BASIC DESIGN STUDY REPORT
ON
THE PROJECT FOR
MINIPE AND NAGADEEPA RURAL DEVELOPMENT
IN
THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA

FEBRUARY, 1989

JAPAN INTERNATIONAL COOPERATION AGENCY

BASIC DESIGN STUDY REPORT
ON
THE PROJECT FOR
MINIPE AND NAGADEEPA RURAL DEVELOPMENT
IN
THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA

FEBRUARY, 1989

JAPAN INTERNATIONAL COOPERATION AGENCY

P R E F A C E

In response to a request from the Government of the Democratic Socialist Republic of Sri Lanka, the Government of Japan decided to conduct a Basic Design Study on the Project for Minipe and Nagadeepa Rural Development and entrusted the study to the Japan International Cooperation Agency (JICA).

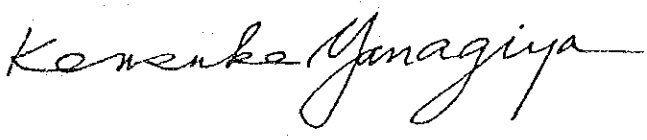
JICA sent to Sri Lanka a study team headed by Mr. Tetsuro Hirano, Director, Land Improvement Engineering Center, Tohoku Regional Agricultural Office, Ministry of Agriculture, Forestry and Fisheries from July 26 to September 15, 1988.

The team held discussions on the Project with officials concerned of the Government of Sri Lanka, and conducted a field survey in Colombo and the Project sites. After the team returned to Japan, further studies were made, a draft report was prepared, and for the explanation and discussion of it, a mission was sent to Sri Lanka. As a result, the present report was prepared.

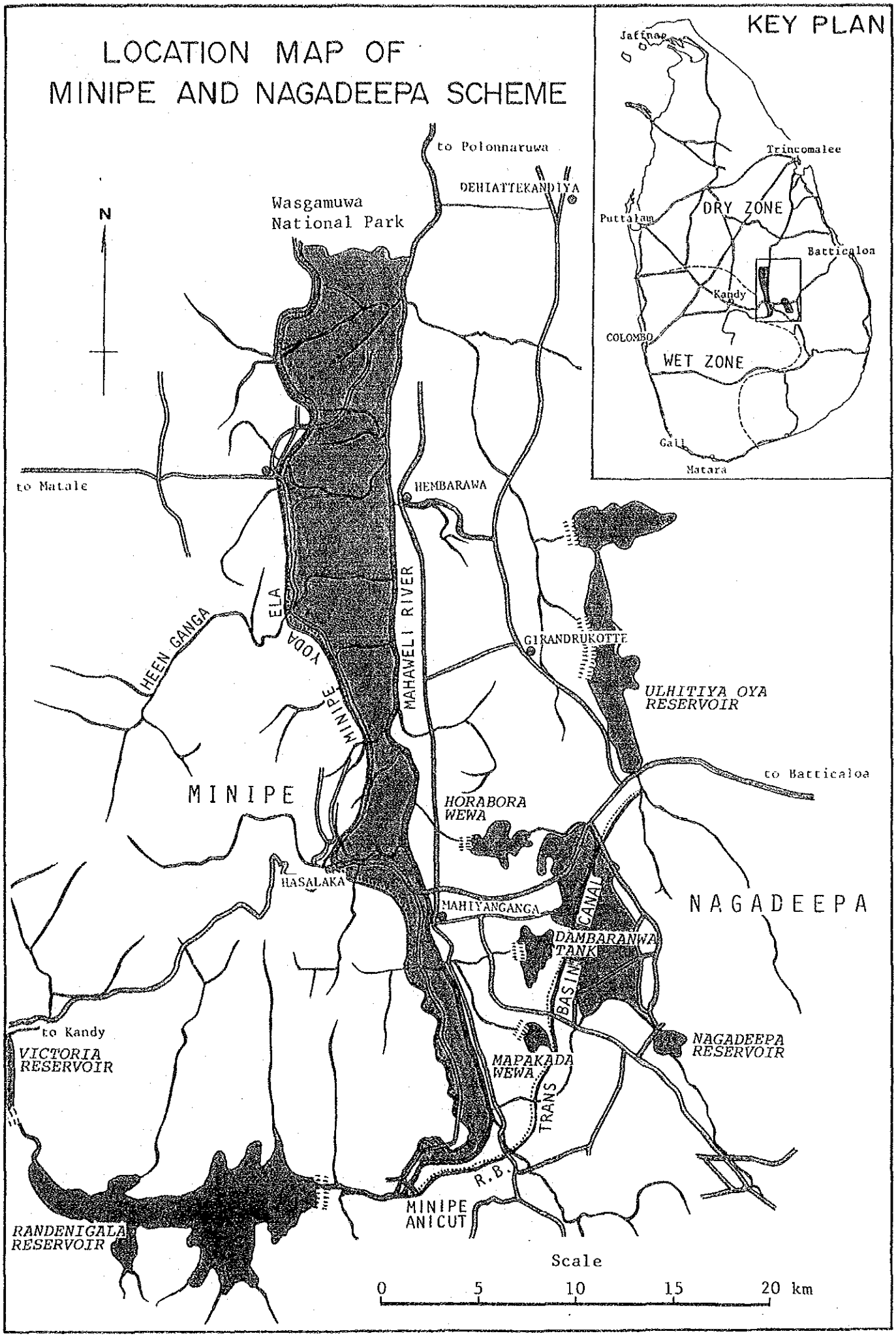
I hope that this report will contribute to the development of the Project and the promotion of friendly relations between our two countries.

I wish to express my sincere appreciation to the officials concerned of the Government of the Democratic Socialist Republic of Sri Lanka for their close cooperation extended to the team.

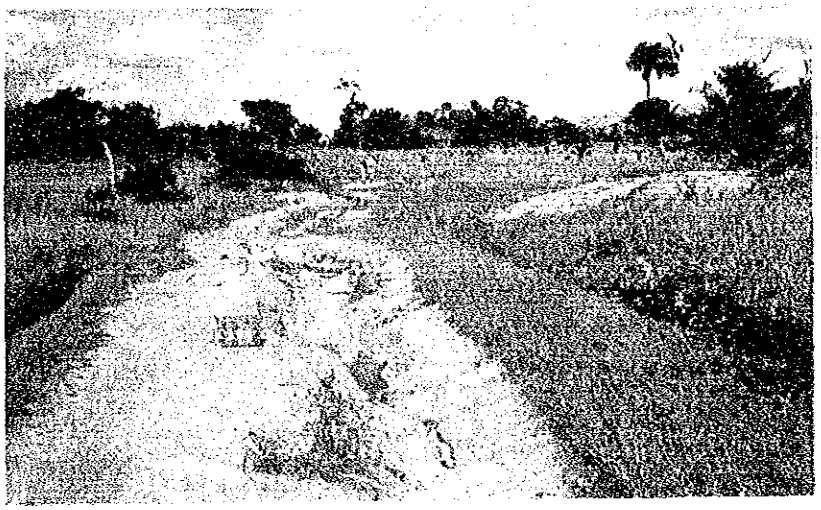
February, 1989



Kensuke Yanagiya
President
Japan International Cooperation Agency

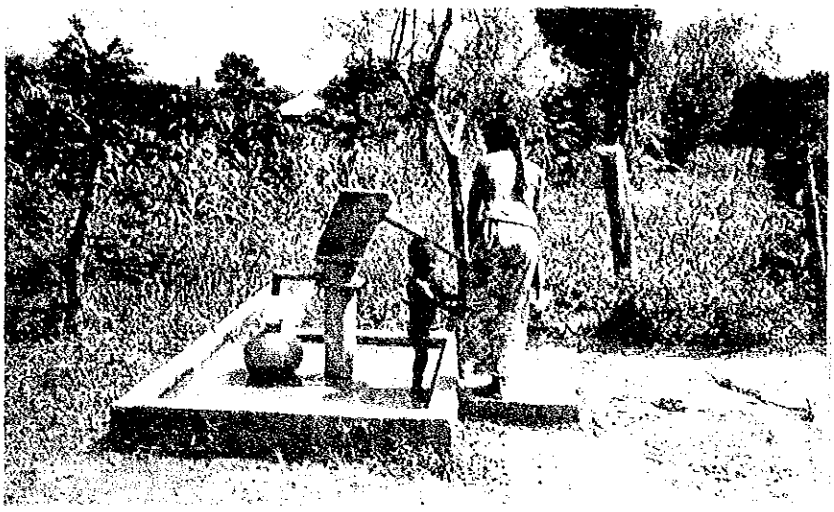

LOCATION MAP OF
MINIPE AND NAGADEEPA SCHEME
KEY PLAN
Jaffna
Trincomalee
DRY ZONE
Puttalam
Batticaloa
Kandy
COLOMBO
WET ZONE
Galle
Matara
N
to Polonnaruwa
DEHIATTEKANDIYA
Wasgamuwa
National Park
to Matale
HEMBARAWA
MAHAWELI RIVER
ELA
YODA
HEEN GANGA
MINIPE
GIRANDURUKOTTE
ULHITIYA OYA
RESERVOIR
to Batticaloa
MINIPE
HORABORA
WEWA
HASALAKA
MAHIYANGANGA
CANAL
NAGADEEPA
DAMBARANWA
TANK
BASIN
to Kandy
VICTORIA
RESERVOIR
NAGADEEPA
RESERVOIR
MAPAKADA
WEWA
TRANS
R.B.
MINIPE
ANICUT
RANDENIGALA
RESERVOIR
Scale
0 5 10 15 20 km

Minipe, Nagadeepa and System-C area

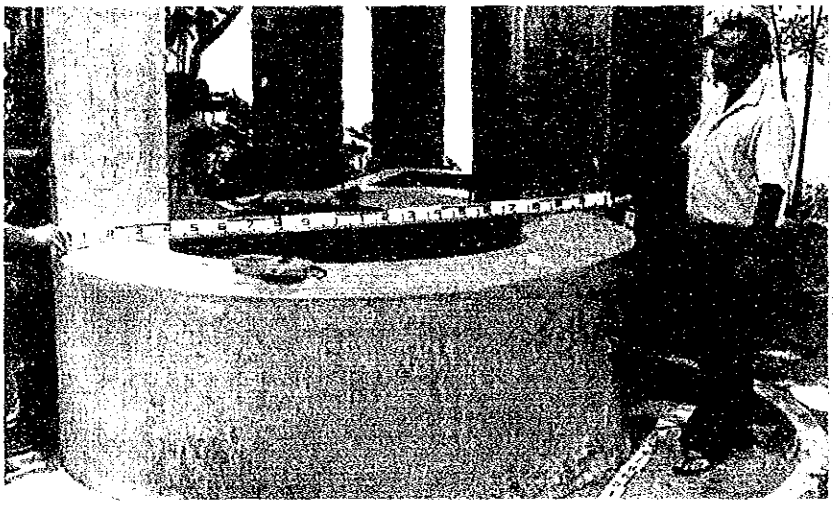


Feeder Road

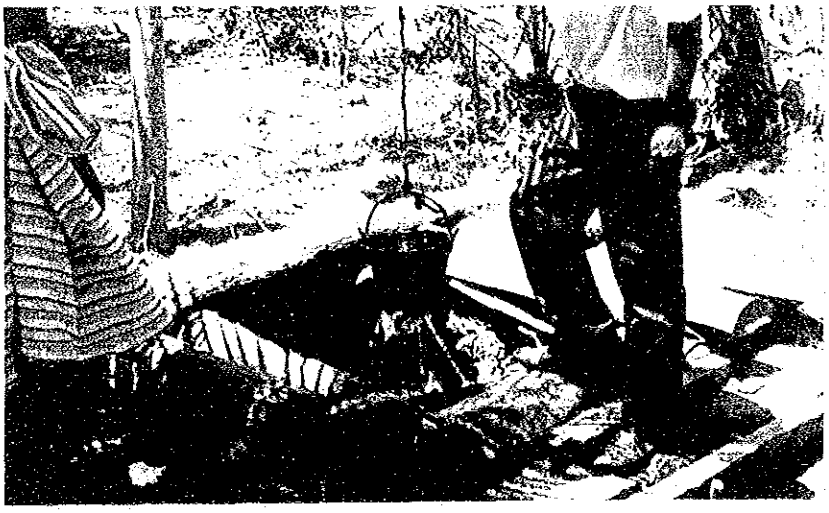
Feeder Road
in the rainy season



Deep tube well



Typical shallow well



Existing Dug Well

SUMMARY

The Democratic Socialist Republic of Sri Lanka is a tropical island country with a land area of 65,610km^2 (one-sixth of Japan's land area) and is located in the Indian Ocean off the southeastern tip of the Indian subcontinent. It is a dominately agricultural country with some 80% of the estimated population of 16.4 million living in rural areas. Agriculture, the main economic activity in Sri Lanka, plays a crucial role in the national economy as it employs almost half of the working population, accounts for nearly quarter of GDP and earns over 40% of export income.

In view of its topographical and climatic conditions, Sri Lanka is divided into a wet zone and a dry zone. The Government of Sri Lanka considers that agricultural development in the dry zone, which covers two-thirds of the nation's land area, is essential for the development of the national economy and has been provided with a large amount of investment for many years in large-scale development projects, a typical example of which is the Mahaweli River Development Project. As a result of such investment in development projects, it has been difficult to secure the necessary funds to maintain the existing irrigation facilities and to consolidate infrastructure of villages. With the deterioration of various facilities, such problems as gaps of the income and living standards between villagers in previously developed areas and those in newly developed areas have arisen.

In the face of these problems, the Government of Sri Lanka has been trying to change its development strategy in the investment plan for 1985 - 89, which was investment in the rehabilitation, consolidation and improvement of such infrastructure as existing irrigation facilities and roads, and in upgrading the living standard of the people.

Under this new economic development strategy, the Government of Sri Lanka has been promoting rehabilitation projects for existing irrigation facilities and comprehensive rural development projects, including social and economic infrastructure construction and consolidation.

The rehabilitation project for the Minipe and Nagadeepa areas (target areas of the present project) was selected as one of these projects. And the Government of Sri Lanka requested the Government of Japan to conduct a feasibility study for the project and the Japan International Cooperation Agency (JICA) carried it out. The feasibility study had been conducted between 1985 and 1986 and, as a result, JICA proposed from the viewpoints of economy and engineering, an agricultural infrastructure (mainly irrigation facilities) rehabilitation project and a rural development project consisting of the improvement of the domestic water supply, road rehabilitation, bridge construction over the Mahaweli River and the development of pasture lands.

Based on the result of the feasibility study, the Government of Sri Lanka decided to implement these projects and made a request to the Government of Japan in July 1987 for the provision of a yen loan for the irrigation facilities rehabilitation project and a grant aid for the rural development project. The former request was approved by the Government of Japan and the Exchange of Notes for the yen loan was concluded between the two governments in April 1988. The Government of Japan also examined the request for the grant aid and decided to conduct a Basic Design Study on the domestic water supply improvement plan and road rehabilitation plan. And JICA sent a Basic Design Study Team to Sri Lanka for the period between July 26 and September 15, 1988 to examine the suitability of the contents of the request for Japan's grant aid and to determine both the necessary and optimal contents and scale of the project.

The Minipe and Nagadeepa areas are located on the right and left banks of the Mahaweli River, at 130km east to the capital city Sri Jayawardenapura (Colombo). In terms of climate, they are located in the semidry zone between the dry and wet zones and suffer from a severe water shortage in the dry season (June to August). They consist of established agricultural development areas, mainly producing paddy rice.

Paddy fields in the Minipe area are mainly irrigated by water from the Mahaweli River. The original irrigation system was developed in the fifth century and some parts of the existing irrigation system and

facilities were built under a development project between 1956 and 1973. In the Nagadeepa area, paddy fields have been mainly formed by the irrigation tank system which was developed in 1972.

The Rural Development Project (hereinafter referred to as the Project), for which Japanese cooperation has been requested, aims at raising the standard of living in the Minipe and Nagadeepa areas by improving the social infrastructure level of these areas and neighboring areas and stimulating local economic activities. The subjects of the Basic Design Study are to make the rual water supply improvement plan and the road rehabilitation plan. The former aims at the construction of new wells and the rehabilitation of existing wells to provide local inhabitants with stable safe domestic water while the latter aims at improving existing roads to provide easy distribution of materials for agricultural production and necessities of life, better agricultural activities and easy marketing of agricultural products. Such plans will thereby contribute to upgrading the standard of living and promoting development in these areas.

Shallow wells are the main source of domestic water for the inhabitants of these areas and the average population per communal shallow well is 310 in the Minipe area and 380 in the Nagadeepa area, far from the national standard of 120 persons (20 households) per well and most of these wells dry up in the dry season. This situation illustrates the difficulty for inhabitants in securing domestic water in the dry season. In comparison, the Mahaweli River Development Project System C area, which is adjacent to these areas, has private shallow wells at the rate of 1 per 1.3 households and these shallow wells do not dry up in the dry season. From the hygienic point of view, water obtained from shallow wells is unsuitable for drinking purposes. On the contrary, deep wells which can supply drinking water are almost non-existent in the Minipe and Nagadeepa areas except for in the northern section of the Minipe area where some deep wells have recently been constructed. In this context, the construction of wells in these areas must be considered a most urgent task in order to supply domestic water which is the most basic requirement for human life.

Meanwhile, road conditions are generally very poor and the maximum possible driving speed at some sections of the trunk roads is as slow as 10km/hr. Most of other roads are passable only by 4-wheel drive vehicles even in the dry season and more than half of them become impassable in the wet season.

For this reason, the provision of bus services (the only means of public transport) is inadequate; villages far from the trunk road are almost isolated from other areas. The present road condition does not serve sufficiently for the transportation of crops as the base of livelihood of the inhabitant, materials for agricultural production and necessities of life.

In view of this situation, it appears to be essential that roads in the Minipe and Nagadeepa areas be rehabilitated to improve the standard of living, stimulate the local economy, and rectify the various gaps between these and other areas.

To improve the above mentioned living conditions, the rural water supply plan is designed to provide a stable supply of domestic water at a rate of 45ℓ/person/day, in which drinking water at a rate of 5ℓ/person/day even in a drought year will be secured taking the current supply, hydrogeological and economic conditions into consideration. The plan consists of the construction of deep and shallow wells and the rehabilitation of existing shallow wells as described below.

	Minipe	Nagadeepa	Total
Construction of Deep Tube Wells	115	44	159
Construction of Shallow Wells	174	53	227
Rehabilitation of Shallow Wells	274	67	341

The shallow wells will be open-type dug wells to accommodate local requests. The deep tube wells will be of the same type as those commonly constructed in Sri Lanka, and an anticorrosive hand pump will be provided with each well in addition to an apron and a drain.

Road rehabilitation priorities have been decided based on both the priority list prepared by the Sri Lankan side and the scope of the Japanese grant aid. The main stress has been placed on the northern section of the Minipe area and the entire Nagadeepa area to improve the road and public transport networks. The target roads have been selected in view of two factors, their importance for local life and the required amount of rehabilitation work which may be beyond the scope of self-maintenance by the local inhabitants. The total length of road scheduled for rehabilitation for each type is as follows:

	Minipe	Nagadeepa	Total
Improvement (Paving) of Roads	20.4km	15.0km	35.4km
Rehabilitation of Paved Roads	2.6km	19.5km	22.1km
Rehabilitation of Gravelled Roads	20.9km	10.1km	31.0km
	43.9km	44.6km	88.5km

As 2 years will be required for both the well construction/rehabilitation and road rehabilitation, the work will be divided into 2 stages pursuantly to the Japanese grant aid system. The Project Area will be divided into 2 areas in terms of location and the construction work in Nagadeepa area will be implemented in the first stage and followed by Minipe in the second stage.

Responsible organization for the Project is the Irrigation Department of Sri Lanka's Ministry of Lands and Land Development under the supervision of the said ministry. Construction work for the Project will be implemented by a Japanese contractor on the basis of a contract with the Irrigation Department under the supervision of a Japanese consultant, both to be selected pursuantly to the Japanese grant aid system.

The implementation of the Project is expected to achieve a number of positive effects including; provision of a perennial safe domestic water in a dry season, prevention of waterborne diseases, reduction of unproductive labour involving women and children, improvement of traffic, vitalization of rural life, development of local communities, improvement

of marketing, modernization of villages, increase of agricultural production, improvement of medical care and rapid communication. In addition, the gap between the standard of living in the target areas and that of neighboring areas will be largely diminished as a result of the Project. The Project is in line with Sri Lanka's current National Development Plan and is believed appropriate as a Japanese grant aid project in view of the fact that it will benefit as many as 86,000 people in the project areas. Its size and contents should also prove appropriate vis-a-vis the Government of Sri Lanka's current limited investment capability.

In conclusion, implementation of the Project with Japanese grant aid is deemed appropriate and its early implementation is recommended.

Maintenance of the facilities to be rehabilitated in this Project should be implemented by the inhabitants. Therefore, the government of Sri Lanka should strengthen the maintenance system by educating the inhabitants in respect of public health, importance of the maintenance and their basic knowledge.

As mentioned above, improvement of the existing road will influence largely to the development of a bus transport network which is deeply expected by the people in the Project area. On the other hand, the Public Bus Transport Centers have a development plan of bus transport network. Therefore, it would be recommended that the executing authority of the Project should discuss the development plan of bus transport network with Public Bus Transport Centers of Matale, Hasalaka and Mahiyangana to realize people's desire and to raise up on effect of this Project.

CONTENTS

CHAPTER 1

INTRODUCTION

CHAPTER 1 INTRODUCTION

The Democratic Socialist Republic of Sri Lanka is a tropical island country with a land area of 65,610km^2 and is located east of the south-eastern tip of the Indian subcontinent. It has a population of 16.4 million (1987 estimate) and is a predominantly agricultural country producing rice, coconuts, tea, rubber, etc. In view of its topographic and climatic conditions, Sri Lanka is largely divided into a dry zone and a wet zone. In the former, rainfall in the 6 months between April and September is only some 15% (approx. 300mm) of the annual rainfall, making agriculture during this season extremely difficult. In addition, water shortages are a recurrent feature of the dry season.

The Government of Sri Lanka has placed priority on the development of this dry zone, which accounts for two-thirds of the nation's land area, and has been promoting a series of large-scale development projects for many years. While these efforts have resulted in significant growth of the national economy, problems related to a worsening financial situation, underdevelopment of the social infrastructure and a depressed standard of living in rural area have arisen. Facing these problems, the Government of Sri Lanka has attempted to change its policies, restricting public investment and new projects, promoting the rehabilitation and effective utilization of existing capital stocks, and also rectifying current gaps in living standards among the different areas. As part of this strategic change, the Government of Sri Lanka prepared irritation facility rehabilitation plans for 10 areas, including the Minipe and Nagadeepa areas which are adjacent to the System C area of the Mahaweli River Development Project, and subsequently requested the Government of Japan to conduct a survey of the said areas.

In response to the Sri Lankan Request, the Government of Japan selected the Minipe and Nagadeepa areas as target areas for the Feasibility Study. The Japan International Cooperation Agency (JICA), commissioned by the Government of Japan, sent the Study Team to Sri Lanka in 1985 and 1986 to conduct the Feasibility Study. The subsequent Feasibility Study Report recommended rural development in both the Minipe and Nagadeepa areas

consisting of rehabilitation of irrigation facilities, improvement of the domestic water supply, rehabilitation of roads, bridge construction over the Mahaweli river and the development of pasture land.

Based on the result of the Feasibility Study, the Government of Sri Lanka decided to make a request to the Government of Japan for a yen loan for the rehabilitation of irrigation facilities to improve the infrastructure related to agricultural production and for grand aid for rural development. Upon receiving this request from the Government of Sri Lanka in July 1987, the Government of Japan examined the possibility of providing grant aid and subsequently decided to conduct the Basic Design Study for domestic water supply improvement and rural road rehabilitation plans.

In response to the decision of the Government of Japan, JICA sent the Basic Design Study Team headed by Tetsuro Hirano, Director of the Land Improvement Engineering Center, Tohoku Agricultural Administration Office, Ministry of Agriculture, Forestry and Fisheries to Sri Lanka for the period between July 26 and September 15, 1988 to examine the suitability of Japanese grant aid and to determine both the necessary and optimal contents and scale of the Project.

The Study Team held a series of discussions on the contents of request with officials of the Government of Sri Lanka and conducted surveys on the current conditions of the domestic water supply, roads, traffic, and local construction capabilities, as well as technical surveys for the preparation of an optimal project plan. The basic agreements of these discussions were compiled as the Minutes of Discussions, and on August 19, 1988 representatives of both governments signed and exchanged the minutes at the Ministry of Lands and Land Development.

On its return to Japan, the Study Team analyzed the field survey results, prepared the project plan, and conducted the basic facility design, project cost estimation, and project assessment. The results of this work were compiled in the Draft Final Report. The Study Team headed by Tetsuro Hirano was sent to Sri Lanka by JICA for the period between November 29 and December 8, 1988 to explain the contents of the Draft Final Report and the present Basic Design Study Report was completed

based on the agreement of the project contents and other relevant items with the Sri Lankan side.

The Minutes of Discussions, Itinerary of Study, List of Study Team Members, List of Interviewed Officials and List of Collected Data and Documents are attached to this report as appendices.

CHAPTER 2

BACKGROUND OF THE PROJECT

CHAPTER 2 BACKGROUND OF THE PROJECT

2-1 Sri Lanka

The Democratic Socialist Republic of Sri Lanka is an island country in the Indian Ocean and is located off the southeastern tip of the Indian subcontinent between 5°55' and 9°50'N latitude and between 79°30' and 81°55'E longitude. It has a total land area of 65,610km^2 (one-sixth of Japan's land area) and an estimated population of 16.4 million (1987), and consists of 9 provinces and 24 districts.

