10. Preliminary Design and Cost Estimate

10.1 Preliminary Design

10.1.1 Track Alignments

(1) Rerouting Alignment Overview

Plane Alignment
The basic policy for rerouting alignment was previously mentioned in Section 8.6. Transition curves shall be inserted into the rerouting line with consideration of the actual track configuration. The calculation method for transition curve length shall be in accordance with the Civil Engineering Manual. Moreover, parameters used for the calculation of transition curve length, including maximum train speed (=80 km/h), maximum cant (=100 mm), and maximum cant deficiency (=50 mm), shall be in accordance with the Civil Engineering Manual.

The rerouting alignment statement is in Appendix X. Additionally, the existing alignment statement is in Appendix W. However, in the existing alignment calculations, transition curves are not considered due to a lack of transition curve data on the existing line.

Table 10.1: Transition Curve Length

Curve Radius	Speed	Actual Cant	Cant Deficiency	0 .72 Ca	0.008CaV	0.008Cdv	Max (1-3)
R (m)	V (km/h)	Ca (mm)	Cd (mm)	1 (m)	2 (m)	3 (m)	TCL (m)
350	75	100	34	72.0	60.0	21.0	72.0
400	80	100	33	72.0	64.0	22.0	72.0
500	80	100	6	72.0	64.0	5.0	72.0
600	80	89	0	65.0	57.0	0.0	65.0
800	80	67	0	49.0	43.0	0.0	49.0
1000	80	53	0	39.0	34.0	0.0	39.0
1500	80	35	0	26.0	23.0	0.0	26.0
5000	80	11	0	8.0	8.0	0.0	20.0

Source: JICA Study Team

Vertical Alignment
Formation Level (FL) is set as 60 cm below the Rail Level (RL). 60 cm is based on a rounding up from the total of rail height (80 lb/yd), sleeper height, and ballast thickness. For this project, vertical curves shall be inserted into the rerouting line with consideration of the actual track configuration. The minimum vertical curve radius shall be R=3,000 m in accordance with the Civil Engineering Manual. Moreover, the Civil Engineering Manual indicates recommended vertical curve lengths, for which the corresponding vertical curve radius figures are indicated in Table 10.2 and Table 10.3.

Table 10.2: Vertical Curve Length (Sag)

Gradient Difference (Per-mille)	Radius (m)
0.00 - 4.99	12,000
5.00 - 9.99	12,000
10.00 - 19.99	9,000
20.00 - 29.99	8,000
30.00 -	7,500

Source: JICA Study Team

Table 10.3: Vertical Curve Length (Summit)

Gradient Difference (Per-mille)	Radius (m)
0.00 - 4.99	12,000
5.00 - 9.99	12,000
10.00 - 19.99	6,000
20.00 - 29.99	6,000
30.00 -	4,500

Source: JICA Study Team

Gradients at the start and end points of the rerouting line shall be compatible with gradients of the existing line. Moreover, gradient alteration points shall be at locations where conflicts with transition curves and vertical curves can be avoided. Railway alignments for each Section shall be as indicated below (additionally, see Appendix V for alignment drawings of rerouting line).

(2) Plan of Section 1

Data
Rerouting Section: Km293.714 – Km295.518
Section Length (Before Rerouting): 1,804 m
Section Length (After Rerouting): 1,860 m

Plane Alignment
The railway shall be relocated to avoid the Bank Erosion Area near Km 294.1 – Km 294.5, which has been assessed to be significantly harmful to the railway. The start point of the rerouting line shall be at Km 293.6, located immediately after the crossing of the existing bridge. The rerouting line shall run parallel to the existing line, offset 100 m towards the mountain. Further offsetting towards the mountain is not feasible due to the excessive cut earth height near Km 0.6 (Rerouting) and Km 1.3 (Rerouting). The rerouting line shall connect back to the existing line scraping along the R=350 m curve at Km 295.3.

Vertical Alignment
From the rerouting line start point onwards, the gradient shall be set steep in order to keep the FL above the Required Dike Level. The reason to set the gradient at 0.9 % instead of 1.0 % is to fit the vertical curve within the IP2 circular curve section.

(3) Plan of Section 2

Data
Rerouting Section: Km 301.694 – Km 307.958
Section Length (Before Rerouting): 5,994 m
Section Length (After Rerouting): 5,991 m

Plane Alignment
The railway shall be relocated to avoid the Bank Erosion Area near Km 302.0 – Km 307.7, which has been assessed to be significantly harmful to the railway. The railway shall be relocated above the estimated high water level with consideration of the embankment height and cut earth height, such that they do not become excessive. However, since this area has considerable undulations, the rerouting line will be located below the estimated higher water level in swamp areas. In that case, embankments shall be provided to set the FL higher than the "Required Bank Level". At locations where adequate horizontal separation between the rerouting line and Bank Erosion Area cannot be provided, protection measures, such as the provision of revetments, shall be provided.

This section has existing bridges at two locations. Since both are lower than the "Design High Water Level", new bridges shall be provided.

Vertical Alignment
FL shall be located higher than the estimated high water level. Moreover, provisions shall be made to balance cut earth height and embankment height. At new bridge locations, pier cap height shall be located higher than the "Required Dike Level".

(4) Plan of Section 3

Data
Rerouting Section: Km 313.284 – Km 316.048
Section Length (Before Rerouting): 2,764 m
Section Length (After Rerouting): 2,775 m

Plane Alignment
The railway shall be relocated to avoid the Bank Erosion Area near Km 312.6 – Km 316.2, which has been assessed to be significantly harmful to the railway. However, in order to avoid the village near Km 313.0, the start point shall be located near Km 313.3. Moreover, to avoid the village near Km 316.3, the end point shall be located near Km 316.0. The railway shall be relocated above the estimated high water level with the consideration that embankment height and cut earth height, such that they do not become excessive. However, since this area has considerable undulations, the rerouting line will be located below the estimated higher water level at swamp and other low areas. At locations where adequate horizontal separation between the rerouting line and Bank Erosion Area cannot be provided, protection measures, such as the provision of revetments, shall be provided.

Vertical Alignment
FL shall be located higher than the estimated high water level. Moreover, provisions shall be made to balance cut earth height and embankment height.

(5) Plan of Section 5

Data
Rerouting Section: Km337.296 – Km 339.210
Section Length (Before Rerouting): 1,913 m
Section Length (After Rerouting): 1,766 m

Plane Alignment
The railway shall be relocated to avoid the Bank Erosion Area near Km 337.6 – Km 338.3 which has been assessed to be significantly harmful to the railway. Since the FL shall be higher than the "Required Bank Level" and the railway will be relocated to harder ground, the rerouting line shall be routed significantly toward the mountains compared to the existing line.

Vertical Alignment
From the rerouting line start point onwards, the gradient shall be set at maximum steepness (1.0 %) in order to reduce cut earth height.

(6) Plan of Section 7

Data
Rerouting Section: Km 346.243 – Km 348.004
Section Length (Before Rerouting): 1,760 m
Section Length (After Rerouting): 1,862 m

Plane Alignment
The railway shall be relocated to avoid the Bank Erosion Area near Km 346.6 – Km 347.2, which has been assessed to be significantly harmful to the railway. In order to avoid the village near Km 347.8, and in order to provide sufficient separation from the water collision point near Km 347.2, the rerouting line shall be routed significantly toward the mountains compared to the existing line.

Vertical Alignment
From the rerouting line start point onwards, the gradient shall be set at a maximum steepness of 1.0 % in order to reduce cut earth height.

(7) Plan of Section 8

Data
Rerouting Section: Km 351.024 – Km 352.825
Section Length (Before Rerouting): 1,801 m
Section Length (After Rerouting): 1,815 m

Plane Alignment
The railway shall be relocated to avoid the Bank Erosion Area near Km 351.7 – Km 352.4, which has been assessed to be significantly harmful to the railway, and to cross the rerouted waterway of the Maswala River. The railway shall have sufficient separation from the Bank Erosion Area at its closest point at Km 352.2, and the value of GL-FL at the river crossing point shall be maximized.

The rerouting line start point shall be located to maximize the GL-FL at the river crossing point (the existing line gradient is 1.0 % from this point to the base point).

Vertical Alignment
From the rerouting line start point onwards, the gradient shall be set at a maximum steepness of 1.0% in order maximize the GL-FL at the river crossing point. Onwards, embankments with height sufficient enough to provide box culverts shall be provided.

(8) Plan of Section 9

Data
Rerouting Section: Km 362.409 – Km 371.563
Section Length (Before Rerouting): 9,154 m
Section Length (After Rerouting): 9,066 m

Plane Alignment
The railway shall be relocated to avoid water-bearing ground from near Km 363 to the Mzase River, and to cross the rerouted waterway of the Mzase River. The existing Gulwe Station is located immediately after the river crossing. Since the FL has been raised for the river crossing, the area in the vicinity of the existing station is on a gradient and is not appropriate for station building. The New Gulwe Station shall be located after the railroad crossing near Km 369.7, having the prescribed station length.

The rerouting line shall be located higher than the “Required Dike Level” at the section between the start point and the Mzase River. Near the existing Gulwe Station, the rerouting line shall be offset 30 m towards the mountain from the existing line.

Vertical Alignment

For the section between the rerouting line start point and the Mzase River, embankments with height sufficient enough to provide box culverts shall be provided. At river crossings, FL height shall be sufficient to provide deck girders. Near the station area, culverts shall be provided and FL shall be higher than the Required Dike Level. Moreover, the station area shall be on level ground.

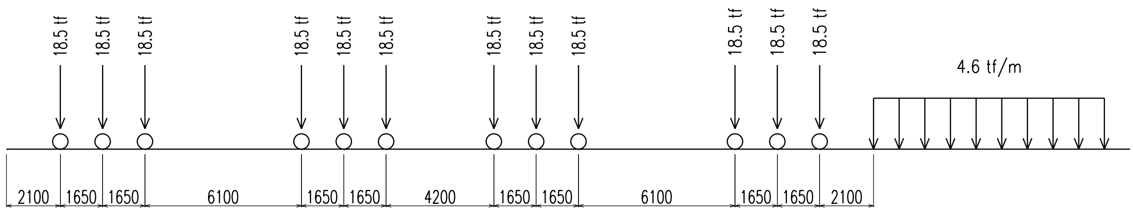
10.1.2 Premise of Design for Railway structure

(1) Overview

Basically drawing from the Civil Engineering Manual 1998 in Tanzania, the preliminary design of railway structure was carried out. For items not specified in this manual, designs were carried out based on the Japanese standards.

1) Axle load

Based on the axle load and the arrangement of S2 Loading shown in Figure 10.1, the preliminary design of the railway structure is carried out. According to RAHCO, it is noted that 16 tons should be set in the case of upgrading/rehabilitation, while 18.5 tons should be set in the case of new construction. Therefore, 18.5 tons is adopted in the preliminary design.



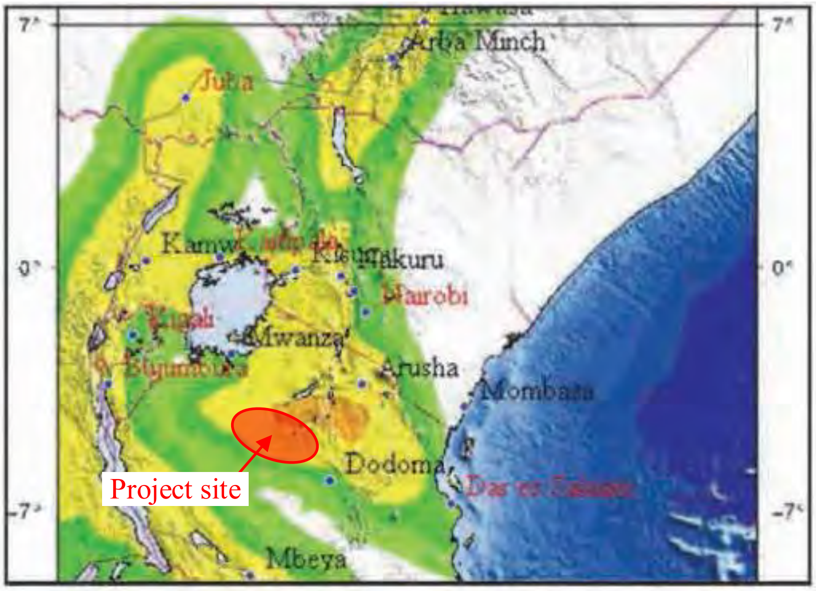
Source: Inspection and Capacity Rating of RAHCO Railway Bridges, Interim Report, December 2015, TIRP

Figure 10.1: Axle Load and Arrangement

2) Seismic design horizontal coefficient

Figure 10.2 shows the Peak Ground Acceleration of east Africa based on Global Seismic Hazard Assessment Program implemented by United Nations in the 1990s. The contours represent the ground surface acceleration at a certain location by predicting the maximum value of ground surface acceleration stochastically occurred over a period of 50 years. The Project site is contained within the range between 0.8 m/s^2 and 1.6 m/s^2. Therefore, there will be a need for a seismic design horizontal coefficient of 0.2.[1]

[1] The maximum value of Peak Ground Acceleration in project site is 1.6m/s^2. Seismic design horizontal coefficient is produced by dividing by 9.8 m/s^2 (gravity). Therefore, the seismic design horizontal coefficient is 1.6/9.8=0.16 (0.2, as rounded up).



Source: Governments of Tanzania, Rwanda and Burundi, *Phase II of the Dar es Salaam–Isaka–Kigali/Keza–Musongati Railway Project Study*, Final Report, Volume 2A, March 2014.

Figure 10.2: Seismic Hazard Map of East Africa

10.1.3 Embankment and Cutting

(1) Embankment

1) Overview

The preliminary design of soil structures is carried out considering the terrain and geological conditions. It is important whether or not there are landslides or terrain damaged by river erosion or water catchment at valley in embankment sections.

In the rerouting section, judging from site surveys and the result of the boring investigation carried out in the project site, since the section damaged by river erosion is rerouted, embankment structures or cutting can be adopted, except in locations where there is a bridge at present. In the preliminary design, bridge or box culverts are planned at valleys, depending on the catchment area.

Source: JICA Study Team

Figure 10.3: Existing Embankment Section near Km 314.0

Source: JICA Study Team

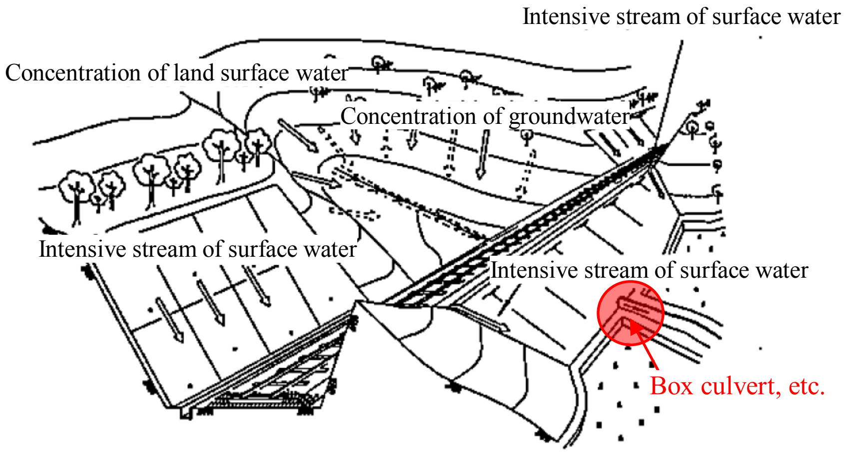
Figure 10.4: Existing Embankment Section near Km 318.4

Source: JICA Study Team

Figure 10.5: Existing Embankment Section near Km 340.9

Source: JICA Study Team

Figure 10.6: Existing Embankment Section near Km 344.7



Source: JICA Study Team

Figure 10.7: Water Catchment at Valley

2) Condition of supporting ground under embankment

It is necessary that the supporting ground is able to support an embankment body safely and does not result in foundation failures nor cause large settlement. Table 10.4 shows an estimated index of supporting ground conditions under embankment for the performance rank 2 and 3 in Japanese standards. Here, the performance rank 2 is defined as “Earth structure that undergoes deformation that can be dealt with by regular maintenance in ordinary conditions, and does not reach devastating failure under Level-2 earthquake motion or extremely rare heavy rainfall. (For example, earth structure supporting a ballasted track in a very important railway line)” and the performance rank 3 is defined as “Earth structure that allows deformation in ordinary conditions, and does not fail under Level-1 earthquake motion or heavy rainfall that occurs several times a year. (For example, earth structure supporting a ballasted track in a normal railway line)”.

Table 10.4: Estimated Index of Supporting Ground Condition under Embankment (Performance Rank 2 and 3)[2]

Classification		Subdivision	Condition with less problems as supporting ground
Rock bed		-	No problem
Soil layer	Diluvium	Gravel grained soil	No problem
		Sandy soil	
		Fine soil	
		Volcanic cohesive soil	N value is 3 or more
	Alluvium	Gravel grained soil	No problem
		Sandy soil	There is no layer with a risk of liquefaction during an earthquake*1
		Fine soil	a) N value is over 4 b) Thickness of layer with N value from 2 to 4 is less than 3 m c) Thickness of layer with N value of less than 2 is less than 2 m*2

Note: *1: In case of loose sandy soil with N value of 20 or less, a judgment of liquefaction may be carried out.
Note: *2: Check the stability of an embankment.
Source: Design Standards for Railway Structures and Commentary (Earth Structures)

When evaluating supporting ground conditions based on Table 10.4 and the result of the boring survey carried out in the project site, it can be judged as satisfactory. However, because this evaluation is by deemed-to-satisfy specifications, a circular slip calculation for supporting ground was carried out based on surface layer information of the boring data “BH09”, which judged that the surface layer condition is poor. Here, the embankment height is assumed as 9 m, which is a maximum height in the preliminary design. Table 10.5 and Table 10.6 show the setting and contents of calculation slip calculation for supporting ground respectively, and then Table 10.7 shows the result.

Table 10.5: Setting of Circular Slip Calculation for Supporting Ground

Item		Contents	
Embankment height (m)		9.0	
Slope gradient		1:1.5	
Permanent design load		Embankment body, ballasted track	
Material data of embankment body		γ (kN/m^3)	14
		C (kN/m^2)	20 (10)
		φ (degree)	25 (20)
Value of supporting ground	Surface	γ (kN/m^3)	16
		C (kN/m^2)	31.25
		φ (degree)	0.0
	Second layer	γ (kN/m^3)	19
		C (kN/m^2)	0.0
		φ (degree)	30.0
	Third layer	γ (kN/m^3)	20
		C (kN/m^2)	0.0
		φ (degree)	42.0

Note: Figure in parentheses shows the value of embankment surface.
Source: JICA Study Team

Table 10.6: Contents of Circular Slip Calculation for Supporting Ground

Required performance	Performance items	Combinations of actions
Safety	Stability of supporting ground	1.0*D

Note) D: Dead load
Source: JICA Study Team

[2] In the case that embankment height is less than 10 m and the supporting ground is not extremely tilted.

Table 10.7: Result of Circular Slip Calculation for Supporting Ground

Required performance	Performance items	Response moment (kNm)	Resisting moment (kNm)	Structure factor	Safety Rate
Safety	Stability of supporting ground	7,888	13,676	1.0	0.58

Source: JICA Study Team

In the preliminary design, the safety on circular slip calculation for supporting ground has been confirmed even if the embankment height is 9 m. However, in the construction stage, when soft supporting ground is visible, it should be subjected to measures such as replacement or soil improvement.

3) Embankment materials

It is necessary to select embankment materials that are easy to compact and maintain their stability against external forces, such as rainfall, etc. In addition, they must not cause a harmful compression settlement.

Earth structures are not often evaluated by a calculation due to large variations in materials and construction compared with other structures. Soil has uncertainty due to a wide variety of soils, intensity that varies greatly depending on the density and confining pressure, and non-uniform, non-homogeneous, and adhesion factors which change by the degree of saturation.

Therefore, it is desirable that design values of embankment body are set according to the characteristics of the soil classification and construction management values by being carried out tri-axial compression test and test construction. In advance, it is necessary to collect the information such as unit volume weight, adhesive strength and the angle of internal friction on embankment materials available in the vicinity of the project site.

However, since the location of the borrow pit is unclear in this moment, some circular slip calculations for embankment body are carried out assuming different types of materials. Table 10.8 and Table 10.9 show the setting and contents of slip calculation for the embankment body respectively, and then Table 10.10 shows the results.

Table 10.8: Setting of Circular Slip Calculation for Embankment Body

Item			Contents
Embankment height (m)			6.0
Slope gradient			1:1.5
Axle load (tons)			18.5
Parameter	Material	-1	γ=18 kN/m^3, c=6 (3) kN/m^2, φ=45 (40) degree
		-2	γ=17 kN/m^3, c=6 (3) kN/m^2, φ=40 (35) degree
		-3	γ=16 kN/m^3, c=6 (3) kN/m^2, φ=35 (30) degree
		-4	γ=14 kN/m^3, c=20 (10) kN/m^2, φ=25 (20) degree

Note: () in above table is the value on embankment surface.
Source: JICA Study Team

Table 10.9: Contents of Circular Slip Calculation for Embankment Body

Required performance	Performance items	Combinations of actions
Safety	Stability of embankment body	$1.0*D_1+1.0*D_2$
		$1.1*D_1+1.2*D_2+1.1*L$
		$1.0*D_1+1.0*D_2+1.0*L+1.0*E_q$

Note) D_1: Fixed dead load, D_2: Variable dead load, L: Train load, E_q: Seismic horizontal force
Source: JICA Study Team

Table 10.10: Results of Circular Slip Calculation for Embankment Body

Case No.	Material			Non-reinforcement			Reinforcement by Geotextile		
	γ (kN/m³)	C (kN/m²)	φ (degree)	Response moment (kNm)	Resisting moment (kNm)	Safety Rate	Response moment (kNm)	Resisting moment (kNm)	Safety Rate
1	18	6 (3)	45 (40)	3084.4	3126.5	0.99	-	-	-
2	17	6 (3)	40 (35)	2961.2	2629.1	1.13	5196.2	6871.2	0.76
3	16	6 (3)	35 (30)	2837.9	2210.3	1.28	5732.9	6699.5	0.86
4	14	20 (10)	25 (20)	2591.4	3094.9	0.84	-	-	-

Note: () in above table is the value on embankment surface.
Source: JICA Study Team

Before the construction stage, it is necessary that design values such as unit volume weight, adhesive strength, and angle of internal friction on embankment materials available in the vicinity of the project site are set according to the characteristics of the soil classification and construction management values, by using a tri-axial compression test and test construction.

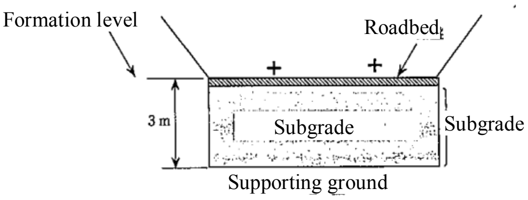
Here, in the Civil Engineering Manual, the cross-sectional configurations, such as roadbed, subgrade, and embankment body as per Japanese standards are not classified. For reference, the cross-sectional configuration based on the Japanese standards is described below.

<u>Cross-sectional configuration</u>

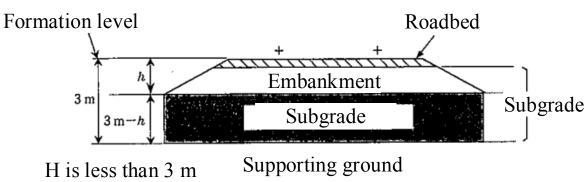
It is necessary for the upper embankment to use materials such that an appropriate rigidity can be obtained and the accumulated deformation caused by cyclic loading of train is reduced. Here, the range of upper embankment is from the formation level largely impacted by train load to 3 m below.

a) Roadbed
The purpose of setting roadbed is a) supporting the track safety, b) distributing the train load to the subgrade, c) preventing the subgrade from weakening, and d) preventing the roadbed from harmful settlement and deformation. In the case of crushed stone roadbed, the thickness is 300 mm, drainage gradient is about 3%, and the material is crushed stone (such as crusher-run, etc.), or a high-quality soil generated by cutting. In addition, even if the roadbed material is used as same as the embankment material, the construction of roadbed shall be performed separately from the construction of the embankment.

b) Subgrade
The purpose of setting subgrade is a) supporting the track and roadbed safety and b) distributing the train load to below. Here, the range of subgrade is as follows:
i) In the case of cutting and natural ground, the range is from formation level to 3 m below (except roadbed).
ii) In the case of low embankment, the range is from formation level to 3 m below (except embankment and roadbed).



In the case of cutting or natural ground



In the case of low embankment

Note: Range from formation level to 3 m below is generally impacted by train load.
Source: Design Standards for Railway Structures and Commentary (Earth Structures)

Figure 10.8: Standard Cross-Section of Subgrade

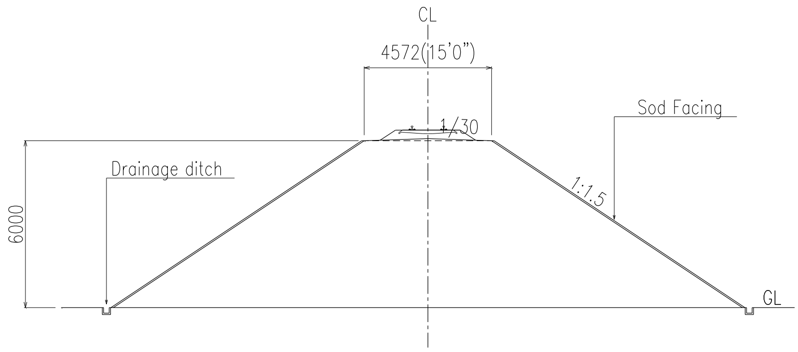
It is necessary that there is no soft layer of having an N value less than 4 in subgrade and that the coefficient subgrade reaction is over 70 MN/m^3.

4) Standard cross-section for general section

According to the Civil Engineering Manual, the slope gradient for embankments is defined as 1:1.5. Following suit, the slope gradient for embankments shall be also defined as 1:1.5 in the preliminary design. For embankments higher than 6 m, berms shall be provided as per Japanese standards, as there is no existing standard for high embankments.

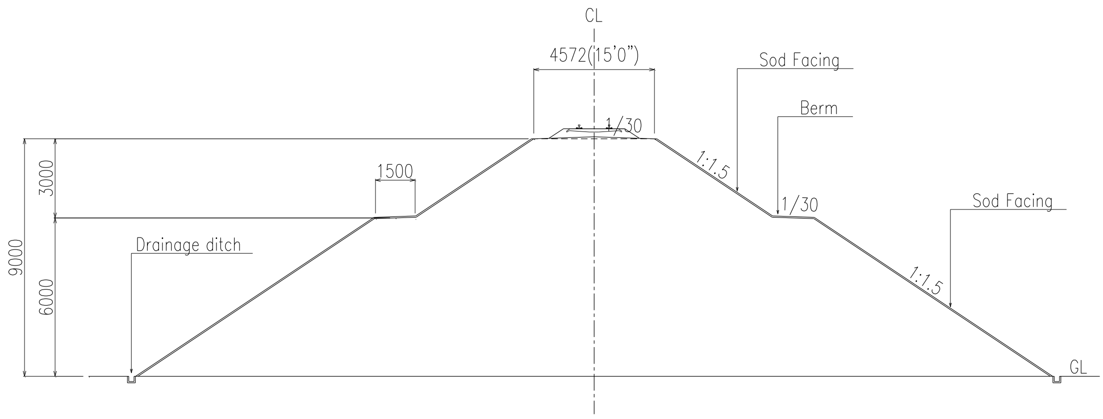
The standard cross-section of embankment for general section is planned to be classified as follows:

a) Type-1: Height is up to 6 m
b) Type-2: Height is from 6 m to 9 m



Source: JICA Study Team

Figure 10.9: Standard Cross-Section of Embankment for General Section (Type-1)



Source: JICA Study Team

Figure 10.10: Standard Cross-Section of Embankment for General Section (Type-2)

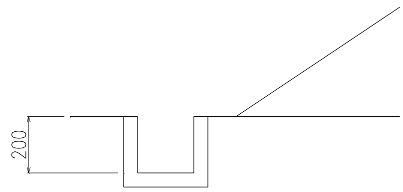
Drainage

The purpose of setting drainage is a) prevention of mud-pumping, b) securing strength of roadbed and subgrade, and c) preventing embankment collapse.

a) Drainage gradient
Drainage gradient of the transverse direction should be 1/30 at embankment crest and berm.
b) Drainage blanket

The purpose of setting the drainage blanket is the prevention of rising pore water pressure in the embankments due to rain. This is because the risk of slope collapse is increased if the internal water level in the embankment rising. The material should function such that the coefficient of permeability is over 1 cm/s, and it is necessary that surfaces in contact with embankment materials are covered by filter materials, such as non-woven fabric, for prevention of an outflow of embankment material to the drainage blanket as far as possible. In the preliminary design, drainage blanket is not considered at the slope toe of embankment. If necessary, it may be included in the design.

c) Drainage ditch
It was found that the drainage ditch was not set at the slope toe of existing embankment during the site surveys. However, in the preliminary design, a drainage ditch is considered in order to guide rainwaters to the end of water flow as shown in Figure 10.11



Source: JICA Study Team

Figure 10.11: Drainage Ditch

<u>Slope protection</u>

As a railway structure, it is necessary to set slope protections in order to prevent erosion of the surface layer from rain. For some examples in Japanese standards, there are zhang block, anti-weed sheet, lattice frame, rock seat zhang, and planting. It was found that slope protection was not set on the slope of existing embankment in the site surveys. However, in the preliminary design, sod facing as a form of slope protection is considered for the reason of it being relatively economical among them.

<u>Berm</u>

Long slopes causes slope erosion due to an increased flow speed and flow volume during rainfall. Berms must be set in order to reduce flow speed. Additionally, berms contribute to the improvement of the stability of the embankment body and become a passageway for slope maintenance. Berms should be applied to the areas with an embankment height of over 6 m.

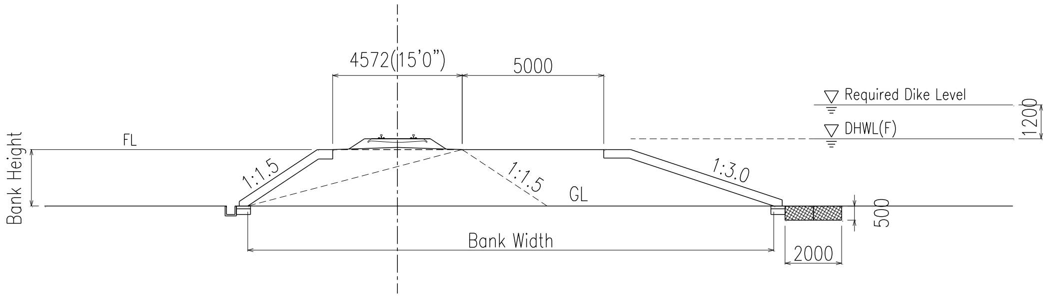
<u>Reinforcement material and layer thickness management material in embankment body</u>

It is judged that reinforcement material, such as geotextiles, is not necessary so long as there is the use of appropriate embankment materials, based on the results of circular slip calculation for embankment body (even if the height of embankment is 9 m). In addition, layer thickness management material is not considered in the preliminary design. However, it may be set in order to manage the thickness per layer and the construction of embankment edge easily.

5) Standard cross-section for the section expected to be impacted by water flows during floods

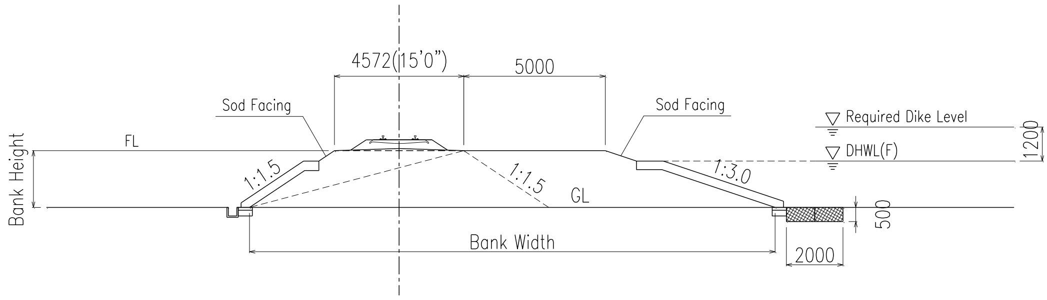
Slope protection as a part of river structures shall be provided for locations that are expected to be impacted by water flows during floods, as shown in Figure 10.12, Figure 10.13, and Figure 10.14. The standard cross-section of embankment for the above purpose are classified as follows:

a) Type-1: Bank Height < DHWL (F)
b) Type-2: Bank Height < Required Dike Level
c) Type-3: Bank Height > Required Dike Level



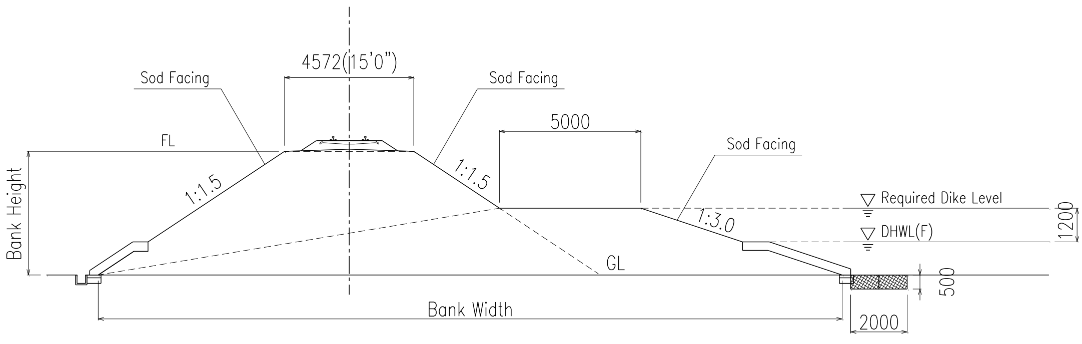
Source: JICA Study Team

Figure 10.12: Standard Cross-Section of Embankment for the Section Expected to be Impacted by Water Flows during Floods (Type-1)



Source: JICA Study Team

Figure 10.13: Standard Cross-Section of Embankment for the Section Expected to be Impacted by Water Flows during Floods (Type-2)



Note: The extent of a concrete protection at the mountain side will be examined in the detailed design stage.
Source: JICA Study Team

Figure 10.14: Standard Cross-Section of Embankment for the Section Expected to be Impacted by Water Flows during Floods (Type-3)

6) List of embankment sections

Table 10.11 shows the length, volume, and maximum height of embankments by section.

Table 10.11: List of Embankment Section Planned in the Preliminary Design

Section No.	Length (m)	Volume (m^3)	Maximum height (m)
1	1,140	27,000	4.93
2	2,800	115,000	7.96
3	820	59,000	8.18
5	480	3,000	2.03
7	160	2,000	2.55
8	1,620	19,000	3.02
9	7,720	147,000	6.30
Total	14,740	372,000	-

Note: Maximum height indicates the height at the center line of the alignment.
Source: JICA Study Team

(2) Cutting

1) Overview

It is important to evaluate the configuration and conditions of the geology and the lithology of the natural ground, because natural ground is generally heterogeneous. The slope surface of the existing cut earth along the existing line was non-treated, as shown in Figure 10.15 to Figure 10.18.

Source: JICA Study Team

Figure 10.15: Existing Cutting Section near Km 304.1

Source: JICA Study Team

Figure 10.16: Existing Cutting Section near Km 314.4

Source: JICA Study Team

Figure 10.17: Existing Cutting Section near Km 314.7

Source: JICA Study Team

Figure 10.18: Existing Cutting Section near Km 315.4

2) Conditions of supporting ground under cutting

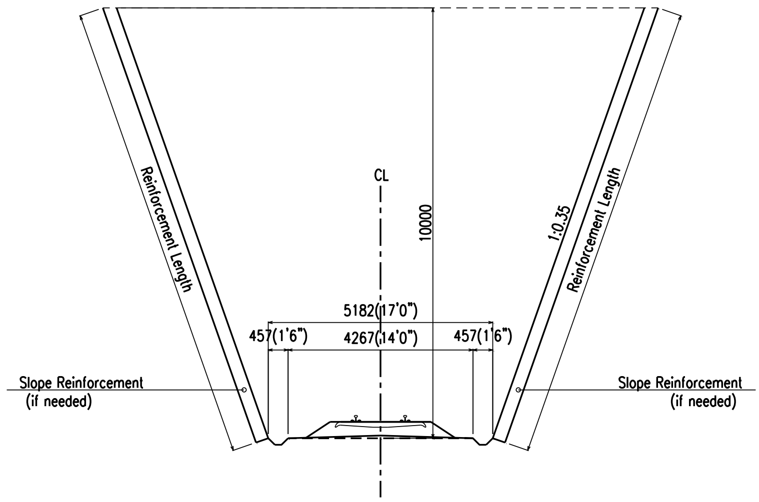
It can be expected that the supporting ground under the cutting functions as a sufficient support, judging from existing cutting structures shown in the above figures.

3) Standard cross-section

According to the Civil Engineering Manual, the slope gradient for cut earth is defined as 1:1 for normal soil. However, the slope gradient is not defined for rock formations. In the study area, cut earth areas along the existing line all contain exposed rock formations, with the gradient being nearly vertical. Therefore, the gradient of cut earth shall be also defined as 1:0.35 in the preliminary design.

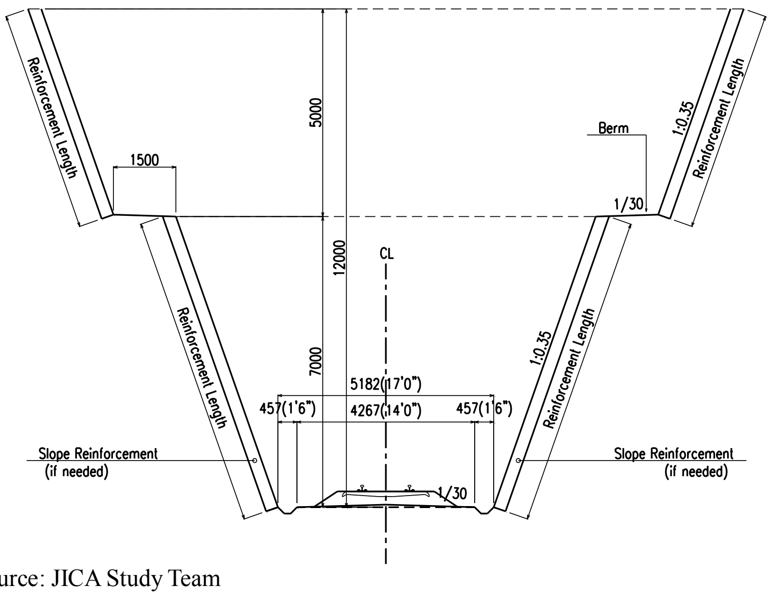
Standard cross section of cutting are classified depending on their height, as follows:

a) Type-1: Height is up to 10 m
b) Type-2: Height is over 10 m



Source: JICA Study Team

Figure 10.19: Standard Cross-Section of Cutting (Type-1)

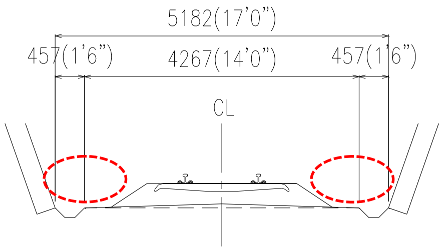


Source: JICA Study Team

Figure 10.20: Standard Cross-Section of Cutting (Type-2)

Drainage

The purpose of setting drainage is a) prevention of mud-pumping, b) securing strength of roadbed and subgrade, and c) preventing slope surface erosion and collapse. In the preliminary design, depending to the Civil Engineering Manual, the drainage of cutting is planned as shown in Figure 10.21.



Source: JICA Study Team

Figure 10.21: Drainage of Cutting

Slope protection

As for railway structures, it is necessary to set slope protection in order to prevent erosion of the surface layer from rain. In the preliminary design, sprayed concrete with a thickness of 200 mm is planned in consideration of safety, in order to prevent a halting train operation from rockfalls, even if the existing cutting slope is non-treated.

In the construction stage, structural changes of geology, soil and lithology, and also spring water conditions and upper cutting conditions should be observed and recorded. Depending on these conditions, it should be judged whether the slope gradient has changed or not, and if slope protection works are necessary.

Berm

Long slopes causes slope erosion due to an increased flow speed and flow volume during rainfall. Berms must be set in order to reduce flow speed. Additionally, berms contribute to the improvement of the stability for cutting body, and become a passageway for slope maintenance. Berms should be applied to the cutting height of over 10 m with each height set at 7 m. The width of a berm is 1.5 m. In addition, if necessary, berms may be set at the boundary of soil and rock or the boundary of a permeable layer and an impermeable layer.

4) List of cutting section

Table 10.12 shows the length, volume and maximum height of cutting per section.

Table 10.12: List of Cutting Section Planned in the Preliminary Design

Section No.	Length (m)	Volume (m^3)	Maximum height (m)
1	740	17,000	12.07
2	3,200	172,000	18.06
3	1,960	98,000	16.61
5	1,300	31,000	9.23
7	1,720	39,000	8.36
8	200	1,000	0.46
9	1,360	8,000	2.43
Total	10,480	366,000	-

Note: Maximum height indicates the height at the center line of the alignment.
Source: JICA Study Team

10.1.4 Tracks

(1) Track Structures

The track rehabilitation for the Dar es Salaam – Isaka section is planned under TIRP. The TIRP package C21: Field Assessment and Preparation of Tender Documents for Track Works and Maintenance provides a set of tender documents, including technical specifications, and is planned to be completed in the end of June 2016. This package will establish technical specifications commonly applied for the section above, including the Kilosa – Gulwe section. Thus, track structures as shown in Table 10.13 are planned for the Project according to the Civil Engineering Manual, 1998, TRC. The details of track structures and execution of track rehabilitation works are described in Section 9.8.4.

Table 10.13: Track Structures

Track structure		
Ballasted track		
Joint	Standard size	
Distribution of joints	Supported joint	
Joint supporting method	Parallel joint	
Track materials		
Rail	Rail type Length of rail Rail steel	80 lb/yd rail Standard size: 24.0 m or over Ordinary rail
Rail Fastening	Composition Fastening spring Fastening method	Double elastic fastening Wire spring, spring crip No-screw fastening
Sleeper	Sleeper type Sleeper interval	Steel sleeper 1477 Units/km, (33 Units/24 m) A=229mm, B=610mm, C=686mm, D=748mm
Ballast	Ballast Thickness of Ballast Width of Ballast shoulder Volume of Ballast	Crushed Stone 250 mm 250 mm 885.0 m^3/km

Source: TRC, Civil Engineering Manual, 1998

(2) Track Materials

Major track materials and track works for the Project are as shown in Table 10.14.

Table 10.14: Track Materials and Track Works

Items	Unit	Quantity			
		1	2	3	Total
Track Materials					
80lb/yd rails	ton	2,180	1,250	80	3,510
Fish plate and accessories	pcs	530	320	20	870
Thermit welding	pcs	1,580	950	-	2,530
Steel sleeper with fastenings	pcs	38,980	23,260	1,440	63,680
Turnout 1:12	sets	6	-	-	6
Buffer stop	sets	2	-	-	2
Ballast	m^3	24,330	13,940	22,670	60,940
Track Works					
Track construction (80lb/yd rails)	km	25.1	15.0	-	40.1
Thermit weldings	pcs	1,580	950	-	2,530
Installation of turnouts 1:12	sets	6	-	-	6
Buffer stop	sets	2	-	-	2
Earth works (Widen and strengthen embankment)	m^3	-	1,735	5,644	7,379

Items	Unit	Quantity			
		1	2	3	Total
Earth works (Re-profiling)	sites	-	5	15	20
Earth works (Drains)	sites	-	3	9	12
Refurbishment of 80lb/yd rails	km	-	-	9	9
Ballasting (300mm), lifting, tamping, distressing	km	-	-	12	12
Ballasting (100mm), lifting, tamping, distressing	km	-	-	17	17

1: Installation of track (25.1km)
2: Renewal of 60lb/yd rails by 80lb/yd rails (15.0km)
3: Refurbishment of 80lb/yd rails section (48.8km)

10.1.5 Bridges

(1) Overview

As described in Subsection 3.2.2 (3), steel truss bridges, steel deck girders and steel through girders were found as bridge types at the project site, and there were no concrete girders with long spans. In addition, these girders are all simple girders and none were continuous girders. Bridges were placed at locations of relatively wide river width. Figure 10.22, Figure 10.23, Figure 10.24, and Figure 10.25 show photos near the locations of bridges planned in this project.

Source: JICA Study Team

Figure 10.22: Existing Steel Deck Girder Bridge (Km 304.3)

Source: JICA Study Team

Figure 10.23: Existing Steel Deck Girder Bridge (Km 306.2)

Source: JICA Study Team

Figure 10.24: Present Status of Maswala River on 20th Nov. 2015 (Km 351.0)

Source: JICA Study Team

Figure 10.25: Present Status near Maswala River on 20th Nov. 2015 (Km 351.7)

Source: JICA Study Team

Figure 10.26: Present Status of Mzase River on 21st Nov. 2015 (Km 369.1)

In the preliminary design, at first, comparisons with superstructure type and substructure type are carried out respectively. Next, some basic calculations on main girder height of superstructure and pile diameter and the length of substructure are carried out. The detailed contents are described below.

1) Comparison between Metal girder and RC T girder

In consideration of several factors, such as cost ratio, transportability by freight wagon, etc., the comparison between Metal girder and RC T girder has been carried out as shown in Table 10.15. As an overall evaluation, metal girders have been recommended in the preliminary design.

Table 10.15: Comparison between Metal Girder and RC T Girder

Item	Metal girder	RC T girder
Span (m)	L=20	L=20
Girder height (m)	1.4 (Deck Girder)	2.4
Girder height / Span	1/14.3	1/8.3
Cost ratio	1.00	1.23
Fabrication method	Shop fabrication (import)	1) Fresh concrete (domestic) 2) Reinforcement bar (import)
Construction method on site	Crane erection	Pipe support, wooden support
Transportability by freight wagon	Available (materials) by high strength bolt joint on site	Available (materials)

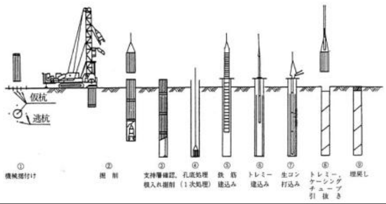
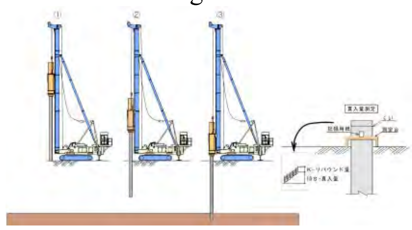
Item	Metal girder	RC T girder
Maintenance	1) General steel: Repainting will be needed depending on the type of paint 2) Weathering steel: Repainting will be not needed	Checking neutralization and crack
Bridges of almost same span confirmed in project site	1) Upper way plate girder bridge 2) Lower way steel truss bridge	Not be confirmed
Applicability in project site	Applicable	Applicable
Overall evaluation	Preferable	Unfavorable

Note: Size of freight wagon is width of 2.5 m and length of 12.5 m according to measured result during the site surveys.
Source: JICA Study Team

2) Comparison between Cast-in-place pile and Ready-made pile

Considering the difficulty in purchasing materials, transportability of construction facilities, and the difficulty of changing the pile length at the project site, etc., the comparison between cast-in-place pile and ready-made pile has been carried out (Table 10.16). As an overall evaluation, cast-in-place has been recommended in the preliminary design.

Table 10.16: Comparison between Cast-in-place Pile and Ready-made Pile

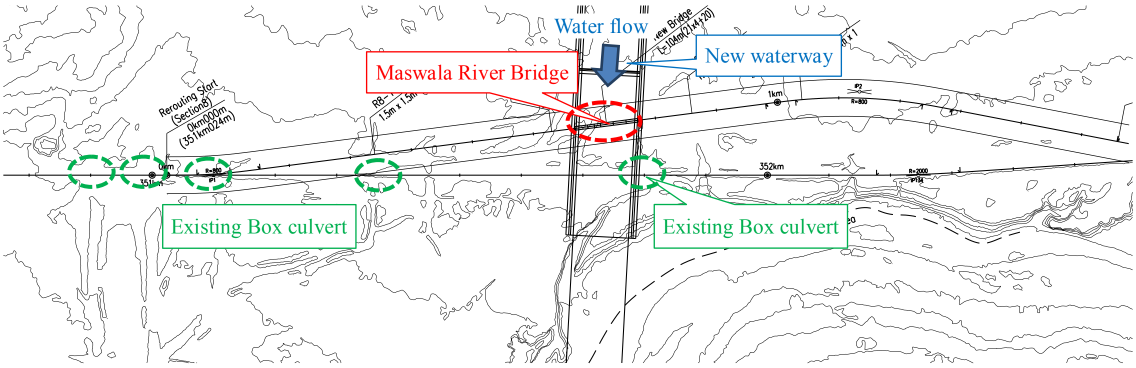
Item	Cast-in-place pile	Ready-made pile	
		PHC pile	Steel pipe pile
Photo			
Applicable diameter	Minimum 0.8 m	0.3 m – 1.2 m	0.4 m – 2.5 m
Difficulty in purchasing materials	1) Fresh Concrete (domestic, a plant will be needed near project site) 2) Reinforcement bar (import)	Shop fabrication (import)	Shop fabrication (import)
Construction method on site	All casing method, preventing collapse of a pore wall 	Driving method 	
Transportability of construction facilities	Available	Difficult	Difficult
Applicability on pile length (m)	Up to approx. 30 m	Up to approx. 30 m	Over 45 m
Transportability by freight wagon	Available (materials)	Available (materials)	Available (materials)
Difficulty of changing pile length on site	Easy	Difficult	Difficult
Applicability in project site	Applicable	Difficult	Difficult
Overall evaluation	Preferable	Unfavorable	Unfavorable

Note: Size of freight wagon is width of 2.5 m and length of 12.5 m according to measured result during the site surveys.
Source: JICA Study Team

(2) Maswala RiverBridge

1) Characteristics

The Maswala River Bridge is a new one, accompanied by tributary refurbishment. The total length of this bridge is 104 m. Figure 10.27 shows the location of the Maswala River Bridge.



Source: JICA Study Team

Figure 10.27: Location of the Maswala River Bridge

2) Design concept

The superstructure is planned as a steel through girder due to the restriction of overhead clearance in the vertical alignment planning. The substructure is planned as cast-in-place pile. The span configuration is 4 x 21 m + 20 m = 104 m.

3) Basic calculation

In the preliminary design, some basic calculations of main girder height and pile diameter and length are carried out as below.

a) Main girder height

Table 10.17 and Table 10.18 show the setting and contents of calculation for main girder height of the Maswala River Bridge, respectively, and then Table 10.19 shows the results.

Table 10.17: Setting of Calculation for Main Girder

Span (m)	20.1
Girder height (m)	1.6
Axial load (tons)	18.5

Source: JICA Study Team

Table 10.18: Contents of Calculation for Main Girder

Required performance	Performance items	Combinations of actions
Safety	Load-carrying capacity	1.0*D+1.1*L+1.1*I
Serviceability	Riding comfort	1.0*L+1.0*I

Note) D: Dead load, L: Train load, I: Impact of train load
Source: JICA Study Team

Table 10.19: Results of Calculation for Main Girder

Required performance	Items		Design response value	Design limit value	Structure factor	Safety rate
Safety	Vending moment (kNm)	Mid-span	7,680.0	22,094.4	1.2	0.42
	Shear (kN)	End-span	1,737.9	6,783.1	1.2	0.31
Serviceability	Deflection (mm)	Mid-span	15.9	22.3	1.0	0.71

Source: JICA Study Team

b) Pile diameter and the length

Table 10.20 and Table 10.21 show the setting and contents of calculations for pile of the bridge, respectively, and then Table 10.22 shows the results.

Table 10.20: Setting of Calculation for Pile

Pile diameter (m)	1.0
Pile length (m)	9.5
Adopted boring No.	BH 19
Minimum embedment length (m)	1.0 (1.0*D)

Source: JICA Study Team

Table 10.21: Contents of Calculation for Pile

Required performance	Performance items	Combinations of actions
Safety (seismic)	Stability	$1.0*D+1.0*L+1.0*E_q+1.0*W_p$
Serviceability	Long-term support performance	$1.0*D+1.0*W_p$
	Short-term support performance	$1.0*D+1.0*L+1.0*I+1.0*W_p$

Note) D: Dead load, L: Train load, I: Impact of train load, E_q: Seismic horizontal force, W_p: buoyancy
Source: JICA Study Team

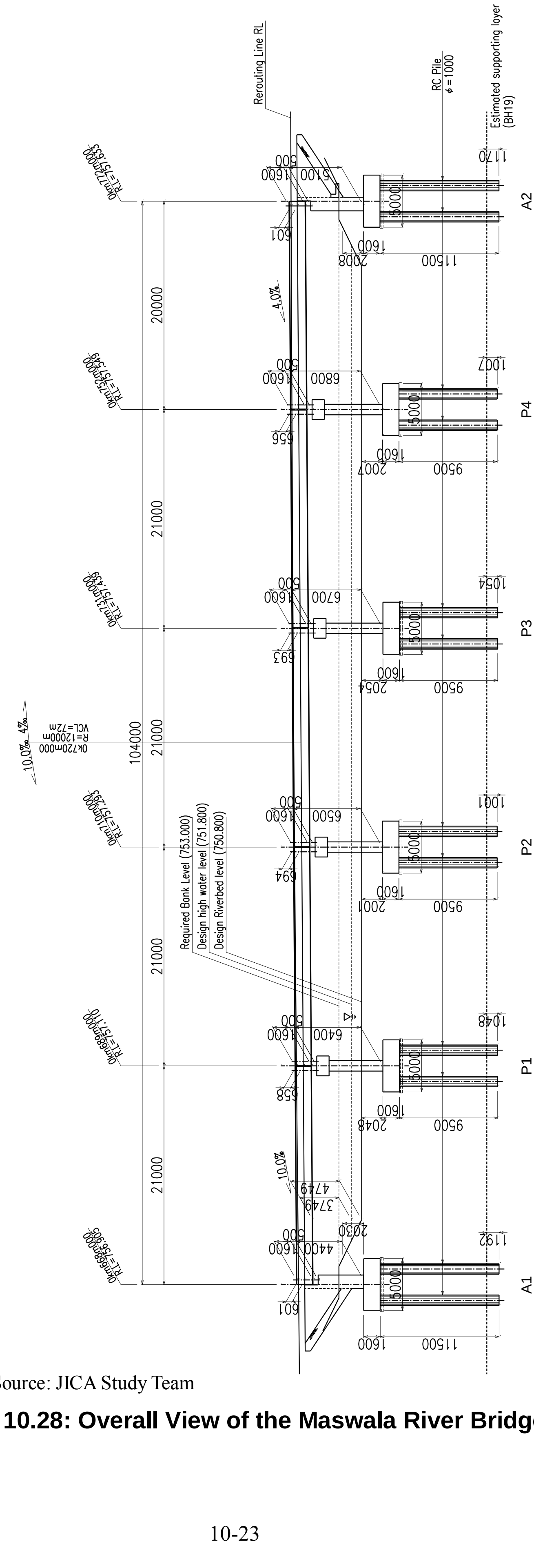
Table 10.22: Results of Calculation for Pile

Required performance	Performance items	Design response value	Design limit value	Structure factor	Safety rate
Safety (seismic)	Stability (kN)	2,149.9	5,781.5	1.0	0.37
Serviceability	Long-term support performance (kN)	960.9	1,981.2	1.0	0.49
	Short-term support performance (kN)	1,436.0	2,611.4	1.0	0.55

Source: JICA Study Team

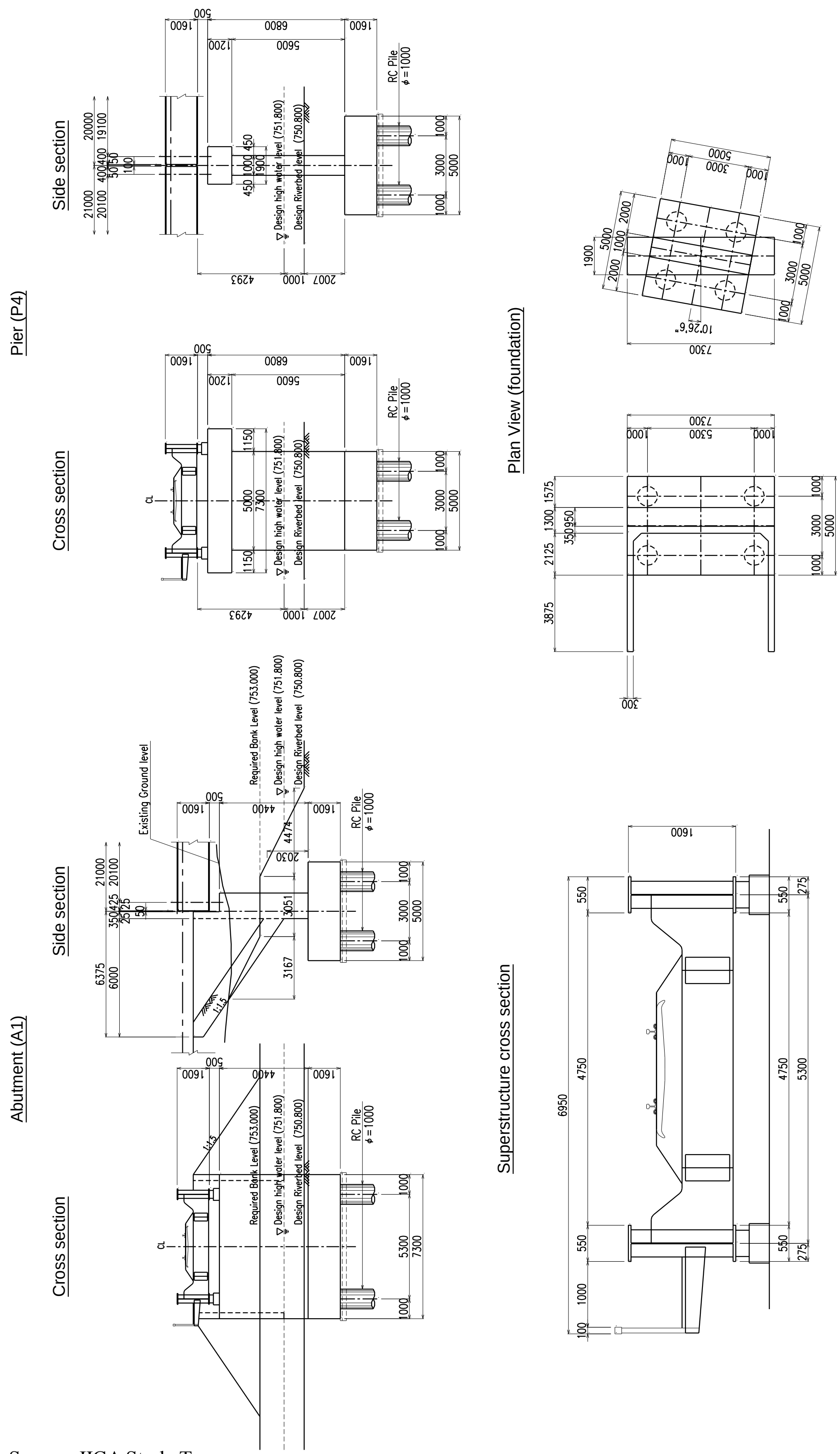
4) Preliminary design drawing

The preliminary design drawing of Maswala River Bridge is shown as below. Figure 10.28 shows the overall view and Figure 10.29 shows the superstructure, abutment, and pier.



Source: JICA Study Team

Figure 10.28: Overall View of the Maswala River Bridge



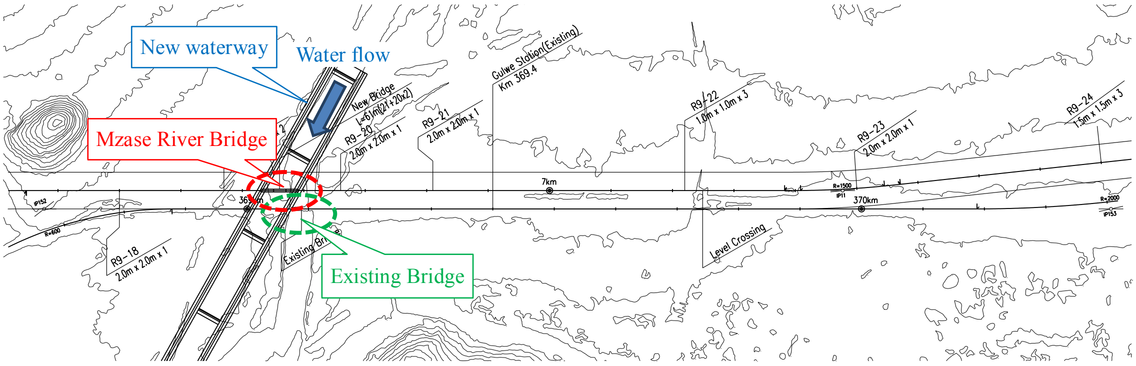
Source: JICA Study Team

Figure 10.29: Superstructure, Abutment and Pier of the Maswala River Bridge

(3) Mzase River Bridge

1) Characteristics

The Mzase River Bridge is a new one accompanied with the tributary refurbishment (linearization of existing channel). The total length of this bridge is 61 m. Figure 10.30 shows the location of the Mzase River Bridge.



Source: JICA Study Team

Figure 10.30: Location of the Mzase River Bridge

2) Design concept

The superstructure is planned as a steel deck girder due to the non-restriction of overhead clearance on the vertical alignment planning. The substructure is planned as cast-in-place pile. The span configuration is 21 m + 2 x 20 m = 61 m.

3) Basic calculation

In the preliminary design, some basic calculations of main girder height and pile diameter and length are carried out as below.

a) Main girder height

Table 10.23 and Table 10.24 show the setting and contents of calculation for main girder height of the Mzase River Bridge, respectively, and then Table 10.25 shows the results.

Table 10.23: Setting of Calculation for Main Girder

Span (m)	20.1
Girder height (m)	1.4
Axial load (tons)	18.5

Source: JICA Study Team

Table 10.24: Contents of Calculation for Main Girder

Required performance	Performance items	Combinations of actions
Safety	Load-carrying capacity	1.0*D+1.1*L+1.1*I
Serviceability	Riding comfort	1.0*L+1.0*I

Note) D: Dead load, L: Train load, I: Impact of train load
Source: JICA Study Team

Table 10.25: Results of Calculation for Main Girder

Required performance	Items		Design response value	Design limit value	Structure factor	Safety rate
Safety	Vending moment (kNm)	Mid-span	7,690.5	20,141.7	1.2	0.46
	Shear (kN)	End-span	1,740.0	5088.8	1.2	0.41
Serviceability	Deflection (mm)	Mid-span	18.5	22.3	1.0	0.83

Source: JICA Study Team

b) Pile diameter & the length

Table 10.26 and Table 10.27 show the setting and contents of calculation for pile of the bridge respectively, and then Table 10.28 shows the results.

Table 10.26: Setting of Calculation for Pile

Pile diameter (m)	1.0
Pile length (m)	6.0
Adopted boring No.	BH MZ-2
Minimum embedment length (m)	2.5 (2.5*D)

Source: JICA Study Team

Table 10.27: Contents of Calculation for Pile

Required performance	Performance items	Combinations of actions
Safety (seismic)	Stability	$1.0*D+1.0*L+1.0*E_q+1.0*W_p$
Serviceability	Long-term support performance	$1.0*D+1.0*W_p$
	Short-term support performance	$1.0*D+1.0*L+1.0*I+1.0*W_p$

Note) D: Dead load, L: Train load, I: Impact of train load, E_q: Seismic horizontal force, W_p: buoyancy
Source: JICA Study Team

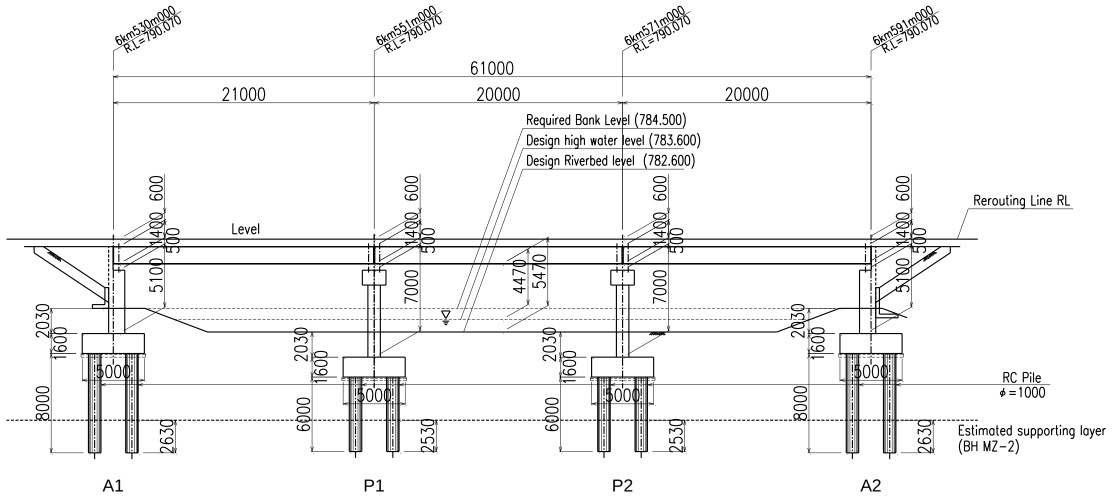
Table 10.28: Results of Calculation for Pile

Required performance	Performance items	Design response value	Design limit value	Structure factor	Safety rate
Safety (seismic)	Stability (kN)	2,069.1	4,623.6	1.0	0.45
Serviceability	Long-term support performance (kN)	845.5	1,068.5	1.0	0.79
	Short-term support performance (kN)	1,322.5	1,646.4	1.0	0.80

Source: JICA Study Team

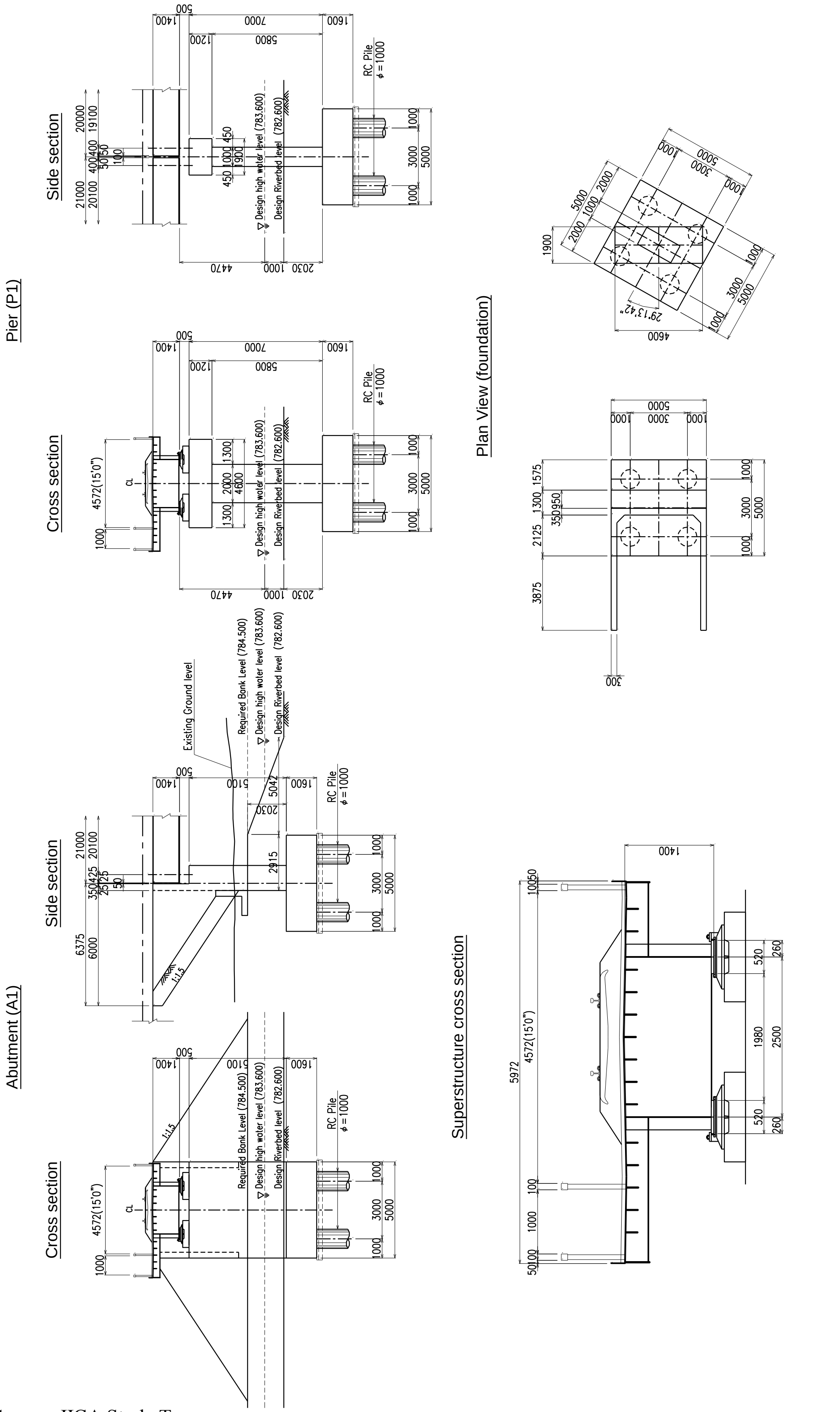
4) Preliminary design drawing

The preliminary design drawing of the Mzase River Bridge is shown as below. Figure 10.31 shows the overall view and Figure 10.32 shows the superstructure, abutment, and pier.



Source: JICA Study Team

Figure 10.31: Overall View of the Mzase River Bridge



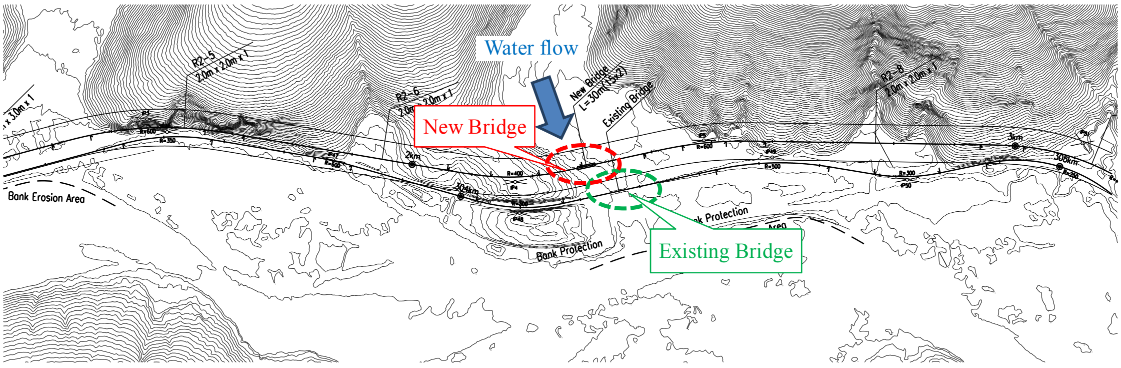
Source: JICA Study Team

Figure 10.32: Superstructure, Abutment and Pier of the Mzase River Bridge

(4) New Bridges near Km 304 and Km 306 of the Existing Railway Line

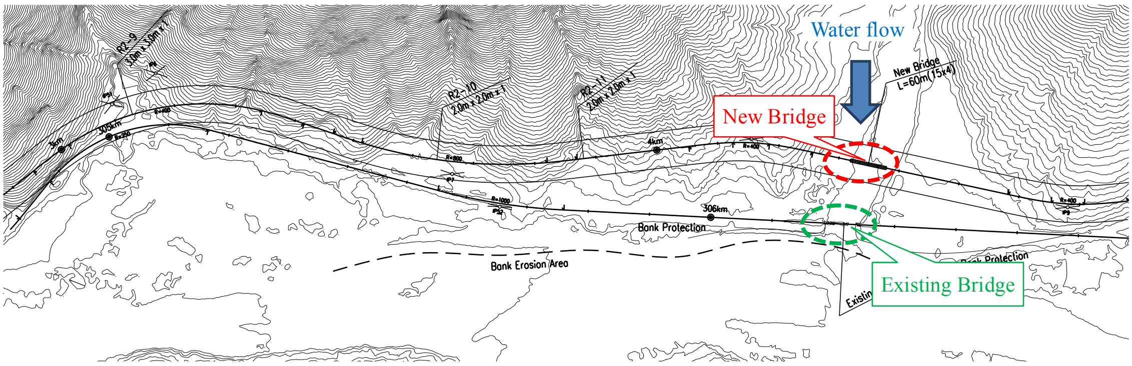
1) Characteristics

Bridges near Km 304 and Km 306 of the existing railway line are new ones to be constructed in the rerouting section. The total lengths of the new bridges are 30 m and 60 m, respectively. Figure 10.33 and Figure 10.34 show the locations of the new bridges.



Source: JICA Study Team

Figure 10.33: Location of New Bridge near Km 304 of the Existing Line



Source: JICA Study Team

Figure 10.34: Location of New Bridge near Km 306 of the Existing Line

2) Design concept

The superstructure is planned as a steel deck girder due to the non-restriction of overhead clearance on the vertical alignment planning. The substructure is planned as cast-in-place pile. The span configuration of new bridges near Km 304 and Km 306 is 2 x 15 m = 30 m and 4 x 15 m = 60 m respectively.

3) Basic calculation

In the preliminary design, some basic calculations of main girder height and pile diameter and length are carried out as below.

a) Main girder height

Table 10.29 and Table 10.30 show the setting and contents of calculation for main girder height of these new bridges, respectively and then Table 10.31 shows the results.

Table 10.29: Setting of Calculation for Main Girder of New Bridges

Span (m)	14.1
Girder height (m)	1.2
Axial load (tons)	18.5

Source: JICA Study Team

Table 10.30: Contents of Calculation for Main Girder of New Bridges

Required performance	Performance items	Combinations of actions
Safety	Load-carrying capacity	1.0*D+1.1*L+1.1*I
Serviceability	Riding comfort	1.0*L+1.0*I

Note) D: Dead load, L: Train load, I: Impact of train load
Source: JICA Study Team

Table 10.31: Results of Calculation for Main Girder of New Bridges

Required performance	Items		Design response value	Design limit value	Structure factor	Safety rate
Safety	Vending moment (kNm)	Mid-span	3,967.0	11994.5	1.2	0.40
	Shear (kN)	End-span	1346.6	6018.5	1.2	0.27
Serviceability	Deflection (mm)	Mid-span	8.9	15.7	1.0	0.57

Source: JICA Study Team

b) Pile diameter and the length

Table 10.32, Table 10.33and Table 10.34 show the setting and contents of calculation for pile of these new bridges and then Table 10.35 and Table 10.36 show the results respectively.

Table 10.32: Setting of Calculation for Pile of New Bridge near Km 304

Pile diameter (m)	0.8
Pile length (m)	9.0
Adopted boring No.	BH 13
Minimum embedment length (m)	0.8 (1.0*D)

Source: JICA Study Team

Table 10.33: Setting of Calculation for Pile of New Bridge near Km 306

Pile diameter (m)	0.8
Pile length (m)	18.7
Adopted boring No.	BH 15
Minimum embedment length (m)	0.8 (1.0*D)

Source: JICA Study Team

Table 10.34: Contents of Calculation for Pile of New Bridges

Required performance	Performance items	Combinations of actions
Safety (seismic)	Stability	$1.0*D+1.0*L+1.0*E_q+1.0*W_p$
Serviceability	Long-term support performance	$1.0*D+1.0*W_p$
	Short-term support performance	$1.0*D+1.0*L+1.0*I+1.0*W_p$

Note) D: Dead load, L: Train load, I: Impact of train load, E_q: Seismic horizontal force, W_p: buoyancy
Source: JICA Study Team

Table 10.35: Results of Calculation for Pile of New Bridge near Km 304

Required performance	Performance items	Design response value	Design limit value	Structure factor	Safety rate
Safety (seismic)	Stability (kN)	1327.2	2406.3	1.0	0.55
Serviceability	Long-term support performance (kN)	537.9	830.2	1.0	0.65
	Short-term support performance (kN)	890.5	1079.1	1.0	0.83

Source: JICA Study Team

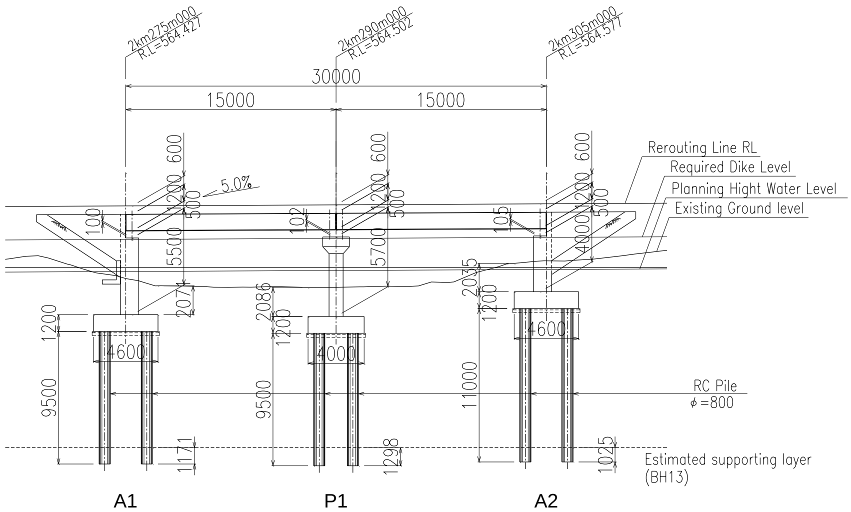
Table 10.36: Results of Calculation for Pile of New Bridge near Km 306

Required performance	Performance items	Design response value	Design limit value	Structure factor	Safety rate
Safety (seismic)	Stability (kN)	1610.0	5832.5	1.0	0.28
Serviceability	Long-term support performance (kN)	567.8	2200.7	1.0	0.26
	Short-term support performance (kN)	916.5	2785.1	1.0	0.33

Source: JICA Study Team

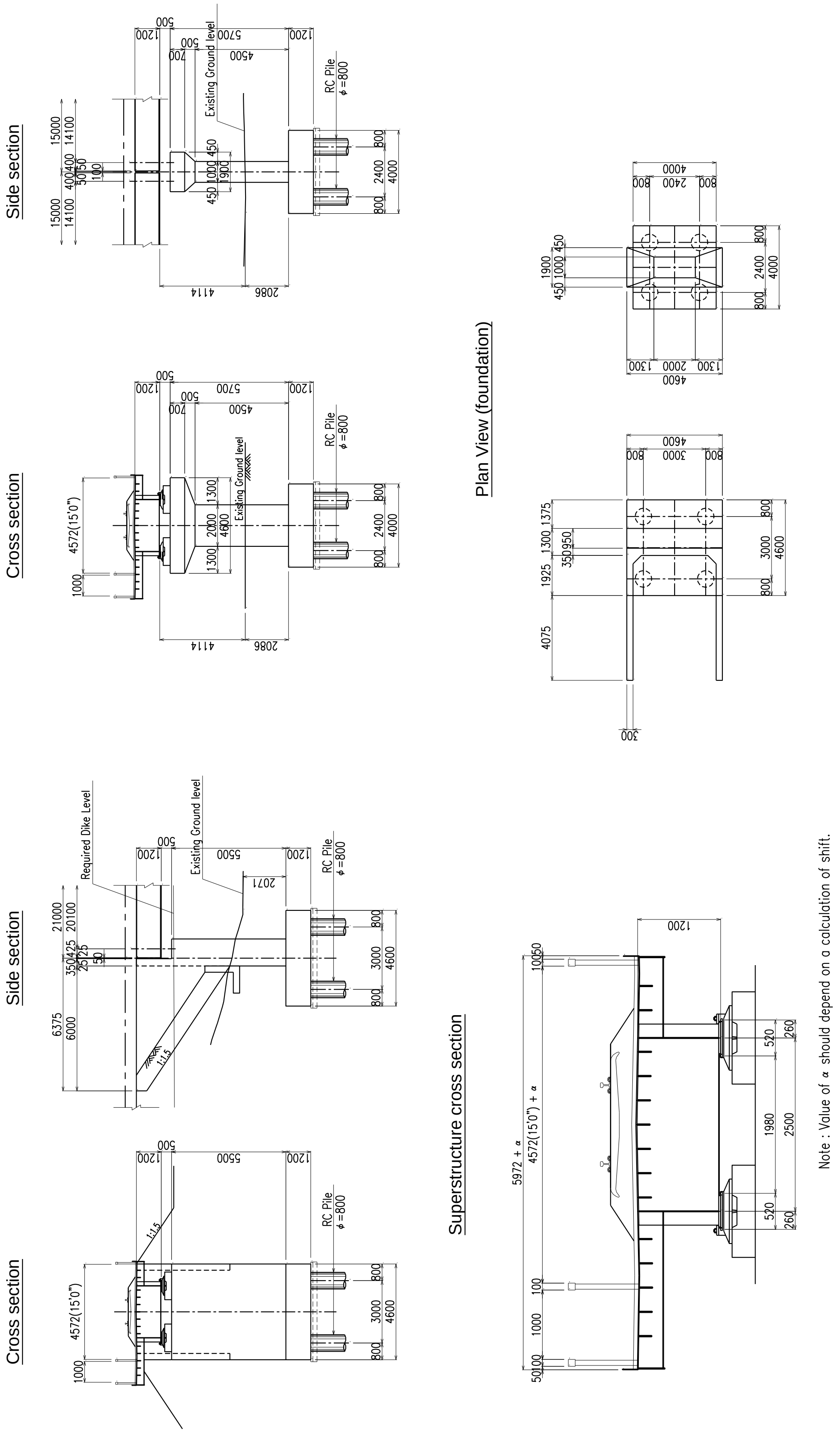
4) Preliminary design drawings

The preliminary design drawings of the new bridges near Km304 and Km306 of the existing railway line are shown as below. Figure 10.35 and Figure 10.37 show the overall view of two bridges, and also Figure 10.36 and Figure 10.38 show the superstructure, abutment and pier respectively.



