRY OF HEALTH, HIGHWAYS
AND SOCIAL SERVICES

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Road Development Authority
"Sethsiripaya", Battaramulla
SRI LANKA.

Prepared by :
University of Sri Jayawardenepura
Gangodawila, Nugegoda
SRI LANKA

October 1996

COLOMBO KATUNAYAKE EXPRESSWAY
ENVIRONMENTAL IMPACT ASSESSMENT
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EXECUTIVE SUMMARY

EXECUTIVE SUMMARY

1. Project objectives

The need for a high speed link between Colombo and Katunayake was first established in the early 1980's to serve the rapidly expanding industrial areas in the region. Although preliminary work for a high speed link was undertaken at the time, the proposal was not developed further. Traffic along the Colombo - Puttalam (A3) road had increased by about 250 % in the decade 1980 - 1990. This has resulted in very low levels of service with low speeds and increase in accidents. It is highly congested causing delays to passenger and freight traffic. The average cost of delays to passenger traffic alone is about one million rupees per day.

A high speed link between Colombo and Katunayake would not only facilitate passenger and freight movement between the two locations but also would serve the traffic to and from the Northern part of the island. It would also permit rapid industrial expansion in the area, enhance employment opportunities and encourage outward migration of people living under congested conditions in and around Colombo.

2. Purpose of the study

The Environmental Impact Assessment (EIA) for the proposed Colombo - Katunayake Expressway (CKE) was carried out for the following purposes :

(i) To evaluate the reasonable alternatives based on their Significant Environmental Impacts (SEI) and to recommend a preferred alternative

(ii) To identify SEIs pertaining to the preferred trace and suggest suitable measures to mitigate adverse impacts.

(iii) To recommend an appropriate monitoring programme

3. Evaluation of alternatives : Primary options

Four different reasonable primary options, each of which can be considered as being capable of providing a high speed transport link were considered. The consequences of doing nothing was also considered as a fifth option.

A proposed which is socially, environmentally technically or financially flowed such as a long tunnel, or an extended viaduct was not considered reasonable.

Following are the five options (Fig. C) that were evaluated on the basis of ecological, hydrological and socio - economic impacts, engineering considerations and economic performance.

Option 1: Access-controlled expressway to the west of the Colombo - Negombo road (A3)

This is an access-controlled expressway from Peliyagoda to Katunayake lying mainly to the west of A3, except at initial parts where it lies between the A3 and the Colombo-Kandy road. Three grade-separated interchanges are proposed to be provided between the two termini. Other road crossings are proposed to be taken as over-passes above the expressway.

Option 2: Access-controlled expressway on the east of the Colombo-Negombo road

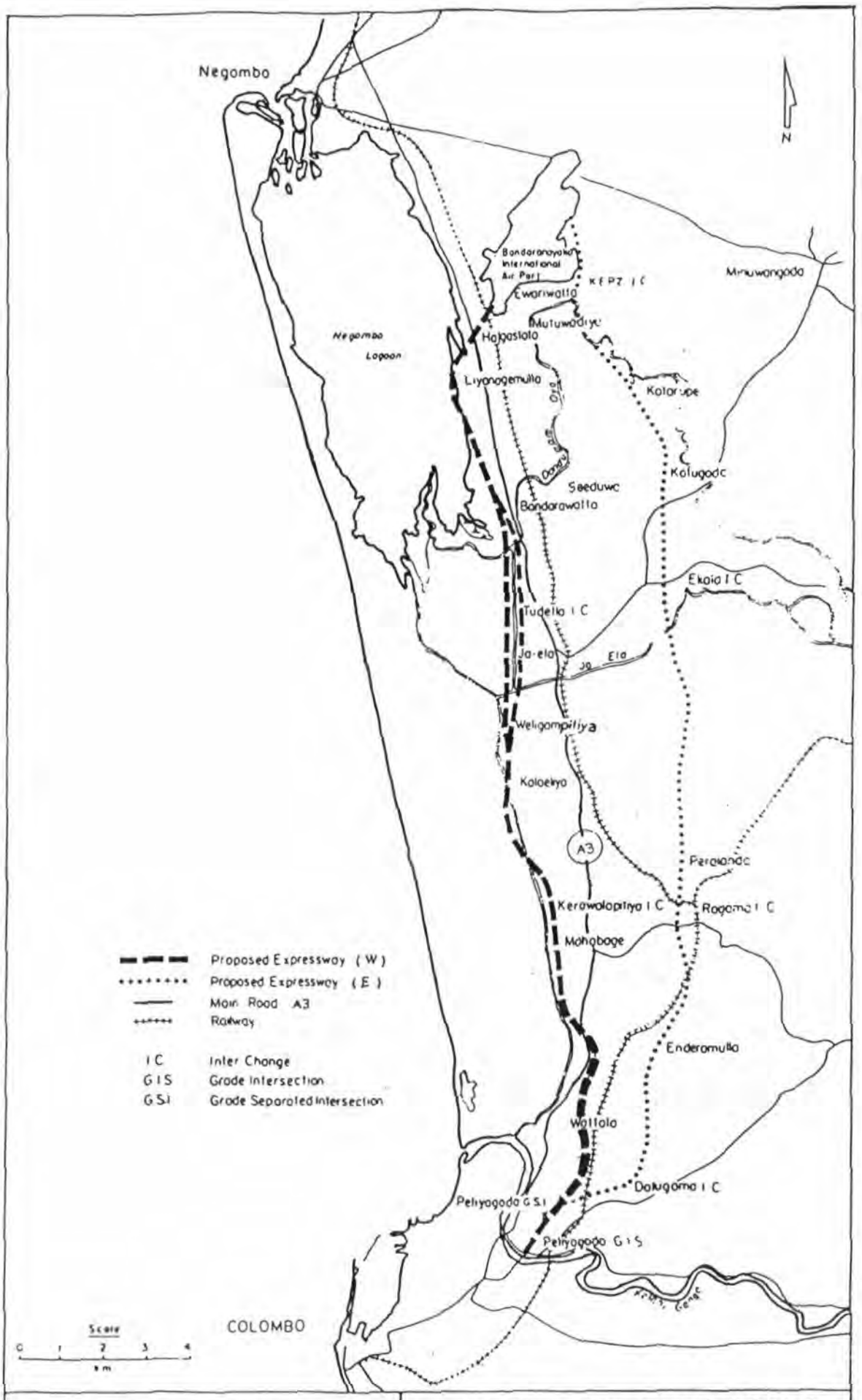
This is an access-controlled expressway from Peliyagoda to Katunayake lying to the east of A3, between the Colombo-Kandy road and the railway to Negombo. This is proposed to be taken on an embankment of height varying from 3 to 9m above the surroundings. Three grade-separated interchanges are proposed to be provided between the two termini. Other road crossings are proposed as under-passes beneath the expressway.

Option 3: Improvements to the existing Colombo - Negombo road

This proposal is to improve the existing road A3 from Peliyagoda to Katunayake so as to provide better conditions for the traffic that uses the road. This will continue to be a road with unlimited access. The improvements will comprise widening of the road and instituting traffic control measures such as traffic lights etc.

Option 4: Improvements to the railway.

This proposal is to improve the railway between Colombo and Katunayake. This will be achieved by engaging more locomotives and rolling stock laying on additional track and improved signaling.



Colombo - Katunayake Expressway Construction Project

ALTERNATIVE PROPOSALS

Fig C Source R D A

Option 5: "No action" option.

This implies doing only normal maintenance and upgrading of the existing facilities of transport between the two points, viz, A3 road and railway. No major capital investment is envisaged under this

In the evaluation of the options, the "no action" option could readily be discounted since the present transport links between the two areas are grossly inadequate and the provision of a high speed link can be considered one of the priority needs for development. If no action is taken to improve the situation, the condition will deteriorate with dire consequences to the economy and society.

Without concurrent upgrading of the rail network, improvements to the railway would not lure passenger traffic on to the railway from roads. Even with such an upgrading, the freight traffic is unlikely to be attracted to the railway as having to change the mode and the consequent multiple handling represents delays and additional costs. Therefore improving the railway does not meet the objective of the project. As the improved railway would not help to relieve the congestion on the A3, there would be no significant reduction of accidents or air pollution on the latter.

Next option, improving the A3 road by widening and traffic management would not meet the objectives of a high speed transport link. This road cannot be made access-controlled, for it serves the local population along the corridor as their means of access, both local and trunk. In addition, the corridor through which the A3 passes is of high population density, with the commercial and residential buildings lining the road almost continuously. Any widening of the road would involve the demolition of 1140 buildings with its attendant impacts. These high adverse social and economic impacts, makes the road widening virtually impractical.

A tabulation of the economic analysis of the five options is given below;

SUMMARY OF ECONOMIC ANALYSIS OF FIVE OPTIONS

	No action	Eastern trace	Western trace	Road widening	Rail option
Capital Cost (Rs billion)	0	20	5	2.98 *	0.1
Cost (capital and operating - discounted over 26 years at 12%) (Rs. million)	0	17,911	4,519	0	108
Benefits (discounted over 26 years at 12%) (Rs. million)	0	131,495	97,403	4,096	1,034
Net present value(over 26 years at 12%) (Rs. million)	0	113,584	92,885	1,061	938
Benefit/cost ratio	0	7.3	21.5	2.5	10.7
Internal rate of return	0	38%	63%	18%	47%

*** road widening discounted over 20 years.**

A comparison of environmental impacts of five options is depicted in figure A.

The foregoing reasoning leaves only the two access-controlled expressways, the eastern trace and the western trace, as the only options capable of meeting the objectives. Of these two, the trace which has lower adverse impacts on the environment and which is cost-effective has to be selected. The salient points are shown below.

Eastern Trace	**Western Trace**
About 1500 houses to be demolished. This would entail very high social impacts.	About 130 houses to be demolished and a further 60 houses to be acquired on the reservation
Cost : Rs. 20 billion	Rs. 5 billion
Ecological Impacts : Traverses already disturbed areas. Therefore entails low level of impacts.	Runs along the eastern edge of the Muthurajawela marsh and a small part of the Negombo Lagoon. (However the area affected is small - less than 3%)
Hydrological impacts : Moderate.	Low
Benefit cost ratio : 7.3	21.5
Economic Internal Rate of Return : 38%	63%
Community severance : high as this is taken on a High embankment through densely populated areas	Low, as this is mainly taken along marshes and unpopulated areas.
Visual amenity : Highly intrusive as it is taken on a high embankment and through populated areas.	Less intrusive as the road is low and is mainly taken along sparsely populated areas.

The above comparison shows that the western trace is clearly the more acceptable of the two alternatives available. It costs only about 25% of the other, is less disruptive socially - involving fewer involuntary relocates, causing less severance and being visually less intrusive - and has a higher rate of return. The ecological impacts are marginally higher than for the eastern trace, but can be mitigated effectively. Therefore the western trace was recommended as the preferred alternative. A comparison of the environmental impacts of three road options is depicted in Fig. B.

How?

4. Evaluation of secondary alternatives for the western trace

Secondary alternatives were considered for four segments of the selected western trace of the CKE. It was necessary to consider these secondary options for segments where it was felt that the selected trace caused serious consequences to the environment. The alternative which would minimize such impacts while still being compatible with the project objectives, and could be implemented at a reasonable cost was selected. A list of the segments with specific reasons for considering several options is given below:

Peliyagoda to Mabole -	This is a highly populated area where the residents are opposed to the proposed layout. The proposal would entail the demolition of their houses and loss of property. The option which affected the least number of people was selected.
Mabole to Kalaeliya -	In this reach the CKE crosses the Old Negombo canal and the conservation zone of Muthurajawela. Other option considered for this segment either affected too many residences -25 houses in one case - or defeated the objectives of the expressway by causing it to terminate well before reaching Katunayake.
Kalaeliya to Dandu-gam Oya -	The proposed trace runs on the west side of the Mahadora ela. Ther for it lies on the eastern edge of the Muthurajawela sanctuary for a short distance. The trace also runs through the premises of the Muthurajawela Visitor Center.

Another option considered for this segment requires the shifting of the interchange to the eastern banks of the Mahadora ela and the deviation of Tudella-Pamunugama road southwards. These two changes and placing the trace along the east of Mahadora ela causes the demolition of about 115 houses and some commercial buildings thus increasing the number to be demolished by nearly 100%. Some of the affected houses are from Wahatiyagama, having very productive coconut lands.

The other option for this segment include terminate the Tudella which fails to meet the project objectives.

Liyanagemulla to Katunayake Airport Junction -

In this reach, the trace runs through the Negombo lagoon and one of its inlets for a combined length of 1.4 km.

Options considered for this segment were either for shifting the trace away from the lagoon or for the construction of the expressway segment running through the lagoon as a long bridge. If the trace were to be shifted, the number of houses to be demolished would increase significantly. It would at the same time introduce a double curve to the expressway, a feature that leads to accidents. As an alternative, if the trace through the lagoon is retained with the expressway taken on a bridge, the cost would increase by almost Rs. 2.5 billion, representing a 50 percent increase in the project cost.

The trace proposed in the Master Plan of Muthurajawela and Negombo Lagoon

The road trace proposed in the Master Plan of Muthurajawela and Negombo Lagoon (MPMNL) follows the western trace of CKE rather closely. However there are two significant differences between the two traces. First, the MPMNL trace terminates at Dandugama on the A3 road without reaching Katunayake. This termination will prevent the CKE from meeting its objectives as an expressway. The second difference is that for more than five kilometers the path proposed in the MPMNL lies to the west of the Old Negombo canal within the Muthurajawela conservation zone, part of which has since been declared as a sanctuary. It will affect about 50 ha of marshland in contrast to the 13 ha taken up by the proposed CKE. The Master plan trace was considered as one of the secondary options under the third segment above.

5. Description of the proposal.

The Western trace of the Colombo Katunayake Expressway (CKE) - the preferred option - will be a fully access-controlled four lane expressway with 3.5 m travel lanes designed for speeds of 100 km / hr. This can be expanded to accommodate six lanes. There are three grade - separated interchanges at Peliyagoda, Kerawalapitiya and Tudella. It is 24.6 km in length and begins at Peliyagoda at the northern end of the New Kelani bridge and ends at Katunayake. (Fig. C)

The CKE will be taken at an elevation of 1.0-1.5 m above the surrounding land. All the existing lateral roads will be taken above the CKE as overpasses. If the need arises new crossings can be constructed without obstructing the traffic on the proposed CKE.

The CKE is estimated to cost Rs. 5 billion and has a Benefit Cost ratio of 21.5. It has an Economic Internal Rate of Return (EIRR) of 63%.

6. Description of the study area

The entire stretch of the study area is a plain which has an average height of 1m above mean sea level, the general slope being from east to west. The average rainfall received mainly from the South West monsoon, ranges between 2000-2500 mm while the temperature varies between 25.0 ^{0}C and 27.5 ^{0}C. Three streams, namely Dandugam oya, Ja ela, and Kalu oya flow through the area.

The Muthurajawela marsh and the Negombo lagoon are the most conspicuous natural features in the area. The marsh proper has a peaty substrate, is temporarily flooded during monsoon rains and remains saturated for most of the year. Large areas of it are covered with grasses, reeds and cattails. A few woody - stemmed species occur in patches. The zone between the Negombo lagoon and the marsh proper is characterised by the presence of mangroves and brackishwater flora. Mangrove forest forms a narrow belt along certain segments of the shoreline of the lagoon.

This is a rapidly urbanizing area with a predominance of urban and urban settlements. There is a mixture of low, medium and high income groups in the area. The low income communities live mainly in shanties located primarily in or near marshes and in road, canal and railway reservations. Population densities are as high as 5000/sq.km close to Colombo and declines to less than 500/sq.km towards Katunayake.

The land use pattern is characterised by a rapid conversion of agricultural land into urban uses. The majority of urban non - residential uses are located along major highways, forming continuously built - up areas with larger nucleations at junctions. Outside the densely populated areas, agricultural land uses predominate.

7. Impacts and Mitigatory measures

Socio-economic impacts : The number of buildings that will be demolished by the 30 m wide CKE include 130 houses and six small shops. Another 60 houses falling within the reservation of the CKE will be acquired by the Road Development Authority (RDA) but not demolished. People living in these 60 houses will be allowed to stay, but new constructions within the reservation would not be permitted. Of the 130 houses that will be demolished, 65 percent are shanties built by encroachers. They engage in such informal sector activities as the cultivation and sale of 'keera' or they work as unskilled or semi-skilled labourers. They will be provided with better housing and other facilities as close as possible to the original settlements. Some will be absorbed as casual labourers of the CKE.

The impact on the people living in permanent houses include loss of property, loss of income from agriculture and fishing, inconveniences in traveling to work and disruption of their social structure. Several steps will be taken to mitigate these adverse impacts. Adequate compensation will be paid to those being displaced. Several sites as close to the original settlement as possible have been identified for people who will opt to receive land. These sites will be provided with water, sanitation, access roads and electricity. Businesses having to relocate will be compensated. The households that will be displaced will be given compensation according to current market prices valued by the Chief valuer. An additional ex-gratia payment will be made by the RDA to compensate for the inconveniences and hardships, the house owners are to undergo.

Although the CKE will cause the severance of communities lying on either side of it, links will be maintained through vehicular and pedestrian overpasses construction phase requires the transport of sand, metal and gravel using the local road network. Proper signaling and traffic management measures would help reduce congestion. Mitigatory measures have been recommended to prevent dust from escaping the loaded trucks while being transported.

Impact from noise during the operation stage and will be minimized by the provision of barriers were necessary.

Operational impacts from the CKE will mostly be beneficial such as the avoidance of delays and accidents and reduction of air pollution close to dwellings. Noise barriers will be installed to reduce noise to acceptable levels where the CKE runs close to dwellings, places of religious significance and other important places such as schools.

Detrimental impacts of the CKE on prime agricultural land are low since the trace runs through marshes and abandoned paddy fields over much of the alignment. The CKE will act as a barrier to further encroachment of the Muthurajawela marsh. The long term impacts on land use of the surrounding area will be the acceleration of the present trend of land conversion from rural to urban uses.

Hydrological impacts : Since the Colombo - Negombo railway and the A3 road already act as constraints to the free flow of water courses, laying the CKE to the west of A3 would cause only marginal increases to the hydrological impacts from the existing road and the railway. The large number of local drainage canals crossing the CKE will be provided with culverts to avoid drainage congestion. These will serve as pathways and refuges for animals trying to cross the CKE. Sufficiently wide bridges would be designed for the major stream crossings which would permit floods to be discharged without upstream inundation.

The CKE trace lies along the bank of the Old Negombo Canal (ONC). In some places the road crosses the existing canal. In order to maintain the hydraulic connectivity, it is proposed to construct short segments of bypass canals, keeping the ONC always to the west of the CKE. This would ensure an unimpeded flow of water in the canal. The horizontal alignment of the canal will be designed to merge with the existing canal by smooth transition curves. The canal width and the depth will be at least equal to those of the original segment being replaced. The proposed deviations of segments of the canal will not have a significant impact. The MPMNL even recommends the construction of the road " on the canal bed", obliterating the canal.

The runoff from the CKE, when it is in operation, will contain a number of pollutants resulting from the traffic. The concentrations usually tend to be lower than the standards for wastewater discharges. Still, in view of the sensitive nature of the study area, it is proposed to send this runoff through a system of wet ponds which would remove much of the pollutants.

Ecological impacts : The expressway runs through man-made habitats such as built-up land, homesteads etc., and wetlands such as the Muthurajawela marsh, brackishwater swamp, canals, and the Negombo lagoon etc. Wetlands, being the habitat of certain rare, endangered and commercially important species, received particular attention as to the impacts from the CKE. The main impact is the inevitable loss of portions of the existing habitats. Apart from the portion taken up by the expressway, a strip of habitat on either side would be affected by the noise and other impacts. However, the combined extent of habitat both lost and affected, expressed as percentages of the existing habitat is relatively small - marsh 133 ha(4.5%), brackish water swamp 8 ha (2.3%); lagoon 16 ha (0.5%); seagrass beds 16 ha (2.3%).

As much of the construction activities take place on the eastern periphery of Muthurajawela, it is necessary to take safeguards against adverse effects on the environment. It is recommended that no new access roads are built to construction sites through the marsh and a strict waste control programme is implemented and observed at all the construction sites.

Road construction needs large quantities of sea sand. This sand is proposed to be dredged off shore. The site selected for dredging is the same one used earlier for the Kerawalapitiya land fill operations in 1994. Measures employed in the above project for laying the pipeline are stipulated in the present instance also to minimize damages to the coral reef and other adverse impacts.

Sea water escaping from the sand stockpiling area has the potential to affect the physical and ecological environment in the vicinity. It is proposed to carry out evacuation pumping simultaneously with the pumping in of the sand / water mix so as to minimize percolation.

The CKE would cut off a narrow strip from the lagoon, the area of which is less than 3% of the entire lagoon area. The impacts caused by the isolation would be marginal as the extent affected is small and it is close to the shore. These impacts too will be mitigated by having two underpasses built into the CKE to permit tidal mixing and navigation.

Other potential impacts on ecological resources are the obstruction of the flow of storm water, obstruction of animal pathways causing severance of their populations, disturbance of animals (especially birds) due to noise generated by machinery during the construction phase and traffic during the operation phase, disruption of the free-flow of water in the Old Negombo canal and the contamination of aquatic habitats with oil, cement, tar and other materials during construction. The road design offsets some of these ; mitigatory measures have been proposed for others.

The construction of the CKE on the eastern boundary of the Muthurajawela sanctuary is likely to have a beneficial effect on the marsh ecology, as it would serve as a physical barrier against the relentless encroachment into the marsh of the increasing human population. Even though the law prevents encroachment, in practical terms enforcement has not been effective. On the other hand an access-controlled expressway will make it physically impossible to encroach into the sanctuary.

Impact on Muthurajawela Visitor Center (MVC) : The MVC is housed in a private building leased by the Wetland Conservation Project (WCP) near Tudella. The CKE, as proposed will run through the premises of the center separating the permanent building from the natural trail area.

The MVC will lose its attraction for visitors during the construction phase, even with the noise and dust barriers erected to mitigate the impacts. Boats rides will have to be suspended for the duration of the bridge over the canal Nonage ela. After the construction phase, the MVC can function with the noise and dust barriers with the over head bridge giving access to the nature trail area. Boat rides can resume in the normal route. Easy access to the place through the interchange at Tudella may even encourage visits.

However a more attractive alternative would be to construct a new Visitor Center away from the CKE. The construction can be carried out by the RDA according to the requirements of the WCP as part of the CKE Project. A suitable location can be selected by the WCP in consultation with the Wildlife Conservation Department from the sanctuary area. Such a move would be desirable in many ways in that the MVC would be in its own premises and can design the center to suit the purposes of the Visitor Center. The peace and tranquillity required for the center can be assured by placing it away from the CKE, while enjoying the benefits easy access at the same time.

8. Monitoring programme

A monitoring programme was prepared to monitor the adverse impacts and the implementation of mitigatory measures. A monitoring committee comprising experts from different fields will be established by the Central Environmental Authority (CEA). All monitoring expenses will be borne by the RDA as part of the project cost.

COMPARISON OF ADVERSE ENVIRONMENTAL IMPACTS FROM THE FIVE OPTIONS CONSIDERED

	OPTIONS				
IMPACTS ON	WESTERN TRACE	EASTERN TRACE	IMPROVE ROAD A3	IMPROVE RAILWAY	"NO BUILD"
Hydrology	●	●			
Fauna & Flora	●	●			
Humans	●	●	●	●	●
Land Use	●	●	●	●	●
Visual Amenity	●	●	●	●	●
Noise Level	●	●	●	●	●
Air & Water Quality	●	●	●	●	●
Economy	●	●	●	●	

Note : The circle size reflects the severity of the impact.

Other considerations :

Engineering Considerations	●	●	●	●	●
Achieve aims & objectives	✓	✓			

Fig. A

COMPARISON OF ADVERSE ENVIRONMENTAL IMPACTS FROM ROAD OPTIONS

IMPACTS ON	OPTIONS: WESTERN TRACE	EASTERN TRACE	IMPROVE ROAD A3
Hydrology	•	●	
Fauna & Flora	•	•	
Humans	•	●	●
Land Use	•	●	●
Visual Amenity	•	●	•
Noise Level	•	●	●
Air & Water Quality	•	•	•
Economy	•	●	●

Note : The circle size reflects the severity of the impact.

Other considerations :

Engineering Considerations	•	●	●
Achieve aims & objectives	✓	✓	

Fig. B

CHAPTER 2

INTRODUCTION

CHAPTER 2

INTRODUCTION

2.1 Purpose and Scope of the Environmental Impact Assessment Report

2.1.1 Background

The need for a high-speed link between Colombo and Katunayake was first established in the early 1980's by the then Greater Colombo Economic Commission (GCEC), present Board of Investment (BOI) to serve the rapidly expanding industries in the region. With assistance from the Government of Japan, a trace was identified and preliminary work was undertaken ; however for numerous reasons, the project was not implemented. The concept was resurrected in 1989 by the Road Development Authority (RDA) by which time many of the underlying assumptions in the GCEC plan had changed in addition to the land use and socio-economic parameters. A new trace has been proposed taking all these into consideration.

The latest proposal to construct an alternate highway between Bandaranaike International Airport (BIA) and Colombo was granted approval by the Cabinet of Ministers on August 23, 1995 subject to an acceptable financing arrangement.

2.1.2 Purpose of the Environmental Impact Assessment

Environmental Impact Assessment (EIA) has become a useful process as well as a tool for collecting, analysing and presenting information for planning and decision making. The purposes of carrying out an EIA for the proposed Colombo - Katunayake Expressway (CKE) are as follows:

(i) To evaluate the reasonable alternatives based on their Significant Environmental Impacts (SEI) and to recommend a preferred alternative.

(ii) To identify SEIs pertaining to the preferred trace and suggest suitable measures to mitigate adverse impacts.

(iii) To recommend an appropriate monitoring programme

2.1.3. Scope of the Environmental Impact Assessment

Scope of the EIA is in accordance with the format of the Terms of Reference (TOR) of the Central Environmental Authority (CEA). (Annexure 1)

The scope of the EIA has been determined by the following themes :

(i) Evaluation of reasonable alternatives
(ii) Description of the existing environment
(ii) Identification of significant environmental impacts of the project
(iii) Proposals for suitable measures to mitigate adverse effects.
(v) Planning for a monitoring programme to ensure adherence to the proposed mitigatory measures.

2.1.4 Comments on TOR

The team of Consultants was of the opinion that the following deviations from the TOR were necessary :

(a) The sequence of Chapters should be amended as follows:

Chapter(3) Evaluation of Alternatives
Chapter(4) Existing Environment and Site Description
Chapter(5) Description of the Proposed Project

(b) Economic appraisal to be carried out for all the alternatives, whilst financial plan to be prepared only for the preferred alternative.

(c) Inclusion of a section on legal provisions.

2.2 Legal Provisions

The preparation of an EIA is a mandatory legal requirement for projects prescribed by the Minister in charge of Environment. Projects for the construction of National and Provincial highways exceeding 10 kilometers fall within the prescribed list.

Some statutes relevant to the present assessment are as follows :

(i) National Environmental Act No. 47 of 1980 as Amendment No. 56 of 1988.
(ii) Coast Conservation Act No. 57 of 1981 as Amendment of 1988.
(iii) Board of Investment Act No. 49 of 1992 (which replaced the GCEC - Act No. 4 of 1978.)
(iv) The Road Development Authority Act 1981
(v) The Urban Development Authority Law. 1978
(vi) Urban Development Projects (Special Provision) Act No. 2 of 1980
(vii) The Greater Colombo Economic Commission Law No. 4 of 1978 (Amended Act. No. 49 of 1992 which established the Board of Investment)
(viii) Land Acquisition Act No. 9 of 1950 as amended
(ix) Flood Protection Ordinance No 4 of 1924 (as amended)
(x) Sri Lanka Land Reclamation and Development Corporation Act No 52 of 1982
(xi) Fauna and Flora Protection Ordinance No 2 of 1934 as amended by Acts Nos. 44 of 1964, 1 of 1970 and 49 of 1993.
(Details of the above statutes are given in Annexure 11)

2.3 Methodology used in the Preparation of the EIA Report

a) Hydrology

Hydrology of the project area was the subject of several studies, either as the main subject or as part of a larger study. Flood studies, drainage pattern and salinity intrusion of the study area hydrology, were among the subject matters of those studies. These sources and calculations using hydrological data collected from various agencies were used in the hydrological study. Field studies were used to supplement and verify these calculations.

b) Ecology

A major part of the trace lies within the Muthurajawela marsh - Negombo lagoon wetland system which has been studied extensively especially in recent years. Therefore a large amount of ecological information is available as publications, unpublished reports and University theses. In the preparation of the sections on ecology, much of the baseline information was obtained from the available literature. Field studies were also carried out in the project area to confirm and supplement this information. Persons engaged in fishing in the Negombo lagoon and the canals and residents of the area were also interviewed.

c) **Socio Economic Environment**

A sample for the socio-economic study was based on the survey of buildings undertaken by the RDA in early 1996, along the proposed western trace. Before commencement of the project, a comprehensive socio- economic survey of the population affected by the trace will be conducted by the RDA.

I. Primary Sources

1.1 Administration of a questionnaire to 100% of squatter households who would be displaced by the CKE.

1.2 Administration of a questionnaire to a 25% random sample of the households selected at random of permanent inhabitants who would be displaced by the CKE.

1.3 Administration of a questionnaire to 50% of commercial establishments selected at random directly affected by the CKE.

1.4 Administration of a questionnaire to 10% of the households within a 50 m corridor on either side of the proposed CKE.

1.5 Structured and unstructured interviews with the general public and Citizens' groups.

1.6 Field observations of the study area.

1.7 The land use map prepared in June 1996, based on 1994 aerial *photographs (1:20000) of the area supplemented by field* checking.

II. Secondary Sources

Published, unpublished reports, existing maps and aerial photographs of the study area.

d) **Traffic Analysis**

The existing traffic analysis has been carried out using the available Origin Destination / Survey / data, (1995), Classification Manual Traffic counts, (1995) and Automatic Machine counts.(1996). Time series data have been compiled from available sources including the RDA and Transport Studies and Planning Centre (TSPC) to identify the rate of traffic growth. The regional Gross Domestic Product (GDP) data were estimated using the Input - Output Model developed by the Department of National Planning. (1979). Using regression

analysis the specific growth rates have been found for different vehicle categories.

e) Economic Appraisal

The economic appraisal methodology is applied to examine different options. Economic appraisal is based on the theory of Social Cost Benefit Analysis (CBA). The benefits and costs of each option are calculated and compared to find the most economically beneficial option, which is generally measured by either the benefit cost ratio or the economic rate of return.

Costs and benefits are calculated at undistorted prices reflecting the real opportunity cost of resources. This requires adjusting actual market prices to remove market failure such as overpriced labour due to labour market distortions and government distortion, such as taxes and subsidies.

To conduct a cost-benefit analysis, a baseline (no action alternative) option is selected, against which all the other options are measured. In this case the baseline is the road and rail system as existing in 1996.

2.4 Existing Transportation System between Colombo and Katunayake

With the economy of the region served by the CKE corridor growing at a rate higher than the national average (Tables 2.1 and 2.2), traffic on the existing primary link between Colombo and Katunayake (A3 road) had increased by almost 250% within the decade from 1981 to 1990 (Table 2.2). In 1995, certain parts of the A3 were carrying 40,000 vehicles per day with approximately

2500 vehicles per hour during peak periods. This four-lane undivided multipurpose road with continuous ("ribbon-like") development on either side is currently operating at very low levels of service during most parts of the day. The average speed between Colombo and Katunayake during the morning and evening peaks is approximately 18 km./ hr. If traffic continues to grow at 6% to 8% per year, the inadequacy of the present facility will be a serious impediment to economic growth in the area and Sri Lanka as a whole. The average cost of delays to passenger traffic at this speed is likely to be approximately Rs. 1 million per day or over Rs. 250 million per year. When energy costs, vehicle idling costs, delays to freight etc. are included, the annual cost will be much higher.

In the most recent traffic count on the A3 road for 1995, the average daily traffic (ADT) was 44, 024. This comprised 24% cars, 39% light and medium vehicles , 17% buses and 20% motorcycles. There are eight main provincial

roads in this region from where traffic originates and proceeds to the Colombo Port via

A3, viz; Ja Ela to Gampaha (A33), Hendala to Negombo (B152), Seeduwa to Udugampola (B400), Minuwangoda to Ja Ela (B19), Kandana to Ganemulla (C), Ja Ela to Ganemulla (C), Kandana to Ja Ela (A3), Hendala to Kandana (C). These roads link with the local access roads as well as the Katunayake Industrial Promotion Zone (KIPZ) and the container depots.

Katunayake and Negombo area is serviced by the Colombo - Puttalam railway. This follows the double track main line up to Ragama (14 km). From Ragama the line is a single track. There is 1 km link to BIA and KIPZ. Only two stations have passing loops in the 17 km stretch between Ragama and Katunayake while all the stations up to Ragama have passing loops.

TABLE 2.1

GROSS REGIONAL PRODUCT PER CAPITA 1981 - 1990

(CONSTANT 1993 PRICES)

Name of *Province*	1981 *Rs.*	1990 *Rs.*	Annual *Growth %*
Western	28,823	44,710	6
Central	14,124	20,039	4
Southern	13,001	16,551	3
Northern	20,119	12,653	-6
Eastern	22,856	23,474	0
North Western	18,066	20,802	2
North Central	20,097	16,849	-2
Uva	17,142	18,238	1
Sabaragamuwa	19,202	17,177	1
Sri Lanka	20,661	25,617	3

Source : Adapted from Dept. National Planning

TABLE 2. 2

GROSS REGIONAL PRODUCT PER CAPITA 1981 - 1990

(CONSTANT 1975 PRICES)

Rs.

Name of Province	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Western	14,239	15,026	15,786	17,344	19,505	19,884	20,888	21,811	22,639	24,060
Southern	3,195	3,432	3,658	3,618	3,969	4,108	4,110	4,523	4,062	4,465
Central	3,825	3,961	4,493	5,080	4,668	4,929	4,988	4,899	5,210	5,353
Sabaragamuwa	2,466	2,601	2,657	3,122	3,004	3,577	3,443	3,321	3,462	3,706
Uva	1,990	2,077	2,249	2,306	2,134	2,162	2,315	2,315	1,920	2,342
North Western	3,827	4,083	3,961	4,169	4,815	5,036	4,824	4,819	4,680	5,084
North Central	1,776	1,818	1,988	2,134	2,234	2,374	2,293	2,369	2,019	2,095
Eastern	2,605	2,908	2,475	2,170	2,584	2,293	2,613	2,425	3,170	3,467
Northern	2,703	2,690	3,136	2,549	1,971	2,111	2,016	2,096	2,386	2,040
Sri Lanka	36,626	38,596	40,403	42,492	44,884	46,474	47,490	48,578	49,548	52,612

Source : Adapted from Dept. National Planning

2.5 Conformity to Urban and Highway Development

The use of land for commercial and industrial purposes in the region has rapidly increased during the last 15 years as KIPZ and Biyagama Investment Promotion Zones (BIPZ) developed. The Muthurajawela Master Plan also envisages commercial development within the designated urban development zone. The past trends of the land use development of the region show a relative increase in the number of container yards, industrial and commercial development.

The CKE will serve the local traffic through intersections and therefore will conform to urban development plans for the region.

The long term highway development plan consists of an expressway to Anuradhapura and Kandy and the proposed CKE will be a part of the Colombo - Anuradhapura expressway and therefore conform to highway development plans. The proposed bridge at Mattakkuliya across the Kelani River may provide a better route to divert the Colombo Port traffic on the CKE. Modal competition for the port bound traffic in the long term may have an impact on the CKE.

CHAPTER 3

EVALUATION OF ALTERNATIVES

CHAPTER 3

EVALUATION OF ALTERNATIVES

Existing links between Colombo and Katunayake for passenger and goods transport are overstrained beyond capacity for roads and inadequate in the case of railway. The Western part of Gampaha District is one of the rapidly expanding residential and industrial areas. It contains the nationally important BIA and several key national security installations. A high speed link between POC and BIA is also important for the benefit of the national economy. The existing links are unable to meet even the current demand let alone the projected demand for the future. Hence the need for a high speed link.

Several primary options which would provide a high speed transport link of sufficient capacity are evaluated to find the best option. The evaluation is limited to reasonable options only. A proposal which is socially, environmentally, technically or financially flawed is not considered reasonable and was not evaluated. For example even though it is possible to take an expressway underground by a long tunnel or elevated on a viaduct, they would not be economical because of the prohibitive cost: a viaduct costs nearly Rs. 3bn a kilometre for the basic structure alone. The cost of a tunnel is even higher. Each of these are vulnerable to sabotage and a long tunnel is unlikely to be accepted by drivers. Therefore four primary alternatives were considered.

3.1 Primary Alternatives

Following are the reasonable primary alternatives that were considered for the purpose of this evaluation.

Three "build" alternative alignments (1), (2) and (3), improvement to the railway (4) and "No action " option (5), have been identified, evaluated and presented in detail.

1)	Alternative	1	-	Western Trace
2)	Alternative	2	-	Eastern Trace
3)	Alternative	3	-	Improvements to the existing road A3
4)	Alternative	4	-	Improvements to the railway - Inter modal option
5)	Alternative	5	-	"No action " option

Essential features of the three build alternatives are shown in Table 3.1

TABLE 3.1

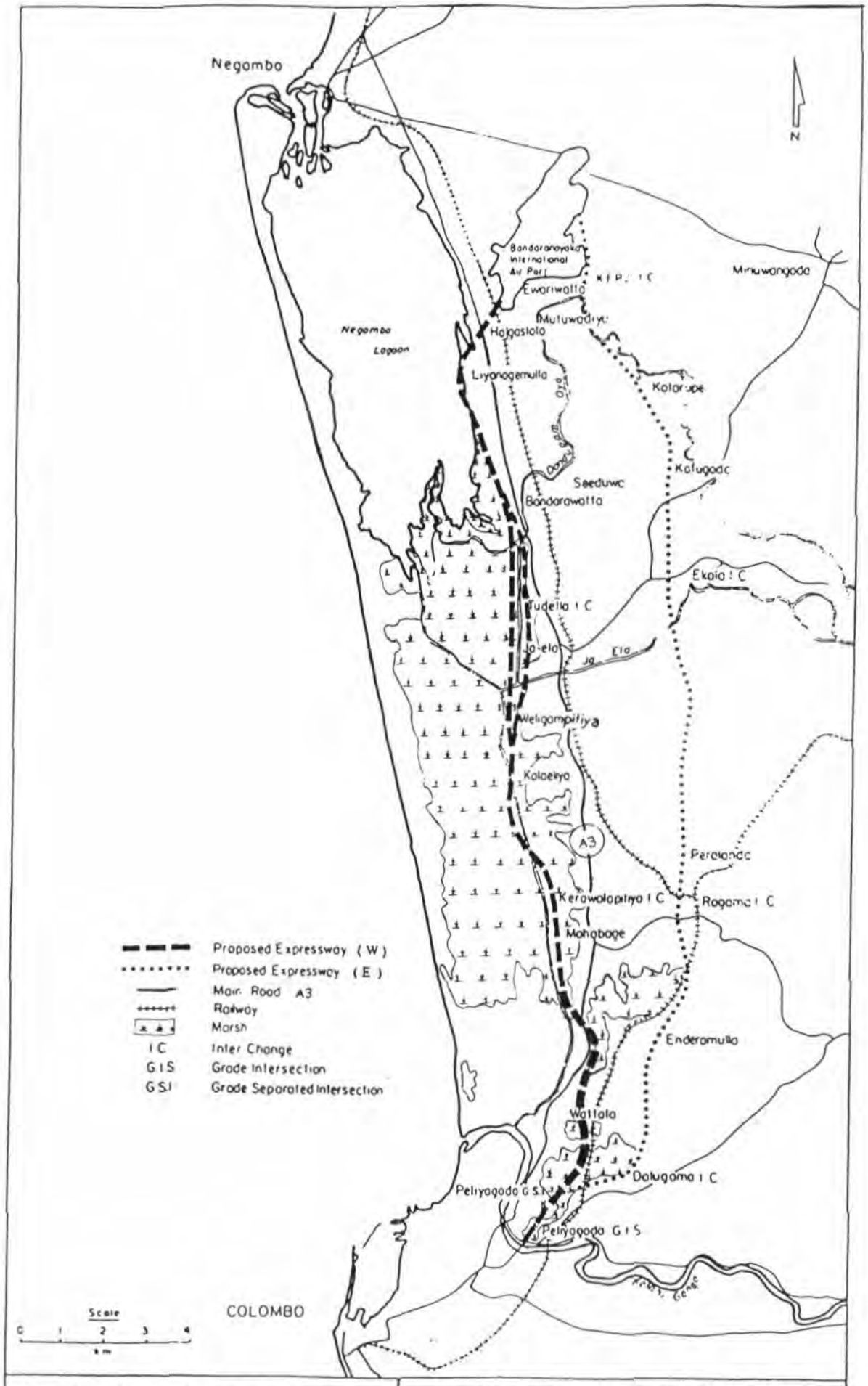
CHARACTERISTICS OF THE THREE BUILD ALTERNATIVES

Characteristics	Alternative Alignment		
	1	2	3
Construction Cost	Rs. 5 bn	Rs. 20 bn	Rs. 3 bn
Length	Rs. 24.6 km	28.3 km	24 km
Travel Time from POC to BIA	33 min	28 min	1.1 hrs.
Capacity at the end of design life for 4 lane (one way)	19,636 VPD	19,636 VPD	39,600 VPD
Expected LOS in year 2020	B	B	D
Time for Completion	48 months	60 months	84 months

POC	=	Port of Colombo
LOS	=	Level of Service
VPD	=	Vehicles per day
B	=	Stable flow and drivers have reasonable freedom to select their speed.
D	=	Approaches unstable flow, with nearly all drivers restricted and substantial drops in speed

3.1.1 Western Trace

The western trace which is an access controlled road begins at the northern end of the New Kelani bridge and proceeds northwards, passes close to the Hunupitiya railway station, then veers left to cross the A3 road at a point close to Mabole in Wattala. After reaching the Old Negombo canal (Old Dutch canal) the alignment heads north and runs almost parallel to it. After crossing Dandugam oya it proceeds to Liyanagemulla where it enters the Negombo lagoon. Then it runs through the lagoon for approximately 1.4 km at a maximum distance of about 50 meters from the shoreline. Turning east it proceeds approximately 0.5 km to join the A3 road at the junction with the Canada Friendship Road (CFR). Three interchanges are proposed at Peliyagoda, Kerawalapitiya, and Tudella and the length of the trace is 24.6 km. (Fig. 3.1). The road surface level is proposed to be 1.0 to 1.5 metres above the surroundings.



Colombo - Katunayake Expressway

Construction Project

ALTERNATIVE PROPOSALS

Fig 3.1 Source R D A

3.1.2 Eastern Trace

The eastern trace which is an access controlled road begins at the northern end of the New Kelani Bridge and crosses the Peliyagoda Integrated Urban Development Project (PIUDP) area. After Peliyagoda it veers right to pass close to Dalugama, where access to the Kandy road (A1) will be provided via an interchange. Past this point , the trace changes to head north, passing close to Ragama, Ekala, and the KIPZ to emerge in front of the BIA passenger terminal. (Fig. 3.1) Four interchanges are proposed at Dalugama, Ragama, Ekala and KIPZ. The length of the trace is 28.3 km. It is proposed to take the trace on a high embankment which varies in height from 3 to 9 metres.

3.1.3 Improvements to the Existing Road A3

The existing A3 road carries mixed traffic with unlimited access. The Average Daily Traffic (ADT) of this road in 1995 was 44, 024. No deviations are proposed in the existing road. Widening of the existing road with suitable traffic management schemes is considered as the third alternative. (Fig. 3.1)

3.1.4. Improvements to the Railway (Inter-modal option)

The only reasonable available inter-modal option is the rail service between Colombo and Negombo. (Fig. 3.1)

On this railway line, commonly known as the Puttalam line, there are 16 trains scheduled to run each way on weekdays. There is no passenger service to the BIA with freight services limited to one train per day on the spur line.

The average peak period headway on the Puttalam line is approximately 25 minutes. The average speed of 27 km/ h is only marginally higher than that on the A3. The off-peak service headway is often 120 minutes or more.

The proposed improvements will reduce the average headway and increase the speed. This will be achieved by engaging more locomotives and rolling stock, laying an additional track and improved signaling.

3.1.5 "No - action" Option

In this case it is assumed that there will be no investment in new main thoroughfare capacity, except normal maintenance activities on the A3 road (e.g. safety and surface condition improvements, etc.), aimed at facilitating continued operation without major reconstruction, rehabilitation or replacement.

Since the widening of the A3 from Katunayake to New Kelani Bridge in the mid 1970's, the only major improvement has been the rehabilitation of its pavement in the early 1990's. The obvious reason is that there are not many options available for improvements without overhauling the Motor Traffic Act and enforcement practices. Even such changes are able to enhance the level of service and safety only marginally. The surface quality and roadside improvements in the long run will not have an impact on the increasing volumes and changing vehicle composition.

As part of the "no action" alternative, Transportation Systems Management (TSM) is considered. These are actions designed to maximize the efficiency of the present system through changes in system operations and traffic flow. The TSM measures considered in this analysis are:

* segregation of motorized from non-motorized modes.
* signalization of intersections
* priority for buses and high occupancy vehicles (HOVs) such as Bus/HOV lanes etc.

3.2 Evaluation of Primary Alternatives

3.2.1 Ecological Considerations

The major impacts of a roadway on fauna and flora are the following :

impacts

a) Loss of parts of their habitats.

b) The immediate vicinity of the roadway will become non-conducive to the normal existence of some plants and animals due to factors such as noise, dust, chemical pollution, altered micro climate, paucity or non-availability of food and places, for sheltering and breeding.

c) Some animals will become vulnerable to accidents

d) Some animal populations will get divided and the free movement of animals within their habitats will be hindered.

e) Impediments to the flow of storm water can bring about changes in the existing eco-systems.

The following alternative traces will be evaluated based on these considerations.

Western Trace

This trace runs through or passes close to built up areas, homestead gardens, cultivated lands, marshlands, brackish water swamps, canals, streams and lagoon Fauna and flora in man made habitats in the study area (buildings, homestead gardens and cultivated lands) are common in the wet zone and there are no endangered species in these disturbed habitats. Animals living in these habitats, when displaced, are capable of moving into similar habitats fairly quickly. Therefore impacts of this trace on fauna and flora found in man made habitats could be considered to be ecologically insignificant.

The marsh, brackishwater swamp, canals, streams and lagoon on the other hand constitute an inter-connected and integrated wetland system. Part of the trace runs on the eastern edge of the proposed conservation zone in the Conservation Management Plan for Muthurajawela marsh and Negombo lagoon (1994).

The fauna and flora of this wetland are ecologically sensitive and there are some endemic endangered species of plants and animals among them. The actual loss of their habitat in terms of area is small.

The western trace will pass through the premises of the recently set up Muthurajwela Visitor Centre (MVC). It will separate the main building of the Centre from nature trail area. The MVC has been established to promote the ecotourism and to foster ecological awareness among the general public. This centre provides opportunities for bird watching, which could be done by walking down nature trails and by cruising along the canals.

Eastern Trace

The expressway will be 28.3 km long and will be built on an embankment 3 - 9m high. The width of the embankment at its base, will vary from 30 m on firm ground to 60 m on marshland.

The terrain through which it runs includes built up areas, homestead gardens, cultivated lands and marshlands. The fauna and flora of these habitats would be the same as those in similar habitats along the Western trace.

Improvements to the existing road (A3) and improvements to the railway

These two alternatives are considered together as adjacent areas of both traces are at present in an ecologically disturbed state. Therefore further physical changes along either trace such as widening or installation of additional structures (e.g. new rail tracks) will have no significant ecological impacts.

No action option Impacts

The ecological status of the Muthurajawela - Negombo Lagoon wetland system through which the Western trace is proposed could undergo changes if activities such as unplanned reclamation of the marsh, dumping of garbage and encroachment by potential squatters occur.

The terrain through which the Eastern trace is proposed will continue to be developed. They will gradually be transformed into "man-made" habitats.

3.2.2 Hydrological Considerations

Western Trace

Western trace lies to the west of the existing A3 road for most of the length. Since the A3 road already serves as a barrier against the free flow of the streams of Attanagalu oya basin , the new road has only a little additional impact on the flow. Where it runs on the banks of Old Negombo canal and Maha Dora canal, if suitable openings are provided to allow cross drainage, the impact will be minimal.

In the Kalu oya sub-basin, there will be some impact on the streams by the CKE embankment. Sufficient openings for small streams as well as a bridge for main Kalu oya will mitigate this impact.

The two other major bridges will be across Ja Ela and Dandugam oya. These are on the downstream of the bridges on the A3 and consequently has little impact.

The part of the trace that lies through the lagoon is only 1.4 km - and close to the shore, 50 m at the farthest point. There are no significant stream outfalls to the lagoon in this reach. Therefore this section does not cause significant hydrological impacts other than preventing tidal mixing. Openings that will be provided for passage of fishing crafts. These will serve for tidal mixing.

Eastern Trace

The trace after leaving Peliyagoda takes a northerly direction on a high embankment varying in height from 3 to 9m. This will effectively form a barrier across Attanagalu oya basin. In this option the existing A3 road will be on the downstream side of the proposed trace. Therefore the eastern trace intercepts the hitherto unconstrained flow of the river system. The impacts will be greater and felt for a longer distance downstream.

As stated earlier, the road will be elevated in this option. Therefore all the mitigatory measures such as providing bridges and culverts etc., will be costlier. As the economy has to be considered, it is likely that some of the impacts will not be fully mitigated. Therefore in this option, the hydrological impacts will be greater and there is the more likelihood of their not being properly mitigated.

Improvements to Railway / A3 road and " no action" option

These are not likely to cause any significant hydrological impacts.

3.2.3 Socio - Economic Considerations

The criteria adopted in evaluating socio- economic impacts are as follows: the number of people that would be displaced and houses and property affected ; loss of business and other sources of income; loss of institutional, cultural and other buildings; loss of prime agricultural land; number of communities severed ; number of sensitive receptors and sensitive locations such as schools, hospitals etc. in the neighbourhood ; impact on visual amenity and the potential for development.

Western Trace

The land use map of the 400 metre corridor (Fig. 3.2) along which the proposed western trace will run, shows that high density areas of over 5000 persons per km^2 occur in Peliyagoda, Wanawasala, Wattala, Mabole and Hunupitiya. These areas are interspersed with uninhabited marshes and abandoned paddy fields. To the north of this densely populated area, land use is a mixture of agricultural, marshland and medium density (2000 - 5000 persons per sq. ft.) residential areas. Beyond Dandugam oya, residential densities decline still further to less than 2000 persons per km^2.

LAND USE PATTERN ALONG THE THREE ROAD OPTIONS

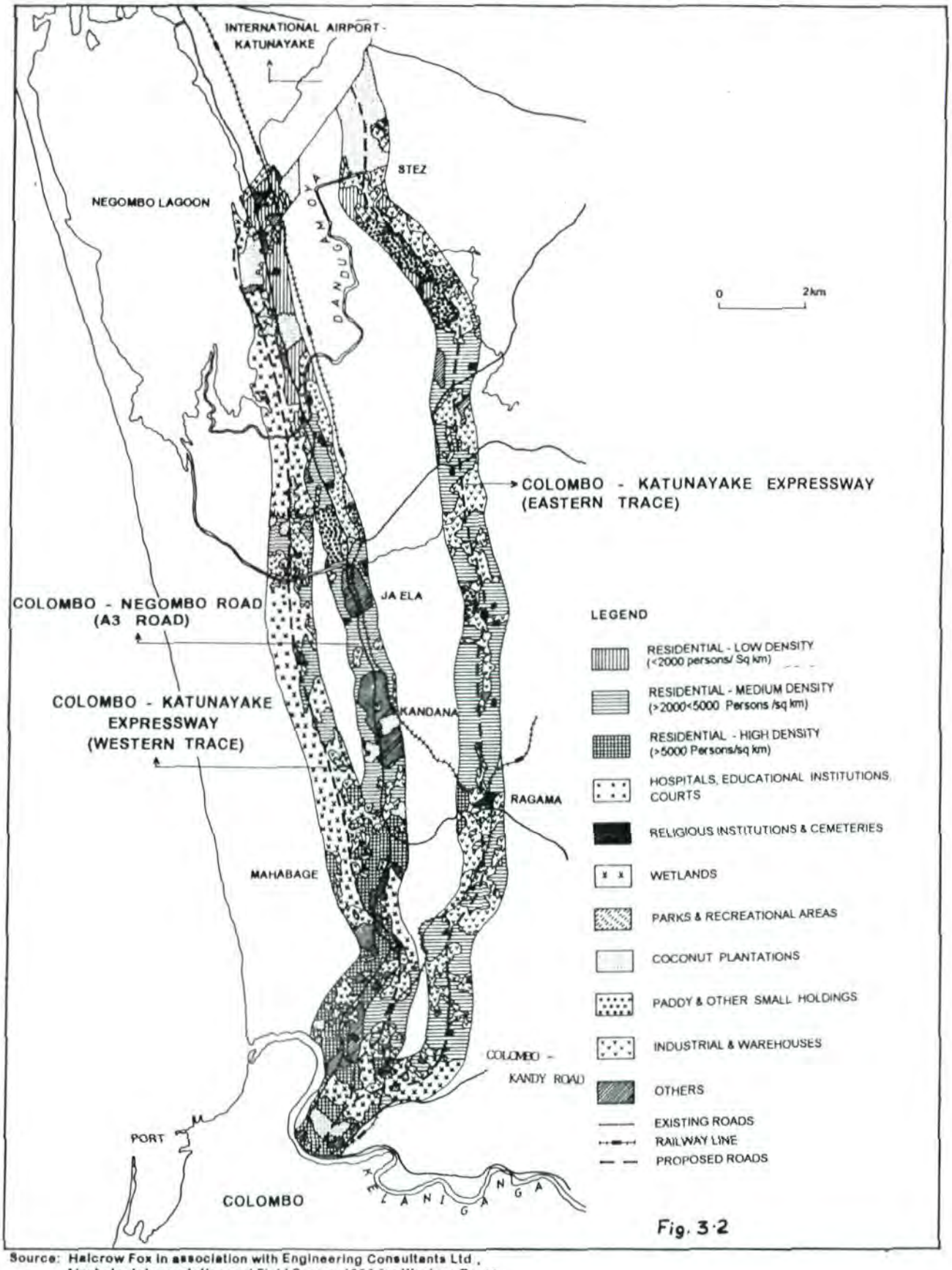


Fig. 3·2

Source: Halcrow Fox in association with Engineering Consultants Ltd., Airphoto Interpretation and Field Survey 1996 for Western Trace

Within the 30 m corridor of the trace however only 130 houses will be demolished. Of these, approximately 65 are shanties constructed by encroachers or squatters. Another 30 m wide strip of land with 60 houses will be acquired by the RDA as a reservation. These structures will not be demolished and the residents will be allowed to stay but no new buildings will be allowed on the reservation.

The resettlement of encroachers in Sites and Services projects as close to the original site as possible (as proposed by the RDA - Annexure III) would have a beneficial impact on these families. They would be assured of better housing with security of tenure and adequate facilities. Although they would lose the income derived from leafy vegetable (keera) cultivation they are in favour of resettlement.

On the other hand people in permanent abodes and owners of small businesses who are concentrated on the southern end of the trace in Peliyagoda, Wanawasala, Hunupitiya and Mabole are under considerable stress and are opposed to relocation. However, their problems would be minimised if relocation sites are chosen from the neighbourhood as proposed by the RDA.

More than 85% of the trace traverses low lying state land and abandoned paddy fields. Hence the impact on prime agricultural land and residential areas would be minimal. However, in the densely populated areas of Wanawasala, Hunupitiya and Mabole, residents who live on either side of the proposed trace are greatly concerned about severance of their communities, and high noise levels that would impact adversely on the mosque and school at Mabole. To reduce noise and dust, the RDA proposes to construct sound barriers in the areas that would be affected by the expressway. Links between communities severed by the CKE will be maintained through overpasses. There would not be changes in visual amenity, along major portion of the road, since the average height of the embankment will be 1.5 metres above ground level.

The trace will not affect lagoon fishermen adversely since openings will be provided for the passage of fishing craft in the lagoon.

The potential for development is higher in the areas to the south west, east, south east and northern sides of the trace. Development on its west is constrained by the presence of the Conservation Zone in the Muthurajawela marsh. The expressway will serve as a barrier to future encroachment by squatters. *The marsh can however be utilized for recreational and educational* purposes. There are possibilities of utilizing certain areas of the marsh for industrial or commercial development in conformity with the Muthurajawela Master Plan.

Eastern Trace

The eastern trace traverses one of the most densely populated areas in the Gampaha District. It cuts across major population concentrations in Peliyagoda, Dalugama, Dippitigoda, Hunupitiya, Enderamulla, Ragama and Ekala. As illustrated (Fig. 3.2) the southern part of the 400 m wide corridor, has very high population densities of 5000 persons per km ^{2}. A significant proportion of the remaining area has medium densities ranging from 2000 - 5000 persons per km^2. At major junctions such as Ragama and Dalugama commercial, institutional and other urban uses are interspersed with residential uses (Fig. 3.2). According to the EIA Report on the eastern trace, of the total land area affected, 54% comprises residential (houses and homestead gardens) and commercial land uses while 32% is under prime agricultural land (coconut, paddy and rubber).

Unlike in the western trace as much as 1480 houses and 101 other buildings in 26 villages and towns would be demolished by the eastern trace. (NHDA Census 1992). These buildings include 19 factories, 17 small industries, 45 commercial establishments 3 places of worship and 4 government buildings. (NHDA Census , 1992). Apart from the material loss of houses, property and businesses and income from agriculture and other sources, there would be adverse social and psychological impacts on a greater number of (a) people on the trace who are to be displaced and (b) people on either side of the trace.

As a result of involuntary displacement of a large number of families in 26 villages and towns family ties would be broken and the frequency of contacts between relations, friends and negihbours would be reduced. Unless they are resettled as close to their original homes as possible, displacement would affect their accessibility to schools, hospitals and other institutions, to places of worship and places of employment. Although previous road links would be maintained by under passes the residents on either side of the trace fear that the expressway would invariably divide communities due to the high elevation of the expressway embankment.

The EIA report on the eastern trace has identified several institutions at Ragama and a large number of residential areas along the trace that would be affected by the higher noise levels if the expressway is constructed. Since the trace cuts across densely populated areas, the number of sensitive receivers susceptible to noise impacts would be higher than that in the western trace. The extent along which sound barriers have to be erected as a mitigatory measure is much greater than for the western trace. The expressway would help improve accessibility to Colombo and Katunayake and to areas around intersections whereby the travel time would be reduced. Hence the potential for development of the surrounding area is high.

Improvements to A3

A contiguous built up area has emerged with a mixture of commercial, industrial, recreational, institutional and residential land uses on either side of the A3 with larger nucleations around major junctions such as Wattala, Kandana, Ja Ela. As shown in Fig. 3.2 high residential densities of over 5000 persons per km^2 occur on either side of the road up to Welisara beyond which densities decline.

A large extent of land has already been acquired for the widening of the road in 1975/ 76 and there would be a strong public sentiment against further acquisition. If the road is widened once again, a total of 1143 buildings would be demolished (Table 3.2). These include 757 commercial buildings, some of which are multistoried, with several establishments, 355 houses and 31 religious, educational and other buildings.