Sri Lanka is generally divided into two climatic zones due to the effects of the mountain range in the centre of the island and the monsoons. The wet zone is in the southwest of the island where Sri Jayawardenapura (Colombo), Sri Lanka's capital, is located while the dry zone covers the north, east and south of the island and comprises two-thirds of the nation's land. (Refer to 3-2-2).

Agriculture is Sri Lanka's most important economic activity and the government has been promoting the National Development Plan with special emphasis on large agricultural development projects, including the Mahaweli River Development Project which is the largest national project in Sri Lanka's history. However, while the Sri Lankan economy has achieved significant growth due to the implementation of these projects, such problems as a worsening state of public finances, deterioration of the existing social infrastructure due to inadequate maintenance, and a depressed of standard of living have emerged.

In view of these problems the government has changed its policy priorities and has reduced public investment of new projects to divert funds to the management and maintenance of existing infrastructure with the aim of improving living standards. The Public Investment Plan 1985 ~ 1989 is currently in progress to achieve these objectives and the implementation of the Rural Development Project was decided on as part of the new economic development

strategy. The Public Investment Plan allocates 24.4%, 36.6% and 16.1% of the total funds to the agricultural sector, economic infrastructure, and social infrastructure respectively.

2-2 National Development Plan and Plans Relevant to the Project

At present, a five year public investment plan which is the economic development plan is prepared annually in the form of a rolling plan. The Public Investment Plan currently in progress was prepared pursuant to the economic readjustment policies aiming at stabilizing government finance and the international balance of payments through investment restrictions and has the following objectives.

① achievement of high economic growth and modernization of the economic structure
② creation of new employment opportunities
③ general improvement of the standard of living
④ fair distribution of the national income
⑤ maintenance of stable government finances and a stable national economy

The following investment strategies have been set to achieve these objectives.

① allocation of substantial government funds to the management and maintenance of existing infrastructure
② restriction of new government investment in those fields where development efforts by the private sector should prove more appropriate and efficient
③ limitation of new investment for nonurgent projects

The Minipe and Nagadeepa Rehabilitation Project, of which the Rural Development Project is part, was prepared pursuant to these strategies and is part of a series of projects which include those for the rehabilitation and improvement of the rural infrastructure (including irrigation facilities and roads) and those for the

provision and improvement of welfare and educational facilities.

While the objectives of the Rural Development Project are in line with those of the above projects, the Project itself is related to the following projects.

(1) Minipe and Nagadeepa Rehabilitation Project

In response to a request by the Government of Sri Lanka, JICA conducted the Feasibility Study for the Rehabilitation of Tank Irrigation Project between 1985 and 1986. As a result JICA proposed the Minipe and Nagadeepa Rehabilitation Project aiming at: ① rehabilitation of deteriorated irrigation facilities in these two areas to enable effective water utilization, in turn increasing agricultural production and improving farming techniques; ② improvement of the social infrastructure and living environment of villages in addition to increasing the income of farmers; and ③ eradication of the bottleneck (i.e., the geographical isolation of these areas) limiting the development of the local economies in order to improve the living standards of the local residents and to increase employment opportunities for the second and third generations.

The Government of Sri Lanka divided the Minipe and Nagadeepa Rehabilitation Project into two projects, namely, ① the Minipe and Nagadeepa Irrigation Rehabilitation Project aiming at agricultural infrastructure rehabilitation, and ② the present Rural Development Project (hereinafter referred to as the Project) aiming at social infrastructure improvement and local development, and requested the Government of Japan's provision of a yen loan for the former and grant aid for the latter.

The Government of Sri Lanka's request for the Irrigation Rehabilitation Project (total project cost: 2,230 million yen) was approved by the Government of Japan and the Exchange of Notes for the yen loan (1,850 million yen) was concluded between the two countries in April 1988. The loan agreement for the Irrigation

Rehabilitation Project was completed on July 15, 1988 between the Government of Sri Lanka and the Overseas Economic Cooperation Fund (OECF). The Irrigation Rehabilitation Project mainly aims at the rehabilitation of irrigation canals (including canal O.M. roads) and related facilities and is planned to commence in 1988 with completion in 1994.

(2) Integrated Rural Development Project

The Integrated Rural Development Project (IRDP) was given high priority in the first public investment plan due to the Government of Sri Lanka's recognition of the importance of rural development, and has been continuously implemented since 1979 in various districts with various types of foreign assistance, including the assistance of the World Bank. As the name suggests, the IRDP is a comprehensive development project for rural areas and covers such diverse fields as agriculture, irrigation, fisheries, forestry, animal husbandry, domestic water, electricity, roads, education, health care, recreation, sports, administration and culture with different priorities from one district to another. The IRDP was implemented in 13 districts between 1979 and 1986 and has been in progress in a further 2 districts since 1987.

The IRDP was implemented in the Matale District, to which Minipe's Stage III and IV areas belong (see 3-1), in 1979 and has almost been completed. Twenty shallow wells have been constructed in these Stage III and IV areas in accordance with the domestic water supply plan and 20km of gravel roads have been rehabilitated in accordance with the road rehabilitation plan. In comparison, the IRDP in the Kandy District, to which Minipe's Stage I and II areas belong (see 3-1), was only approved in 1987, and a concrete project plan was unavailable at the time of the present study. While implementation of the IRDP has been in progress since 1982 in the Badulla District, to which the Nagadeepa area belongs, well construction and road rehabilitation are not planned for the Nagadeepa area.

(3) DANIDA Project

The DANIDA Project is being implemented with the assistance of the Government of Denmark. Fifty-two deep wells and 19 shallow wells were constructed in 1986 in the Stage III and IV areas of Minipe in addition to the rehabilitation of 102 shallow wells. This project plans the construction of a further 24 deep wells in the future.

(4) Other directly related projects

The UNICEF Children's Development Project, sponsored by the United Nations and completed in 1986, constructed 80 shallow wells in the Stage III and IV areas of Minipe.

It has been decided that the implementation of a housing project named the Gamudawa Program will commence in 1989 in Mahiyangana, located on the opposite side of the Mahaweli River facing Minipe's Stage II area. As part of this project, the rehabilitation of the canal O.M. road for the Minipe Main Irrigation Canal (which acts as the area's trunk road) will be conducted for the section between Hasalaka and Hettipola to provide an access road to the housing project area.

(5) Mahaweli River Development Project

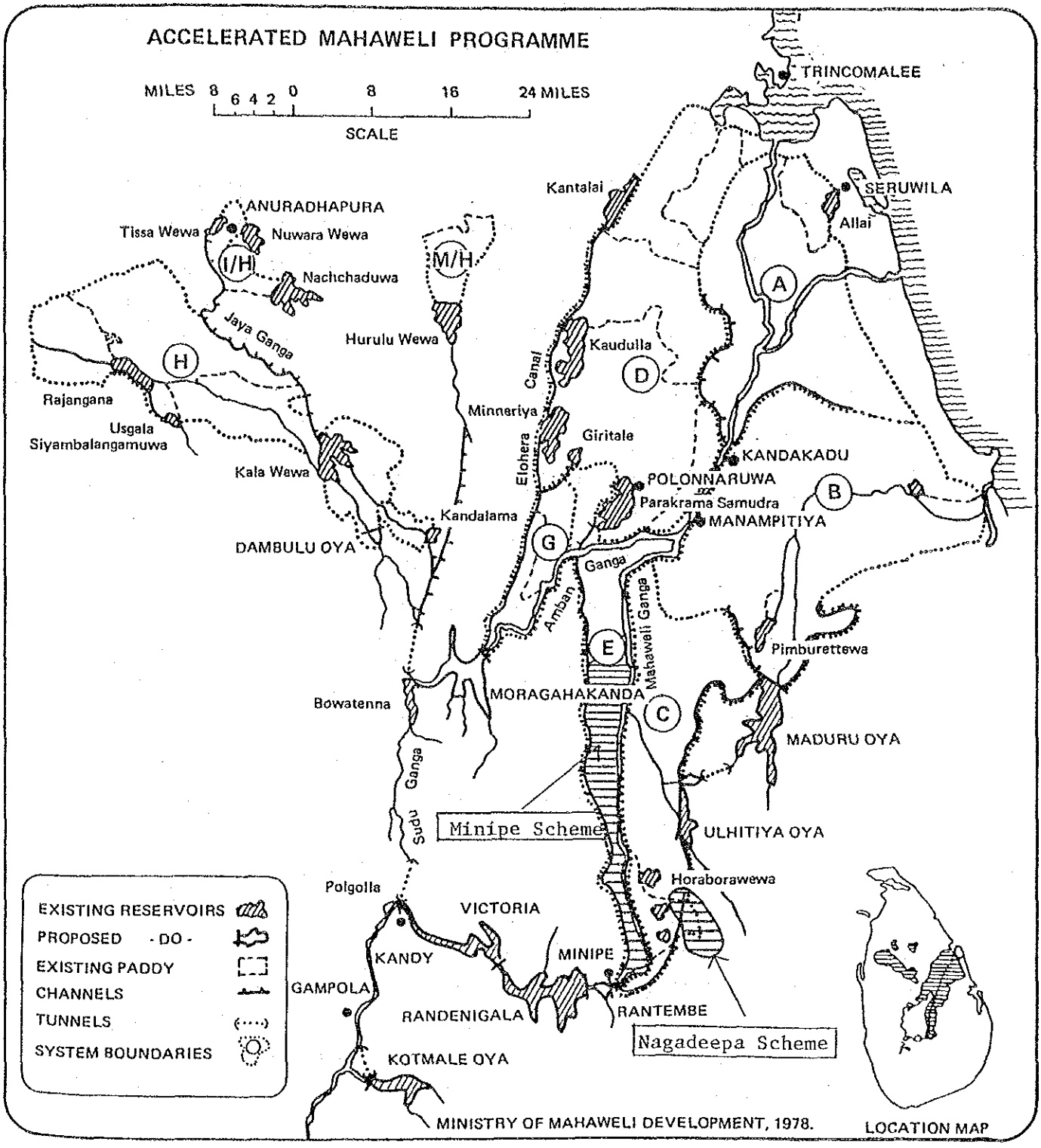
With the technical assistance of the UNDP/FAO, the Government of Sri Lanka prepared the Mahaweli River Development Project (Master Plan) in 1968 with the main aims of developing 360,000ha of irrigated farmland and providing 500MW of hydroelectric power generation in order to achieve three major policy objectives; eradication of food shortages, increasing employment opportunities, and eradication of power shortages. Consequently development efforts were initiated in the Mahaweli River Basin in accordance with the Master Plan. However, the Government of Sri Lanka subsequently considered the original implementation period of 30 years to be too long to achieve the early materialization of the expected benefits and consequently prepared the Accelerated Mahaweli Programme in 1977 to complete the main projects given in

the Master Plan within 5 years.

The Accelerated Mahaweli Programme aimed at simultaneously solving the problems of food shortages and increasing unemployment, fast becoming series at that time, and also at promotion of the development of hydroelectric power generation to alleviate the heavy economic burden imposed on the country by rising oil prices. The Government of Sri Lanka revised the Accelerated Programme the following year (1968) and implemented a series of projects pursuant to the revised plan. The construction of 4 multipurpose dams on the Mahaweli River and 1 multipurpose dam on the Maduru River and the development of 58,000ha of irrigated farmland (part of the System B, C & H areas), and the generation of some 530MW of hydroelectric power had almost been completed by the end of 1987.

The project for the System C area located opposite the Minipe area facing the Mahaweli River targets the channeling of water from the Minipe Anicut (head works) on the Mahaweli River through the R.B. Trans Basin Canal in order to irrigate 24,100ha of Farmland. The work is currently in progress with the assistance of Japan and the World Bank (Figure 2-1-1), and is planned to be completed in 1990.

Fig. 2-2-1 Location Map of Accelerated Mahaweli Programme



2-3 Contents of the Request

The objectives and contents of the Minipe and Nagadeepa Rural Development Project, for which the cooperation of the Government of Japan has been requested by the Government of Sri Lanka, are described below.

2-3-1 Objectives of the project

The objectives of the Project are to raise living standards in the Minipe and Nagadeepa areas, stimulate economic growth in these areas, and narrow the gap in both living standard and established social infrastructure levels between these and neighboring areas.

2-3-2 Contents of the project

(1) Domestic water supply facilities construction plan for Minipe and Nagadeepa areas

The plan aims at consolidation of the domestic water (mainly drinking water) supply facilities through the construction of new wells and the rehabilitation of existing wells and the upgrading of the local inhabitants' standard of living in terms of a stable supply of safe water which is comparable with that of neighboring areas.

	Minipe	Nagadeepa
a) rehabilitation of existing wells	500 wells	100 wells
b) construction of shallow wells	110 wells	85 wells
c) construction of deep tube wells	50 wells	20 wells

(2) Road rehabilitation plan for Minipe and Nagadeepa areas

The plan aims at the stimulation of farming and social activities and the achievement of a smooth transportation flow for agricultural products and production materials through the rehabilitation of existing farm and village roads.

		Minipe	Nagadeepa
a)	rehabilitation of village roads	19km	6km
b)	rehabilitation of farm roads	12km	12km

In the course of discussions with the Government of Sri Lanka, the Government requested the revision of the length of roads scheduled for rehabilitation. The list of the revised request for road rehabilitation was submitted to the Study Team on August 23. The requested length of roads scheduled for rehabilitation is now 155km for the Minipe area and 88km for the Nagadeepa area as shown on Appendix 1-5.

(3) Bridge construction plan for Mahaweli river

Minipe's Stage III and IV areas (see 3-1) are bordered by mountains to the west, by the Mahaweli River (Sri Lanka's biggest river) to the east and by a conservation area to the north, and are located in the eastern corner of the Matale District. These geographical and administrative characteristics have constrained the development of the areas both socially and economically. In contract, with the advancement of the Mahaweli River Development Project, the project's System C area located on the opposite side of the Mahaweli River is fast becoming the largest food production area in the dry zone.

Against this background, the plan provides for construction of a bridge over the Mahaweli River to directly connect the Stage III and IV areas with the System C area, thereby removing the constraints on local economic development and stimulating the social, economic and cultural activities of the inhabitants.

(4) Pasture development plan

The plan provides for the conversion of uncultivated land to pasture to promote animal husbandry in the Minipe area.

While the request of the Government of Sri Lanka originally consisted of the four above plans, (3) and (4) have been dropped

from the Basic Design Study due to the extensive work required for the former and the latter's deviation from the objectives of the Project, i.e., consolidation of a base for rural life or of the social infrastructure.

When the Minutes of Discussions were signed on August 18, 1988, however, the Government of Sri Lanka made a strong request to the Study Team for the implementation of these two plans on the grounds that the Bridge Construction Plan should be given the highest priority and that all four plans are indispensable parts of the overall Minipe and Nagadeepa Rehabilitation Project.

CHAPTER 3

OUTLINE OF THE PROJECT AREA

CHAPTER 3 OUTLINE OF THE PROJECT AREA

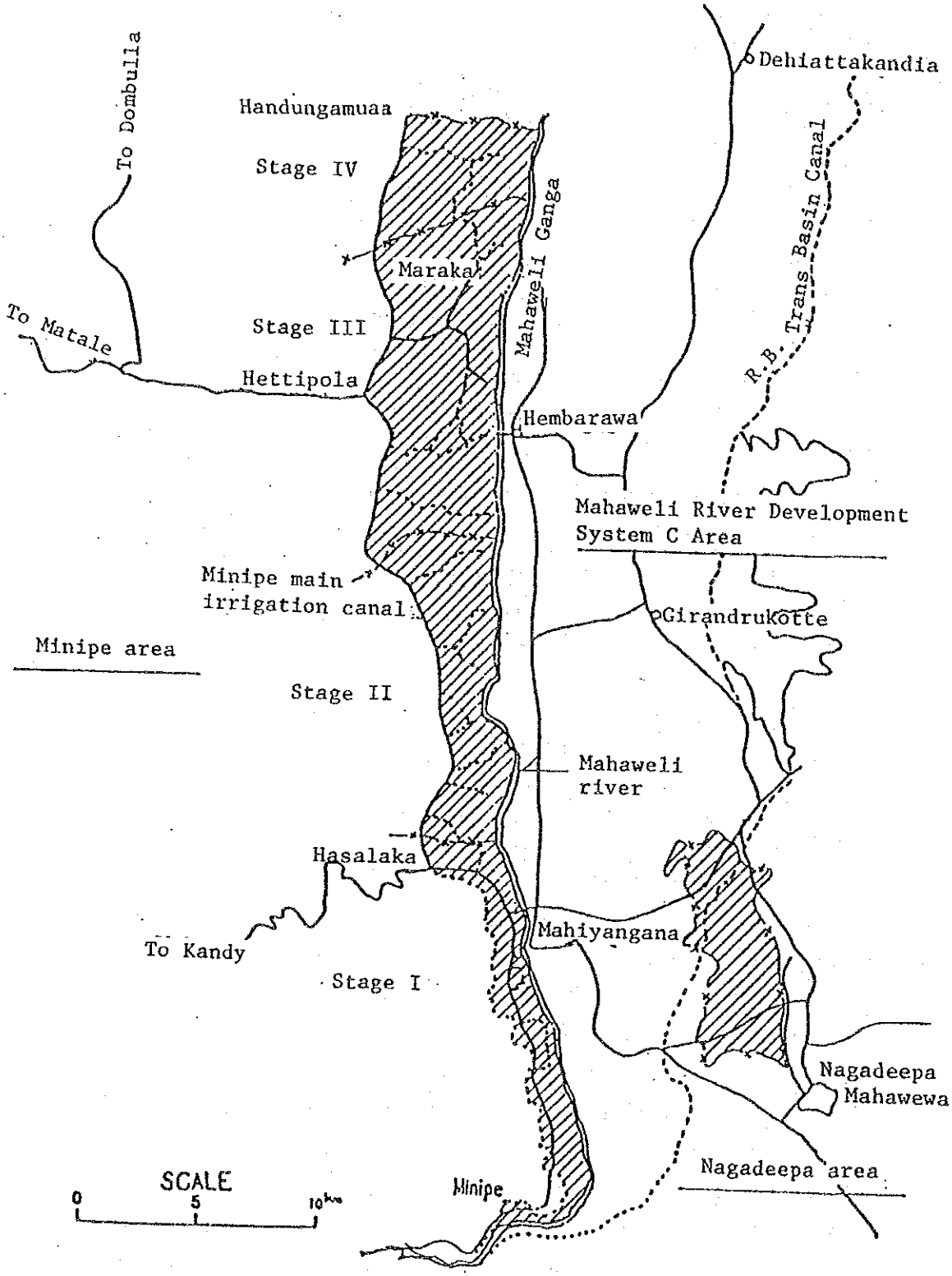
3-1 Project Area

The area included in the Project (hereinafter referred to as the Project Area) are the Minipe Yoda Ela Scheme area and the Nagadeepa Maha Wewa Scheme area.

The Project Area is located at about 130km to the east of Colombo. The Minipe and Nagadeepa areas are located on the left and right banks respectively, of the Mahaweli River which is the biggest river in Sri Lanka and which flows from south to north through these areas in the semi-dry zone. In an administrative context, the Minipe area belongs to Central Province and extends over Kandy and Matale Districts which are divided by the Heen River, a tributary of the Mahaweli River, while the Nagadeepa area belongs to Bintene AGA Division of Badulla District in Uva Province.

The Minipe area (shown in Figure 3-1-1) stretches in a north-south direction between the Mahaweli River and the Minipe Main Irrigation Canal (total length of 74km) which starts at the Minipe Anicut on the Mahaweli River. It is designated an agricultural development area and has a population of some 72,000. Of its land area of approximately 18,600ha, 12,000ha is used for farming, including 6,100ha of paddy fields. The area was first inhabited as long ago as the fifth century. Some of the present irrigation facilities were constructed in the 1930s and an expansion program was implemented between 1956 and 1973 to form the present Minipe area. The Minipe area is divided into four sub-areas called Stages I to IV on the basis of their respective sequence of development which took place from south to north. The Stage I and II areas belong to the Minipe AGA Division of Kandy District while the Stage III and IV areas belong to the Wilgamuwa AGA Division of Matale District. The town of Hasalaka is located on the boundary between the Stage I and II areas and is 65km from Kandy on State Road A26, a drive of about two and a half hours.

Figure 3-1-1 Location of the Subject Areas of Project



The Nagadeepa area is located some 8km east of the Minipe Stage I area on the opposite side of the Mahaweli River. Its development was completed in 1972 and a reservoir constructed on the Heppola River, a right-bank tributary of the Mahaweli River, serves as the area's water source. It is designated a reservoir and irrigation development area and has a population of some 15,000. Of its total area of 4,600ha, 2,700ha is used for farming, including 1,800ha of paddy fields. The area widens towards the northwest from the reservoir located at its southern end. The Trans Basin Canal which channels water to the System C area of the Mahaweli River Development Project crosses the northwestern section of the area.

3-2 General Social and Economic Conditions

3-2-1 Population and Land Use

Both the Minipe and Nagadeepa areas are agricultural settlement areas which were developed with the provision of irrigation facilities. Table 3-2-1 shows the current land use pattern while Table 3-2-2 shows the population as of August 1988 and the estimated population in 1995 (using the annual average population growth rate of 1.7% for rural areas in Sri Lanka).

Table 3-2-1 Land Use (1986/87 Wet Season)

	Minipe	Nagadeepa
Paddy Fields	8,000ha	1,800ha
Highland	3,600ha	900ha
Uncultivated Land	1,500ha	700ha
Rocky Land, Reservoirs, Rivers, Channels and Roads, etc.	5,500ha	1,200ha

Table 3-2-2 Population and Number of Households

	Minipe					Nagadeepa
	I	II	III	IV	Total	
Population	19,830	25,020	19,610	7,570	72,030	14,790
Number of Households	3,200	4,190	3,300	1,240	11,960	2,470
Future Population (1995)	22,300	28,200	22,100	8,500	81,100	16,600

In terms of the administrative organization, each district consists of AGA divisions (Assistant Government Agent's Divisions), which in turn consist of GS divisions (Gramasevaka Divions). Table A3-5-1a shows the population in the Minipe area by GS divisions while Table A3-5-1b shows the population in the Nagadeepa area by tracts (areas introduced at the time of original development).

3-2-2 Employment

Both the Minipe and Nagadeepa areas currently have no industries worth noting except agriculture in which most of the inhabitants are engaged. While the Minipe area has the lowest rate of unemployment in Kandy District (6%), the ratios of landless farmers and food stamp holders are the District's highest at 28% and 66% respectively, indicating the low level of the standard of living (Table A3-2-1).

Due to inadequacy in irrigation water in the dry season, which is so-called the Yala season from May to September (refer to 3-2-2), in the Nagadeepa area, cultivation of paddy fields is made impossible for the inhabitants.

3-2-3 Land Ownership

Settlers in the Stage I area, the earliest developed area in the Minipe area, were originally allocated to 5 acres (2ha) of paddy fields and 1 acre (0.4ha) of highland per household, while later settlers in Minipe's other Stages to 2 acres (0.8ha) paddy fields and 1.3 acres (0.5ha) highland per household and in the Nagadeepa area were only allocated 2 acres (0.8ha) of paddy fields and 0.5 acres (0.2ha) of highland per household. Initially, settlers were only given the right to cultivate. In recent years, however, land ownership has been authorized under a system called Swarnabhoomi and accordingly, the division of land and its inheritance are now permitted with the stipulation that the minimum land area be 1.5 acres (0.6ha) of paddy fields and 0.5 acre (0.2ha) of highland per descendant.

In reality, however, farmland is unofficially divided into smaller plots for inheritance, resulting in such problems as the illegal cultivation of public land and the illegal conversion of highland to paddy fields. For example, although the official paddy filed area is 5,000ha in the Minipe area, a further 1,000ha is under illegal cultivation. A similar situation exists in the Nagadeepa area, in addition to the unauthorized practice of renting farmland to outsiders.

Mahiyangana Temple in the Minipe area is still in possession of 450ha which is rented to farmers who pay in rice.

3-2-4 Agriculture

The main crop in the Project Area is paddy. Double cropping is practiced throughout almost all of the Stage I and II areas and the crop intensity of paddy in the Stage III and IV areas are 100% in the wet season (Maha) and 40% in the dry season (Yala). The single cropping of paddy rice is practiced in the Nagadeepa area due to the water shortage in the dry season.

The paddy rice yield varies. While the unit yield in the Stage I and II areas is equivalent to the national average of 3.7 tons/ha, the unit yield in the Stage III/IV and Nagadeepa areas is 2.7 - 3.5 tons/ha and 1.8 - 3.5 tons/ha respectively, showing the low productivity of these areas. In addition to paddy, minor amounts of chillis, cowpeas, green grams, soybeans, maize, bananas, papayas, etc., are cultivated.

Mechanized farming has not yet been widely adopted and water buffaloes are used for 85% of the ploughing. Table 3-2-3 shows the types and number of farming machines in use in the Project Area.

Table 3-2-3 Types and Number of Farming Machines Currently in Use

	Tractors		Sprays		Water Pumps
	2-Wheel	4-Wheel	Manual	Powered	
Stage I and II Stage III and IV	45 23	46 35	480 375	9 3	46 47
Total	68	81	855	12	93
Nagadeepa	4	5	20	1	2

With regard to the marketing system for agricultural products, only rice has an established system, i.e., farmers - Cooperatives - Paddy Marketing Board - Rice mills - Food department warehouses - Cooperatives. The marketing of all agricultural products in the Project Area is generally hampered by the poor road conditions.

Table 3-2-4 shows the income levels of farming families in the Project Area.

Table 3-2-4 Income of Farming Families

	Stage I/II	Stage III/IV	Nagadeepa
Wet Season	5,385 Rp	4,981 Rp	2,696 Rp
Dry Season	5,341 Rp	1,661 Rp	-
Total	10,726 Rp	6,642 Rp	2,696 Rp

3-2-5 Rural Industries

No major rural industries have developed in the Minipe area except small rice mills, carpentry shops, bakeries, ironmongeries, etc., and only some 1,000 people (1.4% of the total population) are employed in these industries.