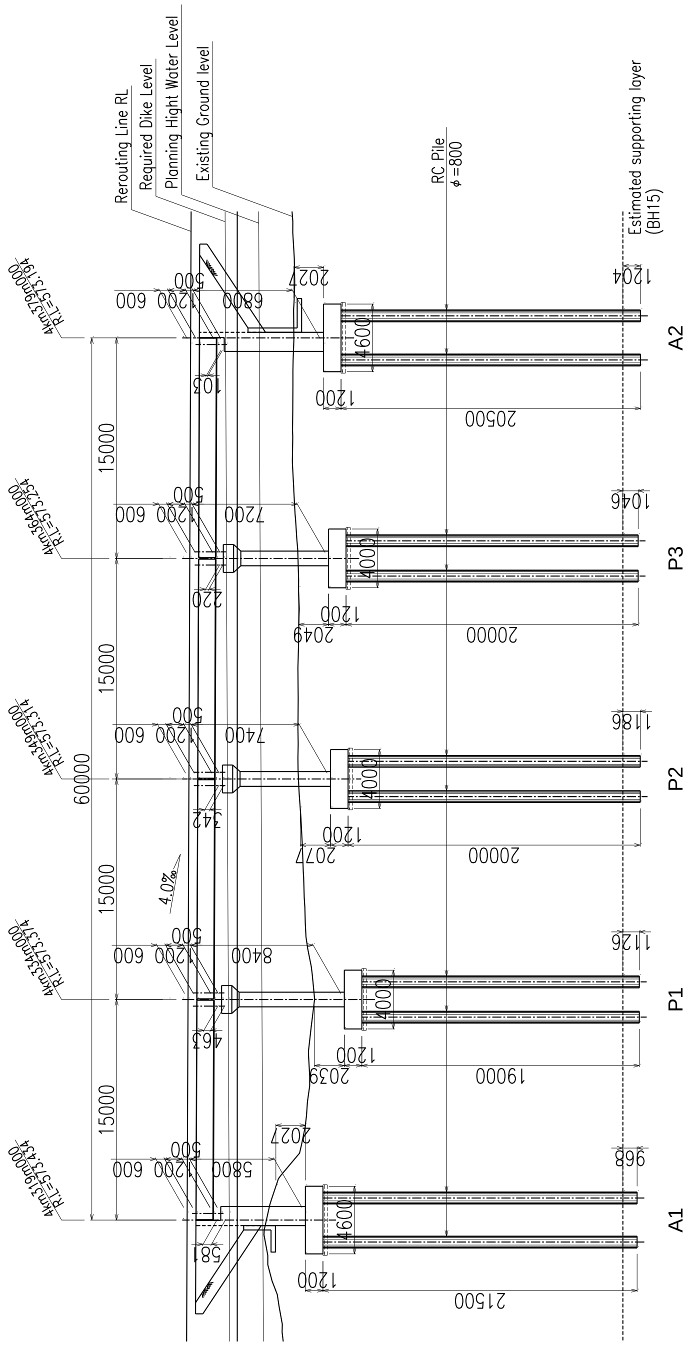
Source: JICA Study Team

Figure 10.35: Overall View of New Bridge near Km 304



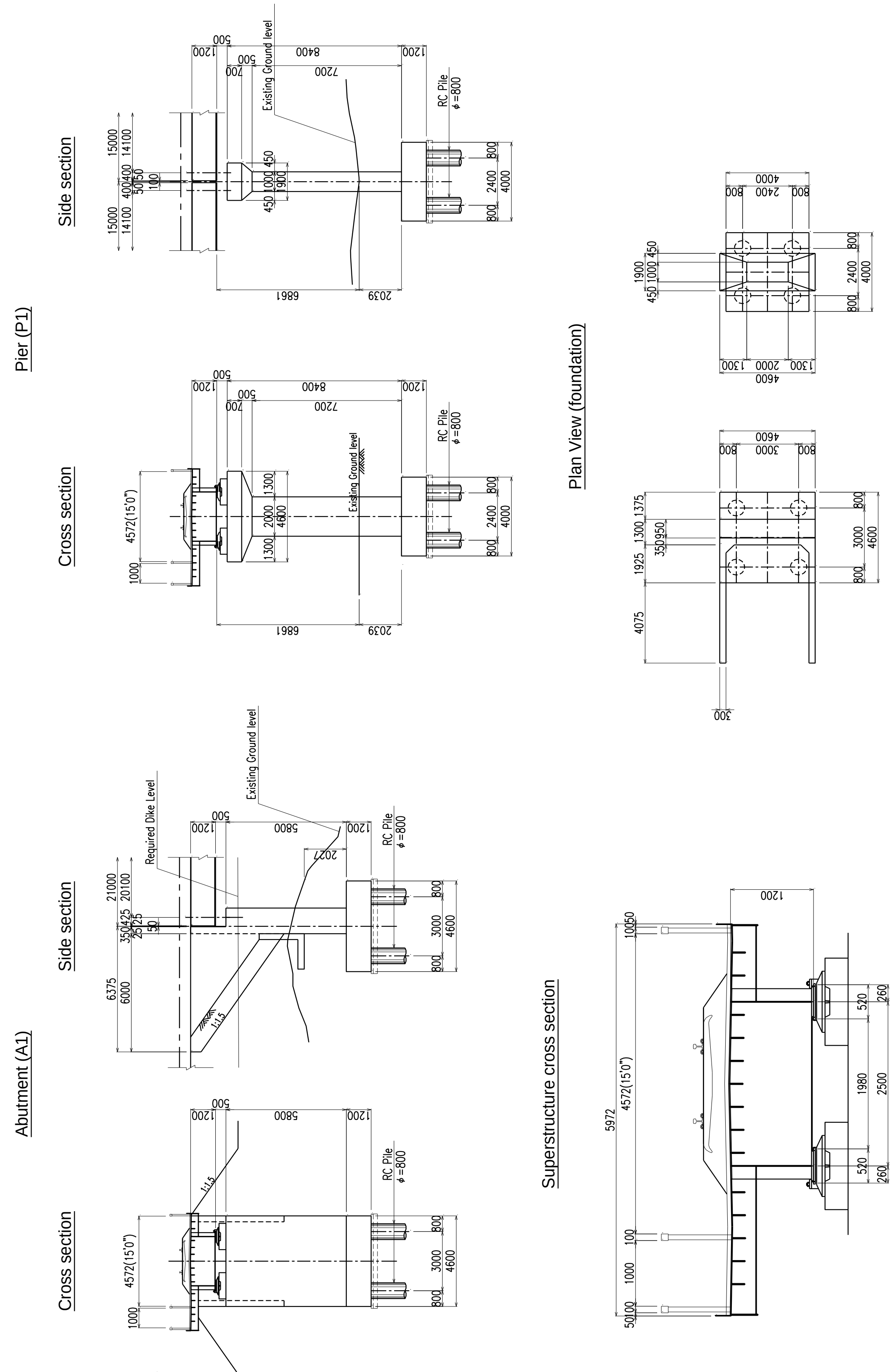
Source: JICA Study Team

Figure 10.36: Superstructure, Abutment and Pier of New Bridge near Km 304



Source: JICA Study Team

Figure 10.37: Overall View of New Bridge near Km306



Source: JICA Study Team

Figure 10.38: Superstructure, Abutment and Pier of New Bridge near Km 306

(5) List of Bridges

Table 10.37 shows a list of new bridges planned in the preliminary design.

Table 10.37: List of New Bridges Planned in the Preliminary Design

No.	Bridge name	Kilometer post of rerouting line (per section)	Bridge type	Span configuration
1	Km 304	Km2.290 (Sec.2)	Steel deck girder	2 x 15 m = 30 m
2	Km 306	Km4.349 (Sec.2)	Steel deck girder	4 x 15 m = 60 m
3	Maswala River Bridge	Km0.720 (Sec.8)	Steel through girder	4 x 21 m + 20 m = 104 m
4	Mzase River Bridge	Km6.560 (Sec.9)	Steel deck girder	21 m + 2 x 20 m = 61 m

Source: JICA Study Team

10.1.6 Device for Prevention of Bridge Collapse

(1) Overview

As described in 3.2.2 (3), the bridge near Km 293 has a possibility of being washed away when water levels rise due to the small clearance between the river water level and the soffit of the bridge girder, as shown in Figure 10.39. Because of this, an additional site survey and preliminary design based on the estimated high water level were carried out.

Source: JICA Study Team

Figure 10.39: Danger Point of Bridge Destruction near Km 293

(2) Additional Site Survey

An additional site survey of this existing bridge was carried out on 20th Nov. 2015. Some photos are shown from Figure 10.40 to Figure 10.44. Additionally, some basic information and dimensions of this bridge are as shown in Table 10.38.

Source: JICA Study Team

Figure 10.40: Steel Through Girder Bridge with a Maintenance Passage of 1.0 m Width on the Upstream

Source: JICA Study Team

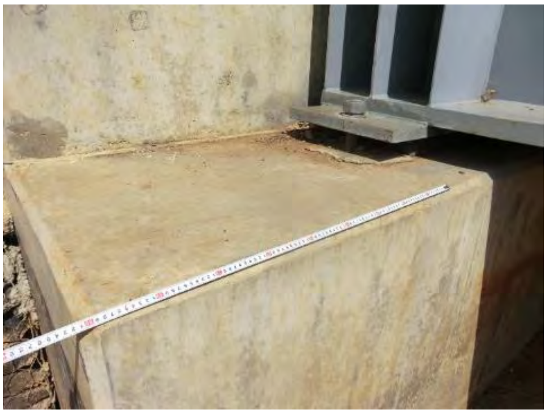
Figure 10.41: Side View on the Upstream: Brackets for a Maintenance Passage & a Cable Pipe

Source: JICA Study Team

Figure 10.42: Side View on the Downstream

Source: JICA Study Team

Figure 10.43: Condition near Shoe on the Upstream



Source: JICA Study Team

Figure 10.44: Condition near Shoe on the Downstream

Table 10.38: Basic Information of Existing River Bridge near Km 293

No.	Items	Contents
1	Span configuration	3 x 30 m = 90 m
2	Track type	Ballasted track
3	Main girder	Girder height: 2.5 m, lower flange width: 710 mm and lower flange thickness: 60 mm
4	Floor beam	Lower flange thickness: 30 mm
5	Shoe	Bridge axis direction width: 450 mm, bridge axis perpendicular width: 710 mm and the thickness : 75 mm
6	Stopper	Diameter: 50 mm

Source: JICA Study Team

(3) Design High Water Level

Relationships of the design high water level and girder height are shown in Table 10.39.

Table 10.39: Design High Water Level near Km 293 and Girder Height

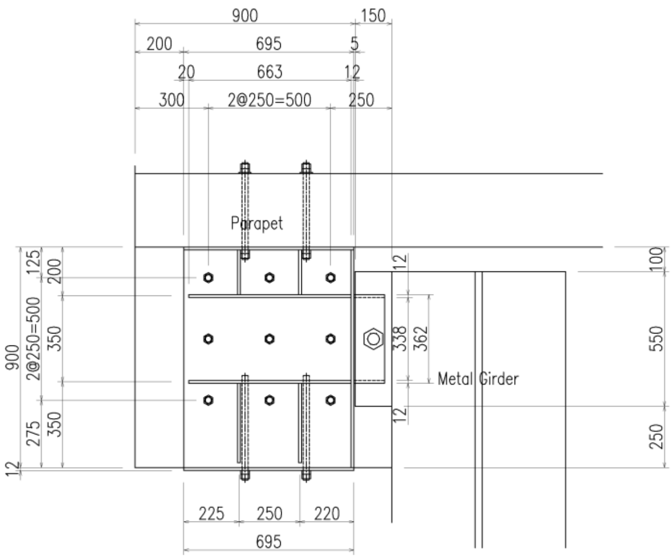
Items	Value	Remarks
Design high water level (m)	521.769	Estimated value
Existing Rail level (m)	520.981	Estimated value
Main girder height (m)	2.50	Measured value
Gap between RL and underside of main girder (m)	1.00	Estimated value
Girder height influenced by high water level(m)	1.79	≒1.80

Source: JICA Study Team

(4) Calculation of Device for Prevention of Bridge Collapse

1) Design concept

Based on the design high water level as shown in Table 10.39, a value of flowing water force on the side of main girder is calculated. As a device for prevention of bridge collapse, a steel side block is planned in the preliminary design. The arrangement of the anchor rebar is as shown in Figure 10.45.



Source: JICA Study Team

Figure 10.45: Arrangement of the Anchor Rebar

2) Basic calculation

In the preliminary design, some basic calculations for prevention of bridge collapse are carried out as below. Table 10.40 shows the setting of calculation for anchor rebar.

Table 10.40: Setting of Calculation for Anchor Rebar

Anchor rebar type	D25
Tensile yield strength (N/mm^2)	345
Effective cross-sectional area of threaded section (mm^2)	352.5
Design compressive strength of concrete (N/mm^2)	23.1

Source: JICA Study Team

a) Safety against shear failure

As shown in Table 10.41, some calculations for checking safety against shear failure are carried out.

Table 10.41: Results of Safety against Shear Failure

Required perfor-mance	Performance items	Design response value	Design limit value	Structure factor	Safety rate
Safety	Safety against shear failure of anchor (N)	18,100	54,000	1.2	0.40
	Safety of compressive stress of embedded base of anchor (N/mm^2)	8.0	23.1	1.0	0.35
	Safety against shear failure of concrete (N)	18,100	23,900	1.0	0.76

Source: JICA Study Team

b) Safety against tensile force

As shown in Table 10.42, some calculations for checking safety against tensile force are carried out.

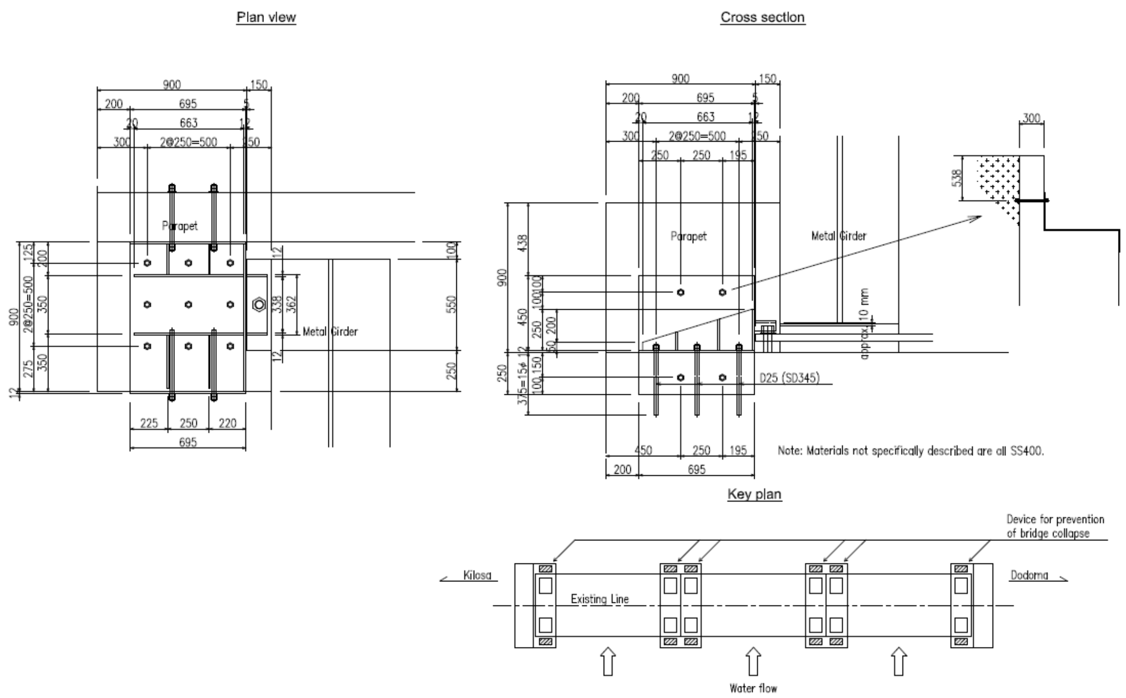
Table 10.42: Results of Safety against Tensile Force

Required perfor-mance	Performance items	Design response value	Design limit value	Structure factor	Safety rate
Safety	Safety against tensile failure of anchor (N)	47,000	63,200	1.2	0.89
	Safety against tensile failure of concrete (N)	47,000	101,500	1.2	0.56

Source: JICA Study Team

(5) Preliminary Design Drawing

The preliminary design drawing of the device for the prevention of bridge collapse due to flood is shown in Figure 10.46.



Source: JICA Study Team

Figure 10.46: Preliminary Design Drawing of the Device for Prevention of Bridge Collapse

10.1.7 Box Culverts

(1) Basic Concept of Preliminary Design

Following the preliminary study on box culverts which should accommodate the required flow areas (identified through hydraulic analysis in Chapter 6), the location and appropriate size of new box culverts are studied from a hydrological point of view in this sub-section. In principle, the target area requiring new box culverts for the preliminary design coincides with the re-routing railway sections, i.e., a total of 25 km in seven sections, as follows:

Table 10.43: New Kilometerage Properties of Re-routing Sections

Re-routing No.	Start Point (m)	End Point (m)	Length to be relocated (m)	Length after re-routed (m)
1	293750.000	295481.600	1731.600	1822.019
2	302000.000	307958.014	5958.014	5957.469
3	313284.446	316048.057	2763.611	2777.164
5	337296.458	339209.541	1913.083	1765.704
7	346243.248	348003.696	1760.448	1862.533
8	351048.323	352800.000	1751.677	1766.087
9	362429.807	371553.379	9124.572	9038.674
Total			25,003.005	24,989.650

Source: JICA Study Team

In order to decide the location of new culverts, the following items were reviewed and revised based on newly-obtained information and design conditions:

1) Topographic conditions along re-routing sections
In principle, the culvert shall be placed at lowest elevation in the concerned area to enable drainage of internal water toward the river side. Therefore, topographic conditions along the planned re-routing sections were carefully reviewed.
2) Minimum embankment height along re-routing sections
As for suitable setting of culvert at designated sites, minimum depth of compaction of overburden soil above upper slab of culvert and required thickness of ballast/height of rail were considered.
3) Size of drainage areas at designated location of culverts
The drainage areas at the proposed culvert were measured on the topographic maps of 1:2,500 and the DEM created by satellite imagery (SPOT). The design scale of opening of culvert is set 30-year return period as recommended in the Interim Report.
4) Interval of neighboring culverts along re-routing sections
The interval of culverts along the re-routing sections is maintained equivalent to the present conditions, which is approximately 300 m to 400 m, as far as topographical conditions and vertical formation of new track allow.

Taking consideration of the preliminary economic analysis and consensus with the Tanzanian side, it should be noted that only the culverts subject to the re-routing sections will be the target for preliminary design and be included in the component of Yen Loan Project with other civil works of re-routings. In seven re-routing sections of approximately 25 km in total, 65 sites of water crossing were identified.

(2) Database of existing culverts along existing track

The principal feature of the existing 233 box and pipe culverts, which were identified through the field reconnaissance of the Flood Risk Assessment and subsequent map study with high resolution DEM (5 m mesh data), are compiled in Table 10.44-Table 10.46. Further, detailed information of 135 structures, which were directly measured in the field in December 2014, were presented in the form of Inventory Sheets (Appendix F) and Straight Line Diagram (Appendix G) in the Progress Report (May 2015) of the current Study. Regarding the other 98 structures, supplemental field reconnaissance and map study conducted in June 2015 clarified properties as displayed in Table 10.44-Table 10.46.

Based on the abovementioned compiled information, the locations of existing culverts are plotted and information of kilometerage of the railway was updated in accordance with new system established in the flood hazard map, as attached in Appendix T.

Table 10.44: Master List of Existing Culverts (1/3)

										Existing Status based on Flood Risk Assessment (Dec. 2014)																	
S/N	Station Km (Original System)	Station Km (New System)	Longitude	Latitude	Easting	Southing	Confirmation Method	Sheet Number (Progress Report)	Waterway Culvert No.	H (m)	W (m)	D (m)	Lane No.	Box Culvert (Field Mesurem't)	Pipe Culvert (Field Mesurem't)	Arch (Field Mesurem't)	Bridge (Field Mesurem't)	Arch Culvert (Total)	Bridge (Total)	Drop Work	D/S canal	Box Culvert (Normal)	Box Culvert (High Risk)	Pipe Culvert (Normal)	Pipe Culvert (High Risk)	Arch Culvert (Normal)	Arch Culvert (High Risk)
1	Km 283.6	283.61	36.9773	-6.8299	276,465	9,244,582	Field Survey	PCL 283.6				0.9	1		1									1			
2	Km 283.9	283.98	36.9754	-6.8273	276,253	9,244,877	Field Survey	BCL 283.9		1.7	1		1	1								1					
3	Km 284.47	284.48	36.9718	-6.8246	275,857	9,245,173	Field Survey	BCL 284.47		0.78	2		1	1								1					
4	Km 285.3	285.29	36.9691	-6.8180	275,549	9,245,894	Aerial Photo																				
5	Km 285.45	285.48	36.9680	-6.8168	275,431	9,246,036	Field Survey	BCL 285.45		1.45	1		1	1								1					
6	Km 285.65	285.67	36.9674	-6.8151	275,360	9,246,217	Field Survey	BCL 285.65		1.2	1		1	1								1					
7	Km 286.15	286.16	36.9673	-6.8107	275,347	9,246,703	Field Survey	PCL 286.15				2	1		1									1			
8	Km 286.4	286.43	36.9674	-6.8083	275,366	9,246,967	Field Survey	PCL 286.4				0.9	3		1									1			
9	Km 286.65	286.66	36.9665	-6.8065	275,260	9,247,172	Field Survey	PCL 286.65	A1			1	1		1									1			
10	Km 286.88	286.91	36.9655	-6.8045	275,146	9,247,387	Field Survey	PCL 286.88				0.9	2		1									1			
11	Km 287.15	287.23	36.9645	-6.8018	275,034	9,247,690	Field Survey	PCL 287.15				0.9	2		1										1		
12	Km 287.25	287.31	36.9641	-6.8011	274,994	9,247,761	Field Survey	BCL 287.25		0.95	7		1	1								1					
13	Km 287.3	287.42	36.9634	-6.8005	274,914	9,247,836	Field Survey	PCL 287.3	A2			0.9	1		1										1		
14	Km 287.7	287.78	36.9619	-6.7977	274,752	9,248,142	Field Survey	BCL 287.7	A3	1.8	2		2	1								1					
15	Km 288	288.15	36.9594	-6.7959	274,472	9,248,342	Aerial Photo												1								
16	Km 288.35	288.46	36.9566	-6.7960	274,159	9,248,329	Field Survey	PCL 288.35	A4	1.2	1.2	1.2	3		1									1			
17	Km 289	289.11	36.9501	-6.7596	273,430	9,252,354	Field Survey	BCL 289		1	0.95		1	1								1					
18	Km 289.1	289.21	36.8998	-6.7454	267,851	9,253,897	Field Survey	BCL 289.1		1.92	3		3	1								1					
19	Km 289.3	289.72	36.9494	-6.7903	273,367	9,248,948	Field Survey	PCL 289.3				0.5	1		1									1			
20	Km 289.6	290.03	36.9496	-6.7876	273,379	9,249,246	Field Survey	PCL 289.6				0.9	1		1									1			
21	Km 289.9	290.31	36.9497	-6.7851	273,393	9,249,524	Field Survey	PCL 289.9				1.2	2		1									1			
22	Km 290.4	290.78	36.9483	-6.7811	273,231	9,249,966	Field Survey	BCL 290.4	A5	1.3	3		1	1									1				
23	Km 290.6	290.78	36.9475	-6.7795	273,151	9,250,144	Field Survey	PCL 290.6				0.9	1		1									1			
24	Km 290.9	291.38	36.9459	-6.7763	272,974	9,250,505	Field Survey	BR 290.9	A6	1.5	10		1				1		1								
25	Km 291.2	291.17	36.9440	-6.7746	272,758	9,250,692	Field Survey	PCL 291.2				0.75	5		1									1			
26	Km 291.5	291.97	36.9421	-6.7726	272,545	9,250,903	Field Survey	PCL 291.5				0.75	1		1									1			
27	Km 291.5B	292.02	36.9418	-6.7723	272,514	9,250,937	Field Survey	PCL 291.5b				0.75	2		1										1		
28	Km 291.7	292.15	36.9410	-6.7714	272,425	9,251,035	Field Survey	PCL 291.7				0.75	2		1										1		
29	Km 291.9	292.37	36.9398	-6.7699	272,286	9,251,209	Field Survey	PCL 291.9				0.75	4		1									1			
30	Km 292.2	292.66	36.9384	-6.7676	272,134	9,251,454	Field Survey	BCL 292.2		1.6	2.5		1	1								1					
31	Km 292.6	293.02	36.9376	-6.7645	272,048	9,251,806	Field Survey	BCL 292.6	A7	3	31.8		3	1								1					
32	Km 292.7	293.17	36.9369	-6.7634	271,972	9,251,927	Field Survey	PCL 292.7				0.45	1		1									1			
33	Km 292.8	293.24	36.9365	-6.7629	271,920	9,251,976	Field Survey	BCL 292.8		0.8	2		1	1									1				
34	Km 293.0	293.42	36.9351	-6.7621	271,764	9,252,061	Field Survey	BCL 293		1.8	2		1	1								1					
35	Km 293.1	293.57	36.9337	-6.7619	271,618	9,252,086	Field Survey	BCL 293.1		3.6	90		3	1								1					
36	Km 293.8	294.30	36.9273	-6.7606	270,908	9,252,227	Field Survey	PCL 293.8				0.6	1		1									1			
37	Km 294.2	294.71	36.9238	-6.7595	270,511	9,252,348	Field Survey	PCL 294.2				0.95	2		1									1	1		
38	Km 294.5	295.06	36.9207	-6.7586	270,170	9,252,442	Field Survey	BCL 294.5	B1	1.1	2		1	1			Re-routing No.1					1					
39	Km 295.1	295.55	36.9183	-6.7554	269,902	9,252,797	Field Survey	BCL 295.1		0.9	2		2	1									1				
40	Km 295.3	295.79	36.9182	-6.7532	269,891	9,253,043	Field Survey	BCL 295.3	B2	1.3	2		1	1								1					
41	Km 295.7	296.19	36.9179	-6.7665	269,867	9,251,574	Field Survey	BCL 295.7				1.15	1	1								1					
42	Km 295.9	296.44	36.9170	-6.7475	269,756	9,253,669	Field Survey	BCL 295.9		0.44	0.9		1	1									1				
43	Km 296.4	296.91	36.9143	-6.7445	269,454	9,254,000	Field Survey	BCL 296.4		0.8	0.92		1	1								1					
44	Km 296.7	297.21	36.9117	-6.7436	269,171	9,254,097	Field Survey	BCL 296.7		1	0.93		1	1								1					
45	Km 297.1	297.61	36.9082	-6.7431	268,785	9,254,150	Field Survey	BCL 297.1		0.8	1.93		1	1									1				
46	Km 297.6	298.07	36.9044	-6.7447	268,359	9,253,980	Field Survey	BCL 297.6	B3	1.2	0.9		1	1									1				
47	Km 299.3	299.76	36.8896	-6.7429	266,722	9,254,169	Field Survey	PCL 299.3	B4			1.1	4		1										1		
48	Km 299.7	300.17	36.8860	-6.7429	266,326	9,254,168	Field Survey	PCL 299.7				1.17	3		1										1		
49	Km 300.1	300.63	36.8819	-6.7420	265,873	9,254,264	Field Survey	PCL 300.1				0.9	1		1										1		
50	Km 300.2	300.74	36.8809	-6.7420	265,760	9,254,263	Field Survey	PCL 300.2				1.2	1		1									1			
51	Km 300.5	300.94	36.8791	-6.7422	265,564	9,254,238	Field Survey	BCL 300.5				1.2	1	1								1					
52	Km 300.6	301.12	36.8775	-6.7426	265,392	9,254,194	Field Survey	BCL 300.6		0.95	2		1	1								1					
53	Km 300.8	301.37	36.8754	-6.7433	265,155	9,254,120	Aerial Photo		B5																		
54	Km 301.3	301.84	36.8713	-6.7445	264,705	9,253,982	Aerial Photo												1								
55	Km 302.0	302.51	36.8655	-6.7463	264,062	9,253,785	Field Survey	PCL 302				0.6	2		1									1			
56	Km 302.2	302.71	36.8637	-6.7464	263,864	9,253,763	Field Survey	BCL 302.2		1.7	1		1	1								1					
57	Km 302.7	303.18	36.8595	-6.7454	263,404	9,253,872	Aerial Photo		B6								Re-routing No.2				1						
58	Km 303.3	303.87	36.8542	-6.7426	262,812	9,254,186	Field Survey	BCL 303.3		1.7	2.5		1	1								1					
59	Km 303.4	304.00	36.8533	-6.7418	262,715	9,254,275	Field Survey	BCL 303.4		1.8	2		1	1							1	1					
60	Km 303.7	304.25	36.8512	-6.7407	262,483	9,254,393	Aerial Photo		B7										1								
61	Km 304.1	304.69	36.8478	-6.7391	262,103	9,254,573	Aerial Photo		B8																		
62	Km 305.2	305.73	36.8440	-6.7315	261,676	9,255,412	Aerial Photo																				
63	Km 305.5	306.04	36.8431	-6.7288	261,578	9,255,702	Aerial Photo																				
64	Km 305.6	306.22	36.8426	-6.7273	261,520	9,255,874	Aerial Photo		B9										1								
65	Km 306.1	306.68	36.8412	-6.7233	261,371	9,256,314	Aerial Photo																				
66	Km 306.7	307.23	36.8397	-6.7186	261,192	9,256,833	Aerial Photo																				
67	Km 306.9	307.50	36.8379	-6.7170	260,999	9,257,013	Aerial Photo																				
68	Km 307.2	307.40	36.8353	-6.7160	260,707	9,257,114	Aerial Photo		B10												1						
69	Km 307.4	307.92	36.8344	-6.7156	260,609	9,257,164	Aerial Photo																				
70	Km 308.1	308.51	36.8318	-6.7106	260,316	9,257,718	Field Survey	BCL 308.1		1.1	2		1	1								1					
71	Km 308.3	308.73	36.8304	-6.7092	260,166	9,257,868	Field Survey	BCL 308.3		0	3.6		1	1									1				
72	Km 308.4	308.82	36.8298	-6.7086	260,095	9,257,929	Field Survey	PCL 308.4				0.83	1		1									1			
73	Km 308.9	309.33	36.8264	-6.7066	259,720	9,258,149	Field Survey	PCL 308.9				1	1		1						1			1			
74	Km 309.4	309.82	36.8221	-6.7057	259,243	9,258,254	Field Survey	BCL 309.4	B11	0.9	1		1	1								1					
75	Km 309.9	310.36	36.8175	-6.7043	258,739	9,258,398	Field Survey	BCL 309.9		0.4	2		1	1									1				
76	Km 310.5	310.99	36.8121	-6.7053	258,133	9,258,286	Field Survey	BCL 310.5	B12	1.5	2		1	1								1					
77	Km 310.8	311.27	36.8095	-6.7050	257,848	9,258,324	Field Survey	PCL 310.8				0.9	2		1									1			
78	Km 311.0	311.47	36.8078	-6.7047	257,659	9,258,359	Field Survey	PCL 311				0.75	2		1									1			
79	Km 311.2	311.72	36.8056	-6.7038	257,423	9,258,451	Field Survey	BR 311.2	B13	1	4.7		1				1										
80	Km 312.2	312.63	36.7980	-6.7007	256,580	9,258,787	Field Survey	BCL 312.2		1.35	1		1	1								1					

Table 10.45: Master List of Existing Culverts (2/3)

										Existing Status based on Flood Risk Assessment (Dec. 2014)																	
S/N	Station Km (Original System)	Station Km (New System)	Longitude	Latitude	Easting	Southing	Confirmation Method	Sheet Number (Progress Report)	Waterway Culvert No.	H (m)	W (m)	D (m)	Lane No.	Box Culvert (Field Mesurem't)	Pipe Culvert (Field Mesurem't)	Arch (Field Mesurem't)	Bridge (Field Mesurem't)	Arch Culvert (Total)	Bridge (Total)	Drop Work	D/S canal	Box Culvert (Normal)	Box Culvert (High Risk)	Pipe Culvert (Normal)	Pipe Culvert (High Risk)	Arch Culvert (Normal)	Arch Culvert (High Risk)
81	Km 312.3	312.74	36.7971	-6.7004	256,475	9,258,822	Field Survey	BCL 312.3		0.8	1		1	1								1					
82	Km 312.4	312.89	36.7957	-6.7006	256,322	9,258,805	Field Survey	BCL 312.4		1.8	4.4		1				1		1			1					
83	Km 312.8	313.25	36.7926	-6.7001	255,974	9,258,857	Field Survey	BCL 312.8		1.6	1		1	1													
84	Km 312.9	313.41	36.7912	-6.6999	255,819	9,258,872	Field Survey	BCL 312.9		1.7	2		1	1							1	1					
85	Km 313.3	313.80	36.7879	-6.6989	255,460	9,258,984	Field Survey	BCL 313.3	B14			0.9	2	1							1	1					
86	Km 313.4	313.83	36.7876	-6.6989	255,427	9,258,984	Field Survey	BCL 313.4		2	2		1	1								1					
87	Km 314.1	314.55	36.7820	-6.6962	254,805	9,259,279	Field Survey	BCL 314.1		0.6	2		1	1								1					
88	Km 314.4	314.81	36.7798	-6.6956	254,559	9,259,348	Field Survey	PCL 314.4				0.95	1		1									1			
89	Km 314.5	314.97	36.7783	-6.6948	254,395	9,259,435	Field Survey	PCL 314.5				0.9	1		1									1			
90	Km 314.9	315.42	36.7751	-6.6928	254,038	9,259,650	Field Survey	BCL 314.9		1.8	2		1	1							1	1					
91	Km 315.5	316.04	36.7702	-6.6901	253,492	9,259,945	Aerial Photo		B15																		
92	Km 316.1	316.63	36.7657	-6.6883	253,001	9,260,143	Aerial Photo												1								
93	Km 316.5	317.03	36.7623	-6.6878	252,624	9,260,203	Aerial Photo																				
94	Km 316.9	317.43	36.7593	-6.6858	252,288	9,260,418	Aerial Photo																				
95	Km 317.3	317.78	36.7563	-6.6848	251,961	9,260,531	Aerial Photo																				
96	Km 317.8	318.35	36.7521	-6.6823	251,494	9,260,809	Aerial Photo		B16																		
97	Km 318.5	318.03	36.7501	-6.6765	251,262	9,261,441	Aerial Photo																				
98	Km 319.1	319.56	36.7458	-6.6747	250,785	9,261,647	Aerial Photo		B17																		
99	Km 319.4	319.89	36.7442	-6.6722	250,608	9,261,917	Aerial Photo																				
100	Km 319.9	320.39	36.7400	-6.6708	250,143	9,262,075	Aerial Photo																				
101	Km 320.3	320.81	36.7362	-6.6707	249,729	9,262,082	Aerial Photo											1									
102	Km 320.8	321.34	36.7317	-6.6706	249,227	9,262,092	Aerial Photo		B18										1								
103	Km 321.4	321.52	36.7309	-6.6692	249,144	9,262,247	Aerial Photo											1									
104	Km 321.0	321.92	36.7313	-6.6656	249,180	9,262,639	Aerial Photo																				
105	Km 321.8	322.29	36.7298	-6.6628	249,010	9,262,945	Aerial Photo																				
106	Km 322.1	322.64	36.7267	-6.6623	248,673	9,263,001	Aerial Photo		B19									1									
107	Km 322.6	323.05	36.7238	-6.6601	248,344	9,263,244	Aerial Photo																				
108	Km 322.8	323.30	36.7215	-6.6601	248,096	9,263,248	Aerial Photo																				
109	Km 323.0	323.46	36.7201	-6.6604	247,940	9,263,216	Aerial Photo											1									
110	Km 323.8	324.32	36.7125	-6.6596	247,096	9,263,297	Aerial Photo												1								
111	Km 324.2	324.74	36.7096	-6.6572	246,774	9,263,557	Aerial Photo		B20																		
112	Km 324.8	325.32	36.7067	-6.6529	246,454	9,264,034	Aerial Photo																				
113	Km 325.7	326.10	36.7057	-6.6461	246,335	9,264,787	Field Survey	PCL 325.7				0.9	2		1										1		
114	Km 325.8	326.19	36.7057	-6.6453	246,339	9,264,870	Field Survey	PCL 325.75				0.9	2		1										1		
115	Km 326.1	326.57	36.7041	-6.6425	246,162	9,265,181	Aerial Photo											1									
116	Km 326.9	327.47	36.6969	-6.6391	245,358	9,265,560	Field Survey	PCL 326.9		arch	shape	2.5	1.0			1		1						1			
117	Km 327.4	327.89	36.6943	-6.6364	245,074	9,265,854	Field Survey	BCL 327.4		2.6	3		1	1						1		1					
118	Km 327.8	328.20	36.6941	-6.6336	245,045	9,266,163	Aerial Photo											1									
119	Km 327.9	328.39	36.6941	-6.6319	245,050	9,266,345	Field Survey	PCL 327.9		arch	shape	5	1			1		1								1	
120	Km 328.8	329.17	36.6913	-6.6266	244,734	9,266,940	Field Survey	PCL 328.8		arch	shape	4	1			1		1								1	
121	Km 329.1	329.52	36.6882	-6.6264	244,390	9,266,957	Aerial Photo											1									
122	Km 329.6	330.07	36.6844	-6.6242	243,973	9,267,199	Aerial Photo																				
123	Km 329.9	330.32	36.6819	-6.6230	243,696	9,267,330	Aerial Photo																				
124	Km 330.2	330.56	36.6798	-6.6224	243,467	9,267,399	Aerial Photo		C1																		
125	Km 330.5	330.88	36.6771	-6.6215	243,160	9,267,493	Aerial Photo																				
126	Km 330.9	331.28	36.6739	-6.6199	242,807	9,267,667	Aerial Photo																				
127	Km 331.2	331.52	36.6726	-6.6181	242,665	9,267,868	Aerial Photo																				
128	Km 331.4	331.76	36.6715	-6.6163	242,545	9,268,066	Aerial Photo																				
129	Km 331.6	331.86	36.6703	-6.6148	242,403	9,268,230	Aerial Photo																				
130	Km 331.9	332.25	36.6679	-6.6139	242,143	9,268,326	Aerial Photo																				
131	Km 332.2	332.52	36.6655	-6.6136	241,876	9,268,359	Aerial Photo																				
132	Km 332.4	332.75	36.6638	-6.6125	241,688	9,268,480	Aerial Photo																				
133	Km 333.0	333.22	36.6626	-6.6087	241,548	9,268,904	Aerial Photo		C2																		
134	Km 332.8	333.39	36.6629	-6.6071	241,582	9,269,076	Aerial Photo																				
135	Km 333.1	333.71	36.6630	-6.6042	241,592	9,269,396	Field Survey	BCL 333.1		0.4	2		1	1									1				
136	Km 333.6	333.95	36.6619	-6.6024	241,476	9,269,600	Aerial Photo																				
137	Km 333.6	334.07	36.6611	-6.6017	241,387	9,269,675	Field Survey	BCL 333.6	C3	3.1	5.0		1.0	1								1					
138	Km 334.1	334.59	36.6584	-6.5981	241,078	9,270,073	Field Survey	BCL 334.1	C4	2.1	2		1	1								1					
139	Km 334.3	334.84	36.6588	-6.5960	241,129	9,270,308	Field Survey	PCL 334.3		arch	shape	4	1		1									1			
140	Km 334.6	335.18	36.6606	-6.5934	241,324	9,270,590	Aerial Photo																				
141	Km 334.7	335.28	36.6588	-6.5959	241,120	9,270,313	Field Survey	BCL 334.7		0.9	1.8		1	1									1				
142	Km 334.8	335.28	36.6609	-6.5925	241,352	9,270,692	Field Survey	BCL 334.8		0.5	2		1	1									1				
143	Km 335.0	335.52	36.6602	-6.5905	241,277	9,270,913	Field Survey	BCL 335		0.5	2		1	1									1				
144	Km 335.1	335.63	36.6595	-6.5898	241,200	9,270,986	Field Survey	BCL 335.1		1.75	2		1	1								1					
145	Km 335.3	335.82	36.6581	-6.5889	241,039	9,271,090	Field Survey	BCL 335.3		1.1	2		1	1								1					
146	Km 335.5	336.07	36.6563	-6.5876	240,839	9,271,227	Field Survey	BCL 335.5		1.75	2		2	1								1					
147	Km 335.8	336.32	36.6555	-6.5855	240,756	9,271,464	Aerial Photo																				
148	Km 335.8	336.42	36.9495	-6.7840	273,367	9,249,653	Field Survey	BCL 335.8		1.55	2		1	1								1					
149	Km 336.1	336.66	36.6535	-6.5834	240,529	9,271,690	Field Survey	BCL 336.1		0.85	2		1	1									1				
150	Km 336.3	336.86	36.6517	-6.5830	240,331	9,271,744	Aerial Photo																				
151	Km 336.3	336.98	36.6507	-6.5825	240,226	9,271,796	Field Survey	BCL 336.3		1.05	2		1	1								1					
152	Km 336.7	337.27	36.6484	-6.5814	239,963	9,271,915	Field Survey	BCL 336.7	C5	2.3	2		1	1								1					
153	Km 337.0	337.56	36.6464	-6.5795	239,744	9,272,123	Field Survey	BCL 337		1.4	2		1	1								1					
154	Km 337.0	337.59	36.6464	-6.5795	239,747	9,272,126	Field Survey	PCL 337	C6			1.2	2		1									1			
155	Km 338.0	338.62	36.6395	-6.5741	238,981	9,272,714	Aerial Photo																				
156	Km 338.4	338.93	36.6368	-6.5745	238,678	9,272,669	Aerial Photo																				
157	Km 338.4	338.95	36.6366	-6.5745	238,661	9,272,671	Aerial Photo																				
158	Km 338.4	338.98	36.6364	-6.5745	238,632	9,272,676	Aerial Photo																				
159	Km 338.7	339.26	36.6341	-6.5733	238,381	9,272,805	Aerial Photo																				
160	Km 338.9	339.51	36.6324	-6.5719	238,189	9,272,957	Aerial Photo																				
161	Km 339.2	339.82	36.6300	-6.5704	237,922	9,273,121	Aerial Photo																				

Re-routing No.3

Re-routing No.5

Table 10.46: Master List of Existing Culverts (3/3)

S/N	Station Km (Original System)	Station Km (New System)	Longitude	Latitude	Easting	Southing	Confirmation Method	Sheet Number (Progress Report)	Waterway Culvert No.	H (m)	W (m)	D (m)	Lane No.	Box Culvert (Field Mesurem't)	Pipe Culvert (Field Mesurem't)	Arch (Field Mesurem't)	Bridge (Field Mesurem't)	Arch Culvert (Total)	Bridge (Total)	Drop Work	D/S canal	Box Culvert (Normal)	Box Culvert (High Risk)	Pipe Culvert (Normal)	Pipe Culvert (High Risk)	Arch Culvert (Normal)	Arch Culvert (High Risk)
										Existing Status based on Flood Risk Assessment (Dec. 2014)																	
162	Km 339.6	340.17	36.6271	-6.5689	237,610	9,273,281	Aerial Photo		C7																		
163	Km 340.0	340.56	36.6241	-6.5671	237,275	9,273,479	Aerial Photo																				
164	Km 340.0	340.61	36.6238	-6.5668	237,239	9,273,514	Aerial Photo																				
165	Km 340.3	340.86	36.6225	-6.5650	237,096	9,273,718	Aerial Photo		C8																		
166	Km 340.9	341.50	36.6206	-6.5596	236,877	9,274,315	Aerial Photo																				
167	Km 341.4	341.99	36.6176	-6.5563	236,548	9,274,672	Aerial Photo																				
168	Km 341.5	342.08	36.6170	-6.5557	236,477	9,274,735	Aerial Photo																				
169	Km 341.8	342.37	36.6148	-6.5543	236,237	9,274,891	Aerial Photo																				
170	Km 341.9	342.50	36.6139	-6.5537	236,131	9,274,956	Aerial Photo		C9																		
171	Km 342.6	343.18	36.6096	-6.5494	235,653	9,275,437	Aerial Photo												1								
172	Km 342.8	343.39	36.6080	-6.5482	235,481	9,275,566	Aerial Photo		C10																		
173	Km 343.5	344.05	36.6031	-6.5448	234,939	9,275,939	Aerial Photo														1						
174	Km 343.7	344.29	36.6017	-6.5431	234,782	9,276,125	Aerial Photo																				
175	Km 344.8	344.80	36.5979	-6.5414	234,361	9,276,314	Field Survey	BCL 344.8				0.92	2	1								1					
176	Km 344.8B	345.08	36.5959	-6.5428	234,134	9,276,153	Field Survey	BCL 344.8B		1.25	2		1	1								1					
177	Km 345.0	345.54	36.5917	-6.5434	233,676	9,276,092	Field Survey	BCL 345.0	C11	2.2	2		1	1								1					
178	Km 345.5	346.04	36.5874	-6.5426	233,193	9,276,173	Field Survey	PCL 345.5		half	cycle	0.55	3		1									1			
179	Km 345.6A	346.14	No record	No record	No record	No record	Field Survey	PCL 345.6a				0.9	2		1									1			
180	Km 345.7A	346.24	36.5869	-6.5426	233,147	9,276,170	Field Survey	BCL 346.6a				0.9	1	1								1					
181	Km 345.8	346.29	36.5866	-6.5428	233,113	9,276,149	Aerial Photo														1						
182	Km 345.8B	346.40	36.5862	-6.5430	233,066	9,276,127	Field Survey	PCL 345.6b	C12			0.92	3		1									1			
183	Km 346.0	346.55	36.5829	-6.5434	232,702	9,276,088	Field Survey	PCL 346				0.9	1		1									1			
184	Km 346.2	346.69	36.5818	-6.5431	232,576	9,276,118	Field Survey	PCL 346.2				0.93	2		1									1			
185	Km 346.6B	347.19	36.5774	-6.5433	232,089	9,276,090	Field Survey	BCL 346.6b		1.85	4		1	1		Re-routing No.7					1	1					
186	Km 347.5	347.93	36.5704	-6.5419	231,320	9,276,244	Field Survey	BCL 347.5	C13	0.51	2.45		2	1								1					
187	Km 347.8	348.53	36.5660	-6.5405	230,833	9,276,399	Aerial Photo		C14																		
188	Km 348.0	348.76	36.5642	-6.5395	230,631	9,276,505	Field Survey	BCL 348		0.81	2		2	1								1					
189	Km 348.3	349.06	36.5642	-6.5395	230,631	9,276,505	Field Survey	PCL 348.3		half cycle		0.72	1		1									1			
190	Km 348.8	349.34	36.5600	-6.5364	230,165	9,276,841	Field Survey	BCL 348.8		1.13	2		1	1								1					
191	Km 349.4	349.88	36.5560	-6.5335	229,723	9,277,162	Field Survey	BCL 349.4	C15	0.8	1.5		2	1								1					
192	Km 349.0B	350.51	36.5514	-6.5302	229,212	9,277,528	Field Survey	PCL 349.0B				0.6	2		1										1		
193	Km 349.4B	350.91	36.5485	-6.5281	228,888	9,277,757	Field Survey	BCL 349.4B	C16	1.7	2		3	1									1				
194	Km 349.5B	350.97	36.5479	-6.5276	228,814	9,277,808	Field Survey	BCL 349.5B		0.7	2		3	1									1				
195	Km 349.6B	351.11	36.5471	-6.5271	228,728	9,277,873	Field Survey	BCL 349.6B		1.1	2		1	1							1		1				
196	Km 349.8	351.36	36.5452	-6.5257	228,524	9,278,023	Aerial Photo														1						
197	Km 349.9B	351.45	36.5446	-6.5252	228,450	9,278,074	Field Survey	BCL 349.9B		0.9	2		1	1							1		1				
198	Km 349.8B	351.48	36.5446	-6.5252	228,447	9,278,074	Field Survey	BCL 349.8B		1.7	2		1	1									1				
199	Km 350.2	351.82	36.5419	-6.5233	228,152	9,278,290	Aerial Photo																				
200	Km 350.3	351.90	36.5413	-6.5228	228,087	9,278,336	Aerial Photo													1							
201	Km 350.5	352.14	36.5395	-6.5216	227,890	9,278,478	Aerial Photo		D1											1							
202	Km 352.1	353.70	36.5273	-6.5148	226,537	9,279,221	Aerial Photo									Re-routing No.8											
203	Km 352.7	354.32	36.5221	-6.5131	225,956	9,279,409	Aerial Photo		D2																		
204	Km 352.9	354.52	No record	No record	No record	No record	Field Survey	BCL 352.9				0.9	1	1								1					
205	Km 353.6	355.25	36.5182	-6.5057	225,519	9,280,224	Aerial Photo		D3																		
206	Km 352.9B	356.36	36.5112	-6.4988	224,744	9,280,985	Field Survey	BCL 352.9B		1.6	4		1	1								1					
207	Km 354.3	356.90	36.5069	-6.4964	224,264	9,281,247	Field Survey	BCL 354.3	D4	0.55	2		1	1									1				
208	Km 355.6	357.29	36.5033	-6.4946	223,870	9,281,439	Field Survey	BCL 355.6		0.95	3		1	1									1				
209	Km 355.9	357.70	36.4999	-6.4933	223,486	9,281,577	Aerial Photo		D5																		
210	Km 356.1	357.76	36.4998	-6.4933	223,480	9,281,579	Field Survey	BCL 356.1		0.8	3		1	1									1				
211	Km 357.0	358.85	36.4905	-6.4899	222,449	9,281,949	Aerial Photo												1	1							
212	Km 357.2	359.08	36.4886	-6.4892	222,238	9,282,024	Aerial Photo												1								
213	Km 357.7	359.47	36.4849	-6.4889	221,825	9,282,058	Aerial Photo																				
214	Km 358.1	359.91	36.4813	-6.4898	221,423	9,281,959	Aerial Photo																				
215	Km 358.8	360.69	36.4751	-6.4873	220,737	9,282,234	Aerial Photo																				
216	Km 359+0.3	361.13	36.4712	-6.4880	220,313	9,282,149	Aerial Photo																				
217	Km 359+0.7	361.58	36.4673	-6.4876	219,872	9,282,189	Aerial Photo		E1																		
218	Km 359+1.4	361.91	36.4643	-6.4868	219,547	9,282,277	Aerial Photo																				
219	Km 359+2.3	362.54	36.4594	-6.4843	218,999	9,282,559	Aerial Photo																				
220	Km 359+2.8	362.78	36.4580	-6.4827	218,843	9,282,737	Aerial Photo																				
221	Km 359+3.5	363.16	36.4557	-6.4801	218,587	9,283,018	Aerial Photo		E2																		
222	Km 360.0	363.41	36.4538	-6.4789	218,373	9,283,145	Field Survey	BCL 360		1	2		1	1								1					
223	Km 360.6	363.92	36.4495	-6.4759	217,901	9,283,475	Field Survey	BCL 360.6	E3	0.62	4.95		1	1									1				
224	Km 360.9	364.35	36.4488	-6.4728	217,816	9,283,818	Field Survey	BCL 360.9		1.3	2			1								1					
225	Km 361.1	364.55	36.4479	-6.4712	217,724	9,283,998	Field Survey	BCL 361.1		0.55	2		1	1									1				
226	Km 361.9	365.11	36.4434	-6.4690	217,227	9,284,236	Field Survey	BCL 361.9		0.33	5		1	1									1				
227	Km 362.1	365.56	36.4406	-6.4662	216,908	9,284,545	Field Survey	BCL 362.1	E4	0.64	1.95		3	1									1				
228	Km 362.5	366.02	36.4384	-6.4628	216,660	9,284,925	Field Survey	PCL 362.5	E5			0.8	2		1										1		
229	Km 362.9	366.03	36.4383	-6.4626	216,657	9,284,941	Field Survey	BCL 362.9		0.66	2		1	1									1				
230	Km 363.3	366.43	No record	No record	No record	No record	Field Survey	BCL 363.3		1.3	4.65		1	1									1				
231	Km 363.7	367.07	36.4298	-6.4593	215,711	9,285,310	Field Survey	BCL 363.7		1.6	2		1	1			Re-routing No.9						1				
232	Km 364.2	367.65	36.4254	-6.4564	215,218	9,285,622	Field Survey	BCL 364.2		0.35	4.65		2	1									1				
233	Km 364.4	367.86	36.4238	-6.4554	215,043	9,285,737	Field Survey	BCL 364.4		1.24	2		1	1								1					
S/N	Station Km (Original System)		Longitude	Latitude			Confirmation Method	Sheet Number (Progress Report)	Waterway Culvert No.	H (m)	W (m)		Lane No.	Box Culvert (Field Mesurem't)	Pipe Culvert (Field Mesurem't)	Arch (Field Mesurem't)	Bridge (Field Mesurem't)	Arch Culvert (Total)	Bridge (Total)	Drop Work	D/S canal	Box Culvert (Normal)	Box Culvert (High Risk)	Pipe Culvert (Normal)	Pipe Culvert (High Risk)	Arch Culvert (Normal)	Arch Culvert (High Risk)

Source: JICA Study Team

(3) Hydraulic Design of Proposed Box Culverts

1) Standard types of box culvert
As discussed in Chapter 6, two standard types of box culvert (square), namely (i) 2.0 m (H) x 2.0 m (W), and (ii) 3.0 m (H) x 3.0 m (W) for opening dimensions, are recommended to apply considering the required flow capacity and existing culverts at the field. Theoretical numbers (barrels) to meet the design flood discharge (30-year return period) for the two types were examined. Pipe culvert was discarded, since many of them had been confirmed clogged and lost drainage function through the Flood Risk Assessment in December 2014 by the JICA Study Team and RAHCO staff. Further, in order to fit the formation of new track alignment, two more sizes, of 1.0 m (H) x 1.0 m (W) and 1.5 m (H) x 1.5 m (W), are to be applied for preliminary design.

2) Design discharge
In order to examine the design discharges corresponding to the size of drainage areas, the relationship between the discharges at waterway culverts versus drainage areas, which were identified at 56 sites on aerial photos (from Kilosa to Gulwe) as presented in Interim Report. The design discharges were determined by TRRL method as tabulated in Table 10.47 (30 year return period). The results are plotted in Figure 10.47 showing regression curves in the lower range and larger range of drainage areas derived from two kinds of sample groups in order to find better appropriateness.

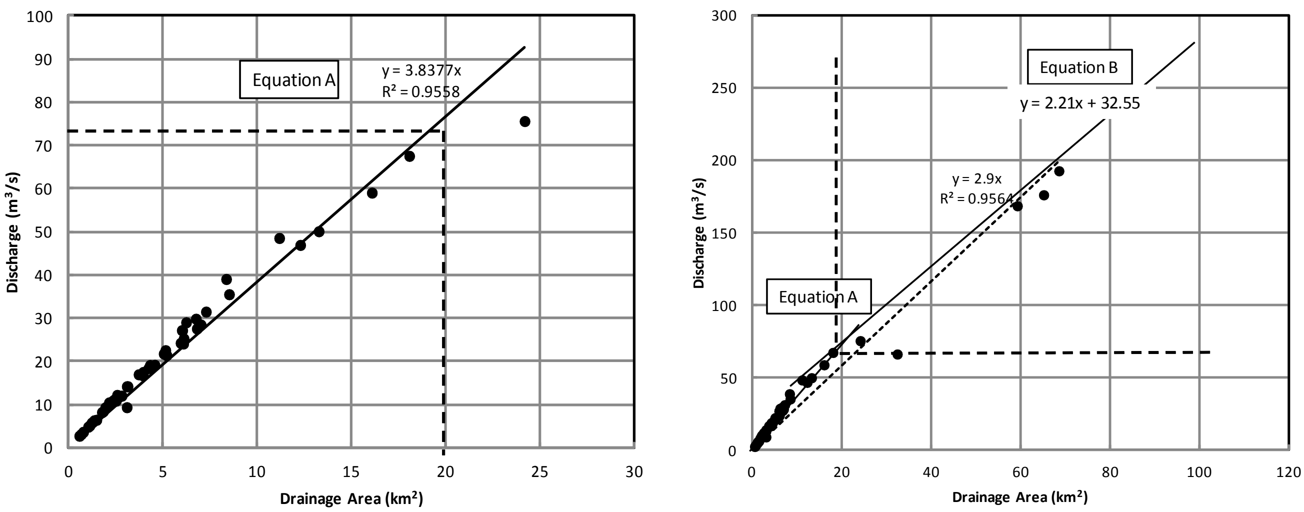
Table 10.47: Area-Discharge Data at Waterways*

No.	Code No.	A ＞ 20 (Equation B)		No.	Code No.	A ＞ 20 (Equation B)	
		Area (km^2)	Discharge (m^3/s)			Area (km^2)	Discharge (m^3/s)
1	A-1	1.94	9.37	30	C-3	6.07	24.14
2	A-2	0.66	3.17	31	C-4	3.95	17.55
3	A-3	16.07	59.07	32	C-5	2.42	11.16
4	A-4	0.77	3.70	33	C-6	59.24	168.61
5	A-5	1.03	4.88	34	C-7	1.47	6.49
6	A-6	2.54	11.43	35	C-8	1.36	6.37
7	A-7	7.28	31.52	36	C-9	13.25	50.13
8	B-1	5.19	21.45	37	C-10	4.30	18.99
9	B-2	0.57	2.79	38	C-11	2.81	12.07
10	B-3	5.13	22.58	39	C-12	12.27	46.97
11	B-4	6.23	29.05	40	C-13	5.94	24.30
12	B-5	11.16	48.58	41	C-14	7.00	28.53
13	B-6	3.08	9.40	42	C-15	2.50	10.89
14	B-7	18.05	67.59	43	C-16	1.30	6.11
15	B-8	2.57	12.23	44	D-1	6.80	27.61
16	B-9	68.54	192.71	45	D-2	4.56	19.20
17	B-10	2.14	10.48	46	D-3	3.08	14.23
18	B-11	1.22	5.82	47	D-4	1.83	8.46
19	B-12	2.19	10.54	48	D-5	6.10	25.30
20	B-13	2.35	10.92	49	E-1	3.71	17.00
21	B-14	6.02	27.22	50	E-2	2.43	11.16
22	B-15	65.12	176.17	51	E-3	6.74	29.88
23	B-16	4.23	18.42	52	E-4	5.04	21.81
24	B-17	1.11	5.17	53	E-5	4.31	19.16
25	B-18	8.50	35.55	54	E-6	3.13	14.24
26	B-19	1.77	8.25	55	E-7	3.93	16.78
27	B-20	24.16	75.64	56	F-1	32.43	66.47
28	C-1	6.00	27.21				
29	C-2	8.35	39.09				

Equation A: 52 samples except A>30 km^2
Equation B: 56 samples

Note: *, These 56 sites were identified and analyzed in the stage of the Interim Report.
Source: JICA Study Team

Samples except of A > 20 km^2 (52 samples) All samples (56 numbers)

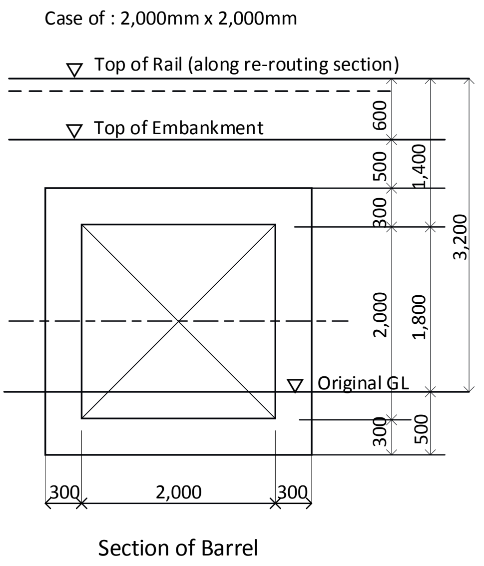


Source: JICA Study Team

Figure 10.47: Discharge–Drainage Area Curve for Culvert Design

3) Appropriate size of culverts

In parallel with selection of appropriate opening sizes of new culverts accommodating the estimated design discharges of new culverts, minimum embankment height from the ground level depending on the opening sizes were examined to safely distribute the weight of the carriage to the ground, as illustrated in Figure 10.48:



Note:

Opening height	Required minimum height of embankment above ground level
2,000:	2,000+1,400-(500-300)=3,200
1,000:	1,000+1,200 = 2,200
1,500:	1,500+1,200 = 2,700
3,000:	3,000+1,200 = 4,200

Unit: mm

Source: JICA Study Team

Figure 10.48: Minimum Height of Embankment for New Culverts

Using the regression equations as presented in the previous clause, the design discharges of the 65 sites of new culverts were estimated. Based on the results, the required size/numbers of barrels at designated 65 sites are tabulated in Table 10.48 together with the information of the embankment height, which is calculated from rail top elevation and existing ground elevation, as well.

Table 10.48: Appropriate Size of New Box Culverts (Rererouting Sections)

No.		Drainage Area (km2)	Q (m3/s)	Ground Elevation (rail center) (EL.m)	Rail Top Elevation (EL.m)	Height of Embankm't H (m)	Flow Capacity				Required Number of Barrel				Site condition
							1.0m* 1.0m	1.5m* 1.5m	2.0m* 2.0m	3.0m* 3.0m	1.0m* 1.0m	1.5m* 1.5m	2.0m* 2.0m	3.0m* 3.0m	
Minimum height of embankment (m) ⇒							2.2	2.7	3.2	4.2	-	-	-	-	
1	R1-1	0.15	0.58	518.84	520.98	2.14	0.6	2.1	4.3	13.1	1	1	1	1	○
2	R1-2	0.23	0.89	520.19	521.82	1.63	0.6	2.1	4.3	13.1	2	1	1	1	○
3	R1-3	0.17	0.64	522.00	524.34	2.34	0.6	2.1	4.3	13.1	2	1	1	1	◎
4	R1-4	0.14	0.55	522.30	526.50	4.20	0.6	2.1	4.3	13.1	1	1	1	1	◎
5	R1-5	0.21	0.79	523.71	528.08	4.37	0.6	2.1	4.3	13.1	2	1	1	1	◎
6	R1-6	4.00	15.37	523.44	526.73	3.29	0.6	2.1	4.3	13.1	26	8	4	2	◎
7	R2-1	0.26	1.0	552.56	554.77	2.21	0.6	2.1	4.3	13.1	2	1	1	1	◎
8	R2-2	0.23	0.9	555.58	557.50	1.92	0.6	2.1	4.3	13.1	2	1	1	1	○
9	R2-3	0.26	1.0	553.88	557.18	3.30	0.6	2.1	4.3	13.1	2	1	1	1	◎
10	R2-4	2.74	10.5	553.59	560.98	7.39	0.6	2.1	4.3	13.1	18	6	3	1	◎
11	R2-5	0.06	0.2	559.63	563.25	3.62	0.6	2.1	4.3	13.1	1	1	1	1	◎
12	R2-6	0.09	0.4	559.35	562.57	3.22	0.6	2.1	4.3	13.1	1	1	1	1	◎
-	R2-7	16.06	61.6	560.20	564.72	4.52	0.6	2.1	4.3	13.1	-	-	-	-	New bridge
13	R2-8	0.10	0.4	561.05	568.34	7.29	0.6	2.1	4.3	13.1	1	1	1	1	◎
14	R2-9	1.43	5.5	565.04	571.94	6.90	0.6	2.1	4.3	13.1	10	3	2	1	◎
15	R2-10	0.32	1.2	565.22	571.70	6.48	0.6	2.1	4.3	13.1	3	1	1	1	◎
16	R2-11	0.09	0.3	570.76	573.02	2.26	0.6	2.1	4.3	13.1	1	1	1	1	◎
-	R2-12	45.75	175.6	569.99	573.01	3.02	0.6	2.1	4.3	13.1	-	-	-	-	New bridge
17	R2-13	0.11	0.4	572.14	574.37	2.23	0.6	2.1	4.3	13.1	1	1	1	1	◎
18	R2-14	0.21	0.8	571.61	575.65	4.04	0.6	2.1	4.3	13.1	2	1	1	1	◎
19	R2-15	0.02	0.1	572.29	576.05	3.76	0.6	2.1	4.3	13.1	1	1	1	1	◎
20	R2-16	0.20	0.8	574.83	576.18	1.35	0.6	2.1	4.3	13.1	2	1	1	1	○
21	R2-17	0.41	1.6	576.38	575.34	-1.04	0.6	2.1	4.3	13.1	3	1	1	1	△
22	R3-1	2.15	8.3	603.68	603.87	0.19	0.6	2.1	4.3	13.1	14	4	2	1	△
23	R3-2	3.34	12.8	602.12	609.87	7.75	0.6	2.1	4.3	13.1	22	7	3	1	◎
24	R3-3	0.42	1.6	602.89	611.67	8.78	0.6	2.1	4.3	13.1	3	1	1	1	◎
25	R3-4	0.21	0.8	614.73	614.47	-0.26	0.6	2.1	4.3	13.1	2	1	1	1	△
26	R3-5	0.10	0.4	610.92	617.07	6.15	0.6	2.1	4.3	13.1	1	1	1	1	◎
27	R3-6	0.13	0.5	611.13	617.03	5.90	0.6	2.1	4.3	13.1	1	1	1	1	◎
28	R3-7	101.07	255.9	614.43	614.36	-0.07	0.6	2.1	4.3	13.1	427	122	60	20	△
29	R5-1	0.16	0.6	694.32	696.95	2.63	0.6	2.1	4.3	13.1	1	1	1	1	◎
30	R5-2	21.22	79.4	701.79	702.15	0.36	0.6	2.1	4.3	13.1	133	38	19	7	△
31	R5-3	39.40	119.6	704.22	705.48	1.26	0.6	2.1	4.3	13.1	200	57	28	10	○
32	R5-4	0.07	0.3	701.54	703.80	2.26	0.6	2.1	4.3	13.1	1	1	1	1	◎
33	R7-1	2.74	10.5	733.65	734.36	0.71	0.6	2.1	4.3	13.1	18	6	3	1	△
34	R7-2	13.92	53.4	739.21	742.36	3.15	0.6	2.1	4.3	13.1	90	26	13	5	○
35	R7-3	8.66	33.2	736.17	736.27	0.10	0.6	2.1	4.3	13.1	56	16	8	3	△
36	R8-1	0.15	0.6	750.93	753.63	2.70	0.6	2.1	4.3	13.1	1	1	1	1	◎
37	R8-2	0.03	0.1	754.41	756.83	2.42	0.6	2.1	4.3	13.1	1	1	1	1	◎
38	R8-3	1.08	4.1	755.06	757.99	2.93	0.6	2.1	4.3	13.1	7	2	1	1	◎
39	R8-4	0.12	0.5	756.86	758.91	2.05	0.6	2.1	4.3	13.1	1	1	1	1	○
40	R8-5	0.38	1.5	754.29	756.48	2.19	0.6	2.1	4.3	13.1	3	1	1	1	○
41	R9-1	0.11	0.4	770.88	773.15	2.26	0.6	2.1	4.3	13.1	1	1	1	1	◎
42	R9-2	0.09	0.3	771.59	775.15	3.56	0.6	2.1	4.3	13.1	1	1	1	1	◎
43	R9-3	0.09	0.3	774.55	776.75	2.20	0.6	2.1	4.3	13.1	1	1	1	1	◎
44	R9-4	1.61	6.2	775.48	778.95	3.47	0.6	2.1	4.3	13.1	11	3	2	1	◎
45	R9-5	0.33	1.3	776.37	779.55	3.18	0.6	2.1	4.3	13.1	3	1	1	1	◎
46	R9-6	0.81	3.1	776.54	781.49	4.95	0.6	2.1	4.3	13.1	6	2	1	1	◎
47	R9-7	4.26	16.4	776.54	780.53	3.99	0.6	2.1	4.3	13.1	28	8	4	2	◎
48	R9-8	1.00	3.8	775.51	780.97	5.46	0.6	2.1	4.3	13.1	7	2	1	1	◎
49	R9-9	4.31	16.5	779.64	782.41	2.77	0.6	2.1	4.3	13.1	28	8	4	2	◎
50	R9-10	0.52	2.0	775.13	782.03	6.90	0.6	2.1	4.3	13.1	4	1	1	1	◎
51	R9-11	0.72	2.8	777.18	782.92	5.74	0.6	2.1	4.3	13.1	5	2	1	1	◎
52	R9-12	3.39	13.0	783.39	786.01	2.62	0.6	2.1	4.3	13.1	22	7	4	1	○
53	R9-13	0.24	0.9	781.29	786.41	5.12	0.6	2.1	4.3	13.1	2	1	1	1	◎
54	R9-14	0.07	0.3	788.28	791.48	3.20	0.6	2.1	4.3	13.1	1	1	1	1	◎
55	R9-15	0.33	1.3	788.67	793.71	5.04	0.6	2.1	4.3	13.1	3	1	1	1	◎
56	R9-16	0.06	0.2	789.22	790.58	1.36	0.6	2.1	4.3	13.1	1	1	1	1	○
57	R9-17	2.75	10.6	782.26	786.68	4.42	0.6	2.1	4.3	13.1	18	6	3	1	◎
58	R9-18	0.22	0.9	784.32	789.18	4.86	0.6	2.1	4.3	13.1	2	1	1	1	◎
59	R9-19	5.05	19.4	784.63	790.07	5.44	0.6	2.1	4.3	13.1	33	10	5	2	◎
60	R9-20	0.22	0.9	786.75	790.07	3.32	0.6	2.1	4.3	13.1	2	1	1	1	◎
61	R9-21	0.19	0.7	785.33	789.76	4.43	0.6	2.1	4.3	13.1	2	1	1	1	◎
62	R9-22	0.46	1.8	784.70	786.68	1.98	0.6	2.1	4.3	13.1	3	1	1	1	○
63	R9-23	0.98	3.8	783.28	786.68	3.40	0.6	2.1	4.3	13.1	7	2	1	1	◎
64	R9-24	1.45	5.6	784.62	786.68	2.06	0.6	2.1	4.3	13.1	10	3	2	1	○
65	R9-25	2.67	10.2	782.69	786.65	3.95	0.6	2.1	4.3	13.1	18	5	3	1	◎
									Nos of barrel		39	33	43	43	158
									Nos of site		28	17	12	8	65

Remarks:
◎ : Able to be fit in embankment
○ : Required minor adjustment of embankment H> 1.0m
△ : Need further arrangement of embankment H < 1.0m

: Recommended size and numbers of barrel

Source:JICA Study Team

(4) Premise of Preliminary Design for Railway Structure

As described in the above hydraulic design for the preliminary design, types of box culvert are classified as shown in Table 10.49.

Table 10.49: Types of Box Culvert

No.	Inner space	
	Height (m)	Width (m)
1	1.0	1.0
2	1.5	1.5
3	2.0	2.0
4	3.0	3.0

Source: JICA Study Team

(5) Basic Calculation of Box Culvert for Railway Structure

In the preliminary design, some basic calculations of floor slab and side wall are carried out as shown in Table 10.50 and Table 10.51, and Table 10.52 shows the results.

Table 10.50: Setting of Basic Calculation for Box Culvert

Embankment height (m)	9.0
Types of Box culvert	No.3 & No.4
Axial load (tons)	18.5

Source: JICA Study Team

Table 10.51: Contents of Basic Calculation for Box Culvert

Required performance	Performance items		Combinations of actions
Safety	Safety for floor slab		$1.1*D+1.0*E_{Dv}+0.6*E_{Dh}+1.1*G_L$
	Safety for side wall		$1.1*D+1.1*E_{Dv}+1.1*E_{Dh}+1.1*G_L$
Serviceability	Long-term		$1.0*D+1.0*E_{Dv}+1.0*E_{Dh}$
	Short-term	for floor slab	$1.0*D+1.0*E_{Dv}+0.7*E_{Dh}+1.0*G_L$
		for side wall	$1.0*D+1.0*E_{Dv}+1.0*E_{Dh}+1.0*G_L$

Note: D: Dead load of box culvert, E_{Dv}: Vertical earth pressure as a permanent load (Embankment body, track and ballast), E_{Dh}: Horizontal earth pressure as a permanent load (Embankment body, track and ballast), G_L: Earth pressure as a variable load (Train load)
Source: JICA Study Team

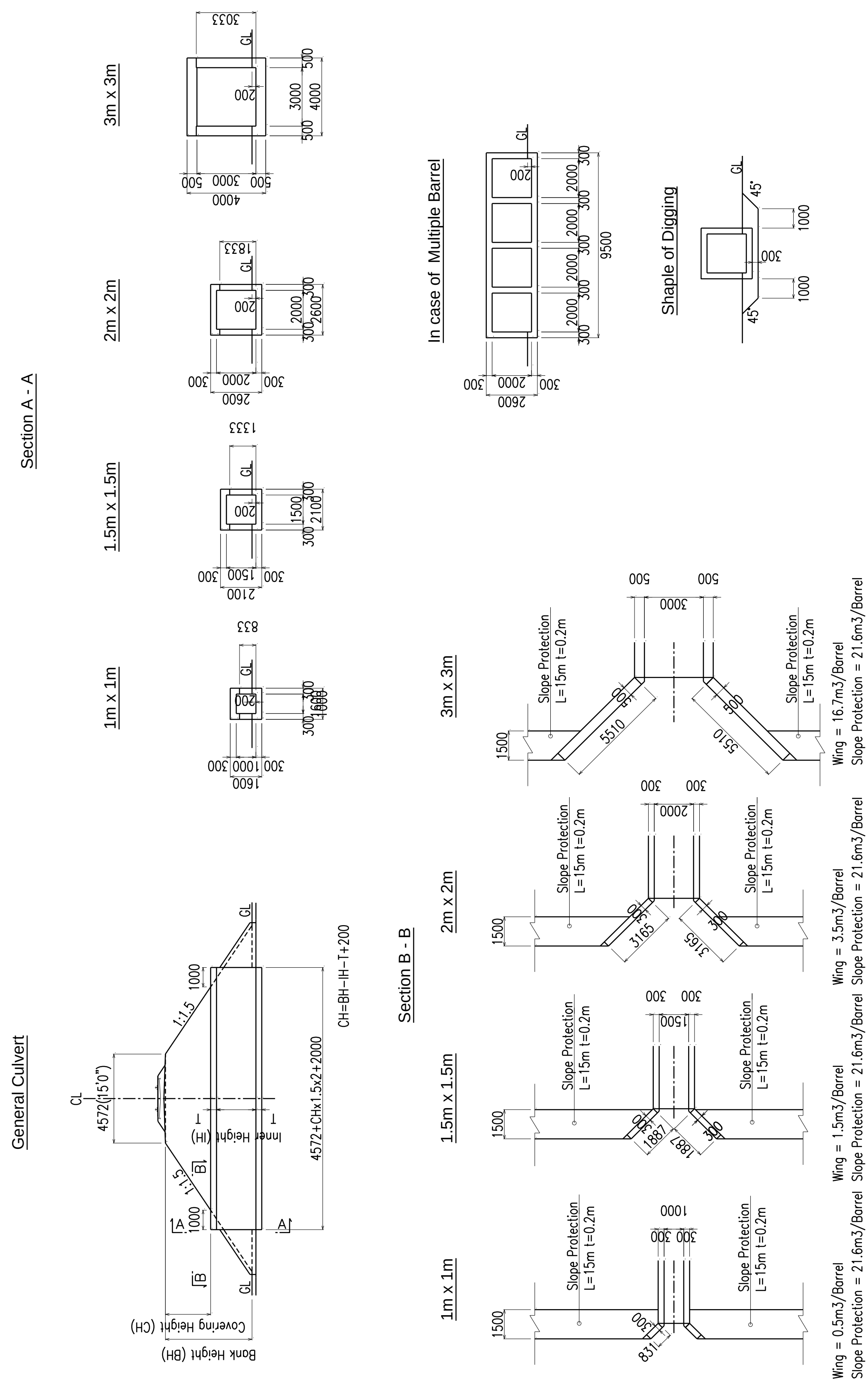
Table 10.52: Results of Basic Calculation for Box Culvert

Types of Box culvert		Member	Thickness (mm)	Main rebar arrangement
No. 3	2.0 m (H) x 2.0 m (W)	Floor slab	300	8 x D19 per m
		Side wall	300	8 x D19 per m
No. 4	3.0 m (H) x 3.0 m (W)	Floor slab	500	8 x D19 per m
		Side wall	500	8 x D19 per m

Source: JICA Study Team

(6) Preliminary Design Drawing

The preliminary design drawing of box culvert is shown as Figure 10.49.



Source: JICA Study Team

Figure 10.49: Preliminary Design Drawing of Box Culvert

10.1.8 New Gulwe Station

New Gulwe Station shall have two sidings carrying forward from the existing Gulwe Station configuration. The sidings shall have an effective length of 450 m. Trap points shall be provided at siding exits to the main line. Although the existing station does not have a platform, the relocated station shall have a platform (5.0 m width) for passenger embarkation and disembarkation (see Appendix Y).

The station building shall be an approximately 600 m^2 single-story structure. A station service room required for station operations, waiting room, ticket counter, and other facilities shall be provided for the station building. The quantity of the Gulwe Station is shown in Table 10.53.

Table 10.53: Quantity of Gulwe Station

Work Items	Quantity	Unit
Station office building	150	m^2
Station equipment building	225	m^2
Station staff rest building	150	m^2
Strage building	180	m^2
Wash building	64	m^2
Paved concourse	225	m^2
Paved station plaza	1,000	m^2
Platform	1,000	m^2
Generator base	1	LS
Water tank base and tower	1	LS
Generator	1	LS
Water tanks	1	LS
Relocation of the existing facilities	1	LS

Source: JICA Study Team

10.1.9 Riverbank Protection for Mainstream

(1) Basic Approach

Based on the concept design prepared in the Interim Report, the objective area and design criteria for the preliminary design for flood protection and sediment management measures are established.

Countermeasures for flood protection and sediment management are proposed in three locations, i.e., along the mainstream, and along the tributaries of Maswala and Mzase Rivers. In this sub-section, preliminary design of riverbank protection for the mainstream is described, and in the subsequent Sub-section 10.1.10, the preliminary design for the tributaries are described.

The accuracy of the design is a preliminarily level, which can be used for evaluation of the adequacy of the Yen Loan Project.

At first, preliminary design adopting the conventional construction methodology and item which have been used in the project sites is prepared as the basis of the design works. Secondary, application of imported technologies will be studied comparing with the conventional ones from the view point of possibility of reduction of construction cost and shortening of construction schedule. The study of imported technology is described in Section 10.4.

(2) Objective Area

The objective areas of riverbank protection works along the mainstream, which was initially proposed at 15 sections of 14.3 km in total in the Interim Report, are shown in Table 10.54.

Table 10.54: Proposed Sections for Bank Protection Works in Interim Report

No.	Section	Distance (km)	Note
1	297.40 – 298.15	0.75	
2	298.50 – 299.00	0.50	
3	300.20 – 300.45	0.25	
4	302.70 – 303.00	0.30	
5	303.10 – 303.45	0.35	
6	304.10 – 304.50	0.40	
7	306.00 – 306.50	0.50	
8	308.60 – 310.10	1.50	
9	310.20 – 314.30	4.10	
10	315.20 – 316.90	1.70	SSP for L=900 m between Km315.2-316.2
11	330.10 – 330.60	0.50	
12	339.70 – 340.20	0.50	
13	341.60 – 342.80	1.20	
14	343.20 – 344.70	1.50	
15	345.00 – 345.25	0.25	

Source: JICA Study Team

(3) Design Criteria

As of yet, the methodology of plan formulation of the river structure is not established, and the design criteria of, and guidelines for, these structures are thus not yet available. On the other hand, design criteria for the railway structures were recently proposed in a report prepared under the railway sector in March 2014.

In addition, Japanese design criteria and guidelines for the related structures are compared and studied for their potential to be adopted, considering the site conditions and purpose of the railway project. The proposed design criteria in the Study can be used for similar projects in the future.

1) Design Criteria and Guidelines for the Related Structures

<u>Design Standard in Tanzania</u>

- OVERSEAS ROAD NOTE 9, A Design Manual for Small Bridge”, International Division, Transport Research Laboratory
- Relative reports :Consultancy Services in Relation to Design and Supervision of Bridge at KM349/350 AND Associated Works between Godegode and Gulwe Stations on the Central Railway Line, Gauf(2014)

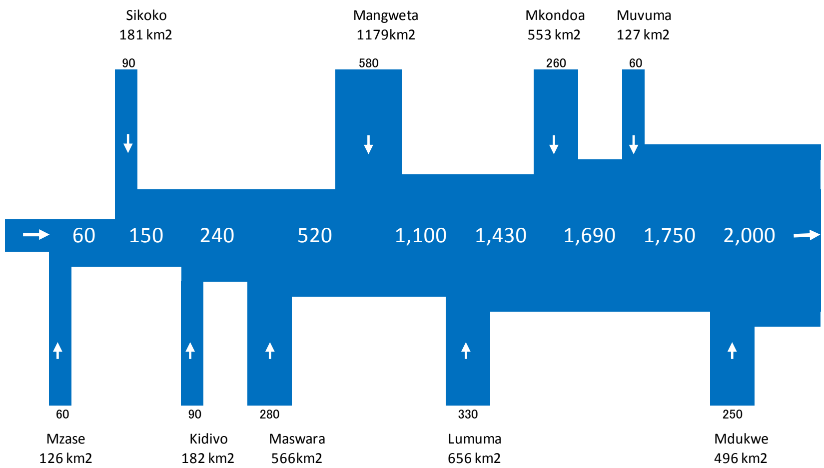
<u>Design Standard in Japan</u>

- Government Ordinance for Structural Standard for River Administration Facilities,
- Technical Criteria for River Works: Practical Guide for Planning and Designing, The Japanese Ministry of Land, Infrastructure, Transport and Tourism
- Design Method of Riverbank Protection Work
- Guideline for Structural Design of Groundsill, Japan Institute of Country-ology and Engineering (1998)

2) Design Criteria for Flood Protection Measures

i) Design Discharge

As mentioned in Chapter 6, design discharge is estimated based on the flood marks along the mainstream. Design discharge distribution is presented in Figure 10.50 below.



Note: Catchment areas include the remaining catchments between tributaries.
Source: JICA Study Team

Figure 10.50: Distribution of Design Flood Discharge between Kilosa and Gulwe

As for the design discharge for planning of river training works in the Maswala and Mzase Rivers, flood discharge with sediment concentration of 10% is applied, referring to the standard used in Japan.

ii) Safety Level against Flood

Target safety level against flood applied for the structural design is equivalent scale of the experienced maximum flood level between Kilosa and Gulwe. It is preliminary assessed with an approximately 30-year flood level based on the hydrological analysis.

For the design of structures in the tributaries where river training works will be implemented, the same safety level as the mainstream is applied, since the railway and bridge across the river training works need to be protected from floods of the same level.

iii) Design Water Level

Water surface profile in the objective stretch between Kilodsa and Gulwe is computed employing a non-uniform flow analysis model generated by the U.S. Army Corps of Engineers (HEC-RAS).

In the hydraulic analysis for the tributaries, the flood water level of mainstream at the confluence is adopted as a boundary condition in the downstream end, such that the backwater effect from the mainstream to the tributary can be considered.

Roughness parameter of Manning’s n is applied as 0.033 for the low water channel and 0.060 for the high water channel.

iv) Design Criteria for Dike

a) Material of dike

Basically, the material of dike is uniform throughout, using suitable earth materials considering stability of dike and easiness for repair.

b) Freeboard

Freeboard of dike subject to magnitude of design flood discharge shall use the design standard in Tanzania, which are currently applied by TANROADS, as shown in Table 10.55 below. The Tanzanian standard of freeboard is stricter than that of Japan, as shown in Table 10.56, from the view point of the corresponding magnitude of discharge.

Table 10.55: Freeboard of Vertical Clearance for Bridges

Discharge (m^3/s)	Minimum Vertical Clearance (m)
< 0.3	0.15 m
0.3 < to 3.0	0.45 m
3.0 to 30.0	0.60 m
30 to 300	0.90 m
> 300	1.20 m

Source: TANROADS[3]

Table 10.56: Design Criteria for Freeboard and Crest Width in Japan

Discharge (m^3/s)	Minimum Freeboard (m)	Minimum Crest Width (m)
<200	0.6	3
200 to 500	0.8	3
500 to 2,000	1.0	4
2,000 to 5,000	1.2	5
5,000 to 10,000	1.5	6
>10,000	2.0	7

Source: Government Ordinance for Structural Standard for River Administration Facilities in Japan

In addition to the above, taking into account the water level rising due to sediment depositions on the riverbed in the object river channel, the freeboard for structures is applied to the Study as per Table 10.57.

