


**BASIC DESIGN STUDY REPORT
ON
VAVA'U HIGH SCHOOL PROJECT
IN
THE KINGDOM OF TONGA**

MARCH, 1983

JAPAN INTERNATIONAL COOPERATION AGENCY

G R B

83-08

**BASIC DESIGN STUDY REPORT
ON
VAVA'U HIGH SCHOOL PROJECT
IN
THE KINGDOM OF TONGA**

JICA LIBRARY

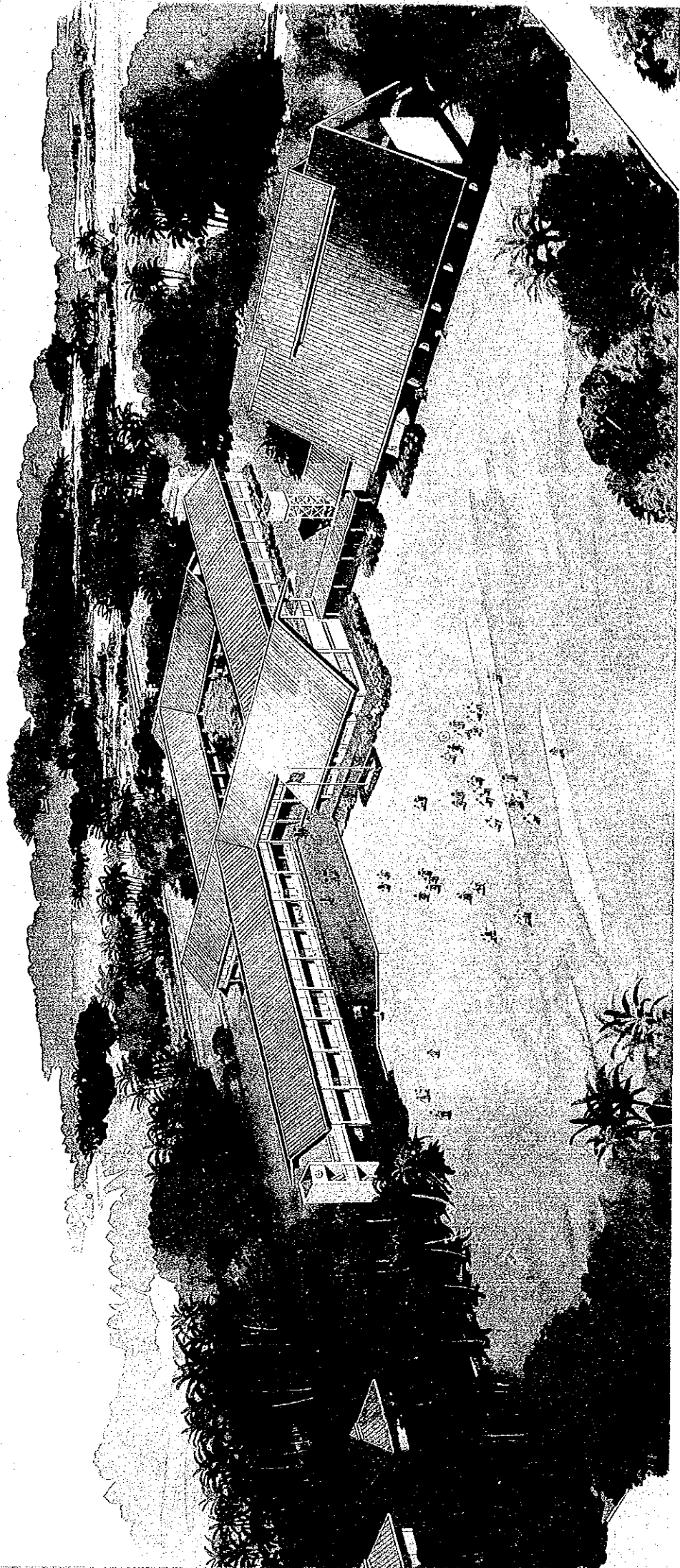


1043454[6]

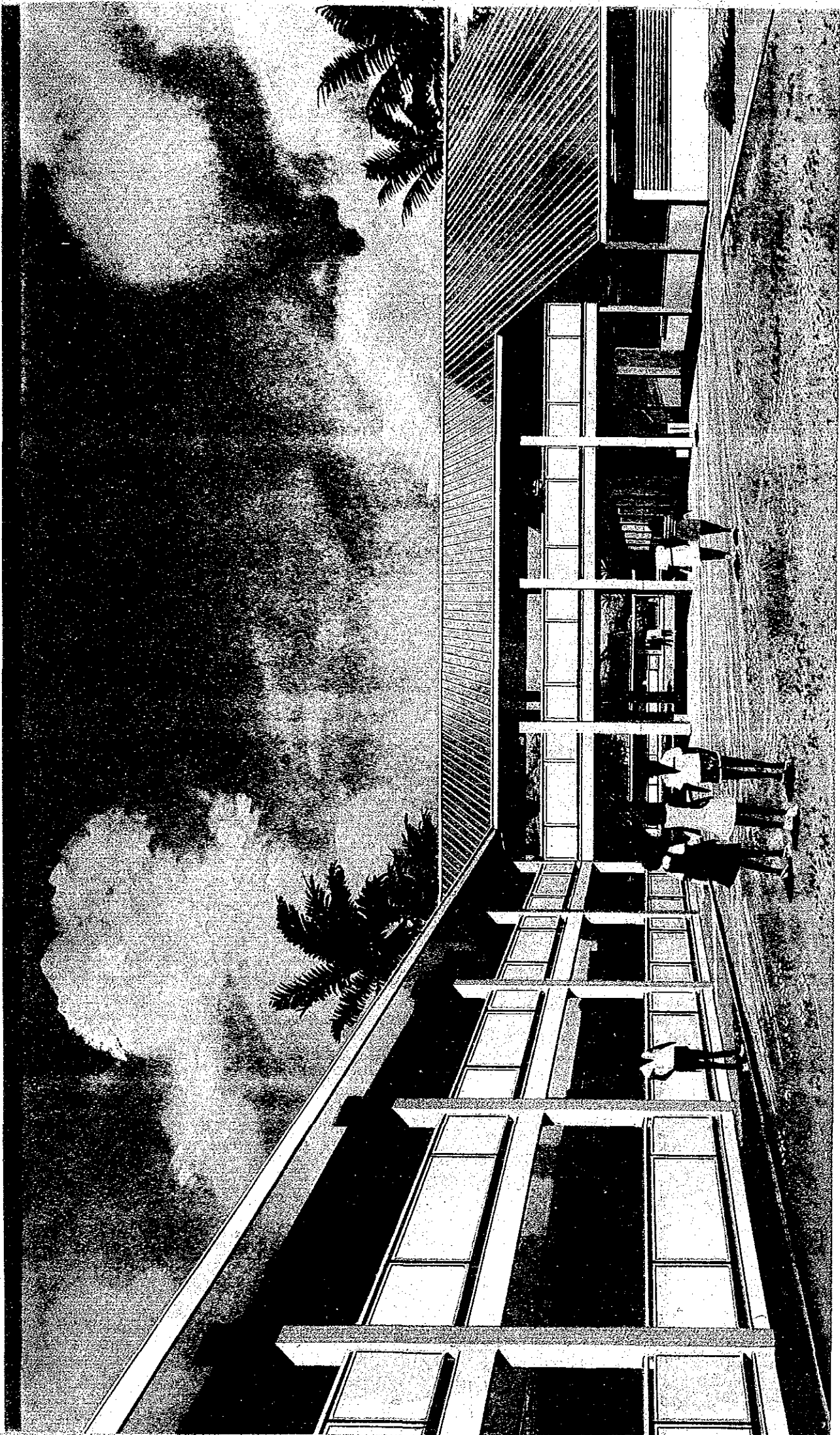
MARCH, 1983

JAPAN INTERNATIONAL COOPERATION AGENCY

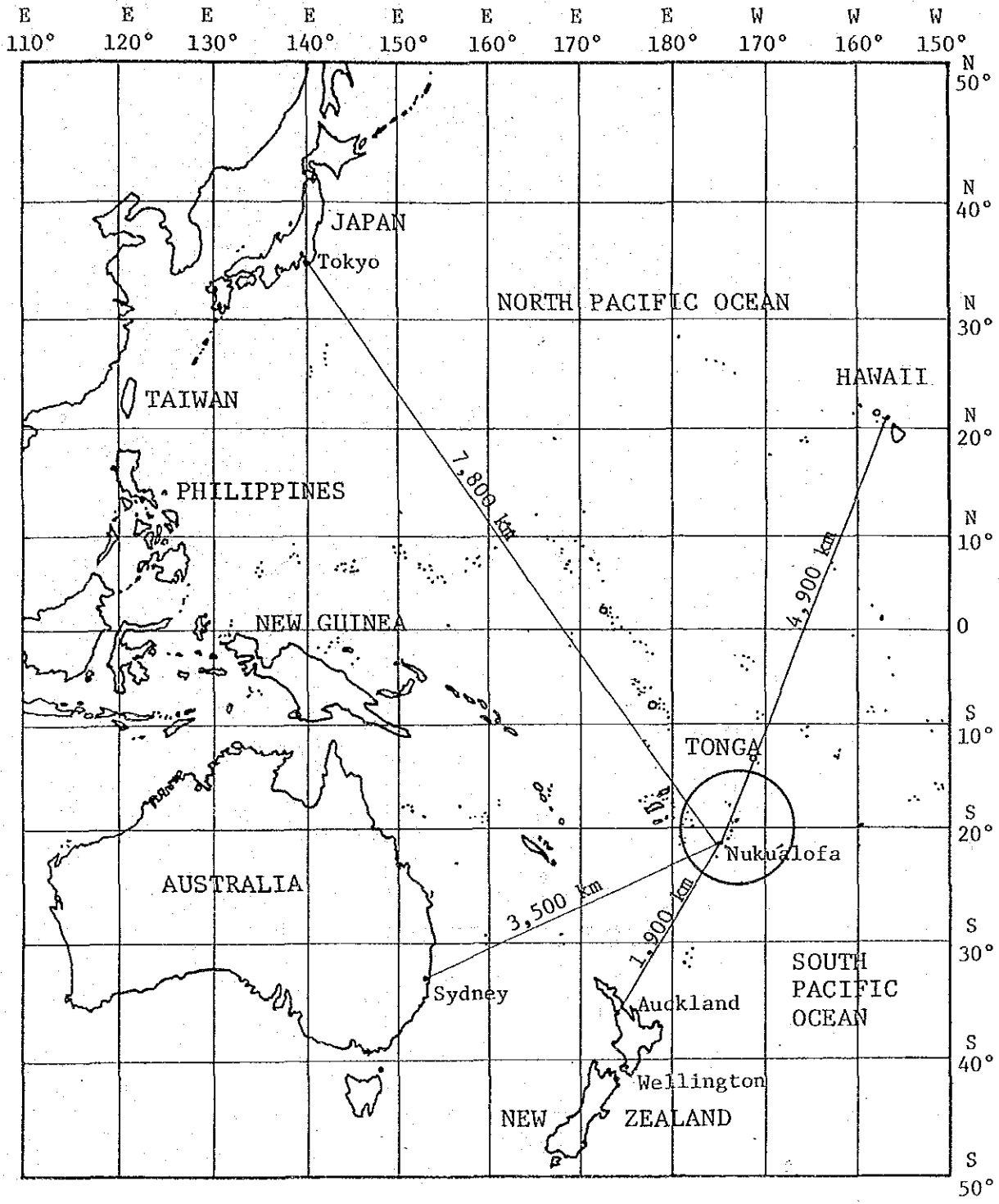
國際協力事業団	
受入 月日 84. 91 - 87	208
	62.5
登録No. 108209	GRB

