JAPAN INTERNATIONAL COOPERATION AGENCY

MINISTRY OF AGRICULTURE, FISHERIES AND FORESTS,

THE REPUBLIC OF FIJI ISLANDS

THE STUDY ON WATERSHED MANAGEMENT AND FLOOD CONTROL FOR THE FOUR MAJOR VITI LEVU RIVERS IN THE REPUBLIC OF FIJI ISLANDS

FINAL REPORT

SUPPORTING REPORT

VOLUME-2

October, 1998

Yachiyo Engineering Co., Ltd.

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COMPOSITION OF FINAL REPORT

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   - Part I Master Plan for Four Major Viti Levu Rivers
   - Part II Feasibility Study for Nadi Diversion Channel

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PART F

SURFACE WATER QUALITY

THE STUDY ON WATERSHED MANAGEMENT AND FLOOD CONTROL
FOR THE FOUR MAJOR VITI LEVU RIVERS
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SUPPORTING REPORT
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LIST OF ABBREVIATION

B/C	: Benefit Cost Ratio
BOD	: Biological Oxygen Demand
COD	: Chemical Oxygen Demand
D&I	: Drainage and Irrigation Division, MAFF
DO	: Dissolved Oxygen
DOE	: Department of Environment, MUDHE
DOF	: Department of Forest, MAFF
EIA	: Environmental Impact Assessment
EIRR	: Economic Internal Rate of Return
FAO	: Food and Agriculture Organization of the United Nations
FEA	: Fiji Electricity Authority
FMS	: Fiji Meteorological Service, MTCA
FSC	: Fiji Sugar Corporation
GDP	: Gross Domestic Product
GIS	: Geographical Information System
IEE	: Initial Environmental Examination
INR	: Institute of Natural Resources
JICA	: Japan International Cooperation Agency
MAFFA	: Ministry of Agriculture, Fisheries, Forests and ALTA
MAFF	: Ministry of Agriculture, Fisheries, and Forests
MPWIT	: Ministry of Public Works, Infrastructure and Transport
MRD	: Mineral Resources Department
MTCA	: Ministry of Tourism and Civil Aviation
MUDHE	: Ministry of Urban Development, Housing and Environment
NLTB	: Native Land Trust Board
NPV	: Net Present Value
PWD	: Public Works Department, MPWIT
SOPAC	: South Pacific Applied Geoscience Commission
SPC	: South Pacific Commission
SS	: Suspended Solids
TH	: Total Hardness
TN	: Total Nitrogen
TOR	: Terms of Reference
TP	: Total Phosphorus
UNDP	: United Nation Development Programme
USP	: University of the South Pacific
WHO	: World Health Organization

CHAPTER 1 WATER QUALITY SURVEY

1.1 Water Sampling and Water Quality Analysis

Water quality survey was conducted twice in early October and later November 1996 for an investigation of surface water quality in the dry and rainy seasons, respectively. At each time, 26 samples were collected from selected locations at the upper, middle and down stream parts of Ba, Sigatoka, Nadi and Rewa Rivers, and also the estuaries adjacent to the river mouths. The locations of these sampling points are shown in Figure-F1.1.

The first water quality survey in the dry season was conducted by the Study Team under the cooperation of D & I and PWD counterparts. The second survey in the rainy season was mainly conducted by the counterparts. The National Water Quality Laboratory, PWD, provided a full technical support to the survey.

A total of 14 water quality items were analyzed by using a portable water quality analyzer (DREL/2000-05) provided by the Study Team and also the equipment in the National Water Quality Laboratory.

1) Water temperature
2) pH
3) Electrical conductivity (EC)
4) Water salinity
5) Total dissolved solids (TDS)
6) Suspended solids (SS)
7) Ammonia (NH_3-N)
8) Nitrate (NO_3-N)
9) Nitrite (NO_2-N)
10) Total nitrogen (TN)
11) Dissolved oxygen (DO)
12) Total hardness (TH)
13) Total phosphorus (TP)
14) Chemical oxygen demand (COD)

1.2 Water Quality Analysis Results

Table-F1.1 shows the water quality analysis results. The general conditions of the main water quality parameters are as follows.

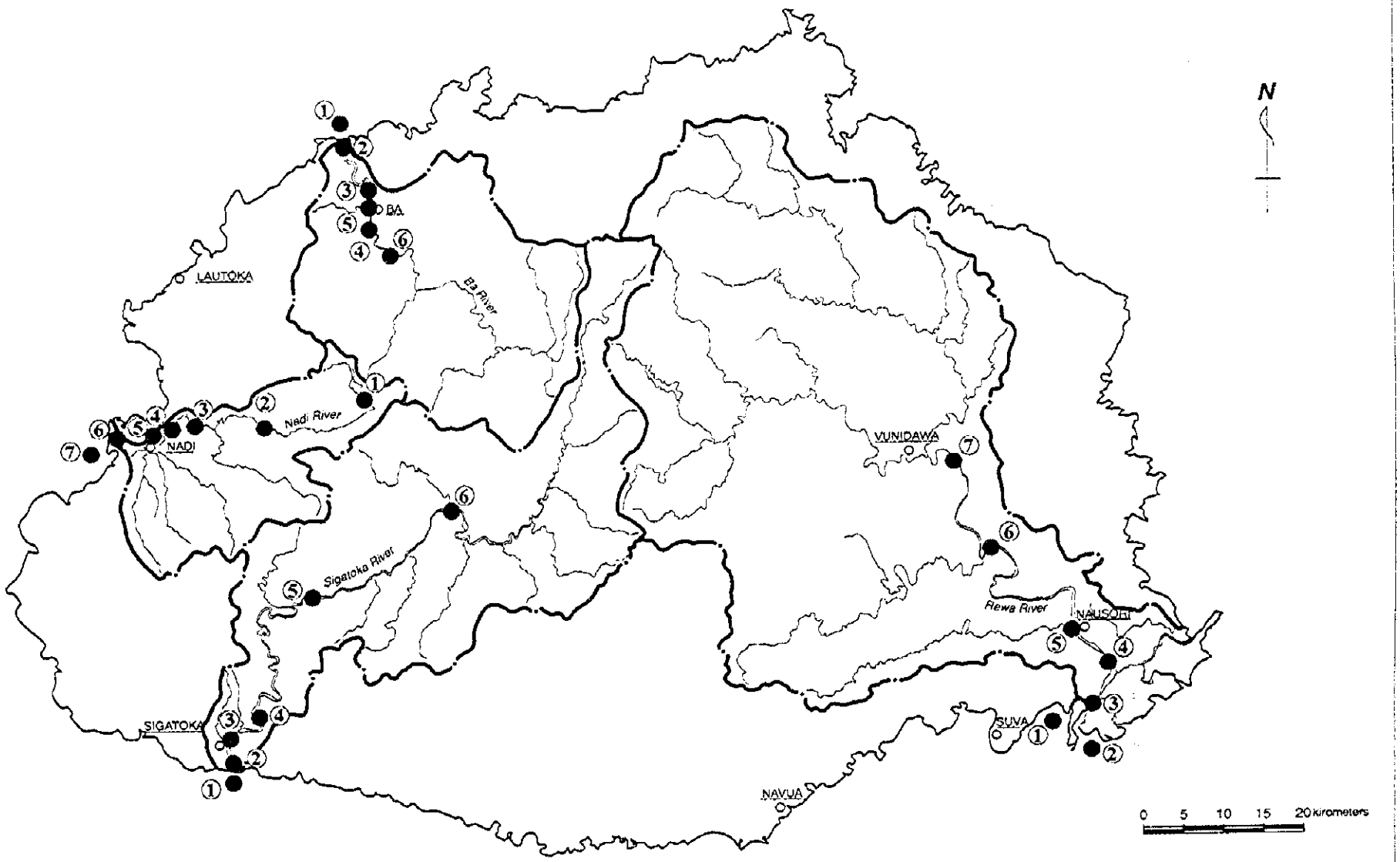

Figure-F1.1 Location of Water Sampling Sites

Table-F1.1 Water Quality Analysis Results

Item	Unit	(1) Ba River												(2) Nadi River											
		Site No. & Location												Site No. & Location											
		1		2		3		4		5		6		1		2		3		4		5		6		7	
		Open Sea		River Mouth		Down-stream the Bridge		Down-stream Sugar-cane Mill		Under the Bridge		Nabou-tolu Crossing		Vaturu Dam		Upper Stream		Middle Stream		Up-stream Nadi Bridge		Down-stream Nadi Town		River Mouth		Open Sea	
Season		Dry	Rainy	Dry	Rainy	Dry	Rainy	Dry	Rainy	Dry	Rainy	Dry	Rainy	Dry	Rainy	Dry	Rainy	Dry	Rainy	Dry	Rainy	Dry	Rainy	Dry	Rainy	Dry	Rainy
Water Tem.	°C	29.5	28.1	30.8	27.9	30.2	27.3	30.8	27.2	27.9	-	27.4	26.9	23.8	26.3	27.2	26.5	26.7	26.8	29.1	27.3	29.1	27.4	28.9	27.8	27.9	27.7
pH	-	6.8	7.52	6.8	7.61	5.54	6.02	5.52	6.15	7.34	-	8.48	7.88	7.66	7.21	8.14	7.38	7.9	7.42	7.88	7.41	8.08	7.55	7.97	7.62	8.13	7.83
EC	µS/cm	44,800	50,000	26,000	26,000	1018	260	293	350	2,410	-	189	150	62.6	680	162	160	195	570	345	470	1,440	1,800	40,550	50,000	47,000	50,000
Salinity	‰	28.8	-	19.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	26.0	-	30.8	-
TDS	mg/L	-	-	-	-	579	-	144	-	1,200	-	89	-	30	-	78	-	92	-	162	-	668	-	-	-	-	-
SS	mg/L	125	180	85.7	74	18.4	23	19	48	11	-	4	12	13	55	99	65	54	13	25	38	15	15	191	208	131	145
NH_3-N	mg/L (as N)	0.08	0.1	0.09	0.26	0.09	0.24	0.1	0.27	0.33	-	0.11	0.18	0.23	0.15	0.09	0.14	0.12	0.14	0.22	0.31	0.53	6.4	0.12	0.04	0.09	0.06
NO_3-N	mg/L (as N)	3.5	0.57	3.1	1.3	7.4	0.59	7.3	0.47	9.7	-	3.3	0.66	0.36	0.66	0.34	0.47	0.31	0.64	0.43	0.97	0.21	0.6	0.33	0.62	0.31	0.61
NO_2-N	mg/L (as N)	0.41	0.46	0.47	0.03	0.17	0.15	0.09	0.17	0.09	-	0.1	0.22	0.03	0.07	0.09	0.15	0.14	0.2	0.18	0.35	0.35	0.6	0.49	0.4	0.46	0.45
TN	mg/L	1.6	1.26	1.5	1.85	3.2	1.35	2.4	2.25	-	-	2.3	1.83	3.1	1.92	1.9	2.25	3.0	3.11	2.6	2.62	2.6	2.73	1.6	2.15	1.5	2.07
DO	mg/L	6.15	7.21	6.45	6.61	1.25	3.25	0.66	2.15	1.12	-	6.8	7.92	6.8	7.45	7.6	7.72	7.4	7.64	8.2	8.25	9.8	8.3	6.75	7.21	6.0	7.18
TH	mg/L	400	2,250	2,370	980	228	150	88	142	305	-	92	132	31	68	84	95	124	155	132	180	85	145	5210	2550	5810	4975
TP	mg/L (as PO_4)	0.6	0.11	0.7	0.11	1.3	0.27	0.9	0.35	-	-	0.8	0.07	0.8	0.28	0.7	2	0.7	2.22	0.8	0.12	1.02	0.13	0.7	0.25	0.6	0.11
COD	mg/L	210	245	202	220	15	28	11	21	-	-	1	2	2.9	4.2	8.3	8.3	13.3	15.1	9.6	18.4	19.6	22.1	225	174	210	152
Remark		Seawater		Half-seawater		Fresh-water		Fresh-water		High-tide time		Fresh-water		Fresh-water		Fresh-water		Fresh-water		Fresh-water		Fresh-water		Seawater		Seawater	

Item	Unit	(3) Sigatoka River												(4) Rewa River											
		Site No. & Location												Site No. & Location											
		1		2		3		4		5		6		1		2		3		4		5		6		7	
		Open Sea		River Mouth		Lawaqa Con-fluence		Naroro		Tonga Village Crossing		Keyasi		Nau-thala Bay		Open Sea		River Mouth		Down Stream		Up-stream the Bridge		Middle Stream		Upper Stream	
Season		Dry	Rainy	Dry	Rainy	Dry	Rainy	Dry	Rainy	Dry	Rainy	Dry	Rainy	Dry	Rainy	Dry	Rainy	Dry	Rainy	Dry	Rainy	Dry	Rainy	Dry	Rainy	Dry	Rainy
Water Tem.	°C	26.6	26.8	27.5	26.3	28.2	26.4	28.21	26.2	29.8	26.3	29.5	26.1	25.5	27.4	26.6	27.6	27.7	27.1	26.7	26.9	27	26.8	26.4	26.6	27	26.2
pH	-	8.79	795	8.82	7.83	7.8	7.81	7.44	7.28	6.99	7.01	6.60	6.97	7.13	7.6	7.12	7.64	6.85	7.45	6.21	7.23	6.02	7.21	7.2	7.19	6.09	7.07
EC	µS/cm	38,900	50,000	22,400	24,000	12,740	4,500	1,040	240	235	210	203	230	41,200	42,500	37,000	40,800	10,680	8,500	180	220	111.5	150	117	140	94	320
Salinity	‰	24.8	-	13.5	-	7.2	-	-	-	-	-	-	-	26.5	-	23.2	-	6.0	-	-	-	-	-	-	-	-	-
TDS	mg/L	-	-	-	-	-	-	489	-	110	-	96	-	-	-	-	-	-	-	85	-	52	-	54	-	42	-
SS	mg/L	149	33	49	39	40	29	23	26	15	27	25	31	30	-	40	-	40	-	40	-	10	-	40	-	40	-
NH_3-N	mg/L (as N)	0.08	0.03	0.07	0.05	0.05	0.08	0.07	0.07	0.08	0.09	0.09	0.06	6.15	0.69	3.85	0.66	1.41	0.31	0.22	0.32	0.25	0.36	0.28	0.29	0.19	0.27
NO_3-N	mg/L (as N)	0.33	0.45	0.62	0.47	0.65	0.5	0.73	0.65	0.4	0.97	0.72	0.82	0.79	0.47	0.35	0.28	0.5	0.26	0.3	0.25	0.24	0.21	0.28	0.19	0.28	0.07
NO_2-N	mg/L (as N)	0.41	0.05	0.41	0.05	0.34	0.07	0.43	0.06	0.35	0.04	0.21	0.05	0.56	0.53	0.47	0.55	0.61	0.68	0.12	0.29	0.05	0.22	0.04	0.13	0.04	0.07
TN	mg/L	1.13	0.97	1.56	1.02	1.23	1.13	1.87	1.74	2.15	1.83	2.55	1.96	2.7	2.15	1.8	1.78	1.75	1.35	0.75	0.68	0.68	0.75	0.62	0.78	0.55	0.63
DO	mg/L	7.3	7.53	6.4	6.61	6.5	6.82	7.6	7.71	9.1	7.95	8.4	8.22	6.9	7.72	6.2	7.75	7.0	7.63	7.8	7.89	7.25	8.18	8.2	8.42	9.1	8.69
TH	mg/L	2,620	3,000	1,340	1,520	1,160	680	121	138	86	70	94	88	5,790	3,010	4,550	2,50	1,225	780	57	166	44	78	47	35	35	76
TP	mg/L (as PO_4)	0.7	0.63	0.6	0.64	0.6	0.68	0.8	0.89	0.7	0.81	0.9	0.35	0.2	1.25	0.7	1.46	0.8	1.11	0.4	0.63	0.3	0.61	0.3	0.58	0.2	0.41
COD	mg/L	232	188	70	84	29	33	19	21	5	11	22	15	180	-	175	-	36	-	5	-	2	-	10	-	9	-
Remark		Seawater		Half-seawater		High-tide time		Fresh-water		Fresh-water		Fresh-water		Sea-water		Sea-water		Half-seawater		Fresh-water		Fresh-water		Fresh-water		Fresh-water	

(1) Temperature

Water temperature is mainly affected by the air temperature. It ranges from 24 to 31 °C in the dry season and 26 to 28 °C in the rainy season and does not show any abnormality if the difference of weather in the two seasons are considered.

(2) pH

At most of the water sampling sites, water shows a neutral pH from 6.0 to 8.0. Only at the middle stream of Ba River (site No. 3 and 4), a lower pH of 5.5 was detected in the dry season. This might have been affected by the wastewater effluent from the sugarcane mill as will be mentioned below for some other water quality items.

(3) Electric Conductivity, Salinity and Total Dissolved Solids

Electric conductivity (EC), salinity or total dissolved solids (TDS) of the river water are affected by sea water intrusion or tidal flow. At the river mouth, EC is similar to or slightly lower than that of the sea water. At the middle stream locations, EC is more or less affected by the tidal flow. Most of the upstream samples show very low EC values. However, due to limited sampling locations and frequency, it is difficult to evaluate the extent of sea water intrusion and salinity fluctuation in these rivers.

(4) Suspended Solids

Suspended solids (SS) in most of the water samples range from 10 to 200 mg/L. SS is higher in samples from the sea or the river mouth. No appreciable difference is noticed between the dry and rainy seasons.

(5) Ammonia, Nitrate, Nitride and Total Nitrogen

Regarding nitrogen, three kinds of inorganic nitrogen: ammonia (NH-N), nitrate (NO_3-N) and nitride (NO_2-N), and total nitrogen (TN) were analyzed. For Ba, Nadi and Sigatoka Rivers, the TN ranges from 1.0 to 3.2 mg/L. Rewa River shows a TN lower than 1.0 along the whole river course except at the river mouth and in the adjacent coastal area. Among the three kinds of inorganic nitrogen, NO3-N shows higher concentration especially in Ba River at the dry season.

(6) Dissolved Oxygen

Dissolved oxygen (DO) is an important indicator of water pollution. For Nadi, Sigatoka and Rewa Rivers, DO ranges from 6.0 to 9.0 and shows a favorable biological condition. However, in the middle stream of Ba River (site No. 3, 4 and 5) DO is as low as 0.66-1.25 in the dry season and 2.15-3.25 in the rainy season. Similar results have also been reported by some previous studies for Ba River (Anderson, 1995; D & I, 1996). Considering that these sampling locations are within 2 km downstream of a wastewater outlet from the sugarcane mill, it is questionable that high concentration organic pollutant may be discharged into the river due to insufficient industrial wastewater treatment.

(7) Total Hardness

The total hardness (TH) in most of the river water samples is at very low level. The higher TH value at the river mouth is due to the high salinity but not the real hardness substance.

(8) Total Phosphorous

Most of the water samples show a total phosphorus (TP) of 0.5-1.2 mg/L as PO_4 which is equivalent to a TP of 0.2-0.4 mg/L as P. There is no apparent difference between the dry and rainy seasons.

(9) Chemical Oxygen Demand

It should be pointed out that by using the reactor digestion method for chemical oxygen demand (COD) analysis in this study, it is difficult to get rid of the interference from a high concentration of chloride (Cl). Therefore, the measured COD values for saline water samples (those from open sea and river mouth) may not be accurate and only the results for fresh water samples are suitable for comparison. Generally speaking, at the upstream side of these rivers, COD is lower than 10 mg/L. Most of the samples from the middle and down stream parts show a COD of 10-20 mg/L.

The above mentioned characteristics of water quality can be schematically presented in Figure-F1.2, where 4 main water quality items, DO, COD, TN and TP, are cited. It is apparent that water quality does not change much along these rivers and in their estuaries. The only exception is Ba River where there is a sharp drop in DO at its middle stream section. However, the other parameters do not differ much from the other rivers.

CHAPTER 2 EVALUATION OF PRESENT WATER QUALITY

2.1 Water Quality Criteria

Since the objectives of the water quality survey are to understand the present condition of river water quality and to study the suitability of water resource development for the purpose of drinking water supply, it is necessary to conduct an evaluation by comparing the water quality analysis results with the water quality criteria currently applied in Fiji.