Table 10.57: Freeboard for Structures Applied to the Study

Item	Segment 1 Upstream of Lumuma Confluence Km 283 – 318	Segment 2 Downstream of Lumuma Confluence Km 318 – 366
(1) Freeboard subject to Design Discharge (Design Standard of Tanzania, via TANROADS)	1.2 m (Q=1,690–2,000 m^3/s)	1.2 m (Q=60–1,690 m^3/s)
(2) Estimated rising of water level due to sediment deposition	1.1 m	1.5 m
Total Freeboard	**2.3 m**	**2.7 m**

Source: TANROADS for (1) and JICA Study Team for (2)

For flood protection works in tributaries in the Maswala and Mzase Rivers, freeboard of dike is applied based on the design standard in Tanzania. In addition, extra freeboard is applied at

[3] Source: "OVERSEAS ROAD NOTE 9, A Design Manual for Small Bridge", International Division, Transport Research Laboratory

bridge sections since floating wood (trees, branches, etc.) has been observed in these rivers during flood events, as shown in Figure 10.51.

Table 10.58: Freeboard for Structures in Tributaries

Item	Maswala River	Mzase River
(1) Freeboard of River Training Works	1.2 m ($Q=308\ m^3/s$)	0.9 m ($Q=66\ m^3/s$)
(2) Freeboard at bridge section	2.0 m	2.0 m

Source: TANROADS for (1) and JICA Study Team for (2)

Source: Above photo is extracted from a video taken by TRL in March 2014.

Figure 10.51: Photo of Floating Woods during Flood in Mzase River

c) Crest width

The crest width of dike shall be designed referring to the design standards used in Japan, as presented in Table 10.55 above. Considering the accuracy of basic data for estimation on the design discharge, and usage of passageway for maintenance vehicles on the dike, the crest width is basically set as equal to the width of the passage plus 1.0 m.

Table 10.59: Crest Width of Dike

Item	Mainstream Kilosa - Maswala Km 283–349	Mainstream Maswala - Gulwe Km 349–366	Tributary
Minimum Crest Width	5.0 m	4.0 m	4.0 m

Source: JICA Study Team

d) Side slope of dike

Side slope of dikes shall be designed gentler than 1v:2.0h, referring to the design standard in Japan. For the dikes along mainstream, the design side slope is 1v:3.0h, considering the stability of dike. For the dikes in the river training works in tributary, the slope is 1v:2.0h, because height of dike is lower than that in mainstream, around 2.0 m.

e) Required seepage length

The width of the dike body shall be designed to secure required safety against piping. The safety level for seepage is assessed by adopting the following formula referring to Creep Ratio of bed materials, as shown in Table 10.60:

Formula

$C : (L1+L2/3+\Sigma Lh)/\triangle h$

where; C: Creep Ratio

L1: Length of bottom of dike (m)

L2: Length of contact surface between dike and structures (m)

Σ Lh: seepage length in vertical direction (m)

$\triangle$h: water head (m)

Table 10.60: Creep Ratio of Bed Materials

Bed Materials	Creep Ratio
Silt	8.5
Fine sand	7.0
Medium coarse sand	6.0
Coarse sand	5.0
Fine gravel	4.0
Medium coarse gravel	3.5
Gravel with cobble	3.0
Cobble and gravel	2.5

Source: Guideline for Structural Design of Groundsill

v) Design Criteria for Groundsill

Design criteria for groundsill and check dam are adopted from the Japanese design criteria, "Guideline for Structural Design of Groundsill, Japan Institute of Country-ology and Engineering (1998)".

(4) Basic Conditions for Preliminary Design of Flood Control Measures

The basic conditions and considerations adopted for the design of the flood protection works are described below:

1) Hydraulic Condition

Basic hydraulic conditions obtained in the course of the Study are listed below:

Table 10.61: Hydraulic Conditions of Proposed Bank Protection Works

Item	Source	Compiled Document
1. Flood mark	Floor mark survey (2015) by JICA Study Team	Appendix 7 in IT/R
2. Flood damage and existing river and culvert conditions	rapid flood risk assessment (December 2014) by JICA Study Team	Recommendation on Urgent Protection Measures for Incoming Rainy Season 2015 (Results of Flood Risk Assessment)
3. Hydraulic parameter of water surface profile and velocity	hydraulic analysis adopting the cross section survey (2015) by JICA Study Team	Chapter 3 in IT/R
4. Riverbed material	riverbed material survey (2015) by JICA Study Team	Appendix 5 in IT/R
5. Riverbed variation	comparison of historical change of cross-section by JICA Study Team	Chapter 6 in IT/R

Source: JICA Study Team

2) Topographic Condition

Basic topographic conditions for the preliminary design are as below:

- Existing topographic map (S=1/50,000; created before 1977).
- New topographic map covering the area of 2 km wide along the existing railway from Kilosa to Dodoma (S=1/2,500) by LiDAR in the Study (January 2015).
- River profile and cross-sections from Kilosa to Gulwe in the Study.

Datum of the river profile and cross-section survey use National Bench Marks placed along or in the vicinity of the existing railway under Survey and Mapping in the Ministry of Lands, Housing and Human Settlements Development as listed Table 10.62 below:

Table 10.62: Bench Marks for River Survey

Name of Bench Mark	Elevation
A4/6	518.925 m
A4/10	536.277 m
A4/25	642.707 m
A4/28	676.571 m
A4/42	739.996 m

Source: JICA Study Team

The outlines of the river cross-section and longitudinal profile survey conducted under the Study between January and June 2015 are presented in Appendix R.

3) Geotechnical Condition

Basic geotechnical information and conditions obtained in the course of the Study are listed in Table 10.63:

Table 10.63: Geotechnical Conditions of Proposed Bank Protection Works

Item		Source	Compiled Document
1.	Geological maps	JICA Wami/Ruvu Basin Study Report 2013	Chapter 4 in IT/R
2.	Design Reports for Consultancy Services in Relation to Design and Supervision of Bridge at Km349/350 AND Associated Works between Godegode and Gulwe Stations on the Central Railway Line	Gauff (2014)	Recommendation on Urgent Protection Measures for Incoming Rainy Season 2015 (Results of Flood Risk Assessment)
3.	Geotechnical investigation in the Study	JICA Study Team (2015)	Contractor's report
4.	Additional geotechnical investigation in the Study	JICA Study Team (2016)	Contractor's report
5.	Riverbed material	JICA Study Team (2015)	Appendix 5 in IT/R

Source: JICA Study Team

The results of geotechnical investigations carried out in this Study and Gauff's previous study of the bridge at Km 349/350 are referred to for setting the design properties of foundation ground at the proposed check dam in Maswalla River as below:

- Material: Silty Sand
- C= 0 kN/m^2, φ 35°
- Bearing capacity 30 tf/m^2

(5) Preliminary Design of Riverbank Protection for Mainstream

1) Layout Plan

The 15 sections requiring the riverbank protection have been identified in the concept design in the Interim Report. Among these, the layout plan of the proposed bank protection along the Kinyasungwe/Mkondoa Rivers are prepared considering the existing river course of the low water channel, distance from riverbank to the railway track, and existence of water-hit areas based on the 1/2500 topographic map and high-resolution aerial photos taken in 2015 and the results of site reconnaissance.

The alignments of the proposed riverbank protection works are basically designed along the existing riverbank in order to directly protect the riverbank from erosion.

The layout plan is presented in Figure 10.53.

2) Cross-Sectional Plan

Crosse sectional plan of the riverbank protection is prepared based on the following conditions.

Protection height:	• Up to the level of existing dike crest/bank shoulder
Embedded depth:	• 1.0 m below the lowest river bed level. In case excavation deeper than around 2m is required to construct the foundation of the bank, sheet pile is installed as supplemental foundation structure.
Slope of bank protection:	• 1v:1.0h considering the existing bank slope and stability of slope and durability against flow velocity.
Toe protection:	• Bed protection work with 1.5 m in width is installed at the toe of the bank protection.
Shoulder protection:	• Bed protection work with 3.0 m in width is installed at the shoulder of the bank protection.
Side protection:	• Side protection of concrete wall with 0.3 m width is installed at both edges of the bank protection and every 50 m of the section.

Typical cross section of riverbank protection works for two types is presented in Figure 10.54.

Table 10.64: Bank Protection Works along Mainstream

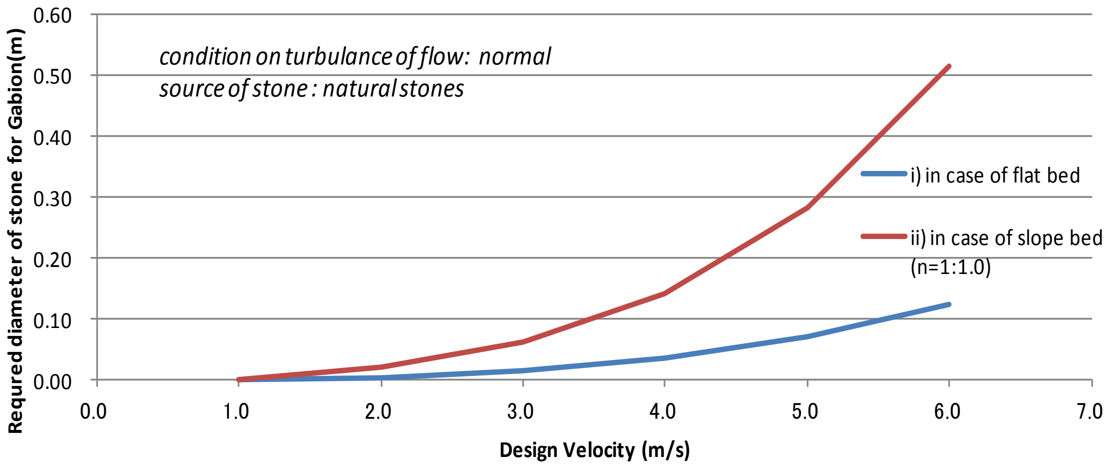
Type	Section	Slope protection	Bed protection
Type A	9,030 m, 13 sections(Section 1-1, 1-2, 2, 3, 6, 7, 8, 9-1, 11-3,12, 13, 14, 15)	Gabion	Gabion
Type B	6,080 m, 7 sections (Section 4, 5, 9-2, 10, 11-1,11-2,16)	Gabion with Steel Sheet Pile	Gabion

Source: JICA Study Team

3) Structural Design

A standard design for the riverbank protection works for the Project is adopted using gabion, which have previously been used in the project area. A comparative study on types of riverbank protection works is carried out taking into account the application of imported technologies as mentioned in Section 10.4.

Required size of stone for the gabion can be determined depending on the design velocity, referring to the relation of design velocity and stone size of gabion as shown in the figure below. To stabilize the gabion against a flow velocity of 5.0 m/s, the required diameter is estimated around 30 cm.



Source: Prepared by JICA Study Team referring to Design Method of Riverbank Protection Work in Japan

Figure 10.52: Relation of Design Velocity and Stone Size of Gabion

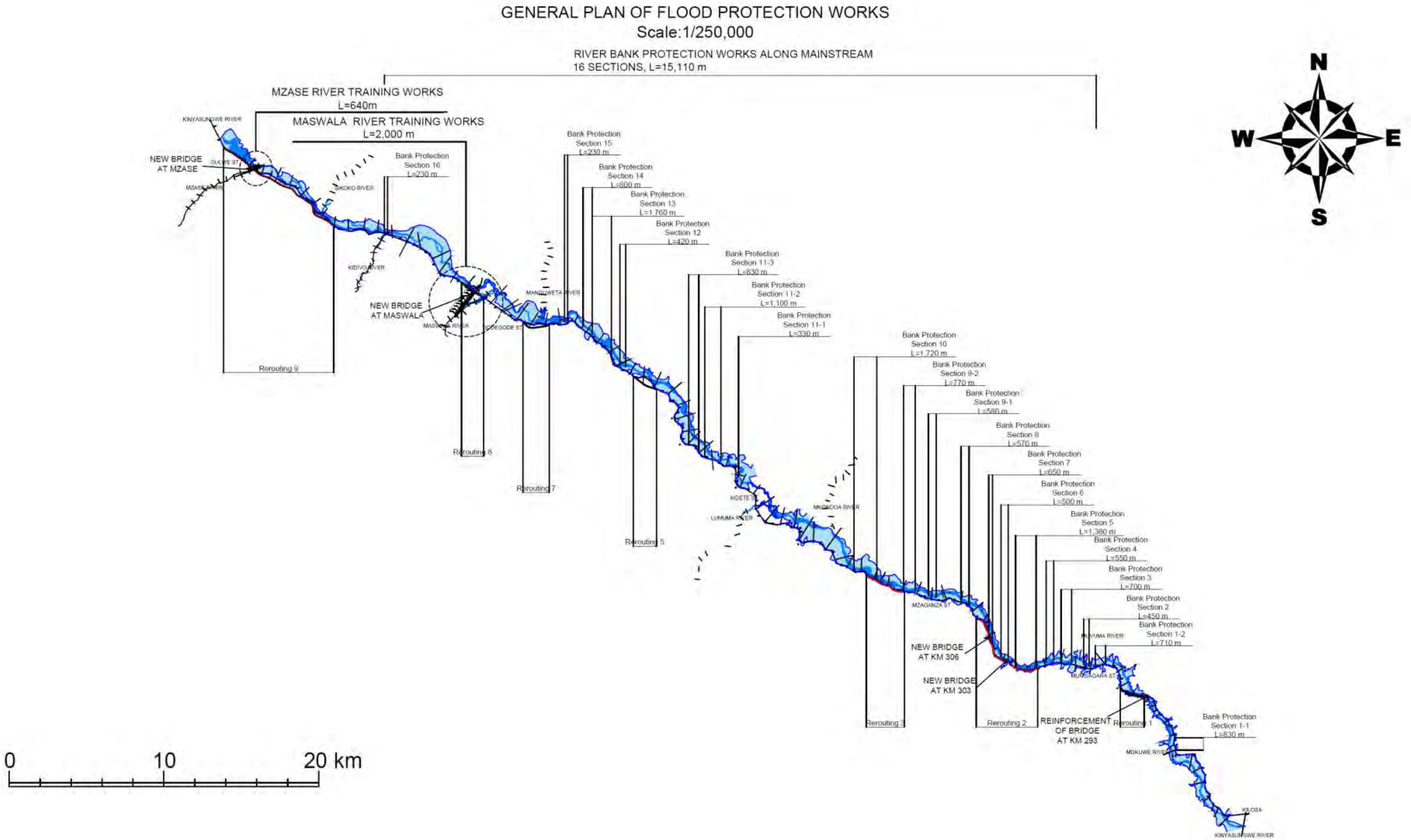


Figure 10.53: Layout Plan of Riverbank Protection Works along the Mainstream

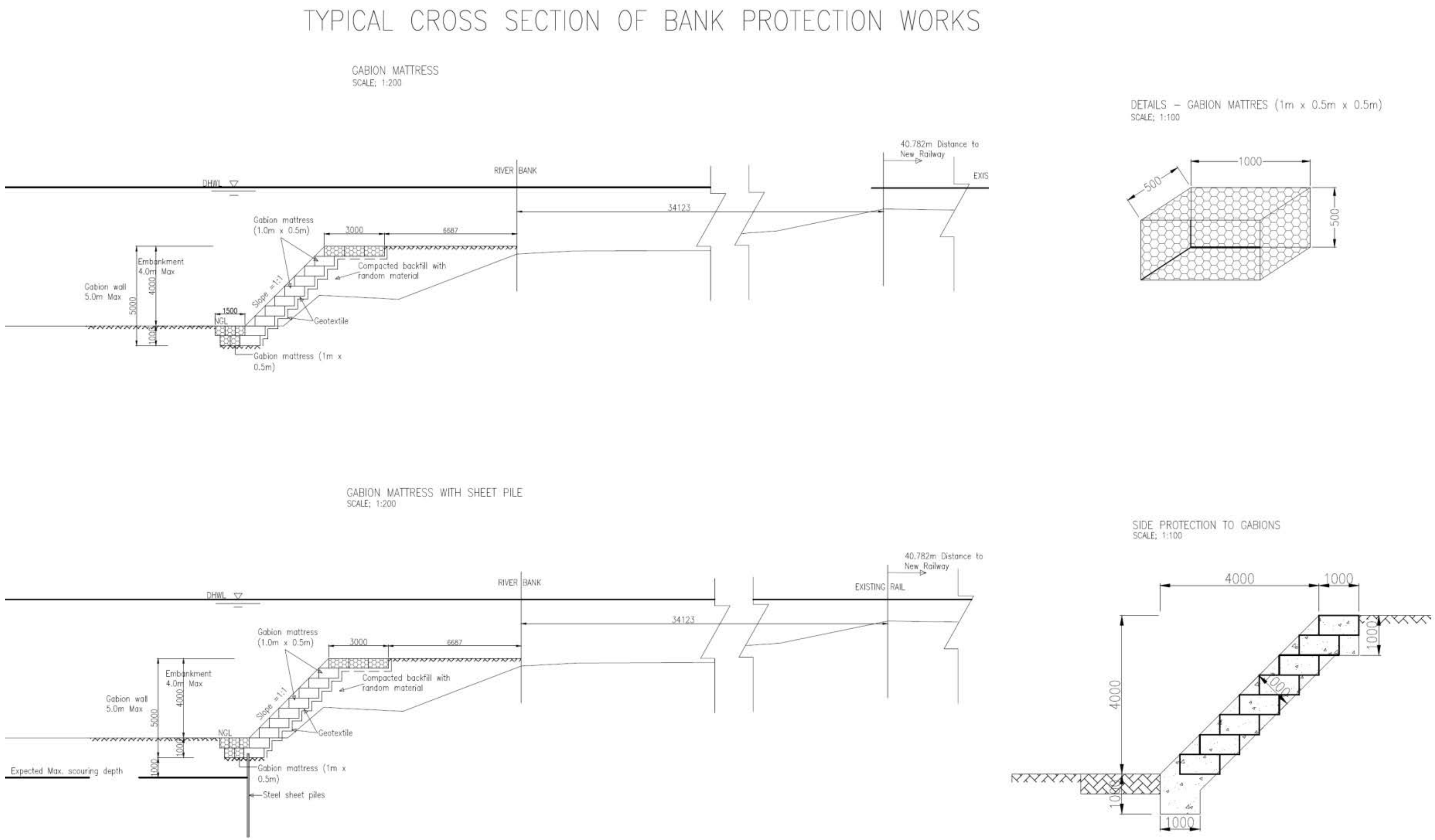


Figure 10.54: Typical Cross-Section of Riverbank Protection Works along the Mainstream

Based on the result of hydraulic analysis, the layout plan and cross-sectional plan, the basic properties of proposed riverbank protection works, such as section length, hydraulic parameters, design height, design river bed level, and design crest level, design velocity of bank protection works are summarized for each section in Table 10.65.

7) Quantity Calculation

A summary of the quantity calculation of bank protection works along the mainstream is presented in Table 10.66.

Table 10.65: Basic Properties of Proposed Bank Protection Works

No.	Item	Remarks	Section 1-1	Section 1-2	Section 2	Section 3	Section 4	Section 5	Section 6	Section 7	Section 8	Section 9-1 (IP311)	Section 9-2 (IP313)	Section 10	Section 11-1	Section 11-2	Section 11-3	Section 12	Section 13	Section 14	Section 15	Section 16
(1)	Station		Km289.38 - Km290.20	Km297.45 - Km298.11	Km298.42 - Km298.99	Km299.75 - Km300.45	Km300.88 - Km301.38	Km302.08 - Km303.48	Km304.14 - Km304.67	Km305.96 - Km306.60	Km308.96 - Km309.48	Km311.15 - Km311.71	Km312.60 - Km313.37	Km315.32 - Km317.04	Km328.29 - Km328.52	Km329.98 - Km331.03	Km331.62 - Km332.40	Km339.92 - Km340.32	Km341.43 - Km343.20	Km343.20 - Km343.88	Km344.92 - Km345.23	Km358.98 - Km358.76
(2)	Section Length (m)		830	710	450	700	550	1,380	500	650	570	580	770	1,720	330	1,100	830	420	1,760	800	230	230
(3)	Design Discharge (m3/s)	2,000 m^3/s @ Kilosa return period (approx. 30-year)	1,750 - 2,000	1,690	1,690	1,690	1,690	1,690	1,690	1,690	1,690	1,690	1,690	1,690	1,100	1,100	1,100	1,100	1,100	1,100	1,100	1,100
(4)	Design High Water Level (El.m)	Enveloped line of flood marks	504.98 - 508.20	530.93-535.56	535.56-538.63	544.83-548.32	544.83-548.32	552.09-556.48	560.81-564.90	568.99-573.03	576.85-584.51	584.51-594.32	594.32-605.22	611.23-616.25	661.92 -664.05	668.30-670.87	670.87 -673.44	699.94-701.25	704.66-708.08	714.24-720.41	726.58-730.37	760.1 1-762.88
(5)	Freeboard of Dike (m)	d/s of Kidete 2.3 m u/s of Kidete 2.7 m	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7
(6)	Riverbed Level at toe of bank (El.m)		*503.92*	*528.76*	*532.70*	*540.15*	*545.32*	*553.51*	*556.75*	*564.45*	*577.54*	*587.14*	*596.061*	*604.25*	*657.72*	*667.56*	*669.31*	*699.58*	*707.65*	*711.93*	*723.00*	*759.25*
(7)	Exiisting Bank Level (EL.m)		*505.93*	*531.21*	*535.74*	*543.56*	*547.77*	*555.62*	*560.38*	*567.06*	*579.43*	*590.35*	*598.788*	*608.02*	*661.55*	*669.39*	*671.37*	*700.84*	*708.54*	*713.92*	*724.94*	*764.94*
(8)	Existing Bank Height (EL.m)	*(8)=(7)-(6)*	*2.01*	*2.45*	*3.03*	*3.41*	*2.45*	*2.11*	*3.63*	*2.61*	*1.89*	*3.20*	*2.73*	*3.77*	*3.82*	*1.83*	*2.05*	*1.26*	*0.89*	*1.99*	*1.95*	*5.69*
(9)	Lowest Riverbed Level (EL.m)		*502.93*	*528.49*	*532.58*	*539.91*	*544.246*	*552.46*	*556.52*	*563.99*	*577.54*	*586.816*	*594.41*	*604.19*	*657.071*	*664.623*	*668.847*	*699.58*	*707.51*	*711.81*	*722.98*	*758.3*
(10)	Estimated Scouring Depth (m)	*(10)=(6)-(9)+1.0m*	*1.99*	*1.27*	*1.13*	*1.24*	*2.08*	*2.05*	*1.23*	*1.46*	*1.00*	*1.33*	*2.65*	*1.06*	*1.65*	*3.94*	*1.47*	*1.00*	*1.14*	*1.12*	*1.02*	*1.95*
(11)	Required Height of Bank Protection (m)	(11)=(8)+(10)	4.0	3.8	4.2	4.7	4.6	4.2	4.9	4.1	2.9	4.6	5.4	4.9	5.5	5.8	3.6	2.3	2.1	3.2	3.0	7.7
(12)	Design Height of Bank Protection (m)		4.0	4.0	5.0	5.0	4.0	4.0	5.0	5.0	3.0	5.0	5.0	5.0	5.0	5.0	4.0	3.0	3.0	4.0	3.0	4.0
(13)	Design Velocity (m/s)		2.7-3.6	3.3-4.1	4.1-4.2	2.2-3.9	2.2-3.9	3.7-4.5	3.6-3.7	2.9-4.0	2.7-4.0	2.5-3.7	2.6-3.5	3.4-3.5	1.7-4.7	2.0-4.1	2.0-3.9	1.5-2.5	2.1-3.0	3.2-3.7	2.5-3.2	1.1-3.2
(15)	Re-routing Section		no	no	no	no	no	re-routing 2	re-routing 2	re-routing 2	no	no	partially re-routing 3	partially re-routing 3	no	no	no	no	no	no	no	no
(16)	Type of Bank Protection Works		gabion	gabion	gabion	gabion	gabion with SSP	gabion with SSP	gabion	gabion	gabion	gabion	gabion with SSP	gabion with SSP	gabion with SSP	gabion with SSP	gabion	gabion	gabion	gabion	gabion	gabion with SSP

Source: JICA Study Team

Table 10.66: Summary of Quantity Calculation of Bank Protection Works along Mainstream

No.	Item		Section											
			Section 1-1	Section 1-2	Section 2	Section 3	Section 4	Section 5	Section 6	Section 7	Section 8	Section 9-1	Section 9-2	Section 10
	Section Length	m	830	710	450	700	550	1380	500	650	570	580	770	1720
	Average Bank Height	m	4.0	4.0	5.0	5.0	4.0	4.0	5.0	5.0	3.0	5.0	6.0	5.0
Ga1	Gabion (Main body)	m^3	4,150.0	3,550.0	2,700.0	4,200.0	2,750.0	6,900.0	3,000.0	3,900.0	2,280.0	3,480.0	4,620.0	10,320.0
Ga2	Gabion (Foot protection)	m^3	1,245.0	1,065.0	675.0	1,050.0	825.0	2,070.0	750.0	975.0	855.0	870.0	1,155.0	2,580.0
Ge1	Geotextile	m^2	8,922.5	7,632.5	5,737.5	8,925.0	5,912.5	14,835.0	6,375.0	8,287.5	4,987.5	7,395.0	9,817.5	21,930.0
Ex1	Excavation	m^3	3,494.3	2,989.1	1,327.5	2,240.0	2,486.0	6,237.6	1,685.0	3,731.0	1,590.3	3,590.2	4,096.4	8,221.6
Em1	Embankment (Backfill)	m^3	5,262.2	4,501.4	9,126.0	7,938.0	3,624.5	9,094.2	3,485.0	3,919.5	5,346.6	7,835.8	8,292.9	23,787.6
S1	Steel Sheet Pile	m^2	0.0	0.0	0.0	0.0	3,300.0	8,280.0	0.0	0.0	0.0	0.0	4,620.0	10,320.0
C1	Concrete Cap	m^3	0.0	0.0	0.0	0.0	137.5	345.0	0.0	0.0	0.0	0.0	192.5	430.0
C2	Side wall	m^3	41.0	34.2	22.8	34.2	27.4	66.1	25.1	31.9	27.4	29.6	36.5	79.8

No.	Item		Section								Quantity
			Section 11-1	Section 11-2	Section 11-3	Section 12	Section 13	Section 14	Section 15	Section 16	
	Section Length	m	330	1100	830	420	1760	800	230	230	Total
	Average Bank Height	m	5.0	5.0	4.0	3.0	3.0	4.0	3.0	4.0	15,110.0 m
Ga1	Gabion (Main body)	m^3	1,980.0	6,600.0	4,150.0	1,680.0	7,040.0	4,000.0	920.0	1,150.0	
Ga2	Gabion (Foot protection)	m^3	495.0	1,650.0	1,245.0	630.0	2,640.0	1,200.0	345.0	345.0	79,370.0 m3
Ge1	Geotextile	m^2	4,207.5	14,025.0	8,922.5	3,675.0	15,400.0	8,600.0	2,012.5	2,484.0	22,665.0 m3
Ex1	Excavation	m^3	2,062.5	6,875.0	5,187.5	1,272.6	5,508.8	2,544.0	726.8	726.8	170,084.0 m2
Em1	Embankment (Backfill)	m^3	1,943.7	6,479.0	4,888.7	2,339.4	11,017.6	3,032.0	724.5	871.7	66,593.0 m3
S1	Steel Sheet Pile	m^2	1,980.0	6,600.0	0.0	0.0	0.0	0.0	0.0	1,380.0	123,510.3 m3
C1	Concrete Cap	m^3	82.5	275.0	0.0	0.0	0.0	0.0	0.0	57.5	36,480.0 m2
C2	Side wall	m^3	18.2	52.4	41.0	20.5	82.1	38.8	13.7	13.7	1,520.0 m3
											736.4 m3

Source: JICA Study Team

8) Summary (Scope of Works)

The Scope of Works for bank protection works along the Kinyasungwe/Mkondoa Rivers is summarized below:

Scope of Works for Bank Protection Works along Kinyasingwe River

No. of sections	: 20 sections
Total length	: L=15,110 m
Bank protection height	: 3.0 – 5.0 m (Average: 4.3m)
Gabion	: 102,035 m^3
Steel sheet pile	: 36,480 m^2
Embankment	:124,080 m^3
Excavation	: 66,593 m^3

10.1.10 Measures for Tributaries

(1) Basic Approach

The preliminary design for the flood protection and sediment management measures for the tributaries is prepared based on the concept design in Chapter 7. The accuracy of the design is a preliminarily level which can be used for evaluation of the Yen Loan Project.

Required clearance at the bridge sections across the tributaries of the Maswala and Mzase Rivers are determined in this section, and will be applied for the design of the longitudinal profile of the proposed rerouting section of the railway.

(2) Objective Area and Structure

Among the proposed measures in the concept design, the areas identified as the highest priority areas are selected for the project area in the tributaries as below:

- Mzase River : Section of 1st Priority
- Maswala River : Section of 1st Priority

The sections of priority 2, both in Maswala and Mzase Rivers and a entirety of the Kidivo River, are out of the project area and thus out of the scope of the preliminary design. They are expected to be implemented as second priority projects.

At the confluence of the Kidivo River, the existing riverbank protection works need to be restored. This restoration work is included in the scope of the works of the project proposed in the mainstream.

1) Mzase River

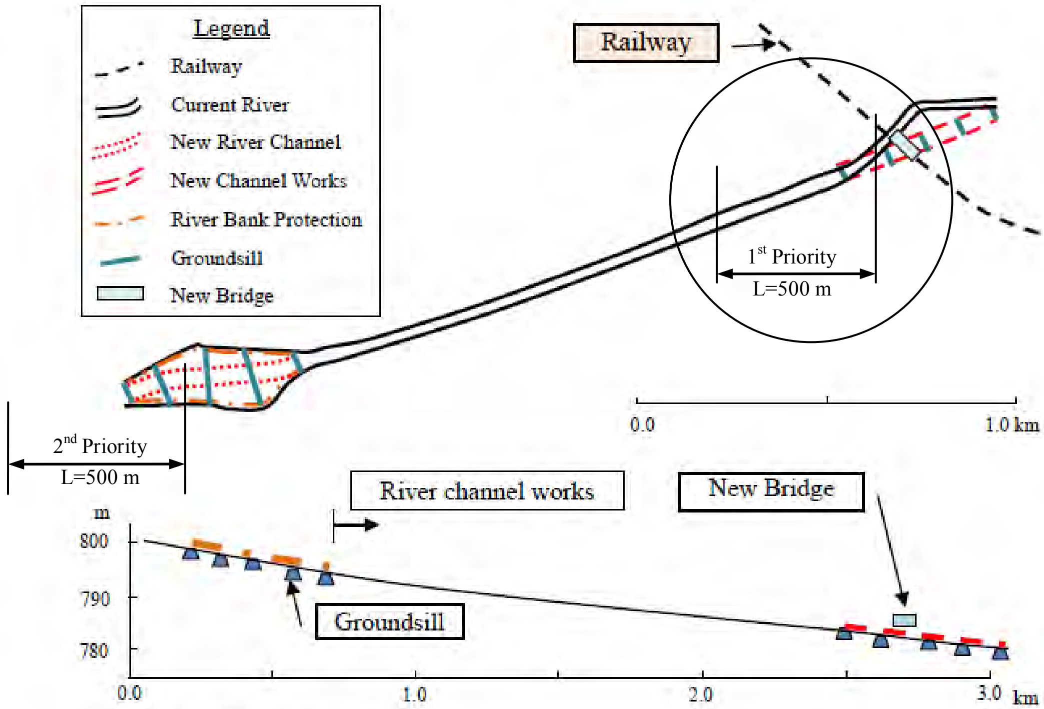
1st priority (in d/s)

- Excavation for New Channel : L=500 m, H-2.0 m, W=40 m
- Bank Protection (gabion) : L=500 m, H=3.0 m x 2 nos. (right and left)
- Embankment : none
- Groundsills in d/s : 5 nos. (average width 40 m), H=4.7 m

2nd priority (in u/s)

- Excavation for New Channel : none
- Bank Protection (gabion) : L=500 m, H=3.0 m x 2 nos. (right and left)
- Embankment : none
- Groundsills in u/s : 5 nos. (average width 80 m), H=4.7 m

Layout Plan and Profile



Source: JICA Study Team

Figure 10.55: Proposed Countermeasures in Mzase River

2) Maswala River

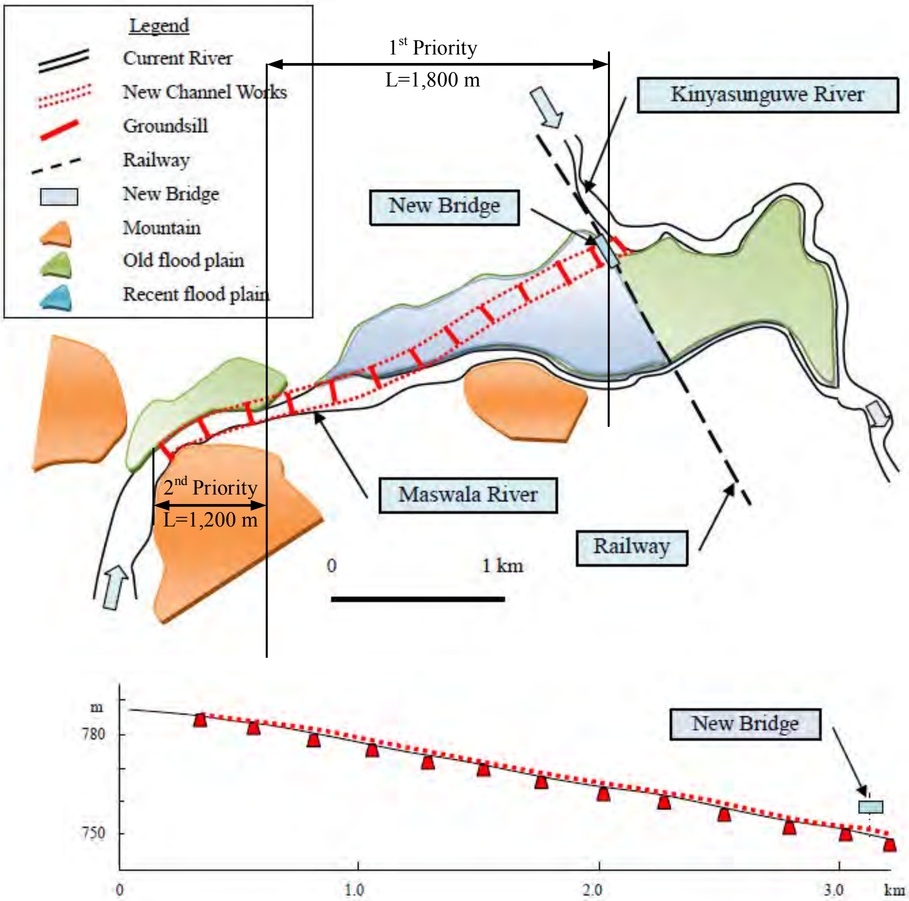
1st priority (in d/s)

- Excavation for New Channel : L=1,500 m, H=2.0 m, W=150 m
- Bank Protection (gabion) : L=1,800 m, H=4.0 m x 2 nos (left & right)
- Embankment : L=1,800 m, H=3.0 m x 2 nos. (left & right)
- Groundsills in d/s : 10 nos. (average width 150 m), H=5.0 m
-

2nd priority (in u/s)

- Excavation for New Channel : L=40 m, H=2.0 m, W=150 m
- Bank Protection (gabion) : L=1,200 m, H=4.0 m x 2 nos. (left & right)
- Embankment : none
- Groundsills in u/s : 3 nos. (average width 150 m), H=5.0 m

Layout Plan and Profile



Source: JICA Study Team

Figure 10.56: Proposed Countermeasures in Maswala River

(3) Design Criteria and Basic Conditions

The design criteria and basic conditions mentioned in the previous Sub-section 10.1.9 are applied.

(4) Preliminary Design of Maswala Training Works

1) Present Issues and Purposed Works

The Maswala River is a natural river where no flood protection measure is installed. The river channel flowing over the alluvial fan is divided into several branched channels at around 2.5 km upstream of the confluence with the Kinyasungwe River. In the surrounding areas of the confluence of the Maswala River, the railway tracks and culverts have been frequently damaged by floods due to erosion and overflow of water drained from the mountain side.

To cope with these issues, the following works are proposed:

i) River training works to construct a new river channel with dike and excavated channel in order to bundle the existing branched rivers over the alluvial fan, and to fix the intersection point with the railway to one location.
ii) Construction of a new bridge across the new river channel

iii) Construction of series of groundsills together with the river training works to stabilize riverbed profile and to control direction of flow into the center of the channel
iv) Construction of a check dam at the downstream end of the new channel to regulate a height difference of around 6 m between the existing ground and riverbed levels.

2) Design Conditions

i) Design Discharge (water) : 280 m^3/s

ii) Design Discharge (water with sediments): 308 m^3/s. (increased by 10% of the design discharge considering sediment flow)

3) Layout Plan

i) River Channel

- A new river channel with dike is constructed as a main structure of the river training works. It starts from 2.5 km upstream of the confluence with Maswala River to the confluence with the straight alignment. Total length of the river channel is 2,000 m.
- The downstream end of the channel is located at around 50 m downstream from the intersection point with the existing railway.
- A new bridge is constructed at around 80 m upstream of the downstream end of the river channel.

ii) Groundsill

- Existing riverbed profile of the Maswala River in the downstream section is around 1/80. The river channel in this section which has faster flow velocity is sediment transported section with the meandering river course branched over the alluvial fan. In order to stabilize the streamline and riverbed slope in the proposed new river channel, nine groundsills are constructed with fixed interval of 220 m.

iii) Check dam

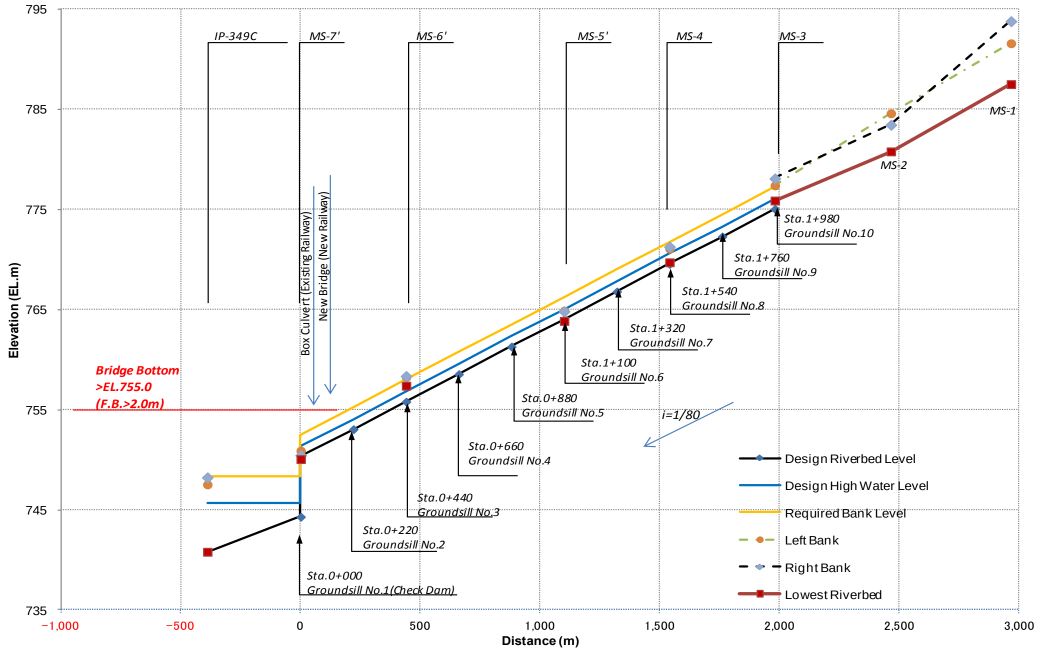
- At the downstream of the new channel, construction of a check dam is proposed to regulate a height difference of around 6 m between the existing ground and riverbed levels.

4) Preliminary Design of River Channel

i) Longitudinal Profile

- Longitudinal profile of the new channel is designed to fit to the existing ground level along the proposed alignment. Based on this condition, the design riverbed slope is adopted as uniform slope of 1/80 between the upstream end and the check dam.

  The design longitudinal profile of the Maswala River is presented in Figure 10.57.



Source: JICA Study Team

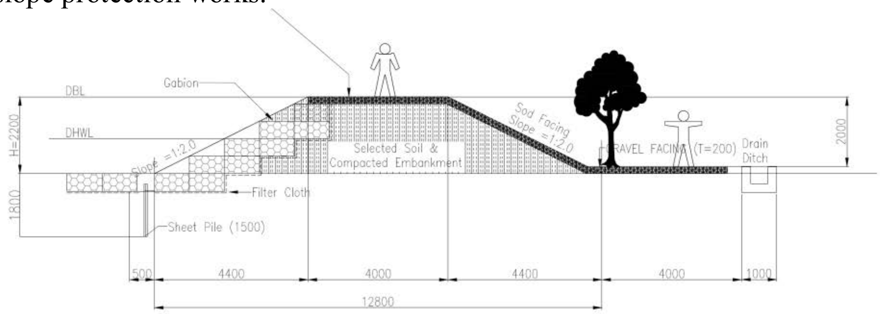
Figure 10.57: Longitudinal Profile of Maswala River Training Works

ii) Cross-Sectional Plan

- The river channel is designed as trapezoid with riverbed width of 90 m, side slope of 1:2.0, the design water depth of 1.0 m and the freeboard of 1.2 m to secure required flow capacity for the design discharge based on the design criteria and design conditions.
- In the section where the design water level is higher than the natural ground level, a new dike is constructed along the riverbank. The new dike is designed with the crest width of 4.0 m and the side slope of 1:2.0.

iii) Slope Protection Works

- The design velocity of the Maswala River is from 1.1-2.6 m/s, based on the hydraulic calculation. To protect from surface erosion of the dike, slope protection works with gabion are proposed.
- To protect from seepage failure, a cutoff wall of 1.5 m is installed at the toe of the slope protection works.



Source: JICA Study Team

Figure 10.58: Typical Section of Dike of Maswala River Training Works

iv) Typical Section

- Basic properties of the Maswala River training works are presented in Table 10.67. The typical section of the Maswala River is presented in Figure 10.60

Table 10.67: Basic Properties of Maswala River Training Works

ID	Station	Location Name	Accutual Distance to next station	Accumulated Distance	Existing River Channel				Flood Record	Design River Channel					
					River Width	Left Bank	Right Bank	Lowest Riverbed	Maximu Flood Level	Design Discharge	Design Riverbed Level	Design High Water Level	Required Bank Level	Design Height of Dike	Computed Velocity
(-)	(-)	(-)	(m)	(m)	(m)	(El.m)	(El.m)	(El.m)	(El.m)	(m3/s)	(EL.m)	(El.m)	(m)	(m)	(m/s)
IP349C	Sta.	Confluence Between Maswala and Main River (IP349C)	390.00	-390.00	179.72	747.53	748.23	740.80	745.62	308.00	740.80	745.62	748.32	7.52	0.00
	0.00	Groundsill No.MS-1(Check Dam) d/s	0.00	0.00						308.00	744.30	745.62	748.32	4.02	1.09
MS-C'	0.00	Groundsill No.MS-1(Check Dam) u/s	220.00	0.00	59.86	750.90	750.45	750.06		308.00	750.30	751.30	752.50	2.20	1.09
	220.00	Groundsill No.MS-2	220.00	220.00						308.00	753.05	754.05	755.25	2.20	2.48
MS-D'	440.00	Groundsill No.MS-3	220.00	440.00	145.20	758.26	758.35	757.39		308.00	755.80	756.80	758.00	2.20	1.75
	660.00	Groundsill No.MS-4	220.00	660.00						308.00	758.55	759.55	760.75	2.20	2.58
	880.00	Groundsill No.MS-5	220.00	880.00						308.00	761.30	762.30	763.50	2.20	1.83
MS-E'	1,100.00	Groundsill No.MS-6	220.00	1,100.00	92.95	764.89	764.82	763.86		308.00	764.05	765.05	766.25	2.20	1.93
	1,320.00	Groundsill No.MS-7	220.00	1,320.00						308.00	766.80	767.80	769.00	2.20	1.85
MS-F	1,540.00	Groundsill No.MS-8	220.00	1,540.00	104.39	771.08	771.28	769.72		308.00	769.55	770.55	771.75	2.20	2.34
	1,760.00	Groundsill No.MS-9	220.00	1,760.00						308.00	772.30	773.30	774.50	2.20	2.28
MS-G	1,980.00	Groundsill No.MS-10	484.62	1,980.00	111.21	777.40	778.10	775.89		308.00	775.05	776.05	777.25	2.20	1.85
MS-H	2,464.62		501.30	2,464.62	147.61	784.60	783.46	780.80							
MS-I	2,965.92			2,965.92	209.97	791.60	793.81	787.52							

Source: JICA Study Team

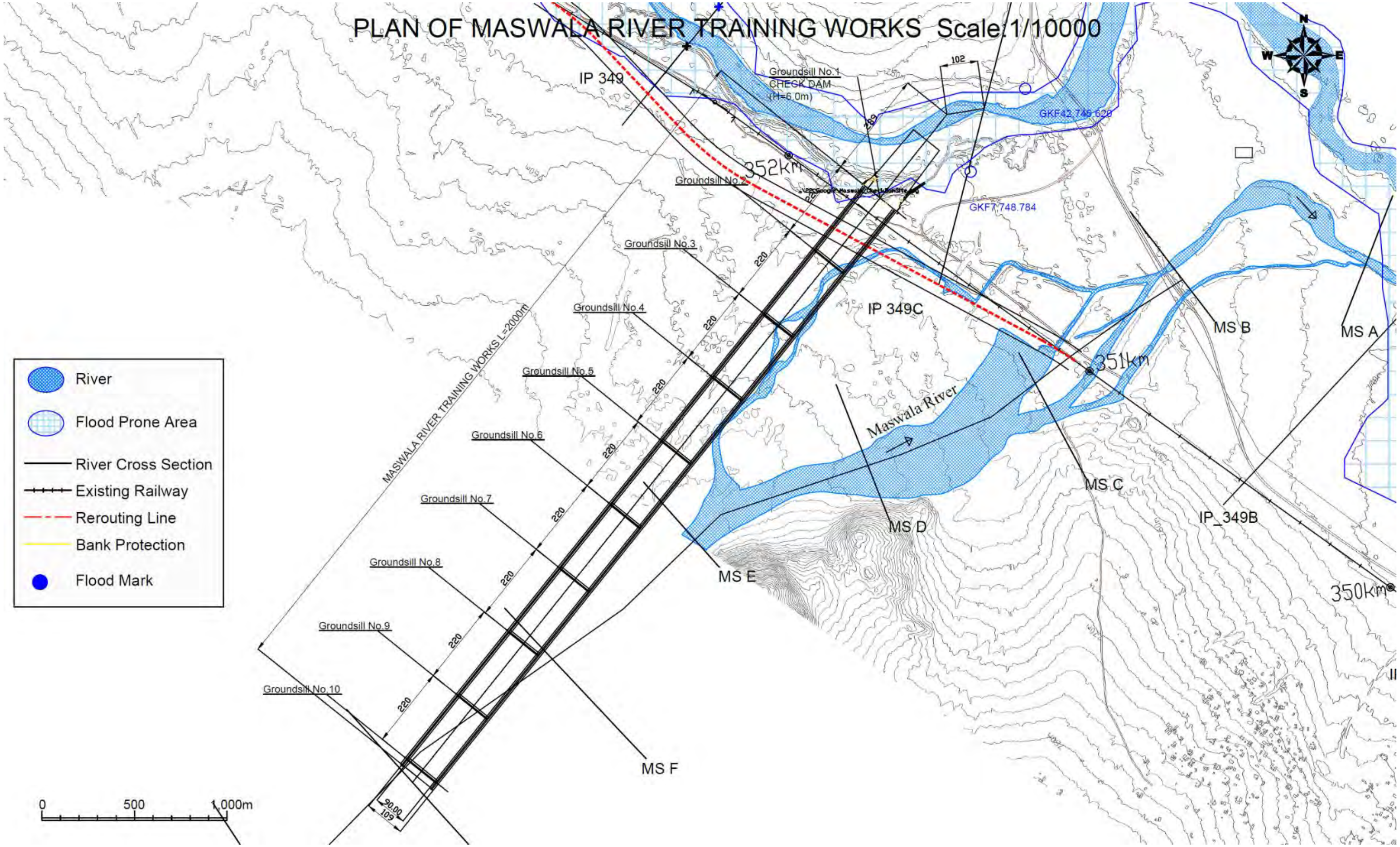


Figure 10.59: Layout Plan of Maswala River Training Works

TYPICAL SECTION OF RIVER CHANNEL AND GROUNDSILL, AND PLAN OF GROUNDSILL IN MASWALA RIVER
Scale 1/400

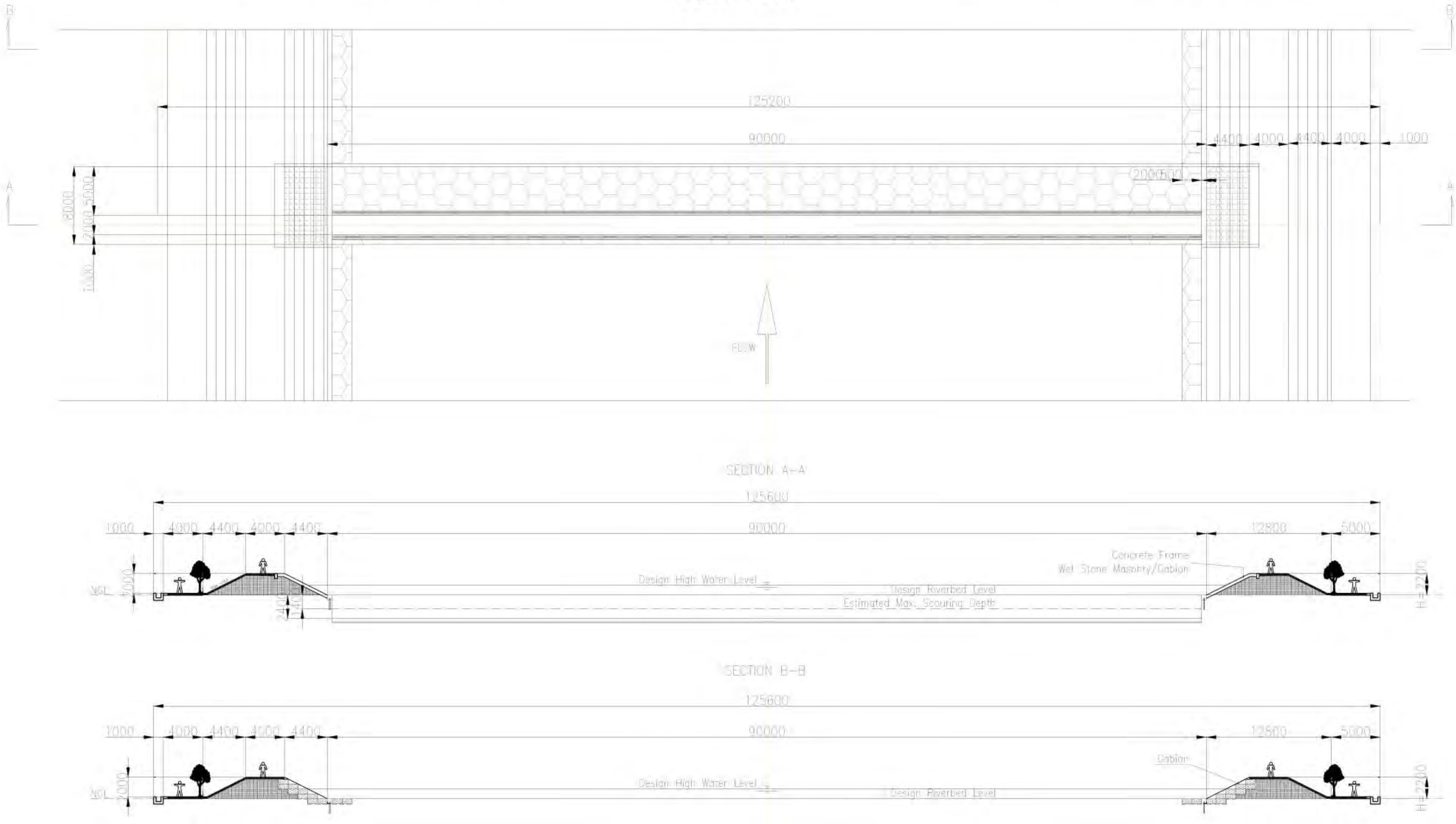


Figure 10.60: Plan and Typical Section of Groundsill and Typical Section of River Channel in Maswala River Training Works

(5) Preliminary Design of Groundsills

The preliminary design of the nine proposed groundsills is prepared adopting a typical plan and cross-section, because of the similarity of design conditions, as per the specifications below:

i) Longitudinal profile
Proposed groundsill is designed as embedded under the design riverbed level.

ii) Main body
Main body of the groundsills is designed as a free-standing structure with the crest width of 2.0 m and height of 2.4 m considering the interval of groundsill and the longitudinal profile of the new channel.
The upstream and downstream slope of main body is 1:0.2.

iii) Overflow section
Overflow section of the groundsills is designed to secure the same cross-section with the river channel, i.e., bed width of 90 m, height of 2.2 m, and side slope of 1:2.0.

iv) Riverbed protection works
The riverbed protection works are provided to protect from local scouring at upstream and downstream of the groundsill. Length of the riverbed protection works is 1 m at upstream and 5 m at downstream.

v) Riverbank protection at groundsill
The riverbank protection works at groundsill section is designed as a ridged type of a concrete frame. The provided section of the protection works is 12.5 m long from 5 m upstream of the groundsill to the 5 m downstream of the ground sill.

(6) Preliminary Design of Check Dam

i) Longitudinal profile
The proposed check dam is designed with a drop height of 6.0 m, taking into account the longitudinal connection between the existing river bed and ground level at proposed check dam site.
The total dam height is as designed 8.5 m, in consideration of the embedded depth of the check dam of 2.5 m below the surface of the apron.

ii) Geological condition
Geological conditions at the construction site of the proposed check dam can be confirmed by referring to the previous geotechnical investigation report (Gauff, 2014).
The results of the investigation are summarized as below and shown in Table 10.68:

- The depth of solid rock is approximately 20 m from the surface of ground.
- Rock is composed of layers of quartzitic sand stone with an n-value of more than 50.
- Above the rock, alternating layers of sand and silt are deposited.
- The n-value of the foundation ground of the proposed check dam is estimated as being between 16-22, referring to the borehole data at the layer around 10 m below the surface of ground. This layer is mainly composed of silty sand and sandy clay. Based on the laboratory test taken nearby this layer shows.

Table 10.68: Results of Geological Investigation at Proposed Check Dam

Characteristic	**BH1**	**BH2**	**BH3**
Depth of solid rock	21.8m	19m	19m
Type ofdeposited materials above the rock	Alternating layers of silt, clay and sand	Alternating layers of silt, clay and sand	Alternating layers of silt, clay and sand
N-Value at foundation layer (10 m deep from surface of ground)	22-28	18-20	17-24
Result of laboratory test	Silty Sand $C=2 tf/cm^2$, $\varphi=40$ degree	Silty Sand $C=42 tf/cm^2$, $\varphi=24.8$ degree	Sandy clay $C=12 tf/cm^2$, $\varphi=36.4$ degree

Source: Design Report for Design and Supervision of Bridge at Km349/350 and Associated Works between Godegode and Gulwe Stations on the Central Railway Line (Gauff, 2014)

Based on the above data, it is considered that the foundation ground of the check dam can be secured with the required bearing capacity of the structure without installation of foundation piles.
The basic design property of foundation soil is assumed as follows:

- Material : silty sand
- Cohesion : 0.0 tf/cm^2
- Friction angle ϕ :35°
- Allowable bearing capacity : 30 tf/m2

iii) Main body
The main body of the check dam is designed as a free-standing structure with a crest width of 2.5 m and height of 8.5 m.
The slope of the dam is determined as 1:0.7 for the upstream section, and 1:0.2 for the downstream section based on the stability analysis (see Appendix S for detail), with the downstream slope of main body set as 1:0.2.

iv) Overflow section
The overflow section of the check dam is designed at 80 m at bottom with side slope of 1:0.5 considering the cross sectional shape of the river channel and embedded depth of the side wall into the natural ground. The overflow depth is estimated at 1.8 m for the design discharge of 308m^3/s. The height of the overflow section is designed as 3.0 m, including the freeboard of 1.2 m above the overflow depth.

v) Apron and sub-dam
To dissipate the energy of overflow water from the check dam with a drop height of 6 m, an apron attached with a sub-dam is provided downstream of the check dam. The length of the apron is designed as 20 m to secure the required dissipation length based on the hydraulic computation.
The apron is concrete structure with 1.5 m in thickness to secure required durability against surface erosion and required stability against uplift.
The sub-dam constructed at the downstream end of the apron is designed at 4.0 m in height, including the embedded depth of 2.5 m, the same as the one in the main body. The overflow section of the sub-dam is designed as the same section of the check dam.

vi) Riverbed protection works
The riverbed protection works are provided to protect from local scouring at upstream and downstream of the check dam. The provided length of the riverbed protection works is 2 m upstream from the crest and 10 m downstream of the sub-dam.

vii) Riverbank protection
The riverbank protection works at the check dam is designed as a ridged type of a concrete retaining wall. The retailing wall along the apron is structurally separated from the apron to secure durability in case of damage. The structural type is a leaning retaining wall with the height of 6.7 m at the section along the apron.
The riverbank protection works downstream of the apron are designed with gabion, the same as that of the river channel. The extent of the riverbank protection of the gabion is up to 15 m downstream from the sub-dam.

The plan, design cross-section, and design profile of the check dam are presented in Figure 10.61 and Figure 10.62 below.

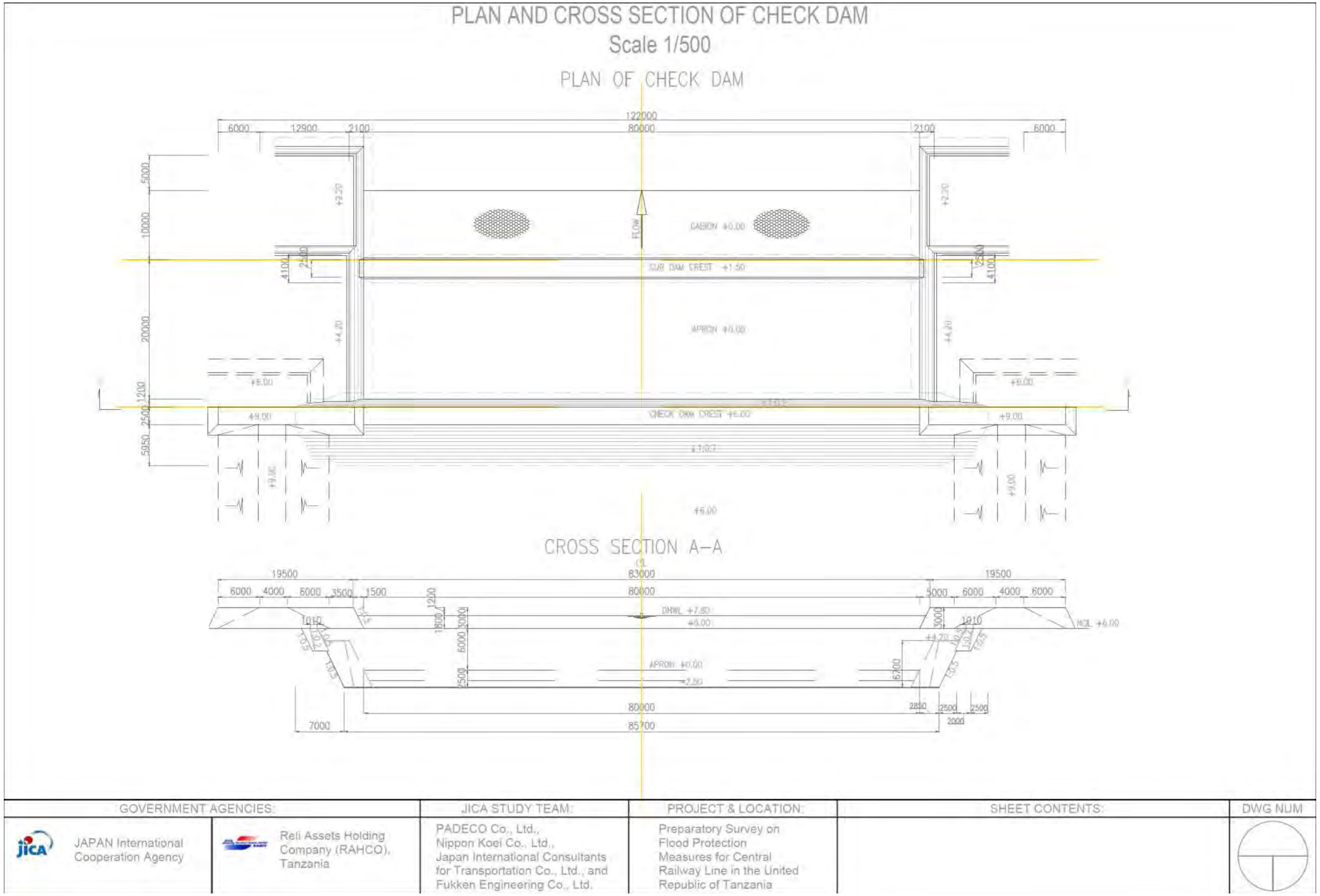


Figure 10.61: Plan and Typical Section of Check Dam in Maswala River Training Works

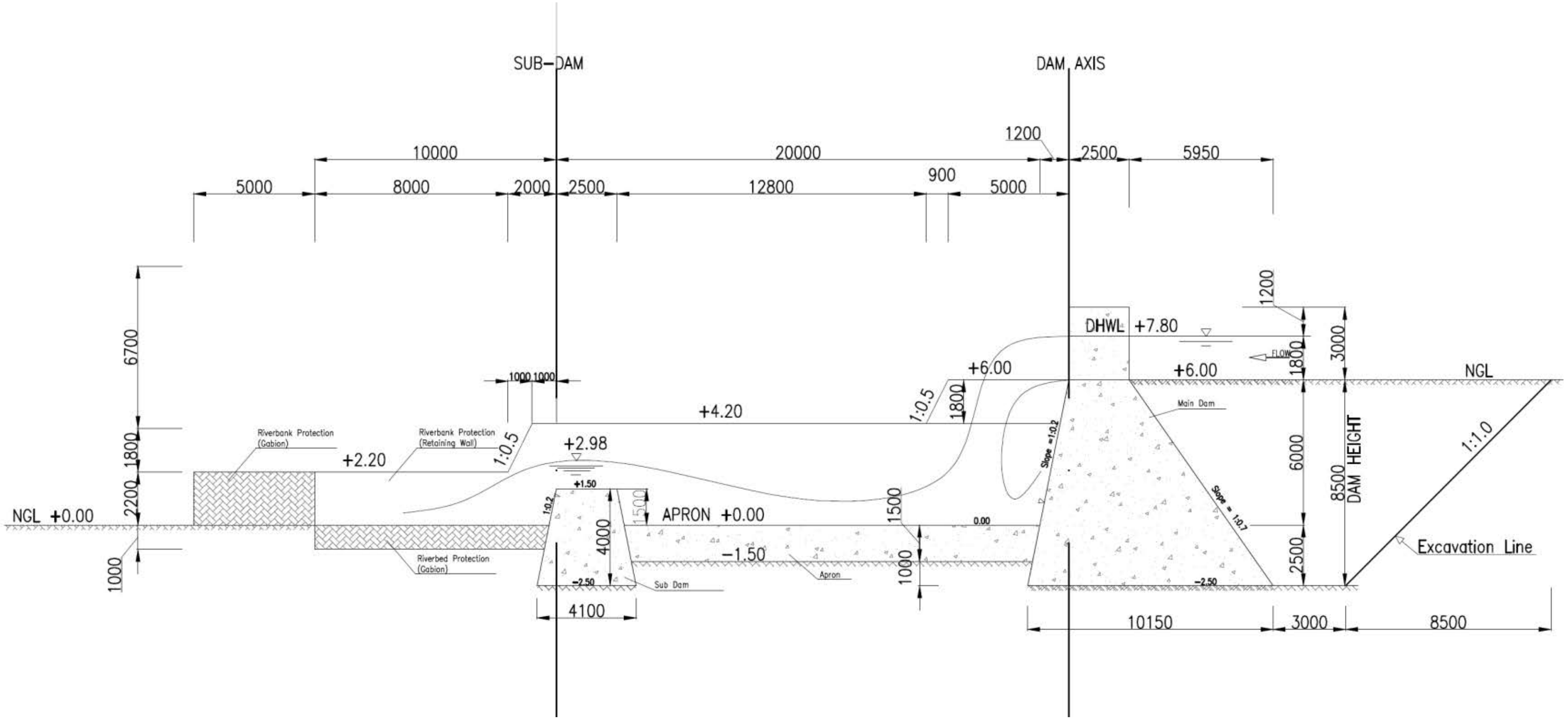


Figure 10.62: Profile of Check Dam in Maswala River Training Works

7) Quantity Calculation

Table 10.69: Summary of Quantity

No.	Item	Quantity	
1	Groundsill (9 nos.)		
	Concrete	Vc =	5,895.9 m^3
	Gabion (Foot protection)	Vg =	4,860.0 m^3
	Geotextile	Af =	4,860.0 m^2
2	Channel		
	Concrete	Vc =	1,075.2 m^3
	Gabion (Main body)	Vg =	5,970.0 m^3
	Gabion (Foot protection)	Vg =	1,194.0 m^3
	Gravel Facing	Vgs =	3,072.0 m^3
	Geotextile	Af =	11,343.0 m^2
	Steel Sheet Pile	Ls =	4,800 m
	Embankment (Backfill)	Vem =	20,071.8 m^3
	Sod Facing	As =	11,929.7 m^2
	Excavation	Vex =	22,081.7 m^3
	Clearing	Ac =	19,661,1 m^2
3	Check Dam (1 nos.)		
	Concrete	Vc =	8,542.0 m^3
	Gabion	Vg =	960.0 m^3
	Geotextile	Af =	960.0 m^2
	Embankment	Vem =	1,238.0 m^3
	Excavation	Vex =	44,392.0 m^3

Source: JICA Study Team

8) Summary (Scope of Works)

The Scope of Works for river training works along the Maswala River is summarized below:

Scope of Works for river training works along Maswala River

- Excavation for New Channel : L=2,000 m, W=89.2 m
- Bank Protection (gabion) : L=4,000 m (for right and left banks)
- Groundsill : 9 units, H=4.7 m
- Check dam : 1 unit, H=8.5 m
- Embankment : 13,148 m^3
- Excavation : 331,864 m^3
- Steel sheet pile : 14,850 m

(7) Preliminary Design of Mzase Training Works

1) Present Issues and Purposed Works

At the confluence of the Mzase River, a culvert is installed at the intersection with the railway. The opening of this culvert is almost clogged with sediment depositions at present. The railway at and within the general vicinity of the culvert have been frequently damaged by floods due to overflow and bank erosion.

It was observed at the site that the sediment derived from the upstream areas would not be deposited in the Mzase River because the flow velocity is fast, but rather, is likely deposited at the confluence because the slower velocity at that point. At present, the river channel in the confluence has accumulated a great deak of sediment deposition that is affecting the existing culvert. In addition, the existing river channel of the Mzase River is refracted at around 200 m upstream of the existing culvert. It is considered that turbulence flow generated at this refraction makes flow velocity at the left side of the culvert slower, resulting in deceleration of much of the sediment depositions.

To cope with these issues, the following works are proposed:

i) Replacement of the existing culvert with a new bridge.
ii) River training works from about 0.7 km upstream of the confluence to the confluence with a straight alignment of the river channel.
iii) Construction of series of groundsills to stabilize the riverbed profile and to control direction of flow into the center of the channel.

2) Design Conditions

i) Design Discharge (water) : 60 m^3/s

ii) Design Discharge (water with sediments): 66 m^3/s (increased by 10% of the design discharge considering sediment flow)

iii) Existing river channel

In the downstream areas of the Mzase River, river channeling works had been implemented previously. The existing channel is around 40 m wide with dikes.

3) Layout Plan

i) River Channel

- A new river channel with dike is constructed as a main structure of the river training works. It starts from 200 m upstream of the refraction section and ends at the confluence with the mainstream.
- The total length of the new river channel is 640 m. The refracted section is changed to the straight alignment.
- It is assessed that the existing channel in the upstream section can be used without any improvements because it has been already improved to a straight channel having the required cross-sectional area to allow the flow of the design discharge.
- A new bridge across the Mzase River is constructed at around 380 m upstream of the downstream end of the new river channel in order to secure a distance from the confluence as much as possible.

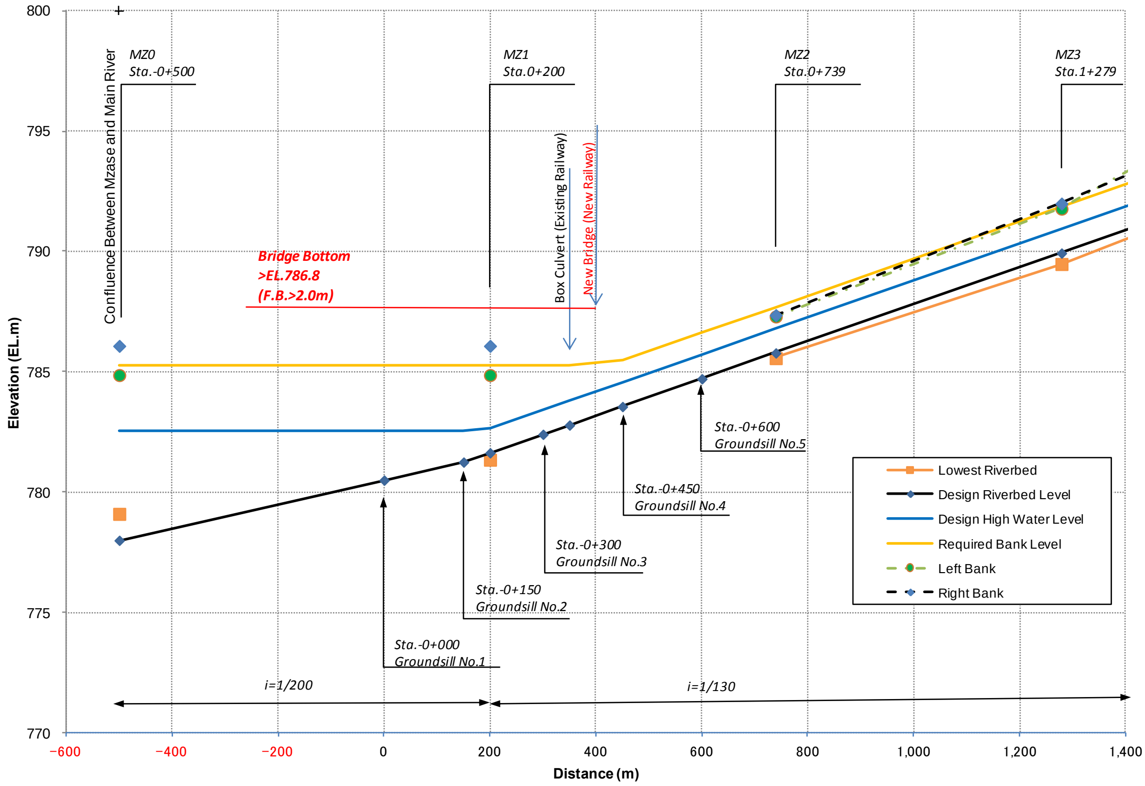
ii) Groundsill

- The riverbed slope of the Mzase River in the downstream section is around 1/130. The river channel in this section is a sediment transport section where a streamline would be unstable under the natural conditions. In order to stabilize the fluctuated streamline and riverbed slope in the proposed new river channel, five groundsills are constructed with a fixed interval of 150 m.

4) Preliminary Design of River Channel

i) Longitudinal Profile

- The longitudinal profile of the new channel is designed to fit to the profile of existing ground along the proposed alignment. Based on this condition, the design riverbed slope is adopted as uniform slope of 1/130 in the upstream of the groundsill No.2 and 1/200 in the downstream.
- Since the existing dike crest level is higher than the required dike level, heightening is not necessary.



Source: JICA Study Team

Figure 10.63: Longitudinal Profile of Mzase River Training Works

ii) Cross-Sectional Plan

- The river channel is designed as a trapezoid with a riverbed width of 40 m, side slope of 1:2.0, design water depth of 1.0 m, and a freeboard of 0.9 m to secure the required flow capacity for the design discharge.
- In the section where the design water level is higher than the natural ground level, a new dike is constructed along the riverbank. The new dike is designed with the crest width of 4.0 m and a side slope of 1:2.0.

iii) Slope Protection Works

- The design velocity of the Mzase River is 2.3 m/s, based on hydraulic calculations. To protect from surface erosion of the dike, slope protection works with gabion are provided.
- To protect from seepage failure, a cutoff wall of 1.5 m is installed at the toe of the slope protection works.

iv) Typical Section

- The basic properties of the Mzase River training works are presented in Table 10.70. The typical section of the Mzase River is presented in Figure 10.64.

5) Preliminary Design of Groundsill
The preliminary design of proposed five groundsills is prepared by adopting the typical plan and cross-section, due to the similarity of design conditions:

i) Longitudinal profile
The proposed groundsill is designed as embedded under the design riverbed level.

ii) Main body

The main body of the groundsills is designed as a free-standing structure with a crest width of 2.0 m and height of 2.0 m, in consideration of the interval between the groundsills and the longitudinal profile of the new channel.

The upstream and downstream slope of the main body is 1:0.2.

iii) Overflow section

The overflow section of the groundsills is designed to secure the same cross-section as the river channel, i.e., abed width of 40 m, height of 1.9 m, and side slope of 1:2.0.

iv) Riverbed protection works

The riverbed protection works are provided to protect from local scouring upstream and downstream of the groundsill. The length of the riverbed protection works is 2 m at upstream and 5 m at downstream areas.

v) Riverbank protection at groundsill

The riverbank protection works at groundsill section are designed as a ridged type with a concrete frame. The provided section of the protection works is 12.5 m long, stretching from 5 m upstream of the groundsill to 5 m downstream of each groundsill.

Table 10.70: Basic Properties of Mzase River Training Works

ID	Station	Location Name	Accutual Distance to next station	Accumulated Distance	Existing River Channel				Flood Record	Design River Channel					Velocity
					River Width	Left Bank	Right Bank	Lowest Riverbed	Maximu Flood Level	Design Discharge	Design Riverbed Level	Design High Water Level	Required Bank Level	Design Height of Dike	Computed Velocity
(-)	(-)	(-)	(m)	(m)	(m)	(El.m)	(El.m)	(El.m)	(El.m)	(m3/s)	(EL.m)	(El.m)	(m)	(m)	(m/s)
MZ00	-Sta.0+500	Confluence Between Mzase and Main River	500.00	-500.00	0.00	784.87	786.08	779.10	782.55	66	778.00	782.55	785.25	7.25	
	Sta.0+000	Grondsill No.1	150.00	0.00						66	780.50	782.55	785.25	4.75	2.26
	Sta.0+150	Grondsill No.2	50.00	150.00						66	781.25	782.55	785.25	4.00	2.26
MZ01	Sta.0+200		100.00	200.00	54.40	784.87	786.08	781.35		66	781.63	782.63	785.25	3.62	2.26
	Sta.0+300	Grondsill No.3	50.00	300.00						66	782.40	783.40	785.25	2.85	2.26
	Sta.0+350	Existing Culvert(railway)	100.00	350.00						66	782.79	783.79	785.25	2.46	2.26
	Sta.0+450	Grondsill No.4	150.00	450.00						66	783.56	784.56	785.46	1.90	2.26
	Sta.0+600	Grondsill No.5	139.43	600.00						66	784.71	785.71	786.61	1.90	2.26
MZ02	Sta.0+739		539.43	739.43	40.40	787.30	787.36	785.57		66	785.78	786.78	787.68	1.90	2.48
MZ03	Sta.1+279		494.45	1,278.86	55.50	791.78	791.99	789.48		66	789.93	790.93	791.83	1.90	1.75
MZ04	Sta.1+773		556.86	1,773.31	49.60	797.83	796.59	793.70		66	793.74	794.74	795.64	1.90	2.58
MZ05	Sta.2+330		456.91	2,330.17	61.40	800.77	800.74	799.42		66	799.60	800.60	801.50	1.90	1.83
MZ06	Sta.2+787		517.39	2,787.08	86.60	807.76	806.99	805.05		66	804.41	805.41	806.31	1.90	1.93
MZ07	Sta.3+304		577.07	3,304.47	50.90	811.40	812.00	809.19		66	809.85	810.85	811.75	1.90	1.85
MZ08	Sta.3+882		518.19	3,881.54	92.40	819.93	819.38	814.95		66	815.93	816.93	817.83	1.90	2.34
MZ09	Sta.4+400		651.44	4,399.73	50.00	824.63	824.80	820.98		66	821.38	822.38	823.28	1.90	2.28
MZ10	Sta.5+051		496.63	5,051.17	63.10	831.54	832.07	828.07		66	828.24	829.24	830.14	1.90	2.07
MZ11	Sta.5+548			5,547.80	66.50	836.98	838.31	833.81		66	833.47	834.47	835.37	1.90	2.14

Source: JICA Study Team

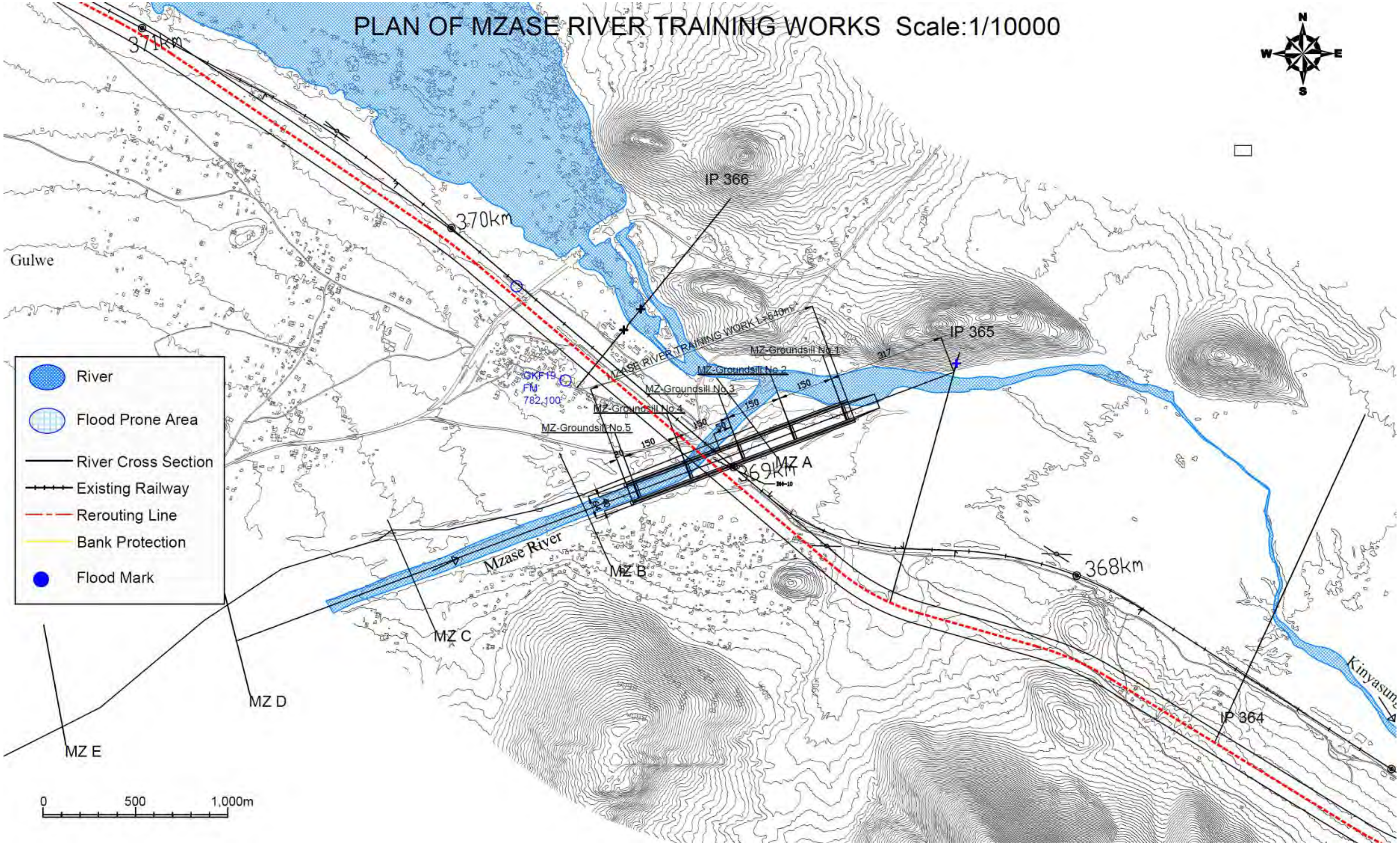


Figure 10.64: Layout Plan of Mzase River Training Works

PLAN AND TYPICAL SECTION OF RIVER CHANNEL, AND GROUNDSILL IN MZASE RIVER
Scale 1/400

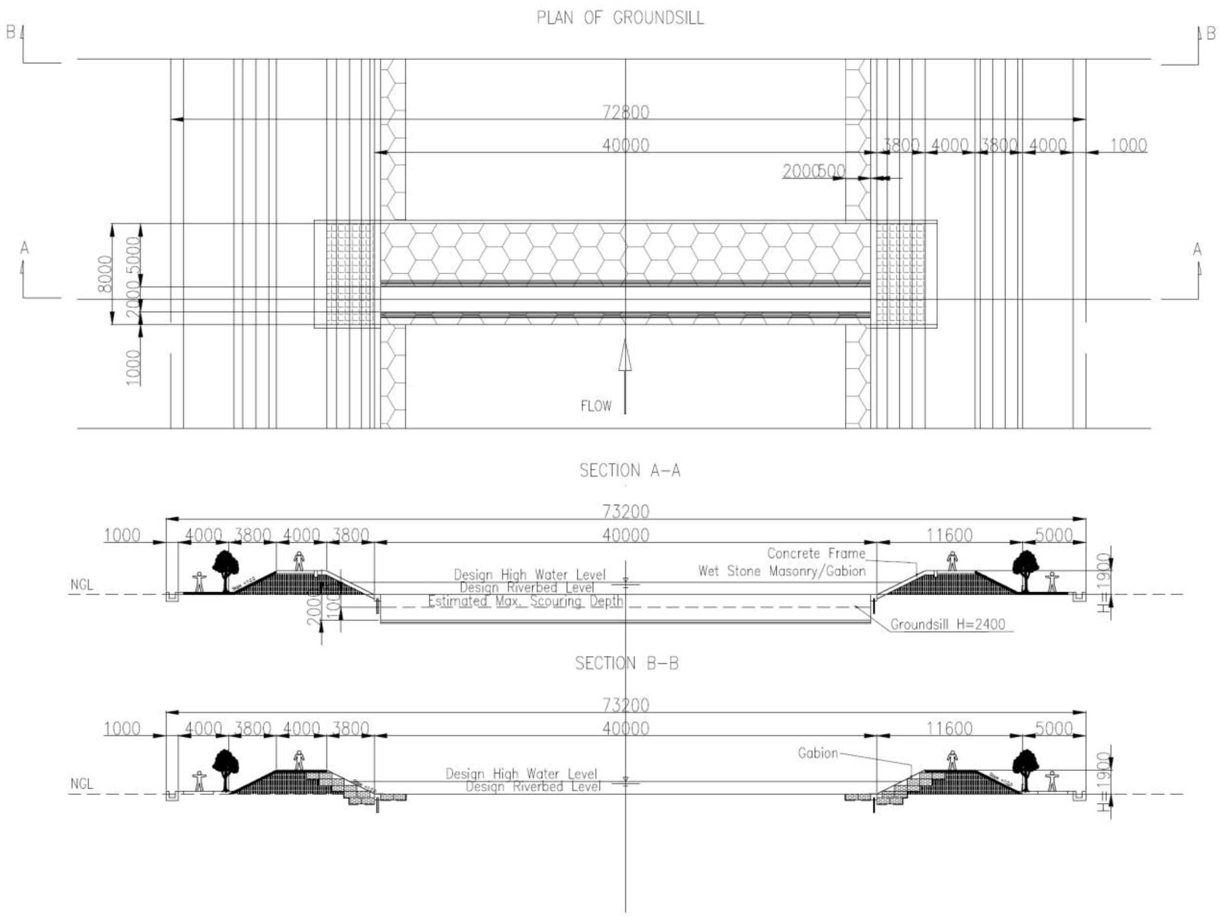


Figure 10.65: Plan and Cross-Section of Groundsill, and Typical Section of Mzase River Training Works

7) Quantity Calculation

Table 10.71: Summary of Quantity of Mzase Training Works

No.	Item	Quantity	
1	Groundsill (4 nos.)		
	Concrete	Vc =	1,046.4 m^3
	Gabion (Foot protection)	Vg =	960.0 m^3
	Geotextile	Af =	960.0 m^2
2	River Channel and Dike		
	Concrete	Vc =	1,075.2 m^3
	Gabion (Main body)	Vg =	5,970.0 m^3
	Gabion (Foot protection)	Vg =	1,194.0 m^3
	Gravel Facing	Vgs =	3,072.0 m^3
	Geotextile	Af =	11,343.0 m^2
	Steel Sheet Pile	Ls =	4,800 m
	Embankment (Backfill)	Vem =	20,071.8 m^3
	Sod Facing	As =	11,929.7 m^2
	Excavation	Vex =	22,081.7 m^3
	Clearing	Ac =	19,661,1 m^2

Source: JICA Study Team

8) Summary (Scope of Works)

The Scope of Works for river training works along the Mzase River are summarized below:

<u>Scope of Works for river training works along Mzase River</u>

- Excavation for New Channel : L=660 m, W=40 m
- Bank Protection (gabion) : L=1,320 m (for right and left banks)
- Groundsill : 4 units(average width 40 m), H=4.7 m
- Embankment : 20,072 m^3
- Excavation : 22,081 m^3
- Steel sheet pile : 4,800 m

All preliminary design drawings of riverbank protections and protection measures in tributaries are compiled in Appendix S.