TABLE 3.2

NUMBER OF BUILDINGS THAT WOULD BE DEMOLISHED IF A3 IS WIDENED

Location	Commercial *	Residential	Educational	Religious	Other	TOTAL
Peliyagoda to Tudella	571	239	03	07	11	831
Tudella to Katunayake	186	116	03	04	03	312
TOTAL	757	355	06	11	14	1143

Source : RDA Field Survey 1996

* **Note : Multiple establishments in the same building counted as one.**

Commercial establishments with road frontages would lose the economic advantage of a prime location. Moreover suitable locations for resettlement are not easily available. Their relocation in the interior will not be acceptable since commercial, recreational and other establishments and institutions cater not only to a local clientele but also to the people who use the road daily.

Widening of the road will not be economically viable since it would involve payment of compensation to thousands of relocatees for loss of valuable property.

If widened, it is anticipated that traffic volumes, noise and air pollution would increase further. Since this is a road with unlimited access it will not be possible to construct sound barriers.

Improvements to the Railway

An additional track will impact adversely on squatters living on the reservation.

Severance of communities would be marginal. The potential for development would not be as high as for an expressway.

No Action Alternative

At present the A3 is over utilized by nearly 120% resulting in traffic congestion and traffic and pedestrian delays especially at major junctions. According to studies conducted by the Metropolitan Environment Improvement Programme (MEIP), traffic congestion from Colombo along the A3 is projected to increase from 26.5 km in 1992 to 28.7 km in 2000. In addition to increases in economic costs there would be the adverse social impacts from excessive noise, vibration, air pollution and from more accidents.

The potential for development is low because the land on either side is already built up and congestion and delays would prevent entrepreneurs from investing in the area.

3.2.4 Engineering Considerations

Western Trace

This trace is 24.6 km long and is estimated to cost Rs. 5 bn. The average height of the embankment is 1.5 m. This needs a narrower base than if it were taken on a high embankment. As the base is narrower, both the area covered by the trace and the volume of material required for embankment construction is smaller.

The trace involves seven road crossings and about 200 m of bridging. As the embankment is low, the number of road crossings can be increased even after construction. should the need arises, as overpasses can be provided without disturbing the expressway.

The road platform is designed for six lanes even though only four lanes of carriageway will be provided initially. The embankment will be provided for the full six-lane width. This is possible owing to the availability of the land. Only 15% of the land is privately owned, the balance being state land.

The construction technique proposed for the embankment is sound and proven as exemplified by the port access road. After two years of use by heavy vehicles no visible cracks and defects on the road pavement have been identified by the RDA.

As the road trace runs through marshy uninhabited lands, only 2 km of roadway requires road barriers and the maintenance cost of diamond fence around the road trace will be very low.

There are three interchanges in the road trace with a toll plaza and administration building. The project construction period is four years.

Eastern Trace

The road trace is 28.3 km long and will have 29 bridges and viaducts. The road pavement is a flexible conventional type. The total length of bridging is 1,700 m. The cost of the project will be around Rs. 20 billion. The project construction period is estimated to be five years.

The eastern trace passes through a highly developed area with a wide network of roads and therefore it has been designed as an elevated highway passing over all other roads. The average height of fill is 3 to 9 meters except for a few cut sections. The road embankment forms a massive earth bund and requires a large quantity of construction material. It cuts across populated areas separating communities, even to the extent of cutting off visibility of the other side of the road. Due to the massive quantity of material involved transporting them through the existing road network in the highly populated areas is not desirable.

The width of the road is planned for four lanes and cannot be increased due to the high cost of construction. There are two important drawbacks inherent to roads constructed on high embankments. The first is that due to high embankment, future widening of the road is difficult and expensive. Secondly lateral crossings will be limited to those provided at the time of construction with no subsequent additions being possible.

Where the road is elevated on embankment fill, the base width will be wider and as a result more land has to be acquired. More than 1500 buildings will be demolished as they are directly affected. However, the height of the embankment increases the area of adverse impact owing to the dust and mud flow. This makes it necessary for additional houses to be acquired as they will become uninhabitable even though they do not fall on the path of the trace.

Only 10% of land to be acquired is state land. Since 90% of land is privately owned, acquisition will be expensive and problematic. A long period of time is required for the acquisition of houses and property and relocation of people. Finding suitable land for relocation in the same area is difficult. People dislike being relocated in distant areas.

At least 15 km of sound barriers will be required where the road runs through highly populated areas, which is considerably more than that needed for the western trace. As the road sides are heavily populated the maintenance of diamond fences and sound barriers will be expensive.

Improvements to A3

Under this alternative, section of road A3 from Colombo to Katunayake will be widened from 20 m (66 ft) to 30 m (100 ft.). The A3 road was widened in 1976 and at present some geometric corrections are being made to obtain the present design width of 20 m (66 ft.). A3 route passes through a continuously built-up areas consisting of a mixture of commercial, industrial, recreational, institutional and residential land. The widening of A3 to 30 m (100 ft.) width involves demolition of 1143 buildings valued at present rate of Rs. 300 million and land valued at Rs. 1.7 billion. Hence the total cost of relocation of 1143 lots is estimated at Rs. 2.00 billion.

Even though actual construction work involved in widening of existing road pavement is much cheaper and quicker than building a new road the acquisition of 1143 lots on the road front may take a long time.

Unlike the two previous alternatives, this not being access controlled, will be subject to traffic conflicts arising from the frequent, uncontrolled intersections and driver behaviour. Therefore improvements to A3 road will not meet the projected demand.

The construction cost of widening the A3 route to 30 m including relocation cost is estimated to be Rs. 3.0 billion and the construction period will be 7 years inclusive of the acquisition period.

Since normal roads do not have wide shoulders and are not maintained up to the same standard used for expressways the cost of maintenance will be considerably lower. In the initial years very little maintenance will be required to the road pavement. Absence of wide shoulders eliminates much of the road maintenance cost. This alternative does not require any operational staff.

Improvements to Railway

This alternative proposes to lay additional tracks between Colombo Fort and Negombo and installation of signals. At present double tracks exist between the Colombo Fort and Ragama Station with a third track available in some sections. The section between Ragama and Negombo has only single track operation with loops at Kandana, Peralanda and Katunayake.

To improve efficiency it needs to increase the speeds and reduce the headway between trains. This could be achieved through the introduction of modern diesel multiple units with high pickup and rapid braking system along with the installation of an efficient train management system.

3.2.5 Evaluation of Automotive Air Pollution, Noise and Accidents with /without CKE against A3

a) Air Pollution

Air pollution from vehicles was calculated separately for the construction and the operation phases of the CKE. The comparison has been done using the CEA base data published in National Environmental (Ambient Air quality) regulations, 1994, Gazette (Extra - Ordinary 850 / 4 dated 20.12.1994) Table 3.3. The analysis clearly shows that there is a reduction of emissions from the new road as a result of higher speeds and diversion of traffic from A3 road to the CKE. The results obtained from Mexico City and Bangkok were used to estimate the emission loads in this section.

TABLE 3. 3

Pollutant	Averaging Time*	Maximum Permissible Level		Method of Measurement
		in mg/m^3	in ppm	
Carbon Monoxide	8 hr.	10	9.0	Non-dispersive infrared Spectroscopy
	1 hr.	30	26.0	
Nitrogen Dioxide	Any time	58	50.0	
	24 hr.	0.10	0.05	Colourimetric using. Saltzman method or
	8 hr.	0.15	0.08	equivalent(gas phase chemiluminescence)
Sulfur Dioxide	1 hr.	0.25	0.13	
	24 hr.	0.08	0.03	Pararosaniline method or equivalent
	8 hr.	0.12	0.05	(pulsed fluorescent method)
	1 hr.	0.20	0.08	
Ozone	1 hr.	0.20	0.10	Chemiluminescence method or equivalent (ultra violet photometric method)
Lead	Annual	0.0005	-	Hi - volume sampling, wet ashing/atomic absorption or spectroscopy
	24 hr.	0.002	-	
Suspended	Annual	0.10	-	HI - volume sampling and Gravimetric
Particulate	24 hr.	0.30	-	
Matter	8 hr.	0.35	-	
(SPM)	3 hr.	0.45	-	
	1 hr.	0.50	-	

* Minimum number of observations required to determine the average over the specified period :
03 hour average - 03 consecutive hourly average,
08 hour average - 06 hourly average,
24 hour average - 18 hourly average,
yearly average - 09 monthly averages with at least 02 monthly average each quarter.

\+ By wet chemistry methods or by automated analysers.

- Source - Central Environmental Authority 1994.

Table 3. 4 shows the annual emission loads from traffic flow of the CKE while Table 3.5 indicates the emissions from the A3 road, if the CKE proposal is implemented. Table 3.6 shows the annual emissions from the A3 road if the CKE proposal is not implemented.

The forecasted emission loads in kgs and the ppm indicated in Tables 3.4, 3.5, and 3.6 shows that the project will help to improve the air quality during the operation phase and it helps to improve the air quality of the existing road as a result of the reduction of traffic. The ppm level will be improved overall but, due to the CKE, new areas will get affected by vehicle emissions.

TABLE 3.4

ANNUAL EMISSION LOADS DUE TO TRAFFIC FLOWS OF CKE

(in ' 000 kgs)

Year	CO	HC	NOx	SOx	Aldehydes	PM
2001	253	59	261	77	15	20
2006	353	82	359	103	33	30
2011	472	109	475	134	32	42
2016	668	151	699	177	46	60

Source : Emission Estimate Model, World Bank.

TABLE 3. 5

ANNUAL EMISSIONS FROM TRAFFIC ON A3 ROAD WITHOUT CKE PROJECT

(in ' 000 kgs)

Year	CO	HC	NOx	SOx	Aldehydes	PM
2001	2,622	733	1,923	919	94	172
2006	3,653	1,004	2,671	1,262	138	246
2011	4,883	1,325	3,570	1,675	197	339
2016	6,381	1,705	4,648	2,169	272	455

Source : Emission Estimate Model, World Bank

TABLE 3.6

ANNUAL EMISSION FROM TRAFFIC ON A3 ROAD WITH CKE PROJECT

(in '000 kgs)

Year	CO	HC	NOx	SOx	Aldehydes	PM
2001	2,240	651	1,593	806	78	145
2006	3,149	898	2,259	1,122	117	210
2011	4,204	1,185	3,022	1,495	166	289
2016	5,471	1,524	3,940	1,946	228	389

Sources : Emission Estimate Model, World Bank

There is a decrease of air pollution as a result of the reduction of traffic congestion on the A3 road as a portion of the traffic is being diverted to the new road. The other factor is that the vehicles on the new expressway will be moving at high speeds with reduced emission levels compared to slow moving vehicles. It is estimated that during the construction period, the diesel -driven equipment moving in the area will add annually 300 kg. of CO, 132 kg of aldehydes and 102 kg of PM.

TABLE 3.7

SUMMARY OF THE NOISE GENERATION BY THE CKE AND ATTENUATION REQUIREMENTS

Area	Year	Zone	Reqd. Noise Level [dB (A)]	Peak Traffic Flow PCU	Speed km ph	Noise Generation [dB (A)]	Attenuation Required [dB (A)	Distance To Attenuate (metres)
Peliyagoda	2001	4	63	3600	60	82	19	(80-90m)
	2011	4	63	4800	60	98	35	(85-100m)
	2021	4	63	5300	60	107	44	(100-110m)
Hunupitiya	2001	3	60	2800	80	85	25	(135-150m)
	2011	3	60	3200	80	102	42	(145-155m)
	2021	3	60	4100	80	113	53	(145-160m)
Kerawalapitiya	2001	2	60	2400	100	88	28	(270-300m)
	2011	2	60	2600	100	105	45	(300-320m)
	2021	2	60	3400	100	115	55	(300-330m)
Ja Ela	2001	2	80	2700	100	79	0	(>300m)
	2011	2	80	3200	100	83	3	(>300m)
	2021	2	80	3900	100	92	12	(>300m)
Tudella - Pamunugama	2001	3	60	2700	100	84	24	(110-120m)
	2011	3	60	3100	100	88	28	(115-130m)
	2021	3	60	3700	100	95	35	(120-135m)
Katunayake	2001	4	63	1800	100	84	21	(100-120m)
	2011	4	63	2700	80	98	35	(115-130m)
	2021	4	63	3600	80	107	44	(120-135m)

Source : Transport Studies and Planning Centre

b) Noise Pollution

A model was used to estimate the noise levels during the operational stage of the road and during the construction stage. The input parameters were passenger car units and vibrations. The noise impacts depend on the road surface, number of tyres and speed of the vehicles, background noise levels, natural topographic shielding effects, shielding due to cutting and proximity to Noise Sensitive Receivers (NSR). The basic calibrations were done to estimate the noise level of the CKE.

The noise levels by zones have been forecast up to 2021. Where the forecast noise level is higher than the tolerable level, the distance required to attenuate also was calculated. These figures are given in the Table 3.7. For example, CKE would generate a noise level of 82 dB (A) at Peliyagoda in year 2001, while in 2021 it would generate 107 dB (A). Tolerable noise level being 63 dB(A), attenuation needed in these two years are 19 dB(A) and 44 dB(A), respectively. Where the required attenuation distance is not available, mitigatory measures have to be used.

C) Accidents

The total number of accidents on the A3 road has increased from 778 in 1992 to 1,347 in 1995. Number of fatalities has increased form 37 to 40 during the same period. The accident forecast has been carried out using the TRRL accident model calibrated using historical data. This model generates the relationship of the number of accidents with the number of Passenger Car Units (PCU) for the same period. Accident data for the past four years (Table 3.8) of the A3 road is used in this analysis.

The total number of accidents on the A3 road forecast from 1997 to 2022 is given in Table 3.9. The number of accidents increases in relation to the volume capacity ratio. The results obtained from the model shows that the proposed CKE would reduce the volume - capacity ratio of the A3 road. Savings from reducing the number of accidents on 1995 prices due to the construction of Colombo - Katunayake Expressway range from Rs. 3.3 million in 1997 to 12.9 million in 2022. Therefore, in terms of accidents the proposed Colombo - Katunayake road is beneficial to the country and this will be further increased with safety measures. The Table 3.10 provides details of the accident costs on the A3 road with the proposed CKE.

TABLE 3.8

ACCIDENT DATA FOR THE
A 3 ROAD (1992 - 1995)

	1992	1993	1994	1995
Fatalities	37	38	35	40
Grievously Injured	68	44	35	40
Non-grievously injured	261	263	321	372
Damaged vehicles	412	879	948	945
Total	778	1224	1339	1347

Source : **Police Stations of Wattala and Seeduwa.**

TABLE 3.9

ACCIDENT FORECAST FOR A3 (WITH THE PROPOSED CKE)

Year	ADT without Motor Bicycles	Fatalities	Grievously Injured	Non-grievously injured	Damage
1997	6,152	9	12	72	189
1998	6,642	10	13	78	204
1999	7,175	11	15	84	221
2000	7,753	12	16	90	238
2001	8,380	13	17	98	258
2002	9,060	14	18	106	279
2003	9,618	15	20	112	296
2004	10,214	16	21	119	314
2005	10,850	17	22	127	334
2006	11,529	18	23	135	355
2007	12,255	19	25	143	377
2008	13,030	20	26	152	401
2009	13,728	21	28	160	422
2010	14,469	22	29	169	445
2011	15,253	23	31	178	469
2012	16,085	24	33	188	495
2013	16,968	25	34	198	522
2014	17,904	26	36	209	551
2015	18,896	27	38	221	581
2016	19,761	28	40	231	608
2017	20,670	29	42	241	636
2018	21,627	30	44	252	665
2019	22,635	31	46	264	696
2020	23,695	32	48	277	729
2021	24,812	33	50	290	763
2022	25,987	34	53	303	799

Source : Transport Studies and Planning Centre.

TABLE 3.10

ACCIDENT COST A3 WITH THE PROPOSED CKE

(in million Rs.)

Year	Fatalities	Grievously Injured	Non-grievously injured	Damage	Total
1997	3.97	1.14	1.31	2.76	9.18
1998	4.28	1.23	1.42	2.99	9.92
1999	4.63	1.33	1.53	3.22	10.71
2000	5.00	1.44	1.65	3.48	11.57
2001	5.40	1.56	1.79	3.77	12.51
2002	5.84	1.68	1.93	4.07	13.53
2003	6.20	1.79	2.05	4.32	14.36
2004	6.58	1.90	2.18	4.59	15.25
2005	6.99	2.01	2.31	4.88	16.20
2006	7.43	2.14	2.46	5.18	17.21
2007	7.90	2.27	2.61	5.51	18.30
2008	8.40	2.42	2.78	5.86	19.45
2009	8.85	2.55	2.93	6.17	20.50
2010	9.33	2.69	3.09	6.50	21.60
2011	9.83	2.83	3.25	6.86	22.77
2012	10.37	2.99	3.43	7.23	24.01
2013	10.94	3.15	3.62	7.63	25.33
2014	11.54	3.32	3.82	8.05	26.73
2015	12.18	3.51	4.03	8.49	28.21
2016	12.74	3.67	4.21	8.88	29.50
2017	13.32	3.84	4.41	9.29	30.86
2018	13.94	4.01	4.61	9.72	32.29
2019	14.59	4.20	4.83	10.17	33.79
2020	15.27	4.40	5.05	10.65	35.38
2021	15.99	4.61	5.29	11.15	37.04
2022	16.75	4.82	5.54	11.68	38.80

Source : Transport Studies and Planning Centre

3.2.6 Economic Cost Benefit Analysis

To conduct a cost-benefit analysis, a baseline (no action alternative) option must be selected, against which all the other options can be measured. In this case the baseline is the road and rail system existing in 1996.

No Action Alternative

The existing road link is the 24 km A3 road from New Kelani bridge to Katunayake, which then continues to Negombo and Puttalam. In the most recent traffic count on this road for 1995, the average daily traffic (ADT) was 44,024 (inclusive of motorcycles) and 35,149 (exclusive of motorcycles). This was 24% cars, 39% light and medium goods, 17% buses and 20% motorcycles. The existing rail system runs 36 km from Colombo Fort to Negombo stopping at Katunayake, with a separate 1km section running to the Airport station. The line is double track from Colombo to Ragama (14km), and single track north of Ragama with passing loops at all stations and two of the halts.

Existing Road and Traffic Conditions:

The existing road access to the airport is along the 4 lane A3 road. Surveys show that traffic decreases with distance from Colombo. Thus ADT - the number of vehicles passing a particular point in both directions - depends on where along the road it is measured. ADTs have been estimated in four sections from Peliyagoda to Wattala (5 km), Wattala to Mahabage (3 km), Mahabage to Tudella (8km) and Tudella to Katunayake (8 km).

The most congested section is from Peliyagoda to Wattala with an ADT measured in 1995 of 44,024 (inclusive of motorcycles) and 35,149 (exclusive of motorcycles). This section has almost twice as much traffic as the last section from Tudella to Katunayake, which had an ADT measured in 1994 of 18,965 (excluding motorcycles).

In order to calculate the total number of vehicles using the road (which is useful to calculate toll revenue), it is necessary to find the number of vehicles which join the road north of Wattala. Estimates are that in addition to the 35,149 vehicles using the road from Peliyagoda to Wattala, another 3374 or 9.2% further vehicles join the road. This gives a total figure of vehicles (excluding motorcycles) using the road as about 38,500 in 1995.

Traffic predictions for the A3 road are based on past traffic growth trends on the A3 of 8% a year and past economic growth in the Western Province of 6% a year. It is assumed that traffic will continue to grow on the A3 road at 8% per year for the first seven years (until 2002), then at 7% a year for the next seven years, then at 3% a year. This gives an estimated ADT (excluding motorcycles) of 54,000 by year 2000, 96,000 by year 2010 and 151,000 by year 2020.

The 1995 journey time varies by time of day, with a minimum of 45 minutes at night, and maximum of 90 minutes during peak hours. Travel speeds average around 18km/hour at peak hours. Forecasts traffic show that by 2000, ADT will increase to above 50,000 (excluding motorcycles). This will cause further reductions in average speeds.

There is no detailed data on the destination and purpose of existing A3 road users. International flight departures and arrivals was 1.76 million during 1994, averaging out at about 4800 per day. Assuming that on average 2 passengers are traveling together (to allow for groups), this suggests that of the 19,000 ADT traffic (excluding motorcycles) reaching Katunayake, about 15% may be passengers going to and from the airport. Surveys in 1991 showed that 3000 vehicles passed in and out of the KIPZ Main Gate, including 469 containers, 1194 vans and 1244 cars (Japan Bridge, 1991). At 6% growth rates, this traffic would have reached 3800 by 1995. In addition, it is estimated that about 1000 buses per day use the Puttalam road to go to Katunayake. This suggests that about 25% of the A3 traffic reaching Katunayake turns off to the KEPZ. The remaining 40-50% of traffic reaching Katunayake would seem to continue on to Negombo.

Rail : The existing rail service runs from Colombo Fort to Negombo (36 km) with a separate 1 km side track to the Airport station. The line is double track on the 14 km up to Ragama, but on the 22km from Ragama to Negombo it is single track. At present about 6-7 locomotives serve the route providing 16 scheduled trains each way on weekdays. The trains run roughly every 2 hours during the day, but with a peak service of 20-25 minutes during the rush hour (peak direction only). The last train in both directions is about 8.30 p.m. However there are frequent cancellations. At present there are no through trains running direct from Negombo down the south coast, and so passengers have to terminate at Colombo and change.

The most recent survey of passenger trips on the Puttalam line in 1994 showed that there are 7,800 passenger trips each way, or 15,600 in both directions. Surveys also show that in 1994, there were an average of 490 passengers per train, with an estimated 1140 passengers in peak hour trains. This is higher than the Kelani line (390 average daily trips per train), but lower than the main line (1,230 passengers per train) and Coast line (1110 passengers per train) (Halcrow Fox, 1996). As with the road, the busiest section is nearer Colombo from Ragama to Peralanda.

One freight train each way serves the Airport station leaving Colombo at 5am and arriving at the Airport at 6.13am, and returning from the Airport at 6.50 p.m. and arriving at Colombo at 8pm. For the Airport station 1990 estimates show 5,386 journeys (both ways) per month. This means that by 1995, there were an estimated 624 daily trips in both directions. The low usage of the Airport station is for a number of reasons. First the direct Airport train arrives too early for factory workers, for whom factories open between 7am to 8am, and leaves too late in the evening. However a more frequent service or a more suitable time tabling is not possible as the locomotives are used to provide services for the Colombo-Negombo connection. In addition, many of the factory workers either live within walking distance, or on areas not served by the railway (eg. Gampaha, Biyagama). According to information from factories at the KIPZ less than 3% of workers use the railway for commuting to work (Japan Bridge, 1992).

No detailed data is available on passenger growth on the Colombo-Puttalam line. However national data for railway demand shows that passenger trips are increasing at 6.2% per year. This means that in 1995, there were an estimated 16,550 passenger trips both ways, increasing to 21,000 passenger trips by year 2000, assuming the same rates are applicable.

Economic Cost Benefit Analysis

For the conventional cost benefit analysis, the benefits of each option include the direct benefits to road and rail users of time savings and reductions in vehicle operating costs (VOC). In the case of the rail and road revenue (ie from tolls), this can be included, but then it must be subtracted from the time savings and VOC savings. Indirect benefits such as opening up land for development are not included. The costs of each option include both the capital costs of construction, land acquisition, as well as the variable costs of maintenance etc.

For the economic appraisal, the project is evaluated over 26 years, with construction assumed to begin in 1997 taking 4 years to compete. Thus the benefits of the project will begin in year 2001 and continue up until year 2022.

Once the annual costs and benefits of each option are known, they are summed over the 26 years, and discounted back to the present to find the net present value. The discount rates selected are 12%.

The forecast volume of traffic on the A3 road is such that it may be economically viable to implement a number of options at the same time. Thus for example, there may be sufficient demand for access to Negombo to justify the construction of an expressway, as well as improving the existing A3 road and improving the rail service. In this analysis, for the sake of simplicity each option is evaluated separately. Based on the benefit cost ratio for each option, it is economically efficient to construct any option whose benefits are higher than the costs, or whose economic rate of return is higher than the discount rate. However given limited resources, it is economically most efficient first to construct the option with the highest benefit cost ratio, or the highest economic rate of return. Thus in this analysis, the recommended alternative will be the option with the highest economic rate of return.

Calculating Benefits of Options

The conventional economic benefits of each option will include time savings and VOC. The VOC and time savings will apply both to passengers using the option, and those left on the existing road, which will proceed more quickly.

Time Savings

These are calculated on the basis of value of time per hour. These take into account the average income of car-owning and non-car owning groups, working hours, trip purpose composition, difference in time values between work trips and other purposes and average occupancy by vehicle type. The relevant data is shown in the Table 3.11.

TABLE : 3.11

ASSUMPTIONS FOR CALCULATION OF TIME VALUES PER VEHICLE PER HOUR

	Car	Train	Bus
Income (Rs/month)	7500	4500	3000
Income (Rs/hour)	47	28	20
Average occupancy	2.5	490	24
Trip purpose (composition) work other	 56% 44%	 66% 34%	 66% 34%
Time value factor work other	 100% 0%	 100% 0%	 100% 0%
Time value/hour/ vehicle (Rs)	66	9055	316

Source: Transport Studies and Planning Centre, 1996

Once the time values per hour per vehicle are calculated, it is necessary to first calculate the baseline time costs without the project. This is the time values per vehicle multiplied by the time taken per vehicle multiplied by the total number of vehicles.

For each option the new total time values then need to be calculated. This must include the time savings that accrue to vehicles on the new route and to those that remain on the A3 which is also going faster. These time values can then be subtracted from the time values with the baseline case, to give the net time savings.

Vehicle Operating Costs (VOCs)

These are a function of fuel, lubricants, tyres, crew, passengers, maintenance labour, maintenance parts, depreciation, interest and overheads. VOCs vary depending on surface roughness and speed. In the financial calculation, fuel makes up 30% of the total cost due to the high taxes on petrol. However in the economic costs, fuel is much lower since here the tax is removed. The Table 3.12 below illustrates these values of one measure of road roughness.

TABLE 3.12

ECONOMIC AND FINANCIAL VEHICLE OPERATING COSTS (VOCs) AT 65 KM/ HOUR WITH ROAD ROUGHNESS 6

Category	Financial Cost		Economic cost	
	Rs per 1000 km	Percentage %	Rs per 1000 km	Percentage %
Fuel	3185	31	1014	18
Lubricants	118	1	89	2
Tyres	184	2	119	2
Maintenance - Labour	189	2	189	3
Maintenance - Parts	1087	11	544	10
Depreciation	1927	19	991	18
Interest	1786	17	684	12
Crew + Passenger	1441	14	1705	30
Overheads	369	4	302	5
TOTAL	10,286	100	5637	100

Source: Transport Study and Planning Centre, 1996

Evaluating Economic Costs and Benefits of Options

Western Trace

The option is the construction of a 4 lane controlled access expressway of 24.6 km from New Kelani bridge to the Katunayake Airport turn-off. In addition to the two end points, the road would have 3 interchanges at Peliyagoda, Kerawalapitiya and Tudella.

Costs

The capital costs of the expressway includes the basic construction cost (including the toll booths) and the cost of land acquisition and relocation. These are estimated by the RDA to cost Rs 5 billion as detailed in Table 3.13. In addition, there are periodic costs of maintenance estimated at Rs 7.7 million per year as the road roughness needs to be kept to a very high quality.

Benefits

For the toll road options it is necessary to model the number of vehicles shifting to the new road. The benefits to these users and to those that remain on the A3 can then be calculated in terms of savings in VOCs and time.

TABLE : 3.13

PROJECT COST (WESTERN TRACE)

No.	Work Items	Preliminary Design (A)
(A)	Construction Cost	
A.1	General Item	340,000,000.00
A.2	Earth Works	330,000,000.00
A.3	Drainage and Pipe Culvert	386,000,000.00
A.4	Road Works	800,000,000.00
A.5	Road Structures (Culverts)	276,000,000.00
A.6	Bridge Works	778,000,000.00
A.7	Highway Utilities	300,000,000.00
A.8	Administration Building	75,000,000.00
A.9	Toll Collection System and Toll Booths	20,000,000.00
A.10	Miscellaneous	20,000,000.00
	Total (A)	3,325,000,000.00
(B)	Engineering Fee	350,000,000.00
(C)	Other Costs	
C.1 C.2	Land Acquisition Fee Compensation	400,000,000.00
C.3	Taxes and Duties	200,000,000.00
C.4	Administration Cost of RDA	15,000,000.00
	Total (C)	615,000,000.00
(D)	Contingency	
D.1 D.2	Physical Contingency) Price Contingency)	710,000,000.00
	Total (D)	710,000,000.00
(E)	Project Cost (A + B + C + D)	5,000,000,000.00

To calculate ADT on the toll road requires an estimate of the level of vehicles that will choose to pay the toll and shift to the new road. As the benefits of the toll road are its faster speed (and hence time savings and lower VOC) the toll should be set to ensure that vehicles shifting to the toll road can maintain an average speed of 80 km per hour. (The road has been designed for 100 km an hour and no speed limit has yet been set). It is assumed that motorcycles will be banned from the toll road to avoid accidents and maintain the 80 km/hour speed limit.

International estimates show that the maximum number of cars per hour that can comfortably travel per lane is 2200 vehicles. Allowing for the mixed traffic of buses (20%), trucks (50%) and cars (30%), and the service volume at the standard level of service C, this will reduce the maximum number of vehicles to 1100 per hour. Allowing for a direction split of 70% in the peak hour, and peak ratio of 10%, this translates into an average daily traffic of 31,500 for a 4 lane road. Thus the toll should be set so that the ADT does not exceed 31,500 vehicles per day.

Taking these maximum capacity constraints, the traffic assignment model is then run to find the maximum revenue for a given level of capacity. The decision by vehicle operators to use the toll road is based on the cost of using the road (ie the toll) versus its benefits. The toll is assumed to be a vehicle specific flat toll (ie it does not vary with distance traveled). The benefits of the toll road are a weighted sum of the benefits from reduced vehicle operating costs and from time savings.

The results suggest that a toll of Rs. 30 for cars, Rs. 20 for buses, Rs.45 for medium and light trucks and Rs. 100 for containers and large trucks gives the right mix of traffic and the desired level of ADT. The results are given in Table (3.14), which shows that toll traffic in the first year of operation will be about one quarter cars, half light and medium goods vehicles and the remainder heavy trucks and buses. This means that most smaller goods vehicles, long distance buses and heavy trucks will shift to the toll road from the A3.

TABLE: 3.14

BASELINE AND ASSIGNED TRAFFIC TO FOUR LANE TOLL ROAD IN YEAR 2001 (AT PELIYAGODA)

	Total daily traffic without project (Nos.)	Toll (Rs)	Total daily traffic on toll road (Nos.)	Total daily traffic staying on A3 (Nos.)	Percentage of vehicles switching (%)	Traffic composition of toll road
Cars	15,780	30	3945	11835	25	26
Medium Buses	5493	20	1373	4119	75	9
Large Buses	4388	20	1097	3291	75	7
Light and Medium Truck	30,275	45	7554	22661	75	50
Heavy Truck	1458	100	1167	292	80	8
	Total ADT= 57,334		Total ADT= 15,136	Total ADT= 42199	Average switch= 26%	100

Source : **Transport Studies and Planning Centre**

Taking these estimates of ADT, the time savings and VOC savings are then calculated. The benefits are shown for selected years, and with a total benefit after discounting. (Table 3.15).

TABLE: 3.15

BENEFITS OF THE WESTERN TRACE

Year	Benefits (Rs million)
2001	11915
2006	17139
2011	24273
2021	42741
2001-2022	97403 (at 12% discount rate)

Source: Transport Studies and Planning Centre, 1996

Results

When the costs and benefits of the western trace are compared, the result is an internal rate of return of 63%, Net present value of Rs 93 billion, and benefit cost ratio of 21.5. (Table 3.16)

TABLE : 3.16

ECONOMIC EVALUATION OF WESTERN TRACE

Year	Benefit	Cost-W	Net Ben-E
1	0	5000	-5000
2	0	0	0
3	0	0	0
4	0	0	0
5	11915	11.2	11903.8
6	12996	11.2	12984.8
7	13961	11.2	13949.8
8	15000	11.2	14988.8
9	16117	11.2	16105.8
10	17319	11.2	17307.8
11	18613	11.2	18601.8
12	20006	11.2	19994.8
13	21334	11.2	19994.8
14	22754	11.2	21322.8
15	24273	11.2	22742.8
16	25898	11.2	25886.8
17	27636	11.2	27624.8
18	29497	11.2	29485.8
19	31490	11.2	31478.8
20	33126	11.2	33114.8
21	34851	11.2	34839.8
22	36669	11.2	36657.8
23	38586	11.2	38474.8
24	40608	11.2	40596.8
25	42741	11.2	42729.8
26	44990	11.2	44978.8

NPV	92885.03
IRR	0.629615
DIS.BENEFIT	97403.72
DIS.COST	4518.699
B/C RATIO	21.5557

Source : Transport Studies and Planning Centre

Eastern Trace

The eastern trace is the proposed 4 lane expressway running from New Kelani bridge to Katunayake via an inland route. The route is described in detail in reports by JICA.

Costs

The costs of the route are given in the Japan Bridge Final report in 1993 prices as construction costs of Rs 6.9 billion and total project costs (including land acquisition, engineering services and contingency) of Rs 10.5 billion. These figures would have risen to about Rs. 16 billion in 1996 prices. However these figures do not include the need to raise the expressway at many points to allow access under the road, which was discussed during public consultation. Including all these additions, the RDA now estimates that the cost of the road would be about Rs 20 billion (1996 prices) - four times the cost of the western trace. This is set out in Table 3.17.

Benefits

While the Japan Bridge report provides estimates of traffic demand for the eastern trace, these are not directly comparable to our estimates for the western trace due to differences in modeling. The Japan Bridge report assumes lower traffic volumes in the without project alternative (44,000 ADT at Wattala - including motorcycles - in year 2000 in their report, compared to 69,000 in our models), but they also assume a higher proportion of traffic will transfer to the toll route (ADT of 15,400 vehicles in 2000 in their report compared to ADT of 11,000 in our model).

Thus according to their model, the eastern toll road will have 35% of the A3 ADT, while in our model the western toll road will have only 26% of the A3 ADT. In other words, according to these results, the eastern trace will attract roughly one third, or 35% as much traffic from the A3 road as the western trace. This is partly because the Japan Bridge report assumes a slightly lower toll for heavy vehicles. However the main explanation for this difference is that there is some evidence that the eastern route by being more inland will attract more traffic. This is both because it is further from the existing A3 road, and because it is closer to the Kandy road, so some traffic may switch from the Kandy road to the eastern toll route.

For the purposes of comparing the two traces, we assume that the eastern trace will attract one third as much traffic as the western trace. For the purpose of simplicity, this can be then assumed to generate one third as many benefits in terms of time saving and vehicle operating cost saving as the western trace. (Table 3.18)

TABLE : 3.17

PROJECT COST (EASTERN TRACE)

No.	Work Items	Preliminary Design (A)
(A)	Construction Cost	
A.1	General Item	1,119,000,000.00
A.2	Earth Works	4,506,000,000.00
A.3	Drainage and Pipe Culvert	598,000,000.00
A.4	Road Works	3,043,000,000.00
A.5	Road Structures (Culverts)	477,000,000.00
A.6	Bridge Works	2,593,000,000.00
A.7	Highway Utilities	486,000,000.00
A.8	Administration Building	129,000,000.00
A.9	Toll Collection System and Toll Booths	135,000,000.00
A.10	Miscellaneous	126,000,000.00
	Total (A)	13,212,000,000.00
(B)	Engineering Fee	1,174,000,000.00
(C)	Other Costs	
C.1	Land Acquisition Fee	1,178,000,000.00
C.2	Compensation	627,000,000.00
C.3	Taxes and Duties	1,898,000,000.00
C.4	Administration Cost of RDA	93,000,000.00
	Total (C)	3,796,000,000.00
(D)	Contingency	
D.1	Physical Contingency	
D.2	Price Contingency	1,818,000,000.00
	Total (D)	1,818,000,000.00
(E)	Project Cost (A + B + C +D)	20,000,000,000.00

Source : Road Development Authority

TABLE : 3.18

BENEFITS OF THE EASTERN TRACE

Year	Benefits (Rs million)
2001	16085
2006	23380
2011	32768
2021	57700
2001-2022	59,736 (at 12% discount rate)

Source: Transport Studies and Planning Centre, 1996

TABLE: 3.19

ECONOMIC EVALUATION OF EASTERN TRACE

Year	Benefit	Cost -E	Net Ben - E
1	0	20000	-20000
2	0	0	0
3	0	0	0
4	0	0	0
5	16085.3	11.2	16074.1
6	17544.6	11.2	17533.4
7	18847.4	11.2	18836.2
8	20250	11.2	20238.8
9	21758	11.2	21746.8
10	23380.7	11.2	23369.5
11	25127.6	11.2	25116.4
12	27008.1	11.2	26996.9
13	28800.9	11.2	28789.7
14	30717.9	11.2	30706.7
15	32768.6	11.2	32757.4
16	34962.3	11.2	34951.1
17	37308.6	11.2	37297.4
18	39821	11.2	39809.8
19	42511.5	11.2	425.003
20	44720.1	11.2	44708.9
21	47048.9	11.2	47037.7
22	49503.2	11.2	49492
23	52091.1	11.2	52079.9
24	54820.8	11.2	54809.6
25	57700.4	11.2	57689.2
26	60736.5	11.2	60725.3

NPV	113583.6
IRR	0.380775
DIS. BENEFIT	131495.2
DIS. COST	17911.56
B/C RATIO	7.341359

Source : Based on Japan Bridge and Structure Institute Inc.,1992

Results

When the costs and benefits of the eastern trace are compared, the result is an internal rate *of return of 38%, Net present value of Rs 113 billion, and benefit cost ratio of 7.3. (Table* 3.19)

C Improvements to Existing A3 Road (widening and traffic management)

The existing A3 road, could be significantly improved to increase traffic flow and reduce accidents. The main problem is currently the loss of the side of the road by parking, the large number of motorcycles and the poor lane discipline by drivers. The situation towards Colombo has improved by the placements of road medians to control over-taking. The road could be improved by widening the road to create a separate lane for cycles and motorcycles, redesigning key junctions and other design improvements.

Costs

It is estimated that the capital costs would be in the region of Rs. 3 billion, including Rs 1.1 billion construction costs and Rs 1.9 billion for relocation set out in Table 3.20. In addition, there will be the same maintenance costs as for the western trace.

TABLE : 3.20

COST ESTIMATE FOR THREE ROAD OPTIONS

1. Cost Estimate for the Western Trace

(a)	The approximate construction Cost	-	Rs.	4,600	Million
(b)	Approximate Cost of Relocation	-	Rs.	400	Million
	Total Approximate Cost Estimate for the Western Trace	-	Rs.	5,000	Million

2. Cost Estimates for Widening of Existing Colombo Katunayake Road (A3)

(a)	The approximate Construction Cost	-	Rs.	1,100	Million
(b)	The approximate Cost of Relocation	-	Rs.	1,900	Million
	Total approximate cost estimate for Widening of existing Colombo - Katunayake Road	-	Rs.	3,000	Million

3. Cost Estimates for the Eastern Trace (Estimated in 1992)

(a)	Total Construction Cost	-	Rs.	18,195	Million
(b)	Total Relocation Cost	-	Rs.	1,805	Million
	Total Cost Estimate	-	Rs.	20,000	Million

Benefits

The benefits of improving and widening the A3 are set out in the Table 3.21.

TABLE : 3.21

BENEFITS OF IMPROVING AND WIDENING A3

Year	Benefits (Rs million)
2001	445
2006	553
2011	688
2017	856

Source: Transport Studies and Planning Centre, 1996

When these benefits are compared with the costs, they give an internal rate of return of 18%, net present value of Rs.1 billion, and benefit cost ratio of 2.5.

D Improvements to rail service

In order to assess the most economically efficient rail option a number of sub-options have been identified. These are given below.

Passenger Service

a. Minor improvement to Colombo-Negombo line: upgrading 36km of line.

b. Minor improvement to Colombo-Negombo line and increased frequency of service to Negombo: upgrading 36km of track and purchase of one new diesel multiple unit.

c. Major improvements to Colombo-Negombo line and increased frequency of service to Negombo: double track for 22km from Ragama to Puttalam (including 2 additional bridges), and one new diesel multiple unit.

d. Major track improvements to Negombo and increased frequency of service to Airport Station: (double track and 2 diesel multiple units to extend improved service to the Airport station).

Cargo Service

e. Cargo service from Colombo Port to Airport Station: Double track on 22km north of Ragama, one extra diesel unit and installation of two container ranes for loading containers.

The option of electrification of the Puttalam line has not been investigated, since data suggest that electric units would not be much faster than modern diesel units (Halcrow Fox, 1996), but would have much higher capital costs.

As with other options it is necessary to compare the capital and operating costs of each option with the benefits. The benefits are calculated in terms of time savings both to existing rail passenger and time savings and vehicle operating cost savings to new passengers who shift to rail from other modes. In addition, there will be savings to vehicles left on the A3 if the switch of passengers to rail has an impact on congestion.

Even if economic appraisal results are positive, the government may still lack funds to make any changes. Indeed financial appraisal of the rail option would give much lower results since current train fares on the Colombo to Puttalam line cover only 27% of operating cost and only 16% of operating and capital costs (Halcrow Fox, 1996). Thus even if the rail option has net social benefits, the railway may not have sufficient revenue to make the investment at the current level of low fares.

TABLE : 3.22

ECONOMIC EVALUATION OF ROAD WIDENING

PELIYAGODA TO KATUNAYAKE (A3) ROAD

(in Million Rs.)

Year	Total VOC Saving	Total PTC Saving	Total Benefit	Cost of Widening	Net Benefit
1	212	162	374	2985	-2611
2	220	170	391		390.58
3	229	179	408		407.9042
4	238	188	426		426.0064
5	248	197	445		444.922
6	258	207	465		464.688
7	268	217	485		485.3431
8	279	228	507		506.9278
9	290	239	529		529.4844
10	302	251	553		553.0573
11	314	264	578		577.6927
12	326	277	603		603.4392
13	339	291	630		630.3476
14	353	305	658		658.4707
15	367	321	688		687.8643
16	382	337	719		718.5864
17	397	354	751		750.6977
18	413	371	784		784.2619
19	429	390	819		819.3454
20	447	409	856		856.018

NPV	**1,061**
IRR	**18%**
C/B RATIO	**2.512888**

Note: These results were obtained using V/C and speed model. (with and without widening.)

Source : RDA

Costs

The costs of rail include capital cost of track upgrading and, new rolling stock and operating costs. The basic data for cost are shown in the table.

TABLE : 3.23

COSTS OF MAJOR RAILWAY INVESTMENTS

Item	Cost (Rs)
Minor improvements to line (e.g. new ballast and sleepers)	3 million/km
Major improvements to line	13 million/km
Cost of signaling	5 million/km
Bridges	1 million/metre or 38 million for 38 metre bridge
Multiple diesel unit (engine and 4 carriages - capacity 1500 passengers)	200 million
Annual operating cost of each train (Rs 0.55 per passenger km x 36 km x 4 x 490 passengers x 200)	7.76 million per year
Mobile container crane	6 million

Source: Railway estimates

The capital costs for the different options are presented in the Table 3.24.

TABLE 3.24

COST OF RAIL OPTIONS

Option	Capital cost: track (Rs)	Capital cost: rolling stock etc. (Rs)	Total capital cost (in million Rs.)	Annual operating cost (in million Rs.)
A Minor track improvement	3 million/ km x 36km = 108 million	-	108	-
B. Minor track improvement and improved frequency	3 million/km x 36 = 108 million	1 diesel multiple unit = 200 million	308	7.75
C. Major improvements and improved frequency to Negombo	(18 million/km x 22km) + (38 million x 2)= 472 million	1 diesel multiple unit = 200 million	672	7.75
D. Major track improvement and improved frequency to Airport	(18 million/km x 22km) + (38 million x 2) = 472 million	2 diesel multiple unit = 400 million	872	15.5
E. Major track improvement and cargo service	472 + (13 million /km x 3) = 508	1 diesel multiple unit (200 million) + 2 container cranes (6 million x 2) = 212 million	720	7.75

Source: Consultant's calculations from Railway data, 1996

Benefits

As with the benefits of road options, the benefits should include the benefits to existing rail passengers from saved time, benefits to new passengers who transfer to rail, and reduced congestion costs for those who remain on the A3.

The benefits of the cargo option are not included but are unlikely to be considerable since lorries which currently charge only Rs 3000 to deliver to Katunayake are already cheaper than the rail option.

TABLE : 3.25

ESTIMATED BENEFITS OF RAIL OPTIONS TO RAIL PASSENGERS

Option	Time saving per train (Rs)	Daily frequency of trains	Daily savings (at Rs 9055 per hour)	Annual savings
A. Minor improvement	0.17 hours (10 min) x 9095 = 1516	32	48,500	9.7 million
B. Minor and frequency	0.17 hours (10 minutes) x 9095	36	54,576	10.9 million
C. Major and frequency	0.33 (20 minutes)x 9095	36	109,140	21.8 million
D. Major improvements and frequency to airport	0.33 x 9095	40	121,280	24.2 million

Source : Consultants' calculations from Railway data, 1996

As with the road option it is necessary to calculate the modal shift from the A3 road to the train service. As with the traffic assignment model, the decision by and individual user to take the train is based on the cost of the train (ie the fair) versus its benefits. The benefits of the shifting to rail for private vehicle owners will be savings in vehicle operating costs, and time savings if there is any. The benefits for bus passengers will be saving in bus fares and any time savings if there are any. The relative benefits must also cover the frequency and quality of service and the problems of access to the train station.

In 1995, average number of train passengers was 21,000. Assume this goes up by 33% to 28,200 due to increased frequency of service by 10 Mts. This will mean a decline of bus passengers by 7200 which at average occupancy of 24 leads to a reduction in buses by 300 per day. This is equivalent to 6% decline.

TABLE : 3.25 b

RAILWAY OPTIONS : COSTS VERSUS BENEFITS TO RAIL USERS ONLY. (Rs. Million)

Option	Annual benefits (in million Rs.)	Benefits over 20 years (in million Rs.)	Operating costs over 20 years (in million Rs.)	Capital costs (in million Rs.)	Costs over 20 years (in million Rs.)	Payback period
A. Minor track improvement	9.7	194		108	108	11 years
B. Minor and frequency	10.9	218	155	308	463	-
C. Major and frequency	21.8	436	155	672	827	-
D. Major improvement and frequency to airport	24.2	484	310	872	1182	-

Source: Consultant calculations with railway data, 1996

Summary of Conventional Cost Benefit Analysis Five Options

From the summary Table 3.27, it is clear that the western trace has a higher rate of return and benefit cost ratio. It has a slightly lower net present value than the eastern trace as fewer traffic will transfer. But based on the internal rate of return and benefit cost ratio, the western trace is the most economically attractive option.

TABLE 3.27

SUMMARY OF ECONOMIC ANALYSIS OF FIVE OPTIONS

	No action	Eastern trace	Western trace	Road widening	Rail option
Capital Cost (Rs billion)	0	20	5	2.98 *	0.1
Cost (capital and operating - discounted over 26 years at 12%) (Rs. million)	0	17,911	4,519	0	108
Benefits (discounted over 26 years at 12%) (Rs. million)	0	131,495	97,403	4,096	1,034
Net present value(over 26 years at 12%) (Rs. million)	0	113,584	92,885	1,061	938
Benefit/cost ratio	0	7.3	21.5	2.5	10.7
Internal rate of return	0	38%	63%	18%	47%

*** road widening discounted over 20 years.**

Source: 1) Transport Studies and Planning Centre, 1996
2) Consultants' calculations

3.2.7 Environmental (Extended) Economic Analysis

From the economic analysis, it is clear that the western expressway has the highest rate of return. The following section attempts to add to the economic analysis, the environmental impacts of the western trace to see if this significantly alters the rate of return, and to provide economic justification for certain mitigatory options.

The "environmental" impacts of operation includes the following components:

Accidents
Severance
Disruption to lagoon (fisheries and biodiversity)
Noise and Visual intrusion
Air quality
Hydrological impacts of increased flooding

Each of these impacts (except air quality) can be mitigated by certain design measures. These are summarised in the Table 3.28.

Loss of land (acquisition costs) and relocation costs have already been included in the conventional economic appraisal, so it is not necessary to include them here.

Environmental impact	Mitigatory measure
Resource extraction - sand dredging and stockpiling	Proper drainage of stockpile, deep sea mining of sand with proper dredging methodology
Damage to road surface from heavy vehicles	Repair and maintenance
Noise	Work restricted to daylight hours in residential areas
Air quality - dust	Dust abatement measures

TABLE 3. 28

KEY ENVIRONMENTAL IMPACTS DURING OPERATION OF THE EXPRESSWAY AND MITIGATORY MEASURES

Environmental impact	Mitigatory measure
Road Accidents	Proper road design, lighting, speed controls, barriers and pedestrian footbridges
Severance (lack of access to lagoon and across road)	Viaducts and footbridges
Disruption to lagoon flora and fauna	Vents under road to allow water flow in lagoon
Noise	Noise screens, surface of road
Visual intrusion	Sight screen
Air quality	Minimum speed restrictions
Increased flooding	Sufficiently wide bridges

A. Accidents

The A3 road is the most dangerous road in the country with about 40 fatalities from accidents in 1995 - equivalent to about 2 deaths per year per km. With the expressway, it is assumed that there will be a decline in traffic on the A3 and hence the number of accidents on the A3 road will also reduce.

The economic cost of injuries and death can be measured by the amount people are willing to pay for different types of insurance. (Table 3.29)

TABLE 3.29

ACCIDENTS COSTS

Category of injury	Cost (from insurance premiums)
Fatalities	420,210
Grievous injured	91,350
Non-grievous injured	18,616
Damage	14,616

Source: Transport Studies and Planning Centre, 1996

When the net reduction in accidents is calculated in monetary terms based on the accidents costs given above, then the net benefits of the expressway in reducing accidents are given in Table 3.30.

TABLE 3. 30

BENEFITS FROM REDUCED ACCIDENTS ON EXPRESSWAY

Year	Benefits (Rs million)
2001	12.5
2006	17.2
2011	22.8
2021	37

Source: Transport Studies and Planning Centre, 1990

B. Severance

Severance refers to the disruption to pedestrian and other movements due to the construction of the expressway. Unlike the eastern trace which divided many communities, the western trace by running along the lagoon and the less populated Muthurajawela area, will cause much less division of existing communities. However in the urban centres, such as Peliyagoda etc., there will be some severance, and this justifies a number of foot bridges / underpasses to allow pedestrians and vehicles to cross.

The other main aspect of severance is loss of access to the lagoon by both fishermen and for waterspouts. The number of fishermen currently entering the lagoon along the 1.4 km stretch is small. However there is considerable use of the lagoon for windsurfing especially from the Airport Garden Hotel. If access under the lagoon costs Rs. 2 million, then it would be necessary for the severance costs to be in the order of Rs 200,000 per year for 10 years to justify viaducts. While this may not be the case at present, it could be so in the future with increased hotels developed in the area. This suggests the need for a number of access points under the road to the lagoon where two viaducts are proposed.

C. Disturbance to lagoon flora and fauna

The economic impact on lagoon, flora and fauna can be measured by the impacts on those currently using the flora and fauna.

The site report for the CEA Wetland Conservation Project estimates that the total value of the Negombo Lagoon is in the order of Rs. 1174 million. This includes the value of the lagoon for fishing (Rs 250 million) and anchorage (Rs. 300 million), as a sink for domestic and industrial waste (Rs 450 million), for its recreational and amenity value (150 million) and as a source for housing (Rs. 69 million).

The total area of the Negombo Lagoon to be affected by the road will be less than 6 hectares. There are two section of about 2.4 hectares and 3 hectares where the road will enter the lagoon. Assuming that three times this area is affected due to run-off etc. from the road, then the area affected will be less than 17 hectares. This is about 0.5 % of the total 3164 hectares of the whole lagoon.

This figure can be converted to a damage figure by finding 0.5% of the estimated Rs 1174 million value for the lagoon. This gives a figure of under Rs 6 million per year.

The most significant impact of the road on the lagoon will be to the seagrass along the lagoon which would be damaged by the road. The road runs over a large extent of sea grass at Liyanagemulla of 19.5 hectares in extent. This 19.5 hectares is about 3% of the total 360 ha. of sea grass in the lagoon.

Research shows that seagrass is a key breeding ground for the estuarine fishery. NARA estimated in 1994 that the value of the Negombo estuary fishery was about Rs 150 million. Taking the most extreme case and assuming that all these fish breed only in the lagoon sea grass, then the destruction of 3% of the sea grass would lead to a 3% decline in the value of the fishery. This would be a loss of Rs 4.5 million.

The other significant area of impact will be on the Muthurajawela Visitors centre which was recently set up by the CEA. The profits from this centre which will be reinvested in conservation activities are forecast to be in the order of Rs. 100,000 per month, or about Rs. 1.2 million per year.

Taking these figures together it can be estimated that the impact on existing users of the lagoon may by be in the order of Rs 12 million per year. However this does not include the "existence" value of the resource which may be shared by those who presently do not use the resource. Since less than 3% of the proposed conservation area is affected, it is assumed that any existence value of the area would not be affected.

Estimates of the benefits of the Negombo Lagoon have been found in a study of Muthurajawela (CEA / Euroconsult / 1994)

TABLE : 3.31

MAJOR VALUES OF NEGOMBO LAGOON

Value	Rs (million)
Lagoon fishery : 3000 fishermen (Rs 4166 per month)	150
Coastal shrimp fishery : 400 fishermen (Rs 5200 per month)	25
Coastal small pelagic : 4000 fishermen (Rs 1500 per month)	75
Sink value for waste from 45 industries	300
Sink value for domestic/municipal waste	150
Recreational value for tourists : 5000 visitors per year x Rs 1000	5
Amenity value : Annual earnings from 120 room Airport Garden Hotel	100
Anchorage for marine fishing craft	300
Land for housing in Muthurajawela marsh (Rs 20,000 per house)	15
Intertidal sand shoals for housing (Rs 20,000 per house)	54
Total	1174

Source: CEA/ Euroconsult, 1994

Noise Impacts

The value of properties and number affected is given in the Table 3.32. It is assumed that property price will decline by 10% due to the noise.

TABLE : 3.32

NUMBER AND VALUE OF PROPERTIES AFFECTED BY NOISE

Location	No. of Properties affected	Value of Land (Rs. / perch)	10% decline in land value of affected properties
Peliyagoda	108	100,000	10.8 million
Hunupitiya	180	50,000	9.0 million
Kerawalapitiya	60	50,000	3.0 million
Ja Ela	24	80,000	1.92 million
Tudella	24	80,000	1.92 million
Katunayake	20	100,000	1.92 million
Total	416	-	28.5 million

Source: Consultants Calculations

Thus the annual decline is Rs. 28.5 million. The value of property is assumed to be increasing at 12% a year (the same as the discount rate) So discounted over 21 years (from 2000 to 2021), the decline will be just under Rs. 600 million.

Health Costs of Air Pollution

The health costs of air pollution can be estimated using UK data for health impacts. The figures have been reduced by two thirds as the Sri Lanka per capita GNP in 1993 of $ 600 was one third the UK GNP at $ 2210. The values for the UK and Sri Lanka are given in the Tables 3.33 and 3.34.

TABLE : 3.33

HEALTH COST OF AIR POLLUTION

	SO_2	NOx	PM
UK Values (in Rs. /gram)	2.21	0.39	4.5
Sri Lanka Values (in Rs./gram)	0.7	0.13	1.5

As the table shows particulate matter (PM) has the highest health impact.

The net impact of the proposed expressway is to reduce air pollution, thus the health impacts will be less. They are estimated to be annual benefits.

TABLE : 3.34

HEALTH IMPACTS WITH AND WITHOUT CKE

WITHOUT CKE PROJECT

Year	NOx	SOx	PM	NOx Val	SOx Val	PM Val	Total
2001	1923	919	172	249.99	643.3	258	1151
2002	1923	919	172	249.99	643.3	258	1151
2003	1923	919	172	249.99	643.3	258	1151
2004	1923	919	172	249.99	643.3	258	1151
2005	1923	919	172	249.99	643.3	258	1151
2006	2671	1262	246	347.23	883.4	369	1600
2007	2671	1262	246	347.23	883.4	369	1600
2008	2671	1262	246	347.23	883.4	369	1600
2009	2671	1262	246	347.23	883.4	369	1600
2010	2671	1262	246	347.23	883.4	369	1600
2011	3570	1675	339	464.1	1172.5	508.5	2145
2012	3570	1675	339	464.1	1172.5	508.5	2145
2013	3570	1675	339	464.1	1172.5	508.5	2145
2014	3570	1675	339	464.1	1172.5	508.5	2145
2015	3570	1675	339	464.1	1172.5	508.5	2145
2016	4648	2169	455	604.24	1518.3	682.5	2805
							27285

WITH CKE PROJECT

Year	NOx	SOx	PM	NOx Val	SOx Val	PM Val	Total	Difference
2001	1593	806	145	207.09	564.2	217.5	988.79	162.5
2002	1593	806	145	207.09	564.2	217.5	988.79	162.5
2003	1593	806	145	207.09	564.2	217.5	988.79	162.5
2004	1593	806	145	207.09	564.2	217.5	988.79	162.5
2005	1593	806	145	207.09	564.2	217.5	988.79	162.5
2006	2259	1122	210	293.67	785.4	315	1394.1	205.56
2007	2259	1122	210	293.67	785.4	315	1394.1	205.56
2008	2259	1122	210	293.67	785.4	315	1394.1	205.56
2009	2259	1122	210	293.67	785.4	315	1394.1	205.56
2010	2259	1122	210	293.67	785.4	315	1394.1	205.56
2011	3022	1495	289	392.86	1047	433.5	1872.9	272.24
2012	3022	1495	289	392.86	1047	433.5	1872.9	272.24
2013	3022	1495	289	392.86	1047	433.5	1872.9	272.24
2014	3022	1495	289	392.86	1047	433.5	1872.9	272.24
2015	3022	1495	289	392.86	1047	433.5	1872.9	272.24
2016	3940	1946	389	512.2	1362	583.5	2457.9	347.14
							23737	3548.6

TABLE : 3.35

SUMMARY TABLE

Environmental impact	**Cost/benefit without mitigation**	**Estimated cost of mitigatory measure**	**Damage Cost following mitigation**
Accidents	Net benefit of reduction 3.3 - 12.9 million/year	-	Net benefit
Severance	-	Footbridges and Viaducts : Rs. 2 million/bridge	Minimal depending on no of bridges
Disruption to lagoon flora and fauna	Reduction in biodiversity and area of lagoon : Rs. 12 million /year	Raised road on lagoon : Rs. 2.5 bn./ km	Some loss of biodiversity is inevitable
Noise	Reduction in property prices Rs. 28.5 million/year	Noise screens, Improved surface of road Rs. 30 million	Some decline in property prices
Visual intrusion	Reduction in property prices (assumed to be covered by noise)	Sight screen Rs.10 million	Some decline in property prices
Air quality	Net benefit of reduced air pollution Rs. 162 - 347 million	-	Net benefit
Increased flooding	Rs. 10 million/year	Sufficiently wide bridges :Rs.30 million	Rs.5 million/year

Conclusions

As the table illustrates for both accidents and health impacts from pollution, the new trace *will be an improvement. These benefits are sufficient to outweigh any of the* environmental costs. In addition the environmental costs can be significantly mitigated by measures proposed in this report.