Table-F2.1 summarizes the water quality criteria specified in the newly published "Fiji's Draft Sustainable Development Bill". Coastal waters and fresh waters have been categorized respectively into three classes according to the purpose of water usage. The water quality items include coliform bacteria, pH, TP, TN, DO and turbidity and other inorganic and organic substances (not listed in Table-F2.1). For a reference, COD and BOD specified in Japan's water environmental criteria for coastal and fresh waters are cited at the bottom of the table.

The results of evaluation on river water quality are shown in Table-F2.2. For each river, both the river course and estuary area are considered, and the criteria for coastal and fresh waters are applied.

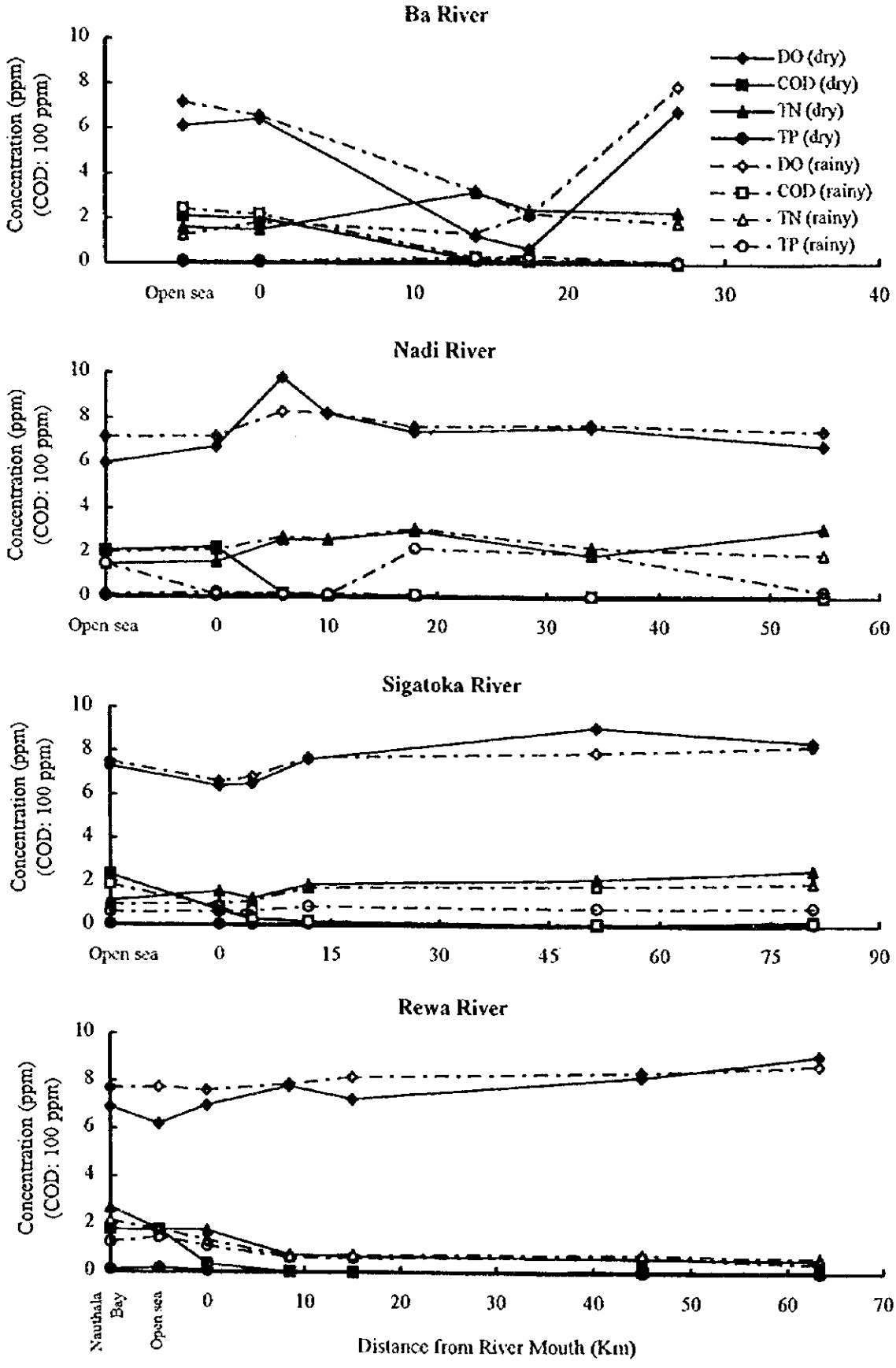

Figure-F2.1 Water Quality of the Four Rivers and Their Estuary

Table-F2.1 Water Quality Criteria

Item		Coastal Waters			Fresh Waters		
		Class AA	Class A	Class B	Class 1	Class 2	Class 3
Faecal Coliform (Count/100 mL)	(a)*	< 70	< 200		< 70	< 200	
	(b)**	< 230	< 400		< 230	< 400	
Enterococci (Count/100 mL)	(a)***	< 33		-	-	-	-
	(b)**	< 60		-	-	-	-
pH		7.7 - 8.5			6.5 - 8.5		6.5 - 9.0
TP (mg/L as P)		< 0.025		< 0.500	< 0.200		
TN (mg/L as N)		< 0.400		< 0.800	< 0.750	< 1.500	
TN/TP Ratio		11.1 - 27.1		6.1 - 18.1	-	-	-
DO (mg/L)		> 6.0	> 5.0	> 4.5	> 6.0	> 5.0	> 4.5
Turbidity (NTU)		< 5.0		-	< 5.0		-
COD or BOD (mg/L) ****		< 8 (COD)			< 8 (COD for lakes) < 10 (BOD for rivers)		

Note: 1) Source: Fiji's Draft Sustainable Development Bill (1996. 11)

2) Water classification:

Coastal Waters

- Class AA: oceanographic research, marine life conservation
- Class A: recreational, aesthetic enjoyment
- Class B: ports and harbors

Fresh Waters

- Class 1: drinking water supply
- Class 2: swimming
- Class 3: industrial activities

3) * for 10 consecutive samples
** for single sample
*** for any 5 samples in a given 30 day period
**** Japan's criteria for reference

4) Criteria for radioactive materials and toxic substances have not been listed in this table.

5) Groundwater has not been listed in this table.

2.2 Water Quality Evaluation

2.2.1 Water Quality in the Estuaries

Regarding water quality in the estuaries, the evaluation results can be summarized as below:

1) pH is within an acceptable range although it is slightly lower than the criteria value of 7.7-8.5 at some locations;
2) DO meets Class AA for all the waters;
3) TN and TP do not meet Class AA nor Class A for all the waters.

Therefore, high concentration of nutrient substances is considered to be the main problem for the estuary areas of the four rivers. By a rough estimation of the TN/TP ratio which shows the condition of a nutrient balance, it is noticed that total phosphorus seems to be over-weighted in the Sigatoka and Rewa estuaries. Since a high nutrient level may result in algae growth and deteriorate the biological condition of the coastal area, it is

recommendable that comprehensive studies should be conducted for identifying the nutrient sources and working out countermeasures for coastal environment protection.

Due to lack of accuracy of COD data for sea water for the reasons mentioned above, COD is not considered in the evaluation.

2.2.2 Water Quality in the Rivers

Regarding water quality in the rivers, the evaluation results can be summarized as below:

1) There is almost no problem with pH;
2) DO meets Class 1 for Nadi, Sigatoka and Rewa Rivers, but is worse than Class 3 for Ba River at its middle stream section;
3) Water in Rewa River and in the upper stream part of Ba and Nadi Rivers meets Japan's river water quality criteria for COD, but Sigatoka River shows higher COD concentration;
4) Similar to the water in the estuaries, TN and TP exceed the criteria values for these rivers except Rewa River.

Although there are certain problems with the water quality in these rivers when comparing with the water quality criteria, using these rivers as the water resource for drinking water supply is considered to be possible if location is carefully selected and suitable treatment processes are applied, since Fiji has already had much experience in river water utilization. However, it is considered to be urgent to take action for river water quality protection and conservation. Restriction on sewage and industrial wastewater discharge is in every sense the most important measure to be taken. For a river itself, eutrophication may not be a significant problem, but if water is stored in a reservoir, high concentration of nutrient substances may become the reason of micro-organism and algae growth, which should be fully taken into account in planning water resources development in a tropical climate region. On the other hand, river water quality protection is also very important to coastal environment conservation, since the river is one of the carriage ways of pollutants to the sea.

Table-F2.2 Water Quality Evaluation

River	Region	Parameter	Measurement*	Evaluation**
Ba	Estuary	pH	6.8-7.5	slightly low
		TN	1.26-1.6	worse than Class B
		TP***	0.04-0.2	Class B
		TN/TP Ratio	about 12	Class AA or A
		DO	6.15-7.21	Class AA
		COD	-	
	River	pH	5.5-7.9	slightly low
		TN	1.35-3.2	Classes 2, 3 or worse
		TP	0.02-0.43	Classes 1, 2, 3 or worse
		DO	0.66-7.92	middle stream section - Class 3 or worse others - Class 1
		COD	1-28	meet Japan's criteria at upper stream side
Nadi	Estuary	pH	7.8-8.1	Class AA
		TN	1.5-2.07	worse than Class B
		TP	0.04-0.2	Class B or worse
		TN/TP Ratio	about 15	Class AA
		DO	6-7.2	Class AA
		COD	-	
	River	pH	7.2-8.1	Class 1
		TN	1.9-3.1	worse than Class 3
		TP	0.04-0.74	Classes 1, 2, 3 or worse
		DO	6.8-9.8	Class 1
		COD	2.9-22.1	meet Japan's criteria at upper stream side
Sigatoka	Estuary	pH	8-8.8	Class AA
		TN	0.97-1.56	worse than Class B
		TP	0.2-0.23	Class B
		TN/TP Ratio	about 6	Class B or worse
		DO	7.3-7.5	Class AA
		COD	-	
	River	pH	7-7.8	Class 1
		TN	1.13-2.55	Classes 2, 3 or worse
		TP	0.12-0.3	Classes 1, 2, 3 or worse
		DO	6.5-9.1	Class 1
		COD	5-22	only 1 sample meets Japan's criteria
Rewa	Estuary	pH	7.1-7.6	slightly low
		TN	1.8-2.7	worse than Class B
		TP	0.23-0.49	Class B
		TN/TP Ratio	about 7	Class B
		DO	6.2-7.8	Class AA
		COD	-	
	River	pH	6.1-7.5	almost Classes 1, 2
		TN	0.55-0.78	Class 1 or Class 2
		TP	0.07-0.21	almost Class 1
		DO	7.2-9.1	Class 1
		COD	2-10	meet Japan's criteria

Note: * based on water quality analysis results shown in Table-F1.1
unit as mg/L except for pH and TN/TP ratio
** based on water quality criteria shown in Table-F2.1
*** TP is calculated as P

CHAPTER 3 REQUIREMENT OF WATER QUALITY MANAGEMENT

Water quality management is one of the tasks for watershed management. Due to a high annual rainfall rate, surface water is rich and becomes the main water resource in Fiji. Although water quality analysis results have not indicate serious water pollution, certain problems do arise at some locations and water quality improvement is necessary in order to meet the requirement for various purposes of water utilization. The followings are recommendations.

3.1 Water Area Classification

In order to make clear the goals of water quality conservation and improvement, it is necessary to classify the major rivers and coastal waters at national level. For example, a river or a section of river should be designated as Class 1 if it is used as source for water supply, and an estuary area should be designated as Class AA if it is important for oceanographic research or marine life conservation. In this way, the water quality criteria to be enacted with the environmental legislation can easily be applied for a critical judgment of the water quality in a specific area.

3.2 Water Quality Monitoring

A long term water quality monitoring program is needed to be implemented for the major rivers and important coastal areas. All the important water quality parameters such as BOD, DO, TP, TN etc. should be monitored regularly and a data base should be built. In this way, the condition of water pollution can be checked and all problems can be solved immediately.

3.3 Restriction on Industrial Wastewater

The water quality analysis results have shown the present condition of industrial pollution on the river at some location. It is necessary to restrict the discharge of industrial wastewater to any of the rivers or coastal areas. All industrial wastewater should be treated before it is discharged to a water body.

3.4 Reduction of Pollutants from Domestic Discharge

In Fiji, large cities and towns have already been served by sewerage systems. However, there are still many sources of untreated domestic sewage which is discharged directly to a water and results in water quality deterioration at some locations especially at the dry season. In addition to expansion of existing sewage treatment plants, installation of small scale treatment facilities and improvement of septic tanks shall also be considered.

3.5 Sanitary Education

For an effective water quality management, sanitary education is indispensable for raising public awareness of the importance of water quality improvement. Although not so common in Fiji, dumping of garbage or other wastes to a water is thought to be one of the reasons for water pollution. This needs a sanitary education to call people of all ages to take actions for keeping a comfortable and beautiful water environment.

SUPPORTING REPORT

PART G

LAND USE AND REGIONAL DEVELOPMENT

THE STUDY ON WATERSHED MANAGEMENT AND FLOOD CONTROL
FOR THE FOUR MAJOR VITI LEVU RIVERS
IN THE REPUBLIC OF FIJI ISLANDS

SUPPORTING REPORT
PART G, LAND USE AND REGIONAL DEVELOPMENT

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LIST OF ABBREVIATION

B/C	: Benefit Cost Ratio
BOD	: Biological Oxygen Demand
COD	: Chemical Oxygen Demand
D&I	: Drainage and Irrigation Division, MAFF
DO	: Dissolved Oxygen
DOE	: Department of Environment, MUDHE
DOF	: Department of Forest, MAFF
EIA	: Environmental Impact Assessment
EIRR	: Economic Internal Rate of Return
FAO	: Food and Agriculture Organization of the United Nations
FEA	: Fiji Electricity Authority
FMS	: Fiji Meteorological Service, MTCA
FSC	: Fiji Sugar Corporation
GDP	: Gross Domestic Product
GIS	: Geographical Information System
IEE	: Initial Environmental Examination
INR	: Institute of Natural Resources
JICA	: Japan International Cooperation Agency
MAFFA	: Ministry of Agriculture, Fisheries, Forests and ALTA
MAFF	: Ministry of Agriculture, Fisheries, and Forests
MPWIT	: Ministry of Public Works, Infrastructure and Transport
MRD	: Mineral Resources Department
MTCA	: Ministry of Tourism and Civil Aviation
MUDHE	: Ministry of Urban Development, Housing and Environment
NLTB	: Native Land Trust Board
NPV	: Net Present Value
PWD	: Public Works Department, MPWIT
SOPAC	: South Pacific Applied Geoscience Commission
SPC	: South Pacific Commission
SS	: Suspended Solids
TH	: Total Hardness
TN	: Total Nitrogen
TOR	: Terms of Reference
TP	: Total Phosphorus
UNDP	: United Nation Development Programme
USP	: University of the South Pacific
WHO	: World Health Organization

CHAPTER 1 PRESENT LAND USE

1.1 Land Use in Viti Levu Island and Study Area

Among 5,998 km^2 of the total Study Area, about 59 % of the island is covered with forests (both natural and plantation) and one third is agricultural land. About 2 % is cities and towns or urban area. The rest is under-utilized land including grassland.

The land use shows clear contrast between the east and the west due to the climatic difference. Sugarcane is dominant in the flat land of the dry western area. In the wet eastern area, forest is still rich and agricultural crops are characterized with rice and vegetables. Grazing is undertaken in the undulating lowland and hills in both eastern and western areas.

Due to the finely undulating configuration, clear macroscopic agricultural zoning is difficult except sugarcane zone and rice zone. In a microscopic view, each land use is scattered in patches and mixed like mosaic. Forest zone and Agriculture/Grazing zone were identified based on the Forest Function Map by the Department of Forest and the topographic maps of the Department of Lands and Survey.

Table-G1.1 Land Use in Viti Levu and Watershed

(Unit : km^2)

Land Use	Rewa		Sigatoka		Nadi		Ba		Total of Water-shed	Viti Levu Total
Forest *1	2,164	70 %	719	49 %	248	48 %	399	42 %	3,530	6,135
Agriculture *2	160	5 %	139	10 %	132	26 %	233	25 %	664	1,330
Sugarcane	12	0 %	29	2 %	92	18 %	186	20 %	319	862
Other crops	148	5 %	110	8 %	40	8 %	47	5 %	345	468
Grazing	399	13 %	423	29 %	93	18 %	165	18 %	1,080	1,878
Grassland & Others	349	11 %	169	12 %	22	4 %	130	14 %	670	827
Urban *3	20	1 %	3	0 %	21	4 %	10	1 %	54	218
Total	3,092	100 %	1,453	100 %	516	100 %	937	100 %	5,998	10,388

*1 Department of Forest (1996), Unpublished data
*2 Estimated from the data of MAFF, 1991
*3 Municipality and Peri-urban area : JICA Study Team estimation
(JICA Study Team estimation based on MAFFA data)

The present land use is shown in Figure-G1.1 and the pictorial characteristics of the 4 watersheds are shown in Figure-G1.2.

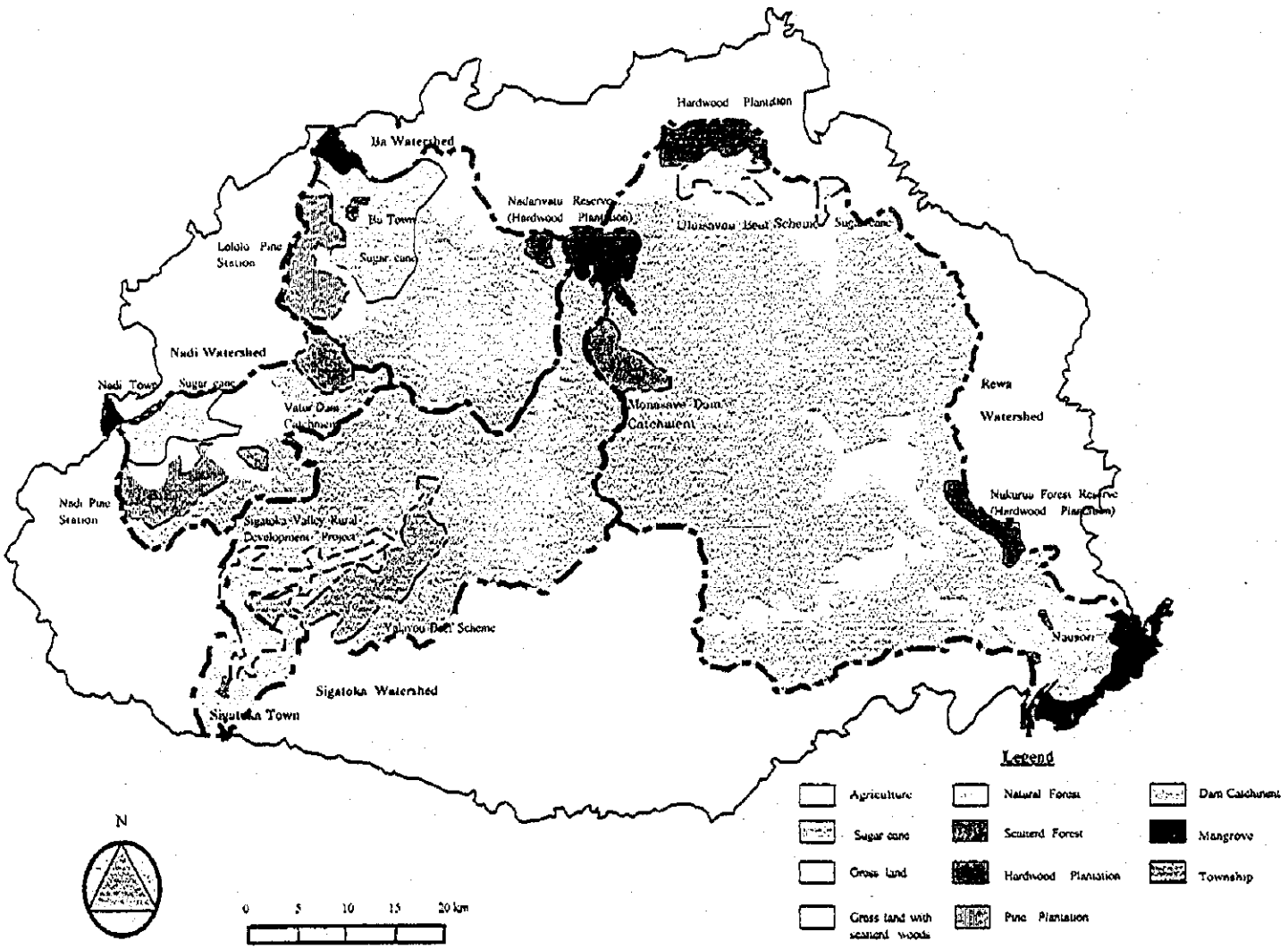


Figure-G1.1 Present Land Use Map

Ba Watershed

2) Sugar cane and pine plantation

Almost whole lower reach is sugar cane. Lololo pine plantation extends. The short-range view of the picture is sugar cane and the distant view is pine plantation.