The situation is similar in the Nagadeepa area which has only a small textile centre, brick factory and workshops (Table A3-2-1).

3-2-6 Sphere of Village Life

Hasalaka and Morayaya are two centres for the daily life of the inhabitants of the Stage I and II areas while Hettipola plays the same role for the inhabitants of the Stage III and IV areas. The social life of the latter, however, is generally not as active as that of the former due to the poor road and transportation conditions. The results of the survey on the sphere of village life for the Minipe area are shown in Table A3-2-3a.

Table A3-2-3b gives the results of the survey on the sphere of village life for the Nagadeepa area. Apart from the dry season when many people seek temporary employment outside the area, activities are confined to a relatively small area.

Since most of the Project Area's inhabitants are Sinhalese Buddhists, the religious centre of the Project Area is Mahiyangana where a highly respected temple is located.

3-2-7 Constraints on Social and Economic Development

Factors imposing constraints on the social and economic development of the Minipe area are considered to be the inadequate social infrastructure due to population increase, low productivity due to the shortage of water and the division of farmland into small plots due to generational changes and the lack of sufficient employment opportunities except for agriculture. These factors have created a vicious circle, lowering the income level and reducing investment efforts. The Stage III and IV areas located in the far corner of Matale District and bordered by a mountain range to the west, the Mahaweli River to the east and Wasgamuwa National Park (conservation area) to the north have a particularly isolated location. Reflecting this locational disadvantage, the volume of physical distribution in these areas is extremely low, preventing social and economic development. In this context, the rehabilitation of irrigation facilities and local roads, direct connection with the Mahaweli River Development Project System C area which is rapidly becoming a large economic area in the neighboring dry zone and promotion of local industries other than agriculture have long been hoped for.

In addition to the shortage of water which is of crucial importance, factors preventing the social and economic development of the Nagadeepa area are similar to those of the Minipe area.

3-2-8 Conditions of Mahaweli River Development Project System C Area

The System C area, which includes the Mahiyangana area and which is adjacent to the Project Area, is a large agricultural development area with a total of 66,100ha, of which 24,100ha will be irrigated. The planned number of settlers is 30,000 households, including 6,000 nonfarming households. Settlement

commenced in 1980 and 14,000 households had moved into the area by the end of 1987 (planned completion of settlement: 1990). The System C area has 63 hamlets, 20 village centres, 9 area centres and 2 cities (i.e., Girandurukotte and Dehiattekandiya), and is expected to form a large economic zone with the largest agricultural production base in the dry zone in the near future.

Figure A3-2-1 and Table A3-2-4 show the location of the System C area and the social infrastructure construction schedule respectively.

3-3 Natural Conditions

3-3-1 Topography

The Project Area is located slightly to the southeast of the center of Sri Lanka between 7°15'N latitude and 80°50'E longitude in the dry zone and is 130km east of Colombo and 40km east of Kandy, an ancient capital.

(1) Minipe Area

The Minipe area is located between the Mahaweli River and the Main Irrigation Canal which takes in irrigation water from the Minipe Anicut (head works) on the Mahaweli River and narrowly stretches in a north-south direction along the Main Irrigation Canal which runs along the mountain range parallel to the Mahaweli River. The Main Irrigation Canal has a total length of 74.2km and was originally an ancient irrigation canal constructed in the fifth century. The construction of a series of dams has been in progress on the Mahaweli River under the Mahaweli River Development Project, including the Victoria Dam (23km upstream from the Project Area) and the Randenigala dam (5km upstream from the Project Area), both of which were completed in recent years. The construction of the Rantambe Dam is currently in progress immediately upstream from the Project Area. The right bank of the Minipe head works is the starting point of the R.B. Trans Basin Canal of the Mahaweli River Development Project.

The Minipe area is bordered by the Mahaweli River to the east and by the mountain range to the west while the area north of the Main Irrigation Canal is Wasgamura National Park which is a conservation area. The general topography of the Minipe area is characterized by an eastward slope from the foot of the mountain range (EL approx. 1,500m) towards the Mahaweli River (EL approx. 60m).

The overall topography of the Stage I and II areas is rather simple with slight undulations of an elevation of approx. 80 -

90m. Many houses and dry fields are located in the highland area and the lowland area is used for paddy fields. The Stage III and IV areas are generally flat (EL approx. 75m) despite a slight gradient and monadnocks (EL 90 - 2,000m) of unweathered gneiss formed by segregated erosion (relative elevation difference of 20 - 130m). There are few trees although some tall trees are found in villages and village perimeter areas. Most of the land is used for paddy fields. Many tributaries of the Mahaweli River, including the Hasalaka and Heen rivers, flow eastward through these areas.

The elevation gradually declines from 90m in the Stage I area to 70m in the Stage IV area.

National highway A26 (Kandy - Mahiyangana Road) runs near the boundary of the Stage I and II areas. This trunk road is the only road with a bridge over the Mahaweli River in the Project Area. The only roads crossing the mountain range to the west and connecting the Minipe area with areas in the west are A26 and the Hettipola - Matale Road in the Stage III area. The only trunk road running in a north-south direction in the Minipe area uses the embankment of the Main Irrigation Canal and comes to a dead end at the Randenigala Dam site upstream and the conservation area downstream.

(2) Nagadeepa area

The Nagadeepa area is located some 10km southeast of Mahiyangana, a historically famous temple city, on the right side of the Mahaweli River and stretches for some 12km in a north-south direction and 5 - 6km in a east-west direction. The distance from the area to Badulla, the capital of Badulla District to which the area belongs, is 48km.

The topography of the Nagadeepa area is characterized by hills and its elevation declines from 100 - 150m in the southwest towards the northwest. The area has many undulations and scattered

villages and tall trees can be observed in the highland. The slopes of the hills are used for both paddy and dry fields. The Nagadeepa Reservoir on the Heppola River, a tributary of the Mahaweli river, is located in the southeastern corner of the Nagadeepa area and serves as the area's water source.

Although the R.B. Trans Basin Canal of the Mahaweli River Development Project runs through the west of the Nagadeepa area, the area cannot use water from the canal due to the canal's lower elevation. National highway A26 runs across the northern end of the area.

3-3-2 Climate

Sri Lanka is a tropical island country located between 5°55' and 9°50'N latitude and between 79°30' and 81°55'E longitude and has a total land area of some 6.5 million ha. A dry wind prevails in the northern, eastern and southeastern parts of the island (three-quarters of the total land area) during the southwest monsoon season (Yala season) between May and September which is caused by the Fohn phenomenon due to the effects of the mountain range in the centre of the southern part of the island and seasonal winds. Figure A3-3-1 shows the rainfall distribution in the dry season. In comparison, rainfall is recorded all over the island during the northeastern monsoon season between February and May (Maha season) as shown in Figure A3-3-1.

The average annual rainfall of Sri Lanka is approx. 1,900mm. Areas with average annual rainfall of less than 1,900mm are classified as the dry zone while areas with average annual rainfall of more than 1,900mm are classified as the wet zone. Areas on the border line are classified as the intermediate zone (Figure 3-3-1).

Figure 3-3-1 Climatic Zones in Sri Lanka

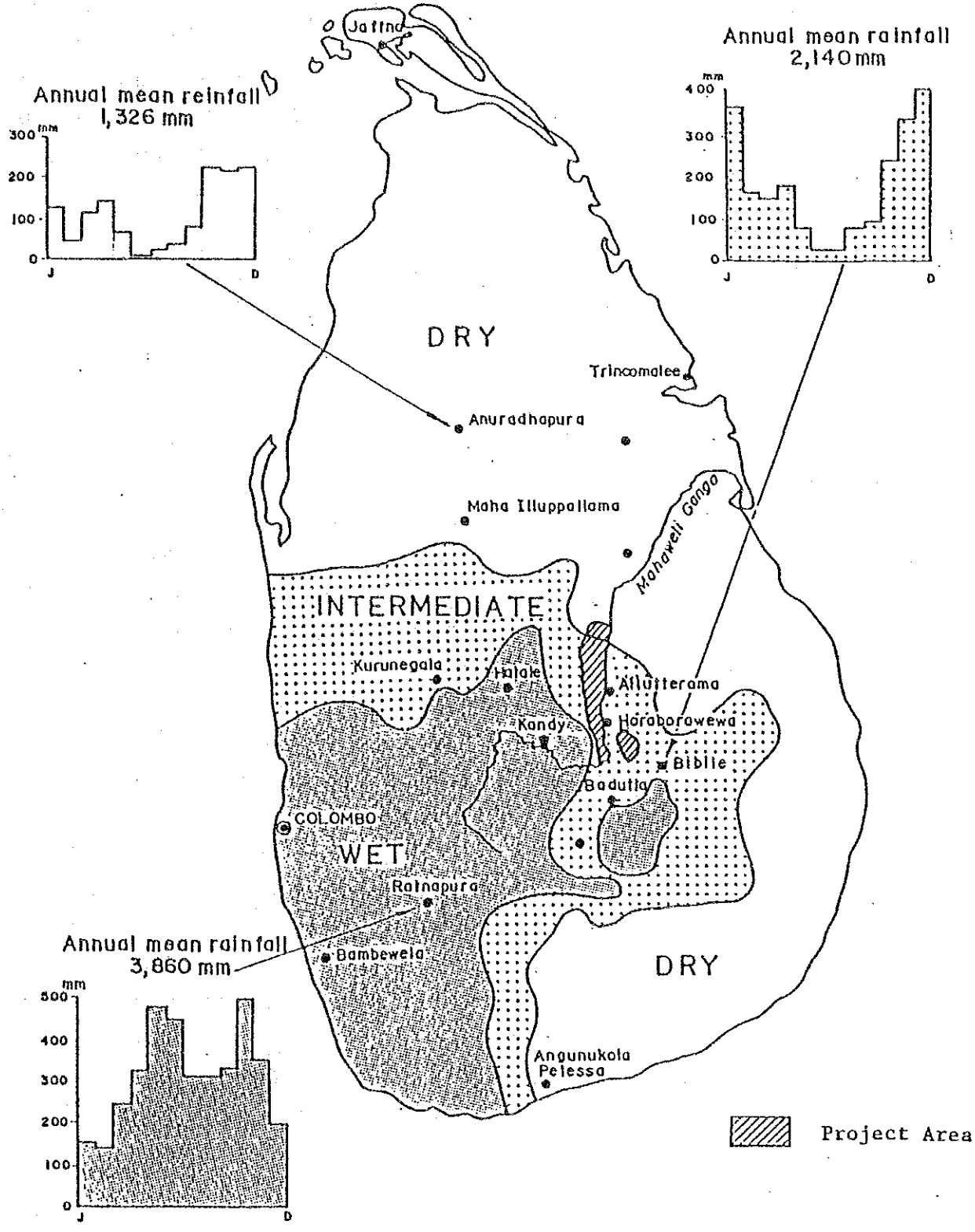


Table 3-3-1 Mean Monthly Meteorological Data (Girandurkotte Section)

Month	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Max. Temperature in C°	29.9	31.5	33.6	34.9	35.7	35.9	36.3	36.2	35.3	33.2	31.3	29.
Min. Temperature in C°	21.0	20.9	21.7	22.7	23.2	23.0	21.6	23.2	22.6	22.0	22.1	21.
Mean Relative Humidity in %	81	78	74	73	71	60	58	57	63	73	82	85
Max. Relative Humidity in %	87	85	84	82	78	68	66	64	68	81	86	88
Mean Wind Velocity in km/hr	2.6	2.5	2.6	2.6	2.6	4.5	5.3	5.1	4.0	3.1	2.9	2.
Sunshine Hour	4.8	6.4	7.3	7.1	7.4	6.8	6.6	6.5	6.5	6.0	4.4	3.
Evaporation in mm/day	3.3	3.8	4.4	4.4	4.3	5.6	6.4	6.1	5.3	4.2	3.4	2.
Rainfall in mm/month	194	156	154	120	73	8	76	39	126	255	353	431

Table 3-3-2 Monthly Rainfall (Hasalaka Station)

Year	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL	AVER
1981	128	216	84	36	44	0	105	0	0	28	-	331	-	-
1982	57	-	178	114	77	0	13	0	51	243	407	585	-	-
1983	139	23	-	50	180	35	75	0	0	139	219	578	-	-
1984	548	166	150	29	4	0	31	0	152	114	226	229	1,649	137
1985	215	214	71	137	23	11	0	63	58	291	333	594	2,010	168
1986	595	215	105	52	29	23	0	0	0	302	312	546	2,179	182
1987	332	61	208	258	156	5	0	5	234	228	329	300	2,116	176
Aver.	288	149	133	97	73	9	32	10	71	198	308	452	1,820	152

The Project Area is located in the intermediate zone and has annual rainfall of 1,800 - 2,000mm, of which 85% is concentrated in the 6 months between October and March. Consequently, the Project Area faces a critical water shortage in the dry season, making it difficult to secure even domestic water.

The nearest weather observation station to the Project Area is located at Girandurukotte at 7°27'N and 80°58'E with an elevation of 96m. Temperature, relative humidity, wind velocity, sunshine hours, rainfall and evaporation volume observations have been conducted since April, 1976. Table 3-3-1 shows the average monthly values of these observation items while Table 3-3-2 gives the rainfall record at the Hasalaka Irrigation Department Office in the Minipe area.

3-3-3 Geology

Almost 90% of the rocks in Sri Lanka are hard crystalline gneiss, granite or similar types which have been subject to conspicuous metamorphism from the Pre-Cambrian to the Early Paleozoic and are considered to be part of the South India Block (consisting of metamorphic rocks) formed in the Pre-Cambrian and, therefore, are very stable. The remaining 10% are sedimentary rocks formed in the Mesozoic Jurassic, limestone sedimented in the Cenozoic Miocene and Quaternary deposits which are thinly spread over the older rocks (Table 3-3-3).

Although gneiss is dominant on gneiss rocks which have undergone harsh metamorphism, close examination finds them to be composite rocks containing crystalline schist, granite, coarse granite and crystalline limestone. Scattered intrusive rocks consisting of volcanic rocks are also observed. Metamorphic rocks in Sri Lanka are classified into the following 3 groups in terms of the rock faces, geological structure and geographical distribution (Figure A3-3-2).

① Highland Series
② Southwestern Group
③ Vijayan Series

The Project Area is in the Vijayan Series zone near the demarcation line between the Highland Series and Vijayan Series zones and has well developed folds with a north-south axis. A geological map and geological cross-section map of the Project Area are given in Figures 3-3-2 and 3-3-3 respectively. Areas of weathered residual soil and alluvia are indicated as alluvium areas on the geological map.

Table 3-3-3 Geological Formation of Project Area

Geological Age			Geological Formation	
Era	Period	Epoch		
Cenozoic	Quarternary	Alluvium	laterite, coral, coastal terrace	Deposits
		Diluvium	red clay, green gravel	
	Tertiary	Miocene	Jafuna limestone	
Mesozoic	Cretaceous		basalt dyke (in parts)	Sedimentary Rocks
	Jurassic		Tabbowa beds, Andigama beds	
Palaeozoic			granite, granogneiss a) Vijayan Series: gneiss	
Proterozoic	Pre-Cambrian		Southwestern Group: schist, khondalite b) Highland Series: crystalline schist, granite, Kataragama complex	Meta-morphic Rocks

a) subject to metamorphism between 450 and 550 million years ago
b) subject to metamorphism between 1.3 and 1.5 billion years ago

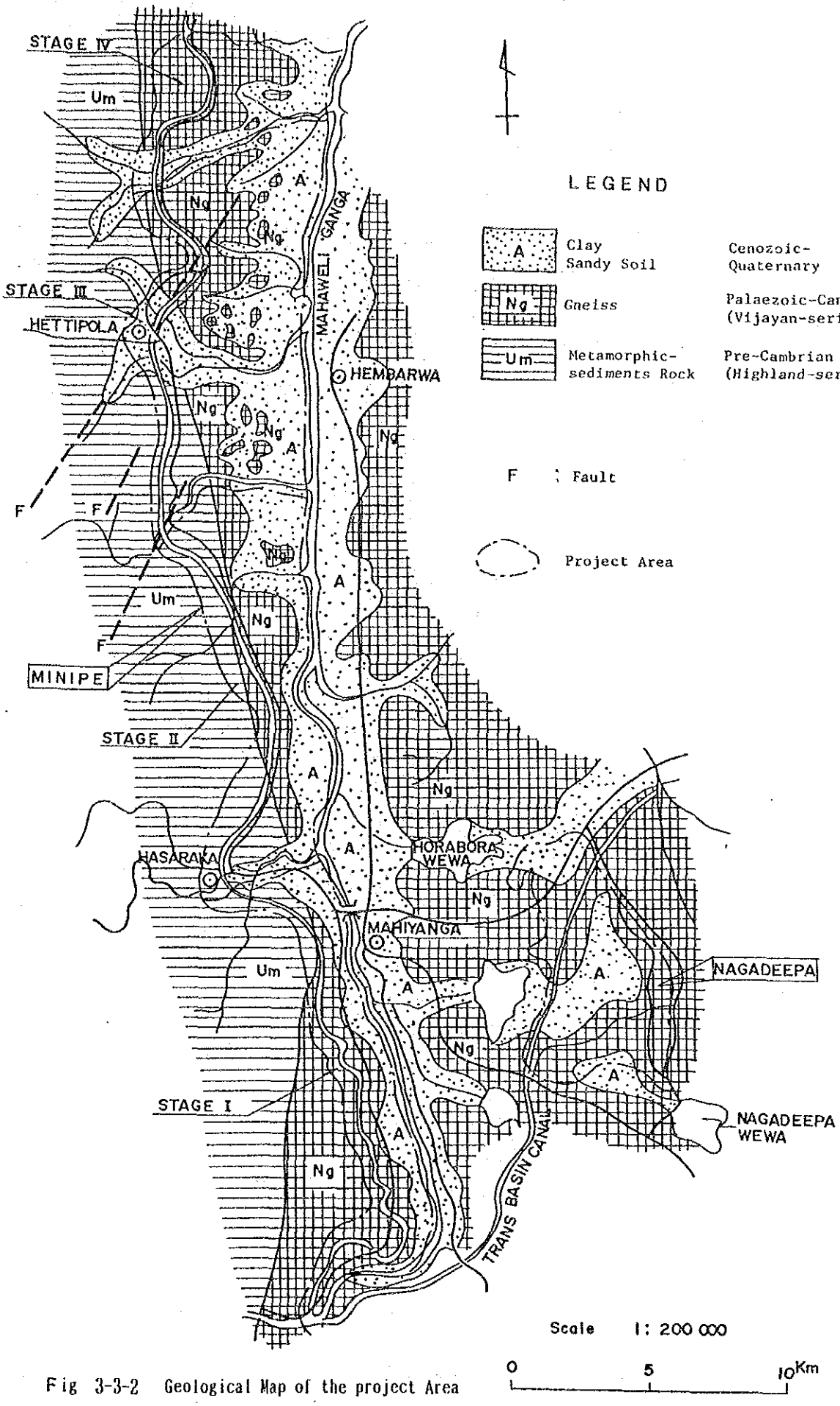


Fig 3-3-2 Geological Map of the project Area

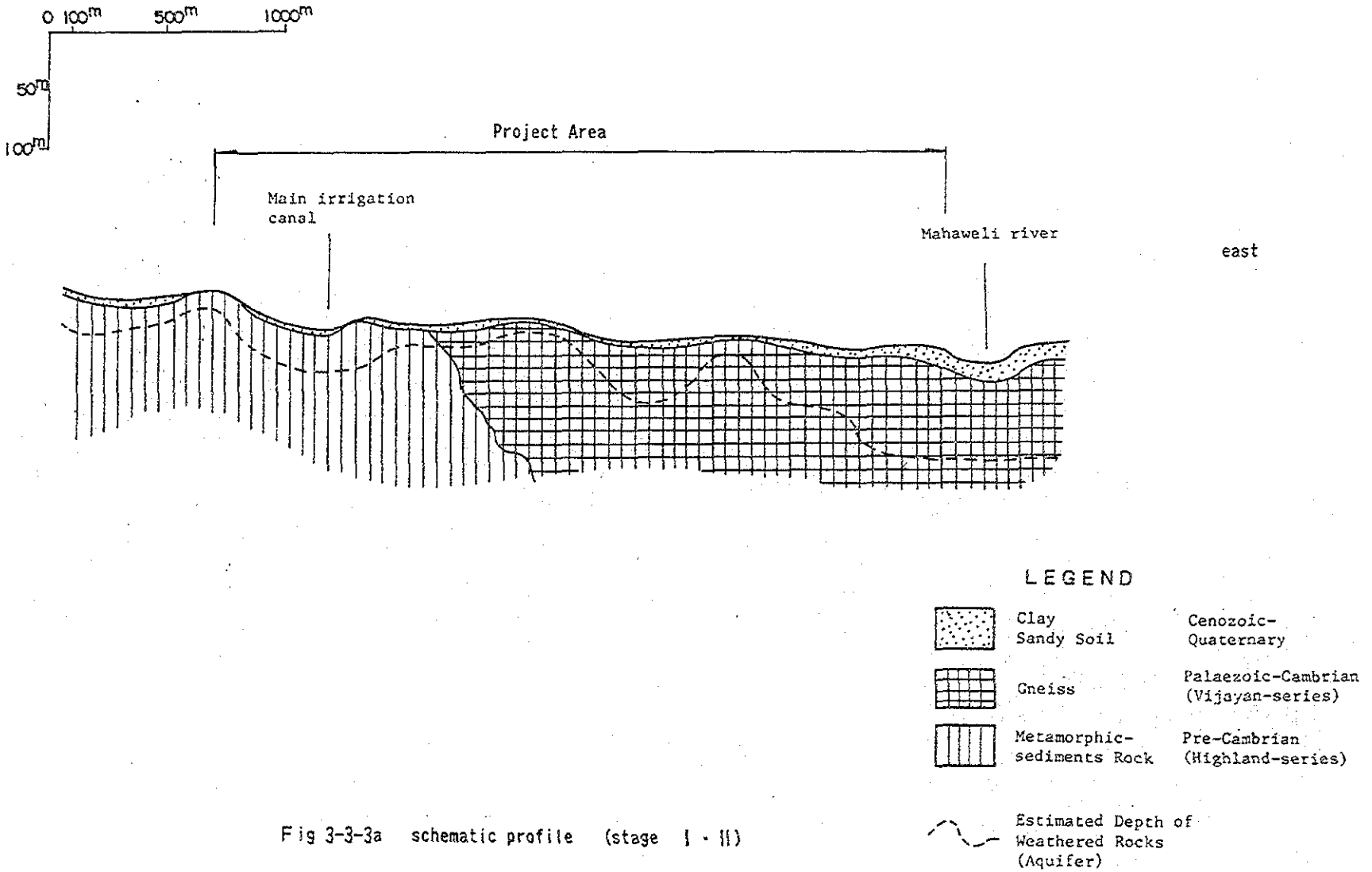


Fig 3-3-3a schematic profile (stage I - II)

