Chapter 15 Preliminary Design

15.1 River Widening

River Widening is intended to flow down 1,800 m3/s flood discharge with full at the Back Road Bridge point in the middle section

※Flow volume after the priority project include natural flood volume at outside section of Important Protected Area

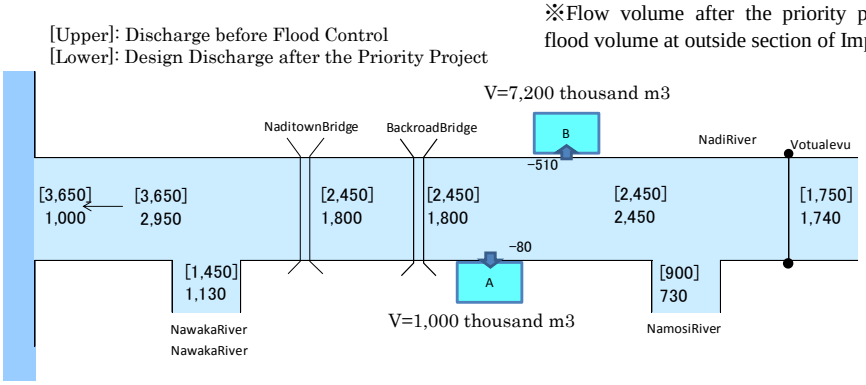


Figure 15-1 Designed Discharge Distribution in the Priority Project

15.1.1 Applicable design standards

Fiji does not have its own technical standards and guidelines for flood control and river facilities. Therefore, *Structural Ordinance for River Facilities* (July 20, 1976), and *Revised Edition, Ministry of Construction, Technical Criteria for River Works, Editorial Supervisor* by River Bureau, Ministry of Construction, is used as references in designing the river facilities.

15.1.2 Plan and Area

(1) Planned Area

River widening is conducted from 5.75k , near Narewa village, to 24.0k, near Votuarevu village.

This area is selected through flood analysis in order to prevent inundation of the Important Protected Area. Only river widening is conducted for the section between 5.75k to 8.0k, and the earth dike is not included in order to mitigate negative impact of the dike of main stream on other areas, including tributaries. The whole plan of the river widening is as described in Figure 15-3.

(2) Plan

Alignment of river widening is set considering the current alignment of the river channel and flood flow. The width of river widening is set, basically, the same as that of from center line between right bank side and left bank side from the point of view for fairness.

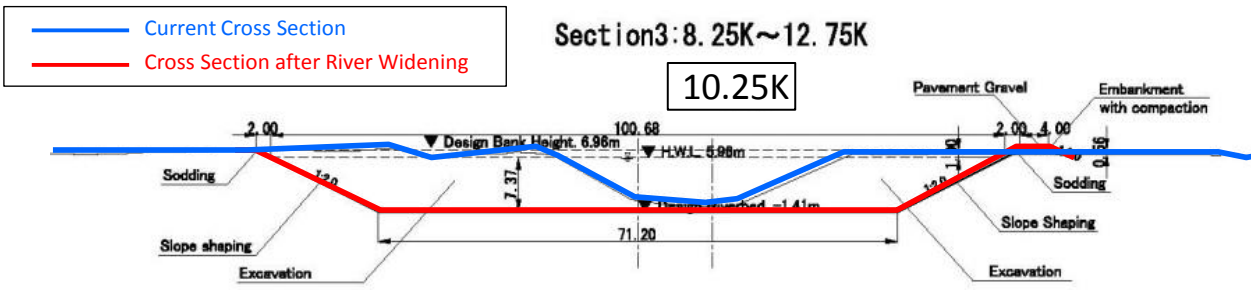


Figure 15-2 Basic Concept of River Widening

Based on the above explanation, the plan of river widening is shown in from Figure 15-3 to Figure 15.6.

15.1.3 Longitudinal Plan

Longitudinal Plan is as shown in Figure 15-7.

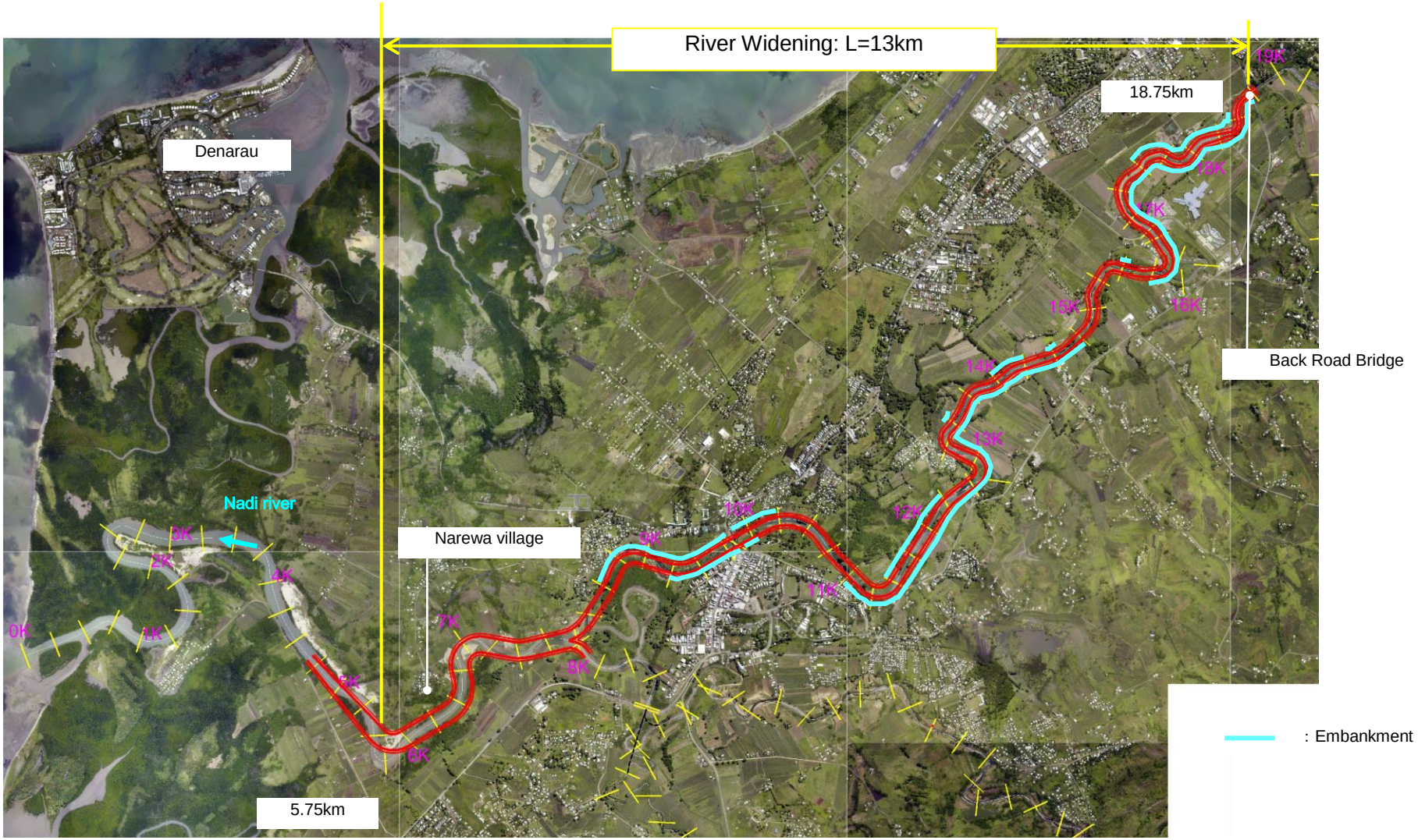


Figure 15-3 Whole Plan of River Widening

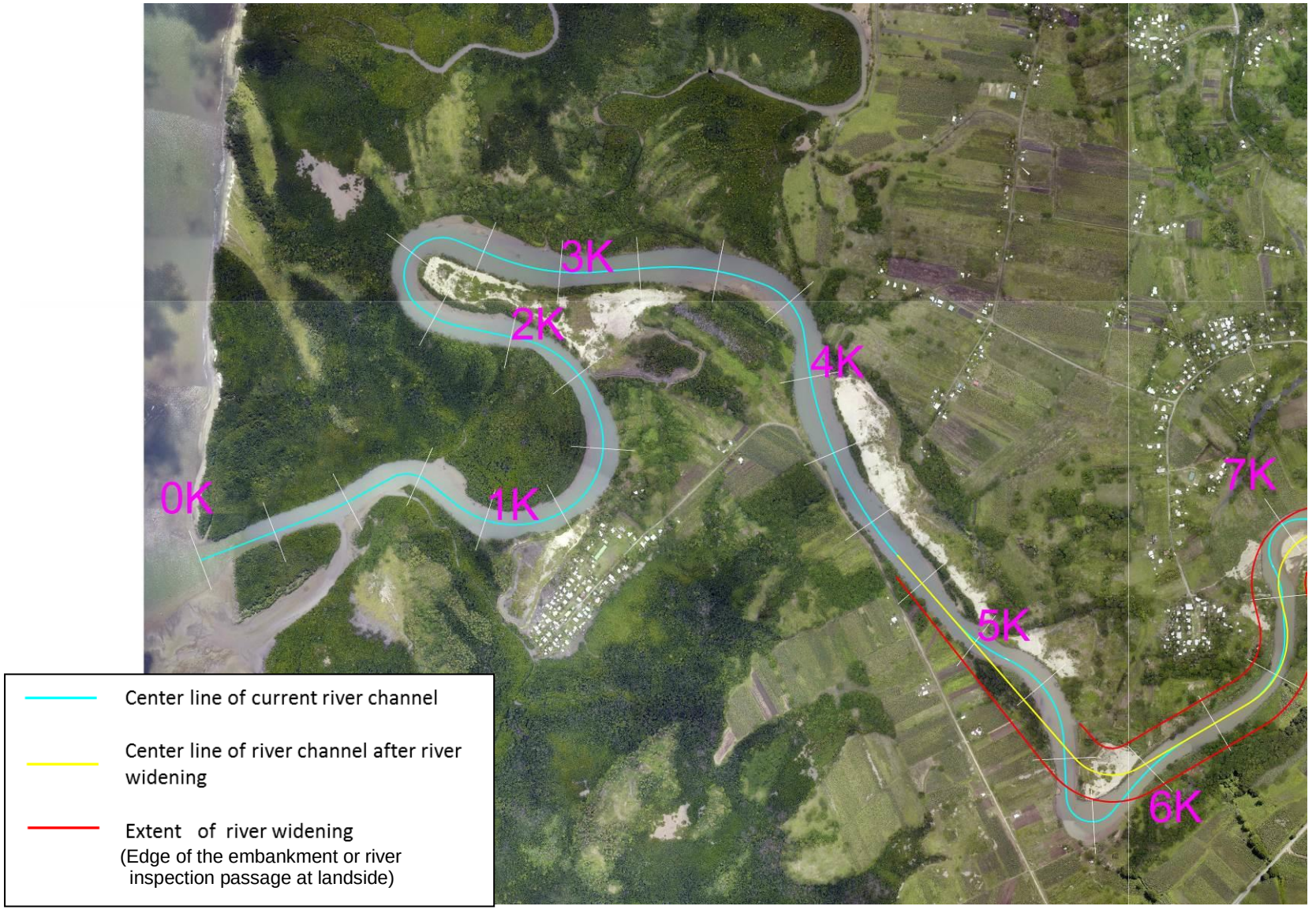


Figure 15-4 Plan of River Widening (1)

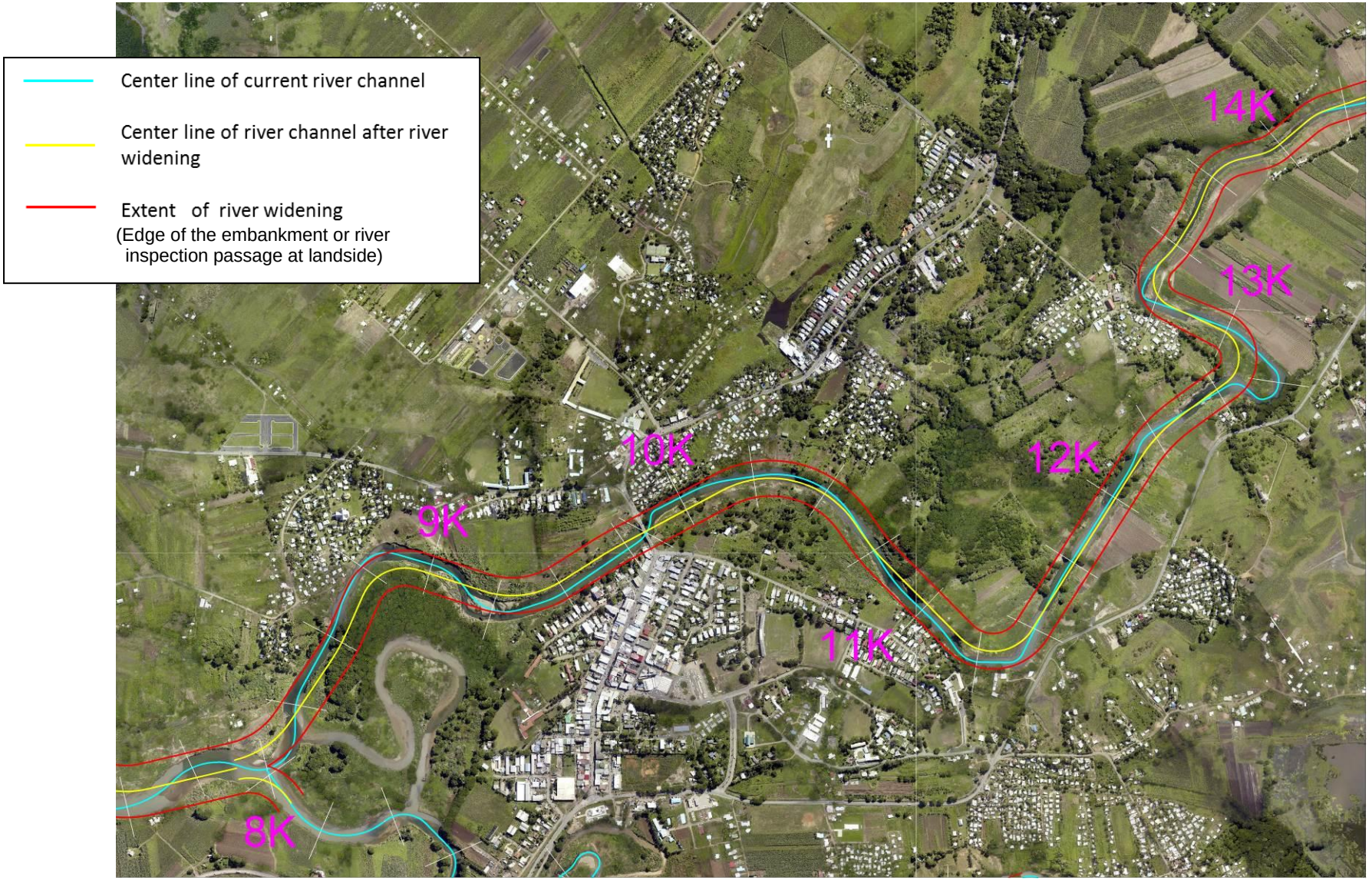


Figure 15-5 Plan of River Widening (2)

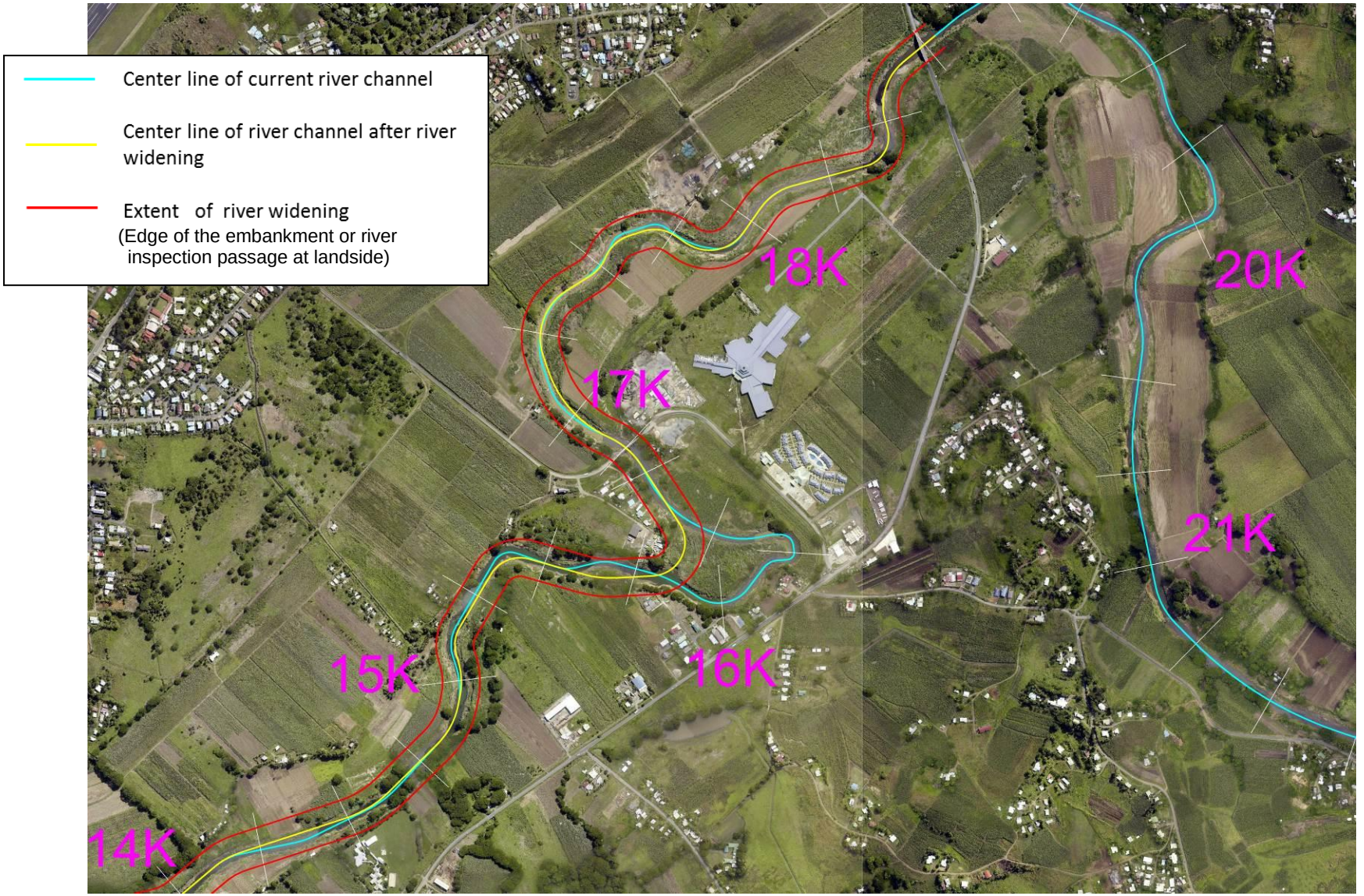


Figure 15-6 Plan of River Widening (3)

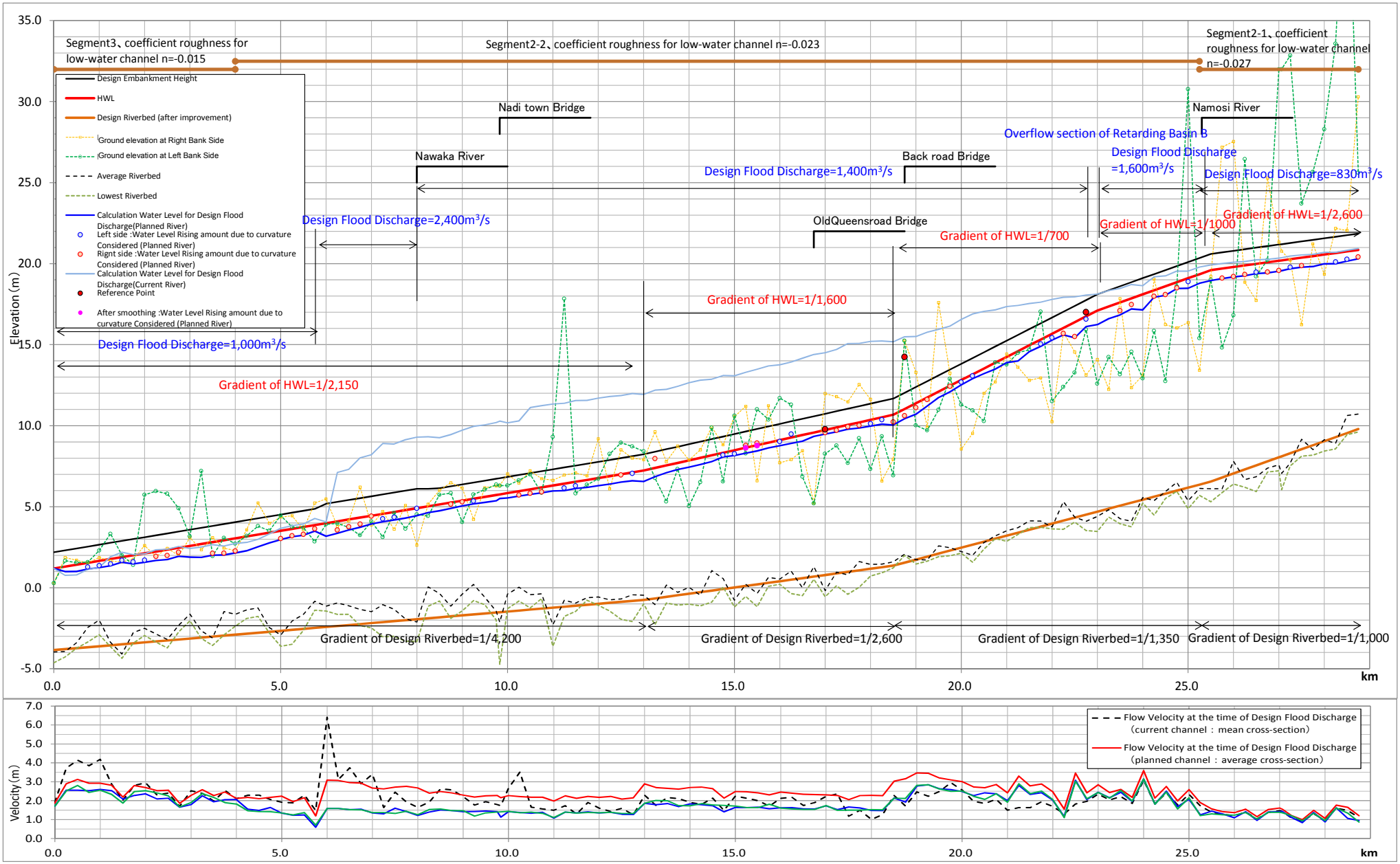


Figure 15-7 Designed Longitudinal Plan

15.1.4 Cross-Sectional Plan

(1) Slope Gradient

Although, in principle, the slope gradient of embankment is set loosely at 1:3 of either river side or land side slope based on River Embankment Design Criteria in Japan, 2007, River Improvement and Management Division, Water and Disaster Management Bureau, Ministry of Land, Infrastructure, Transport and Tourism, the slope gradient of either river side or land side of Nadi River is set as 1:2 for the following reasons: 1) Risk of dike breach due to riverbank erosion is low because cross-sectional shape of Nadi River after improvement is almost engraved to existing ground, 2) Height of embankment is from 0.5m to 3m if embankment is necessary and stability for structural and permeability is considered to be secured, and 3) The present situation of the bank is considered to be stable with almost 1:2 slope gradient through field investigation.

In addition, this project will hardly cause land side because low land area besides embankment will be filled with soil as mentioned later in "Backfilling at Hinterland".

Typical Cross Section of the river is as described in Figure 15-8.

On the other hand, slope gradient for other structures are set as below. Since the details of the structure of each shape are described later, only the outline is provided here for reference.

(2) Bank Width of the crown of embankment

The embankment width is decided in accordance with “Cabinet Order Concerning Structural Standards for River Management Facilities, Chapter III ,Article 21”based on flow rate as described in Table 15-1. As a result, the bank width of the crown is set as 4.0m

Table 15-1 Bank Width

Design Discharge (m3/s)	Bank Width (m)
Less than 500	3
More than 500, Less than 2000	4
More than 2000, Less than 5000	5
More than 5000, Less than 10000	6
Moe than 10000	7

Source: Cabinet Order Concerning Structural Standards for River Management Facilities, etc. Chapter III Article 21

(3) Inspection passage

In accordance with “Cabinet Order Concerning Structural Standards for River Management Facilities, Chapter III Article 27”, the embankment is provided with an inspection passage. Inspection passage width is set as 3.0m

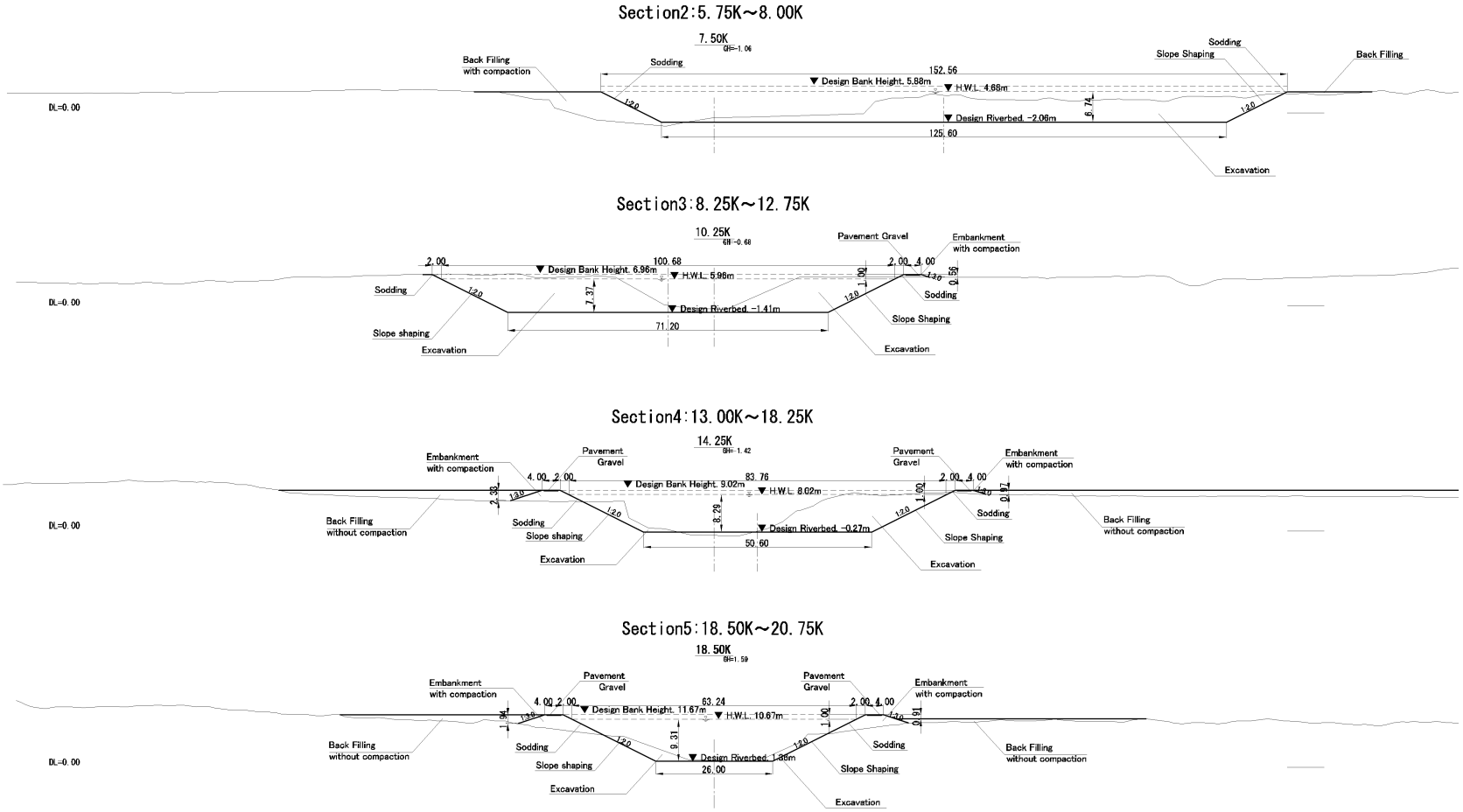


Figure 15-8 Typical Cross Section (Nadi River)

15.2 Retarding Basin A, B

Retarding Basin A and B can temporarily store, respectively, 80 m3/s and 510 m3/s of flood discharge volume 2,450 m3/s before flood control, and flow 1,800 m3/s at Back Road Bridge with full in order to prevent inundation in Important Protected Area in Nadi River Basin.

Although these basins are filled with flood water when large-scale flood (with more than 1/10 design return period) occurs, water is drained to the river after flooding, and basins return to normal condition, which is suitable for cultivation. In addition, the river dike (surrounding dike of retarding basins) is constructed together with the retarding basins to reduce inundation damage by small-scale flood.

15.2.1 Retarding Basin A

(1) Layout and Facilities Design

The profile of retarding Basin A is as shown in Table 15-2, and its layout is as shown in Figure 15-9.

Table 15-2 Specifications for Retarding Basin A of the Priority Project

	Retarding Basin A
Location	Leftbank Side: 18.75 k ～21.0k
Flood Control Discharge （1000m3）	996
Peak Cut Discharge （m3/s)	80
Peak water level in the basin by calculation （EL.m）	14.50
Length and Location of Overflow Dike	60m 20.455～20.5k
Elevation of the top of Overflow Dike （EL.m）	13.53 （20.5k HWL）
Peak water level at overflow dike by calculation （EL.m）	14.51
Overflow Depth (m)	0.98
Design Elevation of Height of Embankment surrounding the basin （EL.m）	14.53 （20.5k Design Embannkment Height）
Specifications of dicharge.	B1.5×H1.5×1Gate Elevation of the bottom of drainage waterway EL. 9.59 m Outflow Rate Q=10.9m3/s Drainage Time t=17.0 hrs

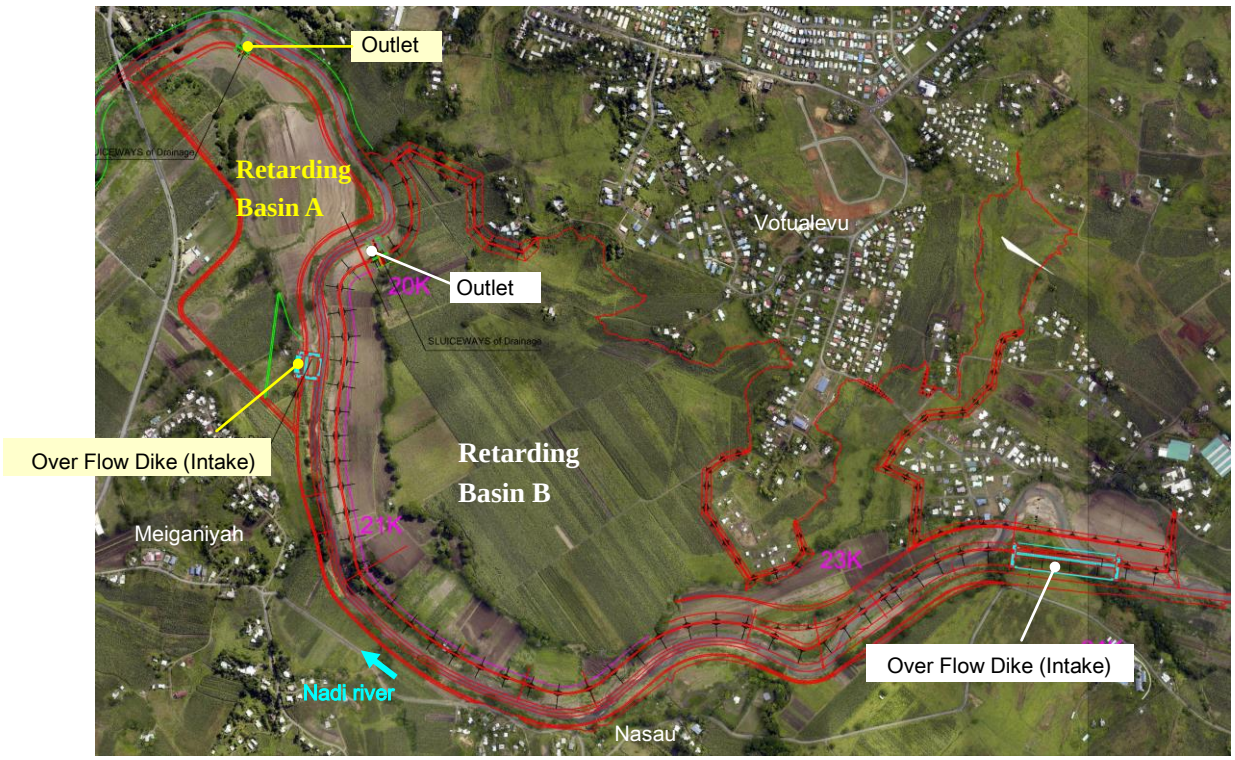


Figure 15-9 Layout of Retarding Basin A

(2) Cross-Sectional Plan

Crown width of embankment is set as 4.0m. Either river or land side of slope gradient is set as 1:3.