10.1.11 Flood Hazard Maps

Flood hazard maps are prepared to show the boundaries of design flood water levels along the Kinyasungwe/Mkondoa Rivers, which indicate the following information. Those are compiled in Appendix T.

(1) Existing and proposed re-routing railway lines between Kilosa and Gulwe with the marks of every kilometer of the new kilometerage system.
(2) Proposed locations of riverbank protection works along the mainstream and sediment control structures along the tributaries.
(3) Survey lines of river cross-section survey conducted from January to June 2015.
(3) Flood marks identified through the Flood Mark Survey conducted between January and April 2015.
(4) Locations of flood damage incurred during past significant floods.
(5) Location of staff gauges, including those installed by the current Study.

10.1.12 Improvement Plan for Igandu Area

(1) Improvement Plan

Although Igandu is an area outside of the project scope, the following measures are recommended to reduce flood damages. This is an area divided by railway embankments. Rivers (dry during the dry season) that flow through this area cross the railway, and culverts are provided at the crossing points. However, due to the culvert openings being too small, water is prone to stanching and is a factor in the frequent occurrence of flooding in this region. As a result of the hydraulic analysis, it has been determined that openings equivalent to 4 contiguous 3.0 m x 3.0 m box culverts are necessary at the railway-river crossing points. As a countermeasure for flood disasters, it is recommended that a rerouting line with the required FL height to provide the required box culverts be built alongside the existing line (refer to Appendix Y).

10.2 Preliminary Construction Plan

10.2.1 Location of Project

The location of the Project and the target structures are shown in Appendix-S. The current conditions for distribution of the structures are shown in Figure 10.66. The structural measures for the Feasibility Study consist of following working items:

a. Flood protection measures for railway and related facilities
b. Track rehabilitation works
c. Relocation of stations and related facilities
d. Flood protection works at tributary

This chapter describes the preliminary construction plan for the Project. The main target area for **"a"**, **b"**, and **"c"** stretches from Kilosa (Km 283) to Gulwe (Km 366). The target area for **"d",** which involves the control of sediment discharge, is located at the three tributaries of the Maswala, Kidibo, and Mzase.

10.2.2 Construction of Structure

Main work items comprise of the proposed Project are shown in Table 10.72 and Table 10.73.

Table 10.72: Major Work Items

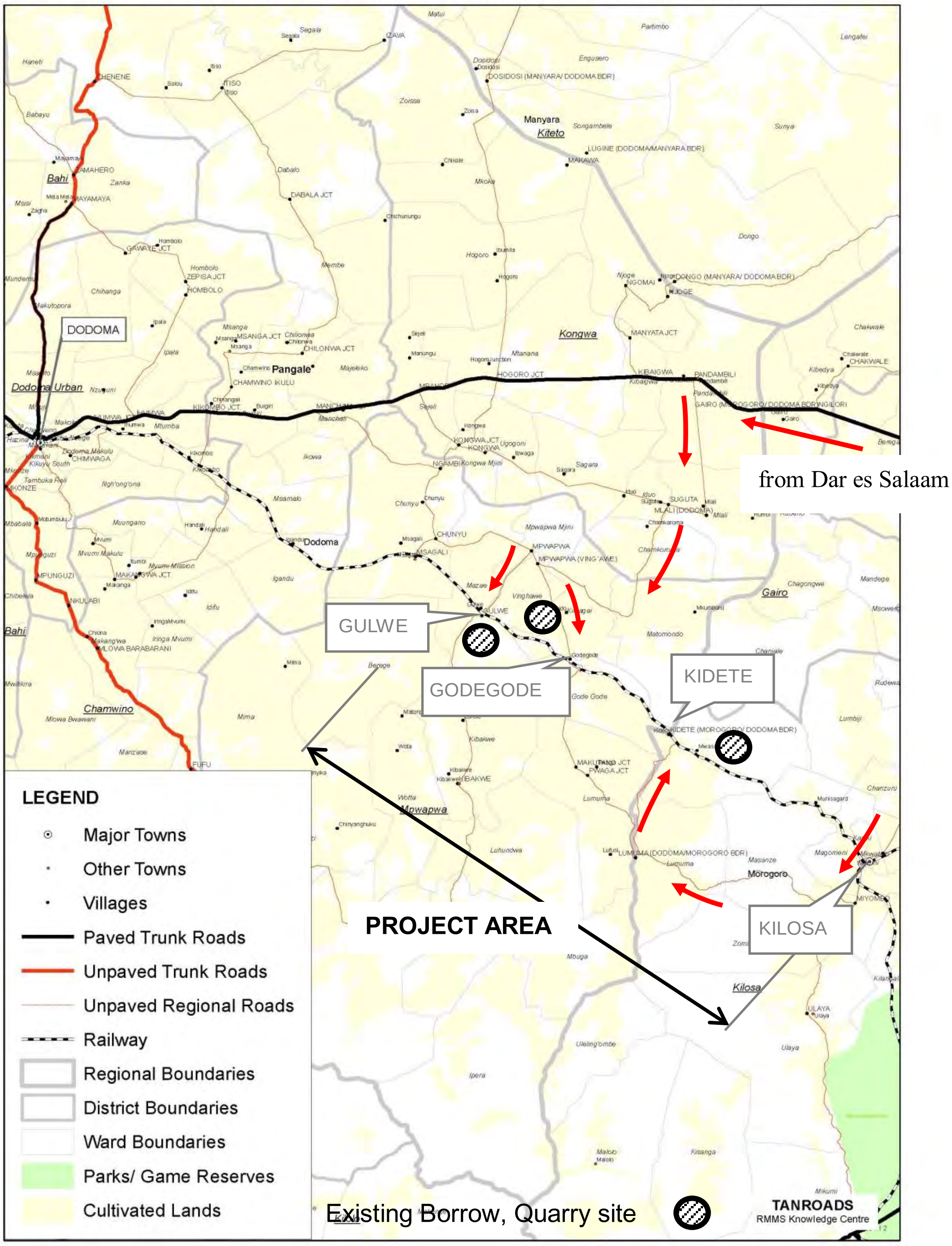
No.	Major Civil Work	Quantity (Approx.)
a.	Flood protection works for railway	
a-1	Railway rerouting construction works (including new bridge 4 nos., culvert 65sets)	25,000 m
a-2	Bank protection for main stream	15,100 m
b.	Track installation/rehabilitation works	
b-1	Installation of track	25,000 m
b-2	Renewal of 60 lb/yd rails by 80 lb/yd rails	15,000 m
b-3	Refurbishment of 80 lb/yd rails section	48,800 m
c.	Relocation of Gulwe Station and related facilities	1. LS.
d.	Flood protection works at tributaries	
d-1	Training work for Maswala River with check dam	2,000 m
d-2	Training work for Mzase River	640 m

Source: JICA sturdy team

Table 10.73: Quantity of Major Work

Major Work items		**a. Flood Protection for railway**		**b. Existing track rehabilitation works**			**c. Relocation of Gulwe station**	**d. Flood Protection at tributaries**		**Total (Approx.)**
		a-1	a-2	b-1	b-2	b-3		d-1	d-2	
		Railway route construction work	Bank protection for main stream	Installation of track	Renewal of rail	Refurbishment of rails section		Maswala	Mzase	
Excavation	m^3	368,000	67,000	—	—	—	—	332,000	22,000	789,000
Embankment	m^3	431,000	124,000	—	—	—	—	13,000	20,000	588,000
Concrete	m^3	Culvert 65set	2,000	—	—	—	—	17,800	2,100	—
Steel Sheet Pile	m	—	91,250	—	—	—	—	14,800	4,800	110,850
Protection work	m^3	135,000	102,000	—	—	—	—	29,000	8,100	274,1000
80lb/yd rail	ton	—	—	2,180	1,250	80	—	—	—	3,510
Track works	m	—	—	25,000	15,000	48,800	—	—	—	88,800
Gulwe station buildings	m^2	—	—	—	—	—	990	—	—	990

Source: JICA sturdy team



Source: JICA Study Team

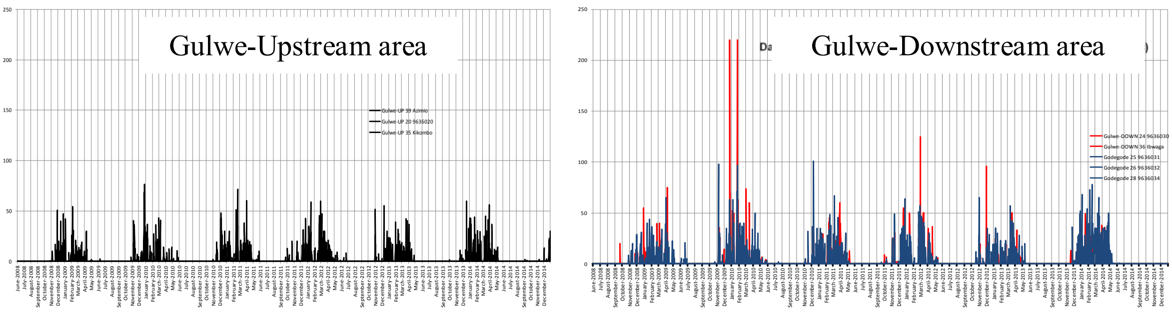
Figure 10.66: Road Network around Kilosa-Dodoma Railway Section

10.2.3 Conditions Affecting Construction Plan

(1) Climate Condition

The daily rainfall observation data near the project site from Jun. 2008 to Sep. 2014 is available for estimation of workable days for construction of the project. The characteristic of daily rainfall data are as follows:

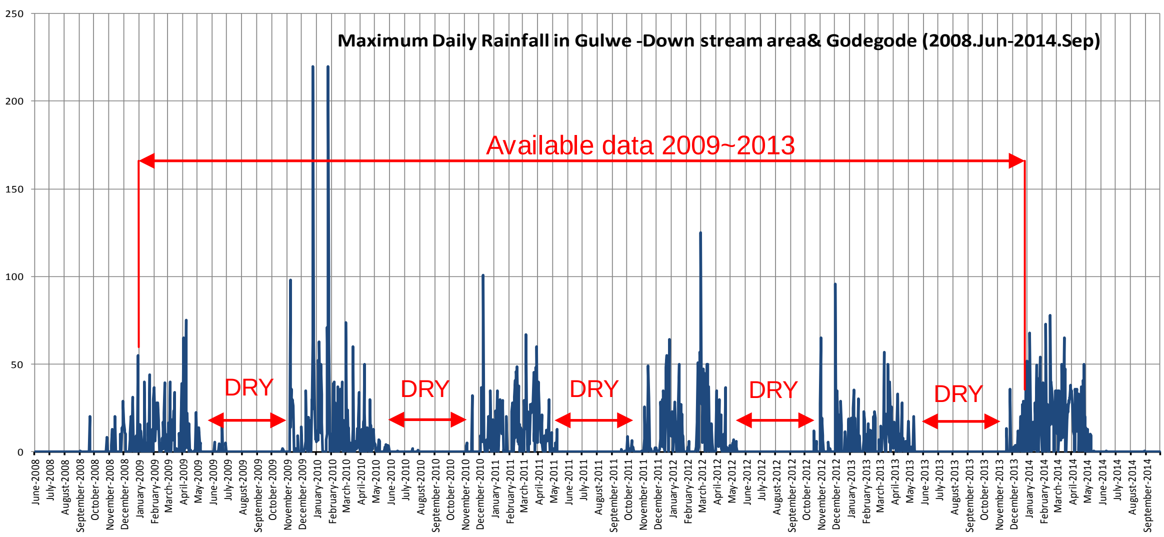
- The rainy season from November to April and the dry season from May to October (Figure 10.67**).**
- However, the rainfall amount in the Gulwe-Upstream area is less than that of Gulwe-Downstream area, which is nearby the construction site.
- Therefore, the Gulwe-Downstream data shall be applied for the workable days study.



Source: JICA Study Team

Figure 10.67: Comparison of Rainfall Gauging Stations between Gulwe-Upstream and Gulwe-Downstream

- The Gulwe-Downstream area has five rain gauging stations. These statiosn are close to Gulwe and Godegode railway stations**.**
- Considering the recent tendency of heavy rainfall and erring on the safe side for construction planning, it is recommended that the maximum railfall among the five stations shall be applied for the workable days study **(**Figure 10.68**).**



Source: JICA Study Team

Figure 10.68: Maximum Daily Rainfall in Gulwe-Downstream Area

Hence, in the construction plan, the wet season and the dry season are considered as follows:

Wet Season: from November to April

Dry Season: from May to October

(2) Workable Days

The issues for estimation of workable day are as follows:

- General number of working days per week
- National holidays
- Rainy days
- Work item

(1) General working days in week

Generally, the working days in a week are from Monday to Saturday in the Tanzania. Hence, the general number of working days per week is six (6).

(2) National holidays

The list of the national holiday, based on 2015, is as in Table 10.74. The number of the national holidays in 2015 was 16 days.

Table 10.74: List of National Holiday in 2015

No.	Holiday	Date
1	New Year's Day	January 01
2	Prophets Birthday (Maulid Day)	January 03
3	Zanzibar Revolution Day	January 12
4	Good Friday	April 03
5	Easter Monday	April 06
6	Sheikh Abeid Aman Karume (Karume Day)	April 07
7	Union Day	April 26
8	Workers Day	May 01
9	Sabasaba	July 07
10	Eid UI Fitr	July 18
11	Nane Nane (Famer’s Day)	August 08
12	Eid AI Adha	September 23
13	Nyerere Day	October 14
14	Republic Day (Independence Day)	December 09
15	Christmas Day	December 25
16	Boxing Day	December 26

Source: http://www.egov.go.tz/home/pages/22

(3) Rainy Days and Estimated Work Suspension Days due to Rainfall

Table 10.75 shows the number of rainy days that has classified 8 ranges of precipitation per day observed at maximum railfall among Ibwaga and other four stations at Gulwe downstream area. from 2009 to 2013. It is assumed that all of the work items can be performed if the rainfall is less than ten millimeters (10 mm). If the rainfall is equal to or more than ten millimeters (10 mm), earth-related works such as excavation, embankment, backfill, topsoil furnishing, and road work are to be suspended until the next day.

If the rainfall is equal to or more than 20 mm, concrete-related works such as form, reinforcing bar, placing concrete, and masonry are to be suspended until the next day.

Table 10.75: Number of Rainy Days (Average 2009~2013)

Rainfall		Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
0mm		13.0	11.4	12.6	9.6	25.0	29.0	30.6	31.0	29.6	28.2	23.4	12.4	255.8
0<p<2mm		0.8	1.4	0.6	2.4	1.0	0.2	0.2	0.0	0.4	1.4	0.6	1.4	10.4
2≦p<5mm		1.2	2.0	2.6	4.8	2.4	0.2	0.2	0.0	0.0	0.6	1.2	3.0	18.2
5≦p<10mm		3.4	2.2	3.2	3.2	1.8	0.4	0.0	0.0	0.0	0.6	1.4	3.6	19.8
10≦p<20mm		6.6	5.0	4.8	5.6	0.6	0.0	0.0	0.0	0.0	0.2	0.6	3.0	26.4
20≦p<30mm		2.4	2.2	3.4	2.0	0.2	0.2	0.0	0.0	0.0	0.0	0.8	3.2	14.4
30≦p<50mm		2.2	3.6	2.0	1.8	0.0	0.0	0.0	0.0	0.0	0.0	1.6	2.6	13.8
over 50mm		1.4	0.4	1.8	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.4	1.8	6.4
Total		31.0	28.2	31.0	30.0	31.0	30.0	31.0	31.0	30.0	31.0	30.0	31.0	365.2

Source: JICA Study Team

The estimated work suspension days due to rainfall is shown in Table 10.76 for earthwork and related works. Table 10.77 shows the suspension days of concrete and masonry works.

Table 10.76: Estimated Work Suspension Days due to Rainfall (Earth and Related Works)

Criteria (Sus.days)		Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
0mm	**0.0**	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0<p<2mm	**0.0**	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2≦p<5mm	**0.0**	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5≦p<10mm	**0.0**	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10≦p<20mm	**1.0**	6.6	5.0	4.8	5.6	0.6	0.0	0.0	0.0	0.0	0.2	0.6	3.0	26.4
20≦p<30mm	**1.0**	2.4	2.2	3.4	2.0	0.2	0.2	0.0	0.0	0.0	0.0	0.8	3.2	14.4
30≦p<50mm	**1.0**	2.2	3.6	2.0	1.8	0.0	0.0	0.0	0.0	0.0	0.0	1.6	2.6	13.8
over 50mm	**1.0**	1.4	0.4	1.8	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.4	1.8	6.4
Total		**12.6**	**11.2**	**12.0**	**10.0**	**0.8**	**0.2**	**0.0**	**0.0**	**0.0**	**0.2**	**3.4**	**10.6**	**61.0**

Source: JICA Study Team

Table 10.77: Estimated Work Suspension Days due to Rainfall (Concrete and Related Works)

Criteria (Sus.days)		Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
0mm	**0.0**	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0<p<2mm	**0.0**	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2≦p<5mm	**0.0**	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5≦p<10mm	**0.0**	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10≦p<20mm	**0.0**	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20≦p<30mm	**1.0**	2.4	2.2	3.4	2.0	0.2	0.2	0.0	0.0	0.0	0.0	0.8	3.2	14.4
30≦p<50mm	**1.0**	2.2	3.6	2.0	1.8	0.0	0.0	0.0	0.0	0.0	0.0	1.6	2.6	13.8
over 50mm	**1.0**	1.4	0.4	1.8	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.4	1.8	6.4
Total		**6.0**	**6.2**	**7.2**	**4.4**	**0.2**	**0.2**	**0.0**	**0.0**	**0.0**	**0.0**	**2.8**	**7.6**	**34.6**

Source: JICA Study Team

The suspension days due to rainfall are summarized as follows:

- Earth and related works:
  Number of the rainy days with 10 mm or more precipitation: 61.0 days
  Percentage of the year: 61.0 / 365 =17%

- Concrete work and related work:
  Number of the rainy days with 20 mm or more precipitation: 34.6 days
  Percentage of the year: 34.6 / 365 = 9%

(4) Workable Day for Each Work Item

The workable days for each work item in Table 10.79 and Table 10.80 are calculated by the following relative equations:

- Rate of holidays (c= b/a):
  Number of holidays and Sundays (b) / Number of calendar days (a)
- Overlapping work suspension days due to rainfall with holidays (e= d x c):
  Work suspension days due to rainfall (d) x Rate of holidays (c)
- Net work suspension days due to rainfall except for holidays (f= d - e):
  Work suspension days due to rainfall (d) - Overlapping work suspension days due to rainfall with holidays(e)
  Number of calendar days (a) - Number of holidays and Sundays (b) - Net work suspension days due to rainfall except for holidays (f)
- Workable days (g= a - b - f):

Table 10.78: Number of Calendar Days in 2015 (Unit: days)

No.	Description	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
Calender days														
a.	Number of calendar days in 2015													
		31	28	31	30	31	30	31	31	30	31	30	31	365
b.	Number of holidays and Sundays in 2015 **(*1)**													
		7	4	5	7	6	4	6	6	5	5	5	7	67
c.	Rate of holidays (= b./a.)													
		23%	14%	16%	23%	19%	13%	19%	19%	17%	16%	17%	23%	18%

Table 10.79: Estimated Workable Days for Earth and Related Works

No.	Description	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
d.	Work suspension days due to rainfall **(*2)**													
		12.6	11.2	12.0	10.0	0.8	0.2	0.0	0.0	0.0	0.2	3.4	10.6	61.0
e.	Overlapping work suspension days due to rainfall with holidays (= d. x c.)													
		2.8	1.6	1.9	2.3	0.2	0.0	0.0	0.0	0.0	0.0	0.6	2.4	11.9
f.	Net work suspension days due to rainfall except for holidays (= d. - e.)													
		9.8	9.6	10.1	7.7	0.6	0.2	0.0	0.0	0.0	0.2	2.8	8.2	49.1
g.	Workable days (= a. - b. -f.), and the rounded off													
		14.2	14.4	15.9	15.3	24.4	25.8	25.0	25.0	25.0	25.8	22.2	15.8	248.9
		14	**14**	**16**	**15**	**24**	**26**	**25**	**25**	**25**	**26**	**22**	**16**	**248**

Table 10.80: Estimated Workable Day of Concrete and Related Works

No.	Description	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
d.	Work suspension days due to rainfall (*2)													
		6.0	6.2	7.2	4.4	0.2	0.2	0.0	0.0	0.0	0.0	2.8	7.6	34.6
e.	Overlapping work suspension days due to rainfall with holidays (= d. x c.)													
		1.4	0.9	1.2	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	1.7	6.7
f.	Net work suspension days due to rainfall except for holidays (= d. - e.)													
		4.6	5.3	6.0	3.4	0.2	0.2	0.0	0.0	0.0	0.0	2.3	5.9	27.9
g.	Workable days (= a. - b. -f.), and the rounded off													
		19.4	18.7	20.0	19.6	24.8	25.8	25.0	25.0	25.0	26.0	22.7	18.1	270.1
		19	**19**	**20**	**20**	**25**	**26**	**25**	**25**	**25**	**26**	**23**	**18**	**271**

Source: JICA Study Team

Note: (*1): The number of days is counted in the calendar 2015.
The overlapping days of holiday and Sunday are already deducted.
(*2): The days are counted based on the precipitation records of Gulwe and Godegode, using the five observation stations from a period of 5 years (2009-2013) (see Table 10.79 and Table 10.80).

The estimated workable days, considering Sundays, national holiday, and rainy days are summarized as follows:

Earth works:

Structural excavation, embankment, backfill, roadwork, and related works

248 days in a year = 20.7 days in one month
Coefficient of non-working days 365/248=1.47

Concrete works:

Masonry, revetment, and related works

271 days in a year = 22.6 days in one month
Coefficient of non-working day 365/271=1.35

(5) Working Hours

Considering the custom of working hours in Tanzania, the working hour in a day is set at eight (8) hours.

(6) Access Road

The project site is located around 50 km south of major road between Dar es Salaam and Dodoma. The bifurcated unpaved regional road (4-6 m width) connects Kilosa, Kidete, Godegode, and Gulwe Stations. Kidete Station is located in the middle of the construction site. Those roads are available for transportation of construction machinery, equipment, and materials (Figure 10.66).

Since most of the construction areas do not have roads along the mainstream, the main access roads along the mainstream from station to station, branch roads connecting to construction sites, and branch roads connecting from construction sites to tributaries are required. The access road shall be constructed from Kilosa, Kidete, Godegode, and Gulwe Stations, which are designed to be passing though the construction site along the mainstream.

The total length of access rod along rerouting railway section and river protection section is estimated around 100.1km. The typical section is shown in the following figure.

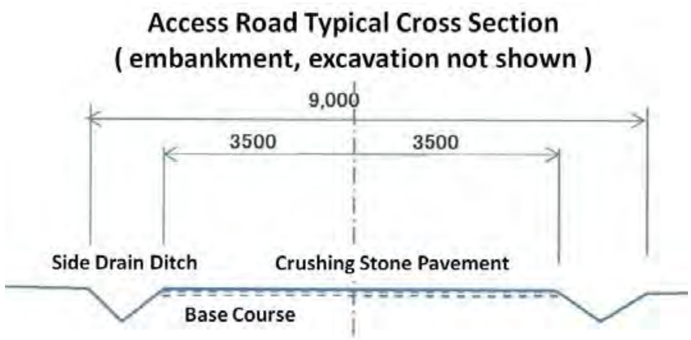


Figure 10.69: Access Road Typical Section

As of May 2016, there has been no discussion among the relevant stakeholders on how to use access (temporary) roads after completion of the Project. While a temporary road within ROW may be used for maintaining the railway and river structures, it may not be opened for the public because of safety issues.[4] In fact, none of the temporary roads have been opened to the public after project completion. As to the access (temporary) road outside ROW, RAHCO has no right to determine its usage due to non mandate on those roads.

(7) Borrow Area, Quarry Site and Disposal Area

Existing deposit of quarries, such as at Km 314 (L), Km 356, and Km 361-Km 362 (L) will be potential borrow areas. Those are shown in the following pictures.

Figure 10.70: Left: Confluence with Kidivo, Right: Km314 Quarry

Figure 10.71: Transportation of Crushed Stone from Borrow Pit at Km 361 to Construction Site at Km 315

4 RAHCO has carried out the maintenance work by means of a railway.

However, the exact candidates of the borrow area(s) for the Project will be selected before construction. Riverbed sands may be also used for the fine aggregate of concrete and/or embankment materials after assuring their quality.

Materials for embankment shall have cohesion for imperviousness, shear strength, and workability. In order to obtain such materials, quality control of the material is important. Before the commencement of construction, laboratory test shall be done for approval of the material from the borrow areas though investigation of soil properties such as water contents, particle size analysis, plasticity indexes, etc. During the construction, visual inspection is recommended in order to remove undesired obstacles, and water content should be frequently checked and well controlled for smooth compaction.

Possible disposal areas have been selected as reference points near by the current study. Considering the soil conditions in construction areas, water content control will be required at the disposal area for smooth compaction. Disposal areas shall be defined by RAHCO before the commencement of construction.

According to the earthwork volume from this Study, the volume of borrow area, quarry site, and disposal area is estimated as per the following table. However, these volumes shall be confirmed before construction, following the results of investigations for the above areas during the detailed design stage.

- Borrow area 50 x 1000 m^3
- Disposal area 90 x 1000 m^3, 110 x 1000 m^3
- Quarry site 350 x 1000 m^3

Table 10.81: Estimated Earthwork Volume

	PACKAGE-1		PACKAGE-2		PACKAGE-3		Total	
Description	Rail=Sec.1+2 River=Sec.1+2--8		Rail=Sec.3+5+7 River=Sec.9+--15		Rail=Sec.8+9 River=Sec.16+Maswara+Mzase			
Earth Work (m3)	Excavation	Embankment	Excavation	Embankment	Excavation	Embankment	Excavation	Embankment
Rail works	191,000	169,000	168,000	64,000	9,000	189,000	368,000	422,000
River works	26,000	52,000	40,000	70,000	310,000	34,000	376,000	156,000
Package total	217,000	221,000	208,000	134,000	319,000	223,000	**744,000**	**578,000**
Package total balance	Embankment > Excavation		Embankment < Excavation		Embankment < Excavation			
Required Spoil bank Volume=(Ex-Em/0.9) x 1.5	-43,000		89,000		107,000			
Soil conversion factor (compaceted soil 0.9)	m3 (Borrow pit)		m3 (Spoil bank)		m3 (Spoil bank)			
Gabion, Access road, Slope protection,	Loosed rock	Natural ground (m	Loosed rock	Natural ground (	Loosed rock	Natural ground (m3)*	Stone	
Rail ballast, etc.m3) Rail works	-	71,000	-	60,000	-	103,000	234,000	
River works	43,000	29,000	58,000	39,000	40,000	27,000	95,000	
Natural=Loosed / 1.5 : Soil conversion factor Package total		**100,000**		**99,000**		**130,000**	**329,000**	
Required volume concidering Tra.+Manu.losses Loss 20%		120,000		119,000		156,000		
Aggregate for concrete (m3)	Concrete (m3)	Aggregate (m3)	Concrete (m3)	Aggregate (m3)	Concrete (m3)	Aggregate (m3)	Aggregate	
Aggregate volume=0.7m3 / 1m3 concrete Rail works	-	2,500	-	2,100	-	3,700	8,300	
70% of concrete vol. River works	793	600	1,393	1,000	11,718	8,200	9,800	
Package total		**3,100**		**3,100**		**11,900**	**18,100**	
Required volume concidering Tra.+Manu.losses Loss 20%		3,700		3,700		14,300		

Source: JICA Study Team

(8) Labor

All necessary laborers can be found in Dar es Salaam, its surrounding areas, and villages surrounding the Project area.

(9) Equipment and Materials

All necessary construction equipment and materials can be purchased in Dar es Salaam and its surrounding areas, or other regions in Tanzania. However, sheet pile, crawler cranes, and mounting vibration hammers are not produced in Tanzania. Hence, those materials and construction equipment will be procured and transported from Japan or another country.

10.2.4 Construction Method

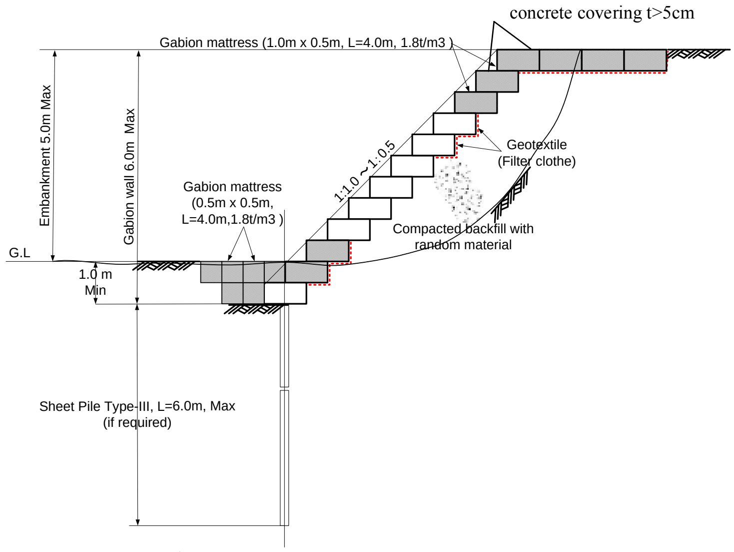
(1) General

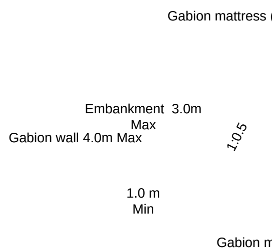
Most of the flood protection measures for rail and river structures include earthwork and concrete work. Considering the local market in Kilosa-Gulwe and its surrounding areas, ready-mixed concrete is not assumed for the construction method and cost estimation. Instead, procurement of concrete plant, or hand-mixing of concrete is considered for construction.

The effect of rainfall is already considered in the workable days calculation. However, detailed effects of the sequence of works, including river diversion works reflected by the dry and rainy season, shall be considered in the detailed design stage.

(2) Riverbank Protection for Main Stream

Structures for riverbank protection consists of slope protection by gabion with filter clothes, embankment, backfilling, concrete capping, and steel sheet piles for leakage failure and foot scouring measures. The standard cross-section of riverbank protection is presented in Figure 10.72.

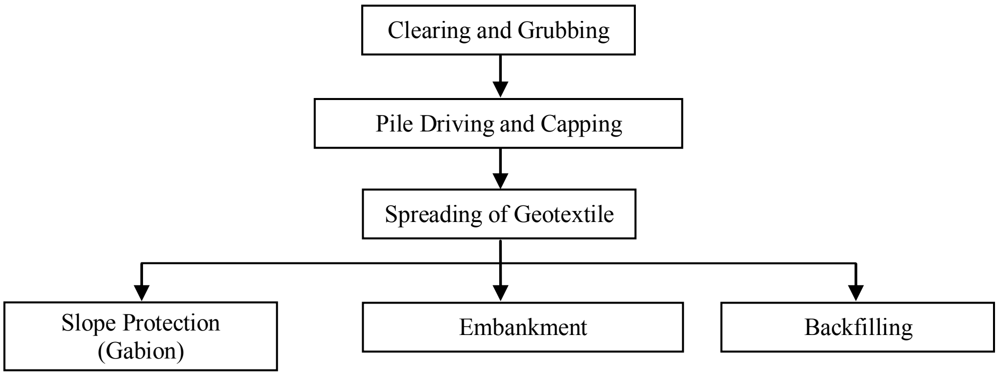




Source: JICA Study Team

Figure 10.72: Standard Cross-Section of Riverbank Protection

Flow of construction of the riverbank protection is shown in Figure 10.73.



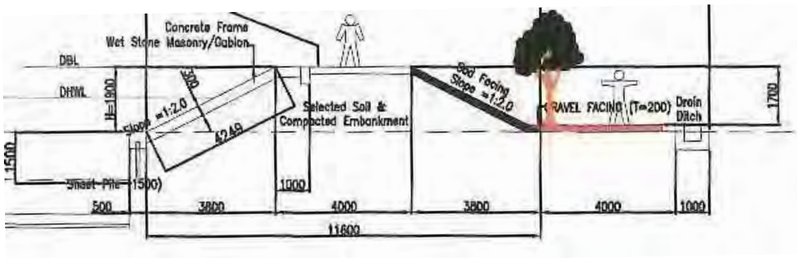
Source: JICA Study Team

Figure 10.73: Construction Flow of Riverbank Protection

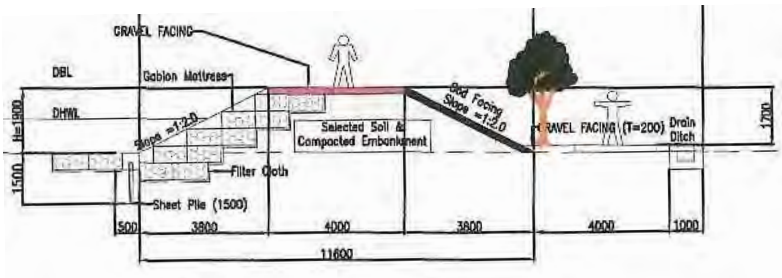
(3) Training Works for Tributary

1) Dike (Maswala, Mzase)

There are two types of dikes: the first one has wet masonry slope protection at groundsill portion. and the other has gabion slope protection. These have steel sheet piles for scouring measures. Dike body consists selected compacted soil, and gravel facing. Standard cross-sections for those dikes are shown in Figure 10.74.



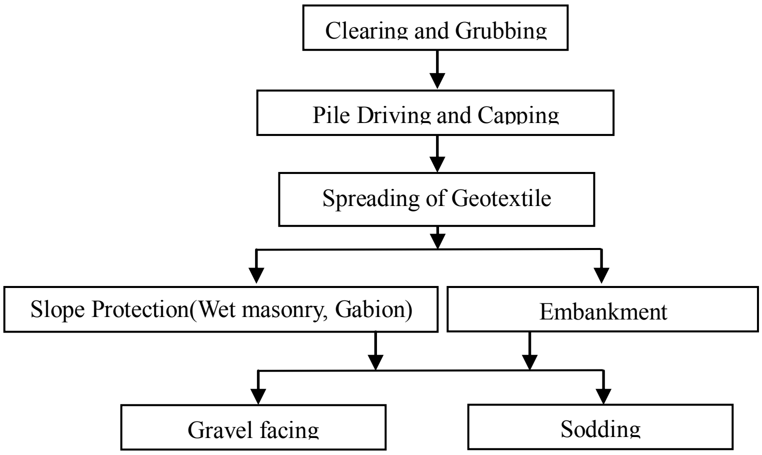
(Groundsill portion)



Source: JICA Study Team

Figure 10.74: Standard Cross-Section of Dike

Flow of construction of the dike is shown in Figure 10.75.



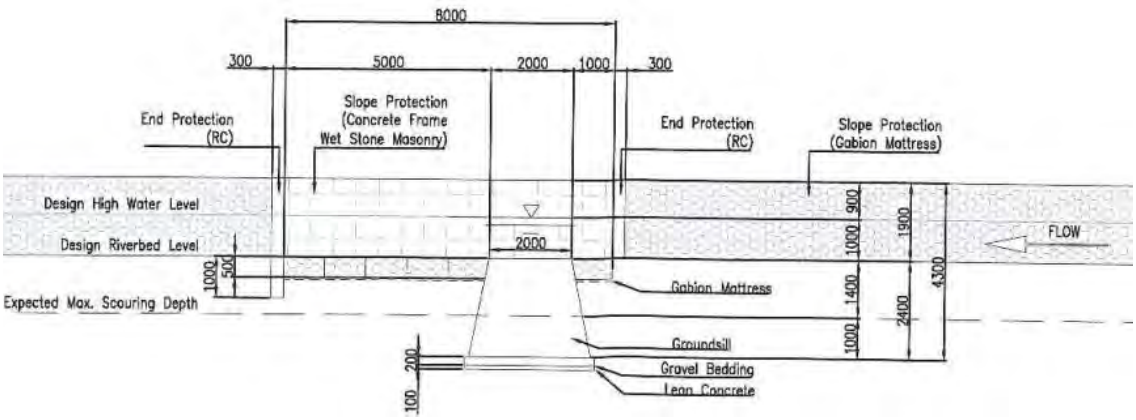
Source: JICA Study Team

Figure 10.75: Construction Flow of Dike

2) Groundsill (Maswala, Mzase)

The nine groundsills of 90 m width are provided in the Maswala River, and five of 40 m width in the Mzase River. The groundsills consist of a main body and apron by gabion mattress.

Standard cross-sections for those dikes are shown in Figure 10.76. The flow of construction of the groundsill is shown in Figure 10.77.



Source: JICA Study Team

Figure 10.76: Standard Cross-Section of Groundsill

Clearing, Grubbing

↓

Excavation for main body of ground sill and gabion mattress

↓

Form work and Concrete work (including gravel bedding and leveling concrete)

↓

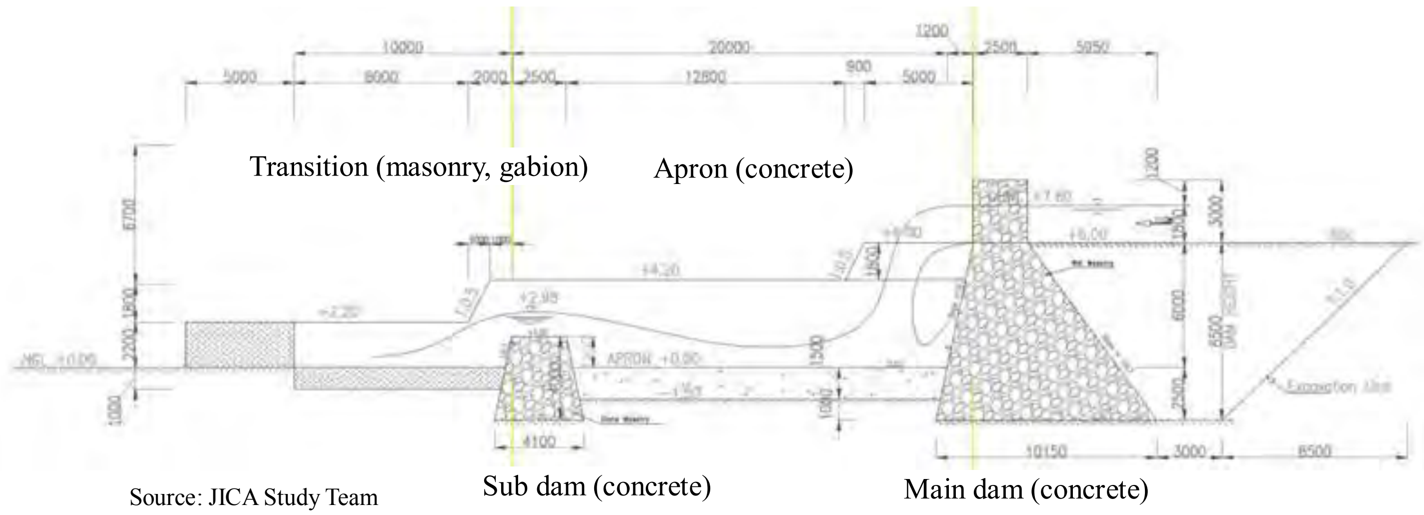
Backfilling | Gabion mattress

Source: JICA Study Team

Figure 10.77: Construction Flow of Groundsill

3) Check dam (Maswala)

The check dam is provided at the downstream end of the Maswala river training works. The check dam consists of a concrete body, apron, and transition structures. The standard cross-section for check dam is shown in Figure 10.78. The flow of construction of the check dam is shown in Figure 10.79.



Source: JICA Study Team

Figure 10.78: Standard Cross-Section of Check Dam

Clearing and Grubbing

↓

Excavation for concrete body, apron, and gabion mattress

↓

Form work and Concrete work (including gravel bedding and leveling concrete)

↓

Embankment, Backfilling | Gabion mattress

Source: JICA Study Team

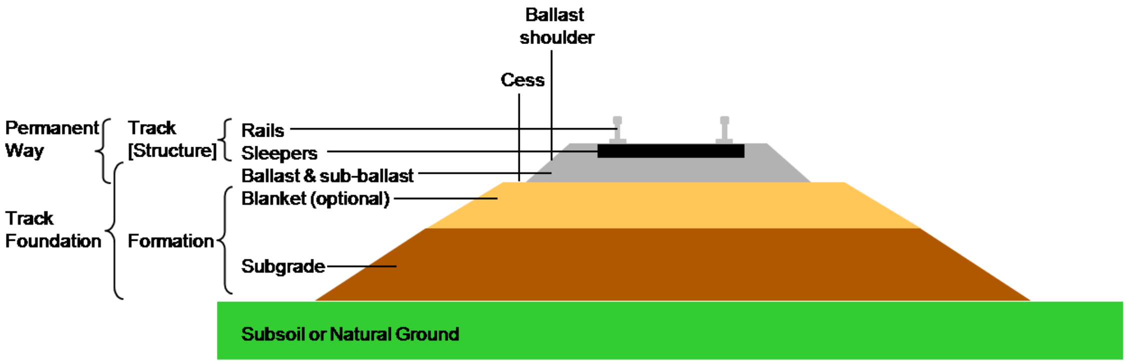
Figure 10.79: Construction Flow of Check Dam

(4) Rerouting of Railway

1) Railway Embankments

i) Track bed

The track bed consists of the layers of ballast and sub-ballast above a prepared subgrade/formation (see Figure 10.83). It is designed primarily to reduce the stress on the subgrade.



Source: JICA Study Team

Figure 10.80: Section of Railway Track and Foundation

ii) Railway Embankments

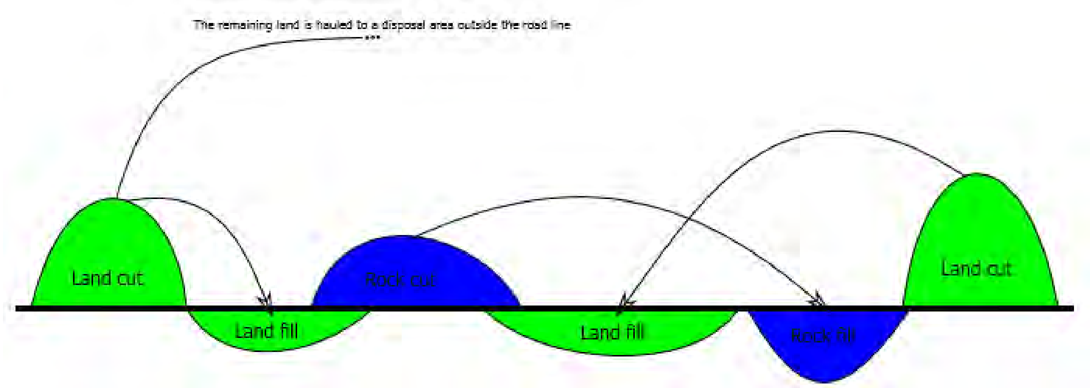
The railway embankment is normally a large structure, the construction of which always involves moving vast amounts of good-quality soil. Therefore, the planning of the railway consists of excavating earth of equal quantity as the embankment requirements necessitate.

- Materials

Embankments are often constructed using materials obtained from a cutting procedure. Embankments need to be constructed using non-aerated, waterproofed, and compacted (or entirely non-porous) material to provide adequate support to the formation and a long-term level surface with stability.

- Cut and fill

In earthmoving, cut and fill is the process of constructing the railway whereby the amount of material from cuts roughly matches the amount of fill needed to make nearby embankments, so minimizing the amount of construction works.



Source: JICA Study Team

Figure 10.81: The Balance of Cut and Fill

For the fill material, it is necessary to check the material and compaction characteristics of the soil at the site, and if it is inadequate, to source it from a separate soil field.

10.2.5 Productivity for Major Works

Table 10.82 shows the relationship between construction equipment for major work items and their associated productivities.

Table 10.82: Productivity for Major Work Item

Work Item	Equipment, Manpower	Productivity	Remarks
Excavation	Dump Truck (4 ton) Backhoe (0.8 m^3)	60 m^3/day/party	Productivity is calculated based on the Standard Cost Estimation for Civil Works in Japan
Embankment	Motorized Road Grader Vibratory Roller (12 MT) (Dump Truck (10 t)	270 m^3/hr./party	-do-
Gabion works	One party consists of: Backhoe (0.6 m^3) -1 set Forman-1 Skilled labor -2 Unskilled labor-5	One party: 300 m^3 Gabion /month	-do-
Steel Sheet Pile (Driving)	Crawler Crane (50 t) Vibratory Hammer (60 kW) Sheet pile 0.4W, 6.0L	One party: 480 m^2 sheet pile/month	-do-
Cutting works	Dump Truck (10 t) Backhoe (1.0 m^3) & Hydraulic breaker	41 m^3/day/party	-do-
Railway Embankment	Dump Truck (10 t) Bulldozer (10 t) Motorized Road Grader (3.7 m) Backhoe (1.0 m^3) Vibratory Roller (12 MT)	360 m^3/day/ party	-do
Slope protection work	One party consists of: Track crane (25 t) -1 set Forman-3 Skilled labor -4 Unskilled labor-10	One party: 48 m^2/day/ month	-do-

Source: JICA Study Team

10.2.6 Location of Construction Works

Table 10.83 shows the location of rerouting railway, riverbank protection, and access road. The construction zone is to be separated into five zones considering the quantities of construction works, construction schedule, and associated costs. The track installation/rehabilitation work is shown in Table 10.84. The layout plan and location of above construction works are indicated in Figure 10.82 and Table 10.85 respectively.

Table 10.83: Construction Zones

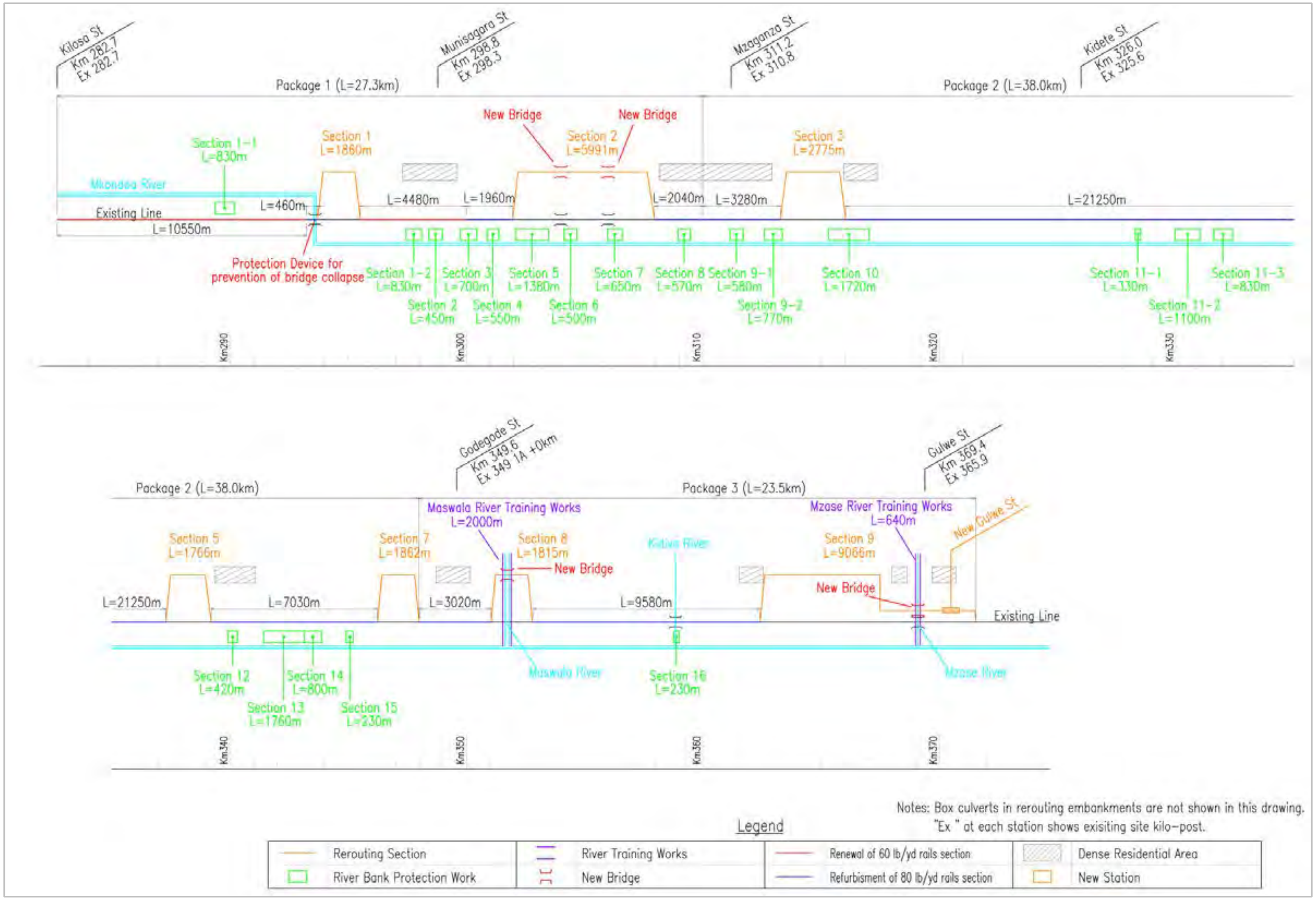
PACKAGE	CONSTRUCTION ZONE	Length for Access road, Re-route of railway, and River bank protection												
		Sheet No.	Description	Length (km)										
				Railway			Access road		Railway			River		
				From	To	Existing	New construction	Improvement of existing	No	Re-route	km	No	Bank protection	km
1	1	1 Kilosa B.P(km283.5 C.E.R)		**283.5**	285.0	1.5								
		2		285.0	288.0	3.0								
		3		288.0	291.0	3.0	1.6					1-1	289.38-290.20	0.83
		4 No.1 SP293.8 Bridge ≒80m is reqiued		291.0	295.0	4.0	4.0							
		5 No.1 EP295.5		295.0	298.5	3.5	3.6		1	293.8~295.5	1.7	1-2	297.45-298.11	0.71
		6 No.2 SP302		298.5	299.0	0.5	0.5					2	298.42-298.99	0.45
		6 No.2 SP302		299.0	300.0	1.0	1.0					3	299.75-300.45	0.70
		6 No.2 SP302		300.0	301.0	1.0	1.0					4	300.88-301.38	0.55
	2	6 No.2 SP302		301.0	302.0	1.0	1.0							
		7 No.2 SP302		302.0	303.0	1.0	3.9		2	302.0		5	302.08-303.48	1.38
		7 No.2 SP302		303.0	304.0	1.0	1.0							
		7 No.2 SP302		304.0	305.0	1.0	1.0					6	304.14-304.67	0.50
		8		305.0	306.0	1.0	1.0					7	305.96-306.6	0.65
		9 No.2 EP307.9		306.0	309.0	3.0	3.1			307.9	5.9	8	308.96-309.48	0.57
2	3	10 MZAGANZA		309.0	312.7	3.7	3.7					9-1	311.15-311.71	0.58
		11 No.3 SP313.3		312.7	317.0	4.3	4.5		3	313.3~316.0	2.7	9-2	312.6-313.37	0.77
		11 MANGALADASI (Conecting to existing road km316 C.E.R)				0.0	0.8					10	315.32-317.04	1.72
		12		317.0	321.35	4.4	4.3							
		12 Conecting to existing road (km 318.9 C.E.R)				0.0	0.4							
		13 Kidete (km 325.8 C.E.R)		321.35	325.8	4.4		5.0	Bridge ≒50m is required					
		14		325.8	326.46	0.7	0.7							
		14		326.46	328.4	1.9		2.0				11-1	328.29-328.52	0.33
		15		328.4	331.8	3.4	3.2					11-2	329.98-331.03	1.10
		16		331.8	335.0	3.2	3.1					11-3	331.62-332.40	0.83
		17		335.00	336.4	1.4		1.4						
		17		336.4	337.1	0.7	0.7							
	4	17		337.10	339.0	1.9		1.9	5	337.3~339.2	1.9			
		18		339.0	340.7	1.7	1.7					12	339.92-340.32	0.42
		18		340.70	342.0	1.3		1.3				13	341.43-343.20	1.76
		19		342.00	345.0	3.0		3.0				14	343.20-343.88	0.80
		20 Godegode (km 349.1C.E.R)		345.00	349.1	4.1		4.1	7	346.2~348.0	1.8	15	344.92-345.23	0.23
3	5	21 Maswala (km351.5 C.E.R)		349.10	351.6	2.5		2.9	8	351.0				
		21 New construction road		351.60	353.0	1.4		1.8		352.8	1.8			
		at left bank to 353.0km (Bridge ≒80m is required)												
		21 Access road for Maswala river measures					2.3						MASWALA	
		22		353.00	355.0	2.0		2.0					check dam including	
		23 Kidebo		355.00	356.1	1.1		1.1					(2000m)	
		23 Kidebo		356.1	356.35	0.25	0.3							
		23 Kidebo		356.35	359.0	2.6		2.6				16	358.76-358.98	0.23
		24 Kidebo		359.00	363.0	4.0		4.0	9	362.4				
		25		363.00	367.0	4.0		4.0						
		26 Mzase		367.00	368.9	1.9		1.9						
		26 Mzase (km369.75 C.E.R)		368.9	369.75	0.9							MZASE	
		26 New construction road											(640m)	
		at right bank Mzase river (Submerged Bridge≒70m required)					0.5	1.0						
		26 Mzase		369.75	**371.4**	1.6	1.6			371.6	9.2			
		26 Access road for Mzase river measures					0.6							
Note ;				Sub total		87.9	50.9	40.1						
C.E.R; Connecting to existing road						**Access Road total (km)**			**Re-routing railway**			**Bank protection**		
Existing rail point in km							**91.0**				**25.0**			**15.11**
6.0m steel sheet pile section : 4,5,9-2,10,11-1,11-2, and 16														
Package-4 : Renewal of 60lb/yd rails by 80lb/yd (15km) and Refurbish of ballast & track rectification (48.8km) not shown														

Source: JICA Study Team

Table 10.84: Summary of Packages (Unit: km)

Work Items	Package 1	Package 2	Package 3	Total
Railway rerouting construction works	7.8	6.4	11.0	25.2
Bank protection for main stream	6.34	8.54	0.23	15.11
Tributary River Training Work	-	-	2.64	2.64
Temporary road	25.5	40.1	34.5	100.1
Installation of track	7.8	6.4	11.0	25.2
Renewal of 60lb/yd rails by 80lb/yd rails	15.0	-	-	15.0
Refurbishment of 80lb/yd rails section	4.6	31.6	12.6	48.8
Relocation of Gulwe Station	-	-	1-lump	1-lump

Source: JICA Study Team



Source: JICA Study Team

Figure 10.82: Layout Plan of Flood Protection Works and Track Rehabilitations of Alternative B-2

Table 10.85: Location of Flood Protection Works and Track Rehabilitation of Alternative B-2

1. Retouting Section

Section	Start (km)[1]	End (km)[1]	Length (m)
1	293.71	295.52	1,860
2	301.96	307.96	5,991
3	313.28	316.05	2,775
5	337.30	339.21	1,766
7	346.24	348.00	1,862
8	351.02	352.82	1,815
9	362.41	371.56	9,066
Total	-	-	25,134

[1] New kilometerage.

2. Renewal of 60 bl/yd rails section

Section	Start (km)[1]	End (km)[1]	Length (m)
1	282.70	293.25	10,550
2	295.52	300.00	4,480
Total	-	-	15,030

[1] New kilometerage.

3. Refurbisment of 80 lb/yd railssection

Section	Start (km)[1]	End (km)[1]	Length (m)
1	293.25	293.71	460
2	300.00	301.96	1,960
3	307.96	310.00	2,040
4	310.00	313.28	3,280
5	316.05	337.30	21,250
6	339.21	346.24	7,030
7	348.00	351.02	3,020
8	352.82	362.41	9,580
Total	-	-	48,620

[1] New kilometerage.

4. River Bank Protection Work

Section	Start (km)[1]	End (km)[1]	Length (m)
1-1	289.38	290.20	830
1-2	297.45	298.11	830
2	298.42	298.99	450
3	299.75	300.45	700
4	300.88	301.38	550
5	302.08	303.48	1,380
6	304.14	304.67	500
7	305.96	306.60	650
8	308.96	309.48	570
9-1	311.15	311.71	580
9-2	312.60	313.37	770
10	315.32	317.04	1,720
11-1	328.29	328.52	330
11-2	329.98	331.03	1,100
11-3	331.62	332.40	830
12	339.92	340.32	420
13	341.43	343.14	1,760
14	343.14	343.88	800
15	344.92	345.23	230
16	358.77	359.00	230
Total	-	-	15,230

[1] New kilometerage.

5. Box Culverts

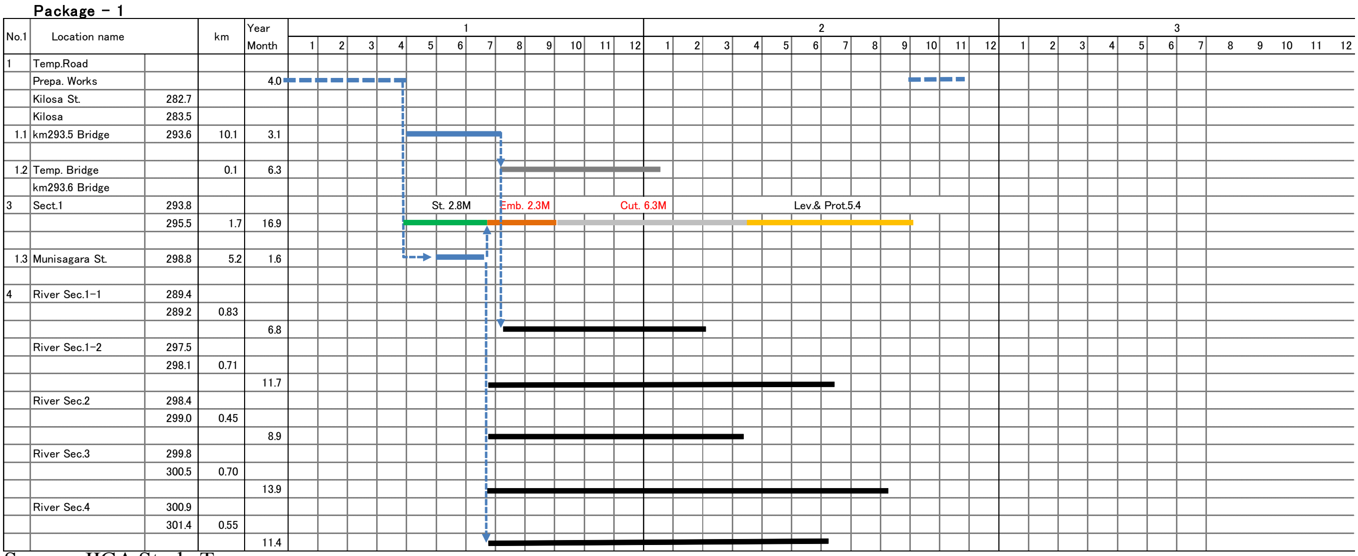
No.		Ground Elevation (rail center) (EL.m)	Height of Embankm't H (m)	Required Number of Barrel			
				1.0m*1.0m	1.5m*1.5m	2.0m*2.0m	3.0m*3.0m
1	R1-1	518.84	1.54	1	1	1	1
2	R1-2	520.19	1.03	2	1	1	1
3	R1-3	522.00	1.74	2	1	1	1
4	R1-4	522.30	3.60	1	1	1	1
5	R1-5	523.71	3.77	2	1	1	1
6	R1-6	523.44	2.69	26	8	4	2
7	R2-1	552.56	1.61	2	1	1	1
8	R2-2	555.58	1.32	2	1	1	1
9	R2-3	553.88	2.70	2	1	1	1
10	R2-4	553.59	6.79	18	6	3	1
11	R2-5	559.63	3.02	1	1	1	1
12	R2-6	559.35	2.62	1	1	1	1
-	R2-7	560.20	3.92	-	-	-	-
13	R2-8	561.05	6.69	1	1	1	1
14	R2-9	565.04	6.30	10	3	2	1
15	R2-10	565.22	5.88	3	1	1	1
16	R2-11	570.76	2.70	1	1	1	1
-	R2-12	569.99	2.42	-	-	-	-
17	R2-13	572.14	1.63	1	1	1	1
18	R2-14	571.61	3.44	2	1	1	1
19	R2-15	572.29	3.16	1	1	1	1
20	R2-16	573.24	2.34	2	1	1	1
21	R2-17	575.25	-0.51	3	1	1	1
22	R3-1	603.68	-0.41	14	4	2	1
23	R3-2	602.12	7.15	22	7	3	1
24	R3-3	602.89	8.18	3	1	1	1
25	R3-4	614.73	-0.86	2	1	1	1
26	R3-5	610.92	5.55	1	1	1	1
27	R3-6	611.13	5.30	1	1	1	1
28	R3-7	614.43	-0.67	427	122	60	20
29	R5-1	694.32	2.03	1	1	1	1
30	R5-2	701.79	-0.24	133	38	19	7
31	R5-3	704.22	0.66	200	57	28	10
32	R5-4	701.54	1.66	1	1	1	1
33	R7-1	733.65	0.11	18	6	3	1
34	R7-2	737.48	4.28	90	26	13	5
35	R7-3	736.17	-0.50	56	16	8	3
36	R8-1	750.93	2.10	1	1	1	1
37	R8-2	754.41	1.82	1	1	1	1
38	R8-3	755.06	2.33	7	2	1	1
39	R8-4	756.86	1.45	1	1	1	1
40	R8-5	754.29	1.59	3	1	1	1
41	R9-1	770.88	1.66	1	1	1	1
42	R9-2	771.59	2.96	1	1	1	1
43	R9-3	774.55	1.60	1	1	1	1
44	R9-4	775.48	2.87	11	3	2	1
45	R9-5	776.37	2.58	3	1	1	1
46	R9-6	776.54	4.35	6	2	1	1
47	R9-7	776.54	3.39	28	8	4	2
48	R9-8	775.51	4.86	7	2	1	1
49	R9-9	779.64	2.17	28	8	4	2
50	R9-10	775.13	6.30	4	1	1	1
51	R9-11	777.18	5.14	5	2	1	1
52	R9-12	783.39	2.02	22	7	4	1
53	R9-13	781.29	4.52	2	1	1	1
54	R9-14	788.28	2.60	1	1	1	1
55	R9-15	788.67	4.44	3	1	1	1
56	R9-16	789.22	0.76	1	1	1	1
57	R9-17	782.26	3.82	18	6	3	1
58	R9-18	784.32	4.26	2	1	1	1
59	R9-19	784.63	4.84	33	10	5	2
60	R9-20	786.75	2.72	2	1	1	1
61	R9-21	785.33	3.83	2	1	1	1
62	R9-22	784.70	1.38	3	1	1	1
63	R9-23	783.28	2.80	7	2	1	1
64	R9-24	784.62	1.46	10	3	2	1
65	R9-25	782.69	3.35	18	5	3	1

Notes:
1) A total of 65 box culverts is planned in the rerouting sections, with an average interval of 380 m
2) The exact location of box culverts will be determined in the detailed design in consideation of a condition of each site
3) Red colored values are chosen as recommendations.

Source: JICA Study Team

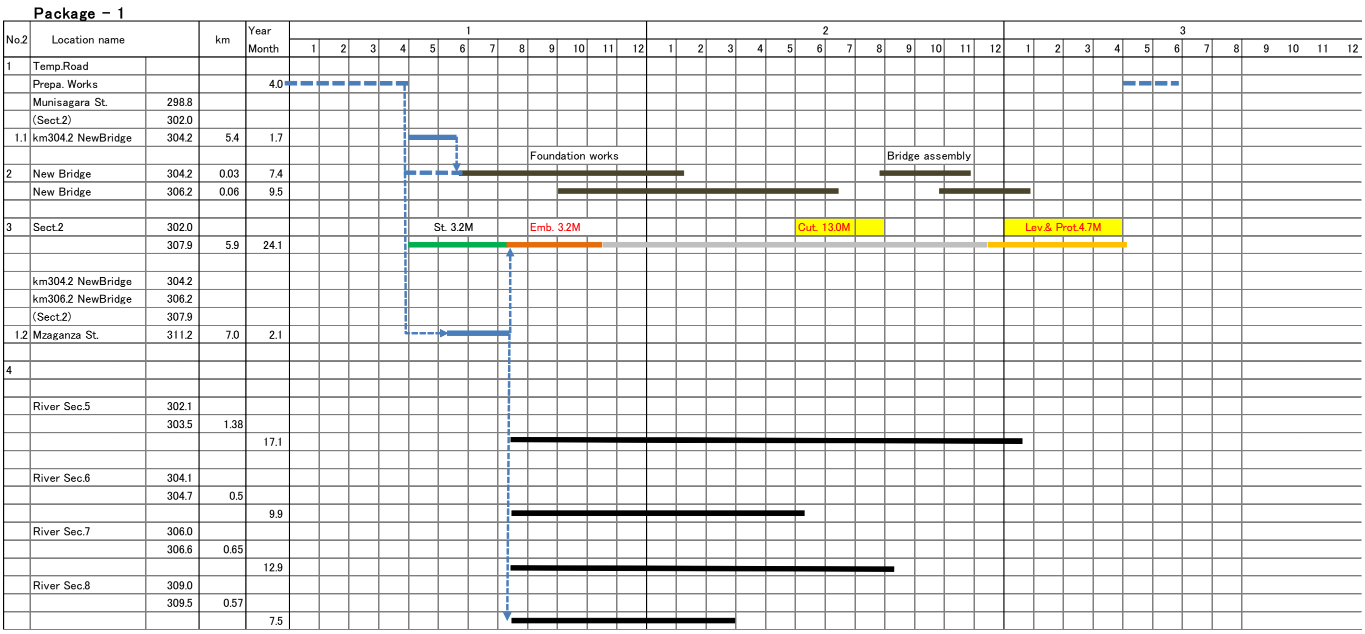
10.2.7 Construction Schedule

Figure 10.83-Figure 10.87 show the construction schedule of temporary roads, railway rerouting, and riverbank protection for the five construction zones.



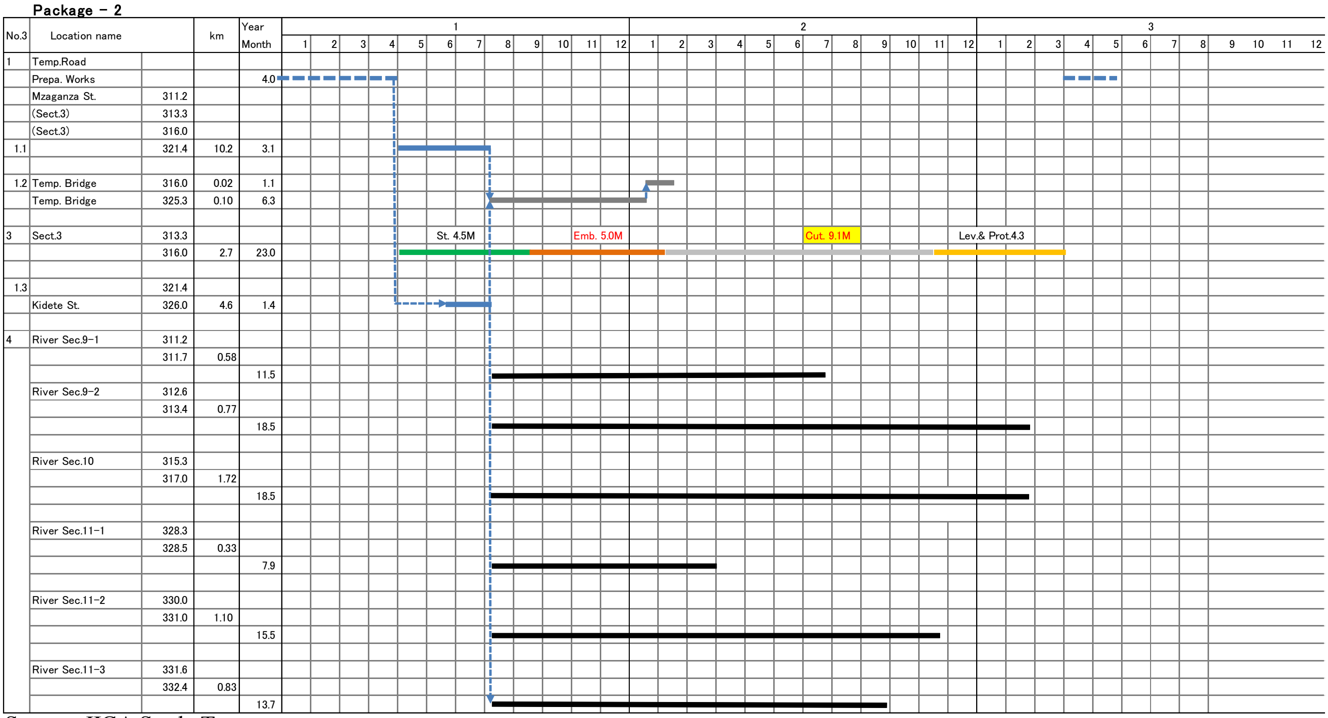
Source: JICA Study Team

Figure 10.83: Construction Schedule Package 1 (Construction Zone 1)



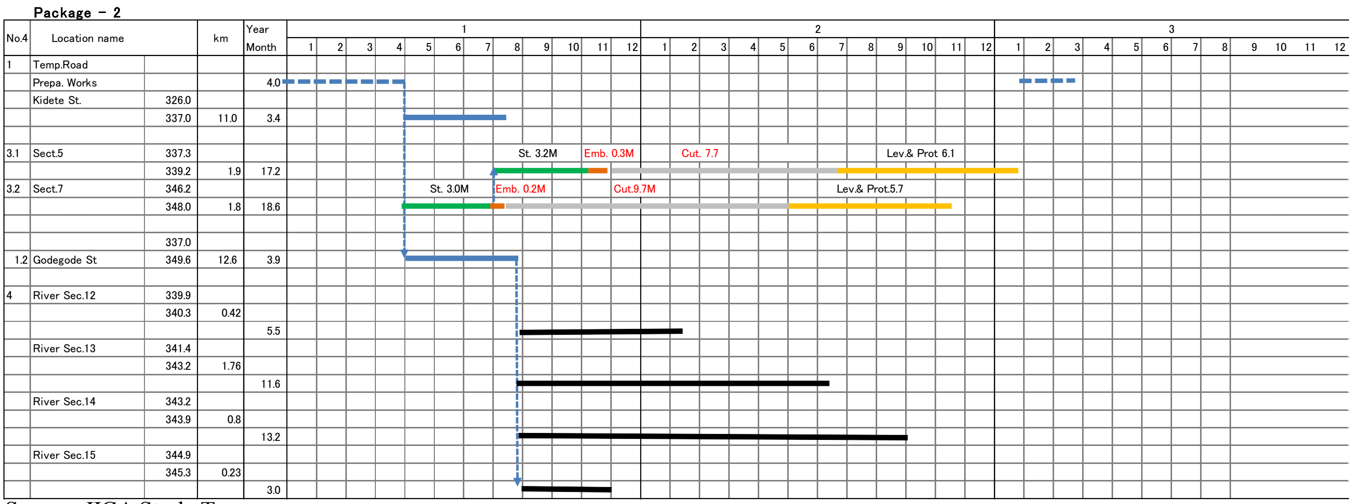
Source: JICA Study Team

Figure 10.84: Construction Schedule Package 1 (Construction Zone 2)



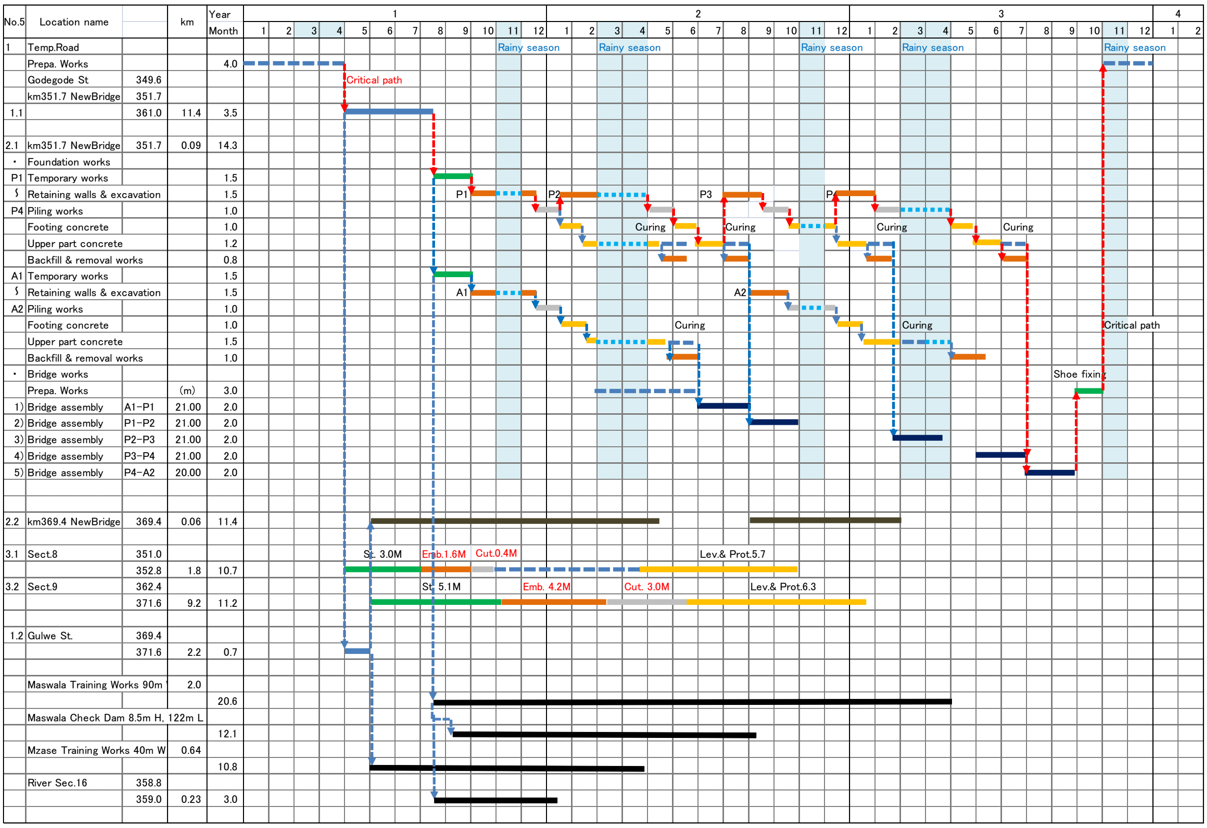
Source: JICA Study Team

Figure 10.85: Construction Schedule Package 2 (Construction Zone 3)



Source: JICA Study Team

Figure 10.86: Construction Schedule Package 2 (Construction Zone 4)



Source: JICA Study Team

Figure 10.87: Construction Schedule Package 3 (Construction Zone 5)

10.3 Preliminary Cost Estimate

10.3.1 Basic Condition of Cost Estimate

(1) Price Level

The cost estimate was conducted using the price levels as of April 2016.

(2) Exchange Rate

The exchange rates are set forth as follows:

TZS1 = 0.0516JPY
US$1 = 2,189.67TZS
US$1 = 113.1JPY

(3) Currency for Cost Estimates

The Project cost components shall consist of local currency (TZS) and foreign currency (JPY) portions. The classifications of local and foreign currency portions are as follows:

1) Local Currency Portion

All labor costs
A part of cost for construction materials
A part of cost for equipment lease
Value Added Tax (VAT)

Import Tax

2) Foreign Currency Portion

A part of cost of construction materials that require international quality
A part of cost for equipment lease and services that require international quality

10.3.2 Methodology of Cost Estimate

Costs for construction works are essentially estimated on the unit price basis. The unit prices include various costs as described below:

(1) Construction Cost

The construction cost consists of labor, material, and equipment cost. These costs are shown in following tables as reference. And additional ten percent (10%) of the estimated direct cost will be added as mobilization and demobilization cost in this Project.

1) Labor Cost

Labor rates are shown in Table 10.86.

Table 10.86: Labor Costs

Description	Unit	Local Currency TZS/day
1. Foreman	man/day	64,000
2. Skilled labor	man/day	34,000
3. Unskilled labor	man/day	25,000
4. Carpenter	man/day	32,000
5. Rigger	man/day	34,000
6. Mason	man/day	34,000
7. Plasterer	man/day	34,000
8. Electrician, Mechanic	man/day	43,000
9. Pipe fitter	man/day	34,000
10. Painter	man/day	34,000
11. Operator (Dump, Heavy equipment)	man/day	42,000
12. Welder	man/day	34,000

Notes on salary:
1) Basic consideration: Tanzania Ministry of Labor and Employment, “New Minimum Wages for Private Sectors 2013-“ +Allowance (40% of minimum wage on construction services sector)
2) Condition of minimum wage: 1 day=9.0 hr (including 1.0 hr overtime), 1 week=6 days working day, and 1 month=26 days working day
3) Various allowance for social insurance, retirement, and taxes are included in “salary”
4) Overtime = weekdays multiplier by normal rate is 1.5, Overtime=weekends multiplier by normal rate is 2.0
Source: JICA Study Team

2) Material Cost

The costs of construction materials and supplies are shown in Table 10.87.

Table 10.87: Material Cost

Material	Description	Unit	US$	TZS	JPY
Cement	42.5 N/mm^2	ton	142.00	309,560	17,296
Sand	0-5 mm	m^3	17.00	37,060	2,071
Crushed stone	5-20 mm	m^3	54.00	117,720	6,577
Gravel	2-20 mm	m^3	54.00	117,720	6,577
Admixture	AE (200lit/drum)	drum	600.00	1,308,000	73,080
Ready mixed concrete	18N/mm^2	m^3	137.09	298,856	16,698
Ready mixed concrete	24N/mm^3	m^3	154.78	337,420	18,852
Hot mix asphalt concrete	AC20	ton	133.84	291,771	16,302
Hot mix asphalt concrete	AC14	ton	133.84	291,771	16,302
Plywood (form)	12 mm	m^2	13.00	28,340	1,583
Deformed bar	BS Grade 460	ton	1,075.00	2,343,500	130,935
Equal angel steel	L-75*75	ton	1,352.00	2,947,360	164,674
Channel steel	[-100*50	ton	1,316.00	2,868,880	160,289
H-Beam	H-300	ton	1,202.00	2,620,360	146,404
Steel sheet pile	SYW295 (II, hat 25H)	ton	1,674.88	3,651,232	204,000
RC pipe	d300 mm, L=1.0 m	nos.	35.00	76,300	4,263
RC pipe	d600 mm, L=1.0 m	nos.	65.00	141,700	7,917
RC pipe	d900 mm, L=1.0 m	nos.	110.00	239,800	13,398
PVC pipe	d 100 mm	m	10.00	21,800	1,218
PVC pipe	d 150 mm	m	14.00	30,520	1,705
Geotextile	t=10 mm with anchor	m^2	8.00	17,440	974
Gabion	0.5H*1.2W*10L (m)	m	27.91	60,854	3,400
Interlocking block	t=60 mm	pc	0.36	785	44
Diesel		lit	1.33	2,899	162

Source: JICA Study Team based on the information from TANROAD and local supplies

3) Equipment Cost

The daily-operated rental rates are shown in Table 10.88. As for special equipment and machinery, such as a vibration hammer, the operation costs have been estimated based on the information presented by local suppliers.