Annual net benefits of air quality improvement is Rs. 62 - 347 million, and of reduced accidents is 3.3 -12.9 million. This gives minimum benefit of Rs. 166 million and maximum benefits of Rs. 360 million. This is about 9 times larger than the costs of reduced biodiversity (12 million/year) and reduced property prices due to noise and visual intrusion (28.5 million), which seems to be about Rs. 40 million. Thus the net environmental impacts of the project are positive.

3.3 Recommendation

The relative magnitudes of adverse impacts from each of the five alternatives discussed previously are graphically depicted in Figures 3.3 a and 3.3b.

It can be seen that the improvements to the railway does not meet the objective of having high speed link as both passenger and goods transport will not change from road to rail transport for a short stretch involving modal changes to complete a trip.

Improvements to the A3 road also does not meet the objectives of the project. The nature of the A3 road does not permit it to be converted into a high speed link capable of meeting the projected demand. Any widening of the road would affect a very large section of the community as a large number of buildings (1143) will be demolished.

As both the above options do not meet the objectives of the project, they can be eliminated as inadequate.

Both the expressway options - western and eastern meet the objectives of the project, as they are access controlled high speed roads. Therefore the selection has to be made between these two.

Ecologically the eastern trace has few adverse impacts as it runs mainly through cultivated lands as home gardens. In case of the western trace, the ecological impacts are higher as it skirts the eastern edge of Muthurajawela marsh and goes into the Negombo lagoon for some distance. However the areas impacted are 4.5% and 3% respectively, which does not affect the entire marsh and lagoon system.

Economically the eastern trace costs Rs. 20 billion while the western trace costs Rs. 5.0 billion to construct. The western trace will have a B/C ratio of 21.5% and that of the eastern trace will be 7.3% only. The Economic Internal Rate of Return is 63% for the western trace and 38% for the eastern trace.

Hydrologically the eastern trace causes more impacts than the western trace as it lies upstream of the existing A3 road and the railway. These two act as shields to the eastern trace. Hence it will cause fewer impacts.

Most of the western trace lies through marshes thus avoiding densely populated areas most of the time. It causes the demolition of 130 houses and acquisition of 60. In contrast the eastern trace will cause the demolition of 1480 houses. Therefore the social impacts from the eastern trace is much greater than those from the western trace.

Other social impacts like visual intrusion and community severance will be much higher from the eastern trace owing to the high density of population in the area and the elevated nature of the expressway.

Considering the above comparison, the western trace is recommended as the better alternative over the eastern trace.

COMPARISON OF ADVERSE ENVIRONMENTAL IMPACTS FROM THE FIVE OPTIONS CONSIDERED

	OPTIONS				
IMPACTS ON	WESTERN TRACE	EASTERN TRACE	IMPROVE ROAD A3	IMPROVE RAILWAY	"NO BUILD"
Hydrology	●	●			
Fauna & Flora	●	●			
Humans	●	●	●	●	●
Land Use	●	●	●	●	●
Visual Amenity	●	●	●	●	●
Noise Level	●	●	●	●	●
Air & Water Quality	●	●	●	●	●
Economy	●	●	●	●	

Note : The circle size reflects the severity of the impact.

Other considerations :

Engineering Considerations	●	●	●	●	●
Achieve aims & objectives	✓	✓			

Fig. A

COMPARISON OF ADVERSE ENVIRONMENTAL IMPACTS FROM ROAD OPTIONS

	OPTIONS		
IMPACTS ON	WESTERN TRACE	EASTERN TRACE	IMPROVE ROAD A3
Hydrology	•	●	
Fauna & Flora	•	•	
Humans	•	●	●
Land Use	•	●	●
Visual Amenity	•	●	•
Noise Level	•	●	●
Air & Water Quality	•	•	•
Economy	•	●	●

Note : The circle size reflects the severity of the impact.

Other considerations :

Engineering Considerations	•	●	●
Achieve aims & objectives	✓	✓	

Fig. B

3.4 Evaluation of Secondary Alternatives for the selected option (Western Trace)

After the western trace was selected as the preferred option, the study evaluated secondary options for some segments of the trace to select the route which would have the least possible adverse ecological, hydrological and socio-economic impacts while maintaining acceptable standards of a high speed expressway. (Fig. 3.4)

The Master Plan of Muthurajawela and Negombo Lagoon (MPMNL) has also proposed a trace (Fig. 3.5) which lies very close to the western trace. The feasibility of using this road trace was also considered as one of the secondary options within the following segments.

1) Peliyagoda to Mabole

This is a highly congested area where the resident population is opposed to the construction of the CKE.

2) Mabole to Kalaeliya

In this reach the CKE crosses the Old Negombo canal and enters the conservation zone of Muthurajawela.

3) Kalaeliya to Dandugam Oya

The proposed trace runs on the east of Old Negombo canal upto Ja ela; north of Ja ela it runs to the west side of Mahadora ela. Therefore it lies on the eastern edge of the Muthurajawela conservation zone south of Dandugam oya. The trace also runs through the premises of Muthurajawela Visitor Centre.

4) Liyanagemulla to Katunayake Airport Junction

In this reach, the trace runs through the Negombo lagoon and one of its inlets for a combined length of 1.4 km.

SECONDARY OPTIONS

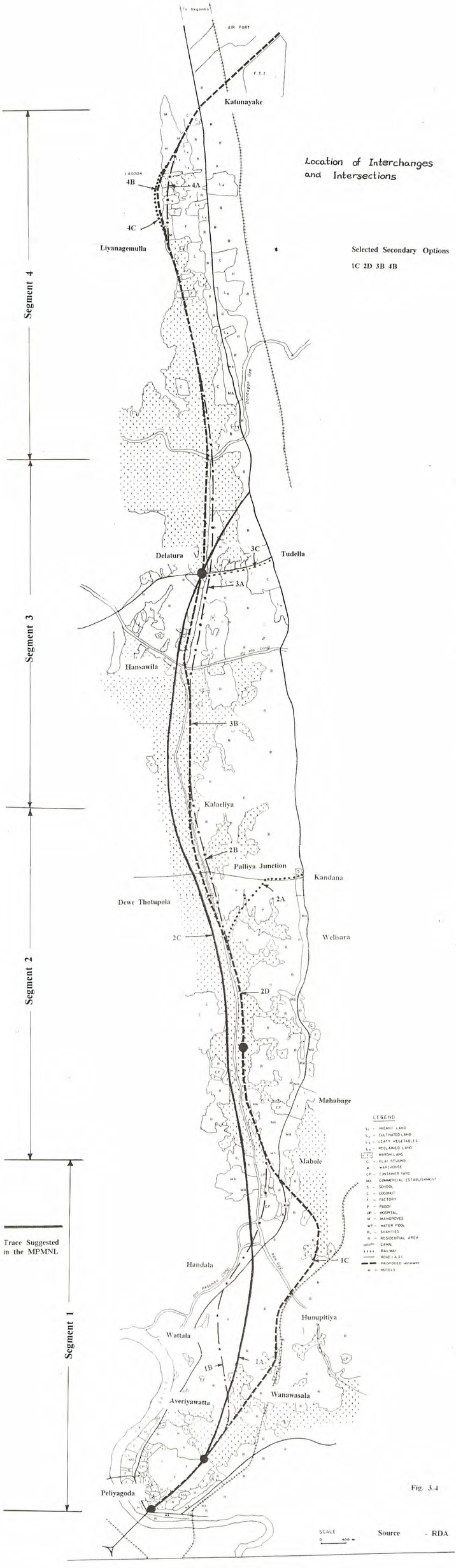


Fig. 3.4

Source - RDA

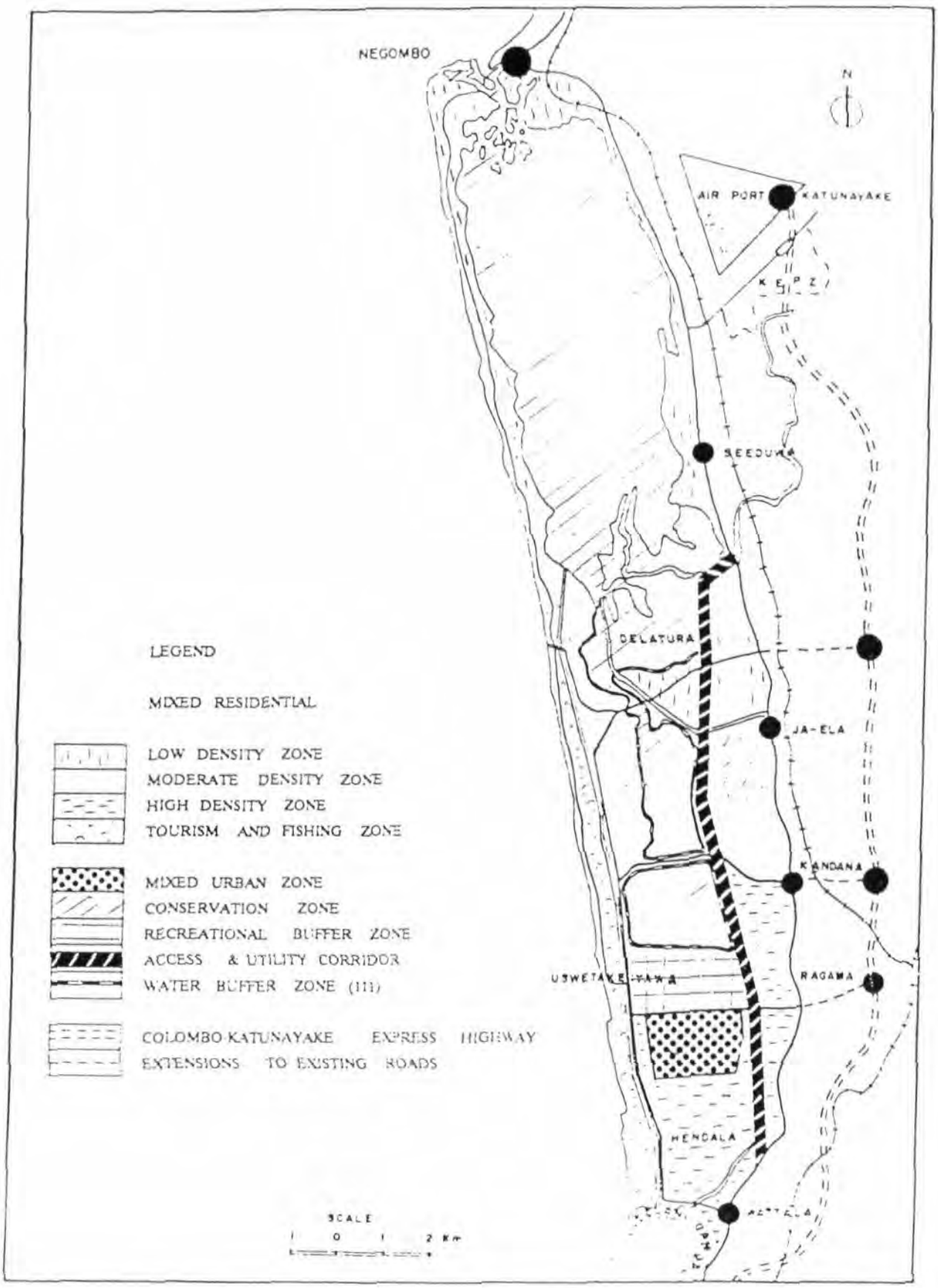


Figure D.1 MUTHURAJAWELA STRUCTURE PLAN CONCEPT

Evaluation of these secondary alternatives is given below:

3.4.1 Segment 1 - Peliyagoda to Mabole

Three alternatives were considered.

Alternative A (Muthurajawela Master Plan trace)

The route proposed in the MPMNL is to proceed from Peliyagoda Interchange to Mabole via Avariawatte and Hendala. This trace would cut across highly populated built up areas with a density of over 5000 persons per km^2. It would have significant adverse impacts on a large number of people and businesses.

Alternative B

To proceed from Wanawasala to Mabole via Avariyawatte and Hendala. This route also will pass through the high density areas as in Alternate A, and would adversely affect a large number of residents in the area.

Alternative C

To reach Mabole via Hunupitiya. The population density is approximately 3000 persons per km^2 and land values are relatively low. Over a significant proportion of the area, the route passes through marsh land and railway reservations, thus avoiding built -up areas. This will result in lower social disruption.

Other considerations been equal, Alternative C which affects the least number of people is recommended.

3.4.2 Segment 2 - Mabole to Kalaeliya

Four alternatives were considered

A - Follows the eastern bank of the Old Negombo canal and falls onto A3 road at Kandana via Palliya Junction.

B - Follows on the eastern bank of the Old Negombo canal upto Kalaeliya.

C - Follows on the western bank of the Old Negombo canal upto Delatura and from there curves to the right to crosses A3 road near Dandugama between the 17th and 18th kilometer posts and proceeds to the Airport. (This is the trace proposed by the MPMNL)

D - Follows the eastern bank of the Old Negombo canal upto Dewatotupola and crosses over to the western bank of the Old Negombo canal between Dewatotupola and Kalaeliya.

Alternative A -

If alternative A is selected the expressway would terminate at Kandana on the A3 road.

Taking the design speed for 100-125 km/h, the minimum curve that has to be allowed is 250 m. In order to provide this curve 65 houses, places of worship and a school will have to be demolished and people relocated. From Kandana to Katunayake the A3 road will have to be widened at a cost of around Rs. 1.3 billion. The social problems that might be encountered in widening the road are given in the evaluation of primary alternatives.

This alternative falls short of the stated aims and objectives of the project.

Alternative B -

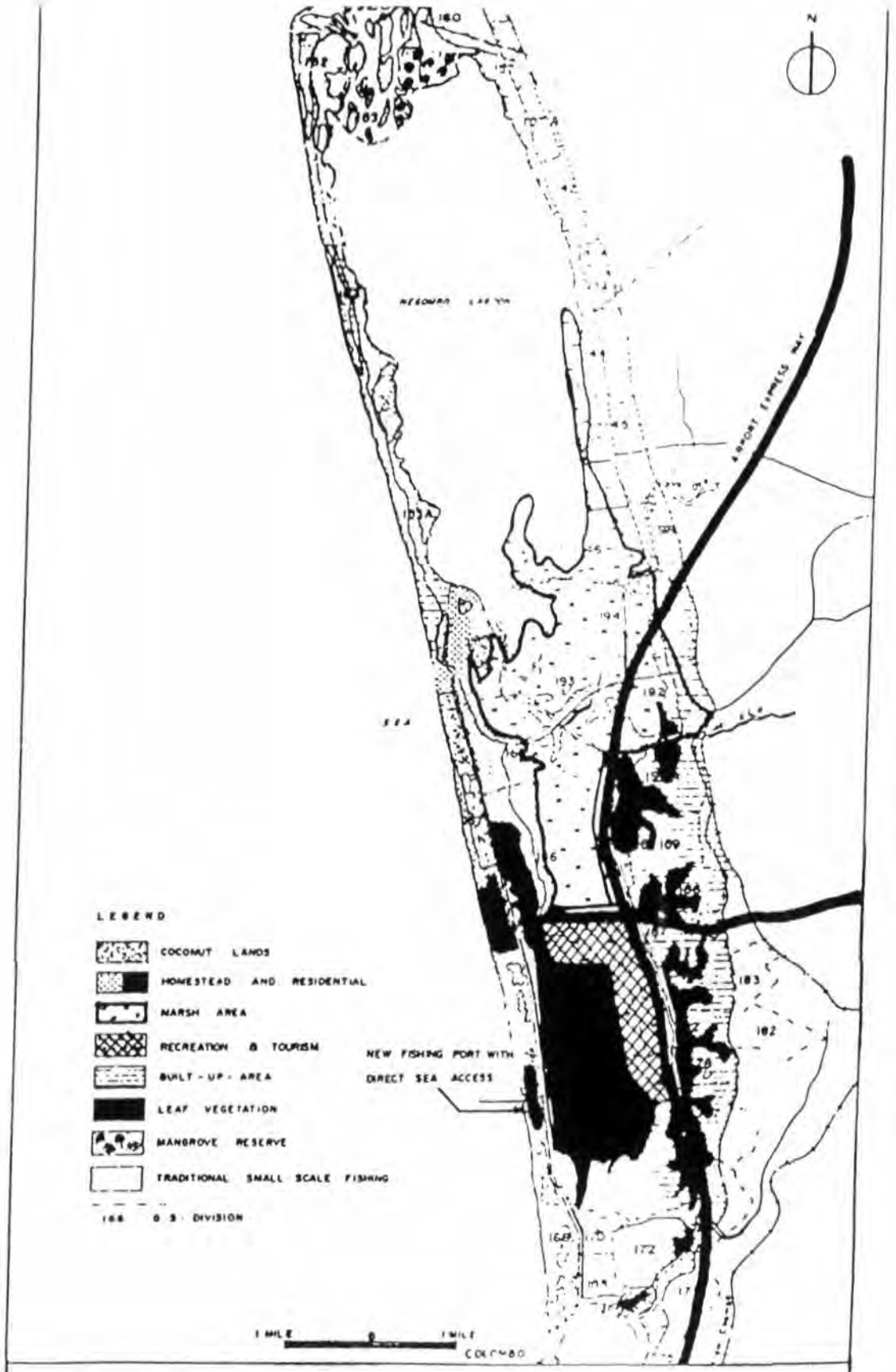
Thirty six houses will be affected if the trace is taken on the eastern bank of the Old Negombo Canal.

Alternative C - (Muthurajawela Master Plan trace)

This is the option provided in the MPMNL as a service corridor for siting trunk facilities and a local access road. In this option, from Mabole to Delatura it lies on the western bank of the Old Negombo canal. Thus more than 5 km of the trace lies on the eastern edge of the Conservation zone to the west of the Old Negombo canal. (Fig. 3.6). The area lost from the Conservation zone is about 50 ha.

At the southern end of the segment the road will affect about 5 houses from the small hamlet called Nai Duwa near Mahabage. In the stretch between Denatura and Dandugama, the trace runs through the village Wahatiyagama, in a medium density (2000-5000 persons / km^2) residential area and a number of industrial and commercial premises.

Beyond the A3 it will cross populated areas such as Raddoluwa Housing Scheme.



LAYOUT OF THE BYPASS ROAD AS PROPOSED BY MPMNL
Fig. 3.6
Source - Figure APP A-3 of MPMNL

Alternative D

About 8.0 ha of the conservation zone will be affected but will not involve demolition of buildings and relocation of people.

Hence alternative D is recommended as the other alternatives cannot be accepted, for the following reasons :

Alternative	**A**	-	Adverse social impacts, failure to reach the objectives of an expressway.
Alternative	**B**	-	Adverse social impacts, unacceptable design standards.
Alternative	**C**	-	Adverse social impacts, and high intrusion into conservation zone (50 ha compared to 8 ha for alternative D)

3.4.3 Segment 3 - Kalaeliya to Dandugam oya

Three alternatives were considered.

A. From Kalaeliya to proceed along the eastern side of the Negombo canal, and Mahadora Ela.

B. From Kalaeliya to proceed along the eastern side of the Old Negombo canal upto Ja ela; North of Ja ela it crosses to the western side of the Mahadora ela upto Dandugam Oya.

C. Turn eastwards at Delatura to join the A3 road at Tudella.

Alternative A -

The trace involves the demolition of 19 houses in Wahatiyagama and 42 houses in the area between Tudella - Pamunugama road and Ja ela and the loss of valuable land.

The households that will be displaced will be given compensation according to the current market prices valued by the Chief Valuer. An additional ex-gratia payment will be made by the RDA to compensate for the inconveniences and hardships, the house owners are to undergo.

The estimated costs for compensation and relocation are as follows:

Compensation for houses and other buildings	-	Rs. 25.2 M
Compensation for lands (commercial value at the rate of Rs. 50,000 per perch)	-	Rs. 95.0 M

Alternative B -

This affects about 7.5 hectares of the total Muthurajawela Conservation Zone which could be compensated by allocating the equivalent area from the Northern boarder of the buffer zone, so that the total extent of the Conservation Zone remains unchanged.

It also passes through the premises of the Visitor Centre separating the office complex from the nature trails. However the RDA proposed to provide access from the office complex to nature trails through an overpass. Boat trips can continue along the same route as at present after construction of the bridges over Nonage ela and Dandugam Oya. With mitigatory measures the ecological impacts on the nature trail area will be minimal. The Visitor Centre which is housed at present in a rented building may be relocated on state land to the west of the expressway obviating the need for an overpass. Furthermore, the new building could be designed specifically to meet the needs of the Wetland Conservation Project (WCP).

The high fencing that will be erected along the full length of the expressway will act as a barrier against encroachment into the marsh.

Alternative C -

This involves the demolition of 29 commercial, residential and school buildings. If the expressway joins the A3 road at Tudella, the problems discussed under the improvement to A3 road in the evaluation of primary alternatives will arise.

Alternative A involves heavy social and economic costs to the people in the area such as separation of long established communities, loss of houses and property. It involves the demolition of 61 houses for this segment alone.

Alternative **C** does not conform to the aims and objectives of an expressway.

The alternative **B** has the least adverse social impacts and ecological problems encountered can be mitigated with appropriate measures. (Fig. 3.3).

However, if it is considered that the expressway should avoid the conservation zone, Alternative **A** may be selected with suitable mitigatory measures.

3.4.4 Segment 4 - Liyanagemulla to Katunayake Airport Junction

Three alternatives were considered.

(A) Without going into the lagoon the route lies along the shoreline of the lagoon and joins the CFR at Katunayake.

(B) Road passing through the lagoon at a distance of 50 m. from the shore at the furthest point

(C) Same as **B** but elevated

Alternative A -

If the lagoon were to be completely avoided, the trace requires the following changes :

1) The departure from A3 road at a sharp angle.

2) Introduction of a very sharp curve to the road and another reverse curve.

3) Demolition of more than 25 houses

A junction at an angle is prone to accidents and unacceptable in the case of an expressway. A very sharp curve will slowdown the traffic leading to long delays. Reverse curves reduce the safety of the highway.

Alternative B -

The stretch of road proceeding from the Katunayake Airport Junction enters the lagoon, then takes a sharp curve south and runs through the lagoon for 1.4 km.

The sharp curve is possible as the expressway is near the terminal and vehicles have not yet accelerated to high speeds or already slowed down for stopping. The roadway will be at a distance is 50 m from the shore at its farthest. After reaching land, it will proceed southwards to Dandugam oya.

This alignment affects eight fishermen belonging to five fishing families, who have brushpiles (athu kotu) in the area to the east of trace. Out of 1800 - 2200 brushpiles operated in the Negombo Lagoon, only twelve are located in the segment to the east of the trace. It is reported that each fishing family owns 20 - 30 brushpiles in the Negombo lagoon (Jayakody, 1996); therefore each affected family has the majority of their brushpiles located outside this segment of the lagoon.

The major source of income of these fishermen is selling foodfish, ornamental fish and crabs. The average catch of fish per fisherman is 108 kg/year and the average income per fishing family is Rs. 16666 per year. (Values computed from data given in the Environmental Profile of Muthurajawela and Negombo Lagoon ; Samarakoon & van zon 1991).

Fishermen adversely affected must be adequately compensated for loss of income during the construction phase of the expressway when fishing activities in this segment are bound to be disrupted and also for any adverse impact on the brushpile fishery of this area should such an impact occur during the operational phase.

Sections of bridging in the expressway will ensure the to and fro movement of tidal currents, fish and fishing craft across the expressway.

Alternative C -

This is geometrically similar to the alternative B, with the difference that in place of the roadway being taken on an embankment, it will be taken on a bridge over the lagoon.

The cost for the 1.4 km length of bridging involved has been estimated at Rs. 1.4 bn for a four lane highway and Rs. 2.5 bn for a six lane highway (RDA sources). This represents a price escalation of 50% to the total cost which is unacceptable.

Considering all the above factors, the alternative 'C' cannot be recommended owing to the high cost and the alternative 'A' owing to the unacceptable alignment and social cost.

Hence alternative 'B' is proposed although people in the five houses to be resettled. (fig. 3.3)

3.5 Financial Analysis for the Western Trace

3.5.1 Project Cost

The total project cost has been estimated at Rs. 5 bn. by the RDA inclusive of costs expected to be incurred on roadway construction, engineering fees and land acquisition/ compensation costs.

This cost is expected to include both foreign and local elements in the proportion of 65% and 35% respectively.

The cost escalation of the foreign component is estimated to be 3% p.a. and the domestic component at 8% p.a.

These costs are expected to be expended annually during the 4 year construction period as follows:

Yr. 1 10%
Yr. 2 25%
Yr. 3 35%
Yr. 4 30%

The other direct cost considered are Maintenance and Operations costs.

Maintenance Cost

Cost incurred on the maintenance of the expressway is divided into two categories, annual maintenance and periodic maintenance.

Annual Maintenance Cost

Annual maintenance cost consists of the following items :

* Routine surface maintenance
* Sweeping costs
* Electricity cost

The routine surface maintenance is the operation of patching road surfaces to eliminate pot holes and cracking.

Sweeping cost involves cleaning and reshaping side drain, shoulder maintenance, removal leaf litter.

Electricity cost is assumed to include the cost of illumination along the expressway and maintenance of adequate inventory of bulbs etc.

This annual maintenance cost is estimated to be Rs. 7.70 M in 1997 prices.

Periodic Maintenance Cost

The periodic maintenance cost involves the overlay of surface courses estimated at a thickness of 6 cm. It is assumed to incur once in every 10 years from the commencement of the expressway. The initial cost to be incurred on maintenance is estimated to be Rs. 210 M in 1997 prices.

These annual and periodic maintenance costs consist of both local and foreign components. Therefore the price escalation is assumed to be 8% per annum.

Operational Costs

The management and operational costs for this evaluation have been estimated at Rs. 3.5 M in 1997 prices. This cost represents mostly local costs. Therefore the price escalation is assumed to be 8% per annum.

The detailed cost estimates are given in Annexure IV.

3.5.2 Project Revenue

Traffic Forecast

Traffic forecasts for the period under consideration have been made on the basis of traffic projections prepared by the Transport Studies and Planning Centre (TSPC). It is assumed that in the 25th year of operation (ie. 2021) the expressway reaches its full vehicle accommodation capacity of 32,000 units of average daily traffic (ADT) and thereafter ADT is assumed to be constant. The detailed traffic projections are given in Annexure V.

Toll Rates

The base toll rates used in the above traffic forecast have been obtained from Transport Studies and Planning Centre. These toll rates are given below:

	Rs. / Trip
Cars	30.00
Light goods vehicles	45.00
Medium goods vehicles	45.00
Heavy goods vehicles	100.00
Light buses	20.00
Medium buses	20.00

Annual price escalation of the toll rates have been estimated to be 8% p.a. However price escalation is assumed to be effected once in every 5 years as given in Annexure VI.

Toll Revenue

Toll revenue estimates based on the above forecasts are tabulated in Annexure VII.

Alternative revenue sources

The Government could release State Land in the vicinity of the interchanges for development as an added incentive.

RDA has already identified 500 acres of land which could be offered to this project. The income that could be generated from these lands have to be worked out in the feasibility study stage of the project.

3.5.3 Project Cash flow

The projected cash flow position of the project is given in Annexure VIII.

CHAPTER 4

EXISTING ENVIRONMENT AND SITE DESCRIPTION

4.1 Physical Environment

4.1.1 Geology and Geomorphology

Geologically the study area developed during the Pleistocene age and a high proportion of the land is covered with Holocene deposits. Pre-Cambrian gneiss prevails in the slightly elevated areas such as Hunupitiya.

Geomorphologically, there are no salient topographical characteristics in the area. The general slope is from East to West; the height variations range from 1.0 to 6.0 m. In areas such as Peliyagoda, southern part of Ragama, the deltas of Ja ela and Dadugam oya and areas around Negombo lagoon, the average height does not exceed 1.5 m. In Wattala, Mabole, Mahabage and Hunupitiya the elevation ranges from 5.0 to 6.0 m.

4.1.2 Climate

Rainfall

The rainfall pattern of the entire study area is determined by two factors viz ; the South West Monsoon (SWM) which prevails from May to September, when the area receives 2000 - 2500 mm of rainfall during this season. The rainfall during the two inter - monsoonal periods, ranges from 1750 - 2000 mm (ie March/April and September/October.)

Temperature

A mean daily maximum of 31.5^0 C has been recorded in April and a mean daily minimum of 22.3^0 C in January. The mean annual temperature varies from 25.0^0 C - 27.5^0 C. Table 4.1 given below summarizes the temperature, humidity and wind speed for Colombo and Katunayake.

TABLE 4.1

CLIMATOLOGICAL RECORD FOR COLOMBO AND KATUNAYAKE

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
Temperature													
Mean Daily Max.	30.3	30.6	31.0	31.1	30.6	29.6	29.3	29.4	29.6	29.4	29.6	29.8	30.0
Mean Daily Min.	22.2	22.3	23.3	24.3	25.3	25.2	24.9	25.0	24.7	23.8	22.9	22.4	23.9
Relative Humidity													
8: 30	81	82	84	83	82	81	82	81	81	83	83	81	82
17:30	70	72	74	78	78	77	78	77	77	77	77	74	75
Prevailing Wind Direction													
8 :30	NE	NE	E	E	SW	SW	WSW	SW	SW	(CALM)	NE	NE	
17 : 30	N	NW	W	SW	SW	SW	SW	SW	SW	SW	NW	N	
Mean Wind Speed													77
8:30	8.7	6.6	15.3	5.3	8.4	9.8	8.9	9.7	98.7	6.8	6.1	8.2	100
17 : 30	11.9	11.1	9.7	8.5	10.1	10.9	10.0	10.8	10.3	8.7	8.0	10.3	

Katunayake

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC		ANNUAL
Temperature														
Mean Daily Max.	31.4	32.2	32.3	32.1	31.1	30.3	30.1	30.2	30.3	30.1	30.8	30.6		31.0
Mean Daily Min.	21.6	21.0	23.0	23.9	25.0	25.1	24.8	24.8	24.2	23.6	22.7	22.3	22.4	23.6
Relative Humidity														
8: 30	78	79	80	80	81	80	80	73	80	81	80	79		79
17:30	63	64	69	72	76	76	76	75	75	76	73	70		72
Prevailing Wind Direction														
8 :30	NE	NE	(VAR)	SW	SW	SW	SW	SW	SW	(VAR)	NE	NE		
17 : 30	N	N	WSM	SW	SW	SW	SW	SW	SW	SW	(VAR)	N		
Mean Wind Speed														102
8:30	12.0	8.2	4.5	4.6	4.6	11.4	15.0	12.9	15.6	12.9	8.2	6.6		144
17 : 30	15.2	15.0	14.1	14.1	13.2	15.7	16.6	15.6	16.1	16.3	12.7	10.6		

Source : Hydrological Studies for Colombo - Katunayake Expressway Japan Bridge & Structure Institute Inc.et al. 1991.

Wind

The study area is generally free from devastating cyclonic storms. The wind records over the past 25 years show that the maximum wind speed had been 5.3 km/hr in March and 15.3 km/h in April.

In addition to the influence of South West Monsoonal winds (May to September) a general phenomenon associated with the wind pattern is that mild winds blow from sea to land (sea breeze) during the day and from land to sea (land breeze) during the night.

4.1.3 Water Resources

Surface Water

In the northern sector of the study area Dandugam oya flows from east to west. This river system is fed by South West Monsoons (May - September) and convectional rainfall during the two inter-monsoon seasons. (March - April and October - November). When rainfall exceeds the rate of infiltration into the ground, phenomena such as increased surface run -off and flood flows are frequent in the study area.

Ground Water

Ground water resources are found at varying depths depending on the location of the land. In areas such as Peliyagoda, Ja Ela, the average depth of ground water table is about 5 m. The depth of ground water table in slightly elevated lands varies between 20-30 m. Most of these areas consist of crystalline rocks which are impervious and generally non - porous. The quality of water in crystalline rocks is fairly good except in marshy lands and lands around the lagoon, where the water is saline.

4.1.4 Soils

The predominant soil group in the study area is organic soil (bog soils) found in low lying marshy lands. The colour of these soils varies from dark brown to black. Most of these soils contain high sulphur levels that may be harmful to agricultural crops. Alluvial soils are confined particularly to delta areas of Ja ela and Dandugam oya. Some of the alluvial deposits are affected by annual floods which result in their rejuvenation. Water logged conditions are likely to develop in areas where drainage facilities are poor. In addition to these two major soil groups, patches of Red-Yellow Podzolic soils and Red Yellow Latosols are also found.

4.1.5 Mineral Resources

The study area is rich in non-metallic mineral resources such as clays. Ball clays which are widely used for manufacturing tiles and bricks are found in the lowlands of Dandugam oya. The extent of deposits and their quality have not been evaluated.

4.1.6 Hydrology

The study area falls within two river basins. Major portion of the study area, starting from the northern end, lies within the Attanagalu oya basin. Southern end falls within the Kalu oya sub-basin of Kelani ganga basin. Between these two, the study area traverses valleys of several small streams draining local catchments into Muthurajawela marsh. (Fig. 4.1)

Kalu oya sub-basin of Kelani ganga basin

Kalu Oya drains an area of 77 sqkm, on the right bank of Kelani ganga. This sub-basin extends upto Mahara, Ragama and Horape area (Fig. 4.1). It has a mild slope and is changing from being predominantly agricultural, to being urban. Wetlands are being converted to building sites with the consequent loss of catchment detention. This results in increased flood peaks, longer flood durations and lowered threshold rainfall value for inundation.

Kalu oya, the main drainage stream of the sub-basin falls to Kelani ganga at Hekitta. The outfall is controlled by a radial gated structure to prevent Kelani ganga floods from entering the right bank area. A number of tributaries join Kalu oya before the outfall, eg, Vedamulla ela and Mahara-Mudun ela etc. CKE crosses Kalu oya about 0.7 km to the east (upstream) of the bridge No 5/2 of A3 road. The 100 year return period rainfall has been calculated to produce a peak flood of 460 cumec.

CKE runs mostly through marshes within this sub-basin. These marshes are inter-connected and are crossed by several smaller drains, excavated as part of the Kalu oya drainage scheme, but neglected now.

In addition to the Hekitta outfall, this sub-basin has two more outfalls. These outfalls at Oliyamulla and Wattala are both connected to the peripheral drainage canal of the PIUDP. A 300 cusec pump has been installed at Wattala by the PIUDP. A second pump of 600 cusec capacity will be installed at Oliyamulla when the second stage of PIUDP is implemented (pers. comment by Mr. G. Abeyratne of UDA).

PROPOSED COLOMBO – KATUNAYAKA EXPRESSWAY CATCHMENT BOUNDARIES

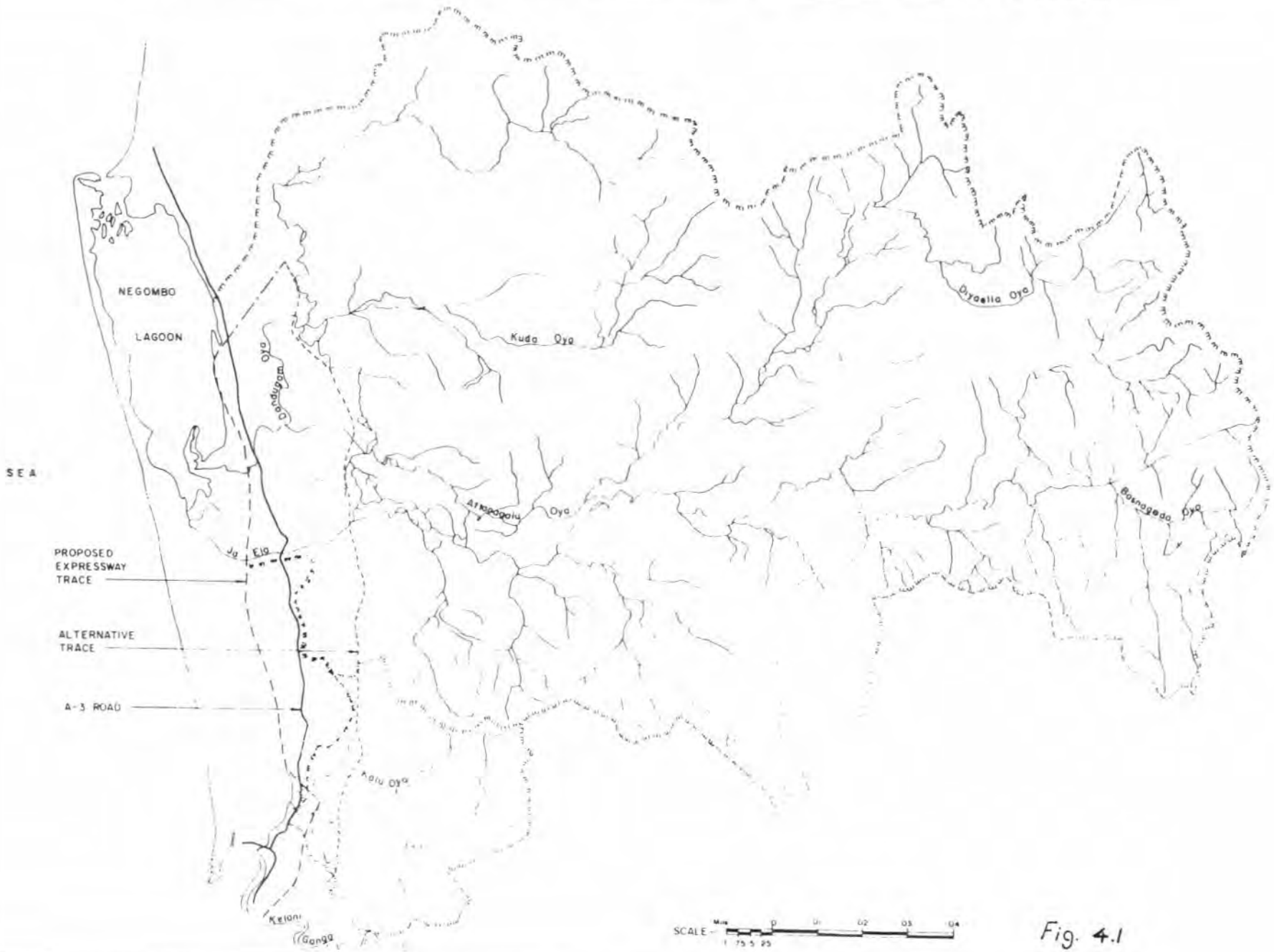


Fig. 4.1

Attanagalu oya basin

This is a medium sized basin extending upto Pasyala in the east covering an area of 812 sqkm. The basin has a moderate slope, getting flatter towards the west. The catchment is predominantly agricultural. Here also the urbanising trend is observed.

The basin is drained by a highly ramified stream system flowing generally in a westward direction. (Fig. 4.1) Main tributaries are Uruwel oya, Attanaglu oya, Diyaeli oya, Mapalam oya and Kimbulapitiya oya. The lowermost section of the combined river is known as Dandugam oya and falls to sea via the Negombo lagoon. The river system is subject to frequent flooding.

CKE crosses Dandugam oya 0.5km below the bridge on the A3 road. The peak flood produced by a 100 year return period storm is computed to be 1840 cumec at the proposed bridge site.

Ja ela

An important hydrological feature in the study area is the canal known as Ja ela. It was constructed by connecting Uruwel oya - a tributary of Attanagalu oya, with the Negombo lagoon. This was constructed in the late 18th Century by the Dutch colonial administrator of the area, Dissave de Costa to irrigate Muthurajawela fields with water from reservoirs in Tammita and Maha ela (Abeysekara, 1954).

Ja ela allows part of the flow in Attanagalu oya system to avoid the main outfall of Dandugam oya and wend to sea by a shorter route. CKE will cross Ja ela about 1.5km to the west (downstream) of the bridge on the A3 road. The 100 year return period rainfall is calculated to produce a flood peak of 800 cumec at the bridge site.

Old Negombo canal and Mahadora ela

Old Negombo canal and Mahadora ela together traverse the two basins from Kelani ganga upto Dandugam oya. Both of these canals run approximately in a north-south direction, the former from Kelani ganga to Ja ela and the latter from there to Dandugam oya. Both are sometimes collectively known as the "Old Dutch canal".

Old Negombo canal starts from Kelani ganga at Hekitta. It shares the same radial gate controlled outfall with Kalu oya. This canal was first constructed by King Weera Parakramabahu of Kotte before the advent of the Portugese. His aim was to provide an inland navigation canal from Kotte to Negombo. The canal succeeded in ruining the paddy cultivation in Muthurajawela for ever by salinity, in turn causing a peasant rebellion (Abeysekara, 1954).

Old Negombo canal has a varying width. It has an average bed level of about 1.5 - 2m below sea level. The canal is not efficient hydraulically owing to obstruction to flow created both by natural causes such as weed growth and by man-made causes such as low and narrow foot bridges.

Old Negombo canal ends at the Ja ela confluence. Mahadora ela starts a little to the east of this point and leads to Dandugam oya, following roughly in a northerly direction. Both ends of Mahadora ela are provided with salt water exclusion regulators with lifting gates. Northern end of the Old Negombo canal also is provided with such a regulator. These have not been operated for a long time and are in a derelict condition now.

Old Negombo canal lies mainly to the west of the CKE. However, immediately after crossing the A3 road at Mabole, the CKE encroaches into the canal near a place called Nai Duwa and obliterates it for a distance of about 600m, before settling to follow it on the eastern bank. About five kilometers further north, near Dewa Totupola, the CKE crosses the canal from east to west. After continuing for about 1.8km, the CKE crosses back to the east near Kalaeliya and continues on the east upto Ja ela confluence. Mahadora ela for its entire length lies to the east of the CKE.

Muthurajawela marsh

Muthurajawela is generally defined by the Hamilton canal in the west, Old Negombo canal and Mahadora ela in the east, Kerawalapitiya village in the south and Negombo lagoon in the north, though in some places the marsh extends farther east than the two canals.

This marsh is low lying with average elevation 0.15m or less above the sea level. It has an area of about 3500 ha. In an average year, the marsh receives about 1500 MCM of water mainly flowing from Attanagalu oya basin. Direct precipitation brings in a further 200 MCM while evaporation and evapo-transpiration removes 150 MCM annually from the area. Salt water exchange is estimated to be 1100 MCM, most of it from the lagoon.
(Environmental Profile of Muthurajawela, 1991)

Old Negombo canal is not hydraulically efficient. With only its two ends having some capacity to serve as a drainage canal, the middle portion of the marsh has to drain elsewhere. In this region, drainage is effected by a series of lateral canals leading west to the Hamilton canal. Some examples of these canals are, Depa ela, Mudiyansege ela, Vedralage ela etc. After a heavy storm these canals are overwhelmed by the inflow and leads to overland flow across the marsh in a continuous sheet westward from Old Negombo canal to the Hamilton canal. Hamilton canal drains to Negombo lagoon on the north and Kelani Ganga in the south.

Existing irrigation and flood protection schemes are described below:

Kelani North Flood Protection Scheme

This is a system of flood bunds constructed along the right bank of Kelani ganga affording protection to the area to the north of Kelani ganga. Flood protection bunds extend from Peliyagoda to Telwatta about 7 km to the east. The flood bunds are being improved in the aftermath of the 1989 floods. With the improvements, the scheme would protect against the 50 year return period flood. The details of the bunds are as follows:

TABLE 4.2

KELANI NORTH FLOOD PROTECTION SCHEME: DETAILS

	At Peliyagoda End	At Telwatta End
Bund top level (m above MSL)	4.99	7.50
Top width (m)	3.65	3.65

The proposed CKE has no impact on the flood protection scheme, as it starts to the north of the flood bunds lies entirely within the area protected by the flood protection scheme.

Kalu oya Scheme (Mahara Mudun Ela Scheme)

This drainage scheme was designed to make an area of 1000 hectares cultivable by improving drainage of the area. Kalu oya was the main drain for the scheme with secondary drainage streams being Mahara Mudun ela, Wedamulla ela etc. This area has now changed from an agricultural to a suburban area. The scheme is now abandoned and no cultivation is done. Former paddy fields have already been filled for construction or have been ear-marked for filling by the SLLRDC.

Muthurajawela Scheme

Sporadic attempts have been made from 1920's to bring parts of the Muthurajawela marsh under paddy cultivation. Most of the efforts succeeded only in the fringes of the marsh. Renewed efforts were made in the war years to cultivate the marsh in Kandana area. Initial successes could not be sustained with falling productivity and increasing costs. Efforts were continued till the late 1950's. Finally, the 1966 Sessional Paper was a tacit admission of failure, as this allowed only for non-agricultural uses. At the moment there are no cultivations in the marsh.

Present Water Uses

Apart from being used for bathing and washing, no use of water is made from Ja ela and Dandugam oya in the study area or downstream. People depend on standposts for potable water.

The waters of Kalu oya below the proposed trace are rarely used. This being an urban area, people depend on pipe borne water for all their needs.

Surface Water Quality

Surface water of the study area can be divided into two main systems- Muthurajawela marsh - Negombo lagoon system and its influent streams form one system while the Kalu oya basin forms the second system. While many studies have been done on the quality of the former system, little or no attention has been given to the second system.

In the first area Muthurajawela marsh and the Old Negombo canal are the most likely to be affected as the proposed road trace lies adjacent to these. In the case of Dandugam oya, and Ja ela the proposed road only crosses them making the impact on water quality minimal.

The wetland formed by the Negombo lagoon and the Muthurajawela marsh opens to the sea by way of a single opening at the northern end. Dandugam oya is the main source of freshwater. The inflow Dandugam oya keeps the delta from becoming too saline. It also tends to vary the salinity in the lagoon from season to season.

Salinity is low in the entire area during the wet season. Salt penetrates into the north eastern part of the area from the Negombo lagoon via Dandugam oya and Ja ela outfalls. Hamilton canal is the conduit for salinity into the south western part during the dry season. High salinity levels of 50 were observed in the south western half of the Muthurajawela area. (Environmental Profile of Muthurajawela, 1991)

Table 4.3 gives the baseline water quality values of water bodies in the project area.

TABLE 4.3

MINIMUM AND MAXIMUM VALUES RECORDED FOR SELECTED WATER QUALITY INDICATORS OF THE FOUR AFFECTED WATER BODIES

Indicators	Negombo Lagoon		Marsh		Dandugam Oya		Ja - Ela	
	Min	Max	Min	Max	Min	Max	Min	Max
PH at 25^0 C	7.1	8.2	5.6	8.8	5.6	8.8	5.4	9.1
Turbidity (NTU)	2.0	25	2	97	2.0	36	3	25
Conductivity (M^S cm)	22.2	31.7	0.2	4.0	0.06	0.22	0.17	0.35
Salinity (g l)	35	43	-	5.85	-	5.85	-	5.85
Total Coliforms per ml	5200	11,200	6000	24,000		-	2100	2100
Faecal califorms per 100 ml.	50	3500	60	6000		-	200	1250
BOD 3 days at 30^0 C	7	40	8	80	16	22	10	40
Total phosphate (mg l)	0.01	1.98	0.02	3.44	0.21	0.58	0.18	0.61
Zinc (mg l)	0.01	0.12	0.01	0.15	0.01	0.02	0.01	0.04
Chromium (mg l)	0.01	0.01	0.03	0.86	0.01	0.01	0.01	0.01
Copper (mg/l)	-	0.03	-	0.02	-	0.01	-	0.01
Ammonia (mg/l)	-	1.0	-	1.0		1.0	-	1.0
Nitrate (mg/ l)	0.06	0.40	0.01	0.02	0.01	0.24	0.05	0.26
Nitrate (mg/l)	0.001	0.003	0.001	0.003	0.002	0.003	0.002	0.003
Cadmium (mg/l)	0.01	0.02	0.01	0.03	0.02	0.02	0.01	0.01
Mercury (mg/l)	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02

Source : **Environmental Profile of Muthurajawela and Negombo Lagoon. Greater Colombo Economic Commission/Euroconsult, 1991.**

Water in the Old Negombo canal, at the western periphery of the marsh is high in nutrients and low in salinity. The presence of blue-green algae in the southern part of the marsh and the dominant species of photo plankton indicate high concentrations of nitrogen and dissolved solids (high conductivity), low pH and reduced oxygen content. This indicates some degree of pollution.

Kalu oya is the main source of inflow to the project area in Kalu oya sub-basin. the main stream and its tributaries pass thorough urbanized areas and therefore convey low to moderate amounts of pollutants. As can be expected from the nature of the surrounding area, the main pollutants are particulate matter, organic nutrients, faecal matter, oily residues and chemicals. Some workplaces discharging untreated effluents into smaller drains have converted them to anaerobic conditions for short stretches. However the large expanses of marsh areas are still able to assimilate the pollution except in certain locations. One such locality is the southern part of this region where the trace enters Peliyagoda. It is a low lying marsh with impaired drainage surrounded by urban areas.

4.1.7 Offshore and Nearshore Environment

Proposed Borrow Site

Zanen Verstoep BV had carried out a series of investigations for SLLRDC in an area 42 km^2 situated within Sri Lanka's territorial waters about 12 km north - north west of Colombo for good quality sand for Kerawalapitiya land fill. Based on results from various investigations a suitable borrow area of 4.6 km^2 had been identified and located approximately 9 to 12 km offshore in the western part of the area of investigation (Fig. 4.2.) Approximately 8.25 million m^3 of good quality sand (envelope of grain size curve, Fig. 4.3) was available in the selected borrow area. Of this 4.80 million m^3 of sand was used for Kerawalapitiya land fill. The balance available is approximately 3.45 million m^3 of sand. The sand requirement for the CKE is approximately 2.50 million m^3. Hence sufficient good quality sand is available offshore for this project.

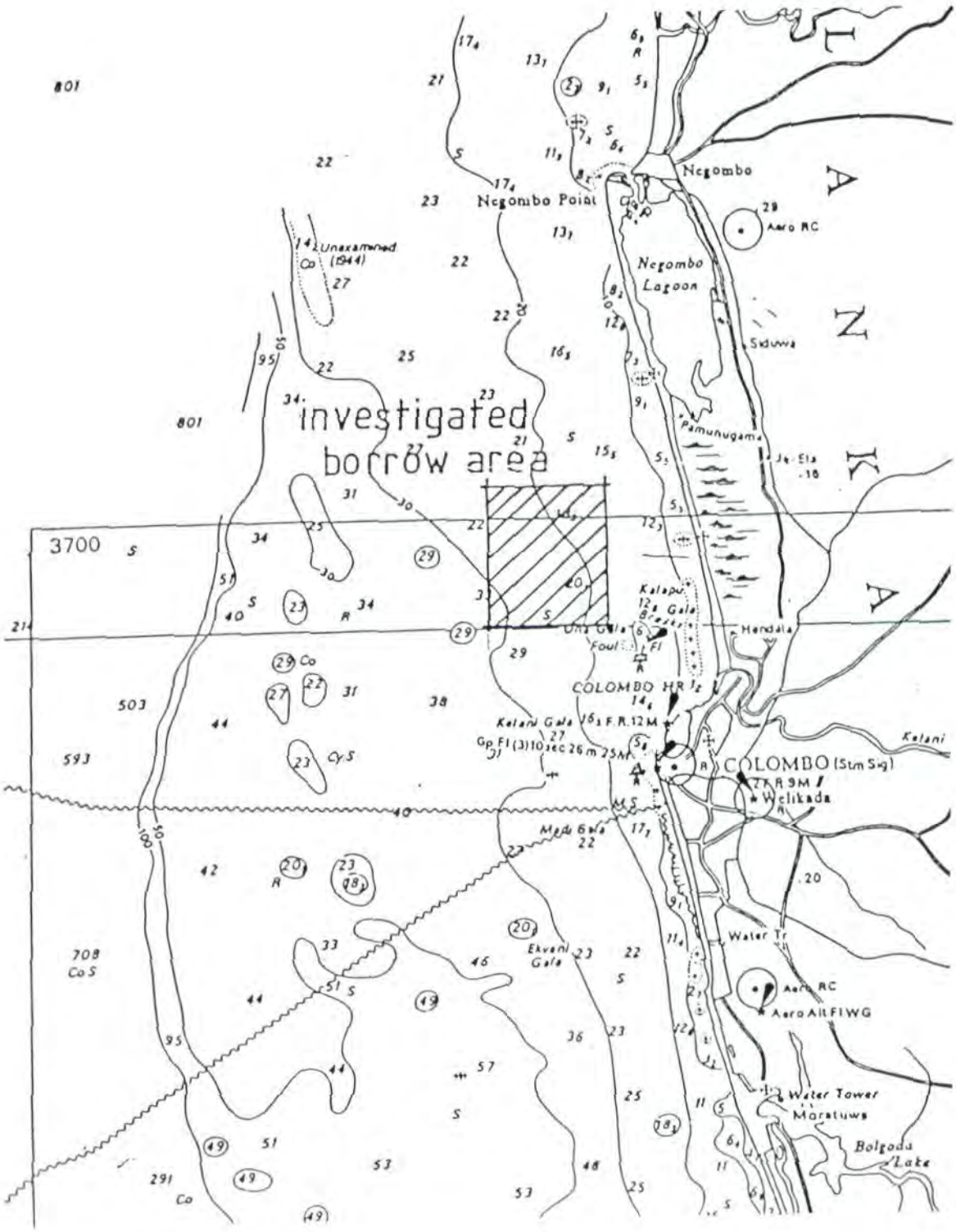


Fig 4.2 Area of Investigation

Source S.L.L.R.D.C

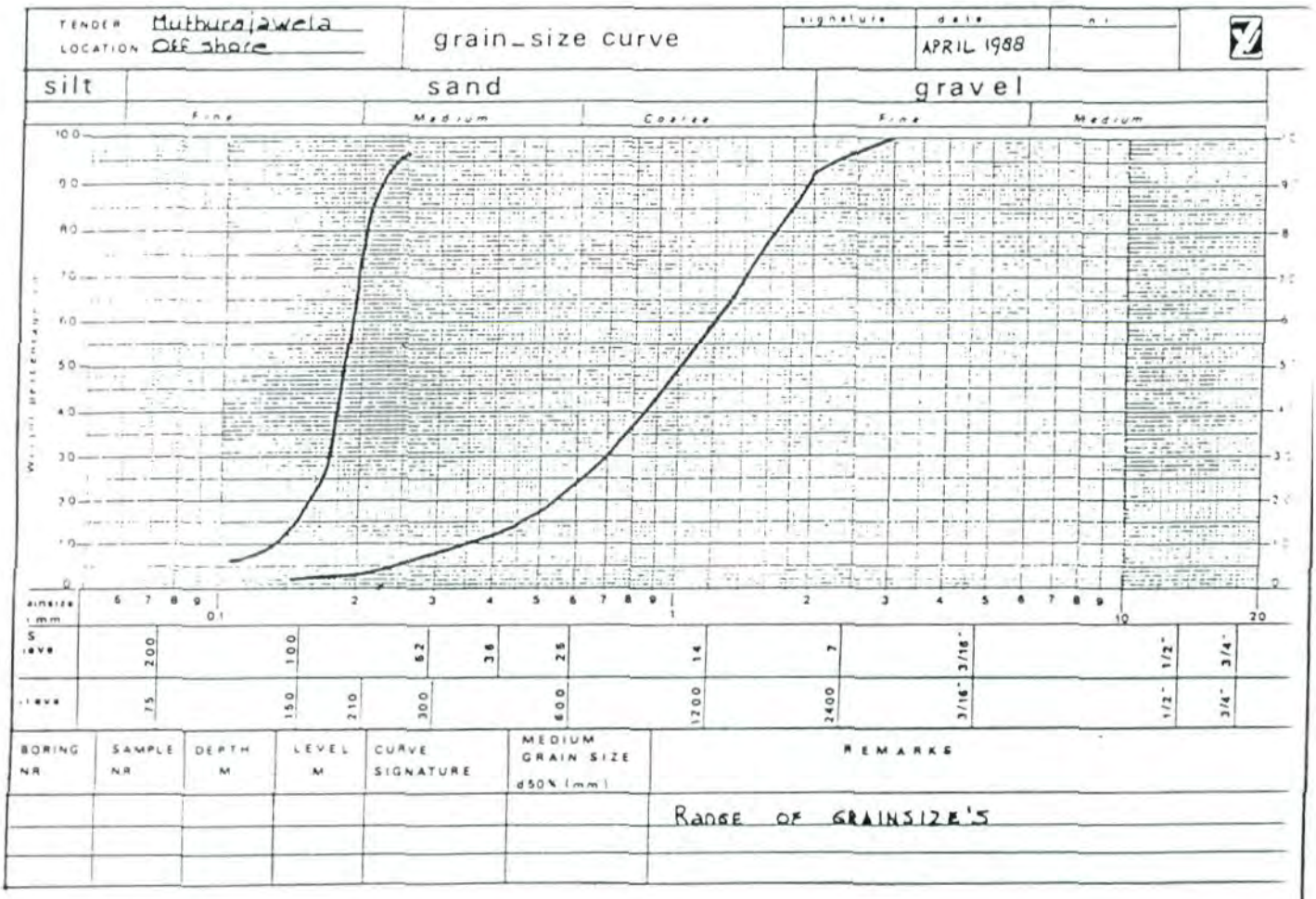


Fig 4.3 Enveloppe of Grain Size Curves

Source - S.L.L.R.D.C

Studies carried out (Environmental -Profile of Muthurajawela - Negombo Lagoon, 1991 and Kerawalapitiya Reclamation Project, EIA 1993) indicate the existence of primary, secondary and tertiary offshore sand stone reefs at distances of 500, 900, and 1500 meters at depths of 2, 6, and 10 meters below MSL respectively which are an integral part of coastline dynamics. Further the borrow area is situated at a 15m depth more than 3 km from the shore which is acceptable from a sediment budget consideration.

4.1.8 Coastline from Colombo to Negombo

The coast line from Colombo to Negombo off which the borrow area is located is a progressively eroding beach. There is a net drift of sand from south to north and a loss of coast has been observed over the last decades.

A system of groynes and revetments has been constructed in the area north of Kelani ganga to protect the coast from sea erosion. Extensive sand mining in Kelani ganga has contributed to a great extent to the erosion process. Muthurajawela marsh is separated from the sea by sand dunes. Beach rock exists along the entire coast extending northwards and exposed where the coast is steep. For the navigation of fishing craft there is an opening in the sand stone reef which to some degree contributes to the damage of the coast line, since this gap creates greater wave activity.

Ocean Environment

From data collected through wave measurement programmes carried out by Lanka Hydraulic Institute (LHI) for Sri Lanka Ports Authority (SLPA) and the Coast Conservation Department (CCD) in 1989, 1990 and 1993, the following may be noted.

* Highest and second highest significant (Hs) wave heights have been recorded during the S-W monsoon. Highest Hs = 4.61 m in June 1992. Minimum Hs = 0.19 m in November 1991.

* Existence of varying wave climates with maximum wave period (Ts) of Ts = 10.96 sec and minimum Ts= 2.81 sec in June 1991 and February 1992 respectively.

Tides observed at Colombo are relevant to this area. Mean tidal range is 0.35 m with 0.2 m during neap tide and 0.6 to 0.7 m during spring tide.

4.2 Ecological Resources

4.2.1 Type of Terrain Traversed

The types of terrain through which the expressway passes may be categorised as built-up land, homesteads, cultivated land, marshes, stream and canal banks, brackish water swamp and lagoon Of these, the last four categories which constitute the Muthurajawela Marsh - Negombo Lagoon wetland system can be regarded as ecologically sensitive, due to the reason that in spite of human activities, it still retains a certain degree of naturalness; remaining categories are man-made habitats.