Typical Cross Section of Retarding Basin

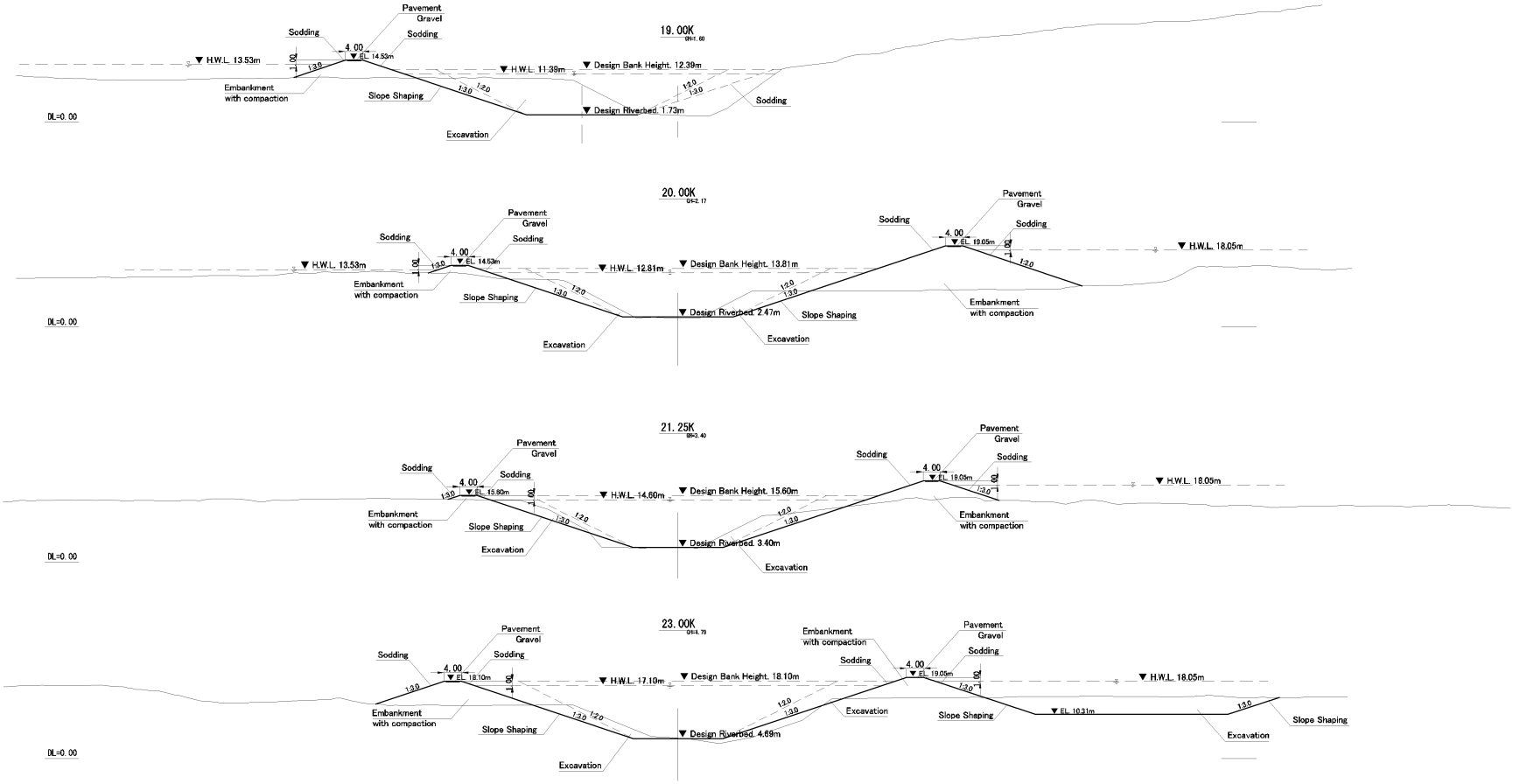


Figure 15-10 Typical Cross Section (Retarding Basin A, B)

(3) Overflow Dike

The specifications of overflow dike are set in order to secure peak cut discharge. A Typical Cross Section of overflow dike is shown in Figure 15-11.

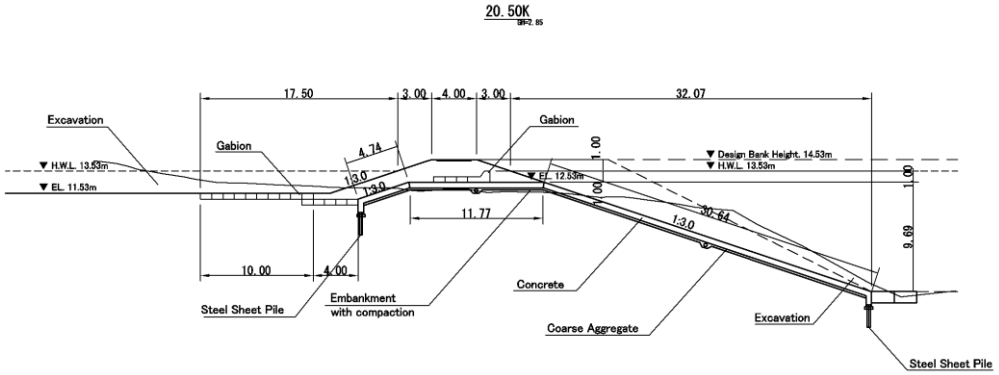


Figure 15-11 Typical Cross Section of Overflow Dike

15.2.2 Retarding Basin B

(1) Layout and Facilities Design

The profile of retarding Basin B is as shown in Table 15-3, and its layout is as shown in Figure 15-12.

Table 15-3 Specifications for Retarding Basin B at the Priority Project

	Retarding Basin B
Location	Rightbank Side: 19.75k～24.10k
Flood Control Discharge（1000m3）	7,157
Peak Cut Discharge（m3/s)	510
Peak water level in the basin by calculation（EL.m）	18.50
Length and Location of Overflow Dike	300m 23.65k～23.95k
Elevation of the top of Overflow Dike（EL.m）	17.25 (23.75k HWL-0.4m)
Peak water level at overflow dike by calculation（EL.m）	18.89
Overflow Depth (m)	1.64
Design Elevation of Height of Embankment surrounding the basin（EL.m）	19.05 （23.95k Design Embannkment Height）
Specifications of dicharge.	B2.5×H2.5×2Gates Elevation of the bottom of drainage waterway EL. 8.20 m Outflow Rate Q=93.1m3/s Drainage Time t=16.4 hrs

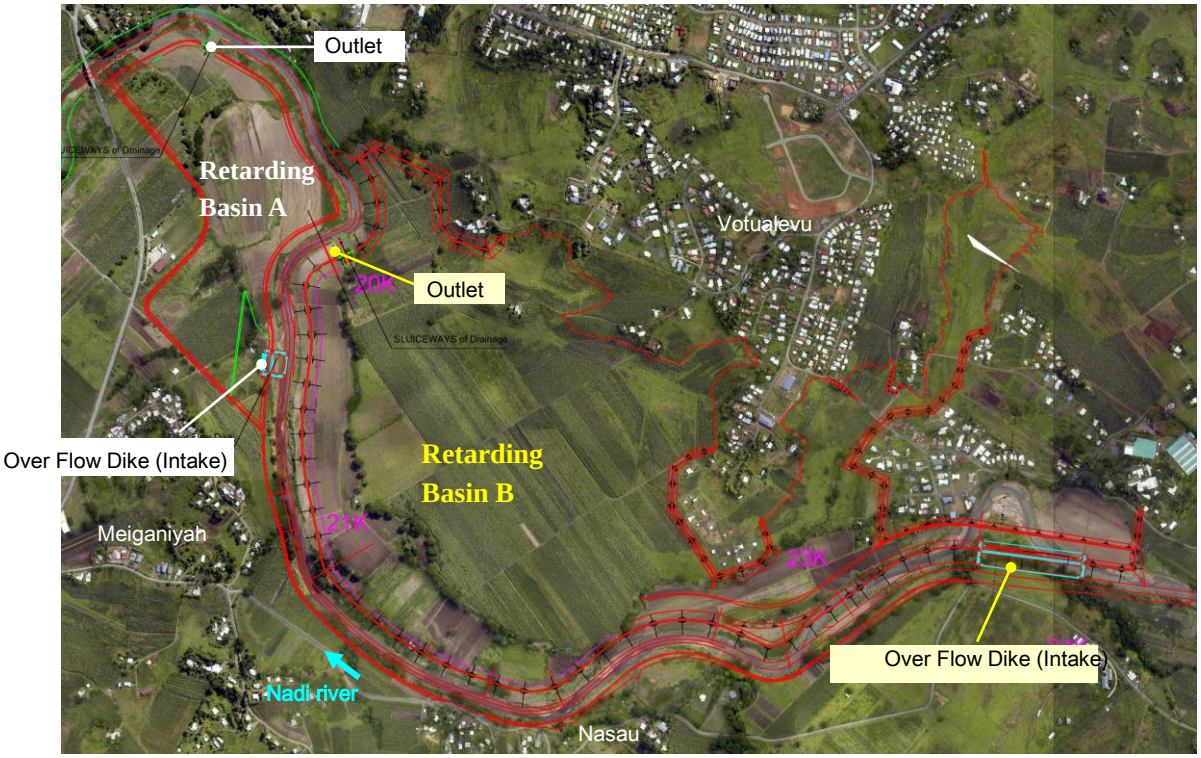


Figure 15-12 Layout of Retarding Basin B

(2) Cross-Sectional Plan

A Typical Cross Section of the retarding basin is as shown in Figure 15-10 earlier.

(3) Overflow Dike

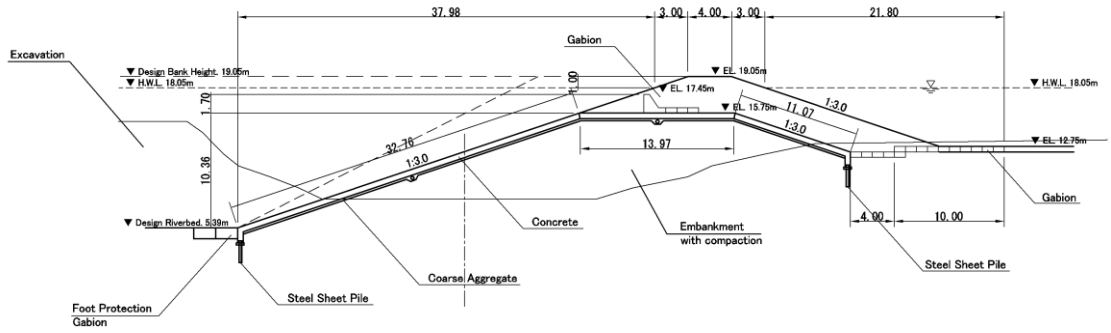


Figure 15-13 Typical Cross Section of Overflow Dike

15.3 Surrounding Dike of Nadi Town

The Surrounding Dike of Nadi Town is built mainly to prevent Nawaka River from flooding the Important Protected Area where Nadi Town center is located. Construction range and height of surrounding dike is determined through hydrological analysis.

(1) Plan

Plan of Surrounding Dike is as described in Figure 15-14.

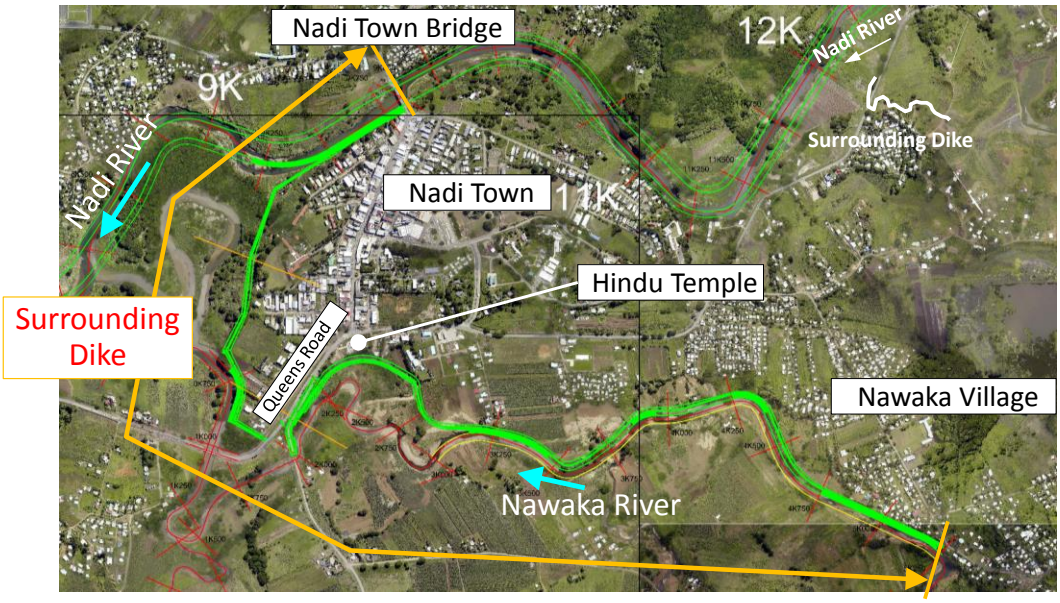


Figure 15-14 Plan of Surrounding Dike

(2) Longitudinal Plan

The height of surrounding dike of Nadi Town is, basically, set the same as that of the Master Plan.

The longitudinal plan of surrounding dike is as shown in Table 15-4.

Table 15-4 Longitudinal Plan of Surrounding Dike of Nadi Town

No.	Cross Section	Existing Ground Level	HWL	Inundation Depth by calculation when 1/50 flood occurs		Proposed height of Surrounding Dike	Setting Basis	
				River	Landside			
1	Cross 1	6.36	5.76	–	–	6.76	Following the elevation of the crest of embankment of the Nadi River	
2	Nadi 9.75K	6.36	5.72	6.28	–	6.72		
3	Nadi 9.50K	5.96	5.61	6.16	–	6.61		
4	Cross 2	5.43	–	–	5.73	6.67		
5	Cross 3	3.31	–	–	5.73	6.70		
6	Cross 4	5.19	–	–	5.73	6.74		
7	Cross 5	5.28	–	–	6.68	8.00		
8	Nawaka 0.75K	5.44	5.79	6.72	6.68	8.00		
9	Cross 6	6.14	–	–	7.79	8.00		
10	Nawaka 2.00K	6.20	7.26	–	8.68	9.00	Following the inundation depth of landside when 1/50 flood occurs	← Location of Queens Road
11	Cross 7	6.24	–	–	8.58	9.00		
12	Nawaka 2.50K	6.50	–	8.78	8.67	9.00		
13	Nawaka 2.25K	6.50	7.56	8.73	8.67	9.00		
14	Cross 8	6.56	–	–	8.76	9.00		
15	Cross 9	6.62	–	–	8.76	9.00		
16	Nawaka 2.75K	6.80	8.15	8.79	8.77	9.15	Following the elevation of the crest of embankment of the Nawaka River	
17	Nawaka 3.25K	7.04	8.73	8.95	8.91	9.73		
18	Nawaka 3.50K	6.23	9.03	9.09	9.02	10.03		
19	Nawaka 3.75K	7.26	9.32	9.24	9.03	10.32		
20	Nawaka 4.00K	6.93	9.62	9.84	9.40	10.62		
21	Nawaka 4.25K	10.07	9.91	10.05	9.29	10.91		
22	Nawaka 4.50K	8.25	10.20	10.85	9.73	11.20		
23	Nawaka 4.75K	9.58	10.50	11.21	11.21	11.50		
24	Nawaka 5.00K	10.94	10.79	11.60	11.23	11.79		
25	Nawaka 5.25K	11.00	11.09	12.11	–	12.09		

(3) Cross-Sectional Plan

Crown width of embankment is set as 4.0m. Either river or land side of slope gradient is set as 1:3.

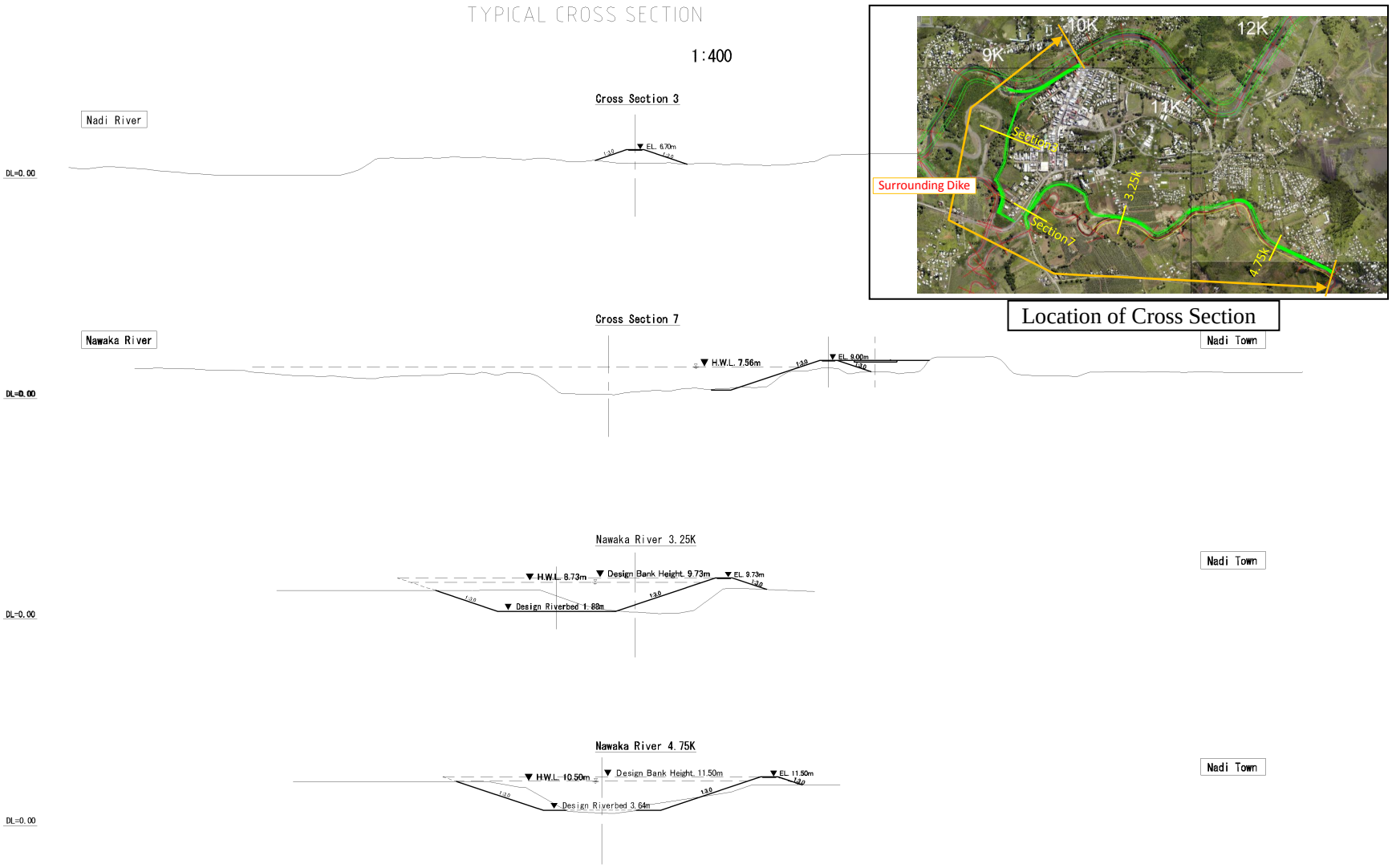


Figure 15-15　Typical Cross Section (Surrounding Dike of Nadi Town)

15.4 Ring Dike

Ring Dike is built in order to protect the community, which is located in downstream natural inundation area, from flooding.

(1) Plan

Ring Dike is built around the outer edge of the community to be protected. Access slope road from outer side of ring dike to inner side, drainage system and outlet are also built.

Plan of Ring Dike is as shown in Figure 15-16.

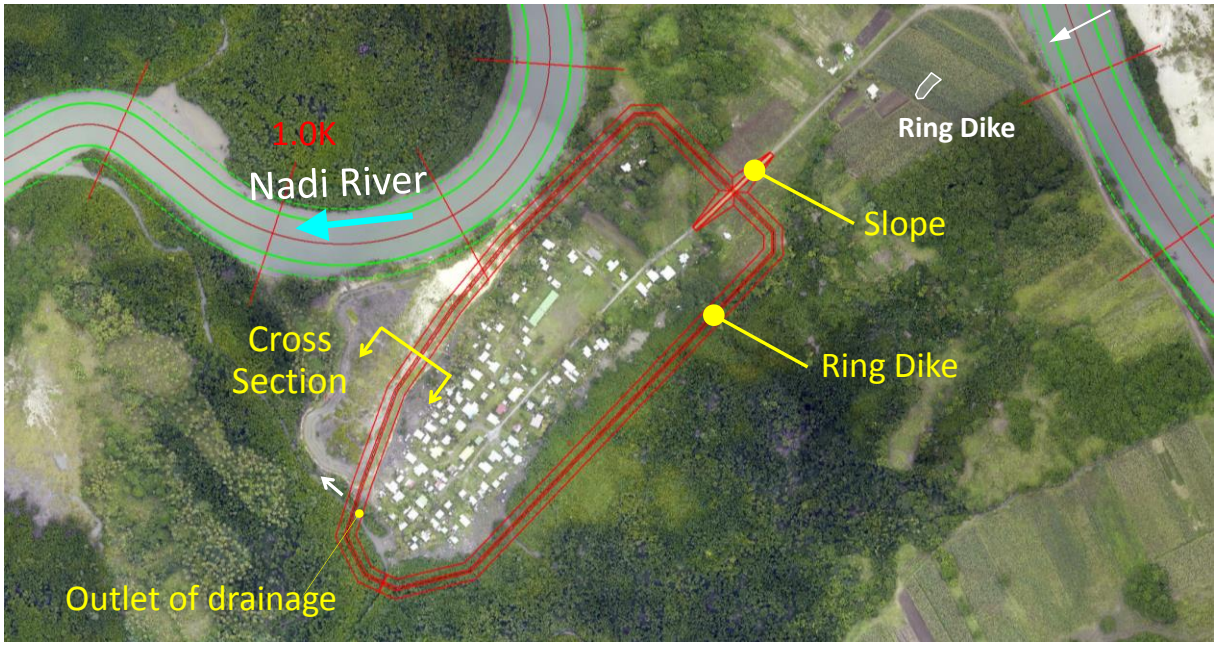


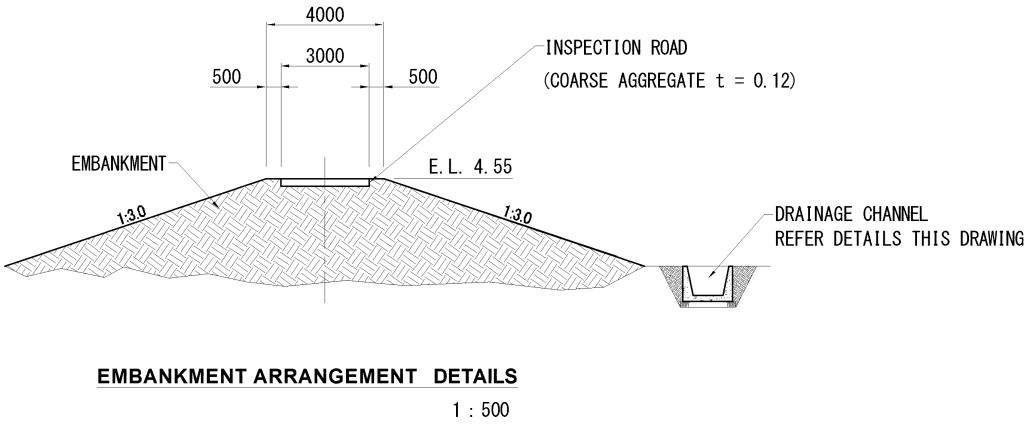
Figure 15-16 Plan of Ring Dike

(2) Longitudinal Plan

The elevation of inundation in downstream retarding basin is higher than water level in the Nadi River. Therefore, the elevation of the crest of Ring Dike is set considering the elevation of inundation. The elevation of the crest of Ring Dike is set at E.L. 4.55m for the entire section.

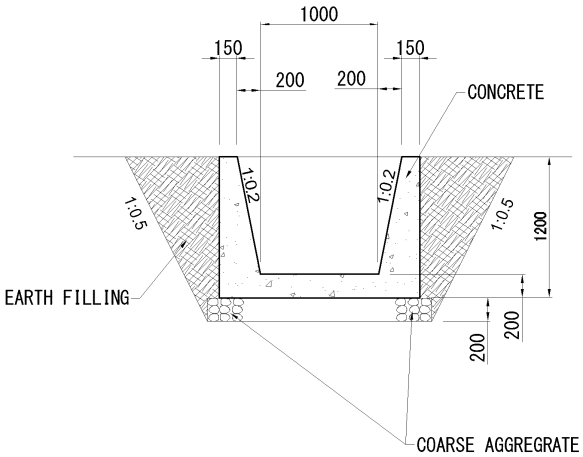
(3) Cross-Sectional Plan

Crown width of embankment is set as 4.0m. Either river or land side of slope gradient is set as 1:3.



EMBANKMENT ARRANGEMENT DETAILS

1 : 500



DRAINAGE CHANNEL DETAILS

1 : 50

Figure 15-17 Typical Cross Section (Ring Dike)

15.5 Shortcuts of tributaries

Surrounding Dike of Nadi Town mentioned before in Chapter 15.3 causes negative impact (Increasing of Inundation Depth) around the confluence points of Nawaka River and the Malakua River. Building shortcuts of tributaries, which can drain the flood flow smoothly to downstream, are planned in order to mitigate the negative impact.

The specifications (length, width) of shortcuts are set through hydrological analysis. Details of selection of counter measures and flood analysis result are mentioned in "*Final Report: Volume Ⅱ, Main Report, Part Ⅰ:Master Plan Sturdy, 7.7.3(3) Counter Measures for Negative Impact caused by the Priority Project*".

The plan and typical cross sections of the shortcuts are described in Figure 15-18 and Figure 15-19, respectively.

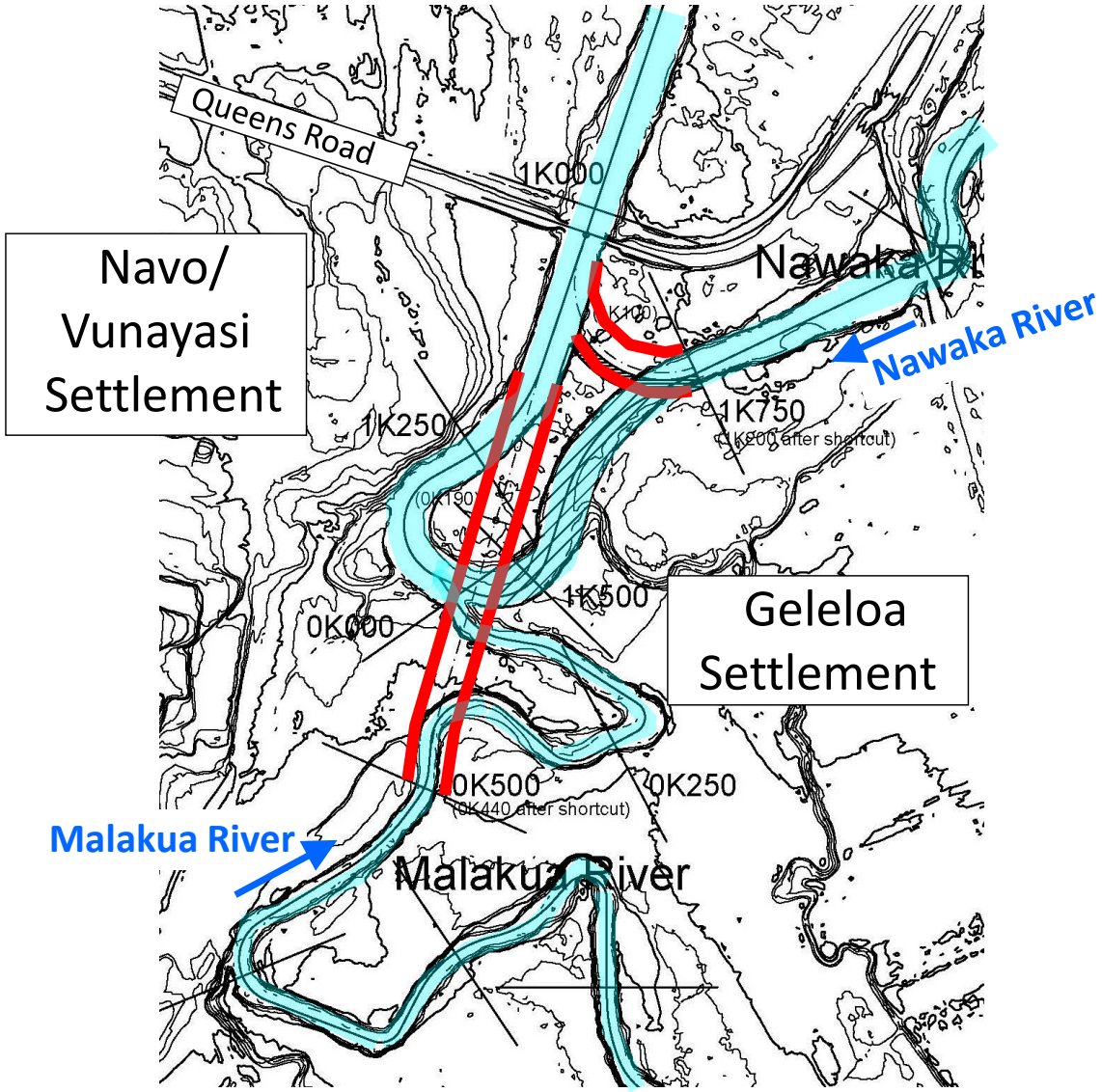


Figure 15-18 Plan of Shortcuts of Tributaries

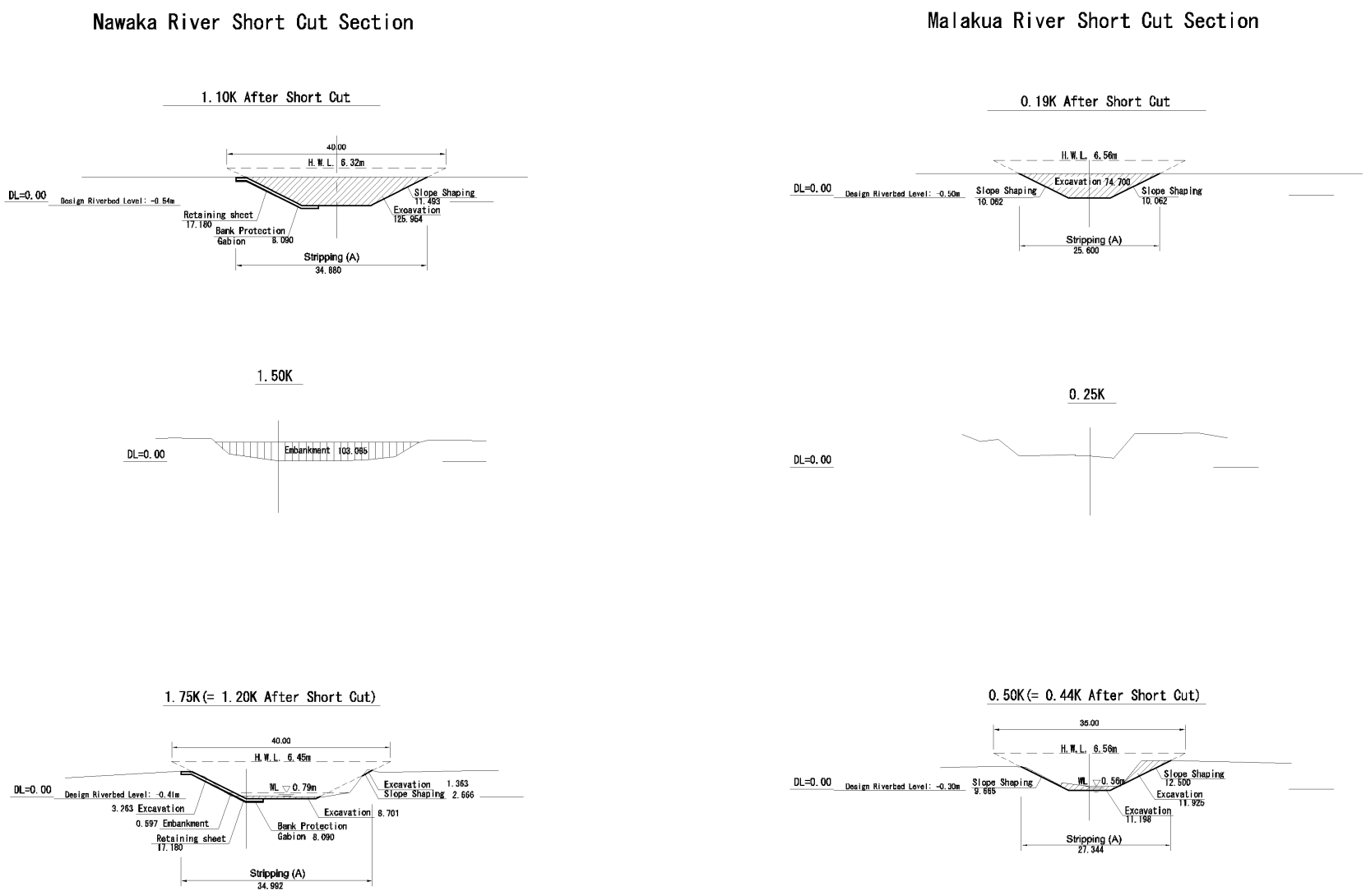


Figure 15-19 Typical Cross Section (Shortcuts of Tributaries)

15.6 Rebuilding of Bridges

15.6.1 Design Standards

The major technical standards shown in the Table 15-5 will be applied in the preliminary design of bridges in this project. There are some bridge design standards based on the standards of New Zealand and Australia in Fiji. These standards specify the basic regulations such as live loads but details are not provided Therefore, the standards of Fiji, New Zealand, Australia and Japan is referred to the preliminary design in this project. Furthermore, the details should be decided through discussion with MOT when the detailed design is implemented.

Table 15-5 Major Technical Standards and Reference Documents

No.	Name	Editor / Publishing Office	Date of publication	Remarks
1	Cabinet Order Concerning Structural Standards for River Management Facilities, etc.	Japan River Association	January 2000	
2	Specifications for highway bridges	Japan Road Association	March 2012	
3	Government Order on Road Design Standards	Japan Road Association	February 2004	
4	Design Guide – Bridge wharf, jetty, culvert and crossing structures - Revision: Version A	Fiji Road Authority	June 2015	Bridge Design Standards
5	Guide to road design	Austroad	August 2010	Road Design Standards
6	Bridge manual (SP/M/022) Third Edition	New Zealand Transport Agency	September 2014	Bridge Design Standards
7	AS/NZS 1170.0:2002	Australian/New Zealand Standard	June 2002	General requirements are shown in structural design
8	NZS 1170.5: 2004	New Zealand Standard	December 2004	Seismic Design Standards
9	NZS 3101:2006	New Zealand Standard	March 2006	Design Standards for Concrete Structures

Source: JICA Study Team

15.6.2 Preliminary Design of Nadi Town Bridge

(1) Summary

The bridge concerned is located at point where Queens Road, a primary arterial road, crosses the Nadi River (see Figure 15-20). The bridge consists of a 3-span steel cantilever girder bridge and a simple span steel girder bridge, with total length of 72.0m, and it was constructed in 1965 (see Photo15-1, Figure 15-21). This bridge was planned to be rebuilt since freeboard (clearance below the girder) could not be maintained and length of bridge is not enough after widening. The plan was to build the new bridge, which is 108 m long, at the same location due to the limitation of land (see Figure 15-22).

Figure 15-20 Bridge Location

Photo 15-1 Current View (from lower left bank)

1) Superstructure

The HWL around the rebuilt bridge location is high; there is no alternative other than making the design vertical alignment higher than existing bridge in order to maintain the design freeboard below girder. Also, it was needed to employ a low height girder bridge because the elevation of road surface could not be raised due to the neighboring traffic junction and shopping street, and river block and cost issue considerations. Therefore, a 3-span PC continuous post-tension T-Girder Bridge was planned considering the past experiences of

successful construction and cost performance.