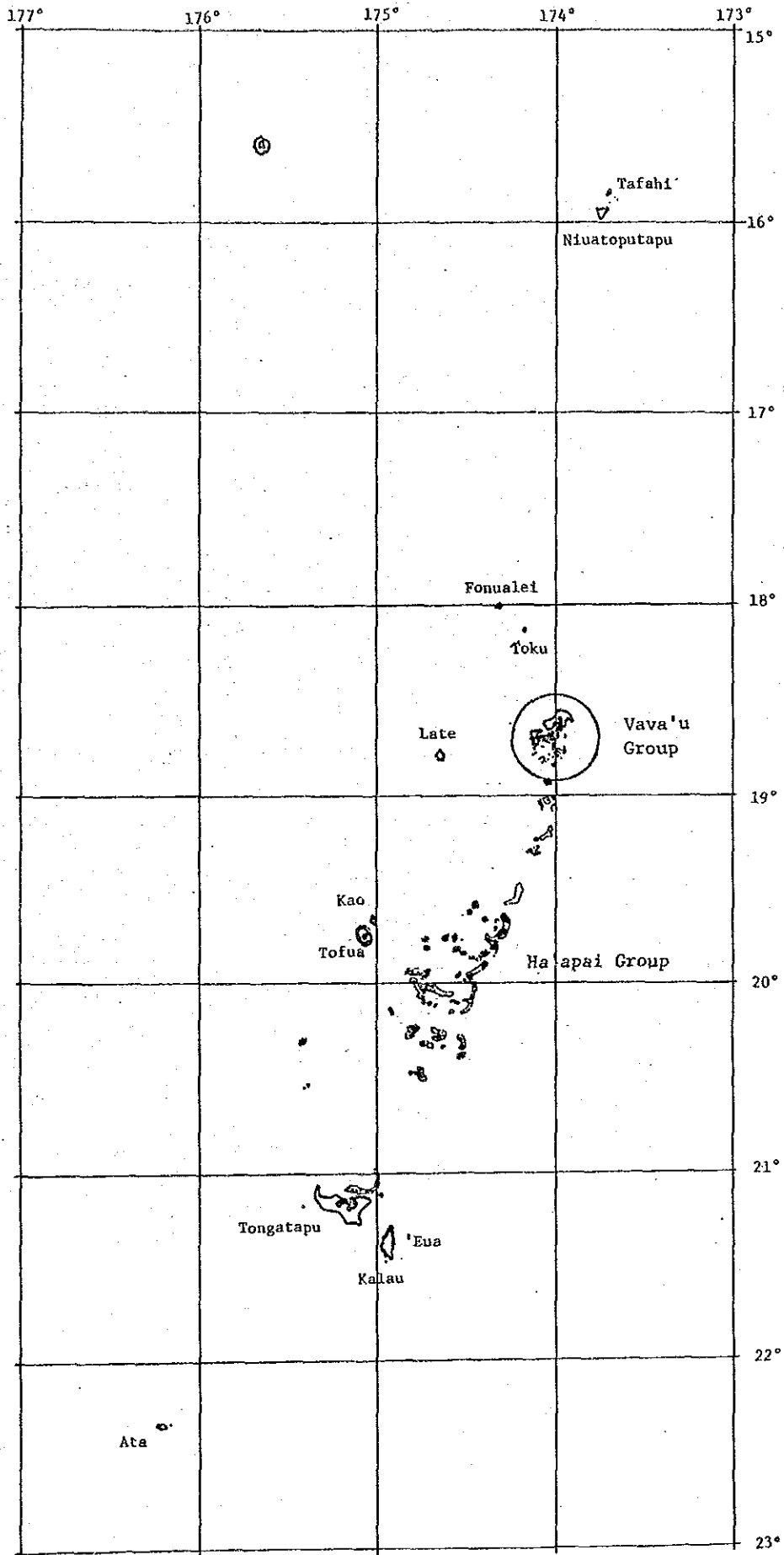


Vava'u High School

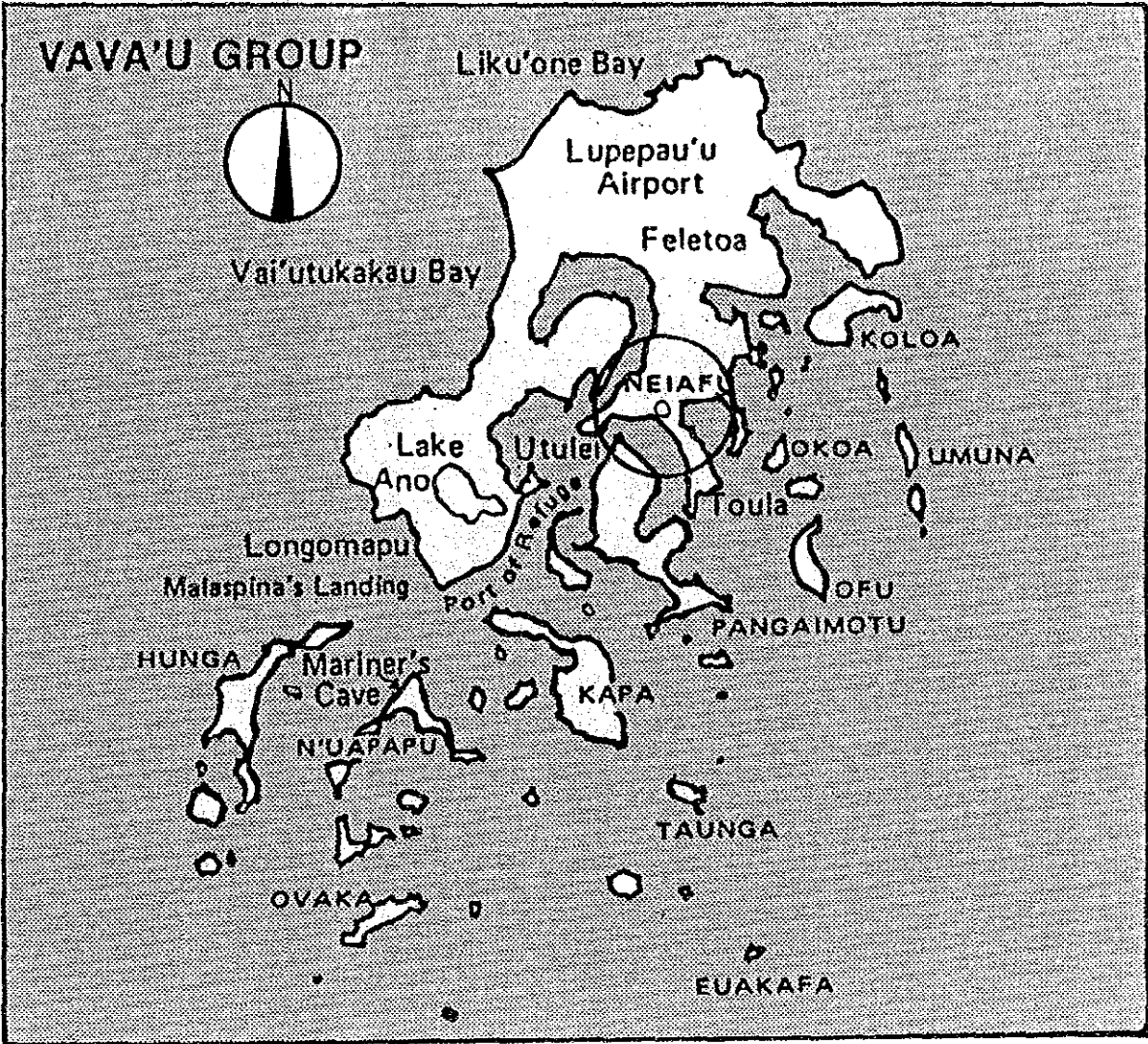


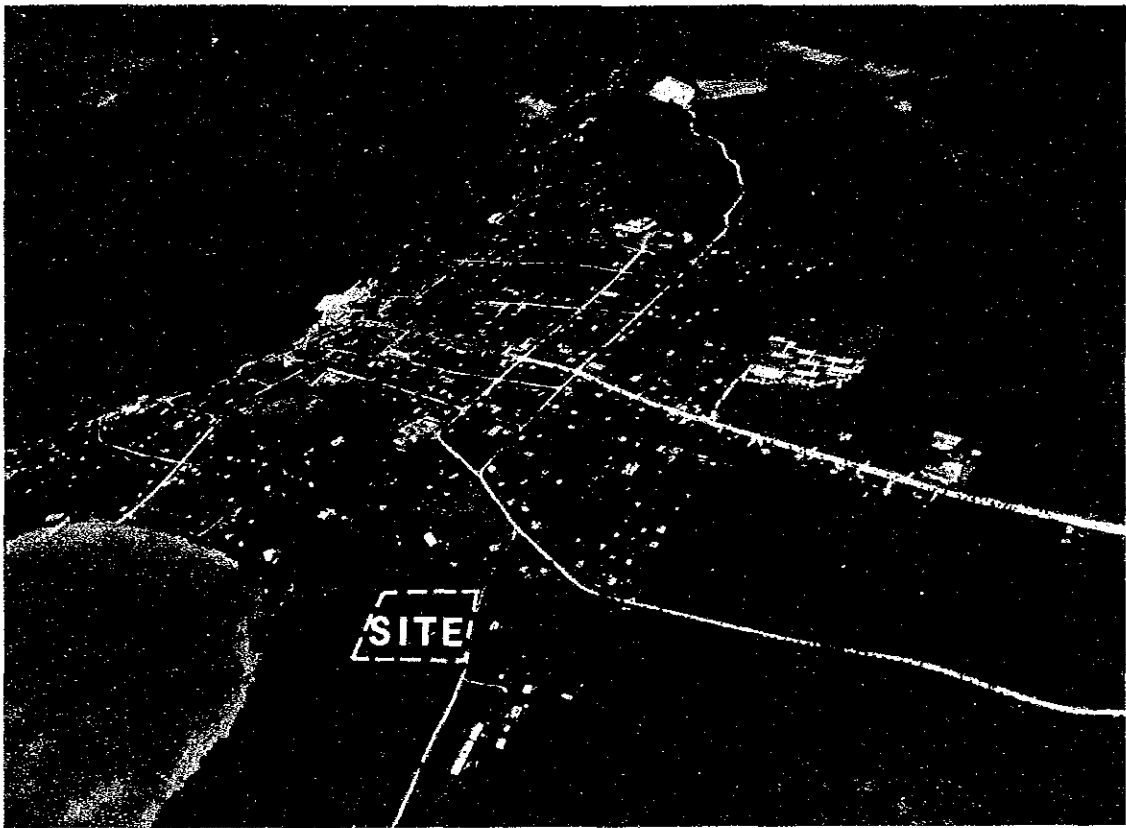
Vava'u High School





THE KINGDOM OF TONGA





Aerial Photograph of Neiafu City

PREFACE

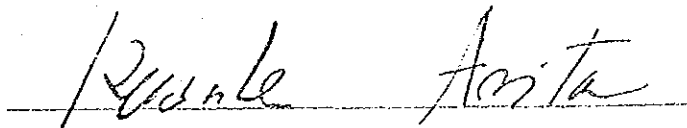
In response to the request of the Government of the Kingdom of Tonga, the Government of Japan decided to conduct a survey on Vava'u High School Project and entrusted the survey to the Japan International Cooperation Agency. The J.I.C.A. sent to Tonga a survey team headed by Mr. Takeshi Komori, Grant Aid Department, JICA from December 4 to December 25, 1982.

The team had discussions with the officials concerned of the Government of Tonga and conducted a field survey in Tongatapu and Vava'u area. After the team returned to Japan, further studies were made and the present report has been prepared.

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

I wish to express my deep appreciation to the officials concerned of the Government of the Kingdom of Tonga for their close cooperation extended to the team.

March, 1983

A handwritten signature in black ink, appearing to read 'Keisuke Arita', is written over a horizontal line.

Keisuke Arita
President
Japan International Cooperation
Agency

SUMMARY

SUMMARY

The formal status of the Kingdom of Tonga changed successively along its history, i.e., it became a constitutional monarchy in 1875, a British Protectorate in 1900 and a member of the British Commonwealth of Countries in 1970. In the meantime it remained always as an independent country. As an insular country of the South Pacific, in the international scene Tonga has adopted a multipolar diplomatic policy based on the philosophy of peace and friendship, while in the domestic scene it is promoting social and economical development based on agriculture. The GDP per capita is growing steadily, with T\$278 (Approximately ¥69,000) in 1975 and T\$545 (Approximately ¥113,000) in 1980, but problems such as increase of population, unemployment and depopulation have actualized in recent years.

In view of the increasing unbalance between the urban area and the rural area, the government of Tonga is tackling the problem of regional development as a nationwide campaign, and the Fourth Quinquennial Development Plan started in 1980 is aimed at strengthening the physical constitution of the nation through balanced regional development of the three principal archipelagos (Tongatapu, Vava'u and Ha'apai) while preserving the idiosyncrasy of the Tonga society. Barely 5% of the working population of Tonga has the education above secondary level, and this is obstructing the progress of development projects. Such being the case, an improvement in the status quo of the educational system is one of the most urgent problems. To cope with this situation, the Government of Tonga is planning an expansion and improvement of the educational system of local districts, and has asked for a grant-in-aid from the Government of Japan for construction of a high school in Vava'u.

In response to the request the basic design study was carried out from December 4th to 24th 1982, with the purpose of surveying the impact and the pertinence of the grant-in-aid to be provided by Japan and to draw up the master plan with the necessary and optimum scale. Under the circumstances, the survey team verified the contents of the request presented by the Ministry of Education of Tonga, investigated the status

quo of the social and educational system of the country and carried out a field survey in Vava'u.

The status quo of the educational system of Vava'u is quite low, and there is no public high school. Resulting from the historical circumstances of the country, there are many schools established and being operated by Christian Churches. Vava'u is no exception to the case and there are currently four such schools in operation in the island which do not meet the standards of the Ministry of Education. Under the circumstances, approximately 10% of the students of Vava'u that want to attend high school are forced to emigrate, sometimes with their families, to Tongatapu Island where the public high schools are located.

The project is aimed at improving the educational situation with the purpose of giving the pupils of Vava'u a chance of high grade secondary education in accordance with the standards established by the Ministry of Education, and in consequence encouraging the economical activity of the Vava'u region through the fostering of a capable working population.

The Vava'u High School will be one of the highest educational institutions of Tonga that will start as a coeducational public high school with a duration of 7 school years (7 forms). It will be an integrated high school comprising vocational training course with each school year consisting of 2 classes with 35 students in each class.

The principal facilities of this high school are planned as follows:

1. Administrative building comprising the principal's office, teacher's room, etc.	177 m ²
2. Ordinary classrooms (16 classrooms)	1,114 m ²
3. Special classrooms (10 classrooms)	715 m ²
4. Library (one room)	150 m ²
5. Multi-purpose hall, to be used principally for physical education	630 m ²
6. Facilities and areas for public use, such as lavatories, corridors, etc.	1,842 m ²
TOTAL	4,628 m ²

The implementation of this project will require a total period of 21 months, consisting of 5 months for detailed design, 2 months for tendering and 14 months for construction.

The project is expected to have a significant impact on the regional development of Tonga, in addition to its contributions to the fostering of a capable working force. Furthermore, it will have the immediate effect on preventing the migration of the population from Vava'u to Tongatapu and to improve the educational level of students in this area. This project is part of an integrated series of aids provided by Japan in the educational field and is a prolongation of the aid that culminated with the successful construction of an elementary school in 1980. Under the circumstances, the project is especially significant both to Japan and to Tonga.