1) Scattered forest / grassland and agriculture

Grassland with scattered forest extend in the middle reach. Flat patches are cultivated from place to place.

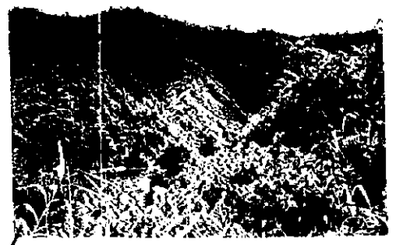
1) Natural forest in Monasavu dam catchment

The catchment of Monasavu dam is a typical natural forest and it is being designated as a protection area. However a part has been logged out.

Rewa Watershed

2) Forest in the middle reach

Most of the middle reach is mountainous and covered with forest. Some points are completely logged out even on steep slops.



3) Grazing in the middle reach along the river

There are flat areas located along the river suitable for agriculture and grazing.

Nadi Watershed

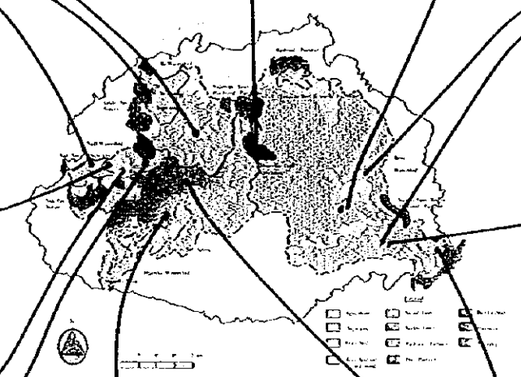
3) Sugar cane in the lower reach

Almost whole lower reach is occupied with sugar cane cultivation, extending the marginal area.

The same land use is observed in the lower reach of Ba watershed.

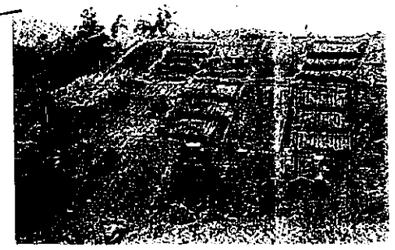
4) Marginal cultivation

The lower grassland is partly cultivated on slopes with thinly scattered woods.



6) Erosion on slope cultivation

Exploitative slope cultivation causes severe soil erosion which gives great damages both to that land and the downstream.



5) Agricultural experiment mitigating erosion

Hedge-raw planting and terracing will mitigate soil erosion on the slop cultivation. Although this landscape and practice is not popular at present, it should be extended together with agroforestry.

Sigatoka Watershed

2) Grassland in the middle reach

There extend grassland of little use in the middle reach. Forest is scattered along the valleys. Burning is practiced unnecessarily.

1) Vatur dam and natural forest

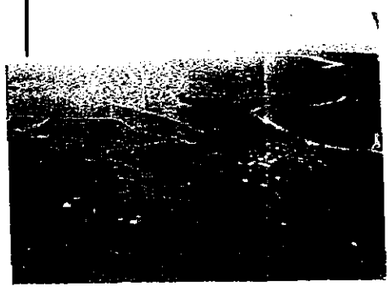
Natural forest is located in the west upper reach.

1) Scattered forest and farms in the middle reach

Agricultural areas are located along the river. The rest is undulating and the forest in the mountains are not dense or no forest.

2) Grazing in the middle reach

Vegetation is comparatively poor in particular in the hilly areas and soil erosion proceeding.



4) Agriculture and settlement in the delta

Agricultural area extends in the wide delta with scattered forest.

Figure-G1.2 Characteristics of Present Land Use

1.2 Land Use in Watershed

(1) Rewa Watershed

About 70 % of the watershed is covered with forests, which consist of protection forest and multiple-use forest etc. The delta is mixed use of agriculture, township, grazing, forest and grassland. Mangrove is clustered along the coast. The agriculture is characterized by rice cultivation with irrigation. Vegetables and crops are farmed in the land along the river and the road to Vunidawa in the middle reach. There is sugarcane cultivation along the King's road in the most upper stream and Uluisaivou Beef Scheme in mildly undulating land on the foot of Nakauvadra Range and along Wainibuka river.

Present land use of the flood prone area is as follows:

Most of area is agricultural land dominated with rice; however, rice cultivation has declined recently and vegetable cropping, grazing and housing have expanded. The Nausori Irrigation Project stopped operation in 1995. Nausori town is expanding and urbanization of the area along the road connecting with Suva is proceeding. There are various facilities including market, shops, offices, schools, airport, industrial estate and housing. East and south coast is surrounded by mangrove.

(2) Sigatoka Watershed

In the most upper stream, there is hardwood plantation and forest remains only the upper stream boarders. Low utilized grassland extends in the middle reach. There is Sigatoka Valley Rural Development Project along the river, producing various vegetables, crops and fruits with irrigation facilities. Large Yalavou Beef Scheme is on the east side of the river. Potential land suitable for grazing and planting is distributed in the middle reach.

Present land use of the flood prone area is as follows:

The commercial center of Sigatoka town is the market on the west bank of Sigatoka river. Residential area is extended to the north and the west, and on the east bank. Institutional facilities such as public offices and schools are distributed in the south. Fijian villages are located both side of the river.

(3) Nadi Watershed

Forests exist in the east upper stream border and Nadi pine plantation is in the south. Almost whole flat lower reach is sugarcane cultivation. Cultivation is slowly expanding to the marginal area to the undulating grassland which extends in the middle reach. Grassland is low utilized and burned from time to time unnecessarily.

Present land use of the flood prone area is as follows:

The major part of Nadi town where the commercial center is located is in the flood prone area. Sugarcane field and Fijian villages of Saunaka, Nawaka Narewa, Sikituru and Vunayasi are liable for flooding.

(4) Ba Watershed

Forests are distributed on the south divide and part of east divide. Lololo pine plantation is in the west. Most of the flat land is sugarcane cultivation. Grassland extends in the middle reach with scattered small agriculture, grazing and plantation.

Present land use of the flood prone area is as follows:

The commercial center and Rarawai Mill is located on the east bank of Ba river. The public/civic areas are both on the east and west bank and the residential areas are surrounding the center of Ba town and expanding to all directions. Sugarcane fields along the lower reach are liable for flooding.

1.3 Agriculture

1.3.1 Agricultural Land

Area of the agricultural land was 5,914 km^2 (32 %) in Fiji in 1991, and the agricultural land in the Central and Western Division (nearly equal to Viti Levu) was 3,465 km^2 (33 %). It has been increasing remarkably (Table-G1.2), and it is apparent that almost all arable land in a good condition has been utilized.

Table-G1.2 Expansion of Agricultural Land Use

Census Year	Cultivation		Pasture		Others		Total
	km^2	%	km^2	%	km^2	%	km^2
1968	1,450	60 %	370	15 %	600	25 %	2,420
1978	1,170	37 %	-	-	2,030	63 %	3,200
1991	2,238	38 %	2,009	34 %	1,667	28 %	5,914

Source : MAFFA, 1996

Among the areas for agricultural purpose in the Central and Western Division, sugarcane was dominant amounting to about 80,000 ha or 63 % in 1995. Root and tubers such as dalo, yam, yangona, cassaba, ginger etc. occupied 29,000 ha or 23 %, rice/maize 7,000 ha and fruits/vegetables 5,000 ha in 1995 (Table-G1.3).

Table-G1.3 Cultivation Area by Crops and by Province, 1995

(unit : ha)

Division and Province	Sugarcane	Rice & Maize	Roots & Tubers *1	Fruits & Vegetables	Tree Crops *2	Total (ha)
Central	0	3,834	19,330	1,978	3,007	28,149
	0 %	14 %	69 %	7 %	11 %	100 %
Naitasiri	0	574	8,303	1,273	742	10,892
Namosi	0	3	846	46	5	900
Rewa	0	1,547	600	124	578	2,849
Serua	0	506	7,611	128	6	8,251
Tailevu	0	1,204	1,970	407	1,676	5,257
Western	80,008	3,653	9,524	3,230	2,020	98,435
	81 %	4 %	10 %	3 %	2 %	100 %
Ba	53,097	752	3,248	695	797	58,589
Nandroga	15,366	2,542	4,224	2,421	360	24,913
Ra	11,545	359	2,052	114	863	14,933
Total	80,008	7,487	28,854	5,208	5,027	126,584
	63 %	6 %	23 %	4 %	4 %	100 %

*1: Dalo, Cassava, Yam, Yaqona, Kawai, Ginger etc.
*2: Citrus fruits, Banana, Coconuts, Cocoa etc.
Source: MAFFA, 1996

1.3.2 Crop Production

The present condition and issues of crop production is described by crop as follows (MAFFA, 1995).

(1) Sugar

Sugar has been the main agricultural product sharing 10 % of GDP and 32 % of total exports in 1994. Most part of the plains in Ba, Lautoka and Nadi are utilized for sugarcane farming. The total area of sugarcane was 99,000 ha in 1993 while the harvested area was 74,000 ha. Sugar production was 442,000 tons in 1993 and 516,000 tons in 1994.

The price of exported to Europe has been higher than the market price by the preferential trade agreements with the European Communities. However, principle of free trading will affect this status and reduction in the price are anticipated. Fiji Sugar Corporation forecasts no significant change of sugarcane land use in the near future. Marginal sugar farms could be expected to switch to alternative crops. Sugar industry should improve production efficiency and the quality in order to survive in the international market.

(2) Coconut

The total area of coconut production in Fiji was 64,450 ha in 1994 and the area has been stable in these years. Copra production was 8,400 tons in 1994. Coconut industry is outstanding in the Northern and Eastern Divisions. Coconut plantation in Viti Levu island is observed in the south-east coast of Rewa plain.

(3) Rice

The total production area of rice in Fiji was 7,865 ha in 1994. The irrigated areas exist only in the Viti Levu island (mainly the Rewa and Navua plains) with the area of 1,665 ha and the rain-fed area was 1,652 ha. The area has been decreasing from 14,248 ha of 1990 due to importation of cheaper rice with deregulation. Nausori Irrigation Project with the area of 310 ha stopped operation in 1995 due to the high operation cost and less competitive price to the imported rice. As rice is one of staple food and good for repeated cultivation, the irrigation area would be recovered with improvement of better variety and production practice.

(4) Root crops

Root crops include dalo (taro), yam, cassava, kumala, kawai and yagona. Dalo is important for domestic consumption and also for export. Most root crops can be cultivated in small areas, even under coconut trees on mild slopes. Root crops are very important as they are staple and can be cultivated on slopes.

(5) Ginger

Ginger is one of foreign currency earner, farmed mainly in Naitasiri Province. The total area was 132 ha in 1994. Although the area is not so large, ginger farming on slopes tends to cause serious land degradation and erosion because of wide spread, shallow and submerging vegetation to soil. Improved farming such as Vetiver grass hedgerows shall be taken immediately.

(6) Vegetables

Vegetable farming is developed in Sigatoka Valley Rural Development area and in and around the Suva metropolitan area. Vegetable will be more important as commercial agriculture according to urban expansion and change of food preference.

(7) Fruit

A large scale fruit farming is not observed in Viti Levu, however various fruits such as bananas, pineapples, pawpaws, mangos etc. are cultivated for subsistence and commercial use mixed with other crops. Sigatoka Valley Development has juice processing factory for pineapples and passion-fruit in the area.

1.3.3 Livestock

The number of livestock has been steadily increasing (Table-G1.4), however only the beef production decreased. Recently, the local competitiveness is getting hard due to the imports in terms of price and quality. To cope with this issue and develop of the livestock industry, the following improvement shall be made.

- To improve pastures for fattening and breeding cattle as well as for prevention of soil erosion
- To upgrade infrastructure and facilities such as access roads, slaughterhouse and cold storage

-- To improve marketing system

Table-G1.4 Livestock Farming

	1990	1991	1992	1993	1994
Beef Cattle (heads)	53,798	55,634	57,470	59,366	62,928
Dairy Cattle (heads)	37,099	36,805	37,396	37,396	37,695
Pig (heads)	95,000	99,000	105,000	110,000	115,000
Goat	179,371	187,235	195,099	203,293	211,831
Sheep		413	637	854	1,595
Broiler (Number of Farms)	23	24	24	24	24

Source: MAFFA, 1995

(1) Beef Cattle

The major beef producing provinces were Nadroga, Ra, Ba in the Western Division and Naitasiri in the Central Division. Total beef cattle in the Western and Central Division was 6,200 and 31.5 cattle per farm in 1991. There are three large scale beef project (Ulvisaivau, Yalavou and Yaqara Beef Schemes). However the local production decreased, while the beef import increased. In order to cope with the demand and stable food security, beef industry should be strengthened improving the quality and the marketing.

(2) Dairy Cattle

The dairy farms are concentrated in the Central Division where most farms supply milk to Rewa Cooperative Dairy Company. There were 1,600 farms (78 %) and 33,000 cattle (90 %) in 1991. To compete with the import, efficiency and quality shall be upgraded through pasture development and herd improvement.

(3) Sheep

Both local product and the imports increased. The local product has kept the level of 10 thousand tons per year. The demand for local sheep meat is considered to increase with local willingness for premium of live sheep.

(4) Goat

During 1993 to 1995, the local product increased and was 801 ton in 1995 while the import was smaller and decreased. The goat industry will continue to expand largely due to the high local demand for fresh goat meat.

(5) Pig

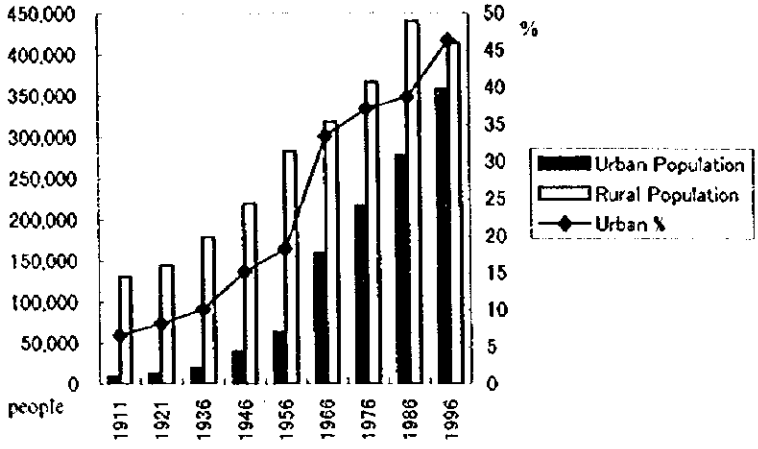
The local production in 1995 was 755 ton. The Central Division remains the major producing area (Central - 82 %, Western - 18 %). The pig production is competitive and is considered to expand.

(6) Poultry

The production of poultry meat and edible eggs was 8,763 ton and 3.8 million dozen in 1995. The production is considered to increase as the consumption grows.

1.4 Urban Land Use

Urbanization, urban population and concentration to urban area is steadily increasing. The change during 1986 to 1996 was drastic. More than 25 thousand rural population converted to urban population and the rate of urban population was counted 46 % in 1996.



Source: Bakker and Walsh (1976) and the provisional results of 1996 census

Figure-G1.3 Growth of Urban Population

Population density in the urban area was as low as 8 people per ha in average of Nausori, Sigatoka, Nadi and Ba as shown in Table-G1.5. The urban area will be expanded according to the increase of urban population.

Table-G1.5 Population of Urban Area in Viti Levu Island, as of 1986

Urban Area		Nausori	Sigatoka	Nadi	Ba	Sub-total	Suva	Lami	Lautoka	Other Towns	Total
Municipality	**Municipality**										
	Population	5,242	2,097	7,709	6,515	21,563	69,665	8,597	28,728	0	128,553
	Area (ha)	330	80	520	340	1,270	2,300	630	1,020	0	5,220
	Density (people/ha)	16	26	15	19	17	30	14	28	0	25
Peri-urban or non municipal Township	**Peri-urban or non-municipal Township**										
	Population	8,740	2,633	7,511	3,745	22,629	71,608	8,110	10,329	13,492	126,168
	Area (ha)	1,620	230	1,540	650	4,040	6,500	2,070	1,260	2,690	16,560
	Density (people/ha)	5	11	5	6	6	11	4	8	5	8
Urban Total	**Total**										
	Population	13,982	4,730	15,220	10,260	44,192	141,273	16,707	39,057	13,492	254,721
	Area (ha)	1,950	310	2,060	990	5,310	8,800	2,700	2,280	2,690	21,780
	Density (people/ha)	7	15	7	10	8	16	6	17	5	12

(Note: Peri-urban areas are administrated by rural local government.)
Source Bureau of Statistics, 1996

1.5 Land Use Conditions

Present conditions of land use are summarized in Table-G1.6 and present major infrastructure is shown in Figure-G1.4.

Table-G1.6 (1/2) Summary of Land Use Conditions

	Rewa	Sigatoka	Nadi	Ba
Topography and Climate	•A wide delta area is formed at the mouth of the river. •The configuration is generally undulating. •Rairainatuku plateau which include the highest mountain in the west, bounds on Sigatoka watershed. •The watershed is in the wet zone which has much rain and the annual rainfall in the mountainous area reaches 4,000 mm.	•The area along the river in the middle reach is alluvial flat land. The other area has steep topography. •The area is in the dry zone. •Rairainatuku plateau is in the east and Nausori highland is in the north-west.	•The configuration is generally undulating. The lower reach forms the alluvial plain. •Nausori highland is in the west. •The area is in the dry zone.	•The configuration is generally undulating. The lower reach forms the alluvial plain. •Mount Evans Range is in the south-west and Naloto Range is in the south-east. •The area is in the dry zone.
Forest	•Forest cover is as high as 2,164 km^2 or 70 %, and dense to medium dense forests dominate. •Partly Nukurua hardwood plantation is included. •Mangrove forest is formed in the coastal area of the delta. •Some parts in the catchment of Monasavu dam has been logged out.	•Forest cover is 719 km^2 or 49 % and scattered to medium dense forests dominate. •Hardwood plantation is in the upper stream. •Grassland with scattered small woods expands in the middle reach.	•Forest cover is 248 km^2 or 48 % and scattered to medium dense forest and pine plantation dominate. •Grassland with scattered small woods in the valleys expands in the middle reach. •Mangrove forest is formed in the coastal area of the delta. •Nadi pine plantation expands in the south.	•Forest cover is 399 km^2 or 43 % and scattered to medium dense forest and pine plantation dominate. •Grassland with scattered small woods expands in the middle reach. •Mangrove forest is formed in the coastal area of the delta. •Lololo pine plantation expands in the west.
Soil Erodibility (by Department of Forests)	•The soil erodibility in the watershed is generally "high". The erodibility of the grassland and the beef scheme area along Wainbuka river in the upper reach, is "severe". •The erodibility of the delta is "low" to "moderate".	•The erodibility in almost all watershed area is "severe" except the low land along the river and the part of Nausori highland.	•The erodibility of most watershed area is "severe", except the plain and part of forest area.	•The erodibility of most watershed area is "severe", except the plain and part of forest area.
Soil Movement	•Sedimentation at the mouth of the river is high and dredging is carried out. •Landslides occur by cyclones and heavy rain and by human activities. •Soil erosion by ginger cultivation is severe, even though area is small compared to the watershed area.	•It is anticipated that the soil erosion in the vast grassland, grazing and the logged out areas around Bukuya etc. is high.	•It is anticipated that the soil erosion in the grassland and the sugarcane in marginal area is high.	•It is anticipated that the soil erosion in the grassland, grazing and the sugarcane in marginal area is high. •Sedimentation at the mouth of the river is high and dredging is carried out.
Agriculture	•The cultivation area extends in the delta. Rice farming with irrigation dominates. There are wide potential agriculture areas remained in the delta. •There are small crop areas and grazing along the river up to the middle reach. Potential agriculture land partly remains to be developed. •Uluisaivou Beef Scheme is in the northern upper reach.	•Various crops such as vegetables and fruits etc. are cultivated in the Sigatoka Valley Development Project along the river. •Sugarcane is farmed in the east of the lower reach. •Yalavou Beef Scheme is in the east of the river of the middle reach. •Unplanned burning practice in the grassland will deteriorate the land.	•Sugarcane is cultivated all over the plain in the lower reach. •Unplanned burning practice in the grassland will deteriorate the land.	•Sugarcane is cultivated all over the plain in the lower reach. •Unplanned burning practice in the grassland will deteriorate the land.