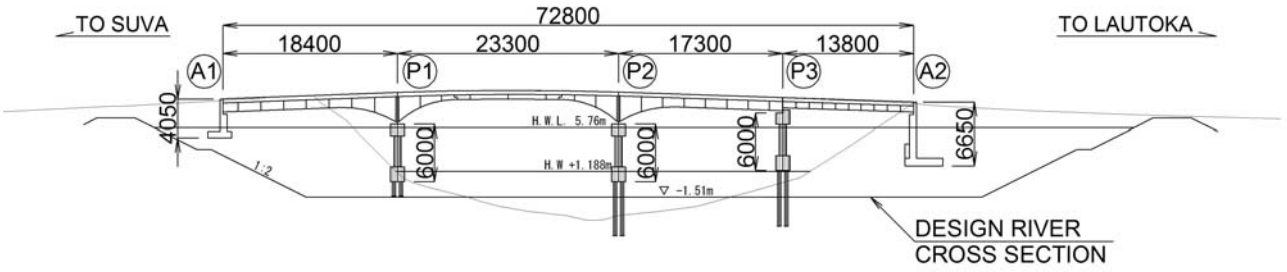


Figure 15-21 (1) Side View of Existing Bridge (Nadi Town Bridge) Source: JICA Study Team

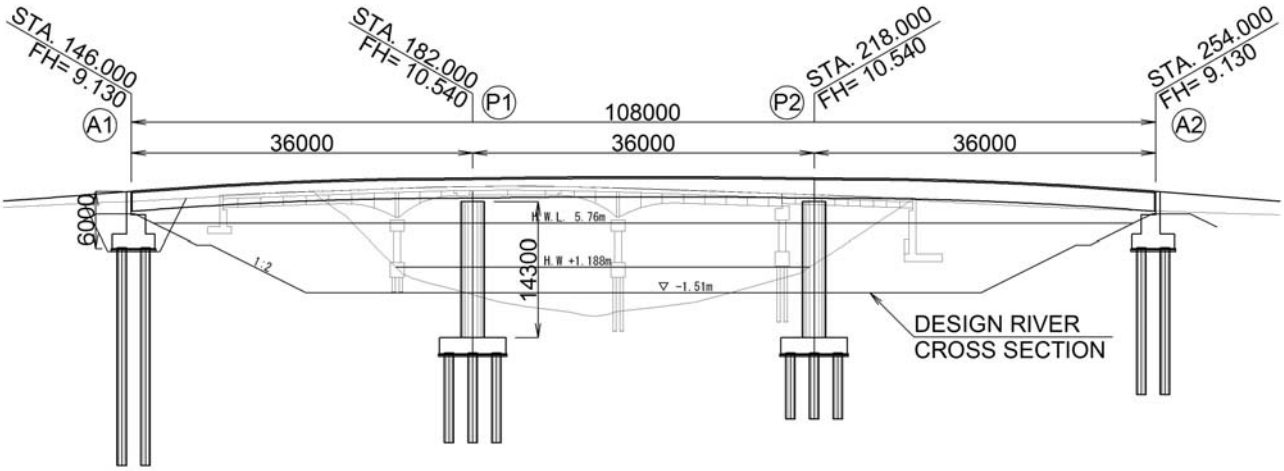


Figure 15-21 (2) Side view of new bridge (Nadi Town Bridge) Source: JICA Study Team

(2) Consideration of Road Alignments

1) Design Policy

In this planning project, cross sectional plan, horizontal and vertical alignment are examined, and also the road alignment for bridge section and approach roads on both sides of the existing bridge are planned in order not to redo the detailed road & bridge design in the future.

The basic design principles in this planning are as follows:

- ✓ The number of carriageways should be the same as that of the existing bridge.
- ✓ The horizontal alignment should not be changed due to the limitation of land.
- ✓ The vertical alignment should be set up based on the girder height of the specified type of superstructure, and the clearance below girder. Also, the approach roads on both sides of the existing bridge should be connected to the present earth work section, but it is required not to raise elevation of road surface around the neighboring traffic junction as much as possible to keep the access to the neighboring shopping stores and residential houses. To realize this, transition toward the existing elevation is considered making the improvement area as short as possible under the applicable standards with consideration of mobility.

2) Consideration of Road Alignments

The plan and vertical section drawings, which are prepared according to the above-mentioned principles, are shown in Figure 15-22.

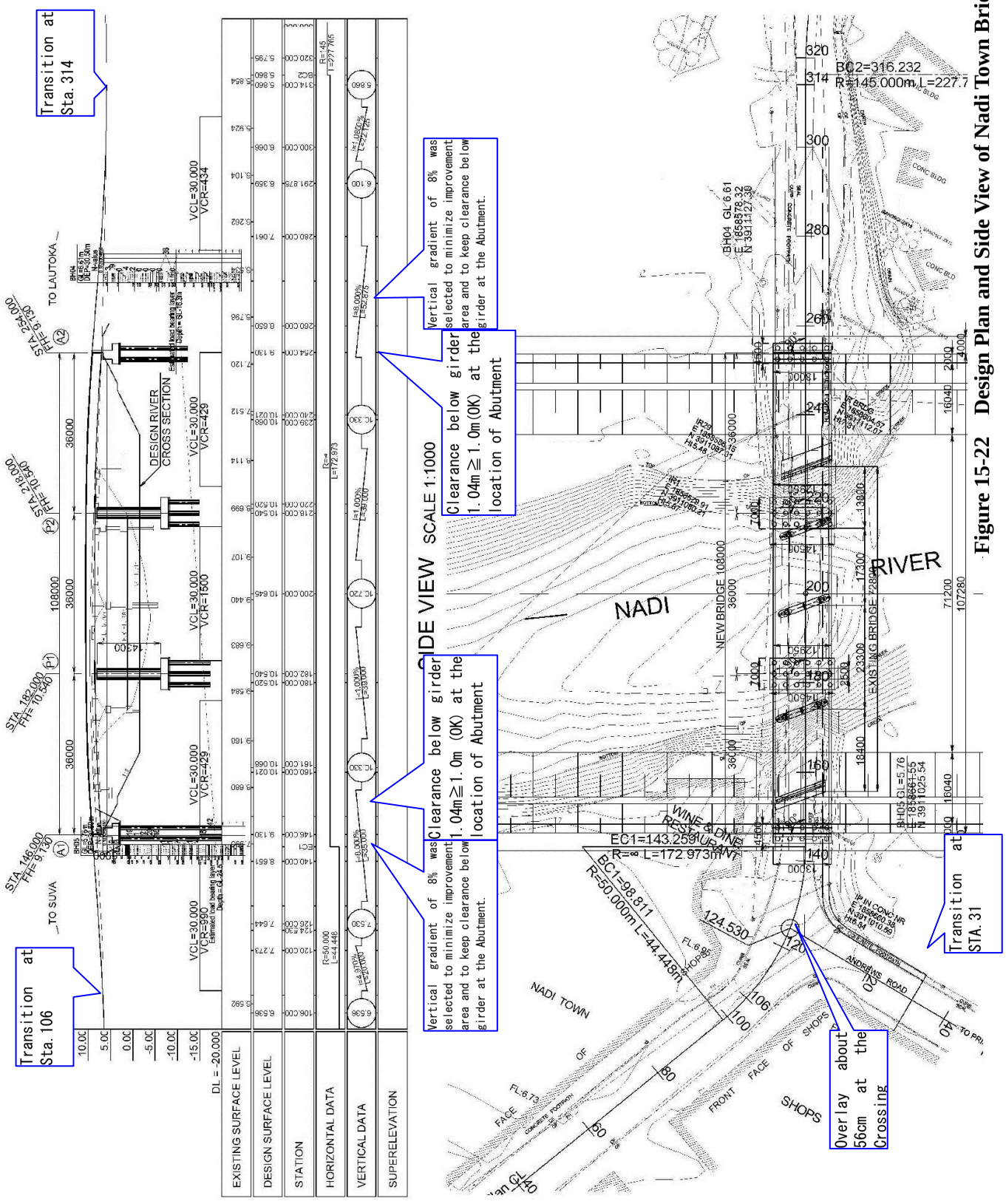


Figure 15-22 Design Plan and Side View of Nadi Town Bridge

Source: JICA Study Team

15.6.3 Preliminary Design of Old Queens Road Bridge

(1) Summary

The bridge concerned is located at the point where the primary rural road of Old Nadi Back Road crosses the Nadi River (see Figure 15-24), and it is a 9-span simple steel bridge, with a total length of 99.3m, constructed in 1936. The width is about 3m and its sidewalk was constructed on the overhanging beam additionally. Moreover, a tramline also passes on this bridge girder, which span is divided the same as that of the road bridge, and the substructure is combined (see Photo15-2, Figure 15-23). This bridge was decided to be reconstructed because of the following reasons:

Figure 15-23 Bridge Location

- ✓ Span length is short (maximum span length is 12.3m, and the number of piers is 8, while, the *Cabinet Order concerning structural Standards for River Management Facilities*, etc. specifies standard span length as 20m, and limits maximum number of piers to 4), and there is inconsistency between the direction of normal river normal line and the direction of piers, which may lead to flow blockage after the improvement.
- ✓ Piers were located within the planned slope, and the stability of revetment body cannot be confirmed.
- ✓ The foundation was exposed due to the scouring of river bed, and structural stability may become a big issue.

Photo 15-2 Site Photo

The new bridge was planned as below considering the site conditions and planned cross section of the river (see Figure 15-24).

1) Road Bridge

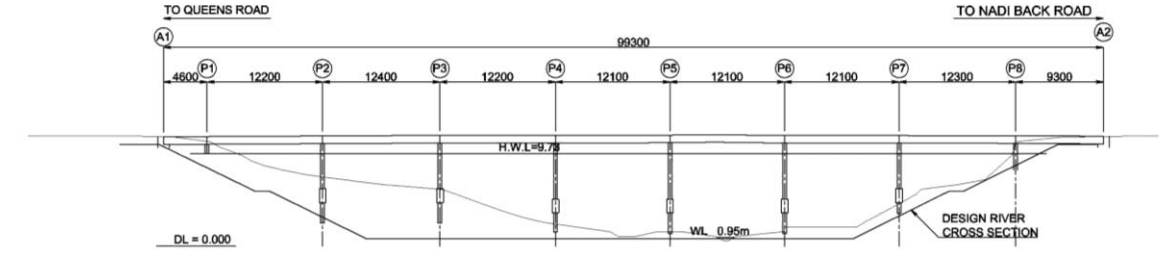
Road width was planned as two-lane road, one lane for each direction like the approach roads, and the tramline was planned to move to the lower river side due to the land limitation.

The clearance below girder was secured by raising the vertical alignment higher than current elevation because of high HWL. Meanwhile, formation level of road surface could not be raised because of adjacent cement factory or many residential houses. In addition, river blockage and cost were to be considered. Considering these situation, it was required to employ low height girders. Hence, PC 3-span Continuous Post Tension I-Girder Bridge (bridge length of 96m) was planned considering the past successful construction experiences in Fiji and construction cost.

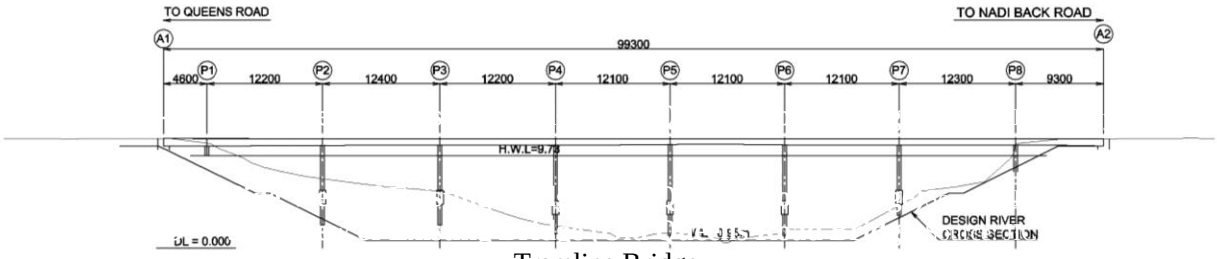
2) Tramline Bridge

"Through bridge type" was selected to secure the clearance below girder because the vertical alignment could not be changed considering the climbing capacity and safe operation of trams.

A Steel 3-span Continuous Through-Bridge with the same span division as that of the Road Bridge was selected considering the past successful construction experiences in Fiji and construction cost.



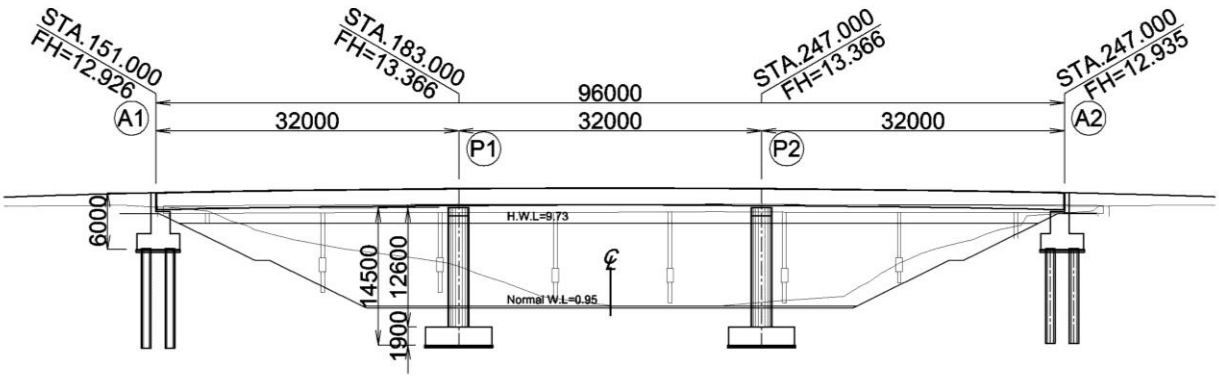
Road Bridge



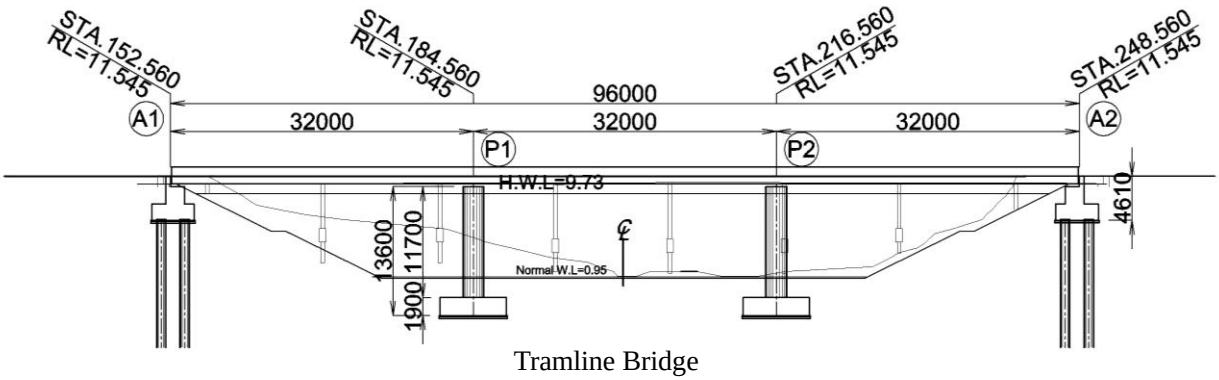
Tramline Bridge

Source: JICA Study Team

Figure 15-24 Side view of existing bridge (Old Queens Road Bridge)



Road Bridge



Tramline Bridge

Source: JICA Study Team

Figure 15-25 Side view of new bridge (Old Queens Road Bridge)

(2) Consideration of Road Alignments

1) Design Policy

In this planning project, cross sectional plan, horizontal & vertical alignment are examined, and also the road & tramline alignments for bridge section and approach roads on both sides of the existing bridge are planned in order not to redo the detailed road & bridge design in the future. The basic principles of the design in this planning are as follows:

- ✓ Road width was planned as two-lane road, one lane for each direction, like the approach roads. Horizontal alignment should be controlled by the land of cement factory on the left bank side.
- ✓ Vertical alignment of road should be controlled by girder height of the superstructure type as mentioned below and the clearance under the girder. The transition section is set at front and behind the bridge. The access should be secured by limiting the raise of the road surface around the entrance of the cement factory.
- ✓ Horizontal alignment of tramline should be parallel to the road, and the transition section should be toward the existing road conditions. The vertical transition should be toward achieving the current level considering the climbing capacity and safe operation of trams.

2) Consideration of Alignments

Plan and side view drawings of the road design prepared based on the above-mentioned principle are shown in the next page.

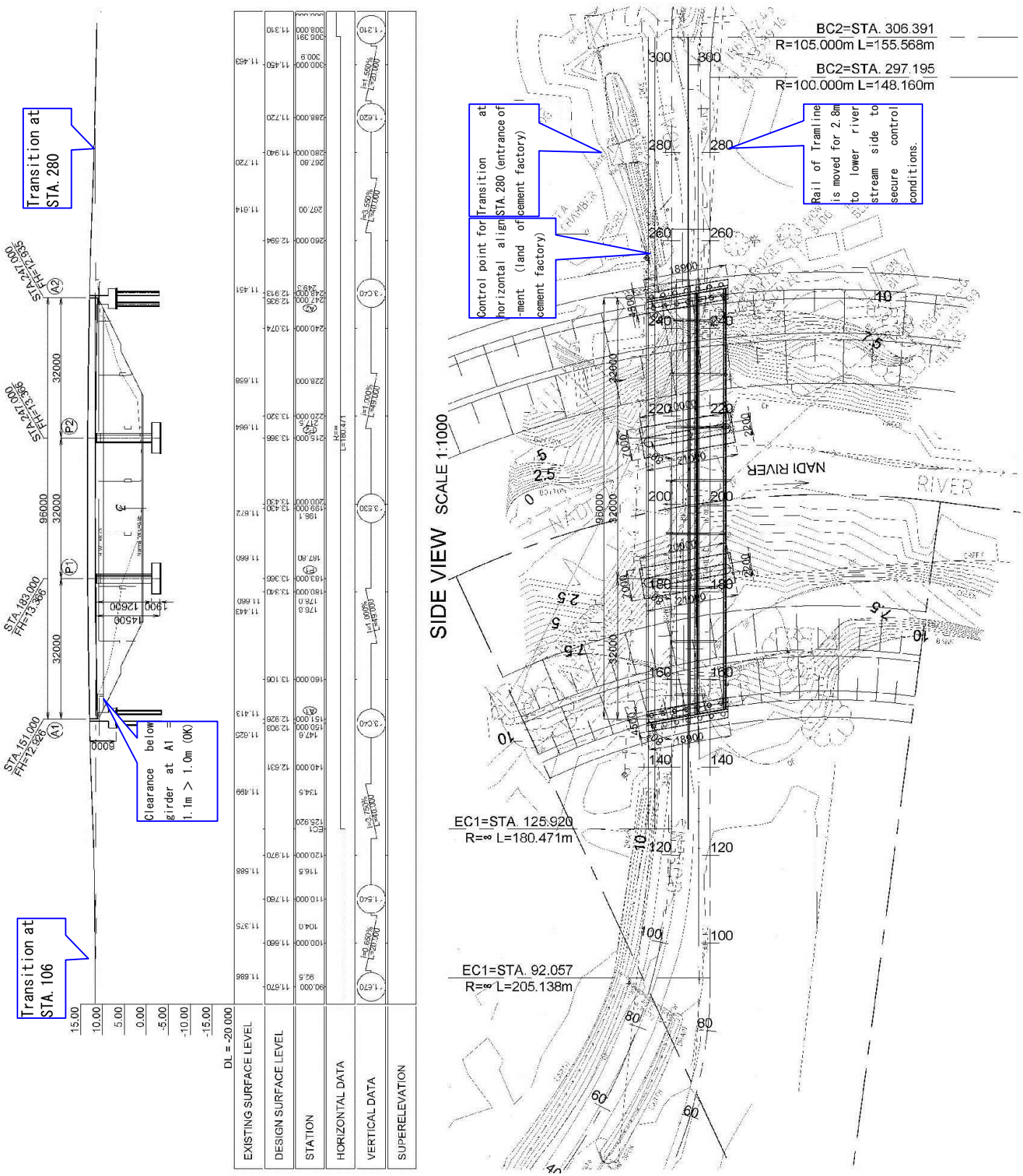


Figure 15-26 Plan and Side View of Old Queens Road Bridge

Source: JICA Study Team

15.7 Approximate Construction Quantity

Approximate Construction Quantity is as described in Table 15-6 and Table 15-7.

Table 15-6 Approximate Construction Quantity (River Works)

Item	Main Works	Description	Unit	Package-1	Package-2	Package-3	Package-4		Total
				River Widening	Retarding Basin A, B	Ring Dike	Surrounding Dike	Short cut of tributaries	
				Quantity	Quantity	Quantity	Quantity	Quantity	Quantity
Ⅰ. Approximate Construction Quantity									
Quantity of Main Works									
	Earth Work	Excavation	m3	3,928,181.0	1,257,034.5	6,446.0	290,737.0	23,431.0	5,505,829.5
		Backfill	m3	868,327.0		21,606.0	34,398.0		924,331.0
		Embankment	m3	328,936.0	1,159,681.3	57,364.0	251,216.0	27,725.0	1,824,922.3
		Trimming of slope (Cuting)	m2	349,832.7	168,133.6		61,321.0	7,568.0	586,855.3
		Stripping topsoil	m2	1,375,000.0	305,000.0	37,387.0	222,240.0	12,092.0	1,951,719.0
	Bank Protection	Gabion	m2	-	1,878.8	-	-	-	1,878.8
	Embankment	Prevent of Crown of levee	m2	110,000.0	5,141.9	7,084.0	19,000.0	-	141,225.9
		Planting	m2	95,760.0	410,498.1	30,807.0	94,236.0	-	631,301.1
	Structures	Overflow Dike	LS	-	2	-	-	-	2
		Drainage Sluice Gate	LS	-	2	-	-	-	2
		Flap Gate	LS	8	2	1	1	-	12
		Flood Wall Gate	LS	-	-	-	1	-	1
	Disposal	Dozing and Loading	m3	2,659,223.0	97,353.2	-	-	-	2,756,576.2
		Transportation	m3	2,659,223.0	97,353.2	-	-	-	2,756,576.2
		Embankment	m3	2,659,223.0	97,353.2	-	-	-	2,756,576.2
Quantity of Temporary Works									
	Temporary Work	Coffer Dam	m3	752,000.0	-	-	-	-	752,000.0
		Temporary Road	m2	84,000.0	-	-	-	-	84,000.0
Compensation Wor									
	Pavement	pavement (t=0.4m)	m²	-	6,724.0	-	-	-	6,724.0

Table 15-7 Approximate Construction Quantity (Bridge Works)

No.		unit	Quantity	
No.	item	unit	Nadi Town Bridge	Old Queens Road Bridge
0000	Earth work			
0001	Excavation(soil)	m3	15,457	14,646
0005	Backfill(clean sand)	m3	4,718	4,649
0007	Banking	m3	1,414	990
0009	Cutting (soil)	m3	3,890	0
0010	Trimming of slope (Cutting)	m2	148	211
0011	Trimming of slope (Banking)	m2	318	193
0100	Foudation Work			
0103	casing cast-in-place pile(φ1.0m)	m	682	630
0200	Substructure Work			
0201	cobble foundation of structure excavation(t=0.2m)	m2	277	485
0202	levelling concrete(t=0.1m)	m2	277	485
0210	abutment/pier base concrete	m3	1,458	2,108
0220	form (for wall, pier)	m2	1,380	1,738
0221	form (for levelling concrete)	m2	15	21
0230	Rebar for the reinforcement of concrete	ton	209	301
0300	Superstructure Work			
0301	produce,transport & erection of main beam(PC I-Beam,	unit	0	21
0302	produce,transport & erection of main beam(PC T-Beam	unit	21	0
0350	Steel Girder Bridge (Through Bridge)L=96m(3@32m)	m2	0	691
0400	Floor Slab Work			
0402	floor slab concrete c=400kg	m3	555	298
0403	form (for slab)	m2	704	969
0404	Rebar for the reinforcement of concrete	ton	56	30
0405	supporting (for slab)	m2	1,771	1,286
0500	Bridge Attachment Work			
0501	bearing	unit	42	50
0502	expansion joint	m	26	34
0600	Bridge Surface Work			
0604	Guard fence	m	216	192
0605	Waterproofing	m2	1,404	960
0606	Asphalt pavement for bridge 50thick	m2	1,404	960
0700	Removal of Existing Bridge Work			
0701	concrete bridge breaking work	m3	563	294
0702	concrete waste disposition	m3	611	335
0703	steel bridge breaking work	ton	92	146
0704	Removal of Existing Pile	m	400	460
0800	Pavement Work			
0801	road upper subbase	m2	1,756	3,092
0803	Asphalt pavement for approach	m2	1,756	1,200
0850	Tramline Orbit	ton	0	17
0900	Temporary Work			
0901	Temporary bridge with H beam	m2	576	576
0902	Pile with H Beam(H=350)	m	35	35
0904	Big sandbag	unit	750	420
0905	temporary construction road	m2	2,000	2,840
0906	Hume Pipe (φ1.0m)	m	0	150
0907	Coffeing Works	m3	8,515	3,720
1000	Concrete Work			
1011	Concrete 18Mpa	m3	632	447
1020	Form	m2	1,275	951
1040	Crushed Stone (t=0.2m)	m2	538	406
1100	Dike Works			
1101	Pavement of Crown of levee	m2	264	376
1102	Plant spraying	m2	148	211
1200	Revetment Work			
1203	Concrete blocks for bank protection	m2	918	1,776
1300	Removal of Surplus Soil Works			
1301	Dozing and Loading	m3	4,700	5,287
1302	Filling materials transport (≦5.5km)	m3	4,700	5,287
1303	Banking	m3	4,700	5,287
2000	Other Work			
2001	removal / relocation of utility pole	unit	6	2

15.8 Construction Planning

15.8.1 River Works

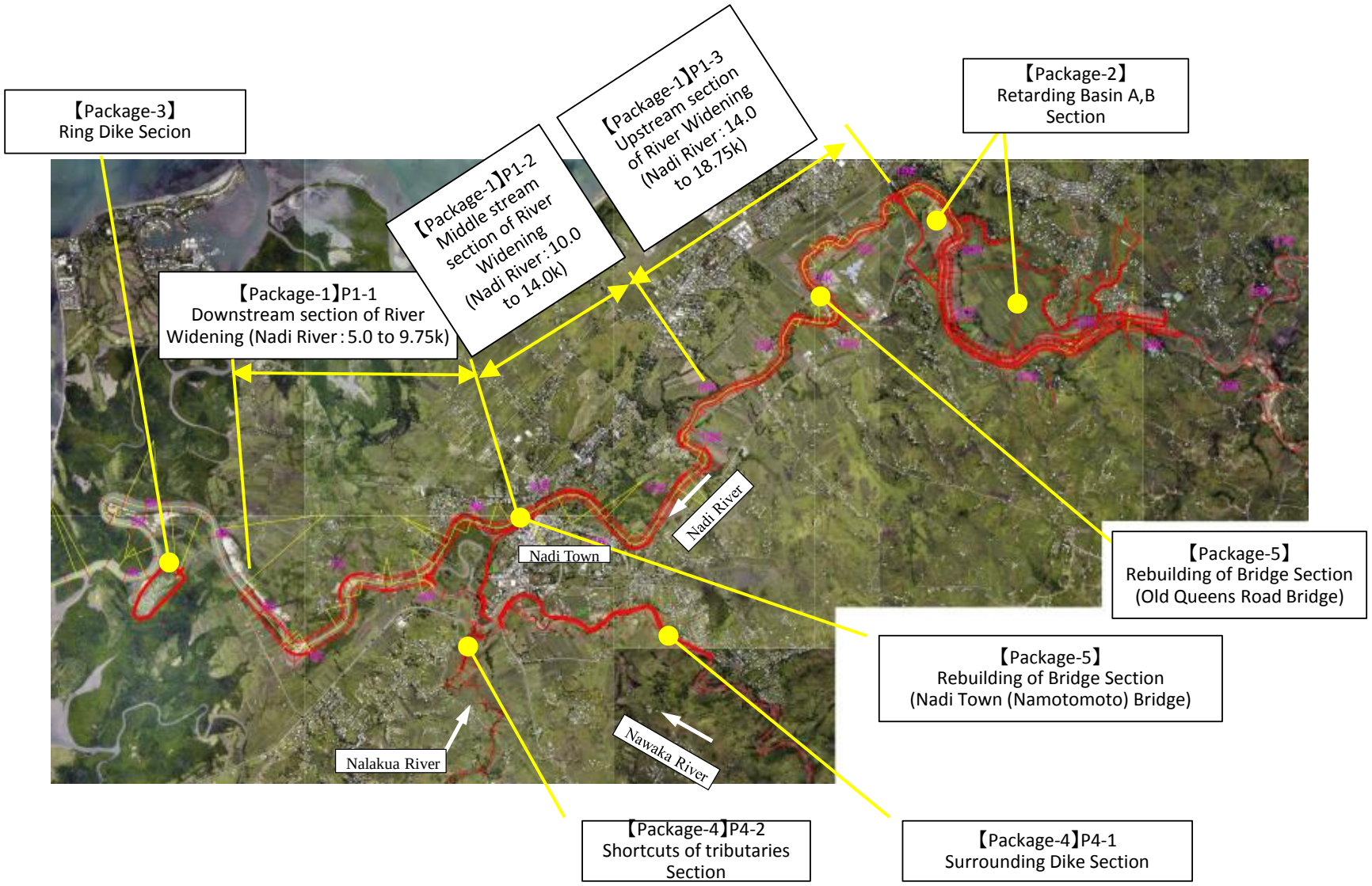
(1) Construction Section

Construction work under this Project has been divided into four (4) major construction sections, some of which are subdivided into smaller construction sections. Construction sections are as shown in Table 15-8 and Figure 15-27.

Table 15-8 Division of Construction Sections

Construction Sections		Contents of Works
Major Section	Break Down	
Package-1: River Widening	P1-1: Downstream section of River Widening (Nadi River : 5.0–9.75k)	・River Widening (Excavation and Embankment)
	P1-2: Middle stream section of River Widening (Nadi River : 10.0–14.0k)	・River Widening (Excavation and Embankment)
	P1-3: Upstream section of River Widening (Nadi River : 14.0–18.75k)	・River Widening (Excavation and Embankment)
Package-2: Retarding Basin A, B Section		・Construction of Retarding Basin A, B
Package-3: Ring Dike Section		・Construction of Ring Dike
Package-4: Surrounding Dike and shortcuts of tributaries Section	P4-1 Surrounding Dike Section	・Construction of Embankment on left bank side of Nadi River ・Construction of Embankment on right bank side of Nawaka River
	P4-2 Shortcuts of tributaries Section	・Shortcuts of tributaries
Package-5: Rebuilding of Bridge Section		・Rebuilding of Nadi Town Bridge (Namotomoto Bridge) ・Rebuilding of Old Queens Road Bridge

Source: JICA Study Team



Source: JICA Study Team

Figure 15-27 Division of Construction Sections

(2) Work Schedule

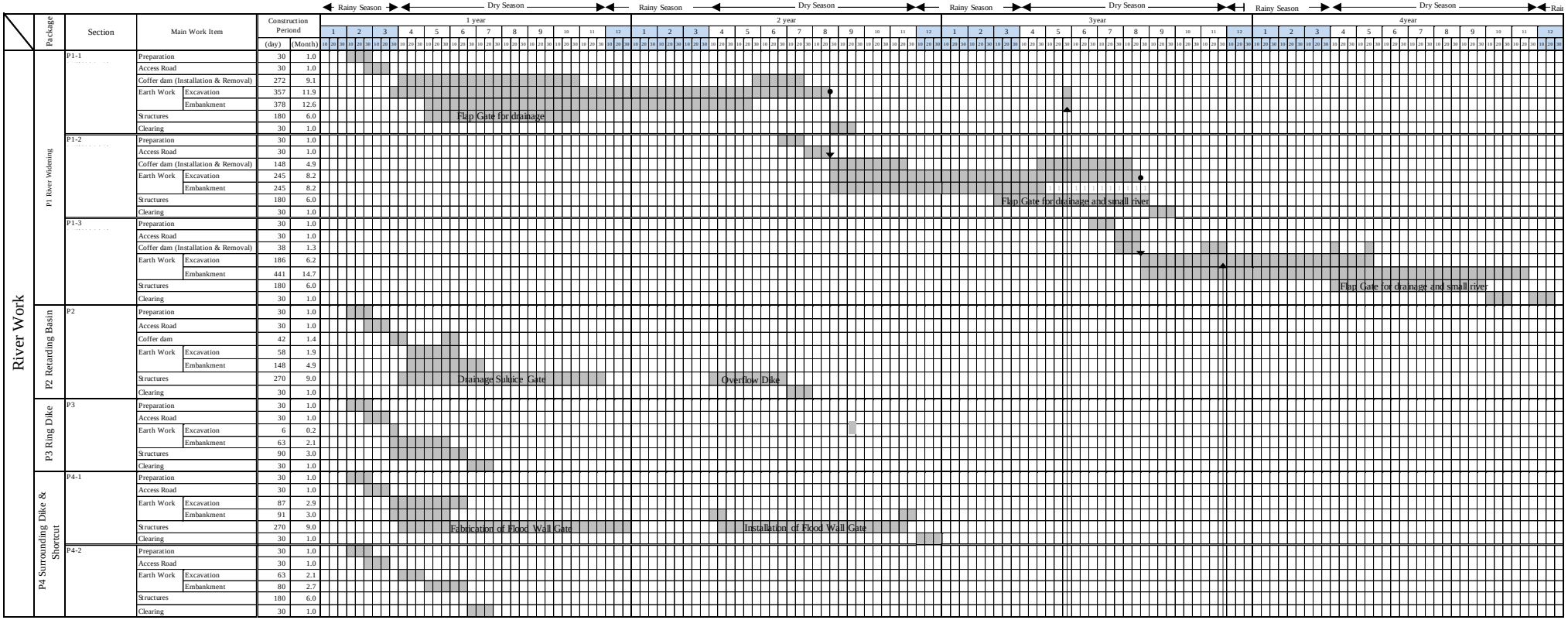
The calculation result of construction period is as shown in Table 15-9. The work schedule is as described in Table 15-10.