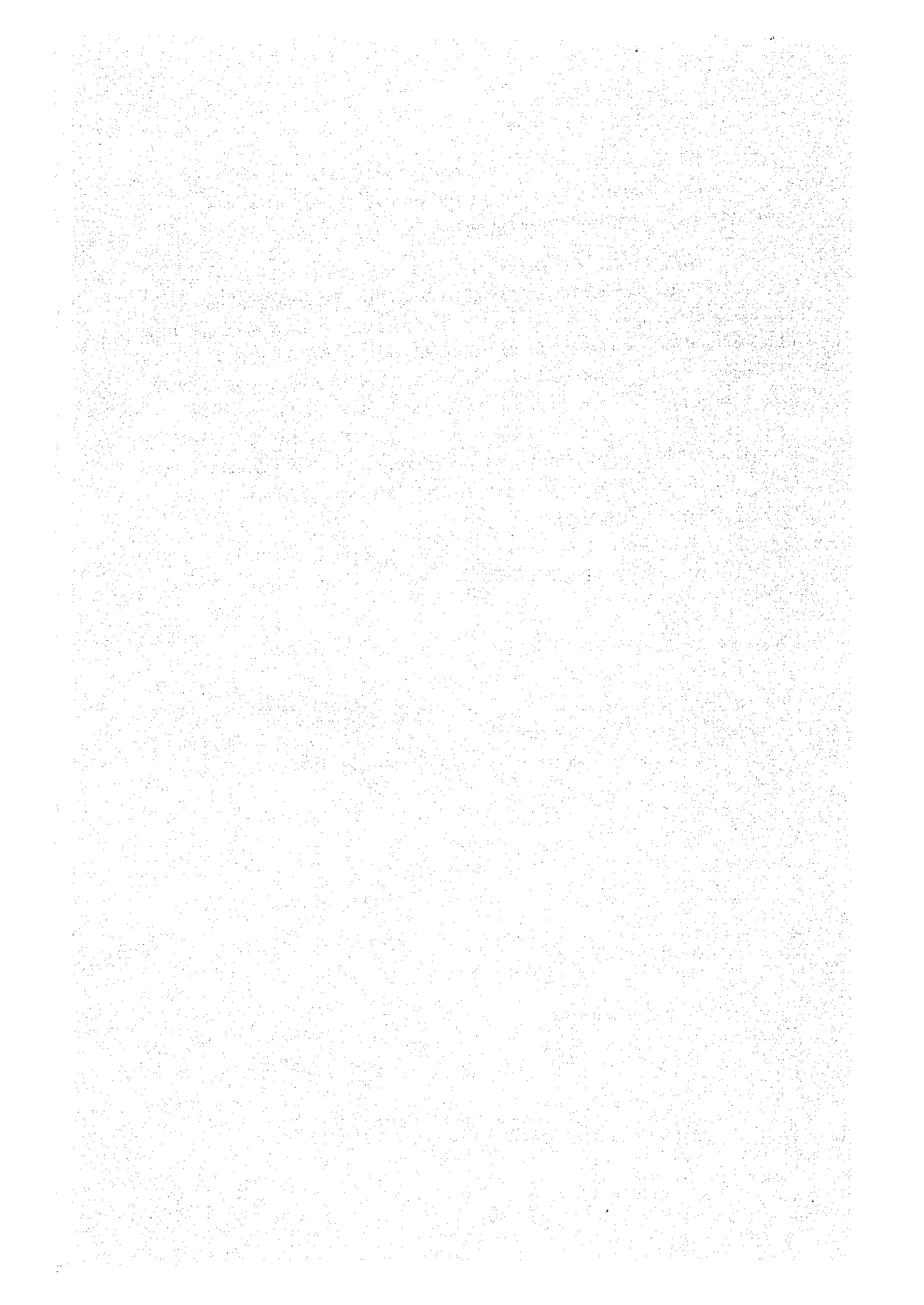


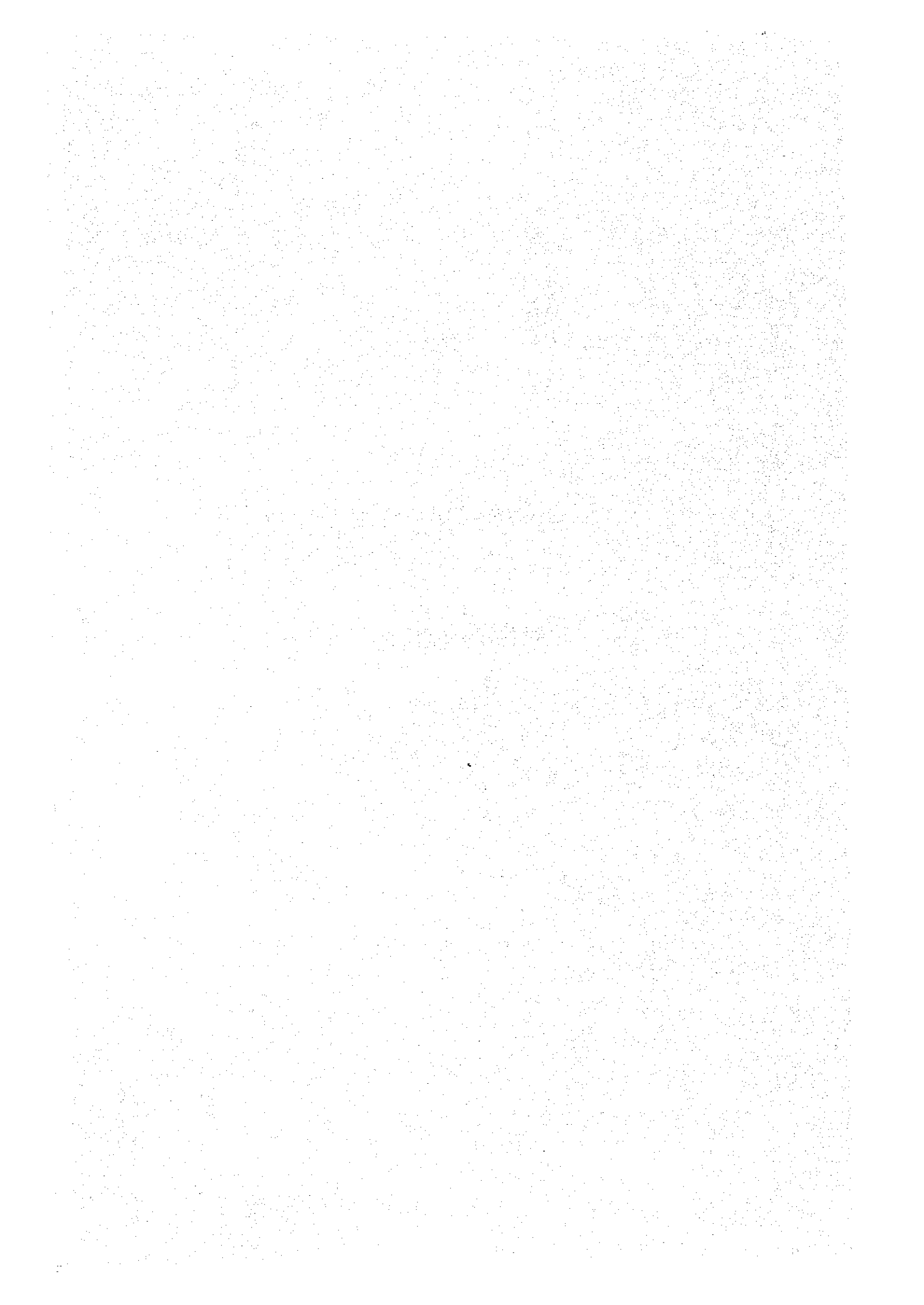
TABLE OF CONTENTS

		<u>Page</u>
MAP		
PREFACE		
SUMMARY		S-1
CHAPTER 1	INTRODUCTION	1
CHAPTER 2	BACKGROUND	3
2-1	Social and Economical Situation	3
2-1-1	Social Situation	3
2-1-2	Economical Situation	4
2-2	Population and Employment	5
2-3	Education	7
2-3-1	System of Education	7
2-3-2	Problems and Countermeasures	10
2-3-3	Educational Development and Funds	12
CHAPTER 3	SITUATION OF THE PROJECT SITE	17
3-1	General	17
3-2	Natural Conditions	18
3-2-1	Geology	18
3-2-2	Earthquakes	19
3-2-3	Hurricanes and Cyclones	21
3-2-4	Meteorology	21
3-2-5	Salt Injury	22
3-3	Infrastructure	22
3-4	Construction	24

	Page
CHAPTER 4	CONTENTS OF THE PROJECT 25
4-1	Purposes and Contents 25
4-1-1	Purposes 25
4-1-2	Contents 25
4-2	Design Policy 29
4-3	Basic Design 31
4-3-1	Site 31
4-3-2	Layout 36
4-3-3	Architectural Planning 39
4-3-4	Water and Electrical System 50
4-3-5	Equipment 54
4-3-6	Preliminary Drawing 54
CHAPTER 5	IMPLEMENTATION OF THE PROJECT 79
5-1	Organization for Implementation of the Project ... 79
5-2	Schedule of the Project 81
5-3	Scope of Works 84
5-4	Operation and Administration Plan 86
5-5	Procurement 92
CHAPTER 6	EVALUATION, CONCLUSION AND RECOMMENDATION 95
6-1	Evaluation of the Project 95
6-2	Conclusion 97
6-3	Proposition 98
CHAPTER 7	REFERENCE DATA 101

CHAPTER 1

INTRODUCTION



Chapter 1

INTRODUCTION

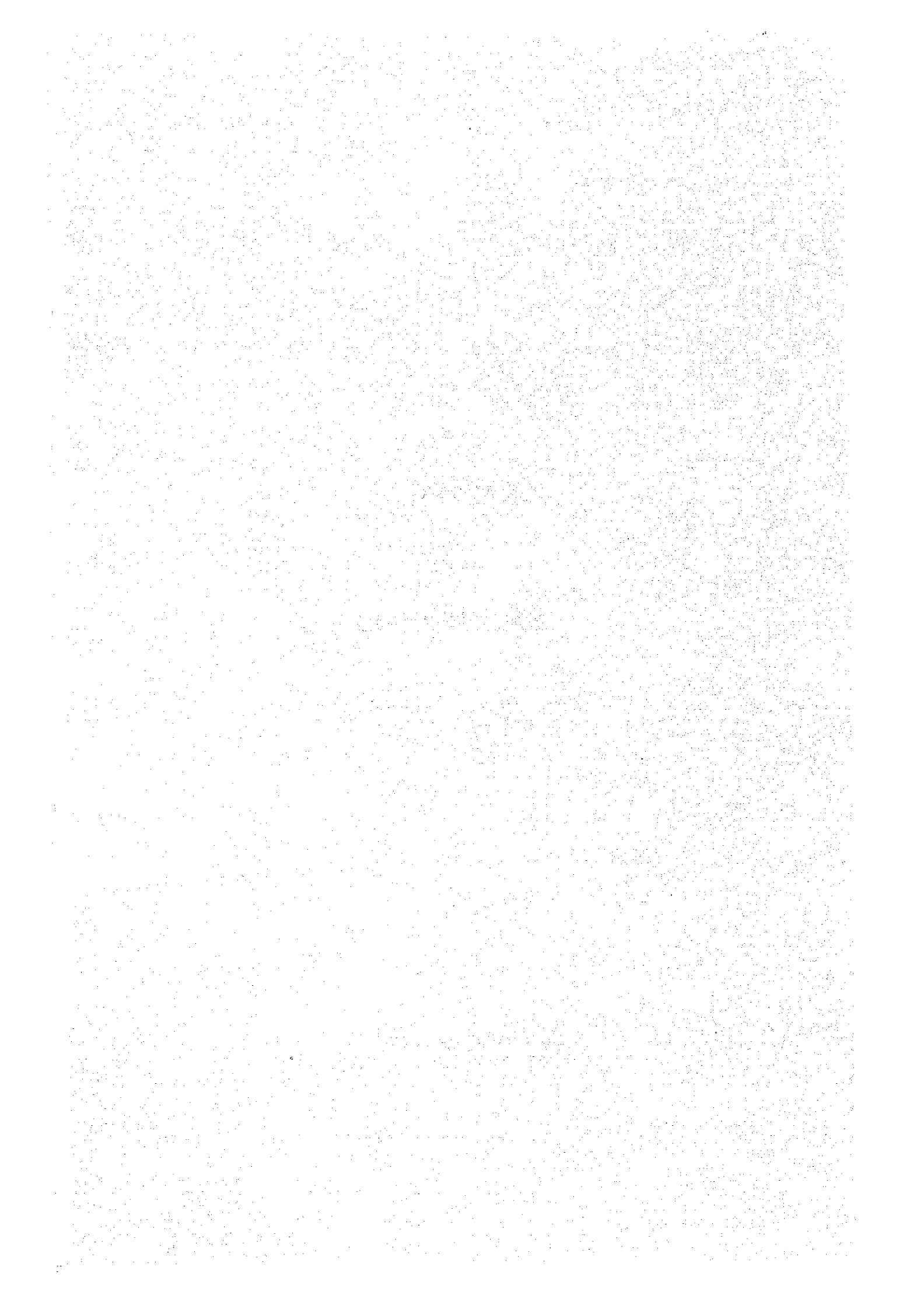
A request was made to the Government of Japan by the Government of the Kingdom of Tonga in 1982 for assistance in the establishment of the Vava'u High School (hereinafter called The Project). As a result, the Government of Japan dispatched through JICA a basic design survey team to Tonga from December 5th to 25th of 1982 and carried out studies on the undermentioned subjects during a period of 21 days with the aim of determining the possibility of implementation of the grant-in-aid.

This basic design report is based both on discussions with the Tongan authorities and also data obtained by the field survey. The background, purposes and contents of the Project, the optimum basic design, the conclusions, organization for implementation of the Project and evaluation of the impact are described in this report.

The minutes of the meetings with the Tongan authorities and member list of the survey team are attached in Chapter 7, REFERENCE DATA.

CHAPTER 2

BACK GROUND



Chapter 2

Background

2-1 Social and Economical Situation

2-1-1 Social Situation

The Kingdom of Tonga consists of 171 islands scattered over an area of approximately 364,000 square kilometers between latitude 15° S and 23°5' S and longitude 173° W and 177° W. The country has a population of approximately 100,000 persons which live in 36 of the islands. The total area of the country is 670 square kilometers, equivalent to the area of the Tsushima Islands of Japan. For geographical and administrative reasons, the Tongan Archipelago is divided into 3 major groups, i.e., Tongatapu, Ha'apai and Vava'u and two minor groups, i.e., 'Eua and Niau. The capital city, Nuku'alofa, is located in Tongatapu Island, which is the largest in the archipelago.

The Tongan people are Polynesian by race. There is no written historical record, but according to oral tradition the history record can be traced back to 950 A.D. In 1826 the first Wesleyan missionaries came to Tonga and founded the Tonga Wesleyan Church. In 1852 a 50-year long tribal struggle came to an end, and the Chief Taufa'ahau, originary of the Ha'apai Islands unified the country and was coronated as King Tupou I, the origin of the present monarchy. In 1875 the country became a constitutional monarchy. In 1900 Tonga became a British Protectorate, but in 1970 it became fully independent. It then elected to become a member of the British Commonwealth. Tonga is unique among the countries of the South Pacific in having maintained its self-government throughout the whole of its recorded history. The form of government is a constitutional monarchy modeled after Great Britain, and consists of three levels, the highest being the Privy Council and Cabinet, then the Legislative Assembly and finally the Judiciary.

2-1-2 Economical Situation

The economy of Tonga has been almost exclusively based on the production of tropical agricultural products. The principal crops are coconut, coconut products, bananas, etc., and 90% of the exports consists of agricultural products. In particular, coconut products share 70% of that total. The exports increased by 170% during the period from 1970 to 1980, while the imports increased by 440% during the same period, indicating a marked deterioration in the balance of visible trade in the last decade. The steep rise in the prices of petroleum products in the '70s and an increase in the expenditure of development capital are the main causes for this imbalance in visible trade.

However, to off-set the deficit in visible trade, there is a favourable invisible trade balance, arising mainly from the expansion of tourism and of remittances from Tongans abroad.

In order to correct the trade imbalance the Government is planning to take action along with the following two main lines of policy through the implementation of the Fourth Quinquennial Development Plan.

- 1) Diversification of the agricultural products and improvement of the productivity.
- 2) Encouragement of small and medium scale industries.

The national financial framework of Tonga comprises two separate budgetary systems namely, Recurrent Revenue and Expenditure, and Development Fund. The Recurrent Revenue and Expenditure is covered by domestic funds, but the Development Fund mostly relies on the aid from foreign countries.

The main countries and organizations that are giving aid to Tonga are Australia, West Germany, New Zealand, English, Japan, Asian Development Bank (ADB), EEC, UNIDO, etc.

2-2 Population and Employment

The population of Tonga tripled in the last 50 years, and as a consequence of this rapid demographic growth, the Land Tenure system which supported the traditional Tongan society exists nowadays in name but not in deed because of unavailability of agricultural land, causing a serious unemployment problem in the regions where the agriculture is the principal economical activity. The migration of the population from the local districts to the capital city, which is one of the main backgrounds for this project, is a phenomenon resulted from this situation. The census carried out in 1976, reported a total population of 90,085. A survey carried out in 1980, when the Fourth Quinquennial Development Plan was enforced, indicated that the population grew to 94,760 persons at that epoch.

The tendency of concentration of the population in the urban areas is particularly pronounced with the demographic growth of the country. In 1956 approximately 55% of the total population of Tonga was living in Tongatapu, but in 1976 the figure increased to 64%. An analysis of the demographic growth rate of the various groups of islands since late 19th Century, when the demographic distribution was well balanced in all islands of the country, indicates that the populations of Ha'apai and Vava'u increased by 2.5 times (from 10,800 persons to 32,877 persons), while in Tongatapu it increased by 8 times (from 7,400 to 57,437) over the period.

The working population of Tonga, between the ages of 15 and 65 years, was 21,400, 23.8% of the total population. Of the total 18,626 are either employed or have their own business. A simple calculation indicates that the rate of unemployment is 13%, but in reality the rate of unemployment in younger ages from 15 upto 30 years is much higher, reaching 28%. This is mainly due to the fact that the younger ages are not benefited by the Land Tenure system. The government is planning to cope with this unemployment problem through the following strategies.

- 1) Employ 600 persons in the government organizations.
- 2) Provide a basis for a more even geographic distribution of employment opportunities through the Rural Development Programme.
- 3) Promote employment schemes with developed countries.