Table-G1.6 (2/2) Summary of Land Use Conditions

	Rewa	Sigatoka	Nadi	Ba
Urban Use	•A commercial area is developed in Nausori town with the market, offices and schools etc. •Industrial estate with a rice mill is along the King's Road. •In addition to the residential areas within the town boundary, residential development within the peri-urban area, are located east, west and south of the town.	•A commercial area is developed in Sigatoka town with the market, offices, schools etc. •Built-up residential areas are located south of the town. Development is progressing in Kulukulu - Veivadravadra areas toward the river mouth.	•A commercial area and tourism facilities are developed in Nadi town with the market, offices and schools etc. •Hotels and restaurants are developed along the Queen's Road. •Extension of the residential areas include Mafolo in the south and Vatualevu in the east. Major hotel development is located in Denarau, south west of the town.	•A commercial area is developed in Ba town with the market, offices and schools etc. •Rarawai mill and its related facilities of FSC are at the town. •Residential development have extended south and west of the town in Koronubu and Yalalevu - Namousau area.
Infrastructure	•Monasavu dam supplies electricity for most demand of Viti Levu island. •The King's road runs in the lower reach and the east of the upper reach. There is a road to Tavua via Monasavu dam in the center of the watershed. •Nausori International Airport is located in the south.	•The road along the river runs to Korolevu of the middle reach and also is connected with Nadi and Ba via Bukuya.	•Vaturu dam supplies water to Nadi and Lautoka. •The Queen's Road runs north - south and the road to Bukuya runs east - west. •Small roads and tram ways are developed in the plain. •Nadi International Airport is located in the north adjacent to the municipality boundary.	•The King's road runs east - west and the road to Bukuya runs north - south. •Small roads and tram ways are developed in the plain.
Land Tenure	•The native land covers most of the watershed. The native reserve extends in the upper reach.	The native land covers most of the watershed. The native reserve extends about half of the middle and upper reach. The leased native land exists in the lower reach.	•The native land covers most of the watershed. The native reserve extends in the upper reach. The leased native land exists in the plain. There are free hold lands in and around Nadi town.	•The native land covers most of the watershed. The native reserve extends in the plain. There are free hold lands in and around Ba town.

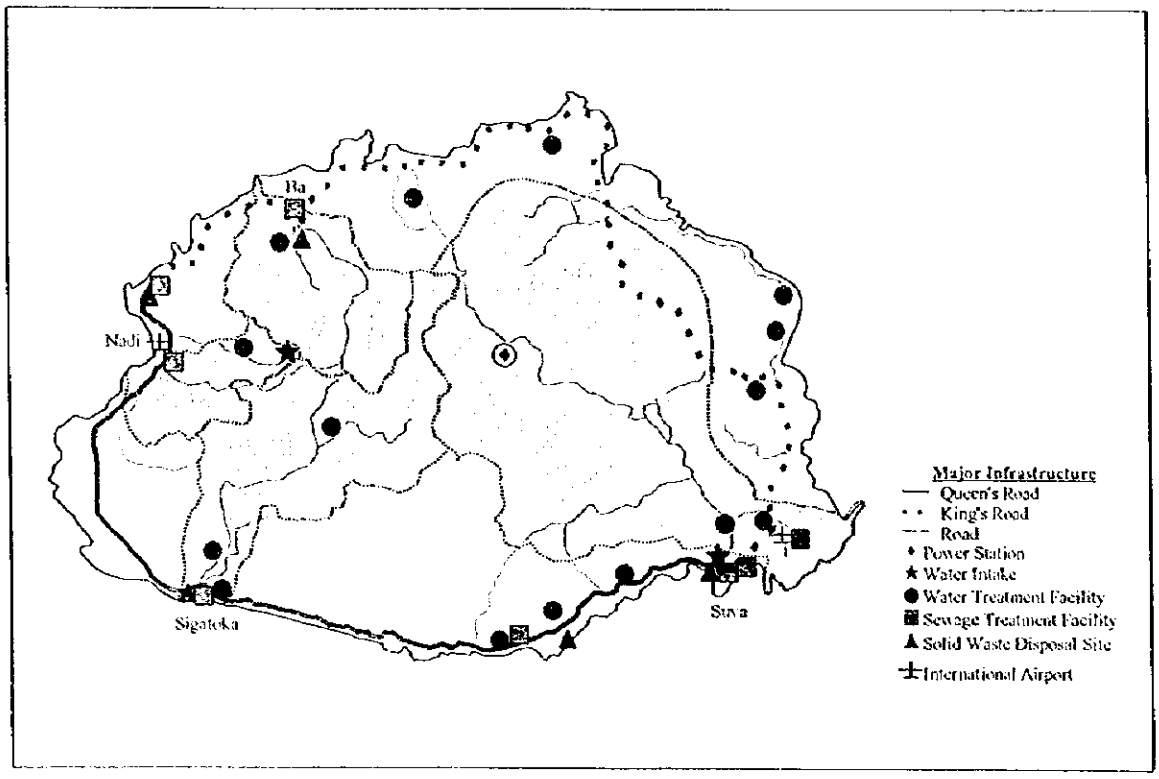


Figure-G1.4 Major Infrastructure

CHAPTER 2 FUTURE LAND USE

2.1 Strategic Policy of Regional Development

2.1.1 Land Use Potential

- The central mountainous area has potential for forest because of heavy rainfall.
- The grassland in the western area should be developed with plantation and grazing taking into consideration of mitigation of soil erosion and runoff control.
- Potential arable land is located in the Rewa delta and the flat land along Rewa river.
- More intensive use of agricultural land is expected because of the present utilization.
- To improve the productivity of agriculture, irrigation and other measures should be introduced as required.
- Tourism development around Nadi seems promising.

2.1.2 Policy from the Basic Conditions

The following five policies are led from the basic conditions described in the above.

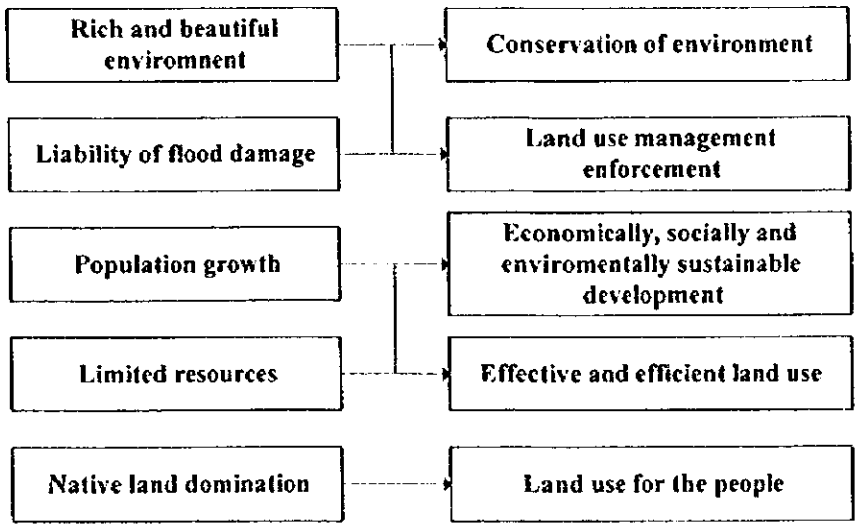


Figure-G2.1 Policy of Land Use

(1) Conservation of Environment

Conservation of environment should be considered on the basis of people's happiness and life. People in Fiji have been fostered by the rich and blessed environment. The nature has recovered from little human exploitation or influence. However, the nature and the land is vulnerable, and once the environment has got damages, the recovery would take time and be costly. In order to avoid degradation of environment, activities harmful to the nature seeking only for short-term mercenary benefit should be regulated. Sound natural water cycle (rain - flow - evaporation - rain) should be formed with proper land use.

The forest in the western zone vanished long time ago. Precious natural forests including mangrove should be conserved and maintained. The logged out forest may remain as "forest" with proper logging practice, carefully considering the configuration and planting density etc.

(2) Land Use Management Enforcement

There are two aspects in the effect of land use on watershed. One is land use inducing more runoff and another is land use causing soil erosion and pollution of water and so on.

The main measure for the former is land use control including preservation such as nature reserve, forest reserve and national park etc. In urban area, severe flood prone area may not be utilized for building but for parks or green zone etc.

The main measure for the latter is appropriate cultivation practice especially on slope land, proper logging practice, fire prevention and adequate waste water treatment etc. This would be promoted with education, public relation and enlightenment etc. through schools, the governmental offices, the disaster management network and local administration structure etc. In addition to logging practice, soil erosion from farms on slopes should be mitigated by appropriate farming practice such as terracing and contour planting. Civil works should be carefully carried out e.g. site preparation and road construction etc. and be controlled and enforced.

The existing land use data (Land Use Section, 1979) needs to be revised because the land use has been changed since 1979 with developments. The land use study proposed should be implemented to formulate the proper land use plans.

"Sustainable Development Act" will soon be proclaimed and legal base will be prepared. A comprehensive land use plan will also be prepared in relation to the Sustainable Development Act. The land lessor and the managing organization should patrol the land and take care of good husbandry practice by legal basis.

(3) Effective and Efficient Land Use

As the land and water resources are limited and scarce, the land shall be utilized effectively and efficiently.

The flat and accessible arable land has been already utilized. In order to increase productivity of agriculture with limited land, intensive agricultural practice should be carried out rather than extension and development of new farms.

Grassland is a significant issue. It should be utilized as grazing, planting, subsistence or recreational park in order to prevent soil erosion and mitigate runoff.

Locating buildings and facilities which are liable to have costly losses by inundation should be refrained from the flood prone areas. Severe flood prone area may be used as grazing.

(4) Economically, Socially and Environmentally Sustainable Development

To sustain the increasing people, the land should maintained and developed in a continuously sustainable manner for the future.

(5) Land Use for the People

Land is for the people. Therefore, mutual consent of people concerned, is necessary for any land use development.

2.2 Future Land Use Projection

2.2.1 Land Use Direction

Future land use will not be set from the historical trend but watershed and land use policy. As described in Supporting Report Part II, afforestation should be implemented and the existing grassland and wasteland should be converted to forest in principle. In the forests, subsistence farming would be conducted to supplement agricultural activities.

Land use change in future is basically as follows:

- Expansion and conservation of forests (conservation of existing forest, afforestation of grassland/wasteland and reforestation of grazing with high erodibility and logged out area)
- Increase of agricultural land (crop land and grazing) with small conversion of existing agricultural land to forest or sustainable pasture
- Increase of urban and built-up area (small percentage to the total area but large influence to socio-economy)
- No room for further crop land expansion in the Nadi and Ba watersheds

2.2.2 Development Scheme

(1) Forest Conservation and Afforestation

Forests retain rainfall and reduce liability of soil erosion. They also maintain eco-system and create scenic and landscape beauty. They provide subsistence base. Once they are lost, recovery takes time and difficulty. Therefore, the existing forests should be conserved as much as possible. The forest that sustain the traditional life is to be passed to the future generations.

Significant forests in terms of nature, ecology or water resource management including Monasavu dam catchment area and Nausori highland forest, are already reserved, but there are important forests left not designated as protection area such as Vaturu dam catchment area etc.

Afforestation with various species in addition to sole pine or mahogany should also be promoted to create eco-system and improve runoff condition.

Eco-tourism and cultural tourism should be promoted in the central area of the island with research facilities of ecology, forestry and culture. Eco-tourism may not earn much money

but it will add variety and attraction of tourism resources and promote tourism, while conducting researches.

(2) Agricultural Development

Sugarcane will be stayed as dominant crop, but its area has been already extended to the limit. On the other hand, there is a problem of international competitiveness in price. Therefore, the area of sugarcane will remain the present range or some part near towns may be converted to vegetables and commercial cropping.

Agricultural area will increase in the Rewa and Sigatoka watersheds, while the expansion will be difficult in the Nadi and Ba watersheds. As there is little room for accessible and sustainable crop land, improvement in cultivation practice and productivity shall be promoted as follows:

- proper and intense cultivation increasing yield and cropping rotation
- promotion of proper cultivation practice on slope lands such as hedgerow planting and agroforestry
- breed improvement and its extension
- good husbandry matching to the land characteristics and marketing

The Beef Schemes in the upper reach of Rewa river and in lower and middle reach of Sigatoka river will be expanded. Therefore, improvement of the pastures is the most important. Afforestation and reforestation in the land with high erodibility, especially pastures on slopes shall be densely vegetated with hedgerow planting for prevention of erosion. As the pastures can be formed faster than forest, it should be promoted with financial and technical assistance of the government. Expansion of grazing area in the 4 watersheds is estimated as some 828 km^2 with small increase of the number of cattle (Table-G2.1).

Table-G2.1 Future Grazing Land

	heads	ha/heads	ha
Beef Cattle	33,000	0.8	26,400
Dairy Cattle	34,000	0.8	27,200
Goat	140,000	0.2	28,000
Sheep	3,000	0.4	1,200
Total Area	---	---	82,800

(3) Urban Development

Urban areas absorb much population and industries in spite of small area compared to the whole watershed. Expansion of residential areas for increased population is one of major urban development.

Tourism will play the most important role. In the vicinity of the Nadi watershed, there are large scale tourism development projects in Vulani island and along the Nadi bay coast as well as Denarau. Taking advantage of good access to the international airport and the resorts, preparation of a cultural core by a international conference hall with multi-purpose

functions will contribute to promote tourism in Nadi. Network of international research organizations will create needs of such facility as Fiji is the hub of the South Pacific.

Future urban development expected in the 4 watersheds is summarized in Table-G2.2.

Table-G2.2 Future Urban Land Use

Town	Nausori	Sigatoka	Nadi	Ba
Residential	In addition to present town boundary, residential development is expanding along the major roads in the surrounding rural area.	Residential development is in the south and west of the town. Also there are residential development along the Queens road on the east bank.	The new residential core in the north and the south will be developed as well as the expansion along the Queens road.	The residential development is expanding all directions in particular to the south and west.
Commercial	The existing commercial center and the area along the Kings road will expand.	The existing commercial center will be expanded.	The existing commercial centers are expanding.	The existing commercial center will be developed further.
Public/Civic	The public/civic area in the east of the center will be developed. Also there will be development on the west bank.	The southern and western public/civic area will be developed.	Large part is located in the town center and will be expanded and upgraded.	The public/civic areas are located in both east and west bank.
Park	The river bank areas in the south of the bridge should be developed as parks. The historical remain forts should be developed for parks.	The area south of the town will be developed for park.	A public park and recreational area will be required.	There will be parks in both east and west bank.
Industrial	Industrial development will be along the east bank, which is liable to inundation.	The industrial development will be south of the town and the east bank.	A small industrial development will be in the south of the airport.	The major industrial development will be the existing Rarawai Mill and its east area.
Others	The existing disposal site of solid waste shall be replaced to new site.	Expansion of the bus terminal and parking will be issues in the limited area.	Tourism development is expected along the Queens Road. Denarau Island is still developing.	The new bridge area outside the town boundary is expected to be developed.

The commercial zone and industrial zone shall not be located in the flood prone area in principle. As the suitable area for commercial and industrial zone is limited, the flood control measures will facilitate the commercial and industrial development and expansion. Thus the urban development depends on implementation of flood control measures. Necessity of flood control measures is discussed below.

- Nausori

Nausori town is located strategic location between the international airport and Suva, which is cultural, political and commercial center of Fiji. Nausori is developing as a part of the Greater Suva Metropolitan Area or as a bed town of Suva. There are wide flat land around Nausori which gives opportunity for industrial and residential development, whereas flat lands are limited in Suva. The flood control measure would facilitate the commercial, residential and industrial expansion of the area.

- Sigatoka

Sigatoka town and villages are developing along the river. If the flood control measure was taken, Sigatoka town would be a center of agro-industry and marketing of crops produced in Sigatoka Valley to distribute to Suva and Nadi.

- Nadi

The existing central commercial zone (Nadi town) is the only place of shopping and dining for tourists and visitors. However, it is the most flood prone area. With flood control measure, development of the area would be accelerated.

- Ba

The town will expand around the existing commercial zone. The flood protection measure will provide possibility of development for a industry in addition to the existing sugar mill.

(4) Town Planning Scheme

There are town and rural schemes in and around the major cities and towns, designating land use based on the town and country planning guideline, in accordance with the Town Planning Act (and Order, Regulation).

The guideline for the Town Planning Scheme sets zoning and the respective regulation for specific land use, such as minimum site area, minimum street frontage, minimum side and rear clearance and plot ratio. The zoning consists of "Residential A to D", "Commercial A to C", "General, Heavy and Noxious Industry", "Civic", "Rural", "Noise hazard" and "Special use". The minimum site area is 200 m^2 for "Commercial A and B" and 1,000 m^2 for "Residential A".

Minimum floor level of habitable room in flood prone area is stipulated in Town Planning Act - General Provisions. However, the level is nearly the existing ground level.

Table-G2.3 Minimum Floor Level

Town	Minimum Floor Level (above mean sea level)
Nausori	7.6 m
Sigatoka	2.5m
Nadi	6.0 m
Ba	5.0 m

Flood level of the cyclone Kina is roughly shown below. Inundated depth depends on location but generally about 1 m.

Table-G2.4 Flood Level and Depth of Cyclone Kina

	Flood level (above mean sea level)	Inundated depth (Cyclone Kina, average)
Nausori	9 m	1.2 m
Sigatoka	6 m	1.8 m
Nadi	7 m	0.8 m
Ba	7 m	1.1 m

Therefore, new maps of flood prone area should be prepared and regulation of floor level or usage should be determined based on the maps.

2.3 Future Land Use Direction by Watershed

The forest should be gradually expanded by conserving the existing forest and planting. The productivity of agricultural area should be enhanced and soil erosion should be controlled. Under-utilized grassland should be planted step by step with sustainable grazing development where the topographic and other conditions are suitable.

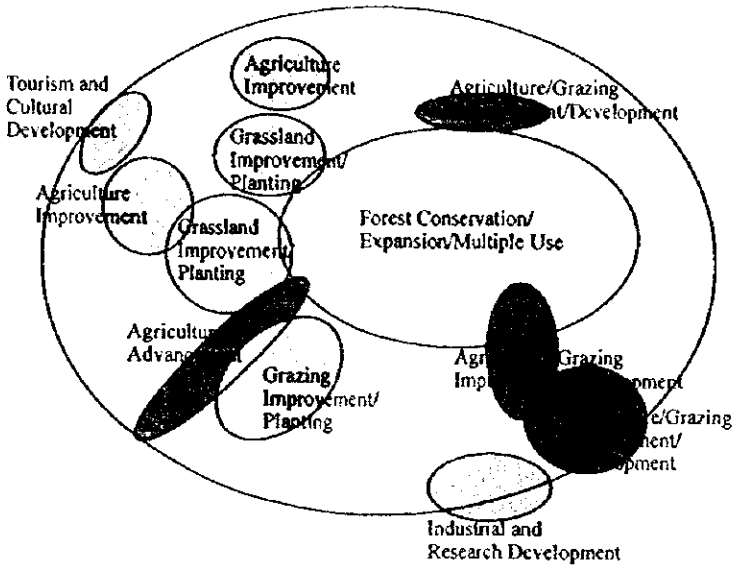


Figure-G2.2 Future Land Use Direction

(1) Rewa Watershed

[Forest Conservation and Sustainable Agricultural Development]

- The existing forest should be conserved and deforestation should be controlled.
- As erodibility of the area from the south Nakanvadra Range to the Wainibuka River is high, agriculture and grazing should be developed in such manner as to mitigate soil erosion.
- Agricultural development in the delta and the area along the river in the middle reach will progress.
- Mangrove at the estuary should be preserved for securing marine resources.
- Commerce, light industry, communication and research should be promoted in Suva metropolitan area.