Table 15-9 Construction Period (River Work)

Package	Section		Main Earth Works	Construction Execution Volume (m3/日)	Construction Volume (m3)	Number of Equipments (Nos)	Work Day (days)	Ratio	Construction Period	
									Day (days)	Month (month)
P1 River Widening	P1-1	River Widening in downstream section	Installation of Coffer Dam	600	143,693	3	80	1.7	136.0	4.5
			Removal of Coffer Dam	600	143,693	3	80	1.7	136.0	4.5
			Excavation	710	1,781,637	12	210	1.7	357.0	11.9
			Embankment and Backfilling	320	424,593	6	222	1.7	378.0	12.6
	P1-2	River Widening in middle stream section	Installation of Coffer Dam	600	76,500	3	43	1.7	74.0	2.5
			Removal of Coffer Dam	600	76,500	3	43	1.7	74.0	2.5
			Excavation	710	1,218,717	12	144	1.7	245.0	8.2
			Embankment and Backfilling	320	276,153	6	144	1.7	245.0	8.2
	P1-3	River Widening in upstream section	Installation of Coffer Dam	600	39,558	6	11	1.7	19.0	0.6
			Removal of Coffer Dam	600	39,558	6	11	1.7	19.0	0.6
			Excavation	710	927,827	12	109	1.7	186.0	6.2
			Embankment and Backfilling	320	496,517	6	259	1.7	441.0	14.7
P2 Retarding Basin	P2	Retarding Basin A,B	Installation of Coffer Dam	600	41,605	6	12	1.7	21.0	0.7
			Removal of Coffer Dam	600	41,605	6	12	1.7	21.0	0.7
			Excavation	710	1,257,035	5	34	1.7	58.0	1.9
			Embankment and Backfilling	320	1,159,681	4	87	1.7	148.0	4.9
P3 Ring Dike	P3	Ring Dike	Excavation	320	6,446	2	3	1.7	6.0	0.2
			Embankment and Backfilling	300	78,970	2	37	1.7	63.0	2.1
			–	–	–	–	–	–		
P4 Surrounding Dike & Shortcut	P4-1	Surrouding Dike of Nadi Town	Excavation	320	290,737	2	51	1.7	87.0	2.9
			Embankment and Backfilling	300	285,614	2	53	1.7	91.0	3.0
			–	–	–	–	–	–		
	P4-2	Shortcuts of tributaries	Excavation	320	23,431	2	37	1.7	63.0	2.1
			Embankment and Backfilling	300	27,725	2	47	1.7	80.0	2.7
			–	–	–	–	–	–		–

Source: JICA Study Team

Table 15-10 Work Schedule（River Work）



	Package	Section	Main Work Item		Construction Period (day)	(Month)
River Work	P1 River Widening	P1-1	Preparation		30	1.0
			Access Road		30	1.0
			Coffer dam (Installation & Removal)		272	9.1
			Earth Work	Excavation	357	11.9
				Embankment	378	12.6
			Structures		180	6.0
			Clearing		30	1.0
		P1-2	Preparation		30	1.0
			Access Road		30	1.0
			Coffer dam (Installation & Removal)		148	4.9
			Earth Work	Excavation	245	8.2
				Embankment	245	8.2
			Structures		180	6.0
			Clearing		30	1.0
		P1-3	Preparation		30	1.0
			Access Road		30	1.0
			Coffer dam (Installation & Removal)		38	1.3
			Earth Work	Excavation	186	6.2
				Embankment	441	14.7
			Structures		180	6.0
			Clearing		30	1.0
	P2 Retarding Basin	P2	Preparation		30	1.0
			Access Road		30	1.0
			Coffer dam		42	1.4
			Earth Work	Excavation	58	1.9
				Embankment	148	4.9
			Structures		270	9.0
			Clearing		30	1.0
	P3 Ring Dike	P3	Preparation		30	1.0
			Access Road		30	1.0
			Earth Work	Excavation	6	0.2
				Embankment	63	2.1
			Structures		90	3.0
			Clearing		30	1.0
	P4 Surrounding Dike & Shortcut	P4-1	Preparation		30	1.0
			Access Road		30	1.0
			Earth Work	Excavation	87	2.9
				Embankment	91	3.0
			Structures		270	9.0
			Clearing		30	1.0
		P4-2	Preparation		30	1.0
			Access Road		30	1.0
			Earth Work	Excavation	63	2.1
				Embankment	80	2.7
			Structures		180	6.0
			Clearing		30	1.0

15.8.2 Bridge Works

(1) Nadi Town Bridge

A1 Abutment of Nadi Town Bridge is located adjacent to the urban area and A2 Abutment is adjacent to the residential houses and a primary school. The traffic volume of Queens Road, which the bridge is located, is quite heavy because it is a primary road in the region. The bridge is located in a tidal river section area.

The flow of bridge rebuilding, principle of construction at each step, and typical construction period are explained hereunder, considering the above-mentioned site conditions.

1) Construction Process

The construction process flow of this bridge is shown in Figure 15-28. The planning of river improvement work planning at the bridge rebuilding location is underway, but it will be implemented separately from this bridge because of its excessive length.

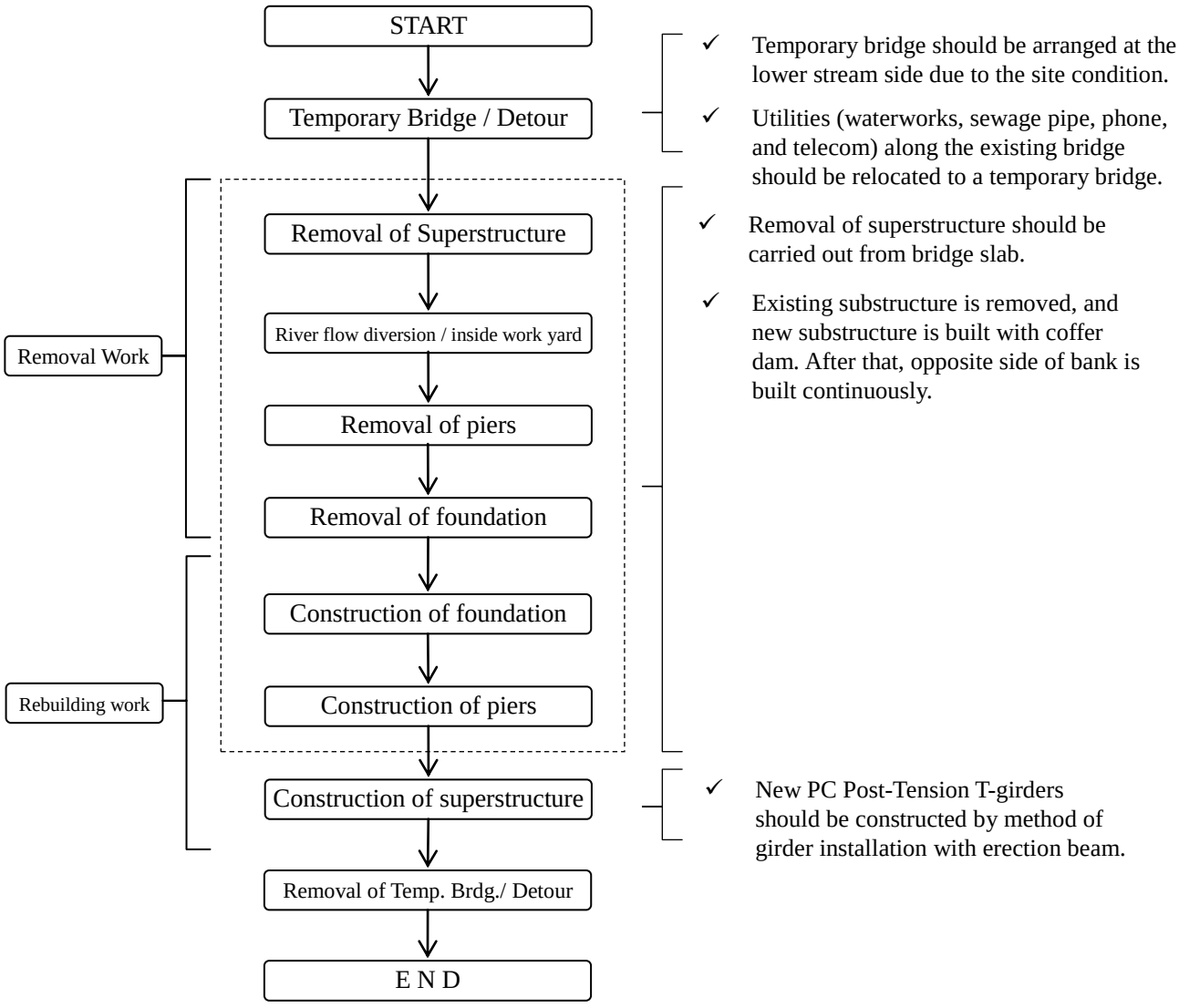
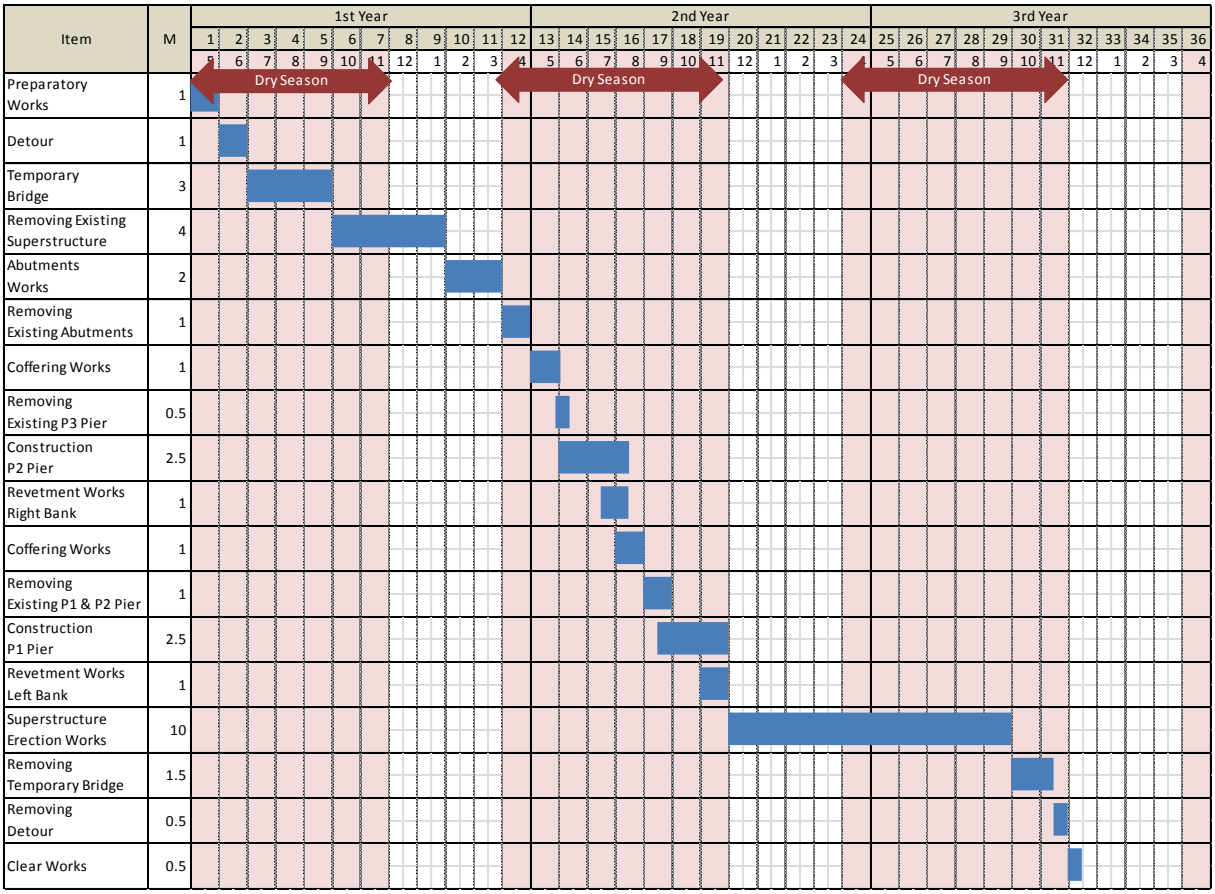


Figure 15-28 Construction Flow（Nadi Town Bridge）

2) Work Schedule

The outline of construction schedule is as shown in Table 15-11. The substructure in the present river channel is to be constructed in a dry season. The superstructure is to be constructed by the erection girder method over the water surface and behind of abutment so that the construction can be done through the year.

Table 15-11 Process Scheduling (Nadi Town Bridge)



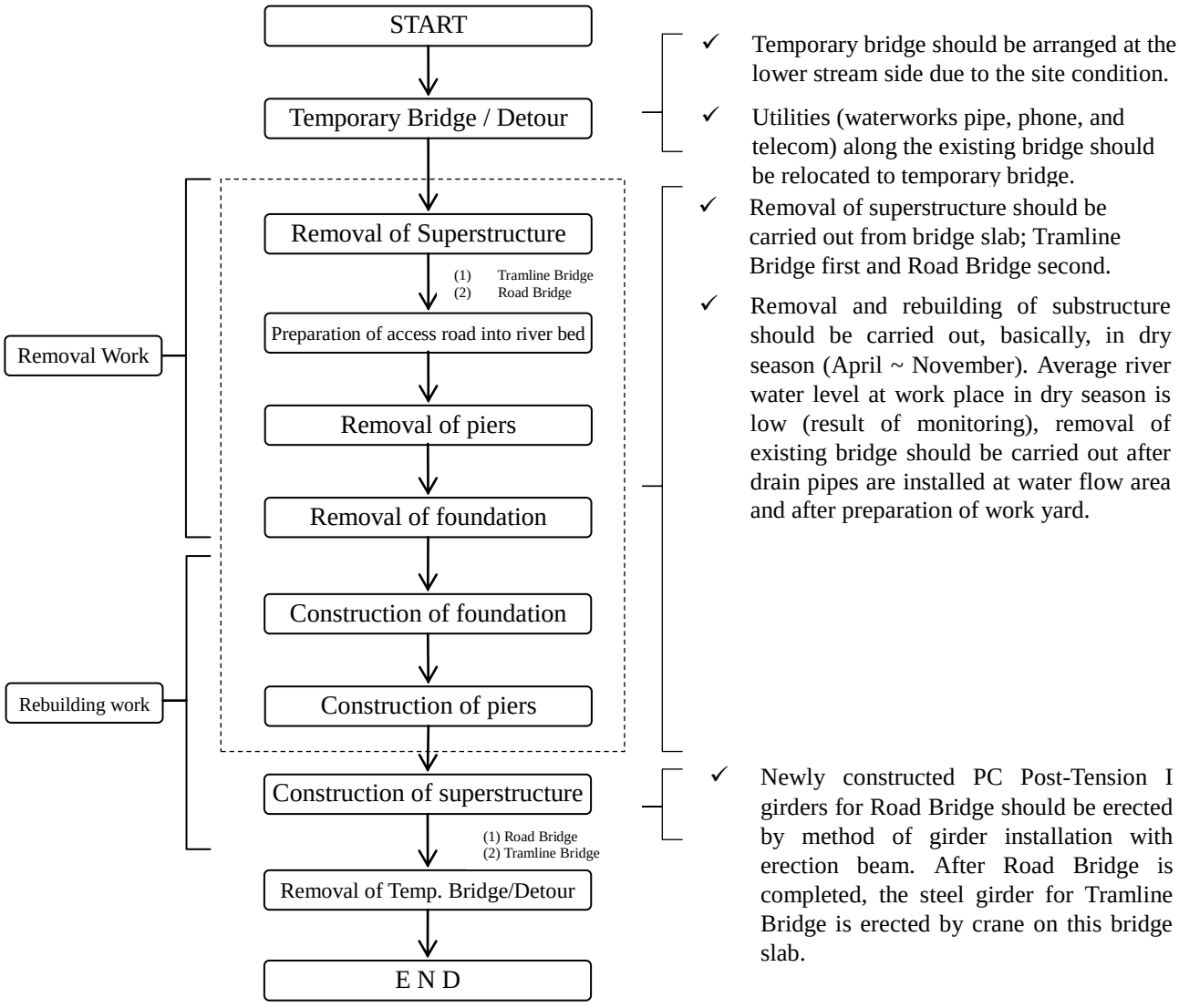
Source: JICA Study Team

(2) Old Queens Road Bridge

A2 Abutment of Old Queens Road Bridge is located adjacent to the cement factory and private houses along the existing road, and the Old Nadi Back Road, which include this bridge, is the primary road of this region. This road connects Queens Road and Nadi Back Road, and the traffic volume is high. The flow of bridge rebuilding, principle of construction at each step, and typical construction period are explained hereunder, considering the above-mentioned site conditions.

1) Construction Process

The construction process of this road bridge and tramline bridge, are shown in Figure 15-29 respectively.

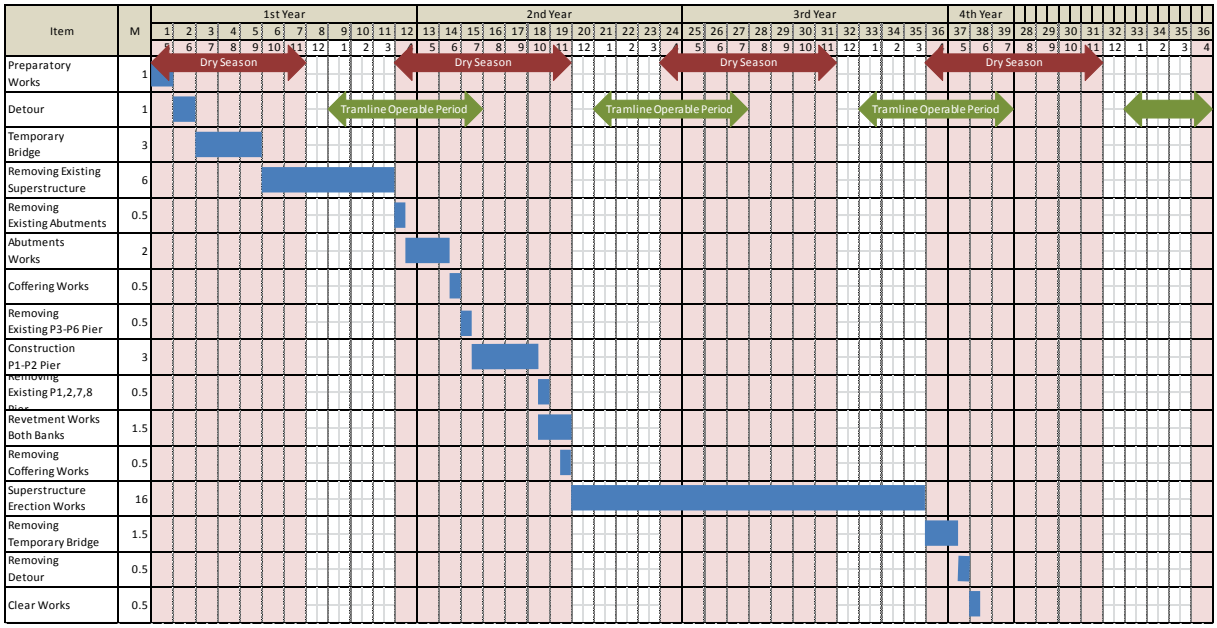


Source: JICA Study Team

Figure 15-29 Construction Flow（Old Queens Road Bridge）

2) Work Schedule

Table 15-12 Process Scheduling (Old Queens Road Bridge)

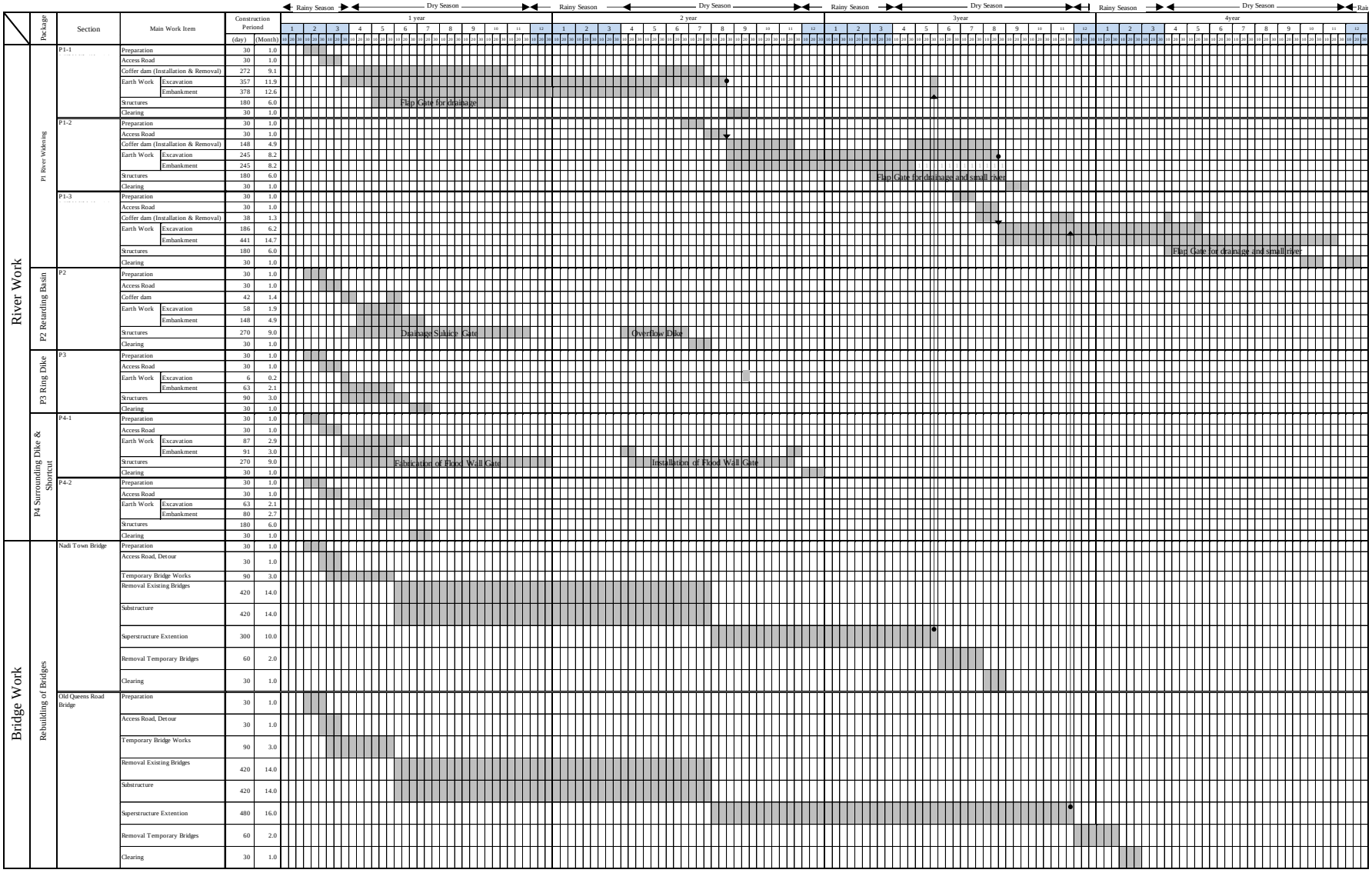


Source: JICA Study Team

15.8.3 Whole Construction Work Schedule

Whole Construction Work Schedule of this project, which is combines river work and bridge work, is as described in Table 15-13.

Table 15-13 Whole Construction Work Schedule



	Package	Section	Main Work Item		Construction Period (day)	(Month)
River Work	P1 River Widening	P1-1	Preparation		30	1.0
			Access Road		30	1.0
			Coffer dam (Installation & Removal)		272	9.1
			Earth Work	Excavation	357	11.9
				Embankment	378	12.6
			Structures		180	6.0
			Clearing		30	1.0
		P1-2	Preparation		30	1.0
			Access Road		30	1.0
			Coffer dam (Installation & Removal)		148	4.9
			Earth Work	Excavation	245	8.2
				Embankment	245	8.2
			Structures		180	6.0
			Clearing		30	1.0
		P1-3	Preparation		30	1.0
			Access Road		30	1.0
			Coffer dam (Installation & Removal)		38	1.3
			Earth Work	Excavation	186	6.2
				Embankment	441	14.7
			Structures		180	6.0
			Clearing		30	1.0
	P2 Retarding Basin	P2	Preparation		30	1.0
			Access Road		30	1.0
			Coffer dam		42	1.4
			Earth Work	Excavation	58	1.9
				Embankment	148	4.9
			Structures		270	9.0
			Clearing		30	1.0
	P3 Ring Dike	P3	Preparation		30	1.0
			Access Road		30	1.0
			Earth Work	Excavation	6	0.2
				Embankment	63	2.1
			Structures		90	3.0
			Clearing		30	1.0
	P4 Surrounding Dike & Shortcut	P4-1	Preparation		30	1.0
			Access Road		30	1.0
			Earth Work	Excavation	87	2.9
				Embankment	91	3.0
			Structures		270	9.0
			Clearing		30	1.0
		P4-2	Preparation		30	1.0
			Access Road		30	1.0
			Earth Work	Excavation	63	2.1
				Embankment	80	2.7
			Structures		180	6.0
			Clearing		30	1.0
Bridge Work	Rebuilding of Bridges	Nadi Town Bridge	Preparation		30	1.0
			Access Road, Detour		30	1.0
			Temporary Bridge Works		90	3.0
			Removal Existing Bridges		420	14.0
			Substructure		420	14.0
			Superstructure Extention		300	10.0
			Removal Temporary Bridges		60	2.0
			Clearing		30	1.0
		Old Queens Road Bridge	Preparation		30	1.0
			Access Road, Detour		30	1.0
			Temporary Bridge Works		90	3.0
			Removal Existing Bridges		420	14.0
			Substructure		420	14.0
			Superstructure Extention		480	16.0
			Removal Temporary Bridges		60	2.0
			Clearing		30	1.0

Chapter 16 Land Acquisition and House Compensation

16.1 Land Acquisition

In this project, land acquisition is required for Package-1 (River Widening), Package-2 (Retarding basin A, B), Package-3 (Ring Dike), Package-4 (Surrounding Dike and Shortcuts of tributaries), and Package-5 (Rebuilding of Bridges). Approximate area of required land acquisition is as shown in Table 16-1. This area is calculated by Department of Land in Fiji.

Table 16-1 Land Acquisition Area

Item	Main Works	Description	Unit	Package-1	Package-2	Package-3	Package-4		Total
				River Widening	Retarding Basin A, B	Ring Dike	Surrounding Dike	Short cut of tributaries	
Land Acquisition Area									
	Area by land ownership	Freehold Land	ha	18.66	-	-	-	-	-
		State Land	ha	20.14	-	-	-	-	-
		Native Land	ha	39.96	-	-	-	-	-
	Area by landuse	Agricultural	ha	-	243.50	1.40	6.69	4.26	-
		Commercial	ha	-	-	-	0.36	-	-
		Residential	ha	-	-	-	0.21	-	-
		Others	ha	-	-	-	0.04	-	-
		Total	ha	78.76	243.50	1.40	7.31	4.26	335.22

Source: Department of Land, Fiji

16.2 Compensation

Relocation of houses for river widening and construction of embankment is required in Package-1 (River Widening) and Package-2 (Retarding Basin A, B). The number of houses that should be relocated is as shown in Table 19-27.

In addition, there are some downstream houses which are to be affected negatively by the Priority Project but not affected directly. The number of affected houses is also as shown in Table 16-2.

Table 16-2 Number of houses to be affected and relocated

Section	Number
Package-1: River Widening	6 houses (house relocations)
Package-2: Retarding Basin A,B	11 houses (house relocations)
Ring Dike	17 houses (affected houses)

Source: JICA Study Team

Chapter 17 Project Cost Estimation

17.1 Project Cost Estimation System

The following items were considered in the project cost estimation:

1. Direct construction cost
2. Consulting service (CS) cost (cumulative)
3. Work site compensation cost (cumulative)
4. Administrative cost (5% of total project cost)
5. Price increase (foreign currency: 1.8%, domestic currency: 0.2%)
6. Contingency (5%)
7. Taxes (VAT: 9%)

(1) Direct Construction Cost (Direct Cost, Base Cost for Construction)

National standards for estimating costs do not exist in Fiji, so direct construction costs were calculated based on work items in Chapter 15.7 and on the unit prices in Table 17-2. The unit price for each type of construction was set based on bidding prices pf past projects implemented by the Ministry of Infrastructure and Transportation (MoIT[1]) and Fiji Road Authority[2], reference documents (Australian Construction Handbook 2015[3], Study on The Transportation and Hydropower Projects for The Mining Development in Waisoi Area, The Republic of Fiji[4]), and on market price of recent constructions within Fiji and Public works multiplication standard unit price in Japan[5].

According to interviews with the Ministry of Agriculture and local construction workers, most of required materials, equipment and workforce can be produced from within Fiji.

(2) Consulting Service Cost

The consultancy consists of the following services, and the cost is calculated by multiplying the cost per engineer by the required man-month (MM).

1) Detailed design of river improvement and non-structural measures and bidding preparation

Detailed design work items such as detail designs for river structures and auxiliary structures (drainage flap gate, land lock and so on), supplemental surveys, drawing preparation, quantity estimation, construction plan and the project will be conducted. Also, tender documents will be prepared and assistance will be provided for bidding based on the results of detailed design.

Development of flood disaster prevention (Development of Meteor-Hydrological Observation Network) is implemented as non-structural measures. Organization strengthening and capability development are planned and detailed design is produced.

Bidding document is prepared and bidding is supported based on detailed design results by consultant.

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1 Ministry of Infrastructure and Transportation (MoIT)

2 Fiji Road Authority

3 Australian Construction Handbook 2015

4 Study on The Transportation and Hydropower Projects for The Mining Development in Waisoi Area, The Republic of Fiji

5 Public works multiplication standard unit price in Japan

2) Construction manegement in Each packages

Schedule control, quality control, performance management, environmental management, health and safety management, and handling of complaints from constructor are performed in the following 4 packages:.

Package-1: Rebuilding of Bridges, River Widening, Non-structure Measures

Package-2: Retarding Basin A, B

Package-3: Ring Dike

Package-4: Surrounding Dike, Shortcut of tributaries

(3) Component Cost

1) Site Acquistion Cost

To acquire work sites for improvement the Nadi River, site acquisition cost was calculated based on the design resultant of this study. It is not common to trade and to lease Landownership in Fiji. Therefore, the site acquisition cost was calculated in cooperation with MOL.

2) House Compensation Cost

House compensation cost estimated from the number of relocated houses for Nadi River improvement is included in project cost.

(4) Administrative Cost

Administrative cost is set at 5% of the project cost.

(5) Inflation Costs (annual rate)

Annual rate of Inflation Cost is set at 1.8% and 4.8% for foreign and domestic and foreign currencies, respectively. This rate is recommended by JICA.

(6) Contingency

Five percent of the project was added as a contingency allowance to the costs both in foreign and domestic currencies.

(7) Tariff or Taxes

Value Added Tax (VAT) is set as 9%. The customs duties, however, were neglected because the duty-paid value is applied.

(8) Exchange Rate and Others

a. Exchange rate : US$1=2.17F$, 1F$=¥54.5

b. Currency configuration: Local Currency Portion, Foreign Currency Portion

c. Interest rate: 0.60% for construction, 0.01% for consultant service

d. Front-end-fee: 0.2%

(9) Project Taking-over and Defect Liability

The Project shall be taken over at the completion of construction.

As for the bond, the term of the performance security (bond) shall be valid until the construction

completion and defect correction, and thus covers the defect liability period. (Standard Bidding Documents under Japanese ODA Loans, Procurement of Works, JICA, October 2012)

17.2 Project Cost Unit Price Estimation

(1) Unit Price for Structure Measurement

The unit prices used to calculate the cost of the project. Sources of unit prices are mentioned in below.

The ratio of foreign currency (FC) and local currency (LC) of each unit price is estimated as shown in Table 17-1 based on interviews with building/construction contractors.