In spite of the aforementioned measures of the Government of Tonga to cope with the unemployment problem, the most important problem of the working population is its low educational level. As indicated in the attached table, people with a university degree or with some kind of training after the secondary education is barely 5.1% of the total labour force and continues to be a serious bottleneck in development. In order to facilitate the various development projects, it is, therefore, indispensable to upgrade the quality of the labour force.

2-3 Education

2-3-1 System of Education

The country is divided in 5 educational regions, each region with one officer responsible for the regional administration and two assistants. The educational system of Tonga consists of two levels, namely (1) Primary Education and (2) Secondary Education.

(1) Primary Education

As a result of the Educational Act established in 1974, the 6-year primary education became gratuitous and compulsory, covering all pupils aged from 6 years to 14 years. In principle, every village of Tonga is provided with one elementary school. The school attendance rate is 99%, with 92% of the pupils in public primary schools and the remaining 8% in the schools operated by the churches. Pupils who have completed the 6-year curriculum until the age of 13 are qualified for the Secondary Education Examination. According to data of 1981, the number of Tongan pupils who took the Secondary Education Examination was 4,832 and the proportion of pupils that passed the examination to enter secondary school was 65.1%. Of the 35% failed in the examination, 28% repeated the 6th grade and the remaining 7% left the school.

In Vava'u Island, where this Project will be implemented, there are 30 primary schools, consisting of 29 public primary schools and one run by the Catholic Church. In 1981 the number of primary school students in Vava'u Island totaled 2,927.

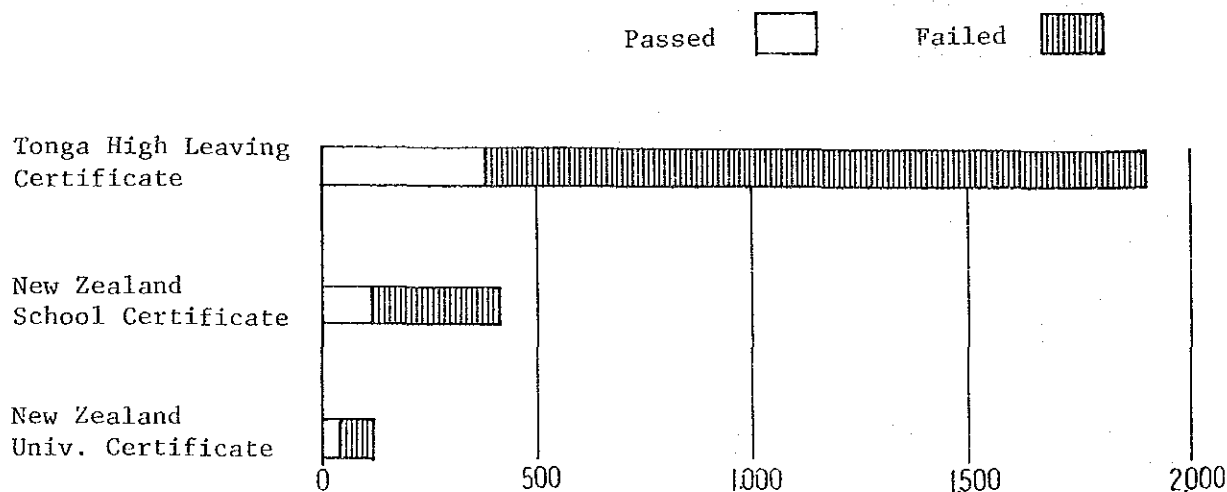
(2) Secondary Education

The duration of the secondary education of Tonga varies ranging from 3 years to 6 years. All public secondary schools - Tonga High School, Tonga College and Niuatoputapu High School, set up anew in 1982 - have 6-year duration. Nevertheless, among the 44 high schools operated by the churches there are also 3-year duration ones, 4-year duration ones and 5-year duration ones in addition to the standard 6-year duration. High schools with duration of 3 years are called Middle School.

According to the survey carried out in 1982, the total number of the secondary school students in Tonga was 14,300. Approximately 10% of the total attend public high schools, and the remaining 90% attend schools operated by churches. High school students who complete the Form 4, Form 5 and Form 6 are respectively qualified to take the following examinations.

- For Students that completed Form 4
Tonga Higher Leaving Certificate
- For Students who completed Form 5
New Zealand School Certificate
- For Students who completed Form 6
New Zealand University Entrance Certificate

Result of the Aforementioned Examination (1978)



According to the report of the Ministry of Education the number of secondary schools of Tonga in 1982 and their students is as follows.

Operated by	No. of Schools	No. of Students
Government	3	1,477
Church	44	12,263
Other Private Organizations	1	543
Total	48	14,283

The secondary educations system of Vava'u Island, where this Project will be implemented, consists of 4 high schools with 4 or more years of duration and 2 middle schools with 3 or less years of duration. All of these schools are operated by churches. Of the aforementioned schools, only one has 6 years of duration.

School Name	Church Operating the School	Form	No. of Students (Boys/Girls)	Others
Mailefihi Siulikutapu	Free Wesleyan Church	F1 ~ F6	858 (427/434)	This is a branch school of the Wesleyan Church School of Tongatapu, and was set up in 1940. Separate classes of boys and girls
St. Peter's Chanel	Roman Catholic Church	F1 ~ F5	289 (127/162)	Separate classes of boys and girls
Saineha High School	Church of the Latter Day Saints	F1 ~ F4	297 (156/141)	Coeducation
Tailulu College	Free Church of Tonga	F1 ~ F4	293 (143/150)	

2-3-2 Problems and Countermeasures

The secondary education system of Tonga presents the under-mentioned problems, because the number of public high schools is 3 and all of the other secondary schools are operated by churches, in which the recruiting of qualified teachers is not satisfactory and the contents and system of the education are not unified.

- 1) Scholastic attainment of the students does not reach the targeted level.
- 2) Content of the education is not unified.
- 3) Depopulation of the schools is pronounced in some regions.

(1) Scholastic Attainment

One of the reasons of the slow improvement of scholastic attainment of the secondary school students of Tonga is considered to be resulting from the usage of English as the medium of instruction. Many of the teachers and other people recognize that it is necessary to provide an additional preparatory year after the completion of the Form 6 in order to adjust to the foreign teaching medium. Such being the case, the Ministry of Education is planning the introduction of Form 7 in the public schools from 1984.

(2) Unification in the Curriculum

The small number of public secondary schools and the heterogeneity of the schools operated by the churches are the causes of the lack of unification in the curriculum of the secondary education system of Tonga.

All of the secondary schools of provincial districts are operated by churches. The types and quality of the curriculum adopted by these secondary schools operated by churches are heterogeneous, of low level and furthermore the facilities are poor in most of the cases.

Therefore the Government of Tonga is planning to increase the number of public schools and to improve the quality and unify the curriculum of the secondary education system.

(3) Depopulation of the Schools

The following table shows the distribution of types of secondary schools in Tonga, and the types of external examinations for which they present candidates:

Name of Region	No. of Schools	S.S	M.S	HL	SC	UE	No. of Students
Tongatapu	33	18	15	5	8	5	9,694
Ha'apai	5	2	3	2	0	0	640
Vava'u	6	4	2	1	3	0	1,793
Niuas	3	0	3		0	0	140
Eua	2	1	1	1	0	0	328
Total	49	25	24	9	11	5	12,595

S.S : Secondary School

M.S : Middle School

H.L : Tonga Higher Leaving Examination

S.C : New Zealand School Certificate

U.E : New Zealand University Entrance Certificate

Most of the secondary schools are concentrated in the Tongatapu region, and furthermore there are many schools in that region that turned out students meeting requirements to take qualification examinations. The aforementioned facts evidence that there is a pronounced unbalance between the Tongatapu region and the other regions not only in terms of number of schools, but also in terms of quality.

Such being the case, students of Vava'u Island who intend to enter universities tend to emigrate to Tongatapu seeking better secondary education.

The number of students in the secondary schools or middle schools of Vava'u in 1981 totalled 1,783. The number corresponds to approximately 14% of the total number of the secondary school students of Tonga. The census of 1976 indicates that 16.7% of the population of Tonga lives in Vava'u Island. The difference (approximately 400 persons) seems insignificant from the quantitative point of view, but it is necessary to have in mind that it does not take into consideration the general loss of population* in the last 10 years. A very recent survey carried out by the Ministry of Education evidences that approximately 10 to 12% of the students of the secondary schools of Tongatapu are originary from Vava'u**. The figure is even higher in the upper grades and is estimated conservatively at 20%.

2-3-3 Educational Development and Funds

The targets of the educational system of Tonga are the upgrading of personality and capacity of the population, the fostering of a capable man with leadership, creativity and spirit of cooperation to cope with the requirements of modern society and to compose the foundation for national development, etc.

* The population of Tongatapu that was born in Vava'u is 3,800, and that is estimated to be the people that emigrated from Vava'u to Tongatapu in the last 10 years. (According to the census of 1976).

** The total number of students of the secondary schools of Tongatapu is approximately 10,000, and consequently approximately 1,000 students originary of Vava'u are in the high schools and middle schools of Tongatapu.

The Ministry of Education is required to take the initiative of improving and expanding the educational facilities and teaching materials, unifying the educational system and its contents, upgrading the quality of the teaching body, developing the curriculum, etc., in order to materialize an educational system in accordance with the aforementioned idea.

The three principal targets set up by the Ministry of Education are described in the followings.

- 1) Development of the teaching body
- 2) Development of the curriculum
- 3) Funds for education

(1) Development of the Teaching Body

The Ministry of Education is carrying out the re-training of the teaching body of the primary schools by means of a continuous program covering the whole country. As for teachers of remote places that can not participate in the seminars, the instructors of the Ministry of Education are dispatched to their places in order to provide the required training. Furthermore, part of the teaching body and officers of the Ministry of Education are participating in "teacher courses" in Australia.

It is indispensable not only to provide an appropriate training to the teachers, but also to improve the treatment of the teachers by providing housing, improving the working environment, etc., in order to upgrade the quality of the teachers and to recruit talented personnel for the teaching body. So far, no residences have been provided for the teachers of Tonga, contrary to other public service personnel. This situation affects the efficiency of teachers and is a serious disincentive to joining the teaching service. It is indispensable to take urgent measures to improve the treatment provided to the Tongan teachers and to upgrade their social status.

(2) Development of the Curriculum

Broadly speaking, the educational curriculum of Tonga consists of 4 Phases. The Phase (1) corresponds to primary education and the Phases (2) to (4) correspond to secondary school.

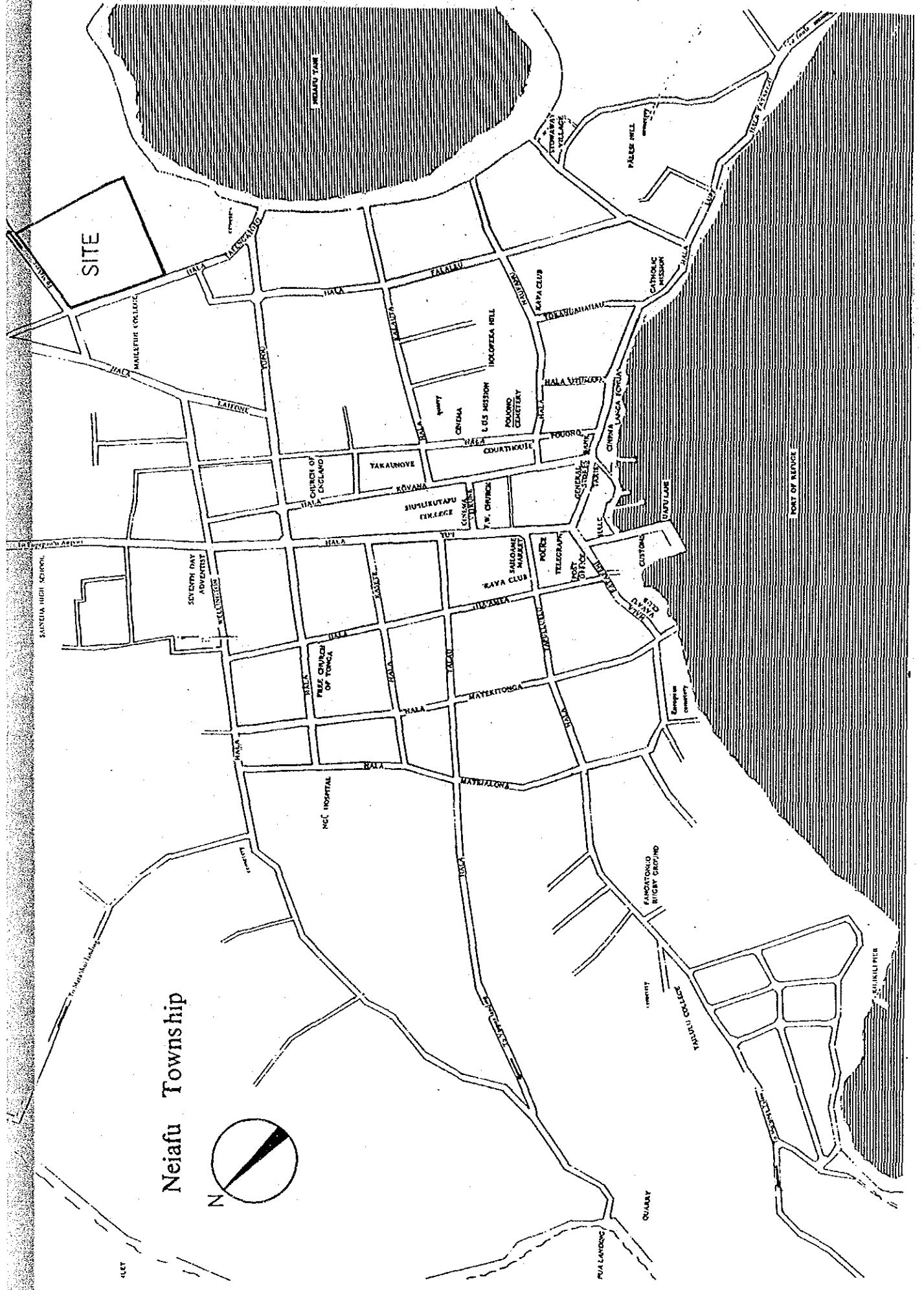
The Curriculum Development Unit of the Ministry of Education has already drawn up the new draft program for teaching of mathematics in the primary school and it is being tentatively implemented in some schools. Furthermore, the curriculum for teaching of English language, which is the second national language of Tonga, will be drawn up anew within the current development plan. The development of the curriculum for secondary education is being carried out jointly by the Ministry of Education and the Mcquare University as a part of the aid program given by Australia. It comes into fields such as industrial design, household management, social sciences, history, agriculture, etc., and at the present time it is in the stage of revision of teaching materials.