2.3 Future Land Use Direction by Watershed

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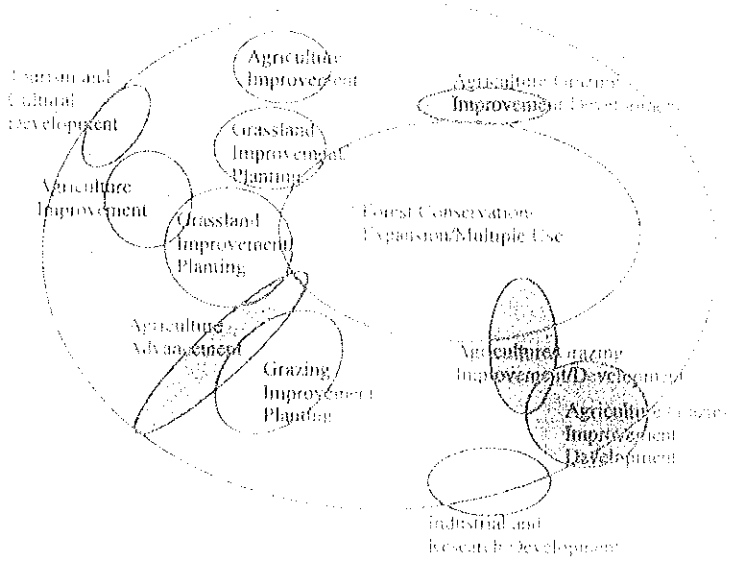


Figure G2.2.2 Future Land Use Direction

(1) Rewa Watershed

[Forest Conservation and Sustainable Agricultural Development]

The existing forest should be conserved and deforestation should be controlled.

As erodibility of the area from the south Nakauvadra Range to the Wainiboka River is high, agriculture and grazing should be developed in such manner as to minimize soil erosion.

Agricultural development in the delta and the area along the river in the middle course will progress.

Mangrove at the estuary should be preserved for securing marine resources.

Commerce, light industry, communication and research should be promoted in Nausori metropolitan area.

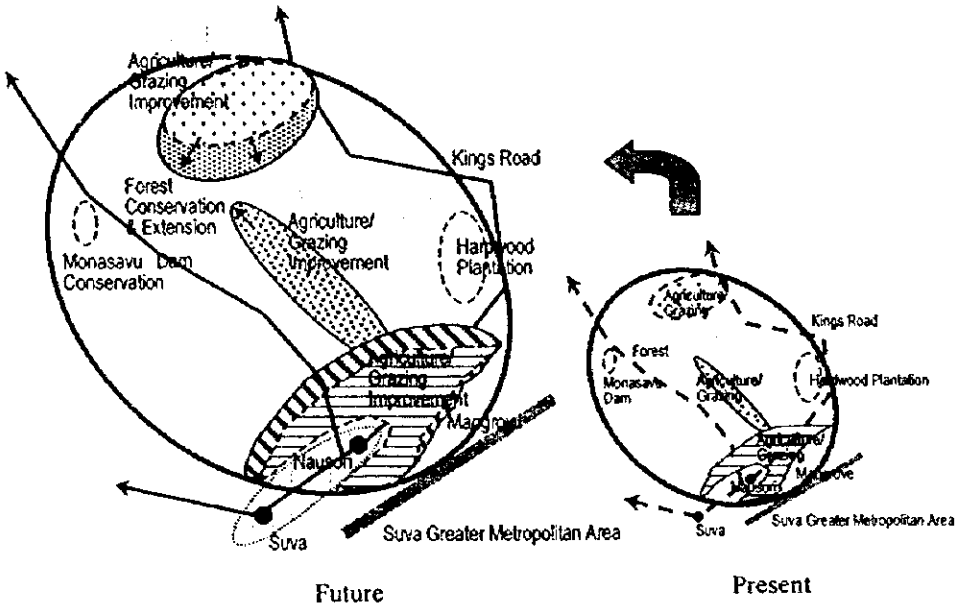


Figure-G2.3 Rewa Future Land Use Direction

(2) Sigatoka Watershed

[Progress of Intensive and Diversified Agriculture and Promotion of Grassland Plantation]

- Sigatoka Valley Rural Development should be advanced further and the intensive and diversified agriculture should be developed in particular in the flat land along the river.
- The grassland should be afforested for the purpose of mitigation of soil erosion, runoff control, timber production and subsistence base. Grazing should be developed in a sustainable manner where topographic and other conditions are suitable.

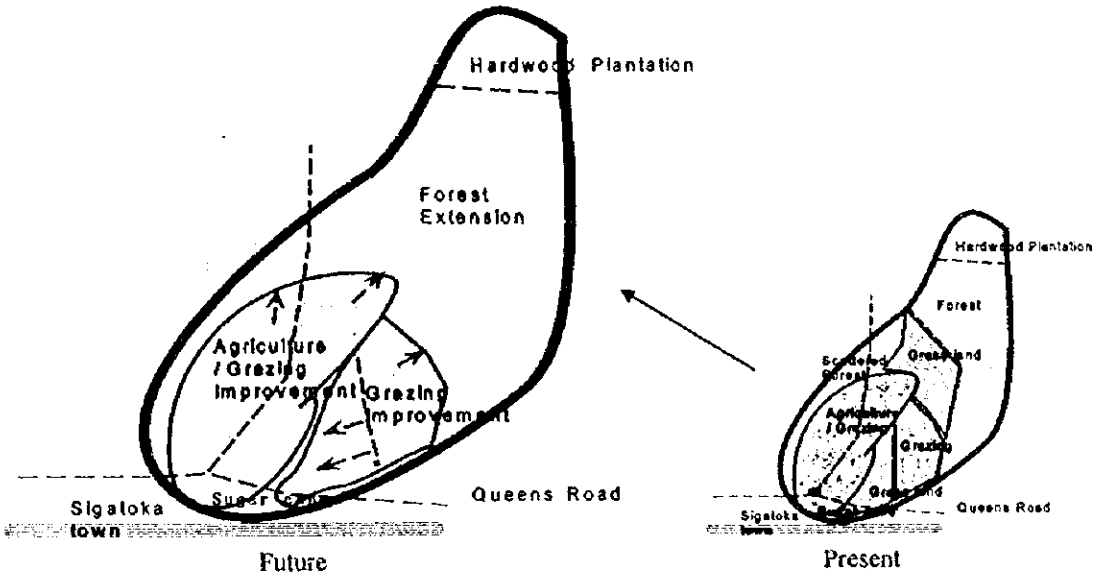


Figure-G2.4 Sigatoka Future Land Use Direction

(3) Nadi Watershed

[Improvement of sugarcane cultivation, grassland planting and tourism development]

- There remains little room for cultivation. Productivity and quality of sugarcane cultivation should be improved with proper inter-planting of commercial products such as vegetables and fruits. The grassland should be afforested for the purpose of mitigation of soil erosion, runoff control, timber production and subsistence base. Grazing should be developed in a sustainable manner where topographic and other conditions are suitable.
- Nadi town area should develop as tourism center with cultural and conference functions. Increased demand for water and electricity should be secured and valuable properties and facilities should be protected from flood damages.

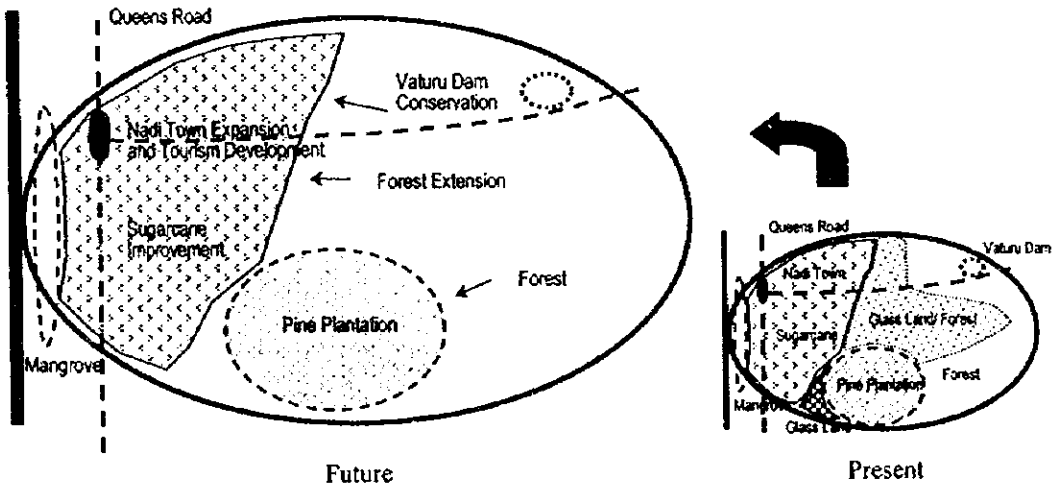


Figure-G2.5 Nadi Future Land Use Direction

(4) Ba Watershed

[Improvement of sugarcane cultivation and grassland planting]

- There remains little room for cultivation. Productivity and quality of sugarcane cultivation should be improved with proper inter-planting of commercial products such as vegetables and fruits. The grassland should be afforested for the purpose of mitigation of soil erosion, runoff control, timber production and subsistence base. Grazing should be developed in a sustainable manner where topographic and other conditions are suitable.
- Mangrove should be preserved to conserve marine resources and eco-system.

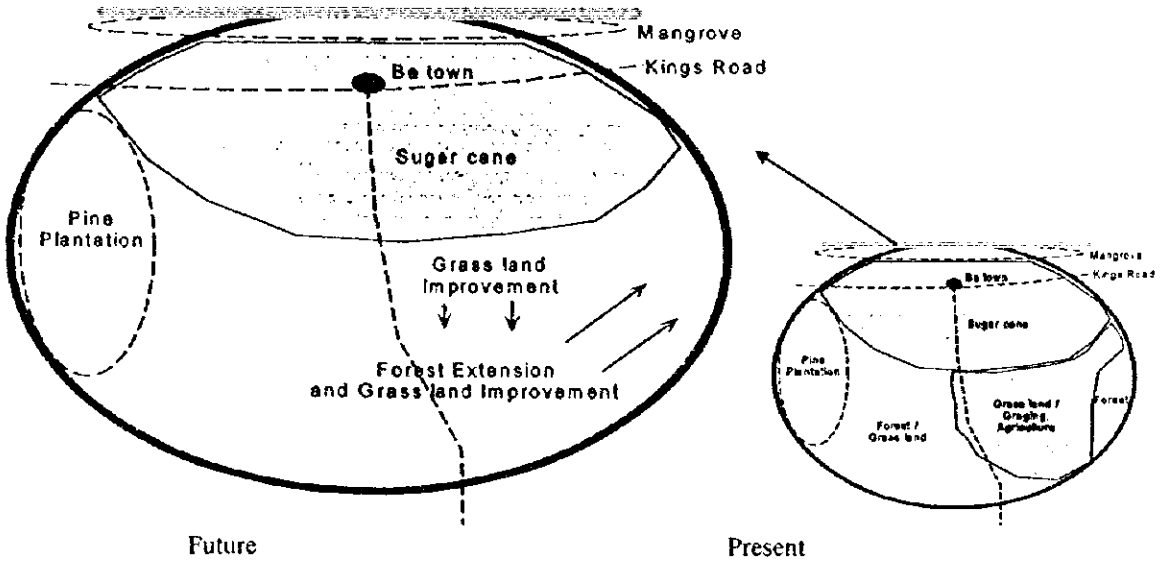


Figure-G2.6 Ba Future Land Use Direction

(5) Development Policies and Directions

The development policies and the project schemes are listed as follows:

Table-G2.5 Development Policies and Project Schemes by Watershed

Development policy	- Conservation of Environment - Land Use Management Enforcement - Economically, Socially and Environmentally Sustainable Development - Effective and Efficient Land Use - Land Use for the People			
Watershed	Rewa	Sigatoka	Nadi	Ba
Watershed Policy	- Forest Conservation and Sustainable Agricultural Development	- Progress of Intensive and Diversified Agriculture and Promotion of Grassland Plantation	- Improvement of sugarcane cultivation, grassland planting and tourism development	- Improvement of sugarcane cultivation and grassland planting
Strategic Scheme	- The existing forest should be conserved and reduction of forest should be controlled. - As erodibility of the area from the south Nakanvadra range to the Wainibuka River is high, agriculture and grazing should be developed as to mitigate soil erosion. - Agricultural development in the delta and the area along the river in the middle reach will progress. - Mangrove at the estuary should be preserved for securing marine resources. - Commerce, light industry, communication and research should be promoted in Suva metropolitan area.	- Sigatoka Valley Rural Development should be advanced further and the intensive and diversified agriculture should be developed in particular in the flat land along the river. - The grassland should be afforested for the purpose of mitigation of soil erosion, runoff control, timber production and subsistence base. - Grazing should be developed in a sustainable manner where topographic and other conditions are suitable.	- There remains little room for cultivation. Productivity and quality of sugarcane cultivation should be improved with proper interplanting of commercial products such as vegetables and fruits. - The grassland should be afforested for the purpose of mitigation of soil erosion, runoff control, timber production and subsistence base. - Grazing should be developed in a sustainable manner where topographic and other conditions are suitable. - Nadi town area should be developed as tourism center with cultural and conference functions. Increased demand of water and electricity should be secured and valuable properties and facilities should be protected from flood damages.	- There remains little room for cultivation. Productivity and quality of sugarcane cultivation should be improved with proper inter-planting of commercial products such as vegetables and fruits. - The grassland should be afforested for the purpose of mitigation of soil erosion, runoff control, timber production and subsistence base. - Grazing should be developed in a sustainable manner where topographic and other conditions are suitable. - Mangrove should be preserved to conserve marine resources and eco-system.
Projects	- Construction of diversion in the delta for mitigation of flood and irrigation . - Improvement of farming and grazing in the south upper reaches. - Conservation of the existing forest. - Afforestation of the Monasavu dam catchment. - Communication, education and enlightenment.	- construction of multipurpose pond for flood control and irrigation. - Afforestation - Improvement and expansion of controlled grazing. - Communication, education and enlightenment.	- Construction of power station at Vaturu dam. - Construction of multipurpose dam for flood control and irrigation. - Afforestation - Improvement and expansion of controlled grazing. - Communication education and enlightenment.	- Construction of multi-purpose dam for flood control, water supply and electricity coping with the increasing demand of Ba, Lautoka and Nadi area. - Construction of multi-purpose pond for flood control and irrigation. - Afforestation - Improvement and expansion of controlled grazing. - Communication, education and enlightenment.

(6) Future Land Use in 2015

Based on the above policy, the future land use in 2015 was projected and the results is shown in Table-G2.6 and Figure-G2.7. Land use of Nadi town and its vicinity area shall be based on Nadi Town Planning Scheme which is prepared by the Department of Town and Country Planning.

Table-G2.6 Land Use Projection in 2015

(km²)

Land Use	Rewa		Sigatoka		Nadi		Ba		Total of Watershed	
Forest	2,573	83 %	952	66 %	295	57 %	554	59 %	4,374	73 %
Conservation	2,164	70 %	719	49 %	248	48 %	399	43 %	3,530	59 %
Afforestation	409	13 %	233	16 %	47	9 %	155	17 %	(1) 844	14 %
Agriculture (Crop)	196	6 %	170	12 %	132	26 %	233	25 %	731	12 %
Grazing	296	10 %	327	23 %	69	13 %	136	15 %	828	14 %
Urban and Others	27	1 %	4	0 %	20	4 %	14	1 %	65	1 %
Total	3,092	100 %	1,453	100 %	516	100 %	937	100 %	5,998	100 %

Note (1): including implementation after 2015

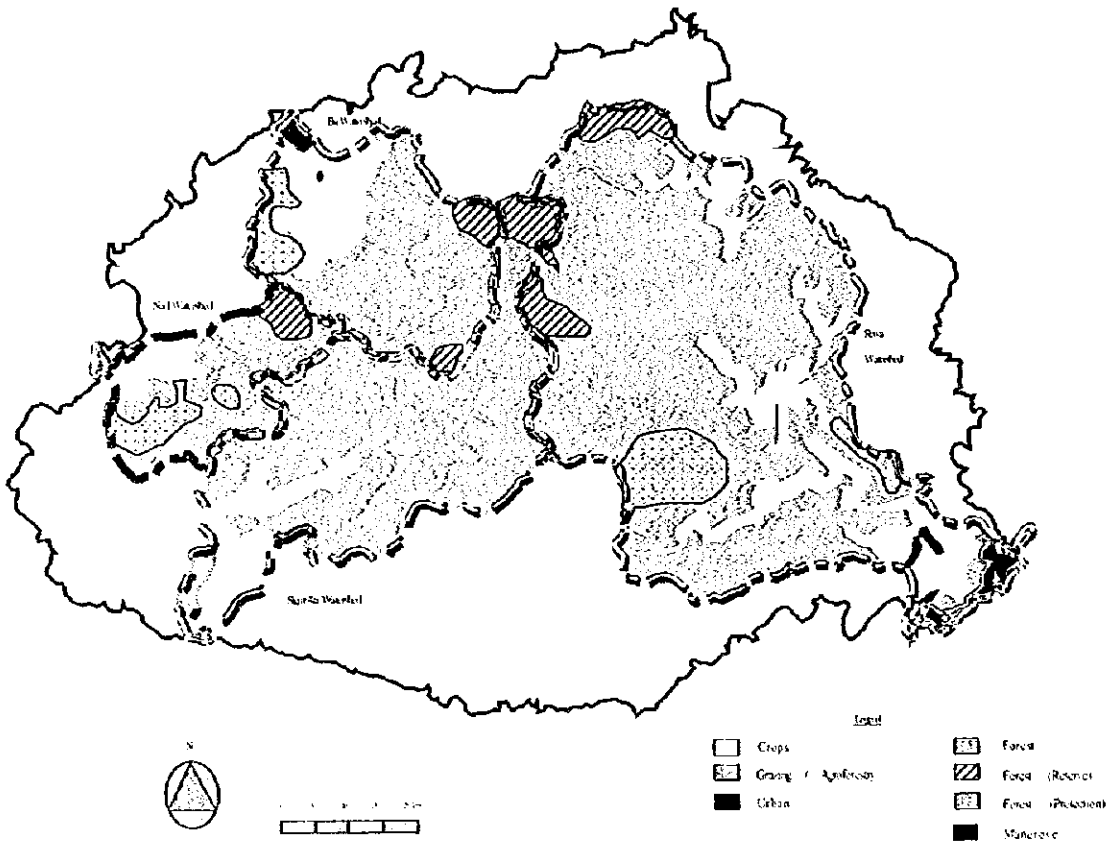


Figure-G2.7 Future Land Use

CHAPTER 3 LAND TENURE SYSTEM AND REGIONAL DEVELOPMENT

3.1 Land Tenure System and Land Use of Native Land

The land tenure system of Fiji is based on the traditional or customary social structure illustrated in Figure-G3.1 (Tabua, 1995). Traditional Fijian social organization was standardized and is classified into Vanua, Yavusa, Mataqali and Tokatoka. Vanua is a group of people or tribe and embodies their belief and value. Yavusa is a sub-tribe or a clan. Mataqali is a sub-clan or land-owning group. Tokatoka is an extended family related group varying in composition from representatives of one household to several families. The head of Vanua, Yavusa and Mataqali is called Turaga-ni-Taukei, Turaga-ni-Qali and Turaga-ni-Mataqali, respectively. All ethnic Fijians are registered into their respective Fijian Social Unit (i.e. Yavusa, Mataqali, Tokatoka). These units can consist of a single person or several hundreds people and the owned land units range from zero to some thousands hectares. The average is some 240 ha. The numbers of the traditional and administrative groups or units are shown in Table-G3.1.

Table-G3.1 Number of Traditional and Administrative Groups

Division / Province	Administrative		Traditional			
	Tikina	Village	Vanua	Yavusa	Mataqali	Tokatoka
Central	55	331	64	416	1,745	3,024
Naitasiri	15	86	22	132	579	780
Namosi	5	26	3	21	72	134
Rewa	9	54	8	64	290	590
Serua	4	24	2	21	63	180
Tailevu	22	141	29	178	741	1,340
Western	62	322	67	399	1,418	2,974
Ba	21	107	20	147	402	1,050
Nadroga	22	122	25	110	346	679
Ra	19	93	22	142	670	1,245
Central & Western Total	117	653	131	815	3,163	5,998

Source : Information from Native Land Commission, 1993

The land tenure system was formalized during Sir Arthur Gordon's term and land was registered in accordance with the Sir Robert Torrens registration system. Through the efforts of various Native Land commissioners, every parcel of land has been surveyed and registered under the various proprietary group which includes the Mataqali or in some cases the Yavusa or Tokatoka or the state or private individuals, since 1874 when Fiji became a British colony.