Table 10.88: Equipment Costs

Description	US$/month	US$/day	TZS/day	JPY/day
Back hoe 0.45 m^3	5,200	200	436,000	24,360
Back hoe 0.8 m^3	9,100	350	763,000	42,630
Dump truck 4 ton	2,600	100	218,000	12,180
Dump truck 10 ton	3,380	130	283,400	15,834
Heavy truck 10 ton	3,380	130	283,400	15,834
Trailer low bed	4,680	180	392,400	21,924
Trailer flat bed	8,320	320	697,600	38,976
Unic truck crane 4 ton	2,860	110	239,800	13,398
Truck crane 25 ton	8,320	320	697,000	38,976
Crawler crane 50 ton	15,600	600	1,308,000	73,080
Motor grader 3.1 m	10,400	400	872,000	48,720
Wheel loader 2.0 m^3	5,200	200	436,000	24,360
Vibration hammer 60 kW	4,680	180	392,400	21,924
Vibration hammer 60 kW (for hat type 900 mm)	10,920	420	915,600	51,156
Concrete agitator truck 5 m^3	7,800	300	654,000	36,540
Concrete pump (boom) 110 m^3/hr	5,200	200	436,000	24,360
Vibration roller 2 ton	6,240	240	523,200	29,232
Vibration roller 10 ton	6,240	240	523,200	29,232
Macadam roller 10 ton	6,240	240	523,200	29,232
Tire roller 13 ton	6,500	250	545,000	30,450
Walkbind roller 700 kg	1,560	60	130,800	7,308
Asphalt finisher 2.4/4.5 m	7,800	300	654,000	36,540
Air compressor 18.5 m^3/min	5,200	200	436,000	24,360

Description	US$/month	US$/day	TZS/day	JPY/day
Power generator 46 kVA	1,170	45	98,100	5,481
Power generator 200 kVA	5,200	200	436,000	24,360

Notes: 1) Average operation hour per month = 260 hr (normal hour 220 hr + overtime 40 hr),
2) 1 month = 26 days operating days,
3) Price is equipment owner ship cost. Not including fuel and operator cost.
Source: JICA Study Team

4) Other Costs

Other costs consists of overhead expenses, temporary construction cost and field expenses, miscellaneous expenses, and contractors' profit margin as follows:

a) Overhead Expenses

The overhead expenses are for engineering and administrative cost, transportation allowance, office expense, a premium on Contractor's All Risk Insurance (CARI), financing costs (such as premium on bid security), etc.

b) Temporary Construction Cost and Field Expenses

The temporary construction cost and the field expenses are for meetings, coordination with other stakeholders, billboards, stages during groundbreaking and inauguration ceremonies, as well as during other unforeseen events.

c) Miscellaneous Expenses

The miscellaneous expenses are included as laboratory tests for quality control and plan preparation.

d) Contractors' Profit Margin

The contractors' profit margin is included in the other costs.

5) Mobilization and Other Expenses

Mainly before the main construction period starts, there are several works or issues shall be done or considered. Mobilization and demobilization, temporary facility, utility, housing, camp set-up, camp take-down, construction safety and health checks, geological survey, etc. This cost is estimated at ten percent (10%) of the sum of direct cost.

10.3.3 Project Cost

(1) Construction Costs

The total construction cost is shown in Table 10.89. The construction cost for each package is shown in Table 10.90-Table 10.92**.**

Table 10.89: Construction Cost (at Current Price)

item	unit	Quantity	Unit Price		Cost		Total
			Foreign	Local	Foreign	Local	
			JPY	TZS	JPY	TZS	JPY
Railway rerouting construction works (25.1km)							
Embankment work	m3	470,000	314.6	54,876.9	147,874,969	25,792,145,820	1,478,749,694
Embankment protection work	m2	41,000	7,375.1	571,713.9	302,379,488	23,440,270,392	1,511,897,440
Embankment sod facing work	m2	107,000	957.6	74,232.5	102,463,092	7,942,875,360	512,315,461
Soil replacement work	m3	528,800	610.3	47,306.3	322,700,735	25,015,560,864	1,613,503,676
Side ditch	m	50,200	5,188.1	402,176.0	260,441,160	20,189,237,208	1,302,205,800
Cutting work	m3	366,000	467.6	81,561.2	171,148,125	29,851,417,134	1,711,481,249
Cutting protection work	m2	103,000	8,767.3	396,454.7	903,033,273	40,834,837,911	3,010,110,909
Bridge work	m	255	2,008,670.8	25,951,818.8	512,211,047	6,617,713,787	853,685,079
Culvert work	set	65	9,098,426.7	264,489,147.4	591,397,734	17,191,794,581	1,478,494,334
Bridge collapse work	set	1	5,006,232.0	97,020,000.0	5,006,232	97,020,000	10,012,464
Bank protection for main stream 15.11km							
Gabion	m3	102,000	8,296.0	375,144.0	846,196,243	38,264,688,000	2,820,654,144
Geotextile	m2	170,000	750.9	9,702.0	127,658,916	1,649,340,000	212,764,860
Excavation	m3	67,000	125.2	21,829.5	8,385,439	1,462,576,500	83,854,386
Embankment	m2	124,000	232.4	40,540.5	28,821,593	5,027,022,000	288,215,928
Steel Sheet Pile	l.m	91,250	10,441.6	134,904.0	952,793,226	12,309,990,000	1,587,988,710
Concrete	m3	2,000	12,622.9	570,801.0	25,245,713	1,141,602,000	84,152,376
Tributary River Training Works (Maswala 2.0km, Mzase 0.64km)							
Gabion	m3	37,000	8,296.0	375,144.0	306,953,539	13,880,328,000	1,023,178,464
Geotextile	m2	54,000	750.9	9,702.0	40,550,479	523,908,000	67,584,132
Excavation	m3	354,000	125.2	21,829.5	44,305,153	7,727,643,000	443,051,532
Embankment	m2	33,000	232.4	40,540.5	7,670,263	1,337,836,500	76,702,626
Steel Sheet Pile	m	20,000	10,441.6	134,904.0	208,831,392	2,698,080,000	348,052,320
Concrete	m3	20,000	12,622.9	570,801.0	252,457,128	11,416,020,000	841,523,760
Gravel Facing	m3	13,000	309.9	54,054.0	4,028,825	702,702,000	40,288,248
Sod Facing	m2	26,000	77.5	13,513.5	2,014,412	351,351,000	20,144,124
Temporary road (Rail:82.6km+River:17.5km=100.1km)							
Temporary road	km	100.1	3,144,941.4	243,793,905.1	314,808,632	24,403,769,900	1,574,043,159
Installation of track (25.1km)							
80lb/yd rails	ton	2,180	154,350.0	0.0	336,483,000	0	336,483,000
Fish plate, bolt, nut, lock nut washer per km	pcs	530	17,850.0	0.0	9,460,500	0	9,460,500
Thermit welding	pcs	1,580	63,000.0	0.0	99,540,000	0	99,540,000
Steel sleeper with fastenings	pcs	38,980	11,550.0	0.0	450,219,000	0	450,219,000
Turnoput 1:12	sets	6	10,143,000.0	0.0	60,858,000	0	60,858,000
Buffer stop	sets	2	1,195,950.0	0.0	2,391,900	0	2,391,900
Ballast	m3	24,940	0.0	82,950.0	0	2,068,773,000	106,748,687
Road-rail 8 ton dump truck	sets	12	43,666,677.9	0.0	524,000,135	0	524,000,135
Road-rail 8 ton crawler crane	sets	4	74,683,304.5	0.0	298,733,218	0	298,733,218
Road-rail power shovel (RPS)	sets	4	34,473,693.1	0.0	137,894,772	0	137,894,772
RPS with 16-tool tie tamper attchment	sets	2	47,114,047.2	0.0	94,228,094	0	94,228,094
RPS wgripper attchment	sets	4	3,447,369.3	0.0	13,789,477	0	13,789,477
RPS 16-tool tie tamper attchment	sets	4	12,640,354.1	0.0	50,561,417	0	50,561,417
Simplified track inspecting instrument	sets	2	5,745,615.5	0.0	11,491,231	0	11,491,231
Track construction (80lb/yd rails)	km	25.1	0.0	276,396,750.0	0	6,937,558,425	357,978,015
Thermit weldings	pcs	1,580	0.0	1,134,000.0	0	1,791,720,000	92,452,752
Installation of turnputs 1:12	sets	6	0.0	22,681,050.0	0	136,086,300	7,022,053
Buffer stop	sets	2	0.0	9,165,450.0	0	18,330,900	945,874
Renewal of 60lb/yd rails by 80lb/yd rails (15.0km)							
80lb/yd rails	ton	1,250.0	142,477.0	0.0	178,096,270	0	178,096,270
Fish plate, bolt, nut, lock nut washer per km	pcs	320.0	16,477.0	0.0	5,272,635	0	5,272,635
Thermit welding	pcs	950.0	58,153.9	0.0	55,246,208	0	55,246,208
Steel sleeper with fastenings	pcs	23,260.0	10,661.5	0.0	247,987,549	0	247,987,549
Ballast	m3	14,290.0	0.0	82,950.0	0	1,185,355,500	61,164,344
Road-rail 8 ton dump truck	sets	6	43,666,677.9	0.0	262,000,068	0	262,000,068
Road-rail 8 ton crawler crane	sets	2	74,683,304.5	0.0	149,366,609	0	149,366,609
Road-rail power shovel (RPS)	sets	2	34,473,693.1	0.0	68,947,386	0	68,947,386
RPS with 16-tool tie tamper attchment	sets	1	47,114,047.2	0.0	47,114,047	0	47,114,047
RPS wgripper attchment	sets	2	3,447,369.3	0.0	6,894,739	0	6,894,739
RPS 16-tool tie tamper attchment	sets	2	12,640,354.1	0.0	25,280,708	0	25,280,708
Simplified track inspecting instrument	sets	1	5,745,615.5	0.0	5,745,616	0	5,745,616
Track construction (80lb/yd rails)	km	15.0	0.0	276,396,750.0	0	4,145,951,250	213,931,085
Thermit weldings	pcs	950.0	0.0	1,134,000.0	0	1,077,300,000	55,588,680
Earth works (Raise cess, widen and strengthen embankment)	m^3	1,735.0	0.0	78,750.0	0	136,631,250	7,050,173
Earth works (Rreprofiling)	site	5	0.0	196,550,550.0	0	982,752,750	50,710,042
Earth works (Drains)	item	3	0.0	262,067,400.0	0	786,202,200	40,568,034
Refurbishment of 80lb/yd rails section (48.8km)							
80lb/yd rails	ton	80.0	154,350.0	0.0	12,348,000	0	12,348,000
Fish plate, bolt, nut, lock nut washer per km	pcs	20	17,850.0	0.0	357,000	0	357,000
Steel sleeper with fastenings	pcs	1,440	11,550.0	0.0	16,632,000	0	16,632,000
Ballast	m3	23,240	0.0	82,950.0	0	1,927,758,000	99,472,313
Refurbishment of 80lb/yd rails	km	8.9	0.0	79,930,200.0	0	711,378,780	36,707,145
Ballasting 300mm, lifting, tamping, distressing	km	11.8	0.0	232,585,500.0	0	2,744,508,900	141,616,659
Ballasting 100mm, lifting, tamping, distressing	km	16.5	0.0	88,316,550.0	0	1,457,223,075	75,192,711
Earth works (Raise cess, widen and strengthen embankment)	m^3	5,644	0.0	78,750.0	0	444,465,000	22,934,394
Earth works (Rreprofiling)	site	15.0	0.0	196,550,550.0	0	2,948,258,250	152,130,126
Earth works (Drains)	item	9.0	0.0	262,067,400.0	0	2,358,606,600	121,704,101
Relocation of Gulwe Station							
Station office building	m^2	150.0	35,437.5	634,200.0	5,315,625	95,130,000	10,224,333
Station equipment building	m^2	225.0	28,350.0	507,150.0	6,378,750	114,108,750	12,266,762
Station staff rest building	m^2	150.0	28,350.0	507,150.0	4,252,500	76,072,500	8,177,841
Strage building	m^2	180.0	21,262.5	380,100.0	3,827,250	68,418,000	7,357,619
Wash building	m^2	64.0	17,718.8	317,100.0	1,134,000	20,294,400	2,181,191
Paved concourse	m^2	225.0	1,595.0	28,560.0	358,864	6,426,000	690,445
Paved station plaza	m^2	1,000.0	2,126.3	37,800.0	2,126,250	37,800,000	4,076,730
Platform	m^2	1,000.0	637.4	26,250.0	637,350	26,250,000	1,991,850
Generator base	LS	1.0	425,245.8	5,071,500.0	425,246	5,071,500	686,935
Water tank base and tower	LS	1.0	212,622.9	2,535,750.0	212,623	2,535,750	343,468
Generator	LS	1.0	3,189,339.3	6,339,900.0	3,189,339	6,339,900	3,516,478
Water tanks	LS	1.0	744,179.1	5,705,700.0	744,179	5,705,700	1,038,593
Relocation of the existing facilities	LS	1.0	0.0	73,500,000.0	0	73,500,000	3,792,600
Environmental and social management plan during construction	Ls	1	0.0	267,750,000	0.0	267,750,000	13,815,900
Environmental and social monitoring plan during construction	Ls	1	0.0	198,135,000	0	198,135,000	10,223,766
Land development for relocation of PAPs	Ls	1	0.0	357,224,700.0	0	357,224,700	18,432,795
Dispute Board (Standing 3 persons)	Ls	1	263,381,625.0	0	263,381,625	0	263,381,625
Total					9,952,299,988	353,089,352,338	28,171,710,568

Source: JICA Study Team

Table 10.90: Construction Cost, Package 1 (at Current Price)

item	unit	Quantity	Unit Price		Cost		Total
			Foreign	Local	Foreign	Local	
			JPY	TZS	JPY	TZS	JPY
Railway rerouting construction works (7.60km)							
Embankment work	m3	194,000	314.6	54,876.9	61,037,753	10,646,119,764	610,377,533
Embankment protection work	m2	23,000	7,375.1	571,713.9	169,627,518	13,149,419,976	848,137,588
Embankment sod facing work	m2	31,000	957.6	74,232.5	29,685,569	2,301,206,880	148,427,844
Soil replacement work	m3	218,300	610.3	47,306.3	133,217,796	10,326,960,924	666,088,980
Side ditch	m	15,200	5,188.1	402,176.0	78,858,678	6,113,075,808	394,293,390
Cutting work	m3	189,000	467.6	81,561.2	88,379,769	15,415,076,061	883,797,694
Cutting protection work	m2	50,000	8,767.3	396,454.7	438,365,666	19,822,736,850	1,461,218,888
Bridge work	m	90	2,008,670.8	25,951,818.8	180,780,370	2,335,663,690	301,300,616
Culvert work	set	21	9,098,426.7	264,489,147.4	191,066,960	5,554,272,096	477,667,400
Bridge collapse work	set	1	5,006,232.0	97,020,000.0	5,006,232	97,020,000	10,012,464
Bank protection for main stream 6.34km							
Gabion	m3	42,798.1	8,296.0	375,144.0	355,055,207	16,055,468,029	1,183,517,358
Geotextile	m2	71,330.2	750.9	9,702.0	53,564,363	692,046,036	89,273,939
Excavation	m3	28,112.5	125.2	21,829.5	3,518,443	613,681,999	35,184,435
Embankment	m2	52,029.1	232.4	40,540.5	12,093,243	2,109,286,531	120,932,428
Steel Sheet Pile	m	38,287.6	10,441.6	134,904.0	399,782,201	5,165,144,712	666,303,668
Concrete	m3	839.2	12,622.9	570,801.0	10,592,840	479,004,413	35,309,468
Temporary road (25.2km)							0
Temporary road	km	25.2	3,144,941.4	243,793,905.1	79,252,523	6,143,606,408	396,262,613
Installation of track (7.80km)							
80lb/yd rails	ton	669	154,350.0	0.0	103,223,869	0	103,223,869
Fish plate, bolt, nut, lock nut washer per km	pcs	163	17,850.0	0.0	2,902,225	0	2,902,225
Thermit welding	pcs	485	63,000.0	0.0	30,536,175	0	30,536,175
Steel sleeper with fastenings	pcs	11,958	11,550.0	0.0	138,114,992	0	138,114,992
Turnoput 1:12	sets	2	10,143,000.0	0.0	18,669,586	0	18,669,586
Buffer stop	sets	1	1,195,950.0	0.0	733,770	0	733,770
Ballast	m3	7,651	0.0	82,950.0	0	634,643,510	32,747,605
Road-rail 8 ton dump truck	sets	12	43,666,677.9	0.0	524,000,135	0	524,000,135
Road-rail 8 ton crawler crane	sets	4	74,683,304.5	0.0	298,733,218	0	298,733,218
Road-rail power shovel (RPS)	sets	4	34,473,693.1	0.0	137,894,772	0	137,894,772
RPS with 16-tool tie tamper attchment	sets	2	47,114,047.2	0.0	94,228,094	0	94,228,094
RPS wgripper attchment	sets	4	3,447,369.3	0.0	13,789,477	0	13,789,477
RPS 16-tool tie tamper attchment	sets	4	12,640,354.1	0.0	50,561,417	0	50,561,417
Simplified track inspecting instrument	sets	2	5,745,615.5	0.0	11,491,231	0	11,491,231
Track construction (80lb/yd rails)	km	8	0.0	276,396,750.0	0	2,128,254,975	109,817,957
Thermit weldings	pcs	485	0.0	1,134,000.0	0	549,651,155	28,362,000
Installation of turnputs 1:12	sets	2	0.0	22,681,050.0	0	41,747,590	2,154,176
Buffer stop	sets	1	0.0	9,165,450.0	0	5,623,424	290,169
Renewal of 60lb/yd rails by 80lb/yd rails (15.0km)							
80lb/yd rails	ton	1,250.0	142,477.0	0.0	178,096,270	0	178,096,270
Fish plate, bolt, nut, lock nut washer per km	pcs	320.0	16,477.0	0.0	5,272,635	0	5,272,635
Thermit welding	pcs	950.0	58,153.9	0.0	55,246,208	0	55,246,208
Steel sleeper with fastenings	pcs	23,260.0	10,661.5	0.0	247,987,549	0	247,987,549
Turnoput 1:12	sets	0	9,362,775.4	0.0	0	0	0
Buffer stop	sets	0	1,103,944.6	0.0	0	0	0
Ballast	m3	14,290.0	0.0	82,950.0	0	1,185,355,500	61,164,344
Road-rail 8 ton dump truck	sets	6	43,666,677.9	0.0	262,000,068	0	262,000,068
Road-rail 8 ton crawler crane	sets	2	74,683,304.5	0.0	149,366,609	0	149,366,609
Road-rail power shovel (RPS)	sets	2	34,473,693.1	0.0	68,947,386	0	68,947,386
RPS with 16-tool tie tamper attchment	sets	1	47,114,047.2	0.0	47,114,047	0	47,114,047
RPS wgripper attchment	sets	2	3,447,369.3	0.0	6,894,739	0	6,894,739
RPS 16-tool tie tamper attchment	sets	2	12,640,354.1	0.0	25,280,708	0	25,280,708
Simplified track inspecting instrument	sets	1	5,745,615.5	0.0	5,745,616	0	5,745,616
Track construction (80lb/yd rails)	km	15.0	0.0	276,396,750.0	0	4,145,951,250	213,931,085
Thermit weldings	pcs	950.0	0.0	1,134,000.0	0	1,077,300,000	55,588,680
Earth works (Raise cess, widen and strengthen embankment)	m^3	1,735.0	0.0	78,750.0	0	136,631,250	7,050,173
Earth works (Rreprofiling)	site	5	0.0	196,550,550.0	0	982,752,750	50,710,042
Earth works (Drains)	item	3	0.0	262,067,400.0	0	786,202,200	40,568,034
Refurbishment of 80lb/yd rails section (4.6km)							
80lb/yd rails	ton	7	154,350.0	0.0	1,144,206	0	1,144,206
Fish plate, bolt, nut, lock nut washer per km	pcs	2	17,850.0	0.0	33,081	0	33,081
Thermit welding	pcs	0	0.0	0.0	0	0	0
Steel sleeper with fastenings	pcs	133	11,550.0	0.0	1,541,176	0	1,541,176
Turnoput 1:12	sets	0	0.0	0.0	0	0	0
Buffer stop	sets	0	0.0	0.0	0	0	0
Ballast	m3	2,153	0.0	82,950.0	0	178,632,418	9,217,433
Refurbishment of 80lb/yd rails	km	0.8	0.0	79,930,200.0	0	65,918,705	3,401,405
Ballasting 300mm, lifting, tamping, distressing	km	1.1	0.0	232,585,500.0	0	254,315,252	13,122,667
Ballasting 100mm, lifting, tamping, distressing	km	1.5	0.0	88,316,550.0	0	135,031,099	6,967,605
Earth works (Raise cess, widen and strengthen embankment)	m^3	523	0.0	78,750.0	0	41,185,594	2,125,177
Earth works (Rreprofiling)	site	1.4	0.0	196,550,550.0	0	273,195,339	14,096,879
Earth works (Drains)	item	0.8	0.0	262,067,400.0	0	218,556,271	11,277,504
Environmental and social management plan during construction	Ls	1	0.0	82,138,446.2	0	82,138,446	4,238,344
Environmental and social monitoring plan during construction	Ls	1	0.0	60,782,450.2	0	60,782,450	3,136,374
Dispute Board (Standing 3person)	Ls	1	87,284,925.0	0.0	87,284,925	0	87,284,925
Total					4,856,719,316	130,003,659,355	11,564,908,139

Source: JICA Study Team

Table 10.91: Construction Cost, Package 2 (at Current Price)

item	unit	Quantity	Unit Price		Cost		Total
			Foreign	Local	Foreign	Local	
			JPY	TZS	JPY	TZS	JPY
Railway rerouting construction works (6.40km)							
Embankment work	m3	87,000	314.6	54,876.9	27,372,601	4,774,290,822	273,726,007
Embankment protection work	m2	11,000	7,375.1	571,713.9	81,126,204	6,288,853,032	405,631,021
Embankment sod facing work	m2	11,000	957.6	74,232.5	10,533,589	816,557,280	52,667,945
Soil replacement work	m3	97,800	610.3	47,306.3	59,682,549	4,626,554,184	298,412,745
Side ditch	m	12,800	5,188.1	402,176.0	66,407,308	5,147,853,312	332,036,539
Cutting work	m3	168,000	467.6	81,561.2	78,559,795	13,702,289,832	785,597,950
Cutting protection work	m2	49,000	8,767.3	396,454.7	429,598,353	19,426,282,113	1,431,994,510
Bridge work	m	0	2,008,670.8	25,951,818.8	0	0	0
Culvert work	set	14	9,098,426.7	264,489,147.4	127,377,973	3,702,848,064	318,444,933
Bridge collapse work	set	0	5,006,232.0	97,020,000.0	0	0	0
Bank protection for main stream 8.54km							
Gabion	m3	57,649.2	8,296.0	375,144.0	478,260,484	21,626,766,083	1,594,201,614
Geotextile	m2	96,082.1	750.9	9,702.0	72,151,366	932,188,193	120,252,277
Excavation	m3	37,867.6	125.2	21,829.5	4,739,354	826,631,589	47,393,544
Embankment	m2	70,083.4	232.4	40,540.5	16,289,636	2,841,215,611	162,896,362
Steel Sheet Pile	m	51,573.5	10,441.6	134,904.0	538,507,886	6,957,466,221	897,513,143
Concrete	m3	1,130.4	12,622.9	570,801.0	14,268,589	645,220,455	47,561,965
Temporary road (40.1km)							
Temporary road	km	40.1	3,144,941.4	243,793,905.1	126,112,149	9,776,135,594	630,560,746
Installation of track (6.40km)							
80lb/yd rails	ton	555.9	154,350.0	0.0	85,796,462	0	85,796,462
Fish plate, bolt, nut, lock nut washer per km	pcs	135	17,850.0	0.0	2,412,239	0	2,412,239
Thermit welding	pcs	403	63,000.0	0.0	25,380,717	0	25,380,717
Steel sleeper with fastenings	pcs	9,939	11,550.0	0.0	114,796,876	0	114,796,876
Turnoput 1:12	sets	2	10,143,000.0	0.0	15,517,578	0	15,517,578
Buffer stop	sets	1	1,195,950.0	0.0	609,887	0	609,887
Ballast	m3	6,359	0.0	82,950.0	0	527,495,904	27,218,789
Track construction (80lb/yd rails)	km	6.4	0.0	276,396,750.0	0	1,768,939,200	91,277,263
Thermit weldings	pcs	402.9	0.0	1,134,000.0	0	456,852,908	23,573,610
Installation of turnputs 1:12	sets	1.5	0.0	22,681,050.0	0	34,699,296	1,790,484
Buffer stop	sets	0.5	0.0	9,165,450.0	0	4,674,014	241,179
Refurbishment of 80lb/yd rails section (31.6km)							
80lb/yd rails	ton	52	154,350.0	0.0	8,009,952	0	8,009,952
Fish plate, bolt, nut, lock nut washer per km	pcs	13	17,850.0	0.0	231,580	0	231,580
Thermit welding	pcs	0	0.0	0.0	0	0	0
Steel sleeper with fastenings	pcs	934	11,550.0	0.0	10,788,915	0	10,788,915
Turnoput 1:12	sets	0	0.0	0.0	0	0	0
Buffer stop	sets	0	0.0	0.0	0	0	0
Ballast	m3	15,075	0.0	82,950.0	0	1,250,506,072	64,526,113
Refurbishment of 80lb/yd rails	km	5.8	0.0	79,930,200.0	0	461,460,144	23,811,343
Ballasting 300mm, lifting, tamping, distressing	km	7.7	0.0	232,585,500.0	0	1,780,319,441	91,864,483
Ballasting 100mm, lifting, tamping, distressing	km	10.7	0.0	88,316,550.0	0	945,277,521	48,776,320
Earth works (Raise cess, widen and strengthen embankment)	m^3	3,661	0.0	78,750.0	0	288,317,404	14,877,178
Earth works (Rreprofiling)	site	9.7	0.0	196,550,550.0	0	1,912,488,416	98,684,402
Earth works (Drains)	item	5.8	0.0	262,067,400.0	0	1,529,990,733	78,947,522
Environmental and social management plan during construction	Ls	1	0.0	68,270,916.3	0	68,270,916	3,522,779
Environmental and social monitoring plan during construction	Ls	1	0.0	50,520,478.1	0	50,520,478	2,606,857
Land development for relocation of PAPs	Ls	1	0.0	357,224,700.0	0	357,224,700	18,432,795
Dispute Board (Standing 3person)	Ls	1	88,048,350	0	88,048,350	0	88,048,350
Total					2,482,580,394	113,528,189,534	8,340,634,973

Source: JICA Study Team

Table 10.92: Construction Cost, Package 3 (at Current Price)

item	unit	Quantity	Unit Price		Cost		Total
			Foreign	Local	Foreign	Local	
			JPY	TZS	JPY	TZS	JPY
Railway rerouting construction works (11.10km)							
Embankment work	m3	189,000	314.6	54,876.9	59,464,615	10,371,735,234	594,646,153
Embankment protection work	m2	7,000	7,375.1	571,713.9	51,625,766	4,001,997,384	258,128,831
Embankment sod facing work	m2	65,000	957.6	74,232.5	62,243,934	4,825,111,200	311,219,672
Soil replacement work	m3	212,700	610.3	47,306.3	129,800,390	10,062,045,756	649,001,951
Side ditch	m	22,200	5,188.1	402,176.0	115,175,174	8,928,308,088	575,875,872
Cutting work	m3	9,000	467.6	81,561.2	4,208,560	734,051,241	42,085,604
Cutting protection work	m2	4,000	8,767.3	396,454.7	35,069,253	1,585,818,948	116,897,511
Bridge work	m	165	2,008,670.8	25,951,818.8	331,430,678	4,282,050,098	552,384,463
Culvert work	set	30	9,098,426.7	264,489,147.4	272,952,800	7,934,674,422	682,382,000
Bridge collapse work	set	0	5,006,232.0	97,020,000.0	0	0	0
Bank protection for main stream 0.23 km							
Gabion	m3	1,552.6	8,296.0	375,144.0	12,880,552	582,453,887	42,935,172
Geotextile	m2	2,587.7	750.9	9,702.0	1,943,187	25,105,771	3,238,644
Excavation	m3	1,019.9	125.2	21,829.5	127,641	22,262,912	1,276,407
Embankment	m2	1,887.5	232.4	40,540.5	438,714	76,519,858	4,387,139
Steel Sheet Pile	l.m	1,389.0	10,441.6	134,904.0	14,503,140	187,379,067	24,171,900
Concrete	m3	30.4	12,622.9	570,801.0	384,283	17,377,132	1,280,943
Tributary River Training Works (Maswala 2.0km, Mzase 0.64km)							
Gabion	m3	37,000	8,296.0	375,144.0	306,953,539	13,880,328,000	1,023,178,464
Geotextile	m2	54,000	750.9	9,702.0	40,550,479	523,908,000	67,584,132
Excavation	m3	354,000	125.2	21,829.5	44,305,153	7,727,643,000	443,051,532
Embankment	m2	33,000	232.4	40,540.5	7,670,263	1,337,836,500	76,702,626
Steel Sheet Pile	m	20,000	10,441.6	134,904.0	208,831,392	2,698,080,000	348,052,320
Concrete	m3	20,000	12,622.9	570,801.0	252,457,128	11,416,020,000	841,523,760
Gravel Facing	m3	13,000	309.9	54,054.0	4,028,825	702,702,000	40,288,248
Sod Facing	m2	26,000	77.5	13,513.5	2,014,412	351,351,000	20,144,124
Temporary road (34.8 km)							
Temporary road	km	34.8	3,144,941.4	243,793,905.1	109,443,960	8,484,027,897	547,219,799
Installation of track (11.0 km)							
80lb/yd rails	ton	955.4	154,350.0	0.0	147,462,669	0	147,462,669
Fish plate, bolt, nut, lock nut washer per km	pcs	232	17,850.0	0.0	4,146,036	0	4,146,036
Thermit welding	pcs	692	63,000.0	0.0	43,623,108	0	43,623,108
Steel sleeper with fastenings	pcs	17,083	11,550.0	0.0	197,307,131	0	197,307,131
Turnoput 1:12	sets	3	10,143,000.0	0.0	26,670,837	0	26,670,837
Buffer stop	sets	1	1,195,950.0	0.0	1,048,243	0	1,048,243
Ballast	m3	10,930	0.0	82,950.0	0	906,633,586	46,782,293
Track construction (80lb/yd rails)	km	11.0	0.0	276,396,750.0	0	3,040,364,250	156,882,795
Thermit weldings	pcs	692.4	0.0	1,134,000.0	0	785,215,936	40,517,142
Installation of turnputs 1:12	sets	2.6	0.0	22,681,050.0	0	59,639,414	3,077,394
Buffer stop	sets	0.9	0.0	9,165,450.0	0	8,033,462	414,527
Refurbishment of 80lb/yd rails section (12.6km)							
80lb/yd rails	ton	21	154,350.0	0.0	3,193,842	0	3,193,842
Fish plate, bolt, nut, lock nut washer per km	pcs	5	17,850.0	0.0	92,339	0	92,339
Thermit welding	pcs	0	0.0	0.0	0	0	0
Steel sleeper with fastenings	pcs	372	11,550.0	0.0	4,301,909	0	4,301,909
Turnoput 1:12	sets	0	0.0	0.0	0	0	0
Buffer stop	sets	0	0.0	0.0	0	0	0
Ballast	m3	6,011	0.0	82,950.0	0	498,620,745	25,728,830
Refurbishment of 80lb/yd rails	km	2.3	0.0	79,930,200.0	0	183,999,931	9,494,396
Ballasting 300mm, lifting, tamping, distressing	km	3.1	0.0	232,585,500.0	0	709,874,207	36,629,509
Ballasting 100mm, lifting, tamping, distressing	km	4.3	0.0	88,316,550.0	0	376,914,455	19,448,786
Earth works (Raise cess, widen and strengthen embankment)	m^3	1,460	0.0	78,750.0	0	114,962,003	5,932,039
Earth works (Rreprofiling)	site	3.9	0.0	196,550,550.0	0	762,574,495	39,348,844
Earth works (Drains)	item	2.3	0.0	262,067,400.0	0	610,059,596	31,479,075
Relocation of Gulwe Station							
Station office building	m^2	150.0	35,437.5	634,200.0	5,315,625	95,130,000	10,224,333
Station equipment building	m^2	225.0	28,350.0	507,150.0	6,378,750	114,108,750	12,266,762
Station staff rest building	m^2	150.0	28,350.0	507,150.0	4,252,500	76,072,500	8,177,841
Strage building	m^2	180.0	21,262.5	380,100.0	3,827,250	68,418,000	7,357,619
Wash building	m^2	64.0	17,718.8	317,100.0	1,134,000	20,294,400	2,181,191
Paved concourse	m^2	225.0	1,595.0	28,560.0	358,864	6,426,000	690,445
Paved station plaza	m^2	1,000.0	2,126.3	37,800.0	2,126,250	37,800,000	4,076,730
Platform	m^2	1,000.0	637.4	26,250.0	637,350	26,250,000	1,991,850
Generator base	LS	1.0	425,245.8	5,071,500.0	425,246	5,071,500	686,935
Water tank base and tower	LS	1.0	212,622.9	2,535,750.0	212,623	2,535,750	343,468
Generator	LS	1.0	3,189,339.3	6,339,900.0	3,189,339	6,339,900	3,516,478
Water tanks	LS	1.0	744,179.1	5,705,700.0	744,179	5,705,700	1,038,593
Relocation of the existing facilities	LS	1.0	0.0	73,500,000.0	0	73,500,000	3,792,600
Environmental and social management plan during construction	Ls	1	0.0	117,340,637.5	0	117,340,637	6,054,777
Environmental and social monitoring plan during construction	Ls	1	0.0	86,832,071.7	0	86,832,072	4,480,535
Dispute Board (Standing 3 persons)	Ls	1	88,048,350	0	88,048,350	0	88,048,350
Total					2,613,000,278	109,557,504,684	8,266,167,520

Source: JICA Study Team

(2) Consulting Services

Two consulting Services are planned under the Project; namely the Consulting Engineering and Supervisory (CES) Services for the Project implementation and the Consulting Advisory Services for the Capacity Building for Construction Management (CBCM). These costs are estimated for "Remuneration and Direct Cost" as shown in Table 10.93.

Table 10.93: Consulting Services, (at current Price)

Item	LC (1,000 TZS)	FC (1,000 JPY)
CES Service		
Remuneration	13,869,100	2,261,728
Direct Cost	8,270,743	649,832
Total	22,139,843	2,911,560
CBCM Services		
Remuneration	928,000	433,293
Direct Cost	719,279	56,078
Total	1,647,279	489,371

Source: JICA Study Team

(3) Cost for Land Acquisition and Compensation

Compensation costs for land acquisition and house relocation for the railway rerouting and the channel construction is calculated and summarized in Table 10.94.

Compensation cost for the land is calculated from the unit price in the project area, 200 TZS/m^2. The cost for crops and trees are also calculated in accordance with the "Regional Valuation Schedule of Morogoro", but seasonal crops, which were not grown at the time of the survey in December, are not considered. Disturbance allowances which correspond to 5% of the total amount are added to the compensation cost based on the Land Act of Tanzania.

For the housing structures, costs are calculated based on the unit rate of the structure type and the area of each structure. Accommodation and transport allowance for relocation are also considered in addition to the disturbance allowance based on the Land Act. On the other hand, depreciation of the structure, which is usually considered in Tanzania, is not considered for this calculation of the 'replacement cost'.

Table 10.94: Summary of Cost for Land Acquisition and Compensation

Items		Amount (TZS)	Total Amount (TZS)
Land	Value	439,569,200	
	Disturbance allowance (5%)	21,978,460	461,547,660
Crops and Trees	Value	14,415,000	
	Disturbance allowance (5%)	720,750	15,135,750
Housing structures	Value	691,569,615	
	Disturbance allowance (5%)	34,578,481	
	Accommodation Allowance	76,946,000	
	Transport Allowance	3,300,000	806,394,096
Total			1,283,077,506

Source: JICA Study Team

(4) Administration Cost

Administration cost includes expenses to be incurred by the Project Management Office of RAHCO from commencement until completion of construction works of the Project.

(5) Maintenance and Recovery Cost

1) Review of estimation in Interim Report

When the project cost was previously estimated in the Interim Report (November 2015), aiming at the selection of most affordable alternative, the maintenance and recovery cost of Alternative B-2, which was eventually selected by comparison, was assumed as follows:

Table 10.95: Annual Maintenance and Recovery Cost of Alternative B-2 in Interim Report

B-2											
	Maintenance cost is estimated under following conditions:										
1	Railway construction + River bank protection				Initial direct cost		395,332,000,000	Tsh.	26,447,711,000	JPY	
	Repair Cost including addional protection of bank (Initial cost x % =						1,976,660,000	Tsh.	132,239,000	JPY	0.50%
2	Removal of sediment in box culvert			4,400	m3 x	233/136=	Total Vol. 7,500	m3	Conducted 3,750	m3	50%
	Cost	(1m3=8.0US$ x % =		2,889	Tsh./m3) =		10,833,600	Tsh.	725,000	JPY	20%
3	Removal of sediment at confluence						Total Vol. 14,000	m3	Conducted 14,000	m3	100%
	Cost	(1m3=8.0US$ x % =		2,889	Tsh./m3) =		40,445,440	Tsh.	2,706,000	JPY	20%
Total							2,027,939,000	Tsh	135,670,000	JPY	
					21-year		**42,587**	Mil Tsh			

Source: JICA Study Team

<u>Supplemental note on Table 10.95.</u>

Item 1. Overall annual operation/maintenance and recovery cost (OM & R cost) is estimated by a constant rate (0.5 %) to the initial investment cost

⇒ approx. <u>97.5 %</u> of total OM & R cost

Item 2. Cost for removal of debris in culverts (based on the results of the Flood Risk Assessment in Dec. 2014, Ref: Appendix J)

- Volume of debris for 136 culverts: 4,400 m^3
- Estimated total volume in 233 culverts: 7,500 m^3
  A half volume is assumed as annual deposit = 3,750 m^3/year

⇒ approx. <u>0.5 %</u> of total OM & R cost

Item 3. Cost for removal of sediment deposit accumulated near confluences of the Maswala, Kidibo, and Mzase Rivers

- Sediment volume: 14,000m^3/year (total volume from three tributaries)

⇒ approx. <u>2.0 %</u> of total OM & R cost

2) Other information on recovery cost

(a) Construction of flood protection measures recommended by the Flood Risk Assessment

⇒ <u>TZS3,000,000,000</u> = USD 1,700,000 = JPY200,000,000
(USD1.0=TZS1,750=JPY118.0)

RAHCO reported that although the funds had been approved by MOF, they have not yet been released to them (December 2015).

(b) Budget of TRL for countermeasures and recovery at damaged section between Kilosa and Gulwe (requested by the Dar es Salaam Civil Engineers' Office to the TRL Central Office)

⇒ Total <u>TZS581,201,000</u> = USD266,606 = JPY32,472,606
(USD1.0=TZS2,180=JPY121.8)

The above amount is estimated for flood protection measures at the nine sites, such as river training works, embankment and revetment, etc. However, as per TRL, it is not certain whether the full amount has been approved or not (December 2015).

3) Estimation in Final Report

The annual maintenance and recovery cost needs to be allocated for (a) remedial works, such as routine maintenance works against future flood damage, and (b) urgent recovery works immediately after flooding to recover railway operation. Therefore, the cost is estimated in such categories as follows:

(a) Maintenance cost (for remedial works after floods)
The following structures should be properly maintained after construction:

- Railway-related civil structures (track, embankment, bridges, culverts, slope protection works, etc.)
- Railway operation systems (signals, station facilities, etc.)
- Riverbank protections by gabion (revetment, foot protection)
- Sediment control structures (ground sills, check dam, new channel)
- Inlet and outlet channels connected with new and existing culverts

◆ Annual maintenance cost (same rate applied in IT/R is adopted: 0.5%)

Initial investment x 0.5 % =TZS335,000,000,000 x 0.005
= TZS1,675,000,000 = JPY93,632,500
(TZS1.0=JPY0.0559)

◆ Removal of debris from culverts and sediment deposit from confluences of tributaries

Excavation :14,000m^3/year x TZS21,000/m^3= TZS 294,000,000
(including hauling and dumping)

Subtotal: 1,675,000,000 + 294,000,000 = TZS 1,969,000,000/year (A)

(b) Recovery cost (for urgent recovery works)
The type of damage and location of flood occurrences which will likely occur at the target area is difficult to reasonably assume. Therefore, the amount estimated by TRL as cited in Item 2) (b) above is used.

On the other hand, after completion of the proposed project, the flood damage could be significantly reduced compared to the present case. It is assumed that a similar magnitude of recovery works will be required once every five years in the future, and thus the annual average recovery cost is estimated as follows:

◆ TZS581,201,000/5 = TZS116,240,200/year (B)

As discussed above, total annual cost is estimated as follows:
(A) + (B) = 1,969,000,000+ 116,240,200 = TZS 2,085,240,200/year
(=JPY 116,565,000/year)

(6) Project Cost

The total project cost is shown in Table 10.96. The basis or the cost estimation has been set forth as follows:

Base cost	: April 2016
Exchange rates	: US$1 = 113.1JPY[5]
	: US$1 = TZS2,189.67[6]
	: TZS1 = 0.0516JPY[7]

[5] The dollar-yen exchange rate is the monthly average in March 2016 announced by the Bank of Japan.
[6] The dollar-shilling exchange rate is the rate of Bank of Tanzania in 6th April 2016.

Price escalation:
- Foreign currency : 1.6 % annually
- Local currency : 7.6 % annually

VAT : 18 % of foreign and local portions
Import tax : 15% of foreign portions
Physical contingency : 10 %
Physical contingency for consultant : 10 %

Table 10.96: Summary of Project Cost (Unit: Million)

Item	Amount		
	FC (JPY)	LC (TZS)	Total in JPY
A. ELIGIBLE PORTION			
I) Procurement / Construction	12,141	513,735	38,650
Package-1	4,922	127,398	11,496
Package-2	2,962	115,205	8,907
Package-3	2,448	100,623	7,640
Base cost for JICA financing	10,332	343,225	28,043
Price escalation	705	123,807	7,094
Physical contingency	1,104	46,703	3,514
II) Consulting services	3,870	31,277	5,484
a. CES Services			
Base cost	2,912	22,140	4,054
Price escalation	98	4,305	320
Physical contingency	301	2,644	437
b. CBCM Services			
Base cost	489	1,647	574
Price escalation	19	341	37
Physical contingency	51	199	61
Total (I + II)	16,011	545,011	44,134
B. NON ELIGIBLE PORTION			
a. Procurement / Construction	0	0	0
b. Land Acquisition	0	1,538	79
Base cost	0	1,283	66
Price escalation	0	115	6
Physical contingency	0	140	7
c. Administration cost	0	25,705	1,326
d. VAT	0	153,954	7,944
e. Import Tax	0	46,544	2,402
Total (a+b+c+d+e)	0	227,741	11,751
TOTAL (A+B)	16,011	772,753	55,885
C. Interest during Construction	18	0	18
Construction	15	0	15
Consulting services	3	0	3
D. Front End Fee	0	0	0
GRAND TOTAL (A+B+C+D)	16,029	772,753	55,903
E. JICA finance portion incl. IDC (A+C+D)	16,029	545,011	44,151

Source: JICA Study Team

10.3.4 Annual Fund Requirement

The annual fund requirement is shown in Table 10.97.

[7] The yen-shilling exchange rate is calculated by the footnote 1 and 2 above.

Table 10.97: Annual Fund Requirement (Unit: Million)

Year	Amount		
	FC (JPY)	LC (TZS)	Total in JPY
2016	824	5,635	1,115
2017	1,031	6,525	1,368
2018	490	3,114	650
2019	5,214	190,836	15,061
2020	3,365	124,661	9,794
2021	3,318	133,489	10,206
2022	1,122	49,124	3,657
2023	665	31,678	2,299
Total	16,029	545,011	44,151

Source: JICA Study Team

10.4 Application of Japanese Technology to the Project Component

The conventional bank protection method is adopted in the main stream, the Maswala and Mzase Rives as mentioned above. However, these conventional methods much remain to be improved as followings:

- Construction cost
- Construction period
- Long-term durability of gabion structure
- Scouring for foundation of bank protection

The problems above have occurred before, but the following technologies (solutions) have been developed in Japan:

- Branch Block (retaining wall construction method)
- Filter Unit (material bagging method)
- In-situ Construction Excavated Material (recycling use of site material)
- Hat-type Steel Sheet Pile (wide shape steel sheet pile)
- TRD Construction Method (underground continuous wall construction method)
- Weathering Steel (materials for bridges build)
- RRR-B (method for construction of railway embankment)

This sections study the application of Japanese technologies to the Project components.

10.4.1 Branch Block

(1) Outline

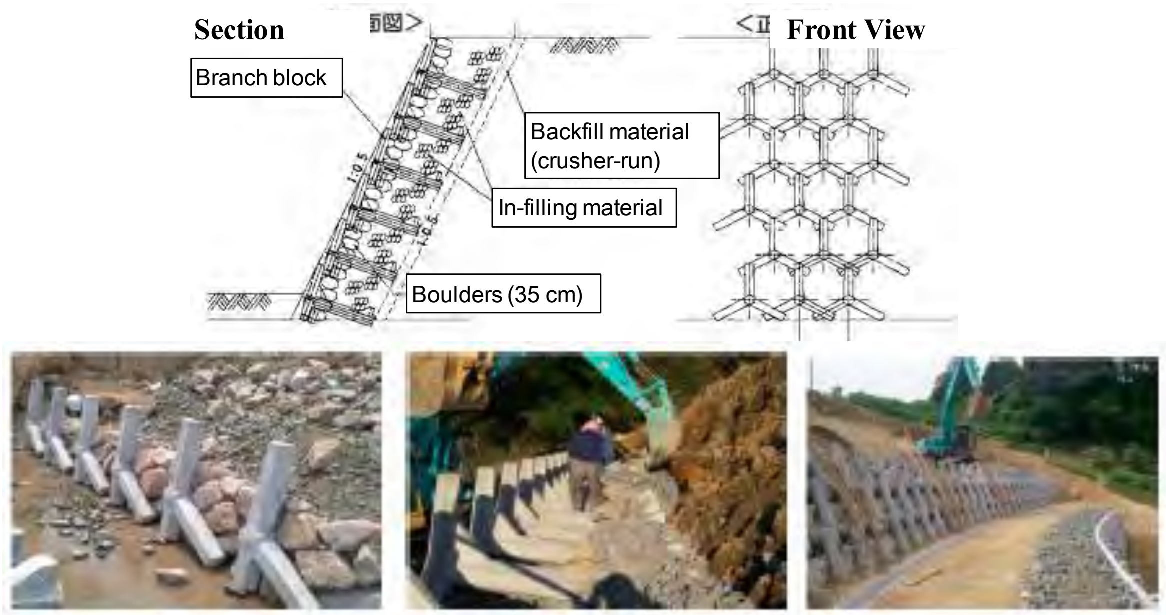
This is one of retaining wall construction methods which is composed of pillar-shaped secondary concrete product, “Branch Block”, with stone filling. This can form revetment structures and protect against slope failures with a reduced construction period.

(2) Principal Features

- Combined by natural stone and concrete products
- Can fit at curve and varied height/gradient
- Unnecessary pouring of concrete at field
- Speedy construction
- Material of random gravel and stone from field can be utilized.
- Regulate flow velocity by surface irregularity at revetment and protect foot erosion

(3) Candidate Sites for Application

Protection at progressive bank erosion sections for the main stream and slope surrounding the Maswala and Mzase Rivers.



Setting first layer | Filling stones in back space | About completion

Figure 10.88: Branch Block

Source: Branch Block Association in Japan

(4) Evaluation for Imported Technology

Table 10.98: Comparison of Slope Protection

Item		Gabion Mattress Bank Protection		Branch Block Bank Protection	
Description of Method		Revetment and Retaining wall construction method which is composed of steel wire mesh cage " Gabion" with stone filling.		Revetment and Retaining wall construction method which is composed of pillar-shaped precast concrete product "Branch Block" with stone filling.	
		This can form revetment structures and protect against slope failure.			
		Wall is constructed by Gabion (W=1.2m, H=0.5m, L=10m) which is arranged in stepwise shape.		Wall is constructed by RC Pillar element (W=1.3m, H=1.2m, L=1.0~2.0m), boulders in front, and in -filling material behind which is similar as masonry retaining wall construction method	
Candidate Sites to be applied		Protection at bank erosion section and slope along main stream, etc		Protection at progressive bank erosion section and slope surrounding the Maswala and Mzase, etc	
Merit		Conventional construction method		**Short-term construction can be attained.** Branch Block Bank Protection has **durable longevity performance**. **Reduce velocity by roughness of the surface can mitigate erosion at foundation**. **Construction cost is lower.**	
Demerit		Gabion steel mesh has no durable longevity performance. This is not suitable to use at eroded bank where high velocity flow is anticipated.		It is necessary to provide technical guidance by experts from JAPAN during construction.	
Construction Direct Cost	Unit price	US\$ 177.0 / Gabion m^3	100%	US\$ 248.9 / Banch Block m^3	141%
	Wall cost (4.0mH, 1.0mThickness, 1:0.5)	US\$ 1,172 / 1.0m length	100%	US\$ 1,062 / 1.0m length	91%
Construction Period	100m^3 wall construction period	9.9 days	100%	8.9 days	90%
Evaluation		Branch Block Bank Protection is recommended in view points of Performance, Construction Cost, and Construction Period. Branch Block Bank Protection is recommended utilizing **in extremely progressive erosion section.** Gabion Bank Protection is recommended utilizing **in moderately progressive erosion section**. Branch Block RC pillar form should be imported from JAPAN. It is necessary to provide technical guidance by experts from JAPAN during construction.			

Note: Construction period and direct cost consists of labor, machine, material, fuel, and miscellaneous expense, which is calculated based on "Daily productivity data per unit construction element in JAPAN.
Direct Cost is current price, not including contractor's indirect cost, VAT and contingency.
Exchange rate: 1US\$=2,189.67TZS, 1JPY=19.36TZS

Source: JICA Study Team

10.4.2 Filter Unit

(1) Principal Features

- Placement of mesh net, which is made of synthetic fiber, of in-filled stone is conducted by crane.
- Having more than 30 years resistance by improving weak points of weather ability.
- Due to the synthetic fiber, it is strong against sea water, acid, corrosion.
- Having advantages in workability and enable to complete in short period.

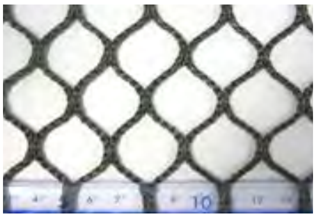
(2) Structure

- Shape : Bag (double layers)
- Material : Recycled polyester Russell net
- Net mesh : 25mm mesh

- In-filling stone crushed of dia. 50-200 mm
- Rounded stones and lump of concrete can be utilized.
- Complete feature
  - For 2t: Dia. 1.9 m x Height 0.4 m
  - For 4t: Dia. 2.4 m x Height 0.6 m

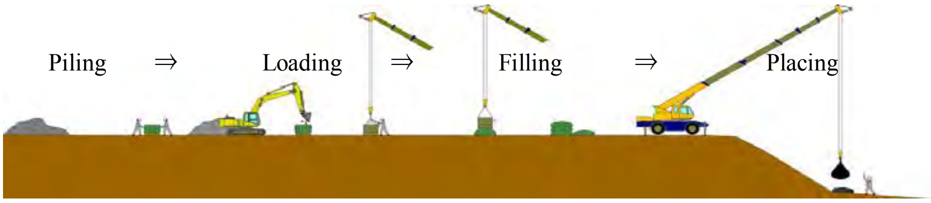
(3) Construction Record

Many examples, since 2002 in Japan and 2009 overseas.



Net

Product



Construction Flow

Under installation (1994)

Just after completion (1994)

19 years after completion (2013)

Site: Uji River in Yodo River basin

Source: Pamphlets of Kyowa Sumitomo Co.

Figure 10.89: Filter Unit

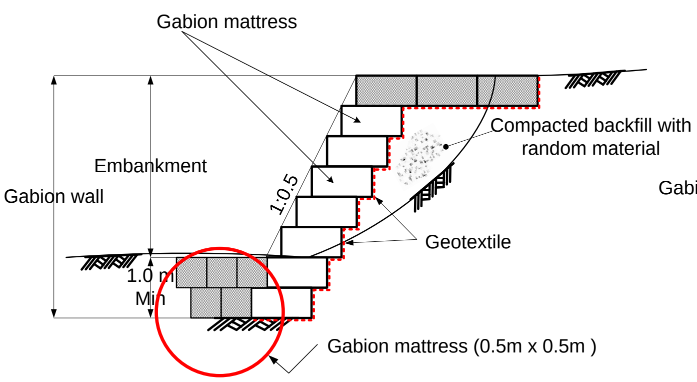
(4) Evaluation for Imported Technology

Table 10.99: Comparison of Gabion and Filter Unit for Measures against Foot Erosion in Structures

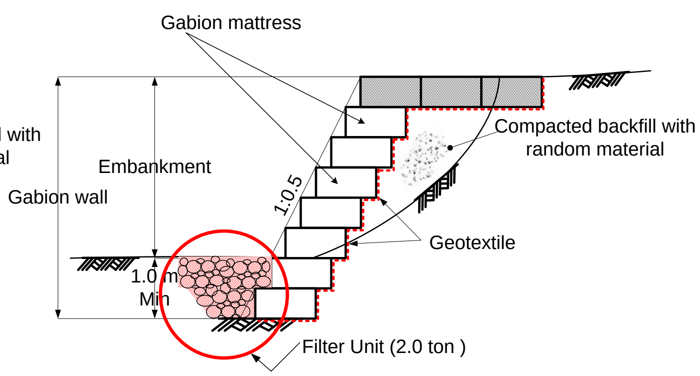
Item		Gabion Mattress Method		Filter Unit Method	
Description of Method		Foot protection for river structure, which is composed of steel wire mesh cage " Gabion" with stone filling.		Foot protection for river structure, which is composed of recycled polyester fiber mesh bag " Filter Unit" with stone filling.	
		Both method can form erosion measures which resist to water current in weight on structure's foot.			
		The foot protection work is constructed by Gabion (Stone = 5.7 m^3 :1.2W x 0.5H x 10.0L) which is arranged in stepwise shape.		The foot protection work is constructed by Filter Units (Stone=5.7m3 :1.25m3 stone / bag x 4.56 bags) which is arranged in a trefoil shape.	
Candidate Sites to be applied		Protection at progressive bank foot erosion and area around bridge pier, abutment, etc			
Merit		Conventional protection work		Short-term construction can be attained by using machines in construction. Filter Unit Protection has **durable longevity performance. Construction cost is lower. Flexibile bag can mitigate erosion at foundation.**	
Demerit		This method can not save labor because stone filling in cage needs manpower.Therefore short-term construction can not be attained. Gabion steel mesh has no durable longevity performance. Construction cost is a little higher.		Recycled polyester fiber mesh bag " Filter Unit" is needed to import from JAPAN.	
Direct construction cost	Unit price	US$ 177.0 / Gabion m^3	100%	US$ 166.5/ Filter Unit m^3	94%
Construction period	100 m^3 foot protection	0.33 month	100%	0.17 month	52%
Evaluation		Filter Unit Foot Protection is recommended in view points of **Performance, Construction Cost, and Construction Period.** Recycled polyester fiber mesh bag " Filter Unit" is needed to import from JAPAN. Gabion Bank Protection is recommended utilizing in moderately progressive erosion section.			

Note: Construction period and direct cost consists of labor, machine, material, fuel, and miscellaneous expense, which is calculated based on "Daily productivity data per unit construction element in JAPAN.
Direct Cost is current price, not including contractor's indirect cost, VAT and contingency.
Exchange rate: 1US$=2,189.67TZS, 1JPY=19.36TZS

Source: JICA Study Team



GABION FOOT PROTECTION



FILTER UNIT FOOT PROTECTION

10.4.3 In-situ Construction Excavated Material (INSEM)

(1) Outline

This is one of the artificial construction materials which is composed of cement, site materials (soil, sand, stone, etc.) and water. The material serves an intermediate function between the soil and concrete, and allows for the recycling of site materials and thus reduction of construction cost.

(2) Principal Features

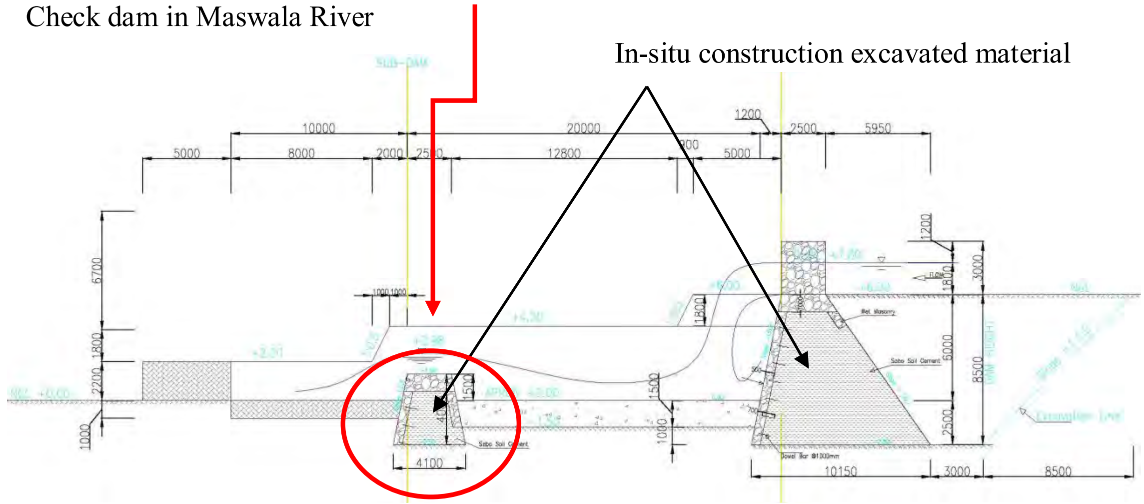
- Having an intermediate function between soil and concrete and reducing construction cost by recycling materials
- Applicable in various parts of construction structures

(3) Consideration for implementation

- A thorough field test is required before it can be applied.
- Inferior in abrasion resistance compared with concrete. Therefore, the surfaces, if required, shall be protected with concrete blocks or stones.

(4) Applicable Sites and Structures

- Groundsills in Maswala, Mzase Rivers
- Check dam in Maswala River



Source: JICA Study Team

Figure 10.90: Applicable Part of In-situ Construction Excavated Material for Groundsill and Check Dam

(5) Evaluation for Imported Technology

Table 10.100: Comparison of Construction Method

Item	**Conventional construction method utilizing normal concrete**		**Construction method utilizing Sabo Soil Cement (INSEM Method: In-situ Stabilized Excavated Materia)**	
Description of Method	Mixing aggregate, cement, water at concrete plant or portable mixer. Then transporting to construction spot, placing concrete.		Mixing excavated soil, sand, water, and cement in field. Then transporting to construction spot, bulldozing mixed material, compacting with vibrating roller. The surface of the above, if required, protected with concrete, masonry.	
Candidate Sites to be applied	Ground sills, check dam at Maswala, Mzase tributary			
Merit	Durable longevity performance is higher. Therefore surface protection is not required		**Construction cost is lower.** **Residual soil could be reduced.**	
Demerit	Construction cost is higher.		**Durable longevity performance is lower. Therefore, if required, surface protection is needed.**	
Direct Construction Cost for Check Dam	US$ 2.9 Mil.	100%	US$ 2.0 Mil.	68%
Construction Period	2,200 m3/month	100%	2,800 m^3/month	79%
Evaluation	Construction method utilizing Sabo Soil Cement is recommended in following view points. **To reduce construction cost 32 %, To reduce construction period 20%** **Residual soil could be reduced. Therefore could contribute to reduction in environment load.** **Furthermore, mixing soil cement is utilizing improvement for soft ground.** Material investigation, sampling, trial mixing, and confirmation of mixing proportion based on the result of hexavalent chromium elution test, is required before construction. Mixing proportion will be conducted to reduce elution on proceeding hydration exothermic reaction.			

Note: Source; SABO & LANDSLIDE TECHNICAL CENTER JAPAN
Direct Cost is current price, not including contractor's indirect cost, VAT and contingency.
Exchange rate: 1US$=2,189.67TZS, 1JPY=19.36TZS

Source: JICA Study Team

10.4.4 Hat-Type Steel Sheet Pile

(1) Principal Features

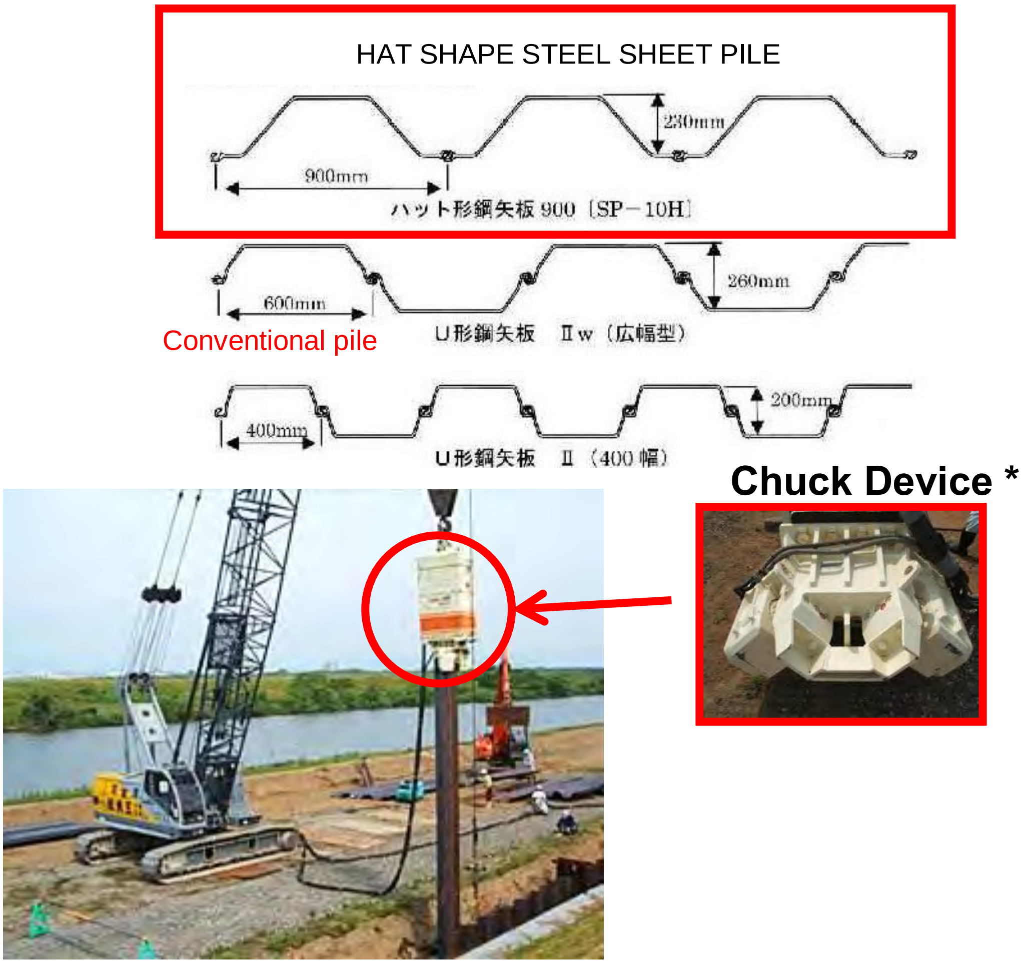
- Having 1.5-2.25 times the width compared with 40-60 cm conventional piles
- Reduction of 10-30% of management costs and construction costs
- Steel sheet pile of 900 mm wide is applied as one of the original technologies of Japan.
- To reduce 1/2 to 2/3 of the construction period as compared with a conventional technology.

(2) Consideration for implementation

- To utilize a vibration-hammer for pile driving.
- The conventional “chuck-duck” device for steel sheet piles cannot be used for hat-shaped ones. Therefore, special devices should be imported from Japan.

(3) Candidate Sites and Structures to be applied

The foundation of bank protection where significant erosion is in progress at 300.88km~358.98km in total 6,080m and tributary 1,310m total distance 7,390m.



Source: Chowa Kogyo co.jp, Japanese Technical Association for Steel Pipe Piles and Sheet Piles

Figure 10.91: Hat-Type Steel Sheet Pile

(4) Evaluation for Imported Technology

Table 10.101: Comparison of Steel Sheet Pile

Item		Conventional Steel Sheet pile (400mm width)		Hat type Steel Sheet pile (900mm width)	
Description of Method (Steel sheet pile for leakage prevention)		Base machine: Hydraulic Crawler Crane 50~55ton		Base machine: Hydraulic Crawler Crane 50~55ton	
		Pile hammer: Conventional Electric Vibration Hammer 60kW		Pile hammer: Electric Vibration Hammer with variable moment float 60kW	
		Steel sheet pile: Type II (W=400mm , t=13mm)		Steel sheet pile: Hat Type 25H (W=900mm, t=13mm)	
Candidate Sites to be applied		The foundation of bank protection where significant erosion is in progress at 300.881km~358.98km in total 6,080m and tributary 1,310m (Total 7,390m)			
Merit		To utilize vibration-hammer for pile driving method, which is high versatility equipment.		**Construction period can be shortened.** **Management and construction cost can be reduced.**	
Demerit		Steel sheet pile is necessary to import.		Steel sheet pile, vibration hammer is necessary to import.	
Construction Direct Cost	Nos.	7,390m / 0.4m =18,475 sheets	100%	7,390m / 0.9m=8211 sheets	44%
	Unit price	US$ 663 / sheet-6m	100%	US$ 1,184 / sheet 6m	179%
	Direct cost (1,000US$)	**12,248**	**100%**	**9,721**	**79%**
Construction Period	10 nos sheets piling period	1.00 day / 4m	100%	0.69 day / 9m	313%
	7,390m construction period	7,360/4*1.0=1,848day=61.6 month	**100%**	7,360/9*0.69=446 day =14.9 month	**24%**
Evaluation		HAT type steel sheet method is recommended considering following items : To reduce 21% of construction cost To reduce 76% of construction period Sheet pile and electric vibration hammer should be imported from JAPAN			

Note: Construction period and direct cost consists of labor, machine, material, fuel, and miscellaneous expense, which is calculated based on "Daily productivity data per unit construction element in JAPAN.
Direct Cost is current price, not including contractor's indirect cost, VAT and contingency.
Exchange rate: 1US$=2,189.67TZS, 1JPY=19.36TZS

Source: JICA Study Team

10.4.5 TRD Construction Method

(1) Outline

This is one of continuous underground wall construction methods in Japan (herein refered to as “**TRD**”: **T**rench Cutting **R**emixing **D**eep Wall Method).

The TRD mechanism works as follows:

- A cutter post which is chain-saw-shaped is used for excavation.
- A mixing machine is inserted into the ground to create a cavity of certain thickness.
- Cement slurry is then injected into the cavity and mixed with the soil.
- This process is continued sideways to create a continuous wall in the ground.

This can form underground revetment structures and protect against slope failures behind walls.

(2) Principal Features

- No work is conducted on the natural riverbank. Therefore, the natural environment is preserved.
- Year-round construction work can be conducted without concern for river pollution and river diversion works.
- Mechanized work will result in labor and cost savings and shortening of construction period.
- Reduced noise and vibration impacts.

(3) Consideration for implementation

- There still remains a possibility of exposed TRD wall erosion when the front of the ground erodes.
- The TRD machine should be imported from Japan, and experts and technical guidance are also required for its usage.

(4) Candidate Sites and Structures to be applied

The foundation of bank protection where significant erosion is in progress at 300.88km-358.98km in total 6,080m and 1,310m in tributary total distance 7,390m.

(5) Evaluation for Imported Technology

The evaluation for imported technology is conducted in a serious bank erosion in distance 7,390m.

Table 10.102: Comparison of Riverbank Protection

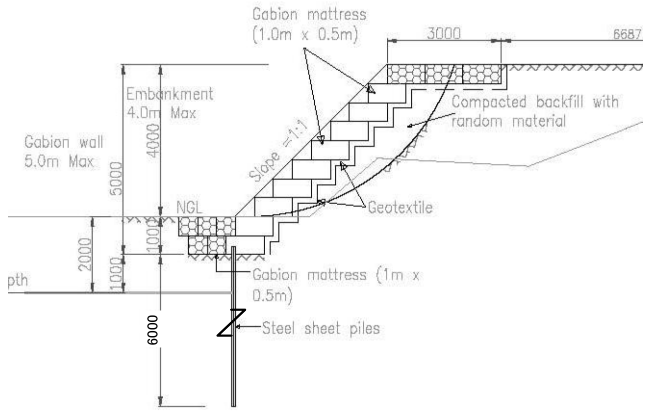
Item		Option 1	Option 2	Option 3
		Protection in front of Bank	Protection behind Bank	
		Gabion with Steel Sheet Pile	TRD Method (Trench Cutting Re-mixing Deep wall)	Sheet Pile alone
Location to be adopted		Section with serious bank erosion in total L=7,390m		
Schematic Cross Section		(See attached drawing)		
Description of Method		•Slope protection with gabion mattress (H=4m) is provided in front of the existing bank. •Scouring protection with sheet pile (L=6m) is provided at bottom of gabion wall	•Slope protection of underground wall behind the existing bank is provided by TRD method (L=15.6m)	•Slope protection of underground wall behind the existing bank is provided by SSP (L=18m)
Advantage		•Conventional construction method adopted in the site at present	•Construction work can be done without coffering •Faster construction speed	•Construction work can be done without coffering
Disadvantage		•Coffering/dewatering is required in case river water is available.	•Additional slope protection works will be provided in case of the wall is exposed due to progressive erosion. •Special equipment shall be imported.	•Highest cost among three options •Deep embedded depth of SSP (L=18m) is required to stabilize the SSP wall in case the wall will be exposed due to extermely progressive erosion.
Effects of protection	Scouring	◎	○	◎
	Surface erosion	◎	△	◎
	Retaining wall	○	◎	○
Cost		◎ US$ 3,122/m	○ US$ 3,496/m	△ US$ 4,950/m
Construction Period		○ 8.2 month	◎ 3.3 month	◎ 7.5 month
Overall evaluation		◎	△	○
		Gabion with Steel Sheet Pile is recommend in view points of Performance, Construction cost.		

Source: JICA study team

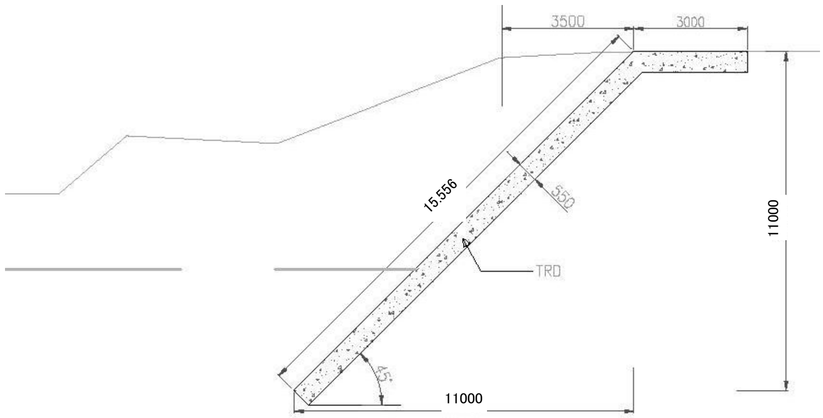
Direct Cost is current price, not including contractor's indirect cost, VAT and contingency.

Exchange rate: 1US$=2,189.67TZS, 1JPY=19.36TZS

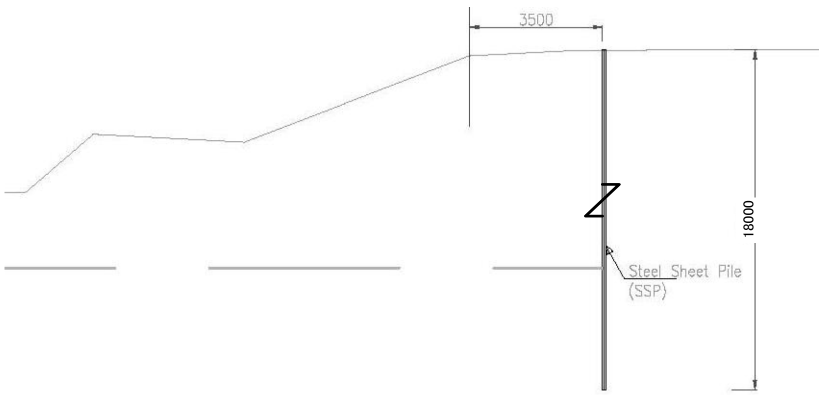
Option-1: Gabion with Steel Sheet Pile



Option-2: TRD method



Option-3: Steel Sheet Pile



Source: JICA Study Team

Figure 10.92: Options for Riverbank Protection

10.4.6 Weathering Steel[8]

(1) Outline

In recent years, concern over Life Cycle Cost (LCC) is calling for structures that are low in cost and maintenance and, at the same time, high in durability. Bridges built with weathering steel can be regarded as meeting these needs.

(2) Principal Features

Weathering steel is produced by adding trace amounts of alloying elements, such as copper, chromium, and nickel to ordinary carbon steel, thereby improving the properties of the rust itself and suppressing the further development of corrosion.

(3) Consideration for implementation

- A comparison is required with ordinary steel bridge and concrete bridge (economic efficiency, construction workability, etc.).
- Weathering steel has a unique color.

(4) Applicable Sites and Structures

- Maswala River Bridge, Mzase River Bridge, and New Bridges near Km304 and Km306.

(5) Comparison of Ordinary Steel and Weathering Steel

Table 10.103: Comparison of Ordinary Steel Cost and Weathering Steel Cost

Item	Ordinary Steel	Weathering Steel
Material Cost	10	12
Production	40	40
Bridging	25	25
Others	25	25
Initial Total Cost (Except Painting)	**100**	**102**
Painting Cost (Initial)	7	0
Initial Total Cost	**107**	**102**
Painting (Maintenance)		
30 years	7※	
60 years	7※	
90 years	7※	
Total Cost (100 years)	**128**	**102**

※Separately require the cost of scaffolding.
Source: JICA Study Team

10.4.7 RRR-B (Method for Construction of Railway Embankment)

(1) Outline

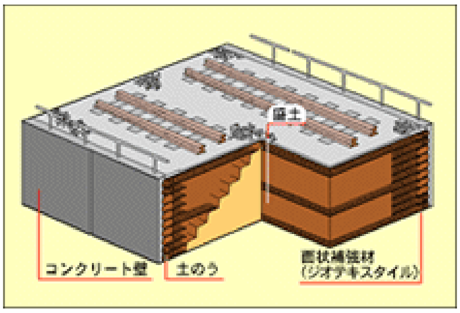
The RRR-B method is a reinforced soil embankment construction method used to build embankments with vertical slopes. RRR-B is a combination of cast-in-place rigid concrete wall and a synthetic polymer-based surface-shaped reinforcing material (geotextile or geo synth tex).

(2) Principal Feature

- It has high stability within a short reinforcement length.
- This method was developed by Japan Railway Technical Research Institute.

[8] Although the accurate wording is “weathering steel”, “weather-resistant steel” is also generally utilized.

- Embankments by RRR are higher in durability than the conventional methods
- RRR can reduce the fill amount and the acquisition of land, because the bank slope can be built vertically.

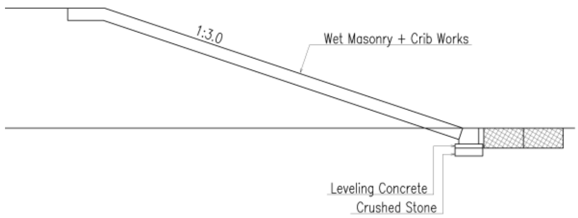
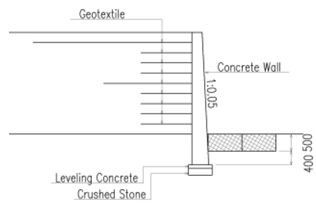


(3) Applicable Sites and Structures

- Areas slated for water protection of the railway embankment.

(4) Comparison of Ordinary Slope and RRR-B

Table 10.104: Comparison of Ordinary Slope and RRR-B

	Ordinary Slope	RRR-B
Figure		
Cost	100%	96%

(5) Evaluation

RRR-B is recommended in comparison with Wet Masonry slope protection. However, in comparison with Branch Block slope protection, the Branch Block method is more advantageous in terms of both cost and construction period. Therefore, RRR-B is not adopted as a slope protection method.

10.5 Adjusted Preliminary Cost Estimate in consideration of Japanese Technology

As the result of methods comparison between conventional technology and Japanese technology in Section 10.4, the following Japanese technology is expected to reduce construction cost, shorten the construction period, ensure long-term durability, and be generally useful in the prevention of scouring in bank foundation.

- Branch Block (retaining wall construction method)
- Filter Unit (material bagging method)
- In-situ Construction Excavated Material (recycling use of site material)
- Hat-type Steel Sheet Pile (wide shape steel sheet pile)
- Weathering Steel (materials for bridges build)

This section studies the construction period and cost in which Japanese technology is applied to the main stream, Maswala River, Mzase River, and parts of the railway sections.

10.5.1 Shortened Construction Period

Table 10.105 shows the comparison of construction period between conventional and Japanese technologies. The construction period could be shortened 0.3 to 5.4 months in all sections by applying the Japanese technology of branch block, filter unit, and hat-type steel pile. The detailed construction period is shown in Appendix U.

Table 10.105: Shortened Construction Period

Package	Section No [9]	Construction period (month)		Shortening of Period (month)	Remarks
		Conventional technology	Japanese technology		
1	1-1	6.8	4.9	1.9	Branch Block and Filter unit instead of Gabion
	1-2	11.7	8.4	3.3	
	2	8.9	6.7	2.2	
	3	13.9	10.4	3.5	
	4	11.7	7.2	4.5	Branch Block Filter unit and Hat type steel pile instead of Gabion, standard steel pile
	5	17.1	11.9	5.2	
	6	9.9	7.4	2.5	Branch Block and Filter unit instead of Gabion
	7	12.9	9.7	3.2	
	8	7.5	5.1	2.4	
2	9-1	11.5	8.6	2.9	
	9-2	18.5	15.8	2.7	Branch Block Filter unit and Hat type steel pile instead of Gabion, standard steel pile
	10	18.5	13.1	5.4	
	11-1	7.9	5.8	2.1	
	11-2	15.5	11.1	4.4	
	11-3	13.7	9.9	3.8	Branch Block and Filter unit instead of Gabion
	12	5.5	3.7	1.8	
	13	11.6	7.8	3.8	
	14	13.2	9.5	3.7	
	15	3.0	2.0	1.0	
3	Maswala Training works	20.6	15.7	4.9	Branch Block, Filter unit, Hat type steel pile, and INSEM instead of Gabion, standard steel pile, and normal concrete
	Maswala Check dam	12.1	9.3	2.8	
	Mzase Training work	10.8	7.0	3.8	
3	16	3.0	2.0	1.0	Branch Block Filter unit and Hat type steel pile instead of Gabion, standard steel pile
1	Rail -2	24.1	23.8	0.3	Branch Block and Filter unit instead of Gabion
3	Rail-9	19.3	19.0	0.3	

Source: JICA study team

10.5.2 Comparison for Direct Construction Cost between Conventional Technology and Japanese Technology

Table 10.106 shows the comparison of construction costs between conventional and Japanese technologies. The direct costs of construction could be reduced by TZS 11,750 million by applying Japanese technologies of branch block, filter unit, hat-type steel pile, and weathering steel. The detailed construction costs are shown in Appendix U.

[9] location name of river section

Table 10.106: Comparison of Direct Construction Cost (Unit: Million TZS)

Construction	Technology	Main stream	Tributary	Total
River construction works	Conventional	70,864	39,920	110,787
	Japanese	65,785	33,361	99,146
	Difference	5,082	6,559	11,641
Railway construction works (weathering steel)	Conventional	11,937		-
	Japanese	11,828		-
	Difference	109		109
Total (of difference)	-	-		11,750

Source: JICA Study Team

10.5.3 Consideration for Japanese Technology

The utilization of Japanese technologies could reduce construction cost and shorten the construction period, as mentioned in Subsection 10.5.2. However, in implementing such technologies, the following considerations are still needed:

Branch Block (retaining wall construction method)

- Measures against scoring at the toe of Branch Block
- Long-term durability in the river if it contains high amounts of silt
- Repair works after completion of the project in case of the Branch Block damaged
- Technical assistance for manufacturing concrete pillar, and masonry work in Tanzania, etc.
- Field-proof testing shall be executed in Tanzania, if possible.

Filter Unit (material bagging method)

- Long-term durability of exposed net in dray season

In-situ Construction Excavated Material (recycling use of site material)

- Technical assistance for producing INSEM in Tanzania

Hat-type Steel Sheet Pile (wide shape steel sheet pile)

- Measures in case the geological conditions are not met with piling work

Weathering steel (for bridge superstructure)

- Weathering steel has a unique color.

11. Project Implementation and O&M Structures

11.1 Project Implementation Structure

Following the implementation arrangements for the World Bank-assisted TIRP, RAHCO will be the Executing Agency for the Project (see Section 3.2.5 for the implementation arrangements for TIRP). The organizational structure of RAHCO is described in Section 3.2.1.

As described in Section 3.2.1, RAHCO has, with only about 50 officials, insufficient technical capabilities to effectively manage a large-scale project such as TIRP and the Project. As of December 2015, for the implementation of TIRP, RAHCO was in the process of establishing a Project Implementation Team (PIT) as described in Section 3.2.5, recruiting several experts from outside of RAHCO.

In order to ensure smooth and effective implementation of the Project, it is essential to make similar arrangements to those for TIRP, and a Project Management Team (PMT) is to be established for the Project. The PMT is to be staffed with core personnel as listed in Table 11.1 who are to be provided by RAHCO and the Project.

Table 11.1: Core Personnel of Project Management Team (PMT) for the Project

Position	No of Staff	Main Responsibility
Chief of PMT	1	To be responsible for overall project management and coordination with concerned agencies.
Deputy Chief of PMT	1	To be responsible for all of the technical and financial aspects of the Project and assist Chief of PMT in overall project management.
Project Engineers (Civil Work/River Structure)	2	To supervise technical aspects of the Project and assist Deputy Chief of PMT in technical management.
Accounting Specialist	1	To undertake accounting management of the Project and assist Deputy Chief of PMT in financial management.
Procurement Specialist	1	To undertake procurement management of the Project and assist Deputy Chief of PMT in procurement management.
Assistant Project Engineers (Civil Work/ Hydrology)	2	To assist Project Engineers in supervising technical aspects of the Project.
Environmental and Social Specialist	1	To undertake environmental and social management of the Project and assist Deputy Chief of PMT in environmental and social management.
Support Staff (Driver)	1	To undertake day-to-day operation of PMT.

Source: JICA Study Team

The PMT for the Project is to undertake, but not be limited to, the following activities:

- Overall project management operations throughout the pre-construction and construction stages, including reviewing, monitoring, coordination, evaluation, modification of, and reporting concerning, project implementation
- Overall planning of the Project at the initial stage, including detailed planning of the implementation program of the Project, establishing and managing fund disbursement procedures, and establishing the organizational structure and communication channels for project implementation.
- Selection of, and contracting with, the consultants to be employed for the Project.

- Supervision of the design work and preparation of tender documents to be undertaken by the consultants employed for the Project.
- Arrangement for securing the budget from the Ministry of Works, Transport and Communications (MWTC) for any local portion of the funds required for the Project.
- Management regarding environmental and social impacts (including RAP/CRP during the detailed design) of the Project in accordance with the procedures and requirements specified in relevant laws and regulations.
- Management of tender processing and contracting for all of the contract packages of the Project, including advertising, pre-qualification of bidders, short-listing of bidders, tender call, pre-tender conference, site orientation, opening of tender, tender evaluation, contract negotiations with successful bidders, and other relevant activities.
- Overall management and monitoring of the construction works and related activities for proper control of the quality, progress and budget of the Project.
- Coordination with TIRP, funded by the World Bank.
- Reporting to, and coordination with, the agencies/entities concerned with the implementation of the Project, including JICA.
- Examination and approval regarding consultant's monthly statements of performance and contractors' monthly certificates of payment.