Table 17-1 Ratio of foreign currency (FC) and local currency (LC) of unit prices

Item			Direct construction cost	
			Ratio	
			FC	LC
Work Item	Earth work	Excavation	60%	40%
		Bckfill	60%	40%
		Banking from Excavated Materials	60%	40%
		Banking from Borrow Materials	60%	40%
		Banking	60%	40%
		Trimming of slope (Cuting)	60%	40%
		Trimming of slope (Banking)	60%	40%
		Stripping topsoil	60%	40%
		Tree trimming	40%	60%
	Concrete work	Concrete 25MPa	80%	20%
		Form work	20%	80%
		Rebar for the reinforcement of concrete	80%	20%
	Revetment work	Gavion mattress	60%	40%
		Geotextiles	80%	20%
		Concrete blocks for bank protection	80%	20%
		Concrete pavement for revetment crest	80%	20%
		Formed of cast-in-place concrete	80%	20%
	Dike work	Prevent of Crown of levee	20%	80%
		Sodding work	20%	80%
	Temporary work	Coffering work (embankment made of earth)	60%	40%
		Temporary road work	60%	40%
	Removal of Surplus Soil work	Dozing and Loading	60%	40%
		Filling ,aterials transport (≦5.5km)	20%	80%
		Banking	60%	40%
	removal work	Steel bridge breaking work	20%	80%
		Concrete breaking work	20%	80%

Table 17-2 Unit Prices for river work project cost estimation

Sorce of cost / item		Item		Direct construction cost				Refer to Direct construction cost[10]						
								Fiji					Japan	
								Interviewed MOIT[1] (2014)	Interviewed FRA[2] (2014)	Reference documents[3]	Reference documents[4]	Reference documents[5]	Reference documents[6]	
		Region		Application Cost[11]	Setting basis and	Ratio[9]		Fiji	Fiji	Fiji	Fiji	Fiji	Tokyo	Remarks
		Unit	Currency	FJD	Reference documents	FC	LC	FJD	FJD	YEN	YEN	YEN	YEN	
Work Item	Earth work	Excavation	m3	6.61	Interviewed MOIT[1]	60%	40%	11.86	12.21	736	5,305	245	270.0	
		Back fill[7]	m3	5.24	Interviewed MOIT[1]	60%	40%	4.36	-	5,407	5,246	289	454.9	
		Banking from Excavated Materials	m3	13.81	Interviewed FRA[2], include material cost	60%	40%		11.51	-	-	-	-	
		Banking from Borrow Materials	m3	48.13	Interviewed FRA[2], include material cost	60%	40%		40.11	4,948	4,346	-	-	
		Banking	m3	5.15	Reference documents[5]	60%	40%		-	-	-	234	281.4	Leveling and Compaction
		Trimming of slope (Cuting)	m2	7.07	Reference documents[3]	60%	40%		-	322	2,268	376	815.9	
		Trimming of slope (Banking)	m2	4.21	Reference documents[4]	60%	40%		-	322	-	191	673.3	
		Stripping topsoil	m2	1.08	Interviewed FRA[2]	60%	40%		0.9	1,701	1,701	-	120.9	Leveling of ground
		Tree trimming	m2	6.08	Interviewed FRA[2]	40%	60%		20.28/a tree (2m×2m:FJD5.07/m2)	-	-	-	277.0	Tree trimming and Transfer
	Concrete work	Concrete 25MPa	m3	479.76	Interviewed MOIT[1]	80%	20%	399.79	1293.7	21,173	36,540	16,051	19350	
		Form work	m2	114.32	Interviewed MOIT[1]	20%	80%	95.27	include avobe	4,633	9,227	1,463	7789	
		Rebar for the reinforcement of concrete	ton	4,016.81	Interviewed MOIT[1]	80%	20%	3347.34	6652.08	163,500	556,970	139,725	150,000	Labor cost and Material cost
	Revetment work	Gavion mattress	m2	331.60	Interviewed MOIT[1]	60%	40%	276.33	-	-	-	-	12320	
		Geotextiles	m2	15.41	Reference documents[6]	80%	20%		-	-	-	-	693.1	
		Concrete blocks for bank protection	m2	220.18	Reference documents[6]	80%	20%		-	-	-	-	9529	
		Concrete pavement for revetment crest	m3	479.76	Interviewed MOIT[1]	80%	20%	398.76	-	-	-	-	41530	
		Formed of cast-in-place concrete	m3	479.76	Interviewed MOIT[1]	80%	20%	398.76	-	-	-	-	53980	
	Dike work	Prevent of Crown of levee	m2	6.61	Reference documents[6]	20%	80%		-	-	-	-	286.0	Road upper subbase
		Sodding work	m2	4.73	Interviewed FRA[2]	20%	80%		3.96	-	-	-		
	Temporary work	Coffering work (embankment made of earth)	m3	5.06	Reference documents[6]	60%	40%		-	-	-	-	222.9	Leveling and Compaction
		Temporary road work	m2	3.30	Reference documents[6]	60%	40%		-	-	-	-	141.0	Unevenness correction
	Removal of Surplus Soil work	Dozing and Loading	m3	6.61	Reference documents[6]	60%	40%		-	-	-	-	291.2	Dozing and Loading
		Filling ,aterials transport (≦5.5km)	m3	17.61	Reference documents[5]	20%	80%		-	-	-	725	876.6	≦5.5km
		Banking	m3	5.15	Reference documents[5]	60%	40%		-	-	-	234	222.9	Leveling and Compaction
	removal work	Steel bridge breaking work	ton	330.28	Past implemented projects in Japan	20%	80%		122946.11/a Bridge	-	-	-	15,000	
		Concrete breaking work	m2	115.07	Interviewed FRA[2]	20%	80%		96.13	-	-	-	6903	

1) Unit price used by Ministry of Infrastructure and Transportation (MoIT)
2) Interviewed Fiji Road Authority
3) Australian Construction Handbook 2015
4) Interveiwed Flecher Construction Company
5) Study on The Transportation and Hydropower Projects for The Mining Development in Waisoi Area, The Republic of Fiji
6) Public works multiplication standard unit price in Japan
7) Include purchasing soil by Australian Construction Handbook 2015
8) Include purchasing soil by Australian Construction Handbook 2015
9) Based on information interviewed MoIT, FRA, Rocal contructors
10) Shaded sells in the table is application cost
*) Exchange Rate(2016.4 JICA)

1	FJD=	54.5
1	YEN=	0.0183

11) According to information Interviewed FRA

Table 17-3 Unit Price for bridge work Cost Estimation (1)

No.	item	unit	Quantity		FC & LC	
			Nadi Town Bridge	Old Queens Road Bridge	Ratio (%)	
					Foreign Currency	Local Currency
0000	Earth work					
0001	Excavation(soil)	m3	15,457	14,646	60	40
0005	Backfill(clean sand)	m3	4,718	4,649	60	40
0007	Banking	m3	1,414	990	60	40
0009	Cutting (soil)	m3	3,890	0	60	40
0010	Trimming of slope (Cutting)	m2	148	211	60	40
0011	Trimming of slope (Banking)	m2	318	193	60	40
0100	Foudation Work					
0103	casing cast-in-place pile(φ1.0m)	m	682	630	80	20
0200	Substructure Work					
0201	cobble foundation of structure excavation(t=0.2m)	m2	277	485	60	40
0202	levelling concrete(t=0.1m)	m2	277	485	80	20
0210	abutment/pier base concrete	m3	1,458	2,108	80	20
0220	form (for wall, pier)	m2	1,380	1,738	80	20
0221	form (for levelling concrete)	m2	15	21	20	80
0230	Rebar for the reinforcement of concrete	ton	209	301	80	20
0300	Superstructure Work					
0301	produce,transport & erection of main beam(PC I-Beam,	unit	0	21	80	20
0302	produce,transport & erection of main beam(PC T-Beam	unit	21	0	80	20
0350	Steel Girder Bridge (Through Bridge)L=96m(3@32m)	m2	0	691	80	20
0400	Floor Slab Work					
0402	floor slab concrete c=400kg	m3	555	298	80	20
0403	form (for slab)	m2	704	969	20	80
0404	Rebar for the reinforcement of concrete	ton	56	30	80	20
0405	supporting (for slab)	m2	1,771	1,286	60	40
0500	Bridge Attachment Work					
0501	bearing	unit	42	50	80	20
0502	expansion joint	m	26	34	80	20
0600	Bridge Surface Work					
0604	Guard fence	m	216	192	80	20
0605	Waterproofing	m2	1,404	960	80	20
0606	Asphalt pavement for bridge 50thick	m2	1,404	960	80	20

Table 17-4 Unit Price for bridge work Cost Estimation (2)

No.	item	unit	Quantity		FC & LC	
			Nadi Town Bridge	Old Queens Road Bridge	Ratio (%)	
					Foreign Currency	Local Currency
0700	Removal of Existing Bridge Work					
0701	concrete bridge breaking work	m3	563	294	20	80
0702	concrete waste disposition	m3	611	335	20	80
0703	steel bridge breaking work	ton	92	146	20	80
0704	Removal of Existing Pile	m	400	460	20	80
0800	Pavement Work					
0801	road upper subbase	m2	1,756	3,092	60	40
0803	Asphalt pavement for approach	m2	1,756	1,200	60	40
0850	Tramline Orbit	ton	0	17	80	20
0900	Temporary Work					
0901	Temporary bridge with H beam	m2	576	576	80	20
0902	Pile with H Beam(H=350)	m	35	35	80	20
0904	Big sandbag	unit	750	420	60	40
0905	temporary construction road	m2	2,000	2,840	60	40
0906	Hume Pipe (φ1.0m)	m	0	150	80	20
0907	Coffeing Works	m3	8,515	3,720	60	40
1000	Concrete Work					
1011	Concrete 18Mpa	m3	632	447	80	20
1020	Form	m2	1,275	951	20	80
1040	Crushed Stone (t=0.2m)	m2	538	406	60	40
1100	Dike Works					
1101	Pavement of Crown of levee	m2	264	376	20	80
1102	Plant spraying	m2	148	211	20	80
1200	Revetment Work					
1203	Concrete blocks for bank protection	m2	918	1,776	80	20
1300	Removal of Surplus Soil Works					
1301	Dozing and Loading	m3	4,700	5,287	100	0
1302	Filling materials transport (≦5.5km)	m3	4,700	5,287	20	80
1303	Banking	m3	4,700	5,287	100	0
2000	Other Work					
2001	removal / relocation of utility pole	unit	6	2	80	20

(2) Cost for Consulting Service

Cost for Consulting Service is shown below.

Table 17-5 Cost for Consulting Service

Consultant	Billing Rate		Remarks
	JPY	F$	
Professional A	3,049,000	74,004	JICA
Professional B	381,500	7,000	Refer to salary of government worker
Supporting Staff	65,400–163,500	1,200–3,000	

US$1=2.17 F$, 1F$= ¥ 54.5

17.3 Quantity of Each Work Item

Quantity of each work item, area of site acquisition and number of houses to be relocated, are shown below. They are used to estimate project cost.

Table 17-6 Quantity of Each Work Item of River Improvement

Nadi River Flood Control Construction Cost (Priority Project)

Item	Main Works	Description	Unit	Package-1	Package-2	Package-3	Package-4		Total	Remarks
				River Widening	Retarding Basin A, B	Ring Dike	Surrounding Dike	Short cut of tributaries		
				Quantity	Quantity	Quantity	Quantity	Quantity	Quantity	
Ⅰ. Approximate Construction Quantity										
Quantity of Main Works										
	Earth Work	Excavation	m3	3,928,181.0	1,257,034.5	6,446.0	290,737.0	23,431.0	5,505,829.5	
		Backfill	m3	868,327.0		21,606.0	34,398.0		924,331.0	
		Embankment	m3	328,936.0	1,159,681.3	57,364.0	251,216.0	27,725.0	1,824,922.3	
		Trimming of slope (Cuting)	m2	487,119.0	168,133.6		61,321.0	7,568.0	724,141.6	
		Stripping topsoil	m2	1,375,000.0	305,000.0	37,387.0	222,240.0	12,092.0	1,951,719.0	
	Bank Protection	Gabion	m2	-	1,878.8	-	-	-	1,878.8	
	Embankment	Prevent of Crown of levee	m2	110,000.0	5,141.9	7,084.0	19,000.0	-	141,225.9	
		Planting	m2	149,625.0	410,498.1	30,807.0	94,236.0	-	685,166.1	
	Structures	Overflow Dike	LS	-	2	-	-	-	2	
		Drainage Sluice Gate	LS	-	2	-	-	-	2	
		Flap Gate	LS	8	2	1	1	-	12	
		Flood Wall Gate	LS	-	-	-	1	-	1	
	Disposal	Dozing and Loading	m3	2,659,223.0	97,353.2	-	-	-	2,756,576.2	
		Transportation	m3	2,659,223.0	97,353.2	-	-	-	2,756,576.2	
		Embankment	m3	2,659,223.0	97,353.2	-	-	-	2,756,576.2	
Quantity of Temporary Works										
	Temporary Work	Coffer Dam	m3	495,000.0	-	-	-	-	495,000.0	
		Temporary Road	m2	16,500.0	-	-	-	-	16,500.0	
Compensation Wo										
	Pavement	pavement (t=0.4m)	m²	-	6,724.0	-	-	-	6,724.0	

Table 17-7 Quantity of Each Work Item of Bridge work

No.		unit	Quantity	
No.	item	unit	Nadi Town Bridge	Old Queens Road Bridge
0000	Earth work			
0001	Excavation(soil)	m3	15,457	14,646
0005	Backfill(clean sand)	m3	4,718	4,649
0007	Banking	m3	1,414	990
0009	Cutting (soil)	m3	3,890	0
0010	Trimming of slope (Cutting)	m2	148	211
0011	Trimming of slope (Banking)	m2	318	193
0100	Foudation Work			
0103	casing cast-in-place pile(φ1.0m)	m	682	630
0200	Substructure Work			
0201	cobble foundation of structure excavation(t=0.2m)	m2	277	485
0202	levelling concrete(t=0.1m)	m2	277	485
0210	abutment/pier base concrete	m3	1,458	2,108
0220	form (for wall, pier)	m2	1,380	1,738
0221	form (for levelling concrete)	m2	15	21
0230	Rebar for the reinforcement of concrete	ton	209	301
0300	Superstructure Work			
0301	produce,transport & erection of main beam(PC I-Beam,	unit	0	21
0302	produce,transport & erection of main beam(PC T-Beam	unit	21	0
0350	Steel Girder Bridge (Through Bridge)L=96m(3@32m)	m2	0	691
0400	Floor Slab Work			
0402	floor slab concrete c=400kg	m3	555	298
0403	form (for slab)	m2	704	969
0404	Rebar for the reinforcement of concrete	ton	56	30
0405	supporting (for slab)	m2	1,771	1,286
0500	Bridge Attachment Work			
0501	bearing	unit	42	50
0502	expansion joint	m	26	34
0600	Bridge Surface Work			
0604	Guard fence	m	216	192
0605	Waterproofing	m2	1,404	960
0606	Asphalt pavement for bridge 50thick	m2	1,404	960
0700	Removal of Existing Bridge Work			
0701	concrete bridge breaking work	m3	563	294
0702	concrete waste disposition	m3	611	335
0703	steel bridge breaking work	ton	92	146
0704	Removal of Existing Pile	m	400	460
0800	Pavement Work			
0801	road upper subbase	m2	1,756	3,092
0803	Asphalt pavement for approach	m2	1,756	1,200
0850	Tramline Orbit	ton	0	17
0900	Temporary Work			
0901	Temporary bridge with H beam	m2	576	576
0902	Pile with H Beam(H=350)	m	35	35
0904	Big sandbag	unit	750	420
0905	temporary construction road	m2	2,000	2,840
0906	Hume Pipe (φ1.0m)	m	0	150
0907	Coffeing Works	m3	8,515	3,720
1000	Concrete Work			
1011	Concrete 18Mpa	m3	632	447
1020	Form	m2	1,275	951
1040	Crushed Stone (t=0.2m)	m2	538	406
1100	Dike Works			
1101	Pavement of Crown of levee	m2	264	376
1102	Plant spraying	m2	148	211
1200	Revetment Work			
1203	Concrete blocks for bank protection	m2	918	1,776
1300	Removal of Surplus Soil Works			
1301	Dozing and Loading	m3	4,700	5,287
1302	Filling materials transport (≦5.5km)	m3	4,700	5,287
1303	Banking	m3	4,700	5,287
2000	Other Work			
2001	removal / relocation of utility pole	unit	6	2

Table 17-8 Quantity of Each Work Item of Site acquisition

Item	Main Works	Description	Unit	Package-1	Package-2	Package-3	Package-4	
				River Widening	Retarding Basin A, B	Ring Dike	Surrounding Dike	Short cut of tributaries
Land Acquisition								
	Breakdown by Land ownership	Freehold Land	ha	18.66	-	-	-	-
		State Land	ha	20.14	-	-	-	-
		Native Land	ha	39.96	-	-	-	-
	Breakdown by Landus	Agricultural	ha	-	243.50	1.40	6.69	4.26
		Commercial	ha	-	-	-	0.36	-
		Residential	ha	-	-	-	0.21	-
		Others	ha	-	-	-	0.04	-
		Total	ha	78.76	243.50	1.40	7.31	4.26

Source: Department of Land, Fiji
In river widening, the low land and depression behind bank are considered to be filled; however, the possibility of back fill will depend on the land owner. Therefore, the land acquisition cost of the area of back fill is not included in the table.

Table 17-9 Number of houses to be affected and relocated by the project

Section	House Relocation and Affected House
Package-1 River widening	6 houses (relocated)
Package-2 Retarding Basin	11 houses (relocated)
Retarding Basin in Lower area	17 houses (affected)

17.4 Project Cost Estimation

As the Project Cost Estimation below shows, the total cost of the project is ¥21 billion (F$385 million).

Table 17-10 Project Cost

Item		Total			
		FC	LC	Total	
		million (Yen)	million (F$)	million (Yen)	million (F$)
A. ELIGIBLE PORTION					
Ⅰ)	Procurement / Construction	6,778	134	14,074	258
	Package 1 River Widening, Rebuilding of Bridge	4,213	77	8,432	155
	Package 2 Retarding Basin	1,281	19	2,299	42
	Package 3 Ring Dike	40	1	76	1
	Package 4 Surrounding Dike	392	5	657	12
	Base cost for JICA financing	5,926	102	11,464	210
	Price escalation	529	26	1,940	36
	Physical contingency	323	6	670	12
Ⅱ)	Consulting services	933	18	1,893	35
	Base cost	828	14	1,579	29
	Price escalation	60	3	223	4
	Physical contingency	44	1	90	2
Total (Ⅰ+Ⅱ)		7,711	151	15,967	293
B. NON ELIGIBLE PORTION					
a	Procurement / Construction	0	0	0	0
	Base cost for JICA financing	0	0	0	0
	Price escalation	0	0	0	0
	Physical contingency	0	0	0	0
b	Land Acquisition	0	38	2,093	38
	Base cost	0	34	1,845	34
	Price escalation	0	3	148	3
	Physical contingency	0	2	100	2
c	Administration cost	0	17	903	17
d	VAT	0	30	1,625	30
e	Import Tax	0	0	0	0
Total (a+b+c+d+e)		0	85	4,621	85
TOTAL (A+B)		7,711	236	20,588	378
					0
C. Interest during Construction		351	0	351	6
	Interest during Construction(Const.)	350	0	350	6
	Interest during Construction (Consul.)	1	0	1	0
D. Front End Fee		32	0	32	1
GRAND TOTAL (A+B+C+D)		8,094	236	20,971	385
E. JICA finance portion (A)		7,711	151	15,967	293

US$1=2.17 F$, 1F$= JPY 54.5

Table 17-11 Base Cost of Each Package

Package 1 River Widening

item	unit	Quantity	Unit Price		Cost		Total	
			Foreign	Local	Foreign	Local		
			million (Yen)	million (F$)	million (Yen)	million (F$)	million (Yen)	million (F$)
River Widening	LS	1			3,115	70	6,952	128
Rebuilding of Bridges	LS	1			1,098	7	1,480	27
Total					4,213	77	8,432	155

Package 2 Retarding Basin

item	unit	Quantity	Unit Price		Cost		Total	Total
			Foreign	Local	Foreign	Local		
			million (Yen)	million (F$)	million (Yen)	million (F$)	million (Yen)	million (F$)
Retarding Basin A, B	LS	1			1,281	19	2,299	42
Total					1,281	19	2,299	42

Package 3 Ring Dike

item	unit	Quantity	Unit Price		Cost		Total	Total
			Foreign	Local	Foreign	Local		
			million (Yen)	million (F$)	million (Yen)	million (F$)	million (Yen)	million (F$)
Ring Dike	LS	1			40	1	76	1.4
Total					40	1	76	1.4

Package 4 Surrounding Dike

item	unit	Quantity	Unit Price		Cost		Total	Total
			Foreign	Local	Foreign	Local		
			million (Yen)	million (F$)	million (Yen)	million (F$)	million (Yen)	million (F$)
Surrounding Dike	LS	1			376	5	630	11.6
Short cut of Tributaries	LS	1			16	0	27	0.5
Total					392	5	657	12.0

US$1=2.17 F$, 1F$= JPY 54.5

Table 17-12 Construction Cost (Package-1: River Widening)

Package-1: River Widening

Item	Main Works	Description	Unit	Quantity	Cost			
					Foreign	Local	Total	
					million (YEN)	million (F$)	million (YEN)	million (F$)
Ⅰ. Construction Cost(A)							**6,952**	**127.6**
Main Works Cost①					**2,800**	**66.2**	**6,409**	**117.6**
	Earth Work	Excavation	Set	1	848	10.4	1,414	25.9
		Backfill	Set	1	149	1.8	248	4.6
		Banking	Set	1	55	0.7	92	1.7
		Trimming of slope (Cuting)	Set	1	81	1.0	135	2.5
		Stripping topsoil	Set	1	49	0.6	81	1.5
	Dike Work	Pavement of Crown of levee	Set	1	8	0.6	40	0.7
		Sodding work	Set	1	9	0.7	47	0.9
		Flap Gate	Set	1	67	0.5	96	1.8
		Land rock	Set	1				
Temporary Cost②					**134**	**1.6**	**223**	**4.1**
	Temporary Work		Set	1				
Compensantion Cost③					**192**	**2.4**	**320**	5.9
	Compensantion Cost		Set	1	192	0.0	320	5.9
Sub Total(Construction Cost(A))					**3,125**	**70.2**	**6,952**	**127.6**

Table 17-13 Construction Cost (Package-1: Rebuilding of Bridges)

No.	item	unit	Quantity	Nadi Town Bridge				Old Queens Road Bridge				TOTAL	
				Cost				Cost				Foreign	Local
				Foreign	Local	Total		Foreign	Local	Total			
				Thousands (Yen)	Thousands (F$)	Thousands (Yen)	Thousands (F$)	Thousands (Yen)	Thousands (F$)	Thousands (Yen)	Thousands (F$)	Thousands (Yen)	Thousands (Yen)
0000	Earth work											0	0
0001	Excavation(soil)	m3	1	8,191	100	13,650	250	7,760	95	12,933	237	26,583	488
0005	Backfill(clean sand)	m3	1	18,367	225	30,613	562	18,098	221	30,165	553	60,779	1,115
0007	Banking	m3	1	5,038	62	8,395	154	3,527	43	5,878	108	14,273	262
0009	Cutting (soil)	m3	1	3,173	39	5,288	97	0	0	0	0	5,288	97
0010	Trimming of slope (Cutting)	m2	1	35	0	58	1	49	1	82	2	140	3
0011	Trimming of slope (Banking)	m2	1	73	1	122	2	44	1	74	1	197	4
				34,877	427	58,127	1,067	29,479	361	49,133	902	107,260	1,968
0100	Foudation Work		1	0	0	0	0	0	0	0	0	0	0
0103	casing cast-in-place pile(φ1.0m)	m	1	50,939	234	63,673	1,168	47,054	216	58,818	1,079	122,491	2,248
0200	Substructure Work		1	0	0	0	0	0	0	0	0	0	0
0201	cobble foundation of structure excavation(t=0.2m)	m2	1	232	3	387	7	407	5	678	12	1,065	20
0202	levelling concrete(t=0.1m)	m2	1	5,021	23	6,276	115	8,794	40	10,992	202	17,268	317
0210	abutment/pier base concrete	m3	1	29,635	136	37,044	680	42,847	197	53,559	983	90,603	1,662
0220	form (for wall, pier)	m2	1	6,138	28	7,672	141	7,730	35	9,663	177	17,335	318
0221	form (for levelling concrete)	m2	1	16	1	80	1	22	2	109	2	189	3
0230	Rebar for the reinforcement of concrete	ton	1	32,773	150	40,967	752	47,245	217	59,056	1,084	100,023	1,835
				73,814	341	92,425	1,696	107,045	496	134,058	2,460	226,484	4,156
0300	Superstructure Work		1	0	0	0	0	0	0	0	0	0	0
0301	produce,transport & erection of main beam(PC I-Beam)	unit	1	0	0	0	0	107,290	492	134,112	2,461	134,112	2,461
0302	produce,transport & erection of main beam(PC T-Beam)	unit	1	149,404	685	186,755	3,427	0	0	0	0	186,755	3,427
0350	Steel Girder Bridge (Through Bridge)L=96m(3@32m)	m2	1	0	0	0	0	139,969	642	174,961	3,210	174,961	3,210
0400	Floor Slab Work		1	0	0	0	0	0	0	0	0	0	0
0402	floor slab concrete c=400kg	m3	1	15,055	69	18,819	345	8,084	37	10,105	185	28,924	531
0403	form (for slab)	m2	1	829	61	4,144	76	1,141	84	5,704	105	9,848	181
0404	Rebar for the reinforcement of concrete	ton	1	8,790	40	10,987	202	4,709	22	5,886	108	16,873	310
0405	supporting (for slab)	m2	1	9,362	115	15,604	286	6,798	83	11,330	208	26,934	494
0500	Bridge Attachment Work		1	0	0	0	0	0	0	0	0	0	0
0501	bearing	unit	1	3,738	17	4,673	86	4,451	20	5,563	102	10,236	188
0502	expansion joint	m	1	2,386	11	2,982	55	3,120	14	3,900	72	6,882	126
				189,564	998	243,964	4,476	275,562	1,395	351,563	6,451	595,527	10,927
0600	Bridge Surface Work		1	0	0	0	0	0	0	0	0	0	0
0604	Guard fence	m	1	8,854	41	11,067	203	7,871	36	9,839	181	20,906	384
0605	Waterproofing	m2	1	2,645	12	3,306	61	1,808	8	2,260	41	5,566	102
0606	Asphalt pavement for bridge 50thick	m2	1	2,719	12	3,399	62	1,859	9	2,323	43	5,722	105
				14,218	65	17,772	326	11,538	53	14,422	265	32,194	591
0700	Removal of Existing Bridge Work		1	0	0	0	0	0	0	0	0	0	0
0701	concrete bridge breaking work	m3	1	2,563	188	12,814	235	1,338	98	6,691	123	19,505	358
0702	concrete waste disposition	m3	1	1,583	116	7,912	145	868	64	4,338	80	12,250	225
0703	steel bridge breaking work	ton	1	3,312	243	16,560	304	5,256	386	26,279	482	42,840	786
0704	Removal of Existing Pile	m	1	712	52	3,558	65	818	60	4,092	75	7,649	140
				8,170	600	40,844	749	8,280	608	41,400	760	82,244	1,509
0800	Pavement Work		1	0	0	0	0	0	0	0	0	0	0
0801	road upper subbase	m2	1	1,103	13	1,838	34	1,942	24	3,236	59	5,074	93
0803	Asphalt pavement for approach	m2	1	2,068	25	3,446	63	1,412	17	2,354	43	5,800	106
0850	Tramline Orbit	ton	1	0	0	0	0	9,841	45	12,302	226	12,302	226
			1	3,170	39	5,283	97	13,195	86	17,892	328	23,175	425
0900	Temporary Work		1	0	0	0	0	0	0	0	0	0	0
0901	Temporary bridge with H beam	m2	1	48,368	222	60,461	1,109	48,368	222	60,461	1,109	120,922	2,219
0902	Pile with H Beam(H=350)	m	1	623	3	778	14	623	3	778	14	1,557	29
0904	Big sandbag	unit	1	4,915	60	8,192	150	2,753	34	4,588	84	12,780	234
0905	temporary construction road	m2	1	216	3	360	7	307	4	511	9	871	16
0906	Hume Pipe (φ1.0m)	m	1	0	0	0	0	5,477	25	6,851	126	6,851	126
0907	Coffeing Works	m3	1	1,410	17	2,350	43	617	8	1,028	19	3,377	62
				55,532	305	72,141	1,324	58,145	295	74,217	1,362	146,357	2,685
1000	Concrete Work		1	0	0	0	0	0	0	0	0	0	0
1011	Concrete 18Mpa	m3	1	12,838	59	16,047	294	9,085	42	11,357	208	27,404	503
1020	Form	m2	1	1,418	104	7,091	130	1,057	78	5,287	97	12,377	227
1040	Crushed Stone (t=0.2m)	m2	1	451	6	752	14	341	4	568	10	1,320	24
				14,707	168	23,890	438	10,483	123	17,211	316	41,101	754
1100	Dike Works		1	0	0	0	0	0	0	0	0	0	0
1101	Pavement of Crown of levee	m2	1	19	1	95	2	28	2	136	2	231	4
1102	Plant spraying	m2	1	7	1	37	1	11	1	54	1	91	2
				26	2	132	2	38	3	190	3	322	6
1200	Revetment Work		1	0	0	0	0	0	0	0	0	0	0
1203	Concrete blocks for bank protection	m2	1	8,813	40	11,016	202	17,050	78	21,312	391	32,328	593
				8,813	40	11,016	202	17,050	78	21,312	391	32,328	593
1300	Removal of Surplus Soil Works		1	0	0	0	0	0	0	0	0	0	0
1301	Dozing and Loading	m3	1	1,692	0	1,692	31	1,903	0	1,903	35	3,595	66
1302	Filling materials transport (≦5.5km)	m3	1	384	28	1,916	35	432	32	2,155	40	4,071	75
1303	Banking	m3	1	27,907	0	27,907	512	31,392	0	31,392	576	59,299	1,088
				29,983	28	31,515	578	33,727	32	35,450	650	66,965	1,229
2000	Other Work		1	0	0	0	0	0	0	0	0	0	0
2001	removal / relocation of utility pole	unit	1	2,197	10	2,747	50	732	3	915	17	3,662	67
				2,197	10	2,747	50	732	3	915	17	3,662	67
TOTAL				486,011	3,257	663,531	12,175	612,329	3,748	816,581	14,983	1,480,111	27,158

Table 17-14 Construction Cost (Package-2: Retarding Basin A,B)

Package-2: Retarding Basin A

Item	Main Works	Description	Unit	Quantity	Cost			
					Foreign	Local	Total	
					million (YEN)	million (F$)	million (YEN)	million (F$)
Ⅰ. Construction Cost(A)							**2,299**	**42.2**
Main Works Cost①					**960**	**14.7**	**1,764**	**32.4**
	Earth Work	Excavation	Set	1	272	3.3	453	8.3
		Backfill	Set	1				
		Banking	Set	1	195	2.4	326	6.0
		Trimming of slope (Cuting)	Set	1	39	0.5	65	1.2
		Stripping topsoil	Set	1	11	0.1	18	0.3
	Dike Work	Pavement of Crown of levee	Set	1	0.4	0.0	2	0.0
		Sodding work	Set	1	40	2.9	200	3.7
		Flap Gate	Set	1	17	0.1	24	0.4
		Land rock	Set	1				
Temporary Cost②					**318**	**3.9**	**529**	**9.7**
	Temporary Work		Set	1				
Compensantion Cost③					**3**	**0.0**	**5**	0.1
	Compensantion Cost		Set	1	3	0.0	5	0.1
Sub Total(Construction Cost(A))					**1,281**	**18.7**	**2,299**	**42.2**

Source: JICA Study Team

Table 17-15 Construction Cost (Package-3: Ring Dike)

Package-3: Ring Dike

Item	Main Works	Description	Unit	Quantity	Cost			
					Foreign	Local	Total	
					million (YEN)	million (F$)	million (YEN)	million (F$)
Ⅰ. Construction Cost(A)							**76.1**	**1.4**
Main Works Cost①					**28.0**	**0.52**	**56.4**	**1.0**
	Earth Work	Excavation	Set	1	1.4	0.02	2.3	0.0
		Backfill	Set	1	3.7	0.05	6.2	0.1
		Banking	Set	1	9.7	0.12	16.1	0.3
		Trimming of slope (Cuting)	Set	1				
		Stripping topsoil	Set	1	1.3	0.02	2.2	0.0
	Dike Work	Pavement of Crown of levee	Set	1	0.5	0.04	2.6	0.0
		Sodding work	Set	1	3.0	0.22	15.0	0.3
		Flap Gate	Set	1	8.4	0.07	12.0	0.2
		Land rock	Set	1				
Temporary Cost②					**10.1**	**0.12**	**16.9**	**0.3**
	Temporary Work		Set	1	10.1	0.12	16.9	0.3
Compensantion Cost③					**1.7**	**0.02**	**2.8**	0.1
	Compensantion Cost		Set	1	1.7	0.02	2.8	0.1
Sub Total(Construction Cost(A))					**39.8**	**0.67**	**76.1**	**1.4**

Source: JICA Study Team

Table 17-16 Construction Cost (Package-4: Surrounding Dike)

Package-4: Surrounding Dike

Item	Main Works	Description	Unit	Quantity	Cost			
					Foreign	Local	Total	
					million (YEN)	million (F$)	million (YEN)	million (F$)
Ⅰ. Construction Cost(A)							**630**	**11.6**
Main Works Cost①					**278**	**3**	**466**	**8.6**
	Earth Work	Excavation	Set	1	63	1	105	1.9
		Backfill	Set	1	6	0	10	0.2
		Banking	Set	1	42	1	71	1.3
		Trimming of slope (Cuting)	Set	1	14	0	24	0.4
		Stripping topsoil	Set	1	8	0	13	0.2
	Dike Work	Pavement of Crown of levee	Set	1	1	0	7	0.1
		Sodding work	Set	1	9	1	46	0.8
		Flap Gate	Set	1	8	0	12	0.2
		Land rock	Set	1	126	1	180	3.3
Temporary Cost②					**84**	**1**	**140**	**2.6**
	Temporary Work		Set	1	84	1.0	140	2.6
Compensantion Cost③					**14**	**0.2**	**23**	0.4
	Compensantion Cost		Set	1	14	0.2	23.3	0.4
Sub Total(Construction Cost(A))					**376**	**5**	**630**	**11.6**

Source: JICA Study Team

Table 17-17 Construction Cost (Package-4: Shortcut of Tributaries)

Package-4: Surrounding Dike

Item	Main Works	Description	Unit	Quantity	Cost			
					Foreign	Local	Total	
					million (YEN)	million (F$)	million (YEN)	million (F$)
Ⅰ. Construction Cost(A)							**27**	**0.5**
Main Works Cost①					**12**	**0**	**20**	**0.4**
	Earth Work	Excavation	Set	1	5	0.1	8	0.2
		Backfill	Set	1				
		Banking	Set	1	5	0.06	8	0.1
		Trimming of slope (Cuting)	Set	1	2	0.02	3	0.1
		Stripping topsoil	Set	1	0	0.005	0.7	0.0
	Dike Work	Pavement of Crown of levee	Set	1				
		Sodding work	Set	1				
		Flap Gate	Set	1				
		Land rock	Set	1				
Temporary Cost②					**4**	**0.04**	**6**	**0.1**
	Temporary Work		Set	1	4	0.04	6	0.1
Compensantion Cost③					**0.6**	**0.01**	**1.0**	0.0
	Compensantion Cost		Set	1	0.6	0.01	1.0	0.0
Sub Total(Construction Cost(A))					**16**	**0.2**	**27**	**0.5**

Source: JICA Study Team

Table 17-18 Land Acquisition Cost

Item	Package-1		Package-2		Package-3		Package-4		Total	
	River Widening, Bridges		Retarding Basin A, B		Ring Dike		Surrounding Dike, Shortcut			
	Cost (FJD)	Cost (JPY)	Cost (FJD)	Cost (JPY)	Cost (FJD)	Cost (JPY)	Cost (FJD)	Cost (JPY)	Cost (FJD)	Cost (JPY)
LA Cost	7,865,000	428,642,500	19,506,171	1,063,086,320	149,566	8,151,373	4,243,448	231,267,937	31,764,186	1,731,148,129

Source: Department of Land, Fiji, for further details see Data Book

Table 17-19 House Compensation Cost

Item	Main Works	Description	Unit	Unit Price (FJD)	Package-1 River Widening			Package-2 Retarding Basin A, B			Package-3 Ring Dike			Total	
					Quantity	Cost (FJD)	Cost (JPY)	Quantity	Cost (FJD)	Cost (JPY)	Quantity	Cost (FJD)	Cost (JPY)	Cost (FJD)	Cost (JPY)
Ⅲ. Compensation Cost															
Quantity															
	House Relocation	Concrete Building	nos	90,636.0	-	-	-	-	-	-	-	-	-	-	-
	Affected House	Wooden Building	nos	61,292.0	6.0	367,752	20,042,484	11	674,212	36,744,554	17	1,041,964	56,787,038	2,083,928	113,574,076
		Tin Shack	nos	36,396.0	-	-	-	-	-	-	-	-	-	-	-

Source: JICA Study Team

Chapter 18 Project Implementation Plan

18.1 Purpose of the Project

The Project is to improve flood control measures in the Nadi River basin, which has been seriously flooded, through infrastructure improvement including river improvement, and thus contribute to the reduction of flood damage and the improvement of the living environment of the local residents.

18.2 Target Area

Purpose of the Priority Project is preferentially to mitigate inundation of Important Protected Area.

Figure 18.1 shows the components of structure measures of the priority project.