NLTB was established in 1946 under the Native Land Trust Act, for the following objectives:

- to ensure the protection of the land interest of Fijian owners by reserving sufficient land for their own exclusive use
- to preserve continuity in land policy and security of tenure
- to obtain for the Fijian landowners adequate rents for their leasing land

The present distribution of the land tenure is shown in Table-G3.2. The Native Land amounts to 84 % of the total area of Fiji, the State Land 9 % and the Free-hold land 7 %. The land tenure in the Viti Levu is shown in Figure-G3.2.

Table-G3.2 Land Tenure

Tenure	Area (ha)	%
Native Land	1,533,298	84 %
State Land	164,281	9 %
Free-hold Land	127,775	7 %
Total	1,825,354	100 %

Source : Native Land Trust Board , Estate Management

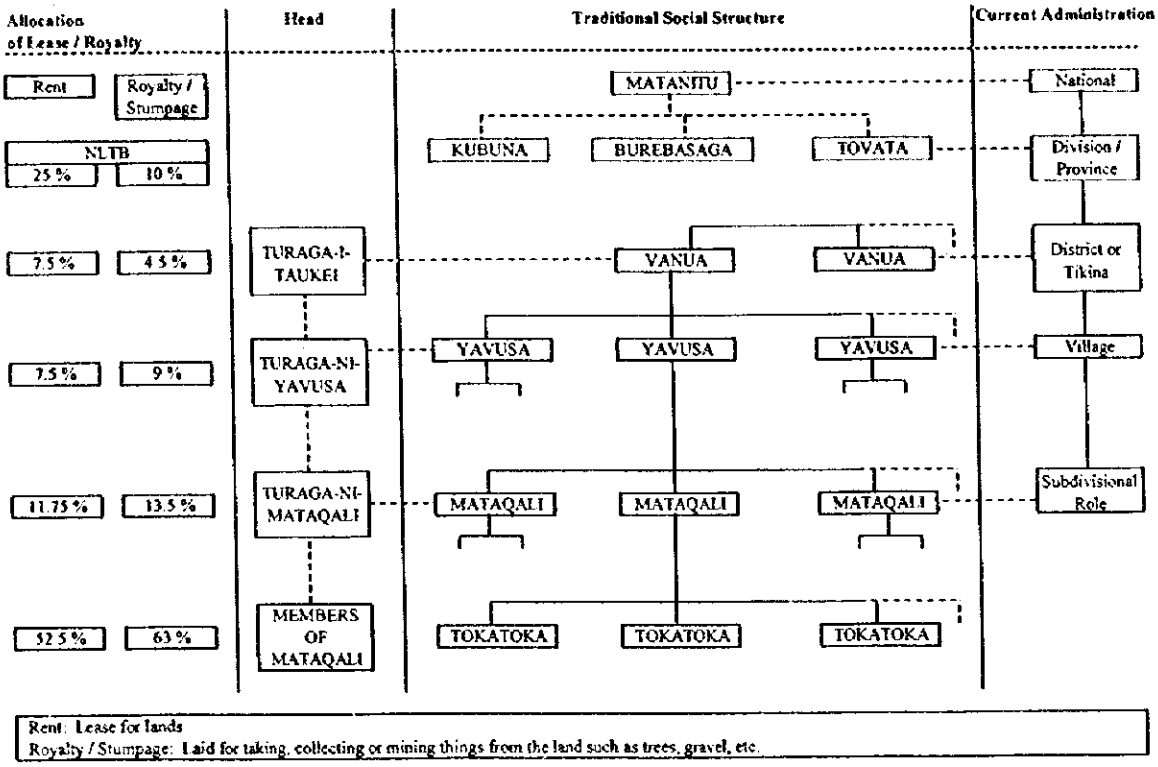


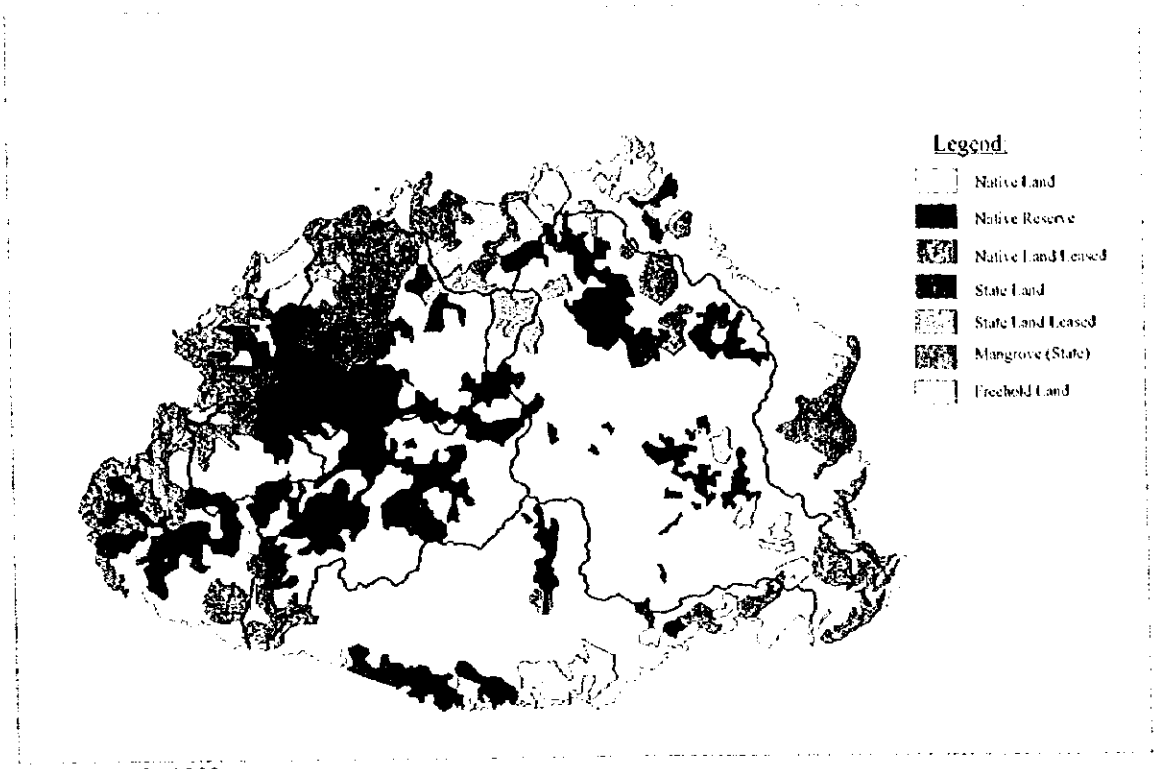
Figure-G3.1 Traditional Social Structure and Allocation of Lease of Native Land

About one third (550,855 ha or 36 %) of the Native Land is designated as Native Reserve. The Native Reserve is retained for the use and support of the landowners, and shall not be leased without unanimous consent (basically more than 75 %).

The leased land in the Native Land amounts to 774,390 ha or 51 % of the Native Land or 42 % of the total land. The classification of lease is agricultural, residential, commercial, grazing, garden, dairy, tram-way, quarry etc. The dominant lease is "timber concession" (25 % to the Native Land). The forestry lease amounts to 32 %, including "Planned Pine Commission". The second is the agricultural lease comprising 19 % to the Native Land including ALTA and the Reserve.

The period of lease varies from a few years to 99 years for hardwood plantation etc. The period of "Agricultural Lease Class A" is 30 years. The standard prices for a lease are given according to the condition and classification of the land.

The NLTB is financed by 25 % of rents and 10 % of royalties or stumpage collected. The heads or the chiefs of Vanua, Yavusa and Mataqali take 5 %, 10 %, 15 % of the rest respectively. The members of Mataqali or equivalent receive the remaining. The use of the rent shares to the heads is at their discretion (Figure-G3.1).



Source : FAO, 1989

Figure-G3.2 Land Tenure

In addition to the fact that the land belongs to the Fijians traditionally, the land tenure system has the following advantages:

- Safeguarding the basis of living and the heritage
- Preventing monopoly of large landlords
- Preventing land speculation

The disadvantage of the system considered would be as follows:

- The tenants tend to seek for short term benefit neglecting long term maintenance and land degradation.
- For new land use, new lease should be required and making consent of the landowners is usually hard and time consuming.
- Strict control and punishment activities are lacking against the violators.
- Distribution of land to Mataqali is not averaged. Some have no land while some have inadequate land.
- Governmental requests for public benefit might be sometimes beyond control over the landowners.

The unique land tenure system should function for protection of disordered development and promotion of proper land use including conservation of natural forests etc. Although it would take time for the consent making, the system is playing an important role in development and conservation. In order to improve practicability, the procedure should be

streamlined and the efficiency should be enhanced as well as promotion of the important projects.

3.2 Regional Development

In general major projects such as national roads with bridges, airstrips and wharves are the responsibility of Ministry of Public Works, Infrastructure and Transport. Ministry of Regional Development supports provision of rural small scale public facilities and utilities such as schools or community halls financially and technically with participation and cooperation of the local inhabitants. They have Rural Housing Scheme, Rural Electrification Scheme and Rural Water Supply Scheme. The local projects are proposed and selected through Village Council, Tikina Council, Provincial Council, District Development Committee, Divisional Development Committee, National Development Committee, etc. Personnels of the related Ministries participate in and give assistance to the Council and Committee.

Major road projects are construction of the bridges over Sigatoka river and Ba river by PWD. Other regional development projects are the irrigation project in Rewa catchment and Sigatoka Valley Rural Development Project.

CHAPTER 4 PRESENT LAND USE AND LAND DEVELOPMENT PLAN IN NADI

4.1 Present Land Use in Nadi

4.1.1 Vicinity of Nadi Town

Land use in the vicinity of Nadi town is characterized as follows:

- Urban development along Queens road with Nadi town in the south
- International airport located in the north - main gateway to Fiji
- Tourism development - concentration of hotels and tourist shops/restaurants
- Sugarcane - historical background and still major industry and landscape
- Fijian native villages distributed adjacent to the urban area
- Urban expansion to the south and to the north-east

The project area is located in the center of the urban area or between the airport and Nadi town. In addition, it faces the coast where urban and tourism area is still small and is going to be developed.

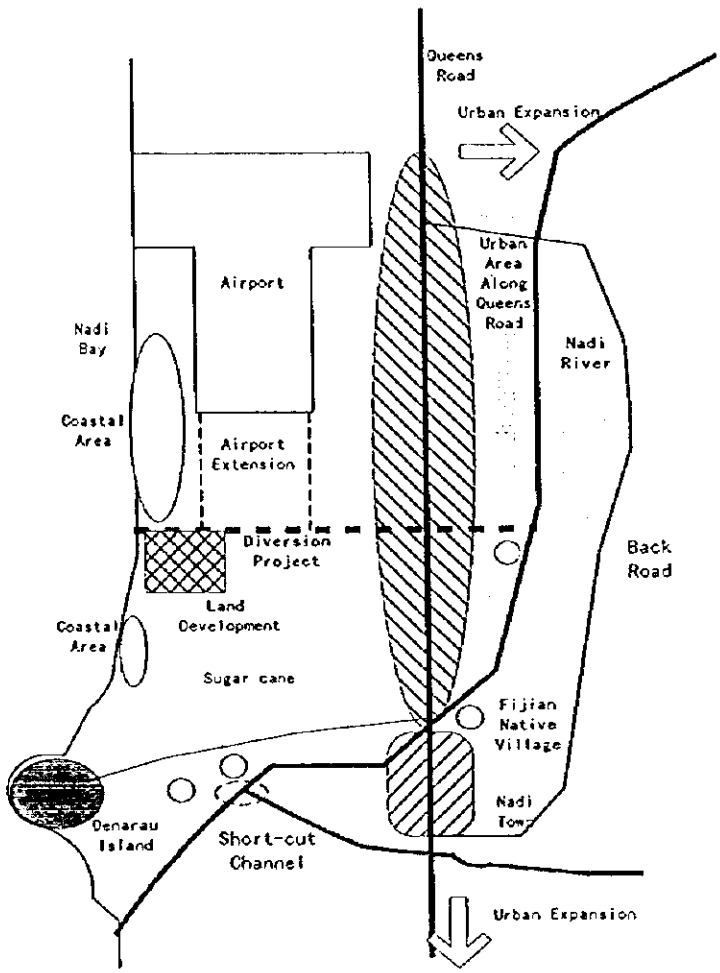


Figure-G4.1 Schematic Plan of Nadi Area

4.1.2 Around Project Area

The present land use around the project area is shown in Figure-G4.2.

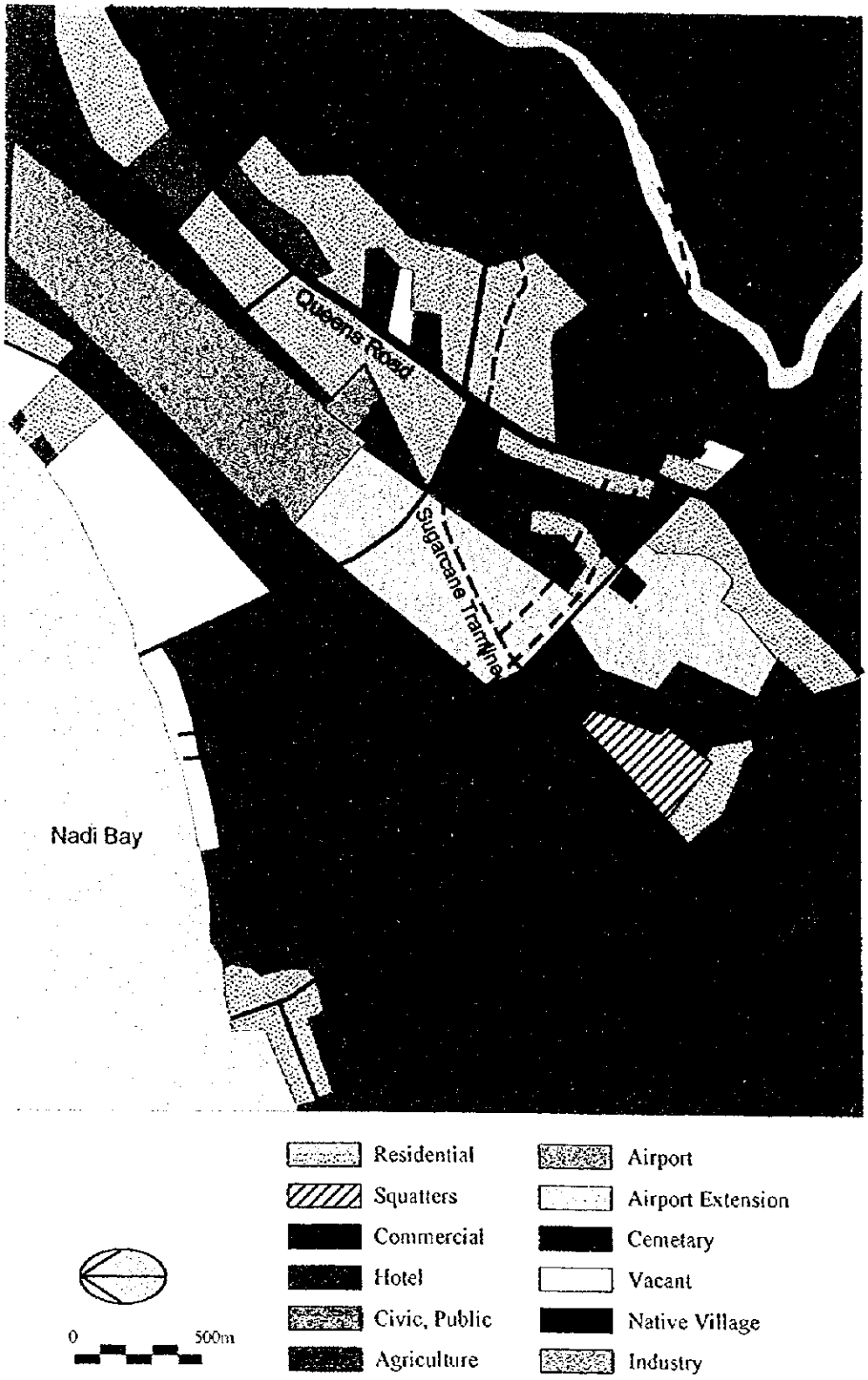


Figure-G4.2 Present Land Use around Diversion Project Area

4.1.2 Around Project Area

A present land use around the project area is shown in Figure-G4.2.

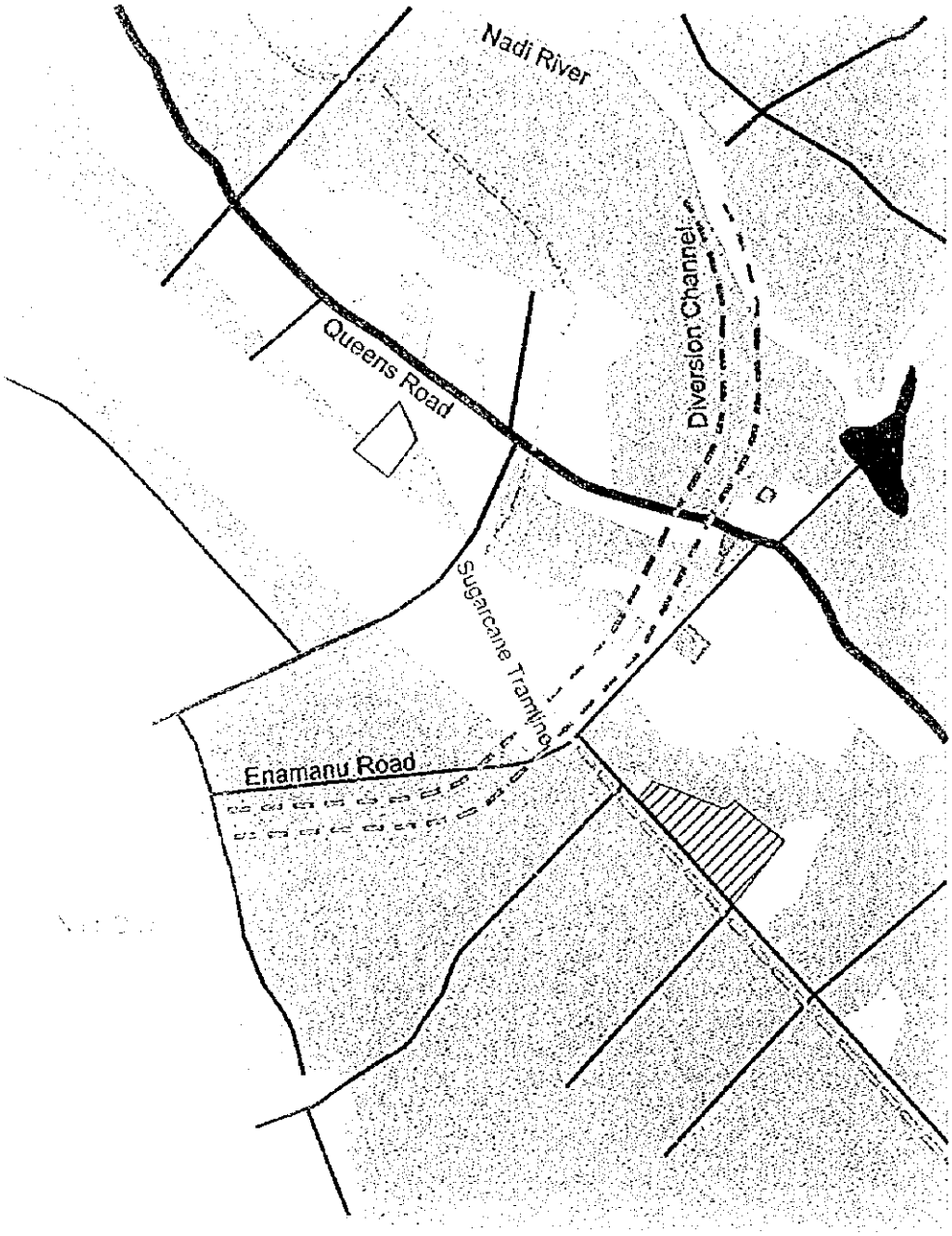


Figure-G4.2 Present Land Use around Diversion Project Area

(1) Around Nadi River

The area around the site for diversion channel between Nadi river and Queens road is agricultural land, mainly of sugarcane and vegetables. There is also a small forest or belt of trees. On the left bank of Nadi river, a small hill extends to the east along Solovi road. There is an international school at the crossing of the back road and Solovi road. At the Saunaka native village, Nadi river winds almost perpendicularly.