11.2 O&M Structure

11.2.1 Division of Roles and Responsibilities in Railway O&M

Table 11.2 shows the current and planned institutional setup for railway infrastructure management and railway services provision (which is an excerpt from Table 3.1 in Section 3.2 of this report).

Table 11.2: Current and Planned Institutional Setup for Management of Railway Infrastructure and Provision of Railway Services

Issues	Current	Transition period	Long term
Railway infrastructure			
Ownership of infrastructure assets	RAHCO	RAHCO	RAHCO
Railway infrastructure development	RAHCO	RAHCO	RAHCO
Routine infrastructure maintenance and casual renewal[1]	TRL	TRL	RAHCO[2]
Railway services			
Provide operational services for operators	TRL	TRL	RAHCO
Ownership of rolling stock	RAHCO	TRL	TRL
Provide railway freight and passenger services	TRL	TRL	TRL
Maintenance and repair of rolling stock	TRL	TRL	TRL
Procurement of new rolling stock	TRL	TRL	TRL

Notes: (1) Based on the Concession Agreement (2007), TRL is currently "responsible for the first US$ 100,000 of the cost of any restoration to such lost or damaged immovable assets and to the extent that the total cost of such restoration is less than US$ 100,000". (2) In July 2015, MOT mentioned that the transfer of this responsibility to RAHCO will be conducted by the end of 2019 when the TIRP Program is completed. However, it is still unclear who will actually conduct the maintenance work (see 3.2.6 (iii) for more details).
Source: Table 3.1 of this report

Currently, routine infrastructure maintenance is carried out by TRL. In the long term, this responsibility is planned to be transferred to RAHCO, although the timing of the transfer and the way RAHCO will conduct maintenance work are still uncertain. It is planned that designing the right maintenance organization and sustainable maintenance activities as well as a training program for RAHCO will be conducted as part of TIRP (see Section 3.2.4). The progress of these initiatives needs to be closely updated before and during the implementation of the Project.

In the short to medium term, TRL will be responsible for routine infrastructure maintenance. As mentioned in Section 3.2.6, considering that RAHCO does not have its own in-house maintenance workforce and that there is no plan to significantly increase the size of RAHCO's workforce, it is envisaged that even after the routine maintenance responsibility is transferred to RAHCO, TRL (and a private company currently contracted out by TRL) will subsequently carry out the maintenance work on a contract basis. It is therefore realistic to assume that TRL will continue to conduct routine infrastructure maintenance in examining the scope of any technical assistance for flood protection by JICA.

The railway services will continue to be provided by TRL. As described in Sections 3.2.3 and 3.2.4, strengthening the capacity of RAHCO and TRL is essential for revitalizing the Central Railway Line before introducing new institutional arrangements, including the implementation of the open access policy. In this regard, the Study Team's concerns over the reintroduction of PPP to the railway system in Tanzania are described in Section 11.2.3.

11.2.2 Setting Up of Operation, Maintenance and Safety (OMS) Team during Construction

The Project needs to be implemented under continued railway operation. Therefore, in order to undertake train operation and infrastructure maintenance safely and efficiently during the construction stage of the Project, an Operation, Maintenance and Safety (OMS) Team is to be set up, consisting of representatives from RAHCO, TRL, the supervision consultant, and the contractors for the Project.

The OMS Team for the Project is to undertake, but not be limited to, the following activities for the section between Kilosa and Gulwe:

- Monitoring of train operations, maintenance activities, and construction works.
- Planning and implementation of safety and protection measures on the construction sites.
- Securing evacuation areas to evacuate staff/workers on the construction sites and construction equipment/machinery, etc., in case of emergency.
- Maintenance of communication equipment.

11.2.3 Concerns over Reintroduction of PPP

Considering that the railway sector of Tanzania experienced a failure in the past of a concession arrangement, the sector should take a very careful step toward any re-use of the private sector forces to provide railway services.

It is necessary to note the important lessons learned from what occurred after PPP were introduced for railways in several African countries, including Tanzania, including the following[1]:

[1] These lessons are based on the findings from a series of JICA studies on the development of economic or transport corridors in SADC countries conducted in the past several years.

- Refurbishment of railway system should be undertaken before transferring operation and maintenance works to concessionaires. Such refurbishment should be implemented with clear specifications and quality, which need to be documented explicitly.
- When deciding terms to be included in the concession agreements, the demarcation and responsibilities of contractors and concessionaires regarding maintenance should be clearly specified with details. In general cases, concessionaires are private commercial enterprises, which tend to seek maximum profit with minimum maintenance cost. Terms in the concession agreements should explicitly include the maintenance items to properly control this tendency.
- When transferring operation and maintenance works to concessionaires, the status of the railway system should be checked in detail, in the presence of contractors and concessionaires, and the conditions and qualities at the time of transfer should be clearly recorded.

11.2.4 Recommended Points on Railway O&M

Taking into account the above lessons on railway PPP and the current conditions of the railway system in Tanzania, it is recommended that the following points be considered by the Tanzanian government with respect to railway O&M:

- To improve railway infrastructure under the management by the public sector as a top priority.
- To achieve the level of rail freight tonnage during the peak times, i.e., in 2001–2004, under the current institutional setup before any re-use of PPP (including the open access policy) is implemented.
- To focus more on freight transport that will contribute to the improvement of financial performance of the railway system while placing lower priority on passenger services that would require operating subsidy.
- To strengthen the capacity of RAHCO and TRL under the current institutional setup.
- Not to rush toward complete vertical separation of the railway system, considering that even in Europe, there is no evidence indicating that vertical separation leads to better railway performance compared to vertically-integrated systems (see Box 11.1 below).

Box 11.1: Results of Selected Recent Research on Vertical Separation versus Vertical Integration in the Railway Sector

(a) J. Drew, and C.A. Nash (2011), "Vertical separation of railway infrastructure – does it always make sense?" Working Paper 594, Institute for Transport Studies, University of Leeds

- The results based on the analysis of railways in EU countries show that there is no correlation between vertical separation and the growth in rail freight traffic or rail's share of total freight traffic.
- If the key objective of vertical separation is to promote the efficiency and growth of rail freight, vertical separation may impede rail growth in some circumstances, particularly those in some Central and Eastern European countries where adequate government funding for infrastructure is not available.
- Before considering whether to make vertical separation mandatory within the EU, a much better understanding is required of the factors which determine competition, efficiency, and growth in the railway industry. On existing evidence, there is no reason to conclude that vertical separation improves rail performance.

(b) C.A. Nash, A.S. Smith, D. van de Velde, F. Mizutani, and S. Uranishi (2014), "Structural reforms in the railways: Incentive misalignment and cost implications," Research in Transportation Economics, Volume 48, pp. 16-23.

- The results based on the analysis of railways in European and East Asian OECD countries indicate that vertical separation raises costs for more densely-used railways and those with a higher proportion of freight traffic.
- It appears that the main reason for the above results is the misalignment of incentives, leading each player in the vertically separated system to seek to optimize their own costs rather than those of the system as a whole.
- There is no evidence that complete vertical separation leads to more competition.
- The findings of this research suggest that alternative railway structures will suit different railways with different patterns of usage and therefore a policy that seeks to impose complete vertical separation on all EU members would increase costs.

(c) Roland Berger (2012), "The optimal setup of a rail system – Lessons learned from outside Europe."

- This study was triggered by the debate on whether to impose complete separation on all EU members. It analyzed rail structures in the US, Canada, Japan, Russia, and China, which together account for 80% of global freight transportation by rail and 50% of passenger rail travel.
- Major railways in these countries have vertically-integrated structures that result in optimum resource allocation and efficient processes while avoiding additional costs. Integrated railways are able to act as a system integrator and help reach decisions by considering infrastructure and rolling stock jointly, based on their direct knowledge of customer requirements. As stated by several senior railway executives in these countries, key operational processes can be handled much more efficiently by integrated railways, especially when changes on short notice come into play and in case of intensely-used infrastructure. Integrated systems also avoid the additional interfaces and transaction costs of vertically-separated systems.
- Railways in these countries significantly improved their traffic volumes and personnel productivity over the last decade.
- Railways in these countries invest increasingly in assets. One reason could be that due to direct customer access, integrated railways are in an ideal position to forecast future transport needs and the required assets. They have an incentive to invest in infrastructure as they themselves are its main users.

12. Project Implementation Plan

12.1 Project Procurement Plan and Method

12.1.1 Public Procurement System in Tanzania

Currently, the public procurement system in Tanzania is governed by the Public Procurement Act (PPA) 2011 and its regulations titled the Public Procurement Regulations (PPR) 2013[1]. As was the case for the previous Public Procurement Act 2004 (which was repealed by the PPA 2011), the PPA 2011 is modeled on the UNCITRAL (United Nations Commission on International Trade Law) Model Law on Procurement of Goods, Construction and Services (1994)[2].

The PPR 2013 has provisions for donor funded procurement (no. 11) as follows:

11.- (1) In dealing with donor funded procurement, the procuring entity shall observe the provisions of section 4(1) of the Act[3].

(2) A procuring entity shall not seek clearance of tender documents or award recommendations from a foreign government, agency or institution that extended the loan, credit or grant before obtaining internal clearance of the same from an appropriate approving authority.

(3) To the extent that the clearance or approval of the appropriate internal approving authority conflict with the external clearance or approval of an external approving authority arising out of the loan or credit or grant agreement, the clearance or approval of the external approving authority shall prevail, but in all other respects, the internal clearance or approval shall prevail.

The above legal instruments are complemented by standard bidding documents and guidelines provided by the Public Procurement Regulatory Authority (PPRA), which is a regulatory body established under the PPA 2011. Table 12.1 shows these documents and guidelines.

Table 12.1: Standard Bidding Documents and Guidelines by PPRA

Standard Bidding Documents	Guidelines
• General Goods • Works • Supply and Installation • Standard Invitation for Quotations • Standard Prequalification Document • SBD (Standard Bidding Document) for Disposal of Public Assets by Tender • RFP (Request for Proposal) for Consultancy Services • STD (Standard Tendering Document) for Procurement of Non-Consultant Services	• Advertisement and Disclosure Forms • Procedural Forms • Circulars to Procuring Entities • Evaluation of Tenders and Proposal • Preparing Responsive Proposals • Tips for Preparing Responsive Bids

Source: Public Procurement Regulatory Authority (PPRA)

[1] The PPA 2011 and the PPR 2013 are downloadable from:
PPA 2011: https://www.ppra.go.tz/index.php/95-legislation/140-public-procurement-act-2011
PPR 2013: http://www.psptb.go.tz/news_files/psptb_496.pdf

[2] For the new features of the PPA 2011 and the PPR 2013 compared with their predecessor act and regulations, see, for example, the following paper:
http://www.academia.edu/7317192/The_New_Facets_of_Public_Procurement_Law_in_Tanzania_A_Walkthrough_of_the_Public_Procurement_Act_2011_and_the_Public_Procurement_Regulations_2013

[3] 4(1) of the Act is as follows: The basic principles of public procurement shall be to make the best possible use of public funds with honesty and fairness.

The bidding documents for donor funded projects in Tanzania may generally be in line with, if any, the standard documents provided by donors. For example, it is reported that the bidding documents for the World Bank-assisted TIRP have been prepared in accordance with the Bank's Standard Bidding Documents.

12.1.2 Recent Major Procurement by RAHCO

Table 12.2 shows recent major procurement conducted by RAHCO. Some of them have been conducted by TRL on behalf of RAHCO.

Table 12.2: Recent Major Procurement by RAHCO

Contract Year	Procurement	Contracting Company
2014	Remanufacturing 14 locomotives (88 Type) (BRN-C2)	Supplier: SMH Rail SDN BHD (Malaysian enterprise)
2013	Procurement of new 22 coaches	Supplier: Sung Shin Rolling Stock Technologies Limited, Korea
2014	Repair of Tura quarry and its equipment	Contractor: CREATIVE
2014	Protection and Replacement of bridges at km 293+050, 303+800 and 517+175 between Kilosa and Kidete on the Central Railway Line	Design and supervision: Gauff Contractor: China Civil Engineering Construction Corporation Ltd. (CCECC)
2013/14	Bridge at km 349/450 and associated works between Godegode and Gulwe Stations on the Central Railway Line	Design and supervision: Gauff (Note that the works were suspended due to the bid price higher than the budget.)

Source: RAHCO, TRL

12.1.3 Situation of Local Consultants

There are several international consulting firms working on railway projects/studies in Tanzania including those listed in Table 12.3.

Table 12.3: International Consulting Firms Working on Railway Projects/Studies in Tanzania

Company Name	Railway Project Experience in Tanzania
H.P. Gauff Ingenieure GmbH & Co. KG -JBG, Dar es Salaam (Germany)	2015: Feasibility study and preliminary design for the Arusha–Musoma railway section 2014: Design and Supervision of Protection and Replacement of Bridges Kilosa to Kidete on the Central Railway Line 2013: Design and Supervision of Bridge at Km 349/450 and Associated Works between Godegode and Gluwe Stations on the Central Railway Line 1988: Assessment of Flood Damages on Railway Line between Kilosa and Kidete", with DE-Consult
CPCS Transcom, (Canada)	2013: Railways Upgrading and Performance Improvement Study, World Bank 2009: East Africa Railway Master Plan
CANARAIL (Canada) (Subsidiary of SYSTRA)	On-going: Inspection and Capacity Rating of Railway Bridges: (Phase1) Dar Es Salaam to Isaka (Phase2) Tabora to Kigoma and Isaka to Mwanza 2014: Phase II of the Study for the Dar Es Salaam–Isaka–Kigali/Keza–Musongati Railway Project
DB International (Germany)	2009: Feasibility Study for the Isaka–Kigali/Keza–Musonagati Railway Project

Company Name	Railway Project Experience in Tanzania
COWI International (Denmark) COWI Tanzania Consulting Engineers & Planners Ltd, Dar es Salaam	2014: Upgrading of Tanga–Arusha and Isaka–Mwanza Railway Lines, Tanzania (aerial mapping, geotechnical investigations etc., feasibility and environmental studies, detailed design, tender documents)
SMEC International (Australia)	1977: Technical assistance for a change management program implemented by the TRC with a particular focus on environmental frameworks

Source: JICA Study Team

As shown in Table 12.4 there are several major local consulting firms in Tanzania while only a limited number of firms have been involved in railway projects, as an associate consultant under international consulting firms.

Table 12.4: Major Local Consulting Firms in Tanzania

Company Name	Field of Specialization	Example of Railway Project Experience
AMBICON ENGINEERING LTD, Dar es Salaam	Design and supervision for: buildings, bridges, highways, maritime & coastal, railways, river training and protection	Design of permanent protection works on the El Nino damaged Kilosa–Kidete section of Central Railway Line, 1999, under WSP International (UK)
INTER CONSULT LTD, Dar es Salaam	Engineering/project management for highways, water & waste, E&M, telecommunication, geotechnical, architecture, land survey, quantity survey	Flood prevention works between Kilosa and Gulwe on TRC Central Line Contract Nr 3806 Additional Works, 1997, under Mott MacDonald, funded by European Union
APEX ENGINEERING CO LTD, Dar es Salaam	Engineering/project management for highways, bridges, airports, harbours/ ports/ferries, water supply/sewerage systems, irrigation systems, buildings	Unknown
MAK CONSULT Engineering & Transport Services Ltd., Dar es Salaam	Engineering/project management for highways, airports, geotechnical, town planning, water & waste disposal, ESIA topographical survey, traffic	Unknown
M- Konsult LTD, Dar es Salaam	Engineering/project management for highways, transportation, bridges, water & public health, electrical/power	Unknown
NORPLAN Tanzania LTD, Dar es Salaam	Engineering for highways, transportation, structural, bridges, water supply & sanitation, ESIA, energy and building services	Unknown
SOU CONSULT, Dar es Salaam	Engineering/construction management for civil/structural, sanitary, hydraulic, roads	Unknown
TANCONSULT LTD, Dar es Salaam	Engineering for structural, bridges, multi-storey buildings, civil, irrigation, roads and highways, urban water supply and sanitation	Unknown
UWP CONSULTING (T) LTD, Dar es Salaam	Engineering/construction supervision for civil/structural, highways, water, mining, information management	Unknown

Source: JICA Study Team

12.1.4 Situation of Local Contractors

The information on contractors in Tanzania can be obtained from the Contractors Registration Board (CRB), which is a regulatory body charged with responsibility for registration, regulation and development of contractors. A number of contractors are registered with the CRB, among which the Class-1 contractors covering civil works are listed in Table 12.5. Class-1 contractors are defined as those with no limit of amount in any single contract.

Table 12.5: Class-1 Contractors Covering Civil Works Registered with CRB

No.	Category	Company Name	Location
1	Foreign	TENDAR INTERNATIONAL CO. LIMITED	Dar es Salaam
2	Foreign	CHINA HENAN INTERNATIONAL COOPERATION GROUP CO. LTD	Dar es Salaam
3	Foreign	CRJE (EAST AFRICA) LIMITED（a member of China Railway Group Limited in China)	Dar es Salaam
4	Foreign	CHINA WU YI CO. LTD	China
5	Foreign	MUTLUHAN CONSTRUCTION INDUSTRY COMPANY LIMITED	Dar es Salaam
6	Foreign	JIANGXI GEO-ENGINEERING (GROUP) CORPORATION	Dar es Salaam
7	Foreign	CHENGDU SHEMNA INTERNATIONAL LIMITED	Dar es Salaam
8	Local	ENGIPLAN LIMITED	Dar es Salaam
9	Local	TONTAN PROJECTS TECHNOLOGY CO. LIMITED	Dar es Salaam
10	Local	KEENMAN LIMITED	Dar es Salaam
11	Local	MASIDO ENTERPRISES AND GENERAL SUPPLIES	Dar es Salaam
12	Local	BUILDING, WATER & EARTHWORK LTD.	Dar es Salaam
13	Local	TANPILE LIMITED	Dar es Salaam

Source: Contractors Registration Board (CRB) of Tanzania

Table 12.6 shows the contractors undertaking recent major construction projects in Tanzania. It is highly likely that large-scale projects in the country will be undertaken by foreign contractors in the years to come.

Table 12.6: Contractors for Major Projects

No.	Name of Project	Contractor	Status
1	Rehabilitation and extension Kilimanjaro Airport, Dar es Salaam	BAM International (Netherlands)	On-going
2	BRT project in Dar es Salaam	STRABAG AG (Germany)	On-going
3	Kigamboni Bridge over Kurasini Creek, Dar es Salaam	China Railway Jiangchang Engineering (T) Ltd., and China Major Bridge Engineering Company	Nearly completed
4	Flyover at Selander Bridge in Dar es Salaam, with length of 1.03 km crossing the Indian Ocean (USD91.032 million financed by South Korean Exim Bank)	Korean contractor	Will start sometime soon
5	Protection and Replacement of Bridges at km 293+050, 303+800 and 517+175 between Kilosa and Kidete on the Central Railway Line	China Civil Engineering Construction Corporation Ltd. (CCECC)	Completed in 2014

Source: JICA Study Team

From the current situation of local contractors in Tanzania, potential bidders for the construction work of the Project are likely to be European, Chinese, Korean, and/or Japanese contractors, some of which may joint venture with local contractors.

12.1.5 Basic Policy on Bidding Method and Conditions of Contract

In order to meet the urgent need for flood protection along the Central Railway Line, the period of time for procurement should be minimized to the extent possible while complying with the Guidelines for Procurement under Japanese ODA Loans (2012) that will be applied if the Japanese ODA loan is provided for the Project. Several potential measures for minimizing the time for procurement include the following:

- Detailed design and preparation of bidding documents
  Preparation of bidding documents is to be undertaken at the same time of detailed design, thereby starting the procurement of contractors earlier.

- Selection of contractors
  The method to select "Single-Stage Two-Envelopment Bidding with Prequalification" rather than "Bids following Prequalification" may be used in order to save time for procurement of contractors, namely cutting a period of two months in the JICA standard procurement schedule as compared with the latter.

- Measures during construction
  Potential measures during construction include the following:
  - ✓ To select contract packaging that will contribute to minimizing the period of construction (See Section 12.2.1 for Project Packages.)
  - ✓ To utilize faster construction methods such as advanced construction methods developed, e.g., in Japan
  - ✓ To include incentive clauses in the conditions of contract
  - ✓ To improve access roads to the project sites before starting the construction, especially between Kilosa and Kidete, and between Godegode and Kidete, both currently unpaved and in very poor condition

- Temporary flood protection measures
  Since it takes several years to complete the Project, it is important to continue to undertake temporary flood protection measures until project completion in order to minimize delays of the Project due to negative impacts of floods on the construction. It would be effective to include annual preventive flood protection measures and faster recovery works in the scope of work of each construction package as Daywork.[4]

12.1.6 Selection of Consultants

The selection method shall be planned and conducted in compliance with the following JICA guidelines

- Chapter 1: Guidelines for the Employment of Consultants under Japanese ODA Loans, Handbook for Procurement under Japanese ODA Loans, April 2012.
- Standard Request for Proposals under Japanese ODA Loans, Selection of Consultants, October 2012.

[4] For Daywork, see, for example, Clause 13.6: Daywork in FIDIC Conditions of Contract for Construction for Building and Engineering Works Designed by the Employer, Multilateral Development Bank Harmonised Edition, June 2010.

It is necessary to prepare the following items in advance:

- Short list of candidate consultants
- Request for Proposal (RFP) including the Terms of Reference (TOR), work plan, organization for the work, and staffing (composition of experts, etc.)

12.1.7 Selection of Contractors

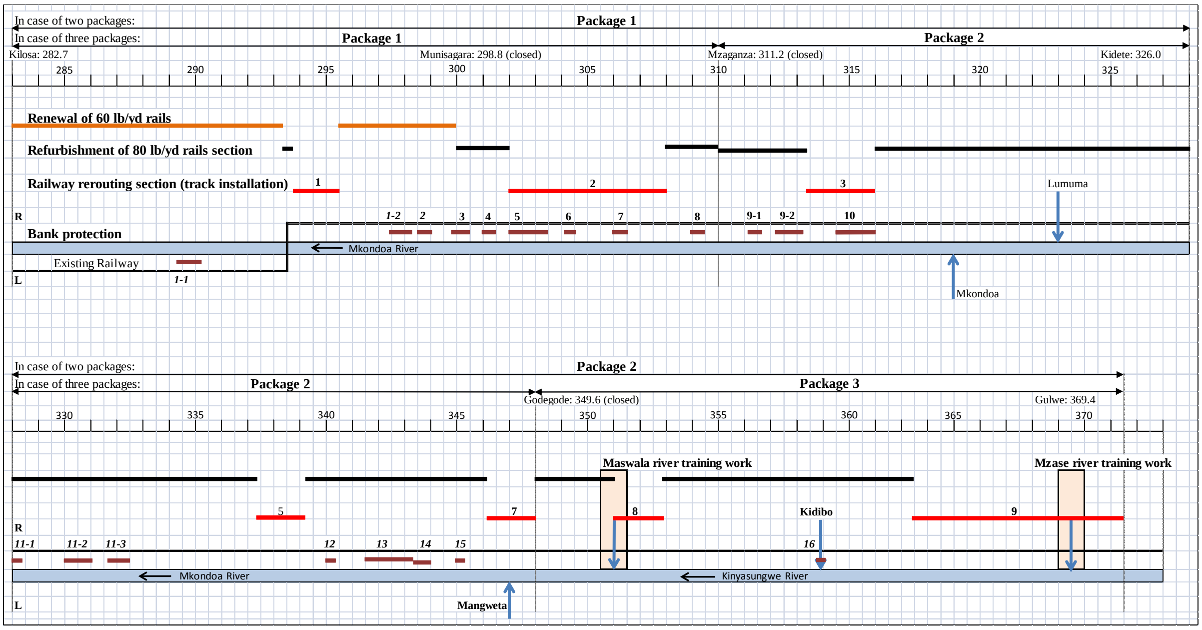
The selection method shall be planned and conducted in compliance with the following JICA guidelines:

- Chapter 2: Guidelines for Procurement under Japanese ODA Loans, Handbook for Procurement under Japanese ODA Loans, April 2012.
- Standard Bidding Documents under Japanese ODA Loans, Procurement of Works, October 2012.
- Standard Bidding Documents under Japanese ODA Loans, Procurement of Goods, May 2013.

12.2 Project Implementation Plan

12.2.1 Project Packages

The Project construction works are distributed along the Central Railway Line between Kilosa and Gulwe as shown in Figure 12.1.



Source: JICA Study Team

Figure 12.1: Distribution of Construction Works

When the Project is divided into a number of contract packages, the following conditions are taken into account:

- Geographical features, which are almost the same among the Project sections.
- Distribution of construction works, which are determined according to the technical requirements, namely the construction of rerouting sections, track rehabilitation works, and riverbank protection works.

- The scale of different packages, such as work volume, contract amount, and completion of work should only have small differences.
- Construction works be completed as early as possible.
- Maintain high bid participation opportunity for potential bidders; contract amount should not be a risk for bidders.
- Ease in project management.

As the number of contract packages in the Project decreases, the size of each contract package (and thus, contract amount) increases. The larger scale contract packages have larger risks for all stakeholders. It is not easy, even for large companies, to bid for the large-scale contract packages, particularly in consideration of the nature of the Project, in which construction works are done over three years, including three annual rainy seasons. Therefore, large contract packages may narrow the range of potential contractors to participate in the bidding process.

Thus, it is important that appropriate packaging is made for potential bidders, and that all the contract packages have bidders and all the bids are successfully contracted. In this respect, the amount of the contract packages should be less than a certain amount, one which allows potential bidders to take part in the bidding. Considering the current state of bidding in the international construction industry, an amount around JPY 15 billion is acceptable.

In view of above considerations, the Study Team carried out a comparison analysis of packaging as shown in Table 12.7. The results indicate that three packages are recommended for the Project.

Table 12.7: Comparison of Packages

Comparison Items	One Package	Two Packages	Three Packages
Geographical features (A length of section, km)	88.9	P1: 44.3 P2: 44.6	P1: 27.3, P2: 38.0 P3: 23.6
Distribution of works			
Rerouting section including track installation (km)	25.1	P1: 10.5, P2: 14.6	P1: 7.7, P2: 6.4, P3: 11.0
Renewal of 60 lb/yd rails	15.0	P1: 15.0, P2: -	P1: 15.0, P2: -, P3: -
Refurbish. of 80 lb/yd rails section	48.8	P1: 19.9, P2: 28.9	P1: 4.6, P2: 31.6, P3: 12.6
Bank protection for main stream	15.1	P1: 10.8 P2: 4.3	P1: 6.4, P2: 8.5, P3: 0.2
Tributary river training work	-	-	P3: 2.6
Temporary road	100.1	P1: 52.0 P2: 48.1	P1: 25.5, P2: 40.1, P3: 34.5
Work volumes per package	Largest	Medium	Small
Construction cost (current price, million JPY)	28,043	P1: 13,458 P2: 14,585	P1: 11,496, P2: 8,907 P3: 7,640
Construction schedule (period)	Could be nearly the same with the three packages	Could be nearly the same with the three packages	P1: 34.5 P2: 36.0 P3: 36.0
Bid participation opportunity	Low	Middle	High
Project soft-management: Project physical aspect:	Integrated and easier than others. Long project section.	Coordination within acceptable level. Mid-length sections.	Coordination within acceptable level. Shortest sections.
Overall evaluation	Not recommended	Not recommended	**Recommended**

Source: JICA Study Team

12.2.2 Procurement Plan of Products and Materials

The procurement sources of major materials and equipment for railway and river construction works are shown in Table 12.8 and Table 12.9, respectively.

Table 12.8: Procurement Source for Major Materials

Materials	Procurement Source		Remarks
	Domestic	Overseas	
Cement	○		m3/unit, 42.5 N/mm^2
Sand	○		m3/unit, 0-5 mm
Crushed stone	○		m3/unit, 5-20 mm
Gravel	○		2-20 mm
Admixture		○	AE (200lit/drum)
Plywood (form)	○		12 mm
Deformed bar		○	BS Grade 460
Equal angel steel		○	ton/unit, L-75*75
Channel steel		○	ton/unit, [-100*50
H-Beam		○	ton/unit, H-300
Steel sheet pile		○	ton/unit, SYW295 (II, hat 25H)
RC pipe	○		Dia. varied, L=1.0m
PVC pipe		○	d=100mm,150nn
Geotextile		○	t=10 mm with anchor
Gabion		○	0.5*1.2W*10L (m)
Rail		○	80 lb/yd, 24.0m or more, 3 holes at each end
Fish plate and accessories		○	For 80 lb/yd rail, 6 holes
Steel sleeper with fastenings		○	For 80 lb/yd rail, with elastic fastening (pandrol)
Turnout		○	80 lb/yd, 1:12
Ballast	○		Graded 20mm - 63mm, Granite stone.

Source: JICA Study Team

Table 12.9: Procurement Source for Major Equipment

Equipment	Procurement Source		Remarks
	Domestic	Overseas	
Back hoe 0.45 m^3		○	Crauler, Bucket Capacity 0.45 m3, Engine power 60 kW
Back hoe 0.8 m^3		○	Crauler, Bucket Capacity 0.8 m3, Engine power 104 kW
Dump truck 4 ton		○	On-road, Diesel, Capacity tonnage 4 ton, Engine power 135 kw
Dump truck 10 ton		○	On-road, Diesel, Capacity tonnage 10 ton, Engine power 246 kw
Trailer flat bed		○	On-road, Capacity tonnage 15 ton
Truck crane 25 ton		○	With the hydraulic telescopic jib, Maximizing lifting load 25 ton, Engine power: 162 kW
Crawler crane 50 ton		○	Hydraulic winch, Lattice jib, Maximizing lifting load 50 ton, Engine power 102 kW
Motor grader 3.1 m		○	Earthwork, Blade width 3.1 m, Engine power 85 kw
Vibration hammer 60 kW		○	Driving of steel sheet piles, Electric, Variable moment type, Engine power 60 kW
Vibration hammer 60 kW (for hat type 900 mm)		○	Driving of Hat-type steel sheet piles, Electric, Variable moment type, Engine power 60 kW
Concrete agitator truck 5 m^3		○	Transport of fresh concrete, Mixed capacity: 4.4 m3, Engine power 213 kw
Concrete pump (boom) 110 m^3/hr		○	Pouring of concrete, Boom-type, Pressure feed capacity 90-110 m3/h, Engine power 199 kw

Equipment	Procurement Source		Remarks
	Domestic	Overseas	
Vibration roller 10 ton		○	Boarding type, Operating weight 8-10 ton, Engine power 77 kw
Asphalt finisher 2.4/4.5 m		○	Wheel type, Paving width: 2.4-4.5m, Engine power: 49 kw
Air compressor 18.5 m^3/min		○	Portable type, Engine drive, Screw compressor, Discharge: 18-19 m3/min, 0.7 MpPas, Engine power 240 kW
Power generator 200 kVA		○	Diesel engine, Rating capacity 200-220 kVA
Road-rail 8 ton dump track		○	Transport of replenishing ballast
			Rubber insulation crawler, Gauge 1,000 mm
Road-rail 8 ton crawler crane		○	Unloading of heavy articles and shifting of track panels in lateral directions
			Rubber insulation crawler, Maximizing lifting load 8 ton, Gauge 1,000 mm
Road-rail power shovel (RPS)		○	Forming of track ballast
			Rubber insulation crawler、Bucket capacity 0.3m3, Gauge 1,000 mm
RPS with 16-tool tie tamper attachment		○	Tamping of track ballast
			Maximizing construction depth under the sleeper 300mm,Vibration force 30000N×2
RPS gripper attachment		○	Unloading and arranging sleepers
Simplified track inspecting instrument		○	Track inspection
			Alignment (left and right）, Longitudinal (left and right) Gauge, Cross level, Twist, Track distance, Gauge 1,000 mm

Source: JICA Study Team

12.2.3 Traffic and Safety Management Plans

Traffic and safety management plans will be prepared in accordance with the relevant laws and regulations of the United Republic of Tanzania and the Guidance for the Management of Safety for Construction Works in Japanese ODA Projects (JICA, September 2014). In case these laws and regulations do not fully cover the safety and health issues for the Project, the relevant regulations of Japan will be applied as much as practical. The basic policy of the management plan is shown as follows:

- Basic Principles of Safety Management: Safety is a top priority
  All Project Stakeholders shall put top priority on safety and use their best endeavors to eliminate the occurrence of accidents.
- Compliance with Relevant Laws and Regulations
  Compliance with laws and regulations of the United Republic of Tanzania will be applied. In particular, as the occurrence of traffic accidents is envisaged, compliance with traffic rules will be stressed.
- Responding to natural disasters such as landslides and floods
  Using flood predictions provided by the collection of weather information, evacuation procedures can be done early.
- Method Statements on Safety
  The method statements, as shown in Table 12.10, will be prepared by contractors.

Table 12.10: Traffic and Safety Management Plans

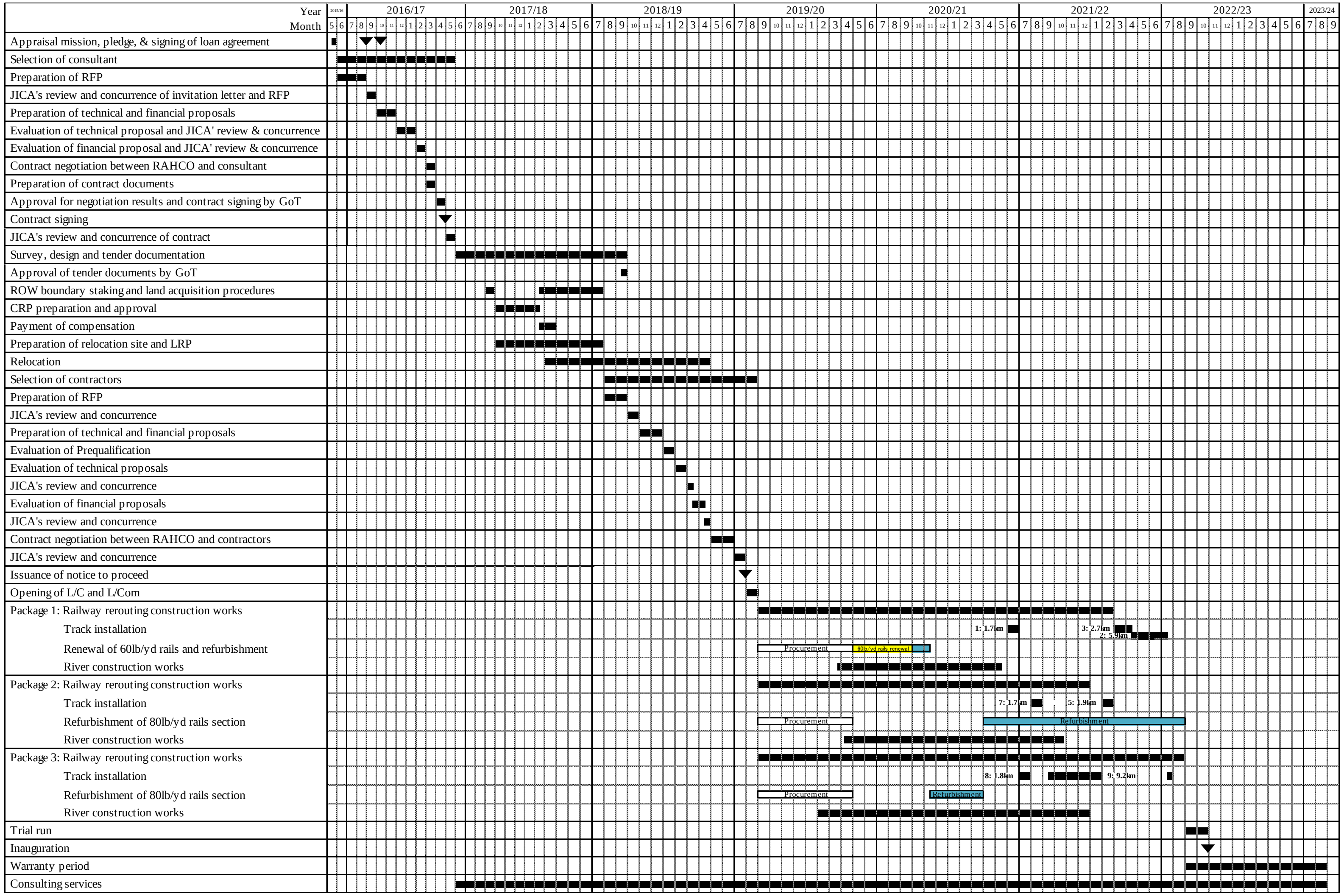
(1) Construction plant and machinery	Specifications and quantity of construction machines to be used
(2) Equipment and tools	Equipment and tools to be used
(3) Construction materials	Specifications and quantities of major materials to be used
(4) Necessary qualifications and licenses	Qualifications or licenses necessary
(5) Order of command (including names of supervisors)	Name of supervisors for each section of work.
(6) Work items	Work items classified into the unit work according to the order in the works schedule.
(7) Procedure for the execution of the works	Procedure for the execution of the major work operations for each type of work item
(8) Foreseeable risks	Foreseeable risks for each work item
(9) Precautionary measures	Countermeasures to prevent foreseeable risks, and the necessary protective gear

Source: JICA Study Team

12.2.4 Project Implementation Schedule

The Project implementation schedule as shown in Figure 12.2 is estimated on the assumption that the conclusion of loan agreement will be in October 2016. The implementation schedule shows major activities beginning from the fund allocation and ending at the end of warranty period. The project stages and their associated durations are as follows:

Loan Agreement	: October 2016
Selection of consultant	: 7 months after loan agreement
Land acquisition	: 10 months from commencement of detail design
Relocation	: 13 months after payment of compensation
Detail design and tender documents	: 16 months
Selections of contractors	: 13 months
Construction work	: 36 months
Completion inspection and trial run	: 2 months
Inauguration	: October 2022
Warranty period	: 12 months after the completion of the Project



Source: JICA Study Team

Figure 12.2: Project Implementation Schedule

13. Environmental and Social Considerations

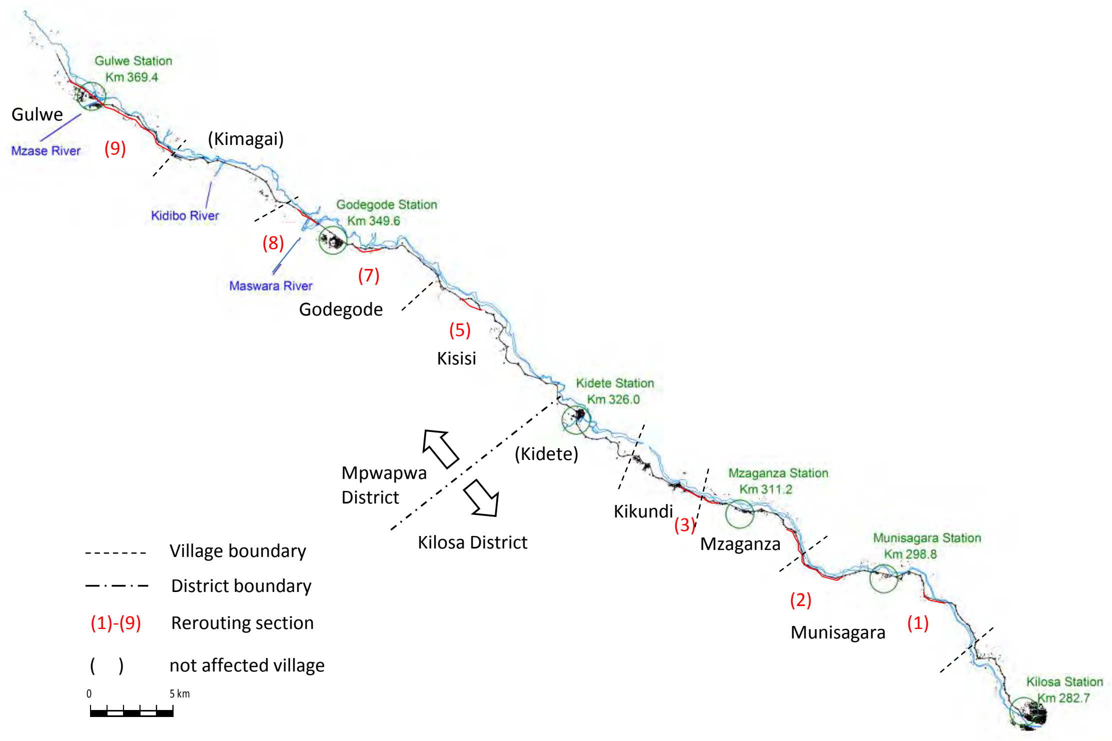
13.1 Environmental Impact Assessment (EIA)

13.1.1 Project Components Which May Affect Environment

The project components to be considered in this chapter are listed below.

(1) Rerouting

In total 25 km of the existing railway between Kilosa and Gulwe is to be relocated toward mountainside, a movement of at most five hundred meters, to avoid the impact of flooding. The rerouting sections consist of the seven sections shown in Figure 13.1; Section 9 includes the relocation of Gulwe Station for one kilometer to the west. Each rerouting section is built by embankment or cutting of the mountain slopes.



Source: JICA Study Team

Figure 13.1: Location of the Rerouting Sections

(2) Bank Protection

The riverbank is protected by installing gabion/blocks. The locations of these are presented in Subsection 10.1.9.

(3) River Training Works

At Maswara and Mzase Rivers, which are tributaries of the mainstream, the river course is straightened and defined by excavating channels together with constructing a check dam and groundsill. The details are presented in Subsection 10.1.10.

(4) Construction Access Road

The temporary construction access road will be prepared along the existing railway within the ROW.

13.1.2 Environmental and Social Conditions of the Study Area

(1) Land Cover and Land Use

Typical conditions of land cover and land use between Kilosa and Dodoma are presented in Figure 13.2 and Figure 13.3. Forest is the typical land cover around Kilosa, while bushland mixed with agricultural land are common in the western half of the Kilosa-Gulwe section. After Gulwe and toward Dodoma, the condition becomes drier. Pasturing is commonly observed at the bushland.

Forest near Kilosa

Bushland at the west half of the Kilosa-Gulwe section

Source: JICA Study Team

Figure 13.2: Typical Land Cover (Vegetation)

Agricultural land (maize) near Gulwe

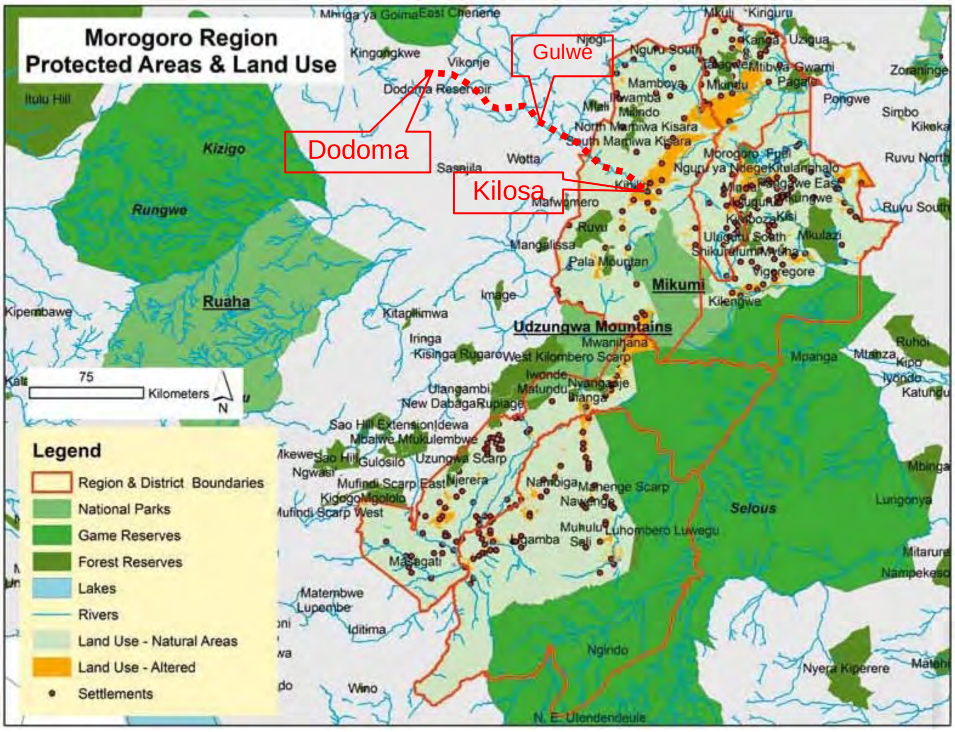
Pasture at the bushland

Source: JICA Study Team

Figure 13.3: Typical Land Use

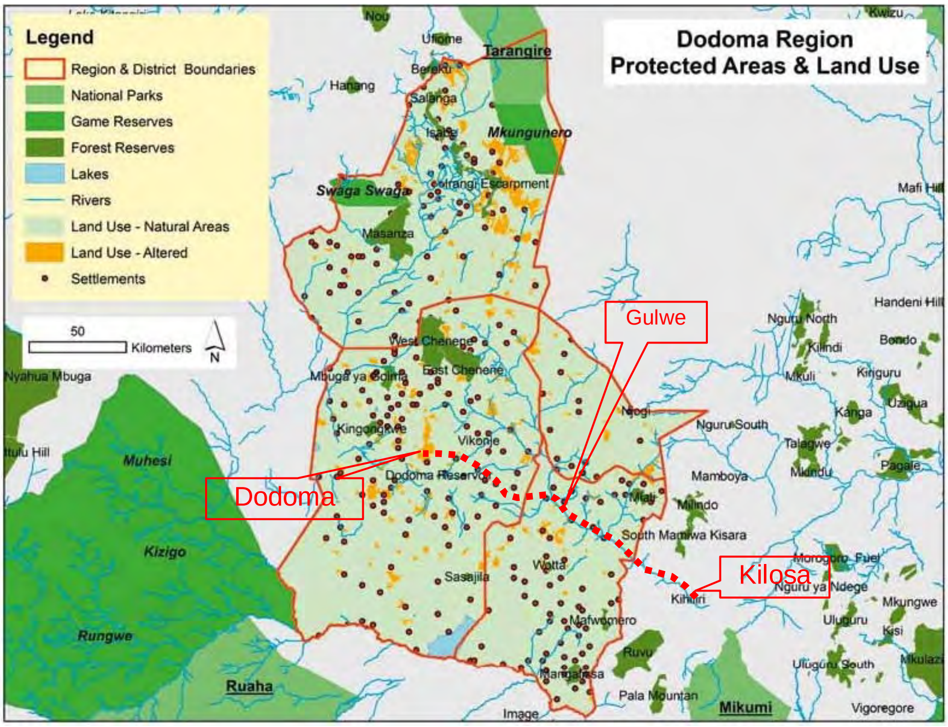
(2) Protected Areas

Distributions of national parks, game reserves and forest reserves in Morogoro and Dodoma region are presented in Figure 13.4 and Figure 13.5. The closest reserve to this project area is Kihiliri forest reserve located near Kilosa Station. Although the location is close to the project area, an environmental impact to the reserve is not anticipated as the location is segregated from the railway by the river (Figure 13.6). The other reserves are located more than several kilometers away from the railway.



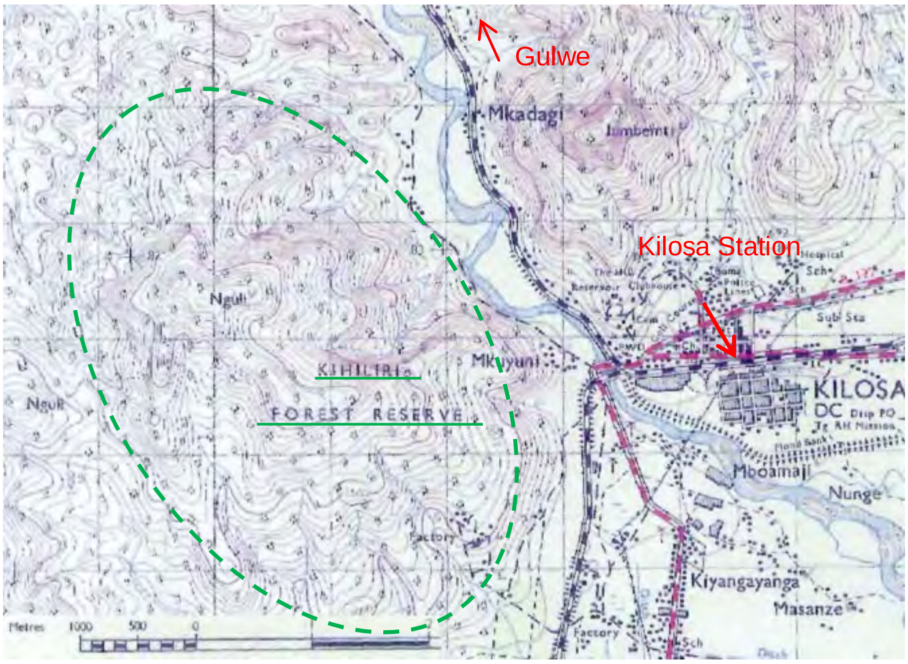
Source: Directory of Natural Resources and Land in Tanzania 2011, PAMS Foundation.

Figure 13.4: National Parks and Reserves in Morogoro Region



Source: Directory of Natural Resources and Land in Tanzania 2011, PAMS Foundation.

Figure 13.5: National Parks and Reserves in Dodoma Region



Source: Topographic map with a scale of 1 to 50,000

Figure 13.6: Location of Kihiliri Forest Reserve and the Railway

(3) Socio-economic Conditions by District

The Railway Line along the Kilosa-Dodoma section runs through the three Districts: Kilosa of the Morogoro Region, and Mpwapwa and Chamwino of the Dodoma Region. The present socio-economic conditions of each District are summarized below based on the information collected from each District Office.

<u>General Land Usage by Districts</u>

Kilosa District:

The District's land use consists of Agriculture (37%), Grazing (33%), Mikumi National Park (22%), Forest (5%), Built-up area and wetlands (1%).

The rail alignment runs through the two agro-ecological zones – Medium High Zone and Plains – where maize, rice, cassava, sorghum and bananas are cultivated.

Mpwapwa District:

The District's land use consists of Agriculture (31%), Grazing (35%), Game Controlled Area (19%), Forest Reserve (1.2%), Community Forest (0.9%), Settlement (4.2%) and Water Bodies (4.2%) – marsh and wetlands.

Agro-ecologically, the rail alignment, existing and proposed, lies within the Intermediate Zone (IZ) and the Low Land Zone (LLZ). Agriculture in the IZ features the cultivation of paddy, maize, sorghum and legumes, as well as dairy and traditional livestock. Agriculture in the LLZ features cultivation of dry resistance crops including millet, maize, sorghum, groundnuts, beans and tropical fruits. However, due to its temperature, the greatest part of the area is used for grazing traditional livestock.
Chamwino District:

Chamwino District has a total area of 8,856 square kilometers (km^2), out of which 4,823.066 km^2 (54.45%) is potential land for agriculture, 1864,937 km^2 (21.05%) is currently under cultivation, 1093.192 km^2 (12.34%) is used as grazing land, 813.1 km^2 (9.18%) is used as residential area, 1960.96 km^2 (22.14%) covers natural forest, 63.08 km^2 (0.71%) is used as forest reserve area and 102.1 km^2 (1.15%) is wetland. (Source: District Vulnerability Report, 2012.)

The District is characterized by two agro-ecological zones in terms of annual precipitation – a zone with 400 mm rainfall and another with 550–650 mm, with different soil features.

Key Socio-economic Features by District

Key socio-economic features by District are collected from respective District Offices. Extracted are the relevant facts in terms of employment structure, ethnic variety, poverty indicators, sources of household cash income, health situation, and availability of water, types of crop cultivated, and so on.

These facts constitute fundamental inputs to comprehend the target area's socio-economic baseline data.

Kilosa District (Extracts from District Profile, 2014):

- **Employment Structure by Sectors:** More than 80% of the District population is employed by the agriculture sector. They are engaged either at the subsistence level, growing (rice, maize, beans, cassava, and bananas) or in cultivating cash crops (sisal, sugar cane, cotton, and sunflowers). Aside from agriculture sector, office work (2.8%), livestock keeping (0.93%), fishing (0.08), plant operations (0.49%), and informal sector (15.7%) constitute other employment patterns.
- **Production of cash crop and food crops:** The District's volume of cash crops, in terms of annual yield in tons (Source: Agricultural & Livestock Dept. August 2010) is as follows: cotton (47,515), onion (13,277), sugarcane (573,294), groundnut (1,763), and coconut (4,549).

  Major food crops produced (for the year 2009/2010, in tons/year) are maize (153,939), cassava (55,543), rice (43,059), banana (27,705), sweet potato (14,799), beans (13,332) and others.
- **Livestock keeping:** Cattle, goats, sheep, pigs, and poultry represent the major livestock kept. This activity is mostly performed by Masai and Sukuma tribes who migrate to the District from other regions. Grazing is the major type of livestock keeping used by livestock keepers which in turn create social and environmental consequences with those settled farmers and cultivators. Nomad-like practices coupled with overgrazing has so far produced social conflicts among farmers and pastoralists, resulted in demarcation of a confined settlement at Twatwatwa for Masai tribes to settle.
- **Proliferation of HIV/AIDS:** According to the District Medical Office report (2010), out of a total of 16,986 persons of age above 15 screened, 1,961 persons are identified as HIV positive.
- **Water Supply:** The District population is served by shallow wells (737 schemes, 139, 985 population served), gravity water supply (4 schemes, 36,226 population served), and piped water supply (33 schemes, 158,650 population served). In particular, at Kidete Ward, villagers depend on 52 shallow wells, of which 43 are working (Source: Kilosa District Water Department, 2009).

Mpwapwa District (Extracts from District Profile, 2014):

- **Village Land Development:** As the existing rail alignment currently does, and proposed rail alignment will, traverse rural village land, it is critical to comprehend current village land use planning statuses in view of conducted surveys. In the Mpwapwa Division, 35 villages were surveyed, however none are offered certificates. (Source: Mpwapwa District Land, Natural Resources and Environment Department, 2012)
- **Main Economic Activities:** About 90% of the people in the District are engaging in agriculture and livestock rearing as their major source of income. Agriculture employs about 86% of the District's labor force population.
- **Crops produced:** During 2011/2012 season, 31,968 tons for food crops were produced. The food requirement for the period of 2012/13 is 70,460 tons and hence there is a food shortage of 38,492 tones. A total of 39,189 households had food shortages.
- **Animal Husbandry:** Livestock keepers who practice traditional animal husbandry (free range system) keep cattle (179,737), goats (148,317), sheep (56,343), donkeys (3,262), pigs (3,102), dogs (9,064), and chicken (204,923). It is estimated that the livestock sector contributes to about 45% of the total District GDP.
- **Ethnic Groups**: The dominant ethnic groups are Gogo (40%), Kaguru (16%), and Hehe (11%), in terms of total District population of 305,056 (National Population Census' Projection (2012)). Also present are a small number of pastoral groups of Wamang'ati and Wamasai, grazing at Mtera Dam and Ruaha Rivers.
- **Rural Women's Domestic Work:** Mpwapwa District's women use about 80% of their time to get essential services such as water; firewood, health services, education, milling machine, markets, shopping, and other services at a distance of 2-10 km.
- **Employment by Sector:** Agriculture and livestock activities employ about 90%, small and medium scale businesses employ 7%, small-scale industries employ 1%, and office works employs 2% of the total population.
- **Poverty Indicators:** Only 28% of Mpwapwa District residents live below the basic needs poverty line (Poverty and Human Development Report, 2005).
- **Access to Clean Drinking Water:** The proportion of households supplied with piped water in the wet season was 37%, compared to 43.9% in the dry season (The National Sample Census of Agriculture 2002/03). The well is the second main source of drinking water in Mpwapwa District, followed by springs and surface water such as river, streams, and dams. The District has 32 boreholes, 81 shallow wells (using hand pumps), and 32 water springs. The number of people served with clean water in the District has been increasing from 52.4% in 2007/08 to 60% in 2012/2013.
- **Fishery:** Fishing is not an economic activity rather than merely for domestic consumption. However, fingerlings, mainly of the Tilapia species, are the main fish type available. Fishing activities are usually undertaken in Mtera Dam in Rudi Ward. Wetlands in Mlunduzi Ward are also potential areas for ponds and fisheries.
- **Health:** The healthcare system consists of 1 hospital, 4 health centers, and 52 other facilities (48 are public, 4 owned by Parastatal, and 1 is private). 46 out of 93 villages have health facilities equal to 51% of the total villages. Only 25.5% of the total population lives within 5 km from health facilities.

- **Types of Toilets:** Almost all households in Mpwapwa District (87.3%) use traditional pit latrines, followed by those with no toilets (8.2%), improved pit latrines (1.4%), and flush toilets (1.3%) (Source: National Sample Census of Agriculture 2002/03)

Chamwino District (Extracted from District Profile, 2012):

- **Limited Dependency on Railway Service**: The Central Railway Line serves about 15.6 km in the District, which passes through Igandu and Mnase villages. However, this means of transport has some caveats, such as the infrastructure being old, and the District has limited influence on the ability to improve the railway.
- **Agriculture and Livestock Sector:** More than 90% of the District population relies on agriculture.
  Out of 563,920 hectares suitable for agricultural production only about 246,821(44%) hectares are used for crop production.
  Common crops produced include food crops such as sorghum, maize, and cassava. Cash crops grown include grapes, sunflower, groundnuts, bulrush millet, and paddy.
  Apart from agriculture, livestock keeping is ranked second as a vital economic activity in the District. In 2012 the District had an estimate of 284,749 indigenous cattle based on 2002 livestock census projection, where number of cattle was 185,659, goats was 41,384, and sheep was 9,007.

  HIV/AIDS Proliferation: HIV/AIDS is still a problem in the community and has been affecting the workforce in the District. The rate of infection dropped from 3.0% in 2007 to 2.6 % in 2013. The District Council will continue enhancing sensitization strategies to reduce the spread of HIV/AIDS and improve care of HIV victims.

  Children' Issue: The District Council is aware of impacts from increased crime rates and social problems, like street children and drug addicts.

  Water Supply: A District-wide absence of reliable water sources – permanent rivers and springs – has led the community to depend on water from boreholes, shallow wells, and rainwater harvesting. The District has 201 water supply schemes capable of providing clean and safe water to 72% people of the District. 66 villages out of 77 in the District have water committees and established water funds.

<u>Fact-Finding through Discussions with District Council Officials</u>

Fact-finding results are grouped by thematic topics of the JICA Study's concern, consolidating District-by-District facts identified by field data collection and interviews with responsible District Officers.

Past Dependency on Railway Services (Freight and Passengers) and Future Expectations:

Kilosa: Railway transport used to be acknowledged as cheaper, reliable, and able transport in bulk compared to road transport. Poor railway services have had some significant negative impact on the socioeconomic development of Kilosa District because of the reduced frequency of traders/middlemen coming to buy agricultural commodities (maize, rice, sunflower, and onions) and transporting via railway.

Mpwapwa: Cash crops were transported by railway in the past. Other goods transported by railway were livestock (cattle and goats).

Copper mining at Kinusi area in Gulwe also depended on railway services in the past. There is a copper processing factory in the Gulwe area which would benefit from improved railway services.

Chamwino: The railway used to be a major means of transport to Dodoma (Town) and other regions in Tanzania as there are no commuter buses in the area. Based on the production capacity (there is little or no surplus production due to rainfall scarcity) in the area, passenger trains are more important than freight trains.

Status of Village-level Land Use Planning Eligible for Development:

Kilosa: None of the villages have a land use plan established.

Mpwapwa: Villages' (in adjacency of existing alignment) land use planning status not known.

Chamwino: Igandu and Mnase are the only villages along the Gulwe-Igandu railway section in Chamwino District. Neither of these villages has a land use plan. Chamwino District has a total of 99 villages and only seven have a land use plan.

Modality of Farmers' Cooperatives Capable of Exercising Power on Railway Operation and Services:

Kilosa: There are groups of small number of farmers (named SACOS) supportive of the railway (freight) services.

Mpwapwa: There are no formal farmers' organizations, but the Mpwapwa Agricultural Society (MPWAGRISO) is emerging as supporter of smallholders.

Traditionally, the local people (ethnicity of Wagogo or Gogo), are not good farmers. They are used to zero tillage associated with shifting cultivation, which triggers soil erosion.

Chamwino: There are no cooperatives/unions in the two villages in the Project area, but there are four agricultural cooperative societies in the District.

Past Incidents of Conflict Caused by Pastoralists with a Herd of Livestock Crossing the Rail-bed Embankment and Measures against Them:

Kilosa: To mediate Masai pastoralists' grazing activity infringing farmland cultivated by settled farmers, the District Council has demarcated and organized a tract of land named TwaTwatwa Reserve (not a formal reserve) at Parakuyo Ward, Mbwande.

Mpwapwa: No report available to provide evidence of such incidents.

Chamwino: No recorded conflicts because livestock-keeping is minimal in the immediate proximity of the railway alignment.

13.1.3 Legal Framework for Environmental and Social Considerations

(1) Tanzanian Laws and Regulations

In the United Republic of Tanzania, ministries are responsible for environmental monitoring of projects under their jurisdiction. However, the Vice President's Office (VPO) has overall responsibility for environmental policy formulation - including coordination and monitoring of National Environmental Management Council (NEMC) activities.

This section addresses the legal and regulatory conditions, which are relevant to this project.

National Policies, Act and Regulations

Table 13.1 is a summary of relevant environmental and social management policies, acts and regulations for the project. Each is aligned with the enforcement or implementation authority.

The list includes framework policies and legislation that provide the basis for more detailed regulatory instruments. Environmental management and governance in Tanzania is underpinned by two such pieces of legislation, namely the Constitution and the Environmental Management Policy (1997) and Environmental Management Act Cap 191.

Table 13.1: Summary of Relevant Policies, Laws and Regulations

NO.	POLICIES, LAWS AND REGULATIONS	AUTHORITY
	National Constitution	
1.	Constitution of the United Republic of Tanzania, Cap. 2 (1977)	Ministry of Justice and Constitutional Affairs
	Environmental and Social Management	
2.	National Environmental Policy (1997)	Department of Environment (in the Vice President's Office) and National Environmental Management Council (NEMC)
3.	Environmental Management Act, Cap. 191	
4.	Environmental Impact Assessment and Audit Regulations (2005)	NEMC
5.	Environmental Management (Air Quality Standards) Regulations (2007)	
6.	Environmental Management (Hazardous Waste Control and Management) Regulations (2009)	
7.	Environmental (Solid Waste Management) Regulations, (2009)	
8.	Environmental management (Quality Standards for Control of Noise and Vibration Pollution) Regulations (2011)	
9.	Environmental Management (Fees and Charges) Regulations (2009)	
	Land and Land Use	
10.	National Land Policy (1997)	Ministry of Lands, Housing and Human Settlement
11.	Land Act, Cap. 113 (1999)	
12.	The Land (Amendment) Act (2004)	
13.	Village Land Act (1999)	
14.	Land Use Planning Act, No. 6 (2007)	
15.	Land Acquisition Act (1967)	
16.	The National Land Use Planning Commission Act (No. 3), 1984	
17.	Land (Forms) Regulations, 2001	
18.	Land (Assessment of the Value of Land for Compensation) Regulations, 2001	
19.	Land (Compensation Claims) Regulations, 2001	
20.	Land (Management of the Land Compensation Fund) Regulations, 2001	

NO.	POLICIES, LAWS AND REGULATIONS	AUTHORITY
21.	The Village Land Regulations, 2001	Village Administration; Ministry of Land Housing and Human Settlement
	Natural Resources Management	
22.	National Water Policy (2002)	Ministry of Water
23.	Water Resources Management Act, No. 11 (2009)	
24.	Water Supply and Sanitation Act, No. 12 (2009)	
25.	Fisheries Sector Policy and Strategy (1997)	Ministry of Livestock and Fisheries Development
26.	Fisheries Act, Cap. 279 (2003)	
27.	Fisheries (Principal) Regulations (1989)	
	Health and Safety	
28.	Occupational Health and Safety Act, No. 5 (2003)	Occupational Health and Safety Authority (OSHA)
29.	Workers' Compensation Act, Cap 263 (2008)	Ministry of Labour and Employment
30.	Employment and Labour Relations Act, No. 6 (2004)	
31.	National Policy on HIV/AIDS (2001)	Prime Minister's Office
32.	HIV and AIDS (Prevention and Control) Act, No. 28 (2008)	Ministry of Health and Social Welfare
33.	TASAF III Resettlement Policy Framework, 2012	
	Archaeology and Cultural Heritage	
34.	Graves (Removal) Act, 2007	Ministry of Culture, Youth and Sports
35.	Antiquities Act No. 10 (1964)	
	Administrative / Public Laws	
36.	Local Government Laws (Miscellaneous Amendments) Act, No. 13 (2006)	Ministry of Regional Administration and Local Governments
37.	Tanzania Commission for AIDS Act, Cap. 379 (2001)	Tanzania Commission for AIDS (TACAIDS), Ministry of Health and Social Welfare
38.	Local Government (District Authorities) Act	Ministry of Regional Administration and Local Governments
39.	Local Government (Urban Authorities) Act	
40.	Road Sector Compensation and Resettlement Guidelines, 2009	Ministry of Works
41.	Guidelines	

Source: JICA Study Team

<u>Laws and Regulations for Environmental Management Aspects</u>

The laws and regulations listed in Table 13.2 address specific environmental and social management aspects.

Table 13.2: Laws for Key Environmental and Social Management Aspects

Management aspect	Relevant acts and regulations
Air Emissions and Ambient Air Quality	Environment Management Act, Cap 191 - Protection of the Atmosphere and Measure on Climate Change (Part V S. 74 and 75); Management of Gaseous Wastes (Part IX d).
	Environmental Management (Air Quality Standards) Regulations, (2007)
	Public Health Act, Cap. 336 (2009) - Gaseous Waste Management (Part IV d).
	Occupational Health and Safety Act, No. 5 (2003)
Solid Wastes	Environmental Management Act, Cap 191 (2004) - Management of Solid (Part IX a)
	Environmental (Solid Waste Management) Regulations, (2009)
	Public Health Act, No. 1 (2009) - Solid Waste Management (Part IV c)
Wastewater and Ambient Water Quality	Public Health (Sewerage and Drainage) Act, Cap. 336 (2009) - (Prevention of Spread of Diseases (Part III, Sub S. b, 15); Sanitation, Housing and Hygiene (Part IV: Sub. S. a - g)
	Environmental Management (Water Quality Standards) Regulations, (2007)
Soil Quality	Environmental Management (Soil Quality Standards) Regulations, (2007)
Hazardous Materials / Substances Management	Industrial and Consumer Chemicals (Management and Control) Act, No. 5 (2003)- Control of Production, Importation, Exportation, Transportation, Storage of and Dealing in Chemicals (Part III); Management of Industrial and Consumer Chemicals (Part IV)
	Environmental Management Act, Cap. 191 (2004) - Management of hazardous wastes (Part IX e)
	Environmental Management (Hazardous Waste Control and Management) Regulations (2009)
Noise Management	Environmental Management Act, Cap. 191(2004) - Environmental Quality Standards (Part X (S. 147)
	Environmental management (Quality Standards for Control of Noise and Vibration Pollution) Regulations, (2011)

Source: JICA Study Team

(2) Procedure of EIA

Legal Framework in Tanzania

Tanzanian environmental matters are governed by the Environmental Management Act, 2004, which is Act No. 20 of 2004 (hereinafter referred to as “the Act”), and its implementation is regulated by the Environmental Impact Assessment and Audit Regulations, 2005 (the Regulation). The Regulation stipulates projects to be classified into either Type A or Type B.

Type A – Project requiring a mandatory EIA:

The Project is likely to have a significant adverse environmental impacts and an in-depth study is required to determine the scale, extent, and significance of the impacts and to identify appropriate mitigation measures.

Among the list of type A projects, item 9 (iii) “Construction or new expansion to existing railway lines” can be applied to the proposed Project. Sub-item (iii) “Construction and expansion/upgrading of roads, harbors, shipyards, fishing harbors, air fields and ports, railways and pipelines” of item 14 “Building and Civil Engineering” can also be applied to the proposed Project.

Excerpted below are relevant projects of Type A.

Listed under item 9 Transport and Infrastructure are:

(i) Construction, expansion or rehabilitation of new trunk roads
(ii) Construction, expansion or rehabilitation of airports and airstrips and their ancillary facilities
(iii) Construction or new expansion to existing railway lines
(iv) Construction of new, or expansion to shipyards or harbor facilities

Listed under sub-item (iii) of item 14 Building and Civil Engineering is:

(iii) Construction and expansion/upgrading of roads, harbors, ship yards, fishing harbors, air fields and ports, railways and pipelines

Type B – Project requiring Preliminary Environmental Assessment:

The Project is likely to have some significant adverse environmental impacts, but as the magnitude of the impacts is not well-known, a preliminary environmental assessment is required to decide whether the Project can proceed without a full environmental impact assessment.

Generally, the EIA procedure for Type A project takes the following steps.

a) An application for an environmental impact assessment certificate shall be made in the format of a project brief set out in the First Schedule to the Regulation, and the applicant shall submit the application together with the prescribed fee to the Council (Article 5, the Regulation).

(1) A developer or proponent shall, depending on the nature of the project or undertaking, register in accordance with Form No. 1 specified in the Third Schedule to these Regulations and prepare a project brief stating:
(a) the nature of the project in accordance with the categories identified in the Third Schedule to the Act and the First Schedule to these Regulations;
(b) the location of the project including to the physical area that may be affected by the project's activities;
(c) the activities that shall be undertaken during the project construction, operation and decommissioning phases;
(d) the design of the project;
(e) the materials to be used, products and by-products, including waste to be generated by the project and the methods of their disposal;
(f) the potential environmental impacts of the project and the mitigation measures to be taken during and after implementation of the project;
(g) an action plan for the prevention and management of possible accidents during the project cycle;
(h) a plan to ensure the health and safety of the workers and neighboring communities;
(i) the economic and socio-cultural impacts to the local community and the nation in general;
(j) the project budget; and
(k) any other information which the Council may require.

(2) In preparing a project brief under this Regulation, the proponent or developer shall pay particular attention to other issues specified in the First Schedule to these Regulations.

(3) A project brief shall be prepared by an environmental impact assessment expert registered as such under the regulations made under the Act.

b) A proponent or developer shall submit at least ten copies of the project report to the Council or the Council's appointed agent in Form No. 1 specified in the Third Schedule to the Regulations accompanied by the prescribed fees. "Council" means the National Environment Management Council (NEMC) established under section 16 of the Act.

c) Comments on the Project Brief

(1) Where the project brief conforms to the requirements of regulation 6, the Council shall, within seven days upon receipt of the project report, submit a copy of the project brief to:
(a) each of the relevant ministry or public institution;
(b) the relevant local government environmental management officer; and
(c) where more than one District is involved, to the relevant Regional Secretariats, for their written comments.

(2) Comments shall be submitted to the Council within twenty one days from the date of receipt of the project brief.

(3) On receipt of the comments or where no comments have been received the Council shall proceed to determine the project brief.

d) Screening of project brief

(1) The Council shall screen the project brief according to the screening criteria specified in the Second Schedule to these Regulations.

(2) The screening process shall be undertaken with the objective of determining whether an environmental impact assessment is to be undertaken.

e) Approval of Project Brief

(1) On determination of the project brief, the decision of the Council, together with the reasons thereof, shall be communicated to the developer or proponent within forty-five days of the submission of the project brief.

(2) Where the Council is satisfied that the project shall not have significant negative impact on the environment, or that the project brief discloses sufficient mitigation measures, the Council may proceed to recommend to the Minister to approve the project.

(3) Approval of the project or undertaking shall be made in Form 3 specified in the Third Schedule to these Regulations.

f) Decision that an Environmental Impact Statement (EIS) be prepared

(1) Where the Council finds that the project shall have a significant impact on the environment and the project report discloses no sufficient mitigation measures, it shall require the developer or proponent to:
(a) undertake an environmental impact assessment in accordance with these Regulation; or
(b) undertake a preliminary assessment, where more information is required to determine a screening decision.

(2) A preliminary assessment shall proceed along the following steps:
(a) description of the project characteristics and the affected environment;
(b) identification of impacts on the local environment; and

(c) assessment or evaluation of the significance of the impacts in terms of energy flow, transformation of matter, effects on sensitive ecosystems relative to the baseline state, and socioeconomic impacts.

(3) Where the Council finds that the project shall have no significant negative impact on the environment and the project report discloses sufficient mitigation measures, it shall not require the developer or proponent to undertake an environmental impact assessment, and may proceed to recommend to the Minister for approval of the project.

Comparison of JICA Guidelines and Tanzanian EIA

The policy framework of Tanzanian EIA was compared with the requirements of JICA Guidelines. As shown in Table 13.3, Tanzanian EIA mostly satisfies JICA Guidelines.

Table 13.3: Comparison and Gaps of JICA Guidelines and Tanzanian EIA

No.	JICA Guidelines	Tanzanian EIA	Gaps	Policy to fill the gaps in this study
1	When assessment procedures already exist in host countries, and projects are subject to such procedures, project proponents etc. must officially finish those procedures and obtain the approval of the government of the host country.	EIA procedure is required by the Environmental Management Act, 2004, to be approved by NEMC.	None	-
2	EIA reports (which may be referred to differently in different systems) must be written in the official language or in a language widely used in the country in which the project is to be implemented. When explaining projects to local residents, written materials must be provided in a language and form understandable to them	EIA reports must be accompanied with a stand-alone non-technical summary in both Kiswahili and English languages.	Language for written materials for local explanation is not stipulated by the regulation.	Materials for explanation to local residents shall be made in Kiswahili.
3	EIA reports are required to be made available to the local residents of the country in which the project is to be implemented. The EIA reports are required to be available at all times for perusal by project stakeholders such as local residents and copying must be permitted	NEMC shall grant any person who desires to consult the EIA reports and any other information submitted to NEMC access to those documents.	None	-
4	In preparing EIA reports, consultations with stakeholders, such as local residents, must take place after sufficient information has been disclosed. Records of such consultations must be prepared	Public participation and consultation are required through the procedure and the records shall be included in the EIA report.	None	-

No.	JICA Guidelines	Tanzanian EIA	Gaps	Policy to fill the gaps in this study
5	Consultations with relevant stakeholders, such as local residents, should take place if necessary throughout the preparation and implementation stages of a project. Holding consultations is highly desirable, especially when the items to be considered in the EIA are being selected, and when the draft report is being prepared	During the process of conducting an environmental impact assessment study, the developer or proponent shall in consultation with NEMC, seek the views of any person who is or is likely to be affected by the project. Consultation is taken place by the developer or proponent at scoping stage. NEMC holds public hearing before approval of the EIA report.	None	-
6	It is desirable that EIA reports cover the items enumerated in the following: -Executive summary, -Policy, legal, and administrative framework, -Project description, -Baseline data, -Environmental impacts, -Analysis of alternatives, -Environmental Management Plan (EMP), and -Consultation.	EIA report shall closely be styled and contain the following information: (i) executive summary; (ii) acknowledgement; (iii) acronyms; (iv) introduction; (v) project background and description; (vi) policy, administrative and legal framework; (vii) baseline or existing conditions; (viii) assessment of impacts and identification of alternatives; (ix) impacts management or environmental mitigation measures; (x) environmental and social management plan; (xi) environmental and social monitoring plan; (xii) resource evaluation or cost benefit analysis; (xiii) decommissioning; (xiv) summary and conclusions (xv) references; (xvi) appendices.	None	-

Source: JICA Study Team

RAHCO's Procedure for EIA

As this Project, a railways rehabilitation project, falls under type A of "construction and expansion/upgrading of roads, harbors, ship yards, fishing harbors, air fields and ports, railways and pipelines", the First Schedule of the Regulation, RAHCO, is mandated to obtain an EIA clearance from the environment authority. Therefore, the proponent agency (RAHCO) is undertaking the following actions to proceed with the project.

Step 1: Project Registration and Screening--- Already completed in March-April 2015.

(a) Developer or proponent submits a dully filled registration form and project brief to the Council as per Regulation 9;
(b) Council shall then undertake a review of the project brief in accordance with Regulation 10 and 11; and
(c) Council undertakes the screening of the proposed project in accordance with Regulation 12 and undertake the screening in accordance with any guidelines that the Minister may issue for this activity.

Step 2: Scoping--- Already completed in June-July 2015.

The developer, proponent, environmental experts or firm of experts shall undertake a scoping exercise in order to:

(a) Identify the main stakeholders that will be negatively or positively impacted by the proposed project;
(b) Identify stakeholder's main concerns regarding the proposed project;
(c) Identify main project alternatives;
(d) Identify likely impacts, data requirements, tool and techniques for impact identification, prediction and evaluation;
    (i) identify project boundaries in terms of spatial, temporal and institutional aspects;
    (ii) environmental experts or firm of experts must ensure there is adequate stakeholder participation in this and all the other stages of the environmental impact assessment; and
(e) the developer or the environmental experts or firm of experts prepare a scoping report and terms of reference for the environmental impact assessment of the proposed project and submits to the Council for approval.

Step 3: Baseline Study --- Already completed in December 2015.

(a) The environmental experts or firm of experts undertake detailed survey of the existing social, economic, physical, ecological, social-cultural and institutional environment within the project boundary area; and
(b) The consultant must ensure adequate stakeholder participation is engaged.

Step 4: Impact Assessment--- Already completed in January 2016.

(a) The consultant undertakes impact identification, impact prediction and evaluation of impact significance following a variety of appropriate techniques and approaches as specified in the guidelines issued under this Regulation;
(b) The environmental experts or firm of experts must ensure that concerns and views from stakeholders are fully taken into account during the assessment of impacts; and
(c) The environmental experts or firm of experts assess all possible alternatives and their impacts and recommends most appropriate options.

Step 5: Impact mitigation and enhancement measures --- Already completed in January 2016.

(a) environmental experts or firm of experts prepare impact mitigation measures for all negative significant impacts, either by elimination, reduction or remedial methods;
(b) environmental experts or firm of experts prepare enhancement measures for all significant positive effects arising from the project so as to increase the contribution from the project to social development and environmental conservation;
(c) environmental experts or firm of experts prepare Mitigation and Enhancement Plan for all significant negative impacts and positive effects, with details about institutional

responsibilities and costs were appropriate; and

(d) environmental experts or firm of experts prepare a Monitoring Plan and Environmental and Social Management Plan with details about institutional responsibilities, monitoring framework, parameters, indicators for monitoring and costs of monitoring were appropriate.

Step 6: Preparation of Environmental Impact Statement (EIS) --- Already completed in March 2016.

(a) environmental experts or firm of experts prepare an Environmental Impact Statement (EIS) adhering to the contents outlined in these Regulations;
(b) EIS must be accompanied with a stand-alone non-technical summary in both Kiswahili and English languages; and
(c) All technical details, including assessment methodologies, list of consulted stakeholders and their signatures, drawings and terms of references are put in the appendix.

Step 7: Review of EIS--- Ongoing as of March 2016.

(a) Council reviews the EIS adhering to the review criteria and any guidelines that may be issued under these Regulations;
(b) Council may call for a public hearing and public review of the EIS in accordance with conditions and procedures stipulated under these Regulations; and
(c) Council shall submit review report to the Minister with its recommendations and all documents used in the review for approval or disapproval.

Step 8: Environmental Monitoring and Auditing--- Will be conducted when the Project is implemented.

The Council shall conduct environmental monitoring in order to evaluate the performance of the mitigation measures following the prepared Environmental and Social Management Plan as well as the Monitoring Plan, thus:

(a) monitoring include the verification of impacts, adherence to approve plans, environmental standards and general compliance of terms and conditions set out in the Environmental Impact Assessment certificate;
(b) developer can also undertake monitoring of the implementation of the project to ensure if mitigation measures are effective;
(c) both the developer and the Council collects data that can be used in future projects and for environmental management;
(d) Council and the developer undertake environmental audits for the project;
(e) mechanisms for stakeholder participation during the monitoring and auditing process must be defined and followed through; and
(f) the auditing exercise may focus on the following areas:
    (i) implementation/enforcement audit, which takes place when the Council verifies if the mitigation measures and levels of pollution are within limits;
    (ii) performance/regulatory audit that entails identification of compliance to relevant legislation or safety standards;
    (iii) impact prediction audits checks the accuracy and efficacy of the impact prediction by comparing them with monitored impacts;
    (iv) Council collects and compiles information arising from auditing for future use; and
    (v) developer collects data from the audit and compiles information for project management and also for submission to the Council.

13.1.4 Alternatives

(1) Without Project Option

'Without project option' means no flood protection measures are formulated and no action will be taken to change the present situation of the Kilosa-Dodoma section. As transport demand is rapidly increasing, the following issues are expected to occur if "without project":

1) The railway line will continuously be affected by floods and be washed away frequently. This situation means the railway service faces serious problems for securing safe and stable transportation.
2) Once the line is washed away, the railway passengers and freight are hindered in their ability to travel until the recovery works are completed. It will affect the social and economic activities relying on the railway transport by the Central Railway Line, which is not limited to the section of Kilosa-Dodoma.
3) Because of the unreliability of the railway service, passengers and freight will be shifted to road traffic. As heavy tracks are applied for the freight, it will cause deterioration of road infrastructure, and increase risks of road accidents and freight transportation costs.
4) As the emission of carbon dioxide from the road traffic is generally larger than the railway, shifting to the road traffic will result in emissions increases.

Therefore, flood protection measures needs to be taken to improve the safety and reliability of the railway transportation, as well as to protect environmental and social conditions.

(2) Consideration of Alternative Plans

As presented in Subsection 8.6.2, Alternative A, B, and C for the flood protection measures were proposed to select the most optimal option in terms of the cost, reduction in danger of flood damages, technical difficulties, and environmental and social considerations. As the track relocation (rerouting) will affect the residential area by traversing villages when it is planned only from the engineering aspects, an additional alternative was drawn attempting to reduce the number of the affected buildings. Consequently, in total six alternatives were planned and compared: A-1, B-1, and C-1 are favoring track alignment in terms of engineering aspects, while A-2, B-2, and C-2 are those to avoid traversing residential area as much as possible.

The basic idea of Alternative A-2, B-2, and C-2 is to draw the rerouting alignment at lower elevation than Alternatives A-1, B-1, and C-1, avoiding dense residential areas. Instead of securing the high elevation above the design condition, the embankments of Alternatives A-2, B-2, and C-2 were reinforced by bank protection.

A comparison between the alternatives was presented in Subsection 8.6.2 (Table 8.40). As a result of the comparison, Alternative B-2 was selected as the optimal alternative.

13.1.5 Scoping

A scoping exercise was done for proposed Project's anticipated impacts.

Anticipated impacts are rated by A, A+, B, B+, C, C+, and D, in terms of their spatial extent, magnitude of the number of people and settlements affected, impact's duration – temporal or persistent, irreversible or reversible, etc.

The following scores are employed in rating the impacts:

- A+/−: Significant positive/negative impact is expected.
- B+/−: Positive/negative impact is expected to some extent.
- C+/−: Extent of positive/negative impact is unknown. (A further examination is needed, and the impact could be clarified as the study progresses)
- D: No impact is expected.

The result from the exercise is shown in
Table 13.4.

Based on the scoping results, Terms of Reference (TOR) for Environmental and Social Considerations are prepared as shown in Table 13.6 and Table 13.7.