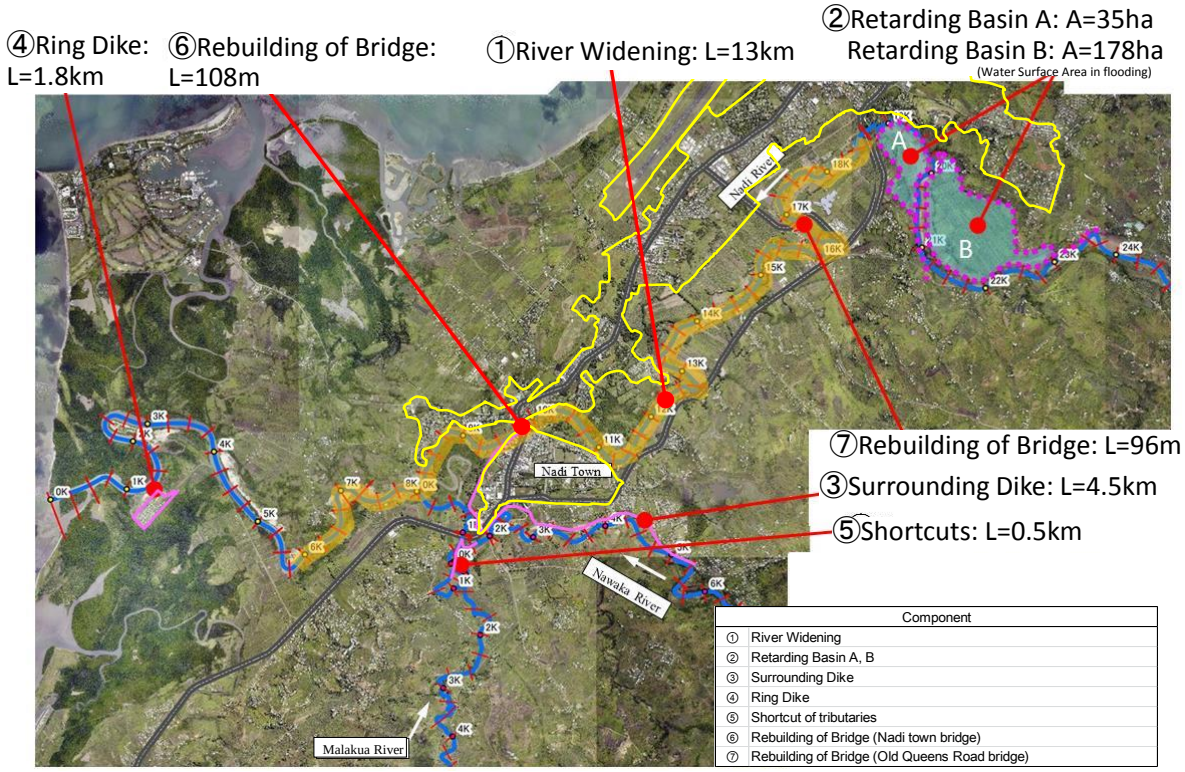


Figure 18-1 Components of structure measures of the priority project

18.3 Project Overview

18.3.1 Contents of Construction Works

(1) The Nadi River Flood Control Structures

For the Nadi River projects, sufficient cross-sectional area has been secured for the design flow of 1,800m^3/s with a design scale based on the return period of 50 years in condition of full flow[1] in the section at the Back Road Bridge. The structural measures of the Priority Project are river improvements (levee construction and river-bed excavation) necessary for the design flow, construction of two retarding basins for storage of design flood discharge, construction of ring dike for protecting the downstream community, construction of surrounding dike for protecting Nadi town, and shortcut in Malakua River for reducing negative impact,. These components are included in the Master Plan as the Priority Project to be implemented in advance. Two bridges exist in the river widening section, and they have to be rebuilt.

[1] When the Master Plan will be completed, since the upstream dam will be constructed, the discharge of 1,800 m3/s can flow down in the cross section considered free-board. In the Priority Project the discharge is permitted to flow down with water level between HWL and top of dike.

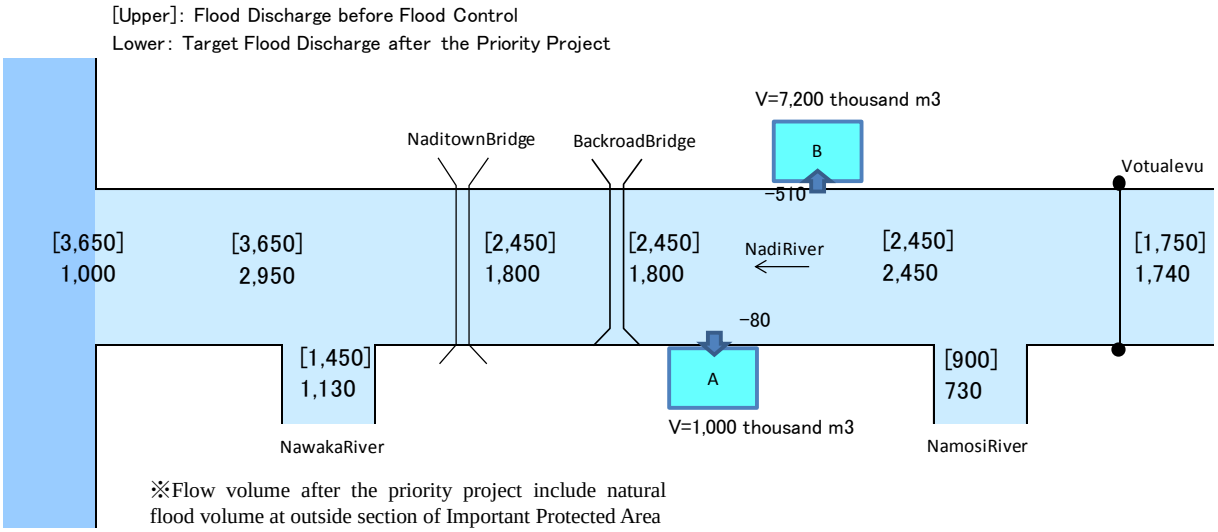


Figure 18-2 Design Flood Discharge of The Priority Project

Table 18-1 Summary of Structure Measures in the Priority Project

Classification	Main Works	Description	Unit	River Improvement Works					Rebuilding of Bridge	
				①	②	③	④	⑤	⑥	⑦
				River Widening	Retarding Basin A, B	Surrounding Dike	Ring Dike	Short cut of tributaries	Nadi Town B.	Old Queens Road B.
Outline				L=13 km	A: 178 ha B: 35 ha	L=4.5 km	L=1.8 km	L=0.5 km	L=108 m	L=96 m
Main Works	Earth Work	Excavation	m3	3,928,181	1,257,035	290,737	6,446	23,431	—	—
		Embankment	m3	328,936	1,159,681	251,216	57,364	27,725	—	—

18.3.2 Contents of Consulting Services

Consulting services are for overall project management, detailed design (D/D), assistance in preparation of bidding documents (tender assistance), construction supervision, environmental/ social impact monitoring. The consulting services are also for planning for the above-described river improvements, construction of retarding basins and rebuilding bridge. Details of the consulting services are shown in the attached Terms of Reference (TOR) for the consultant services concerning the Project. The following table shows the outline of the staff members and man-months required for the consulting services. The total man-months required will be 702 (255 for Professional A and 447 for Professional B).

Table 18-2 Outline of the Consulting Service Team

No.	Position for Professional	Required Experiences	Expertise for Consulting Service	Total M/M (Months)
Detailed Design and Construction Supervision Team				
A-1	Team Leader/Project Management	15 years	Overall Project Management	58
2	River Engineer	12	Review of basic concept, design criteria and river facility plan, Superintend of D/D D/D of river improvement works, river facilities	27
3	River Structure Engineer	10	D/D of river improvement works, river facilities, Calculation of quantities Supervise of River Survey	9
4	Bridge Engineer (1)	12	D/D of bridge works and calculation of quantities	6
5	Bridge Engineer (2)	7	Ditto	3
6	Mechanical Engineer	10	D/D of Machine such as gate and calculation of quantities	3
7	Hydrologist	12	Hydrological analysis for river improvement and prepare manuals for river management	3
8	Hydraulic Engineer	7	Hydraulic analysis for river improvement and specifying the profile of retarding basins	3
9	Geotechnical Engineer	12	Survey & Geotechnical investigations	4
10	Construction Planner & Cost Estimator (1)	12	Construction plan & cost estimate for river works	3
11	Construction Planner & Cost Estimator (2)	7	Construction plan & cost estimate for bridge works	3
12	Environment & Social Environment Specialist	10	Monitor social & environmental consideration in the project area	6
13	Spec Writer & Bid Specialist	12	Prepare tender documents	12
14	Construction Engineer (1)	12	Construction supervision of civil works	46
15	Construction Engineer (2)	7	Ditto	46
	Sub Total M/M for Professional A			232
B-1	Co-Team Leader/River Engineer	15	Support Team Leader D/D of civil works	72
2	Design Engineer B-1	10	D/D of river improvement works and calculation of quantities	9
3	Design Engineer B-2	10	Ditto	9
4	Design Engineer B-3	10	Ditto	9
5	Design Engineer B-4	10	D/D of bridge works and calculation of quantities	6
6	Survey Engineer	10	Survey and Investigation	6
7	GIS Specialist	5	Analysis of Lidar data and survey data	6
8	Geotechnical Engineer	7	Survey & Geotechnical investigations	4
9	Mechanical Engineer	10	D/D of Machine such as gate and calculation of quantities	3
10	Hydrology & Hydraulic Engineer B-1	7	Hydrologic & hydraulic analysis for river and dam	3
11	Hydrology & Hydraulic Engineer B-2	5	Ditto	3
12	Construction Planner & Cost Estimator B-1	7	Construction plan & cost estimate for river works	5
13	Construction Planner & Cost Estimator B-2	5	Construction plan & cost estimate for bridge works	3
14	Social Environmentalist	7	Environmental consideration/ Monitoring selected environment items	4
15	Spec Writer & Bid Specialist B-1	7	Tender documents & bid assistance	12
16	Spec Writer & Bid Specialist B-2	5	Tender documents & bid assistance	12

17	Construction Engineer B-1	7	Construction supervision of civil works	50
18	Construction Engineer B-2	7	Ditto	26
19	Construction Engineer B-3	5	Ditto	37
20	Construction Engineer B-4	5	Ditto	34
	Sub Total M/M for Professional B			313
Project Management Unit Supporting Team				
A-16	Deputy Team Leader/Project Management	15	Coordination for the smooth project implementation among MOA, Project Management Unit (PMU), JCC and other agencies Organize Consultant's team to provide efficient assistance to the PMU	23
	Sub Total M/M for Professional A			23
B-21	Co-Team Leader/Project Management Specialist	10	Assist PMU to conduct the smooth Project management, expediting project implementation. Assist PMU to monitor the progress of consulting services, construction works, and prepare the solution for problems encountered during project	84
22	River Engineer / Quality Inspector	5	Assist PMU to evaluate construction works and inspect quality of construction	50
	Sub Total M/M for Professional B			134
Total				
	Total M/M for Professional A			255
	Total M/M for Professional B			447
	Grand Total for Professional (A+B)			702

18.4 Project Cost

The project cost is ¥21 billion (F$385 million), including a foreign currency portion of ¥8 billion (F$ 149 million) and a domestic currency portion of ¥13 billion (F$236 million). Yen loan is to cover ¥16 billion (F$294 million) (76.1%) of the project cost in case of yen loan project.

Table 18-3 Total Cost of the Project

(FC&Total: Million JPY, LC: Million FJD)

Item		Total			
		FC	LC	Total	
		million (Yen)	million (F$)	million (Yen)	million (F$)
A. ELIGIBLE PORTION					
Ⅰ)	Procurement / Construction	6,778	134	14,074	258
	Package 1 River Widening, Rebuilding of Bridge	4,213	77	8,432	155
	Package 2 Retarding Basin	1,281	19	2,299	42
	Package 3 Ring Dike	40	1	76	1
	Package 4 Surrounding Dike	392	5	657	12
	Base cost for JICA financing	5,926	102	11,464	210
	Price escalation	529	26	1,940	36
	Physical contingency	323	6	670	12
Ⅱ)	Consulting services	933	18	1,893	35
	Base cost	828	14	1,579	29
	Price escalation	60	3	223	4
	Physical contingency	44	1	90	2
Total (Ⅰ + Ⅱ)		7,711	151	15,967	293
B. NON ELIGIBLE PORTION					
a	Procurement / Construction	0	0	0	0
	Base cost for JICA financing	0	0	0	0
	Price escalation	0	0	0	0
	Physical contingency	0	0	0	0
b	Land Acquisition	0	38	2,093	38
	Base cost	0	34	1,845	34
	Price escalation	0	3	148	3
	Physical contingency	0	2	100	2
c	Administration cost	0	17	903	17
d	VAT	0	30	1,625	30
e	Import Tax	0	0	0	0
Total (a+b+c+d+e)		0	85	4,621	85
TOTAL (A+B)		7,711	236	20,588	378
					0
C. Interest during Construction		351	0	351	6
	Interest during Construction(Const.)	350	0	350	6
	Interest during Construction (Consul.)	1	0	1	0
D. Front End Fee		32	0	32	1
GRAND TOTAL (A+B+C+D)		8,094	236	20,971	385
E. JICA finance portion (A)		7,711	151	15,967	293

US$1=2.17 F$, 1F$= JPY 54.5

Source: Calculation Result for Annual Fund Requirement based on the Cost Estimate Kit (JICA Study Team)

The project cost has been calculated under the following conditions:

a. Base for unit prices: Apr. 2016

b. Exchange rate: US$1 = ¥118.3, 1 US$1 =F$2.17, F$1=¥54.5

c. Combination of currency: Local currency portion , Foreign currency portion

d. Inflation rate: 1.8 % for Foreign currency portion, 4.8% for Local currency portion

e. Consultant labor cost:

International consultants: 3,049,000 yen/M (FC)

Local consultants: 7,000 FJ$/M (LC)

Local support staff: 1,200~3,000 FJ$/M (LC)

f. Contingency: 5.0% both for consultants and main construction

g. Tax: 9% VAT

h. Office administration cost at project implementing organization: 5.0% of the total project cost

i. Interest during construction: 0.6% for main construction, 0.01% for consultant

j. Commitment charge rate: 0.2%

18.5 Project Implementing Schedule

We set the project implementation schedule after considering the major processes. Table 18-4 shows the processes and times required for each process. In addition, we assumed that the pledge will be made in March 2017 and 25 months will be required for the selection of the consultant.

Table 18-4 Time Periods Required for Major Processes and their Contents

No.	Process	Required time period	Contents
1	Yen loan procedures	-	Mar 2017 Pledge
2	Land acquisition	35 months	After Pledge and before the start of construction
3	Selection of consultants	12 months	Creation of RFP and short list and consent of JICA Invitation and submission of proposal Evaluation of the proposal and consent of JICA Contract negotiation Preparation and conclusion of contract Consent of JICA on contract and notice to commence
4	Detailed design	12 months	Location survey and research Detailed design related to river improvement, bridges and river structures Volume calculation and estimation of accumulation Preparation of bidding documents
5	Selection of contractors	12 months	Prequalification of bidders, creation of bidding documents and consent of JICA Bidding Bidding evaluation Consent of JICA Negotiation and conclusion of contract JICA's consent to contract, opening of L/C and issue of L/Com
6	Implementation of main construction works	48 months	River improvement, Rebuilding of Bridge, Retarding basins, Ring dike, Surrounding dike, Shortcut
7	Completion of construction and delivery	-	Completion of construction and delivery

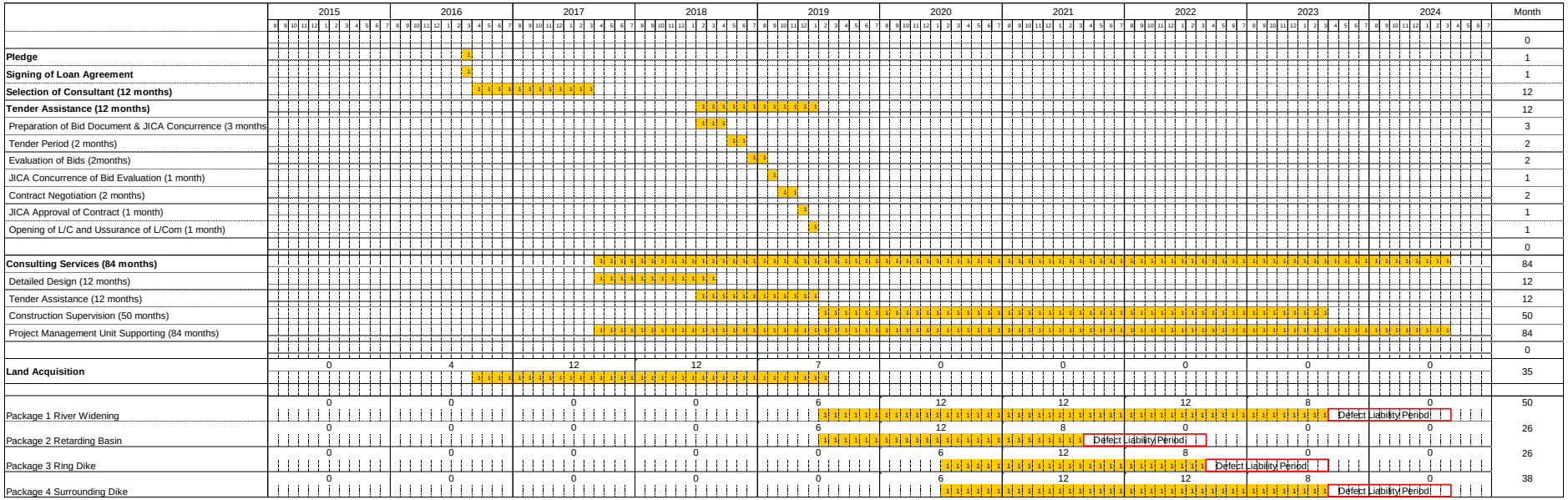
Note: The time period required for JICA's consent on procurement differs depending on the type (of consultant or contractor) and the amount.

Table 18-5 below shows the implementation schedule of the Project under the above-described conditions.

Land acquisition has to be completed before the initiation of the Project.

Table 18-5 Implementation Schedule of the Project

Implementation Schedule



18.6 Project Implementing Structure

For the Implementation of the Projects, the establishment of a Project Management Unit (PMU) will be considered. A draft of the project implementing structure is shown below.

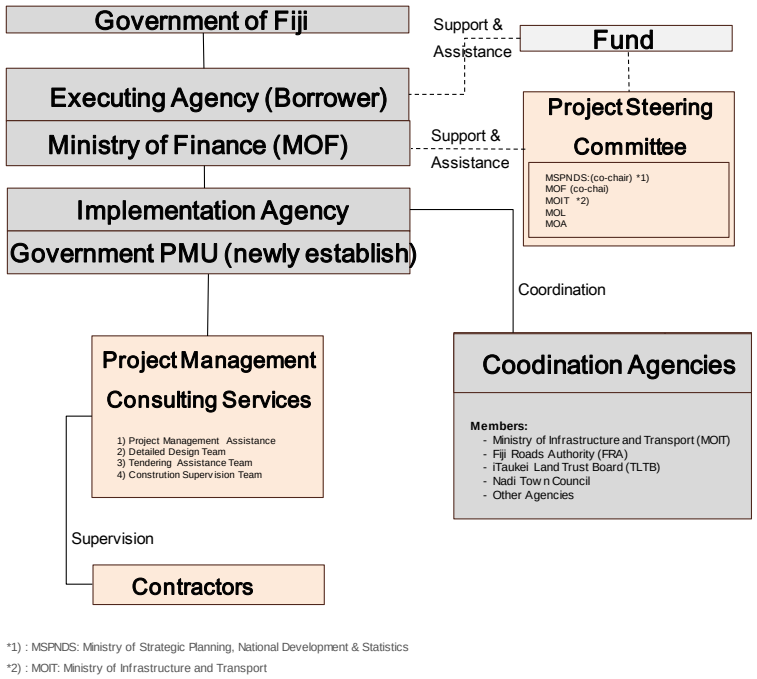


Figure 18-3 Draft project implementing structure

18.7 Performance Indicators

The annual maximum flow amount is selected as operation index, and the annual maximum flood area and annual maximum number of flooded houses due to dike breakage or overflow is selected as effect index for evaluating the operational effect of this project quantitatively and qualitatively. A reference value and target value of two (2) years after the completion of project are shown in Table 18-6.

Table 18-6 Operation and Effect Indicators of the Project

Operation and effect indicators		Reference level (50-year flood)	2027 target (2 years after the project completion) (50-year flood)
Operation indicator	Annual maximum water level (m) *1	2,450 m3/s (Calculated flood discharge before flood control)	1,800 m3/s (Channel Full Flow) (Design Discharge: Q50)
Effect indicator	Annual maximum inundation area (km^2) *2	9,137 ha	0 km2
	Annual maximum flood damage (houses) *2	10,975 houses	0 houses

*1:Discharge in Nadi Town Bridge

*2: Due to destruction or overflow of dike (river water inundation) except inland inundation by rainfall

Chapter 19 Economic Feasibility of the Project

19.1 Preconditions

19.1.1 Evaluation Period

The evaluation period for the project is 50 years from 2026 to 2075. Expected schedule of the project implementation is as follows:

2016 - 2017: land acquisition

2018 - 2023: construction

2024: residual payment

2026 - 2075: evaluation period

The year means here the fiscal year of Fiji, from August 1 to July 30 of next year

19.1.2 Price level, price escalation

Economic value is set at 2015 price level. Foreign exchange rate is set as follows, using JICA rate of April 2016:

1JPY=0.01835FJD, 1FJD=JPY54.50

Forecasting the long-term inflation rate involves many uncertainties and not reliable. Price escalation of benefit and cost will balance out if the escalation rate is the same for the both of them in this investment plan.

And it is necessary to avoid introduction of assumption which is price escalation rate during long project period, and to secure the logical consistency the EIRR estimated by the present value and capital opportunity cost.

Therefore, the analysis is based on 2015 price, and price escalation in evaluation period is not considered.

19.1.3 Economic Price

Market price is converted to economic price for the project valuation. The following items are considered in calculating the economic price of the project.

(1) Tax and public dues

Tax and public dues are not included in the economic price. Value added tax that is 9% is not included in the calculation of the benefits and costs.

(2) Land price

Land price is calculated through deducting the cash flows from land usage when there is a big gap between market and economic price. Market price of land is used for the project valuation as such price gap does not exist in project area.

(3) Standard Conversion Factor (SCF)

SCF is used to convert domestic price to market price. The SCR used by ADB for development projects in Fiji is 0.986, which shows very small difference between domestic and market prices. Therefore, SCF of 1.0 is used for this project.

19.1.4 Social Discount Rate (SDR)

Social Discount Rate (SDR) is set at cut off line of 10−12% level in the economic analysis guidelines of the World Bank, Asian Development Bank and Inter-American Development Bank. The discount rate applied to the project is set at 10% as this rate is often applied to Fiji aid projects by Asian Development Bank, the World Bank and other international aid agencies.

19.1.5 Project Cost

The total project cost used in this study for the economic evaluation is ¥16.4 billion (F$ 301million). This cost does not include tax, price escalations and public dues. Operational and maintenance cost is set at 0.5% of the capital expenditure in reference to the cases of other countries.

19.2 Economic evaluation

The result of the economic evaluation is shown in Table 19-1.

The result confirms the cost-effectiveness and the positive economic effect of the project.

Table 19-1 Result of Economic Evaluation

Economic indicator	Result	Evaluation
Economic internal rate of return (EIRR)	12.0%	Since EIRR is well over 10% , a rate applied to the development assistance project in Fiji, the economic effectiveness is high.
Benefit-cost (B/C) ratio	1.20	Since the B/C ratio is over 1.0, the cost-effectiveness is high.
Net present value (NPV)	JPY 1.8 billion (FJD33 million)	Since the value is plus, the cost-effectiveness is high.

Source: JICA study team

19.3 Sensitivity analysis

Sensitivity analysis is conducted with fluctuating benefits and costs for analyzing changes of EIRR. As shown in Table 19-2, the EIRR of Case 1 (5% benefit decrease and 5% cost increase) is 10.7%, 9.60% for Case 2 (10% benefit decrease and 10% cost increase), and 8.5% for Case 3(15% benefit decrease and 55% cost increase). Although, these EIRR results of Case 2 and Case 3 are slightly below the target rate of 10%, their possibility possibilities are estimated to be low based on the prospect of increase of the benefits by economic growth in Nadi area.

Table 19-2 Result of sensitivity analysis

	Case 1	Case 2	Case 3
Benefit	-5%	-10%	-15%
Cost	+5%	+10%	+15%
EIRR	10.7%	9.6%	8.5%

Source: JICA Study Team

Chapter 20 Environmental and Social Considerations

20.1 Impact Assessment

20.1.1 Comparison of Scoping and Impact Assessment based on Survey Results

Based on the survey on baseline environmental conditions, impact prediction as well as the mitigation measures to be incorporated in the project, the environmental and social impacts of the project are evaluated as listed in Table 20 1.

20.1.2 Conclusion of Environmental Impact Assessment

(1) Pollution

Among eight (8) components of pollution related components, there is no component of which potential impact is evaluated as A- (Significant negative impact is expected.). Five (5) components are evaluated as B- (Negative impact is expected to some extent.) based on the survey results, including 1) Air pollution, 2) Water pollution, 3) Wastes, 4) Soil Contamination, and 5) Noise and vibration. The impacts on these components are to be caused by the construction works. Regarding the other components, the potential impacts are evaluated as D (No impact is expected.) during both construction and operation phases.

(2) Natural Environment

Among six (6) components of natural environment components, there is no component of which potential impact is evaluated as A- (Significant negative impact is expected.). Three (3) components are evaluated as B- (Negative impact is expected to some extent.) based on the survey results, including 10) Hydrological Situation, 12) Ecosystem and 14) Topography and Geographical Features. The impacts on these components are to be caused by the construction works.

As to 12) Ecosystem and 14) Topography and Geographical Features, the conditions will be continuously changed during operation phase. These components require continuous monitoring and implementation of countermeasures. Therefore, these components are evaluated as B+/-.

Regarding the other components, the potential impacts are evaluated as D (No impact is expected.) during both construction and operation phases.

(3) Social Environment

Among the social components, the most considerable impact by the project is in voluntary settlement. Number of involuntary settlement households by the Project is six (6) based on the social and economic survey.

During construction phase, the Project gives positive and negative impact to the local society and economy. Therefore, to monitor and implement mitigation measures adequately, comprehensive management scheme is required. The Resettlement Action Plan (RAP) prepared for the Project to provide a policy and a plan for the mitigation measures among resettlement and land acquisitions.

Table 20-1 Comparison of Scoping and Impact Assessment based on Survey Results

Environmental Components			River Widening / River short cutting / Construction of Bridges					Surrounding Dike					Ring Dike					Retarding Basin				
			Assessment at scoping		Assessment based on survey results		Explanation for the evaluation	Assessment at scoping		Assessment based on survey results		Explanation for the evaluation	Assessment at scoping		Assessment based on survey results		Explanation for the evaluation	Assessment at scoping		Assessment based on survey results		Explanation for the evaluation
			Period I & II	Period III	Period I & II	Period III		Period I & II	Period III	Period I & II	Period III		Period I & II	Period III	Period I & II	Period III		Period I & II	Period III	Period I & II	Period III	
Physical-Chemical Environment (Pollution)	1	Air Pollution	B-	D	B-	D	[Construction] Air pollution due to dust and emission gas by construction equipment and vehicles as well as earth works will occur. [Operation] No air pollution which is attributed to the project components will occur because the project facilities are not pollution source.	B-	D	B-	D	[Construction] Air pollution due to dust and emission gas by construction equipment and vehicles as well as earth works will occur. [Operation] No air pollution which is attributed to the project components will occur because the project facilities are not pollution source.	B-	D	B-	D	[Construction] Air pollution due to dust and emission gas by construction equipment and vehicles as well as earth works will occur. [Operation] No air pollution which is attributed to the project components will occur because the project facilities are not pollution source.	B-	D	B-	D	[Construction] Air pollution due to dust and emission gas by construction equipment and vehicles as well as earth works will occur. [Operation] No air pollution which is attributed to the project components will occur because the project facilities are not pollution source.
	2	Water Pollution	B-	D	B-	D	[Construction] Suspension of sediments and release of sediment pollutants will occur as a result of excavation/dredging for river widening, river short cutting and construction of bridges. Creation of bare land and waste water from contractor base camp and/or office would also cause water pollution in the river. [Operation] There will be no pollution source of water.	B-	D	B-	D	[Construction] Creation of bare land and waste water from contractor base camp and/or office would also cause water pollution in the river. [Operation] There will be no pollution source of water.	B-	D	B-	D	[Construction] Creation of bare land and waste water from contractor base camp and/or office would also cause water pollution in the river. [Operation] There will be no pollution source of water.	B-	D	B-	D	[Construction] Suspension of sediments and release of sediment pollutants will occur as a result of construction a facilities and excavation/dredging in the river. Creation of bare land and waste water from contractor base camp and/or office would also cause water pollution in the river. [Operation] There will be no pollution source of water.
	3	Wastes (including Dredged Material)	A-	D	B-	D	[Construction] Dredged material would be generated as a result of river widening, river short cutting and bridge construction. Part of the dredged material would be use as material for dikes. General wastes from contractor office and base camp and demolished structures would be generated. [Operation] There will be no wastes from flood control facilities.	B-	D	B-	D	[Construction] General wastes from contractor office and base camp and demolished structures would be generated. [Operation] There will be no wastes from flood control facilities.	B-	D	B-	D	[Construction] General wastes from contractor office and base camp and demolished structures would be generated. [Operation] There will be no wastes from flood control facilities.	B-	D	A-	D	[Construction] Dredged material would be generated. Part of the dredged material would be use as material for dikes. General wastes from contractor office and base camp and demolished structures would be generated. [Operation] There will be no wastes from flood control facilities.
	4	Soil Contamination	B-	D	B-	D	[Construction] Survey results of the water and riverbed sediment quality indicate that the riverbed sediment is non-hazardous materials, and hazardous level of heavy metals is not detected. Spilled oil from construction equipment would also cause soil contamination. [Operation] There will be no pollution source of soil contamination.	B-	D	B-	D	[Construction] Spilled oil from construction equipment would also cause soil contamination. [Operation] There will be no pollution source of soil contamination.	B-	D	B-	D	[Construction] Spilled oil from construction equipment would also cause soil contamination. [Operation] There will be no pollution source of soil contamination.	B-	D	B-	D	[Construction] Spilled oil from construction equipment would also cause soil contamination. [Operation] There will be no pollution source of soil contamination.
	5	Noise and Vibration	B-	D	B-	D	[Construction] Noise and vibration caused by construction activities and transportation will occur. [Operation] There will be no source of noise or vibration from the project facilities.	B-	D	B-	D	[Construction] Noise and vibration caused by construction activities and transportation will occur. [Operation] There will be no source of noise or vibration from the project facilities.	B-	D	B-	D	[Construction] Noise and vibration caused by construction activities and transportation will occur. [Operation] There will be no source of noise or vibration from the project facilities.	B-	D	B-	D	[Construction] Noise and vibration caused by construction activities and transportation will occur. [Operation] There will be no source of noise or vibration from the project facilities.
	6	Land Subsidence	D	D	D	D	No land subsidence is anticipated during both construction and operation stage because pumping of groundwater, deep excavation work, or tunneling work is not included in the project activities.	D	D	D	D	No land subsidence is anticipated during both construction and operation stage because pumping of groundwater, deep excavation work, or tunneling work is not included in the project activities.	D	D	D	D	No land subsidence is anticipated during both construction and operation stage because pumping of groundwater, deep excavation work, or tunneling work is not included in the project activities.	D	D	D	D	No land subsidence is anticipated during both construction and operation stage because pumping of groundwater, deep excavation work, or tunneling work is not included in the project activities.
	7	Offensive	B-	B-	D	D	[Construction] Offensive odor during	D	D	D	D	No occurrence of offensive odor is	D	D	D	D	No occurrence of offensive odor is	D	D	D	D	No occurrence of offensive odor is

Environmental Components			River Widening / River short cutting / Construction of Bridges					Surrounding Dike					Ring Dike					Retarding Basin				
			Assessment at scoping		Assessment based on survey results		Explanation for the evaluation	Assessment at scoping		Assessment based on survey results		Explanation for the evaluation	Assessment at scoping		Assessment based on survey results		Explanation for the evaluation	Assessment at scoping		Assessment based on survey results		Explanation for the evaluation
			Period I & II	Period III	Period I & II	Period III		Period I & II	Period III	Period I & II	Period III		Period I & II	Period III	Period I & II	Period III		Period I & II	Period III	Period I & II	Period III	
		Odor					construction work will be minimal because the sludge or other cases of odor accumulation is not recognized based on the field survey results. [Operation] Generation of offensive odor is not anticipated because there is no possibility of generation of closed water area which cause a blooming of algae in the river area.					anticipated during both construction and operation stage					anticipated during both construction and operation stage					anticipated during both construction and operation stage
	8	Riverbed Sediment Contamination	D	D	D	D	No riverbed sediment contamination is anticipated during both construction and operation stage because survey results of the riverbed sediment quality indicate that the river sediment is non-hazardous materials, and hazardous level of heavy metals is not detected.	D	D	D	D	No riverbed sediment contamination is anticipated during both construction and operation stage because survey results of the riverbed sediment quality indicate that the river sediment is non-hazardous materials, and hazardous level of heavy metals is not detected.	D	D	D	D	No riverbed sediment contamination is anticipated during both construction and operation stage because survey results of the riverbed sediment quality indicate that the river sediment is non-hazardous materials, and hazardous level of heavy metals is not detected.	D	D	D	D	No riverbed sediment contamination is anticipated during both construction and operation stage because survey results of the riverbed sediment quality indicate that the river sediment is non-hazardous materials, and hazardous level of heavy metals is not detected.
Natural Environment	9	Protected Area	D	D	D	D	There is no protected area in and around the presumed project area.	D	D	D	D	There is no protected area in and around the presumed project area.	D	D	D	D	There is no protected area in and around the presumed project area.	D	D	D	D	There is no protected area in and around the presumed project area.
	10	Hydrological Situation (River flow)	B-	C +/-	B-	B-	[Construction] Changing of river flow would occur as a result of temporally river closure works. [Operation] Result of the Project, river discharge capacity will increase and the flood risk will be mitigated. On the other hand, result of widening of the river, water depth will be decrease in a non-flood situation. But the impact of decreasing of water depth is not significant and can be mitigated by a ingenuity of cross section design.	D	D	D	D	No impact to hydrological situation (river flow) is anticipated during both construction and operation stage	D	D	D	D	No impact to hydrological situation (river flow) is anticipated during both construction and operation stage	D	D	D	D	No impact to hydrological situation (river flow) is anticipated during both construction and operation stage
	11	Groundwater	D	D	D	D	No pumping of groundwater, deep excavation work, or tunneling work is included in the Project.	D	D	D	D	No pumping of groundwater, deep excavation work, or tunneling work is included in the Project.	D	D	D	D	No pumping of groundwater, deep excavation work, or tunneling work is included in the Project.	D	D	D	D	No pumping of groundwater, deep excavation work, or tunneling work is included in the Project.
	12	Ecosystem	B-	B +/-	B-	B +/-	[Construction] Construction works in Nadi River would cause the temporary clearing of vegetation and changing of topographical features. [Operation] Changing of river topography, would cause the variation of frequency of inundation, flow velocity etc. These changes would cause change of river ecosystems. However, creation of new habitats will be the mitigation measures for the impact and it helps to increase of environmental value as well.	B-	B+/-	B-	B +/-	[Construction] Construction works would cause the clearing of vegetation and changing of topographical features. [Operation] On the dike slope and crown surface, new grass land habitat will be appeared. It is required to maintain the area properly.	B-	B+/-	B-	B +/-	[Construction] Construction works would cause the clearing of vegetation and changing of topographical features. [Operation] On the dike slope and crown surface, new grass land habitat will be appeared. It is required to maintain the area properly.	B-	B+/-	B-	B +/-	[Construction] Construction works would cause the clearing of vegetation and changing of topographical features. [Operation] On the dike slope and crown surface, new grass land habitat will be appeared. It is required to maintain the area properly.
	13	Mangrove Forest	D	C +/-	D	D	[Construction] The mangrove forest are located in Nadi River mouth, however, the project area is upstream form 5.75km. There is no direct impact to the mangrove forest. There is possibility to generate turbid water from the construction sites. However, the possibility of reaching turbid water from construction site to mangrove forest is quite small. The impact of construction works for mangrove forest is not anticipated.	D	D	D	D	There is no mangrove forest in the project site. No impact to mangrove forest is anticipated.	D	D	D	D	There is no mangrove forest in the project site. No impact to mangrove forest is anticipated.	D	D	D	D	There is no mangrove forest in the project site. No impact to mangrove forest is anticipated.