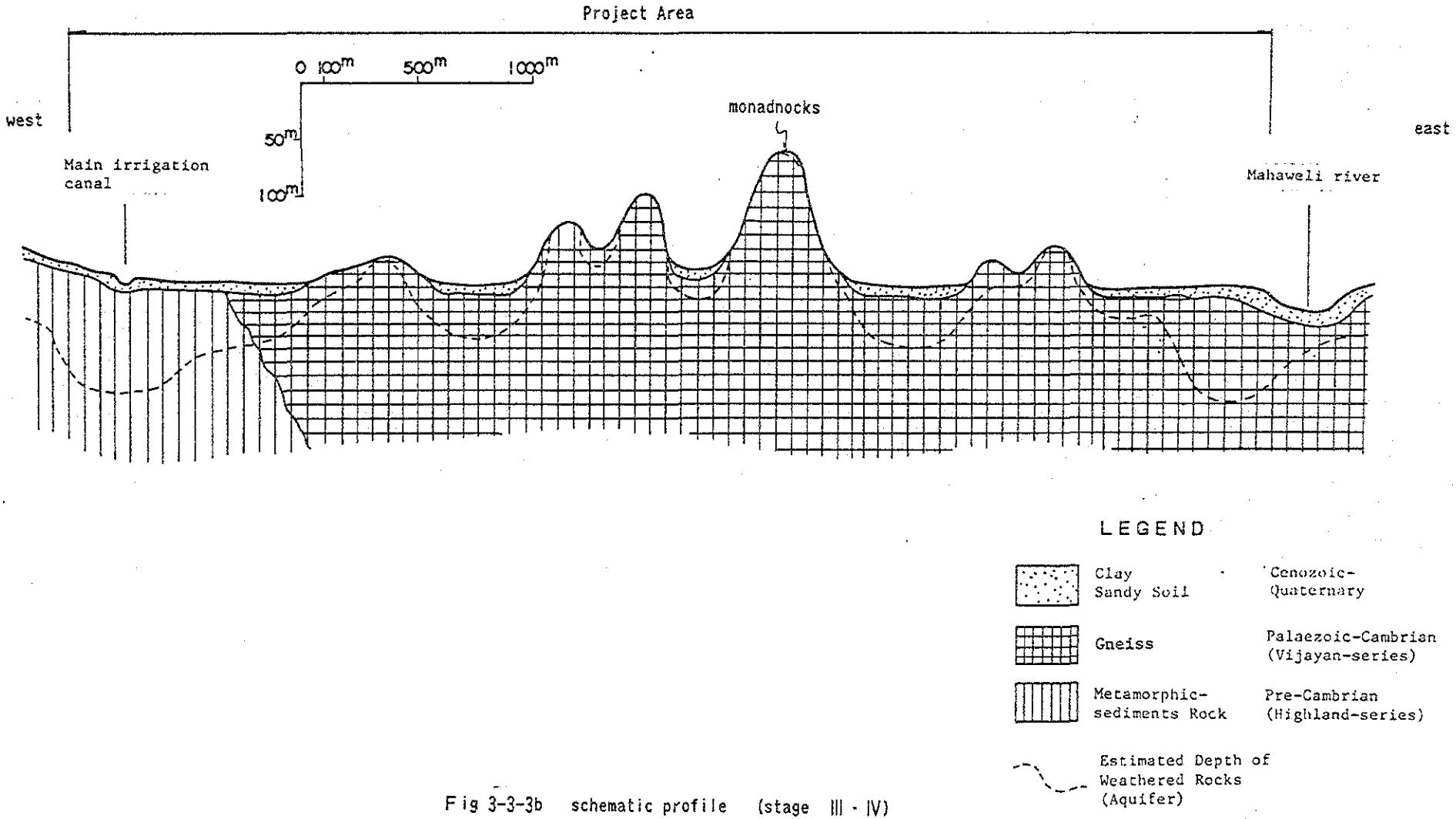
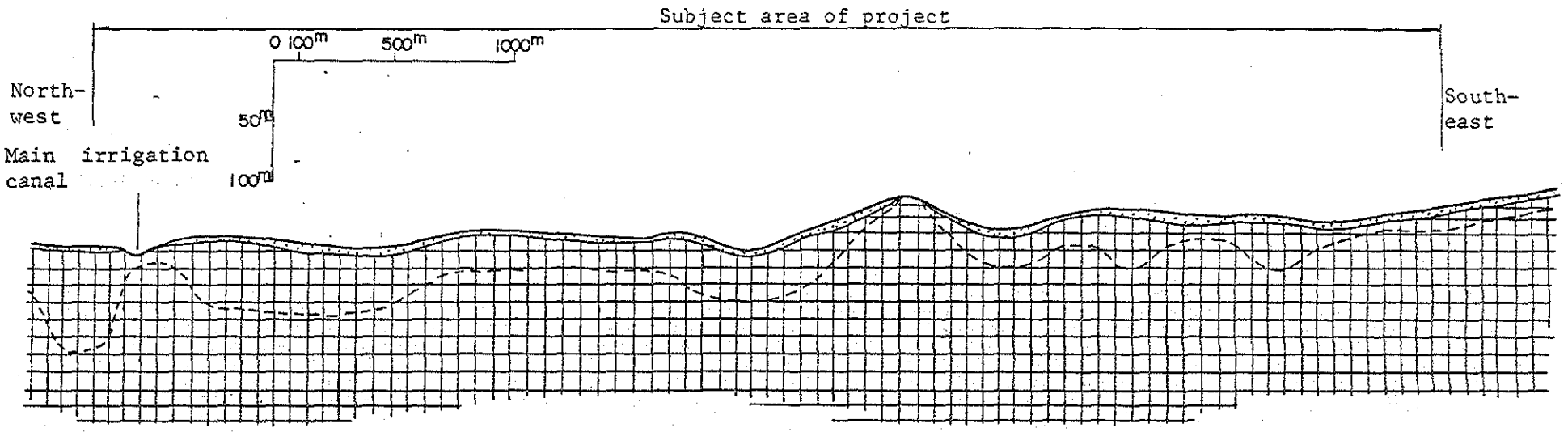


Fig 3-3-3b schematic profile (stage III - IV)



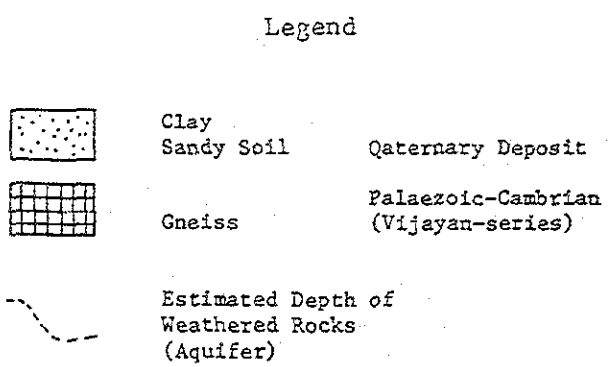


Fig. 3-3-3c Geologic Section(Nagadeepa)

3-4 Hydrogeology

3-4-1 Hydrogeology of the Project Area

The Project Area is classified into the following 3 areas in terms of its hydrogeological conditions.

(1) gently sloping Minipe Stage I and II areas
(2) basically flat Minipe Stage III and IV areas with many scattered monadnocks of unweathered gneiss
(3) hilly Nagadeepa area

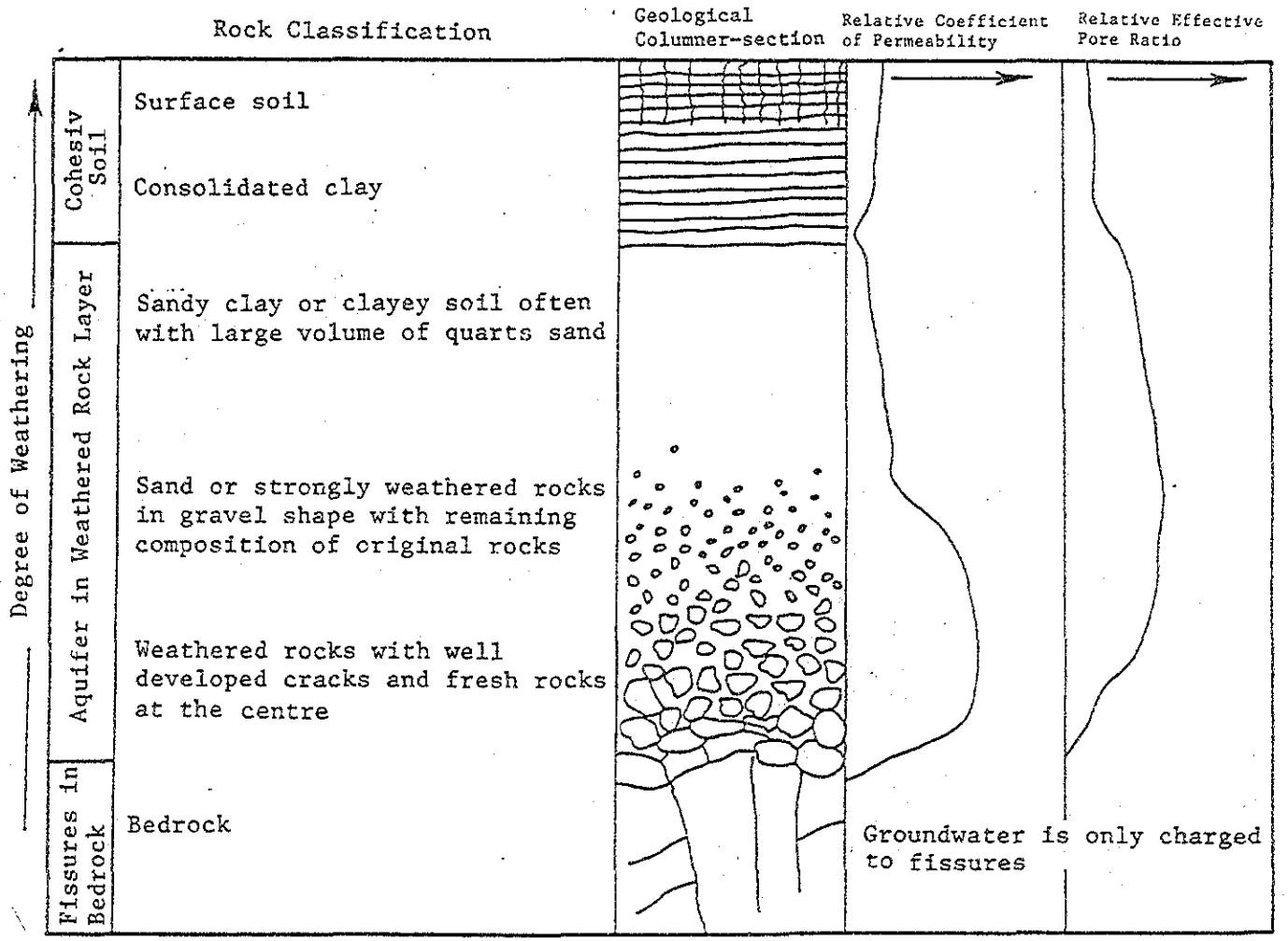
Cohesive soil (mostly farming soil) with low permeability is dominant in the Stage I and II areas. However, as this cohesive soil layer is thin and as strongly weathered rocks with well-developed cracks are distributed below the clayey soil layer, forming aquifers, surface water and rainwater easily permeate through the top layer.

The Stage III and IV areas have many monadnocks of unweathered gneiss and little permeation of rainwater into the ground can be expected. In places other than monadnock areas, the hydrogeological conditions are suitable for groundwater accumulation, as in the case of the Stage I and II areas.

The Nagadeepa area is slightly undulated and the gentle slopes used for farming have low permeability. However, the top cohesive soil layer is thin, no monadnocks of unweathered gneiss exist and weathered rocks with well-developed cracks are extensively spread below the top layer, forming aquifers.

In all areas, aquifers are formed by weathered rocks with well-developed cracks and the groundwater level shows seasonal fluctuations. The distribution of these aquifers is largely determined by the bedrock type, geological structure and thickness of the weathered rocks. An example of aquifer formation by weathered rocks is given in Figure 3-4-1.

Figure 3-4-1 Aquifer in Weathered Rock Layer



3-4-2 Electric Prospecting Results

(1) Summary

Electric prospecting was conducted by the Study Team to obtain an understanding of the hydrogeological structure, distribution of aquifers, and groundwater conditions in the Project Area.

The target sites were arbitrarily selected in those villages and surrounding areas where the construction of wells is planned. Although it would have been preferable to conduct as much prospecting as possible to obtain a more accurate understanding of the underground hydrogeological structure, the following number of prospecting sites was decided on for each area in view of the limited field study period of 1.5 months, the necessity of guessing the actual geological structure through topographical surveys in this limited time period, and the size of the Project Area.

Electric Prospecting Sites

Area	No. of Sites
Minipe - Stage I	12
Stage II	12
Stage III	17
Stage IV	12
Nagadeepa	17
Total	70

(2) Method and equipment

The equipment used was the standard 3244 model widely used in Japan. A depth of up to 100m was prospected using the Wenner method while Sundberg's standard curve method and the direct sight method were used for analysis purposes.

Equipment Used

Model	Specifications
3244	Current: 100mA Electric Measuring Potential: 150/300/600V Power Source: DC12V

(3) Prospecting results

The cross-sectional resistivity for each area was determined based on the prospecting results (Figure A3-4-1). As Figure A3-4-2 shows, 3 to 4 layers were identified. Table 3-4-1 gives the prospecting results for each area.

Comparison of these cross-sectional resistivities and the geological formations shows a correspondence between the 1st layer and dry clay, between the 2nd, 3rd and 3' layers and strongly weathered or weathered rocks and between the 4th layer and slightly weathered or unweathered rocks.

Cross-Sectional Resistivity Values and Geological Formations

Layer	Cross-Sectional Resistivity (Ω-m)	Thickness or Depth (m)	Corresponding Geological Formation
1	3 - 1,320	1 - 7	dry surface soil and cohesive soil
2	10 - 99	0 - 28	wet cohesive soil, sandy soil, strongly weathered rocks (gravel - sand)
3	100 - 580	0 - 96	strongly weathered rocks (gravel), weathered rocks (with many cracks)
3'	613 - 930	0 - 70	weathered rocks (with little cracks), slightly weathered rocks
4	1,020 - 14,000	4 - 100<	slightly weathered or unweathered rocks

Table 3-4-1 Results of Electric Prospecting

Area		1st Layer		2nd Layer		3rd Layer		3'rd Layer		4th Layer		Remarks
		ρ	t	ρ	t	ρ	t	ρ	t	ρ	t	
MINIPE	I	28-205	1-3	11-99	0-12	112-540	0-34	756-930	0-27	1,020-10,000	6-80	3'layer is located in a part of the 3rd layer. There are a few layers which have low resistivity in the 4th layer.
	II	52-390	1-4	22-93	0-28	100-490	0-96	613-920	0-62	1,175-10,000	7-72	"
	III	3-1,320	1-3	10-88	1-9	108-580	9-72	625-900	0-24	1,150-10,000	14-100<	"
	IV	18-900	1-4	18-90	1-7	125-580	0-43	720-920	0-59	1,020-5,000	11-100<	"
NAGADEEPA		27-324	1-7	12-92	0-11	100-550	0-56	624-855	0-70	1,050-14,000	4-80	"

ρ : Resistivity of layer (Ω-m)
t : Thickness of layer (m)

(4) Aquifers

Table 3-4-2 gives the results of the comparison between the prospecting results and the available data on existing deep wells in the Stage III and IV areas (relevant materials were collected during the study visit). According to these comparison results, the cross-sectional resistivities of the layers up to the depth of the existing wells have a range between 113 and 810 Ω-m, corresponding to the values of the 3rd and 3'layers in the table above. Coupled with the fact that the average depth of the existing wells (approx. 40m) corresponds to the assumed depth of the 3rd and 3' layers (6 - 35m), the 3rd and 3'layers distributed in the Project Area are considered to provide good aquifers.

As the electric prospecting results for the Stage I and II areas, as well as for the Nagadeepa area, were similar to those for the Stage III and IV areas, the utilization of groundwater accumulated in the 3rd and 3'layers is considered feasible except for those places where the 4th layer has a shallow depth.

The 4th layer, with a resistivity of over 1,000 Ω-m, consists of bedrock with small cracks and the accumulation of ground-water in this layer cannot be expected except for those areas bordering the 3rd layer.

The average depth of the 4th layer and the distance from the bottom of existing wells to this layer are shown in Table 3-4-2. Since the depth of the 4th layer is considered to be generally less than 10m in the eastern part of the Nagadeepa area, the implementation of a more thorough survey is deemed necessary to construct deep wells with sufficient yield.

Table 3-4-2 Comparison Between Electric Prospecting Results and Available Data on Existing Wells

Available Data					Prospecting Results		Approx. Distance Between Prospecting Site & Existing Well
Area	Well No.	Main Geological Formation	Well Depth (m)	Yield (ℓ/min)	Resistivity Value (Ω-m) & Corresponding Layer	Distance from Bottom of Existing Well	
Stage III	WI-4	weathered rocks (gneiss)	30.0	398.0	113-480 (3) 780 (3')	18.0-29.0 10.0-18.0	200m
	WI-8	weathered rocks (metamorphic limestone)	36.0	398.0	350-400 (3)	0.0-31.0	"
	WI-14	weathered rocks (gneiss)	33.0	23.0	700 (3)	11.0-29.0	"
	WI-16	weathered rocks (gneiss)	48.0	18.0	810 (3)	18.0-38.0	100m
	WI-23	weathered rocks (charnockite)	69.0	5.0	528 (3) 620 (3')	56.0-64.0 39.0-56.0	"
	WI-29	weathered rocks (granogneiss)	31.0	30.0	456 (3)	26.0-41.0	"
Stage IV	WI-19	weathered rocks (gneiss)	30.0	10.0	256 (3) 740 (3')	19.0-24.0 0.0-19.0	"
	WI-46	weathered rocks (gneiss)	30.0	32.0	245-460 (3)	0.0-25.0	"
	WI-50	weathered rocks (gneiss)	31.0	30.0	190-480 (3)	11.0-28.0	200m
	WI-55	weathered rocks (gneiss)	31.0	30.0	398 (3)	11.0-22.0	300m

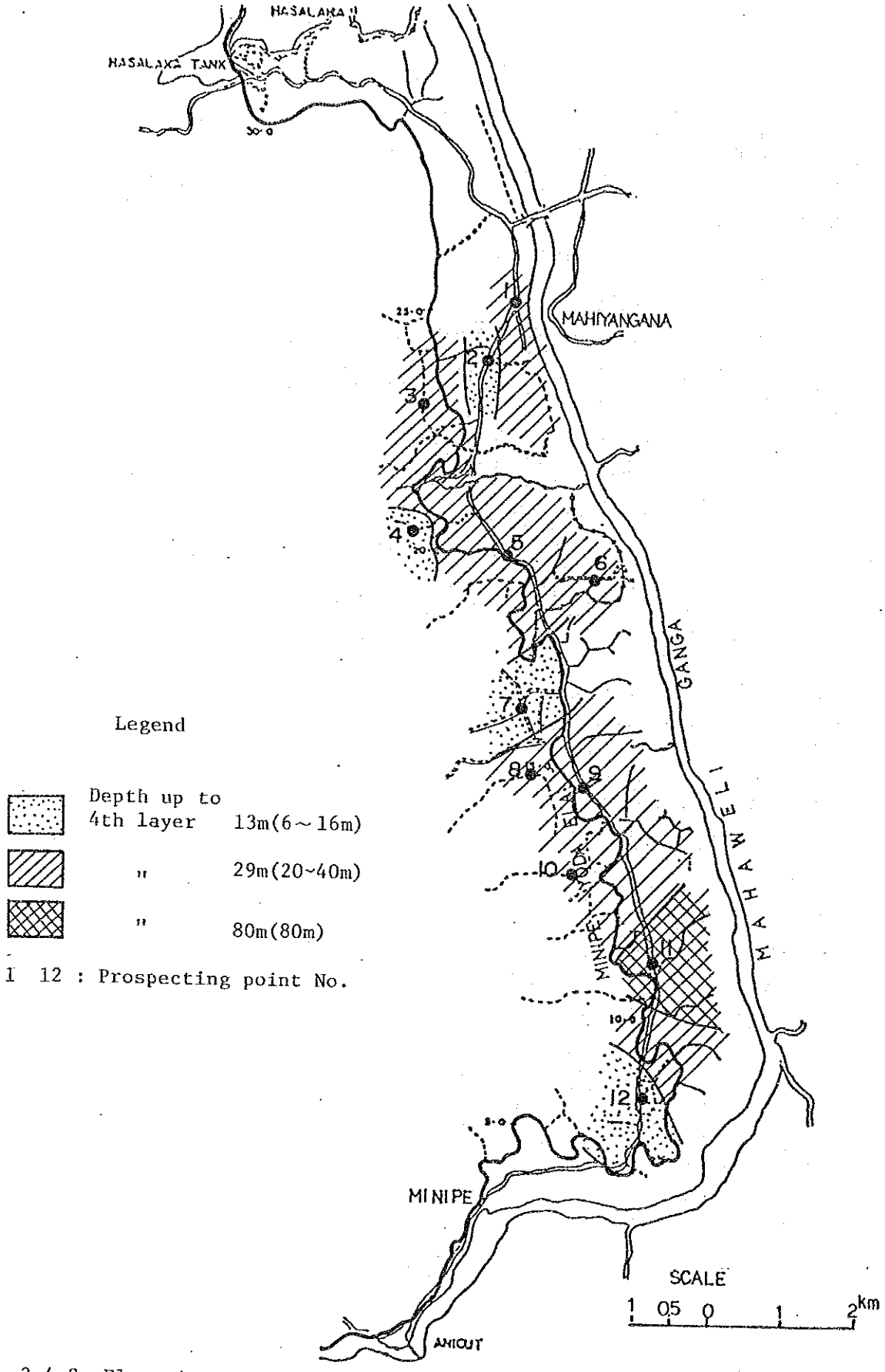


Fig. 3-4-2a Electric Prospecting Points and Average Depth up to Layer (in Minipe Stage I)

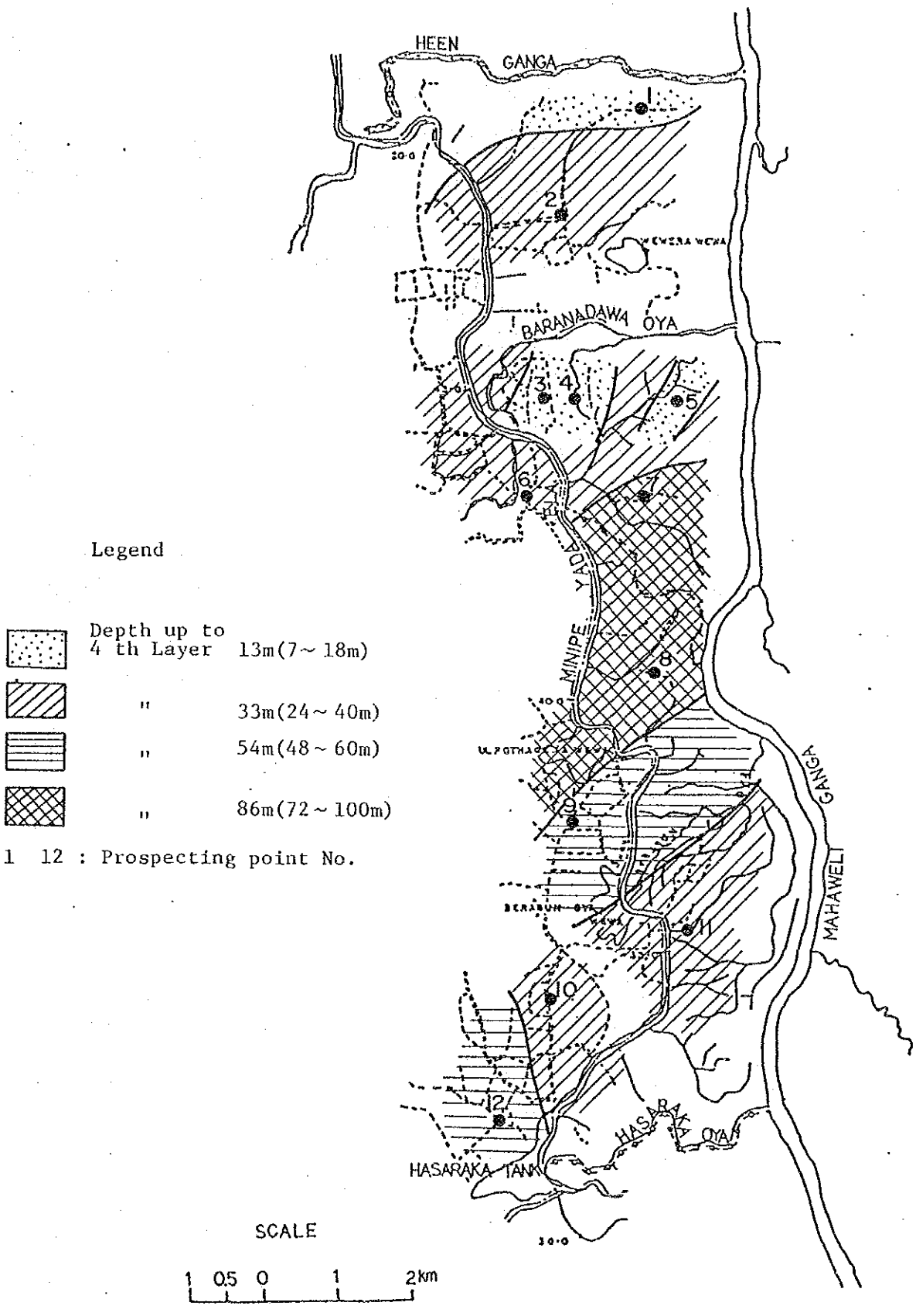


Fig. 3-4-2b Electric Prospecting Points and Average Depth up to 4th Layer (in Minipe Stage II)

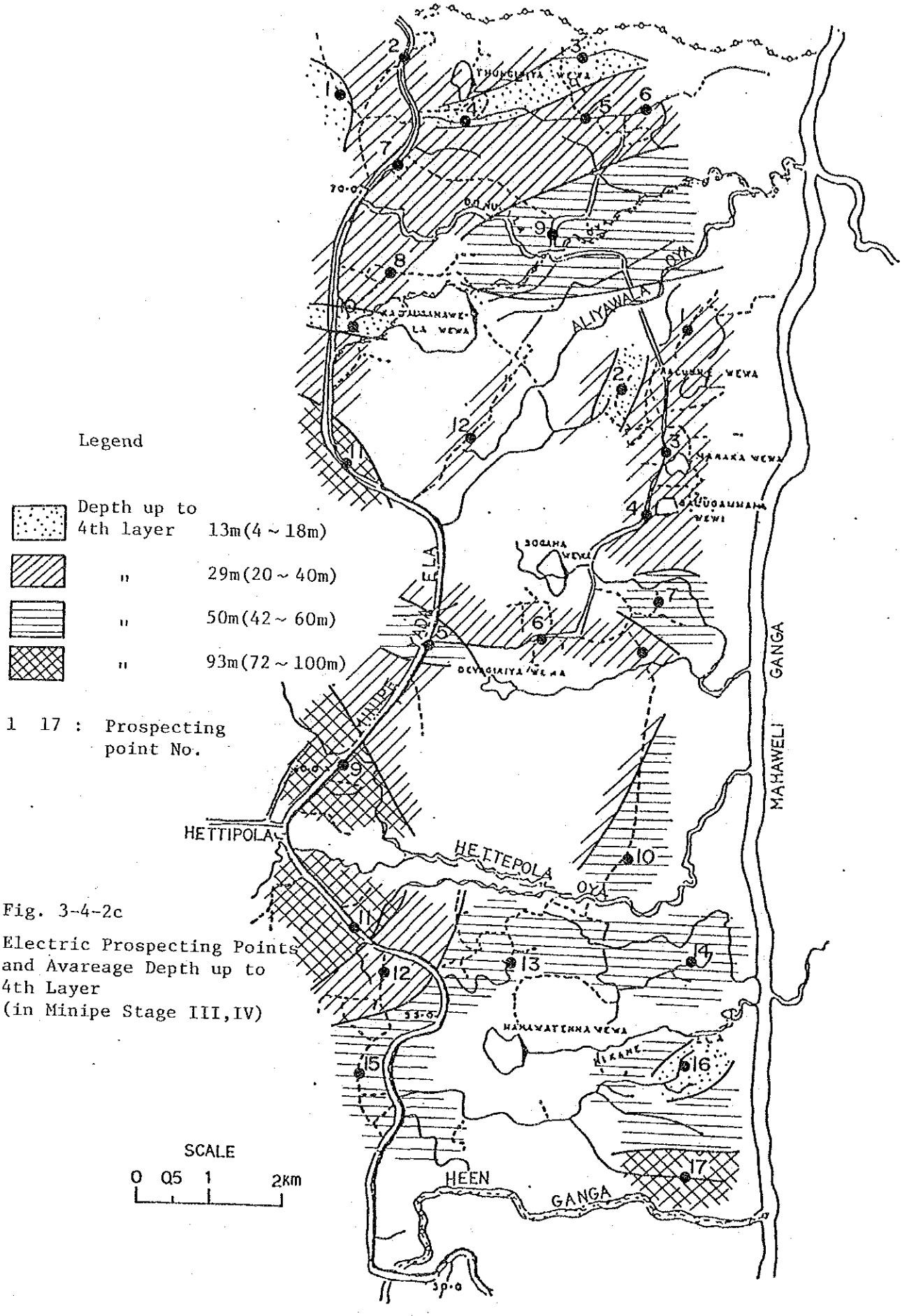


Fig. 3-4-2c

Electric Prospecting Points and Avareage Depth up to 4th Layer (in Minipe Stage III,IV)