(2) Around Crossing of Queens and Enamanu Roads

The west side of Queens road where the diversion channel will cross is residential area with housing lots; however, a few houses are built in the lots or not all lots have been utilized. At the corner of the crossing between Queens road and Enamanu road, there is the McDonald's with parking lots and the delivery house.

(3) Along Enamanu Road

From the crossing between Queens road and Enamanu road to the coast is mainly farm land with scattered houses along the Enamanu road and Wailoaloa road. There are facilities of CAAF (Civil Aviation Authority of Fiji) and PWD (Public Works Department), and the cemetery on the west side of Enamanu road. Both sides of Enamanu road is the extension area of Nadi airport. At the crossing of Enamanu road and the tramline, there is a small Hindu temple. At the end of Wailoaloa road, there is a damaged rock jetty. The coast is public sand beach.

(4) Along Coast

Along the coast, there are a small crematorium, two small resort hotels (24 + 15 rooms), "Fantasy Project" and vacant or undeveloped land to the west. The Fantasy Project is under construction to develop the residential area and hotel. In the eastern area of Nadi Bay road, there are the residential area with small hotels, Turtle Airways and a golf club house.

(5) Around the Short-cut Project Site (Figure-G4.3)

The proposed site for the short-cut channel is basically agricultural land belonged to Native Fijian; however, it is not fully utilized but left uncultivated. Narewa native village is located on the right bank of Nadi river but the village is not in the project site for the short cut channel.

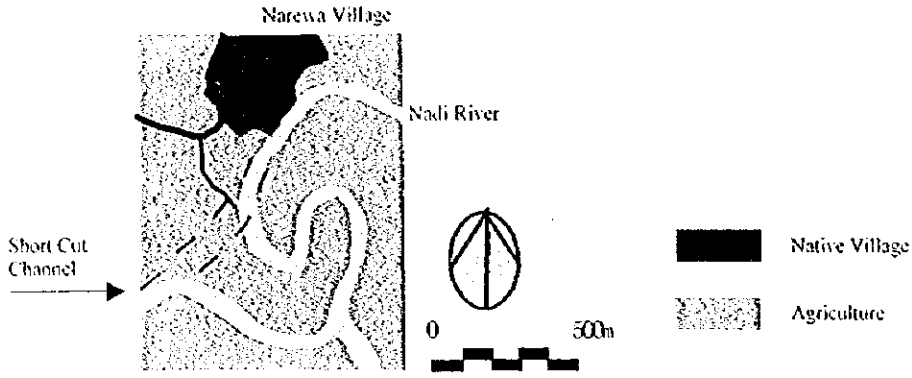


Figure-G4.3 Present Land Use around Sort Cut Channel

4.1.3 Hotels

There are 1,653 hotel rooms in the Nadi area as shown in Table-G4.1.

Table-G4.1 Number of Hotel Rooms in Nadi Area

Location	Number of Rooms
Near the airport gate	448
Along Queens Road (including Nadi Town)	541
Coastal area	79
Denarau island	585
Total	1,653

The grade of the hotels along the Queens road varies from economy to first class. The hotels in Denarau island are all luxury. Many of the first class hotels along Queens road are getting old and need renovation.

4.2 Future Land Use in Nadi

The future land use in Nadi town and its vicinity shall be lead by Nadi Town Planning Scheme which is prepared by the Department of Town and Country Planning (Figure-G4.4). The expected changes are extension of the airport in the east of Enamanu road and tourism development on the coastal area integrated with the Fiji Tourism Development Plan.

4.2.1 Nadi Town Planning Scheme

Nadi Town Planning Scheme, covering Nadi town, Nadi urban area and Nadi rural area, was provisionally approved in December 1996 and supposed to have the final approval by the end of 1997. The scheme aims to enhance the growth of Nadi in an efficient equitable and sustainable way paying particular concern to supporting the growth of the airport, facilitating tourism and protecting good cane land. To cope with flooding, development on flood prone area is restricted, and dredging of Nadi river and formulation of a flood mitigation plan are recommended.

In addition to the new expanded town centers of Vatualevu and Malolo, residential areas of Saunaka, Waqadra, Namaka etc. will be filled with houses. The main commercial center

will continue to be Nadi Town and secondary centers will be Narewa, Martintar, Namaka and Vatualevu. Hotel sites are earmarked in Denarau, Wailoaloa, Vulani and Vatualevu.

Table-G4.2 Land Use by Nadi Town Planning Scheme

Land use	Area (ha)	%
Residential	246	40%
Commercial	54	9%
Industrial	37	6%
Open space	130	22%
Tourism	82	14%
Civic	53	9%
Total	603	100%

Source: Department of Town and Country Planning, 1996

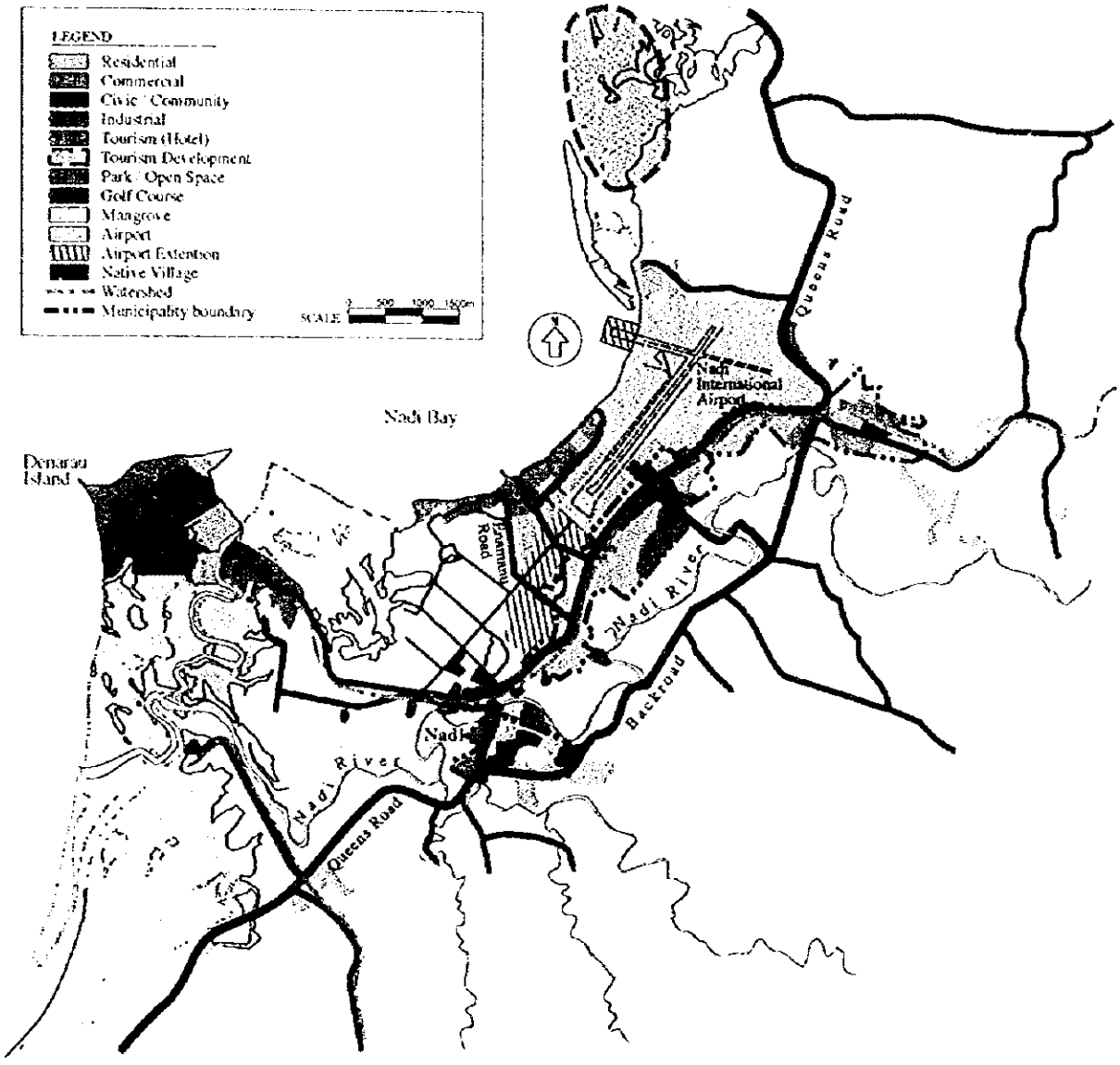


Figure-G4.4 Nadi Town Planning Scheme

4.2.2 Fiji Tourism Development Plan, 1998 - 2005

Fiji Tourism Development Plan, 1998 - 2005, was issued in 1997, presenting the policy and direction of the tourism development. The emphasis is placed on the main existing tourism areas to be improved and consolidated, while more dispersed development of quality tourism throughout the islands is promoted. In Fiji overall, introduction of 2,500 rooms is aimed by 2005.

The plan has identified the Tourism Development Areas. Nadi bay is recommended for the pilot area including Wailoaloa bay in the center because Nadi bay has the potential for being a major resort center. The resort centers such as Denarau island within the Tourism Development Area should be integrated into a whole. Wailoaloa beach should be zoned for tourism and domestic recreation with a public beach facility. A beach center is proposed near Wailoaloa jetty.

4.2.3 Related Projects

(1) Fantasy Development Project

The total project area is about 32 ha comprising the state land and reclaimed land adjacent to the flood gate. The soil for reclamation is dredged from the sea forming channel and marina. The marina and housing lots which mostly front to the marina will be provided in the first phase. The number of lots is 95 with the area of 10.1 ha and 2.6 ha of roads. A hotel site with the area of 4.6 ha, villa site with recreation facilities of 3.8 ha fronting to beach, and foreshore reserve of 2 ha will be developed in the second phase.

(2) Wailoaloa Jetty Development Project

The application for development of Wailoaloa Jetty has been submitted for approval. It comprises expansion and improvement to the existing jetty preparing wharf, marina, restaurant, shops, tour offices and parking etc. The area is about 8,000 m^2.

(3) Vulani Island Development Project

Vulaini Island Project is located at 8 km north from the Nadi airport. In Stage I and II, it will include 4 hotel sites (10 ha x 4, about 1,000 rooms), 18 hole golf course, driving range, marina, 120 housing lots, commercial, condominiums, small aquarium, museum and cultural center in the area of about 160 ha. It is under construction.

(4) Development in Denarau Island

Denarau island is still under development having vacant sites for international hotels and condominiums. The condominiums with about 80 rooms and the hotel with about 300 rooms have been completed. There are still the sites for condominiums of 400 rooms and hotels of 300 rooms reserved. Denarau island is given completion priority in the "Fiji Tourism Development Plan, 1997".

4.2.4 Future Land Use

Based on the existing land use schemes discussed above and land development plan proposed in the next section 4.3, the future land use in the vicinity of the diversion channel

was projected. Land use conditions around the project site for the Nadi diversion channel are summarized below.

- Both sides of Nadi river adjacent to the diversion channel site are rural or agricultural areas.
- The area along Queens road is residential. The east side is about 20 m wide and the west side extends to the airport extension area.
- The airport runway will be extended up to Enamanu road and the airport facilities will be constructed on the west of Enamanu road. Accordingly the route of the tramline will be relocated outside the airport extension.
- The west of Enamanu road is rural area except the area along Queens road which is residential.
- The area in the north of the airport extension between Enamanu road and Wailoaloa road will be residential and hotel areas. The hotel area is located seaside and residential area is between the hotel area and the airport extension.
- The beach is public open space for recreation and access to the sea.
- The coastal area along Nadi bay road is designated as residential and hotel areas.

The projected future land use around the project area is shown in Figure-G4.5.

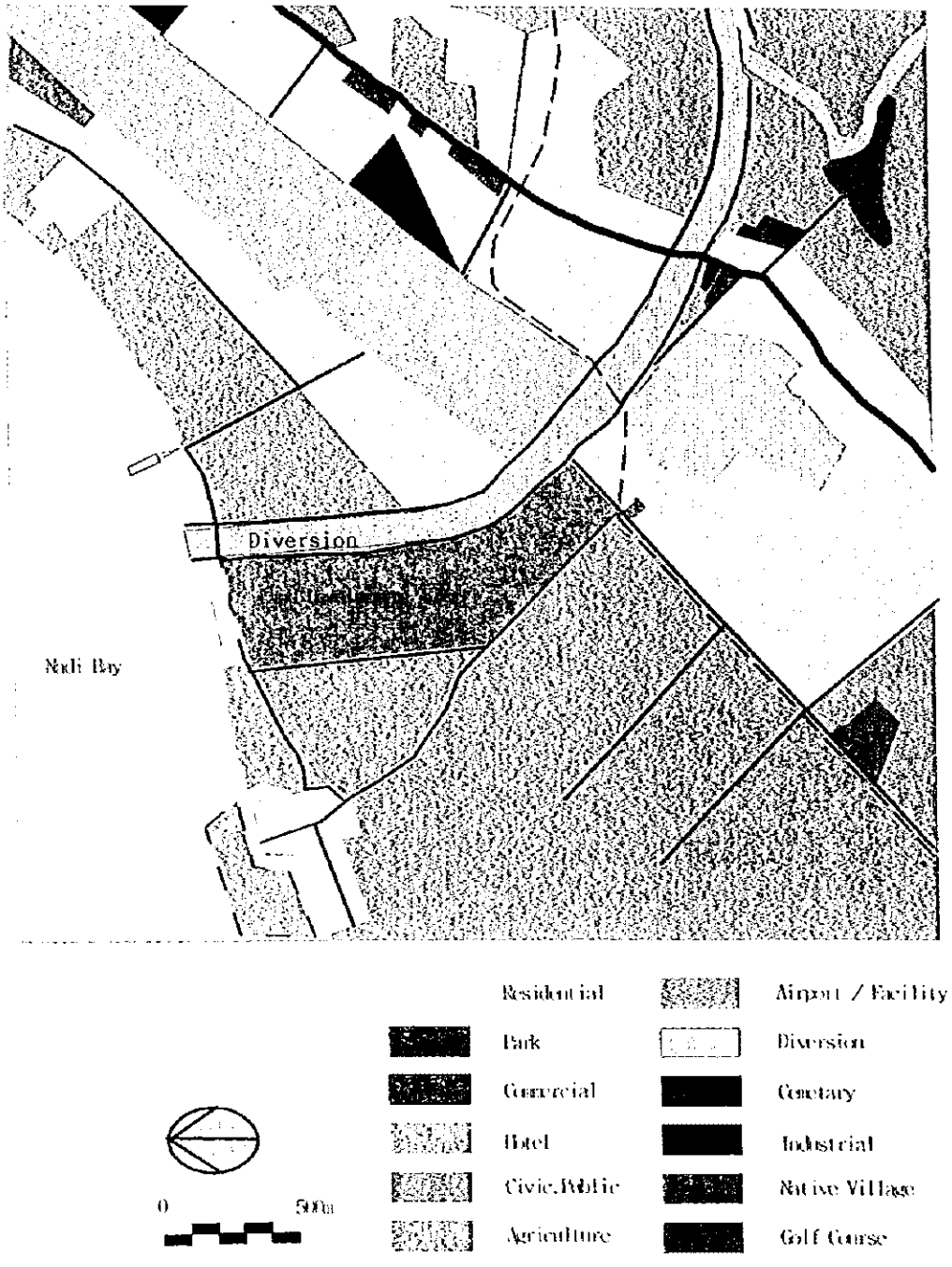


Figure-G4.5 Land Development and Future Land Use

4.3 Proposed Land Development Plan with Diversion Project

4.3.1 Land Development of Soil Disposal Area

The proposed diversion channel will pass through a small hill after its inlet. Therefore, the upper reach of the channel (about half of the total channel length) will be the cutting section, while the lower reach will be the embankment section. Excavated soil will be used for the embankment section of the channel and surplus soil will be dumped in the disposal area located on the left bank in the lower reach of the channel. The maximum height of the soil disposal area is 6 m.

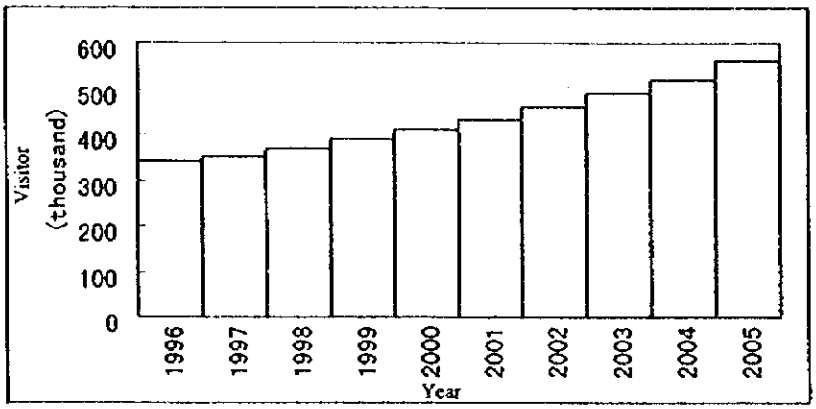
Since the soil disposal area is located seashore and its vicinity is designated as Tourism Development Area, this area has potential for urban development. Therefore, development of the soil disposal area was examined.

(1) Objectives of Development

Based on the present and future land use in the vicinity of the proposed site for the diversion channel, the following items were examined to assess their suitability for land development.

1) Hotel

Tourism is one of the most important sectors for the economy in Fiji and tourism development seems to be promising as the visitor arrivals are expected to increase considerably (Figure-G4.6). More accommodation will be required for the increase of visitors. Therefore, a large scale luxury hotel should be promoted to cope with not only accommodation but also international conference, events and so on. The site as large as 20 ha facing the sea would provide ideal opportunity for such development of a luxury hotel with over 500 rooms with swimming pool, gardens, sports facilities, convention centers etc.

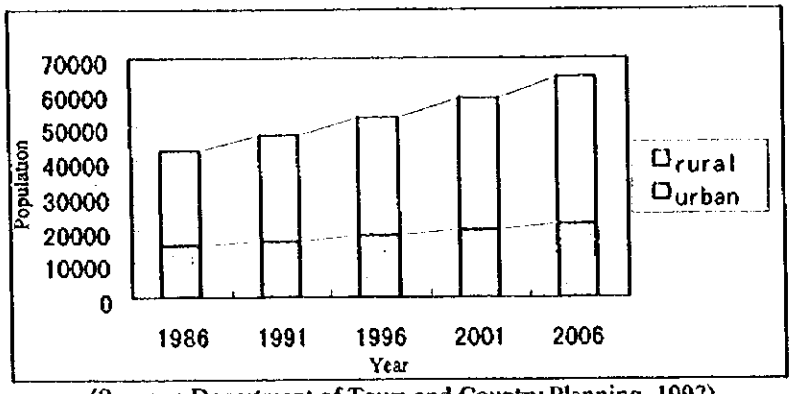


(Source : Ministry of Transport and Tourism, 1997)

Figure-G4.6 Visitor Arrivals Projection

2) Housing

Housing is expected to be constantly required due to population increase in Nadi region (Figure-G4.7). In particular, the demand for the first class residential area is anticipated to increase as appropriate land is limited and there are problems in tenure for development.



(Source : Department of Town and Country Planning, 1997)

Figure-G4.7 Projected Population of Nadi Region

3) Shopping Center

Development of large scale shopping center might be difficult, considering the small future population in Nadi region (about 64,000 in 2006).

4) Park

As there is no large public park in Nadi area, it is worth to be considered for the public and tourists.

5) Nadi Theme Park (Fiji Experience)

Fiji Tourism Development Plan proposes a cultural center of "Fiji Experience", which includes a visitor center of Fijian history and culture, facilities for dance and cultural display and a wedding chapel. The cultural center would attract visitors.

As a result of examination of the above items, the soil disposal area is considered to be suitable for a high class hotel, residential area and park. Land development for the high class hotel and residential area would be profitable to the project (Nadi diversion and short cut channel), while the park is beneficial to the society.

(2) Land Development Scheme

Land development scheme in the soil disposal area (49 ha) is proposed as follows and the area of each land use proposed is shown in Table-G4.3.