Environmental Components			River Widening / River short cutting / Construction of Bridges					Surrounding Dike					Ring Dike					Retarding Basin				
			Assessment at scoping		Assessment based on survey results		Explanation for the evaluation	Assessment at scoping		Assessment based on survey results		Explanation for the evaluation	Assessment at scoping		Assessment based on survey results		Explanation for the evaluation	Assessment at scoping		Assessment based on survey results		Explanation for the evaluation
			Period I & II	Period III	Period I & II	Period III		Period I & II	Period III	Period I & II	Period III		Period I & II	Period III	Period I & II	Period III		Period I & II	Period III	Period I & II	Period III	
	14						[Operation] In case of flood situation, mangrove forests located in Nadi River mouse would be inundated, however, this phenomenon is also observed in this area before the project. So, the impact of the project is not anticipated.															
	14	Topography and Geographical Features	B-	C+/-	B-	B+/-	[Construction] River widening would cause the change of topographical features along the Nadi River. [Operation] From the long term point of view, sand accumulation and bank erosion will occur. Adequate monitoring activities will be needed to grasp accurate conditions.	B-	D	B-	D	[Construction] Construction of dike would cause the change of topographical features. [Operation] No impact to topography and geographical features is anticipated.	B-	D	B-	D	[Construction] Construction of dike would cause the change of topographical features. [Operation] No impact to topography and geographical features is anticipated.	B-	D	B-	D	[Construction] Construction of dike would cause the change of topographical features. [Operation] No impact to topography and geographical features is anticipated.
Social Environment	15	Involuntary Resettlement	B-	D	B-	D	[Pre-Construction / Construction] There will be a total of 6 households of involuntary resettlement required by river widening. Resettlement of the affected households needs to be completed before construction is commenced. [Operation] There is no impact to involuntary resettlement.	B-	D	D	D	[Pre-Construction / Construction] No involuntary resettlement is anticipated in the surrounding dike construction area. [Operation] There is no impact to involuntary resettlement.	B-	D	D	D	[Pre-Construction / Construction] No involuntary resettlement is anticipated in the surrounding dike construction area. [Operation] There is no impact to involuntary resettlement.	B-	D	D	D	[Pre-Construction / Construction] No involuntary resettlement is anticipated in the surrounding dike construction area. [Operation] There is no impact to involuntary resettlement.
	16	Poverty Group	C-	C-	B-	B-	[Pre-Construction/Construction] As the result of survey, 41% of households (4 households are required for involuntary resettlement) are living with less than 5,000FJD income per annum. Measures aimed to improving standard of living need to be provided to project affected households before construction begins. [Operation] There is possibility of inflow of informal settlers to Nadi River side.	C-	C-	B-	B-	[Pre-Construction/Construction] As the result of survey, 41% of households are living with less than 5,000FJD income per annum. Measures aimed to improving standard of living need to be provided to project affected households before construction begins. [Operation] There is possibility of inflow of informal settlers to Nadi River side and dike side.	C-	C-	B-	B-	[Pre-Construction/Construction] As the result of survey, 41% of households are living with less than 5,000FJD income per annum. Measures aimed to improving standard of living need to be provided to project affected households before construction begins. [Operation] There is possibility of inflow of informal settlers to outside of ring dike.	C-	C-	B-	B-	[Pre-Construction/Construction] As the result of survey, 41% of households are living with less than 5,000FJD income per annum. Measures aimed to improving standard of living need to be provided to project affected households before construction begins. [Operation] There is possibility of inflow of informal settlers to inside of retarding basins..
	17	Indigenous Peoples	C+/-	C+/-	D	D	Fiji's indigenous people, Fijian is one of the major ethnic group in Fiji. There is no indigenous groups are observed in the project area.	C+/-	C+/-	D	D	Fiji's indigenous people, Fijian is one of the major ethnic group in Fiji. There is no indigenous groups are observed in the project area.	C+/-	C+/-	D	D	Fiji's indigenous people, Fijian is one of the major ethnic group in Fiji. There is no indigenous groups are observed in the project area.	C+/-	C+/-	D	D	Fiji's indigenous people, Fijian is one of the major ethnic group in Fiji. There is no indigenous groups are observed in the project area.
	18	Local Economy such as Employment and Livelihood	C+/-	A+	B+/-	A+	[Pre-Construction/Construction] Agricultural production might be affected by construction works. However, the project would contribute for temporary job creation and accelerate local economy such as tourism industry. The result of type of employment shows farming in 15 %, tourism in 35%. [Operation] Development of flood control facilities would decrease a vulnerability of flood and contribute for developing of industries.	C+/-	A+	B+/-	A+	[Pre-Construction/Construction] Agricultural production might be affected by construction works. However, the project would contribute for temporary job creation and accelerate local economy such as tourism industry. The result of type of employment shows farming in 15 %, tourism in 35%. [Operation] Development of flood control facilities would decrease a vulnerability of flood and contribute for developing of industries.	C+/-	A+	B+/-	A+	[Pre-Construction/Construction] Agricultural production might be affected by construction works. However, the project would contribute for temporary job creation and accelerate local economy such as tourism industry. The result of type of employment shows farming in 15 %, tourism in 35%. [Operation] Development of flood control facilities would decrease a vulnerability of flood and contribute for developing of industries.	C+/-	A+	B+/-	A+	[Pre-Construction/Construction] Agricultural production might be affected by construction works. However, the project would contribute for temporary job creation and accelerate local economy such as tourism industry. The result of type of employment shows farming in 15 %, tourism in 35%. [Operation] Development of flood control facilities would decrease a vulnerability of flood and contribute for developing of industries.
	19	Land Use and	B-	C+/-	B-	B-	[Pre-Construction / Construction] Land use and utilization of local resources will	B-	C+/-	B-	B-	[Pre-Construction / Construction] Land use and utilization of local resources will	B-	C+/-	B-	B-	[Pre-Construction / Construction] Land use and utilization of local resources will be changed as a result of land	B-	C+/-	B-	B-	[Pre-Construction / Construction] Land use and utilization of local resources will

Environmental Components		River Widening / River short cutting / Construction of Bridges					Surrounding Dike					Ring Dike					Retarding Basin				
		Assessment at scoping		Assessment based on survey results		Explanation for the evaluation	Assessment at scoping		Assessment based on survey results		Explanation for the evaluation	Assessment at scoping		Assessment based on survey results		Explanation for the evaluation	Assessment at scoping		Assessment based on survey results		Explanation for the evaluation
		Period I & II	Period III	Period I & II	Period III		Period I & II	Period III	Period I & II	Period III		Period I & II	Period III	Period I & II	Period III		Period I & II	Period III	Period I & II	Period III	
	Utilization of Local Resources					be changed as a result of land reformation by the project. However, the affected area is limited for along the river. [Operation] New administration area will be created and current land use will be changed by the river widening. It is needed to have agreement among land owners and users.					be changed as a result of land reformation by the project. However, the affected area is limited for along the dyke. [Operation] New administration area will be created and current land use will be changed by the construction of surrounding dike. It is needed to have agreement among land owners and users.					reformation by the project. However, the affected area is limited for along the dyke. [Operation] New administration area will be created and current land use will be changed by the construction of surrounding dike. It is needed to have agreement among land owners and users.					be changed as a result of land reformation by the project. [Operation] Regarding retarding basin, use as farmland for normal situation and as flood water storage for flood situation. Utilization of land will be different from current condition. It is needed to have agreement among land owners and users.
20	Water Usage	B-	B+	B-	B+	[Construction] Nadi river is used as area for fishing, playing etc. During construction, restriction of access and occurrence of turbid water would be occur. [Operation] There is no possibility for negative impact for water usage since flow amount will not be changed. Moreover, is possible to increase accessibility to the river by the project.	B-	C+/-	B-	D	[Construction] Nadi river is used as area for fishing, playing etc. During construction, restriction of access and occurrence of turbid water would be occur. [Operation] Existing of dike will be change the accessibility to the river. However, existence of dyke will not disturb the utilization of Nadi river.	B-	C+/-	B-	D	[Construction] Nadi river is used as area for fishing, playing etc. During construction, restriction of access and occurrence of turbid water would be occur. [Operation] Existing of dike will be change the accessibility to the river. However, existence of dyke will not disturb the utilization of Nadi river.	B-	C+/-	B-	D	[Construction] Nadi river is used as area for fishing, playing etc. During construction, restriction of access and occurrence of turbid water would be occur. [Operation] Existing of dike will be change the accessibility to the river. However, existence of dyke will not disturb the utilization of Nadi river.
21	Existing Social Infrastructures and Services (Sensitive Facilities)	B-	B+/-	B-	B+/-	[Construction] The access to school and commercial facilities would be affected by construction works. Usage and operation of these facilities would be affected by noise, change of car/pedestrian's route etc. [Operation] Increasing of traffic convenience in the region by rebuilding of bridges. On the other hand, existing of dike will be change the accessibility to the river.	B-	B-	B-	B+/-	[Construction] Usage and operation of these facilities would be affected by noise, change of car/pedestrian's route etc. [Operation] Existing of dike will be change the accessibility to the river.	B-	B-	B-	B+/-	[Construction] Usage and operation of these facilities would be affected by noise, change of car/pedestrian's route etc. [Operation] Existing of dike will be change the accessibility to the river.	B-	B-	B-	B+/-	[Construction] Usage and operation of these facilities would be affected by noise, change of car/pedestrian's route etc. [Operation] Existing of dike will be change the accessibility to the river.
22	Social Institutions such as Social Infrastructure and Local Decision - making Institutions	D	D	D	D	This Project aims at flood risk mitigation done by Fiji government. Thus, it is not expected that this Project is affected to the social infrastructure and Local Decision-making Institutions.	D	D	D	D	This Project aims at flood risk mitigation done by Fiji government. Thus, it is not expected that this Project is affected to the social infrastructure and Local Decision-making Institutions.	D	D	D	D	This Project aims at flood risk mitigation done by Fiji government. Thus, it is not expected that this Project is affected to the social infrastructure and Local Decision-making Institutions.	D	D	D	D	This Project aims at flood risk mitigation done by Fiji government. Thus, it is not expected that this Project is affected to the social infrastructure and Local Decision-making Institutions.
23	Misdistribution of Benefits and Damage	C-	C-	B-	B-	[Pre-Construction] Misdistribution of benefits and damage could be observed among the people who need resettlement and those who do not need along the river when land acquisition is required for the project facilities. [Operation] There is possibility of generation of misdistribution of benefits and damage between priority project area and other areas, inside and outside of dykes etc.	C-	C-	B-	B-	[Pre-Construction] Misdistribution of benefits and damage could be observed among land owners who are targeted of land acquisition and not. [Operation] There is possibility of generation of misdistribution of benefits and damage between priority project area and other areas, inside and outside of dykes etc.	C-	C-	B-	B-	[Pre-Construction] Misdistribution of benefits and damage could be observed among land owners who are targeted of land acquisition and not. [Operation] There is possibility of generation of misdistribution of benefits and damage between priority project area and other areas, inside and outside of dykes etc.	C-	C-	B-	B-	[Pre-Construction] Misdistribution of benefits and damage could be observed among land owners who are targeted of land acquisition and not. [Operation] There is possibility of generation of misdistribution of benefits and damage between priority project area and other areas, inside and outside of dykes etc.
24	Local Conflicts of Interest	C-	C-	B-	B-	[Pre-Construction] Local conflicts of Interest could be observed among the people who need resettlement and those	C-	C-	B-	B-	[Pre-Construction] Local conflicts of Interest could be observed among land owners who are targeted of land	C-	C-	B-	B-	[Pre-Construction] Local conflicts of Interest could be observed among land owners who are targeted of land	C-	C-	B-	B-	[Pre-Construction] Local conflicts of Interest could be observed among land owners who are targeted of land

Environmental Components		River Widening / River short cutting / Construction of Bridges					Surrounding Dike					Ring Dike					Retarding Basin				
		Assessment at scoping		Assessment based on survey results		Explanation for the evaluation	Assessment at scoping		Assessment based on survey results		Explanation for the evaluation	Assessment at scoping		Assessment based on survey results		Explanation for the evaluation	Assessment at scoping		Assessment based on survey results		Explanation for the evaluation
		Period I & II	Period III	Period I & II	Period III		Period I & II	Period III	Period I & II	Period III		Period I & II	Period III	Period I & II	Period III		Period I & II	Period III	Period I & II	Period III	
						who do not need along the river when land acquisition is required for the project facilities. [Operation] There is possibility of generation of local conflicts of interest between priority project area and other areas, inside and outside of dykes etc.					acquisition and not. [Operation] There is possibility of generation of local conflicts of interest between priority project area and other areas, inside and outside of dykes etc.					acquisition and not. [Operation] There is possibility of generation of local conflicts of interest between priority project area and other areas, inside and outside of dykes etc.					acquisition and not. [Operation] There is possibility of generation of local conflicts of interest between priority project area and other areas, inside and outside of dykes etc.
25	Cultural Heritage	C-	D	D	D	[Pre-Construction/Construction] As the result of the survey, there is no cultural facilities, sensitive facilities such as grave site, shrine etc. in the project area. However, during project implementation, it is required to observe the actual situations. [Operation] There is no possibility of influence for cultural heritage.	C-	D	C-	D	[Pre-Construction/Construction] As the result of the survey, there is no cultural facilities, sensitive facilities such as grave site, shrine etc. in the project area. However, during project implementation, it is required to observe the actual situations. [Operation] There is no possibility of influence for cultural heritage.	C-	D	C-	D	[Pre-Construction/Construction] As the result of the survey, there is no cultural facilities, sensitive facilities such as grave site, shrine etc. in the project area. However, during project implementation, it is required to observe the actual situations. [Operation] There is no possibility of influence for cultural heritage.	C-	D	C-	D	[Pre-Construction/Construction] As the result of the survey, there is no cultural facilities, sensitive facilities such as grave site, shrine etc. in the project area. However, during project implementation, it is required to observe the actual situations. [Operation] There is no possibility of influence for cultural heritage.
26	Landscape	C-	B+/-	B-	B-	[Construction] Change of landscape is evaluated by the generation of bare lands and movement of construction equipment during construction works. [Operation] River widening would be changed. However, river itself is part of nature scenery. So that negative impact to social and economy is limited. In addition, there is positive impact for urban design by re-construction of bridges.	C-	B-	B-	B-	[Construction] Change of landscape is evaluated by the situation of after construction phase. [Operation] Existence of dyke would cause obstruction to landscape views especially at the vicinity where the dike is relatively high.	C-	B-	B-	B-	[Construction] Change of landscape is evaluated by the situation of after construction phase. [Operation] Existence of dyke would cause obstruction to landscape views especially at the vicinity where the dike is relatively high.	C-	B-	B-	B-	[Construction] Change of landscape is evaluated by the situation of after construction phase. [Operation] Existence of dyke would cause obstruction to landscape views especially at the vicinity where the dike is relatively high.
27	Gender / Socially Vulnerable Groups	C-	C+/-	D	D	Negative impact for gender is not anticipated in this project. The rsults of survey indicate that very few number of disability persons are identified, and they are not included to resettlement households.	C-	C+/-	D	D	Negative impact for gender is not anticipated in this project. Results of survey indicate that very few number of disability persons are identified, and they are not included to resettlement households.	C-	C+/-	D	D	Negative impact for gender is not anticipated in this project. Results of survey indicate that very few number of disability persons are identified, and they are not included to resettlement households.	C-	C+/-	D	D	Negative impact for gender is not anticipated in this project. Results of survey indicate that very few number of disability persons are identified, and they are not included to resettlement households.
28	Rights of Children	C-	D	D	D	Negative impact to the children rights is not anticipated by the project. The results of survey did not find the any issues regarding children's rights.	C-	D	D	D	Negative impact to the children rights is not anticipated by the project. The results of survey did not find the any issues regarding children's rights.	C-	D	D	D	Negative impact to the children rights is not anticipated by the project. The results of survey did not find the any issues regarding children's rights.	C-	D	D	D	Negative impact to the children rights is not anticipated by the project. The results of survey did not find the any issues regarding children's rights.
29	Infectious Diseases such as HIV/AIDS	C-	D	B-	D	[Construction] Number of infected person in Fiji is increasing. So that there is possibility of HIV infected worker would participate to the construction works.	C-	D	B-	D	[Construction] Number of infected person in Fiji is increasing. So that there is possibility of HIV infected worker would participate to the construction works.	C-	D	B-	D	[Construction] Number of infected person in Fiji is increasing. So that there is possibility of HIV infected worker would participate to the construction works.	C-	D	B-	D	[Construction] Number of infected person in Fiji is increasing. So that there is possibility of HIV infected worker would participate to the construction works.
30	Labor Environment (Including Occupational Safety)	B-	D	B-	D	[Pre-Construction/ Construction] The construction works of the Project is in a certain scale. So that it is required to consider safety and work environment.	B-	D	B-	D	[Pre-Construction/ Construction] The construction works of the Project is in a certain scale. So that it is required to consider safety and work environment.	B-	D	B-	D	[Pre-Construction/ Construction] The construction works of the Project is in a certain scale. So that it is required to consider safety and work environment.	B-	D	B-	D	[Pre-Construction/ Construction] The construction works of the Project is in a certain scale. So that it is required to consider safety and work environment.
31	Accidents	B-	B-	B-	B-	[Construction] Construction related accidents by heavy equipment and transportation vehicles might occur. [Operation] There is a possibility to occur of accidents in the maintenance road along the river.	B-	B-	B-	B-	[Construction] Construction related accidents by heavy equipment and transportation vehicles might occur. [Operation] There is a possibility to occur of accidents in the maintenance road along the river.	B-	B-	B-	B-	[Construction] Construction related accidents by heavy equipment and transportation vehicles might occur. [Operation] There is a possibility to occur of accidents in the maintenance road along the river.	B-	B-	B-	B-	[Construction] Construction related accidents by heavy equipment and transportation vehicles might occur. [Operation] There is a possibility to occur of accidents in the maintenance road along the river.
32	Global Warming	D	D	D	D	The scale of changes are large. However, the project will be conducted in the river	D	D	D	D	The scale of changes are large. However, the project will be conducted in the river	D	D	D	D	The scale of changes are large. However, the project will be conducted in the river	D	D	D	D	The scale of changes are large. However, the project will be conducted in the river

Environmental Components			River Widening / River short cutting / Construction of Bridges					Surrounding Dike					Ring Dike					Retarding Basin				
			Assessment at scoping		Assessment based on survey results		Explanation for the evaluation	Assessment at scoping		Assessment based on survey results		Explanation for the evaluation	Assessment at scoping		Assessment based on survey results		Explanation for the evaluation	Assessment at scoping		Assessment based on survey results		Explanation for the evaluation
			Period I & II	Period III	Period I & II	Period III		Period I & II	Period III	Period I & II	Period III		Period I & II	Period III	Period I & II	Period III		Period I & II	Period III	Period I & II	Period III	
							area. The impact will not exceeding the area. In addition, no impact for global warming is anticipated.					area. The impact will not exceeding the area. In addition, no impact for global warming is anticipated.					area. The impact will not exceeding the area. In addition, no impact for global warming is anticipated.					area. The impact will not exceeding the area. In addition, no impact for global warming is anticipated.

A+/-: Significant positive/negative impact is expected.

B+/-: Positive/negative impact is expected to some extent.

C+/-: Possibility of impact and its magnitude are unknown.

(A further examination is needed, and the impact could be clarified as the study progresses.)

D: No impact is expected.

Period I: Pre-construction, Period II: Construction, Period III: Operation

20.2 Environmental Management Plan

20.2.1 Pollution

Environmental impacts and mitigation measures for pollution related components are described in Environmental Management Plan shown in Table 20-2.

Table 20-2 Environmental Management Plan for Pollution Related Components

Project Phase	Potential Impact	Mitigation Measures / Perspective on Impact Mitigation	Implementation Organization / Responsible organization	Cost
1) Air Pollution				
Constriction	Air pollution by dust due to earth works for dike and excavation, etc.	• Excavation materials must be properly stockpiled and properly disposed of immediately from the construction site when not needed. • Provision of covers to stockpiles that will be left idle for a long time, • Dust generation will be mitigated with watering at dusty place and covering the load of trucks by tarpaulin, • Periodical and timely cleaning of the spilled materials on road or other public space along the transportation route of construction materials and spoil materials	Implementation: Contractor, Responsible Org.: Proponent , Consultant and DOE(Department of Environment)	Included in the construction cost
	Air pollution by emission gas due to the operation of construction equipment and vehicles	• Using a low emission type construction equipment and vehicles, • Regular maintenance of construction equipment and vehicles, • Consideration of operation manner of the equipment due to the regular education to the operators.	Implementation: Contractor, Responsible Org.: Proponent , Consultant and DOE(Department of Environment)	Included in the construction cost
2) Water Pollution				
Constriction	Water pollution of the river water due to earth works near the river bank, excavation and dredging works in the river	• Installation of temporary embankment and drainage at the boundary of periphery of project site, • Installation of sedimentation pond at appropriate location to avoid the turbid water discharge	Implementation: Contractor, Responsible Org.: Proponent , Consultant and DOE(Department of Environment)	Included in the construction cost

Project Phase	Potential Impact	Mitigation Measures / Perspective on Impact Mitigation	Implementation Organization / Responsible organization	Cost
		• Selection of less agitation method of dredging and its proper implementation.		
	Water pollution by waste water (effluent and used oil) from construction yards and offices, and accidental oil spill	• To ensure not to directly drain the waste water from construction yard and offices to the river, • Waste water is to be properly treated and disposed using septic tank or other appropriate treatment method • Provision of portable toilet for the workers at the construction work sites. • To ensure not to cause accidental oil spill and other chemicals.	Implementation: Contractor, Responsible Org.: Proponent , Consultant and DOE(Department of Environment)	Included in the construction cost
3) Wastes (including Dredged Material)				
Constriction	Waste generation associated with demolition of buildings and structures	• Reduction of wastes generation by segregation, re-use and recycle of the materials used in the demolished buildings and structures in the affected areas. • Appropriate treatment and disposal of the wastes from demolished structures by delegating to the accredited waste contractor.	Implementation: Contractor, Responsible Org.: Proponent , Consultant and DOE(Department of Environment)	Included in the construction cost
	Dredged material generation associated with dredging and excavating	• Dredged material can be facilitated through the DMR (Department of Mineral Resources) direction. • Temporary disposal area for dredged materials can be prepared through the coordination among native land owners (LOU: Land Owning Unit). Received dredged materials by a landowner can be sold based on the permission from DMR. Gain on sale of dredged material can be used for public purpose in LOU by landowners.	Implementation: Contractor, Responsible Org.: Proponent, Consultant, DOE (Department of Environment) and DMR (Department of Mineral Resources).	Included in the construction cost
4) Soil Contamination				
Constriction	Soil contamination at the construction site by oil leaking from	• Regular maintenance of construction equipment and	Implementation: Contractor,	Included in the construction

Project Phase	Potential Impact	Mitigation Measures / Perspective on Impact Mitigation	Implementation Organization / Responsible organization	Cost
	construction equipment and vehicles.	vehicles. • Consideration of operation manner of the equipment due to the regular education to the operators.	Responsible Org.: Proponent , Consultant and DOE(Department of Environment)	cost
5) Noise and Vibration				
Construction	Noise and vibration during construction works due to operation of construction equipment and vehicles	• Using a low noise and vibration type construction equipment and vehicles, • Regular maintenance of construction equipment and vehicles, • Consideration of operation manner of the equipment due to the regular education to the operators. • Regular communication with local residents about the methodology and implementation schedule of construction works. • Adjustments in the operation time of construction equipment and dump trucks, transportation route, etc. • Installation of sound abatement wall during construction work in the vicinity of residents and sensitive facilities such as schools or settlement areas, if necessary.	Implementation: Contractor, Responsible Org.: Proponent , Consultant and DOE(Department of Environment)	Included in the construction cost

20.2.2 Natural Environment

Environmental impacts and mitigation measures for natural environment related components are described in Environmental Management Plan shown in Table 20-3.

Table 20-3 Environmental Management Plan for Natural Environment Related Components

Project Phase	Potential Impact	Mitigation Measures / Perspective on Impact Mitigation	Implementation Organization / Responsible organization	Cost
10) Hydrological Situation (River flow)				
Constriction	Variation of river water flow by temporary closure works	• To mitigate turbid water generation from closure works by steel sheet pile. • Transfer/rescue of aquatic organism from closed water area before dredging.	Implementation: Contractor, Responsible Org.: Proponent , Consultant and DOE(Department of Environment)	Included in the construction cost
Operation	Reduction of average water depth by river widening.	• To consider the water route for initial condition of cross sections. After operation, initial water route can be helped to create original the river flow by river power. • Regular maintenance cross section survey to inspect the condition of river bed maintained adequately.	Implementation: Contractor, Responsible Org.: Proponent and DOE(Department of Environment)	included in the operation cost
12) Ecosystem				
Construction	Loss of vegetation cover and change of habitat of wildlife	• Limiting land and vegetation clearance as much as possible by considering the construction method. • Appropriate plant species for greening and compensation should be planted.	Implementation: Contractor, Responsible Org.: Proponent , Consultant and DOE(Department of Environment)	Included in the construction cost
Operation	Change of frequency of flood and river velocity	• Cross section design should consider the creation and maintenance of habitat of wild life by river power.	Implementation: Consultant (detailed design) and Proponent (operation) Responsible Org.: Proponent and DOE(Department of Environment)	Design is included in the detailed design study included in the operation cost

20.3 Abbreviated Resettlement Action Plan

The Abbreviated Resettlement Action Plan (RAP) for this project will be prepared based on JICA Environmental and Social Considerations, April 2010 and World Bank Safeguard Policy.

1. Necessity of Land Acquisition and Resettlement
2. Regal Framework for Land Acquisition and Resettlement
3. JICA's policy for Resettlement
4. Gaps between JICA Guideline and Fiji's legal Frameworks
5. Policy for Land Acquisition and Resettlement for the Project
6. Scope of Resettlement Impact
7. Concrete Measures for Compensation and Support
   - 7.1 Impact and Compensations by the Project
   - 7.2 Compensation for Loss of Assets
   - 7.3 Assistance on Entitlements for land acquisition and resettlement
   - 7.4 Countermeasures for Restoring of Living
   - 7.5 Relocation Land
   - 7.6 Entitlement Matrix
   - 7.7 Responsible Institutions of Land Acquisition and Resettlement
   - 7.8 Land Acquisition Procedures
   - 7.9 Responsible Institutions and Mechanism of Grievance Redress
   - 7.10 Resettlement Implementation Schedule
   - 7.11 Cost and Fund Source of Land Acquisition and Resettlement
   - 7.12 Monitoring Framework by Implementation Institutions

20.4 Public Consultations and Stake Holders Meetings

20.4.1 Outline

Three (3) Public Consultations are held to inform the situation of project examination and collect an opinion and comment from residents. The dates of public consultations are follows;

1st Public Consultation: 2 July, 2015 (Tuesdays)

2nd Public Consultation: 12 September, 2015 (Wednesday)

3rd Public Consultation: 5 April, 2016 (Tuesday)

20.4.2 Participants and major opinions

(1) 1st Public Consultation

The number of participants of 1st Public Consultation are 46. Name and organization of participants are shown below.

1. IntazHussain (Lands – Lautoka)
2. Neel Chandra (Fiji Police Force)
3. P. Bainivalu (Fiji Military Force)

4. EpineriDalituicama (Ministry of Agriculture)
5. UmendraPratap (Ministry of Agriculture)
6. Mahendra K. (Ministry of Agriculture)
7. Shiri N (Agriculture Department)
8. ViliameMomoivalu (Department of Environment)
9. Vinod Kumar (Min. of Primary Ind.)
10. Albert Queet (SCOPE Pacific)
11. Melissa Toro (SCOPE Pacific)
12. Neela Prasad (JICA)
13. Ifereimi (Nadi Rural Local Authority/Ministry of Health)
14. Robin Anganu (Nadi Town Council)
15. IliesaRakaseta (Housing Authority)
16. JoneMataiqe (Housing Authority)
17. IliesaTaivei (Housing Authority)
18. Sekove Q (Housing Authority)
19. Vishnu (Sheraton Resort)
20. John Ross (Fiji Sun)
21. SaloteQalubau(Fiji Sun)
22. ArujDevia(Devia Bookshop)
23. Pravin (Brij& Co)
24. Yeh Chang Wai (PIL Foodhall Supermarket)
25. ManojJeet(VIB)
26. Charles Dewan(ANZ)
27. R. Sanday (Nadi Sports Council)
28. B. McElrath (McDonalds)
29. Jeff Wang (EMEI)
30. Rapek (Avon Store)
31. Marsh (Jet tex S P L)
32. Sunt Kumar (Farmer)
33. P. Watson (Landowner)
34. Norman Yee (NadiResident)
35. ApenisaVuki (Nadi Resident)
36. TevitaRatu (Nakovacake)
37. IliaseriVano (Nakovacake)
38. TomasiNaulumatua (Natoqocake)
39. Egi T. Dodd (Businessman)
40. Anil Gounder (Businessman)
41. Ash Yam(Namotourio)

42. Nacanieli V (MH Nadi)
43. Nikan K (Nadi Resident)
44. M. W
45. VilimoniTabuanitoga (Narewa Village)
46. KapilBhagwan (Unknown)

Major opinions from participants are shown below.

- What type of embankment are considered along with the river (Resident in Nakovacake)
- What kind of impact will be anticipated due to the river widening? In Nakovacake, we are worry for Landslide. (Resident in Nakovacake)
- More than 77 year living in Nadi Basin, a planting in upstream area is needed. (person in charge of agriculture sector)
- Construction of Diversion channel needs huge cost and may it make several impacts to the area. The idea of river widening is simple and acceptable. (Resident in Namotomoto)
- Under the low tide condition, estuary of Nadi river is very shallow. Not to navigate by the boat. Is there (Resident in Nacovi)
- Can house owners which are affected by the river widening receive the proper assistance? (Nakomorake Development Trust)

(2) 2nd Public Consultation

The number of participants of 2nd Public Consultation are 22. Name and organization of participants are shown below.

1. Khin Maung Cho (LWRM/MOA)
2. Josefa Nawai (LWRM/MOA)
3. Jonetani B (LWRM/MOA)
4. Vinesh (LWRM/MOA)
5. Sauri Mitchell (SDC)
6. Netani Qicatabua (Consulting Engineer, Netts Planning & Infrastructure)
7. Peceli Nakavulevu (Min of Lands)
8. Robin Ali (Nadi Town Council)
9. Jone Mataitoga (Housing Authority)
10. IliesaTaivei (Housing Authority)
11. Tevita King (SCOPE Pacific)
12. Nina Sikiti (SCOPE Pacific)
13. Joseva Rokocoko (Yavusania Village)
14. Sakiasi Radibi (Yavusania Village)
15. Ilisoni R (Moala Village)
16. Vuniani L (Moala Village)
17. Takashi Toyoda (JICA Study Team)
18. Hajime Watanabe (JICA Study Team)

19. Metuisela Mua (JICA Study Team)
20. Ashok Kumar (JICA Study Team)
21. Joe Waqavakatoga (JICA Study Team)
22. Amelina Ratubuli (JICA Study Team)

Major opinions from participants are shown below.

- The examination done by JICA is based on the evaluation which the frequency of flood in 2015 is 1/50. Do you conduct the calculation for the 1/100, 1/25 flood? Can we review the draft repot? (Civil Engineer)
- How many years are needed for completion of the Project? (Housing Authority)

(3) 3rd Public Consultation

The number of participants of 2nd Public Consultation are approximately 30 (this number including person who are not record the name on attendance list). Name and organization of participants are shown below.

1. Rita Pickering (Air New Zealand)
2. Samisoni Vouratukula (Waqadra Residence)
3. Daya Lal - (Waqadra Residence)
4. Palpana Nand (Waqadra Residence)
5. V. Ramani (Unknown)
6. Kamlesh Chandra - (Qeleloa Settlement)
7. Mahesh Khatri (ACME Garments)
8. Jitendra Singh (Deo Street, Namaka)
9. Ana Dugulele (Rustic Pathways)
10. Laupaama (Unknown)
11. Ravin Devia (Devia Bookshop)
12. Jainendra Vikash - (Mega Paper Power)
13. Naseer Khan (Khans Service Station)
14. Roneel Deo (Sharma Design)
15. Aung Yi (MOA)
16. Josefa Nawai (MOA)
17. Sant Pratap (MOA)
18. Filimoni Vananalagi (MOA)
19. Vinesh Kumar (MOA)
20. Hideki Sawada (JICA)
21. Nila Prasad (JICA)
22. Takashi Toyoda (JST)
23. Yoshio Nakagawa (JST)
24. Metuisela Mua (JST)
25. Ashok Kumar (JST)

26. Amelina Ratubuli (JST)

Major opinions from participants are shown below.