From its starting point at Peliyagoda upto Mabole, the expressway passes through marshland, homestead gardens, keera (leafy vegetable) fields, and built up areas; from Mabole to Nedurupitiya (Jayasooriya road,) it goes over marshland and homestead gardens; from Mabole at first it runs on the east side of the Dutch canal, but 1.1 km south of Jayasooriya road, it comes over to the west side, proceeds 1.8 km and then returns to the east side of the canal, creating an isolated segment of canal 1.8 km long. The continuity of the canal will be restored by constructing a stretch of canal linking the two ends on the eastern boundary of the coservation zone. From Jayasooriya road to Ja ela (canal) the express way runs through marshland (abandoned paddy fields) and homestead gardens. Northwards of Ja ela, it runs on the west side of Mahadora ela passing through the Muthurajawela Visitor Centre (MVC) at Delature. From Ja ela to Dandugam oya, besides the MVC premises, it goes through marshland, brackish water swamp and a coconut cultivation. Then it enters the Negombo lagoon at a point in Liyanagemulla, about 1.0 km south of the Airport Garden Hotel. (AGH). It runs approximately 1.1 km through the lagoon keeping within a distance of 150 m from the shoreline. This stretch of the expressway passes through seagrass beds. After moving onto land, it passes through a patch of mangrove forest to the north of the AGH, then across a creek (running 0.5 km through the lagoon), veers eastwards and runs a further 0.5 km through a coconut cultivation and homestead gardens to join the Colombo - Negombo road at its junction with the Canada Friendship Road (Airport access road) (Fig. 4.4 - 1: 50,000 map).

PROJECT AREA MAP

Scale 1: 50,000

Fig. 4.4

4.2.2 Man -made habitats

This category includes buildings, home gardens and cultivated lands which provide shelter and sustenance to both plants and animals. Plants found in these habitats may either be there by choice (ornamental plants, fruit trees, medicinal plants, vegetables) or by chance (weeds, wild shrubs and trees) which are often removed by weeding or cutting. Animals present, are there by choice (livestock and pets) or by chance (eg. house rats, shrews, civet cats, bandicoots, insects, slugs and snails). There are also amphibians, reptiles, birds and mammals, common to both home gardens and cultivated land.

There are characteristic ecosystems operating within man-made habitats, but they are by no means confined to the study area. Similar plant and animal communities occur widely throughout the wet zone. Many plants in these habitats are propagated by man and others destroyed when necessary. However, fauna of these habitats are not totally isolated from the marsh and riverine ecosystems. For example birds frequenting home gardens may nest in the marsh vegetation. Such animals are highly mobile and may travel considerable distances in search of food.

4.2.3 Wetlands

4.2.3.1 Flora of the Wetland

a) Marsh Proper and Abandoned Paddy Fields

The marsh proper and abandoned paddy fields have a peaty substrate, is temporarily flooded during monsoon rains and remains saturated for most of the year. Large areas of it are covered with grasses (Graminae), reeds (Poaceae) and cat -tails (Typhaceae). *Acrostichum aureum* (karan) and *Hydrocera triflora* (diya koodalu) also occur in patches. Among the woody stemmed species are the aggressive introduced species *Annona glabra* (wel aththa) spreading to the marshes from canal and stream banks, *Cerbera manghas* (gon kaduru), *Osbeckia aspera* (bovitiya), *Syzigium caryophyllatum* (dan) *Hibiscus tiliaceus* (beli-patta) and *Calophyllum inophyllum* (domba). The most abundant species growing in abandoned paddy fields are *Ischaemum rugosum* (kudu kedu), *Panicum repens* (atora) and *Carex indica.*

b) Brackishwater Swamp and Mangrove Forest

The brackishwater zone marks the transition from the marsh proper to the Negombo lagoon. It is characterised by the presence of mangrove species. Ecologically and economically the swamp is very important; it maintains a high productivity, acts as a silt trap, removes pollutants, provides nursery and feeding grounds for a variety of economically important fish and shrimp species and constantly supplies the lagoon with nutrients. It also provides a wildlife habitat.

The vegetation of the brackishwater swamp comprises ferns, sedges and reeds associated with typical mangrove species. Common sedges are *Fimbristylis polytricha* (hal pan) and *Cyperus exaltatus*. *Cerbera manghas* (gon kaduru) and *Annona glabra* (wel aththa) also occur on raised banks.

Vast areas of the swamp are covered by the fern, *Acrostichum aureum (karan)* which is used by fisherman for making "brush piles" in the canals. ("Brush piles" are fish aggregation devices made by sticking mangrove twigs and branches on the lagoon bottom, covering a circular area about 3 m across.) Other associated plant species are *Derris uliginosa* (kala wel) and *Dolichandrone spathacea* (diya danga).

Mangrove forest forms a narrow belt along certain segments of the shoreline of the lagoon. In estuarine environments, mangroves are known to provide important nursery habitats to young fish and crustaceans. However, since the tidal amplitude of the Negombo lagoon is less than 20 cm, mangroves that can function as nurseries are confined to a narrow band of about 10 m (CEA/Euroconsult, 1994). Mangrove species found in the study area are *Rhizophora apiculata* (kadol), *R. mucronata* (ela kadol), *Sonneratia caseolaris* (kirala), *Acanthus ilicifolius* (ikili), *Aegiceras corniculatum* (heen kadol), *Avicennia marina* (kadol), *Bruguiera gymnorhiza* (path kadol), *B. sexangula*, *Ceriopstagal* (mutti kadol), *Excoecaria agallocha* (thela keeriya), and *Lumnitzera racemosa* (beriya).

Mangroves are used for purposes connected with fisheries, house construction, cottage industries and for medicinal purposes; mangrove branches and twigs are extensively used for making "brush piles", which practice constitutes the greatest threat to mangroves growing around the lagoon. However at the northern end of the lagoon, some fishermen cultivate mangroves in order to obtain twigs and branches for their brush piles (Amarasinghe, 1988).

The expressway will pass through a small area of the brackishwater swamp and a patch of mangrove forest to the north of the AGH.

c) Ponds, Canals and Streams

Factors that influence the occurrence of aquatic plant species in these habitats are the depth of water, salinity and eutrophication. In shallow water, like in the southern part of the Dutch canal, occur grasses such as *Panicum repens* (atora) and *Ischaemum rugosum* (kuda kedu) and sedges such as *Carex indica*, *Eleocharis geniculata* (boru pan) and *Cyperus spiralis*. In the nutrient rich but not too saline water are found the primary and secondary stages of the floating weed *Salvinia molesta* (salvinia). Also present are islands of another aquatic weed *Eichhornia crassipes* (water hyacinth). In stagnant pools and canals rich in nutrients is found *Lemna* species (duck weed) in addition to salvinia and water hyacinth. In not too deep water occur rooted aquatic plants such as *Nymphoides indica* (olu), *Nymphaea lotus* (nelum) *Nymphaea stellata* (manel), *Aponogeton crispus* (kekatiya) and the submerged strands of *Hydrilla verticellata* (hydrilla).

Growing on the canal banks in the southern part of the marsh from Mabole upto Dandugam oya are the woody stermmed species *Cerbera manghas* (gonkaduru), *Osbeckia aspera* (bovitiya), *Syzigium caryophyllatum* (dan), *Pandanus odorotissimus* (wetakeiya), *Hibiscus tiliaceus* (belipatta), *Calophyllum inophyllum* (domba) *Acrostichum aureum* (karan) and the introduced aggressive species *Annona glabra* (wel aththa). Tangled among these trees and shrubs are creepers such as *Mikania scandens* (wathupalu), *Lygodium microphyllum* (pamba), *Flagellaria indica* (goi wel), *Ipomaea* species and *Derris uliginosa* (kala wel). In the brackishwater swamp area of these canals and streams, the banks are invaded by *Acanthus illicifolius* (ikiliya), *Sonneratia caseolaris* (kirala), *Hibiscus tiliaceus* (belipatta), *Phragmites karka* (waluk), *Dolichadrome spathacea* (diya danga), *Bruguiera gymnorhiza* (path kadol), *Lumnitzera racemosa* (beriya), *Excoecaria agallocha* (thela keeriya) which occur along with some other species such as *Cerbera manghas* (gon kaduru) and *Acrostichum aureum* (karan). The transition from freshwater to brackishwater vegetation is gradual.

These waters are also rich in phytoplankton which constitute a primary link in the aquatic food webs of this ecosystem..

d) Negombo Lagoon

In addition to phytoplankton the lagoon has seven species of sea grasses. These have been studied by Jayasooriya (GCEC/Euroconsult 1991) She has not found seagrasses along the offshore area of the lagoon through which the expressway will pass.

According to Jayasooriya, the sea grasses *Halodule pinifolia*, *Halophila minor*, *Potamogeton pectinatus* and *Ruppia maritima* undergo major seasonal changes. Random bottom sampling in the area off Liyanagemulla carried out by Fernando (1996) indicated a paucity of sea grasses within a belt of approximately 150 m from the shoreline, which may be due to seasonality of the grasses. However, thick mats of the green alga *Chaetomorpha* species were abundant at the bottom and it is possible that this may have suppressed the growth of sea grasses.

Seagrasses play an important part in the functioning of the lagoon ecosystem. They bind the sediments in the lagoon and stabilise the bottom. They are also very important primary producers. Leaf litter from the seagrasses contribute significantly to the trophic status of the habitat. Detritus produced by seagrasses and mangroves is very important in the diet of many species of commercially important finfish and shell fish (Wijeyaratne and Costa 1990.) In addition to this, blades of certain seagrasses provide a substrate for the growth of other tiny plants and animals. Many fish and shrimp species depend on these for food, thus making seagrasses a major link in the foodweb of the Negombo lagoon. Seagrasses thus provide microhabitats for many species of euryhaline fauna so that they contribute significantly to the existence of a high biodiversity in this habitat. These microhabitats provide excellent places for nature studies.

Seagrass beds in the Negombo lagoon are said to be faced with severe threats from pushnets and dragnets used in the lagoon. However, recent studies carried out by Amarasinghe et al. (1993) suggest that these types of fishing gear do more harm to the fish and shrimp stocks of the lagoon than to the sea grasses themselves.

4.2.3.2. Fauna of the Wetland

a. Mammals

At Muthurajawela, 34 species of mammals have been recorded of which two are endemic and six are threatened. (Annexure IX) The endemic species are the fruit bat *Rousettus seminudus* (ma-waula) and the toque macaque, *Macaca sinica sinica* (rilawa). The fruit bat occurs in fairly large numbers in the wet lowlands and also in the lower hills upto about 1200 m. They feed on many species of flowers and fruits growing in home gardens. They usually roost in caves and occasionally in tall trees. They can fly many miles in search of food and are not endangered. The toque macaque has adapted well to the marshland and seems to relish fruits of *Annona glabra*. They even swim across rivers. They feed on flowers, fruits, seeds, barks, stems and roots of many plant species and also on insects. The macaque is found in many parts of Sri Lanka and is not endangered.

The six mammalian species that are threatened are the painted bat, *Kerivoula picta* (kiri waula) the slender loris, *Loris tardigradus* (una hapuluwa), the otter *Lutra lutra* (diya balla), the mouse deer, *Tragulus meminna* (meeminna) and two wild cat species, *Felis viverrina* and *Felis rubiginosa*, (wal balallu).

F. rubiginosa is also included in the IUCN red list of threatened animals. *Kerivoula picta* occurs in small numbers throughout the lowlands and lower hills in the wet zone as well as the dry zone. Its favourite sheltering place is banana groves; it hides among leaves during the day and flies out at night in search of insects on which it feeds. Therefore Muthurajawela is not a critical habitat for this species.

Loris tardigradus (una hapuluwa) is confined to the lowlands of the wet zone. It is not abundant anywhere but is well distributed in suitable wooded habitats (Not confined to Muthurajawela). It feeds on insects, small birds, lizards, frogs and fruits.

Lutra lutra (diya balla) although listed as threatened is moderately abundant in and near rivers, streams, lakes, lagoons and paddy fields in most parts of island (De Silva, 1996). Its food consists of fish, freshwater crabs, frogs, water fowl, young birds and small rodents.

The wild cat *Felis viverrina* (wal balala) is also not confined to Muthurajawela. It occurs in small numbers throughout Sri Lanka in the highest mountains as well as lowlands in both the wet and the dry zones. Its food consists of fish, fresh water molluscs, crabs and small reptiles. It lives in forests, swamps and reed beds beside rivers.

The other wild cat *Felis rubiginosa* (wal balala) although threatened by the dwindling forest cover is found throughout the jungles of the whole island but is not abundant anywhere. Its food consists of small mammals, birds, lizards and frogs. Muthurajawela is not a critical habitat for this cat.

The mouse deer *Tragulus meminna* (meeminna) is moderately plentiful throughout the woodlands and jungles of the lowlands as well as the highlands. It is nocturnal and shy and therefore not easily observed. It feeds on grasses, herbaceous plants, leaves, seedlings and fallen fruits and berries. Muthurajawela is not a special habitat for it.

b) Birds

Except for the endemic species indigenous avi fauna are common to Sri Lanka and the Indian mainland. According to De Silva (G.C.E.C./EUROCONSULT 1991) none of the resident species observed at Muthurajawela are endemic.

The many canals and abandoned paddy fields of Muthurajawela provide a suitable habitat for many species of small to medium sized fish upon which a variety of birds feed. Stalkers such as herons and egrets prefer shallow waters. Plunge divers favour deeper waters and shags and cormorants dive deep down in pursuit of prey. Extensive marshes are home to many insectivorous and omnivorous birds such as warblers, prinias, swallows and shrikes. Frugivorous birds such as bulbuls, mynahs and barbets, nectar feeders like sunbirds and mud-flat feeders like the short and long billed species of waders are also present in the marshland. Migrant rapators, which feed mainly on small rodents are also present from September to January.

The lagoon/swamp transition area is of great importance for a wide variety of avifauna and the MVC is ideally located for the obersevation and study of the multitude of birds that use the marshland as their permanent habitat or winter feeding grounds.

A list of 85 indigenous species recorded at Muthurajawela is given in Annexure X.

De Silva (1991) has listed 38 migrant species that have been recorded from Muthurajawela (Annexure XI). Waders, ducks and wag tails are the main migrant groups generally associated with wetland habitats. They come from eastern Europe and westen Asia and arrive at Muthurajawela towards the end of August and leave in April or May the following year. Of these, the threatened species are *Halcyon pileata*, (black -capped purple king fisher), *Sterna hirundo tibetana*, (tibetan common stern) and *Phalacrocorax carbo sinensis*, (Indian cormorant). *H. pilieata* is a coastal bird frequenting mangrove lined estuaries; it feeds mainly on crabs. *S. hirundo tibetana* is an irregular winter visitor, partial to estuaries, where it feeds on fish, crustaceans and molluscs. *P. carbo sinensis* is a winter visitor which is not common in Muthurajawela. It feeds on fish which it pursues under water.

Among the many birds that may be observed throughout the year are the pied kingfisher, (*Ceryle rudis*), the purple heron, (*Ardea purpurea*), the whistling teal, (*Dendroctonus javanica*), the purple coot, (P*orphyrio porhyrio*) the little cormorant, (Phalacrocorax niger), large, medium and small egrets, (*Egretta alba*, *E. intermedia* and *E garzetta*), the brahminy kite, (*Haliaster indus*), the plain and large prinias. (*Primia subflava* and *P. sylvatica*) and the red vented and white browed bulbuls (*Pycnotus cafer and P. luteolus*).

c) Reptiles

In Muthurajawela, 37 reptilian species have been recorded, of which 15 are tetrapods and 22 serpenoids (Annexure XII). Of the Tetrapods, seven species are threatened; they are the two endemic skinks (*Mabuya macularia* and the rare *Sphenomorphus falle*), two freshwater terrapins (*Melanochelys trijuga* and *Lissemys punctata*) the estuarine crocodile (*Crocodylus porosus*), the green garden lizard *Calotes calotes* and another lizard (*Typhlina bramina*). *Crocodylus porosus* is listed in the IUCN red data book as an endangered species as its breeding grrounds are greatly reduced. It still breeds in Muthurajawela and the conditions for continued breeding still exist.

The land monitor lizard (*Varanus bengalensis*) is not as common as it used to be, due to over exploitation for its flesh. The water monitor lizard (*Varanus salvator*) a protected species, is common in the marsh mainly because it is not eaten by the humans.

Of the 22 snake species, three are endemic and six are listed as threatened in the National Status Report of the IUCN (1993). Two very rare species Guenther's roughside (*Aspidura guentheri*) (both genus and species are endemic) and *Gerada prerostiana* have been recorded from Muthurajawela. Another snake, not very common at Muthurajawela is the python(*Python molurus*) which has been included in the IUCN red data book. The endemic Sri Lanka pipe snake *Cylindrophis maculatus* is the only representative of its family found in Muthurajawela.

These reptilian species also occur elsewhere, but they are an important component of this wetland ecosystem.

d) Amphibians

The number of amphibians recorded from Muthurajawela is 15; they belong to the families Ranidae (6 species), Bufonidae (3 species), Rhacophoridae (3 species), Microhylidae (3 species) (Annexure XIII)

Two of the recorded species, Atukorale's dwarf toad, *Bufo atukoralei* and the greater hourglass tree frog *Polypedatedes cruciger* are endemic to Sri Lanka and also listed as threatened. *B. atukoralei* has been recorded from many places in the wet zone and dry zone. *P. cruciger* occurs throughout Sri Lanka in both the dry and wet zone.

Ranidae prefer Muthurajawela's aquatic habitats *Rana hexadactyla* and *Rana tigerina* dominate in open waters with floating vegetation. *Rana cyanophlyctis* and L*imnonectes limnocharis* occupy shallow pools with abundant water plants . *Rana temporalis* is mainly found in marshes with reeds especially along canals.

Rana brevipes is a burrowing frog breeding in rainwater holes on higher ground. *Bufo melanosticus* is found on high ground, often under disturbed conditions, close to human habitations. *B. stomaticus* found in Muthurajawela lives in habitats similar to that of *B. melanousticus.* An unindentified tiny tree frogs species, (*Philautus species),* is found throughout Muturajawela among low bushes. *Polypedates maculatus* and *P. cruciger* are also tree frogs common in Muthurajawela; they may sometimes be found inside houses. *P. maculatus, P cruciger* and *Philautus species* build foamy nests attached to foliage hanging over water. Tadpoles on hatching drop into water where they spend their larval stages. Except for *Bufo stomaticus* which is suspected to be an introduced species, other species have been recorded from many places in Sri Lanka. Therefore Muthurajawela is not a unique habitat for any of the amphibians found there.

e) Fish

Muthurajawela marsh - Negombo lagoon wetland is an important fish habitat not only because of its extent, but because of the series of interconnected diverse biotopes such as pools, canals, streams and lagoon. Pinto (1991) has listed 21 species sampled in Muthurajawela from September 1990 - February 1991. (Annexure. 4.6). In the pools of Muthurajawela, typical freshwater species are reported to be *Ophicephalus striatus*, *Heteropneustes fossilis*, *Trichogaster pectoralis*, *Anabas testudineus*, *Puntius vittatus*, *Oreochromis mossambicus* and *Etroplus suratensis*. In the canals, Pinto (1991) has found that the common species were *Ambassis dayi*, *Puntius vittatus*, *Etroplus suratensis*, *E. maculatus*, and *Panchax panchax*. Species such as *Caranx sexfasciatus*, *Heteropnenstes fossilis*, *Elops echinata* and *Megalops cyprinoides* have been found to be less common. Mullets and half beaks have also been observed in the canals.

In the rivers, the abundant species have been recorded as *Etroplus suratensis* and *Oreochromis mossambicus*. Less abundant species recorded were *Ambassis dayi*, *Tachysurus* species, *Gerres abbreviatus*, *Lutjanus argentimaculatus*, *Eleotris fusca*, *Oligolepis acutipennis*, *Puntius vittatus* and *Panchax melastigma*.

In the southern part of the estuary the abundant species reported are *Ambassis dayi* and common species are *Leiognathus equulus*, *Oligolepis acutipennis*, *Etroplus suratensis*, *Eleotris fusca*, *Epinephelus tauvina*, *Lutjanus argentimaculatus* and *Lates calcarifer*.

At least 133 different fish species are known to inhabit the Negombo lagoon (Silva & De Silva, 1979; De Silva & De Silva 1992; Wijeyaratne & Perera 1992). More than half of these are marine species that move into the estuary to feed and some are known to move deep into the canals in the marshes without which these marine migrant species would diminish. Among these, are numerous species of economic importance such as groupers, snappers, mullets and sunbream which are abundant and moray eel, snake eel and conger eel which are less abundant.

There are also species found in the estuary that migrate from freshwater to marine habitats for breeding. Among them is the freshwater eel, *Anguilla bicolor bicolor*.

Some illustrations of fish occurring in the wetland are given in the Annexure XIV.

f) Aquatic Invertebrates

The zooplankton of Muthurajawela is composed of cycloid copepods, nauplius larvae, rotifers, cladocerans, ichthyoplankton and shrimp larvae. Of these, the most abundant are copepods, but their numbers decrease with increasing salinity. Nauplius larvae are most numerous in Delature but virtually absent in the Dutch canal. Rotifers are widely distributed in Muthurajawela and abundant in the Delature area. Cladocerans show a somewhat narrow distribution, being restricted to Mudun ela and Kudagahapitiya ela (GCEC/EUROCONSULT 1991). Zooplankton is an important food source of fish, crustaceans and some birds; it also contains larvae of commercially important fish and shrimp species.

The most important freshwater and brackishwater macro invertebrates of this wetland ecosystem include crustaceans, molluscs, worms, insects and insect larvae.

A large number of crustacean species have been reported from the wetland; among them are the estuarine shrimp, *Metapenaeus dobsoni* and the large white shrimp, *Penaeus indicus* present in the northern parts of the marsh and the lagoon. The giant freshwater prawn *Macrobrachium rosenbergii* occurs further south in Dandugam oya, Ja ela and the Dutch canal ; it spends its larval life in the estuary and the post larvae return to freshwaters. The mangrove crab *Scylla serrata* and the crab *Neosernatium malabaricum* have been found in the canal system.

Aquatic insects reported from Muthurajawela include dragonfly and mayfly larvae and the creeping water bug *Holeocaris bengalensis*. Numerous annelids have also been reported from the benthos of the canal system. *Hirudinaria manillarsis* is a common form. Among the aquatic molluscs present in Muthurajawela are *Pila globosa*, *Indoplanorbis* species, *Faunus ater* and *Melanoides* species (Gamalath 1996). So far none of Sri Lanka's 12 endemic species of aquatic mollucscs have been reported from the area.

g) Terrestrial Invertebrates

Of the numerous groups of invertebrates present in Muthurajawela, information on the species composition is available for butterflies and dragonflies. Karunaratne (1990) has recorded 67 species of butterflies including nine endemic subspecies. Of these, 28 species are reported to be migratory. They are present only during the migratory seasons March - April and October - December. The families of butterflies present in Muthurajawela are given in Annexure XV.

The Muthurajawela area has at least 34 species of dragonflies including eight endemics. (Karunaratne,1990) Dragonflies are found in marshy waters with heavy aquatic vegetation. The families of dragonflies present in Muthurajawela are given in Annexure XVI.

4.2.3.3 Disease Vectors

Rats, *Rattus norvegicus* and *Rattus rattus* present in the wet land, are responsible for the spread of leptospirosis, a potentially fatal disease caused by the bacterium *Leptospira ictiohaemorrhagica.*

The most important mosquito vectors of disease present in Muthurajawela belong to the genera *Aedes, Culex* and *Anopheles* for which there are numerous breeding places in the wetland. Diseases caused by pathogens transmitted by these mosquitoes include dengue haemorrhagic fever, filariasis, Japanese Encephalitis and malaria.

4.2.3.4 Stockpile Area

Two sites about 0.5 km apart with a total extent of 40 ha. situated between the reclaimed (sandfilled) Kerawalapitiya Project area and the Dutch canal have been identified for the purpose of stockpiling sand. (Fig.4.5).The fauna and flora present here are typical of the marsh and are not unique,endangered or rare.

4.2.4 Existing Fauna of Borrow Site

Turbidity prevails for most of the year particularly during rainy season when vast amount of silt enter the sea south of the borrow area. This sediment fans out for several kilometers from the Kelani river mouth and is transported northwards covering the borrow area. Probably due to this reason, no sea grass beds have been observed in the borrow site.

Sea benthos shows a decrease in animal life with increase in depth. Futhermore at the dredging depth the faunal diversity in the benthos is known to be low. The animals most likely to occur at this depth are deposit feeders such as annelids (worms) and crustaceans. Molluscs such as bivalves and gastropods are also known to be present at this depth.

The benethic fauna associated with the reefs includes sea fans, black corals, soft corals, polychaete worms, shrimps, bivalves, crabs and spiny lobsters. Among the fish species are the groupers, snappers,jacks, angel fish, puffer fish, damsel fish etc. However the faunal diversity compared to that of the area south of the borrowsite or north of it is less. The reefs close to Kelani river inflow has a large number of predatory fish such as seer, herring skip jack tuna, makerel etc. List of reef fauna between Colombo (Fort) and Negombo is given in Annexure XVII.

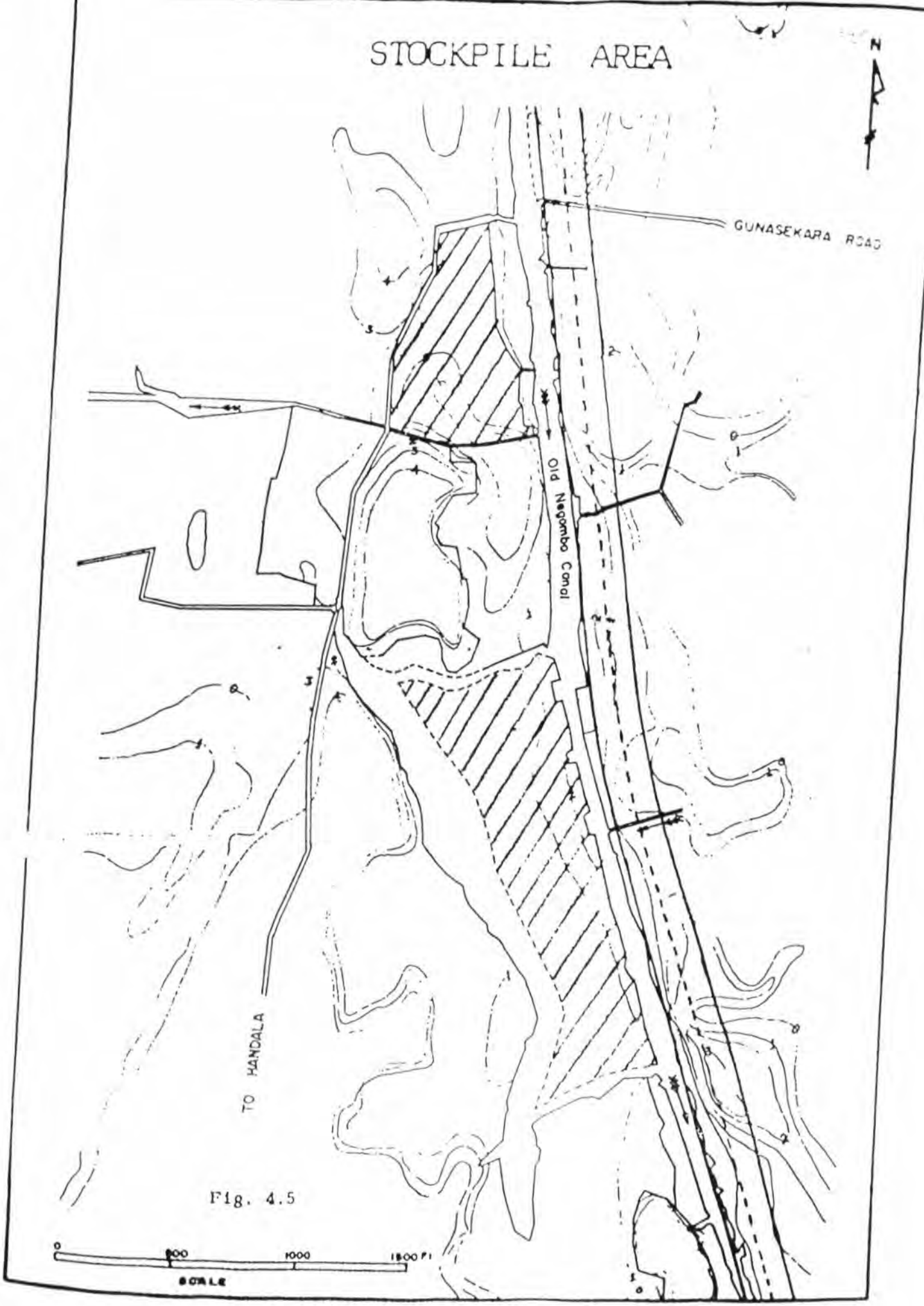

STOCKPILE AREA
N
GUNASEKARA ROAD
Old Negombo Canal
TO HANDALA
0
500
1000
1500 Ft
SCALE

Fig. 4.5

4.3 Socio - Economic Environment

4.3.1 Major Settlement Types

The study area is located in the rapidly urbanizing Colombo Metropolitan Region (CMR). Hence most of the settlements in the area belong to urban and "rurban" categories. Rurban settlements can be described as former villages that are in the process of being transformed into suburbs or towns. They are characterized by a mixed urban and rural land use pattern, rapid population growth and an influx of migrants. Since the majority of their working population are commuters, these settlements can be described as commuter settlements that perform dormitory functions.

The urban settlements in the study area include areas administered by Urban Councils such as Wattala - Mabole, Peliyagoda, Je Ela, and Seeduwa - Katunayake, as well as former Town Council areas that have been incorporated with Pradeshiya Sabhas (PS) such as Hendala, Dalugama, Kelaniya, Kandana and Welisara. Most of these urban settlements had evolved as suburbs of Colombo. Wattala - Mabole and Peliyagoda for example, are two of Colombo's oldest suburbs and they had experienced rapid growth of population prior to 1970 due to the influx of migrants who work in Colombo. Although there was a decline in the growth rates between 1971 - 1981, due to the diversification of economic activities in the region and the resultant increase in employment opportunities, there was once again a rise in their average annual growth rates (aagr) to 1.2% and 0.7% respectively during 1981 - 1991. As reflected in Table 4.4 very high growth rates of 4.61% and 6.17% per annum are predicted for these two suburbs during the period 1994- 2014. It is anticipated that their population densities would rise from 44 persons/hectare (p/ha) to 86 p/ha and from 46 p/ha to 90 p/ha respectively by 2014.

The remaining urban and rurban settlements too have experienced relatively high growth rates. Population in the Wattala PS area had increased at the rate of 3.15% per annum between 1981-1991. In future, the already congested high density suburbs such as Dalugama (80 p/ha), Kelaniya (62 p/ha) and Hendala (65 p/ha), are not expected to grow as rapidly as the less densely populated areas in the northern and eastern parts of the study area. It is anticipated that the availability of buildable serviced land in these areas at relatively low cost will attract more industries and other economic activities as well as migrants to Biyagama, Ja Ela, Katana and Seeduwa - Katunayake. During 1994 - 2014, their population is projected to increase at rates between 4.45% to 8.30 % per annum. (Table 4.4)

Only a few rural settlements, where the majority of the working population are engaged in farming or fishing remain in the area. The more accessible rural settlements are in the process of being converted to rurban settlements.

TABLE 4.4

ESTIMATED AND PROJECTED POPULATION IN SELECTED URBAN AND RURBAN SETTLEMENTS IN THE STUDY AREA

Urban Centre	Extent (Sq.km)	Estimated Population 1994	Density 1994 (P/ha.)	Projected Populatio n 2014	Density 2014 (P/ha.)	Average Annual Growth Rate % 94-2014
1. Wattala Mabola U.C.	4.4	19,184	44.0	37,776	86.0	4.61
2.Peliyagoda U.C.	3.6	15,058	42.0	33,661	94.0	6.17
3.Ja Ela U.C.	7.7	27,967	36.0	57,967	82.0	5.36
4.Negombo M.C.	10.4	98,354	94.0	118,354	113.8	1.02
5.Seeduwa Katunayake U.C.	21.8	36,559	16.0	71,559	32.8	4.45
6.Dalugama P.S.	7.7	61,734	80.0	80,337	104.0	1.50
7.Hendala P.S.	7.7	50,262	65.0	68,865	90.0	1.85
8.Kelaniya P.S.	7.7	47,524	62.0	66,127	77.0	1.95
9.Biyagama P.S.	5.0	12,568	25.0	32,568	65.0	7.90
10.Kandana P.S.	7.7	28,022	36.0	48,022	68.0	3.56
11.Katana P.S.	5.0	4,801	10.0	2,801	25.0	8.30

Source : UDA, Colombo Metropolitan Regional Structure Plan 1995

*** Projections by Consultant, 1996.**

There is a mixture of low, medium and high income groups in the study area. The Low Income Communities (LICs) live mainly in 3 types of settlements viz ;

i) unauthorised squatter settlements or shanties of encroachers.
ii) unserviced semi urban neighbourhoods
iii) upgraded or relocated new settlements

LICs living in shanties do not have a legal right to the land they occupy. Shanties are temporary or semi -permanent structures that are located primarily in or near marshes and in road, canal and rail reservations without adequate sanitation facilities or a potable water supply. Shanty dwellers in this area are employed as casual labourers, petty traders and in other informal sector activities.

There are 7686 housing units in 78 unserviced semi-urban neighbourhoods in the study area. The LICs in these settlements do not have adequate infrastructure facilities and amenities; some of their dwellings are in a dilapidated state. However, their occupants have a legal right to the land and houses they occupy. Due to the inadequacy of facilities even some of the model villages and aided self-help housing schemes in the area fall into this category.

Upgraded or relocated new settlements in the study area include electoral housing schemes, model villages and aided self-help housing schemes eg. Wahatiyagama model village close to the western trace.

4.3.2 Industries

The study area contains some of the largest industrial concentrations in the island. As much as 22% of the industries operating under Section 16 and 45% of industries operating under Section 17 of BOI Law are located in the Gampaha District, particularly in the study area. The major industrial concentrations located in the vicinity of the proposed trace are BIPZ, KIPZ, Ekala Industrial Estate and PIUDP. (Table 4. 5)

TABLE 4.5

MAJOR INDUSTRIAL CONCENTRATIONS IN THE STUDY AREA, 1993

Name of Industrial Concentration	Number of Units	Number of Employees
B IPZ	40	32852
K IPZ	79	55077
Ekala Industrial Estate	48	2000
Peliyagoda Integrated Urban Development Project	22	15000
TOTAL	189	104929

Source : UDA, Colombo Metropolitan Region Master Plan 1995

Smaller concentrations occur around the Ekala Industrial Estate and at Sapugaskanda, Mahara, Kandana, Ja Ela, Kelaniya and Wattala areas. The majority of registered and unregistered industrial units located in these areas belong to four categories viz; textiles and wearing apparel; food and beverages, basic metals and non metallic mineral products. (Table 4. 6)

TABLE 4.6

LOCATION OF INDUSTRIES (REGISTERED & UNREGISTERED) IN THE STUDY AREA 1993

	Categories	Settlements							
		Peliya goda	Wat-tala	Kela-niya	Dalu-gama	Hen-dala	Kanda na	Ja Ela	Weli-sara
		Number of Units							
01	Food, beverages and tobacco	12	21	08	27	34	25	22	16
02	Textiles, wearing apparel	48	23	87	102	55	27	13	33
03	Wood and Wood Products	28	08	22	19	05	08	02	06
04	Paper and Paper Products	04	06	18	22	27	02	06	05
05	Chemical, Petroleum Rubber and Plastics Products	30	08	07	07	19	01	-	08
06	Non Metallic Mineral Products	06	14	60	02	14	01	-	34
07	Basic Metal Products	34	-	07	43	-	04	38	01
08	Fabricated metal Products, Machinery and Transport Equipment	19	15	09	53	08	06	02	03
09	Products not elsewhere specified	64	34	62	132	72	29	31	10
	TOTAL	245	129	280	407	234	103	114	116

Source : Unpublished data from Local Authorities

4.3.3. Employment

The number of jobs in the Gampaha District has increased from 440,000 in 1985 to 533,000 in 1992 (approx. 20% increase). The study area provides employment to a significant proportion to the establishment of manufacturing industries in and around the KIPZ and the Ekala industrial estate. The estimated and projected employment data for the major settlements in the area are shown in Table 4. 7. In 1995 the Hendala and Welisara urban settlements provided jobs for 33,600 persons while Ja Ela employed 49,300.

TABLE 4.7

EMPLOYMENT ESTIMATES AND PROJECTIONS, IN SELECTED SETTLEMENTS IN THE STUDY AREA - 1995 - 2015

TRANSPORT ZONE		1995	2000	2005			2015		
No.	Name			Trend	Structure Plan Scenario(SP)	Control Trend (CT)	Trend	Structure Plan Scenario (SP)	Control Trend (CT)
53	Kelaniya	25000	25800	27200	27200	29300	28300	28300	30600
54	Dalugama	19000	22000	22400	22500	23900	26100	25800	30200
55	Wattala UC	7500	9100	9700	10000	10500	11700	12000	12900
56	Hendala	21200	29400	34900	34100	32400	44600	42100	38400
57	Welisara	12400	15100	16100	16100	16600	19400	18300	21100
58	Biyagama W.	23600	27600	28600	29000	29300	34400	34400	37200
59	Biyagama E.	14100	18100	18800	17900	19300	24900	21300	23200
63	Ja Ela S.	25700	29900	30700	31100	32400	37000	38500	40500
64	Ja Ela N.	23600	29200	30000	29300	28800	38900	32800	37600
67	Katana S.	44900	66700	63600	55800	57600	92700	64900	69300
69	Negombo	48400	69500	73900	67300	67400	97200	76800	82800

Source : Halcrow Fox Associates and Transport Study and Planning Centre, Colombo Urban Transport Study, September, 1995

4.3.4 Land Use Pattern

a) Urban Land Use

The study area exhibits a mixed urban and rural land use pattern and is characterized by a rapid conversion of agricultural and other rural land uses into urban uses. In the past, due to push factors operating in Colombo and the pull exerted by the nearby suburbs and rurban areas, there was an increasing demand for land in the study area by urban uses such as residential, industrial, commercial, educational, health and recreational activities. Consequently, in the older suburbs of Wattala - Mabole and Peliyagoda as much as 85% and 74% respectively of the total land area is currently utilized for urban purposes (Table 4. 8). Of this amount more than 50% is under residential uses.

The present trend is for the area, under agriculture and other developable land to decline while that of urban uses to increase. At Peliyagoda UC area for instance, there was a reduction of developable area from 74 ha to 15 ha between 1990 and 1995 while the area under commerce and industries increased from 33 ha to 97 ha. during the same period. In Kelaniya PS area, recent land conversion is primarily for industrial and commercial activities and the ratio of urban to rural land use is 3 :1.

The majority of urban non-residential uses are located along major highways forming continuously built up areas with larger nucleations at junctions. The interstices are filled in by low, middle and high income residential areas.

b) Agricultural Land Use

Outside the densely populated areas, agricultural (paddy, coconut and vegetables) land uses predominate. In Biyagama and Ja Ela PS areas for example, the proportion of urban to agricultural uses is 1 : 1 as shown in Table 4.8.

TABLE 4.8

Land Use Pattern In Selected Settlements In the Study Area, 1995 (In Hectares)

Settlements	Residen-tial	Commer-cial	Indus-trial	Insti-tutional	Parks, Roads & Open Spaces	Agri-cultural	Water & Marshy
Peliyagoda U.C	177	16	61	05	68	0	41
Wattala Mabole U.C	208	07	38	08	18	02	98
Ja Ela U.C	408	09	18	12	52	107	268
Katana P.S	1200	186	87	98	280	955	32
Seeduwa Katunayake U.C	380	15	108	208	60	120	145
Wattala P.S	2388	42	60	12	210	3205	1638
Ja Ela P.S	1590	48	250	134	170	1650	1700
Kelaniya P.S	1500	40	100	54	184	219	190
Biyagama P.S	2340	40	325	27	220	2889	0

Source : National Water Supply and Drainage Board,
Ministry of Housing, Construction and Public Utilities
Greater Colombo Wastewater and
Sanitation Master Plan - April 1993

c) Marshes

A significant proportion of the land in Wattala and Ja Ela PS areas is under marshes and water bodies. They include the proposed strict conservation zone, a major part of which has since been gazetted as a santuary (Fig. 4.7) and the buffer zone of the Muturajawela marsh. (Table 4.8)

d) Land Use in a 600 wide m corridor

The detailed land use map of a 300 m wide corridor on either side of the trace (Fig. 4.6) indicates that the area can be divided into two main sections namely the area from Peliyagoda to Mabola in the south and the area from Mabole to Katunayake in the north. The densely populated southern area depicts two clusters of highly residential, commercial and industrial land uses in Peliyagoda and Mabole, giving rise to high building density. Apart from these two clusters, residential areas and marshes are interspersed with patches of reclaimed land, paddy fields and small plots of coconut cultivation. Shanty settlements form a significant component of the land use in these marshlands especially close to the New Kelani Bridge. In the section to the north of Mabole, marshes and abandoned paddy fields and keera plots constitute the major proportion of the land area. Sand filled area in Kerawalapitiya exhibits a significant land use feature while smaller plots of reclaimed land dot the area. Residential land uses are dispersed on either side of the trace up to Katunayaka. Residential and commercial building density is considerably lower than that in the southern section.

e) Land Values

Due to the increasing demand for accessible serviced land, there has been an escalation of the price of buildable land. Land values had increased by 19.7% per annum between 1978 and 1994 in Wattala and by 23.0 % and 27.2 % in Kelaniya and Biyagama PS areas respectively during the same period. (Table 4.9). The construction of an expressway would lead to an appreciation of commercial and industrial land values.

LAND USE PATTERN ALONG THE PROPOSED COLOMBO-KATUNAYAKA EXPRESSWAY

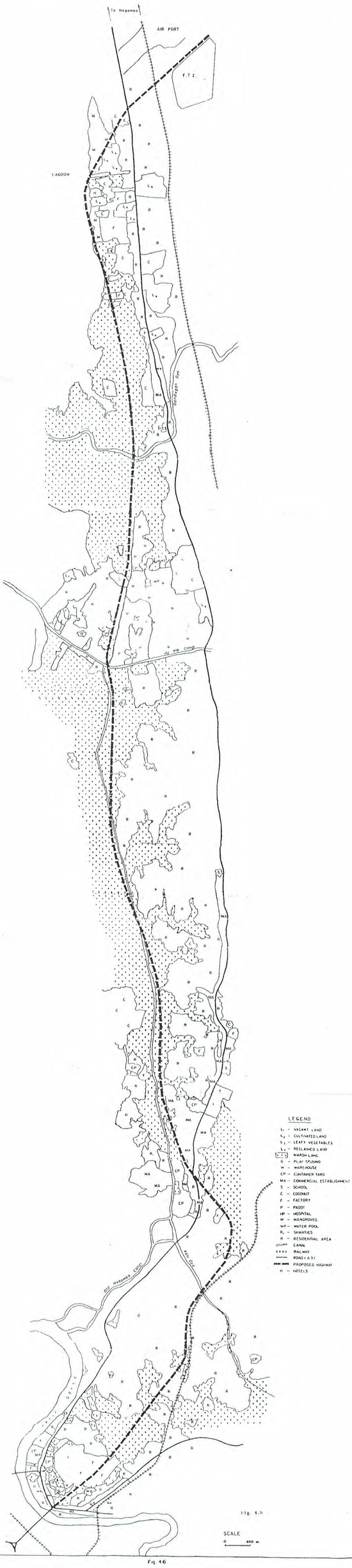


Fig. 4.6

Muthurajawela Sanctuary

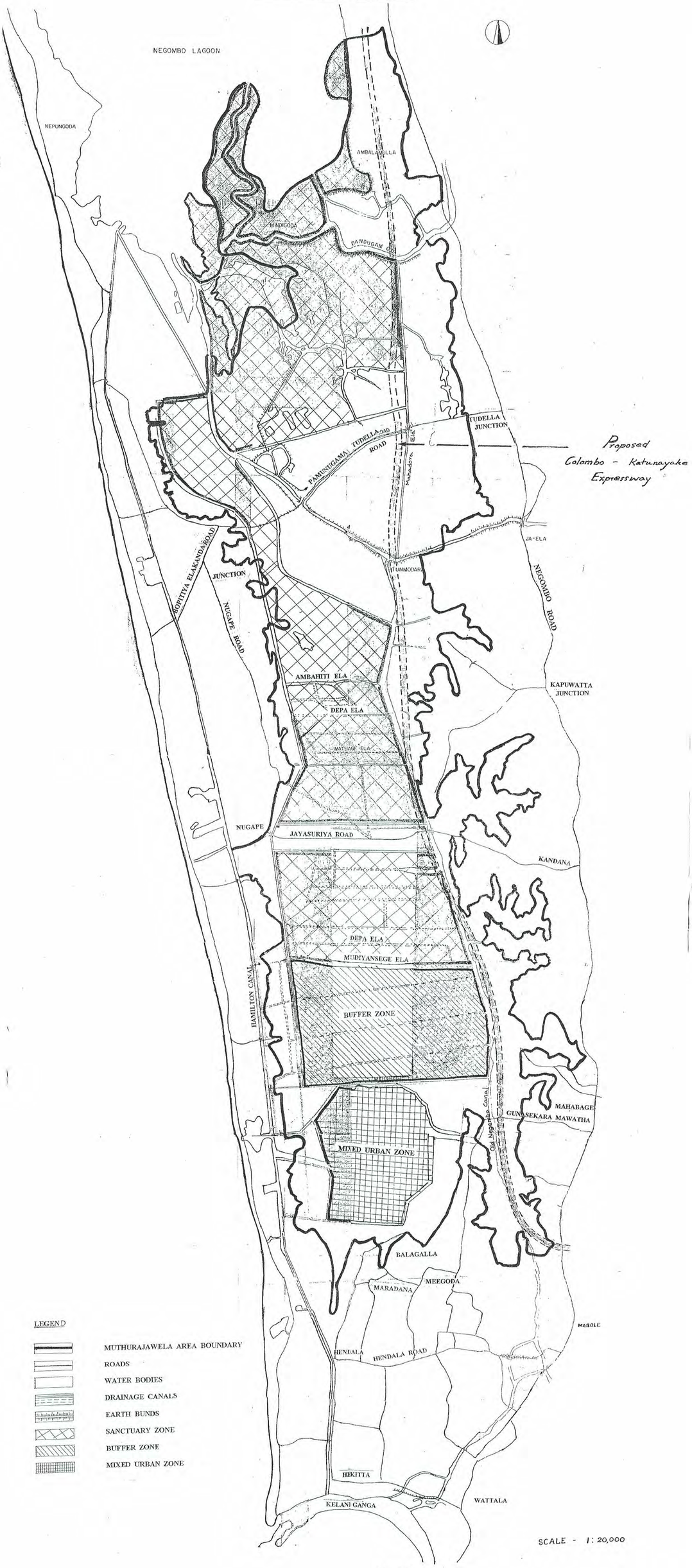


Fig. 4·7

TABLE 4.9

Increases in Land Values 1978 - 1994
In selected Urban Settlement in the Study Area

Settlement	Investment in 1978	Average Value in 1985	Average Value in 1994	Annual RAte of Increase 1978-85	Annual Rate of Increase 1985-94	Annual Rate of Increase 1978-94
Colombo	100	406	1,609	22.2%	16.5%	19.0%
Mahara	100	392	1,675	21.6%	17.5%	19.3%
Wattala	100	566	1,768	28.1%	13.5%	19.7%
Kelaniya	100	534	2,749	27.0%	20.0%	23.0%
Biyagama	100	904	4,678	37.0%	20.0%	27.2%
Colombo Consumer Price Index 13.1%						

Source : ADB, Urban Land Management Study, 1994

f) Future Trends

The projected land use pattern for 2020 in Table 4. 10 indicates that the rate of land conversion for urban uses will increase in future. With the CKE it is anticipated that development will be accelerated and the land use mix will change further.

4.3.5 Environmental Issues in the Study Area

Numerous environmental issues identified by individual researchers as well as by agencies and institutions such as the MEIP, UDA, NHDA, NWS & DB, SLLRDC include the contamination of ground and surface water, and air pollution, spread of vector borne, water washed and water related diseases.

These environmental problems are caused by following factors :

- rapid population growth and high density of population
- concentration of industries
- inadequacy of a safe water supply. Only 7% of the population of the Gampaha District is provided with a pipe-borne water supply. In Wattala Mabole UC and Wattala PS areas water is obtained from wells while pipe borne water and wells provide water for the Peliyagoda UC area.
- inadequacy of a sewage disposal system. Conventional sewage is provided in a few places such as the KIPZ, BIPZ and Ekala Industrial estate.
- absence of a controlled solid waste disposal system in a large part of the study area.
- Frequent inundation and salt water intrusions of low-lying areas.
- Environmental health problems in the study area include the incidence of vector borne diseases such as filaria, Dengue Haemorrhagic Fever (DHF)and Japanese Encephalitis (JE) as well as Leptospirosis, caused by the contamination of stagnant water by rat urine. Data for the MOH Divisions of Gampaha reveal that water related diseases such as bacillary dysentery (shigellosis), amoebiasis, helminthiasis and other ill defined infections occur due to use of contaminated water.

TABLE 4. 10

Land Use Pattern In Selected Settlements In the Study Area, 2020 (In Hectares)

Settlements	Residen-tial	Commer-cial	Indus-trial	Insti-tutional	Parks, Roads & Open Spaces	Agri-cultural	Water & Marshy
Peliyagoda U.C	180	17	63	06	70	0	41
Wattala Mabole U.C	226	25	61	13	26	02	26
Ja Ela U.C	497	17	34	24	66	17	241
Katana P.S	1642	216	113	128	394	370	32
Seeduwa Katunayake U.C	414	19	116	214	66	81	126
Wattala P.S	2688	53	150	30	246	3100	1338
Ja Ela P.S	2273	60	400	188	254	982	1400
Kelaniya P.S	1654	76	250	66	253	0	0
Biyagama P.S	2640	54	620	40	270	2247	0

Source : National Water Supply and Drainage Board,
Ministry of Housing, Construction and Public Utilities
Greater Colombo Wastewater and
Sanitation Master Plan - April 1993

Squatters are more at risk from these diseases than other residents since they live in crowded substandard houses in marginal areas. The high occupancy rate and overcrowding in these poorly ventilated houses leads to the rapid transmission of communicable diseases. The incidence of vector borne and water related diseases is due to the inadequacy of water, sanitation and waste disposal facilities. The problems created by these conditions are exacerbated by poverty and malnutrition.

Some of the following on-going/proposed programmes attempt to address the major environmental issues in the study area :

- Greater Colombo Canal and Drainage Systems Rehabilitation Project
- Wetlands Conservation Project
- Master Plan for Muturajawela Marsh and Negombo Lagoon.
- Colombo Environmental Improvement Project (CEIP)
    - Clean Settlement Programme
    - Industrial Waste Water Abatement Programme
    - Solid Waste Water Management Project
- Greater Colombo Water Supply Master Plan (update)
- Greater Colombo Flood Control and Environmental Improvement Programme
- Coastal Zone Management Plan (CZMP)
- " Coastal 2000 "

CHAPTER 5

DESCRIPTION OF THE PROPOSED PROJECT

5.1 Aim and Scope

The proposed expressway aims to provide a high speed road link between the capital Colombo and BIA at Katunayake. The expressway would allow unimpeded passenger and goods transport between the two points. In addition this will facilitate traffic to and from the North avoiding the worst congested part of the journey. This six lane expressway, which starts at New Kelani bridge and ends at Katunayake, will be access controlled with interchanges at Peliyagoda, Kerawalapitiya and Tudella.

5.1.1 The Alignment

The proposed CKE is 24.6 km in length and begins at Peliyagoda at the northern end of the new Kelani bridge. It runs northwards, passing the Hunupitiya railway station to the west of the rail track, before veering north-west and crossing the A3 road at Mabole. It then proceeds alongside the Old Negombo canal on its east bank till it reaches the Ja ela canal and continues on the west side of the Mahadora ela, passing through the premises of the MVC. It crosses Dandugam oya, and enters the Negombo lagoon at Liyanagemulla, proceeding 1.1 km through it. The average distance from the trace to the shoreline will be 50 m. After moving onto land it again passes through a creek of the lagoon north of the AGH over a distance of 0.3 km, and veers north-east and continues for a kilometer to join the A3 road at its junction with the Canada Friendship Road at Katunayake. Interchanges with toll gates will be provided at Peliyagoda, Kerawalapitiya, Tudella and Katunayake. (Fig. 5.1)

5.2 Justification of the Project

The proposed CKE is a fully access controlled four lane highway, expandable to six lanes with a design speed of 100 km / hr with 3.5 meter travel lanes, and three grade separated interchanges. Its primary purpose is to provide (a) high-speed travel between the BIA and its principal catchment area (including the city of Colombo) and (b) provide a link to the POC from the northern part of its hinterland. Additionally, once the widening of the A3 road north of Katunayake and the construction of the new Katunayake - Kandy road are completed the CKE is expected to serve as the main conduit for passenger and freight movement between the Western Province and the North / North - Western / North Central Provinces.

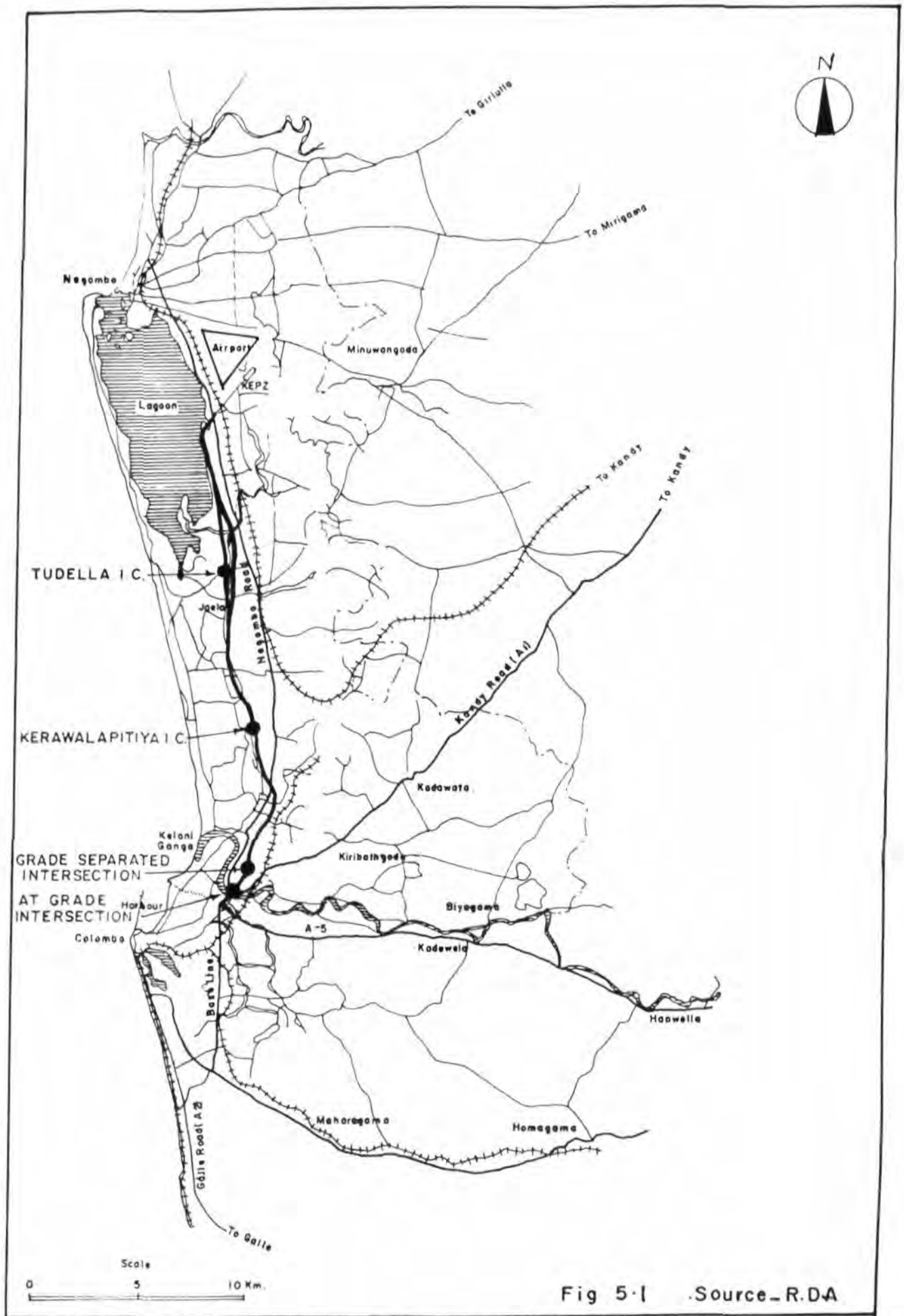


Fig 5·1 .Source_R.D.A

ALTERNATE ROUTE FOR COLOMBO KATUNAYAKE EXPRESSWAY
(Western Trace)

Water Supply

Pipe - borne water supply is available in all the areas covered by the project. Additional clean water for drinking, production of concrete etc. could be transported from nearby sources with bowsers and could be stored in storage tanks. However water for the construction of aggregate base course, preparation of embankment layers, subgrade subbase and dust control could be obtained from following sources :

1) Negombo lagoon
2) Old Negombo canal
3) Hamilton canal
4) Dandugam oya

Power supply

Single and three phase supply from the national grid is available in the project area. However, independent generating capacity to cover any unforeseen breakdowns should be available.

5.3.3. Construction Programme

The timing and duration of all project activities as programmed by RDA are indicated in Fig. 5.4.

5.3.4 Elements of the Toll Plaza

Toll gates

A single full width barrier type toll gates will be installed (Fig. 5.5). This is a simple and easily maintained system.

Toll Booths and Islands

Toll islands divide the expressway into the required number of lanes, accommodate toll booths and prevent vehicles from knocking against toll booths. A toll island is a raised platform approximately 20 m long and 2.2 m wide. It has to accommodate a number of sign boards and service ducts which are essential to the toll system operation (Fig. 5.6). The Toll booth houses the operator and serves as repository of cash and tickets.