Table 13.4: Summary of Scoping Result

Impact Rating	Elements
A+: Significant positive impact is expected.	*During Construction* Employment and Local Economy, Land Use and Local Resources Utilization *Railway in Service* Employment and Local Economy, Land Use and Local Resources Utilization, Existing Social Infrastructure and Social Services
A−: Significant negative impact is expected.	*Prior to Construction* Resettlement
B+: Positive impact is expected to some extent.	*Prior to Construction/During Construction* Soil Erosion, *Railway in Service* Gender, Global warming
B−: Negative impact is expected to some extent.	*During Construction* Air Quality, Water Quality, Solid Waste, Soil Erosion, Soil Contamination, Noise Vibration, Ecosystems, Water Use, Existing Social Infrastructure and Services, Infectious diseases HIV/AIDS, Working Environment, inclusive of occupational safety, Accidents *Railway in Service* Accidents, Resettlement, Solid Waste, Noise/Vibration, Ecosystems
C+/−: Extent of positive/negative impact is unknown. (A further examination is needed, and the impact could be clarified as the study progresses)	*During Construction* Poor, Hydrology/Water Regime, Topography and Geology, Social Capital and Local Decision Making Institution, Cultural Heritages, Landscape, Children's Rights, Indigenous People *Railway in Service* Water Quality, Social Capital and Local Decision Making Institution, Cultural Heritages, Children's Rights,, Infectious Diseases, Working Environment, inclusive of Occupational health, Water Use, Poor, Landscape
D: No impact is expected.	*Prior to/During Construction* Land Subsidence, Protected Area/Forest Reserves, Trans boundary pollution *Railway in Service* Air Quality, Solid Waste, Soil Contamination, Land Subsidence, Protected Area/Forest Reserves, Hydrology/Water Regime, Topography and Geology, Trans boundary pollution

Source: JICA Study Team

Table 13.5: Scoping Result

Environmental Domain		Environmental Elements Impacted	Assessment: Prior to Construction/ During Construction	Assessment: Railway In Service	Reasons of Assessment
Pollution	1	Air Quality	B-	D	Prior to construction/During Construction 1.1 Construction work will generate dust. 1.2 Construction equipment will emit air pollutants. Railway in service 1.3 Emission from train operation will be the same condition with the existing operation.
	2	Water Quality	B−	C−	Prior to construction/During Construction 2.1 High potential of soil runoff and/or sedimentation/siltation by the riverbank protection works and bridge/culvert construction/improvement works resulting from earthmoving and/or piling/foundation works. As a result, temporal increase in turbidity and an increase in suspended solids in the water bodies are anticipated (streams/stagnant water) at the construction sites and downstream. 2.2 Earth-moving works (cut and fill) at the hillside (proposed rerouting alignment) or inland away from the riverbanks will yield temporal soil runoff, causing water quality degradation (Mkondoa River /Kinyasungwe River) and sedimentation. Railway in service 2.3 Least possibility of surface runoff from rail embankment contaminating the Mkondoa River. 2.4 Effluents from stations and associated facilities are minimal.
	3	Soil Erosion	B−	B+	Prior to construction/During Construction 3.1 The existing alignment runs through a flood-prone area, in parallel with the frequently-flooded river systems of the Mkondoa and Kinyasungwe Rivers. The alignment lies over land sensitive to any earth-moving civil work, which has a high potential to trigger soil erosion and land degradation. Proper mitigation work needs to be devised and implemented to avoid soil erosion and sedimentation. Railway in service 3.2 Progress of flood-protection work in the entire sections will reduce soil erosion/sedimentation to a certain extent, though the incidents are anticipated to occur.
	4	Solid Waste	B−	B−	Prior to construction/During Construction 4.1 Surplus/excess soil volume generated by cut/fill is anticipated.

Environmental Domain		Environmental Elements Impacted	Assessment: Prior to Construction/ During Construction	Assessment: Railway In Service	Reasons of Assessment
					Railway in service 4.2 Hazardous/toxic waste generation by railway operation is not anticipated.
	5	Soil Contamination	B−	D	5.1 Some construction activities such as burying piles may cause soil contamination. 5.2 No significant impacts during railway in service.
	6	Noise/ Vibration	B−	B-	6.1 Construction noise will be generated by works of equipment. 6.2 Noise and vibration caused by train passing will be increased if the railway is relocated into the residential area.
	7	Land subsidence	D	D	7.1 No significant impact is anticipated as underground construction, which causes land subsidence, is not planned. 7.2 No significant impact is anticipated as drawing groundwater, which causes land subsidence, is not planned for the railway operation.
Natural Environment	8	Protected Area/Forest reserve	D	D	8.1 National Parks, Wildlife Management Areas (WMA), Forest Reserves (National Level) are not found within a 1 km-radius range of the existing rail alignment. 8.2 Districts (Kilosa, Mpwapwa, and Chamwino) have their own designation of Forest Reserves, however none with their boundaries conflicting with existing rail alignment. The Kihili Forest Reserve is situated in the vicinity of Kilosa Station. In proposing a rerouting of the alignment, potential conflicts with District Forest Reserve need to be checked.
Natural Environment	9	Eco-systems	B−	B−	9.1 The project site, including proposed rerouting alignment, does not encompass ecologically valuable habitats like those designated by IBA's area. 9.2 The Project site, including proposed rerouting alignment, does not encompass the protected habitats of endangered species designated by the country's laws or international treaties and conventions. 9.3 Adequate mitigation measures are to be taken to avoid conflicts with wildlife/livestock migration routes. 9.4 Proposed railway re-routing alignment may pass through primary forest in undeveloped hillside areas, resulting in loss of natural vegetation.
Natural Environment	10	Hydrology/ Water Regime	C−	C−	10.1 Anticipated changes in water regime in the water bodies affected by flood protection works, which may result in changes in aquatic ecosystems. 10.2 Anticipated changes in aquatic biota (fish species).

Environmental Domain		Environmental Elements Impacted	Assessment: Prior to Construction/ During Construction	Assessment: Railway In Service	Reasons of Assessment
	11	Topography and Geology	C−	D	11.1 There is a possibility that civil works, such as cutting and filling along the re-routing alignment at the hill side, will cause slope failures or landslides. 11.2 There is a possibility that soil runoff will result from cut and fill areas, waste soil disposal sites, and borrow sites.
Social Environment	12	Resettlement	A−	D	<u>Prior to construction/During construction</u> 12.1 No more than 40 households, at one site, are anticipated to be relocated, due to the re-routing alignment at Gulwe and the smaller number of households at Godegode. 12.2 Recovery of livelihoods of those relocated need to be secured and compensation delivered.
	13	Poor	C	C	<u>Prior to construction/During construction</u> 13.1 Poor or vulnerable people may be included in those to be relocated. <u>Railway in service</u> 13.2 The poor and vulnerable will benefit from the relocation and be able to upgrade their quality of life. On the other hand, their livelihood may be affected by resettlement if they are among that population.
	14	Indigenous People	C	C	<u>Prior to construction/During construction</u> 14.1 Masai people often traverse the alignment with their herds of livestock. Need to identify their grazing area to assess the impacts. <u>Railway in service</u> 14.2 Underpasses will be designed to allow Masai with their herds to traverse the alignment safely, reducing potential accidents and degradation of embankment.
	15	Employment and Local Economy	A+	A+	<u>Prior to construction/During construction</u> 15.1 Construction of rerouting sections may absorb local laborers. 15.2 Employment opportunities may generate positive impacts to the local economy.
	16	Land use and local resources utilization	A+	A+	<u>Prior to construction/During construction</u> 16.1 For the re-routing sections, the new alignment will pave the way for village land use transformation, leading to potential industrial development. <u>Railway in service</u> 16.2 The new alignment together with transformed village land use as "General Land" will accelerate development.
	17	Water Use	B−	C	<u>Prior to construction/During construction</u> 17.1 Residents making avail of nearby river water systems as sources of water are adversely (access to water bodies/water quality degradation) affected by

Environmental Domain		Environmental Elements Impacted	Assessment: Prior to Construction/ During Construction	Assessment: Railway In Service	Reasons of Assessment
					the flood protection works. 17.2 Project's impact on water use is temporal and local residents can enjoy previous river water usage.
	18	Existing Social infrastructure and Social services	B−	A+	Prior to construction/During construction 18.1 Flood protection works will entail increased traffic of construction machinery/heavy duty trucks on the narrow village roads, impacting village people's access to roads, resulting in degraded quality of their living environment. Railway in service 18.2 Villagers' access to social services will be improved due to improved railway service.
	19	Social capital and local decision-making institutions	C	C	Prior to construction/During construction 19.1 The new alignment due to rerouting transforms village land use into general land suitable to economic and industrial development, triggering changes in traditional social capital and local decision-making institutions. Railway in service 19.2 Neighboring communities along the newly rerouted alignment will undergo gradual changes in social capital and local decision-making institutions.
	20	Cultural Heritage	C	C	20.1 Cultural and historical heritage sites to be found in the project affected area along the railway alignment, both new and existing, are not well-explored/recorded.
	21	Landscape	C	C	Prior to construction/During construction 21.1 The new alignment, due to rerouting, that runs the hillside in the primary forest, will have visual impact for the village people living in the community nearby the new alignment. Railway in service 21.2 Local community people will be exposed to the new landscape with the improved new railway track.
	22	Gender	B−	B+	Prior to construction/During construction 22.1 Traditional rural women's work load of capturing water and care for livestock husbandry is going to be interfered during construction work in progress, in particular obstacle are access to water sources and community roads blocked by traffic by heavy-duty trucks and construction machinery. Railway in service 22.2 Local community women's domestic work is less hampered by heavy-duty vehicles' traffic.

Environmental Domain		Environmental Elements Impacted	Assessment: Prior to Construction/ During Construction	Assessment: Railway In Service	Reasons of Assessment
	23	Children's rights	C	C	<u>Prior to construction/During construction</u> 23.1 The Project is not deemed to impact present situation of children's rights living in the rural environment.
	24	Infectious diseases HIV/AIDS	B−	C	<u>Prior to construction/During construction</u> 24.1 Laborers to be engaged in construction work may come from outside may have potential to trigger HIV/AIDS proliferation in the community.
	25	Working Environment, inclusive of occupational safety	B−	C	<u>Prior to construction/During construction</u> 25.1 Need to care for construction workers' occupation health environment. <u>Railway in service</u> 25.2 No impacts on operators/laborers engaged in railway service.
Others	26	Accidents	B−	B−	<u>Prior to construction/During construction</u> 26.1 Need to devise countermeasures to reduce accidents during construction. <u>Railway in service</u> 26.2 Increased service frequency will induce higher chances of transport accidents.
	27	Trans-boundary pollution	D	D	<u>Prior to construction/During construction</u> 27.1 The Wami-Ruvu watershed has no internationally-connected water systems within the basin. Water pollutants shall not have a chance to migrate to surrounding countries. There are no significant sources of air-pollutants emitted from industrial establishments within the basin. <u>Railway in service</u> 27.2 No trans-boundary pollution impacts are anticipated during railway in service.
	28	Global warming	D	B+	<u>Prior to construction/During construction</u> 28.1 Emission of greenhouse gas by construction works is limited. <u>Railway in service</u> 28.2 Emission of greenhouse gas will be reduced by improving the railway because road transportation is expected to shift to the railway.

A+/−: Significant positive/negative impact is expected.
B+/−: Positive/negative impact is expected to some extent.
C+/−: Extent of positive/negative impact is unknown. (A further examination is needed, and the impact could be clarified as the study progresses)
D: No impact is expected.
Source: JICA Study Team

Table 13.6: Survey Items and Methodology

Environmental elements	Survey items	Survey methodology
Air quality	− Ambient air quality	− Field measurement
Water quality	− Water quality of the river along the railway	− Field measurement − Sampling and analysis
Soil erosion	− Current condition of soil erosion of the riverbank	− Field observation
Solid waste	− Volume of surplus/excess soil − Type of waste and the volume generated by the railway operation	− Reviewing construction plan and method − Interview with TRL
Soil contamination	− Source of soil contamination through the construction	− Reviewing construction plan and method
Noise/vibration	− Current noise/vibration along the railway − Noise level of construction equipment	− Field measurement − Existing data collection
Eco-systems	− Fish species in the river − Terrestrial vegetation − Avifauna − Mammals − Reptiles and amphibians	− Field observation − Interview with local people − Literature survey
Hydrology/water regime	− Plan of flood protection measures which may change the river flow such as embankment and bridge pier	− Reviewing project plan
Topography and geology	− Topographic feature	− Reviewing topographic map
Resettlement	− Number of affected people and their properties	− Census and inventory survey
Poor	− Social condition of the affected people	− Interview with the affected people
Indigenous people	− Existence of indigenous tribes	− Interview with local government
Employment and local economy	− Employment opportunities and the local people's intention	− Interview and consultation with the local people
Land use and local resources utilization	− Current land use along the railway	− Interview with local government
Water use	− Domestic water source − River water use	− Interview with local people
Existing social infrastructure and social services	− Village road condition − Current railway operation − Local people's expectation on traffic infrastructure	− Field observation − Data collection from TRL − Consultation with local people
Social capital and local decision-making institutions	− Local people's intention for developing economic and industrial conditions and local decision-making institution	− Consultation with local people
Cultural heritage	− Type and location of cultural heritage	− Field observation − Interview with local people
Landscape	− Landscape condition	− Field observation
Gender	− Existing gender issues − Women's work	− Interview with local people
Children's right	− Existing children's issues − Children's work	− Interview with local people
Infectious diseases HIV/AIDS	− Prevalence of HIV/AIDS	− Data collection from local government

Environmental elements	Survey items	Survey methodology
Working environment, inclusive of occupational safety	− Working conditions of workers related to the railway	− Interview with TRL
Accidents	− Number of railway accidents and their causes	− Data collection from TRL

Source: JICA Study Team

Table 13.7: Baseline Survey Plan

Survey items	Survey Area	Outline
Natural environment		
Air quality	Around the railway track	✓ Measurement by portable outdoor monitor ✓ Parameters: NO_2, CO
Water quality	Mkondoa River (along the railway line)	✓ Two times – the dry and the wet season (June and December) ✓ Parameters: EC, pH, SS, turbidity, temperature, heavy metals, etc. ✓ Observation of stream flow condition
Fish species	Mkondoa and Kinyasungwe River (along the railway line)	✓ Collecting species by net ✓ Interview with local people nearby the riverbank
Terrestrial vegetation	Along rerouting track alignment	✓ Species identification consisting the representative vegetation
Avifauna, mammals, reptiles and amphibians	Around the track alignment including rerouting track	✓ Species identification through field observation ✓ Interview with local people ✓ Literature survey
Noise and vibration	Around the railway track	✓ Measurement at the time of train passing
Social environment		
District/ward level	Kilosa, Mupuwapwa and Chamwino Districts	✓ Secondary data collection (e.g., population, ethnicity, religion, industry, employment, livelihood, education, health condition) to compare with the primary data of village level.
Village level	Villages along the railway track of Kilosa-Dodoma	✓ Interview with the communities (e.g., population, ethnicity, religion, industry, employment, livelihood, education, health condition, means of transport, flood effects)

Source: JICA Study Team

13.1.6 Survey Results for Environmental and Social Considerations

Survey results are summarized in Table 13.8.

Table 13.8: Survey Results

Environmental elements	Survey Results
Air quality	Ambient air quality was measured at five stations between Kilosa and Gulwe in December 2015. The results showed that the ambient air quality was in good condition: the average value of NO_2 at each station was 0.0-0.05ppm (standard of US EPA:0.053 ppm), CO was 1.5-10.0 ppm (standard of US EPA: 35 ppm).

Environmental elements	**Survey Results**
	(Summary of the air quality measurement)

Station	Average		Recommended air quality standard of US EPA	
	NO_2 (ppm)	CO (ppm)	NO_2 (ppm)	CO (ppm)
Kilosa	0.0	5.0	0.053	35
Munisagara	0.0	1.5		
Kidete	0.0	4.0		
Godegode	0.05	8.0		
Gulwe	0.05	10.0		

Water quality

Water quality at the rivers along the railway was examined in both the dry season (June 2015) and the wet season (November-December 2015). It was found that turbidity was very high in the Mkondoa and Kinyasungwe Rivers, which flow along the railway (101-120 NTU in the dry season, 368-1060 NTU in the wet season). This is due to the natural condition of the rivers (brown in color) carrying a great deal of sediment, especially in the wet season.

Considering this situation, turbidity generation by the construction works will not cause significant impacts to the rivers, although it is better to minimize the impacts, especially at the tributaries whose turbidity is not so high comparing with the main stream. On the other hand, leakage of oil and the other chemicals from the construction equipment and the railway operation, domestic wastewater from the construction workers, and storm water need to be managed as to not to affect the river and the water quality. (Impact #5, 6, 9, and 20 in the EIS.)

(Results of the water quality examination)
[Dry season: 7-13 June, 2015]

PARAMETERS	UNITS	Sample						TZ. STD*
		SI	S2	S3	S4	S5	S6	
Physical Parameters								
Turbidity	NTU	2.35	120	8.00	101	10.20	1.15	30
Colour	PtCo/1	9.40	300	18.60	286	26.40	7.20	50
Total Suspended Solids	mg/l	10	90	15	100	20	10	1000
Total Hardness	mg/lCaC03	360	440	212	85	40	255	600
Total Alkalinity	mg/lCaC03	230	280	148	70	45	298	N.M.
Chemical analysis								
Chlorides	mg/l	88.64	66.48	65.45	45.00	18.50	160	250
Sulphates	mg/l	71.20	24.00	10.0	28.20	12.0	84.20	400
Ortho-Phosphate	mg/l	0.04	0.02	Nil	0.02	Nil	0.05	N.M
Nitrate	mg/l	2.10	2.0	0.60	2.0	0.80	3.90	30
Nitrite	mg/l	0.10	0.05	Nil	0.06	Nil	0.10	N.M.
Ammonium	mg/l	0.10	0.01	Nil	0.01	Nil	0.50	0.50
Fluorides	mg/l	Nil	Nil	Nil	Nil	Nil	Nil	1.5 -8.0
Bi-carbonates	mg/l	160	65	25	7S	40	210	N.M.
Carbonates	mg/l	Nil	Nil	Nil	Nil	Nil	Nil	N.M.
Aluminium	Mg/l	0.01	Nil	Nil	Nil	Nil	Nil	0.30
Sodium	mg/l	40.00	12.00	2.00	10.30	2.S0	30	250
Potassium	mg/l	8.48	21.36	9.41	5.25	1.40	17.50	200
Magnesium	mg/l	12.47	23.24	10.47	6.0	0.60	21.40	150
Calcium	mg/l	33.64	16.82	50.46	10.50	2.80	36.20	300
Iron	mg/l	0.21	1.90	0.11	0.04	0.01	0.20	0.30
Manganese	mg/l	0.08	0.05	Nil	Nil	Nil	0.04	0.10
Copper	mg/l	Nil	Nil	Nil	0.10	0.10	0.30	1.5
Arsenic	mg/l	Nil	Nil	Nil	Nil	Nil	Nil	0.05
Lead	mg/l	Nil	Nil	Nil	Nil	Nil	Nil	0.10
Zinc	mg/l	0.10	0.23	0.07	0.40	Nil	0.10	5
Cyanide	mg/l	Nil	Nil	Nil	Nil	Nil	Nil	0.10
Cadmium	mg/l	Nil	Nil	Nil	Nil	Nil	Nil	0.05
Chromium	mg/l	Nil	Nil	Nil	Nil	Nil	Nil	0.05
Bacteriological analysis								
Faecal Coliform	No/100	Nil	Nil	Nil	Nil	Nil	Nil	Nil
Total coliform	No/100	Nil	Nil	Nil	Nil	Nil	Nil	Nil

*Environmental Management (Water Quality Standard) Regulations 2007
SI = Mkadage borehole; S2 = Mkondoa River at Mkadage village; S3 = Mdukwi River at Mkadage village, S4 = Mkondoa River at Munisagara village, S5 = Isima River at Munisagara village, S6=Kikundi borehole

Environmental elements	**Survey Results**

[Wet season: 30 November-8 December, 2015]

PARAMETERS	UNITS	Sample				TZ. STD*
		S1	S2	S3	S4	
Physical Parameters						
Turbidity	NTU	1060	19.20	708	368	30
Colour	PtCo/l	1700	45	1260	810	50
pH	-	7.97	7.80	7.60	7.45	6.5 – 8.5
Electrical Conductivity	uS/Cm	710	138	520	490	2000
Total Suspended Solids	mg/l	410	100	280	200	1000
Total Dissolved Solids	mg/l	360	90	300	280	NIL
Total Hardness	mg/l $CaCO_3$	280	65	150	140	600
Total Alkalinity	mg/l $CaCO_3$	250	60	120	110	N.M.
Chemical analysis						
Chlorides	mg/l	85.10	19.50	60.0	56.50	250
Sulphates	mg/l	62.0	15.40	48.20	40.0	400
Ortho-Phosphate	mg/l	0.05	Nil	0.02	0.03	N.M.
Nitrate	mg/l	1.65	0.03	0.09	0.06	30
Nitrite	mg/l	0.80	Nil	0.02	Nil	N.M.
Ammonium	mg/l	Nil	Nil	Nil	Nil	0.50
Fluorides	mg/l	0.07	Nil	Nil	Nil	1.5 – 8.0
Bi-carbonates	mg/l	260	60	130	120	N.M.
Carbonates	mg/l	Nil	Nil	Nil	Nil	N.M.
Aluminium	mg/l	Nil	Nil	Nil	Nil	0.30
Sodium	mg/l	32.0	10.50	21.20	18.60	250
Potassium	mg/l	25.40	6.40	16.60	16.80	200
Magnesium	mg/l	29.0	10.20	18.0	15.0	150
Calcium	mg/l	43.50	15.0	26.0	24.60	300
Iron	mg/l	0.18	0.10	0.07	0.08	0.30
Manganese	mg/l	0.03	Nil	Nil	Nil	0.10
Copper	mg/l	Nil	Nil	Nil	Nil	1.5
Arsenic	mg/l	Nil	Nil	Nil	Nil	0.05
Lead	mg/l	Nil	Nil	Nil	Nil	0.10
Zinc	mg/l	Nil	Nil	Nil	Nil	5
Cyanide	mg/l	Nil	Nil	Nil	Nil	0.10
Cadmium	mg/l	Nil	Nil	Nil	Nil	0.05
Chromium	mg/l	Nil	Nil	Nil	Nil	0.05
Bacteriological analysis						
Faecal Coliform	No/100 mls	Nil	Nil	Nil	Nil	Nil
Total coliform	No/100 mls	30	Nil	40	20	Nil

*Environmental Management (Water Quality Standard) Regulations 2007
S1 = Mkondoa River at Munisagara village; S2 = Isima/Muvuma River at Munisagara village; S3 = Mkondoa River at Mzaganza village; S4 = Kinyasungwe River at Gulwe village

Soil erosion

Riverbank erosion is one of the major causes which damage the railway. Additionally, upstream erosion brings a great deal of sediment to the rivers and it encourages the flood damages through the sedimentation. Those facts were observed throughout the Study indicate that soil erosion is easily occurring in the project area, and it affects both infrastructure and the environment.

As the project cuts the mountain slope and fills to develop embankment, the earth-moving activities may cause soil run-off and erosion. (Impact #1 and 7 in the EIS.)

Solid waste

Surplus soil will be generated by cutting the mountain slope; however, the disposal volume will be minimized by utilizing it for filling the embankments. The minimized excess soil will be disposed at a proper site which will be agreed upon with the local government.

During the construction phase, waste oils from construction equipment and domestic waste from the construction workers will be generated. Demolition of the existing station and tracks will also generate solid waste. (Impact #6, 9, and 15 in the EIS.)

During the operation phase, it is concerned that the passengers may dispose their waste around the station. However, the volume will be limited and the current condition around the stations is kept clean by the station staffs.

Soil contamination

'Sabo Soil Cement', which will be used for constructing a check dam and ground sill at Maswara and Mzase Rivers, may cause dissolution of hexavalent chromium into the existing soil, though the possibility is generally low. The dissolution will be examined before the construction works.

Environmental elements	**Survey Results**
Noise/vibration	Although it is not an urban area, the construction noise will affect surrounding residents and fauna, such as birds. Expected range of the noise emission of the construction equipment to be used is 55 dB (vehicle)-85 dB (bulldozer). (Impact #2,10, 13, and 16 in the EIS.) As the rerouted section does not pass through residential areas, the impacts of noise and vibration by trains will be the same with the current condition. The results of noise measurement at a train passing showed the noise level by trains was not so high comparing with international guidelines, and it will last only a short time, at most several times in one day.

(Measured Noise Level at Kilosa Station)

Condition	**Noise Level (dBA) Max. - Min.**
No train with no passengers shouting	40.2 – 44.2
No train with passengers talking/shouting/laughing	55 - 61
Train approaching without whistling	65 - 66
Stationary train	65 - 66
Train moving away from the station	65 - 66

(Guidelines for ambient noise)

	One Hour L_{Aeq} (dBA)	
	Day time 7:00-22:00	Nigh time 22:00-7:00
Residential; institutional; educational	55	45
Industrial; commercial	70	70

IFC EHS Guidelines

(Guidelines for occupational health)

Duration per day	**Noise level (dB A)**
8 hours	85

Environmental Management (Standards for the Control of Noise and Vibration Pollution) Regulations, 2011, and
IFC EHS Guidelines.

Eco-systems	The project site does not encompass ecologically-valuable habitats, such as primeval forests. Fauna and flora in the area are as follows: <u>Aquaticecology:</u> The fish found in the rivers consists of small barbs (*Barbus paludinosus*), african sharptooth catfish (*Clarias gariepinus*), tilapias (*Oreochtomis niloticus*), etc. Of these, three species are migratory fish species: *Labeo* sp., *Barbus paludinosus,* and *Anguilla* sp. Most of the fish specimen were found in large pool areas especially at the Gulwe swamp, while the river stretch had only small sized fish. Other aquatic animals reported were crocodiles (*Crocodylus niloticus*) and monitor lizards (*Varanus niloticus*). These reptiles were, however, not encountered during the survey period. None of the identified species are categorized as vulnerable, threatened, or endangered as per CITES. As the water quality is an important living condition for those aquatic species, they will be affected if the river water is polluted by the construction and the operation of the rail, such as by oil leakage (Impact #5, 6, 9, and 20, in the EIS.). <u>Flora:</u> The vegetation of the proposed project site falls under two main Phytocorions.

Environmental elements	**Survey Results**
	One of them is Zambezian regional centre of endemism, characterized by drier miombo woodland, patches of flood plain grassland and riparian woodland. The other phytocorion is Somali-Masai regional centre of endemism characterized by *Acacia-Commiphora* deciduous bushland and patches of Halophytic vegetation dominated with *Tamarix nilotica* stands. Based on physiognomic characterisation within the proposed project area, seven main vegetation categories have been classified from the project area includes: *Acacia –Commiphora* deciduous bushland, Drier miombo woodland, Settlements with alien species, Cultivations, Marshland with sands, Riparian, and *Tamarix nilotica* stands**.** Around the project site, one tree species (*Cordyla densiflora*) has been identified growing in *Acacia – Commiphora* deciduous bushland at Kitete and Gulwe which is considered vulnerable under International Union for Conservation of Nature (IUCN) list. Although the construction site is not in a primary forest, railway rerouting and the access road construction will directly affect the vegetation within the site. (Impact #2 in the EIS.) <u>Amphibians and Reptiles:</u> Eleven species of amphibians were recorded between Kilosa and Gulwe. None of the species are threatened of extinction according to the IUCN list. Twenty-three species of reptiles were observed along the proposed rerouting sections and the access road. Most of the species do not appear in the IUCN list. Although those species can move away from the construction, vegetation clearance in the site and construction noise/vibration will affect the living conditions. (Impact #2 in the EIS.) <u>Avifauna:</u> 126 species of birds were recorded. Out of them, Fisher's Lovebird, or *Agapornis fischeri,* is categorized as Near Threatened (NT) according to IUCN list. However, the impacts will not be critical as it was commonly observed in the project area between Godegode and Gulwe, and not specified in the construction site. <u>Mammals:</u> 26 species of mammals were recorded in the study area through direct observation and interview with the locals. Out of the species, Leopard (*Panthera pardus*) and African Elephant (*Loxodonta africana*) were categorized Near Threatened (NT) and Vulnerable (VU) by IUCN. Presence of Leopard was mentioned by local pastoralists. African Elephant was also mentioned by the locals. However, they are not commonly observed; especially African Elephant, which is very occasionally observed and the frequency is very low. Migratory species which frequently or seasonally move through the project area were not recognized.
Hydrology/water regime	Out of the project components, the river-training works at Maswara and Mzase River will change the river course of those tributaries. The works at Maswara is to fix the river course and secure the enough cross-section area by excavating within the present flood plain (see Subsection 10.1.10). As the works are conducted in the existing flood plain, water flow which runs into Kinyasunguwe River will not be changed; therefore, the downstream hydrology will not be altered.

Environmental elements	**Survey Results**
	The works at Mzase are to straighten the curved river course to secure a smooth flow. The same as with the works at Maswara River, training works are conducted in the present flood plain. Therefore, the alteration of the river course will not affect downstream hydrology. The other project components, namely rerouting, bank protection and access road, will not cause hydrological changes.
Topography and geology	As the rerouting is to be conducted by cutting and filling the mountain slopes, topography around the rerouting section will be altered. Although the excavated soil will be utilized for filing the embankment, additional soil needs to be procured if the volume is not enough. In this case, it is necessary to develop new quarry near the construction site, and it will cause additional topographic change.
Resettlement	Compensation and Resettlement Plan (CRP) survey results showed that in total 952 people (201 households) will be affected by the rerouting and river-training works. Out of them, 414 people (109 household) are affected for their housing structures. (Impact #12 in the EIS)
Poor	Average household income of the affected household is about 4 million TZS/year (range of 100,000-73,440,000 TZS/year). As the average number of the household member is 4.74, average income per capita is estimated to be about 840,000 TZS/year. Comparing with the national poverty line, USD 1/capita/day which is equivalent to 730,000 TZS/capita/year, the average affected household's condition is close to be the poverty line. The project will affect those poor household by taking their agricultural land and the other properties. On the other hand, it is expected that the construction works will provide income source such as by employment of workers and procurement of materials. Additionally, the stable railway operation brought by the project will contribute to their income improvement through increase of the economic activities.
Indigenous people	In Kilosa District, various ethnic groups are living together due to the history of plantations of the colonial period, which made the laborers migrate from various parts of the country. As indigenous tribes, the Sagara and the Kaguru are living as minority; however, the lifestyle has already become similar with the others. In Mpwapwa District, the Gogo, the indigenous tribe is dominated but the others are also living together and the lifestyle is common. The Gogo are predominantly Christian. The Maasai and the Mang'ati are living in both Districts as pastoralists. They are new comers to the areas and not recognized as the indigenous. Kiswahili is commonly spoken between and within the tribes.
Employment and local economy	Through the local stakeholder meetings, expectations of the employment opportunities for the construction and the railway operation were raised by the villagers. Especially for the construction works, it is reasonable for employing local people for simple labor works such as vegetation clearance and making gabions. During operation, it is expected that increased passenger trains will provide opportunities to the locals to sell their products such as food and fruits. (Impact #31, 32, and 33 in the EIS.)
Land use and local resources utilization	As the rerouting distance at most several hundred meters from the existing railway, it will not change the land use at the project site. The construction will require construction materials such as sand, gravel and stone. Those materials need to be procured from existing quarries or a new quarry which is approved by NEMC and local authorities. (Impact #3 in the EIS)

Environmental elements	Survey Results
Water use	Domestic water is collected from boreholes and streams at the project site. Although the construction works may use some water, the volume will not be huge and not to affect the existing water use. On the other hand, there is a possibility to pollute water quality due to the construction and railway operation such as by oil leakage. (Impact #5, 6, 9, and 20 in the EIS.)
Existing social infrastructure and social services	Although it is not an authorized proper road, the local people are using the space along the railway as a road for their daily transport by motorbikes and bicycles. As the construction works will affect the usage, it is necessary to arrange good site management to minimize the disturbances as well as preventing accidents. (Impact #14 in the EIS.) (Motorbikes along the railway) The project will bring reliable and stable train operation. It will directly contribute to the social transport service. (Impact #24 in the EIS.)
Social capital and local decision-making institution	The project area is in an agricultural area organized by the village government. As the rerouting distance is at most several hundred meters in the same vicinity, it will not affect the local decision-making institution.
Cultural heritage	Archaeological and cultural heritage of the project area remains relatively unknown. During the survey, archaeological site of early iron working was recorded at Mkadage in Kilosa District. Scatters of ancient settlements were observed at Munisagara Village. Additionally, a few potsherds from between the 17th and 19th centuries, and a huge scatter of ceramic materials were recorded. In Kikundi, ceramics of different age periods, ranging from the 8th to the 18th centuries, were recorded in the vicinity of the railway. (Impact #11 in the EIS.)
Landscape	The project site is between the river and the mountain slope. As the railway rerouting will create embankments with several meters height and cut the mountain slope, the landscape will be changed. However, as it is mountainous area with various topographic conditions and there are no specific views to be protected, the change will be acceptable.
Gender	Although it is a patriarchal society, there is evolution towards acceptance of women's rights; for example, each village has women council members and a women's committee. Most of the domestic works, such as fetching water, cooking, and collecting firewood tend to be carried out by women. However, the construction and the railway operation will not cause impacts to those domestic activities.
Children's right	Every village community has at least one primary school and every ward has at least one secondary school. The rate of enrolment of pupils in class is 77.3% in the Morogoro Region and 70.8% in the Dodoma Region.
Infectious diseases HIV/AIDS	The HIV prevalence rate of Tanzania is about 5% in 2013 (Ministry of Health (2014) 'Global AIDS Response Country Progress Report'). Annual new infections in the project area decreased recently: in Kilosa District, from 430 people in 2009 to 132 people in 2014; in Mpwapwa District, from 342 people in 2009 to 153 people in 2014. However, inflows of construction workers may cause the spread of infectious diseases as they will stay a certain period close to the local communities away from their own families. (Impact #18 in the EIS.)

Environmental elements	**Survey Results**
Working environment, inclusive of occupational safety	Construction works will involve hazardous situations, such as falling objects, moving vehicles and machines, generation of noxious fumes, working on elevated heights, exposure to welding blaze, falling in ditches, high temperature surfaces, noisy operations, etc. All these constitute occupational health and safety risks. Occupational health hazards may also be promoted by lack of procedures that mitigate negligence at work, fatigue due to understaffing and long working hours, employing wrong people on particular jobs and low morale etc. (Impact #13 and 17 in the EIS.) For the railway operation, the working condition of TRL staffs are regulated by the following regulations: − Employment and Labor Relations Act No.6, 2004 − Government Notes No.42, 2007 − Collective agreement: Agreement between management and workers of TRL. It is agreed every two years. The latest one is for 2013-2015. − Service regulation 1984 :Internal regulation − Railway Act No.4, 2002 − Public Service Act, 2003 According to TRL, accidents of TRL staff during working time are very common. Gumboots, groves, overcoats and helmets are provided to staffs working at workshops. For gang men, gumboots and grove are provided. However, the quantity of these is not enough. For the workers in workshop, in-house training to avoid accidents is carried out. For the gang men, they are trained by supervisors.
Accidents	Users of land abutting or neighboring the project site are likely to be affected by accidents during construction (traffic movements, open pits filled with water) due to lack of appropriate/sufficient signage at construction sites and timely notification. Workers are commonly exposed to health risks that are prevalent in the project area. (Impact #13 in the EIS.) During the railway operation, there are tendencies of passengers to jump on and off the train while the train is moving. Additionally, there are people, particularly children and elderly people, who may cross the railway line while the train is approaching. Another vulnerable group are motorcycle riders who at times are knocked off their vehicles at level-crossings. With the expected increase in the number of trains (both cargo and passenger trains), accidents may happen more frequently. (Impact #23 in the EIS.) Additionally, there is a risk of accidents related to the transportation of dangerous goods. Dangerous goods are frequently transported by rail, which represents a potential risk of release into the environment in the event of an accident. In intermodal containers spills and leaks may result from improper packing and the resultant shifting of loads during transport. Additionally, there is potential diesel release during fueling operations. (Impact #27 in the EIS.)

13.1.7 Impact Assessment

Results of the impact assessment are summarized in Table 13.9.

Table 13.9: Results of the Impact Assessment

Environmental Domain		**Environ-mental Elements Impacted**	**Assessment for Scoping**		**Final Assessment**		**Reasons of the Final Assessment**
			Prior to Construction/ During Construction	**Railway In Service**	**Prior to Construction/ During Construction**	**Railway In Service**	
	1	Air Quality	B–	D	B–	D	<u>During Construction</u> (same as the scoping results) <u>Railway in service</u> (same as the scoping results)
Pollution	2	Water Quality	B–	C–	B–	B–	<u>During Construction</u> Leakage of oil and the other chemicals from the construction equipment and waste water generated from the activities need to be managed not to affect the river/ground water quality. <u>Railway in service</u> Waste oils generated by the railway operation and the wastewater discharge from the station facilities need to be managed not to affect the river/ground water quality.
	3	Soil Erosion	B–	B+	B–	B+	<u>During Construction</u> As the project cuts the mountain slope and fills to develop embankment, the earth-moving activities may cause soil run-off and erosion. <u>Railway in service</u> (same as the scoping results)
	4	Solid Waste	B–	B–	B–	D	<u>During Construction</u> Waste oils from construction equipment and domestic waste from the construction workers will be generated. Demolition of the existing station and tracks will also generate solid waste. <u>Railway in service</u> Waste disposal by the passengers is limited. The current condition around the stations is kept clean by the station staffs.
	5	Soil Contamination	B–	D	B–	D	<u>During Construction</u> 'Sabo Soil Cement' which will be used for constructing check dam and ground sill may cause dissolution of

Environmental Domain		Environ-mental Elements Impacted	Assessment for Scoping		Final Assessment		Reasons of the Final Assessment
			Prior to Construction/ During Construction	**Railway In Service**	**Prior to Construction/ During Construction**	**Railway In Service**	
							hexavalent chromium. It will be examined before the construction works. Railway in service (same as the scoping results)
	6	Noise/ Vibration	B−	B-	B−	D	During Construction The construction noise will affect social and natural environment. Railway in service Noise from the train lasts only in short time during train passing.
	7	Land subsidence	D	D	D	D	During Construction (same as the scoping results) Railway in service (same as the scoping results)
Natural Environment	8	Protected Area/Forest reserve	D	D	D	D	No protected area/forest reserve is found at the project site.
	9	Eco-systems	B−	B−	B−	B−	The construction will directly affect the vegetation within the site. The vegetation clearance and construction noise/vibration will affect the terrestrial fauna. For the aquatic fauna, they will be affected if the river water is polluted by the construction and the operation such as by oil leakage.
	10	Hydrology/ Water Regime	C−	C−	D	D	The river-training works at Maswara and Mzase Rivers will change the river course; however, it will not affect downstream hydrology because they are conducted within the present flood plain.
	11	Topography and Geology	C−	D	B−	D	During Construction Developing a new quarry for filling embankment will cause another topographic change. Railway in service No activities is expected which causes topographic/geological change.
Social Environment	12	Resettlement	A−	D	A−	D	Prior to Construction 952 people (201 households) will be affected for their land/housing structures.

Environmental Domain		Environ-mental Elements Impacted	Assessment for Scoping		Final Assessment		Reasons of the Final Assessment
			Prior to Construction/ During Construction	Railway In Service	Prior to Construction/ During Construction	Railway In Service	
	13	Poor	C	C	B-/+	B+	Prior to/During Construction The project will affect the poor households by taking their properties. On the other hand, it is expected that the construction works will provide income source such as such as by employment of workers and procurement of materials. Railway in service The stable railway operation brought by the project will contribute to the people's income improvement through an increase of economic activity.
	14	Indigenous People	C	C	D	D	There are various tribes in the project area. Some of them are indigenous; however, the lifestyle has become similar with the others.
	15	Employment and Local Economy	A+	A+	A+	A+	(same as the scoping results)
	16	Land use and local resources utilization	A+	A+	B-	D	During Construction The construction will not change land use. It is necessary to procure construction materials from registered quarries. Railway in service The railway operation will not change land use.
	17	Water Use	B−	C	B-	B-	Although water volume will not be affected by the construction and the operation of the railway, it is necessary to prevent water pollution caused by oil leakage and others.
	18	Existing Social infrastructure and Social services	B−	A+	B-	A+	During Construction The construction work will affect the informal local road along the railway. Railway in service The railway operation will become reliable and stable.
	19	Social capital and local decision-making institutions	C	C	D	D	As the rerouting distance is maximally within several hundred meters in the same village, it will not affect the local decision-making institution.

Environmental Domain		Environ-mental Elements Impacted	Assessment for Scoping		Final Assessment		Reasons of the Final Assessment
			Prior to Construction/ During Construction	**Railway In Service**	**Prior to Construction/ During Construction**	**Railway In Service**	
	20	Cultural Heritage	C	C	B-	D	During Construction Some archaeological materials were found through the survey, especially in Kilosa District. The construction may affect those things. Railway in service As the materials are buried in the ground, railway operation will not affect them.
	21	Landscape	C	C	D	D	Landscape will be changed because of the embankment and cutting mountain slope; however, it will be acceptable as it is mountainous area and no specific views to be protected.
	22	Gender	B−	B+	D	D	The construction and the railway operation will not cause impacts to the domestic activities by women.
	23	Children's rights	C	C	D	D	The construction and the railway operation will not cause impacts specified for children.
	24	Infectious diseases HIV/AIDS	B−	C	B-	D	During Construction Inflow of the construction workers may cause spread of the infectious diseases as they will stay certain period close to the local communities away from their own families. Railway in service Risk of the spread of diseases is low because the railway passengers will not stay long at the project site except residents.
	25	Working Environment, inclusive of occupational safety	B−	C	B-	B-	During Construction Occupational health and safety risks need to be considered for construction workers. Railway in service There are risks of an increase of accidents affecting TRL staff due to the increase of train operations.
Others	26	Accidents	B−	B−	B-	B-	During Construction There are risks of accidents for local people. Railway in service Train accidents affecting local people may be increased due to the increase of train operations.

Environmental Domain		Environ-mental Elements Impacted	Assessment for Scoping		Final Assessment		Reasons of the Final Assessment
			Prior to Construction/ During Construction	**Railway In Service**	**Prior to Construction/ During Construction**	**Railway In Service**	
	27	Trans-boundary pollution	D	D	D	D	(same as the scoping results)
	28	Global warming	D	B+	D	B+	During Construction (same as the scoping results) Railway in service (same as the scoping results)

A+/−: Significant positive/negative impact is expected. B+/−: Positive/negative impact is expected to some extent.
C+/−: Extent of positive/negative impact is unknown. (A further examination is needed, and the impact could be clarified as the study progresses) D: No impact is expected.
Source: JICA Study Team

13.1.8 Mitigation Measures

Negative impacts which were evaluated as A, B, and C in the above section were presented in the Environmental Impact Statement (EIS) as Impact #1-27. The correspondence relations are tabulated in Table 13.10.

Table 13.11 presents mitigation measures and the Environmental/Social Management Programme (ESMP) describe in the EIS.

Implementation responsibility of the ESMP is solely under the project proponent, RAHCO. RAHCO shall supervise and monitor all components implemented by the Contractor. RAHCO shall provide the necessary supervisory oversight to ensure the mitigation measures are implemented.

RAHCO shall designate an Environmental Control Officer (ECO) who takes responsible for oversight of environmental compliance. The ECO shall serve in a day-to-day supervisory role during the entire construction period. The ECO shall have the capacity to coordinate the implementation of the various activities in the ESMP and ensure all RAHCO's Health Safety and Environment (HSE) management requirements are met by all aspects of the project. The ECO shall be the main contact person on all environmental and social matters related to the project (shall maintain contacts with officials in the various relevant Ministries, Departments and agencies both central and within Local Government Authorities and the RAHCO).

The Contractor shall ensure that those mitigation measures that are to be implemented during mobilization and construction are attended to. The Contractor shall designate among its staff/appoint an officer to act as Environmental Liaison Officer (ELO), and he/she will be responsible to ensure the environmental and social management mitigation measures are implemented during the contract period.

Table 13.10: Correspondence Relation Between Above Section and the EIS

Impacts in the above section			**EIS**	
No.	**items**	**Rating**	**No.**	**Impact description**
Prior to construction/during construction				
1	Air quality	B-	Impact #4 and #8	Impaired air quality & contribution to climate change due to release of dust, greenhouse gases and other noxious air pollutants
2	Water quality	B-	Impact #5	Release of oils and fuels in the aquatic environment
			Impact #6	Contamination of surface and ground water with demolition debris
			Impact #9	Impaired land and water qualities and contained resources from discharge of pollutants (wastes, oily substances, etc.)
3	Soil erosion	B-	Impact#1	Land disturbances/soil erosion at offsite locations - sources of construction materials - (sand, ballast, concrete blocks, aggregates, and stones)
			Impact #7	Land disturbances/soil erosion
4	Solid waste	B-	Impact #6	Contamination of surface and ground water with demolition debris
			Impact #9	Impaired land and water qualities and contained resources from discharge of pollutants (waste, oily substances, etc.)
			Impact #15	Loss of aesthetics due to haphazard disposal of demolition waste
5	Soil contamination	B-	-	(Although it is not specified in the EIS, implementation of the examination will be secured in the detailed design stage.)
6	Noise/vibration	B-	Impact #2	Loss/damage/disturbance of indigenous vegetation and contained biodiversity species
			Impact #10	Temporary disturbances/flight of fauna from noise, gaseous and dust emissions
			Impact #13	Construction health and safety hazards
			Impact #16	Nuisance and disturbances from noise/ vibrations (exceeding allowable level for the zone)
9	Ecosystem (Aquatic ecology)	B-	Impact #5,6,9	(Impacts from water pollution)
	(Terrestrial flora and fauna)	B-	Impact #2	Loss/damage/disturbance of indigenous vegetation and contained biodiversity species
11	Topography and geology	B-	-	(EIA for new quarry development will be conducted if necessary.)
12	Resettlement	A-	Impact #12	Change or modification of population and its quality of life due to land take
13	Poor	B-	Impact #12	Change or modification of population and its quality of life due to land take
16	Land use and local resource utilization	B-	Impact #3	Depletion at point source
17	Water use	B-	Impact #5,6,9	(Impacts from water pollution)

Impacts in the above section			**EIS**	
No.	**items**	**Rating**	**No.**	**Impact description**
18	Existing social infrastructure and services	B-	Impact #14	Temporary disruption of socioeconomic activities
20	Cultural heritage	B-	Impact #11	Destruction of archaeological and cultural heritage resources
24	Infectious disease HIV/AIDS	B-	Impact #18	Public HSS risks: traffic accidents, risks of human-human transmission of diseases (STD, HIV, etc.), Infections from putrescible wastes with disease pathogens
25	Working environment, inclusive of occupational safety	B-	Impact#13	Construction health and safety hazards
			Impact #17	Occupational HSS risks (Serious injuries, Disturbances/nuisance and discomfort, Fatalities, Sickness and ill-health, Negligence due to fatigue, Loss of morale
26	Accidents	B-	Imact#13	Construction health and safety hazards
Railway in service				
2	Water quality	B-	Impact #20	Release of oils and fuels in the aquatic environment
9	Ecosystem (Aquatic ecology)	B-	Impact #20	(Impacts from water pollution)
17	Water use	B-	Impact #20	(Impacts from water pollution)
25	Working environment, inclusive of occupational safety	B-	Impact #22	Occupational and Public health and safety during operation
26	Accidents	B-	Impact #23	Potential loss of lives and property as a result of falling off from moving train, collision with train at road crossing as a result of increased train frequencies
			Impact #27	Impairment of environmental quality due to accidental events

Source: JICA Study Team

Table 13.11: Mitigation Measures and the Environmental/Social Management Program

Receptor	Project Aspect/ Potential Direct Impacts	Mitigation Measures/Management Program	Target Level/ Standard	Responsi-bility	Estimated Cost [TZS]
DESIGN AND MOBILISATION PHASE					
Natural Resource Receptor	Impact #1: Land disturbances/soil erosion at onsite and offsite location	In order to mitigate land degradation onsite and offsite the contractor shall, through the entire mobilisation phase, implement the following measures: ▪ Implement soil erosion control and land rehabilitation measures at all project sites and offsite locations ▪ Ensure strict control of trucks, vehicles as well as equipment and machinery to ensure that they operate only within the project area ▪ Limit excavations area needed for construction works, construct temporary drainage grooves and sedimentation ponds for surface runoff collection and compact the disturbed areas soon after construction. ▪ Compact the disturbed areas soon after construction. ▪ Whenever possible development activities shall be implemented when the agents of erosion (i.e., rain and wind) are not active. ▪ RAHCO will monitor areas of exposed soil during periods of heavy rainfall throughout the project development phase.	All disturbed land is rehabilitated	RAHCO	25,000,000
Natural Resource Receptor	Impact #2: Loss/damage/disturbance of indigenous vegetation and contained biodiversity species	In order to mitigate loss, damage, disturbance of indigenous flora and fauna, through the entire project phases, RAHCO shall ensure the following measures are implemented: ***Vegetation*** ▪ Develop and Implement a Flora and Vegetation Conservation and Soil Restoration Plan – which shall include: conduct pre-construction floristic conservation survey; identification and re-planting of the species to be conserved in similar alternative habitats; collection of their seeds and bulbs and establishment of small-scale nurseries and ex- situ and in situ conservation measures. ▪ Train the workers and construction site managers in avoiding cutting of trees and bushes along the RoW and destruction of soils on large areas ***Fauna*** Examine at each section: ▪ breeding areas of special wildlife and invertebrates in water objects ▪ presence of small mammals; ▪ presence of the nests of protected birds; ▪ presence of colonies of bats in the trees to be cut; and ▪ whether the individual section of a big mammal falls within the construction zone.	As minimum impact as possible	RAHCO	50,000,000

Receptor	Project Aspect/ Potential Direct Impacts	Mitigation Measures/Management Program	Target Level/ Standard	Responsi-bility	Estimated Cost [TZS]
		Mitigation of noise The Contractor shall implement the following measures: ▪ Maintaining machinery and equipment in good running conditions and avoiding sudden loud noise ▪ Establish and enforce good site management ▪ Develop and observe best practice - methods of working ▪ Restrict hours of working during day light at the settlements; ▪ Exercise efficient material handling ▪ Define access routes to the site with the smallest number of properties in proximity ▪ Keep trucks and vehicle movements to a minimum possible			
Material efficiency and waste receptor	Impact #3: Depletion at point source	▪ RAHCO shall ensure that the construction materials such as sand, gravel, natural stones, ballast are procured from registered quarry and sand mining firms, whose projects have undergone satisfactory environmental assessment/audit and received NEMC/District Council approval. ▪ RAHCO shall impress the Contractor to avoid over procurement of construction materials ▪ RAHCO shall impress the Contractor to avoid wastage, damage or loss (through run-off, wind, etc.) of materials at the construction site	Resources are used as per requirement	RAHCO	0
Air quality and climate change receptor	Impact #4: Impaired air quality & contribution to climate change due to release of dust, greenhouse gases and other noxious air pollutants	In order to mitigate the impairment of climate change, throughout the project cycle, the Contractor, RAHCO will continuously implement the following measures: ▪ Use of best practice management techniques during extraction, loading and transporting raw materials. ▪ Use efficient trucks and vehicles ▪ Train driver-training to minimize emissions (e.g., prevention of over revving, shut off engines when vehicles not in use). ▪ Regular (monthly) servicing of engines ▪ Avoiding idling of engines ▪ Ensure efficient equipment operations and maintenance measures to minimize emissions. ▪ Institute proper planning of transportation of materials to ensure that vehicle fills are increased in order to reduce the number of trips done or the number of vehicles on the road.	Environmental Management (Air Quality Standards) Regulations, 2007	RAHCO	100,000,000 per year
Water resources receptor	Impact #5: Release of oils and fuels in the aquatic environment	In order to protect the receiving environment against fuels the Contractor and RAHCO shall implement the following measure: ▪ Fuels and lubricants shall be stored only at designated areas. ▪ Storage of fuel and lubricants shall be kept at least 30m from the edge of the	Environmental Management (water Quality Standards)	RAHCO	Covered under impact #4

Receptor	Project Aspect/ Potential Direct Impacts	Mitigation Measures/Management Program	Target Level/ Standard	Responsi-bility	Estimated Cost [TZS]
		surface waters, e.g., rivers ▪ Refuelling and lubrication of equipment shall be restricted to areas at least 30m away from the edge of the surface waters ▪ Perform all routine equipment maintenance at least 30 meter away from the edge of the rivers and recover and dispose of wastes in an appropriate manner. ▪ Fixed fuel dispensing locations will be provided with secondary containment to capture fuel from leaks, drips, and overfills. ▪ A supply of sorbent and barrier materials sufficient to allow the rapid containment and recovery of spills shall be maintained at construction site ▪ Ensure that all equipment is free of leaks prior to use on the Project and prior to entering or working in or near the water bodies. ▪ Conduct regular maintenance and inspections of the equipment to reduce the potential for spills or leaks. ▪ Rubber-tired vehicles (trucks) shall refuel at commercial fuel stations. Tracked machinery (e.g., backhoes, bulldozers) shall be refuelled and lubricated on the construction site.	Regulations, 2007		
Water resources receptor	Impact #6: Contamination of surface and ground waters with demolition debris and soils	In order to mitigate impacts of demolition waste the Contractor together with RAHCO shall be guided by the waste management guidelines as follows:[1] ▪ Prevent the generation of hazardous waste; ▪ Where elimination is not possible apply means and techniques to reduce the quantity of hazardous waste generated; ▪ Minimize amount of waste for disposal by recycling, reuse and/or recovery. This includes the recovery of energy which may be available from the waste. ▪ Treat waste to stabilize, immobilize, contain or destroy hazardous properties. ▪ Dispose of residues with minimum environmental impact. ▪ Appropriately contain, isolate and store hazardous waste for which no acceptable treatment or disposal option is currently available. Other specific measures that will be implemented are: ***Inert Construction Materials:*** These materials shall be used for construction of embankments, acoustic barriers or as filling materials on rural roads. **Non-hazardous Waste:** ▪ Concrete waste will be disposed in similar manner as inert wastes. ▪ Metal waste shall be disposed separately for reuse and recycling.	All waste are handled accord to respective regulations	RAHCO	10,000,000

[1] Environmental Management (Hazardous Waste Management) Regulations, 2008

Receptor	Project Aspect/ Potential Direct Impacts	Mitigation Measures/Management Program	Target Level/ Standard	Responsi-bility	Estimated Cost [TZS]
		Hazardous Waste: ▪ Hazardous wastes will be collected and transported to Dar es Salaam for their final disposal. ▪ Uncontrolled incineration will not be allowed. ▪ Before removal of wastes from the site, the quantity (volume) and size of wastes; the name of waste collector/disposal agent and the name of the place of their final disposal/measure shall be specified. This issue shall be controlled by site manager ▪ The technical personnel shall be trained and informed about the appropriate regulations for handling hazardous waste i.e., Environment Management (Hazardous Waste Control and Management) Regulations, 2008 ▪ After demolition the place shall be restored to the pre-construction state.			
CONSTRUCTION PHASE					
Land resources receptor	Impact #7: Land disturbances/soil erosion	In addition to mitigation measures listed under impact #1 following measures will also be implemented: ▪ RAHCO shall make land management and soil erosion control a requirement in the bidding document; ▪ RAHCO shall develop management plans for its existing quarry sites, and new sources of construction materials. ▪ Contractors will be required to control soil erosion and rehabilitate disturbed land; RAHCO shall provide oversight supervision and monitoring during and after project implementation. ▪ Contractor shall identify erosion prone areas, identify permanent erosion control measures (applicable for a particular site) and plan construction works and sites to limit quantity of material likely to be eroded and transported into the nearby rivers. ▪ Deliberately the Contractor will cover exposed soils with grass and other appropriate species as soon as possible and temporarily will bind exposed soil and redirect flows from heavy runoff areas that threaten to erode or result in substantial surface runoff to adjacent water courses. ***Topsoil removal, disposal and piling*** ▪ First of all the topsoil and then subsoil shall be cut and piled (stocked) separately on specially selected area for their purposeful use. ▪ The stocked topsoil should not be mixed up with unfertile soils, stones, etc. It should be prevented from washing to preserve the structure, fertility and seeds base of the topsoil. ▪ Topsoil will be stored in the form of stockpiles having the height up to 2 m and	All site with erosion tendencies	RAHCO	The cost of implementing these measures are part of the project implementation. They will be included in bill of quantities

Receptor	Project Aspect/ Potential Direct Impacts	Mitigation Measures/Management Program	Target Level/ Standard	Responsi-bility	Estimated Cost [TZS]
		slope inclination up to 30-35^{o}. ▪ Erosion of stockpile surface shall be provided through compacting surfaces to the level having no threat of development of anaerobic processes. ▪ The Contractor shall stop topsoil removal and stocking operations if topsoil is saturated with water. ▪ Stocked soil shall be protected from washing, therefore, it is necessary to arrange drainage [system] in the bottom of the storage. ▪ Stocking of removed topsoil outside the RoW, shall be avoided as far as possible. If this is not possible appropriate sites shall be identified and used in accordance with the current Tanzania Laws (e.g., Village Land Act, 1999)			
		Erosion control Following erosion control measures shall be implemented: ▪ Arrangement of berms, stone mounds and gabions will be required at the cut slopes and in the bottom of the slopes. ▪ Cut topsoil shall not be used for construction of berms within the RoW. ▪ At the location of cult slopes and ravine crossings where the excavation works are to be carried out, water collecting and conveyance canals shall be built to regulate the flows of surface waters. ▪ At the ends of water conveyance canals the settlers shall be arranged (pits, sand sacks) to prevent damage of areas adjacent to RoW with water. ▪ Phyto-amelioration measures shall be implemented to stabilize the edges of slopes and cut slopes if required. ▪ It is particularly important to protect the removed and stocked topsoil from erosion processes – as follow. ✓ Stocked topsoil shall be drained. ✓ To control erosion processes at the edge of the cut slope, phyto-amelioration measures shall be implemented on the slope. ✓ For regulation of surface waters, berms and water canals shall be arranged at the edge of the slope that will be connected to natural water courses to avoid development of lateral erosion. ***Soil reinstatement measures*** ▪ After completion of excavation works and laying the rails the soil reinstatement activities shall be implemented in the areas adjacent to the embankment. ▪ The reinstatement works shall be carried out in favourable meteorological (dry) conditions and in the shortest possible time. ▪ During implementation of soil reinstatement works mechanical and physical-	All site with erosion tendencies	RAHCO	The cost of implementing these measures are part of the project implementation. They will be included in bill of quantities

Receptor	Project Aspect/ Potential Direct Impacts	Mitigation Measures/Management Program	Target Level/ Standard	Responsi-bility	Estimated Cost [TZS]
		chemical characteristics of soils shall be taken into account. ▪ Soils shall be reinstated at least to its initial state for the purpose of observation of the principles of environmental safety and preservation of the recreational value of landscapes.			
		▪ Reinstatement works to be carried out within the framework soil quality management; therefore the following will be required: ✓ preservation of landscapes and their recreational value; ✓ reinstatement-conservation of the areas modified as a result of construction activities to their initial visual-aesthetic state as much as possible; ✓ the construction shall not cause negative impact on the environment of the railway route and the RoW; ✓ implementation of slope stabilization and designing activities at the crossings of the railway with ravines; ✓ reinstatement of the private land parcels located in the vicinity of the railway bypass to their initial state, conservation of their fertility and natural characteristics; ✓ implementation of erosion control measures along and in the vicinity of the railway. Other mitigation measure include: ▪ ***Training of workers and construction site managers*** to avoid, along other impacts, destruction-trampling and mechanical damage of soils by construction machinery in the areas adjacent to the construction sites.	All site with erosion tendencies	RAHCO	The cost of implementing these measures are part of the project implementation. They will be included in bill of quantities
Air quality and climate change receptor	Impact #8: Impaired air quality & contribution to climate change due to release of dust (including fugitive (unavoidable, residual), greenhouse gases and other noxious air pollutants	Mitigation measures listed under Impact #4 apply.		RAHCO	Covered under Impact #4

Receptor	Project Aspect/ Potential Direct Impacts	Mitigation Measures/Management Program	Target Level/ Standard	Responsi-bility	Estimated Cost [TZS]
Water resources receptor and Land Resources Receptor	Impact #9: Impaired land and water qualities and contained resources from discharge of pollutants (wastes, oily substances etc.)	In addition to mitigation listed under Impact #5 and Impact #6 , the Contractor and RAHCO shall implement following additional measures: ▪ Develop and implement project-specific Waste Management Procedure/Plan (i) identify what type of solid or liquid wastes and categories of wastes the project will generate or handle (biodegradable/organic wastes; packaging materials; non-biodegradable (metallic, plastic), and hazardous wastes i.e., fuels, oils, lubricants, vehicle/machinery fluids etc.); (ii) identify ways to reduce the volume of waste by reusing or recycling initiatives (iii) establish technological interventions to capture and removal unwanted materials and sand before entering the water ways i.e., bar screens, sand traps and grit chambers. The following are specific waste management procedures to be implemented: ▪ During earthworks, i.e., excavation, digging pits, quarrying, etc. Contractor shall ensure the top soil is pilled aside at one place, then after finishing the earthwork the top soil shall be used to fill any bare land surfaces around the site. ▪ Plastic and glass bottles (about 9 kg per day) shall be collected into litter bins, and transported to plastic recyclers. ▪ At completion of each day, site shall be left clean and tidy; debris, scrap and spill materials removed. ▪ Biodegradable waste of about 900 kg per day consisting of mainly paper, etc. from offices and open workshop will be disposed by burying ▪ Batteries will be sent to YUASA in Dar es Salaam for recycling ▪ No waste oil will be disposed at the site during construction. Fuel, oils and lubricants (300kg per day) on average from construction machinery and equipment from maintenance workshops, fuelling points etc. will be collected for use in furnaces ▪ Demolition debris will be used during construction as construction aids or distributed to community project and filling of rural roads. Following specific measures shall be implemented where applicable: ***Inert Construction Materials:*** measures listed under impact #6 apply	Environmental Management (Waste Management) Regulations, 2008	RAHCO	50,000,000
		The Contractor and RAHCO shall implement following additional measures to mitigate water pollution from vehicle related activities: ▪ vehicle fuelling stations (in case of their existence at the construction stage) shall be embanked to prevent spread of fuel and pollution of the surrounding area in case of accidental spills; ▪ vehicle wash areas within the garages shall be embanked. For wastewater			

Receptor	Project Aspect/ Potential Direct Impacts	Mitigation Measures/Management Program	Target Level/ Standard	Responsi-bility	Estimated Cost [TZS]
		treatment a primitive treatment facility in the form of concrete covered two-step ditches to prevent discharge of untreated waters in ravines and rivers; ▪ washing of vehicles in river and other surface water object shall not be allowed; ▪ layers of soil polluted by fuel and lubricants spilled from construction machinery shall be removed and transported to the place agreed with the Vice President's Office (VPO), Division of Environment (DoE), Department Natural Resources in advance; ▪ when painting metal constructions, especially metal bridges, tin or other covers shall be placed under the sections to be painted to avoid spill of paints into the surface water objects; ▪ Crossing of the planned railway with water bodies shall be designed in a manner to avoid penetration of pollutants in water bodies. Other wastes ▪ places for toilets within the construction camps shall be selected with consideration of the groundwater levels. ▪ Cesspools shall be covered with cement solution to avoid pollution of groundwater with faeces. ▪ Cesspools shall be emptied on a regular basis in accordance with the number of workers living in the construction camp. ▪ construction waste shall be piled at a distance of at least 50 m from the riverbeds of rivers and ravines prior to disposal to the specially allocated dumpsites; ▪ temporary barriers shall be arranged at the small ravines and gullies to avoid movement of increased volumes of solid materials from the RoW to large ravines and rivers at the construction stage; ▪ the design of shall ensure protection of the groundwater and the river water from pollution			
		Non-hazardous Waste - *mitigation measures listed under impact #6 apply* ▪ Construction camps will be provided with toilet/shower facilities connected to a regularly empting septic tank; ▪ Special waste bins and waste collection system will be introduced to ensure disposal of wastes at landfills; ▪ The concrete wastewater will be collected, processed through a sedimentation tank and neutralized, usually with gaseous CO_2, before their disposal; ▪ Vegetation wastes generated from site clearance during construction can be left on the site only in exceptional cases. They will be transported to the suitable waste management facility;	Environmental Management (Solid Waste Management) Regulations, 2009 Environmental Management (Hazardous	RAHCO	

Receptor	Project Aspect/ Potential Direct Impacts	Mitigation Measures/Management Program	Target Level/ Standard	Responsi-bility	Estimated Cost [TZS]
		Hazardous Waste – mitigation measures listed under impact #6 apply ▪ Reserves of potential polluters will be stored on special insulating bedding and fenced by a berm made of the similar material to retain the polluter in an amount of 10% more than stored. ▪ During operation all stationary construction machinery operating on diesel and petrol will be equipped with a special container to collect leaking fuel for disposal. ▪ Main equipment and vehicles will be fuelled on special insulating bedding wherever possible. ▪ A special attention will be paid to prevention of fuel spills. Special collectors will be installed at the points of potential leakage. Absorbents will be used as well. Fuel will be transported by specially designed fuel trucks. ▪ Collection, treatment and transportation of waste wastes generate at the construction site will be implemented in accordance with the general plan of waste management. ▪ Wastes shall be collected on a daily basis. Waste bins labelled with special signs will be placed on specially allocated points for collection and further disposal of wastes.	Waste Control and Management) Regulations 2008		
Natural environment & biodiversity receptor	Impact #10: Temporary disturbances/flight of aquatic fauna from noise emission	In addition to mitigation listed under Impact # 2, the Contractor and RAHCO shall implement following additional measures: ▪ During the construction phase small supporting enterprises, construction camps, parking and maintenance areas shall be arranged at a considerable distance from the settlements. ▪ If protected species are found, special measures to minimize their disturbance during reproduction and breeding periods will be develop and implemented; ▪ Arrange fences to prevent animals from falling into the trenches. Before filling the trenches make sure that there is no animal there. In general, it will be sufficient to place wooden boards in trenches that will be used by animals for escaping; ▪ Keep old trees near the RoW during the construction works; ▪ After completion of construction works the water courses and forest strips shall be recovered, topsoil shall be reinstated and re-cultivated, shrubbery shall be planted along the RoW. Pipes laid in gorges will play the role of so-called “Green Bridges” for animals.	Environmental Management (Noise and Vibration) Regulations, 2008	RAHCO	The costs are covered under impact #2

Receptor	Project Aspect/ Potential Direct Impacts	Mitigation Measures/Management Program	Target Level/ Standard	Responsi-bility	Estimated Cost [TZS]
SOCIAL IMPACTS					
SITE SELECTION, MOBILISATION AND CONTSRUCTION PHASES					
Acrcheology and Cultural Heritage Receptor	Impact #11 Destruction of archaeological and cultural heritage resources	▪ During implementation of earthworks at the project sites and adjacent areas permanent inspection/monitoring of the archaeologist shall be done ▪ The results of inspection will be reflected in the construction progress report ▪ If cultural/archaeological heritage is discovered or the grounds for assuming its existence are revealed during construction works, RAHCO (or/and its Contractor) is legally bound to stop the activities that bear the risk of damaging cultural heritage and inform in writing the Director of Archaeology and Cultural Resources in the Division for Antiquities, Ministry of Natural Resources and Tourism . The Director has to verify the discovered cultural heritage or the grounds for supporting the discovery and inform RAHCO 9or /and its Contractor) about the verification results in writing no later than in 2 weeks offer receipt of the notification.	Antiquities Act No 10 of 1964	RAHCO	Part of construction costs
Community wellbeing receptor	Impact #12: Change or modification of population and its quality of life due to land take	In order to mitigate impact associated with land take and land use change RAHCO shall implement the following measures, before project implementation begins; ▪ The Project Affected People will be compensated as proposed in the Resettlement Action Plan (RAP) ▪ Ensure user participation at the planning, design, and implementation stages of the project. Consultations with. ▪ Ensure women and other vulnerable groups are not disadvantaged by the project. ▪ Encourage the PAPs to join Village Community Bank (VICOBA) as a way of protecting their money. ***Loss of land and property*** ▪ To minimize the negative effects of the relocation of affected communities RAHCO shall develop a Resettlement and Compensation Plan. RAHCO has developed a preliminary Project Resettlement Framework containing possible mitigation measures ▪ Consultations with the PAPs on the developed relocation program shall be continuously be made. Information on timeframe of the relocation program should be provides. In addition, railway staff should be trained on relocation program if appropriate. ▪ Consultations should be conducted not only with the people that are subject of displacement but also with the host community members. The affected community members should be involved in the decision-making process related to the resettlement process: compensation packages, resettlement assistance,	All PAPs to be compensated for their land and property before the project kicks off	RAHCO	The estimated costs are contained in the CRP

Receptor	Project Aspect/ Potential Direct Impacts	Mitigation Measures/Management Program	Target Level/ Standard	Responsi-bility	Estimated Cost [TZS]
		suitability of proposed resettlement sites and the proposed timing. ▪ In terms of mitigation and reduction of negative impacts from disruption of social relationships and networks while considering resettlement opportunities priority should be given to those areas where the possible resettlement of the whole community/settlement exists. ▪ To address in a timely manner specific concerns that will be raised during the resettlement process Grievance Mechanism should be established at an early stage as possible.			
CONSTRUCTION PHASE					
Welfare, Health & Well-being receptor	Impact 13: Construction health and safety hazards	In order to mitigate these impacts RAHCO should oblige construction company through contractual terms to conduct the following activities: ▪ To develop and implement *Public health and Safety and Construction Health and Safety Plans* - these should address the dust and noise issues. ▪ Where possible erect special fences; provide adequate sheeting of vehicle, ensure loads up until tipping point when moving around the site; use of dust filters on fixed plant and machinery. ▪ The workers should be provided with and require wearing protective special masks especially those workers who are involved in the implementation of dust generating works. ▪ Where possible avoid conduction works during night-time ▪ Develop and implement Grievance Mechanism through which local residents and workers could bring their concerns on the noise and dust caused to the construction. Additional measures include: ▪ Avoid and minimize the pollution and ensure environmental safety of workers and the population all construction equipment is maintained in good running conditions. ▪ Develop and implement Construction Site Management Plan: which will regular watering of relevant sites, especially in dry and windy weather, regular washing of construction machinery and their wheels and use of closed waste containers to ensure additional protection from unpleasant smell ▪ Use of diesel engines in closed spaces shall be restricted within depots and maintenance areas, exhaust mufflers shall be installed on internal boilers and proper ventilation of closed spaces shall be ensured.	OSHA Regulations	RAHCO	20,000,000

Receptor	Project Aspect/ Potential Direct Impacts	Mitigation Measures/Management Program	Target Level/ Standard	Responsi-bility	Estimated Cost [TZS]
Community wellbeing receptor	Impact #14: Temporary disruption of socioeconomic activities	During construction the Contractor shall implement the following measures to mitigate disruption of other socioeconomic activities: ▪ Establish and enforce good site management to limit the construction activities as close as possible to the construction site ▪ Develop and observe best practice - methods of working – e.g., avoid unnecessary noise ▪ Restrict hours of working during day light; ▪ Exercise efficient material handling to minimise vehicle movement ▪ Define access routes to the site, and try to avoid the large port area ▪ Keep trucks and vehicle movements to a minimum possible	As minimum as possible	RAHCO	Part of contract sum
Landscape & Visual Amenity receptor	Impact #15: Loss of aesthetics due to haphazard disposal of demolition waste	▪ Mitigation measures listed under Impacts #6 & 9 apply			
Natural environment and habitants receptor	Impact #16: Nuisance and disturbances from noise/vibrations (exceeding allowable level for people comfort) due to construction activities	▪ Mitigation measures listed under Impact #10 apply			
Community wellbeing receptor	Impact #17: Occupational Health and Security and Safety (HSS) risks	In order to mitigate Occupational and Health safety Hazards the Contractor and RAHCO shall implement the following measures: ▪ Avoid use of faulty equipment, tools and risk practices: Standards and operations and equipment: lifting, electrical isolation/installation, working at heights, manual handling, fitness for work, hand tools, housekeeping, building and office, vehicle and driving, hazardous substances, etc. ▪ Employ trained /qualified and competent Personnel. ▪ Provide appropriate equipment and working condition. ▪ Provide PPEs (to workers and visitors) and enforce their use. ▪ Put in place fall-prevention systems for people working at elevated sites. ▪ Install Signage: post warning signs with appropriate text (local language) and graphics. ▪ Observe standard working hours (8 hours per day) ▪ Secure equipment properly and demarcate any hazardous areas. ▪ Enforce best code of practices at the work place: Observe internationally acceptable Performance Standards on health/safety requirements.	OSHA Regulations	RAHCO	Part of contract sum

Receptor	Project Aspect/ Potential Direct Impacts	Mitigation Measures/Management Program	Target Level/ Standard	Responsi-bility	Estimated Cost [TZS]

		▪ Institute procedures and guidelines, work procedures, inspections and maintenance system,
		▪ Implement in-house health and safety manual /guidelines
		▪ Avoid inadequacies in water and sanitation provisions
		  ▪ The demolition and construction work shall be contracted to class one contractor to avoid unnecessary health risks.
		  ▪ OSHA guidelines on workers safety shall be implemented
		▪ Raise awareness on construction hazards to construction workers.
		  ▪ Use water sprinklers to suppress dust during construction
		▪ Post warning signs with appropriate text (local language) and graphics.
		▪ Workers Code of Conduct with the Community Liaison Plan will be developed and implemented – this will provide rules of conduct while conflict situations; emphasizing cultural characteristics of the local communities if migrants from different cultures enter the area shall be developed. Moreover, workers should be trained in order to ensure that they behave according to the developed Workers Code of Conduct.			

Community wellbeing receptor	Impact #18: Public HSS risks: traffic accidents, Risks of human-human transmission of diseases (STD, HIV, etc.) Infections from putrescible wastes with disease pathogens	In order to mitigate public health and safety hazards, the Contractor and RAHCO shall implement the following measures: ▪ Cooperate with local Civil Society Organizations (CSOs)/public health offices in programmes for reduction/eradication of the diseases and establish worker's health protection procedures (e.g., make available free condoms to workers) ▪ Enforce surveillance measures, e.g., yellow fever vaccination, potential Ebola infection, etc. ▪ Enforce speed limit for vehicles ▪ The construction area shall be isolated with special fences from the settled areas; clear signs should be posted at the entrance to the construction area to ensure that community members will avoid entrance of this area and will be more cautious when passing the construction site Other measures include: ▪ *Public Health and Safety Plan* shall be developed and implemented to mitigate the impacts of the movement of heavy equipment on existing local roads. ▪ *Construction Traffic Management Plan* shall be developed which will allow re-routing of the truck traffic from residential streets or using local roads with fewest homes for transportation of construction materials. ▪ Develop and implement a Grievance Mechanism to facilitate early notifications of any concern from the public	No injuries to the public	RAHCO	Part of contract sum

Receptor	Project Aspect/ Potential Direct Impacts	Mitigation Measures/Management Program	Target Level/ Standard	Responsi-bility	Estimated Cost [TZS]
	Impact #19: Vandalism of structures/equipment, theft of materials and portable items during construction	In order to mitigate vandalism tendencies RAHCO shall implement the following measures: ▪ Strengthen patrol of project construction sites and routes ▪ Strengthen security on construction sites	No theft or vandalism	RAHCO	Part of contract sum
RAILWAY OPERATION					
Water resources receptor	Impact #20: Release of oils and fuels in the aquatic environment	In order to protect the receiving environment against oils and fuels during operation TRL shall implement the following measure: ▪ Fuels and lubricants shall be stored only at designated areas. ▪ Storage of fuel and lubricants shall be kept at least 30m from the edge of the surface waters, e.g., rivers ▪ Refuelling and lubrication of equipment shall be restricted to areas at least 30 m away from the edge of the surface waters ▪ Perform all routine equipment maintenance at least 30 meter away from the edge of the rivers and recover and dispose of wastes in an appropriate manner. ▪ Fixed fuel dispensing locations will be provided with secondary containment to capture fuel from leaks, drips, and overfills. ▪ A supply of sorbent and barrier materials sufficient to allow the rapid containment and recovery of spills shall be maintained at construction site ▪ Conduct regular maintenance and inspections of the locomotives to reduce the potential for spills or leaks.	Environmnetal Management (Water Quality Standard) Regulations 2007	TRL	Normal Operation and Maintenance of TRL
Air quality receptor	Impact #21: Impairment of local air quality	Mitigation measures listed under Impact #4 & 8 apply Other mitigation measures include: ▪ Proper maintenance of trains, rails and wheels; ▪ Speed of trains may be restricted when passing the sensitive areas; ▪ Supporting structures may be constructed along the railway track which will play a role of acoustic screens.	Environmental management (Standards for Control noise and vibration pollution) Regulations 2011	RAHCO	100,000,000 per year
Welfare, Health & Well-being receptor	Impact #22: Occupational and Public health and safety during operation	In addition to mitigation measures under Impact #17, TRL shall implement the following measures to reduce risks of worker accidents during rail operations: ▪ Develop and implement a *Safety Program* in accordance with the international norms. ▪ Ensure that every manager and worker receives training before they perform any work on the line, and are provided refresher training at least every year thereafter. This applies to temporary workers as well.	OSHA Regulations	TRL	20,000,000 per year

Receptor	Project Aspect/ Potential Direct Impacts	Mitigation Measures/Management Program	Target Level/ Standard	Responsi-bility	Estimated Cost [TZS]
		▪ Train workers in personal track safety procedures ▪ Block train traffic on lines where maintenance is occurring (green zone working) or if blocking the line is not possible use an automatic warning system ▪ Segregation of stabling, marshalling and maintenance areas from running lines. ▪ Railway workers should schedule rest periods at regular intervals and during the night to the extent feasible, to maximize the effectiveness of rest breaks and in accordance with international standards and good practices for work time in order to avoid fatigue of workers and accidents invoked by this.			
Welfare, Health & Well-being receptor	Impact #23: Potential loss of lives and property as a result of falling off from moving train, collision with train at road crossing as a result of increased train frequencies	To avoid, minimize and control the risks associated with railway operation including railway crossings the RAHCO and TRL shall implement the following measures: ▪ Use of bridges or tunnels is recommended. ▪ If level crossings are unavoidable, signals shall be installed and their regular inspection/maintenance provided. ▪ Increase the security at all railway stations ▪ Continuously provide awareness campaign to inform passengers on the dangers of boarding or disembarking train while the train is moving. ▪ TRL will develop and implement a *Safety Program* in accordance with the international norms. Underpasses or level crossings should be developed based on the consultations with the public and representatives of local government. ▪ Post visible warning signs at potential points of entry to track areas. ▪ Fencing or other barriers should be installed at station ends and other locations to prevent access to tracks by unauthorized persons. ▪ Stations should be designed in such a way to ensure that the authorized route is safe, clearly indicated and easy to use. ▪ In addition awareness raising campaign should be conducted in the area for the local public to provide them relevant information and increase their awareness on the risks of trespassing.	OSHA Regulations Zero accident	TRL RAHCO	20,000,000 per year
Welfare, Health & Well-being receptor	Impact #24: Additional pressure and demands on local social services and resources (increase water users, toilet users)	RAHCO shall implement the following measures ▪ Ensure there enough toilets and washrooms at all stations ▪ Ensure availability of clean water at all stations ▪ Construct passenger waiting room ▪ Provide areas for canteen operation	Adequate numbers and quantities	TRL RAHCO	100,000,000

Receptor	Project Aspect/ Potential Direct Impacts	Mitigation Measures/Management Program	Target Level/ Standard	Responsi-bility	Estimated Cost [TZS]
Welfare, Health & Well-being receptor	Impact #25: Vandalism of structures/equipment, theft of materials and portable items	In order to mitigate vandalism tendencies RAHCO shall implement the following measures: ▪ Strengthen patrol of the railway infrastructure ▪ Work with village leadership to get their cooperation to guard the infrastructure ▪ Strengthen community outreach and Corporate Socio Responsibility programmes			
NATURAL, ACCIDENTAL AND ANTHROPOGENIC EVENTS					
Water and land resources receptor	Impact #26: Physical damage of project structures and disruption of railway operations and schedules due to natural causes	This project is aimed at mitigating recurrent flood risk as such efforts should be made to implement it In order to protect the environment from natural or accidental events RAHCO shall implement the following mitigation measures: ▪ RAHCO should develop a disaster management program. The main tasks of this programme are: ✓ Introduction and systematic use of methods for analyzing, evaluating and predicting the risks of disasters in practice; ✓ Improve the management and coordination activities for the reduction of disaster risk and increase the resilience of sites of critical infrastructure; ✓ Establishment of an early warning system and notification of disasters; ✓ Improving the quality of management, organization and technical provision of the single rescue system; ✓ Development of systems for seismic surveys and monitoring of water basins and rivers; ✓ Improving the system for training of managerial staff for disaster response; ✓ Public education using modern technologies and media to form a culture of safe life activity.	Minimum or no damage	RAHCO	Const are included in the project costs. For additional measures 50,000,000 for developing a disaster management programme
Natural Environment & Biodiversity receptor	Impact #27: Impairment of environmental quality due to accidental events	RAHCO in collaboration with TRL shall implement the following measures: ▪ Carry out continuous research and monitoring to determine the reasons for and reduce the risk of freight train derailment – e.g., the probability that a train will be involved in a derailment is a function of the quality of track, the length of train, and exposure in terms of distance travelled etc. ▪ Implement rail operational safety procedures aimed at reducing the likelihood of train collisions, such as a positive train control (PTC) system. ▪ Conduct regular inspection and maintenance of rail lines and facilities to ensure track stability and integrity in accordance with national and international safety standards. ▪ Implement an overall safety management program that is equivalent to			

Receptor	Project Aspect/ Potential Direct Impacts	Mitigation Measures/Management Program	Target Level/ Standard	Responsi-bility	Estimated Cost [TZS]
		internationally recognized railway safety operations. For example, the Safety Management System published by the Safety Management in Railways group of the International Union of Railways (IUR). **Accidents related to the transportation of dangerous goods** ▪ TRL should develop and implement a system for the proper screening, acceptance and transport of dangerous goods. ▪ RAHCO should develop spill prevention and control, and emergency preparedness and response plans and ensure its implementation. ***Vegetation*** ▪ TRL and RAHCO should develop and implement a system to rehabilitate areas of damaged vegetation as a result of railway accidents (oil spills, destruction of the soil horizon, etc.) along with implementation of the Emergency Response Plan. ▪ Conduct regular training of the relevant employees for preparedness and timely and effective response to emergency situations.			
Natural Environment & Biodiversity receptor	Impact # 28: Impairment of railway operations as a result of flooding of Gombe Dam	RAHCO shall continuously liaise with operator of the Gombe Dam to ensure that the dam is effectively managed to ensure it does not flood beyond its boundaries	The flood does not extend beyond the boundaries of the dam	RAHCO	5,000,000 per year
Social Impacts					
Welfare, Health & Well-being receptor	Impact #29: Increased train frequencies and therefore smoothen passenger and cargo movement	In order to enhance the benefits that will result from the implementation of this project TRL and RAHCO shall ▪ Invest in other infrastructure and operational requirements such as procuring more wagons and more engines, improving welfare of workers etc.	At least one passenger train per day to operate from Dar es Salaam and One from Kigoma and Mwanza	RAHCO TRL	
Built environment receptor	Impact #30: Protection of roads from heavy cargo as is the current practice	In order to improve the usage of railway system to transport cargo instead of roads the following mitigation measure should be considered: ▪ Tanzania should make it mandatory to transport heavy cargo with railway system instead of using road			
Welfare, Health & Well-being receptor	Impact #31: Increased income to local suppliers	In order to enhance the benefits that may result from procurement of construction materials and other services from local business people the following measures may be implemented:			

Receptor	Project Aspect/ Potential Direct Impacts	Mitigation Measures/Management Program	Target Level/ Standard	Responsi-bility	Estimated Cost [TZS]
		▪ RAHCO and TRL will develop a plan aiming at providing opportunities, where possible, for procurement contracts with local companies in the context of all areas of service requirement during construction and operation			
Welfare, Health & Well-being receptor	Impact #32: Employment opportunities	In order to enhance the employment benefits the following measures may be implemented: ▪ RAHCO and TRL will develop and implement a Local Workforce Recruitment Plan aiming at providing opportunities for employment of local workforce. ▪ Information with regard to construction recruitment will be comprehensively and timely communicated to the local community members by contractors.			
	Impact #33: Increased income and improved or livelihoods as result of increased agricultural production, trading activities, and movement of people within the region and bordering countries	Measures under Impact #29 will apply.			
	Impact #34: Improved comfort of passengers as a result of increased train frequencies	Measures under Impact #29 will apply.			
Landscape & Visual Amenity receptor	Impact #35: Improved quality of the landscape features and appearance of the river embankments	▪ River embankment protection will be implemented as planned			
Natural Environment & Biodiversity receptor	Impact # 36: Improved flood management emanating from proper operation of the Gombe Dam	▪ Mitigation measures under Impacts # 28 apply			

Source: Environmental Impact Statement

13.1.9 Monitoring Plan

Table 13.12 shows the Environmental/Social Monitoring Program (ESMoP).