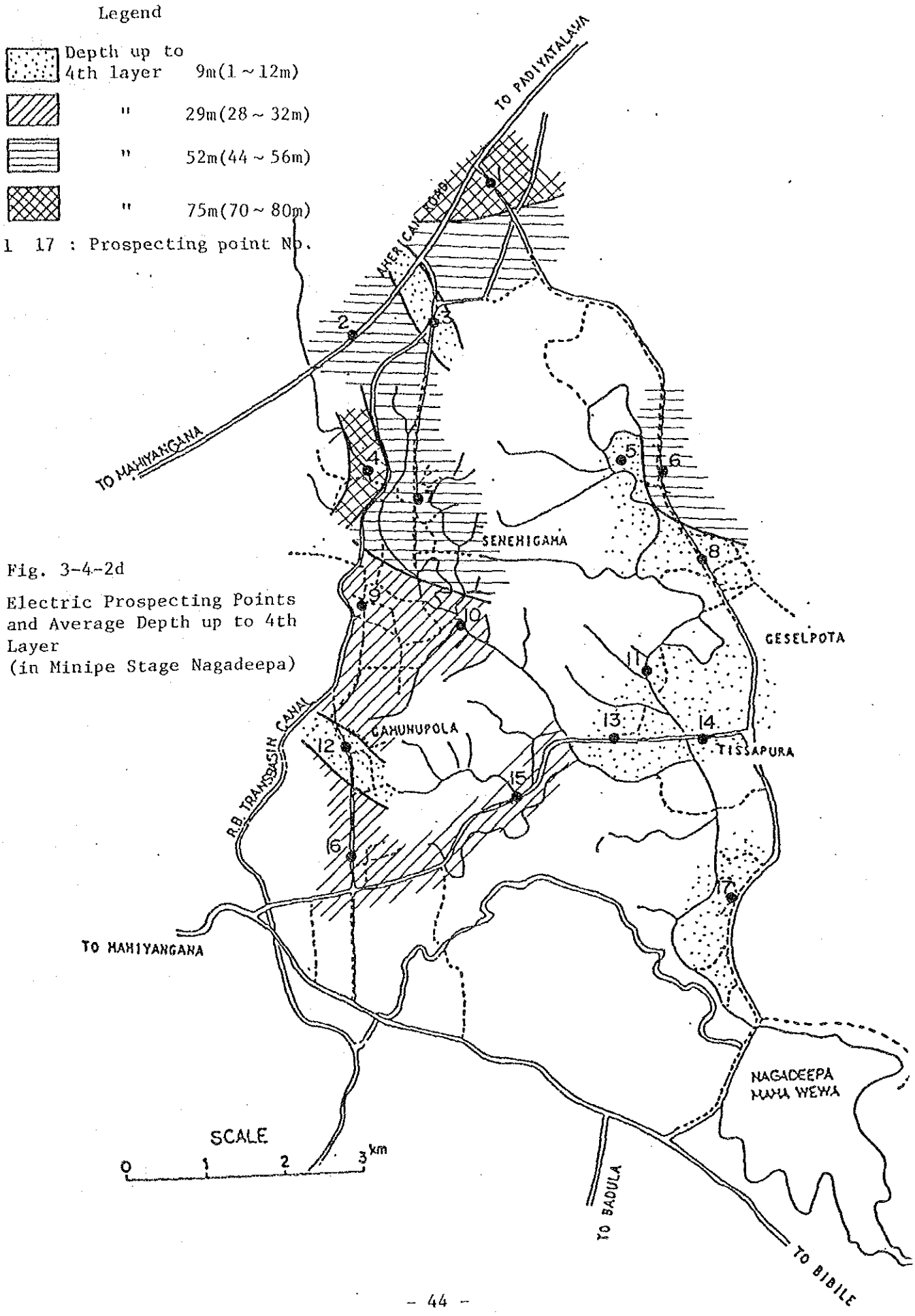


Fig. 3-4-2d

Electric Prospecting Points and Average Depth up to 4th Layer
(in Minipe Stage Nagadeepa)

3-5 Domestic Water Supply

3-5-1 Domestic Water Sources

Domestic water sources in the Project Area are as follows.

Drinking water ..... wells and to some extent rivers

Cooking water ..... wells and to some extent the Main Irrigation Canal (for Stage I area)

Bathing water ..... Main Irrigation Canal, distributary irrigation canals, reservoirs and to some extent wells (wells when canals are dried up)

Washing water ..... same as bathing water

While there are two types of wells, i.e., deep and shallow wells, the alter may be dried up during periods when the intake of water into the canals is suspended. When this suspension of canal water occurs, the inhabitants must make extra efforts to secure domestic water from deep wells, shallow wells which have not dried up, and/or rivers. Such suspensions occur twice a year in the Minipe area, for one and a half months each time (middle of March to end of April, beginning of September to middle of October), during the transition between the dry and wet seasons. Since most of the canals in the Nagadeepa area have little water during the dry season, the inhabitants face a more severe water shortage than those of the Minipe area.

The Stage I area has a small-scale water pipeline network using water form the Mahanna River and its two facilities are designed to supply water to the national hospital and to schools. Another pipeline network using water from a tributary of the Hasalaka River supplies 320ℓ/min to the Irrigation Department Office, police station and other public offices and shops in Hasalaka.

3-5-2 Distribution of Existing Wells

In terms of ownership, the existing wells for domestic water in the Project Area are classified as communal and private wells. Except for those owned by two hospitals and a bank, all deep wells are communally owned while some 87% of the shallow wells are privately owned. Approx. 20% of these private wells are, however, used by many inhabitants (5 families or more) and act as communal wells.

Table 3-5-1 gives various data relating to these wells by areas. Figure 3-5-1 shows the locations of the wells while Table A3-5-1 gives the number of wells by GS Divisions.

As Table 3-5-1 clearly shows, the number of deep wells in the Stage III and IV areas is relatively higher than in other areas due to the construction of 52 wells by the Danish International Development Agency (DANIDA) in 1986.

Table 3-5-1 Number of Existing Wells

	Minipe					Nagadeepa
	I	II	III	IV	Total	
Deep Wells	6	13	48(16)	18(8)	85(24)	3*
Shallow Wells for Communal Use	47	62	74	47	230	39
Private Wells for Communal Use	98	107	55	12	272	46
Private Wells	390	430	309	112	1,241	234
Population	19,830	25,020	19,610	7,570	72,030	14,790
Population per Deep well	3,300	1,920	410	420	850	4,930
Population per Shallow Well for Communal Use	420	400	270	160	310	380

Note: Figures in brackets indicate the number of wells to be constructed by DANIDA in the future.

* Currently not used for drinking water.

Number of Existing Wells and Wells to be Rehabilitated

Subject Area	Deep Wells	Shallow Wells	Wells to be Rehabilitated (A)	(B)
1	1	3	1	1
2	0	7	2	1
3	0	3	1	2
4	0	3	1	1
5	0	2	1	1
6	0	4	2	0
7	0	3	2	1
8	0	4	1	2
9	1	6	3	1
10	0	3	0	2
11	0	6	1	2
12	0	5	3	1
13	0	5	1	2
14	0	4	2	1
15	0	3	2	0
16	0	2	2	0
17	1	5	3	1
18	0	6	1	3
19	1	3	2	0
20	1	8	2	4
21	0	8	3	0
22	1	8	3	5
23	0	7	2	1
24	0	6	2	2
25	0	3	1	0
26	0	3	0	2
27	0	2	1	0
28	0	4	1	2
29	0	1	1	0
30	0	10	4	2
31	0	8	3	3
31	6	145	54	43

Shallow Wells = Communal Wells + Communally Used Private Wells

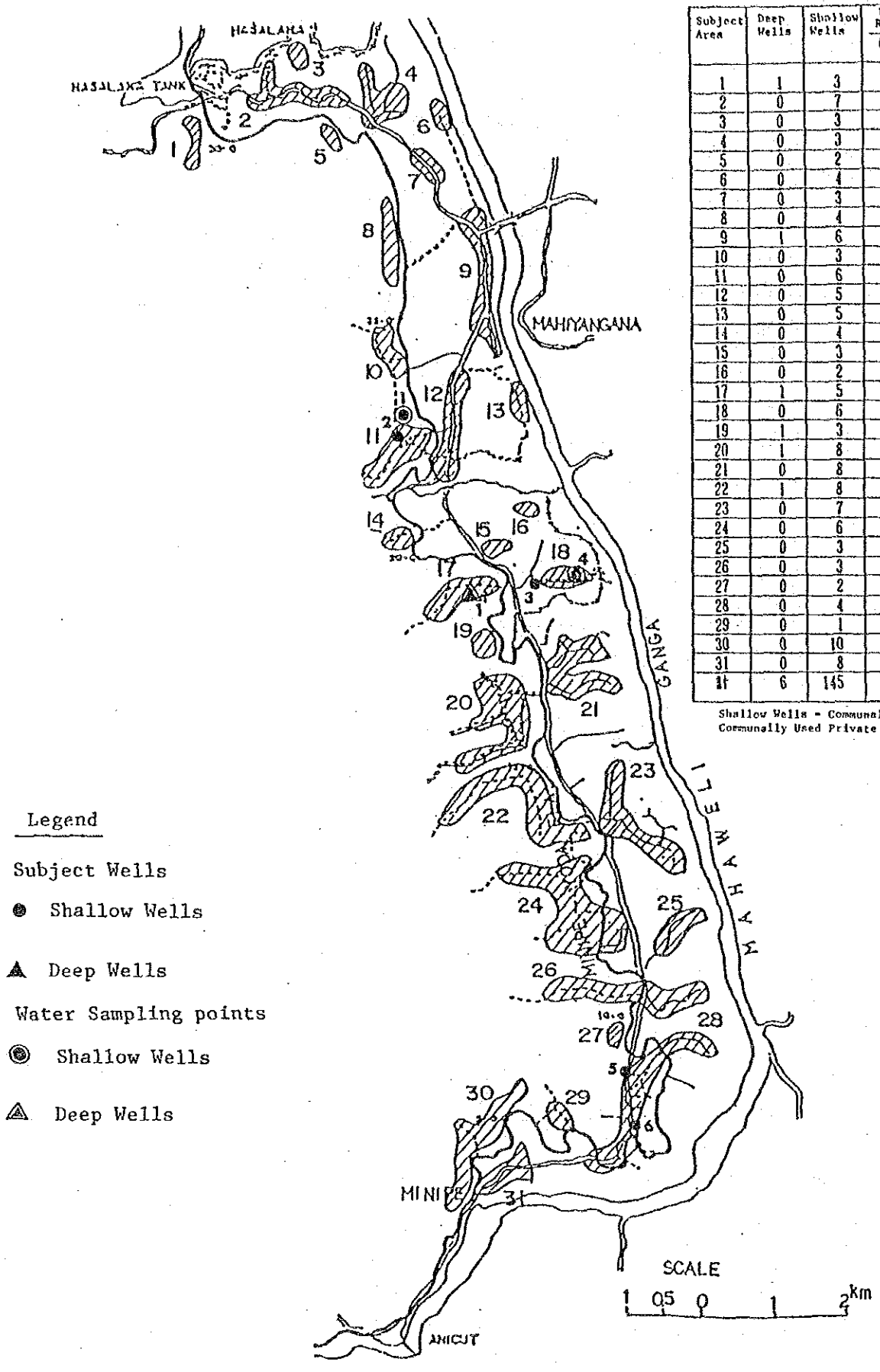


Figure 3-5-1a Location and Number of Existing Wells, Subject Wells and Water Sampling Points (Minipe Stage I)

Number of Existing Wells and Wells to be Rehabilitated

Subject Area	Deep Wells	Shallow Wells	Wells to be Rehabilitated (A)	(B)
1	0	4	1	2
2	0	12	5	3
3	1	3	1	1
4	1	2	0	2
5	1	5	2	1
6	2	8	3	1
7	0	2	1	1
8	1	5	2	2
9	0	10	4	3
10	0	3	1	1
11	0	3	1	1
12	0	5	1	2
13	2	12	5	2
14	0	1	0	1
15	1	8	3	4
16	0	2	0	1
17	1	8	4	3
18	0	3	1	1
19	0	2	1	0
20	0	5	1	2
21	0	9	2	4
22	0	10	5	3
23	1	20	5	6
24	1	9	4	3
25	0	4	2	1
26	0	6	3	3
27	0	2	0	1
28	1	6	2	1
計	13	169	60	56

Shallow Wells = Communal Wells + Communally Used Private Wells

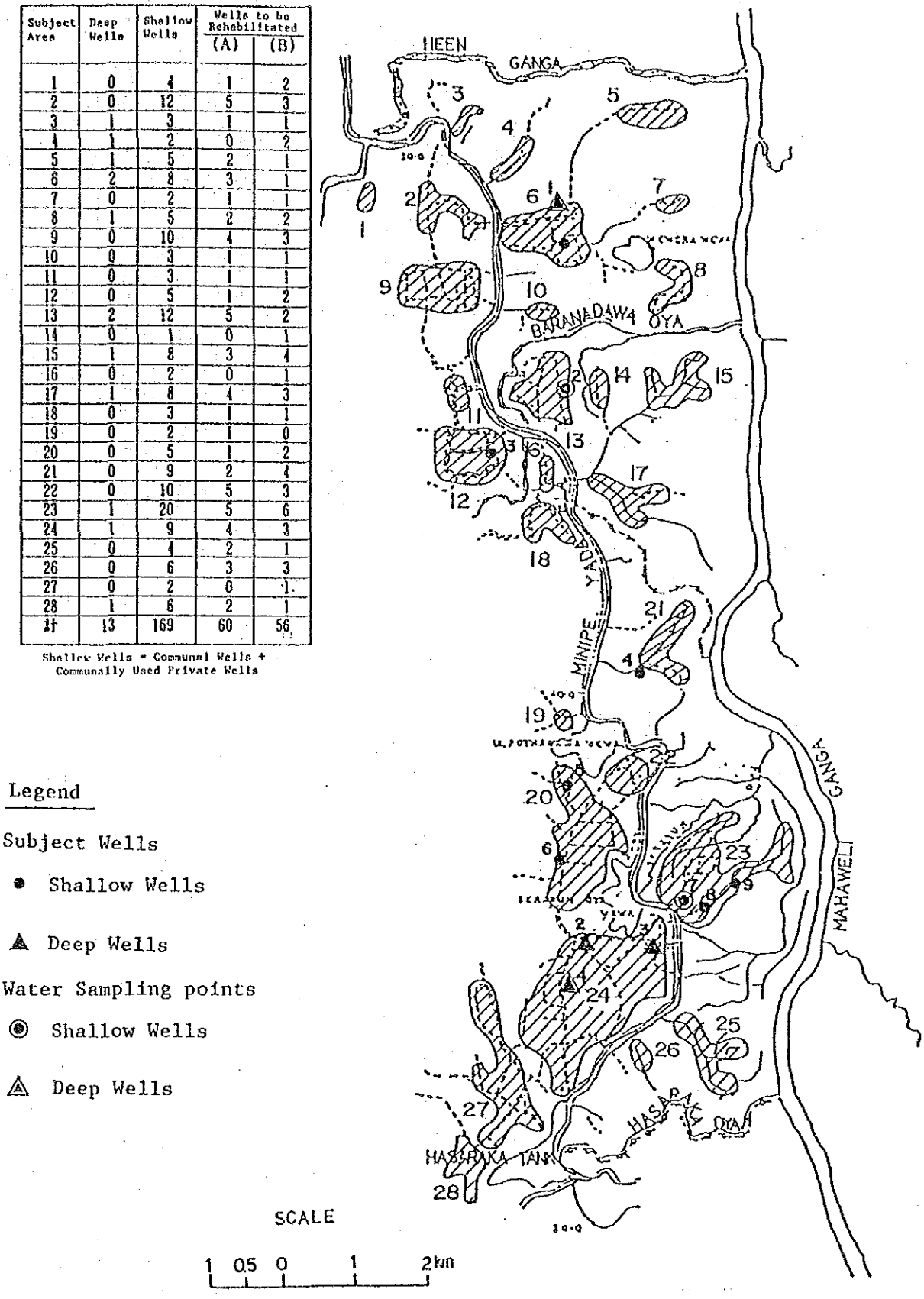


Figure 3-5-1b Location and Number of Existing Wells, Subject Wells and Water Sampling Points (Minipe Stage II)

STAGE IV
Number of Existing Wells and Wells to be Rehabilitated

Subject Area	Deep Wells	Shallow Wells	Wells to be Rehabilitated (A)	(B)
1	4	19	2	3
2	0	2	0	0
3	0	3	0	0
4	1	10	1	2
5	5	10	1	1
6	2	8	1	0
7	3	3	0	0
8	3	5	1	2
Tt	18	60	6	8

Shallow Wells = Communal Wells + Communally Used Private Wells

STAGE III
Number of Existing Wells and Wells to be Rehabilitated

Subject Area	Deep Wells	Shallow Wells	Wells to be Rehabilitated (A)	(B)
1	1	3	1	0
2	3	3	1	1
3	1	5	2	0
4	1	3	0	1
5	2	2	0	1
6	7	12	4	7
7	4	12	3	1
8	2	8	1	1
9	3	10	1	1
10	0	3	0	1
11	1	2	0	0
12	3	6	2	1
13	0	2	0	1
14	2	3	1	0
15	2	6	1	0
16	5	6	0	2
17	0	3	0	1
18	2	7	3	1
19	1	6	1	1
20	2	7	1	1
21	1	5	1	0
22	0	2	0	1
23	0	1	0	1
24	3	7	2	1
25	2	5	2	1
Tt	48	129	27	26

Shallow Wells = Communal Wells + Communally Used Private Wells

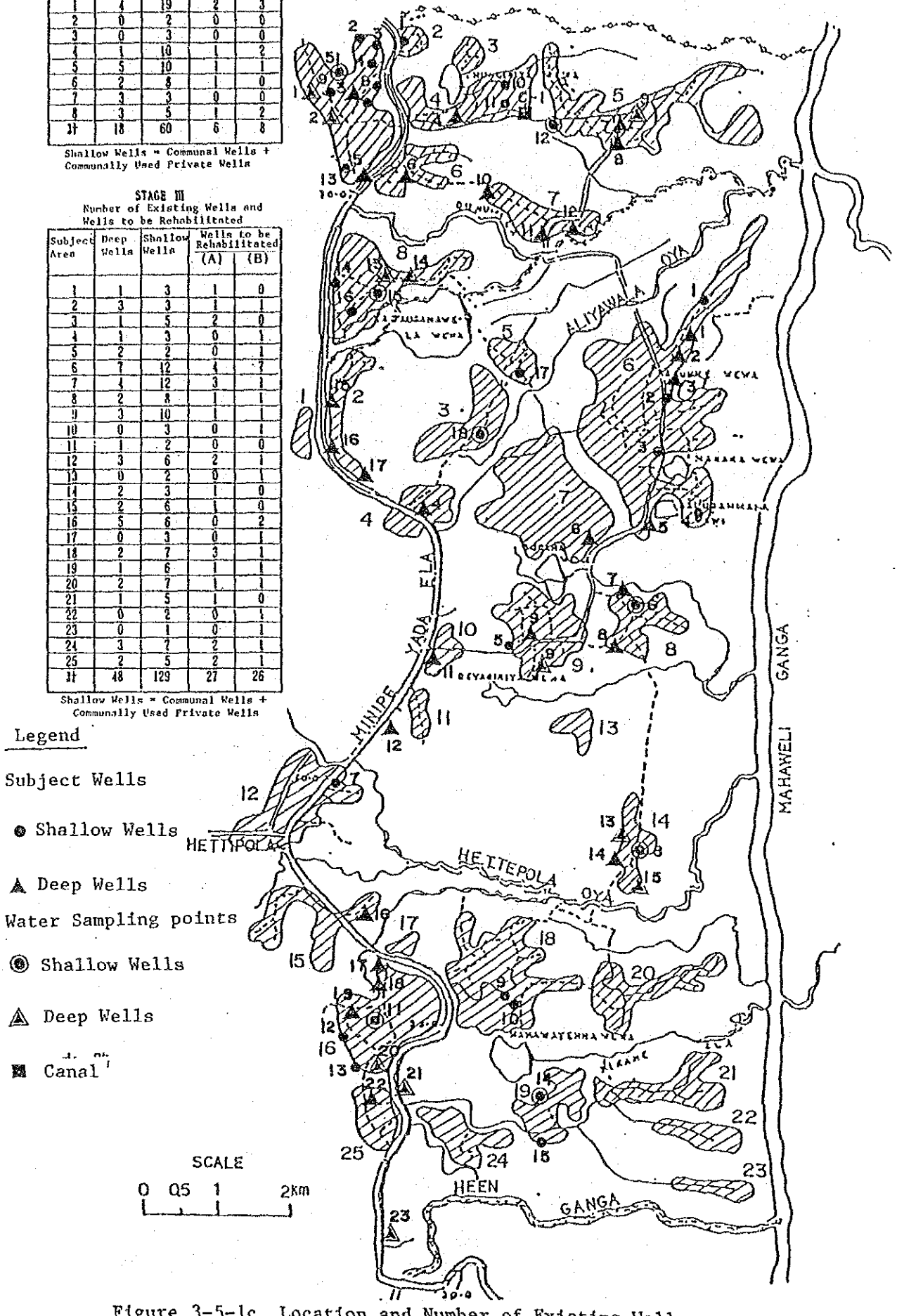
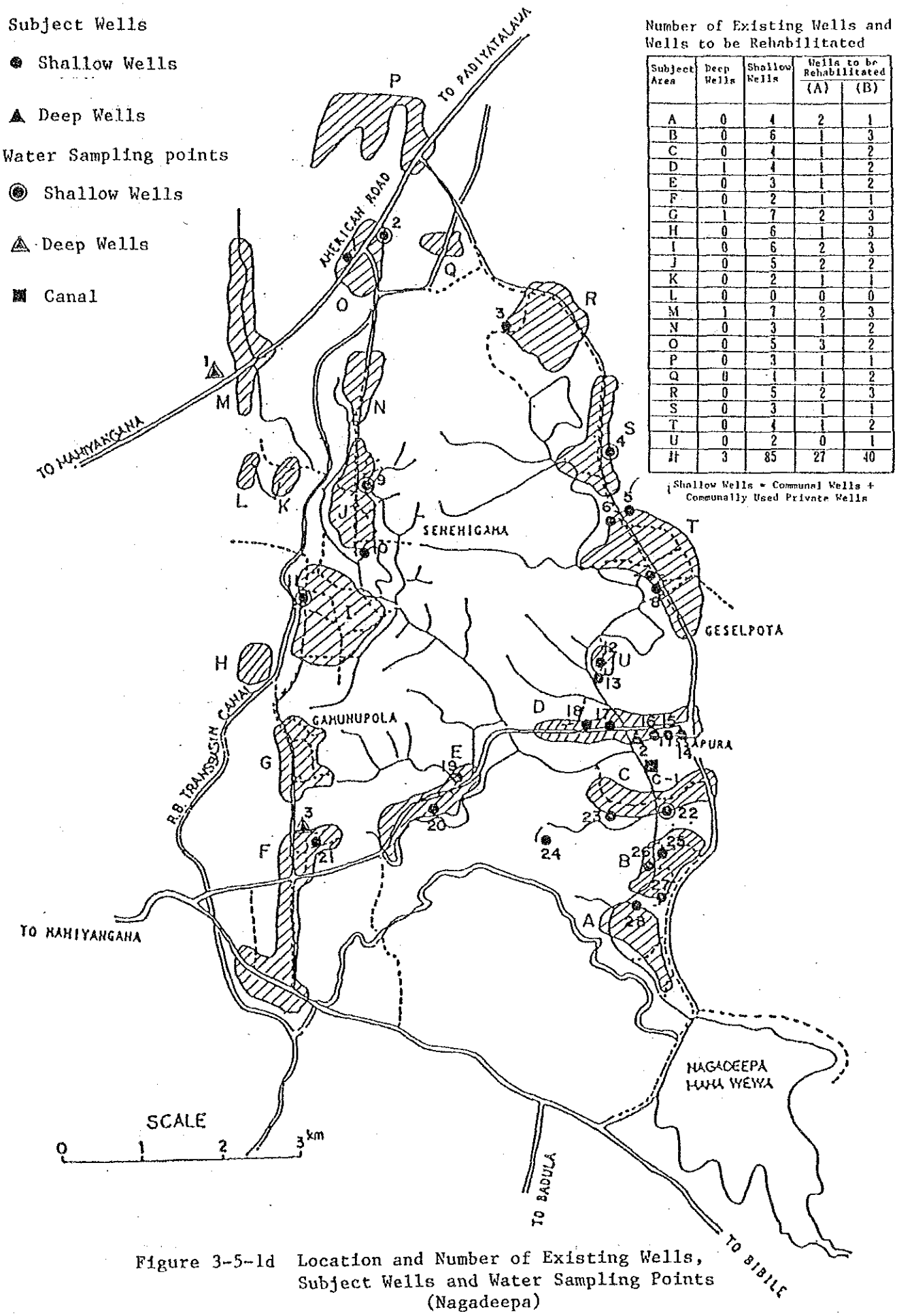


Figure 3-5-1c Location and Number of Existing Wells, Subject Wells and Water Sampling Points (Minipe Stage III, IV)



Number of Existing Wells and Wells to be Rehabilitated

Subject Area	Deep Wells	Shallow Wells	Wells to be Rehabilitated (A)	Wells to be Rehabilitated (B)
A	0	4	2	1
B	0	6	1	3
C	0	4	1	2
D	1	4	1	2
E	0	3	1	2
F	0	2	1	1
G	1	7	2	3
H	0	6	1	3
I	0	6	2	3
J	0	5	2	2
K	0	2	1	1
L	0	0	0	0
M	1	7	2	3
N	0	3	1	2
O	0	5	3	2
P	0	3	1	1
Q	0	1	1	2
R	0	5	2	3
S	0	3	1	1
T	0	4	1	2
U	0	2	0	1
計	3	85	27	40

Shallow Wells = Communal Wells + Communally Used Private Wells

Figure 3-5-1d Location and Number of Existing Wells, Subject Wells and Water Sampling Points (Nagadeepa)

Most of the deep tube wells for communal use in the Project Area are located on village streets or main roads in or near villages or at public facilities, including schools. In comparison, a plan to provide a shallow well for each household is currently in progress in the adjacent Mahaweli River Development Project System C area and, in fact, 11,000 of the 14,000 already settled families already have their own wells.