Construction Schedule of the Project

	Work Items	Quantity	Unit
A	PRE - CONSTRUCTION STAGES		
B	CONSTUCTION STAGES		
1	MOBILIZATION		
2	CONSTUCTION OF CAMP YARD		
	2a Stockpiling of sand		
3	EARTH WORKS		
	1) Section (i) Pellyagoda IC to Pellyagoda Ad grade IC		
	Soil Improvement	70,000	m³
	Embankment	19,000	m³
	Consolidation		
	1 Embankment & Subgrade	6,000	m³
	2 Subbase course & Base course	10,000	m³
	3 Binder course	3,000	m³
	4 Wearing course	2,000	m³
	2) Section (ii) Kerawalapitiya IC to Pellyagoda IC		
	Soil Improvement	291,000	m³
	Embankment	80,000	m³
	Consolidation		
	1 Embankment & Subgrade	20,000	m³
	2 Subbase course & Base course	42,000	m³
	3 Binder course	9,600	m³
	4 Wearing course	6,400	m³
	3) Section (iii) Ja - ela IC to Kerawalapitiya IC		
	Soil Improvement	364,000	m³
	Embankment	100,000	m³
	Consolidation		
	1 Embankment & Subgrade	32,000	m³
	2 Subbase course & Base course	53,000	m³
	3 Binder course	11,400	m³
	4 Wearing course	7,600	m³
	4) Section (iv) Pamunuwa IC to Ja - ela IC		
	Soil Improvement	115,000	m³
	Embankment	39,000	m³
	Consolidation		
	1 Embankment & Subgrade	8,000	m³
	2 Subbase course & Base course	17,000	m³
	3 Binder course	3,600	m³
	4 Wearing course	2,400	m³
	5) Section (v) Katunayake Ad grade to Pamunuwa IC		
	Soil Improvement	250,000	m³
	Embankment	80,000	m³
	Consolidation		
	1 Embankment & Subgrade	15,000	m³
	2 Subbase course & Base course	36,000	m³
	3 Binder course	8,400	m³
	4 Wearing course	5,600	m³
4	BRIDGE CONSTRUCTION		
	1) Dandugama Bridge		
	Foundation (Steel Pile)		
	Abutments & Piers		
	Deck		
	2) Ja - ela Bridge		
	Sub - Structure		
	Deck		
	3) Wabole Over head Bridge		
	Sub - Structure		
	Deck		
	4) Hunupitiya Over head Bridge		
	Sub - Structure		
	Deck		
	5) Other Bridges	12	Nos
5	OTHER ROAD STRUCTURES		
	Culverts	44	Nos
6	IMPROVEMENT OF EXISTING ROADS		
	1 Widening of existing roads	48	Km
	2 Road Structures & Culverts	19	Nos
	3 Road Drains	3,000	Lm
7	HIGHWAY UTILITIES & ROAD FURNITURE		
	1 Administration Building	1	No
	2 Traffic sign		
	3 Toll Gate Facilities	5	Units
	4 Emergency Telephone system	1	Ls
8	MISCELLANEOUS WORKS		
	1 Guard rail / Others	10,000	Lm
	2 Fencing with Diamond mesh	52,000	Lm
	2 Single Footpath	30,000	m²
	3 Tree Plantation	8,000	Nos
9	DE MOBILIZATION		

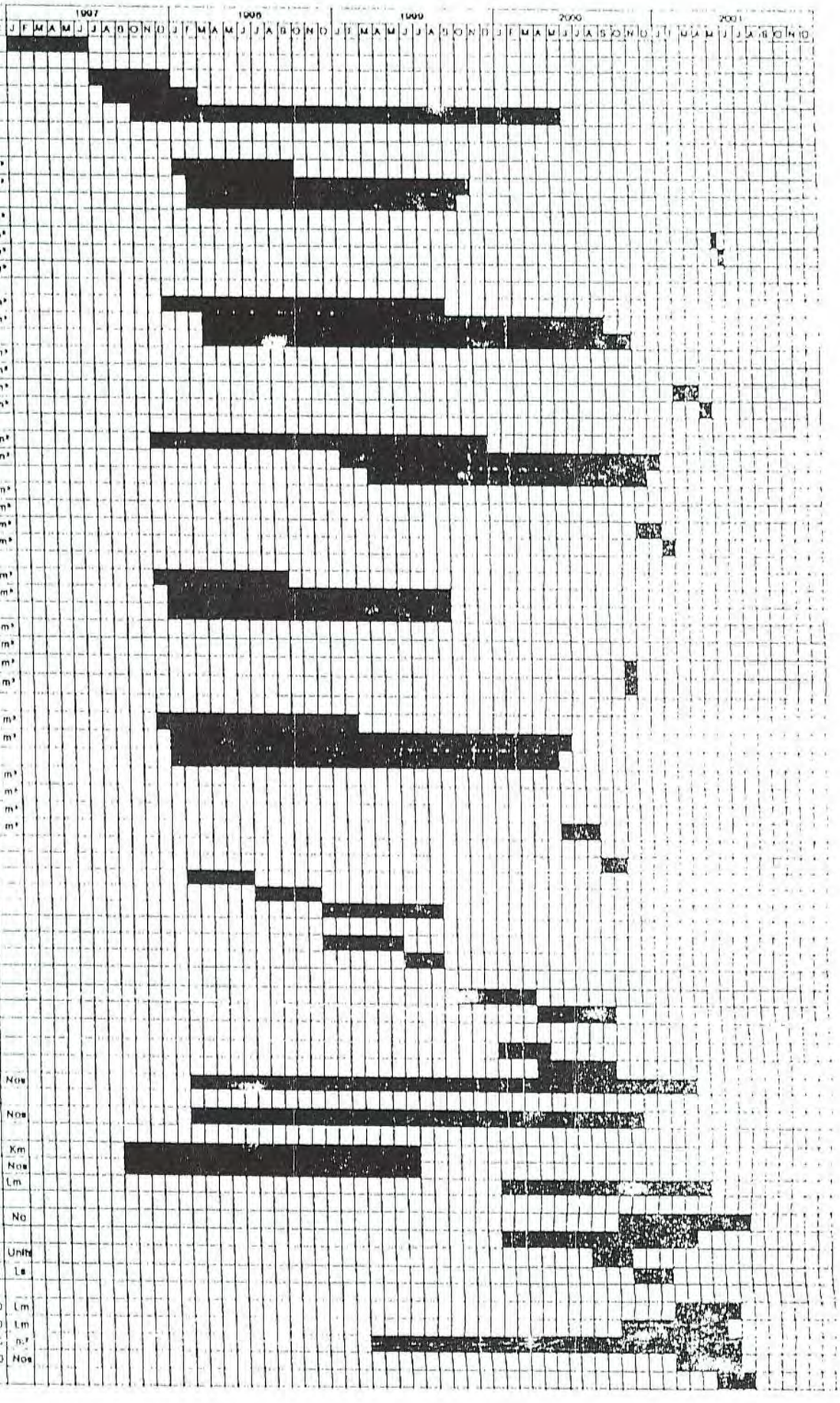


Fig. 5.4

The social and economic need for the CKE is as strong as the operational need mentioned above. For instance, the reduction in travel time would permit outward migration of people living under congested conditions in the city and suburbs of Colombo, thereby relieving the heightened pressure for housing and other amenities. Moreover, experience from other countries in the region suggest that development activities that normally accompany highway projects are better planned and therefore more conducive to family living due to better sanitation, enhanced access to services and efficient utilities.

Aided by developments in the POC, BIA, and rapid industrial expansion in the area, it is anticipated that employment opportunities will increase significantly in the next decade.Consequently, the CKE is needed to open new labour markets through enhanced access to areas that were hitherto accessible entirely by sub-standard local roads.

Connecting BIA and the Sri Lanka Air Force Base at Katunayake with the city of Colombo by a high-speed link has many strategic advantages. It will permit rapid deployment of resources among key economic installations, and / or evacuation of areas north of Colombo in case of emergencies and other events of national importance.

System Linkage

Once completed, the CKE is expected to attract at least 25% of the through traffic on the existing roadway, which in 1995 was carrying a mixed load of approximately 44,000 vehicles per day. By placing access points at major commercial and industrial centers such as Peliyagoda, Kerawalapitiya and Tudella, the CKE will also serve the commercial and private traffic from the smaller townships in the corridor and link up the local and collector road system with the BIA, POC, and the city of Colombo.

Safety

The divided controlled - access design of the CKE is expected to derive significant safety benefits, particularly in terms of reduced accidents involving pedestrians and cyclists. The main contributing factors will be better sight distance, limited need for passing and turning and uniform speeds on the CKE in comparison to the A3 roadway.

5.3 Nature of the Project

5.3.1 Description of Major Features, Locations and Layout

The terrain through which the CKE passes is mostly marshy land and to a smaller extent built up land and the Negombo lagoon (Fig. 3.1). These marshes are soft ground consisting mainly of peat. The soft ground treatment will be subjected to accelerated consolidation settlement as an applicable countermeasure. This activity is the most time consuming and the critical phase of the project. As construction of minor bridges and road structures on soft ground would commence after the consolidation settlement is completed, this activity is very critical. It is expected that the consolidation settlement will be completed in one year using the accelerated measures such as a combination of sand mat, vertical drains and preloading. Soil improvements in sections, I, II, III, IV and V will commence simultaneously to minimize the construction period. (Fig. 5.2).

Construction of embankments too will commence simultaneously in all five areas in order to minimise the construction period. This includes the filling of three sections of length 1.9 km of the canal. Construction of the canal deviation to maintain hydraulic continuity would be completed before the filling.

Work on asphalt concrete pavement will proceed concurrently with the construction of base course and sub base course and be completed within one year.

Bridges over Dandugam oya and Ja ela will be constructed concurrently and be completed within 25 months and 24 months respectively.

From the assessment of the above factors the minimum construction period for the project will be 48 months.

5.3.2 Pre- construction Activities

Pre-construction activities are considered under the following items :

- Office and housing
- Workshops and repair facilities
- Warehouse and stockpiling areas
- Quarry sites and crushing plant
- Concrete batching and mixing plant
- Asphalt mixing plant
- Power and water supply
- Major construction equipment
- Site laboratory

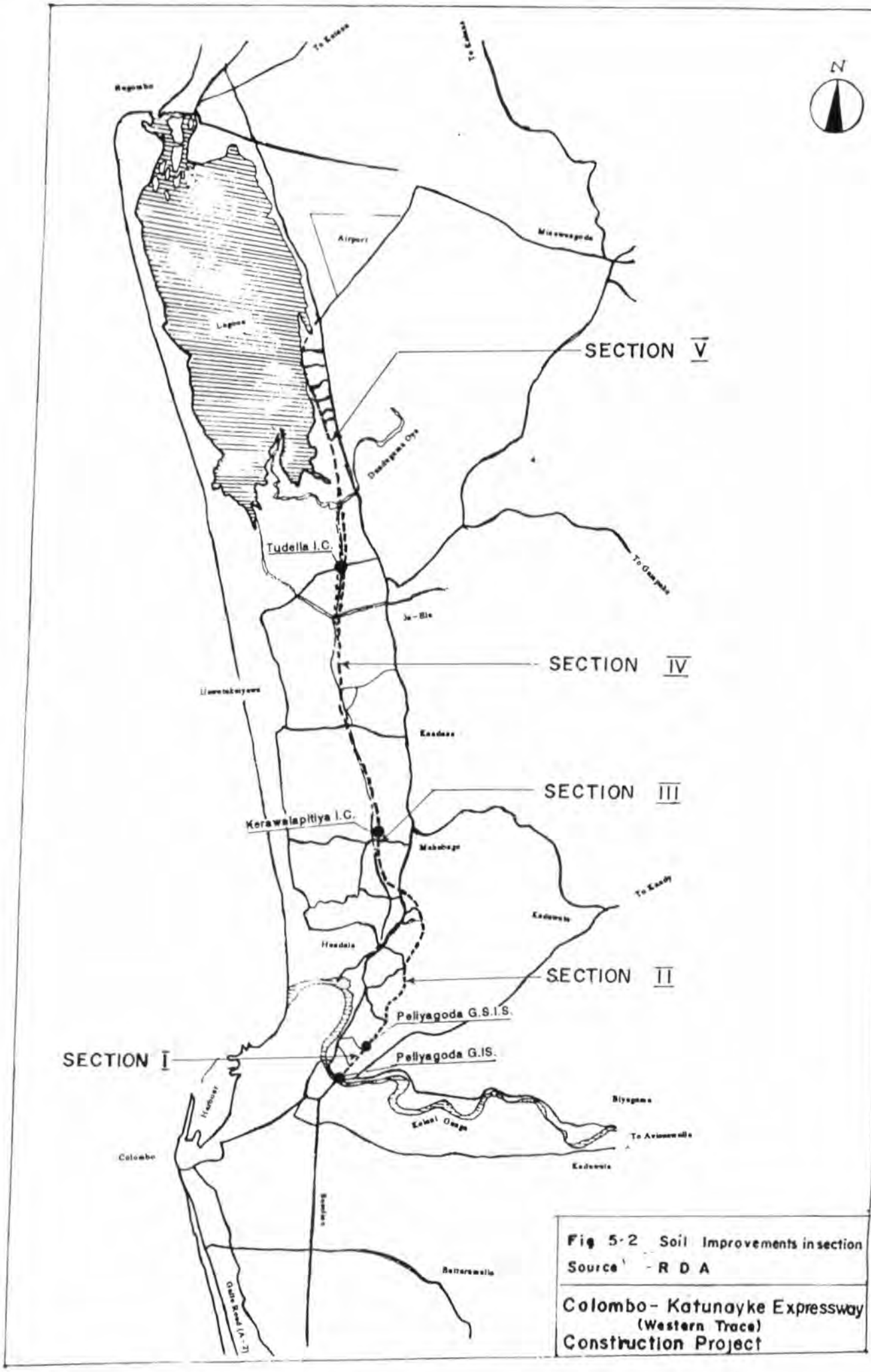


Fig 5-2 Soil Improvements in section
Source : - R D A

Colombo - Katunayke Expressway
(Western Trace)
Construction Project

Stock yards are required to store large quantities of materials such as sand, gravel, aggregate, PVC pipes, bamboos, lighting columns, PC beams and kerbs, bitumen etc. Stock yards could be located in the camp yard and in several places where it is close to the installation.

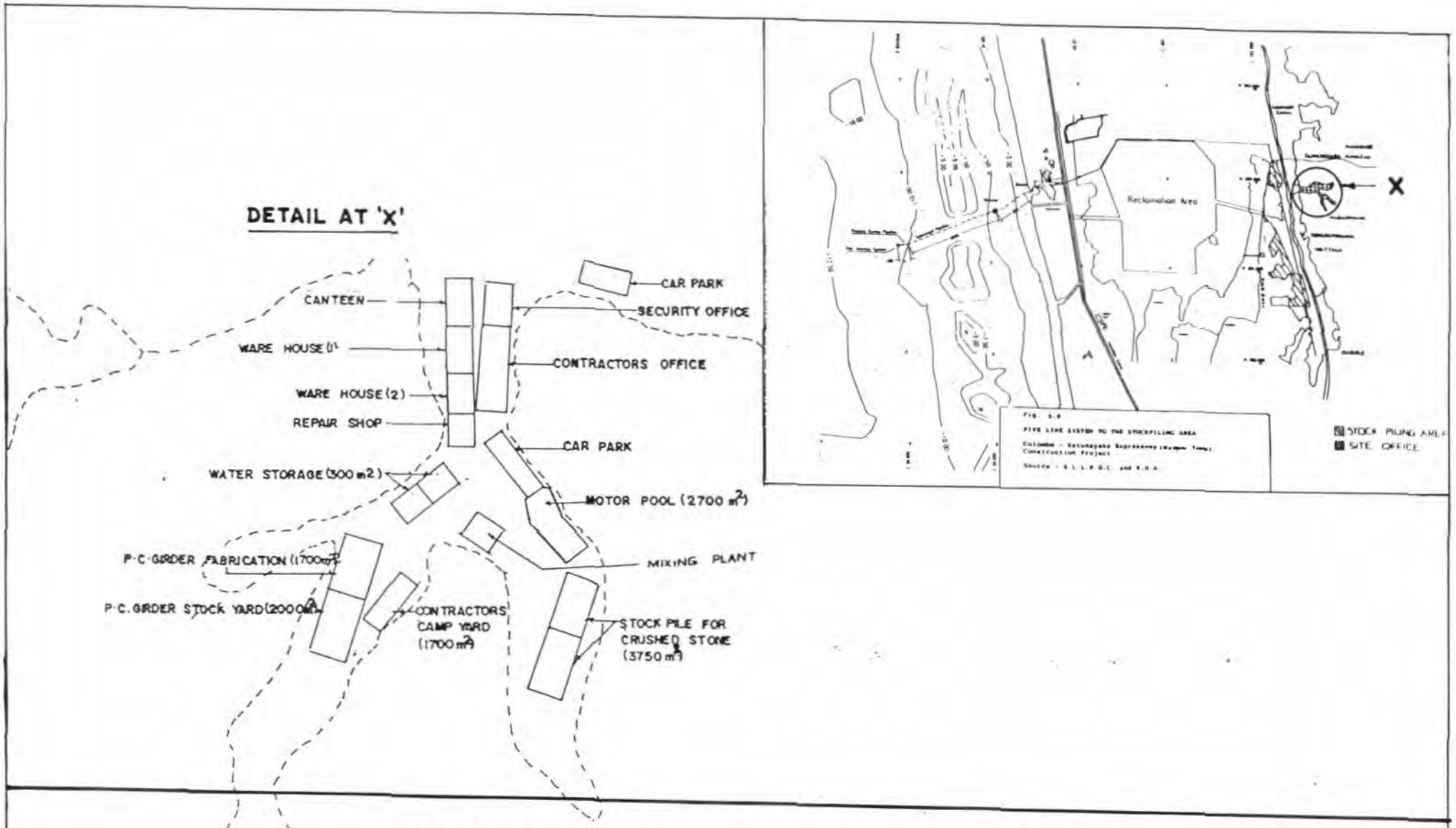
The area identified for the construction camp is shown in Fig. 5.3.

It is expected that between 1000 to 1500 personnel would be employed on the construction of the proposed CKE. List of key personnel involved is shown in Table 5.1.

TABLE 5.1

PROBABLE LIST OF STAFF TO BE EMPLOYED

1.	Project Manager	1	No.
2.	Deputy Project Manager	7	Nos.
3.	Mechanical Engineer	5	Nos.
4.	Site Engineer	15	Nos.
5.	Specialist Foreman	08	Nos.
6.	Foreman	20	Nos.
7.	Mason	20	Nos.
8.	Carpenter	20	Nos.
9.	Explosion Loader	10	Nos.
10.	Heavy Equipment Operator	40	Nos.
	Light Equipment Operator	50	Nos.
11.	Labour Skilled	200	Nos.
12.	Labour Semi- Skilled	250	Nos.
13.	Labour Unskilled	500	Nos.
14.	Security Officer	03	Nos.
15.	Security Guard	50	Nos.
16.	Driver	150	Nos.
17.	Nurse	03	Nos.



LAYOUT PLAN OF CONTRACTORS CAMP YARD

Fig. 5·3

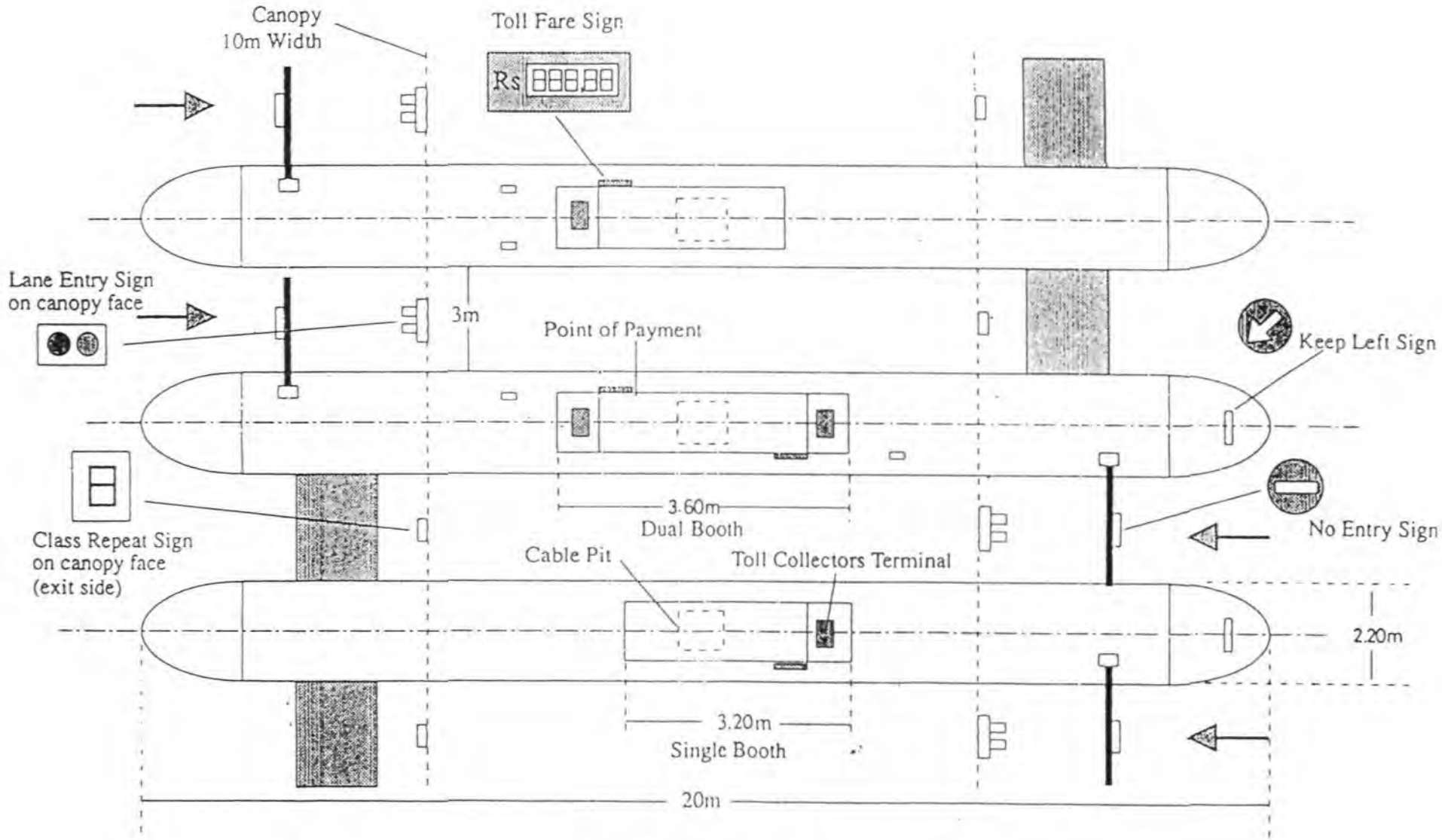
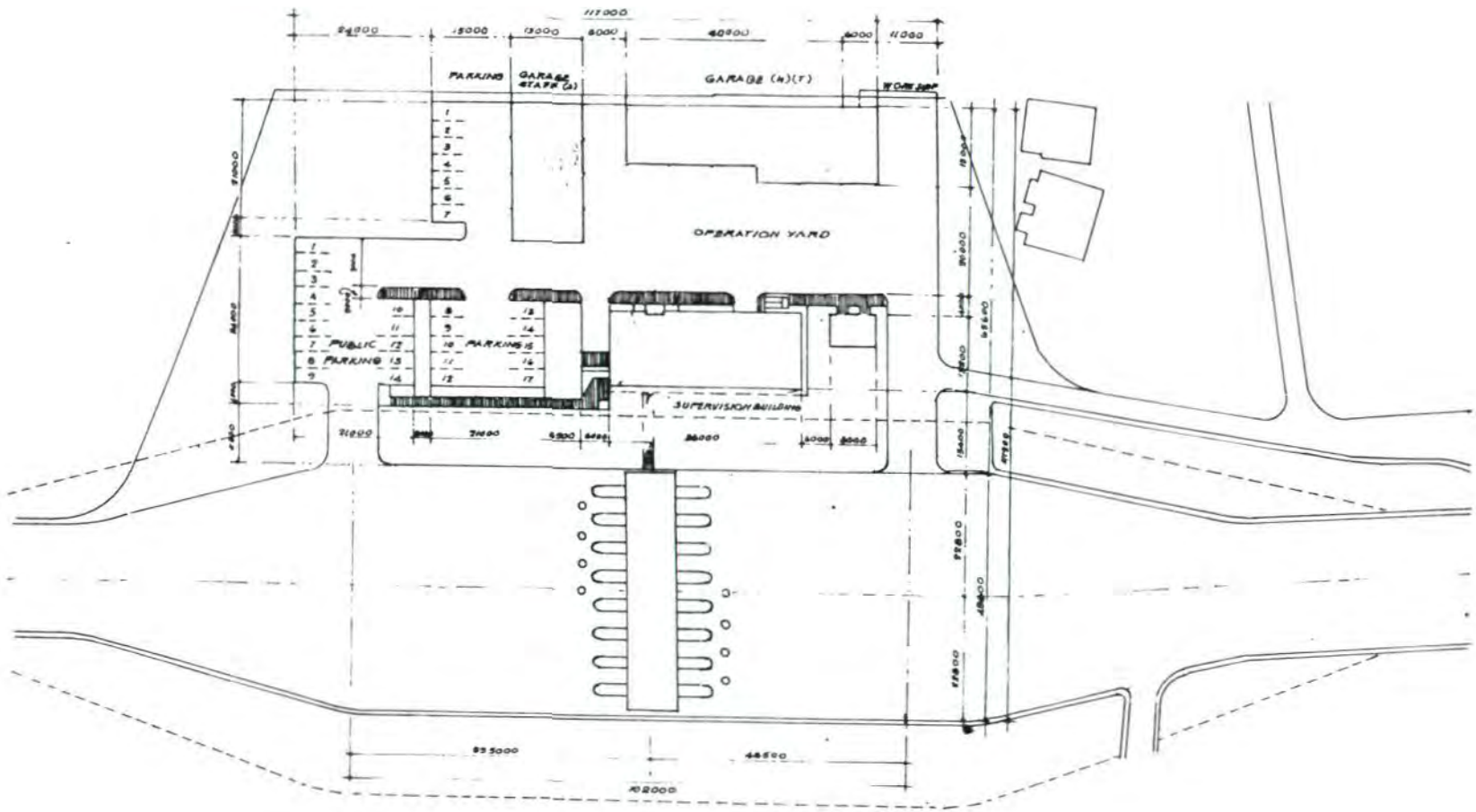


Fig 5.5 Typical Toll Lane Layout

SOURCE - R.D.A



LOCATION OF TOLL PLAZA
Fig 5·6

Source – .R D.A

Supervision Building

This is a two storeyed building which in addition to being a centre for monitoring and implementing toll collection, serves as the Central Administration Office for the expressway. Facilities at this supervision building provide direction and support for the whole operation. The main functions are :

a. Administration
b. Maintenance
c. Traffic control and emergency telephone communication
d. Police enforcement (staff not directly employed by the RDA)

The ground floor of the supervision building accommodates finance / cash and security rooms located close to each other with easy access from toll gates and are separated from the rest of the activities of the building for security reasons.

5.4 Methodology of Construction

The methodology of construction and the sequence of events have been indicated by the RDA. (where appropriate, reference is made to Japanese EIA Reports of the Eastern Trace 1992 and Kerawalapitiya Reclamation Project 1993)

5.4.1. Raw Material Required

It has been estimated that for the CKE following materials will be required.

Sand for sand blanket	=	2.5 million	m^3
Sand for concrete and road works	=	60,000	m^3
Gravel	=	400,000	m^3
Aggregate	=	160,000	m^3

Sand for the sand blanket has to be obtained from offshore dredging. Sand for concrete and road works is to be purchased locally from contractors over a period of four years.

5.4.1.1. Dredging and Transport of Sand to Stockpiling Area

The methodology recommended for dredging, mooring, pipeline laying, installation of booster pumps, stockpiling of sand etc. is as follows : (Kerawalapitiya Reclamation Project EIA report 1993 and SLLRDC sources).

i) Dredging Operation

The methodology adopted in the extraction of sand is by dredging in an area located at a minimum distance of 3 km offshore since this is beyond the wave breaking zone, it will not have an effect on the near shore sediment budget. Dredging is at a depth of 15 m below the sea level which is safe from coastal engineering considerations. The depth of dredging will be limited to 2 m below the existing sea bed level since it would not create hydraulic and geotechnical problems. Dredging will be carried out parallel to the shore line in linear channels, avoiding scattered deep holes in the sea bed. The quantity of sand to be extracted is 2.5 million m^3.

For dredging operations for the excavation of offshore sand, self-propelled ocean-going suction hopper dredgers have been found to be the most suitable as they can operate in rough and open seas without creating too much turbidity. Experience by SLLRDC and others have confirmed this.

ii) Pipeline Laying Operation

A system of pipelines with floating, submerged and onshore sections having 80-90 cm diameter will be used for pumping.

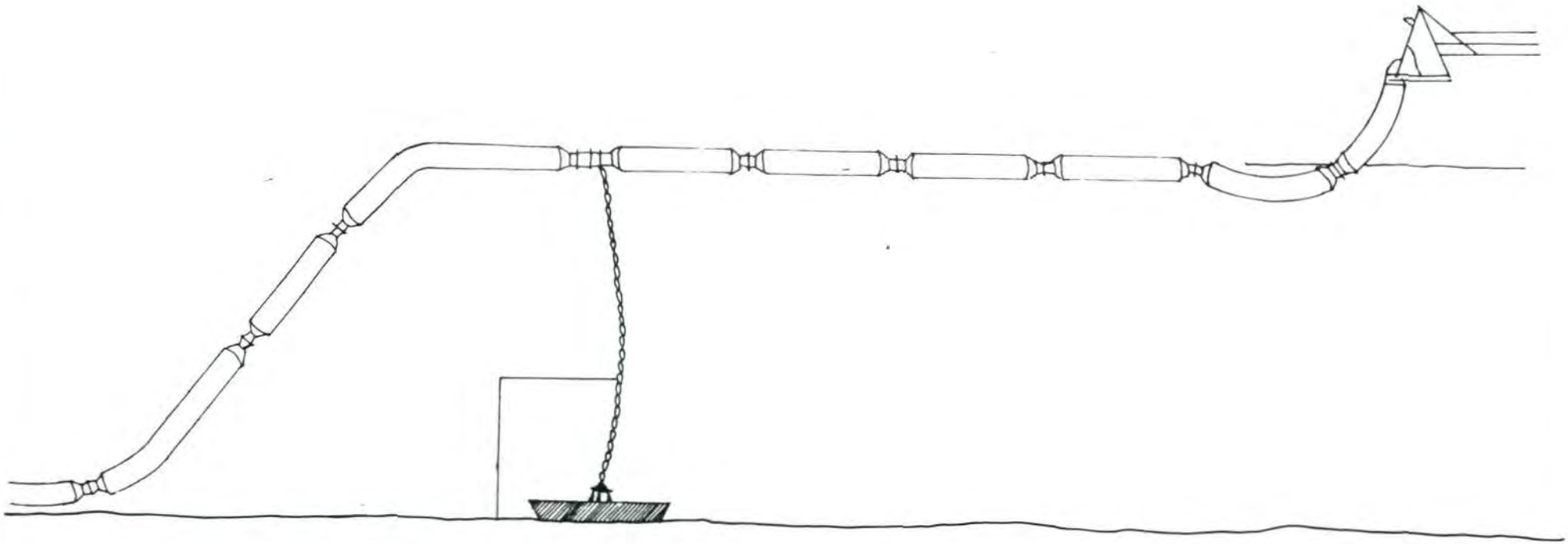
The floating pipeline consisting of flexible elements will be connected to the submerged pipeline.This fully welded pipeline will be connected to the onshore pipeline (Fig 5.7)

The pipeline will be laid through the same gap in the reef that was used by SLLRDC for Kerawalapitiya Reclamation Project (Fig. 5. 8)

The route of the onshore pipeline of length 4.87 km will be selected in order to minimize adverse impacts on people and property. As such the route followed upto the road crossing by the Kerawalapitiya Project is suggested. Beyond which it will follow the northern boundary of the sand filled area (Fig. 5. 8).

iii) Transport of Dredged Material

The dredged sand is transported through the pipeline system where the dredged material is pumped to the stockpiling area. A booster station is necessary to supplement the capacity of the pumps and is located at a place where cooling water is available . (Fig. 5.8) The power for the booster station is 2500 kw. (SLLRDC).



FLOWTING PIPE LINE WITH MOORING FACILITY

Source - S.L.L.R.D.C

Fig 5·7

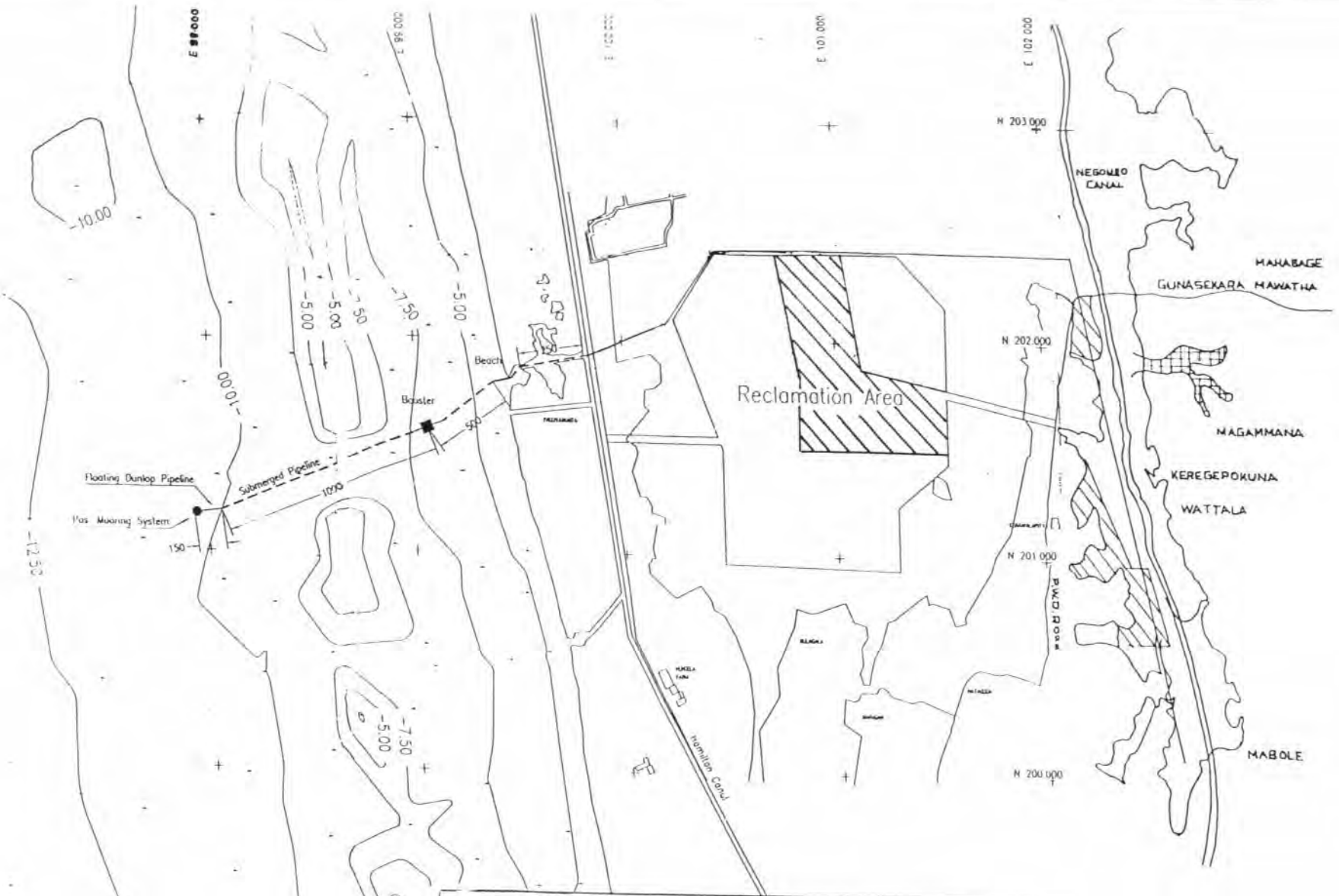


Fig. 5.8

PIPE LINE SYSTEM TO THE STOCKPILING AREA

Colombo - Katunayake Expressway (Western Trace) Construction Project

Source - S.L.L.R.D.C. and R.D.A.

STOCK PILING AREA

SITE OFFICE

The material pumped to the stockpiling area is a mixture of sand and sea water in the ratio of 1 : 4 by volume. Hence for 2.5 million m^3 of sand 10.0 million m^3 of water will be pumped from the sea, which will drain from the stockpiling area leaving sand in the pile. The drainage water will be pumped back to sea by a drainage pump via another pipeline laid adjacent to the in-coming pipeline.

iv) Mooring System

The same anchoring system used by the SLLRDC for sand pumping will be used. It comprised a sunken heavy weight held fast by three anchors of ten ton weight and two chains attached to the heavy weight. One chain would hold the floating pipeline while the second will be connected to the dredger when discharging sand. (Fig. 5.9)

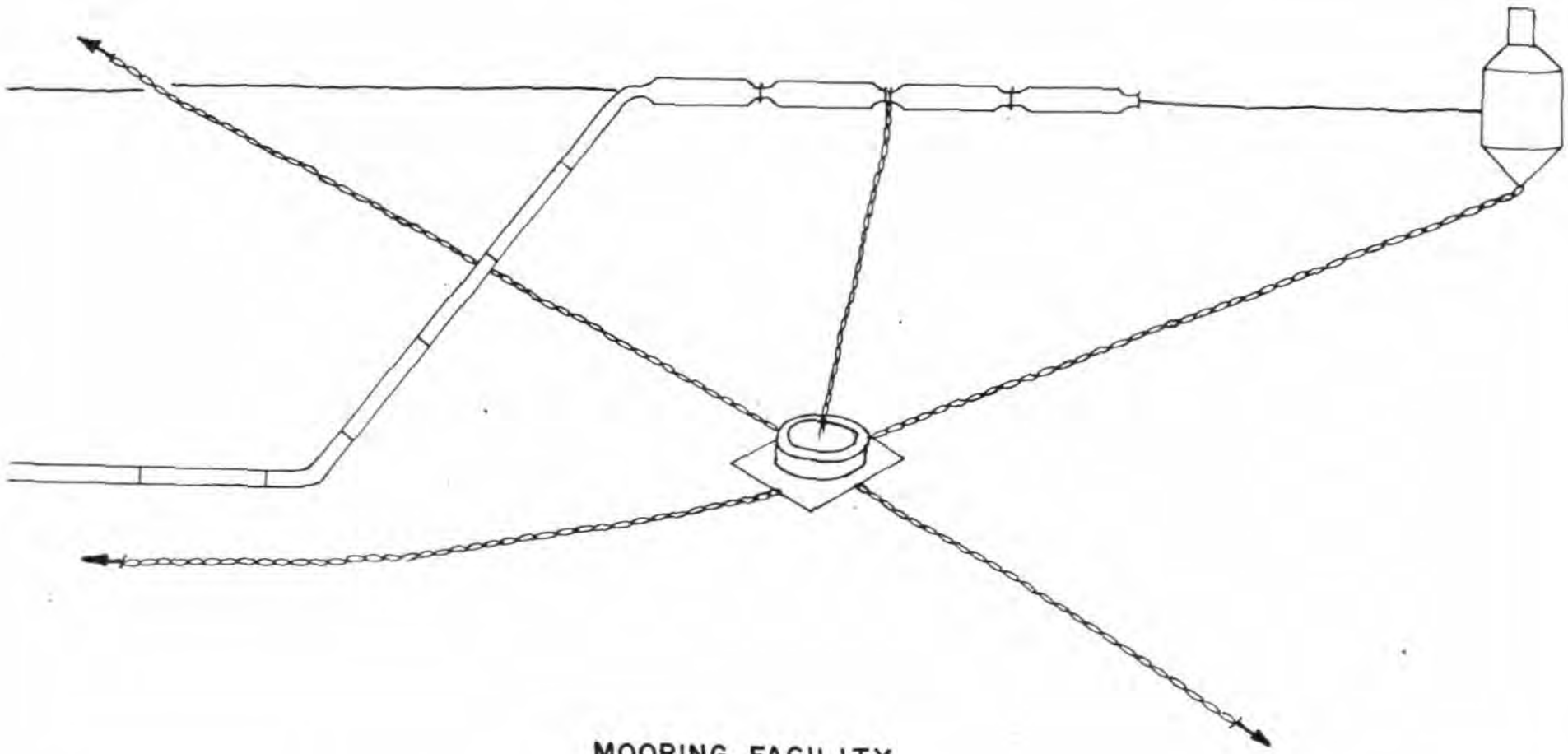
v) Stockpiling of Sand

For easy construction RDA has proposed to stockpile sand in Kerawalapitiya area which is convenient for transporting to all five sections of the CKE. RDA considers two alternative sites for stockpiling purposes. First, it hopes to negotiate an arrangement with the SLLRDC to obtain about 100 Acs from the area already reclaimed. (see the fig. 5.8). On the alternative, a land bordering the Old Negombo Canal has been identified by the SLLRDC as a possible stockpiling area. (Fig. 5.8). This land is already earmarked for development by the SLLRDC.

5.4.1.2 Aggregates

Approximate quantity of aggregates and crushed stones required for the project is 160,000 m3.

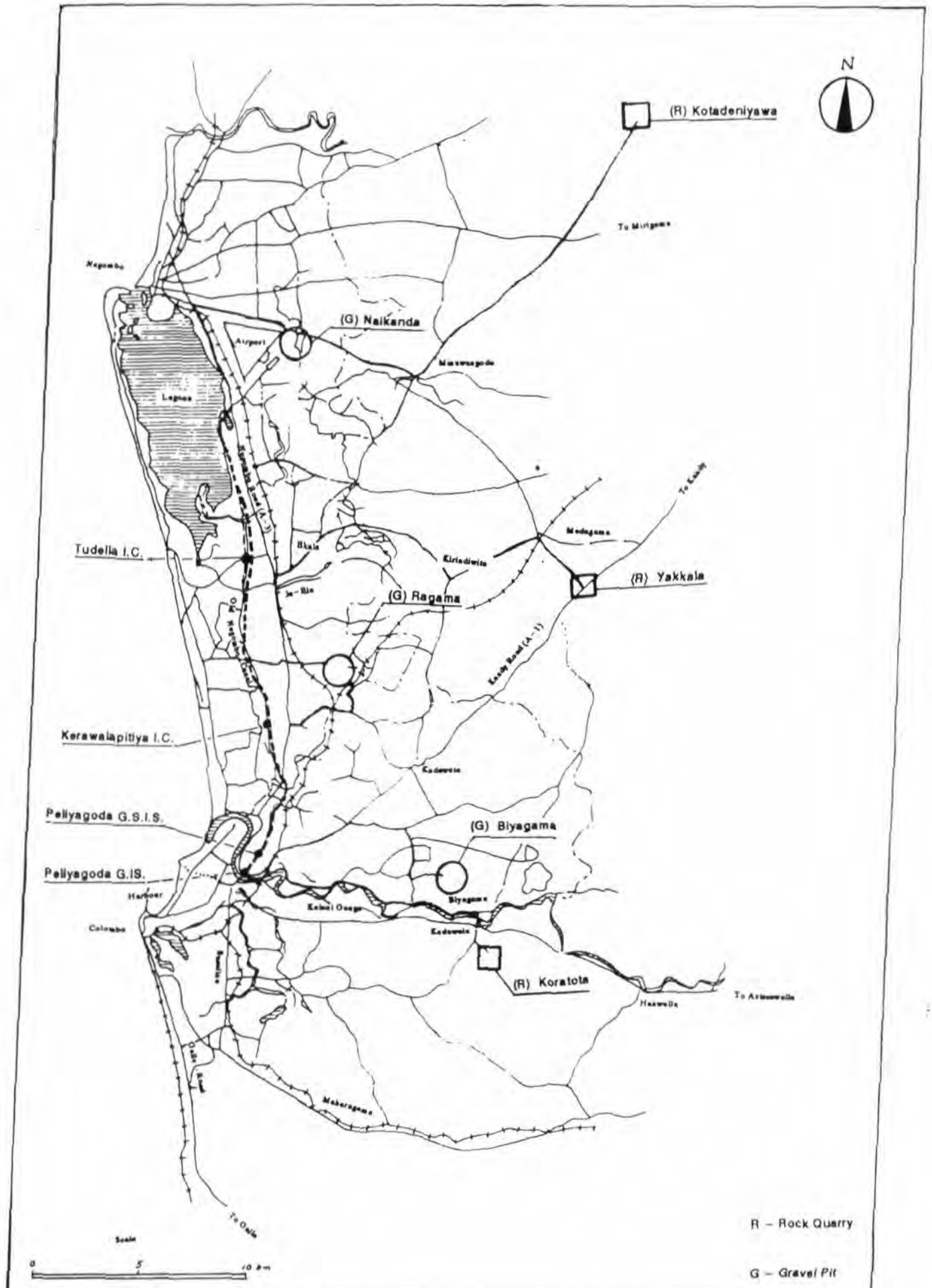
Quarry sites that are already in operation at Koratota , Yakkala and Kotadeniyawa will be used. Quarry site at Nawagamuwa is close to the southern section of the project, quarry site at Yakkala is close to middle section of the project and the site at Kotadeniyawa is close to the northern section. Access from the quarry sites to the project sites will be along the existing "B" and "C" class roads as indicated in Fig. 5.10.



MOORING FACILITY

Source – S.L.L.R.D.C

Fig 5·9



Colombo – Katunayake Expressway (Western Trade) Construction Project	Fig. 5.10 Locations of Proposed Gravel Pits & Rock Quarries

TABLE 5.2
THE DETAILS OF THE QUARRY SITES

Location	Ownership	Access Road	Approx. Qty. (m^3)	Distance (km)
Koratota	JEDB	B & C	100,000	20
Yakkala	PRIVATE	A & B	200,000	35
Kotadeniyawa	SD & CC	A & B	300,000	40
		TOTAL	600,000	

Source : RDA

A royalty payment has to be given to the Government or owner of land for using the rock site. Necessary approval will be obtained from Institutions such as CEA and Pradeshiya Sabhas.

5.4.1.3 Gravel

Estimated quantity of gravel is 400,000 m^3.

Location of borrow area are as follows :

Naikanda, Katunayake	:	12 km to Northern section
Danduwatta, Ragama	:	11 km to Central section
Biyagama	:	16 km to Southern section

(Fig. 5.10)

These borrow areas are abandoned at present.

5.4.2 Formation of Road Embankment

a) Land Clearance

The road trace passes through 20.61 km of marshy land, 3 km of built up area and 1.4 km of lagoon. Bulldozers and excavators with wide crawlers will be used to clear the vegetation and remove topsoil from the road trace. The spoil will be deposited in the designated waste dumping areas by the side of the road and covered with surcharge materials.

b) Excavations

The road pavement is mainly on embankment and excavations are only on two stretches totalling 300 m ; one at Mabole, where proposed expressway crosses the existing A3 road and the other adjoining Hunupitiya railway station. Bulldozers, front end loader and dump trucks (10 tonne capacity) will be used for this purpose. Excavated materials will be used for road body and waste material will be used as surcharge in the adjoining embankment sections.

Details of machinery and equipment used in the construction is shown in Table 5.3.

TABLE 5.3

MAJOR EQUIPMENT TO BE USED FOR THE PROJECT

No.	Plant & Equipment	Capacity	No. of Units
(1)	Bulldozer	D8	02
(2)	Bulldozer	D4	08
(3)	Wheel Loader	1.4 m^3	10
(4)	Wheel Loader	3.0 m^3	06
(5)	Dump Truck	10 ton	90
(6)	Dump Truck	21 ton	10
(7)	Backhoe	1.2 m^3	02
(8)	Backhoe	0.6 m^3	04
(9)	Chemical Drain Driving Machine	-	16
(10)	*Vibrating Roller Tyre Tandom*	*15 ton*	*04*
(11)	Macadam Roller	10 ton	02
(12)	Tire Roller	8-20 ton	10
(13)	Motor Grader	4 m	10
(14)	Tamping Roller	20 ton	05
(15)	Asphalt Finisher	2.4 - 5m	02
(16)	Asphalt Sprayer	2001	02
(17)	Crawler Crane	50 ton	01
(18)	Crawler Crane	30 ton	04
(19)	Truck Crane	2.5 ton	01
(20)	Truck Crane	5 ton	08
(21)	Diesel Hammer	2.5 ton	15
(22)	Concrete Mixer Truck	5 m^3	05
(23)	Concrete Pump	-	02
(24)	Water Bowser	38 kl	10
(25)	Trailer low bed	32 ton	02
(26)	Asphalt Plant *	110 t/h	01
(27)	Crushing Plant *	100 t/h	02
(28)	Cement Batching Plant	80 t/h	01
(29)	Generator	100 kva	01
(30)	Generator	300 kva	01
(31)	Air Compressor	7 m^3	04
(32)	Crawler Drill	5 ton	02
(33)	Water Pump	4" dia.	10
(34)	Water Pump	6" dia.	05
(35)	Concrete Vibrator	45 mm	20
(36)	Cargo Truck / Crane	4 ton	06
(37)	Lane Marker (Thermo Plastic)	2 lit./min	02

* **If necessary**

c) **Road Works**

Sand for sand blanket will be extracted from offshore dredging. This option has been decided upon by the RDA after evaluating all possible sources. Sea sand will be pumped to the designated stockpiling area at Kerawalapitiya (Fig. 5.8 , vide 5.4.1.1).

Sand blanket formation will commence simultaneously in all five sections. Sand will be transported from the main stockpile to sections I, II, III, IV and V (Fig. 5.2) using 10 ton dump trucks through local roads as shown in Fig. 5.11. For the transport of sand 4 Nos. existing culverts and minor bridges have to be strengthened and 11 Nos. of culverts and minor bridges have to be rebuilt in the existing road net work. Special unit will be set up to maintain the existing road network used for sand transportation.

Typical cross sections of the CKE are shown for built up areas and non- built up areas in Fig. 5.12 for four lanes and Fig. 5.13 for six lanes.

d) **Method of Soft Ground Treatment**

The following five methods will be used for treating soft ground. These have previously been applied in Sri Lanka and found to be cost effective. A brief explanation of each method is given below :

i) **Surface Treatment**

To ensure the mobility of heavy construction equipment and also to prevent local failures of sub-surface soil, a combination of bamboo nets and construction sheets will be adopted. A bamboo mesh of 1m x 1m will be placed directly on the soft ground surface and construction sheets are spread over the bamboo nets so placed. Subsequently a sand mat to a thickness of 1m will be placed over them. (Fig. 5.14)

To lower the groundwater table in the embankment, stone-filled trenches will be installed in the sand mats at 30 m intervals. Ground water will be pumped out to keep the water level below the sand mats.

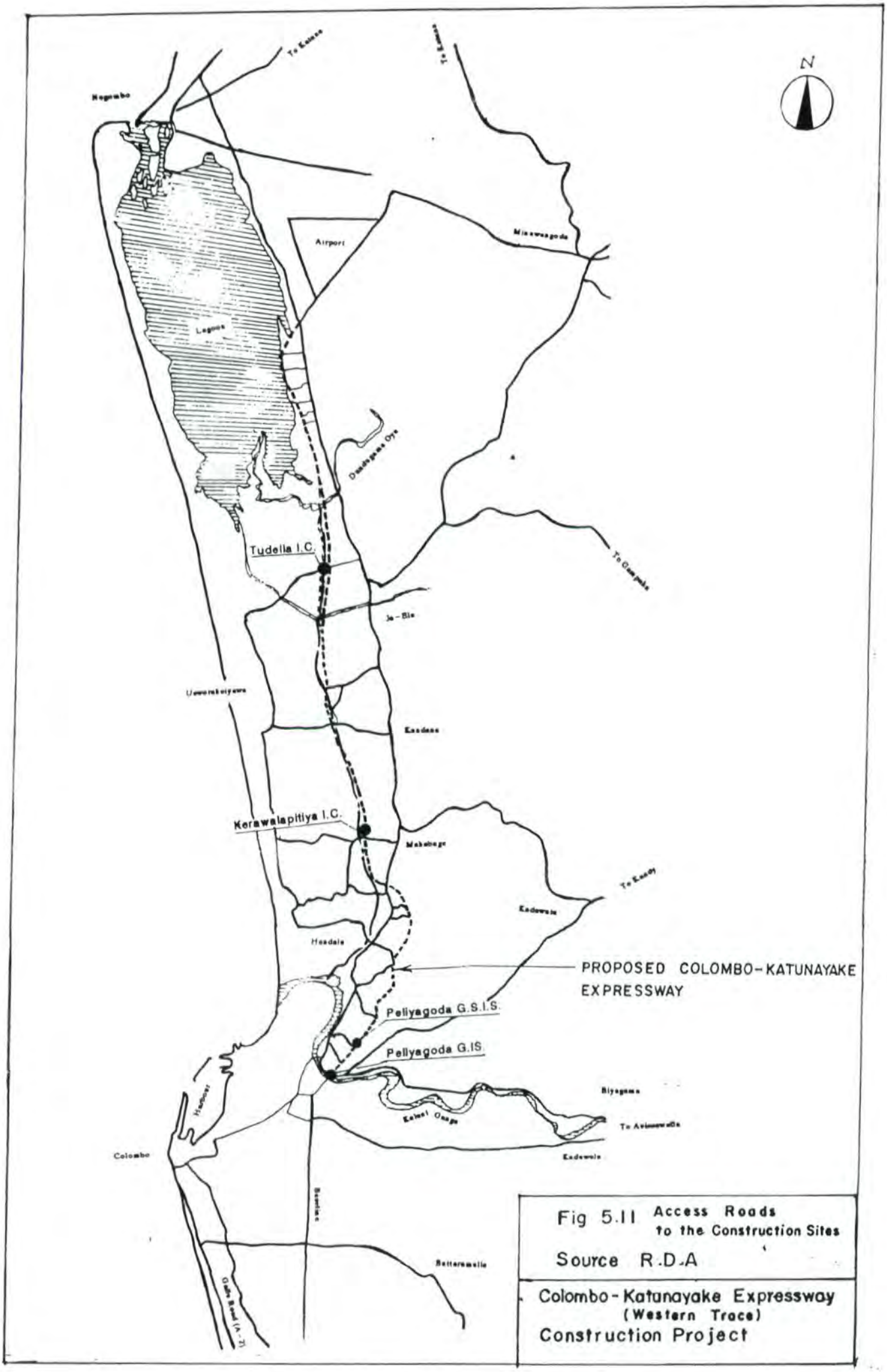
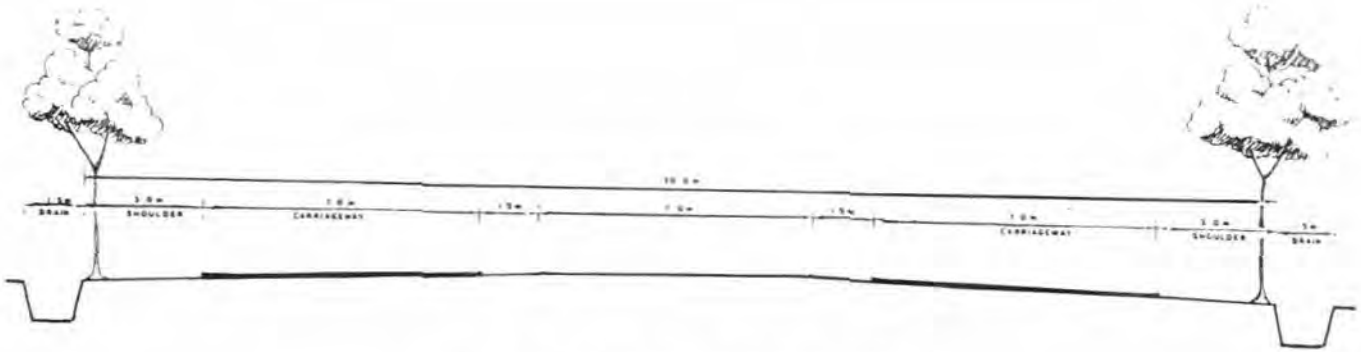


Fig 5.11 Access Roads to the Construction Sites

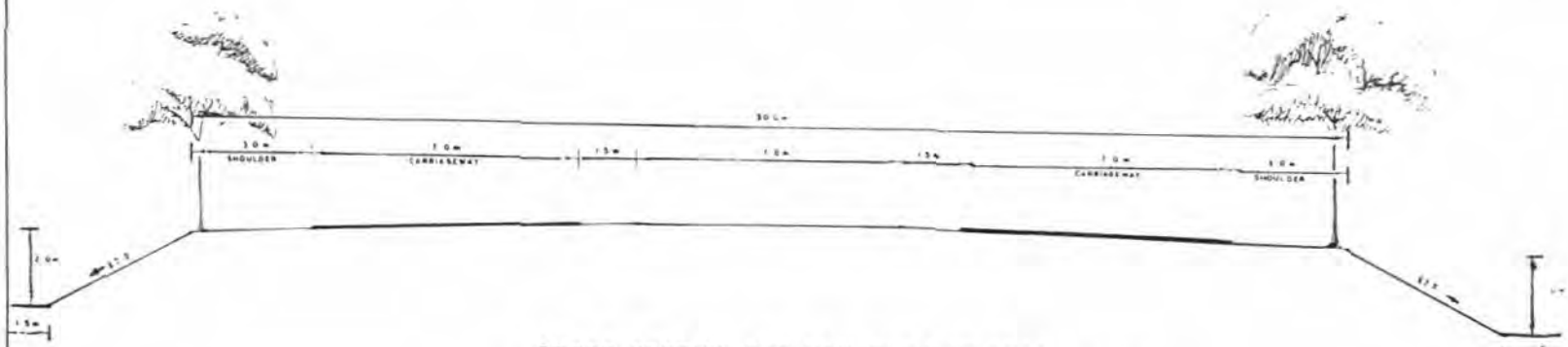
Source R.D.A

Colombo - Katunayake Expressway (Western Trace) Construction Project



CROSS SECTION FOR BUILT UP AREA - 4 LANE

SCALE 1 100

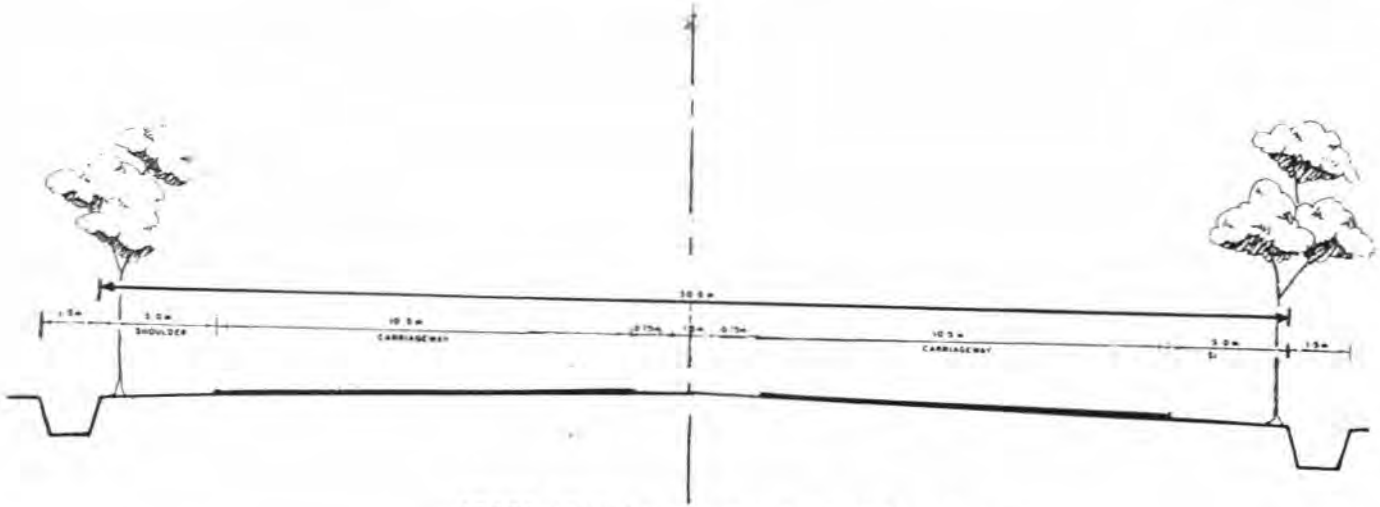


CROSS SECTION FOR NON-BUILT UP AREA - 4 LANE

SCALE 1 100

Source : N.D.A.