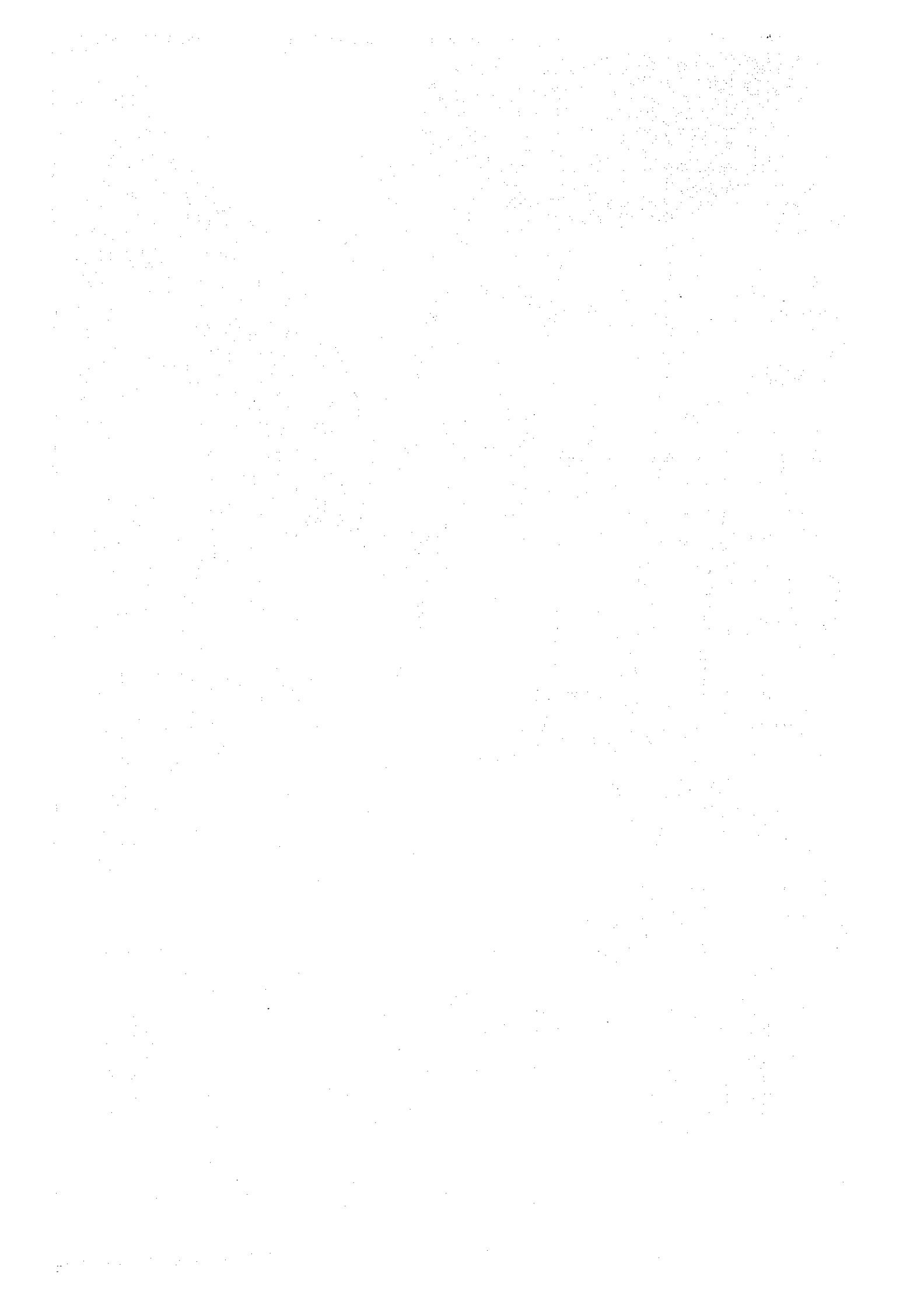
(3) Funds for Education

A further fund-raising campaign both domestically and overseas is indispensable in order to make possible the materialization of the education development targets planned by the Government of Tonga. Most of the expenditures related to the education in Tonga are financed by public funds. In 1981 the ordinary expenditures related to education amounted T\$1,840,535.50 and it corresponds to 13.38% of the expenditures of the government. (The income related to education totaled T\$73,174.60).

The results of the Third Quinquennial Development Plan have given an account of the present state of funding for education of Tonga. According to that Plan, the initial target referring to the investments for education was T\$4,100,000 (Government investments : T\$2,800,000 and private investments : T\$1,300,000) but the actually invested sum totalled only T\$1,006,700 (Government investments : T\$627,200 and private investments : T\$379,000) and consequently most of the principal projects of the plan did not materialize.

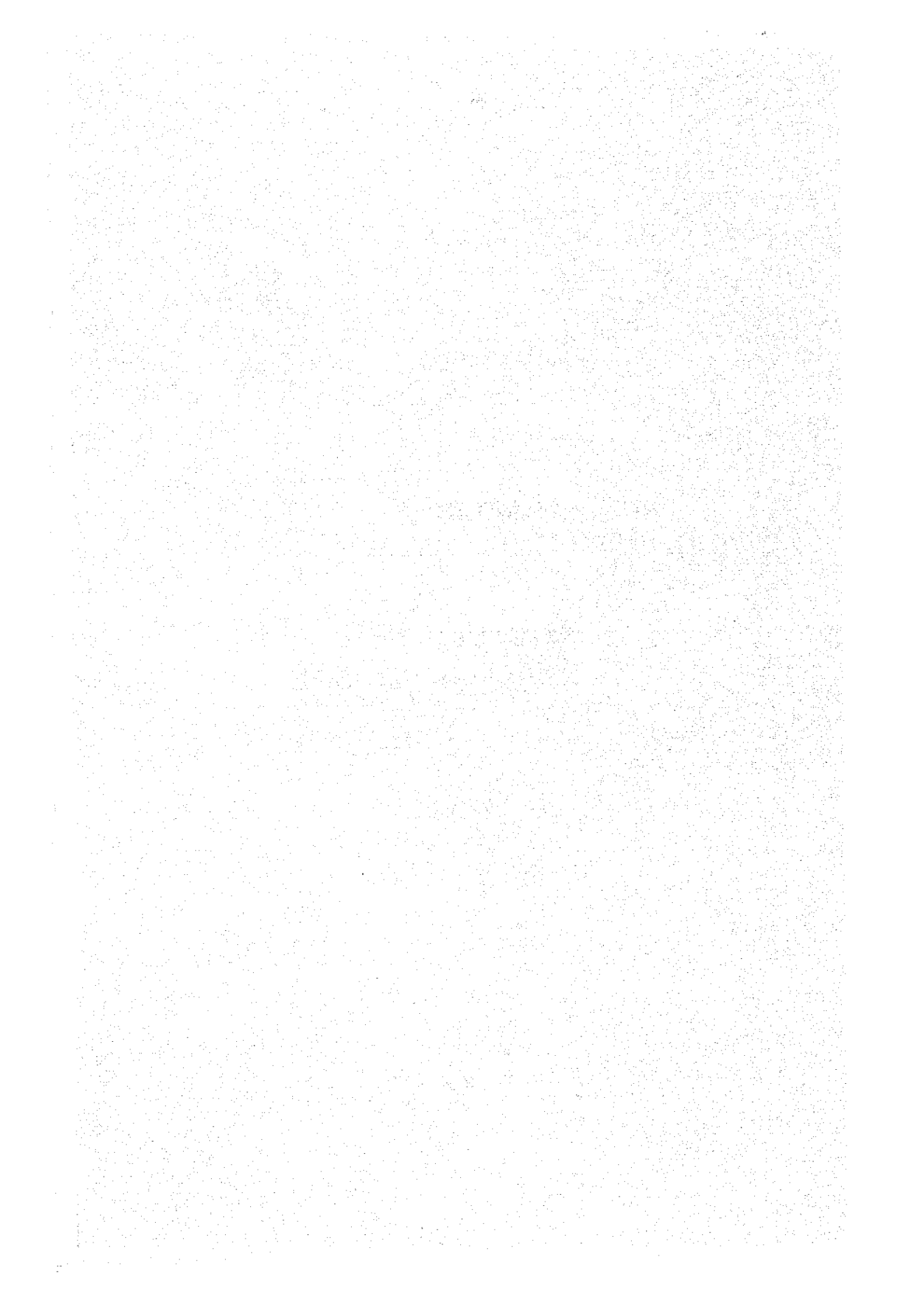
Neiafu Township





CHAPTER 3

SITUATION OF THE PROJECT SITE



Chapter 3

SITUATION OF THE PROJECT SITE

3-1 General

The Vava'u archipelago consists of 70 small islands among which 50 are inhabited. The main island is the Vava'u Island, where the Project is to be implemented, is the second largest island of Tonga with an area of approximately 90 km². This archipelago is located at the northern extremity of Tonga, approximately 280 km from Togatapu the main island of the Kingdom.

According to the last census carried out in 1976, the population of the Vava'u region is approximately 15,000 persons, which corresponds to 16.7% of the total population of Tonga. Approximately 4,600 persons, which corresponds to 30% of the local population, is concentrated in the town of Neiafu, which is the center of the Vava'u Island (Ūta Vava'u).

The economy of the Vava'u region is stagnant in spite of its good potentialities. The most important reason of the economical stagnation of the Vava'u region is essentially due to the lack of appropriate means to transport the agricultural and fishery products to the market places. Vava'u has a promising future from the economical point of view, should market be ensured for its products under conditions equivalent to those ones of Tongatapu. As a matter of fact, the soil of the Vava'u archipelago is suited for farming (the GDP of the agriculture of Vava'u surpasses the average value of Tonga as a whole). Furthermore, it has excellent fishing grounds in the neighbouring areas, and the island is provided with an excellent port. In addition, the Vava'u Island has a beautiful natural landscape and accordingly it has excellent potentials in terms of tourism resources compared with other archipelago of Tonga which generally have flat topography.

One of the basic guidelines of the Fourth Quinquennial Development Plan which is under way at the present time is the promotion of the balanced development of the three principal archipelago of the country, namely the Tongatapu Group, Ha'apai Group and Vava'u Group. In particular, the Government of Tonga is paying special attention to the development potential of various kinds of the Vava'u region, and has set up concrete plans for local development. The said plans comprise three key points, i.e., the development of the agricultural and fishery resources of Vava'u, development of the secondary processing industry of agricultural and fishery products and the development of touristic resources.

3-2 Natural Conditions

3-2-1 Geology

The Tonga Islands are located at the west side of the Tonga deep (approximately 3,000 kilometers long, approximately 100 kilometers wide, maximum depth 10,882 meters, the second largest deep of the Pacific Ocean) which stretches in row to the east-northeast of the Kerumadek deep (maximum depth 10,047 meters). This archipelago consists of upheaved coral reefs and volcanic islands scattered approximately parallel to these deeps. The disposition of the Tonga archipelago and Tonga deep have typical geographical features that make possible to observe "in loco" the plate tectonics theory which became famous recently as a model to explain the mechanism of the earthquakes. In other words, the Asia-Australia plate located at the west side and the Pacific plate located at the east side are pushing one another, and the place where the Pacific plate dives under the Asia-Australia plate is the Tonga deep.

The Tongatapu Island has a generally flat topography with an altitude 60 meters above the sea level. On the other hand the Vava'u Island has geographical features with abundant undulations unlike the Tongatapu Island. The west side of the Vava'u Island has an altitude 210 meters above the sea level. The overburden of the Vava'u Island consists of clay soil, like in the case of Tongatapu.

3-2-2 Earthquakes

As mentioned before, the Tonga archipelago is located at a typical place where the plate tectonics theory fits perfectly. Accordingly, this is a place where earthquakes break out very often. In December 19th 1982 during our survey period in Tonga, a large scale earthquake with 7.7 magnitude intensity broke out in this area. Fortunately, the epicenter of this earthquake was located somewhere between Tonga and New Zealand, and consequently no damage took place.

The earthquakes with intensity exceeding magnitude 6.0 which broke out at the environs of Tonga in the 1980-1981 period are as follows. (Source : Rika Nenpyo - 1982 and 1983 Editions).

Occurrence of Earthquakes in Tonga

Year	Month	Date	Intensity (Magnitude)	Depth of Epicenter (Km)	South Latitude	West Longitude
1980	Jan.	14	6.0	33	22.4	175.0
	Feb.	3	6.2	33	17.6	171.2
	Mar.	31	6.2	33	20.6	173.8
	Apr.	1	6.0	37	20.7	173.6
	May	27	6.1	33	18.6	174.7
	June	18	6.7	43	15.3	173.6
	Aug.	24	6.4	39	15.2	173.7
	Oct.	9	6.2	33	15.4	173.4
	Nov.	30	6.0	202	19.4	175.9
	Dec.	15	6.2	33	17.6	172.3
	Dec.	19	6.1	33	21.3	174.4
1981	Feb.	6	6.0	618	21.1	178.9
	Aug.	25	5.9	33	22.9	175.9
	Sep.	1	5.8	33	15.1	173.3
	Sep.	1	7.7	25	15.0	173.1
	Oct.	7	5.8	620	20.8	178.6
	Nov.	4	6.0	33	20.0	174.3

3-2-3 Hurricanes and Cyclones

The climate in Tonga becomes very hot and sticky from December to April. This is the hurricane season and the hurricanes generated at the vicinity of the equator go down south while growing rapidly. These hurricanes are accompanied with heavy rain and strong winds, causing damages not only in the principal crops of Tonga such as coconuts, copra, etc., but also in ships and buildings. For example, at the vicinity of the center of the cyclone that broke out in March 2nd 1982 a long way to the northeast of Vava'u, the wind speed reached approximately 61 m/s. That cyclone advanced south toward the Tonga archipelago and hit directly the Haaipai Islands, causing huge damages. The damages occurred in the Tongatapu Island were considerable too. In 3rd of March that cyclone went off Tonga toward the southwest direction.

3-2-4 Meteorology

The Tonga Islands belong to the sub-tropical zone, and the monsoon is interrupt all over the year. It belongs weak in the winter season (May - August) and strong in the summer season (December - April). The dominant directions of the monsoon are SE and E-SE with a frequency of 70%. The average temperature in Vava'u is 20°C to 27°C in the summer season and 23°C to 24°C in the winter season, and is 2°C to 3°C hotter than Tongatapu. The monthly average rainfall is of the order of 200 mm to 300 mm in the summer season and of the order of 100 mm to 200 mm in the winter season. The annual average rainfall of Tonga is of the order of 200 mm. The rainfall is slightly larger in Vava'u than in Tongatapu.

The relative humidity in Vava'u exceeds 80% during the summer season, while in the winter season it is of the order of 67% to 72%, with an annual average of approximately 79%. The relative humidity of Vava'u is 2 to 3% higher than that one of Tongatapu.

3-2-5 Salt Injury

Salt injury due to the wind and rain coming from the sea is expected to take place in Vava'u, because it is a small island sized approximately 18 km in the EW direction and approximately 13 km in the NS direction. Furthermore, the high temperature and the high humidity contributes to worsen the conditions regarding the corrosion of metallic materials. Accordingly, the exposure of parts made of iron shall be prevented as much as possible. With regard to the other metals, it is also recommendable to provide anti-corrosive means. Most of the roofs of the buildings of Vava'u are thatched with iron sheets. The use of aluminum sheets seems to be better for that purpose, but local people told that this material is not used due to economical reasons.

3-3 Infrastructure

The Vava'u airport is located approximately 20 minutes by car to the north of the town of Neiafu. The Neiafu-Airport arterial road is being enlarged by the Ministry of Works (MOW). The extension work of the landing strip of the Vava'u airport aiming to make possible the access of medium sized jet planes is included in the Fourth Quinquennial Development Plan. It is one of the important projects for development of tourism in Tonga. The Tonga Airlines and the South Pacific International Airline have daily flights between Vava'u and Tongatapu, with exception of Mondays.