3-5-3 Types of Wells and Current Conditions

(1) Deep tube wells

More than half of the existing deep tube wells were constructed by DANIDA and have a diameter of 150mm (6" casing pipe) in the soil and weathered rock sections and 144mm (4 1/2" boring hole) in the deep rock section. The depth is generally 30 - 40m although some wells have a depth of 80m. The deep wells have hand pumps (Indian type) and aprons (Figure 3-5-2).

The static water level is between GL -5m and -8m (in March) and the yield varies from 10ℓ/min to more than 100ℓ/min. The actual consumption volume with the use of hand pumps is believed to be around 20ℓ/min (Table A3-5-2).

It was observed that 20% of the deep wells in the Stage III and IV areas and all three deep wells in the Nagadeepa area are not used for drinking water due to the poor water quality caused by rusted pumps and casing materials.

(2) Shallow wells

Shallow wells are either simply dug or lined with bricks or concrete. Some are even equipped with equipped with a concrete lid and a hand pump. Most communal wells are lined while 70% of the private wells for communal use and all private wells for family use are simply dug.

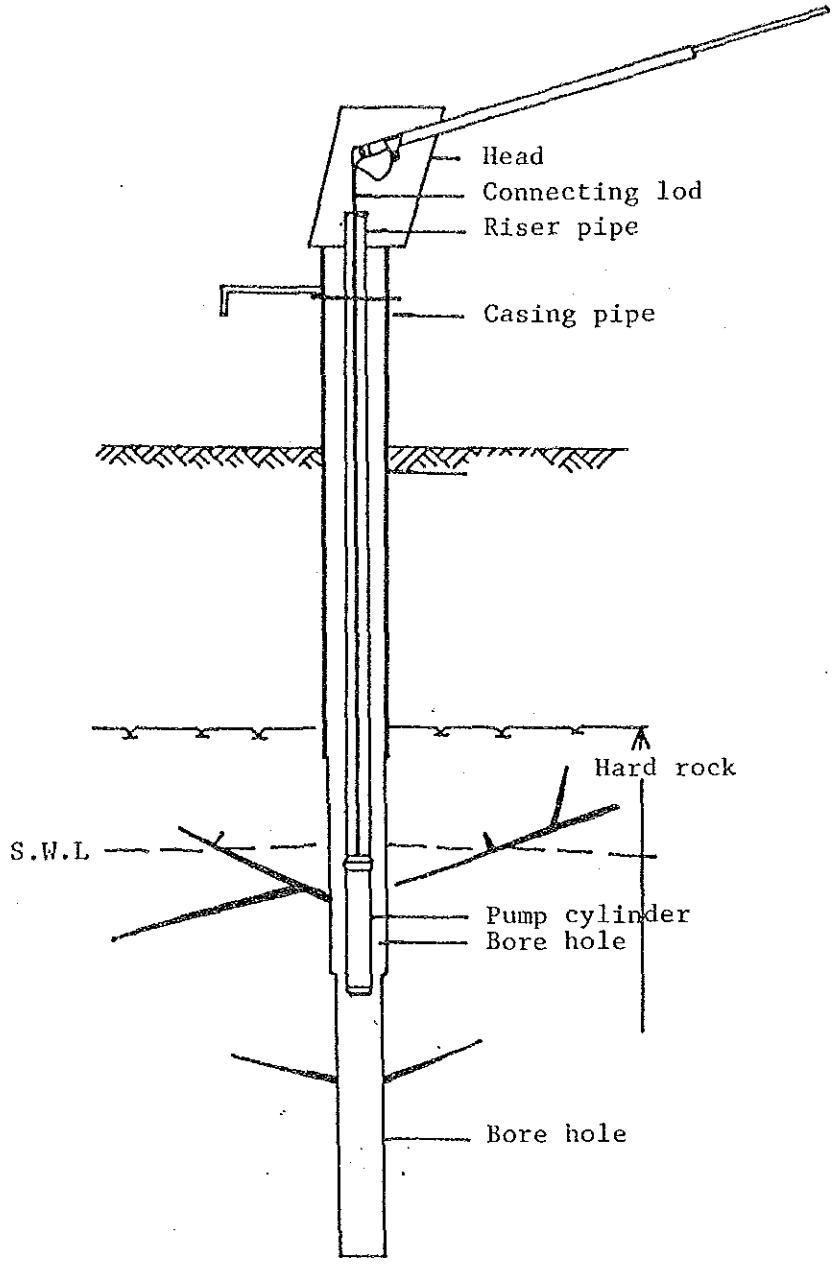


Fig. 3-5-2(a) Typical Deep Tube Well

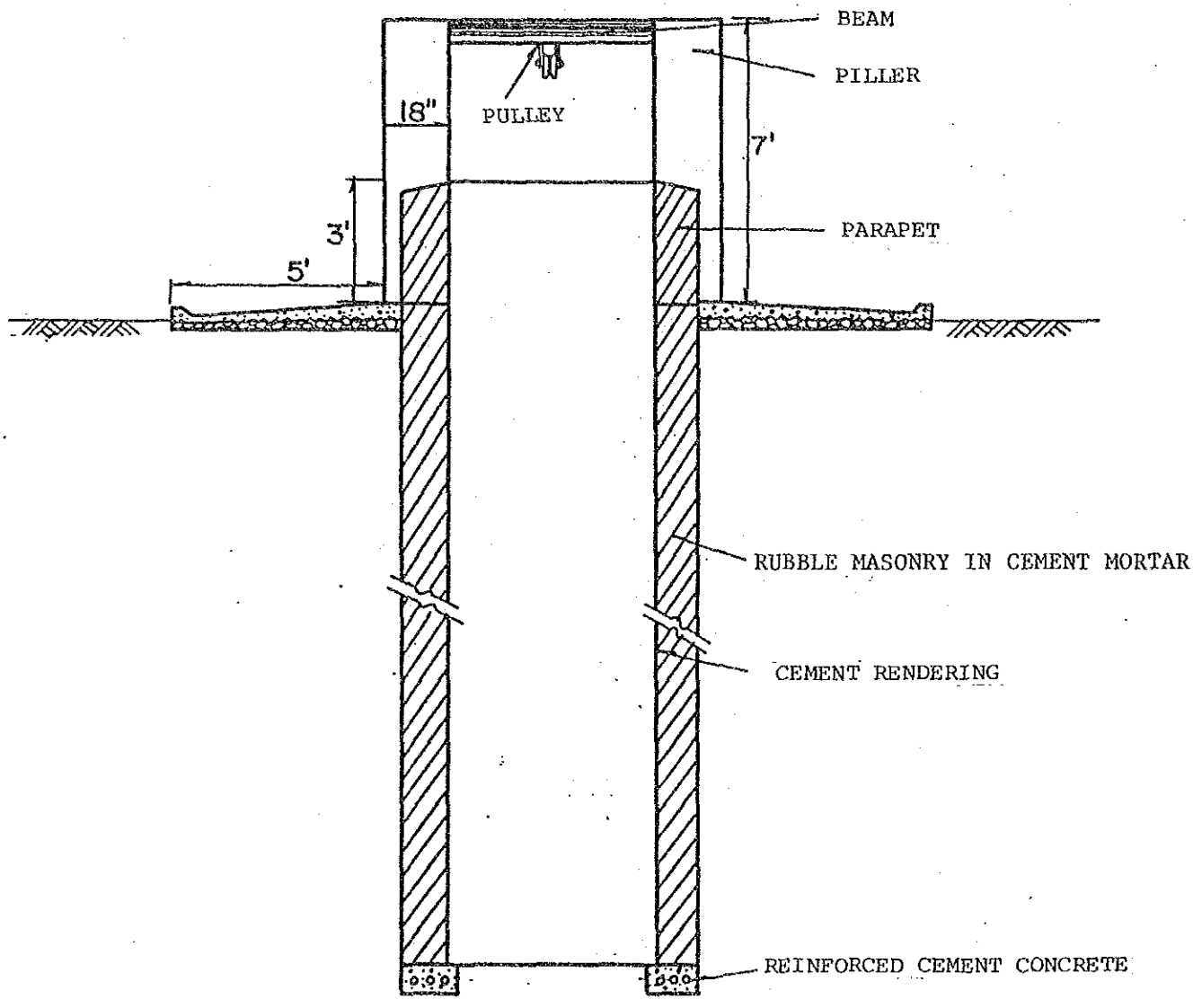


Fig. 3-5-2(b) TYPICAL COMMUAL WELL

The depth and diameter of most lined wells are 3.5 - 9.6m and 1.5 - 2.0m respectively. The traditional lining material consists of either bricks covered by mortar or concrete with crushed stones. The lining of those wells rehabilitated by DANIDA consists of reinforced concrete cylinders. Most lined wells have a 0.7 - 1.0m high parapet made of reinforced concrete and an apron. Many of these wells were constructed between 1975 and 1985. Except for recently rehabilitated wells, most wells have loose brick lining joints or cracks. Many aprons show exfoliation of the mortar cement and have a broken overflow. Some wells are out of use due to poor water quality caused by the inflow of dirty surface water.

Most of the shallow wells equipped with hand pumps have been either rehabilitated or newly constructed (121 wells) and are located in the Stage III and IV areas. However, the hand pumps appear to be unpopular with the inhabitants and have in part been replaced by the conventional method of using a bucket on a rope.

The water level of these wells fluctuates seasonally and almost reaches ground level in the wet season at some wells. On the other hand, it can drop to GL -5m or 6m in the dry season. Some wells dry up when water intake to canals is suspended. During that period, the number of communal wells, including communally used private wells, which are able to supply water is about one well per 50 households.

Many privately owned wells are simply excavated to a shallow depth of 2.5 - 4.0m and, therefore, these tend to dry up in the dry season.

Table 3-5-2 gives the well survey results.

3-5-4 Water Utilization

As already described in 3-5-1, well water is mainly used for drinking and cooking and also for bathing and washing purposes.

Shallow wells located in villages are frequently utilized for a variety of purposes. In comparison, wells located outside villages on main roads for miscellaneous purposes, including bathing and washing, are less frequently utilized in relation to their distance from the nearest village.

Since many privately owned shallow wells and communal shallow wells of insufficient depth dry up when the water intake to canals is suspended, most inhabitants are dependent on deep wells. As a result, the distance over which they must carry water is longer at such times than usual and inhabitants are forced to make great efforts to secure drinking water.

Deep well water is mainly used for drinking and cooking purposes. In the period number of the communal wells including communally used private wells which are able to supply water is about one well per 50 households.

Women are responsible for collecting water from wells using a ground-shaped metal pot. The longest carrying distance is 250 - 400m in the Minipe area and 500m in the Nagadeepa area although the distance generally increases in the dry season when many shallow wells dry up.

3-5-5 Water Consumption Volume

The general consumption volume of well water is estimated to be 25ℓ/person/day. However, the volume increases when canal water cannot be used.

Sri Lanka's design water consumption volume is 45ℓ/person/day when well construction is expected to provide domestic water as part of rural development or agricultural development projects while the average design number of families per well is 20.

Table 3-5-2a List of Deep Wells in Minipe and Nagadeepa

Area		No.	Village	Year of Construction	Depth (m)	Water Level GL-(m)	Subject Population	Water Carrying Distance	Current Use	Remarks
Stage I	KANDAGANAWA	1	KANDAGANAWA	1984	36		700	400	Drinking Water	
Stage II	NAMAYAYA	2	YAYA	1988	45		75	400	〃	
	HASARAKA	3	ELA	1988	38		250	200	〃	
		4	HALARAKA	1988	39		150	400	〃	
	WEWARE	1	KO DAGOBA	1987	27		75	150	〃	
Stage III	KALAEGAMA WEWA	1	KANDUNNE WEWA	1986	30	5.0	100	250	Drinking Water	
		2		1986	30	9.0	150	300	〃	
		3		1985	30		100	200	〃	
		5	HARAKA	1986	69		100	250	〃	Pump Out of Order
		6		1986	60		100	300	〃	
	BOGAHAWEWA	7	GURUWELAYAYA	1986	33	4.0	110	200	〃	Slightly Muddy Smell
		8		1986	48		400	300	〃	Pump Out of Order
		9	DEWAGIRIYA	1986	33	4.0	150	300	〃	
		10		1986	—		200	400	〃	
		11	KUMBURUWEAGAYAYA	1986	58		200	400	〃	
	NAMINIGAMA	13	VIJAYAGAMA	1986	51				Miscellaneous Water	Slightly Rusty and Muddy Smell
		14		1986	36				〃	
		15		1986	30	3.8	80	500	Drinking Water	
	METTIPOLA	12	MAMUYAGAYA	1986	33		20	200	〃	Slightly Muddy Smell
	WILGAMUWA	16	BATHGAMPOLA	1986	33		100	300	〃	Slightly Muddy Smell
		17		1986	30	2.5	150	100	〃	
		18	MUGAGOLLATRAKT-11	1986	30	6.0	125	200	〃	
		19		1986	39		45	150	Miscellaneous Water	Dirty Water
	MUGAGOLA	20	MAGAGOLLATRAKT-10	1986	36	3.0	150	200	Drinking Water	
		21		1986	33		60	800	〃	
		22		1986	33		150	300	〃	
		23	UDUWELWALA	1986	45		80	200	Miscellaneous Water	Slightly Rusty and Muddy Smell
	LIDIYANGARA	4	LEDIYANGALA	1986	30		130	250	Drinking Water	
Stage IV	HANDWAGAMUWA	1	KANDURUPITIYA	1986	31		175	300	Drinking Water	
		2		1988	31		100	500	〃	Slightly Muddy Smell
		3	HANDUNGAMUWA	1986	54				Miscellaneous Water	Slightly Rusty and Muddy Smell
		5	TOPWALAPITYA	1986	33				〃	Rusty Smell
	TUMGIRIYA	4	ELAYAYA	1986	72		150	200	〃	Slightly Rusty and Muddy Smell
	MEDAKANDA	7	MEDAKANDA	1986	30		130	200	Drinking Water	
		8		1986	31	6.0	125	200	〃	Pump Out of Order
		9		1986	31		150	250	〃	
	KUMBUKANDA	6	ELAYAYA	1986	31		30	200	〃	
		10	KUMBUKANDA	1986	63		60	300	〃	
		11	AKKARAKKA GAMA	1986	30		40	350	〃	
		12		1986	30		100	400	〃	
		13	ELA YAYAZ	1986	31	1.0	40	150	〃	
		14		1986	62		30	200	〃	
	LEDIYANGALA	15	ALIYAWALA	1986	48		100	350	〃	
		16		1986	30		100	100	〃	
		17		1986	30		70	250	〃	
Nagadeepa	GAMUWPURA	1		1986	60		50	200	Miscellaneous Water	Slightly Rusty and Muddy Smell
	TISSAPURA	2		1986	60				〃	Pump Out of Order
		3		1988	51				〃	

Table 3-5-2b List of Shallow Wells in Minipe

Area		No.	Village	Year of Construction	Depth (m)	Diameter (m)	Water Level at Time of Study GL-(m)	Water Level in Wet Season GL-(m)	Well Characteristics	Subject Population	Water Carrying Distance	Current Use	Broken Part	Remarks
Stage I	MORAYAYA	1	MORAYAYA	1984	6.5	1.0	4.5	0	Concrete	490	800	Drinking Water	Apron	Inclusion of Foreign Matter
		2		1984	5.0	2.0	3.5	0	Bricks	420	400	Drinking Water		
	HANDAGANAWA	3	HANDAGANAWA	1985	5.0	1.0	2.0	0.5	Concrete	200	400	Drinking Water		
		4		1985	4.5	1.0	2.5	0.5	Concrete	20	100	Drinking Water		
	AMBAGAHAPELESSA	1	AMBAGAHAPELESSA	1986	4.8	2.0	5.0	0.5	Bricks	160	200	Drinking Water		
		2		1986	5.0	1.5	4.0	1	Bricks	300	400	Drinking Water	Apron	Some Smell
Stage II	ULPOTHAGAMA	4	DAMBEPITIYA	1992	5.0	1.5	3.0	0	Bricks	100	200	Miscellaneous	Apron	Slight Smell
		5	ULPOTHAGAMA	1868	3.5	1.5	2.5	0	Bricks	75	100	Drinking Water	Apron	
		6	MORAYAYA	1958	9.0	1.5	4.0	1.5	Bricks	175	100	Drinking Water	Apron	Some Smell
	HASALAKA	7	HASALAKA	1992	5.0	1.5	5.0	0	Bricks	50	150	Drinking Water	Apron	
		8		1868	3.5	1.3	1.5	0	Bricks	125	150	Drinking Water	Apron &	Little Smell
		9		1958	6.0	1.5	2.0	0	Bricks	200	200	Drinking Water	Apron	Some Smell
	WEWA E	1	KILONGADA	1983	5.0	1.5	4.0	0	Bricks	75	100	Drinking Water		
	KINDIGODA	2	25ELA	1983	6.8	2.2	3.0	0	Bricks	150	400	Drinking Water		
	UDATAWA	3	DAMBAGAHAWELA	1960	8.0	1.5	1.0	1	Bricks	100	800	Drinking Water		
Stage III	KALAUGAHAWEWA	1	RANDUNNEWEWA	1998	5.5	2.1	2.5	0	Bricks	20		Drinking Water	Apron	Some Smell
		2		1967	6.0	1.2	3.0	0	Bricks	300	300	Miscellaneous	Apron	
		3	MARAKA	1980	6.5	2.0	3.0	0	Bricks	100	200	Drinking Water	Apron	Slightly Cloudy
		4		1983	6.6	2.0	5.5	0	Concrete	40	100	Drinking Water		
	BOGANAWEWA	5	DAVAGIRIYA	1985	7.5	2.0	6.0	0	Bricks	50	100	Drinking Water		(Hand Pump Type)
		6	GURUWELAYAYA	1985	7.0	1.0	4.3	0	Concrete	75	250	Drinking Water	Hand Pump	(Hand Pump Type)
	NAMINIGAWA	8	VIJAYAGAMA	1986	16.0	1.2	7.5	0	Bricks	50	100	Drinking Water		Slightly Cloudy
	METTIPOLA	7	HAMINI OYA	1975	4.4	1.5	4.0	0	Bricks	100	500	Drinking Water	Apron	Some Smell
	WILGANUWA	11	NUGAGOLLATRACT-11	1987	6.0	1.5	5.4	1.5	Bricks	80	100	Drinking Water		
		12		1986	9.0	1.5	6.0	2.0	Concrete	160	200	Drinking Water	Apron.Hand Pump	(Hand Pump Type)
	NUGAGOLA	13	NUGAGOLLATRACT-10	1969	4.1	1.5	3.5	2.0	Bricks	15		Drinking Water	Apron	
	MAHAWATE	9	PERAKANATTAYMA	1975	6.0	1.0	3.0	0	Concrete	70	200	Drinking Water	Hand Pump	(Hand Pump Type)
		10		1986	4.5	1.0	2.5	0	Bricks	50	300	Drinking Water		(Hand Pump Type)
	SONUTTA	14	SONUTTA	1979	8.0	2.2	3.0	0	Bricks	10	800	Drinking Water	Apron &	Some Smell
		15		1981	4.5	1.0	2.0	0	Bricks	70	800	Drinking Water	Hand Pump	(Hand Pump Type)
Stage IV	HANDUNGAMUWA	1	DIVISION-19	1986	6.0	1.0	4.5	0.5	Concrete	60	200	Drinking Water		(Hand Pump Type)
		2		1987	6.0	1.0	4.0	0.5	Concrete	100	300	Drinking Water		(Hand Pump Type)
		3		1983	6.0	1.0	5.5	0.5	Concrete	150	300	Drinking Water		(Hand Pump Type)
		4		1987	6.0	1.0	4.6	0.5	Concrete	65	200	Drinking Water		(Hand Pump Type)
		9		1987	6.0	1.0	5.5	0.5	Concrete	50	200	Drinking Water		(Hand Pump Type)
		5	HANDAUGAMUWA	1987	6.0	1.0	5.5	0.6	Concrete	80	250	Drinking Water		(Hand Pump Type)
		6		1968	7.0	2.2	4.0	2	Bricks	100	300	Drinking Water	Apron	
		7		1978	5.8	1.8	4.0	1.5	Bricks	100	300	Drinking Water		
		8		1987	5.0	1.4	4.5	3	Bricks	75	200	Drinking Water	Apron	
		13		1967	6.3	1.5	4.9	.3	Bricks	100	300	Drinking Water	Apron	
	TUNGIRIYAWEWA	10	HANDUNGAMUWA	1987	4.3	1.0	2.0	0	Concrete	40	200	Drinking Water	Apron	
		11	ELLAYAYA	1986	6.0	1.0	4.5	1.0	Concrete	100	300	Drinking Water	Hand Pump	(Hand Pump Type)
	MEDAKANDA	12	ELLAYAYA 3 YAYA	1986	6.0	1.0	4.5	0.5	Concrete	75	250	Drinking Water	Hand Pump	(Hand Pump Type)
	KUBUKANDA	14		1984	5.2	1.0	4.0	0	Concrete	75	400	Drinking Water	Hand Pump	(Hand Pump Type)
		16	GAMBURUOYA	1983	5.5	1.2	4.0	1.5	Bricks	30	200	Drinking Water	Apron	
		17	UNNE WEWA	1974	3.8	1.5	1.1	0	Bricks	40	150	Drinking Water	Apron	
		15	RENDVAEWEWWA	1983	5.0	1.2	4.0	0.5	Bricks	25	150	Drinking Water	Parapet	
	LEDIYANAGALA	18	LEDIVANGALA	1969	5.0	1.5	3.7	0	Bricks	150	350	Drinking Water		

Table 3-5-2c List of Shallow Wells in Nagadeepa

Area	No.	Year of Construction	Depth (m)	Diameter (m)	Water Level at Time of Study GL-(m)	Water Level in Wet Season GL-(m)	Well Characteristics	Subject Population	Water Carrying Distance	Current Use	Broken Part	Remarks
Tissapura	12	1970	5.5	1.5	3.5	0	Bricks	50	400	Drinking Water	Apron	Slightly Cloudy
	13	1899	6.5	1.8	3.0	0	Bricks	200	800	Drinking Water	Apron, Parapet	
	14	1973	8.0	1.5	2.0	0	Bricks	150	400	Drinking Water	Apron	
	15	1972	6.5	1.5	3.0	1.0	Bricks	50	350	Drinking Water	Apron	
	16	1986	7.0	1.5	2.0	0	Bricks	50	400	Drinking Water	Apron	
	17	1965	7.0	1.5	6.0	2.0	Bricks	80	800	Drinking Water	No Apron	Slightly Cloudy
	18	1970	5.5	1.5	4.0	0	Bricks	60	300	Drinking Water	Apron &	Some Smell
	19	1982	6.0	1.5	4.0	0	Bricks	50	800	Drinking Water	Apron	
	20	1980	7.0	1.5	6.0	2.5	Bricks	75	400	Drinking Water	Apron	Slightly Cloudy
	21	1985	8.8	2.0	7.8	4.0	Bricks	60	500	Drinking Water		
	22	1984	8.0	1.5	6.0	0	Bricks	40	400	Drinking Water	Apron	
	23	1981	8.0	1.5	5.3	3.0	Bricks	100	800	Drinking Water	Apron	
	24	1981	8.0	1.5	6.0	2.0	Bricks	125	500	Drinking Water	Apron	Slight Smell
	25	1981	5.3	1.8	3.0	0	Bricks	60	800	Drinking Water	Apron &	
	26	1984	5.4	1.5	2.5	0	Concrete	50	800	Drinking Water		(Hand Pump)
	27	1984	7.9	2.0	7.0	0	Bricks	60	300	Drinking Water	Apron	
	28	1972	6.0	1.5	3.0	0	Bricks	250	400	Drinking Water	Apron	
Keselpotha	3	1971	6.0	1.5	5.0	0	Bricks	100	400	Drinking Water	Apron	
	4	1973	5.0	1.5	2.3	0	Bricks	—	—	Drinking Water		
	5	1970	6.0	1.5	3.0	0	Bricks	40	400	Drinking Water	Apron	
	6	1982	7.0	2.0	4.0	1.0	Bricks	400	600	Drinking Water		
	7	1974	7.0	1.5	5.0	1.5	Bricks	50	800	Drinking Water	Apron	
	8	1978	9.6	1.5	4.6	1.0	Bricks	—	—	Drinking Water		
Gemunupura	1	1978	6.0	1.7	3.0	0	Bricks	35	400	Drinking Water	Apron	
	2	1984	7.0	2.0	5.0	0	Bricks	50	800	Drinking Water		
	9	1979	7.0	2.0	4.0	0	Bricks	25	300	Drinking Water	Apron &	
	10	1985	6.0	1.9	3.0	0	Bricks	50	300	Drinking Water		
	11	1972	8.7	1.5	6.0	1.8	Bricks	200	300	Drinking Water	Apron, Parapet	

3-5-6 Water Quality

An on-the-spot simple water quality test was carried out on samples from 18 deep wells and 18 shallow wells and laboratory tests were also subsequently conducted. Table 3-5-3 gives the test results. The water quality test results for the Feasibility Study and those for the tests on the deep wells conducted by DANIDA are attached to this report for reference purposes (Tables A3-5-4 and A3-5-5). Based on these results, the quality of well water in the Project Area is judged to be as follows:

(1) Deep wells

The iron content exceeded the water quality standard for drinking water in 5 out of the 18 samples. The Study Team was told that the wells in question were originally used for drinking water but their use was ended due to the water's strong smell of iron. Rust on the casing pipe (GS pipe), Riser pipe and pump are said to have caused this water quality deterioration.