Fig 5.12



CROSS SECTION FOR BUILT UP AREA - 6 LANE

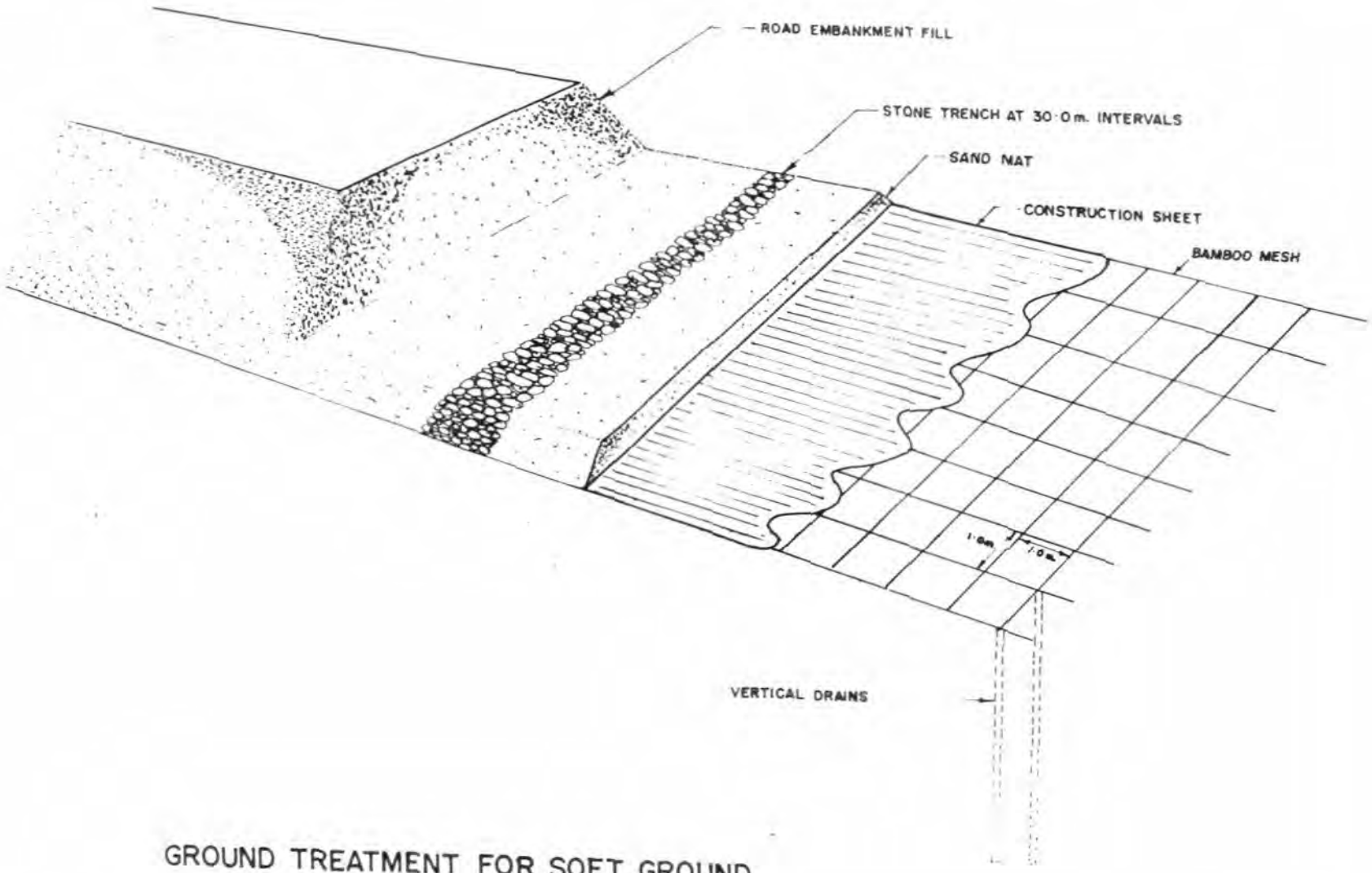
SCALE 1:100

CROSS SECTION FOR NON-BUILT UP AREA - 6 LANE

SCALE 1:100

Source R D A

Fig 5.13



GROUND TREATMENT FOR SOFT GROUND

Source - R.D.A

Fig 5·14

ii) Stage Construction

Since the shearing strength of the subsurface soils is small, the amount of fill that can be placed at one stage is limited, as the weight of fill imposes additional shearing stresses. Therefore stage construction method is essential.

iii) Preload

The peaty / organic clay that forms the ground has a high water content which results in significant amounts of secondary settlement. In order to minimize the residual settlement due to compression, preloading method is adopted. (Fig. 5.15)

iv) Counter Embankment

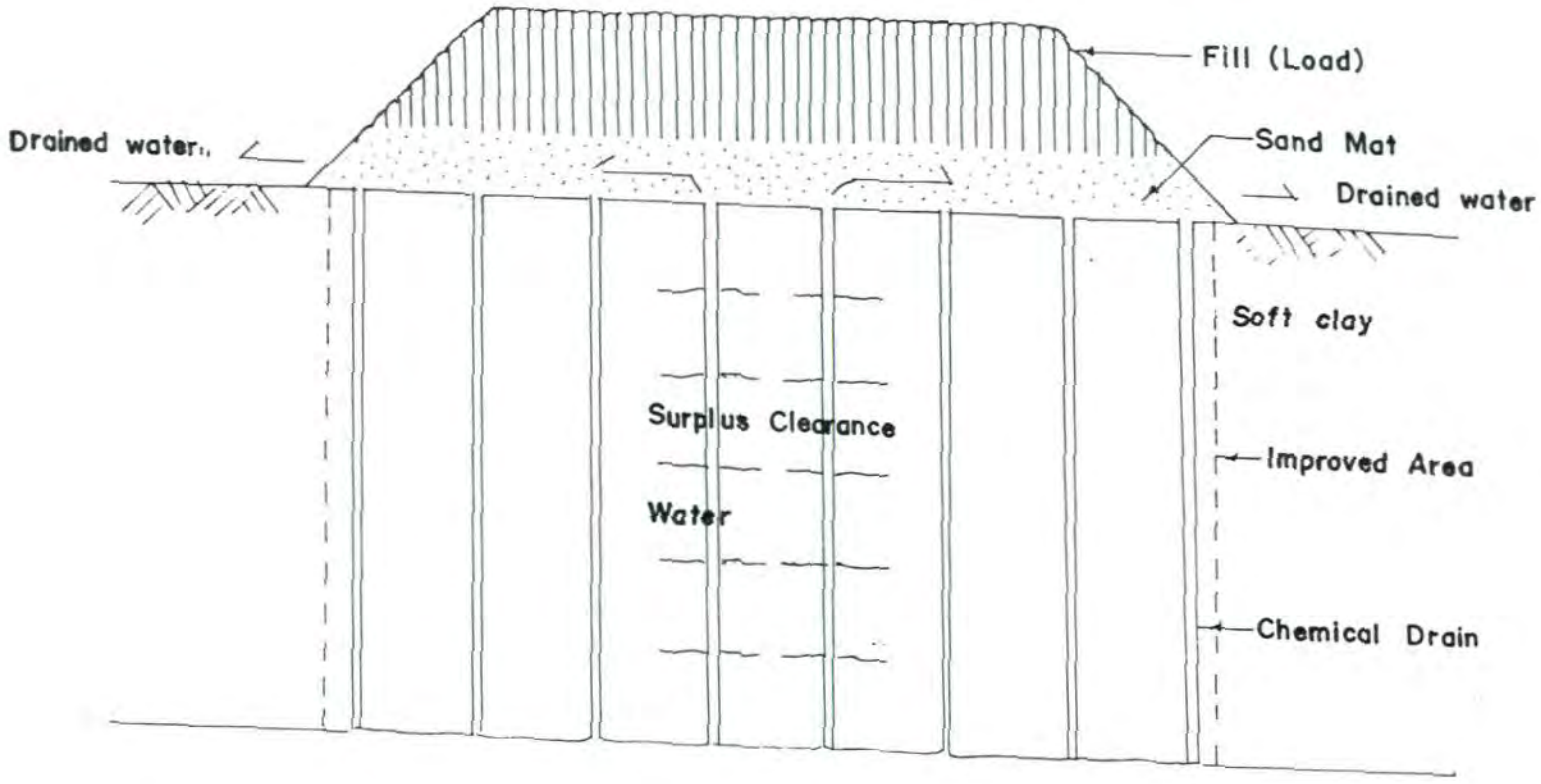
It has been found that the most popular and economical method of ensuring a safety measure against slip failure of the embankment is to provide counter embankment. However due to limitations of area, it is proposed to limit the widths of counter berms to 45 m from the *centre line as much as possible.*

v) Vertical Drains

The maximum thickness of soft clay is about 10 m and the time required to complete 90% of the primary consolidation settlement is in approximately 10 years. In order to speed up the consolidation of soft clays, vertical drains will be installed. Stone packed drains will be provided to ensure connectivity with the vertical drains. (Fig. 5.14 and 5.15)

e) Formation of the Embankment

Materials from borrow areas will be transported to each section independently using 10 ton dump trucks through local roads (Fig. 5.11). The total volume of materials to be transported is 400,000 m^3. This borrowed material will form road embankment, subgrade and sub-base course.



Basic action of the prefabricated drain

Source - R.D.A (Port Access Road Project)

Fig 5.15

f) **Formation of Base Course**

The aggregate base course produced at Kotadeniyawa quarry will be transported through local roads to sections I, II and III using 10 ton dump trucks. The base course material produced at Koratota quarry will be transported to sections III, IV and V, through local roads.

5.5 Maintenance and Operation

5.5.1 Cost of Maintenance and Operation

The annual maintenance of expressway is estimated at Rs. 7.7 million while the annual operation cost is estimated at Rs. 3.5 million.

5.5.2 Toll Collection

A toll will be collected at the point of entry.

5.5.2.1 Toll Plaza

A toll plaza will be constructed at Peliyagoda comprising toll gates, toll booths, islands, supervision buildings, garages, parking areas and other associated facilities. The functioning of the toll plaza is shown schematically in Figure 5.16.

The toll plaza will be manned by the following :

Manager	01
Toll collectors	40
Accounts Assistant	01
Accounts Clerk	01
Security Officer	01
Assistant Security Officers	04
Office aid	01

Architectural design of the toll plaza will conform to the following :

a. International guidelines and standards set out for *expressways*
b. Traditional architecture of Sri Lanka
c. Accepted standards of the RDA

In addition the design will take into account the local weather and site conditions.

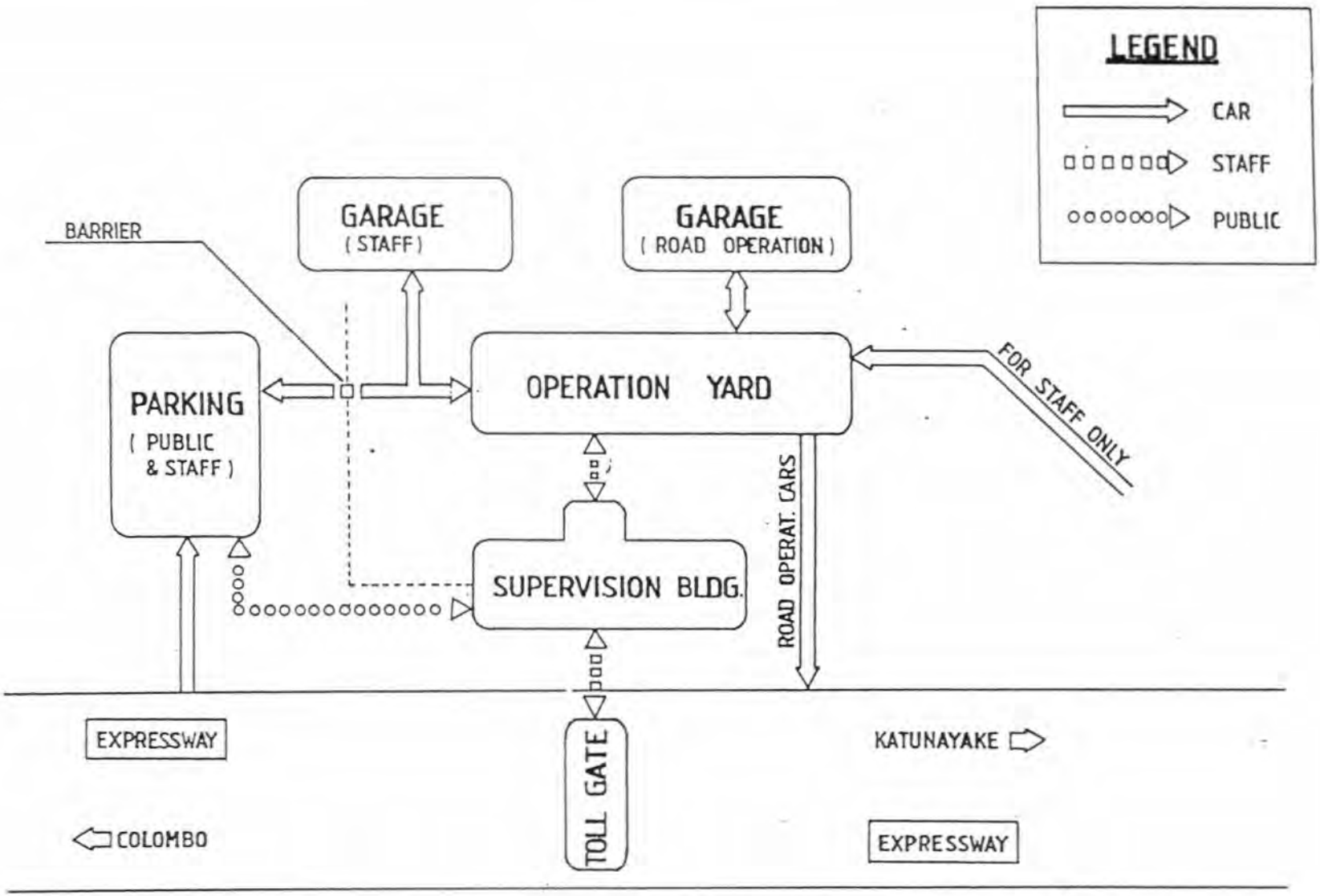


Fig. 5·16 TOLL PLAZA SCHEMATIC FLOW

Source _ R. D. A

CHAPTER 6

ANTICIPATED ENVIRONMENTAL IMPACTS OF THE RECOMMENDED ALTERNATIVE

CHAPTER 6

ANTICIPATED ENVIRONMENTAL IMPACTS OF THE *RECOMMENDED ALTERNATIVE*

6.1 Impacts Related to Project Location

6.1.1 Socio-Economic Impacts on Settlements

Impacts of the proposed CKE are identified on two groups of communities. The first group is likely to be uprooted and transplanted in a new location as their immovable properties are on the path of the alignment. The second group is referred to as the "remaining group" whose immovable properties are located close to the trace. *The second group will be vulnerable to ill effects, even after* construction.

The present land use map of the trace shows that there is a considerable number of vulnerable structures including houses, commercial and other buildings, roads, bridges and culverts.

One major concern at the design time was to minimize the number of families to be displaced. The CKE is expected to relocate approximately 130 low and middle class families. About 58% of the families in the sample received some form of Government grant such as food stamps or Samurdhi assistance. Among the families that would be displaced, as much as 50% belong to low income groups who had encroached on state lands. They live in shanties or temporary makeshift structures and it was observed that in many houses two or three families live together. The majority of these encroachers have constructed huts in low-lying marshy areas near the Kelani bridge and in the land allocated for the expressway within the PIUDP area.

Only 6% of the squatter families have permanent employment and 80% worked in temporary occupations in the informal sector as casual labourers, petty traders, carpenters, masons, watchers etc. and as many as 77% earned a monthly income of less than Rs. 3000/=. Squatters normally live close to areas that can provide employment. Hence the majority of squatters in this area work within a five mile radius from their homes. As many as 78% of the chief householders belong to the 26-55 age group and 64% had not studied beyond Grade 10.

The squatter families fear that they would not be able to obtain regular employment if they have to leave the area. Relocation would also increase time and cost in travelling to present places of employment and to services such as Government hospitals, dispensaries, schools and to places of worship. Another fear expressed was about breaking of social ties with relations, friends and neighbours.

If unmitigated the detrimental impact on squatters would be as follows:

i) Loss of income

   a) from cultivation and sale of *keera* or leafy vegetables
   b) from other informal sector activities in the neighbourhood.

ii) Depending on the sites selected for relocation, the distances to hospitals, *schools, Government institutions and places of work could be increased,* resulting in corresponding increases in travel time and cost.

iii) Severance of communities.

Relocation would also have the following beneficial impacts which the squatters readily acknowledge.

i) Security of tenure
ii) *Better housing*
iii) Relief from overcrowding
iv) Freedom from flood hazards
v) Better access to infrastructure-
   regular water supply sanitation, electricity and waste disposal.
vi) Improvement of health conditions
vii) Access to community development programmes
viii) Upliftment of living standards

6.1.2 Impact on Human Behaviour

A high proportion of the population living in permanent houses in Wanawasala , Hunupitiya, Wattala and Mabole shows great resentment to the CKE. Those families who live directly on the path of the CKE will therefore be subject to "involuntary resettlement".

It is therefore important to review the behavioural pattern of the population that *will be involuntarily re-settled. The behavioural pattern of these people will vary* depending on the stage of construction.

As depicted in Figure 6.1, people generally panic when they hear about the proposed highway at its planning stage. It is unrealistic to expect an unbiased and objective view of the project from such people who have enjoyed secure and comfortable living conditions for several decades. During the planning stage, people are likely to voice their displeasure and anger through community based organisations.

IMPACT OF INVOLUNTARY RESETTLEMENT ON HUMAN BEHAVIOUR

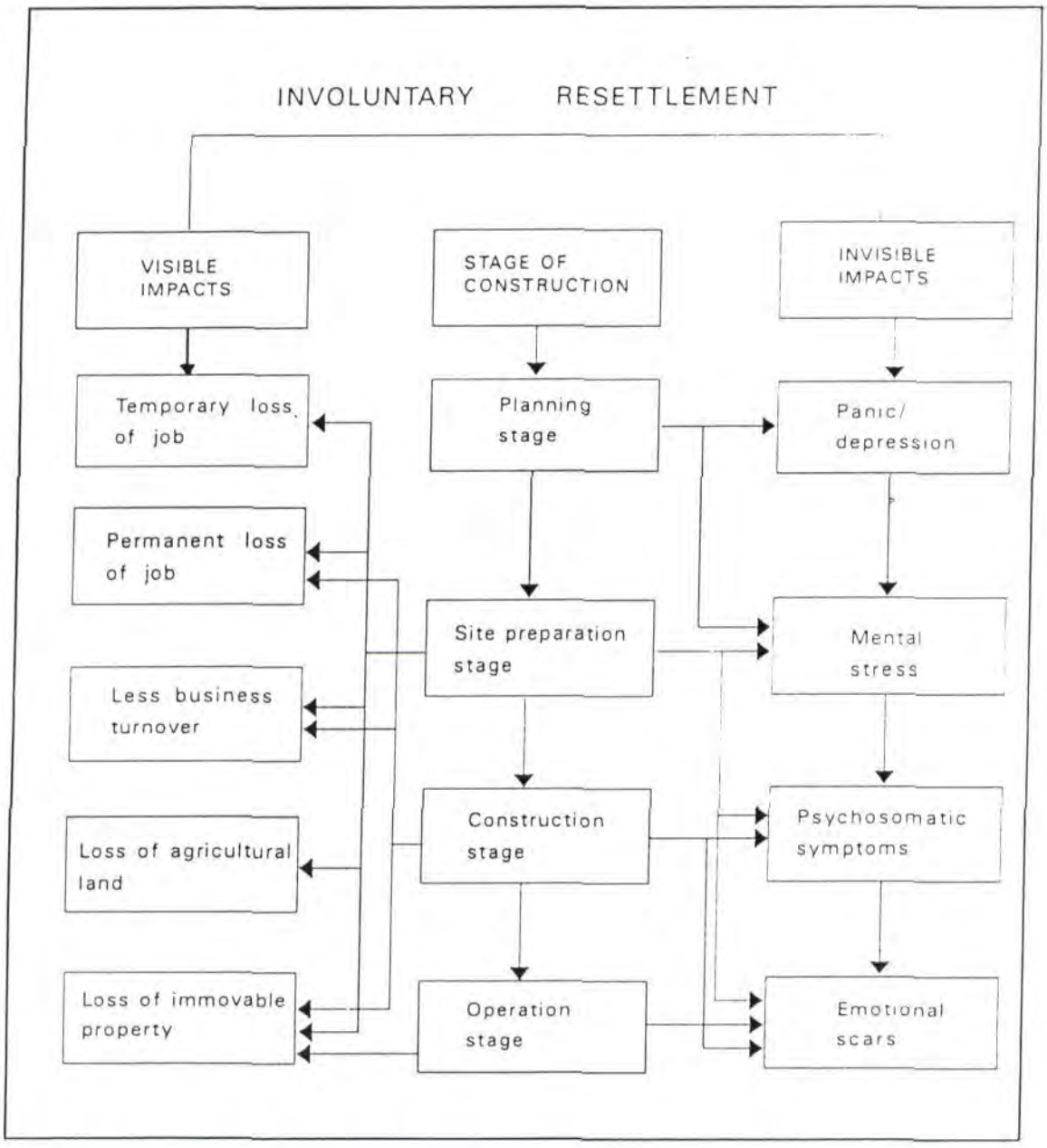


Figure 6.1

These permanent residents are opposed to relocation and to the severance of their communities. Some residents have inherited ancestral property while others have purchased land and constructed houses recently. They expressed the fear that they would lose valuable trees in their home gardens, and income from garden produce. They are of the opinion that they would not be adequately compensated for the time and effort devoted to building up their homes. They express fears that compensation paid will be "too late" and "too little".

According to the findings of the survey, they profess unwillingness to be uprooted from the present environment because they maintain cordial relationships with their community and are active members of a number of welfare societies. Hence they would find it difficult to get adjusted to a new environment. They also believe that they would not be able to find suitable locations for resettlement.

The traumatic experiences of having to be uprooted from their homes and having to start afresh in a new location can be listed as follows:

i) Loss of ancestral and acquired house and property
ii) Loss of income from home garden product
iii) Severance of communities - loss of close contacts with relations, neighbours and friends.
iv) Loss of educational, health, and other facilities
v) Difficulties in travelling to places of employment, schools, dispensaries etc.
vi) Inability to find suitable locations for settlement.

There are small boutiques and shops in temporary or permanent buildings that provide a variety of goods and services. The adverse impacts on the commercial establishments are given below:

i) Loss of clientele
ii) Loss of income and property
iii) Loss of prime location

The view held by residents and shop keepers who will continue to remain on either side of the expressway, is that it would have an adverse impact on the physical, cultural, social and economic environment of the area. They maintain that there would be a decrease in residential satisfaction because of the following changes :

i) severance and consequently a disintegration of old established communities
ii) noise and air pollution
iii) access restrictions
iv) loss of visual amenity
v) reduction of land values.

6.1.3 Impact on Land Use

The alignment extends for 25.41 km and covers approximately 128 ha of land area. The expressway traverses marshes and abandoned paddy fields over a great part of the alignment. The proportion under prime agricultural land and buildings is low. (Table 6.1)

TABLE 6. 1

LAND DIRECTLY AFFECTED BY THE PROPOSED WESTERN TRACE

		Residential Uses				Commercial & Other urban uses		Agricultural uses		Marshes	
		Shanties		Permanent houses & homestead gardens							
Section	Length (km)	Extent (ha)	%	Extent (ha)	%	Extent (ha)	%	Extent (ha)	%	Extent (ha)	%
1 Kelani Bridge to Kelanitissa Mawatha	3.28	0.35	28.23	0.22	11.76	-	-	0.11	68.75	17.14	13.80
2 Kelanitissa Mawatha to Mahabage	6.22	0.38	30.65	1.47	78.61	0.55	100%	-	-	11.15	8.97
3 Mahabage to Katunayake	15.91	0.51	4.12	0.18	9.63	-	-	0.05	31.25	95.96	77.23
Total	25.41	1.24	100	1.87	100	0.55	100	0.16	100	124.25	100

Source : Field Survey, 1996

6.1.4 Impact on Population and Employment

Direct impacts of the CKE on population increase will not be significant during the construction phase since it is proposed to recruit unskilled and semi-skilled workers locally. Skilled employees would either be living within daily commuting distance of the project or live in temporary accommodation provided at the site. Hence there may not be an influx of migrants except for retailers and people who provide personal services.

6.2 Impacts Related to Design and Construction Activities

6.2.1 Design Impacts

The following design impacts have been identified.

a) To maintain design speed at the end section of the CKE, the road trace was shifted into the Lagoon about 1.4 km length stretch.

b) If lagoon is traversed by way of an embankment rather than by viaduct this will result in isolation of a narrow strip of the Lagoon.

c) To avoid demolition of existing 19 houses at Wahatiyagama and MVC the road trace was shifted into the "Conservation Zone" by about 150 m. Impacts arising from a, b and c above are described in detail under 6.2.4.2.

6.2.1.1. Impact from encroaching on to the Old Negombo canal near Mabole

CKE crosses the A3 road at Mahabage going in a westerly direction and curves to the north before ending up on the eastern bank of the Old Negombo canal going on a northerly direction. However at the western -most section of the curve the expressway encroaches into the canal. The design allows for the deviation of the canal to the west so that it would avoid being obliterated by the CKE. This deviation would be effected by smooth curves joining with the existing canal at either end and the deviated portion will be of sufficient section to be comparable with the original section. It will then function as if the old canal has not been obstructed at all. This will avoid the canal being severed into two parts by a fill of about 600 m in length.

If no deviation is made and the Old Negombo canal is obstructed, it will result in the following :

a) Rising of flood levels to the east if no outlet is provided across the CKE to relieve the local runoff. This will cause more frequent inundation with increased depths after rains.

b) *Disturbance to the existing hydraulics of the Old Negombo canal and the* nearby marshes by the loss of continuity of the canal. Areas around Kerawalapitiya and Gunasekara road drain partly to the south via this canal and partly to the west via the peripheral canal provided by the Kerawalapitiya sand fill. Removal of the ability to drain south would affect the overall drainage of this area.

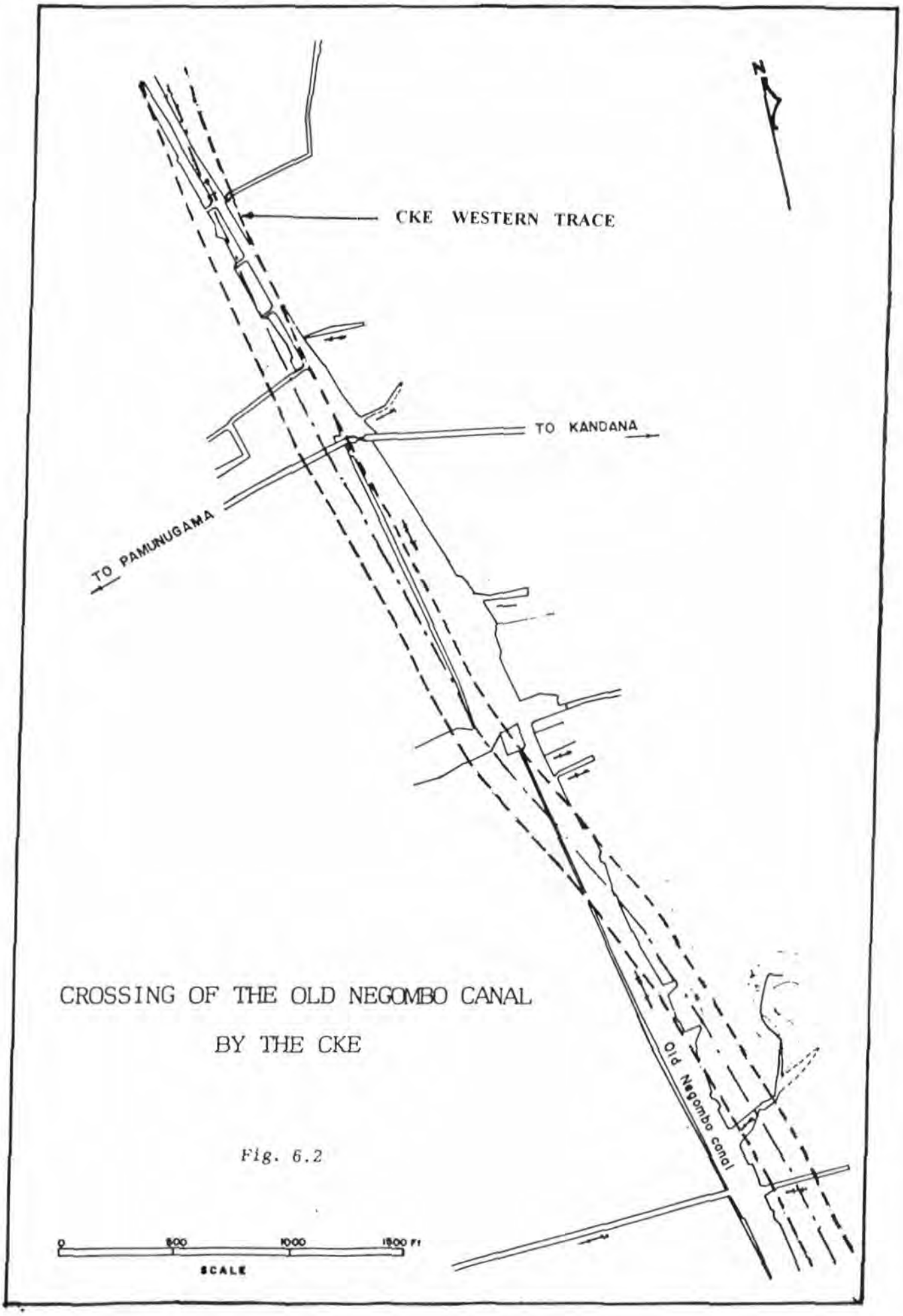
c) Stagnation of water in the canal segment immediately to the north of the point of severance.

6.2.1.2 Impact from crossing the Old Negombo canal near Kalaeliya

At 10.9 km of the trace, the expressway crosses the canal from east to west. After 1.8 km, it again crosses to the east. (Fig. 6.2) Both crossings take place at a very oblique angle, thus covering long stretches of the canal, 900 m and 450 m respectively. These lengths make providing bridges uneconomical. On the other hand, providing culverts also is not effective as it is not possible to maintain such long openings without obstruction. Once obstructed, it will be very difficult to clear them. Therefore only possibility is for the canal to be filled at these two places.

However the design provides a bypass canal to the west of the CKE which would connect the two canal segments lying to the north and the south of the two crossing points. This will ensure the hydraulic continuity of the Old Negombo canal. An opening under the CKE connecting the new canal to the isolated segment to the east would provide an outlet for the runoff from the east and conjoining of waters.

Therefore the design avoids the severance of the canal and the stagnation of water.



CROSSING OF THE OLD NEGOMBO CANAL

BY THE CKE

Fig. 6.2

6.2.2. Construction Impacts

a) Dredging and Sand Pumping

Impacts due to offshore dredging of sand and transport of dredged material are identified as follows,

i) Dredging Operation : Physical

Offshore dredging can be expected to have an impact on the near shore sediment movement and the stability of the nearshore coastline. During the dredging operation there is a possibility of subsidence of adjacent areas, subsoil failure, alteration of soil characteristics, hydraulic and geotechnical problems . Turbidity is another dredging induced impact, which will be exaggerated by the spilling of dredged material.

ii) Dredging Operation : Ecological

Sand mining from the sea bottom will result in the destruction of part of the benthic habitat as well as the organisms living therein. However the physical substrate removed will be naturally restored with time and the fauna will reestablish themselves at the borrow site. Some of the benthic fauna such as molluscs are prolific breeders capable of producing millions of egs and the impact of dredging operations on their populations will be negligible . Furthermore, considering the vastness of the benthic habitat when compared to the area of the borrow site, it may be concluded that the ecological loss resulting from the loss of habitat due to sand mining operations would be negligible.

Besides loss of habitat two important factors which can be detrimental to benthic fauna are turbidity and turbulence caused by dredging operations. These conditions may also prevail naturally at the borrow site from time to time due to factors such as high wind velocity and rapid discharge of large volumes of water from rivers. Turbidity is due to fine particles of sand going into suspension. These particles can damage delicate body parts of marine animals such as gills of fish and molluscs. resulting in mortality. Turbulence can also dislodge some sedentary animals from their places of attachment which may lead to their destruction. However, the state - of the - art methodology utilised in the extraction of sea sand has been designed to minimize turbulence and turbidity during operations.

There are no established fishing grounds within the borrow area and therefore there will be no impact on fishing.

(iii) Transport of Dredged Material

The dredged material will be transported through a pipeline system crossing the reef and shoreline and facilitated by a booster pump. This will cross the Hamilton canal and the adjacent road. (Hekitta - Pamunugama)

As the pipeline will be laid through the existing opening of the reef (Fig. 5.8), there will be no additional impact on the shoreline.

The floating pipeline will be well anchored to prevent it coming into contact with the reef, thus avoiding damage to reef. The submerged pipe line laid through the reef opening will be placed closer to the seabed to ensure that there is no obstruction to the movement of fishing craft through the reef opening. The pipeline system will not be of any hindrance to fishing craft.

The shoreline crossing will be submerged. Therefore, it will not act as a littoral barrier and have an impact on the coast.

The site for the booster pump will be the same as for the SLLRDC project which had been selected to avoid any impacts such as noise and vibration on local population.

When crossing Hamilton canal the pipeline will be elevated to allow sufficient head room for fishing craft. When the pipeline crosses the road it will be buried so as to prevent any obstruction to traffic.

The pipeline will be laid from this point skirting the sand filled area upto the designated stockpile area. Since the pipeline boarders the marsh and covers an insignificant area it will have no adverse impact, (EIA reports of Kerawalapitiya Reclamation Project 1993, Japan Eastern Trace 1992 and communication by SLLRDC, RDA).

b) (i) Discharge of salt water from the sand stockpile

The dredger will discharge the sand from its hopper to the stockpile area by pumping a slurry of sand and water in the ratio of 1:4. The dredger used for the Kerawalapitiya sand fill had a hopper capacity of 8,000m^3 (information from SLLRDC). Therefore when the dredger is discharging the load, a volume of 32,000m^3 sea water will be pumped into the stockpiling area within about one hour. The cumulative sea water volume from the entire operation would be about 4.5 million m^3.

If unmitigated, this will lead to the following impacts :

a) Waterlogging of the area
b) Increase of ground water salinity
c) Overloading of the Old Negombo canal
d) Salinity increase in the Old Negombo canal

(ii) **Ecological Impacts**

The existing flora at the site will be eliminated as a result of sand being piled up on top of the vegetation. Fauna that could move out will do so and the rest, mainly invertebrates will perish as a result of being buried. Although a mixture of sand and sea water in the ratio of 1:4 by volume will be pumped to this site, the design provides for the rapid pumping of water back to the sea minimizing the seepage of salt water into adjacent areas.

c) **Embankment formation**

i) Transport of sand at the rate of 900 m^3/day, gravel and earth 300 m^3/day using 10 ton dump trucks for road embankment and sub-base will cause damage to roads and culverts. Total road network impacted includes 33 km of tarred roads excluding A3 road and 15 km of gravel road. (Fig. 5.11)

Vibrations and dust will cause a nuisance to road side residents. Added traffic will cause congestion on the road.

ii) Dust emissions due to the operation of concrete batching and mixing plant, asphalt concrete plant, the movement of heavy construction machinery, stockpiling of sand, gravel and aggregates will have an adverse impact on the people and their property in the area.

iii) Dust, noise, and vibrations from drilling, blasting, crushing and loading operations from quarries will have an adverse impact in the vicinity. As the selected quarries are operational at present, the above impacts will be marginal. The impacts from borrow pit operation will be higher as they are abandoned at present. However, unlike quarries, borrowing gravel produces less noise and dust.

iv) Pollution by operation of construction machinery will produce the following pollutants :

a) Spent lubricants / hydraulic fluids
b) Fuel from spills
c) Old tyres and tubes
d) Old batteries and their components
e) Other solid items such as used filter elements, metal engine parts, packing cases, etc.

Poor management will lead to the following impacts :

a) Pollution of waterways and the marsh in the vicinity by oily refuse
b) Littering of waterways and marsh by solid debris
c) Addition of toxic wastes, such as lead from batteries

6.2.3 The Impact on Health

The proposed expressway will not have significant adverse impacts on public health. blocking of waterways and formation of stagnant pools provide ideal breeding places for vectors that transmit filariasis (*Culex quinquefasciatus*) since the study area falls within the filaria endemic zone with a micro filarial rate which ranged between 0.29 % - 0.34 % in 1993. Other vector-borne diseases that are prevalent in the region and most likely to spread during the construction phase if unmitigated include Dengue Haemorrhagic Fever (DHF) transmitted by *Aedes aegypti* and *Aedes albopictus* that breed in fresh water collections and Japanese Encephalitis (JE) transmitted by *Culex tritaeniorhynchus* that generally breed in marshes, paddy fields, ditches and other water collections. There is a danger of workers getting infected with Leptospirosis by coming into contact with contaminated water.

6.2.4 Ecological Impacts During Construction

6.2.4.1 Man-made habitats (built-up areas, home gardens and cultivated lands)

The flora found in man -made habitats along the corridor of the proposed trace will perish and the fauna will be either destroyed or displaced. The displaced fauna will move into other man-made habitats. However, as explained in section 4.2.2. flora and fauna of these habitats are neither rare, endangered nor threatened, and the impacts of the trace on them are ecologically insignificant.

6.2.4.2 Impacts on the wetlands

Wetlands affected by the Western trace are the Muthurajawela marsh, the network of canals, ponds, brackishwater swamps, streams and the Negombo lagoon. These wetlands have been extensively studied in the recent past (GCEC/ Euroconsult 1991 - 1996, CEA/ Euroconsult 1994). The Master Plan of Muthurajawela and Negombo Lagoon (MPMNL) (GCEC/ Euroconsult 1991) which

is based on the earlier studies, has taken a balanced view of developmental needs and environmental concerns ; it has paved the way for both developers and conservationists to adopt a fresh approach towards development and conservation' which were earlier regarded as incompatible processes. The current approach to wetland conservation lays more emphasis on safeguarding the functioning and sustainability of wetland ecosystems as a whole for human benefit rather than the mere conservation of individual species.

The loss of wetland habitats in terms of area due to the trace is shown in Table 6.2. Although the actual width of the expressway is 30 m, a corridor of 100m is considered as being directly affected since fauna and flora within this corridor will be subjected to the full impact of the expressway during its construction as well as operation. The loss of habitats in terms of area is relatively small. Most of the vertebrate fauna and active terrestrial invertebrates living along the corridor will move to adjacent safe areas when construction activities begin; plants and sluggish invertebrates, however, will perish.

TABLE 6.2

EXTENT OF HABITATS AFFECTED BY THE WESTERN TRACE

Type of Habitat	Existing Area (ha)	Extent Affected (ha)		Extent as percentage	
		Physically	Ecologicall y	Physically	Ecologically
Marsh	2906	79.8	133	2.7	4.5
Mangroves (Brackishwater swamp)	350	4.8	08	1.38	2.3
Lagoon	3200	9.6	16	0.3	0.5
Seagrasses	704	9.6	16	1.38	2.3

* After reclamation of the Kerawalapitiya marsh

** The embankment width (60 m) is considered in the computation of the extent affected physically

*** A corridor of 100 m is considered in the computation of the extent affected ecologically

Sources :
1) Land use map 1996
2) Profile of Muthurajawela marsh - Negombo Lagoon, 1991.

The extent of marshland obliterated will be approximately 2.7% of the Muthurajawela marsh. Therefore, the impact on the ecosystem due to the depletion of habitat per se would be insignificant.

The extent of mangrove forests destroyed will be approximately 5 hectares ie. 1.4% of the total extent of mangroves found in this wetland system. Therefore, the impact due to loss of mangroves would also be insignificant.

Since the expressway runs a distance of 1.4 km through the lagoon off Liyanagemulla, close to its eastern shore, it will affect seagrasses that grow along this stretch of the trace. The maximum distance of the trace perpendicular to the shoreline will be 150 m. Surveys of the seagrasses of the Negombo lagoon have been carried out by Jayasooriya (1990) and Amarasinghe et al (1993). Jayasooriya has not found seagrasses while Amarasinghe et al have recorded *Halophila beccari* and *Halodule pinifolia* off Liyanagemulla extending about 215 m into the lagoon from the shore. Absence of seagrasses in the area was noted in July 1996. The lagoon bottom in this area was covered by a filamentous algae (*Chaetomorpha sp.*) which may have smothered the seagrasses. However, seagrass roots were present in mud samples. The foregoing observations seem to suggest a seasonal cycle in the growth of seagrasses. Based on the assumption that seagrasses were present in this area throughout the year and the proposed trace would completely destroy the seagrasses in the area between the shoreline and the western margin of the trace (worst case scenario), the extent of seagrasses destroyed will be approximately 0.5% of the total extent of seagrasses growing in the lagoon. Therefore, the juvenile fish and the crustacean larvae for which sea grasses constitute a critical habitat will still be left with 99.5% of this habitat.

During the construction phase, in the absence of mitigatory measures, the following adverse impacts on the MVC can be expected.

(1) Severance of the main building from the "nature trail " zone.
2) Disruption of the popular boat trips
3) Elimination of the model cadjan / wattle & daub huts
4) Annoyance to visitors caused by noise, dust and smoke.

Since the expressway is to be constructed on an embankment (1.5 m high), it will interfere with the normal drainage patterns of storm water causing the east side of the embankment to be flooded; this would have an adverse impact on some terrestrial fauna. The embankment will not act as an obstruction to the free movement of terrestrial animals such as birds, bats and insects which can fly. However, it will act as a barrier to

small mammals, reptiles, amphibians and some invertebrate animals such as land snails. The Dutch canal itself acts as a barrier to animals that do not fly or swim and confines them to either side of the canal. Amphibians confined to the east side of the embankment, which normally breed in the canal, will lose access to it.. However, there is no scarcity of suitable breeding places on the east side of the embankment.

During the construction stage, oil from machinery and materials such as asphalt and cement may spill into the marsh, streams and lagoon causing harm to aquatic flora and fauna. Excessive noise generated by machinery can scare away aquatic birds and other fauna sensitive to high noise levels. Sand mining operation can affect benthic fauna; oil leaks from the dredger, sand leaks from the pipeline and mechanical impacts of the pipeline on the reefs can harm marine life. These possible hazards must be anticipated and mitigated whenever they occur. how.

6.2.5 The Impact on Air Quality

Dust and emissions from the vehicles and equipment to be used for construction of the CKE will have an adverse impact on air quality. Based on the estimate of air quality (as discussed in section 3.2.5) on baseline assessment made by the National Building Research Organisation (NBRO) an increase of carbon dioxide (0.05%), diesel particulate (0.08 %) and toxic pollutants such as CO, NOx, and Hydrocarbons (HC) (0.02%) could be anticipated in the area. According to the forecast, in the corridor of 400 metres, an increase of 40% of dust is envisaged, which is likely to fluctuate from time to time. This could have a high adverse impact on human health and ecology in the corridor area during the construction period.

6.2.6 The Impact on Noise Levels

The impact on noise levels during the construction period have been estimated by taking into account activities such as the use of machinery and equipment, transportation of construction material etc. The dB (A) levels of these items are within the tolerable ranges according to international standards (estimates as dB (A) 42). It is expected that there will be dB (A) 90 during the peak period of construction. It is recommended that mitigatory measures should be implemented in respect to the different zones of the proposed CKE.

6.2.7 The Impact due to Accidents

During the four year construction period accidents have been forecast based on the calibration carried out with similar projects. These indicate that accidents all carried by such activities as transportation of material to the construction sites, heavy equipment movements with normal traffic in the area etc. Accidents can be minimized by the mitigatory measures.

6.3. Impacts Related to Operation

6.3.1 The Impact on Ecology

Animals such as small mammals, lizards and amphibians whose free movement is obstructed by the road embankment will clamber up the sides of the embankment and cross the expressway. Such animals will be in danger of being run over by vehicles and mitigatory measures are required to minimize the possibility.

If suitable mitigatory measures are not adopted, noise and smoke generated by traffic can cause many animals, especially birds and mammals to move away from the vicinity of the trace. Some of these animals may eventually get accustomed to traffic noise.

At night bright lights of the expressway are likely to attract many insects such as moths and dragonflies. These lights will also act as a source of disturbance to birds roosting close to the expressway.

6.3.2 Impact on Land Use

After the completion of the expressway in the long term, it is anticipated that the CKE would accelerate the present trend of rapid land conversion. It would also *trigger a set of circular and cumulative changes towards further growth and* change in a wider area bringing about an increase in population and densities in the region and consequently an increase in the area under residential uses (Table 4.9).

Although the CKE is access controlled, it would contribute to the concentration of commercial and industrial activities around nodes of high access and potential interaction such as the areas around interchanges, in the strip of land between the CKE and the A3 and along feeder roads.

The present trend of the suburbs north of Colombo to attract more industrial, commercial, recreational and other urban activities instead of residential development is expected to continue. Land values would accelerate because of the advantage of high accessibility with parcels of land close to interchanges commanding the highest price. As a result, residential development would occur in areas away from the expressway and its interchanges.

The CKE will act as a physical barrier against further encroachment into the Muthurajawela conservation area, which has recently been declared as a sanituary.

Judging by past trends, the long-term impacts that are likely to occur in the surrounding area are as follows :

(i) *The area connected by Tudella, Kerawalapitiya and Peliyagoda* intersections.

These are nodes of high access and areas of potential interaction. These *advantageous locations will be secured by land uses that can command* the highest prices (bid rent). The bid rent system will result in the retail and other commercial establishments and industries occupying the most accessible locations while the soaring land values would discourage new residential development.

(ii) The strip of land between A3 and CKE

Since the three exits in the expressway allows high access along the corridor between A3 and the CKE it would attract more commercial, industrial and other non- residential uses. Land conversion would be either from agricultural to non-residential uses such as commercial and industrial or from residential to non-residential urban uses.

(iii) The area around existing industrial concentrations

The CKE provides access to all the major industrial nodes in the region and it is anticipated that more industries would be attracted to the area around these nodes.

iv) Residential Development

The current low density residential areas of Seeduwa - Katuanayake and Katana as well as the high density areas of Wattala and Ja ela PS. that have plenty of buildable land are expected to experience rapid population growth and an increase in residential uses.

As a result of the above activities population in the region is predicted to increase at aagrs ranging from 1.50% in Dalugama PS area to 8.50% in Biyagama and Kandana PS areas between 2014 - 2020 . (Table 6.3) Enhanced employment opportunities in industry, retail and wholesale trade and other enterprises as forecast in Table 4.6 is expected to attract temporary and permanent migrants including squatters.

TABLE 6.3

ESTIMATED AND PROJECTED POPULATION IN SELECTED URBAN AND RURBAN SETTLEMENTS IN THE AREA

Settlements	Estimated Population 1994	Projected Population 2014	Average annual growth *rate (aagr)* 1994 to 2014 (%)	Projected Population 2020 *	Average annual growth *rate* (aagr) 2014 to 2020 (%)
1. Wattala Mabole U.C.	19,184	37,776	4.61	46,842	4.00
2. Peliyagoda U.C.	15,058	33,661	6.17	44,769	5.50
3. Ja-ela U.C.	27,967	57,967	5.36	78,835	6.00
4. Negombo M.C.	98,354	118,354	1.02	125,455	1.00
5. Seeduwa-Katunayake U.C.	36,559	71,559	4.45	97,320	6.00
6. Dalugama P.S.	61,734	80,337	1.50	87,567	1.50
7. Hendala P. S.	50,262	68,865	1.85	76,509	1.85
8. Kelaniya P.S.	47,524	66,127	1.95	73,863	1.95
9. Biyagama P.S.	12,568	32,568	7.90	49,177	8.50
10. Kandana P.S.	28,022	48,022	3.56	59,547	4.00
11. Katana P.S.	4,801	2,801	8.30	4,229	8.50

aagr - Average Annual Growth Rate

Source : UDA, Colombo Metropolitan Regional Structure Plan 1995

* Projections by Consultants 1996

6.3.3 The Impact on Hydrology

6.3.3.1 Basin Hydrology

In the project area, it is necessary to consider different stretches of the roadway:

Dandugam oya basin : In this stretch, the flood plain is already influenced to a large extent by the presence of the existing A3 road. This makes the floods of Dandugam oya and Ja ela already constrained by the opening sizes provided in the A3 road.

The distance between the existing Dandugam oya bridge on the A3 road and the proposed bridge site on the expressway is only about 0.5 km. The area between the existing and the proposed roads are mainly low lying marshes with a fringe of high ground bordering the existing road. The flood plains of Dandugam oya and Ja ela canal are connected by the band of low lying areas. Mahadora ela provides a direct hydraulic connection between Dandugam oya and Ja ela canal.

Below the A3 road bridge, the river channel conveys much of the discharge with overbank flow accounting for a small amount. This is a result of the channelisation by the existing bridge, which builds up a high velocity head in the river. The distance upto the proposed bridge is too short for the velocity to be dissipated appreciably and for the flow to spread over the flood plains. Therefore, placing of the road embankment does not impose a drastic change in the flood hydrograph of Dandugam oya.

In the same basin, Ja ela canal discharges 800 cumecs after the design storm. In this case, the distance between the proposed and the existing bridges are much greater, being about 1.5 km. This makes a higher proportion of the flood to be discharged by the mechanism of overland discharge.

Kalu oya Basin : Southern part of the Kalu oya basin has been developed under the PIUDP. This allows for a perimeter drainage canal for the project with two drainage pumps at Peliyagoda and Oliyamulla with 300 and 600 cusec capacities each. The expressway lies within the boundary of the development zone of the PIUDP and therefore does not affect the flood flow, which is already intercepted by the perimeter canal.

North PIUDP, the trace follows a number of marshes. The trace serves as a restriction on the flood plain.

6.3.3.2 Water Quality

Main pollutants from highways have been shown to be

a) Solid particles including sand, rock fragments, and other detritus from the wearing of the paved surface
b) Lead, Zinc, Iron etc., from moving vehicles
c) Rubber, from wearing of tyres
d) Oil and grease from vehicles
e) Salt : the source is mainly the de-icing salt used in cold climes. Therefore this is not a serious pollutant in the local context.
f) Solid litter thrown by vehicle users : the social status of the road users makes the following types of litter to be the most likely :

   i) *Aluminium cans and laminated packs*
   ii) Plastic and polythene containers and polypropylene bags
   iii) Paper articles such as containers, tissues etc.

Levels of pollution has been the subject of extensive studies in USA and elsewhere. Only conclusion which can be drawn is that the pollution loading is highly variable and is usually given within a range. (Transportation Research Board USA , Stormwater Management for Transportation Facilities, 1993)

Poor management of pollution from expressway will have the following impacts :

a) Silting of drains by solid particles
b) Addition of chemicals to the eco-system
c) Oil pollution
d) Littering of the surroundings by solid garbage

Observation of impact by existing roads, which are rather poorly managed, indicates that by itself a roadway does not pollute the surroundings drastically or irremediably. Only in combination with roadside development, it has been observed to create serious threats of pollution. However, in the case of solid garbage, with the propensity to use more non biodegradable packaging, litter generated by a roadway is going to be a significant source of pollution in the long term.

6.3.4 Impact on Air Quality

During the operational stage, the main impact on air quality will be from the vehicle emissions operating on the proposed CKE. The contribution of CO in year 2001 is estimated to be 2240 kg while the relevant figure for year 2021 is 1524 kg. (Table 3.4) Assuming the fuel used in Sri Lanka maintains the same quality, HC in year 2001 estimated as 651 kgs, will rise upto 1524 kg in year 2021. The NO_X and SO_X levels which are harmful toxic pollutants will also increase.

Residents on either side of CKE will be affected by the lead levels and the particulate matter.

6.3.5 Noise

During the operating stage, the use of vehicles along the CKE will generate noise levels from dB(A) 60 to dB(A) 113 within a period of 20 years. Different zones of the proposed CKE will have different tolerant levels as shown in Table 3.7. The noise level given in this table highlights the need for strict mitigatory measures and implementation of appropriate monitoring specified in this study.

6.3.6 Accidents

In the year 2001, the cost of accidents of the CKE is estimated to be Rs. 12.51 million. This will rise upto Rs. 37.04 million in year 2021. (Table 3.10).

CHAPTER 7

MEASURES TO MITIGATE OR MANAGE ENVIRONMENTAL CONSEQUENCES

CHAPTER 7

MEASURES TO MITIGATE OR MANAGE ENVIRONMENTAL CONSEQUENCES

7.1 *Mitigatory Measures for Impacts Related to Project Location*

7.1.1 Mitigatory measures for Socio - Economic Impacts

A special unit to co-ordinate resettlement will be established in the RDA comprising officers of the RDA and representatives of service organisations, NGOS, communities, religious leaders. As far as possible, in order to minimize the adverse impacts associated with displacement, the ethnic structure and social relationships of the existing communities willl not be disturbed in the resettlement process .

Similar or better facilities will be provided for the affected families in areas of resettlement.

The CKE will be displacing 130 housing units (permanent, semi-permanent, and temporary.) within the 30 m corridor of the trace. The 60 housing units in the reservation will not be immediately affected.

Having noted the attitudes and feelings of the affected communities, groups and individuals and their social and economic characteristics, (Annexure XVIII), the following mitigatory measures have been recommended to ameliorate and minimize adverse impacts.

7.1.1.1 Resettlement of encroachers

a) The new settlements will be located as close to the original settlement as possible so that the commuting distance to their previous work places is not significantly increased. (The location of sites selected by the RDA for resettlement are given in Annexure III)

b) The development of the resettlement area will be completed before the relocatees arrive. Housing will be provided at least on 2-3 perches of land. Water supply, sanitation and waste disposal facilities, open spaces and recreational facilities for the community shall be provided according to guidelines laid down by the NHDA for their Sites and Services projects.

c) There will be a follow up, operation and maintenance phase arrived at the re-establishment and consolidation of the relocatees and the operation and maintenance of the resettlement site.

d) RDA will give preferential treatment to people who have lost their sources of income when recruiting labour for the CKE.

e) RDA will facilitate community development programmes in the new settlements with the help of NGOs and local religious and community organisations.

7.1.1.2 Permanent residents along the trace

a) Adequate compensation will be paid prior to evacuation and residential land will be purchased at prevailing market prices. The basis of calculation of compensation will be made public.

b) Buildable and serviced land will be selected as close to the original settlements as possible for those requesting land. (The sites selected for suitable development by the RDA are given in Annexure III)

7.2 Mitigatory Measures for Impacts Related to Design and Construction

7.2.1 Design

7.2.1.1 Mitigatory Measures for the Encroachment of Old Negombo canal near Nai Duwa

The only practical mitigatory measure available is to excavate a new canal to the west of the CKE, connecting the two severed ends. There is sufficient space between the highland Nai Duwa and the canal for the deviation. To the north of Nai Duwa, the area is marshy and allows sufficient width for the deviation. Sufficient depth and width will be allowed for the passage of flood water. It is suggested that the new canal section will have a width of 15 m and a depth of 3 m.

The new canal will be taken in a gentle curve where it connects with the existing ends of the canal. Where the banks are too soft to stand unsupported, they will be protected by means of gabions.

To effect the drainage for the area to the east of the CKE, an undercrossing will be provided connecting with the new canal segment.

7.2.1.2 Mitigatory Measures for the Crossing of Old Negombo Canal near Kalaeliya

Following mitigatory measures are recommended :

a) The excavation of a new canal on the western side of the expressway connecting the two severed sections of the canal - ie, the section of the canal to the south of the first crossing point and the section of the canal to the north of the second crossing point. The new segment of the canal must have a width of 15 m and a depth of 3 m so as to have the same discharge capacity as the original canal. It must be set out using gentle curves to connect with the existing canal. Where the soil is found to be too weak to support firm banks , they must be protected with gabions.

b) *Provision of an under-crossing to discharge the flow coming from east on to* the isolated segment of the canal. This will be placed at a point that will help in the drainage towards the west. The place near the existing Pan ela can be recommended, subject to surveys carried out at the time of design.

7.2.2 Construction

7.2.2.1 Dredging and Sand Pumping

The methodology of operation will minimise most of the impacts. However, important mitigatory measures that have to be ensured during the progress of sand dredging and transport of dredged material are as follows: (EIA reports of Kerawalapitiya Reclamation Project 1993, Japanese Eastern Trace 1992 and communication by SLLRDC.)

a) Dredging Operation

i. In order to minimise the impact on the shoreline, the dredging has to be confined to the identified region which is located at least 3 km offshore from the shoreline and at depths between 15m and 30 m.

ii. The depth of dredging should be limited to 1.5 - 2 m below the existing sea bed and should conform to uniform linear channels along the sea bed within the borrow area and not scattered deep holes to avoid hydraulic and geotechnical problems.

iii To reduce the effect of dredging - induced turbidity the measures are :

- Filling of hoppers / barges to safe levels and usage of splash screens or hoses to minimize overflowing.
- The use of Trailing Suction Hopper Dredger (TSHD) will minimize turbidity.
- Monitoring of hoses to prevent leakages.

b) Transport of Dredged Material

The pipeline will be regularly maintained and monitored to avoid any leakages.

During the transport of dredged material the existing gaps in the reef shall be used to avoid any additional impact on the shoreline due to erosion. The floating pipeline will be anchored to withstand wave action under all conditions and will not damage the reef.

The pipeline will be placed at the existing reef openings. These will not cause any obstruction for the fishing craft. Warning signals will be provided to inform fishermen the location of the pipeline with buoys, flags and lamps. The pipeline will be submerged when crossing the shoreline so that it will not act as a barrier obstructing littoral transport.

To avoid inconvenience to the local residents due to land crossing of pipeline the initial part of the crossing shall coincide with that used by SLLRDC for the land fill project and the balance part will be taken along the periphery of the land fill which will cause least damage and booster pump shall be located at a site which will cause least disturbance to residents due to noise. (Fig. 5.8). Across the Hamilton Canal, the pipeline will be taken sufficiently elevated to permit the passage of 3 1/2 ton fishing crafts. At the road crossing, the pipeline will be placed on the ground with a ramp over it for the road traffic to move unimpeded.

7.2.2.2 Mitigatory Measures for the Discharge of Salt Water

a) From the stockpiling area

All the impacts identified under section 6.2.2. (b) (i) can be obviated if the salt water incoming is pumped in is removed from the land immediately without allowing it to either percolate into the ground or to flow down the local drains. This can be effected by installing a pump at the site of the sand stockpile to remove the effluent leaving the stockpile.

As shown previously, sea water will be pumped in at a rate of around 32,000 m^3 in one hour. This works to a rate of around 310 cusec. Therefore if a pump having a capacity of 300 -350 cusec is installed at the stockpile area, all the saltwater can be pumped back to the sea without it being allowed to get into the ground water or any of the drains. The same strategy was adopted in case of Kerawalapitiya sandfill.

Therefore the following steps will be taken :

- Prepare a confining bund on the site to prevent the salt water from getting into the Old Negombo canal, surrounding marshes or into other local drains or inhabited areas.
- Landscape the stockpile area so as to channel the sea water from the stockpile into a prepared sump for evacuation by pumping.
- Install a pump of capacity 350 cusec and lay a pipeline taking the water back to the sea. If a shorter route can not be found, the same route as the incoming pipeline will be selected. The evacuation of water will be carried out at the same time as the on-shore pump sending in the sand waterslurry.
- Landscape the area surrounding the stockpile so as to allow the local drainage to continue unimpeded flowing around the site.