The port of Neiafu, which is the center of Vava'u, is also called Refugee Port, and is located in a natural bay with excellent characteristics. The ships sailing the neighbouring waters use this port for refuge in the cases of hurricanes. The water depth of the port of Neiafu is of the order of 7.0 m, and is a representative international port of Tonga together with the port of Nuku'alofa located in the Tongatapu Island. The port of Neiafu is provided with customs, facilities for procurement of the living necessities, storage facilities (Commodities Board) and construction material warehouse. Furthermore,

the port is equipped with flat deck trucks and forklifts. Public facilities such as post office, bank, supermarket, schools, etc., in addition to administrative functions such as city office, police, etc., are located at the environs of the port. There is a ferry boat route between Vava'u and Tongatapu, and its charge is T\$16/person.

The Ministry of Works (MOW) is making efforts to improve the road network, but all roads of Vava'u including those ones at the center of the town of Neiafu have only random paving consisting of compacted coral rock.

Electricity (3-phase 415V and single phase 230V) is supplied by the Tonga Electric Power Board located nearby the site of the present Project, by means of two 150 KW fuel-oil thermoelectric generators (187.5 KVA, 600 RPM, 50 Hz). The electrified area covers only the environs of the town of Neiafu.

Running water is supplied to the town of Neiafu by the Tonga Water Supply Board located on the plateau at the east side of the Vava'u Island. As for the quality of the supplied water, it is quite hard containing much calcium in addition to salt because it is pumped from underground. The quality of the water supplied to the population of Tongatapu is similar to that one of Vava'u. Any way, there is no problem from the sanitary point of view, because it meets the WHO standards referring to potable water. The water supply system of Vava'u is equipped with a 40,000 gallon elevated tank, and the daily consumption of water in Neiafu is approximately 20,000 gallon. Rain water is collected and stored in the areas not served by the running water supply network, and the said rain water is used for drinking and cooking purposes. The use of rain water plays an important part in the water supply system in Tonga, because it has the following advantages.

- Rain water is available with relative abundance throughout the year
- The taste of rain water is better
- Lathering of soap is better with rain water.

Rain water storage tank provided with heat insulation is used very commonly in Tonga.

There is no sewerage in Vava'u. Flush toilet with treatment of sewer by means of the storage & infiltration system is used in large scale facilities such as hotels, schools, churches, markets and banks.

3-4 Construction

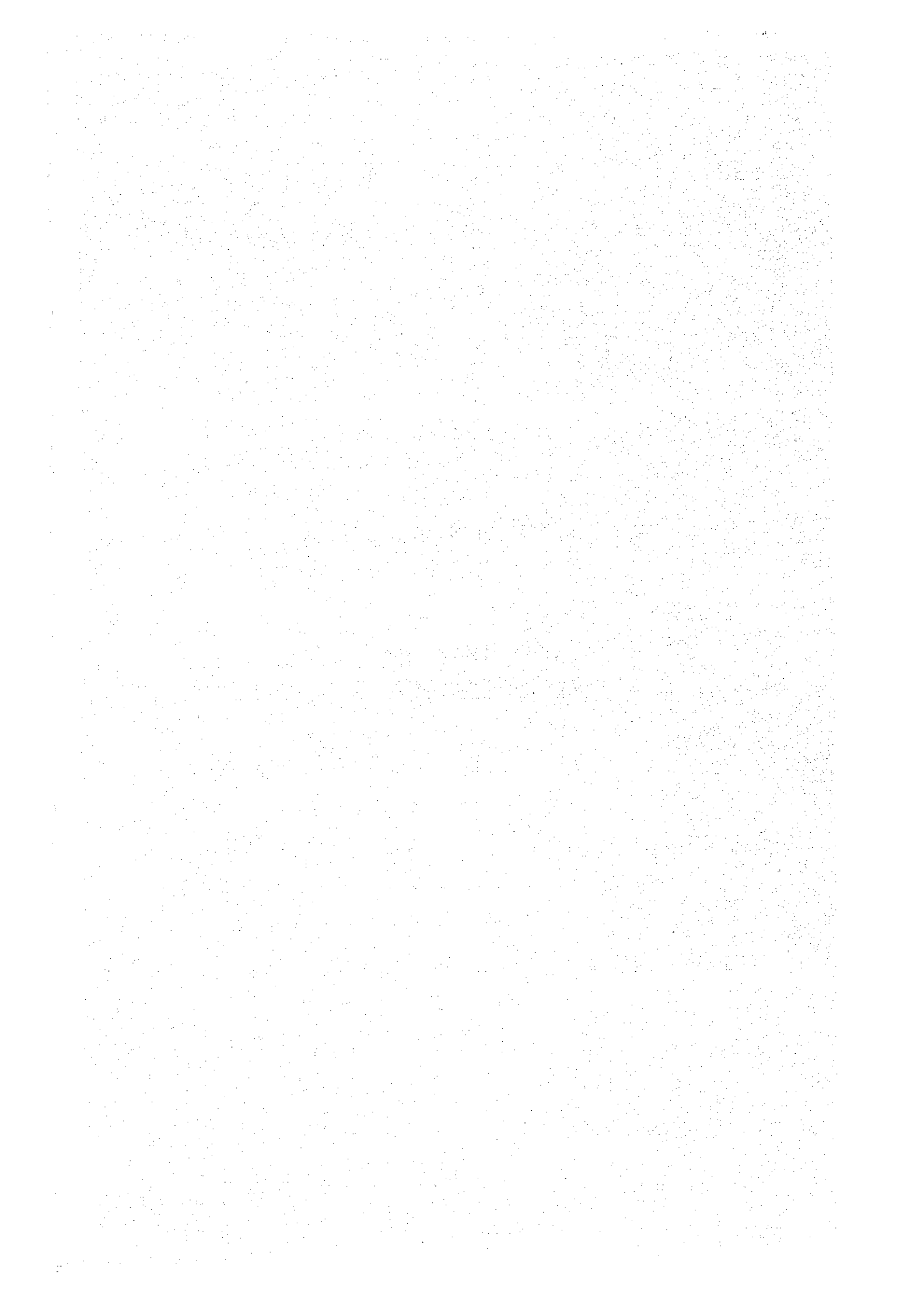
The survey team had the opportunity to visit two construction sites in Neiafu, branches of the Tonga Bank and Tourist Bureau. These two construction sites, in addition to the enlargement work of the airport road, are under the direct control of the Ministry of Works. The construction capacity of the Vava'u Island itself is small as can be seen from the foregoing.

The construction works of Tonga are carried out either under government management or by several private contractors. The materials required for execution of the construction works under government management are provided by the Commodities Board, and are cheaper compared with those ones used by private contractors. This is one of the reasons obstructing the development of private construction companies.

There is a considerable difference between Tonga and Japan regarding the local availability of construction materials, machinery, equipment and technical level of the construction workers. Practically the totality of the construction materials are imported from overseas, with exception of some minor items available in Tonga. Nevertheless, it is not recommendable to use too much imported materials in view of the considerable transportation costs and the low technical level of the local construction industry.

CHAPTER 4

CONTENTS OF THE PROJECT



Chapter 4

CONTENTS OF THE PROJECT

4-1 Purposes and Contents

4-1-1 Purposes

The ultimate purpose of this Project is to promote further the friendly relations between Japan and Tonga through the construction of the Vava'u High School, which will be the first public secondary school to be constructed in the Vava'u Island. The object of the Project has three principal purposes.

- 1) To provide secondary education of the same level as that one of the public secondary schools of Tongatapu to the students of Vava'u. (The existence of such a high school in Vava'u is expected to contribute to prevent the emigration of secondary school students and their parents to Tongatapu).
- 2) To contribute for school and economical development of Vava'u through the fostering of middle class manpower that will be the base of the economical activity of the local community.
- 3) To solve the problems related to the secondary education system occurred so far by increasing the number of the public high schools. (Establishment of the Form 7).

4-1-2 Contents

(1) Duration

The Vava'u High School to be constructed anew will provide an ordinary coeducational secondary course with duration of 7 years, ranging from the Form 1 to the Form 7. The Ministry of Education is planning to establish anew the Form 1, which will function as a preparatory course for university entrance examination in Australia and New Zealand for students who have completed the Form 6 and is one of the most important points of this Project.

(2) Number of Students and Number of Classes

The new Vava'u High School will have capacity for 70 students in each school year, divided in 2 classes with 35 students each. (The standards of the Ministry of Education requires 30-35 students/class).

Consequently, the total number of students will be 70 students/school year x 7 school years = 490 students. The number of classroom of the Vava'u High School will be 7 school years x 2 classes = 14 classrooms.

Table 4-1 Students Admission Plan

	1st Year	2nd Year	3rd Year	4th Year	5th Year
F1	70	70	70	70	70
F2		70	70	70	70
F3			70	70	70
F4				70	70
F5					70
F6				70*	70
F7					70*
	70	140	210	350	490

* The full capacity will be reached in the 5th year after the start of operation of the school. Consequently, students of the Form 6 will be admitted in the 4th and 5th year from other secondary schools of the island operated by churches.

(3) Contents of the Education

The new Vava'u High School will provide the ordinary secondary school education in accordance with the form laid down by the Ministry of Education, in addition to some vocational training. This form of education is approximately the same as that one of the Tonga High School. As for the contents of the education, the current curriculum of the Tonga High School will be introduced in the new Vava'u High School. The course of study will consist of English, Natural Sciences, Social Sciences, Mathematics, Tongan Language, Music, Painting and Home-making. In first four years, i.e., Form 1 to Form 4, all courses will be taught uniformly by putting emphasis on English. Optional courses will be provided from the Form 5 (corresponding to the 2nd year of senior high schools of Japan). For example, the natural sciences will be divided into physics, chemistry and biology, to be conveniently taught in accordance with the course of the student.

(4) Staff

The teaching body of the new Vava'u High School, object of the present Project, will consist of 10 diplomates of the Teachers' Training College of Tonga and 15 graduates of universities of Australia and New Zealand, totalling 25 teachers.

Recruiting Plan	1st Year	2nd Year	3rd Year	4th Year	5th Year	Total
Principal	1	-	-	-	-	1
Vice-Principal	0	1	-	-	-	1
Teachers	5	4	5	8	3	25
Librarian	0	1	-	-	-	1
Office Clerk	1	-	-	-	-	1
Typist	1	-	-	-	-	1
Servant	1	-	-	-	-	1
Total	9	6	5	8	3	31

Of the 25 teachers, 16 will be allotted to the ordinary courses, while the remaining 9 will be allotted to teach special courses. Of the 9 teachers in charge of special courses, 1 will be allotted to teach physical education, 4 to teach natural sciences, 2 to teach handicraft, 1 to teach artcraft and 1 to teach home-economics. The 4 teachers allotted to natural sciences will teach physics, chemistry, biology and general sciences, respectively. The only office clerk of the Vava'u High School will be charge mostly of the accounting work.

(5) Contents of the Facilities of the School

The Vava'u High School will consist principally of the administration & operation component which will accomodate the administration & operation functions and the classroom component, where the studnets will see the teachers. Other subsidiary facilities will support the functions of the aforementioned principal components. The total floor area of the Tonga High School will be approximately 4,628 m².

1) Administration component

The administration component will comprise the principal's office, vice-principal's office, a large room to be used in common by all of the 25 teachers for discussion, rest and meal purposes, reception, toilet and warehouse. The total area of the administration component will be approximately 177 m².

2) Classroom component

The classroom component will consist of a total of 16 ordinary classrooms, 8 classroom for lower school year students and 8 classrooms for higher school year students, respectively, in addition to 10 special classrooms for laboratories, handicraft & artcraft (vocational training), home-economics, business course, etc. The special classrooms will be pro-

vided with some equipment, instruments and apparatuses. Furthermore, these classrooms will be provided with preparation rooms to be used by the teachers and warehouses to store teaching materials located at strategic points. The classroom component will have a total area of approximately 1,829 m².

3) Others

The subsidiary facilities of the new Vava'u High School will consist of a library (150 m²) for 1,800 books, hall be used principally for physical education purposes (630 m²), corridors, toilets and other common spaces (1,842 m²).

4-2 Design Policy

The design policy to be adopted on the occasion of setting forth the concrete architectural design work, determined by taking into consideration the premises described in the foregoing (including the aspect of the software), the requests of the Government of Tonga, and the contents of the discussions carried out during the field survey, is summarized in 6 items.

(1) The Design shall be Substantial

The object of this Project will function as one of the highest educational institutions of Tonga, and as the only Public Secondary School of the Vava'u Island, and its buildings shall be suitable for that purpose. Such being the case, the design shall be set forth by attributing emphasis to the construction of solid buildings with long life.

(2) The Design Shall be Set Forth by Respecting the Intention of the Government of Tonga

The design shall be set forth by respecting the intention of the Government of Tonga based on the state of things of the public secondary schools of the country and the local mode of life, in order to make possible for the school to attain the goals of this Project with ease and to function appropriately.

(3) The Site Shall be Used in the Most Effective Way

The site allotted for implementation of this project shall be used as effectively as possible. The form of utilization of the site shall be planned by taking into consideration not only the present Project but also the possibility of future expansions, and the design shall be set forth in such a way to prevent the function of each building from impaired after the extension.

(4) The Design Shall Fit the Local Climate and Natural Conditions

The architectural form fitting the conditions of the sub-tropical climate is taking root in Tonga. In concrete, the aforesaid architectural form consists of details such as corridors open to the exterior, buildings arranged conveniently with regard to the direction of the wind, use of many glass louvers aimed at guiding the wind into the rooms, frequent use of sloped roof (thatched mostly with iron sheets), projected eaves, etc.

These peculiarities have many points in common with the architectural design methods adopted in Japan, but it is an original architectural form based on the natural conditions of this country. Furthermore, the utilization of rain as a potable water source is an artifice firmly rooted in Tonga.

(5) The Design Shall Fit the State of Things of the Local Construction Industry

The plan for procurement of the construction material and the construction method shall be determined by taking into consideration the availability of the materials in question in the local market, the technical level of the local construction industry and also the state of things of the local construction manpower. The design shall be set forth by adopting a reasonable construction method used commonly by the local construction industry.

(6) The Design Shall Minimize the Maintenance and Operation Cost to be Shared by the Government of Tonga

One of the basic policies of this Project is to minimize not only the costs for ground levelling and other subsidiary works required in the preparation stage but also the maintenance and operation costs after the start of operation of the school, to be shared by the Government of Tonga. Furthermore, the school shall be designed in such a way to make possible an easy maintenance and operation.