Water quality test data obtained by DANIDA at the time of well construction was studied to determine if the groundwater itself has a higher iron content than the standard value. According to the data, only 3 of the 47 deep wells have an iron content higher than the standard value and, therefore, it is inferred that the iron content of the groundwater did not originally exceed the standard value. However, the relatively high conductivity (EC) indicates generally high soluble contents in the groundwater. As part of the simple water quality test, the existence of Escherichia coli and common bacteria was examined. The former were found in 50% of the wells while the latter were found in 80% of the wells. From the results of the tests for both bacterias, it is reasonable to infer that the well structure is inadequate (i.e., the casing pipe does not reach a sufficiently solid layer or dirty water infiltrates the well without adequate purification due to the incomplete sealing), rather than that the groundwater itself contains bacteria. Therefore, it is concluded that clean

water which is not contaminated by bacilli can be obtained if the casing pipe is inserted deep enough to reach a solid layer and the bottom is completely sealed at the time of well construction.

(2) Shallow wells

The Feasibility Study found the quality of the shallow well water in the dry season to be strongly affected by the canal water quality as most well water is charged from canals. It also pointed out that the shallow well structure easily allows the infiltration of dirty surface water. The Study Team also detected Escherichia coli and common bacteria in 80% of the shallow wells, indicating the main problem to be water contamination. Therefore, it is concluded that water from most shallow wells is unsuitable for drinking. However, as shallow well water has a minimum heavy metal content, it can be used for drinking after sterilization.

3-5-7 Waterborne Diseases

As may be inferred from the water quality test results, diseases caused by bad water infected with bacteria occur from time to time in the Project Area. Through interviews at four hospitals and two chemists, the Feasibility Study Team found that some 17% of all patients, including those with influenza, suffer from diseases cased by drinking bad water. Dysentery was found to be the disease with the highest mortality rate (Table A3-5-6).

3-5-8 Necessity of New Wells

As described above, the provision of facilities to supply good domestic water, the very basis of life, is very low in the Project Area.

A simple calculation shows the population dependent on each communal shallow well is over 400 except in the Stage IV area (150) (Table 3-5-1). The ratio of privately owned wells is 1 per 10 households in the Minipe area and 1 per 5 households in

the Nagadeepa area, indicating heavy dependence on canals and other water sources and the shortage in the total number of wells. In comparison, in the Mahaweli River Development Project System C area which is adjacent to the Project Area, the provision of a well for each household is planned and 80% of the already settled families have their own wells.

Deep wells to supply clean drinking water are scarce in the Project Area except in the Stage III and IV areas where they have recently been constructed.

In view of the Project Area conditions so far described, the construction of wells in the Project Area is urgently required to meet the based human need (BHN) for a stable water supply as well as to rectify the infrastructural gap between different areas. It is recommended that rehabilitation of the existing wells in order to ensure sufficient domestic water and to improve water quality should be included in this Project from an economic point of view.

Table 3-5-3a Simple Field Water Quality Test Results

Area		Well Type	Well No.	Smell	Temperature (°C)	PH	NH_3 (PPm)	EC(us/cp)	TH (PPm)	Cℓ (PPm)	Mn (PPm)	Fe (PPm)	Colon Bacilli	Common Bacilli
MINIPE	I	Deep Well	No.1	Yes	27.8	7.2	0.5 Under	402	255	35	0.5Under	0.2Under	Yes	Yes
			No.4	No	28.3	6.6	0.5 〃	244	175	40	0.5 〃	0.2 〃	Yes	Yes
		Shallow	No.1	No	27.1	6.0	0.5 〃	214	100	25	0.5 〃	0.2 〃	No	No
	II	Deep Well	No.2	No	28.3	6.6	0.5 〃	275	160	35	0.5 〃	0.2 〃	Yes	Yes
			No.7	No	27.5	7.2	0.5 〃	346	5	35	0.5 〃	0.2 〃	Yes	Yes
		Shallow Well	No.1	No	30.8	6.2	0.5 〃	189	100	30	0.5 〃	0.2 〃	Yes	Yes
			No.4	No	28.3	7.0	0.5 〃	351	250	15	0.5 〃	0.2 〃	Yes	Yes
	III	Deep Well	No.6	No	28.2	6.6	0.5 〃	270	150	25	0.5 〃	0.2 〃	Yes	No
			No.11	No	28.4	6.8	0.5 〃	356	255	60	0.5 〃	0.2 〃	Yes	Yes
			No.14	Yes	27.9	7.0	0.5 〃	242	150	45	0.5 〃	0.2 〃	Yes	Yes
		Shallow Well	No.7	Yes	28.8	6.0	0.5 〃	252	50	100	0.5 〃	0.2 〃	Yes	Yes
			No.9	No	29.9	6.6	0.5 〃	405	250	30	0.5 〃	0.2 〃	No	No
			※No.13	Yes	30.0	7.2	0.5 〃	799	300	55	0.5 〃	10	No	Yes
			No.20	No	28.4	6.8	0.5 〃	378	220	35	0.5 〃	0.2Under	Yes	Yes
			No.21	Yes	29.9	7.2	0.5 〃	348	200	50	0.5 〃	0.2 〃	No	Yes
			No.23	Yes	29.0	6.2	0.5 〃	95	35	15	0.5 〃	0.2 〃	Yes	Yes
	IV	Deep Well	No.1	No	29.0	7.0	0.5 〃	640	350	50	0.5 〃	0.2 〃	No	No
			No.5	No	28.8	6.6	0.5 〃	324	175	30	0.5 〃	0.2 〃	Yes	Yes
			No.12	No	29.4	7.0	0.5 〃	379	150	50	0.5 〃	0.2 〃	Yes	Yes
			No.18	No	28.2	7.2	0.5 〃	385	140	50	0.5 〃	0.2 〃	No	No
		Shallow Well	No.1	Yes	29.2	6.8	0.5 〃	213	350	25	0.5 〃	0.2 〃	No	Yes
			No.2	Yes	29.0	6.6	0.5 〃	272	400	60	0.5 〃	0.2 〃	No	Yes
			※No.3	Yes	29.0	6.6	0.5 〃	352	110	30	0.5 〃	5	Yes	Yes
			※No.4	Yes	29.1	6.4	0.5 〃	260	120	50	0.5 〃	10	No	Yes
			No.9	No	29.2	7.0	0.5 〃	352	90	50	0.5 〃	0.2Under	No	No
		Canal	C-1	Yes	32.0	7.4	0.5 〃	269	100	50	0.5 〃	0.2 〃	Yes	Yes
NAGADEEPA		Deep Well	No.2	No	27.0	7.2	0.5 〃	445	155	55	0.5 〃	0.2 〃	Yes	Yes
			No.4	No	27.7	6.8	0.5 〃	242	100	50	0.5 〃	0.2 〃	Yes	Yes
			No.9	No	27.1	7.6	0.5 〃	610	140	75	0.5 〃	0.2 〃	Yes	Yes
			No.22	No	26.7	6.8	0.5 〃	288	150	50	0.5 〃	0.2 〃	No	No
		Shallow	※No.1	Yes	27.3	7.0	0.5 〃	548	200	35	0.5 〃	10	No	No
		Canal	C-1	Yes	29.7	7.6	0.5 〃	257	155	20	0.5 〃	0.2Under	Yes	Yes
WHO Standard *						6.5 ~8.5	0.5		500	250	0.1	0.3		
Sri Lankan Standard						7.0 ~8.5			100	200	0.1	0.3		

* Max.Acceptable Concentration ※ Hardly used because of deteriorated water quality

Table 3-5-3b Analysis Results of Water Laboratory

Subject Well		Residual Content	Colour	Turbidity	Fe	Mn	Cu	Ca	Mg	Cℓ	SO_4		pH
MINIPE Stage Ⅲ	Shallow Well (No.8)	480	10	32	2.54	1.30	0.05	41.60	27.84	18.24	108.25		6.67
	Deep Well (No.15)	248	5 Under	10 Under	0.18	0.10	0.05	24.00	14.40	16.22	72.00		5.91
MINIPE Stage Ⅳ	Shallow Well (No.15)	308	5 Under	10 Under	0.06	0.1 Under	0.19	27.20	17.28	16.22	80.00		6.48
	Deep Well (No.14)	340	5 Under	10 Under	0.96	0.35	0.11	36.80	20.16	8.11	96.00		6.65
NAGADEEPA	Shallow Well (No.11)	140	5 Under	10 Under	0.44	0.1 Under	0.14	9.60	7.68	18.29	35.80		5.93
	* Deep Well (No.3)	378	70 Over	300	12.40	0.10	0.03	56.00	18.24	8.11	102.70		6.59
WHO Standard*		1000	15	5	0.3	0.1	1.0	75	50	250	400		6.5 ~ 8.5
Sri Lankan Standard		500/1500 (mg/ℓ)	5/50 (Unit)	5/25 (Unit)	0.3/0.5 (mg/ℓ)	0.1/0.5 (mg/ℓ)	1.0/1.5 (mg/ℓ)	75/200 (mg/ℓ)	50/150 (mg/ℓ)	200/600 (mg/ℓ)	200/400 (mg/ℓ)		6.5 ~ 9.2

* Hardly used because of deteriorated water quality * Max. Acceptable Concentration/Max. Allowable Concentration

3-6 Road and Traffic Conditions

3-6-1 Summary

Road transport is the only transport method in and around the Project Area. Figure 3-6-1 shows the road network in the Project Area.

National highway A26 from Kandy (ancient capital)crosses the Minipe area via Hasalaka while a B-class national highway connecting Matale and Hettipola runs through the northern part of the area. The Minipe area is administratively divided into north and south sections with the Heen River as the boundary and the Road Development Authority (RDA) Executive Engineer's Offices at Nalanda and Udadunbara are responsible for the maintenance of trunk roads in the north and south sections respectively.

In the Nagadeepa area, National highway A26 runs eastwards from Hasalaka via Mahiyangana, passing further east. A B-class state road leading to Bibile also runs through the southwest of the area. Turn roads in the Nagadeepa area branch off from these two state roads and the Mahiyangana area RDA Executive Engineer's Office is responsible for their maintenance.

The Matale and Hasalaka Bus Transport Centres operate bus services in the north and south sections of the Minipe area respectively, while the Mahiyangana Bus Transport Centre operates bus services in the Nagadeepa area. These services are provided daily, in addition to which are microbuses which are privately operated as a supplement to the public bus services. Bus transport is an essential part of life in the Project Area (Figure 3-6-2).

Other transport methods include privately owned motorbikes and oxcarts, and there are not taxis or pedicabs.

The road conditions are generally poor and cars are often forced to drive as slowly as 10km/hr. even on turn roads. Old trunk

roads passing through villages are badly maintained and can only be used by jeeps or similar vehicles in certain sections.

Roads in the Project Area are classified into trunk roads, feeder roads which are consisted of internal roads within the settlement and village roads, and operation and maintenance roads of canal (canal O.M. roads) according to their main objectives and the following offices are responsible for their maintenance.

Trunk Roads ..... RDA Construction Office

Feeder Roads

Internal Roads within Settlement ..... Land Commissioner's Department

Village Roads ..... Divisional Development Councils (Local Authority)

Canal O.M. Roads ..... Irrigation Department Office

The maintenance of all these roads is inadequate due to lack of funds and, in reality, internal roads and village roads are repaired by local farmers at their own expense.

3-6-2 Current Conditions of Target Roads

The study on the current road conditions in the Project Area commenced on August 3, 1988 in response to the original request by the Government of Sri Lanka. However, as the Study Team received a revised requested road rehabilitation list (Appendix 1-5) from the Sri Lankan side on August 23, the original schedule was changed and an additional study commenced on August 24.

The Study Team first confirmed the locations of the target roads (Figure 3-6-3) through interviews with the related officers and inhabitants in each area and then conducted the road conditions survey accompanied by the related officers and the Sri Lankan counterparts. The results of the study are given in Table 3-6-1.

Fig. 3-6-1 Road Network in Project Area

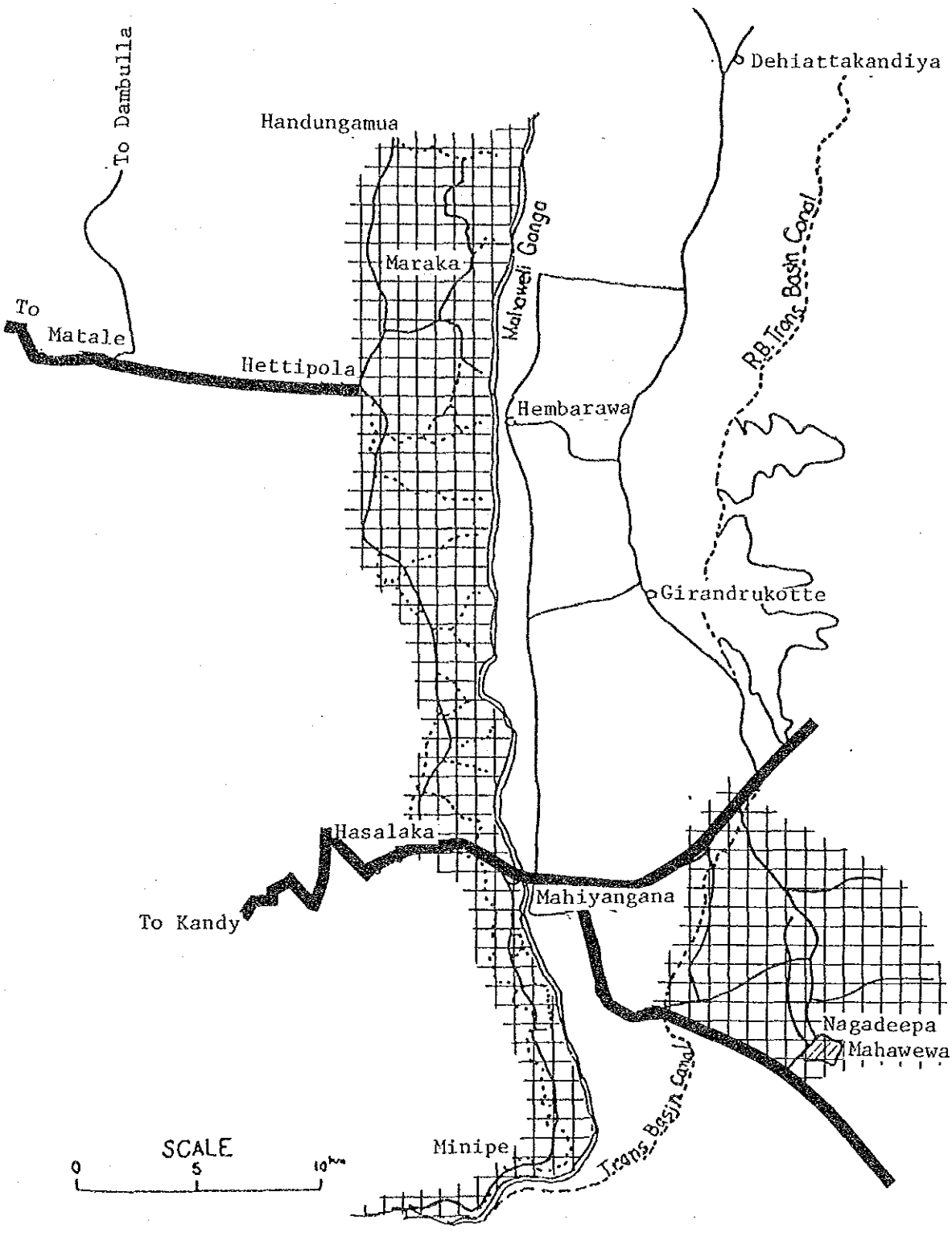
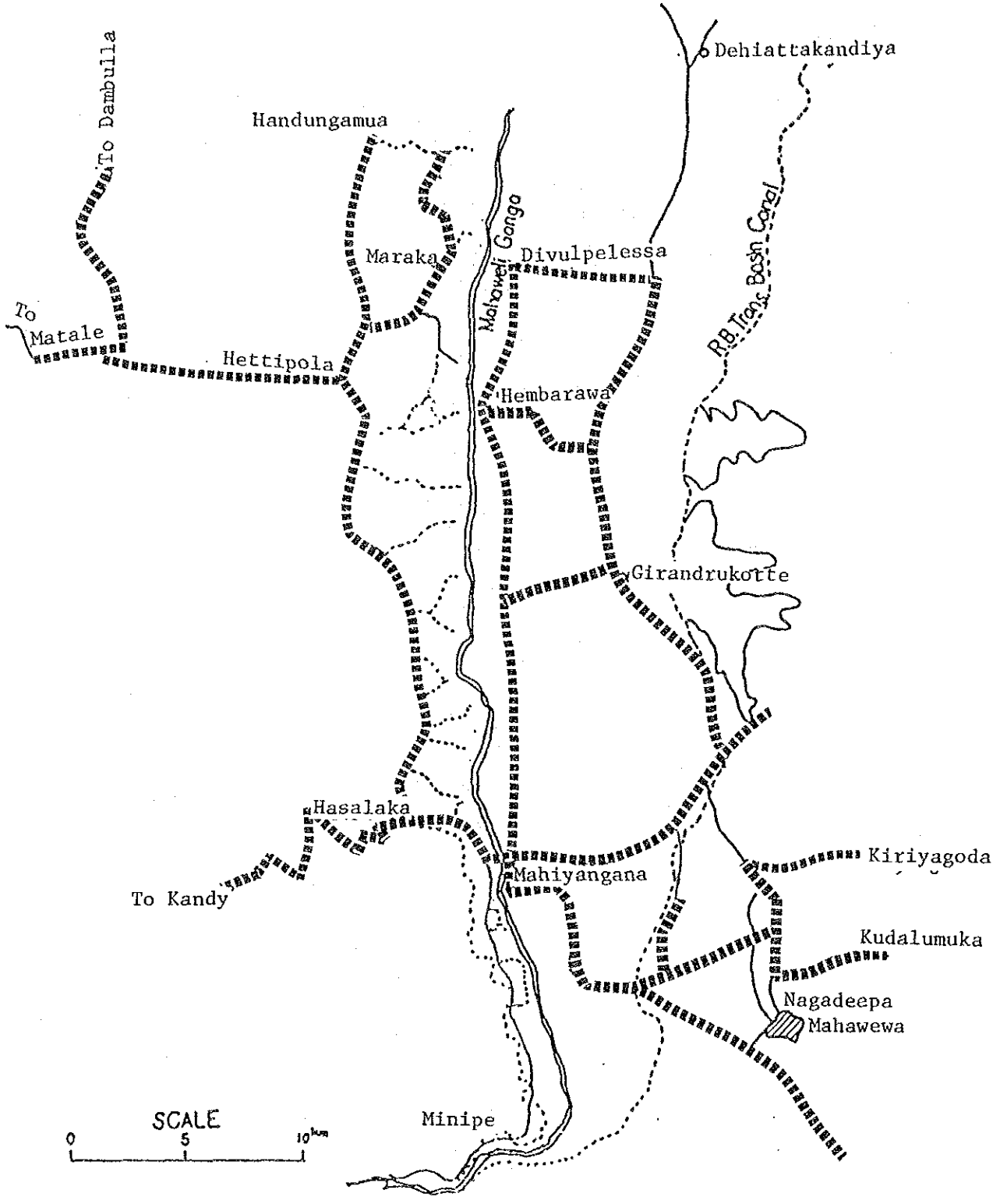


Fig. 3-6-1
Road Network in Project Area



Bus Route

Fig. 3-6-2 Bus Routes

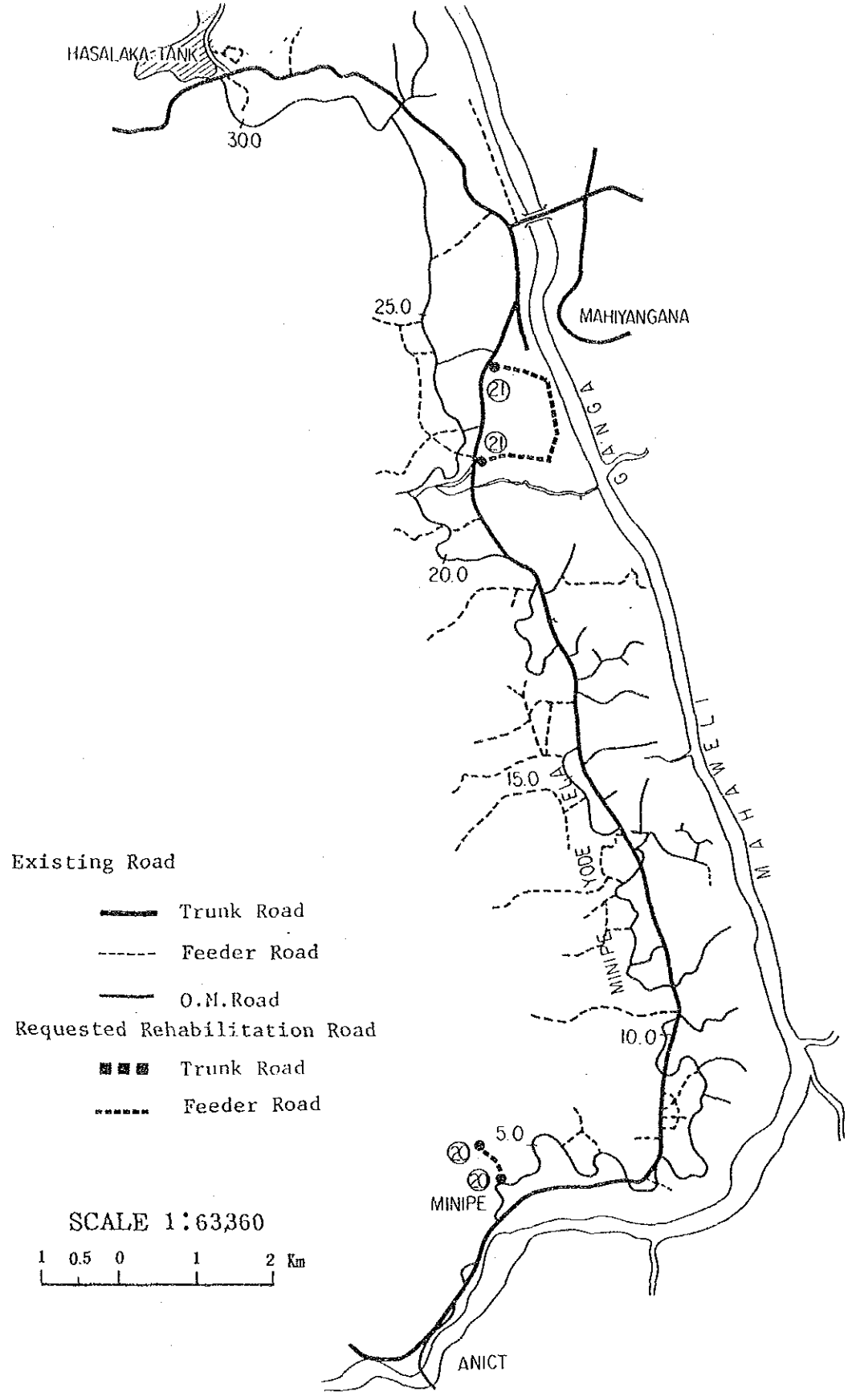


Fig. 3-6-3a Requested Road Rehabilitation (Minipe)