The project proponent will submit a detailed site plan showing the various components of the above plan before commencing the sandfilling.

b) **At the point of discharge into sea**

When pumping sea water draining off from the sand stockpile back to the sea, turbidity and turbulence must be minimized by directing the outflow onto a boulder bed thereby reducing the velocity to an acceptable level.

7.2.2.3 Embankment Formation

During the embankment formation, the following mitigatory measures shall be taken.

i) Improvement of 48 kilometers of roads (excluding A3) 33 kms tarred road and 15 km of gravel road with corrections to geometry and shoulders. (Fig. 5.11)

ii) Inventory of house and property will be obtained along the routes where material is transported in order to assess and compensate any damage caused due to frequent travel of project machinery.

iii) The following structures identified along the road network should be repaired or rebuilt.

8 Nos. Culverts to be rebuilt
2 Nos. Culverts to be repaired
3 Nos. Minor bridges to be rebuilt.
2 Nos. Minor bridges to be repaired

iv) A Special Road Maintenance unit will be formed by RDA to maintain these roads and structures where sand gravel aggregate and other construction materials are transported. While transporting gravel, sand and other materials in dump trucks, they will be covered with tarpaulin to avoid any dispersion of dust to the atmosphere.

v) If asphalt concrete and ready mix concrete are purched from existing sources, the impacts due to increased production will be marginal. Any new plants installed will have dust collector and sprinkler systems incorporated so that impacts will be low.

The proposed site for these plants is indicated in Fig. 5.3

vi) Traffic wardens will be employed on the roads and detour sections to control traffic so that no nuisance or inconvenience is caused to the general road users from heavy construction machinery and vehicles.

vii) Hoarding and fencing will be erected where construction work is carried out close to population areas and crossings with existing roads.

7.2.2.4. Mitigatory Measures for Pollution Caused by Construction Machinery

Proper management within the construction site can eliminate much of the pollution caused by construction machinery. Specifically, the following management practices shall help in stemming the pollution related to construction practices;

i) Collect and take away all the spent lubricants / hydraulic fluids that get produced at servicing.

ii) Introduce a system where worn tyres, tubes and any other discarded parts are returned to a central warehouse for proper disposal.

iii) Assigning an officer to be responsible for keeping the construction site free of debris.

7.2.2.5 Aggregates - Quarry Operation

Although the quarries identified are in operation at present it is necessary that the following mitigatory measures are ensured.

i) Controlled blasting will be carried out to minimize dust emissions, noise and vibration impacts. In addition sprinkler system will be installed to further minimize dust emissions due to blasting and vehicle movement.

ii) Damage to houses and property etc. will be minimized when transporting material by avoiding roads which run through densely populated areas wherever possible.

iii) In transporting material, vehicles will be covered with tarpaulin or other type of covering.

iv) Quarry operations will be limited to daytime.

v) Quarry operations will be carried out so that no stagnant pools of water will be present within the quarry.

7.2.2.6 Gravel Borrow Areas

The same mitigatory measures stipulated for aggregate quarry operation will be adhered to.

7.2.2.7 Mitigatory Measures During the Construction Phase for Air, and Noise Pollution, Accidents and Health Impacts.

a) Air Pollution

- All the equipment used in the construction will comply with the emission standards specified by CEA regulations
- Exhaust pipes of the equipment will be directed upwards.
- Vehicle emission levels will be checked every three months.
- Air pollution control equipment will be installed and operated at asphalt and concrete batching plants.

b) Local Dust and Noise

- Water will be sprinkled periodically on the temporary roads
- Mufflers will be installed and maintained on machinery and equipment
- Sound proof enclosures will be used for equipment emitting sound at levels higher than the CEA standards.

c) Accidents

Construction materials will be transported during off-peak hours.

d) Adverse health impacts

- Proper management within construction sites
- Close supervision by Public Health Inspectors (PHI), RDA could temporarily engage the services of qualified Health Inspectors to identify potential breeding places.
- Use of protective clothing for labourers who come into contact with infected water in the marsh (Vide 7.3.2.2)

7.2.2.8 Mitigatory Measures for Ecological Impacts

Mitigatory measures for significant impacts on ecological resources during the construction stage as well as the operational stage of the CKE are considered below:

Marsh

About 1.5% of the existing extent of the Muthurajawela marsh will be taken up by the expressway. Further depletion could occur if new access roads to the project area are constructed. Therefore existing roads will be used for transporting materials, without constructing any new roads.

Oil spilling from construction machinery as well as materials such as cement and asphalt can harm the fauna and flora, (especially the aquatic forms) in the vicinity of the trace. This will be mitigated by adopting measures given in sub section 7.2.2.4.

The CKE embankment will divide the populations of terrestrial animals which cannot fly, such as small mammals, reptiles, amphibians, land snails, and certain arthropods. Many of these animals will clamber up the sides of the embankment and cross the expressway thereby facing the risk of being run over. Amphibians which breed in the Old Negombo canal will find themselves on the "wrong" side of the expressway during the breeding season. However, the culverts that will be constructed at regular intervals for hydrological requirements, will serve as "through passages" for these animals.

Trees such as *Cerbera manghas* (gon kaduru) and *Pandanus odorotissimus* (wetakeiya) will be grown on either side of the embankment. These trees are fast growing and will serve as noise and dust barriers, and also provide sheltering and nesting places for birds and other animals.

Canals and Streams

A short segment of the Old Negombo canal between Naiduwa and Pillewa will be obliterated by the CKE. The flow of water in the canal will not be obstructed if mitigatory measures suggested in sub section 7.2.1.1 are implemented.

Another segment of the Old Negombo canal 1.8 km in length, will be isolated by the CKE crossing over to the west of the canal south of Jayasooriya road and again to the east side, north of it, in order to avoid a populated area. The isolated canal segment will be connected to the main canal to prevent stagnation of water, and the continuous flow of the canal will be established by measures proposed in sub section 7.2.1.2

Engine oil, cement and asphalt may fall into the canals, streams and the lagoon during the construction stage. Measures given in sub section 7.2.2.4 should be implemented to avoid such spillage and constant monitoring is necessary to minimize harm to aquatic flora and fauna. During the operational stage, pollutants generally associated with motor traffic such as lead, copper, manganese, cadmium and engine oil will inevitably enter the canals, streams and lagoons by way of surface run off after rain. Relevant Mitigatory measures are given in sub section 7.3.2.2

Brackishwater Swamp

Eight hectares of mangroves will be destroyed by the CKE (2.3 % of the existing total extent around the lagoon). This impact can be offset to some extent by growing mangrove species such as *Dolichandrone spathacea.. Bruguiera gymnorhiza, Sonneratia caseolaris* and *Excoecaria agallocha* on either side of the road embankment where the CKE traverses the swamp.

The Lagoon

During the construction stage, disturbances will occur in the lagoon along the trace and on either side of it (possibly upto 15 m). Turbidity caused will make the sea grasses perish and the fish and crustaceans are likely to move away from the vicinity of the trace during the construction of the embankment. Once the construction process is over, the seagrasses are likely to recover.

The portion of the lagoon which is cut off by the CKE situated between itself and the mainland will be connected to the main body of the lagoon by way of passages built across the embankment, large enough for fishermen's boats to pass through as recommended in sub section 7.3.2.1. These passages can serve as access points to juvenile fish and crustacean larvae that use the sea grass beds for feeding and sheltering.

The Muthurajawela Visitor Centre (MVC)

Impacts on the MVC can be mitigated in two ways. In the first, a number of mitigatory measures are proposed to be adopted so that the MVC can continue to function at least with some degree of attraction to the visitors.

The measures are described below :

Alternative 1

1) The possible severance by the trace, of the main building of the MVC from the nature trail zone will be offset by constructing an overhead foot bridge across the embankment. This will be constructed prior to the commencement of work on the stretch of the CKE running through the MVC premises.

2) During the construction of bridges across Nonage ela and Dandugam oya, boat trips operated by MVC will either have to be suspended or operated from a point on Nonage ela to the west of the bridge site. If boat trips are suspended, the MVC will be compensated for use of income from this source during this period. If the other option is favoured by the MVC, cost of construction of another pier and foot paths leading to it will be borne by the RDA.

3) Adequate funds shall be provided for the relocation of the model huts.

4) The MVC will be shielded from noise generated by machinery and the dust resulting from construction activities. A high fence will be erected on either side of the road corridor along the entire length of the trace passing through the MVC premises and the fence be clad with suitable material to act as a dust and visual screen before any construction activity commences.

5) During the operational stage it is essential to have artificial noise barriers on either side of the segment of the expressway passing through the MVC premises. In addition, selected trees such as *Pandanus* sp. and *Accasia* sp. adapted to the ground conditions will be grown on either side of the embankment to serve as a noise, dust and visual screen.

Even after the adoption of the measures given in the alternative 1 above, it is unlikely that anything like the peace and tranquillity one expects for a communion with nature will be restored. Therefore the following alternative is given and strongly recommended.

Alternative 2

This proposes a radically different method of mitigation. It is clear that no amount of in situ mitigation is going to eliminate completely the impacts on the MVC. Therefore the logical alternative is to shift the MVC away from the CKE to a new site and avoid the adverse impacts altogether.

For this purpose it is proposed that a suitable site is located by the WCP in collaboration with the DWLC. The selected site must be accessible to the visitors and must have easy access to the canal system so that boat excursions can take place. Once the site is identified, the land can be ceded to the WCP by the DWLC. RDA will construct the new MVC building, the boat pier etc. according to the plans drawn by the WCP. New nature trails can be laid by the WCP.

This alternative has several desirable features which merit its adoption :

1) The MVC will be in its own premises rather than being housed in a leased building as now.

2) MVC will be able to design the premises and the buildings to suit its requirements.

3) There will be no disruption owing to the CKE construction activities. After the CKE is commissioned, the improved access will attract more visitors.

4) The peace and tranquillity which is a sine qua non for the MVC can be attained here: no amount of mitigation is likely to restore it in the alternative 1.

Therefore the adoption of alternative 2 is strongly recommended.

Light Pollution

Street lamps will be designed so as to illuminate the expressway without the light straying upwards or sideways. This would minimize any adverse impacts of light on fauna at night.

Borrow Sites and Transport of Material

Ecological impacts on borrow sites and transport of material have been considered and mitigatory measures recommended in sub section 7.2.2.2

Stockpile Area

The stockpile area is located on 40 ha of the marsh in Kerawalapitiya . The sites have been earmarked by the SLLRDC for development irrespective of their use as stockpile areas. The major ecological impact which can result from sand mixed with sea water pumped to this site is the seepage of salt water into the surrounding marsh. Preventive measures have been recommended in sub section 7.2.2.2.

7.2.2.9 Mitigatory Measures for Socio- economic Impacts

a) Alternative transport links will be provided until permanent links are restored.

b) Noise impacts will be reduced during the construction phase by erecting sound barriers in populated areas.

7.3 Mitigatory Measures Related to Operation

7.3.1 Mitigatory Measures for Socio - economic impacts

a) Air Pollution

The CKE will pass through some areas of human habitations and birds habitats such as Peliyagoda, Hunupitiya, Kerawalapitiya and Muthurajawela. Air pollution due to vehiclular emissions should be reduced with following mitigatory measures;

Design the speed level of CKE on appropriate levels to reduce the emission levels.

Install and operate monitoring equipment at selected locations along the CKE.

b) Noise Pollution

Noise pollution from vehicle operations will be felt mostly in populated areas traversed by the CKE. In such places sound barriers will be installed to mitigate the noise impact.

c) **Accidents**

All road crossings will be maintained upto proper standards and well illuminated.

On the CKE the following measures taken to minimize accidents :

- Provision for markers on the road
- Provide of hard shoulders for emergency stopping
- Provide of emergency calling equipment
- Formulation of special operational rules for hazardous material transport and emergency plans to contain damages from accidental spills.

7.3.2 Mitigatory Measures for Hydrological Impacts

7.3.2.1 Mitigatory Measures for Flood Impacts

The following mitigatory measures are proposed for the hydrological impacts :

- Making the bridge span sufficiently large so as to avoid upstream inundation. This will be attended to at the detailed design stage.

- In the area between Mahabage and Ja ela, a number of suitable openings will be placed to drain the upstream inflow across the expressway embankment.

- In the area north of Ja ela, lateral canals connecting with Mahadora ela will be provided with large openings across the CKE. Where navigable canals are crossed, they will be provided with sufficiently large openings for the fishermen to take their fishing crafts across.

- In the stretch of the CKE taken through the lagoon, two underpasses shall be constructed, each large enough for small fishing boats to sail through.

- In the area between Peliyagoda and Hunupitiya, where the CKE traverses a number of marshes, a continuous drainage canal will be provided along the eastern toe of the embankment with sufficient number of openings provided at suitable places to discharge the inflow intercepted by the drain across the CKE. The number and the positioning of these openings will be decided at the time of the final design.

7.3.2.2 Mitigatory Measures for Water Quality

As discussed before, impact on water quality is not serious. However, the presence of the ecologically important habitats of Muthurajawela marsh and the Negombo lagoon compels special attention to the measures to prevent pollution.

Following measures are suggested to mitigate the effects of pollution;

- Declare the expressway as a non-littering zone and prohibit throwing of litter from moving vehicles. Give publicity to the concept of litter free zone by media campaigns, billboards etc. Impose and enforce a system of fines as deterrent. Collect and dispose litter that is still thrown, in designated disposal areas separated by type and recycle where possible.

- Enforce an effective sweeping programme and remove the sweepings to designated disposal areas.

- Lead away the runoff from paved areas to wet or dry ponds or wetlands created at intervals by the roadside and release after a 24 hour detention. This will remove much of the pollutants from the runoff. The ponds or the wetlands will be inspected and maintained on a regular basis to keep them functioning at optimal levels of efficiency. The ponds will be planted with local reeds to remove pollutants.

  To prevent the mosquitoes from breeding in these ponds, the detention times have to be properly designed to avoid prolonged stagnation. At the periodic inspections, if mosquito larvae are discovered, the ponds will be drained.

  In addition to the above measures, runoff in the road stretch lying within the Negombo lagoon, will be collected by a suitable drain system to be directed to land and then sent through a system of ponds for the removal of pollutants. No runoff from the paved area will be allowed to enter into the lagoon directly.

CHAPTER 8

PROPOSED MONITORING PLAN

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PROPOSED MONITORING PLAN

8.1 Composition of the Committee

Monitoring programme shall be administered by a monitoring committee appointed by the CEA before the implementation of the project. The monitoring committee shall comprise experts/representatives from the following agencies:

- CEA : Chairman of the monitoring committee
- SLLRDC
- DWLC
- Wetlands Project
- ID
- An NGO representing wildlife/ornithology/environment
- NHDA
- UDA

In addition, the representatives from the following agencies will serve as short term members for the duration of offshore dredging:

- CCD
- Sri Lanka Ports Authority (SLPA)
- NARA
- Ministry of Fisheries and Aquatic Resources (MFAR)

The Chairman will co-opt other specialists for advice as required for specific issues.

8.2 Mode of Operation

The monitoring committee shall meet monthly or at such other interval as decided by the committee.

The Project Proponent (PP) shall appoint a senior officer of rank not less than a Deputy Director to liaise with the committee. He shall be empowered to furnish any material information regarding the project. He will also facilitate the committee to function by arranging meeting venues, providing for inspections and getting access to any relevant information etc.

The PP will bear all the costs of surveys, measurements, reporting and any other cost associated with monitoring. Where any measurement of specialised nature needs to be carried out, the PP will engage such a consultant acceptable to the committee to carry out the measurement.

At the outset, the PP will deposit a sum of money with the CEA, as determined by the latter, to meet incidental expenses, pay for any tests which may become necessary and to pay an honorarium to the members.

8.3 Monitoring Plan

Major points to monitor are given below. The monitoring committee may modify this plan from time to time if or when it deems necessary. For example it can terminate monitoring of an impact after it has become stabilised or effectively mitigated or initiate new monitoring measures for unforeseen impacts or increase the monitoring frequency for an impact found to have serious consequences.

8.3.1 Monitoring of Land Acquisition and Resettlement Process

1. Re-settlement programme 1	
Frequency and Duration of Reporting	Reported once, before commencement
Prepared by	PP
Format and Contents	Socio-economic survey of all the families along the trace. Maps showing location of houses and other buildings.
Evaluated by	NHDA, UDA

2. Re-settlement programme II	
Frequency and Duration of Reporting	To commence before any land acquisition and to continue monthly, until the re-settlement programme is complete.
Prepared by	The special land acquisition and resettlement unit setup within the PP
Format and Contents	• Textual supported by maps. • Census data obtained by the Survey. • List of householders to be relocated with the following details: i) Status of relocation. ii) Places of origin and destination. iii) Amount and the status of compensation payment. • Status of completion of new houses being built. • Maps and site plans of re-housing areas.
Evaluated by	NHDA, UDA.

3. Land acquisition	
Frequency and Duration of Reporting	To commence before any land acquisitions and to continue monthly until all compensation is paid
Prepared by	The special land acquisition and resettlement unit setup within the PP
Format and Contents	• Map of the corridor with properties marked in different colours according to the status of acquisition and payment of compensation. • Map of the 30 m reservation with properties marked. • List of properties prepared for different categories above. • List of delayed compensation payments prepared indicating the period of delay, the reasons for the delay and estimated date for payment. This list shall be in the descending order of delay, i.e., with the most delayed payments at the top.
Evaluated by	NHDA, UDA

8.3.2 Monitoring of Offshore Dredging for Sand

1. Faunal survey of the borrow area	
Frequency and Duration of Reporting	Once, before the commencement. (Only if considered necessary by the committee)
Prepared by	Specialist diver recommended by NARA, engaged by the PP
Format and Contents	Textual report giving a description of all the fauna found in the borrow site, supported by maps
Evaluated by	NARA, MFAR

2. Dredging	
Frequency and Duration of Reporting	Fortnightly for the duration of dredging,
Prepared by	Specialised dredging contractor
Format and Contents	Graphical report depicting on a borrow area plan, the lines and the depths of dredging and the date of dredging. The map must be based on the instrumentation aboard the dredger such as sonar and global positioning system
Evaluated by	CCD, SLPA, NARA

3. Status of anchorage and pipelines	
Frequency and Duration of Reporting	Fortnightly until the dredging operations are completed
Prepared by	PP
Format and Contents	Textual report describing the condition of anchors, chains, floating, submerged and on-land pipelines, their couplings, flanges, any leakages, marking buoys, warning lights etc.
Evaluated by	CCD, SLPA

4. Clearing after operations	
Frequency and Duration of Reporting	Within a month after the dredging operations are terminated
Prepared by	PP
Format and Contents	Textual report, supported by maps. This shall describe the status of clearing the sites affected by the dredging/pipe laying operations, whether any items have been carelessly left behind etc.
Evaluated by	CCD, SLPA

8.3.3 Monitoring of Sand Stockpiling

1. Site preparation	
Frequency and Duration of Reporting	Prepared before commencement of stockpiling
Prepared by	PP
Format and Contents	• Contour map(s) of the stockpile area(s) and the surroundings including all the drainage paths at 1:1000 scale. • Plan of the isolation bunds for the stockpile area(s), internal drainage path, location of the evacuation pump, preparation of the sump and the path of the exit pipeline. • Calculations of pumping out of sea water with pump capacities taking into account different heights of the sand pile
Evaluated by	ID, SLLRDC

2. Surface and ground water salinity and water logging	
Frequency and Duration of Reporting	Sampling to commence two weeks before the operations begin to establish the existing salinity levels. Daily samplings while the pumping operations continue; fortnightly after the operations cease, for one year. May be terminated sooner if all the samples revert to the values prior to the operations.
Prepared by	PP : water samples to be tested at a laboratory acceptable to the committee
Format and Contents	• *Sampling points to be indicated on a large scale* (1 : 10,000) map of the area with code numbers given to each sampling point. • *Tabulated salinity values for the sampling points* for each sampling, giving date and time. • Graphical display of salinity values for each *sampling point as a graph of salinity against time* to show the build-up and dissipation of salinity. • Salinity value isolines for surface and ground *water marked on the map* • Textual report on depths and periods of inundation at points of reference established to *warn of water logging*
Evaluated by	ID, SLLRDC

8.3.4 Monitoring of Hydrological Impacts

1. Re-alignment of Old Negombo Canal	
Frequency and Duration of Reporting	At the design stage and after completion
Prepared by	Design office of the PP
Format and Contents	• Complete geometric and structural design with data for the re-alignment of the Old Negombo canal near Nai duwa and near Kalaeliya, showing all the important topographical features • As-built drawings with photographs
Evaluated by	ID, SLLRDC, Wetlands Project, DWLC

2. Flood Mitigation	
Frequency and Duration of Reporting	At the design stage
Prepared by	Design office of the PP
Format and Contents	• Detailed flood routing calculations for the three major bridges of the CKE • Details of all the drainage openings provided across the CKE • Details of other flood relief measures proposed such as upstream toe drains etc.
Evaluated by	ID, SLLRDC

8.3.5 Monitoring of Air, Water and Noise Pollution During Construction

1. Construction activities of CKE	
Frequency and Duration of Reporting	Weekly at sensitive locations; fortnightly at other locations; spot checks on request by affected parties
Prepared by	CEA : For CEA to carry out this monitoring, the PP shall make available a four-wheel-drive vehicle fitted with the following equipment - • Air sampling equipment for pollution and particulate matter • Water sampling equipment • Decibel meters • Video and photographic camera CEA will use this mobile unit only for the monitoring work on CKE during construction and operation
Format and Contents	• Sampling points to be shown on a large scale map of the corridor. Code numbers must be given to each sampling point. The code number must easily indicate the particular locality • Tabulate the air-borne dust, air pollution, and noise values observed as appropriate indicating the date and time • Tabulate the water quality parameters tested with a description of the type of water body it was taken from, eg. stagnant pool, drain, well etc.
Evaluated by	CEA

2. Quarries and gravel pits and hauling	
Frequency and Duration of Reporting	Fortnightly until the quarrying and borrowing operations cease
Prepared by	PP and CEA using the mobile unit
Format and Contents	• Operation times of quarries/gravel pits (PP) • Air-borne dust sampled • Noise levels observed • Complaints from the residents around the quarries/pits and the haul roads about nuisance and damage. Structural damage must be established by inspection. (PP) • Stagnation of water at site (PP) • Observance of dust abatement measures (PP) • Surface condition of the haul roads (PP) • Congestion on haul roads and measures of traffic management (PP)
Evaluated by	CEA

CHAPTER 9

CONCLUSIONS AND RECOMMENDATIONS

CHAPTER 9

CONCLUSION AND RECOMMENDATIONS

Existing links between Colombo and Katunayake for passenger and goods transport is overstrained beyond capacity for road links and inadequate in the case of railway. The western part of Gampaha District is one of the rapidly expanding residential and industrial areas. It contains the nationally important BIA and several key national security installations. A high speed link between POC and BIA is important for the benefit of the national economy. The existing links are unable to meet even the current demand, let alone the projected demand for the future. Hence the need for a high speed link.

For improving the transport links, several reasonable options were considered in this study. They included two alternative traces for an access-controlled expressway, improvements to the existing A3 road, improvements to the railway and the no action option . However the last option could be easily discounted as even at present, the transport links between the two areas are inadequate. It was demonstrated that the railway improvement cannot serve as a reasonable option unless a concurrent upgrading of the entire national rail network can be undertaken. Without such an improvement a shift of use from roads to railways cannot be expected.

The existing A3 road has unlimited access and runs through a highly populated area. If this is to be improved to cater to the projected traffic loads, it will be necessary to widen it and effect at least partial access control measures. Both these exercises would be impossible without concomitant social impacts of such magnitude as to make them unacceptable. Even after such improvements, the A3 road would not meet the requirements of a high speed link..

Only the expressway option with its two alternative traces remain to be considered. These alternatives can be compared succinctly as follows:

Eastern Trace	Western Trace
About 1500 houses to be demolished.	About 130 houses to be demolished and a further 60 houses to be acquired.
Cost : Rs. 20 billion.	*Rs. 5 billion*
Ecological Impacts : Traverses already disturbed areas.	Runs along the edge of the Muthurajawela marsh and a part of the Negombo Lagoon. However the area affected is small (less than *3% of the combined total)*
Hydrological impacts : Moderate.	**Low**
Benefit cost ratio : 7.3	**21.5**
Economic Internal Rate of Return : 38%	63%
Community severance : high as this is taken on a high embankment through densely populated areas.	Low, as this is mainly taken along marshes.
Visual amenity : Highly intrusive	Less intrusive

A comparison of the impacts of the two traces shows that the Western trace costs substantially less, has lower hydrological impacts and less social impacts. During the operation stage this trace will cause no damage to Muthurajawela Visitor Centre. As the trace runs close to sensitive areas the ecological problems that can crop up can be mitigated by adopting suitable measures.

Construction of the CKE requires the commitment of resources. Of physical resources committed, the construction materials used - sand, aggregate and gravel are locally quarried and are not in short supply. The commitment of these is irreversible, but as they are abundantly available and the project is essential, it cannot be termed as a deprivation of another sector.

In this study, the need for a high speed transport link between Colombo and Katunayake was established. Out of the four build options, the western trace was the preferred option on the basis of impacts and economic performance. Evacuation and resettlement increases social vulnerability because it disrupts established communities, families and kinship groups. Therefore the trace which disrupts the established pattern to a minimum was selected. The significant environmental impacts of this option was examined in detail and measures to mitigate the adverse impacts were suggested. A monitoring programme was prepared to be adopted during implementation.

Therefore in conclusion the study recommends the western trace of the CKE with the adoption of the mitigatory measures and the monitoring programme.

TERMS OF REFERENCE FOR THE PREPARATION OF THE ENVIRONMENTAL IMPACT ASSESSMENT REPORT FOR COLOMBO - KATUNAYAKE EXPRESS HIGHWAY PROJECT

OUTLINE OF EIA REPORT :

1 Executive Summary
2 Introduction
3 Description of project
4 Evaluation of alternatives
5 Existing environment and site description
6 Anticipated environmental impacts of the recommended alternative/s
7 Measures to mitigate or manage environmental consequences
8 Proposed monitoring plan
9 Conclusion and recommendations

Annexes

i Sources of data and information
ii List of preparers, qualifications, experience etc.
iii Comments made by affected people, public, NGO and other agencies during the scoping sessions conducted by EIA study team.
iv List of contacts
v Bibliography : A list of references should be presented including all references cited in the EIAR.

1 EXECUTIVE SUMMARY :

This should be a brief non-technical summary of the proposal including a brief but concise description of its nature, size and location, description of environment including physical, ecological resources, anticipated environmental impacts, alternatives, proposed mitigatory measures and recommendations.

2 INTRODUCTION

2.1 Purpose and scope of the EIA Report

2.2 Methodology used in the preparation of the EIAR

2.3 Existing transportation systems between Colombo and Katunayake, highlighting significant limitations.

2.4 Conformity to Urban Development Plans, Highway Development Plans.

3 DESCRIPTION OF THE PROPOSED PROJECT

3.1 Aim and Scope of the Project

3.2 Justification of the Project

3.3 Nature of the Project

A comprehensive description (essentially salient information on the project at a degree of *detail comparable to that presented in a feasibility level engineering report) of all* components of the project including location, general layout, size, pre-construction activities, construction and operation activities, time schedule, staffing and support facilities, technologies, inputs of energy and materials. Illustrative figures and tables should be used as needed. Drawings at appropriate scale where necessary could be used. A project layout plan should be provided including the road stretch on a scale of 1 : 50,000

This section should also include the construction programme (Timing and duration of all *project activities from preconstruction to full operation.), methodology of construction* (Land clearing, excavation, earth moving, removal of vegetation and construction of bridges / culverts etc., sources and quantities of raw material including soil, sand and metal, land based fill material, sources, quantities and methods of transport), operation and maintenance, financial commitments.

4 EVALUATION OF ALTERNATIVES

Describe the primary and secondary alternatives that were examined in the course of developing the proposed project which would achieve the same objectives. The concept of alternatives extends to siting, design, technology selection, construction techniques and phasing, operating and maintenance procedures. Compare the alternatives in terms of potential environmental impacts and suitability under local conditions associated with each alternative. When describing impacts indicate which are irreversible or unavoidable and which can be mitigated. The basic environmental, engineering and economic parameters and criteria including methodologies used in the investigations and evaluation of alternatives should be stated under this section.

Environmental (extended) cost, benefit analysis.

Environmental costs and benefits arising out of the proposed project and recommended alternatives should be discussed. The extended cost - benefit analysis should be performed through the following steps :

1) Financial plan
2) Detailed cash flow of the recommended alternatives.
3) Financial and economic cost / benefit analyses for the evaluated alternatives
4) Incorporation and valuation of environmental impacts identified in the EIAR, using appropriate environmental valuation techniques to the extent possible.
5) Presentation of extended cost - benefit analysis by incorporating environmental valuations into economic cost benefit analysis.

On the basis of the comparison and evaluation, one or more alternatives should be recommended for further assessment. This section should also include the reasons why other alternatives were rejected in preference to the one/s recommended.

The " no action " alternative ie. if this development does not proceed, and its consequences should be explained in order to demonstrate environmental conditions without the project.

5 EXISTING ENVIRONMENT AND SITE DESCRIPTION

This section should provide a concise description of the social, economic and environmental setting of the areas that have a high likelihood of being significantly impacted. Additionally, any other aspects that are known or expected to be of concern to the public and /or the PAA should be identified and discussed under this section. The characteristics and data as well as any other pertinent information on the areas likely to be impacted and the impacts that would be addressed in Section 6 must be provided in this section. Such data should include, but not be limited to, the following :

Note : Presently available information could be utilised at all stages of report preparation. The environmental profile of the Muthurajawela Marsh and Negombo Lagoon (Greater Colombo Economic Commission 1991) Master Plan of Muthurajawela and Negombo Lagoon (Greater Colombo Economic Commission 1991) and Conservation Management Plan for Muthurajawela Marsh & Negombo Lagoon (WCP /CEA October, 1994) and associated surveys contain most of the information called for in this section.

5.1 Physical Environment

- Hydrology of the area including water balance
  Present storm water drainage patterns and drainage capacity of adjacent drainage channels including Old Dutch canal, Hamilton canal, Kalu-oya, Ja Ela and Dandugam oya. Present flood discharge and available flood detention in the Old Dutch canal and surrounding marshes.
  Flood water levels with respect to MSL and flood problems in the area.
- *Flood peak values and retention areas.*
- List of existing irrigation or flood protection schemes encountered. *
- Present uses of surface water /s including water supply intakes.
- Surface water quality of the water bodies along the trace.
- General geology of the area (using one inch geological maps) *
- Mineral resources (utilised & potential). *
- *Present land use pattern along the project area.* *
- Current development trends and growth (both planned and unplanned).

If fill material is to be obtained from offshore, for the purpose of describing the existing environment the project area will be described to include the borrow areas, transportation routes and the access area to the pipe line.

- A hydrographic survey of the borrow area, indicating coral reefs / seagrass beds (if any)
- Representative bottom sampling and grain size diameter of sea bed within the borrow area
- Location /hydrographic detail at mooring buoy / booster station
- Hydrographic detail of the pipeline access, with specific detail of trace in the vicinity of the near -shore reef
- Assessment of existing level of fishing activities
- Survey of marine fauna and flora

5.2 Ecological Resources

- Special characteristics of the project area and its vicinity eg. marshes, lagoons, reservations and other areas of ecological sensitivity. *
- Forest and other protected areas should be marked on a map (scale 1: 50,000) *

5.3 Socio - Economic Aspects

- Concise socio - economic profile of the area
- Existing infrastructure facilities
- Existing settlements and other land use forms *
- Demographic characteristics
- Social infra - structure
- Housing (numbers and socio -economic status)
- Communication facilities
- Water supply and sanitation sources
- Agricultural pursuits
- Existing air quality, noise and vibration levels along the road trace and vicinity concentrating on specific areas such as schools, hospitals etc.
- Relocation sites (alternative sites available) *
- Capacity of the existing roads and traffic loads, special reference should be given to the points at Kelaniya Bridge site and Katunayake.

5.4 Archaeological and cultural consideration

- Recognised archaeological and culturally important areas, their status and conservation programmes if any. *

- To the extent possible maps at appropriate scale should be provided in EIAR.

6 ANTICIPATED ENVIRONMENTAL IMPACTS OF THE RECOMMENDED ALTERNATIVE/S.

In this section, show the overall effects on the total ecosystem of the area as well as address the impacts on the individual environmental components. Identification of impacts should be on the following basis:

- Impacts related to project location,
- Impacts related to project design,
- Impacts related to construction activities,
- Impacts related to operational activities.

Impacts should include the foreseeable direct and indirect, long and short term effects. Any irreversible and irretrievable commitments of resources should be identified. In all cases where an assessment is made, the criteria which has been used to assess the impacts should be stated clearly. Where possible impacts should be quantified and uncertainties highlighted. Bases of predictions should be justified. At the end of this section, provide an overview or synthesis of how the project will interact with the total eco-system and its elements.

7 MEASURES TO MITIGATE OR MANAGE ENVIRONMENTAL CONSEQUENCES

This section should propose measures to minimize the impacts identified in Section 6. This should also outline the effectiveness of the proposed measures that are to be provided.

8. PROPOSED MONITORING PLAN

This section should specify the aspects which should be monitored in order to assess the effectiveness of the proposed mitigatory measures and environmental impacts during preconstruction, construction and operational stages of the proposed project. A plan for monitoring the implementation of the measures including parameters to be monitored, coordination efforts with the appropriate agencies and funding needed should be included. The proposed plan should make provision for any continuous post-construction monitoring for assessing the actual environmental impacts of the project and for recommending needed correction measures.

9 CONCLUSION AND RECOMMENDATION

The acceptability of the proposed project and the alternative/s should be analysed and ranked accordingly. The consultants should make a firm recommendation of one of the alternatives based on the above observations.

Section II

NON TECHNICAL REQUIREMENTS

1 The Terms of Reference (TOR) is a guideline underlining the minimum expectations of the Project Approving Agency.

2 A preliminary meeting with the Project Proponent (PP) together with the consultants is expected by the CEA to discuss the methodologies and the TOR. Any suggestions to the TOR is welcome.

3 It is suggested that consultants in the following expertise areas should be included in the EIA Study Team:

Land use Planning
Sociology
Hydrology
Ecology
Coastal Engineering
Transportation Planning
Economics

The consultants are expected to work closely both with the PP and the Design Engineers, and Architects of the project. The EIA is an important phase in the process of decision making on the final shape of the proposed project.

4 After the final document is checked for adequacy by the PAA,15 copies of the English version and 05 copies each of the Sinhala and Tamil versions should be submitted to the PAA. Translations should be undertaken only after the PAA has determined that the report is prima facia adequate.

5 An unbound copy of the original should be submitted to the PAA.

6 The original documents should be submitted duly authenticated by the preparers.

7 The EIA report will be made available for public inspection for 30 days.

[R1]

ANNEXURE II

LEGAL PROVISIONS

National Environmental Act (NEA) No. 47 of 1980 and Amendment

The relevant provisions in the NEA (as amended) are : Parts IV A, IV B and IV C which deal with environmental protection, including environmental protection licence (EPL): environmental quality: and approval of projects, including environmental impact assessments respectively. While an EPL is necessary in order to operate an industrial plant etc., approval to commence a project is necessary under Part IV C. Thus, the provisions in Part IV C require careful attention here.

According to Section 23 AA of the NEA, notwithstanding the provisions of any other law, all prescribed projects that are being undertaken in Sri Lanka are required to obtain approval under the NEA. This provision applies in relation to all prescribed projects whether they are being undertaken by the government, local authority, company, firm or an individual. Thus, no distinction is made between governmental activities and private activities.

Coast Conservation Act No. 57 of 1981 and Amendment

Similar provisions exist in the Coast Conservation Act of 1981 (amended in 1988). The Coast Conservation Act was the first statute to adopt the EIA and the permit procedure in relation to development activities which fall within the coastal zone. Thus, if any component of the proposed expressway falls within the coastal zone, approval under the Coast Conservation Act would also be necessary. The provisions here are similar to the NEA.

The Road Development Authority Act of 1981

Established to carry out integrated road planning and development of roads within areas designated by the Minister, the RDA enjoys extensive powers under the Act, including the power to acquire and hold any movable or immovable property. Where any immovable property is required to be acquired for the activities of the RDA and the Minister has approved proposed acquisition, that property is deemed to be required for a public purpose and may be acquired under the Land Acquisition Act and be transferred to the RDA (Section 22).

The Urban Development Authority Law 1978

The Urban Development Authority (UDA), established under Law No. 41 of 1978 (amended), was set up to promote integrated planning and implementation of economic, social and physical development of areas declared by the Minister to be development areas. The provisions in this Law is important with respect to the procedure laid down for the acquisition of land.

Under section 16, where any land in any area declared as a development area, is required by the UDA for any of its purposes, such land may be acquired under the Land Acquisition Act by the Government. Such land will be considered to be required for a public purpose. Thus, if any land is required for the proposed expressway which forms part of any development areas under the UDA Law, the procedure laid down in the UDA law will have to be followed.

Urban Development Projects (Special Provisions) Act No. 2 of 1980

This Act provides for the acquisition of lands urgently required for carrying out urban development projects. Section 2 provides that where the President, upon a recommendation made by the Minister in charge of urban development, is of the opinion that any land in any area is urgently required for the purpose of carrying out an urban development project which would meet the just requirements of the general welfare of the people, the President may declare that such land is required for such purpose.

The Greater Colombo Economic Commission Law No. 4 of 1978 (amended by Act No. 49 of 1992)

The BII (previously GCEC, BOI) is in charge of the administration of the Area of Authority and for any development activity falling within this area, the approval of the BOI is necessary. It also lays down provisions relating to the acquisition of land which are similar to those in the UDA Law.

An important provision in the above Amendment Act of 1992 stipulates that no power, duty or function under the NEA shall be exercised, performed or discharged by the Board except in consultation with, and the concurrence of, the CEA established by that Act. Thus, in order to exercise the provisions in the NEA, the BII needs the concurrence of the CEA.

Land Acquisition Act No. 9 of 1950 (as amended)

Section 2 of the Act lays down the procedure to be followed where the Minister decides that land in any area is needed for any public purpose. Notice to the land owners, surveying of such land, objections to such acquisition etc., are laid down in the Act. Lands to be acquired under the UDA Law, the RDA Act and the BOI Act are covered by the provisions in this Act.

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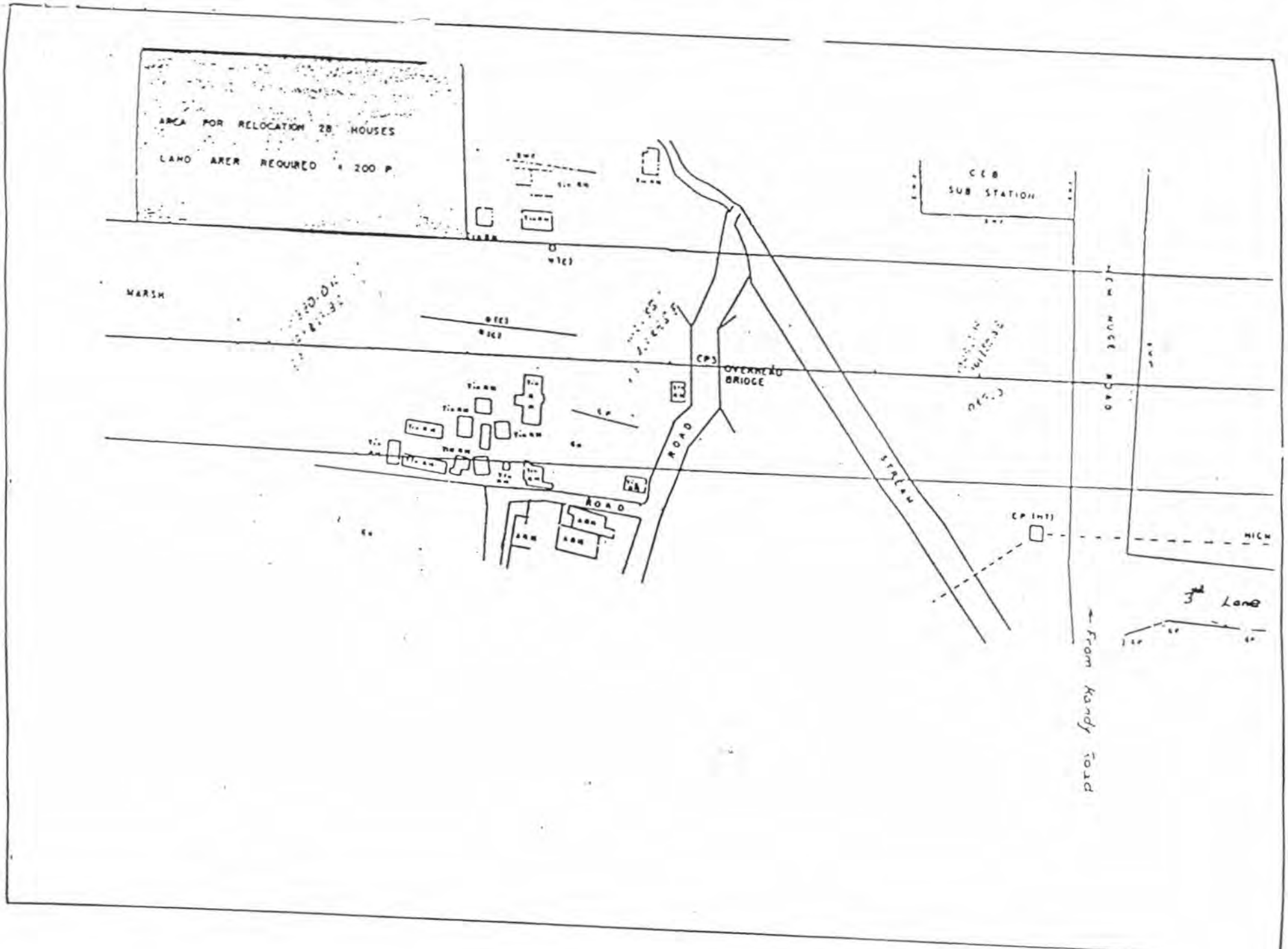
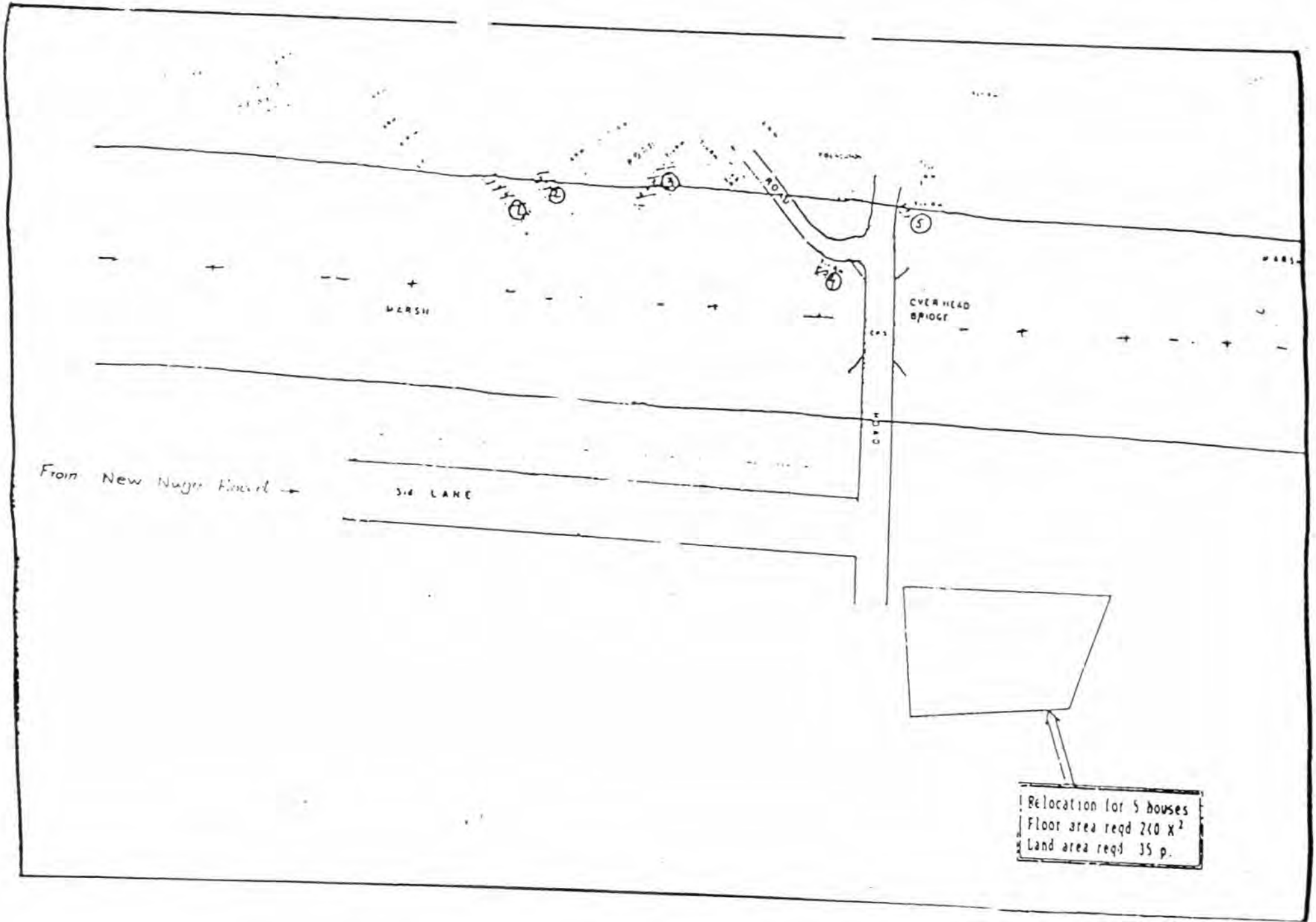
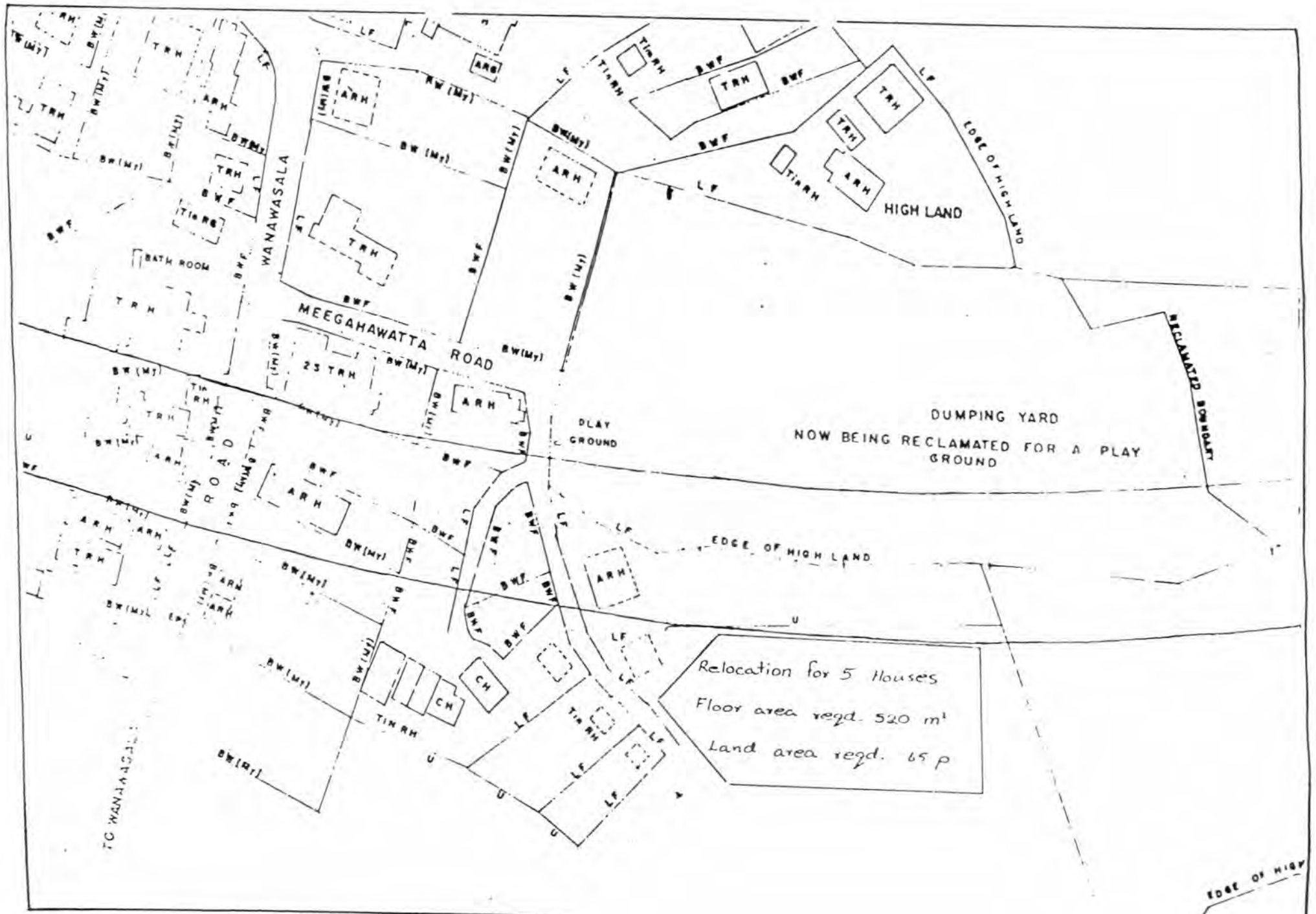
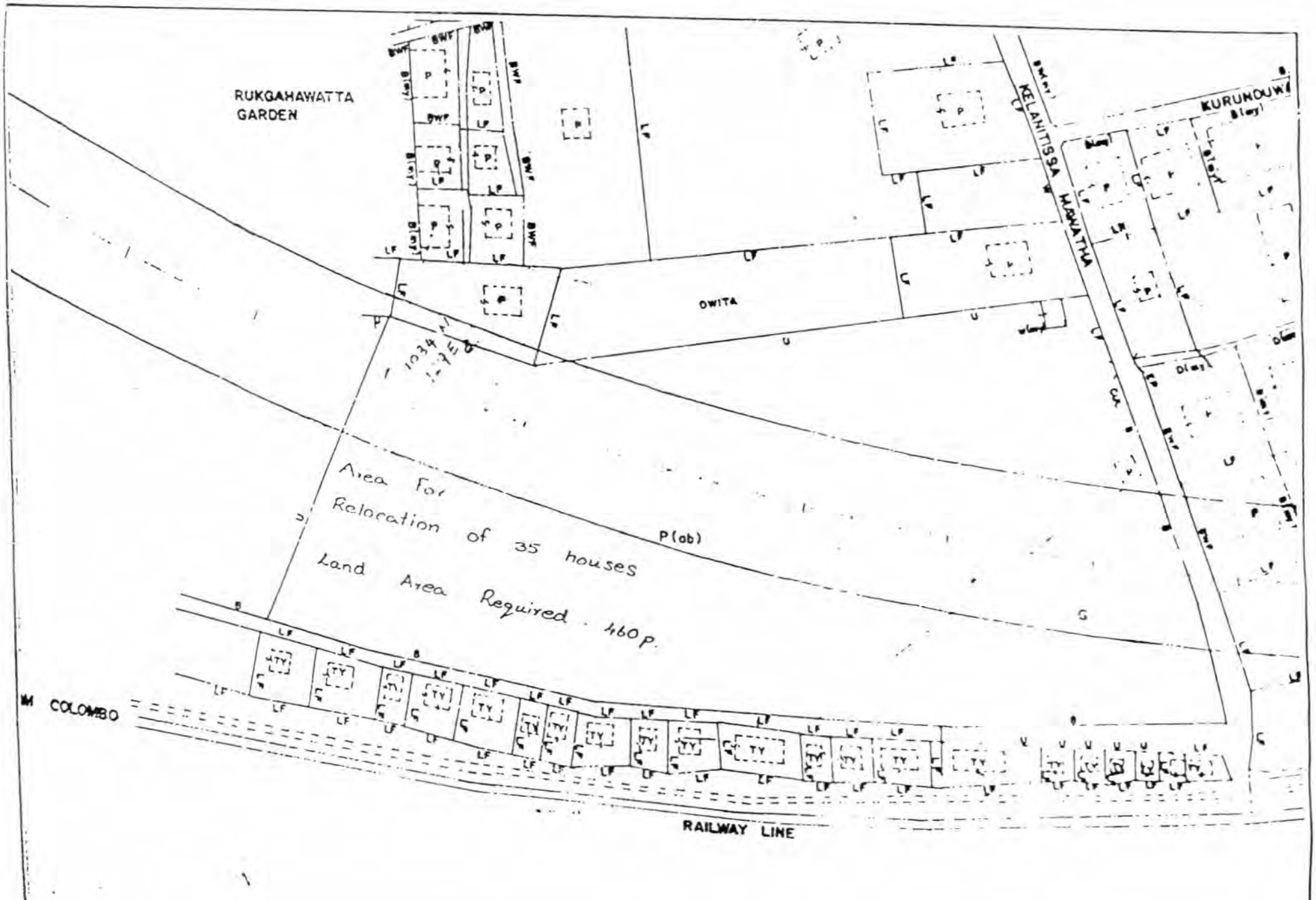
Annexure III

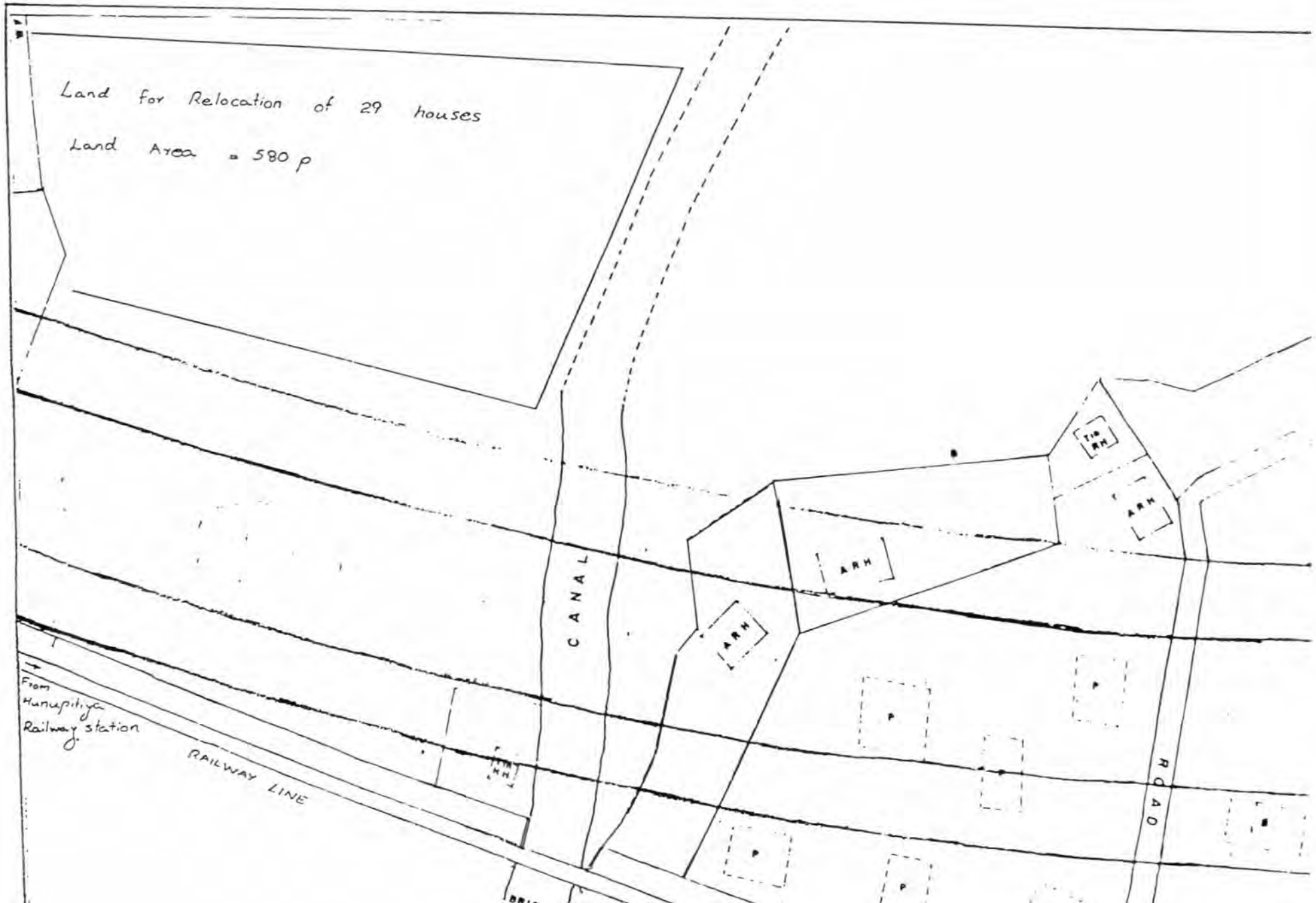
PROPOSED RESETTLEMENT SITES

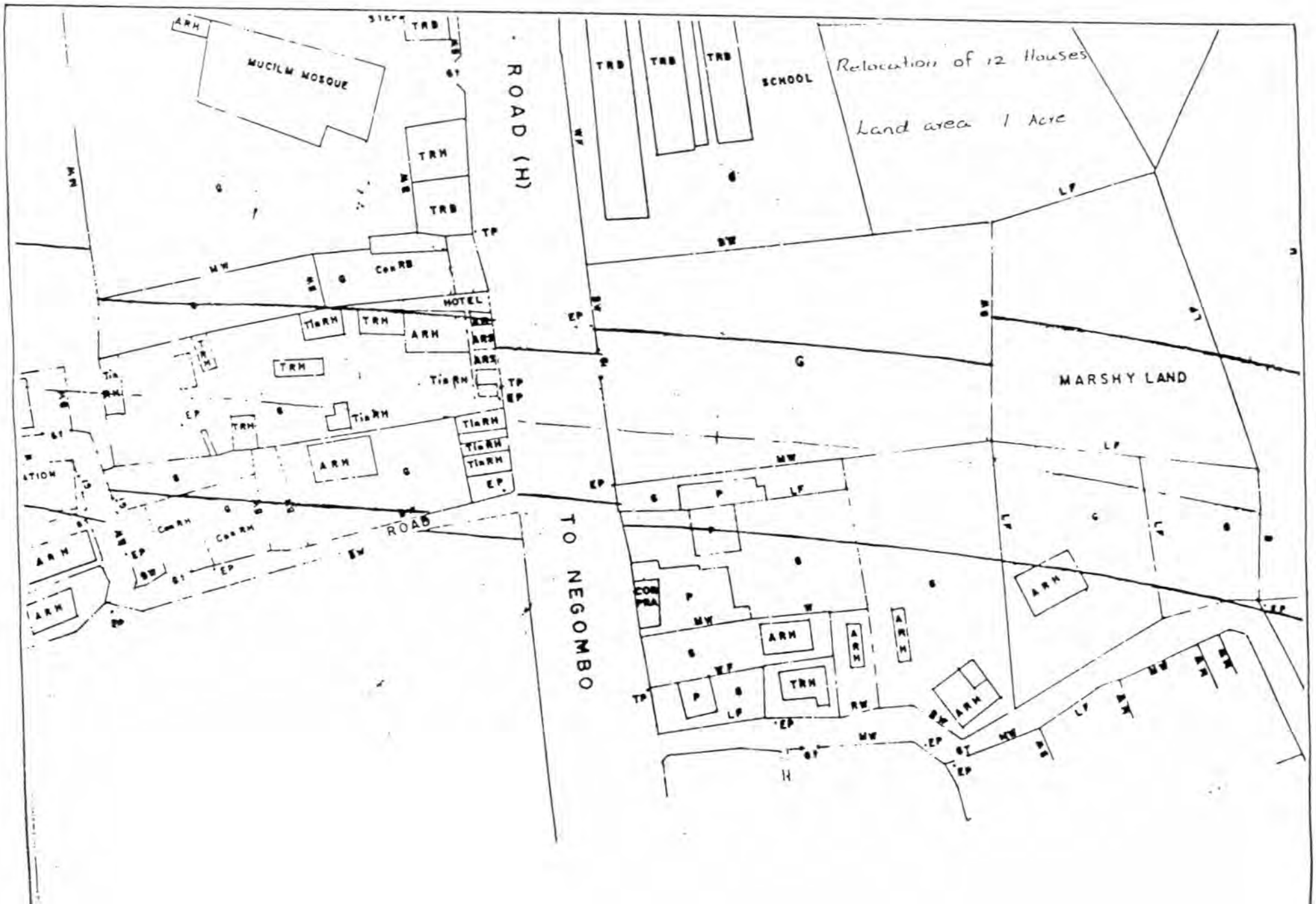

AREA FOR RELOCATION 28 HOUSES
LAND AREA REQUIRED 200 P
CEB
SUB STATION
MARSH
OVERHEAD
BRIDGE
ROAD
ROAD
STREAM
MUSE ROAD
HIGH
3rd Lane
From Kandy Road

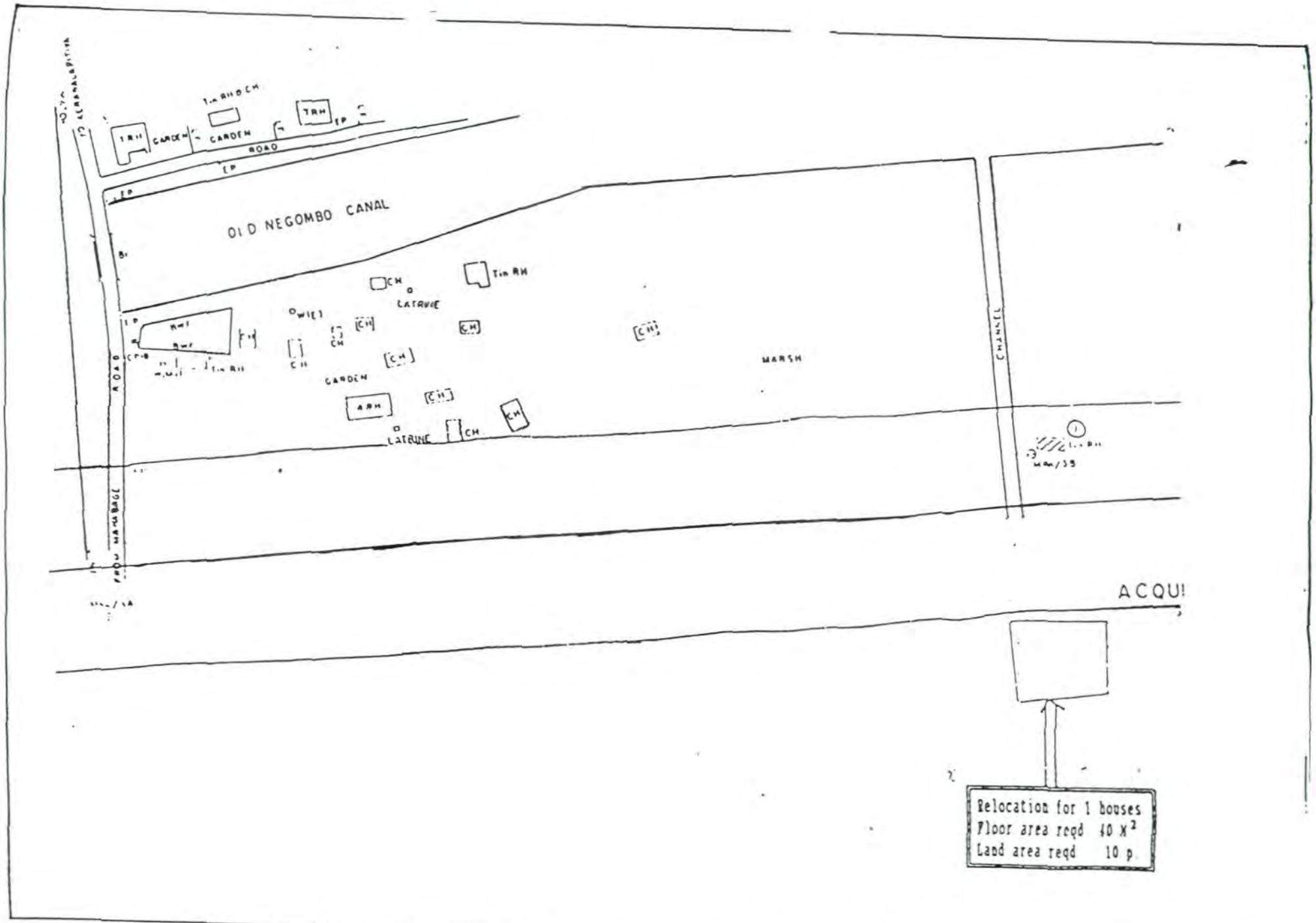

WARSH
OVERHEAD BRIDGE
From New Nuger Kinard
SIE LANE
Relocation for 5 houses
Floor area reqd 200 X²
Land area reqd 35 p.