4-3 Basic Design

4-3-1 Site

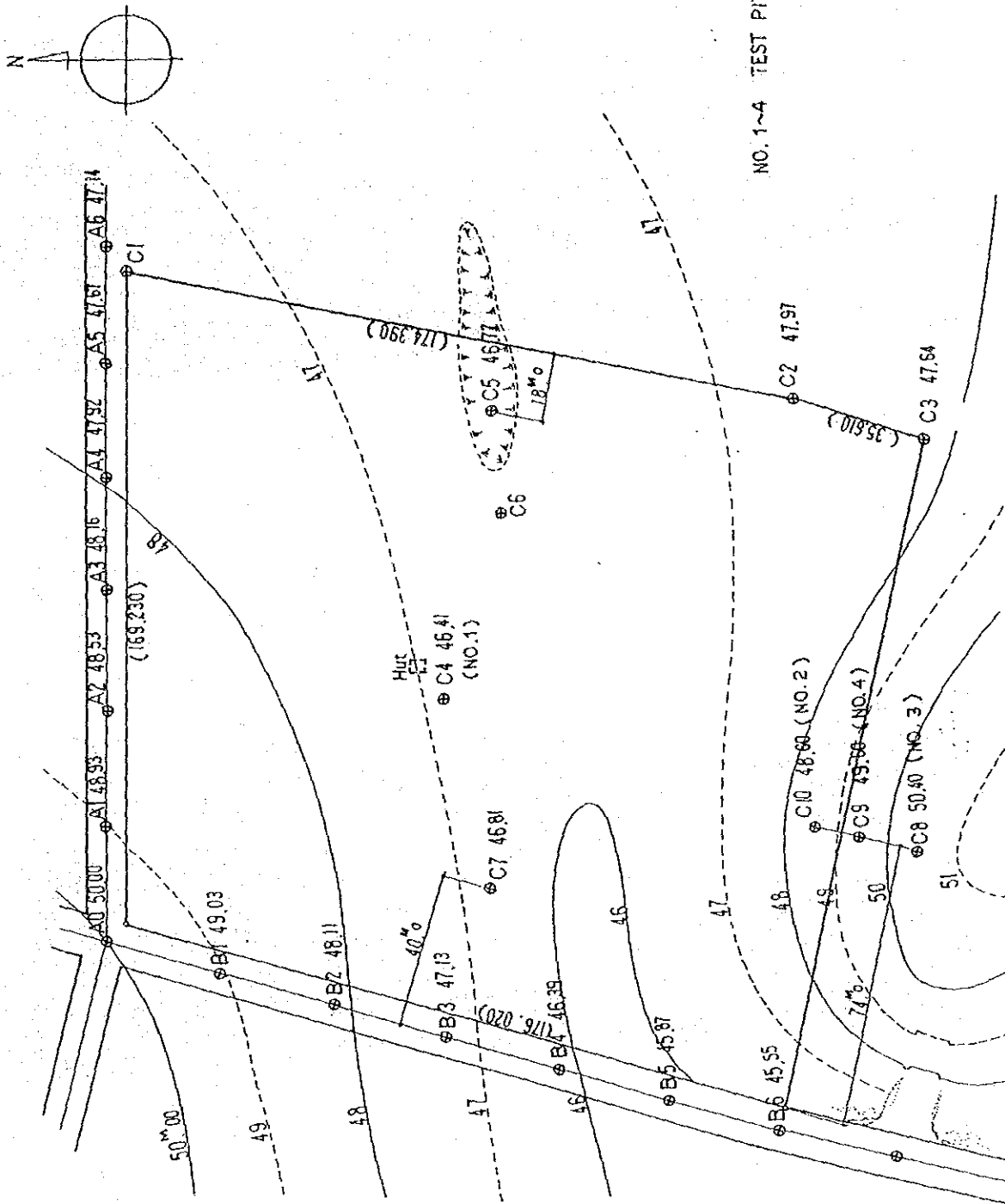
The site of this Project is located in Kameli, Neiafu Town District. On the occasion of the field survey, the project site Lot No. 44 in the registration of the Ministry of Land & Survey was privately possessed by an individual. Nevertheless, it is presumed that its expropriation can be carried out with no problem at all because the Governor of the Vava'u Island is the authority entitled to make decisions referring to the land administration of this region, and furthermore the Governor is particularly interested in the implementation of this Project.

The project site is located in the outskirts of Neiafu, the center of

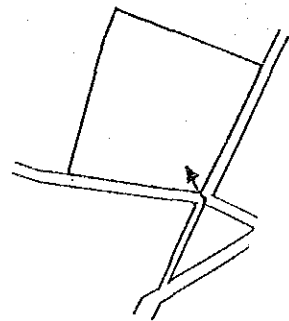
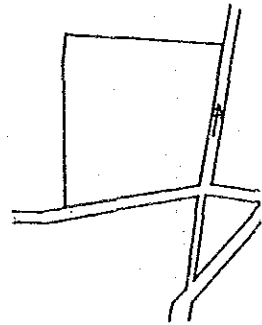
the Vava'u Island, but it is distant only 800 m in straight course from the Neiafu Port. Accordingly, there is no obstacle against the function of the school. The road located at the north side of the project site is the main approach road from the Neiafu Town to the site, and is provided with random paving composed of compacted coral stone. At the present time the effective width of the road is approximately 7 m, but the distance to the border of the road is 10 m, and there are plans for future enlargement of the width to 10 m and paving. The project site is a corner lot adjacent the aforementioned road at the north side and with the road going to the seashore at the west side. The road at the west side of the project is not paved at the present time and its effective width is approximately 5 m, but in the official map it is registered as a 10 m road like that one at the north side.

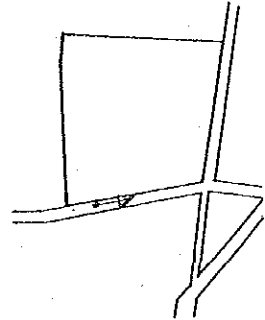
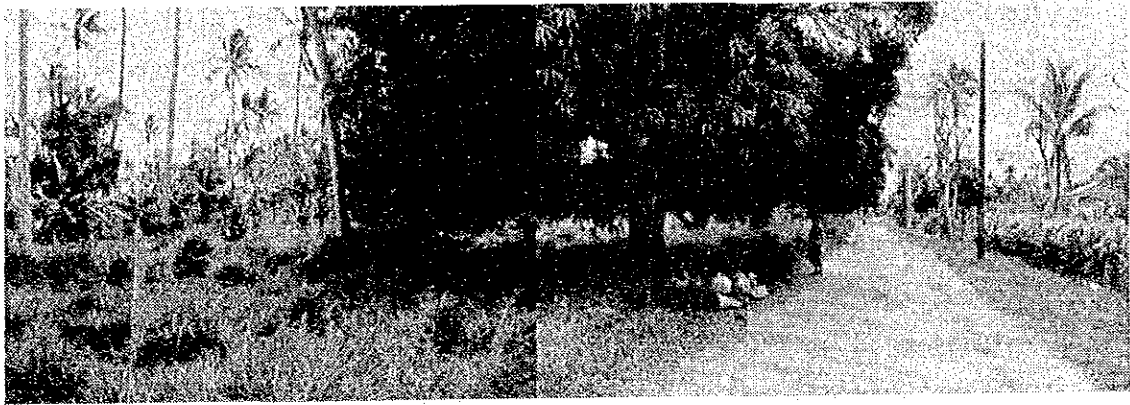
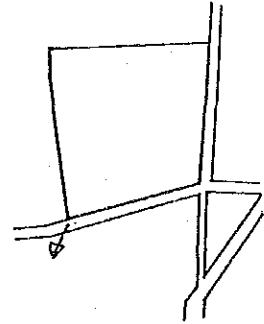
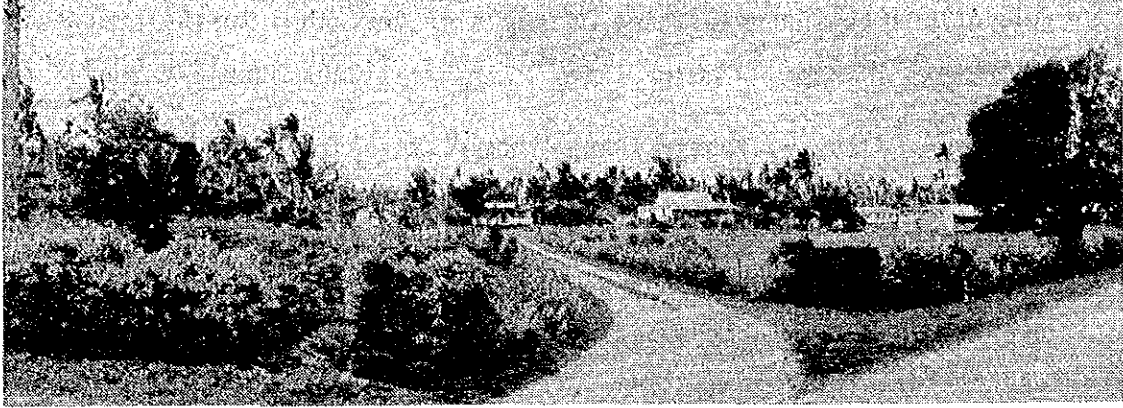
There are coppices consisting of coconut and other kinds of trees at the south and east sides of the project site and there is no habitation in the adjacent lots. At the west side and northeast side of the project site are located the Mailefihi College operated by the Wesleyan Church and the Saineha High School operated by the Seventh Day Adventist Church, respectively, across the roads. Residences of people related to the said schools are also scattered nearby.

At the present time the project site is planted with coconut trees, yaan and taro. Generally speaking the project site is flat, but there is a gentle slope in the southeast direction and the center is rather low. There is a difference of level of approximately 2.5 meters between the northwest extremity of the project site and its center. At the south border of the site, which is the seashore side, the topography swells from the vicinity of the borderline and then falls down to the seashore line. The altitude of the site is approximately 20 meters above the sea level at its northwest extremity. The overburden of the site consists of humus with thickness of the order of 150-300 mm, with a subjacent layer of loam of the order of 1,000 mm, followed by coral reef limestone.



Site Survey Drawing





4-3-2 Layout

The layout is determined based on 5 fundamental points, by taking into considerations the peculiarities of the site described in the preceeding paragraph.

(1) Simplification of the Site Zoning

A simple zoning is adopted in the layout in order to obtain the largest possible multi-purpose space in order to overcome the small size of the available space and utilize the site as effectively as possible.

(2) Improvement of the Ventilation

The longitudinal axis of the buildings is arranged in the E-W direction by taking into consideration the direction of the monsoon, which is practically constant from the southeast direction throughout the year. Furthermore, the space between adjacent buildings is made as wide as possible in order to improve the ventilation effect.

(3) Consideration to the Public Use of the Facilities

The facilities to be used by the local public in general and students of other areas, such as the multi-purpose hall, open space and library and other subsidiary facilities of the Vava'u High School such as the residences of the principal and vice-principal, etc., are arranged at the road side in order to facilitate their access by the users and to provide the students with a more calm and comfortable ambient for study.

(4) Construction of Two Ways of Access

The Vava'u High School is provided with two ways of access, from the roads of the north side and west side of the site. The main gate of the school is located at the north side access, which leads

directly to the entrance hall of the Vava'u High School. The access from the west side shall be used either for service purposes or by users coming from other areas.

(5) The Buildings are Arranged at the Southeast Side of the Site

The school building is a two-storey structure, with exception of the facilities to be used by the home-making and handicraft (vocational training) courses which require many outdoor activities, intense physical distribution and generate noise. Furthermore, the buildings are arranged at the southeast of the site, in order to make as effective as possible the plan for utilization of the site described in the foregoing.

The layout of the various components of the Vava'u High School is determined as follows, by taking into consideration the 5 aforementioned points.

An entrance hall is provided at the center of the school building. This entrance hall does not have walls and is open to the exterior. The entrance hall is the starting point for access to the ordinary classrooms, special classrooms, library, administration building and multi-purpose hall. The layout of the various components of the school is determined in such a way that they are easily visible from the entrance hall. When the students come to school and leave it, move from the ordinary classroom to the special classroom, go to the library, etc., and when the teachers move from the teacher's room to the classroom, etc., they have to pass through this entrance hall. Therefore, it will be used very frequently as a place of communication of the high school as a whole and also as a lobby of the students and teachers. Furthermore, this entrance hall is located in front of the approach road, and it can be easily identified by the visitors located at the gate of the school. Therefore, the visitors are freed from the trouble of passing through complicate labyrinths to access the entrance hall.

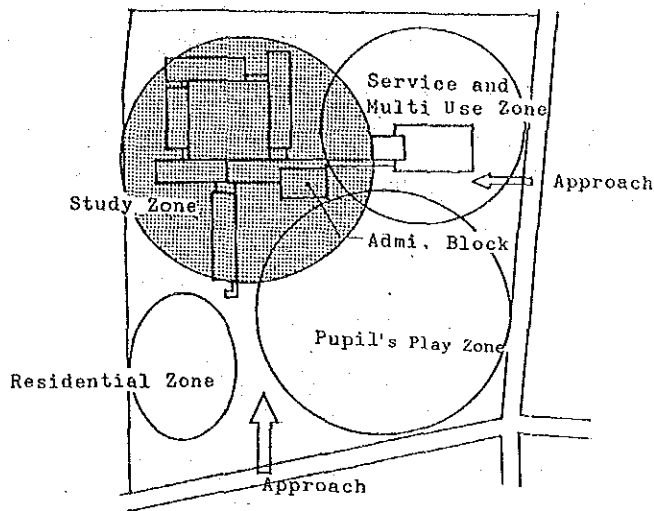
The ordinary classrooms are divided in two buildings, i.e., the classrooms for lower school years and those ones for higher school years, with each one composing an independent area. These two buildings stretch in the N-S direction with direct access from the entrance hall, and are arranged in such a way to have sufficient ventilation.

The special classrooms are separated from the ordinary ones in such a way to compose an independent area, because some of them generate noise. It is desirable to arrange the home economics classroom at the ground floor in order to facilitate the access to the kitchen and external cooking space (UMU), and the vocational training classroom shall be arranged at the ground floor too, in order to facilitate the installation of heavy machinery and handling of materials. On the other hand, the commerce course classroom that do not generate much noise and the laboratories are arranged in the two storeys of the building adjacent to the ordinary classrooms.

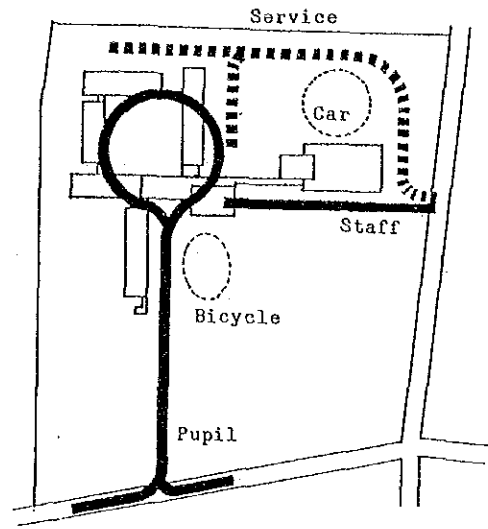
The administration building is located at a place easily visible from the gate, and directly accessible from the entrance hall. It is desirable to have the school as a whole, particularly the athletic ground and the approaches visible from the administration building, and therefore the layout is determined by taking into consideration this requirement.

Generally speaking, it is desirable to arrange the library close to the center of the traffic line and also close to the entrance hall. Therefore, the library is located in the 1st floor of the administration building, in order to facilitate its access by the students and teachers.

The multi-purpose pass is located at the west side of the school building, close to the road at the west side of the site, and is provided with a sub-gate, by taking into consideration its use by the ordinary population of the surrounding areas as mentioned before.



Zoning



Circulation

4-3-3 Architectural Planning

The 6 design policies explained in the section 4-2 are repeated here.

- 1) Substantial design
- 2) Design taking into consideration the intention of the Government of Tonga
- 3) Effective use of the site
- 4) Design fitting the local climate and natural conditions
- 5) Appropriate design in accordance with the state of things of the local construction industry
- 6) Minimization of the construction costs to be shared by the Government of Tonga and minimization of the maintenance & operation costs.