- Seaside park with tropical plants, a pond and facilities, such as picnic table, bench, children play lot, car parking and so on
- Resort hotel with 500 ~ 600 rooms, inclusive of swimming pool, sports facility, convention hall, shopping arcade and so on
- High-grade residential area (1,200 m^2 x 100 lots)

- Buffer green belt on boundary slope to protect bank and improve landscape from the surrounding area because the soil disposal area is elevated 6 m at maximum from the present grand
- Road construction on the western boundary
- Road within the residential area

Table-G4.3 Land Development Plan Proposed for Soil Disposal Area

Land Use	Area
Park	12 ha
Hotel	20 ha
Residential Area	15 ha
Buffer Slope Green Belt	2 ha
Total	49 ha

There are two alternatives depending on the location of hotel as shown in Figure-G4.8. One (Alternative A) is to locate the hotel on the beach with about 250 m width and 800 m length. The park is located along the diversion channel with about 50 ~ 100 m width and 1,300 m length. The residential area is in the south of the soil disposal site.

Another (Alternative B) is to locate the park on the beach with about 350 m width and 340 m length. The hotel is located between the park and residential area.

Image of land development scheme (Alternative A) with the diversion channel is shown in Figure-G4.9.

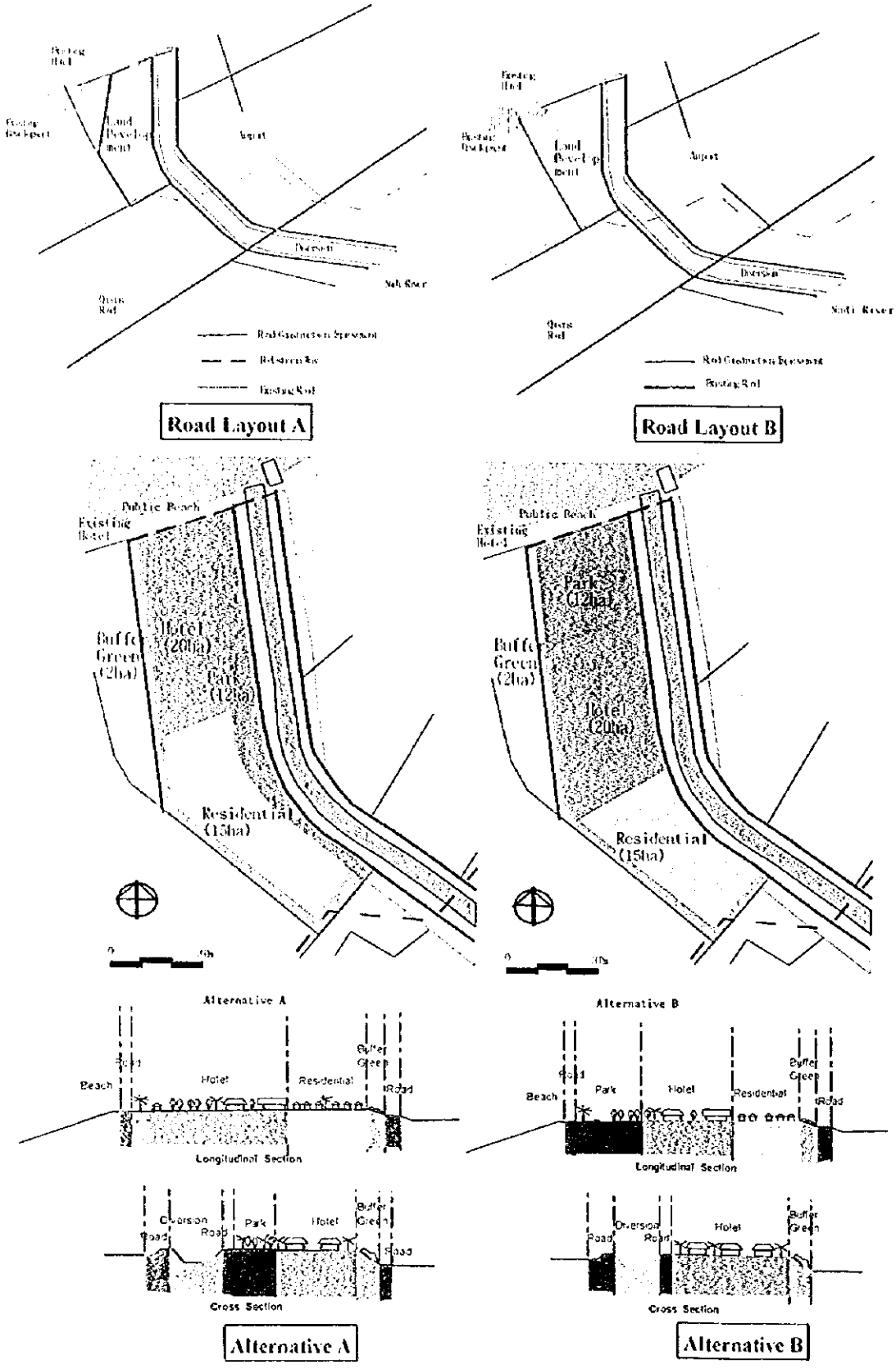


Figure-G4.8 Schematic Plan of Land Development Alternatives

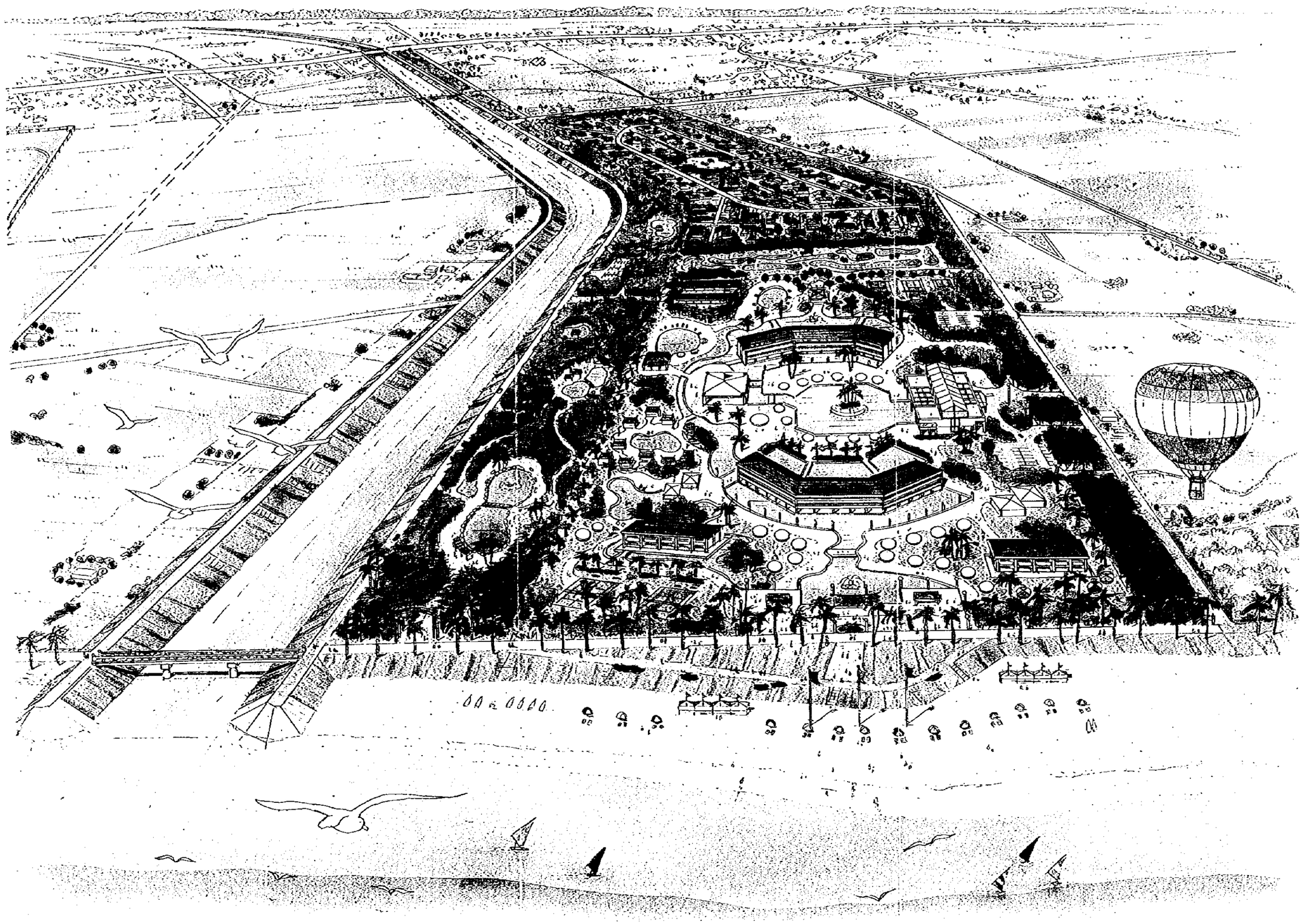


Figure-G4.9 (1/3) Image of Land Development in Soil Disposal Area with Diversion Channel

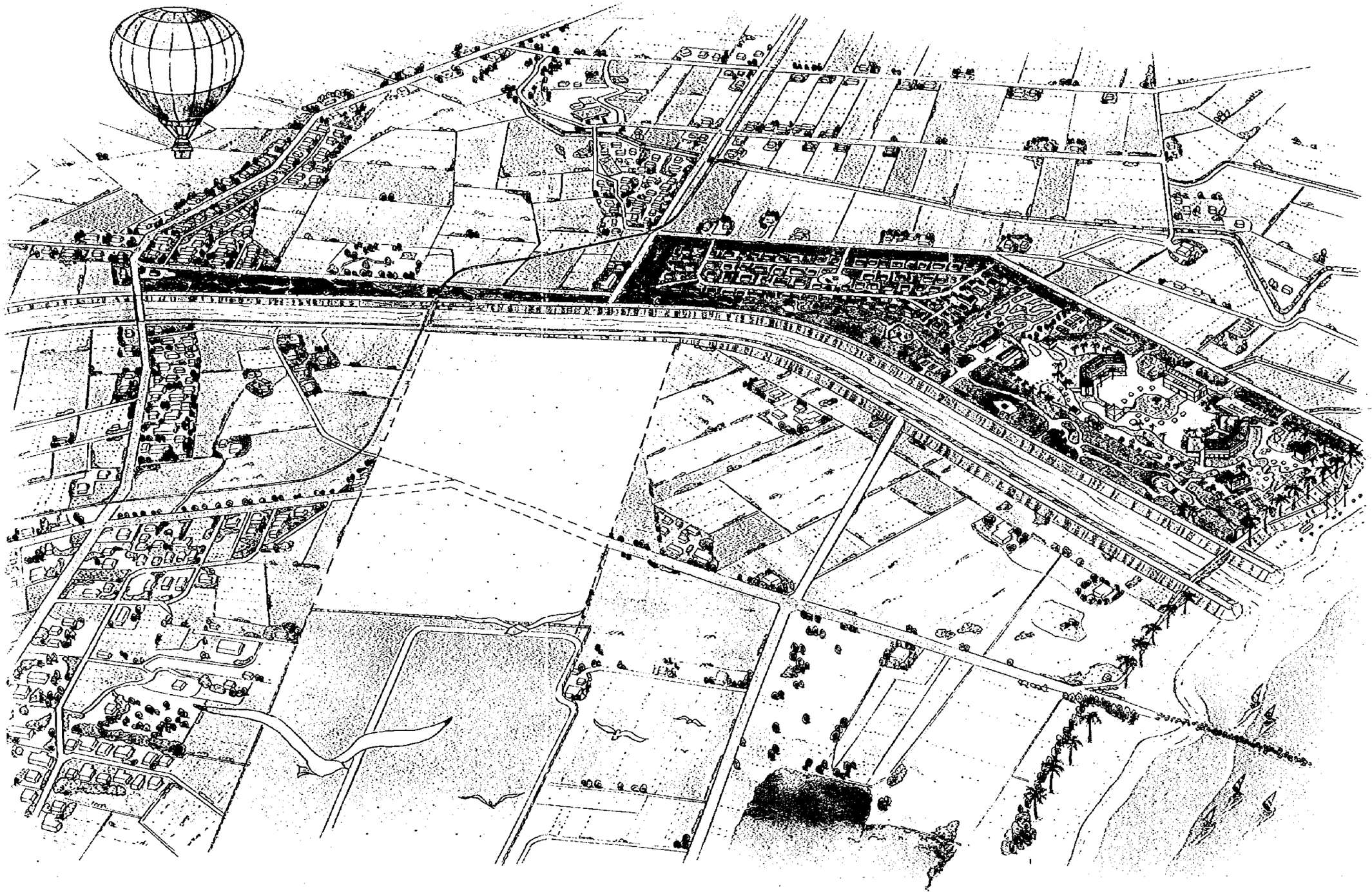


Figure-G4.9 (2/3) Image of Land Development in Soil Disposal Area with Diversion Channel

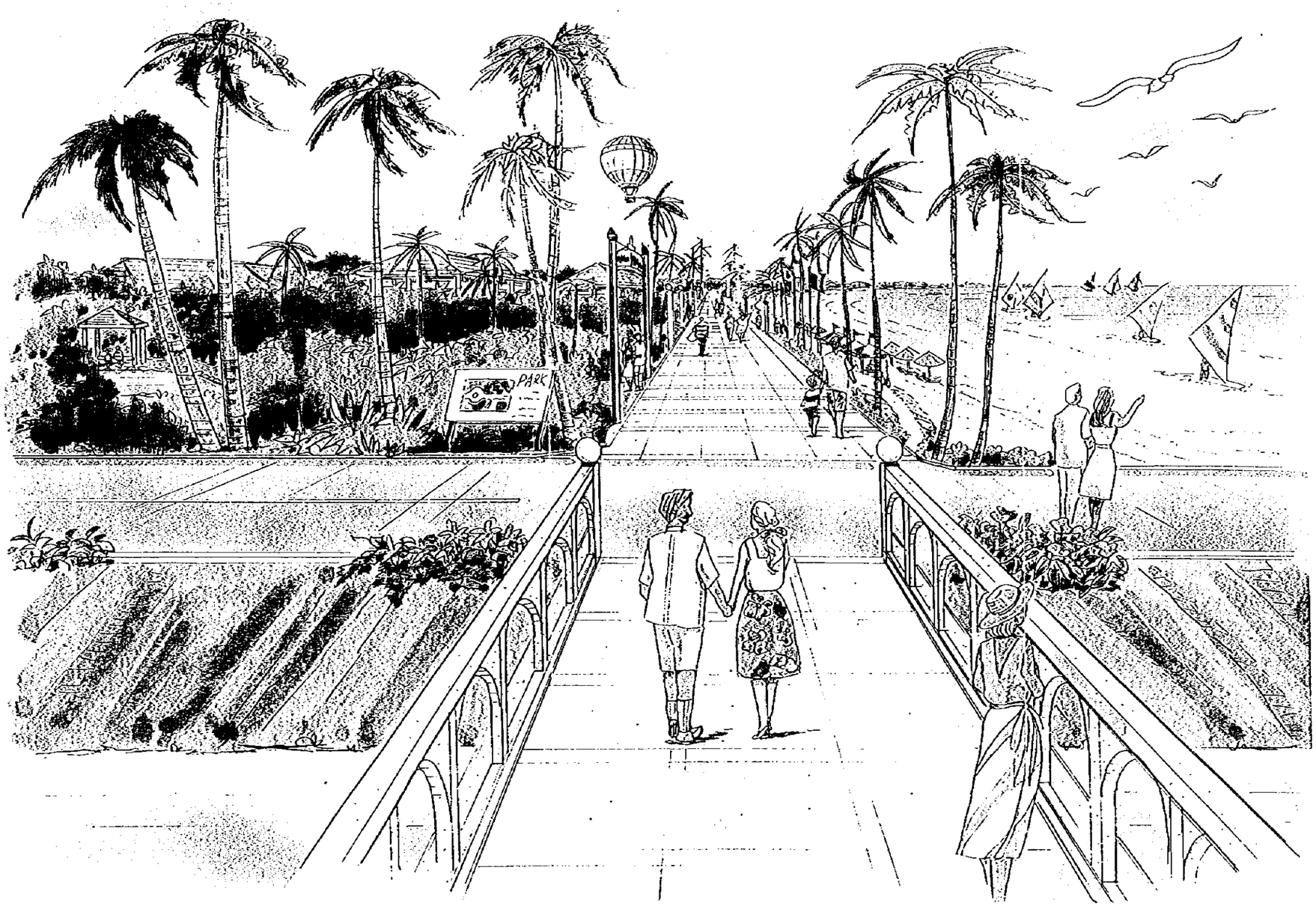


Figure-G4.9 (3/3) Image of Land Development in Soil Disposal Area with Diversion Channel

4.3.2 Cost Estimate

Cost for land development consists of items shown in Table-G4.4. Embankment of the soil disposal area, land acquisition are already included in the cost for the diversion channel, while construction of the hotel area is conducted by a private sector. Therefore, the cost of land development is mainly preparation of site with the public infrastructures, such as a park, roads, water supply, sewerage, electricity and telephone.

Construction cost and project cost is shown in Table-G4.4 and Table-G4.5, respectively. Since the construction is expected to be completed in one year, price contingency is not necessary.

Table-G4.4 Construction Cost for Land Development

Description	Quantity	Unit	Amount (1,000 F$)	Remarks
Road construction within residential area	1,100	m	330	paved road within residential area
Road construction and improvement	1,500	m	530	along the west boundary
Extension of sewer and pump station	1	L.S.	450	1,200(hotel) + 120(residential) m^3/day
Extension of water supply	1	L.S.	350	1,200(hotel) + 120(residential) m^3/day
Extension of electricity	1	L.S.	1,300	3,000 kW (hotel) + 300 kW(residential)
Underground telephone line	1	L.S.	300	30 pairs (hotel) + 120 pairs (residential)
Park	12	ha	1,300	landscaping, facilities
Green belt landscaping	2	ha	20	vegetation
Infrastructure in residential area	1	L.S.	1,150	water supply, sewerage, electricity
Total			5,730	

Table-G4.5 Project Cost of Land Development

[Financial Cost] (1,000 F$)

	Project cost	Local	Foreign
1. Construction cost	6,000	2,280	3,720
1.1 Material & Equipment	4,200	840	3,360
1.2 Labor	1,800	1,440	360
2. Administration	300	300	0
3. Engineering	900	180	720
4. Physical contingency	360	140	220
Sub-total	7,560	2,900	4,660
5. Price contingency	—	—	—
6. Tax	760	760	0
Total	8,320	3,660	4,660

4.3.3 Economic Evaluation of Land Development with Diversion Channel Project

Economic cost of the land development was estimated based on the financial project cost (Table-G4.5). As a result, economic project cost is F$ 7.30 million as shown in Table-G4.6.

Benefit of the land development is acquired by selling or leasing the hotel and residential areas to a private sector developer and individuals. The price for land was assumed to be F$ 70/m^2 for both hotel and residential areas, resulting in the total income of F$ 22.4 million (F$ 70 x 320,000 m^2). Based on the financial benefit, economic benefit was estimated and result is shown in Table-G4.6.

Table-G4.6 Economic Cost and Benefit of Land Development

Unit: F$ 1,000

Economic Cost	Economic benefit
7,300	18,950

Economic evaluation of the combined project of flood control (Nadi diversion channel and short cut channel) and land development was conducted to assess the economic feasibility of the whole project. For the diversion channel, the economic cost and benefit for 1/20 probability flood was adopted. The result is shown in Table-G4.7.

Table-G4.7 Economic Analysis for Combination of Flood Control & Land Development

Item of Analysis	Result of Analysis
Annual economic benefit of 3rd year (F$1,000/year)	27,228
Annual economic benefit after 4th year (F$1,000/year)	8,278
Economic project cost (F$1,000)	56,297
Annual economic OM cost (F$1,000/year)	36
EIRR (%)	17.24
B/C (ratio)	1.58
NPV (F$1,000)	30,176

Discount rate: 10 %

EIRR and B/C of the economic evaluation for the whole project are 17.24 % and 1.58 respectively, while those for the diversion and short cut channels (1/20 probability flood) are 14.45 % and 1.46. Some of the total financial project cost (approximately F$ 71.3 million) for the combined project could be financed by selling or long-term leasing the developed land (F$ 22.4 million). The remaining cost to be financed by the Government would be F$ 48.9 million. The result is favorable to the combined project.

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