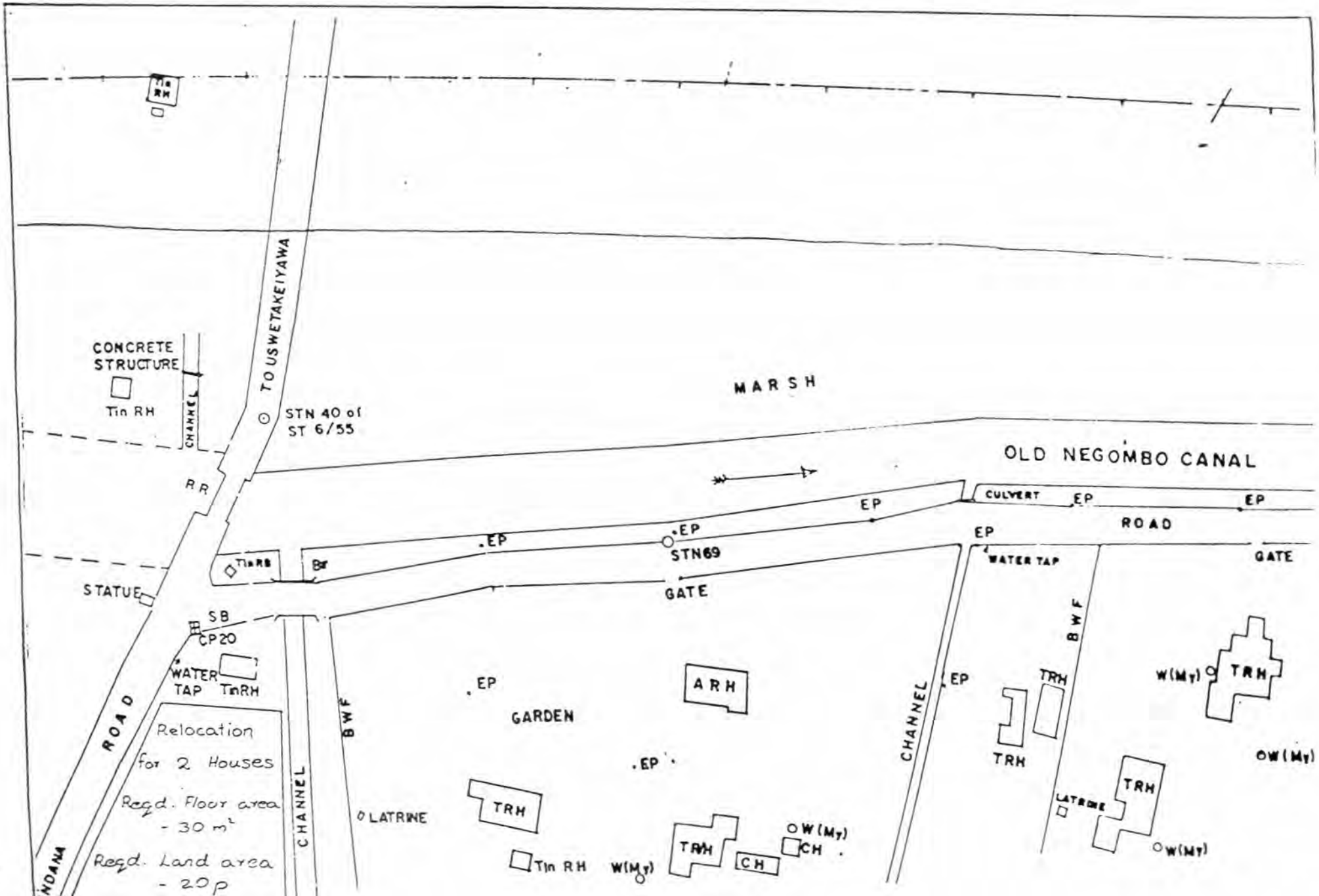

WANAWASALA
ROAD
MEEGAHAWATTA ROAD
HIGH LAND
EDGE OF HIGH LAND
DUMPING YARD
NOW BEING RECLAMATED FOR A PLAY GROUND
RECLAMATED BOUNDARY
PLAY GROUND
BATH ROOM
23 TRH
Relocation for 5 Houses
Floor area reqd. 520 m²
Land area reqd. 65 p

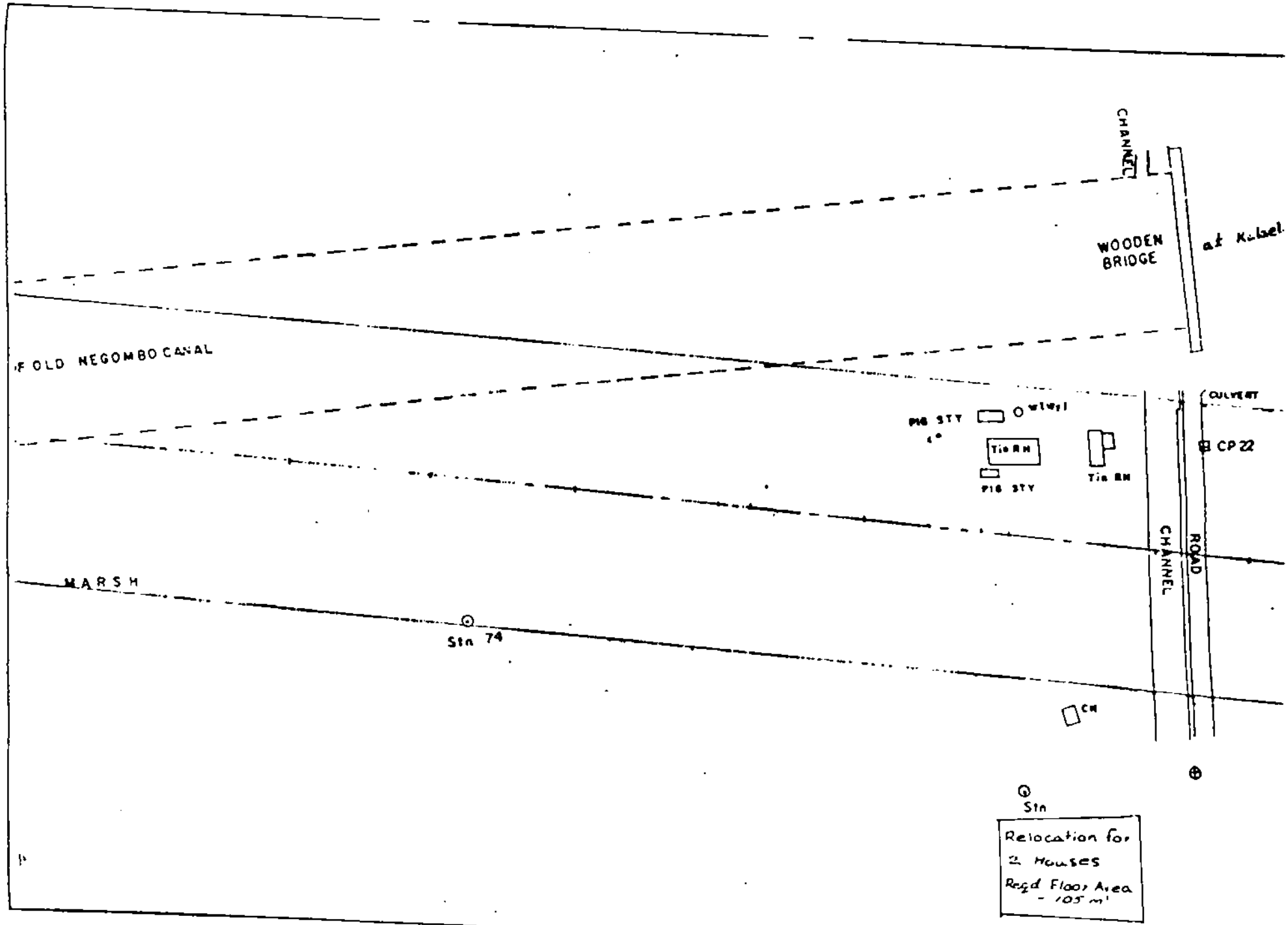

RUKGAHAWATTA
GARDEN
KELANITISSA HAWATHA
KURUNDUWA
OWITA
Area For
Relocation of 35 houses
Land Area Required . 460p.
P(ab)
COLOMBO
RAILWAY LINE

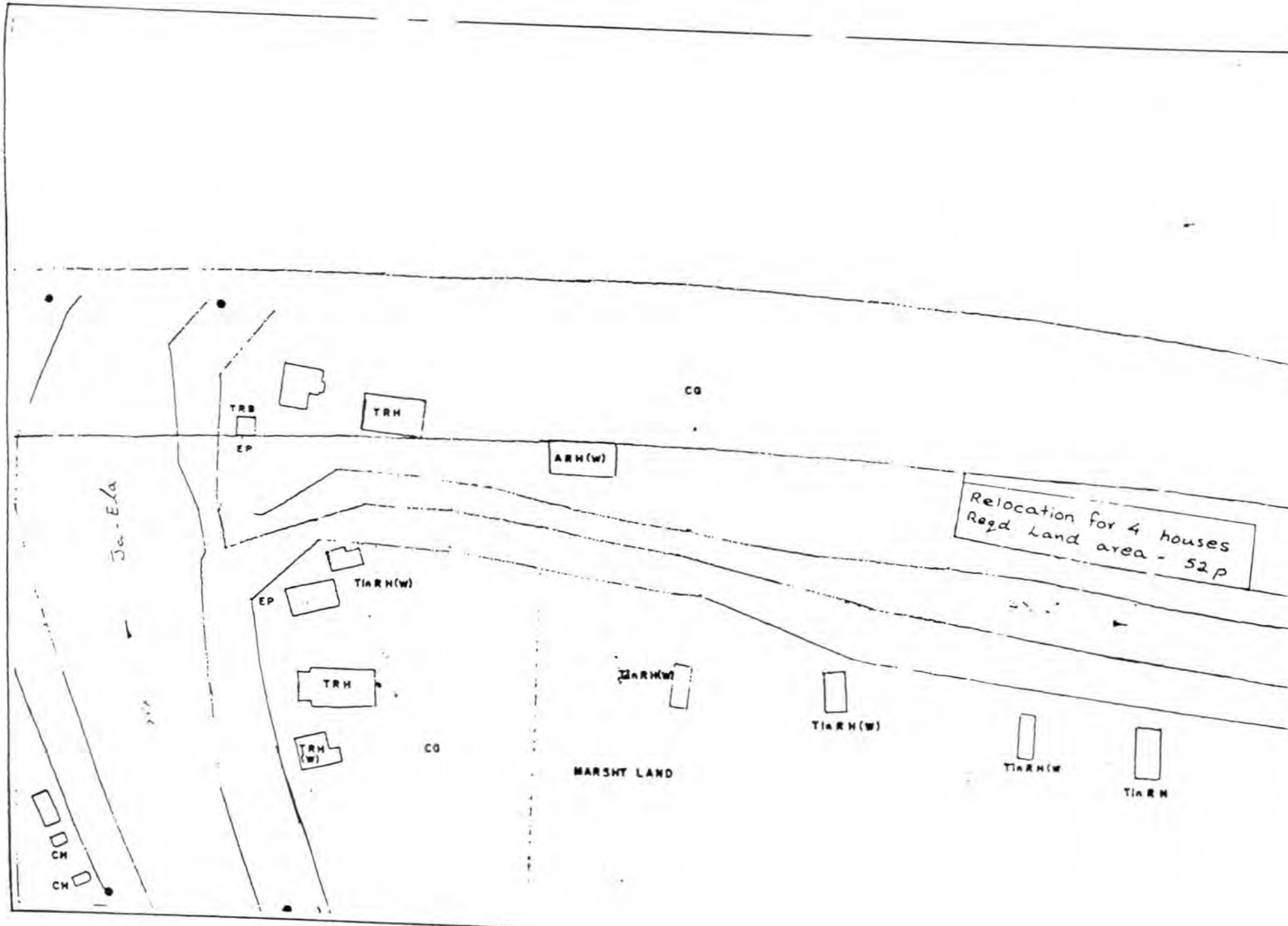

Land for Relocation of 29 houses
Land Area = 580 p
CANAL
ARH
ARH
ARH
ARH
ARH
ROAD
From Hunupitiya Railway station
RAILWAY LINE

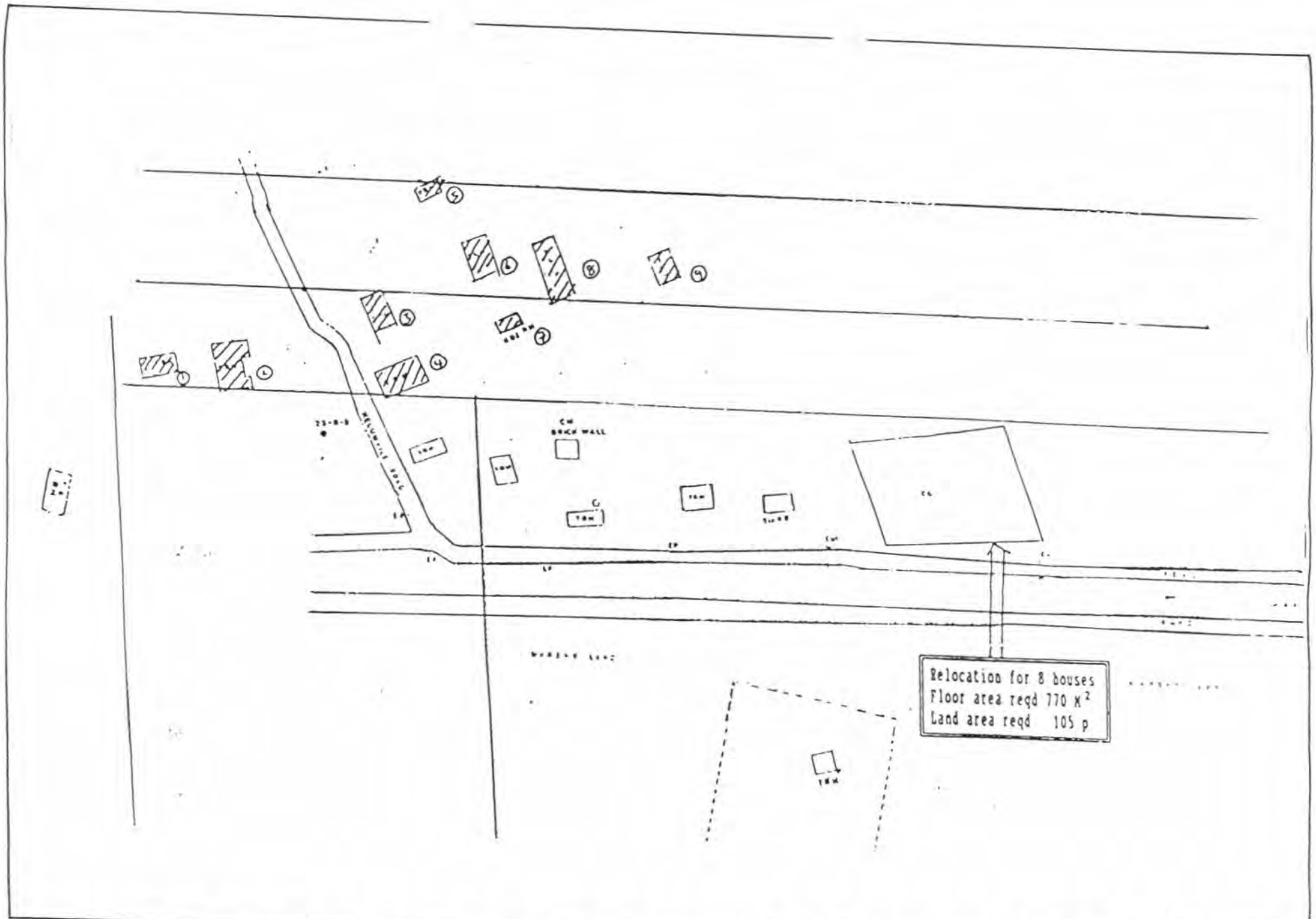

Relocation of 12 Houses
Land area 1 Acre
MUCILM MOSQUE
SCHOOL
ROAD (H)
HOTEL
MARSHY LAND
TO NEGOMBO
ROAD


OLD NEGOMBO CANAL
ROAD
GARDEN
LATRINE
MARSH
CHANNEL
ACQU!
Relocation for 1 houses
Floor area reqd 40 M²
Land area reqd 10 p


Tin RH
TO USWETAKEIYAWA
CONCRETE STRUCTURE
Tin RH
CHANNEL
STN 40 of ST 6/55
MARSH
OLD NEGOMBO CANAL
RR
CULVERT
EP
ROAD
EP
STN69
WATER TAP
GATE
Tin RB
STATUE
SB
CP20
WATER TAP
TinRH
ROAD
Relocation for 2 Houses
Reqd. Floor area - 30 m²
Reqd. Land area - 20 p
CHANNEL
BWF
GARDEN
ARH
LATRINE
TRH
Tin RH
W(My)
CH
OW(My)
TRH
W(My)
OW(My)


CHANNEL
WOODEN BRIDGE
at Kubel
OLD NEGOMBO CANAL
PIG STY
well
Tile RH
PIG STY
Tile RH
CULVERT
CP 22
CHANNEL
ROAD
MARSH
Stn 74
CH
Stn
Relocation for
2 Houses
Reqd Floor Area
- 105 m²


Relocation for 4 houses
Reqd Land area - 52p
CO
TRB
EP
TRH
ARH(W)
Ja-Ela
TinRH(W)
EP
TRH
TRH (W)
CO
TinRH(W)
TinRH(W)
MARSHY LAND
TinRH(W
TinRH
CH
CH


Relocation for 8 houses
Floor area reqd 770 M^2
Land area reqd 105 p

Annexure: IV

MAINTENANCE AND OPERATIONAL COSTS.

(Rs. '000)

YEAR		ANNUAL MAINTENANCE COST	PERIODIC MAINTENANCE COST	OPERATIONAL COST
1	1997			
2	1998			
3	1999			
4	2000			
5	2001	9,359		4,762
6	2002	9,827		5,143
7	2003	10,318		5,554
8	2004	10,834		5,998
9	2005	11,376		6,478
10	2006	11,945		6,997
11	2007	12,542		7,556
12	2008	13,169		8,161
13	2009	13,828		8,814
14	2010	14,519	395,986	9,519
15	2011	15,245		10,280
16	2012	16,007		11,103
17	2013	16,807		11,991
18	2014	17,648		12,950
19	2015	18,530		13,986
20	2016	19,457		15,105
21	2017	20,430		16,313
22	2018	21,451		17,618
23	2019	22,524		19,028
24	2020	23,650	645,020	20,550
25	2021	24,832		22,194
26	2022	26,074		23,970
27	2023	27,378		25,887
28	2024	28,746		27,958
29	2025	30,184		30,195
30	2026	31,693		32,610
PRICE ESCALATION PER ANNUM		5%	5%	8.0%

Annexure V

TRAFFIC FORECAST

YEAR		ADT	CARS	LIGHT GOODS	MEDIUM GOODS	HEAVY GOODS	LARGE BUSES	MEDIUM BUSES
1	1997							
2	1998							
3	1999							
4	2000							
5	2001	10,765	4,080	3,801	1,613	228	522	520
6	2002	11,656	4,376	4,182	1,721	251	574	552
7	2003	12,391	4,605	4,516	1,803	271	620	576
8	2004	13,175	4,847	4,877	1,888	293	670	600
9	2005	14,011	5,101	5,268	1,977	317	723	626
10	2006	14,904	5,369	5,689	2,070	342	781	652
11	2007	15,856	5,651	6,144	2,167	369	844	680
12	2008	16,872	5,948	6,636	2,270	399	911	709
13	2009	17,789	6,200	7,100	2,354	427	975	732
14	2010	18,758	6,464	7,597	2,442	456	1,043	756
15	2011	19,785	6,738	8,129	2,532	488	1,116	781
16	2012	20,872	7,025	8,698	2,626	523	1,195	806
17	2013	22,024	7,323	9,307	2,724	559	1,278	833
18	2014	23,243	7,634	9,958	2,825	598	1,368	860
19	2015	24,535	7,958	10,655	2,930	640	1,463	888
20	2016	25,659	8,217	11,295	3,010	679	1,551	908
21	2017	26,840	8,484	11,972	3,091	719	1,644	928
22	2018	28,081	8,759	12,691	3,175	763	1,743	949
23	2019	29,385	9,044	13,452	3,262	808	1,848	971
24	2020	30,755	9,338	14,259	3,350	857	1,958	993
25	2021	32,197	9,641	15,115	3,441	908	2,076	1,015
26	2022	32,197	9,641	15,115	3,441	908	2,076	1,015
27	2023	32,197	9,641	15,115	3,441	908	2,076	1,015
28	2024	32,197	9,641	15,115	3,441	908	2,076	1,015
29	2025	32,197	9,641	15,115	3,441	908	2,076	1,015
30	2026	32,197	9,641	15,115	3,441	908	2,076	1,015

Source : Transport Sector Planning Centre

TOLL RATES
(Rs)

YEAR		CARS	LIGHT GOODS	MEDIUM GOODS	HEAVY GOODS	LARGE BUSES	MEDIUM BUSES
1	1997						
2	1998						
3	1999						
4	2000						
5	2001	41	61	61	136	27	27
6	2002	41	61	61	136	27	27
7	2003	41	61	61	136	27	27
8	2004	41	61	61	136	27	27
9	2005	41	61	61	136	27	27
10	2006	60	90	90	200	40	40
11	2007	60	90	90	200	40	40
12	2008	60	90	90	200	40	40
13	2009	60	90	90	200	40	40
14	2010	60	90	90	200	40	40
15	2011	88	132	132	294	59	59
16	2012	88	132	132	294	59	59
17	2013	88	132	132	294	59	59
18	2014	88	132	132	294	59	59
19	2015	88	132	132	294	59	59
20	2016	129	194	194	432	86	86
21	2017	129	194	194	432	86	86
22	2018	129	194	194	432	86	86
23	2019	129	194	194	432	86	86
24	2020	129	194	194	432	86	86
25	2021	190	285	285	634	127	127
26	2022	190	285	285	634	127	127
27	2023	190	285	285	634	127	127
28	2024	190	285	285	634	127	127
29	2025	190	285	285	634	127	127
30	2026	280	419	419	932	186	186

Price Escalation 8% per annum effected in every 5 year

TOLL REVENUES
(Rs. 000)

	YEAR	CARS	LIGHT GOODS	MEDIUM GOODS	HEAVY GOODS	LARGE BUSES	MEDIUM BUSES	TOTAL REVENUE
1	1997							
2	1998							
3	1999							
4	2000							
5	2001	60,781	84,937	36,044	11,322	5,184	5,164	203,433
6	2002	65,191	93,451	38,458	12,464	5,701	5,482	220,747
7	2003	68,602	100,915	40,290	13,457	6,158	5,721	235,142
8	2004	72,207	108,982	42,189	14,550	6,654	5,959	250,541
9	2005	75,991	117,719	44,178	15,742	7,181	6,217	267,028
10	2006	117,523	186,791	67,966	24,954	11,397	9,514	418,144
11	2007	123,695	201,730	71,151	26,924	12,316	9,923	445,739
12	2008	130,196	217,884	74,532	29,113	13,294	10,346	475,366
13	2009	135,712	233,119	77,290	31,155	14,228	10,682	502,187
14	2010	141,491	249,437	80,180	33,271	15,220	11,032	530,632
15	2011	216,709	392,171	122,152	52,317	23,929	16,746	824,024
16	2012	225,940	419,621	126,687	56,070	25,623	17,282	871,222
17	2013	235,524	449,001	131,415	59,929	27,402	17,861	921,133
18	2014	245,527	480,408	136,288	64,110	29,332	18,440	974,104
19	2015	255,947	514,033	141,353	68,613	31,369	19,040	1,030,356
20	2016	388,310	800,650	213,365	106,958	48,864	28,606	1,586,754
21	2017	400,928	848,640	219,107	113,259	51,794	29,236	1,662,963
22	2018	413,923	899,606	225,061	120,190	54,913	29,898	1,743,592
23	2019	427,392	953,550	231,228	127,279	58,221	30,591	1,828,260
24	2020	441,285	1,010,755	237,466	134,997	61,686	31,284	1,917,473
25	2021	669,432	1,574,286	358,394	210,159	96,099	46,985	2,955,355
26	2022	669,432	1,574,286	358,394	210,159	96,099	46,985	2,955,355
27	2023	669,432	1,574,286	358,394	210,159	96,099	46,985	2,955,355
28	2024	669,432	1,574,286	358,394	210,159	96,099	46,985	2,955,355
29	2025	669,432	1,574,286	358,394	210,159	96,099	46,985	2,955,355
30	2026	983,615	2,313,143	526,598	308,793	141,201	69,036	4,342,386

PROJECTED CASH FLOW STATEMENT
(Rs. '000)

	YEAR	INVESTMENT	REVENUE	EXPENDITURE					NET INFLOW	CUM. INFLOW
				MAINTENANCE						
			TOLL	ANNUAL	PERIODIC	OPERATION	TOTAL		(OUTFLOW)	(OUTFLOW)
1	1997	523,750							(523,750)	(523,750)
2	1998	1,372,281							(1,372,281)	(1,896,031)
3	1999	2,014,551							(2,014,551)	(3,910,582)
4	2000	1,811,628							(1,811,628)	(5,722,210)
5	2001		203,433	9,359	0	4,762	14,121		189,312	(5,532,897)
6	2002		220,747	9,827	0	5,143	14,970		205,776	(5,327,121)
7	2003		235,142	10,319	0	5,554	15,873		219,270	(5,107,851)
8	2004		250,541	10,835	0	5,998	16,833		233,708	(4,874,143)
9	2005		267,028	11,376	0	6,478	17,855		249,173	(4,624,970)
10	2006		418,144	11,945	0	6,997	18,942		399,202	(4,225,768)
11	2007		445,739	12,542	0	7,556	20,099		425,640	(3,800,128)
12	2008		475,366	13,170	0	8,161	21,330		454,035	(3,346,093)
13	2009		502,187	13,828	0	8,814	22,642		479,545	(2,866,548)
14	2010		530,632	14,519	395,986	9,519	420,025		110,607	(2,755,940)
15	2011		824,024	15,245	0	10,280	25,526		798,499	(1,957,442)
16	2012		871,222	16,008	0	11,103	27,110		844,112	(1,113,330)
17	2013		921,133	16,808	0	11,991	28,799		892,334	(220,996)
18	2014		974,104	17,649	0	12,950	30,599		943,505	722,510
19	2015		1,030,356	18,531	0	13,986	32,517		997,839	1,720,348
20	2016		1,586,754	19,458	0	15,105	34,562		1,552,191	3,272,540
21	2017		1,662,963	20,430	0	16,313	36,744		1,626,220	4,898,759
22	2018		1,743,592	21,452	0	17,618	39,070		1,704,521	6,603,280
23	2019		1,828,260	22,525	0	19,028	41,552		1,786,708	8,389,988
24	2020		1,917,473	23,651	645,020	20,550	689,221		1,228,253	9,618,241
25	2021		2,955,355	24,833	0	22,194	47,027		2,908,328	12,526,569
26	2022		2,955,355	26,075	0	23,970	50,045		2,905,311	15,431,879
27	2023		2,955,355	27,379	0	25,887	53,266		2,902,089	18,333,968
28	2024		2,955,355	28,748	0	27,958	56,706		2,898,649	21,232,618
29	2025		2,955,355	30,185	0	30,195	60,380		2,894,975	24,127,593
30	2026		4,342,386	31,694	0	32,610	64,305		4,278,082	28,405,675

ANNEXURE IX - MAMMALS RECORDED FROM MUTHURAJAWELA

SCIENTIFIC NAME	ENGLISH NAME	STA-TUS *	REMARKS**
Suncus murinus mirinus	musk shrew	VC	-
S. murinus caerulescens	musk shrew	C	-
Pteropus g. giganteus	fruit bat	VC	-
Rousettus seminudus	fruit bat	VC	-END
Rhinolopus r. rouxi	bat	C	-
Hipposideros l. lankadiva	bat	C	-
H. galeritus brachyotus	bat	SU	-
H. bicolor ater	bat	SU	-
Megaderma lyra lyra	bat	C	-
Pipistrellus m. mimus	bat	C	-
Scotophilus heathi heathi	bat	SU	-
Kerivoula picta picta	painted bat	R	THR
Taphozous saccolaimus erassus	-	C	-
Loris tardigradus tardigradus	slender loris	R	THR / PRO
Macaca sinica sinica	toque macaque	VC	END
Lepus nigricollis singhala	black - naped hare	C	-
Funambulus palmarum favonicus	Indian palm squirrel	VC	-
Hystrix indica	Indian crested porcupine	C	-
Bandicota indica indica	larger bandicoot rat	VC	-
Mus musculus castaneus	house mouse	C	-
M. cervicolor fulvidiventris	fawn coloured mouse	VC	-
Rattus rattus rattus	common rat	VC	-
R. rattus alexandrinus	brown rat	SU	-
R. rattus kandianus	brown rat	C	-
R. norvegicus	brown rat	SU	-
Lutra lutra nair	Ceylon Otter	C	THR
Canis aureus lanka	Asiatic jackal	R	-
Viverricula indica mayori	larger Indian civet	R	-
Paradoxurus hermaphroditicus	palm civet	C	-
Herpestes fucus rubidior	brown mongoose	C	-
H. smithi zeylanicus	ruddy mongoose	C	-
Felis (Zibethailurus) viverrina	fishing cat	R	THR / PRO
F. (Prionailurus) rubiginosa	rusty spotted cat	VR	THR / PRO
Tragulus meminna	mouse - deer	R	THR

* E = Endangered : VR = Very Rare ; R = Rare ; C = Common ; VC = Very Common
SU=StatusUnknown

** END = Endemic species ; THR = Threatened species ;
PRO = Protected under Wild life Ordinance

(After Karunaratne) Source : **GCEC / EUROCONSULT 1991.**

ANNEXURE X - RESIDENT BIRDS RECORDED FROM MUTHURAJAWELA

SCIENTIFIC NAME	ENGLISH NAME	STATUS *	REMARKS **
Podiceps ruficollis capensis	Little Grebe		B
Phalacrocorax fuscicollis	Indian Shag		B
P. niger	Little Cormorant		B
Ardea cinerea rectirostris	Grey Heron		
A. purpurea manilenisis	Purple Heron		B
Butorides striatus javanicus	Little Green Heron		B
Ardeola grayil grayii	Pond Heron		B
Bubulous ibis coromandus	Cattle Egret		B
Egretta aba madesta	Large Egret		B
E. intermedia intermedia	Median Egret		B
E. garzetta garzetta	Little Egret		
E. gularis schistacea	Reef Heron		THR
Nycticorax nycticorax nycticorax	Night Heron		B
Ixobrychus cinnamomeus	Chestnut Bittern		
I. sinensis	Yellow Bittern		B
Dupetor flavicollis flavicollis	Black Bittern		
Ibis leucocephalus	Painted Stork		
Anastomus oscitans	Open - bill Stork		
Threshkiornis mrlanocephala	White Ibis		
Dendrocygna javanica	Whistling Teal		
Haliastur indus indus	Brahaminy Kite		
Accipiter badius badius	Shikri		
Ichthyophaga ichthyaetus plumbeiceps	Grey - Headed fishing Eagle		THR
Coturnix chinensis chinensis	Blue - breated - Quail		
Rallus striatus albiventer	Blue - breasted banded Quali		THR
Amaurornis fuscus zeylonicus	Ruddy Crake		
A. phoenicurus phoenicurus	White - bleasted Waterhen		B
Gallicrex cinera cinera	Kora		
Gallinula chloropus indica	Indian Moorehen		B
Porphyrio porphyrrio poliocephalus	Purple Coot		B
Hydrophasianus chirurgus	Pheasant - tailed Jacana		
Vanellus indicus lankae	Red - wattled Lapwing		B
Rostratula bengalensis	Painted - Snipe		
himantopus hintantopus ceylonensis	Black - winged Stilt		
Sterna albifrons	Lesser Tern		
S.bergii velox	Swift Tern		
Streptopelia ceylonensis	Spotted Dove		
Psittakula krameri manillensis	Rose - ringed Parakeet		
Clamator jacobinus jacobinus	Pied Crested Cuckoo		
Eudynamys scolopacea scolopacea	Koel		
Centropu sinensis parroti	Common Coucal		
Otus bakkamoena bakkamoena	Collared Scops Owl		
Bubo reylonensis reylonensis	Brown Fish Owl		
Ninox scutulata hirsuta	Brown Hawk Owl		
Apus melba bakeri	Whte - bellied Swift		
Cypsiurus parvus batasiensis	Palm Swift		
Ceryle rudis leucomelanura	Pied Kingfisher		
Alcedo atthis taprobana	Common Kingfisher		
Pelargopsis capensis capensis	Stork -billed Kingfisher		
Halcyon smyrensis fusca	White - breasted Kingfisher		
H. pileata	Black-capped Kingfisher		
Coracias bengalensis indica	Indian Roller		THR
Megalaima zeylanica zetlanica	Brown - headed Barbet		
M. rubricapilla rubricapilla	Small Barbet		

* E = Endangered ; VR = Very Rare; R = Rare; C = Common; VC = Very Common; SU = Status Unknown
** END = Endemic species; THR = Threatened species; B = Breeding in the area confirmed

(After de Silva) Source : GCEC / EUROCONSULT 1991.

Annexure X (Contd.)

SCIENTIFIC NAME	ENGLISH NAME	STATUS*	REMARKS**
Dinopium benghelense psarodes	Red-becked Woodpecker		
Hirundo dauraca hyperythra	Sri Lanka Swallow		
Oriolus xanthornus ceylonensis	Black - headed Driole		
Dicrurus cierulescens leucopygialis	White -vented Drongo		
Artamus fuscus	Ashy Swallow Shrike		
Acridotheres tristis melanosternus	Common Mynah		
Corvus splendens protegatus	House Crow		
C. macrorhynchos culminatus	Black Crow		
Coracina melanoptera sykesi	Black-headed Cuckoo Shrike		
Pericrocotus C. cinnamomeus	Little Miniver		
Aegithina tiphia multicolor	Common Iora		
Pycnonotus cafer haemorrhousud	Red-vented Bulbul		
P. luteolus insulae	White - browed Bulbul		
Turdoides affinis taprobanus	Common Babbler		
Terpsiphone paradisi ceylonensis	Ceylon Paradise Flycatcher		
Cisticola juncidis omalura	Fantail Warbler		
Prinia subflava insularis	Plain Prinia		
P. sylvatica valida	Large Prinia		
Orthotomus sutirius sutorius	Tailor Bird		
Acrocephalus stentoreus	Great Reed Warbler		
Copsychus saularis ceylonensis	Magpie Robin		
Saxicoloides fulicata leucoptera	Black Robin		
Parus major maharattarum	Grey Tit		
Anthus novaseelandidae malayensis	Indian Pipit		
Dicaeum erythrorhynchos ceylonense	Tickell's Flowerpecker		
Nectarinia zeylonica zeylonica	Purple-rumped Sunbird		
N. lotenia lotenia	Loten's Sunbird		
Passer domesticus indicus	House Sparrow		
Lonchura striata striata	White - backed Munia		
L. punctulata punctulata	Spotted Munia		
L. malacca malacca	Black -headed Munia		

* E = Endangered : VR = Very Rare ; R = Rare; C = common ; SU = Status Unknown

** END = Endemic species ; THR = Threatened species ; B = Breeding in the area confirmed

(After de Silva) Source : GCEC / EUROCONSULT 1991.

ANNEXURE XI - MIGRATORY BIRDS RECORDED FROM MUTHURAJAWELA

SCIENTIFIC NAME	ENGLISH NAME	STA-TUS *	REMARKS**
Phalacrocorax carbo sinensis	Ingian Cormorant		THR
Arda goliath	Goliath Heron		SU
Gorsachius m. melanolophus	Mallay Bittern		-
Anas accutaPintail	-		-
A. querquedula	Gargany		-
Circus macrorous	Pale Harrier		-
C. aeruginosus aeruginosus	Marsh Harrier		-
Heiraaetus pennantus	Booted Eagle		-
Rallus eurrizonoides amauroptera	Banded Crake		-
Pluvialis aquatarola	Grey Plover		-
P. Dominica fulva	Eastern Golden Plover		-
Charadrius mongolus atrifrons	Lesser Sandplover		-
C. leschenaultil	Large Sandplover		-
Numenius phaeopus phaeopus	Whimbrel		-
Tringa totanus eurithinus	Redshank		-
T. nebularia	Greenshank		-
T. glareola Wood sand piper	-		-
T.stagnatilis	Marsh sandpiper		-
T. hypoleucos hypoleucos	Common sandpiper		-
Capella stenura	Pintail Snive		-
Calidris feruginea	Curiew Sandpiper		-
Larus fucus	Lesser Black - backed Gull		-
L.brullicephalus	Brown - headed Gull		-
Childonias hybrida indica	Indian Whiskered Tern		-
Gelochilidon nilotica nilotica	Gull - billed Tern		-
Hydroprogne caspia caspia	Caspian Tern		-
Sterna hirundo tibetana	Common Tern		THR
S. bengalensis	Lesser Crested Tern		-
S. repressa	White - cheeked Tern		SU
S. sandvicensis	Sandwitch Tern		-
Merops Philippinus Philippinus	Blue - tailed Bee - eater		-
Pitta brachyura brachyura	Indian Pitta		-
Hirundo rustica gutturalis	Eastern swalliw		-
Lanius cristatus caristatus	Brown Shrike		-
Mascicapa latirostris	Brown Flycatcher		-
Terpsiphone paradisi paradisi	Paradise Flycatcher		-
Acrocephalus dumetorun	Blyth's Reed Warbler		-
Anthus novaeseelandidae richarde	Richard's Pipit		-
Motacilla flava	Grey - headed Yellow Wagtail		-
M. caspica caspica	Grey Wagtail		-

* E = Endangered ; VR = Very Rare ; R = Rare ; C = Common ; VC = Very Common
SU=Status Unknown

** END = Endemic species ; THR = Threatened species ;
PRO = Protected under Wild life Ordinance

(After Karunaratne) Source : GCEC / EUROCONSULT 1991.

ANNEXURE XII - REPTILES RECORDED FROM MUTHURAJAWELA

SCIENTIFIC NAME	ENGLISH NAME	STA-TUS *	REMARKS **
Cnemaspis k. kandianus	diurnal gecko	R	
Hemadactylus brooki parvimaculantus	jungle gecko	C	
H. Frenantus	jungle gecko	C	
Calotes calotes	green garden lizard	VC	THR
C. versicolor	garden lizard	VC	
Mabuya carinata lankae	skink	VC	
M. macularia	spotted skink	C	END THR
Sphenomorphus fallz	brown skink	R	END THR
Riopa punctata	skink	C	
Varanus bengalensis	monitor	C	
V. salvator salvator	monitor	C	PRO
Crocodyl7us porosus	estuarine crocodile	C	THR PRO
Melanochelys trijuga thermalis	hard - shelled terrapin	C	THR
Lissemys punctata ceylonesis	soft- shelled terrapin	C	THR
Typhlina bramina		C	THR
Cylindrophis maculatus	Sri Lankan pipe snake	R	END THR
Python molurus	rock python	R	THR
Acrochordus granulatus		C	
Lycodon striantus	wolf snake	C	
L. aulicus	wolf snake	C	
Oligodon armensis	kukri snake	R	
Pryas mucosus	rat snake	VC	
Boiga ceylonensis	cat snake	C	
Dendrelaphis tristis	bronze back	C	
Ahaetulla nasuta		C	
Aspidura guentheri	Guether's roughside	VR	END/THR
Xenochrophis asperrimus	common pond snake	C	END/THR
Amphiesma stolata		C	
Xenochrophis piscator	pond snake	C	
Atretium schistosum		C	
Cerberus rhynchops	dog-faced water snake	VC	THR
Gerada prevostiana		VR	THR
Naja naja naja	cobra	C	
Bungarus caeruleus	krait	R	
Vipera russelli	Russel's viper	R	
Hypnale hypnale	Merrem's hump-nosed viper	C	THR

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PRO = Protected under Wild life Ordinance

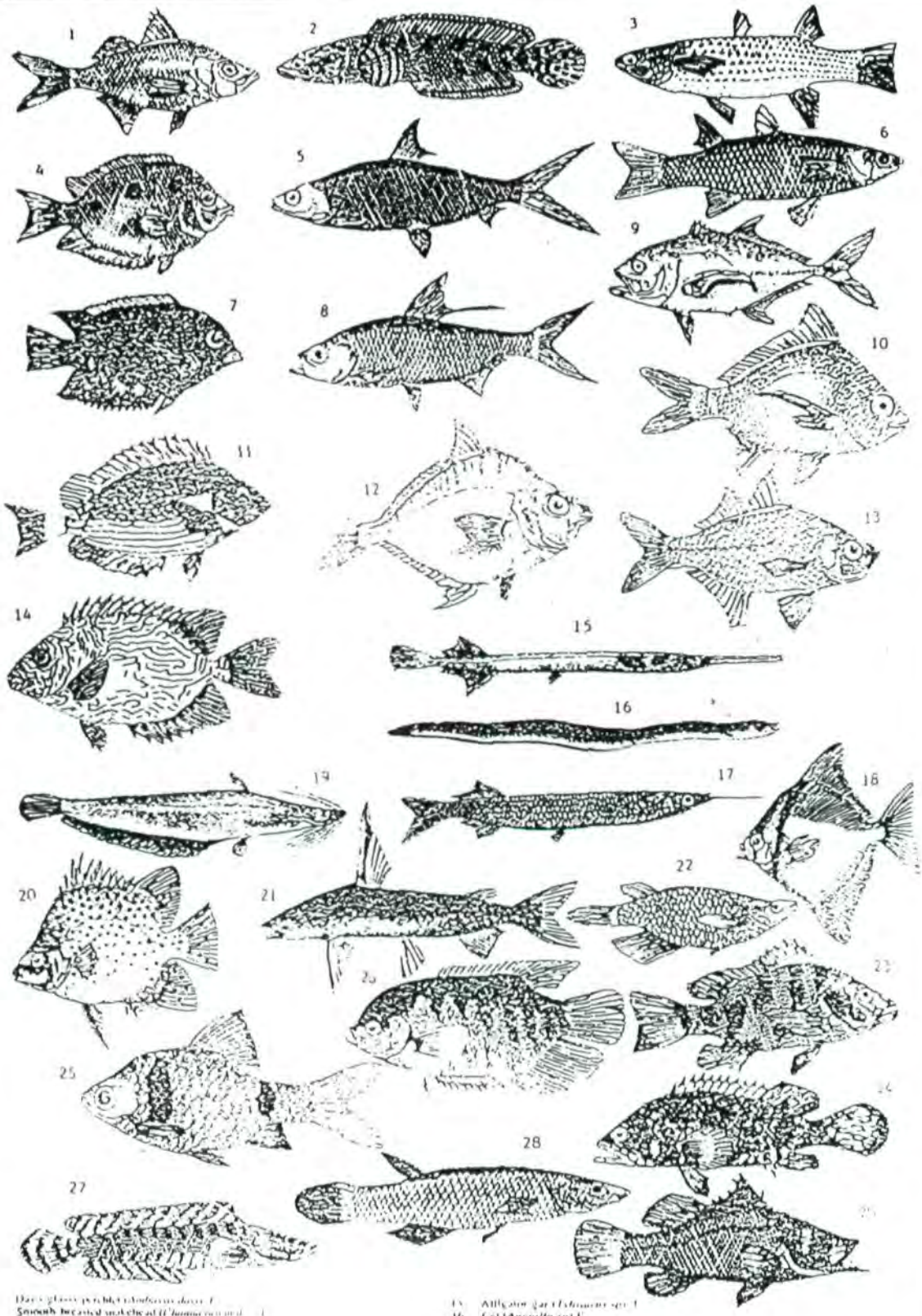
(After Karunaratne) Source : GCEC / EUROCONSULT 1991.

ANNEXURE XIII - AMPHIBIANS RECORDED FROM MUTHURAJAWELA			
SCIENTIFIC NAME	ENGLISH NAME	STA-TUS *	REMARKS**
Bufo melanosticus	toad	VC	
B. stomaticus	toad	R	
B. atukoralei	Atukorali's dwarf toad	C	END/THR
Rana hexadactyla	frog	VC	
R. c. cyanophlyctis	frog	VC	
R. tigrina crassa	frog	C	
R. l. limnocharis	frog	VC	
R. (Tomoptera) breviceps	frog	C	
R. (Hylarana) temporalis	frog	C	
Rhacophorus (polypedates) cruciger	greater hourglass tree frog	C	END/THR
R. (P.) leucomystax maculatus	tree frog	VC	
Philautus sp. (P. hayli?)	tree frog	VC	
Kaloula pulchra taprobanica		C	
Uperodon systoma		C	
Microhyla rubra		C	

* E = Endangered : VR = Very Rare ; R = Rare ; C = Common ; VC = Very Common
SU=Status Unknown

** END = Endemic species ; THR = Threatened species ;
PRO = Protected under Wild life Ordinance

(After Karunaratne) Source : GCEC / EUROCONSULT 1991.



1 Dart-glass perchlet (*Ambassis dayi*) F
2 Smooth breasted sandchelat (*Chanda ranga*) F
3 Diamond scale mullet (*Liza* sp) F
4 Orange Chromide (*Etroplus suratensis*) F OX
5 Milkfish (*Chanos chanos*) F
6 Grey Mullet (*Mugil cephalus*) F
7 Pearl Spot (green chromide (*Etroplus maculatus*)
8 Tarpon (*Megalops cyprinoides*) F
9 Trevally (*Caranx* sp) F
10 Silver Moby (*Rastrelliger kanagurta*) F
11 Rabbit fish (*Siganus javus*) F
12 Puffer fish (*Tetraodon* sp) F
13 Common Green glass perchlet (*Ambassis*
14 Rabbit fish (*Siganus vermiculatus*) F

F Food Fish OX Ornamental Fish export

15 Alligator gar (*Lepisosteus* sp) F
16 Eel (*Anguilla* sp) F
17 Halfbeak (*Hemiramphus* sp) F
18 Moon angel silver batfish (*Monodactylus argenteus*) OX
19 Singing catfish (*Heteropneustes fossilis*) F
20 Spotted bonefish (*Scatophagus argus*) F OX
21 Common catfish (*Tachysurus* sp) F
22 Tarpon top minnow (*Poecilia melanogaster*
23 Groupers (*Epinephelus* spp) F AX
24 Groupers (*Epinephelus* spp) F AX
25 Common Gourd bunded bonefish (*Barbus*
26 Gourami (*Trichogaster* sp) F
27 Striped sandchelat (*Ophiocephalus striatus*) F
28 Ingoumine (*Puntius jerdoni*)
29 Sea Bass (*Lates calcarifer*) F AX
AX Aquaculture Seed Export

Some important fishes of the Negombo lagoon marsh. Negombo Lagoon wetland

ANNEXURE XIV

Source : GCE/EUROCONSULT. 1991

ANNEXURE XV - BUTTERFLIES OF MUTHURAJAWELA				
FAMILIES	MUTHURAJAWELA TOTAL	ENDE-MIC	THREA TENED-	
	SPP	SPP	SUBSPP	THREA-TENED
DANEIDAE			4	-
SATYRIDAE	8	-	1	-
AMATHUSHDAE	4	-	-	-
NYMPHALIDAE	-	-	1	-
LYCAENIDAE	17	-	-	-
PIERIDAE	14	-	-	-
PAPILIONIDAE	9	-	3	1
HESPERIDAE	9	-	-	-
TOTAL	67	-	9	1

(After Karunaratne) Source : GCEC /EUROCONSULT 1991.

ANNEXURE XVI - DRAGONFLIES OF MUTHURAJAWELA			
FAMILIES	**MUTHURAJAWELA TOTAL**	**ENDEMIC**	
	SPP	*SPP*	*SUBSPP*
EUPHAEIDAE			-
CHLOPTERYGIDAE	-	-	-
LESTIDAE	2	2	-
PLATYSTICTIDAE	-	-	-
PROTONEURIDAE	-	-	-
PLATYCNEMIDAE	2	2	-
COENAGRIONIDAE	3	3	-
GOMPHIDAE	1	-	-
AESHNIDAE	12	1	-
CORDULIDAE	1	-	-
LIBELLULIDAE	13	-	-
TOTAL	34	8	

(After Karunaratne) Source : GCEC / EUROCONSULT 1991.

ANNEXURE XVII

LIST OF REEF FAUNA BETWEEN COLOMBO (FORT) AND NEGOMBO

Family : Acanthuridae (Surgeon fish)

Acanthurus xanthopterus
Acanthurus pyroferus
Acanthurus hariene
Acanthurus triostegus
Acanthurus blochii
Ctenochaetus striatus
Ctenochaetus strigosus
Naso lituratus

Family : Aponogonidae (cardinal fish)

Cheilodipterus sp.

Aponogon sp

Family : Balistidae (Trigger fish)

Melechthys indicus
Sufflamen chrysopterus
Sufflamen bursa
Odonus niger

Family Blennidae (Blennies)

Ecsenius sp.
Runula sp.
Plagiotremus sp.

Family : Chaetodontidae (Butterfly fish)

Chaetodon unimaculatus
Chaetodon decussatus
Chaetodon guttatisimus
Chaetodon vagabundus
Chaetodon kleinii
Chaetodon gairdneri
Forcipiger flavissimus
Hemitaurichthys zoster

Family : Cirrhitidae (Hawk fish)

Paracirrhites fosteri
Cirrithys pinnulatus
Cirrithys sp.

Family: Caesionidae (Fusiliers)

Caesio sp.
Pterocaesio sp.

Family: Carangidae (Jacks)

Trachinotus sp.
Caranx melanpigus
Caranx sp.

Family: Diploprionidae (Two banded grouper)

Diploprion bifaciatus

Family : Ephippidae (Bat fish)

Platax orbicularis

Family : Gobiidae (Gobies)

Tereleotris sp.
Nemateleotris sp.
Valenciennea sp.

Family : Haemulidae (Sweet lips)

Plectorynchus lineatus
Plectorynchus sordidus
Plectorynchus sp.
Pomadasys sp.

Family : Holocentridae (Squirrel fish)

Adioryx coudmacculatus
Adioryx spinifer
Adioryx sp
Holocentrus diadema
Myripristis murdjan
Myripristis adustus
Myripristis sp

Family : Labridae (Wrasses)

Halichoeres sp.
Thallasoma lunare
Thallasoma quinquivittata
Coris sp.
Labroides dimidiatus
Cheilinus chlorurus
Cheilinus fasciatus
Cheilinus trilobatum
Cheilinus undulates
Parachelynus sp.
Pseudochelynus sp.
Bodianussp.
Hemigymnus faciatus
Anampses sp.
Gomphosus varius
Macropharyngdon sp.

Family : Lutjanidae (Snappers)

Aphreus sp
Lutjanus bohar
Lutjanus rivulatus
Lutjanus lunulatus
Lutjanus johnii
Lutjanus gibbus
Pinjals sp.
Macolor sp.

Family : Mullidae (Goat fish)

Parupaneus sp.
Upeneus sp.
Mullordichthys sp.

Family : Monocanthidae (File fish)

Cantherhines sp.
Amanses sp.
Aluterа sp

Family : Monodactylidae (Silver mono)

Monodactylus argenteus

Family : Nemipteridae (Monocle breams)

Scolopsis sp

Family : Pomacentridae (Damsel fish)

Amphiprion sp
Pomacentrus similis
Pomacentrus philippines
Pomacentrus chrysurus
Chromis dimidiatus
Chromis turneterni
Chromis viridis
Chromis sp
Neopomacentrus taeniurus
Neopomacentrus azyron

Family: Pomacanthidae (Angel fish)

Pomacanthus semicirculatus
Pomacanthus annularis
Pomacanthus imperator
Holocanthus xanthurus
Centropyge multispinnis
Centropyge edibli
Centropyge flavipectoralis

Family: Pseudochromidae (Basslets)

Pseudochromis sp.

Family: Pempheridae (Sweepers)

Pempheris sp.

Family: Priacanthidae

Priacanthus hamrur

Family: Serranidae (Groupers)

Aetherloperca rogaa
Cephalopholis formosa
Cephalopholis argus
Cephalopholis argus
Cephalopholis sonnerati
Cephalopholis miniatus
Epinephelus fuscoguttatus
Epinephelus caeruleopunctatus
Epinephelus merra

Factors Considered in Relocating Displaced Population

The factors that should be taken into consideration when relocating the displaced population are as follows:

1) Of the total sample 69% of the children had walked to school 78% had spent less than half an hour to reach the school

2) 82.7 % of the household heads were employed. The majority worked in the informal sector. Of the family members only 23% were employed.

3) 37% of the respondents had worked within a 5 mile radius (53 % either did not or could not respond to the question)

4) 62% lived within 500 meters of a bus route or the railway station.

5) 50% were encroachers

6) 81.7% had requested houses in a new location rather than cash or land for housing.

7) Expected services in rank order were as follows :
   i) Water supply
   ii) Electricity
   iii) Sanitation facilities
   iv) Transport

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Annexure XXI

LIST OF CONTACTS AND THEIR COMMENTS

LIST OF CONTACTS

1. Society for the Protection of the Environment and Human Rights (Wanawasala, Awariwatta, Old Negombo Road and Wattala)

2. Villagers Protest Organization (Oliyamulla - Galwettiya - Hekitta)

3. Rev. Thotupola Wimalakiththi

The following fears were expressed by the representatives of the Citizen's committees at the meeting held at St. Mary's Church. Wattala on 9th July 1996 under the auspices of Rev Ernest Poruthota.

(i) Thier properties located on the path of the CKE will not be correctly assessed by the RDA.

(ii) Compensation will not be paid on time.

(iii) They will be resettled in reclaimed marshy lands.

(iv) They will not benefit from the proposed CKE only the affluent will benefit.

(v) The Mabole mosque will be adversely affected: the lifestyle of the Muslims will be disrupted and the community devided.

(vi) Hunupitiya Fertilizwr factory will be affected..

(vii) Buddha statue will be demolished.

People disputed the figure given by the RDA on the number of houses affected by the CKE.

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