(1) Planning

The existing Tonga High School is used as a reference for the sake of calculation of the optimum area of the Vava'u High School, by taking into consideration the intention of the Government of Tonga. Furthermore, some minor modifications are made, by taking into consideration the relevant standards prevailing in Japan. The area calculated in the aforementioned way is arranged in the grid and then the planning of the two-storey buildings is drawn up by adding the subsidiary elements such as the corridors and stairways which function as circulation and evacuation routes. The framework of the ground plan is the so-called UV type, divided into the group of home classrooms for the ordinary courses (consisting of the low school year building and high school year building) and the group of special classrooms for special courses.

This layout reflects the intention of the Government of Tonga and furthermore it is a proven one, since it is used in 80% of the junction high schools of Japan. The corridors are one-side type ones open to the external space because it fits the local climate and natural conditions.

General Classroom Group : (1,114 m²)

- Area of each classroom : 62 m²
- No. of classrooms : 16
- No. of preparation rooms : 16

The ordinary classrooms will be used principally to give lectures, with the students sat on their desks. the standard size of the desks used in Tonga is 180 cm x 50 cm. The space corresponding to each student is 60 cm, because they are shared by 3 students. It can be safely said that this desk size is the minimum indispensable limit in the case in view of the physican constitution of the Tongan students. Each classroom has capacity for 35 students, and accordingly, 12 desks (3 rows x 4 columns) are arranged in each classroom.

The 60 cm-wide passageways are required in order to provide space for circulation between the desks, in addition to some space around the teacher's desk and working space behind the desks of the students. Such being the case, the size of each ordinary classroom will be of the order of (7.0 to 8.0) x (8.0 x 9.0) square meters. The design is set forth by assuming classrooms sized 7.2 x 8.6 m, which turns out to be equivalent to the size requested by the Government of Tonga. The space per student is $62/36 \approx 1.72 \text{ m}^2/\text{student}$.

Special Classroom Group : (715 m²)

- No. of classrooms : 10

The science laboratories will be used principally to give lectures and to carry out experiments. Two special classrooms of this kind will be used to study physics, chemistry, biology and physical geography. These special classrooms will be used by the low school year students and high school year students, respectively, in accordance with their form of study. The special classrooms are sized 7.2 x 9.6 m, and are equivalent to the standard size of Japan. Between these two classrooms it is necessary to provide one preparation-room/specimen-room sized 34 m² and one reserve room sized 43 m² to be used by students of the Form 6 and Form 7. As for the number and size of rooms to be used as vocational training classrooms, home economics classrooms and commercial course classrooms, they are determined by taking into consideration the survey carried out at the Tonga High School and the results of the discussions referring to the required area, because they are strongly influenced by the local peculiarities. The one-storey building that contains the vocational training classrooms and the home economics classrooms composes the courtyard in the ground plan and this open space sized 33 x 33 m can be used for activities of various kinds such as meetings, school festivals, etc.

(Science laboratories)

- Laboratory (I) 7.2 x 9.6 m
- Laboratory (II) Ditto
- Reserve room (to be used by students of Form 6 and Form 7) 7.2 x 6.0 m
- Preparation-room/specimen-room 7.2 x 4.8 m

(Handicraft classrooms) (Vocational training rooms)

- Woodworking classroom 7.2 x 9.6 m
- Metal working classroom 7.2 x 9.6 m
- Instrument, apparatus & material warehouse 7.2 x 4.8 m
- Tool room 2.0 x 3.6 m

(Home economics classroom)

- Cooking classroom 7.2 x 9.6 m
An UMU space for outdoor cooking shall be attached to this room.
- Sewing classroom 7.2 x 9.6 m
- Laundry room 7.2 x 4.8 m

(Commercial course)

- Commercial course classroom 7.2 x 8.6 m
- Commercial course practice room 7.2 x 5.8 m
The commercial course practice room shall be a model office equipped with reception, office work equipment, filing equipment, typewriters and telephone.

Administration Building (177 m²)

- Teachers' room
- Office
- Principal's office, etc.

The space per head in the administration building is 3 m²/person. The teachers's room to be used by 25 persons is rather small, but the classroom component is provided with preparation rooms that can be used by the teachers, and accordingly it can be considered pertinent notwithstanding. The principal's office and vice-principal's office will be equipped with desk and furnitures to receive visitors and to carry out small meetings. An office sized 28.8 m² is provided beside the entrance ahl1, where three persons will work, functioning as a reception, counter for payment of school fee, accounting, issue of certificates, etc. Subsidiary facilities such as toilets, water heater room, warehouse, etc., are also included in this administration building.

- Teachers' room + water heater room	87.8 m ²
- Reception & office	6 x 4.8 m
- Principal's office	4.1 x 4.8 m
- Vice-principal's office	3.1 x 4.8 m
- Health center	3 x 4.8 m

Library (150 m²)

- Reading room	115.2 m ²
- Stack room	2.4 x 4.8 m
- Working room	2.4 x 9.6 m
- Rest corner (used also as a corridor)	34 m ²

Multi-Purpose Hall : (630 m²)

The basketball court and the open hall are the standard equipment in the local secondary schools. This design is modeled after the aforesaid standard. The shower room, dressing room and toilet are designed to serve one class of 35 students. As for the floor of the hall, it seems recommendable to construct it with a substrate made of coral and surface of compacted clay. The use of wooden floor and concrete floor does not seem to be appropriate because troublesome maintenance in the future.

(2) Selection of the Type of Building

The school building has an essentially public character, and special emphasis shall be put on the safety, because it may function as a place of refugee in the case of calamities (typhoon, earthquake, etc.). Calamities such as earthquakes, typhoons, etc., are quite frequent in Tonga. As for the ground, the maximum value of the permissible bearing power is of the order of 8.0 t/m² (we intend to set forth the design by assuming a bearing power of the order of 5 t/m²).

Three types of structure are discussed here.

- 1) Reinforced concrete structure
- 2) Steel structure
- 3) Concrete block structure

1) Reinforced concrete structure

The reinforced concrete structure is seen commonly in Tonga, and according to information provided by the Ministry of Works (MOW), the aggregate consists of crushed coral limestone, and the compressive strength of this kind of concrete is of the order of 3,500 Lb/sq-in (Approx. 246 kg/cm²). Nevertheless, the bad influence of the said contained in the coral limestone is feared in the case of reinforced concrete. Subsidiary works such as construction of forms, arrangement of bars, etc., is required in the case of adopting the reinforced concrete structure. We feel uneasy about aspects of the local construction industry, such as the experience of the workers, efficiency of work, etc., and accordingly the adoption of the reinforced concrete structure is not necessarily related with the shortening of the term of works and reduction of the construction cost.

On the other hand, the state of things of the ground requires the construction of a light weight building, and the frequent earthquakes and typhoons require a building with considerable tenacity. Such being the case, the reinforced concrete structure has many problems.

2) Steel structure

The steel structure seems appropriate from the point of light weight and tenacity of the building, but on the other hand the frequent typhoons and the proximity to the sea in an insular country causes the corrosion of the steel. Furthermore, the procurement of steel materials and their preparation and erection are impossible in New Zealand. Such being the case, it is necessary to prepare the steel materials in overseas countries (e.g. New Zealand or Japan) and to transport it to Tonga. Even in this case there are problems related to the availability of cranes to land the material and to erect the structure.

Nevertheless, the procurement in overseas countries makes possible to obtain steel materials of better quality compared with their preparation at the construction site, and in the worst case it is possible to prepare members that can be handled and erected with arm power. Furthermore, it is possible to design a structure that can be erected with ease by adopting an exhaustive simplification and standardization.

The erection of the structure can be commenced immediately, should the foundation work be finished. Accordingly, the adoption of the steel structure has considerable merits regarding the shortening the term of works.

In the case of adopting the steel structure, the use of deck plates and cast-in-place concrete to construct the floor of the second storey is advantageous from the point of view of ease of construction and reduction of weight of the building. Furthermore, this type of floor structure is also advantageous from the points of view of sound isolation and prevention of vibration.

3) Concrete block structure

The adoption of the concrete block structure is advantageous from the point of view of availability of the materials in Tonga, shortening of the term of works and construction cost. Nevertheless, the concrete block structure can not be necessarily considered the best alternative in the case of buildings like schools that require large space and flexibility.

The wood structure is another alternative, but it has problems regarding to the fire, durability, availability of the construction material in Tonga, etc. On the other hand, the SCR structure is not appropriate in view of the scale of the building.

In view of the discussion presented in the foregoing, we decided to adopt the construction method that uses steel in the principal

parts of the structure such as the columns and beams. In this kind of structure the use of concrete is minimized, and the walls are constructed with concrete blocks. The length of the steel members on the ground plan and the types of junctions are minimized, and furthermore the grid planning is adopted and the various buildings are standardized in order to improve the ease of work.

(3) Section and Elevation

The characteristics of the section adopted commonly in the design of the buildings of Tonga with the purpose of fitting the local climate and natural conditions are roofs with relatively steep slope and projected eaves with the purpose of shielding the sunlight and coping with the rain. This pattern is adopted in this Project too, and the buildings are made as tall as possible in order to disperse the radiant heat due to the sun and the suspended ceiling is provided in order to insulate the heat by means of natural ventilation in the space comprehended between the roof and the ceiling.

The walls consist of concrete blocks produced in Tonga and sash surfaces. The openings are designed as large as possible and glass louvers are used frequently in order to provide natural lighting and ventilation in the classrooms.

The elevation plan consists of horizontal lines comprising deep eaves and vertical lines of the columns. As for the external appearance of the buildings, emphasis is put on the horizontal lines and on the roof surfaces, and these peculiarities match perfectly with the surrounding landscape.

The roofs of the entrance hall and special classroom building stretch in a row, and the corridor of the second storey is arranged at the northside. Consequently, a stair-well thrusts through the two storeys of the building at the vicinity of the entrance hall. The roof stretches further in row over the administration building

and building, composing as a result a very large roof continuum.

It is desirable to construct the floor as high as possible, because the ground of the project site consists of loam and the water drainage is therefore expected to be bad. Furthermore, it is necessary to construct an efficient drainage system around the buildings in order to cope with the hurricanes. Nevertheless, the construction of buildings with high floor can be omitted should rain water be drained to the road at the west side of the site, because the site is higher than the road. Furthermore, it is possible to cope with the situation by constructing the buildings with concrete floor 300 mm above the ground level.

The height of the ceiling of the classrooms is 3 m.

Foundation	Reinforced concrete on rubble of crushed coral stone.
1st storey floor	Vapour barrier, trowel-finished reinforced concrete and vinyl tile on rubble consisting of crushed coral stone.
2nd storey floor	Trowel-finished concrete and vinyl tile on deck plate.
Columns	Steel structure with concrete block masonry lining, finished with mortar and acrylic resin paint.
Beams	Steel structure with rustproof coating and finished with oil paint.
Main house	Ditto
Roof	Thatched with galvanized steel sheets
Walls	Reinforced concrete block masonry, exterior finished with mortar and acrylic resin paint.

2) Wind load

Pressure caused by the wind velocity

$$q = 60 \sqrt{h} \quad (\text{Building height } h < 16.0 \text{ m})$$

Assuming $h = 9 \text{ m}$, we have

$$q = 180 \text{ kg/m}^2$$

Nevertheless,

$$q = 1/2 \times \rho V^2$$

where,

$$\rho = \text{wind density} \quad \dots \quad 0.113 \text{ kg} \cdot \text{s}^2 \cdot \text{m}^{-4}$$

$V = \text{wind velocity}$

The maximum recorded wind velocity is approximately 61 m/sec.

Assuming $v = 60 \text{ m/sec}$. we have

$$q = 1/2 \times .113 \times 60^2 = 203.4 \text{ kg/m}^2 \quad \dots \quad 210 \text{ kg/m}^2$$

Therefore, the value of q for design purposes is assumed to be

$$q = 210 \text{ kg/m}^2$$

4-3-4 Water and Electrical System

No material related to the equipment of the buildings is produced in Tonga and consequently everything has to be imported. The Vava'u Branch of the Ministry of Works (MOW) has a stock of equipment parts covering a relatively wide variety, but there is shortage of maintenance technicians. The equipment of the building shall be designed by putting emphasis on the minimization of the running cost and easy maintenance. As for the contents of the equipment, they shall consist of those ones commonly used in Vava'u, and limited to the minimum indispensable items.

(1) Water Supply System

A water supply main pipe sized 2"φ is expected to be laid in the road located at the north side of the site, and consequently water will be supplied at local cost up to the extremity of the site. Nevertheless, an acute shortage of water takes place during the dry season, and accordingly rain water falling on the roof of the multi-purpose wall shall be stored in the tank located under the stage. Rain water stored in that tank shall be pumped to an elevated tank made of resistant FRP and distributed to the required places. The school shall be provided with two water supply systems, i.e., running water system and rain water system.

a) Running water system

In this system water shall be supplied directly from the mains laid in the road in front of the school via branch pipe.

Running water shall be supplied to the following points: all toilets, chemistry laboratory, cooking classroom, laundry and shower room of the gymnasium. (The branch pipe from the water mains shall be provided separately, and this work shall comprise only the water supply system from the border of the site).

b) Rain water system

Rain water falling on the roof of the gymnasium shall be stored in an underground storage tank (35 m³). Then, the rain water shall be pumped to an elevated tank (2 m³, 11 m above the ground) and supplied to the various parts of the school.

Rain water shall be supplied to the following points: toilet of the administration building and shower room of the gymnasium.

c) Piping material

Steel pipe (black) with vinyl lining.

(2) Drainage System

As mentioned in the section referring to the present state of things of the infrastructure, there is no treatment facilities in Vava'u, and the totality is processed by infiltration. The settling tank and the infiltration tank are designed in accordance with the local standards.

Sanitary sewage and miscellaneous waste water are drained separately, and the former ones are discharged in the purifying tanks located nearby the toilets. Hard vinyl chloride pipes (VP) are used in the drainage system.

(3) Gas System

Liquid Propane Gas (LPG) will be supplied to the laboratories, kitchen of the home economics class and kitchenette room of the teachers' room. The gas cylinders will be installed nearby the required places, either indoor or outdoor. The centralized gas supply system is not adopted because it requires a long gas piping. The piping system will be constructed individually, and the gas heaters will be installed at the required places. A small gas cylinder will be installed indoor in the water heating room.

(4) Ventilation System

Exhaust fans shall be provided in the toilets, shower room, chemistry laboratory and cooking classroom.

(5) Electrical System

1) Illumination and outlets

a) Classroom component

- i) Wiring 600V vinyl-insulated wires
- ii) Switches
- iii) Outlets
- iv) Lighting fixtures

b) Gymnasium

- i) Wiring
- ii) Switches
- iii) Outlets
- iv) Lighting fixtures

2) Narrow Cast

a) Classroom component

- i) Wiring 600V vinyl-insulated wires
- ii) Equipment Desk-top amplifier and microphone in the teachers' room, double sided loudspeakers in the corridors and trumpet loudspeakers at the entrance and stair halls located at the road side (outdoors).

b) Gymnasium component

- i) Wiring 600V vinyl-insulated wires
- ii) Equipment Desk-top amplifier, loudspeaker

3) Lightning arrester system

Lightning arresters consisting of hard copper wires shall be installed a top the roofs of the classroom component buildings and on the crest of the roof of the gymnasium.