- Where is the starting point of river widening? In case of the flood happen in upstream, the area around Novotel inundated? (Waqadra Residence)
- In case of flood in Nadi river, the water going to the sea with out any flooding? (unknown)
- After the development of retarding basin and river widening, the amount of water which flow into the ocean is changed? How to drain the water from retarding basins (Unknown)
- Dam construction is included to the Project? (Khans Service Station)
- In case of collapse of Vaturu Dam, what kind of even is anticipated? (Rustic Pathways)

Chapter 21 Project Evaluation and Recommendations

21.1 Project Evaluation

21.1.1 Economic Valuation

Total cost of the priority project is ¥21 billion (F$385 million) and the average annual benefit is ¥ 1.88billion (F$34.5 million). These figures lead to EIRR of 12.0%, B/C of 1.2 and NPV ¥1.8 billion (F$33 million) respectively. This investment rate of return is above the target investment rate of return of 10% in Fiji and show the positive economic effect.

21.1.2 Financial Valuation

Fiji government has to consider external borrowing to secure the fund necessary to implement the project. The amount of the external borrowing is estimated to be JPY15,967 million (F$ 293million), which is 76% of the total project cost, in case of Yen loan by Japanese government. The following typical Yen loan condition is assumed:

- ✓ Interest rate 0.6% p.a., repayment period 40 years (of which 10 years is a grace period) as priority condition for middle income country.

The total repayment amount will be ¥ 17.3 billion (F$318 million). Maximum annual payment will be ¥ 590 million (F$10.8 million) and average annual payment will be ¥ 430 million (F$7.9 million). These maximum and average payments will be approximately 11.6% and 8.4% of the average external debt payment of ¥ 5.1 billion (F$94.7 million), respectively, according to the Fiji government plan of medium term fiscal estimate.

The remaining ¥ 4.7 billion (F$86.2 million), which is accounting for 24% of the total project cost, should be provided by the Fiji government. However, such funding, which is considered to be provided within the regular annual budget as annual payment of ¥ 190 million (F$3.5 million) (≒¥ 4.7 billion/25 years), is estimated only 0.1% of the total expenditure and 0.4% of public investment expenditure of the budget. Apart from the annual project cost shown in Table Table 20-5 in Chapter 20, VolumeII, Main report, the Fiji government should provide the additional budget necessary for acquisition and compensation of the private land.

21.1.3 Environmental Impact Evaluation

By the implementation of the Project, the inundation area and period will be reduced significantly, and as a result the direct and indirect damages caused by flooding will be reduced. This will have large positive impacts on the social economic development and peoples' welfare.

Although the various countermeasures will be able to cope sufficiently with the negative impacts on the social and natural environment as described in this report, the items which will relatively have important effect are shown below.

(1) Relocation of housing

Seventeen households have to be relocated in the Priority Project. Sufficient negotiation on land acquisition and compensation will be required from now on. In addition to the above 17 households, there are other 17 households scattered in the retarding basin area planned in the Master Plan; these households will be affected by the negative impact of the river channel widening in the middle stream of Nadi River, and as a result compensation negotiation of will be necessary.

(2) Change of topography and landscape

Since the river width will be widened approximately by 2 times of its present width after implementation of the Project, the topography and landscape will be change. Therefore, it is desirable to implement the land use planning and town planning along the river, facilitating such as building parks and walking trails in parallel with the Project.

(3) Influence on tourism

During implementation of the Project, vehicles and heavy construction equipment may frequently move here and there including dump trucks transporting soil. Such traffic may pass through main road together with that of tourism vehicles, and there is some risk that the river channel excavation may cause turbid

water. The reduction of such minus impacts on tourism should be considered by planning adopting a construction method avoiding such impacts on tourism and environment. However, after completion of the Project a large plus impact on tourism is expected by reducing remarkably direct and indirect damage of flooding.

21.2 Recommendations for the Implementation of the Project

21.2.1 Recommendations for the Implementation of the project

(1) Implementation of the Priority Project

The recommended Priority Project has large economic effect and sufficient financial feasibility. The implementation of the Project will present a great benefit to social and economic development and peoples' welfare. Therefore, the Project should be implemented as soon as possible to avoid repeated flood damage.

(2) Consensus building

Consensus should be built among the stakeholders of the government on the implementation of the project. Moreover, the understanding and consensus of the residents that may be affected by the project are required.

(3) Commencement of loan procedure for project fund

The major part of the fund for implementation of the Project is likely to be procured by foreign loan. Such loan process requires long period, and it is necessary to start the loan process as early as possible. Since the government has to cover part of the cost, the project should be included in the government budget, and the process necessary to realize this should commence immediately.

(4) Commencement of negotiation for land acquisition and compensation

Since the negotiation of land acquisition and compensation requires generally long time, the explanation to residents and negotiation should commence as early as possible so that there will be enough time for discussion after which the agreement of the residents should be obtained.

(5) Commencement of consultant procurement and environmental monitoring

Prior to the construction of flood control counter measures, the detail design is necessary. Therefore, after the decision of Project implementation, the consultant is procured immediately to prepare the detail design of the Project.

And in order to assess the natural and social impact of the implementation of the Project, various types of monitoring of environmental factors should be started.

(6) Establishment of flood control legislation

The legislation of flood control in Fiji is not yet accomplished; it should be established on various items including definition of river area (boundary of river) and compensation method of retarding basin and so on.

(7) Establishment of organization responsible for flood control and capacity building

At present the organization responsible for flood control is not clearly defined in the legislation. The Ministry of Agriculture (MOA), which is a counterpart agency of this Study, is and only responsible for flood control of agricultural village and land; however flood control of urban area and examination of influence of climate change and so on are out of its responsibility.

The number of engineers in LWRM of MOA is few and very limited. The establishment and strengthening of the organization responsible for flood control is urgently required, including increase of engineers and capacity building, and budget allocating.

(8) Preparation of criteria and standard

The preparation of criteria and standard as well as organization and legislation concerning flood control is necessary. It is understood from a discussion with LWRM that since there are no specific criteria and standard in Fiji, at present engineers relay on their own knowledge, experience and information obtained from internet. The criteria and standard matching to the natural, social and environmental situation of Fiji should be prepared.

(9) Securing of maintenance budget for flood control

At present, the maintenance budget for flood control is not always secured, and as a result, the maintenance of flood control facilities is not carried out sufficiently. The maintenance work of flood control facilities to be constructed by the Project is inevitable; therefore, yearly budget has to be secured for continuous maintenance work.

(10) Establishment of flood control master plan for overall Fiji and implementation

The flood control master plan in the Nadi River basin was established in this Study; however, there are 4 large river basins in Viti Levu island in addition to Nadi River, which are Rewa River, Navua River, Sigatoka River and Ba River, without master plans. Master plans for these rivers is to be established and the implementation of flood control facilities of it should be implemented step by step.

21.2.2 Recommendations for Inland water Drainage

(1) Present situation and issues of inland water drainage

Although the inundation phenomena by river water is the objective of this study, inundation damage by inland water occurs often due to insufficient capacity of drainage system for rainfall in the central area of Nadi town, which is included in the Important Protected Area defined in the Project. Therefore it is impossible to protect completely the inundation in the city center area by only the counter measures against river water. Therefore, the improvement of the inland water drainage system is an urgent issue that should be carried out soon.

Figure 21-1 shows the current situation of the rainfall water (inland water) drainage system. The central area of Nadi town is often inundated due to slight topography depression and insufficient drainage system.

There is a drainage plan promoted by Nadi town (discussed later in Section (2),2), which is not concrete plan, but the maintenance of drainage channel is carried out partly limited to removing rubbish.

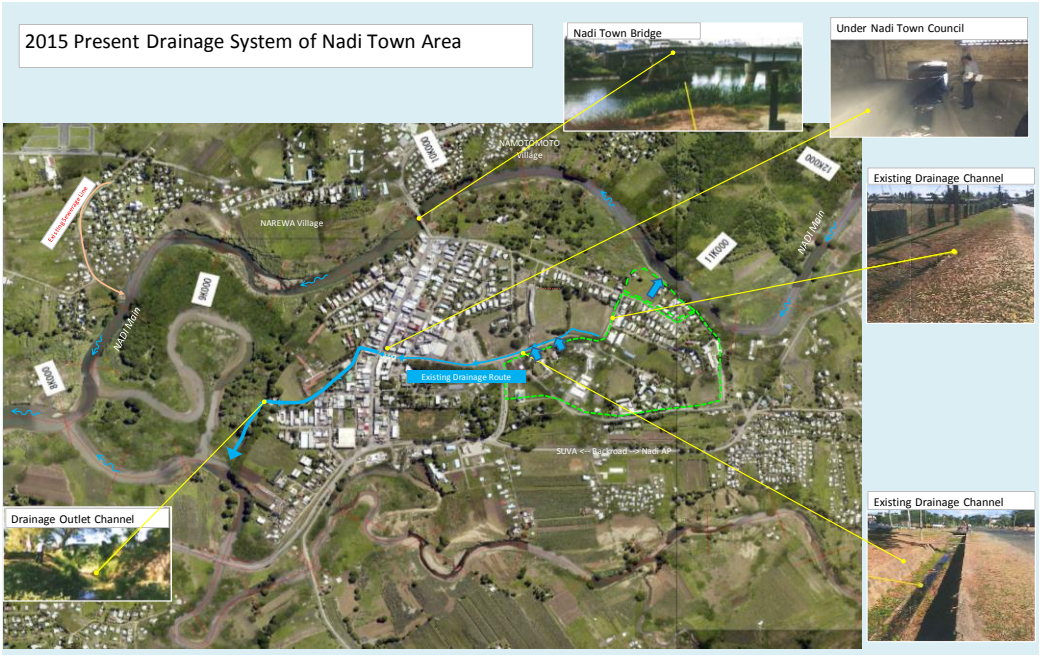


Figure 21-1 Drainage system of rainfall water in the central area of Nadi town

(2) Drainage counter measures for inland water

1) Mitigation method of inundation by inland water in the Project

In the Project, the river channel widening is to be implemented. In the flood control plan the design high water level (HWL) is planned to be equal to or lower than the ground height of the river side land so that the increase of inundation by inland water is restrained. In addition, depression area besides the dike is recommended to be filled to the top of bank so that there will be no depression area.

2) Review of Nadi Town Drainage Plan

Nadi Town Drainage Plan was completed for the solution of drainage problems and reduction of flood damage of Nadi town in August 2000 by the Department of Town and Country Planning, Nadi Town Council, LWRM, Western Drainage Board, National Disaster Management Committee, Nadi Rural Local Authority.

In the plan, present situation and issues were studied, and the long-term, and short- and medium-term plans were recommended to solve the issues (refer to Table23-1). However, the plan was studied without demarcation of inland water and river water, without hydraulic analysis and verification, and scientific ground.

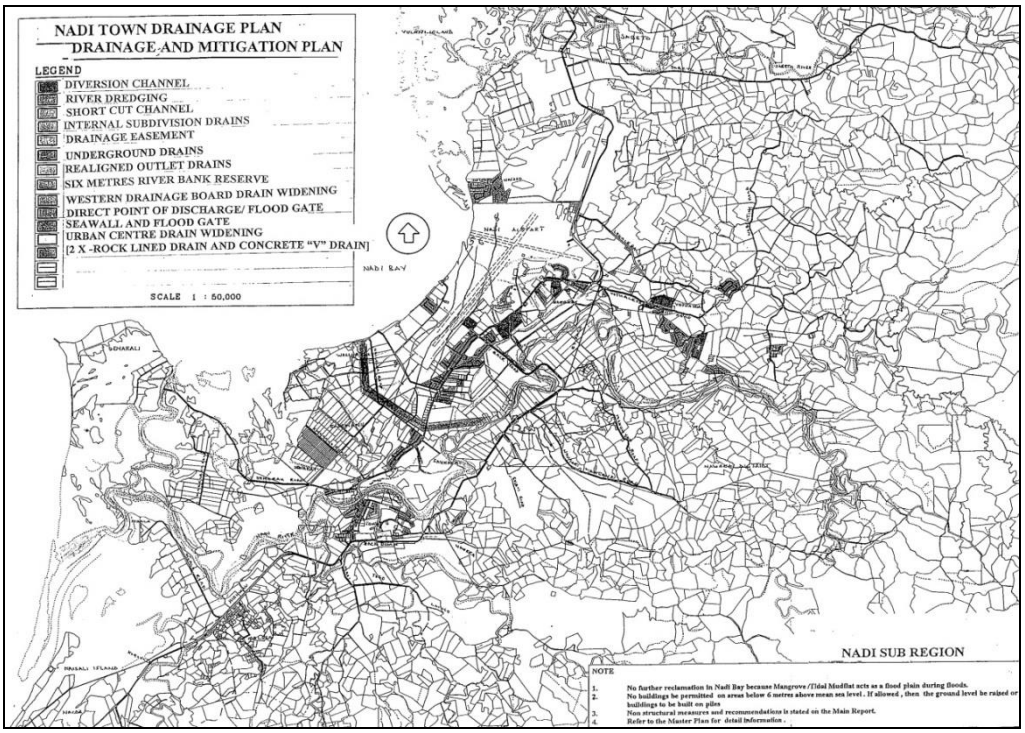
In addition to the above, the plan included the diversion channel and short cut recommended by JICA study carried out from 1996–1998, titled as [*The study on watershed management and flood control for the four major vitilevu rivers*](herein after referred to as Development Study1998)

As the progress of Nadi Town Drainage Plan, although the retention dams are constructed by LWRM separately, the other facilities are not confirmed remarkable progress in the investigation carried out by JICA study team in 2016.

Table 21-1 Contents of the 2000 Nadi Town Drainage Plan

Period	Contents of Plan
Short- and medium-term plan	Widening drainage channel and review of the alignment
Long-term plan	Construction of retention dam, embankment, diversion channel, short cut and so on

Source：Nadi Town Drainage Plan (2000)



Source: Nadi Town Council, Department of Town and Country Planning

Figure 21-2 Nadi Town Drainage Plan (2000)

21.2.3 Recommendations for Mitigation and Management of Disaster Risk

The present conditions and issues of flood control and the mitigation measures of disaster damage is as described in " VolumeII Main Report, Part I: Master Plan Study, Chapter 4 Present Conditions and issues of Flood control and Basin Management

The flood control and flood damage mitigation measures executed up to now are limited to local river bank protection works, small scale retention dam construction, and introduction of early flood warning system and so on, which are not systematic measures for overall river basin. Considering the above situation the following recommendations are made.

(1) Background of mitigation and management of disaster risk

The inundation analysis was carried out for the maximum flood recorded in the past, and the predicted inundation area was presented. However, it is necessary to envisage possibility of new disaster risk resulting from extraordinary flood and different rainfall pattern, and to promote the counter measures by recognition of occurrence frequency, possible damage, by the government agencies, municipalities and residents.

Accurate and comprehensive information on frequency of inundation, risk of loss of human life, capacity and condition of facilities should be presented by the related agencies using hazard map or other appropriate means. The measures reducing the disaster risk should be promoted by sharing disaster risk information among agencies.

(2) Basic concept of implementation of adaptive measures

On the other hand, the increase of impact and risk of frequent and severe disasters of flood, sedimentation, high tide and drought by climate change has become a major concern in recent years. The importance of adaptive measures to the adverse effect of the climate change as well as mitigation measures is pointed out in the Conference of the Parties to the United Nations Framework Convention on Climate Change (COP). The measures were proposed considering change of future socioeconomic situation and uncertainty of risk such as climate change and movement of population, economy, and technology level and so on. In order to mitigate such disaster risk, it is important that adaptive measures are to be applied.

When adaptive measures are implemented as risk mitigation measures, the measures have to be promoted based on the concept listed below. And the measures have o be implemented adaptively and verified and reviewed based on the knowledge and experience of not only upgrading the basic technology on the hydrology, which is based on scientific ground, but also promoting continuous monitoring of climate change, prediction, investigation and research, technological development of climate change.

The basic concept of implementation of adaptive measures is as follows:

- Adaptive management based on uncertainty
- Coping with existing phenomena
- Consideration of impact on future
- Comprehensive structural and non-structural measures
- Consideration of climate change for each project plan
- Symbiosis with nature and conformity with environment
- Consideration of regional characteristics and promotion of activity in each level

1) Adaptive management based on uncertainty

The prediction of future impact of climate change (timing of occurrence, place, and extent) is accompanied by uncertainty. When the adaptive measures are to be promoted, adaptive management has to be applied. Moreover, appropriate measures have to be selected when necessary with continuous monitoring of climate change, progress of climate change, up-to-date climate data, socio-economic reginal variation, effect of the existing and new risk reduction measures.

2) Coping with existing phenomena at present

The influence of climate change has not been observed clearly in Nadi River basin, but if the climate change will be observed and becomes obvious by observation and monitoring, the measures in the Priority Project in this Study is basically to be adopted and promoted.

3) Consideration of impact on future

Although the extent of impact and time of occurrence of climate change is uncertain, the phenomena at present may become worse and cause the large disaster in progress of climate change. Therefore, the study on adaptive measures for various phenomena is to be carried out taking into consideration the change of the frequency of occurrence of phenomena.

4) Structural and non-structural aspects of measures

The adaptive measures include structural measures such as construction of facilities and non-structural

measures such as early flood warning, town and land use planning based on the disaster risk. The comprehensive measures have to be implemented immediately by appropriately combining the structural and non-structural measures.

5) Consideration of adaptive measures and disaster prevention of each project plan

In order to implement the adaptive measures effectively and efficiently, the concept of adaptation to the impact of climate change and disaster prevention should be involved in each project plan. If necessary, concept of adaptive measures and disaster prevention should be considered in the design of facilities, maintenance, renewal of infrastructure and systems.

6) Prevention and reduction of disaster based on symbiosis with nature, conformity with environment and ecosystem

It is important to look at nature closely, utilize natural function and conform to nature in the development of infrastructure. Similarly, in the implementation of adaptive measures and disaster prevention measures, it is necessary to consider conservation, renewal and creation of natural environment.

The restoration and conservation of water conservation forest by watershed management not only strengthen the function of water conservation area but also increase regional toughness, and contribute to the prevention and reduction of disaster in community, and mangrove forest, natural retarding basin and swamp mitigate flooding. The ecosystem has various functions for prevention and reduction of disaster, and Eco-DRR (Ecosystem-based Solutions for Disaster Risk Reduction) is to be promoted.

A forestation in the upstream of Nadi River has been carried out by MOA, and this is expected to conserve the basin and protect the sediment run off. The downstream area on left bank side of Nadi River is natural retarding basin where mangroves make their habitat. This area will be planned as an artificial retarding basin in the future in the Master Plan and will contribute to conservation of natural environment as well as reduction of disaster.

7) Consideration of regional characteristics and promotion of activity in each level

In promotion of the accommodated measures, the scenario of measures and implementation timing is to be assumed beforehand, and the preparation of flexible measures is to be considered. The Government is required to assist sufficiently the regions to understand the impact of climate change and the adaptive measures.

(3) Recommendation for adaptive measures in Nadi River basin

Based on the present situation of Nadi River basin and the Master Plan presented in this Study and the basic concept of adaptive measures above, the following measures are recommended.

1) Disaster prevention measures for floods with relatively low occurrence probability

a) Immediate implementation of Priority Project

The damage caused by the floods with relatively low occurrence probability such as once in two or three years will be eliminated by the implementation of the Priority Project targeting flood with occurrence probability of 1/50. Therefore, the Priority Project has to be implemented immediately.

b) Upgrading function of existing facilities

Upgrading the function of the existing facilities is to be carried out by strengthening drainage facilities and construction of reservoir for rainfall water.

c) Full execution of maintenance and renewal

The maintenance and renewal of existing facilities are to be fully executed after preparing the inventory of existing facilities and understanding the present condition of the facilities.

d) Expanding and upgrading hydrological observation network

The hydrological network such as rainfall observation and water level observation is to be expanded and upgraded and the information on flood and inland water is to be collected and integrated with river basin management

e) Comprehensive sediment management

In the entire sediment transport system, the target of sustainable sediment management is to be studied, and comprehensive sediment management is to be promoted for monitoring sediment yield, mitigation of

sediment discharge by watershed conservation like planting in upstream area and planning maintenance works like dredging.

f) Upgrading of flood forecasting technique for plan and design of facilities

The flood forecasting technique is to be upgraded not only for reduction of disaster risk but also for reflecting it to the plan and design of facilities.

g) Integrated preparation and operation of river and rainfall drainage systems

Although the flood control is executed by the implementation of the Priority Project and the Master Plan, in order to eliminate the inundation damage in Nadi town, rainfall water drainage system should be facilitated; moreover, an integrated operation of the river and rainfall drainage systems is necessary for inundation caused by river water and rainfall water. Therefore, a system connecting river and rainfall water drainage systems is to be established to strengthen their function, and rainfall water reservoirs are to be promoted.

2) Disaster reduction measures for extraordinary floods

a) Enhancement hydrological observation network

The hydrological observation network is to be enhanced not only for rainfall and river water level but also for inland water level and tide level (high tide) by improvement of observation equipment and promotion of flood forecasting technique. Assistance to the related organizations and support system should be enhanced so that the appropriate evacuation recommendation is possible in extraordinary flood situations, and in normal time the detail information on disaster risk of dangerous location is to be supplied.

b) Evaluation of disaster risk for various external forces

The Master Plan for the external force of the maximum flood recorded in the past was established in this Study. However, in the long-term, after continuous hydrological observation and monitoring is carried out, it is necessary to estimate the external force of not only the recorded maximum flood, but also for that of extraordinary floods that may result from exceptionally different rainfall pattern. And the occurrence frequency of inundation above floor level and risk of loss of human life, capacity and conditions of facilities are to be evaluated.

c) Structural inspection of Vaturu Dam

As for the Vaturu Dam located in the most upstream of Nadi River, the study is to be carried out on the safety such as structural damage and its influence in case the external force exceeds the design capacity of the dam, and counter measures are to be implemented, if necessary.

d) Restraining inundation area collaborated to town and regional planning

The embankment and rising of road in Back Road is examined to restrain development of the inundation area collaborated to town and regional planning and respond to extraordinary flood.

e) Drainage of inundation water

It is very important in the large scale flood disaster to drain the inundation water as soon as possible to prevent the expansion of inundation area, and for early restoration and rehabilitation. Therefore, the drainage plan is to be examined beforehand and all necessary preparation regarding drainage water gate, pumping station, secure of access road to supply fuel, reserve power, stock fuel and so on is to be promoted.

f) Enhancement of emergency evacuation system

The number of the dead and isolated persons including travelers is estimated in case of large scale flood disaster, based on this assumed damage, the timeline (action plan in time series) will be prepared in cooperation with related organizations so that the evacuation, first aid service, emergency transportation will be possible. The emergency evacuation system should include allocating boat, preparing evacuation place, securing evacuation route, preparing stock of supplies and so on.

g) Presentation of understandable information to urge evacuation

Simple and easily understandable information on the approaching danger, such as flooding and high tide, should be provided to the public.

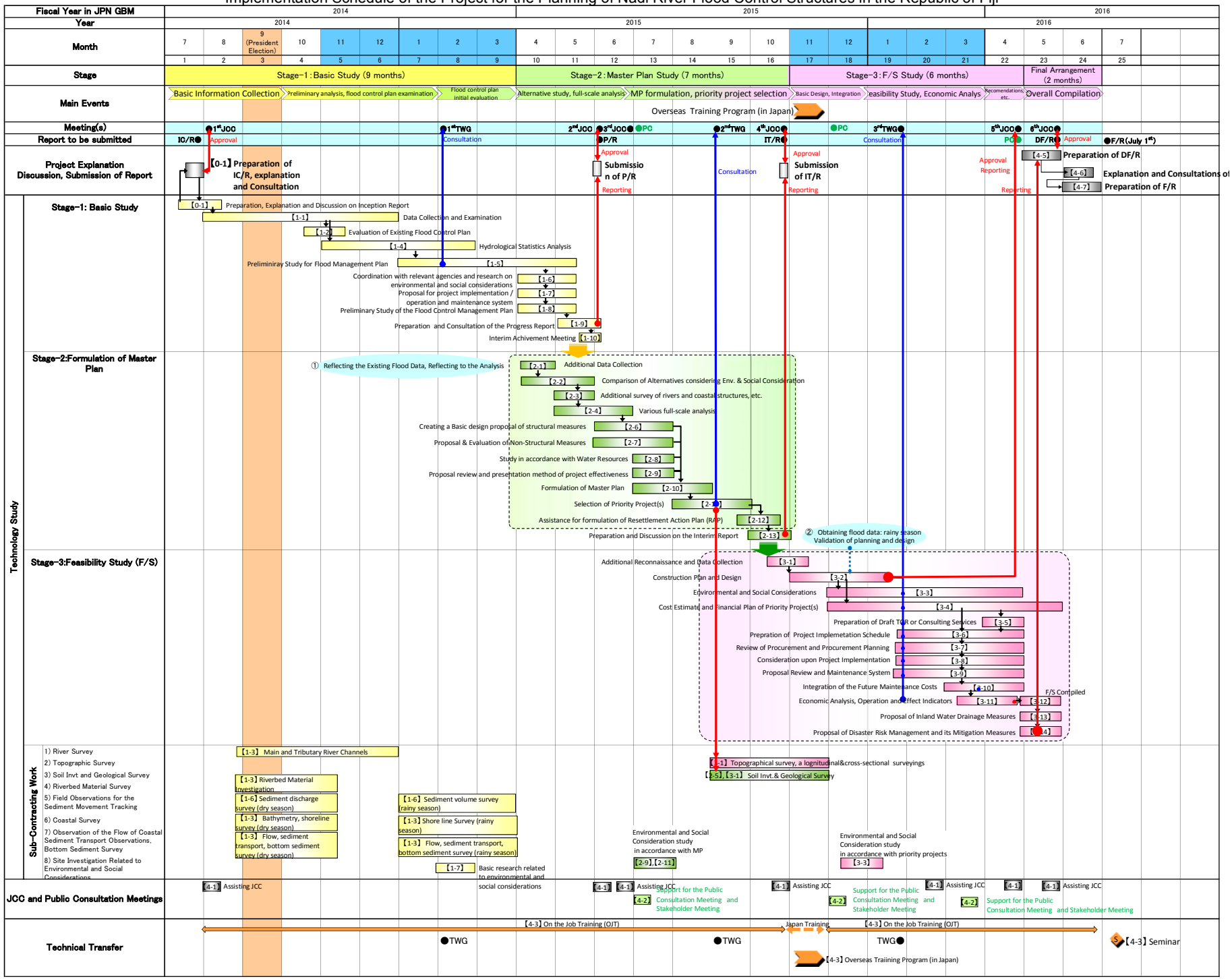
Moreover, hazard map which is can be easily understood by residents and travelers has to be prepared, and the installation of notice board in the town, on which the estimated inundation depth and the elevation at the place, direction of evacuation, name and distance to the evacuation place are indicated, has to be promoted.

Appendix

Appendix-1

Implementation Schedule of the Study

Implementation Schedule of the Project for the Planning of Nadi River Flood Control Structures in the Republic of Fiji



Remaks: JCC : Joint Coordination Committee, TWG : Technical Working Group (Technical Work Group), Submission of a Report: IC/R : Inception Report, P/R : Progress Report, IT/R : Interim Report, DF/R : Draft/Final Report, F/R : Final Report

Appendix-2

Staffing Plan

Staffing Plan

The Project for the Planning of the Nadi River Flood Control Structures in the Rep

	Name (Assigned field)		Trip	2014 Jul	Aug	Sep	Oct	Nov	Dec	2015 Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	2016 Jan	Feb	Mar	Apr	May	Jun	Jul	Total (days)	MM Fiji	MM Japan
Fiji	Yoshio NAKAGAWA Team Leader/ Flood Management	Plan	6		(25)						(9)				(18)					(13)				(21)			(16)		102	3.40	
		Actual	7		8/12 (20) 9/5 (5)						2/1 (9) 2/9				5/24 (8) 6/10 (10)					10/27 (5) 11/8 (8)				2/18 2/26 (9)			4/24 (7) 5/6 (6)	5/29 (3) 6/10 (10)		100	3.33	
	Takashi TOYODA Deputy Team Leader/ Flood Management	Plan	10		(30)			(41)			(32)				(58)			(13)			(20)		(19)	(18)		(32)		(21)		284	9.47	
		Actual	12		8/12 (20) 9/10 (10)			10/19 (13) 11/28 (28)			1/18 (14) 2/18 (18)				5/19 (13) 7/15 (30) (15)			8/23 (9) 9/4 (4)			10/18 (14) 11/6 (6)	11/30 (1) 12/18 (18)		1/17 1/29 (13)	2/16 2/29 (14)		4/10	4/17 (8) 4/24 (7)	5/6 (6)	5/29 (3) 6/10 (10)	274	9.13	
	Hajime TANAKA Water Resource Management	Plan	2				(20)									(40)													60	2.00	
		Actual	2				10/26 (6) 11/14 (14)									6/14 (17) 7/23 (23)													60	2.00	
	Tamotsu SHIBATSUZI Seacoast Management	Plan	3		(14)						(27)					(30)													71	2.37	
		Actual	3		8/12 8/25 (14)						1/18 2/13 (14) (13)					6/21 (10) 7/20 (20)													71	2.37	
	Tomoyuki SUZUKI Sediment Management	Plan	3		(21)				(16)							(24)													61	2.03	
		Actual	3		8/12 (20) 9/1 (1)				11/9 11/24 (16)							6/14 6/28 (15) 7/7 7/15 (9)													61	2.03	
	Makoto YONEKURA Hydrological Analysis/ Runoff Analysis	Plan	4		(30)			(39)			(20)					(30)													119	3.97	
		Actual	4		8/12 (20) 9/10 (10)			10/21 (11) 11/28 (28)			1/18 (14) 2/6 (6)					6/18 (13) 7/17 (17)													119	3.97	
	Masahiro KITANO Flood Control Planning/River Planning	Plan	3		(14)			(16)												(13)									43	1.43	
		Actual	3		8/12 8/25 (14)			10/26 (6) 11/10 (10)												10/27 (5) 11/8 (8)									43	1.43	
	Masaharu MIZOGUCHI River Structures/ Construction Planning/ Cost Estimation	Plan	3													(30)					(23)		(20)							73	2.43	
		Actual	3													6/21 (8) 6/28 7/8 7/29 (22)					12/3 12/25 (23)		1/7 1/25 (19)							72	2.40	
	Hiroshi NAKATA Facility Design/ Construction Planning/ Cost Estimation	Plan	2													(30)					(45)									75	2.50	
		Actual	2													6/21 (10) 7/20 (20)					11/12 (19) 12/26 (26)									75	2.50	
	Tomoko MIZUYORI Institutional, Legal System Analysis	Plan	3								(18)					(21)							(21)							60	2.00	
		Actual	3								1/18 2/4 (14) (4)					6/9 6/29 (21)							1/12 2/1 (20) (1)							60	2.00	
	Akira WATANABE Non-Structural Measures (Predecessor)	Plan	1					(20)																						20	0.67	
		Actual	1					10/26 (6) 11/14 (14)																						20	0.67	
	Tomohiro UMEKI Non-Structural Measures (Successor)	Plan	2													(42)				(18)										60	2.00	
		Actual	2													5/28 (4) 7/8 (30) (8)				10/20 (12) 11/6 (6)										60	2.00	
	Hajime WATANABE Environmental and Social Considerations	Plan	7				(27)				(34)					(12)			(25)		(16)		(22)	(12)						148	4.93	
		Actual	7				10/26 (6) 11/21 (21)				2/1 3/6 (28) (6)					6/9 6/20 (12)			9/10 10/4 (25)		12/5 12/20 (16)		1/11 1/31 (21)	2/18 2/24 (7)						142	4.73	
	Yoshiyuki CHOSO Economic Analysis/ Financial Analysis	Plan	3					(14)									(20)				(40)									74	2.47	
		Actual	3					11/4 (14) 11/17 (14)									7/5 7/24 (20)				11/12 (19) 12/21 (21)									74	2.47	
	Takeshi WATANABE Project Implementation Planning	Plan	7		(28)											(11)	(16)		(8)		(13)				(21)	(9)				106	3.53	
		Actual	5		8/12 (20) 9/8 (8)											5/31 (1) 6/10 (10)	6/22 7/7 (9) (7)		8/29 (3) 9/5 (5)		10/27 (5) 11/8 (8)									76	2.53	
	Tomohiro UMEKI Operational coordination/ Flood Control Planning, River Planning Assistance (Predecessor)	Plan	2		(30)			(39)																						69	2.30	
		Actual	2		8/12 (20) 9/10 (10)			10/19 (13) 11/26 (26)																						69	2.30	
	Tu KANEKO Operational coordination/ Flood Control Planning, River Planning Assistance (Successor)	Plan	3													(23)				(13)							(9)			45	1.50	
		Actual	3													6/21 (10) 7/13 (13)				10/27 (5) 11/8 (8)							5/29 (3) 6/10 (10)			49	1.63	
	Naim OTAKI Facility Design/ Construction Planning/ Cost Estimation (Own Expense)	Plan	-																													
		Actual	-													6/21 (10) 7/20 (20)																
	Makoto MIZUYA Facility Design/ Construction Planning/ Cost Estimation (Own Expense)	Plan	-																													
		Actual	-																		12/13 12/26 (14)											
																												Sub Total (Fiji)	Plan	1,470	49.00	
																													Actual	1,425	47.50	
Japan	Yoshio NAKAGAWA Team Leader/ Flood Management	Plan	-		(5)															(5)							(5)			15		0.75
		Actual	-		7/27 7/31 (5)																11/16 11/20 (5)							4/18 4/22 (5)			15		0.75
	Takashi TOYODA Deputy Team Leader/ Flood Management	Plan	-		(5)								(20)		(6)															31		1.55
		Actual	-		7/27 7/31 (5)								4/1 4/28 (20)		5/11 5/18 (6)												4/18 4/22 (5)	5/9 5/27 (15)		51		2.55
	Tamotsu SHIBATSUZI Seacoast Management	Plan	-										(4)																	4		0.20
		Actual	-										4/13 4/16 (4)																	4		0.20
	Tomoyuki SUZUKI Sediment Management	Plan	-										(4)																	4		0.20
		Actual	-										4/13 4/16 (4)																	4		0.20
	Makoto YONEKURA Hydrological Analysis/ Runoff Analysis	Plan	-										(16)																	16		0.80
		Actual	-										4/1 4/22 (16)																	16		0.80
	Masahiro KITANO Flood Control Planning/River Planning	Plan	-										(18)																	18		0.90
		Actual	-										4/1 4/28 (18)																	18		0.90
	Hajime WATANABE Environmental and Social Considerations	Plan	-												(10)															10		0.50
		Actual	-												5/11 5/22 (10)															10		0.50
	Tu KANEKO Operational coordination/ Flood Control Planning, River Planning Assistance (Successor)	Plan	-										(20)																	20		1.00
		Actual	-										4/1 4/28 (20)															5/16 5/27 (10)		30		1.50
																												Sub Total (Japan)	Plan	118		5.90
																													Actual	148		7.40
	Reporting				△ IC/R								△ P/R							△ IT/R								DF/R△	Seminar △ ★ F/R				
																													Total	Plan	54.90	
																														Actual	54.90	

: Actual : Plan : Own Expense