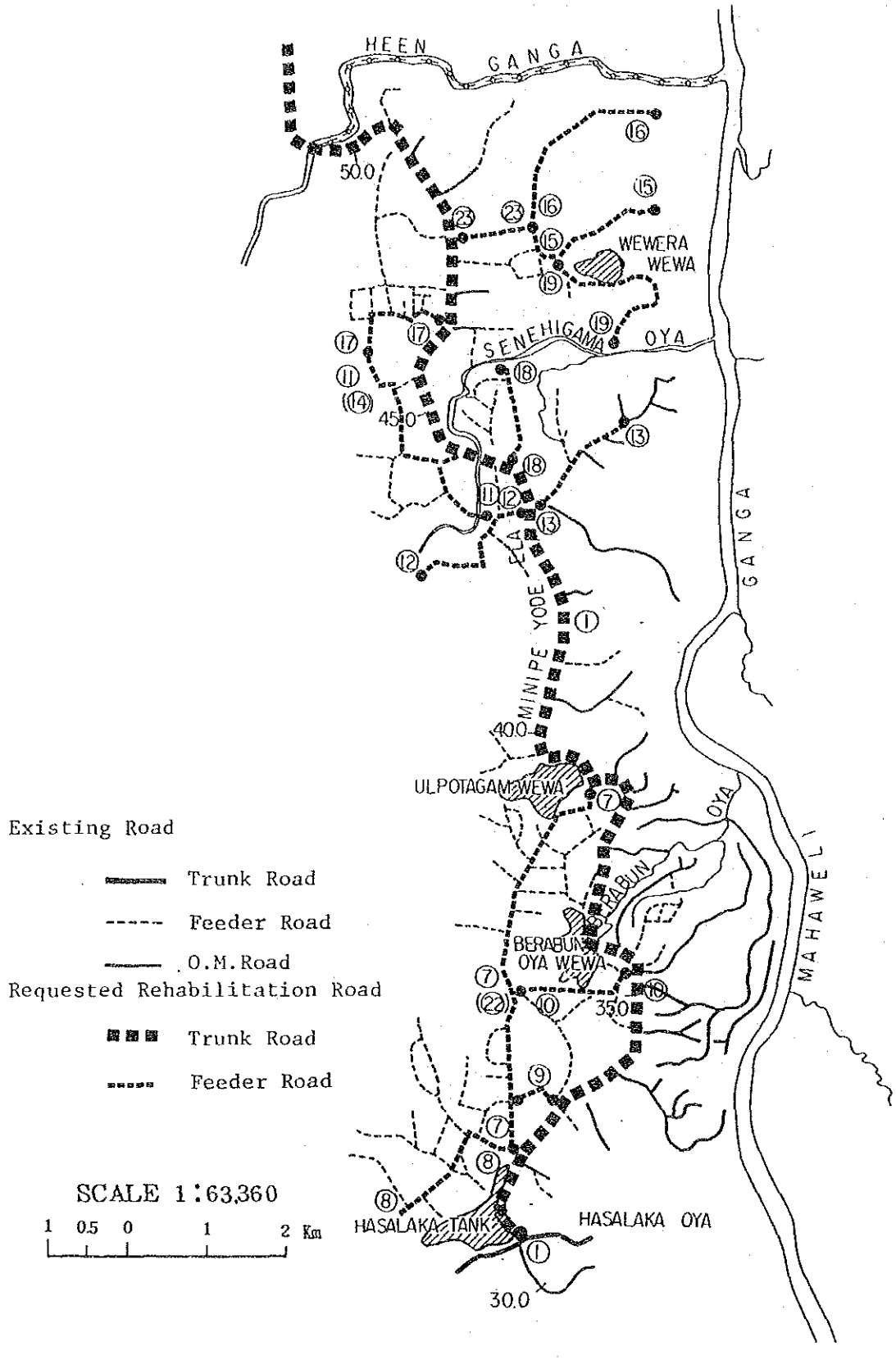


Fig. 3-6-3b Requested Road Rehabilitation (Minipe)

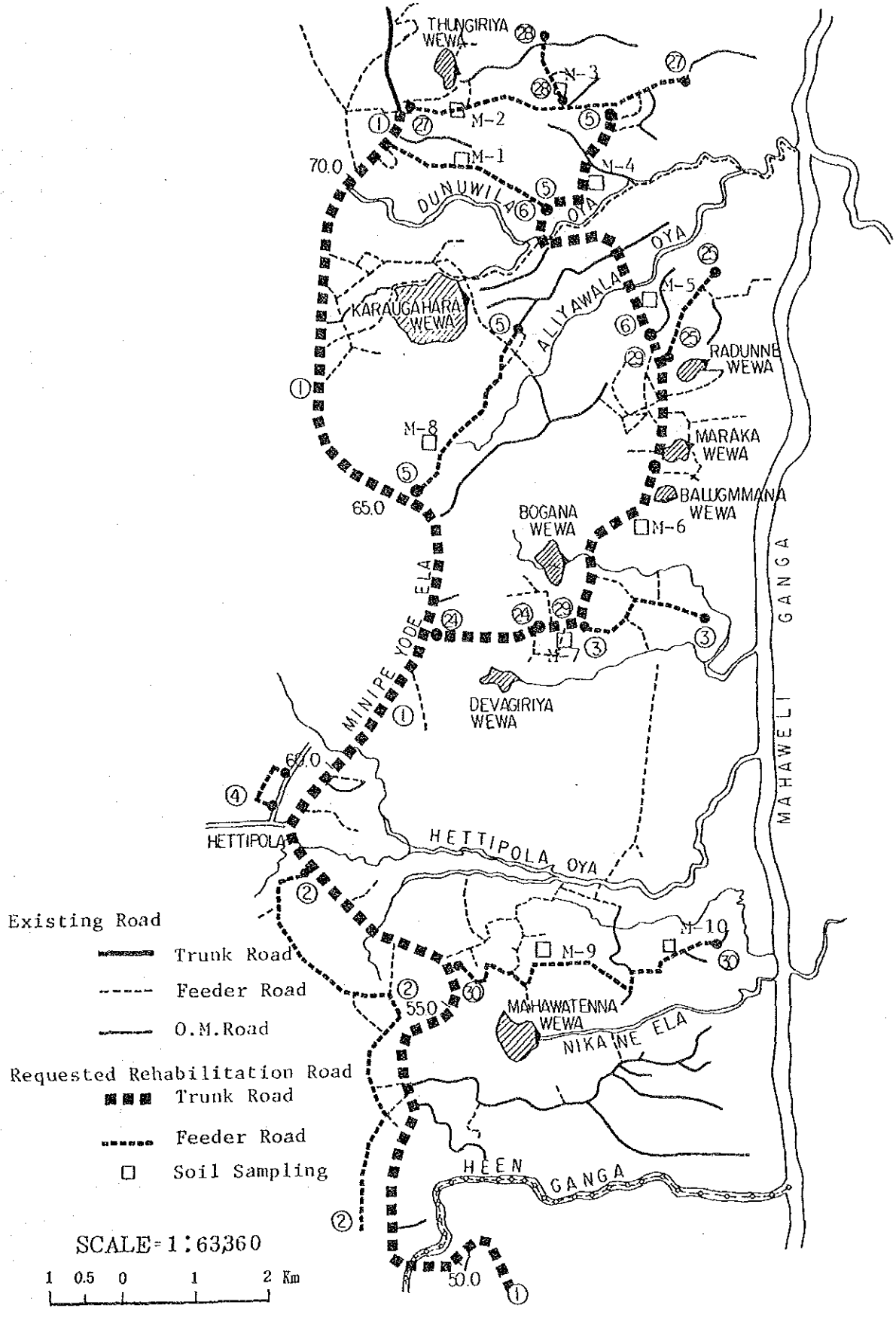


Fig. 3-6-3c Requested Road Rehabilitation (Minipe)

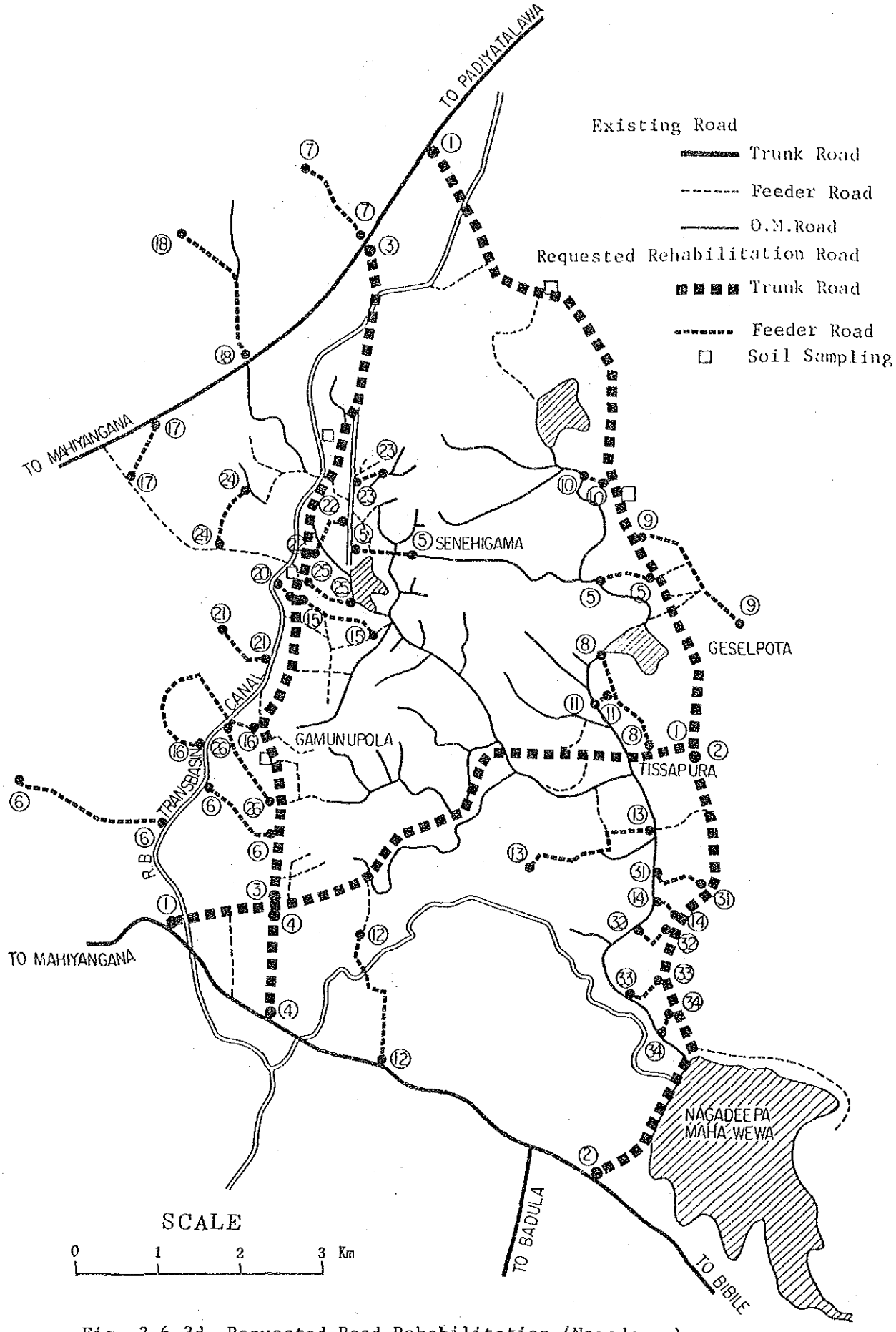


Fig. 3-6-3d Requested Road Rehabilitation (Nagadeepa)

Table 3-6-1 Summary of Road Conditions

(Minipe)

Route No.	Route	Length (km)	Description
1	Hasalaka-Hettipola-Handunganuwa (Trunk Road)	44.4	Trunk road in Stage II, III and IV areas using embankment of Main Canal. 35km section between Hasalaka (K.P. 31) and Lediyangala (K.P. 65) is tarred while remaining 7.7km is gravelled, except section near Dunuwila Reservoir (0.9km). Pot holes of various sizes are found on tarred section. A 2km section near K.P. 49 and a 3km section after K.P. 64 have lost their paved surface. Width of 3.6m is relatively narrow for a trunk road and vehicles have to use road shoulders to avoid collisions with oncoming traffic. Shoulders have dropped due to erosion.
2	Polonnaruwa Road (up to Temple)	6.9	Trunk road which existed prior to recent development efforts. Locally called Old Polonnaruwa Road. Located in highland to left of Main Canal. Earth road except for a few gravelled sections. Connects with present trunk roads at several points. Rocks are exposed due to heavy erosion, making overtaking difficult.
3	Gruwelayaya Cemetery to Mahaweli River	1.9	Starting from junction with Route 24, first 0.9km section is earth road, next 1.0km section is gravelled, then becomes a footpath and O.M. road, passing through Bogahawewa Ela to Mahaweli River (vehicle traffic for first 1.9km section).
4	Amuneyaya Road	1.4	New gravelled road bypassing Hettipola with relatively good road conditions.
5	Leidiyangala to Kumbukandana (Part)	5.7	3km section from Leidiyangala (K.P. 65 on trunk road) is gravelled and 2 small valleys (6m length bridges required). 2.7km gravelled section near Kumbukandana is part of bus route and includes 1.5km long O.M. road.
6	Radunna Tank to Karawgaha (Part)	4.9	0.4km earth section from Radunna Tank has very poor surface. Next 2.1km gravelled section is extension of bus route described in Route 5 above. Section between end of this 2.1km section and Karawgaha is either O.M. road or footpath. The route will break away from existing route at Kumukandana to reach Karawgaha via Handungamuwa. Of this 2.4km section which is gravelled, 1.3km section is located on same level as paddy fields, making its use in wet season difficult.
7	D1 to Ulpotagama	5.2	Highland trunk road in Stage II-1 area. 2.5km section from D1 to Mahayaya is tarred. Some

			parts located in steep slope areas have been washed away. 0.3km section in Ulpotagama is tarred but road conditions are poor. Remaining section is gravelled and road conditions are poor.
8	D1 to Mahaaswedd-uma	1.9	First 0.5km tarred section from D1 is shared by Tropiteya Road, then branches out towards Mahaaswedduma. Rocks are exposed in steep slope areas of this 1.4km gravelled section, resulting in poor road conditions.
9	Keenapessa to D4	0.7	Connects Route 7 to a trunk road is completely tarred but road conditions are poor.
10	D7 to Mahayaya	1.3	Gravelled road connecting Route 7 with a trunk road.
11	Udawela Co-op to Habutuwa	4.5	Highland trunk road in Stage II-2 area connecting with Route 17. Mostly tarred but several sections are gravelled. Road conditions of tarred sections are particularly poor.
12	Udawela Co-op to End of the Colony	2.4	Part of village road leading to Udattewa and Hasalaka. Entire route is tarred. Road conditions are very poor and paved surface has been washed away in several places.
13	Udawelapola to D25	-	Entire route consists of O.M. road.
14	Dambagaha-wela Road	-	Part of Route 11.
15	Weware Road	2.0	Gravelled village road between Weware and Route 23 with some O.M. road sections. Some sections are level with paddy fields, causing problems in the wet season. Outcrops of rocks observed in parts.
16	Palugalla Road	2.4	Partially tarred and gravelled road between Route 23 and Palugalla and O.M. road in parts.
17	Pundalugas-yaya Road	1.2	Extension of Route 11. Section in Dahamigama New Town is tarred and remaining sections are gravelled. Road conditions of the tarred section are poor.
18	Meegalla Road	1.2	Gravelled village road starting from an O.M. road of D27. Good maintenance of ditches in village section.
19	Wileyaya Road	2.3	Gravelled road branching from Route 15 towards Wileyaya. Section near Weware Wewa is level with paddy fields, causing problems in the wet season.

20	Muthettuthe-na to Main Canal	3.7	Mountain road in Stage I area starting from D1B to Muthettuthena. Sections with series of steep slopes with outcropped rocks after hair-pin curve midway makes its passage very difficult. Sections near the Main Canal consist of gravelled village and O.M roads.
21	D34-Weragantota	1.5	1.3km O.M road section from D34 is tarred. Section from Weragantota to RVDC factory is tarred but road conditions are poor. Remaining middle section is gravelled with steep slopes in parts.
22	D1-D13	-	Same as Route 7.
23	Kolongata to Hospital	0.8	Tarred road connecting Routes 15 and 16 with trunk road.
24	Devagiriya-Kanaththa	2.4	Beginning section of trunk road from Maraka Junction to Maraka. Section as far as Devagiriya School is tarred and remaining section is gravelled.
25	Radunna Road	1.8	Gravelled road from Maraka to Radunna.
26	Kawawgahawe-wa Kumbkandana	-	Part of Routes 5 and 6.
27	Medakanda Road	3.6	O.M.road in Stage IV D3 area and final section of a bus route. Gravelled surface shows much corrugation.
28	Tungiriya-Medakanda Road	1.5	Gravelled road located in the northernmost part of Stage IV area connecting north and south.
29	Maraka Road	5.2	Additional road connecting bus route in Stage III and IV areas with trunk road to form a ring road. Mainly gravelled but section near Maraka School is tarred.
30	Mahawatenia Road	4.4	Gravelled village road connecting trunk road (near K.P. 56) and Mahawatenia. Road conditions are poor. Added to list due to strong local request.
	Total	115.2	

(Nagadeepa)

Route No.	Route	Length (km)	Description
1	Mapakada-Kongaha Junction-Tissapura-Keselpotha-Mile Post 50	16.5	Bus route from Mahiyangana to Keselpotha via Ikiriyagoda and is trunk road in Nagadeepa area. 4.7km section in Keselpotha area is gravelled and other sections are tarred. Road conditions of section between Tissapura and Mile Post 50 (on A26) are very poor in many places.
2	Andalupotha - Tissapura	5.9	Road between Andalupotha and Tissapura via embankment of Nagadeepa Reservoir. Section between B46 and Nagadeepa Reservoir is tarred but poorly maintained. 1.7km section from Tissapura towards Kuda Lumuka, located further east, is a tarred bus route. Middle section, including crest of Nagadeepa Reservoir Dam, is gravelled with some outcrops of rocks.
3	Kongaha Junction-Gemunupura-Senevipura-Orubeduwewa (Mile Post 49)	8.6	Bus route (up to Gemunupura) branching from Route 1. Middle 5.2km section is gravelled and remainder is tarred. Sloping section between Gemunupura and Senevipura is heavily eroded with some outcrops of rocks and only 4-wheel drive cars can use this section even in dry season.
4	Kongaha Junction-Mile Post 16 (Mapakada)	1.5	Gravelled road connecting Route 1 and B46 with some outcrops of rocks.
5	Keselpotha-Arawatta (BOP Road); 2.3km O.M. Road	1.9	Road connecting eastern and western parts of Nagadeepa area. More than half is O.M. road along a canal. Watercourse moved eastward due to collapse of causeway across Diyabana River, causing problems for pedestrians. Section near Arawattawewa is submerged when water level of Diyabana River is high.
6	Abayapura-Mile Post 20 (Mapakada)	4.3	Formerly shortest route between Mahiyangana and Abayapura but divided by Trans Basin Canal. 1.7km section from Mile Post 20 is tarred while total 2.6km sections on both sides of dividing point are gravelled and heavily eroded with some outcrops of rocks, making passage difficult.
7	Orubeduwewa Temple - Diyabana River	1.2	Gravelled road partly passing crest of Nagadeepa Reservoir Dam and O.M. road. Road is submerged just before Diyabana River, making passage even on foot difficult.

8	Tissapura Dispensary-Rotawewa	1.8	Village road in Tissapura highland. No bridge over Main Canal at Rotawewa. Gravelled and difficult to pass due to heavy erosion.
9	Keselpotha-Ikiriyagota	2.6	Gravelled road leading to Ikiriyagota. Road conditions are particularly good in dry season. A bus operator says there is no trouble using this road in wet season.
10	Keselpotha-Main Canal	0.4	Village road connecting Route 1 and Main Canal. Gravelled but heavily eroded.
11	Hospital-Tract 10	0.5	Gravelled road branching from Route 8 and leading to Main Canal.
12	Badulla (Mile Post 15) Road-Tract 3/FC18	1.6	1.0km section from B46 to Temple is gravelled. Reaches Route 1 after bypassing Temple and crossing Heppola River.
13	Tract 2/Lot 59 - Tract 3/ Lot 01	2.0	Gravelled village road from Main Canal.
14	Tract 2/Lot 36 - Tract 2/ Lot 40	0.5	Gravelled village road connecting Route 2 and Main Canal.
15	Tract 5/D-Lot 6/74	1.4	Gravelled village road connecting a branch canal and Route 3. Sometimes difficult to pass due to heavy erosion.
16	Tract 5 - Lot 5/23	-	Gravelled village road connecting Route 3 and Route 19 crossing Trans Basin Canal
17	Peradeniya Stores - Kolongala (Mile Post 47)	0.8	Gravelled village road connecting A26 and Mile Post 47 - Arawatta Road.
18	Hussai Stores-Puwakgaswela	1.2	O.M. road heading north from A26.
19	Lot 5/105-Lot 5/144	1.2	Gravelled village road to Trans Basin Canal from route 16 via a village.
20	Lot 6/91-Lot 6/86	0.3	Gravelled road connecting Route 3 and Trans Basin Canal.
21	Lot 5/155-Lot 5/175	1.0	Gravelled village road from Trans Basin Canal to Dambarawa Wewa.
22	Senevigama (Bogaha Junction)-Tract/Lot 158)	0.6	Gravelled village road in Senevigawa.

23	Lot 6/223-Kongaha Junction	0.4	Same as above.
24	Lot 8/17-Arawatta Vidyalaya	1.4	Mostly O.M. road. Impossible for cars to pass in many places.
25	16 Boutique-Arawatta (near Laundry)	0.6	Gravelled village road connecting Route 3 and Arawatta Wewa.
26	Tract 5/Lot 37-Abhayapura School	1.4	Gravelled village road from Trans Basin Canal to Abhayapura School (Route 3). Section at small valley near Canal has been washed away.
27	Abhayapura School-Tract 4/D1	0.4	Gravelled village road heading east from Abhayapura School (Route 3) and connecting with an O.M. road.
28	Gemunupura School-Gemunupura Temple	0.6	Gravelled temple road which is heavily eroded with some outcrops of rocks.
29	Tract 4/Lot 8 - Tract 4/D	0.8	Gravelled village road connecting Route 3 and Route 27.
30	Tract 2/56-Tract 2/46	0.6	Gravelled village road from Route 2 to Trans Basin Canal. Added to list due to local request.
31	Tract 2/04-Tract 2/08	0.6	Same as above.
32	Tract 1/44-Tract 1/57	0.7	Same as above.
33	Tract 1/19-Tract 1/17	0.4	Same as above.
34	Tract 3/142 - Tract 3/109	0.5	Gravelled village road from Route 1 to Tract 4/D in north. Some outcrops of rocks. Added to list due to local request.
35	Tract 3/139 - Tract 3/127	0.7	Gravelled village road running south from Route 1. Added to list due to local request.
	Total	65.9	

List of local officers

Irrigation Engineers	(Hasalaka and Nagadeepa areas)
Project Managers (RDA)	(Minipe and Nagadeepa areas)
Executive Engineers	(Mahiyangana, Udadumbara and Nalanda areas)
Assistant Government Agents	(Wilgamuwa, Minipe and Mahiyangana areas)
District Officers, Colonization Officers and Cultivation Officers	(Hettipola, Hasalaka and Nagadeepa areas)
Technical Officers	(Hettipola and Hasalaka areas)

The field study on the roads given in the revised list found some duplications and wrong entries of road distances, making the total length of target roads approx. 181km.

3-6-3 Soil Conditions of Target Roads

A soil survey was conducted on the subgrade soil of existing roads in the Project Area at 10 sites in the Minipe area and 5 sites in the Nagadeepa area in addition to those roads with high rehabilitation priority. The laboratory soil test was conducted at the Soil Laboratory of the Irrigation Department while the filed CBR test was commissioned to local companies.

Sampling sites for the soil test and the CBR test sites are shown in Figure 3-6-3 and the test results are given in Table A3-6-1. According to the test results, sandy soil (SC, SM) accounts for 70% in the Minipe area, indicating the soil to be of good quality for use as subgrade soil. Sandy soil (SC, SM), also of good quality, accounts for 80% in the Nagadeepa area.

The filed CBR test results for 3 sites in the Minipe area vary greatly, from 13.7% to 57.3%. The CBR value of 13.7% corresponds to cohesive soil in the soil classification but presents no problems vis-a-vis its use as subgrade soil. The CBR values for the 2 test sites in the Nagadeepa area are as high as 43.9% and

51.8%.

In view of the above test results, it is concluded that the subgrade soil in the Project Area is generally of good quality.

3-6-4 Traffic Conditions

A survey on the traffic conditions in the Project Area was conducted in August 1988 by the Ministry of Lands and Land Development on the following trunk roads/sections.

Minipe

(1) Weragama - Radenigala Road
(2) Mahiyangana - Kandy Road
(3) Hasalaka - Hettipola (Bund Road)
(4) Rodenigala - Waragantota
(5) Hettipola - Handungamuwa
(6) Matale Naula - Pallegama - Hettipola

The Study Team also conducted a traffic volume study at the following points in the Minipe and Nagadeepa areas for 12 hours between 6:00 am and 6:00 pm at midweek to supplement the above survey.

Minipe

(7) Maraka Junction (Devagiliya) - Maraka Road
(8) Maraka Village - Maraka Road

Nagadeepa

(9) Kongaha Junction
(10) Tissapura Junction

Based on the survey results of the Ministry of Lands and Land Development and those of the Study Team, the daily traffic volumes at the main points are compiled in Table 3-6-2.

Table 3-6-2 Daily Traffic Volumes (6:00 am - 6:00 pm)

Observation Point	Road Name	Traffic Volume (No. of Vehicles)
Hasalaka	Hettipola - Hasalaka	286
"	Kandy - Mahiyangana	503
Hettipola Jn (Wilgamuwa)	Hettipola - Matale	45
"	Hettipola - Hasalaka	77
"	Hettipola - Handungamwa	55
Handagawa (Minipe)	Waragantota - Randenigala	238
"	Kandy - Mahiyangana	1,320
"	Waregama - Randenigala	620
Moraka Jn	Maraka Jn - Maraka	45
Maraka	Devagiriya - Kumbukandana	19
Kongaha Jn	Kongaha Jn - Mapakoda	127
"	Mapakoda - Gemunupura	31
"	Tissapura - Kongaha Jn	101
"	Gemunupura - Tissapura	5
Tissapura Jn	Tissapura Jn - Kongaha	48
"	Kongaha - Kudalumuka	23
"	Kongaha - Keselpotha	25
"	Keselpotha - Kudalumuka	9