The project proponent, RAHCO, has sole responsibility on implementation of the ESMoP. RAHCO shall supervise and monitor components of the monitoring plan and keep records of the monitoring outcome.

Table 13.12: Environmental/Social Monitoring Program

Potential Impact	Parameter to be monitored	Monitoring frequency	Monitoring areas	Measurement units	Target level or standard	Responsible party	Estimated Cost TZS
Mobilisation							
Impact #1: Land disturbances/soil erosion at onsite and offsite location	Rills and gullies (visual observation of soil erosion) Sediments in receiving water bodies	Once every six months	Project site	None mg/l	No erosion None	RAHCO	10,000,000 per year
Impact #2: Loss/damage/disturbance of indigenous vegetation and contained biodiversity species	Types of vegetation being cleared Existence of endemic /protected species Area being cleared	Continuously during mobilisation and construction phase	Entire project site	Numbers	No endemic/ protected species cleared Clearance should be restricted to project corridor	Contractor	Part of contract costs
Impact #3: Depletion at point source	Procurement records	Monthly during construction	Point of sourcing and Project site	all procurements from licensed operator	No material from unlicensed supplier, No new borrow pit	RAHCO Environmental Manager	200,000 per month
Impact #4: Impaired air quality & contribution to climate change due to release of dust, greenhouse gases and other noxious air pollutants	CO, NOx, dust	Once every six month	Construction site	mg/l, ppm	NOx = 150 $\mu g/Nm^3$ for 24-hours average value[2] CO = Daily average of hourly values shall not exceed 10mg/kg and average of hourly values in eight consecutive hours shall not exceed 20 mg/kg. Dust (measured as PM10) = 150$\mu g/m^3$	Contractor ELO ECO	1,000,000 per month

[2] Environmental Management (air Quality Standard)Regulation of 2007

Potential Impact	Parameter to be monitored	Monitoring frequency	Monitoring areas	Measurement units	Target level or standard	Responsible party	Estimated Cost TZS
					measured over 24hour average[3]		
Impact #5: Release of oils and fuels in the aquatic environment	Oil contents	Once every six month	Surface water bodies	mg/l	10[4]	RAHCO	500,000 per year
Impact #6: Contamination of surface waters with demolition debris and soils	All types of waste including ▪ Heaps of soils ▪ Plastics wastes ▪ Glass wastes ▪ Turbidity ▪ Suspended solids in receiving water bodies ▪ BOD	Continuous throughout the project cycle	Project site	None NTU mg/l mg/l	No haphazard disposal of waste 300[4] 100 [4] 30 [4]	RAHCO Environmental Manager	500,000per month
Construction							
Impact #7: Land disturbances/soil erosion	Rills and gullies Sediments in receiving water bodies	Once every six months during construction	Project site	None mg/l	No erosion None	RAHCO	2,000,000 per year
Impact #8: Impaired air quality & contribution to climate change due to release of dust (including fugitive (unavoidable, residual), greenhouse gases and other noxious air pollutants	CO, NOx, dust	Once every year during construction	Construction site	mg/l, ppm	NOx = 150 µg/ Nm^3 for 24-hours average value[5] CO = Daily average of hourly values shall not exceed 10mg/kg and average of hourly values in eight consecutive hours shall not	Contractor ELO ECO	1,000,000 per month

3 USA National Air Quality Standard
4 Environmental Management (Water Quality Standards) Regulations, 2007
5 TBS - Ambient air quality

Potential Impact	Parameter to be monitored	Monitoring frequency	Monitoring areas	Measurement units	Target level or standard	Responsible party	Estimated Cost TZS
					exceed 20 mg/kg. Dust (measured as PM10) = 150µg/m^3 measured over 24hour average[6]		
Impact #9: Impaired land and water qualities and contained resources from discharge of pollutants (wastes, oily substances etc.)	Oil contents All types of waste including ▪ Heaps of soils ▪ Plastics wastes ▪ Glass wastes ▪ Turbidity ▪ Suspended solids in receiving water bodies ▪ BOD	Once every year during construction	Surface water bodies	mg/l NTU mg/l mg/l	10[7] 300[31] 100 [31] 30 [31]	RAHCO	1,000,000 per year
Impact #10: Temporary disturbances/flight of aquatic fauna from noise emission	Noise levels	Once month after commencement of construction	Project site	dB	<85 dB[8]	RAHCO Environmental Manager	1,000,000
Impact #11: Destruction of archeological and Cultural heritage resources	No. of discoveries	Continuously	Project site	Number	All discoveries should be reported	RAHCO Contractor	12,000,000 per year
Impact #12: Change or modification of population and its quality of life due to land take	Existing of land related conflicts Types of land use	Continuously	All villages along the project corridor	Number of conflicts	Zero	RAHCO	500,000 per six months
Impact #13: Construction health and safety hazards	▪ Personnel health records ▪ Noise levels ▪ Concentration of pollutants such as	Once every year	Project site	None dB ppm numbers	 Noise = <85dB Dust = Not to exceed	RAHCO OHS Officer	5,000,000 per year

[6] USA National Air Quality Standard
[7] Environmental Management (Water Quality Standards) Regulations 2007
[8] Environmental Management (Noise and Vibration Management and Control) Regulations of 2007

Potential Impact	Parameter to be monitored	Monitoring frequency	Monitoring areas	Measurement units	Target level or standard	Responsible party	Estimated Cost TZS
	dust in the working environment ▪ Number injuries				250 mg/Nm^3 (24h mean value)[9] Zero injuries		
Impact #14: Temporary disruption of socioeconomic activities	Existence of complaints	Continuously during construction	Entire project site	Number of complaints	As minimum as possible	Contractor RAHCO	Included in impact #11
Impact #15: Loss of aesthetics due to haphazard disposal of demolition waste	All types of waste including ▪ Heaps of soils ▪ Plastics wastes ▪ Glass wastes ▪ Turbidity ▪ Suspended solids in receiving water bodies ▪ BOD	Continuous throughout the project cycle	Project site	None NTU mg/l mg/l	No haphazard disposal of waste 300[31] 100 [31] 30 [31]	RAHCO Environmental Manager	500,000per month
Impact #16: Nuisance and disturbances from noise/vibrations (exceeding allowable level for people comfort) due to construction activities	Noise levels	Once month after commencement of construction	Project site	dB	<85 dB[10]	RAHCO Environmental Manager	Covered under #10
Impact #17: Occupational Health and Security and Safety (HSS) risks	Incidences of breach of health and safety	Continuously	Project area	Number of incidence	Zero	RAHCO	3,000,000 per year
Impact #18: Public HSS risks: traffic accidents, Risks of human-human transmission of diseases (STD, HIV, etc.) Infections from putrescible wastes with disease pathogens	STDs HIV/AIDS infections Cholera	At the beginning of the project and once every year	hospital/dispensary	Number of people infected	No or as minimum infectious cases	District Medical Officer	2,000,000 per year

[9] Environmental Management (Air Quality Standard) Regulation of 2007
[10] Environmental Management (Noise and Vibration Management and Control) Regulations of 2007

Potential Impact	Parameter to be monitored	Monitoring frequency	Monitoring areas	Measurement units	Target level or standard	Responsible party	Estimated Cost TZS
Impact #19: Vandalism of structures/equipment, theft of materials and portable items during construction	Destroyed infrastructure and loss of equipment	Continuously during construction phase	Construction site and stores	Number of theft incidences	No or minimum vandalism cases	RAHCO	10,000,000
Railway Operation							
Impact #20: Release of oils and fuels in the aquatic environment	Oil contents	Once every six month	Surface water bodies	mg/l	10[11]	RAHCO	
Impact #21: Impairment of local air quality	CO, NOx, dust	Once every six month	Construction site	mg/l, ppm	NOx = 150 µg/ Nm^3 for 24-hours average value[12] CO = Daily average of hourly values shall not exceed 10mg/kg and average of hourly values in eight consecutive hours shall not exceed 20 mg/kg. Dust (measured as PM10) = 150µg/m^3 measured over 24hour average[13]	Contractor ELO ECO	1,000,000 per month
Impact #22: Occupational and Public health and safety	▪ Personnel health records ▪ Noise levels ▪ Concentration of pollutants such as dust in the working	Once every year	Project site	None dB ppm numbers	Noise = <85dB Dust = Not to exceed 250 mg/Nm^3 (24h mean value)[14]	RAHCO OHS Officer	

[11] Environmental Management (Water Quality Standards) Regulations, 2007
[12] Environmental Management (Air Quality Standard) Regulation of 2007
[13] USA National Air Quality Standard
[14] Environmental Management (Air Quality Standard) Regulations of 2007

Potential Impact	Parameter to be monitored	Monitoring frequency	Monitoring areas	Measurement units	Target level or standard	Responsible party	Estimated Cost TZS
	environment ▪ Number injuries				Zero injuries		
Impact #23: Potential loss of lives and property as a result of falling off from moving train, collision with train at road crossing as a result of increased train frequencies	Reported cases of such injuries	Once every month	Railway stations	Number	Zero	TRL RAHCO	500,000 per year
Impact #24: Additional pressure and demands on local social services and resources (increase water users, toilet users)	Number of toilets at each station Incidences of open defecations	Once at the beginning of operation and then one year and availability of clean water Continuously	Railway stations	Number of functioning toilets Clean water Signs of open defecation	As many as possible No open defecation	TRL RAHCO	500,000 per year
Impact #25: Vandalism of structures/equipment, theft of materials and portable items	Reported cases of vandals	Continuously	Entire project	Reported cases	No or minimum vandalism cases	TRL RAHCO	500,000 per year
Impact #26: Physical damage of project structures and disruption of railway operations and schedules due to natural causes	Physical strength of impacted structure Visual monitoring of soil erosion along the unpaved project areas and river banks	Once every year	Project site	None	No structure weakness	Contractor RAHCO	5,0000,000 per year
Impact #27: Impairment of environmental quality due to accidental event	Vegetation Oil contamination	Immediately after accident and once every six months	Site of accident	Decontaminated soils and plants mg/l	10[15]	TRL	5,000,000 per year
Impact # 28: Impairment of railway operations as a result of flooding of Gombe Dam	Flooding tendencies	Continuously during rainy season	Gombe Dam Area	Visual	Floods should not extend beyond the dam boundaries	RAHCO	5,000,000 per year

[15] Environmental Management (Water Quality Standards) Regulations, 2007

Potential Impact	Parameter to be monitored	Monitoring frequency	Monitoring areas	Measurement units	Target level or standard	Responsible party	Estimated Cost TZS
Impact #29: Increased train frequencies and therefore smoothen passenger and cargo movement	Train frequencies	Once every year	TRL Head Quarters	Number	At least one passenger train per day	TRL	0
Impact #30: Protection of roads from heavy cargo as is the current practice	Cargo tonnage transported by train	Once every year	TRL Head Quarters	Tonnage	At least 80% of cargo is reported by train by 2019	TRL	0
Impact #31: Increased income to local suppliers	Supplies and services received from the residents	Monthly	Procurement supply list	Number of supplies and services from the residents	As many supplies and services from the residents	Procurement manager	0
Impact #32: Employment opportunities	Number of residents employed	Every year	Employed employees	Number of employees	As many tenant employees as possible	RAHCO	0
Impact # 33: Increased income and improved or livelihoods as result of increased agricultural production, trading activities, and movement of people within the region and bordering countries	Incomes of local people in the project area	Once every year	Affected villages	Per capita income	National per capita income average	RAHCO	10,000,000 per year
Impact # 34: Improved comfort of passengers as a result of increased train frequencies	Passenger perception	Once (six months after commissioning of the project sections)	Affected villages	Perception	Positive perception	RAHCO	5,000,000
Impact # 35: Improved quality of the landscape features and appearance of the river embankments	Landscape	Once after completing the construction work	The project area	Visual appearance	Attractive visual appearance	RAHCO	2,000,000
Impact # 36: Improved flood management emanating from proper operation of the Gombe Dam	Flooding tendencies	Continuously during rainy season	Dam area	Over flooding	No flooding beyond the border of the dam	RAHCOO	5,000,000 per year

Source: Environmental Impact Statement

13.1.10 Stakeholder Meetings for EIA

(1) The First Meeting

Outline

In accordance with the Environmental Management Act and JICA Guidelines, the first series of stakeholder meetings were held in the villages along the railway in the study area. The meetings aimed to involve local communities at an early stage such as to collect necessary information for the EIA study and encourage local participation into the mitigation measures for possible environmental and social impacts.

The meeting was held in six villages in the Kilosa–Gulwe section and three villages in the extended project section to Dodoma (Table 13.13). In the Kilosa–Gulwe section, the meetings basically consisted of two sessions: the first was for village leaders and the second was for the village assembly. Participants in the first session included about 20–30 representatives in each village including village council members, ward officers, elders, religious leaders, women committee members, members of youth groups, security officers, political leaders, and so on. After the first session, the results were presented in the village assembly, in which about 100 villagers participated at each meeting to collect comments from the villagers.

The schedule of the village assembly was informed through village leaders and networks among villagers. As representatives from women's committee were invited for each village leader's meeting, participation of women was secured in all of the meetings and the village assemblies.

Table 13.13: Outline of the First Stakeholder Meetings (8–12 June 2015)

Date	Village name (Ward and District name)	Village information: km post	Village information: Status of the station	Village information: Accessibility by car	Number of participants: Leaders' meeting	Number of participants: Village assembly
8 June	Mkadage (Magomeni, Kilosa)	286	No station	No access	47	
9 June	Munisagara (Msanze, Kilosa)	298	Closed	No access	25	72
	Mzaganza (Kidete, Kilosa)	311	Closed	No access		140
10 June	Kikundi (Kidete, Kilosa)	316	No station	No access	24	80
	Godegode (Godegode, Mpwapwa)	349	Closed	Available	25	98
11 June	Gulwe (Gulwe, Mpwapwa)	366	Operational	Available	31	87
12 June	Musagali (Chunyu, Mpwapwa)	382	Closed	Available	18	-
	Igandu (Igandu, Chamwino)	402	Closed	Available	21	-
	Ihumwa (Mtumba, Dodoma)	439	Closed	Available	20	-

Note: Village assemblies were not planned in Musagali, Igandu and Ihumwa as they are out of the main project area.
Source: JICA Study Team

Results

The possible positive and negative impacts by the project were raised by the participants responding to the facilitator's question (Table 13.14). As a positive impact, expectations for job opportunities for the construction works and railway operation were raised at almost every village. On the other hand, some negative concerning was also raised such as compensation for resettlement and sexual disease/HIV effects. Those concerns were addressed in the mitigation plan in the EIA.

Apart from the project impacts, participants expressed various requests related to the project; for example, flood protection for agricultural land in addition to the railway, and improvement of train service and road infrastructure (Table 13.15). Although most of them are out of the scope of this project, their requests shall be noted for possible future plans.

Table 13.14: Positive and Negative Impacts Raised in the Meetings

Subjects	Raised Issues		Response
Positive impacts	1)	Job opportunities for construction and train operation. It should be prioritized to the local villagers.	The contractor is to be coordinate with the local government closely and prioritize the job opportunities to the villagers considering equal distribution through the village government.
	2)	Improvement of the railway service for transporting agricultural products.	-
	3)	Protection of the agricultural land and people's properties from flood, not only the railway.	The project aims to protect the railway, not the agricultural land and people's properties.
	4)	Economic growth of the villages/villagers.	-
Negative impacts	5)	House relocation and land acquisition. It should be compensated properly.	Addressed in the CRP.
	6)	Sexual diseases such as HIV and marriage destruction caused by inflow of construction workers. Education is necessary for both community and workers.	Addressed in the mitigation plan.
	7)	OHS (Occupational Health and Safety)/ worker's insurance	Addressed in the mitigation plan.
	8)	Students may leave their studies to seek employment.	Addressed in the mitigation plan.
	9)	Environmental degradation such as deforestation and pollution such as dust.	Addressed in the mitigation plan.
	10)	It is concerned that the culvert improvement might affect downstream agricultural land by the increased flood flow (Igandu).	To be addressed in the culvert improvement planning at Igandu.

Source: JICA Study Team

Table 13.15: Requests to RAHCO/the Government and TRL

Topics	Requests		Villages	Response
Flood protection measures	1)	Kidete Dam should be renovated as the first priority for protecting both agricultural land and the railway from flood.	Mkadage, Mzaganza Kikundi	Flood flow prevention shall be addressed in future project such as watershed management project.
	2)	Flood flow from Kibakwe should be prevented for the same reason as above.	Godegode	
	3)	Flood flow from Kimagai and Kidete Dams should be prevented for the same reason as above.	Gulwe	
	4)	Flood flow from Bujuku and Maschilo should be considered	Musagali	
	5)	Number of culvert under the railway needs to be increased to discharge flood flow from agriculture land (near Musagali Station).	Musagali	To be addressed in the future improvement plan.
Irrigation	6)	Reserving water is necessary at the same time with flood protection.	Musagali	To be noted for the future development.
Train services/ operations	7)	Existing station to be operated and rehabilitated.	Munisagara, Mzaganza Godegode, Musagali Igandu	To be noted for TRL.

Topics	Requests		Villages	Response
	8)	A station to be built in the village.	Mkadage, Kikundi	To be noted for the future development.
	9)	Trolley or small train to be operated for local transportation.	Mkadage, Mzaganza	To be noted for TRL.
	10)	Train operation to be regulated more strictly for safety control. (e.g., speed limitation, sounding phone more frequently)	Munisagara, Igandu	To be noted for TRL.
	11)	Communication system needs to be improved to find the flood disaster points on the railway.	Musagali	To be noted for TRL.
Side road	12)	The road along the railway to be improved for securing safety and local transportation.	Mkadage, Munisagara Mzaganza, Kikundi	To be discussed the possibilities.
	13)	Temporary road for construction to be utilized for local transportation after the construction.	Mzaganza	
	14)	After relocating the railway, the existing railway location to be utilized for a local road. Existing bridge and culvert to be maintained after the relocation.	Munisagara, Kikundi	
Crossing road	15)	Roads to cross the railway (with livestock) to be built.	Mkadage, Munisagara Mzaganza, Igandu Ihumwa	Underpass is to be planned in this study for the section of railway embankment.
	16)	The existing culvert needs to be improved not only for flood protection but also for crossing the railway.	Igandu	

Source: JICA Study Team

(2) The Second Meeting

Outline

The second series of the meetings were held in order to provide feedback of the EIA results to the local stakeholders. The meetings were held at five villages with participants from six villages which would be affected by the project, especially by the railway rerouting. It was called for the village leaders as shown in Table 13.16 including women leaders.

Table 13.16: Outline of the Second Stakeholder Meetings (22–24 February 2016)

Date	Village name (Ward and District name)	Participants	Number of participants Total	(Women)
22 Feb.	Munisagara (Msanze, Kilosa)	Village Executive Officer (VEO), village chairman, village council members, sub-village leaders	18	(5)
	Mzaganza (Kidete, Kilosa)	VEO, village chairman, village council members, sub-village leaders, secretary of political party, teacher	16	(3)
23Feb.	Kikundi (Kidete, Kilosa)	Ward Executive Officer(WEO), VEO, village chairman, village council members, sub-village leaders, elder	12	(2)
24 Feb.	Gulwe (Gulwe, Mpwapwa)	WEO, ward councilor, VEO, village chairman, village council members, sub-village leaders, village land officers, teacher, nurse, TRL staff	20	(8)
	Godegode (Godegode, Mpwapwa) Kisisi (Godegode, Mpwapwa)	WEO, VEO, village chairman, village council members, sub-village leaders, village health officer, party leader, elders	20	(7)

Source: JICA Study Team

Results

During the meetings, the entrusted consultant explained the major points of the ESMP including responses to the comments at the first meetings. After that, the participants made questions/comments and the consultant and RAHCO answered (Table 13.17). Through the meetings, the results of the ESMP were well accepted and the understandings on the project were encouraged among the participants. It was agreed by the participants to explain the meeting results to the other villagers.

Table 13.17: Questions/Comments and Response in the Meeting

Questions/Comments		Response
1)	The service of local shuttle trains (pick-up train - locally known as “punguza”) should be re-established to serve communities located away from the existing main railway stations and who haven’t any other means of reliable transport. (Munisagara)	The plans will be put in place to resume the services of the shuttle train during operation phase.
2)	It is concerned that heavy truck and equipment will be used during construction phase and will cause environmental degradation particularly to the existing flora and fauna. (Kikundi)	Appropriate mitigation measures have been put in place to mitigate all environmental impacts including degradation of existing flora and fauna in the project area.
3)	Is the EMP applied for the existing construction work for the flood damage this year? (Kikundi)	The proposed EMP is for the JICA project.
4)	Is it possible for constructing a school and a dispensary at the relocation site? (Kikundi)	As far as they are not affected, the new facilities are not planned.
5)	Is the 30 m distance away from the water source enough to avoid water pollution by the construction works specified in the EMP? Is it legal? (Kikundi)	It is legally acceptable and seems to be enough.
6)	Pathway for livestock keepers is requested for crossing the new track. (Gulwe)	Culverts will be prepared with enough size for livestock to cross the rail.

Questions/Comments	Response
7) Is there any physical properties left for village use after project construction phase? (Gulwe)	The camp site might be left for village use at the end of construction phase, but this will be discussed and agreed at the end of project implementation. Also livelihood restoration shall be provided to the affect people.
8) Flood measure at Mzase River is necessary. (Gulwe)	Already planned.
9) Will the village land be compensated if it is affected? (Gulwe)	Yes it will.
10) There might be conflict between Contractor and village government on issue of payment of village levy for construction materials. (Gulwe)	Contractor shall abide and follow all local government by-laws and regulation including the payment of all relevant levy. Contractor shall also source construction materials at authorized areas in order to avoid conflicts with local communities and environmental degradation.
11) Road damage by the heavy construction materials is concerned. (Gulwe)	Construction access road will be prepared. If the village road is damaged, the contractor is to be responsible for repairing.
12) Is there any regulation for paying tax for the material procurement? (Gulwe)	Is should be consulted with the local government in accordance with the regulation.
13) It is necessary to collaborate between contractor and the local people in order to secure the environmental and social management. (Gulwe)	-
14) The construction access road is requested to be left for public use. (Godegode/Kisisi)	It will be left.
15) Pollution of water source by the construction is concerned. (Godegode/Kisisi)	It will be managed by the EMP and EMoP.
16) There is water scarcity in Godegode village, thus requested the Contractor to be engaged to build water well as compensation for taking construction materials within the village area. (Godegode/Kisisi)	The village government should discuss and see the possibility of this matter with the Contractor prior to commencement of the construction works.
17) Accident is concerned because of the shortage of medical facilities and staffs. (Godegode/Kisisi)	Safety management plan will be prepared to prevent accidents.

Source: JICA Study Team


Meeting with village leaders
In the first meeting


Village assembly
In the first meeting


Meeting with village leaders
In the second meeting

Source: JICA Study Team

Figure 13.7: Stakeholder Meetings for the EIA

13.2 Compensation and Resettlement Plan

13.2.1 Necessity of Resettlement

The following project components will cause resettlement.

(1) Rerouting

In accordance with the Railway Act (2002), “railway strip” which means ROW is defined as land adjacent to the railway track reserved to facilitate future development of rail infrastructure. In this strip, a person shall not erect any building or structure or execute any works without written permission of RAHCO. The act also defines the width of the strip as fifteen meters in urban area and thirty meters in rural area from the center line of the track. Based on the act, it is necessary to acquire the land for thirty meters of both sides of the newly rerouted railway tracks.

As explained in Subsection 8.6.2 and 13.1.4, the rerouting course was selected to minimize the house relocation by comparing Alternative A-1, B-1, and C-1 versus A-2, B-2, and C-2. However, not all of the residential areas were avoidable and the agricultural land would be affected.

(2) River-Training Works

Excavating a new channel at Maswara River will directly affect the agricultural land in the flood plain. However, no house relocation is required.

Training works at Mzase River will not affect either agricultural land or housing structures as the location is bare land and not used for any such purpose.

13.2.2 Legal Framework for Compensation and Resettlement

The Tanzanian legal framework for land acquisition and Compensation and Resettlement Plan (hereinafter referred to as “CRP”) is summarized in Table 13.18.

Table 13.18: Tanzanian Legal Framework for Land Acquisition and Resettlement

Types	Name of policies/laws
National Policies	National Land Policy, 1997
	National Environmental Policy, 1997
	National Human Resettlement Development Policy, 2000
	TASAF III Resettlement Policy Framework, 2012
Legal Framework	The Land Act, 1999
	The Land (Amendment) Act, 2004
	The Village Land Act, 1999
	The Land Acquisition Act, 1967
	The National Land Use Planning Commission Act (No. 3), 1984
	Urban Planning Act, 2007
	Graves (Removal) Act, 2007
	Local Government (District Authorities) Act
	Local Government (Urban Authorities) Act
	Land (Forms) Regulations, 2001
	Land (Assessment of the Value of Land for Compensation) Regulations, 2001
	Land (Compensation Claims) Regulations, 2001
	Land (Management of the Land Compensation Fund) Regulations, 2001
	The Village Land Regulations, 2001
Guidelines	Road Sector Compensation and Resettlement Guidelines, 2009

Source: JICA’s Tanzanian Environmental and Social Consideration Profile, Sept. 2011, with updated revisions by JICA Study Team

(1) Summary of Relevant Policies and Regulations for Social Considerations in Tanzania

Tanzanian main laws and regulations on land acquisition and compensation and resettlement plan procedures, can be summarized as below.

The Land Acquisition Act, 1967

The Land Acquisition Act, 1967 is the principal legislation insofar as land acquisition is concerned. The provisions of Section (1) draw attention to the requirements of the Constitution: *"Subject to the provision of this Act, where any land is acquired by the President under Section 3, the Minister shall on behalf of the Government pay in respect, thereof, out of moneys provided for the purpose of the Parliament; such compensation as may be argued upon or determined in accordance with the provision of this Act."*

The most common instruments which the state has and can apply to access land are: negotiations and persuasion, legalized force, and compulsory acquisition. The latter is normally effected through the power of "eminent domain". This gives the state powers to expropriate private property for public use without necessarily seeking the owners' consent. However, this is subject to payment of fair and prompt compensation. Compulsory land acquisition involves four key steps, namely: (i) planning and the decision to acquire land, (ii) legal preliminaries, including getting statutory authority and serving notices, (iii) field investigations, including valuation, and (iv) payment of compensation to those being dispossessed.

Normally it is the local or central government that initiates the process of land acquisition for public use. Valuation of land and other improvements therein is done either by the government or by private companies, but the central government must give approval. While dispossessed households are entitled to fair and prompt compensation, the allocation of alternative land for resettlement is not a right, but is instead at the discretion of the government or any other institution involved in the acquisition of land for public use. In the Tanzanian context, the provision of alternative land in an appropriate location seems to be a key pre-condition not only for restoring land occupiers to the situation they were in before the acquisition of their land for public use, but also for promoting sustainable use of environmental resources on which the survival of urban settlers depends.

The Land Act (No. 6), 1999

The current basic law in effect in relation to land can be identified as the Land Act (No. 6), 1999, excluding village land management, settlement of disputes and related matters. The Act relates to land-use planning processes, land-use management, and guidance to landownership in Tanzania. The law vests all land in the name of the President, empowering him to grant occupancy rights to individuals, legal persons and territorial communities. The President is and empowered to revoke the "Right of Occupancy" of any landholder for the "public/national interest" should the need arise. The President can acquire land for public use and benefit, for instance, to resettle people from densely populated areas to sparsely populated areas, and so forth. The President can also acquire land for other national projects, like railway infrastructure. However, the law declares the value attached to any piece of land and as such any land rights transfer is subject for compensation.

Under the Government Standing Order on expropriation for public utility, the holder of a Right of Occupancy is guaranteed a free enjoyment of the land and is entitled to compensation if dispossessed by the Government for public use. In many cases, whilst the holders agree to leave their land, they are not happy with the amount and delay of the compensation. Often, for example, improvements that they have made to the land are omitted or underrated. The expropriation should match the price that improvements could fetch if sold in the open market. Replacement value (defined as the cost of putting up a structure equivalent to the evaluated one) makes allowances for age, state of repair, and economic obsolescence.

The Village Land Act (No. 7), 1999[16]

This Act was enacted for the purpose of regulating administration and management of land in villages. Under the provisions of the Act, the Village Council[17] is responsible for the management of village land, taking respect of balance in land use, other natural resources development, and environmental preservation, by upholding the principle of sustainable development.

The Land (Assessment of the Value of Land for Compensation) Regulations, 2001

The regulation outlines that the basis for assessment of the value of any land and un-exhausted improvement for the purpose of compensation shall be its market value:

(a) The asset evaluation related to land and accommodated properties, shall be based on market value.
(b) The market value of land and accommodated properties, shall be set up based on comparative proof, of equivalent land's recent actual selling price, by income approach, or by replacement cost method.
(c) In terms of payment by the government or by the local authority in charge, the land and all the remaining value identified, must be confirmed by the administrative auditor or by the competent representative in charge.
(d) If compensation is not paid promptly, and payment of interest rate may become an additional obligation, then the government or the local authority in charge must be held accountable in bearing such cost.
(e) In order to evaluate the interest rate of the compensation payment, "prompt payment of compensation" stated in above item, shall mean, within 6 months, after the subjected land acquisition or after expiration of its land right.
(f) If in case, within 6 months, after the subjected land acquisition or after expiration of its land right, the compensation is not paid, then payment of the interest rate, by adopting the commercial banks' fixed deposit standard rate, until the compensation payment period, shall additionally be paid.

The Land (Allocation Committee) Regulations, 2001

This regulation established a Land Allocation Committee in every District and Urban Authority as well as in the Ministry Headquarters. Allocation of identified resettlement sites to PAPs would ideally be done by the five District's District Land Allocation Committee.

The Land (Compensation Claims) Regulations, 2001

The Regulation sets out the rights and entitlement for one to claim compensation against the Government or local government or any public institution under the Act. The below categorized groups are entitled to put up such a claim:

(a) Based on Article 5 of the Land Act (hereinafter referred to as "the Act"), land title holder of general land transferred into village land, or protected land; based on Article 22 of the

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[16] Extract from and reference to, Working Paper no. 82 –Cities and Fragile States- Land Acquisition for Public Use: Emerging Conflicts and their Socio-Political Implications, Wilbard Kombe, ARDHI University, Oct. 2010
[17] Based on article 25 of the Local Government (District Authorities) Act, 1982, all villages are obligated to set up each Village Council.

Act, land title holder of land, subjected for compulsory land acquisition upon order by the President for the purpose of public use; or based on Article 54 of the Act, land title holder whose land rights are subjected for expiration.

(b) Based on Article 7 of the Act, title holder of awarded customary occupancy rights of the land registered as hazardous land.

(c) Land title holder based on customary occupancy rights, whose subjected land are to be occupied by a third person.

(d) Land title holder awarded or transferred customary occupancy rights, whom have had withdrawn his/her rights based on Article 54 of the Act.

(e) Land title holder of urban area and its surrounding area, whom have had acquired land under order by the President based on Article 60 of the Act.

The Land Management Officer appointed from the Commissioner, or Officer who has competent right, upon implementation of the land acquisition procedure, shall put up a notification at the public bulletin board, and at the same time, notify to all the land title holders, based on below mandated style:

(a) Notify to the land title holders to be subjected for compensation

(b) To request the subjected land title holders to submit a request of compensation

(c) To request the subjected land title holders to attend at the inspection place at the appointed date and time for its assessment

The Land Management Officer or the Officer with the competent power shall conduct the assessment on the compensation amount, required for payment (based on Valuation Form 1 provided by MLHHSD). The Officer in charge shall then draft a compensation payment schedule, and along with the request for compensation form, submit the forms to the Land Compensation Fund (hereinafter referred to as “the Fund”) established under the Act.

(a) The Fund based on the compensation schedule drafted by the Land Management Officer or the Officer with the competent right, must decide within 30 days prior to compensation payment schedule, on the relevancy of the payment.

(b) This regulation applies to all the compensation applications and/or claims to the government, local government, public organizations, and public institutions.

(c) Compensation based on Article 156 of the Act, does not apply to non-governmental organizations or individual entitled with public easement rights.

The payment shall be in monetary payment form. Although in principle, compensation should be in monetary payment form, according to decision by the government, compensation can be provided in the form of all the following, or any of its combination.

(a) In the form of land, equivalent in quality, scale of area and potential productivity, to the land to be lost

(b) In the form of building, equivalent in quality, scale of area, and purpose of usage, to the building to be lost

(c) Plants and nursery trees

(d) Crops and basic food

(2) Social Consideration Related Authorities in Tanzania

Historically, the Ministry of Lands was established as the Department of Lands, and later changed into a full ministry, which changed its name according to its functions at that specific period in time. The current name is Ministry of Lands, Housing and Human Settlements Development encompass core sector Departments which are: Land Administration, Survey and Mapping, Physical Planning and Housing. Core sector units are Registration of Titles, Property Valuation, and District Land and Housing Tribunal. The mandate of the ministry is to facilitate an effective management of land and human settlements development services for the betterment of social and economic well-being of Tanzanian society.

MLHHSD is the sole Ministry in charge of certifying approval of the CRP Report, and if there is no problem with its content, it usually takes merely approximately a week in obtaining approval after submission to the section in charge.

(3) Land Acquisition and Compensation and Resettlement Plan (CRP) Procedure in Tanzania

In reference to the Road Sector Compensation and Resettlement Guideline, 2009, the following steps are taken to fulfill Compensation and Resettlement Plan (CRP) procedural requirements in Tanzania.

Initial (Reconnaissance) Survey

(a) During initial surveys and field trips (on site surveys) undertaken for the EIA Study, discussions should be held with the District administrations to inform about the project and activities, and to ask them what the social impacts of the project are likely to be.
(b) District authorities are often well aware of locations where displacement of people are likely to occur, and can therefore be able to arrange meetings with the ward and village administrations. At the meeting, below items (c) to (g) should be discussed.
(c) The subjected route and its length, possible realignments, municipal rights of way.
(d) The type of improvement works.
(e) Likelihood of persons being displaced or in some way affected by the construction works.
(f) The criteria adopted for eligibility for compensation and resettlement (including possible cut-off-date).
(g) Total project time, from planning to completion, including indication of the time required for the C & R process.

The Ward and Village Administration's Role

(a) Identifying the PAPs and confirming their eligibility.
(b) Identifying and providing land for the relocation of houses and buildings.
(c) Providing assistance to PAPs during the resettlement process and monitoring the progress of the CRP, in particular the status of the resettled persons.
(d) Assisting the formation of a Compensation and Resettlement Implementation Sub-Committee.
(e) To assist the PAP Census and Survey Team, to set up meetings with the local communities.

The PAP Census and Socio-Economic Survey

(a) After alignment has been confirmed, and PAP surveys are about to begin, meetings have to be held again with the District, ward and village administrations to re-affirm above issues and in more detail including below (b) to (d).
(b) Setting of cut-off-date, usually given at the date of completion of the PAP census.
(c) Physical identification of the possible relocation areas within the village or ward.

(d) Prevailing land tenure and transfer systems in the areas to where resettlers may be relocated.

(e) The purpose of the PAP census is to identify each and every project affected party (people as well as private and public institutions). Information collected during the census is typically recorded **Valuation Form 1** provided by the Ministry of Lands.

(f) As a minimum, the following information should be collected during the socio-economic survey, for preparing a **socio-economic profile**; to be able to plan the types of facilities required, as well as the kind of assistance required for the PAPs.

- Household head and Structure
- Household size
- Gender structure
- Age structure
- Ethnicity and religion
- Migratory status
- Occupations of the PAPs
- Income and expenditure
- Education levels
- Health status
- Vulnerable groups; requiring special assistance

Land/ Property Assessment Survey

Information on the property and assets is also collected on Valuation Form 1, including:

(a) Type of property
(b) Details of construction
(c) Accommodation characteristics
(d) Condition of the property
(e) Purpose/use of property
(f) Area of affected buildings/structures (built-up-area)
(g) Types of crops grown
(h) Area of cultivated land affected
(i) Total area of land

Note 1: Though the Form does not explicitly ask for it, information on trees, fences and/or boundary walls, wells, should be included in the survey of assets.
Note 2: The Valuation Form 1 must be signed by the PAP, a representative of the local administration and the land valuer/surveyor.

Consultations with the Authorities and the PAPs

Based on the Road Sector Compensation and Resettlement Guidelines, 2009, consultations with the related Authorities should be held at least in three stages.

The first is during the Initial (Reconnaissance) Survey stage of SIA, also corresponding with the scoping stage of the EIA procedure. Above explained contents of the survey, for example project outline and assumed impacts based on rapid assessment, should be informed to the District, Ward and Village Administrations, as well as for asking in advance, assistance in formation of the Compensation and Resettlement Implementation Sub-Committee, to monitor the CRP process, identification and eligibility, status of the PAPs, to identify and provide the land for the relocation of houses and buildings, and to assistance the PAPs during the resettlement process.

For the PAP Census (and Socio-Economic Survey to be held concurrently) preparation, so that the surveying team will be able to hold the first meetings with the local communities, these meetings should also be arranged by the local Administrations, upon request from the Implementing Sub-Committee. Since a number of critical issues will be discussed here, it is important that there is good representation from local communities at this meeting.

It is important to keep a consultation log, and to have a record of all the consultations. Minutes of the consultations should therefore be drawn up and signed by the local community leaders present, as well as by an official representative from the District, ward or village.

When the Sub-Committee surveying team undertakes the PAP Census and Socio-Economic Survey, information disclosure to the communities, such as an outline of the project, etc. (details described in page 55 of Road Sector Compensation and Resettlement Guideline) must be informed, and the District, Ward and Village Administrations are committed to assist in the CRP process, also (so that the community will recognize that it is an official process).

After the PAP Census, Socio-Economic Survey, and Socio-Economic Profile are compiled, consultations with local Administration, yet again must be held. The agenda for the consultations shall be: (a) to have the Administrations to approve the list of PAPs, and (b) reconfirm on areas to where affected households can be relocated, (c) confirm that the village, ward, District and town Administrations are aware of their specific responsibilities regarding the monitoring of the compensation and resettlement process (please refer to p. 54 of Road Sector Compensation and Resettlement Guideline for further details), (d) discuss and develop grievance redress mechanism that will be most appropriate for the affected communities, and (e) determine existing social networks and social support systems that can help persons affected by the project, and ways in which support can be given.

(4) JICA's Policies on Resettlement

The key principle of JICA policies on involuntary resettlement is summarized below.

I. Involuntary resettlement and loss of means of livelihood are to be avoided when feasible by exploring all viable alternatives.
II. When, population displacement is unavoidable, effective measures to minimize the impact and to compensate for losses should be taken.
III. People who must be resettled involuntarily and people whose means of livelihood will be hindered or lost must be sufficiently compensated and supported, so that they can improve or at least restore their standard of living, income opportunities and production levels to pre-project levels.
IV. Compensation must be based on the full replacement cost as much as possible.
V. Compensation and other kinds of assistance must be provided prior to displacement.
VI. For projects that entail large-scale involuntary resettlement, resettlement action plans must be prepared and made available to the public. It is desirable that the resettlement action plan include elements laid out in the World Bank Safeguard Policy, OP 4.12, Annex A.
VII. In preparing a resettlement action plan, consultations must be held with the affected people and their communities based on sufficient information made available to them in advance. When consultations are held, explanations must be given in a form, manner, and language that are understandable to the affected people.
VIII. Appropriate participation of affected people must be promoted in planning, implementation, and monitoring of resettlement action plans.
IX. Appropriate and accessible grievance mechanisms must be established for the affected people and their communities.

Above principles are complemented by World Bank OP 4.12, since it is stated in JICA Guideline that “JICA confirms that projects do not deviate significantly from the World Bank’s Safeguard Policies”. Additional key principle based on World Bank OP 4.12 is as follows.

X. Affected people are to be identified and recorded as early as possible in order to establish their eligibility through an initial baseline survey (including population census that serves as an eligibility cut-off date, asset inventory, and socioeconomic survey), preferably at the project identification stage, to prevent a subsequent influx of encroachers of others who wish to take advance of such benefits.
XI. Eligibility of Benefits include, the PAPs who have formal legal rights to land (including customary and traditional land rights recognized under law), the PAPs who don't have formal legal rights to land at the time of census but have a claim to such land or assets and the PAPs who have no recognizable legal right to the land they are occupying.
XII. Preference should be given to land-based resettlement strategies for displaced persons whose livelihoods are land-based.
XIII. Provide support for the transition period (between displacement and livelihood restoration.
XIV. Particular attention must be paid to the needs of the vulnerable groups among those displaced, especially those below the poverty line, landless, elderly, women and children, ethnic minorities etc.
XV. For projects that entail land acquisition or involuntary resettlement of fewer than 200 people, abbreviated resettlement plan is to be prepared.

In addition to the above core principles on the JICA policy, it also laid emphasis on a detailed resettlement policy inclusive of all the above points; project specific resettlement plan; institutional framework for implementation; monitoring and evaluation mechanism; time schedule for implementation; and, detailed Financial Plan etc.

(5) Comparison of JICA Guidelines and Tanzanian Related Policies

Harmonization of Tanzanian Compensation and Resettlement policies with international donor policies, such with as the World Bank Operational Policy, O.P. 4.12 on Involuntary Resettlement, of which, basically speaking, the JICA Environmental and Social Consideration Guideline (April 2010 version) follows suit, is gradually in progress, as taken up in the contents of the National Human Resettlement Development Policy, 2000 and TASAF III Resettlement Policy Framework, 2011 (Draft).

Table 13.19 summarizes the abovementioned gap. However, current works are still based on past laws and regulations, from around 2008. Therefore, further revisions are needed.

Table 13.19: Comparison and Gaps of JICA Guidelines and Tanzanian Policies

No.	Resettlement and compensation Aspect	JICA Guidelines (A)	Resettlement Policy of Tanzania (B)	Gaps (C) between JICA (A) and Tanzania (B)	Resettlement Policy under the Project (D)
1.	Avoidance	Involuntary resettlement and loss of means of livelihood are to be avoided when feasible by exploring all viable alternatives. (JICA GL)	Literally the same	None	Adopt both
2.	Impact minimization	When population displacement is unavoidable, effective measures to minimize impact and to compensate for losses should be taken. (JICA GL)	Literally the same	None	Adopt both
3.	Livelihoods restoration	People who must be resettled involuntarily and people whose means of livelihood will be hindered or lost must be sufficiently compensated and supported, so that they can improve or at least restore their standard of living, income opportunities and production levels to pre-project levels. (JICA GL).	Landowners, with or without formal legal rights, are entitled to full, fair and prompt compensation. They also get disturbance allowance, transport allowance, accommodation allowance and loss of profit if they were in actual occupation of the acquired property. There are no legal provisions requiring the government to restore livelihoods or to provide assistance towards the restoration of such livelihoods.	Payment of compensation for loss of assets, allowances and other relocation assistance to restore/improve livelihoods.	Full, fair and prompt compensation; as well as disturbance allowance, transport allowance, accommodation allowance and loss of profit should satisfy both JICA GL and Tanzanian requirements.
4.	Calculation of compensation and valuation	Compensation must be based on the full replacement cost as much as possible. (JICA GL)	The basis for assessment any land and unexhausted improvement for purposes of compensation is the market value of such land. The market value is arrived at by the use of comparative method evidenced by actual recent sales of similar properties; or by the use of the income approach, or replacement cost method, where the property is of special nature and not saleable.	Literally none as the Tanzanian approach attempts to achieve full replacement cost by using replacement cost method.	Adopt both

No.	Resettlement and compensation Aspect	JICA Guidelines (A)	Resettlement Policy of Tanzania (B)	Gaps (C) between JICA (A) and Tanzania (B)	Resettlement Policy under the Project (D)
5.	Timing of compensation payments	Compensation and other kinds of assistance must be provided prior to displacement. (JICA GL)	Tanzanian law requires that compensation be full, fair and prompt. “Prompt” means it should be paid within six months, failure to do so results in an interest rate equivalent to the average rate offered by commercial banks on fixed deposits.	In terms of timing, both Tanzanian laws and JICA GL require that compensation be paid promptly. However, the practice in Tanzania, compensation is hardly paid promptly, and delays are not rectified by paying the interest rate as required by the law.	Compensation and other kinds of assistance must be provided prior to displacement.
6.	Requirement for preparation of RAPs	For projects that entail large-scale involuntary resettlement, resettlement action plans (RAPs) must be prepared and made available to the public. (JICA GL)	Literally the same. The Land Act allows displaced persons to fill in forms requiring that their land be valued, and giving their own opinion as to what their assets are worth.	Literally none	Adopt both
7.	Consultation	In preparing a RAP, consultations must be held with the affected people and their communities based on sufficient information made available to them in advance (JICA GL)	Several Tanzanian land laws have provisions insisting on the urgency for consultation with project affected persons.	Literally none	Adopt both
8.		When consultations are held, explanations must be given in a form, manner, and language that are understandable to the affected people. (JICA GL)	The Land Act allows displaced persons to fill in forms requiring that their land be valued, and giving their own opinion as to what their assets are worth.	Literally none	Adopt both
9.	Participation	Appropriate participation of affected people must be promoted in planning, implementation, and monitoring of resettlement action plans. (JICA GL)	As above. And PAPs are to be informed about their options and rights, offered choices/alternatives, but also given chance to choose their preferences.	Literally none	Adopt both
10	Grievance mechanisms	Appropriate and accessible grievance mechanisms must be established for the affected people and their communities. (JICA GL)	In practice the government tries to resolve grievances through public meetings of the affected persons.	None	Appropriate and accessible grievance mechanisms must be established for the affected people and their communities.

No.	Resettlement and compensation Aspect	JICA Guidelines (A)	Resettlement Policy of Tanzania (B)	Gaps (C) between JICA (A) and Tanzania (B)	Resettlement Policy under the Project (D)
11.	Identification of project affected persons (PAPs)	Affected people are to be identified and recorded as early as possible in order to establish their eligibility through an initial baseline survey (including population census that serves as an eligibility cut-off date, asset inventory, and socioeconomic survey), preferably at the project identification stage, to prevent a subsequent influx of encroachers of others who wish to take advance of such benefits. (WB OP4.12 Para.6)	The entitlement cut-off date refers to the time when the assessment of persons and their properties in the area is carried out, i.e., the time when the project area has been identified and when the socio-economic study is taking place. Thereafter, no new cases of affected people will be considered. Persons who encroach the area after the socio-economic study (census and valuation) are not eligible for compensation or any form of resettlement assistance.	Literally none	It will be important to set a cut-off date early on in the RAP preparation process in order to avoid speculation and spurious claims. An appropriate cut-off date will possibly be the time when the location of project is identified on the ground and when the baseline survey and socio-economic study is undertaken.
12.	Eligibility criteria	Eligibility of benefits includes: the PAPs who have formal legal rights to land (including customary and traditional land rights recognized under law), the PAPs who don't have formal legal rights to land at the time of census but have a claim to such land or assets and the PAPs who have no recognizable legal right to the land they are occupying. (WB OP4.12 Para.15)	The *Land Acquisition Act*, the *Land Act* 1999 and the Village *Land Act* 1999 have it clearly that landowners, with or without formal legal rights, are entitled to full, fair and prompt compensation.	There is no gap between JICA GL and Tanzania laws as far as those with formal legal rights and those without formal legal rights but have a claim to land and assets are concerned.	As long as ownership can be proved compensation is payable.
13.	Land-based resettlement	Preference should be given to land-based resettlement strategies for displaced persons whose livelihoods are land-based. (WB OP4.12 Para.11)	Tanzanian laws do not provide for relocation and resettlement. However, there are a few cases where the government has provided both compensation and alternative land, but this has been done at its discretion. In general however, the government feels that it has discharged its duty once compensation is paid, and it is up to the displaced persons to resettle and re-establish themselves elsewhere.	Occasionally, in a discretionary manner, an alternative land is awarded.	Ensure full replacement cost as much as possible; and where possible provide alternative land.

No.	Resettlement and compensation Aspect	JICA Guidelines (A)	Resettlement Policy of Tanzania (B)	Gaps (C) between JICA (A) and Tanzania (B)	Resettlement Policy under the Project (D)
14.	Transition period support	Provide support for the transition period (between displacement and livelihood restoration). (WB OP4.12 Para.6)	Tanzanian law provides for transport allowance for 12 tons of luggage for up to 12 km from the acquired land, provided the displaced person was living on that land. In lieu of housing accommodation allowance is made in the form of rent for 36 months.	Literally none	Ensure full replacement cost as much as possible to the extent that PAPs could withstand challenges of transition period.
15.	Vulnerable groups	Particular attention must be paid to the needs of the vulnerable groups among those displaced, especially those below the poverty line, landless, elderly, women and children, ethnic minorities etc. (WB OP4.12 Para.8)	There are no specific provisions that require the government to pay special attention to vulnerable groups or indigenous peoples.	Vulnerable groups are treated as other PAPs.	Particular attention to be paid to the needs of the vulnerable groups.
16.	Abbreviated resettlement plan	For projects that entail land acquisition or involuntary resettlement of fewer than 200 people, abbreviated resettlement plan is to be prepared. (WB OP4.12 Para.25)	No specific provisions on preparation of RAPs based on the number of people to be involuntarily resettled.	Literally none	RAP to be prepared irrespective of the number of PAPs.

Source: Input by the JICA Study Team, using JICA template for Gap Analysis.

(6) Objectives of the CRP in This Study

As land acquisition and house relocation are unavoidable due to the project, a Compensation and Resettlement Plan (CRP) which corresponds to the Resettlement Action Plan (RAP) in the World Bank (WB) Safeguard Policies (Operational Policy (OP) 4.12) shall be prepared in accordance with the JICA Guidelines for Environmental and Social Considerations.

In Tanzania, valuation of affected land/assets for compensation is carried out after the detailed design stage, when all proposed project activities are approved by the relevant authorities. As it is still in the feasibility study stage, the valuation of affected land/assets is conducted as a **preliminary valuation** at this point. Objectives of the CRP in this study which includes the preliminary valuation are listed as follows. The results of the valuation in this survey need to be updated at the detailed design stage.

The objectives of the CRP in this study are to:

- Clarify compensation policy for this project which fulfills both Tanzanian law and JICA Guidelines/the WB OP 4.12;
- Identify social impacts at the early stage and prepare appropriate mitigation measures, including compensation;
- Obtain consensus of the affected peoples in the early stage and incorporate their views to the mitigation measures; and
- Estimate compensation amount for preparing the project budget.

As the initial step for preparing the CRP, the framework of the CRP is drafted as follows.

13.2.3 Framework of the CRP

(1) Key Principles

The key principles of the compensation and resettlement policy are as flows:

(i) Involuntary resettlement and loss of means of livelihood are to be **avoided** whenever feasible, or **minimized**, by identifying possible alternative project designs that have the least adverse impact on the communities in the project area.

(ii) Where displacement of households is unavoidable, all PAPs (including communities) losing assets, livelihoods, or resources will be **fully compensated** and assisted so that they can improve, or at least restore, their former economic and social conditions.

(iii) Compensation and rehabilitation support will be provided to any PAPs, that is, any person or household or business which on account of project implementation would have his, her or their:

- Standard of living adversely affected;
- Right, title or interest in any house, interest in, or right to use, any land (including premises), agricultural and grazing land, commercial properties, tenancy, or right in annual or perennial crops and trees or any other fixed or moveable assets, acquired or possessed, temporarily or permanently;
- Income earning opportunities, business, occupation, work or place of residence or habitat adversely affected temporarily or permanently; or
- Social and cultural activities and relationships affected or any other losses that may be identified during the process of resettlement planning.

(iv) All affected people will be eligible for compensation and rehabilitation assistance, **irrespective of tenure status**, social or economic standing, and any such factors that may discriminate against achievement of the objectives outlined above. Lack of legal rights to the assets lost or adversely affected tenure status and social or economic status will not bar the PAPs from entitlements to such compensation and rehabilitation measures or resettlement objectives. All PAPs residing, working, doing business and/or cultivating land within the project impacted areas **as of the date of the latest census** and inventory of lost assets (IOL), are entitled to compensation for their lost assets (land and/or non-land assets), at replacement cost, if available, and restoration of incomes and businesses, and will be provided with rehabilitation measures sufficient to assist them to improve or at least maintain their pre-project living standards, income-earning capacity, and production levels.

(v) PAPs that **lose only part of their physical assets** will not be left with a portion that will be inadequate to sustain their current standard of living. The minimum size of remaining land and structures will be agreed during the resettlement planning process.

(vi) People **temporarily affected** are to be considered PAPs and resettlement plans will address the issue of temporary acquisition.

(vii) Payment for land and/or non-land assets will be based on the principle of **replacement cost**.

(viii) Compensation for PAPs dependent on agricultural activities will be **land-based** wherever possible. Land-based strategies may include the provision of replacement land, ensuring greater security of tenure, and/or upgrading livelihoods of people without legal land titles. If replacement land is not available, other strategies may be built around opportunities for re-training, skill development, wage employment, or self-employment, including access to credit. Solely cash-based compensation will be avoided as an option if possible, as this may not address losses that are not easily quantified, such as access to services and traditional rights, and may eventually lead to those populations being worse off than without the project.

(ix) Replacement lands, if the preferred option of PAPs, should be **within the immediate vicinity** of the affected lands wherever possible and be of **comparable productive capacity and potential**. As a second option, sites should be identified that minimize the social disruption of those affected; such lands should also have access to services and facilities similar to those available in the lands affected.

(x) The resettlement plan must consider the needs of those most **vulnerable** to the adverse impacts of resettlement (including the poor, those without legal title to land, ethnic minorities, women, children, the elderly, and the disabled) and ensure they are considered in resettlement planning and mitigation measures identified. Assistance should be provided to help them improve their socio-economic status.

(xi) PAPs will be **involved** in the process of developing and implementing resettlement plans.

(xii) PAPs and their communities will be **consulted** about the project, the rights and options available to them, proposed mitigation measures for adverse effects, and, to the extent possible, be involved in the decisions that are made concerning their resettlement.

(xiii) **Displacement does not occur before provision of compensation and of other assistance** required for relocation. Sufficient civic infrastructure must be provided at the resettlement site prior to relocation. Acquisition of assets, payment of compensation, and the resettlement and start of the livelihood rehabilitation activities of PAPs, will be completed prior to any construction activities, except when a court of law orders so in expropriation cases. Livelihood restoration measures must also be in place but not necessarily completed prior to construction activities, as these may be ongoing activities.

(xiv) **Organization and administrative arrangements** for the effective preparation and implementation of the resettlement plan will be identified and in place prior to the commencement of the process; this will include the provision of adequate human resources for supervision, consultation, and monitoring of land acquisition and rehabilitation activities.

(xv) Appropriate reporting (including auditing and redress functions) and **monitoring and evaluation mechanisms** will be identified and set in place as part of the resettlement management system.

(2) Principle of Valuation for Compensation

All affected land and non-land assets needs to be valuated for compensation based on the **full replacement cost,** in accordance with the JICA Guidelines/WB OP4.12. "Replacement cost" refers to the entire amount required to acquire the asset, with equal value to the affected asset, at the present time, covering the market value of the asset as well as the cost of any registration and transfer taxes.

Tanzanian laws also stipulate valuation in market value and compensation to include allowances, which cover costs for acquiring alternative assets for land and buildings/structures. However, some disparities with JICA Guidelines/WB OP4.12 are found as follows:

(i) In Tanzania, the market value of buildings/structures is valuated factoring in depreciation, while WB OP4.12 requires valuation **without depreciation**.

(ii) In Tanzania, non-land assets owned by encroachers who does not have legal right to land cannot be compensated while WB OP4.12 recognize them as eligible for the compensation.

(iii) In Tanzania, compensation is paid principally by cash, while JICA Guidelines/WB OP4.12 strongly prefer '**land-based**' replacement, especially when the PAP's livelihood is dependent on land and a large portion of the land (greater than 20%) is affected.

Considering the disparities, the following principles shall be applied for this project to comply with JICA Guidelines/WB OP4.12.

(i) The valuation of non-land assets including buildings/structures owned by PAPs with land right for compensation shall basically follow Tanzanian laws including allowances. In addition, community support will be provided and covered by the loan. The requests on the community support from the affected community are described in Table 13.45.

(ii) The number and status of assets without land which are in the existing ROW and which might be in the proposed ROW are described in Table 13.32 and Table 13.33. Resettlement policy for those assets will be applied as described in Table 13.33.

(iii) Land-for-land replacement shall be prioritized over cash compensation, especially when the PAP's livelihood is based on the land and greater than 20% of the land asset will be affected. If a land-for-land replacement is not feasible, LRP shall be provided to restore the livelihood without the land asset.

For valuation of assets in replacement cost, the following definition of replacement cost by Resettlement Guidelines, 2009, developed by the Ministry of Infrastructure Development, is noted as the basic principle for this project:

- For agricultural land, it is the pre-project or pre-displacement, whichever is higher, market value of land of equal productive potential or use located in the vicinity of the affected land, plus the cost of preparing the land to levels similar to those of the affected land, plus the cost of any registration and transfer taxes.

- For land in urban areas (residential area), it is the pre-displacement market value of land of equal size and use, with similar or improved public infrastructure facilities and services and located in the vicinity of the affected land, plus the cost of any registration and transfer taxes.
- For houses and other structures, it is the market cost of the materials to build a replacement structure with an area and quality similar to or better than those of the affected structure, or to repair a partially affected structure, plus the cost of transporting building materials to the construction site, plus the cost of any labor and contractors' fees, plus the cost of any registration and transfer taxes.

Regarding the allowances to be included in compensation, the Road Sector Compensation and Resettlement Guidelines are summarized as follows:

- **Disturbance allowance** based on the principle of "the value of the Estate multiplied by the rate of interest prevailing and payable to fixed deposits by commercial banks".
- **Transport allowance,** which is the actual cost of transporting twelve tons of luggage by rail or road within 20 km from the point of displacement.
- **Accommodation allowance** based on market rent for 36 months. These can be determined based on actual rents stated by property owners, although further investigation may be necessary to verify reliability.
- **Loss of rental income restoration**, based on loss of rental income for 36 months rent per tenant.
- **Loss of profits** is calculated on the basis of net monthly profits of the business carried out on the land, for a period of 36 months.
- **Loss of wages**, equivalent to payment in lieu of wages while rebuilding.

In addition, costs associated with the acquisition of the subject land; and any loss or capital expenditure incurred to the development of the subject land must be included in the valuation.

The PAP is eligible to obtain hard copy of the valuation form which will be recorded during the census/valuation survey to confirm his/her valuated properties.

(3) Policy for Vulnerable People

There are no specific provisions that require paying special attention to vulnerable people in Tanzanian laws for compensation and resettlement. However, Road Sector Compensation and Resettlement Guidelines list the following people who require special assistance – physical and moral – during the compensation or relocation process:

- Old people (>65 years)
- Women heads of households
- Widows
- Single mothers
- Orphans
- Physically and mentally challenged
- The infirmed.

(4) Livelihood Restoration Program

There are no legal provisions for restoring livelihoods or providing assistance towards the restoration of such livelihoods in Tanzania. However, considering that the project may severely affect their livelihood in the cases of lost agricultural land or other means of income, the project shall consider preparing the Livelihood Restoration Program (LRP) for those affected people.

The details of the LRP are prepared after the census/socio-economic survey, based on the affected people's needs and requests.

(5) Entitlement Matrix

The entitlements for compensation and rehabilitation assistance for this project are developed and presented in Table 13.11 below:

Table 13.20: Entitlement Matrix

Types of Asset	Types of Impact	Person(s) Affected		Compensation/Entitlement/Benefits
Agricultural land	**Loss of land under cultivation** Greater than 20% of land holding lost	Title holder [Both statutory and customary]	(a)	• Land-for-land replacement where feasible, or compensation in cash for the entire landholding according to the PAP's choice. Land-for-land replacement will be in terms of a new parcel of land of equivalent size and productivity with a secure tenure status at an available location which is acceptable to the PAP. • Tax for transferring the land to the PAP, registration fee, and other costs for obtaining the land shall be compensated. • If the livelihood is affected by losing agricultural land, the PAP is entitled to be compensated for the loss or join the Livelihood Restoration Program. • Compensation for land users will be paid through land owners based on their contracts. Land owners/land users are allowed harvesting crops that are within the affected area. The deadline for the harvest shall be discussed and determined with the PAP during the Detailed Design stage.
		Land user (Tenant/lease holder)	(b)	• In case the livelihood is affected by losing agricultural land, the PAP is entitled to join the Livelihood Restoration Program.
		Encroacher	(c)	• The PAP is allowed harvesting crops that are within the affected area. The deadline for the harvest shall be discussed and determined with the PAP during the Detailed Design stage. • If the livelihood is affected by losing agricultural land, the PAP is entitled to join the Livelihood Restoration Program..
		Vulnerable title holder	(d)	Same with (a) plus: • Process for obtaining and registering alternative land shall be assisted. • Assistance for securing the livelihood depending on the PAP's situation.
		Vulnerable land user (Tenant/lease holder)	(e)	Same with (b) plus: • Assistance for securing the livelihood depending on the PAP's situation.
	Less than 20% of land holding affected	Title holder [Both statutory and customary]	(f)	• Cash compensation for affected land equivalent to replacement value OR alternative land of equivalent size and productivity with a secure tenure status at an available location which is acceptable to the PAPs where feasible. • Tax for transferring the land to the PAP, registration fee, and other costs for obtaining the land shall be compensated. • If the livelihood is affected by losing agricultural land, the PAP is entitled to be compensated for the loss or join the Livelihood Restoration Program. • Compensation for land users will be paid through land owners based on their contracts. Land

Types of Asset	Types of Impact	Person(s) Affected	Compensation/Entitlement/Benefits	
				owners/land users are allowed harvesting crops that are within the affected area. The deadline for the harvest shall be discussed and determined with the PAP during the Detailed Design stage.
		Land user (Tenant/lease holder)	(g)	• In case the livelihood is affected by losing agricultural land, the PAP is entitled to join the Livelihood Restoration Program.
		Encroacher	(h)	Same with (c).
		Vulnerable title holder	(i)	Same with (f) plus: • Process for obtaining and registering alternative land shall be assisted. • Assistance for securing the livelihood depending on the PAP's situation.
		Vulnerable land user (Tenant/lease holder)	(j)	Same with (g) plus: • Assistance for securing the livelihood depending on the PAP's situation.
	Loss of land under cultivation by public/ community	Public/community	(k)	• Cash compensation for affected land equivalent to replacement value.
Commercial land	**Loss used for business** The remaining assets become insufficient for business purposes	Title holder	(l)	Same with (a) plus: • Opportunity cost compensation equivalent to 2 months net income based on tax records for previous year (or tax records from comparable business, or estimates) • Compensation for land users will be paid through land owners based on their contracts.
		Land user (Tenant/lease holder)	(m)	• In case the livelihood is affected by losing agricultural land, the PAP is entitled to join the Livelihood Restoration Program.
	The business can be continued by the remaining assets	Title holder	(n)	Same with (f) plus: • Opportunity cost compensation equivalent to 5% of net annual income based on tax records for previous year (or tax records from comparable business, or estimates where such records do not exist). • Compensation for land users will be paid through land owners based on their contracts.
Residential land	**Loss of residential land either partially or entirely**	Title holder	(o)	• Land-for-land replacement or compensation in cash according to the PAP's choice. • Land-for-land replacement shall be of minimum plot of acceptable size under the relevant law(s) or a plot of equivalent size, whichever is larger, in either the community or a nearby resettlement area with adequate physical and social infrastructure systems. • When the affected holding is larger than the relocation plot, cash compensation to cover the

Types of Asset	Types of Impact	Person(s) Affected	Compensation/Entitlement/Benefits	
				difference in value. • Tax for transferring the land to the PAP, registration fee, and other costs for obtaining the land shall be compensated.
		Vulnerable title holder	(p)	Same with (o) plus: • Process for obtaining and registering alternative land shall be assisted.
	Loss of residential land used by public/ community	Public/community	(q)	• Cash compensation for affected land equivalent to replacement value.
The other type of land	Loss of the other type of public land (e.g., forest, pastureland)	Public/community	(r)	• Cash compensation for affected land equivalent to replacement value.
Buildings and structures	Entire structures are affected	Owner	(s)	• Cash compensation for entire structure and other fixed assets with depreciation following Tanzanian laws, including allowances. • Relocation allowances which include those for disturbance, transportation, accommodation and loss of income during relocation.
		Renter	(t)	• Relocation allowances which include those for disturbance, transportation, accommodation and loss of income during relocation.
		Squatter/informal dweller	(u)	▪ The policy described in the Table 13.33 will be applied.
		Vulnerable owner	(v)	Same with (s) plus: • Process for obtaining alternative structure shall be assisted. • Assistance for securing the livelihood depending on the PAP's situation.
	Entire public structures are affected	Public/community	(w)	• Cash compensation for entire structure and other fixed assets, or alternative structure of equal or better size and quality in an available location which is acceptable to the PAP. • Relocation allowances which include those for disturbance, transportation and accommodation.
	Structures are partially affected Remaining structures are	Owner	(x)	• Cash compensation for affected building and other fixed assets • Cash assistance to cover costs of restoration of the remaining structure • Disturbance compensation equivalent to applicable rental costs or time that will take to finish construction work.

Types of Asset	Types of Impact	Person(s) Affected		Compensation/Entitlement/Benefits
	viable for continued use			
Standing crops	Crops affected by land acquisition or temporary acquisition	Owner of crops	(y)	• PAP allowed harvesting crops if fully matured OR cash compensation of the crops equivalent to the market value for the mature and harvested crop.
Trees	Trees lost	Owner of trees	(z)	• Cash compensation based on type, age and productive value of affected trees.
Cultural properties	Loss of graves, archaeological sites	Owner of graves, Community	(aa)	• Compensation based on the relevant law (Graves (Removal) Act, 1969; Antiquities Act, 1964)

Source: JICA Study Team

(6) Cut-off Date

The “cut-off date” refers to the date prior to which the occupation or use of the project area makes the occupants/users eligible to the entitlement. Establishment of a cut-off date is intended to prevent the influx of ineligible non-residents who might erroneously or inadequately get benefits from the project entitlement.

In Tanzania, the cut-off date is usually set as the date of completion of the census survey which is conducted together with asset valuation for compensation. As the survey in this study is for preliminary valuation without official approval by the Ministry of Lands, Housing and Human Settlements Development (MLHHSD), the official cut-off date is to be set at the time of the official survey after the detailed design stage. In order to prevent an influx of ineligible people to the project area before the official cut-off date, the cooperation of the local governments is to be asked to not to allow any individuals/groups to occupy or use the project area after the date of the completion of the census survey in this study. As the project area is village land under management of village government, the village government has enough power to restrict the land transaction and occupation before the official cut-off date. In this context, the date of the completion of the census survey in this study is recognized as ‘preliminary’ cut-off date prior to the official cut-off date.

(7) Institution Arrangements for the CRP Implementation

After the detailed design is completed and when the CRP is updated, it is appropriate to set up a Compensation and Resettlement Implementation Committee. The Committee will consist of representatives from RAHCO and local governments, including village leaders as representatives of affected community. Basic responsibilities of the relevant agencies for implementing the CRP are proposed in Table 13.21.

Table 13.21: Responsibilities of Relevant Agencies for Implementing the CRP

Agency		Responsibility
MLHHSD		• Approval of the CRP, including valuation results for compensation. • Ensuring that compensation is paid or resettlement is undertaken as agreed.
Committee	**RAHCO**	• **Overall responsibility for implementing the CRP, including compensation payment and LRP.**
	Regional government	• Facilitating and assisting local governments.
	District government, Ward government, and Village government.	• Consultation with affected people, • Arrangement of plots for resettlement, • Assisting mobilization, • Assisting LRP implementation, • Receiving grievances from affected villagers.
Consultant/NGO* commissioned by RAHCO		• Coordinating with relevant agencies for proceeding with the activities, • Preparing plots/structures for resettlement coordinating with RAHCO and the contractor, • Assisting vulnerable affected people, • Implementation of LRP, • Recording progress of the CRP implementation, • Monitoring and evaluating the process.

*Qualifications of the Consultant/NGO:
- Experience of implementing CRP which complies with WB OP 4.12 in Tanzania.
- Including the following specialists who have experience in each field: valuer, sociologist, community development expert, and social worker.

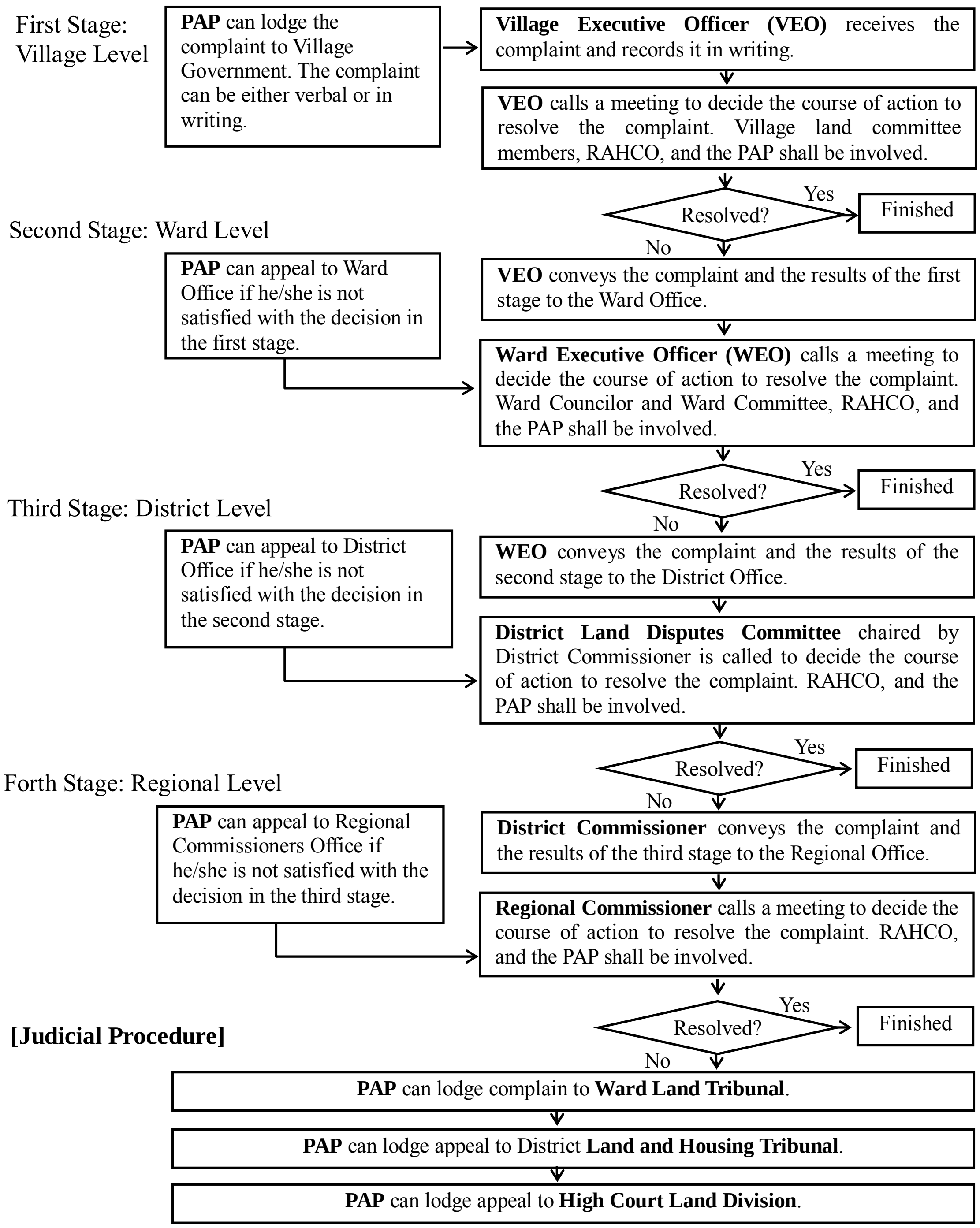
Source: JICA Study Team

(8) Grievance Redress Mechanism

In order to redress any grievances during implementation of the CRP, such as regarding compensation amount, entitlement, resettlement places, livelihood restoration and any of the survey results related to the CRP which includes PAP census and socio-economic survey, the following grievance redress mechanism shall be established before implementation. Although Tanzania has judicial procedures for land acquisition and compensation disputes to bring to the Court (Land Act 1999 and Village Land Act 1999), negotiation and mediation procedures before the judicial procedure shall be established to precede this, as the judicial procedure may not be easy to access for most of the affected people.

A flow chart of the grievance redress mechanism is presented in Figure 13.8. At each stage, RAHCO shall be involved as the responsible agency of the CRP implementation.

[Negotiation and Mediation Procedure]



Source: JICA Study Team

Figure 13.8: Flowchart of Grievance Redress Procedure

13.2.4 Scope of Resettlement Impact

(1) Determination of the Preliminary Cut-off Date

Population census was conducted on 2-9 December, 2015 together with the asset inventory. The date of the completion, 9 December 2015 was identified as the 'preliminary' cut-off date. The preliminary cut-off date was defined as the date after which an influx of ineligible people and unnecessary development are prevented under the villagers' consensus and observation by the village leaders and the neighbors. After the official project decision, the official cut-off date will be set at the time of the official survey to be conducted based on Tanzanian laws and approved by the Ministry of Lands, Housing and Human Settlements Development (MLHHSD) for determination of the compensation amount to be provided to each PAP. The eligibility will be finalized at the time of the official cut-off date together with the valuation for compensation.

The preliminary cut-off date was agreed in the consultation meetings with PAPs.

(2) Population Census

The results of the population census showed that 201 households with 952 populations would be affected by the project (Table 13.22). As the PAPs are cultivating the land around their houses, most of the PAPs are affected because of their land and less frequently because of the existence of structures (Table 13.23). Eleven illegal land users were identified who cultivated crops or built structures within the existing ROW. In addition to the individual PAPs, village owned public land (village land) is affected at each village.

Table 13.22: Number of Total PAHs and PAPs by Village

Region	Village	Project Affected Households (PAHs)	Project Affected Persons (PAPs)
Morogoro	Munisagara	37	159
	Muzaganza	32	138
	Kikundi	39	199
Dodoma	Kisisi	4	27
	Godegode	28	125
	Gulwe	61	304
Total		201	952

Source: JICA Study Team

Table 13.23: Number of Total PAHs and PAPs by Impact

Type of impact	Project Affected Households (PAHs)			Project Affected Persons (PAPs)		
	Legal	Illegal	Total	Legal	Illegal	Total
Land without structure is affected	87	5	92	505	33	538
Both land and structure are affected	92	6	98	354	28	382
Structure without land is affected	11	0	11	32	0	32
Total	190	11	201	891	61	952

Source: JICA Study Team

(3) Asset Inventory

The measured total affected land area is presented in Table 13.24. Most of the affected land is agricultural land cultivated by individuals (private). The other land type is village land managed by the village government. The village land is basically not used as they are not suitable for either cultivation or housing due to the topographic conditions.

The number of affected structures is presented in Table 13.25. In total, 317 structures are affected. Out of them, 150 were identified as houses. Although the structures need to be relocated, it is difficult to identify whether the PAP needs to move out from their land to another area, because they may be able to stay within their plot just by shifting their house location. The necessity and the preference of the moving shall be decided in the detailed design stage after the project area is demarcated physically.

Table 13.24: Affected Land Area

Land type	Area (m^2)
Private used land (agricultural land with/without housing)	1,538,508
Village land (bare land/forest)	659,338
Total	2,197,846

Source: JICA Study Team

Table 13.25: Number of Affected Structures

Type of structures		Number
House	Traditional	135
	Modern	10
	Mixed modern & ultra-modern	5
Outer structures	Outer kitchen	53
	Outer toilet	59
	Warehouse/animal shed	48
Public structures	Grain storage	1
	Grave yards	6
Total		317

Traditional: grass/fronds roof, mud/stick walls, mud floor; Modern: corrugated iron sheets, burnt bricks, cement floor; Ultra modern: tiled roof, cement blocks, tiled floor
Source: JICA Study Team


House


House


Community grain storage

Source: JICA Study Team

Figure 13.9: Examples of the Affected Structures

(4) Socio-Economic Conditions of the Affected Households

In the project area, various ethnic groups are living together, especially in Kilosa District, while the Gogo is dominant in Mpwapwa District. The Gogo is predominantly known as Christian. The lifestyles of each tribe are not specified and Kiswahili is commonly spoken between and within the tribes.

From the results of the interview surveys with the affected households, 15% of the affected household heads were found to be illiterate who could neither read nor write Kiswahili. The number of household members was varied, ranging one to twenty per household (Table 13.26). Almost all of the households are small-scale farming households (Table 13.27) and the income of the majority of them is below 5 million TZS/year (equivalent to 2,294 USD/year). Comparing with the national poverty line, USD 1/capita/day, the averaged affected household's condition is close to be the poverty line.

Table 13.26: Number of Affected Households by Number of Household Members

	Number of household members															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	16	20
Land affected household	19	13	25	30	26	29	10	9	5	7	4	1	1	1	1	1
Structure affected household	10	8	7	21	10	13	2	3	3	4	2	1	0	0	1	0

Source: JICA Study Team

Table 13.27: Number of Affected Households by Occupation

	Occupation					
	Farmer	Livestock keeper	Trading	Agricultural officer	Fisherman/ woman	Artisan
Land affected household	190	-	2	2	1	2
Structure affected household	107	2	-	-	-	-

Source: JICA Study Team

Table 13.28: Number of Affected Households by Income

	Household Income (TZS/year)				
	100,000-1,000,000	1,000,001-5,000,000	5,000,001-10,000,000	10,000,001-20,000,000	20,000,001-80,000,000.00
Land affected household	68	85	14	6	1
Structure affected household	23	52	4	16	3

Source: JICA Study Team

(5) Vulnerable Affected Households

Through the interview survey, vulnerable persons listed in Table 13.29 were identified in the affected households.

Table 13.29: Number of Vulnerable Affected Persons

Vulnerability	Frequency
Disease /Sick	4
Elderly	39
Orphan	2
Widow	5
Women household heads	47
Total	**97**

Source: JICA Study Team

(6) Tenants

Five affected tenants of land are identified through this survey. Information of those tenants are summarized in Table 13.30.

Table 13.30: Information of Affected Land Tenants

Tenant	Village	Description
1.	Gulwe	Small scale peasant, a tenant on the father's land; has another small farm away.
2.	Godegode	Rents a land on which he grows seasonal crops (maize, sunflower). Has another plot in the nearby village
3.	Kikundi	A rich peasant living in Dar es Salaam; rents land at Kikundi for irrigation farming for commercial reasons. Has other source of income.
4.	Mzaganza	Rents on land of his father in law on which he grows maize. Does not have another plot.
5.		Rents a plot on which he grows seasonal crops. Has other source of income.

Source: JICA Study Team

13.2.5 Compensation Plan

(1) Compensation for the Loss

The affected people are small scale farmers who are based on their farm land. Although the percentages of the affected area of each owner's land were not quantified through this survey, 136 landowners out of 172 respondents answered that they did not have alternative plots other than the land in the project area. In such cases, JICA's compensation policy generally leads to land-for-land compensation by providing alternative land instead of cash compensation. However, a problem in this area is the difficulty to find alternative spare land due to the mountainous topographic conditions. As many people were aware of this situation, the majority of the affected landowners replied that they prefer cash compensation rather than in-kind compensation because the area is precarious; namely, hilly, periodically affected by floods, dry and inaccessible (Table 13.31).

Considering this situation, cash compensation is deemed to be suitable for those who prefer cash compensation in this project, given that they will receive livelihood support from the Livelihood Restoration Program (LRP).

Table 13.31: The PAP's Preference on Compensation Form

Compensation form	Number of respondents
Cash	108 (61%)
In-kind (land)	27 (15%)
Both cash and in-kind	42 (24%)
Total respondents	177

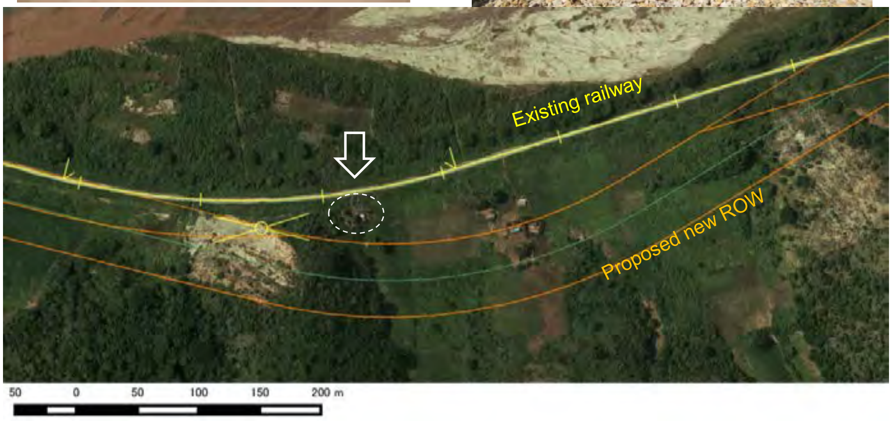
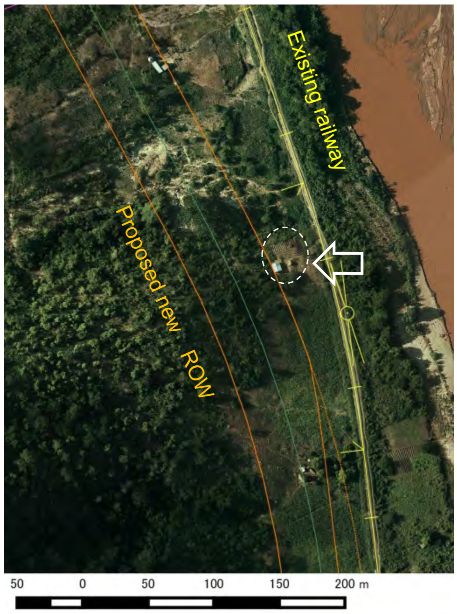
Source: JICA Study Team

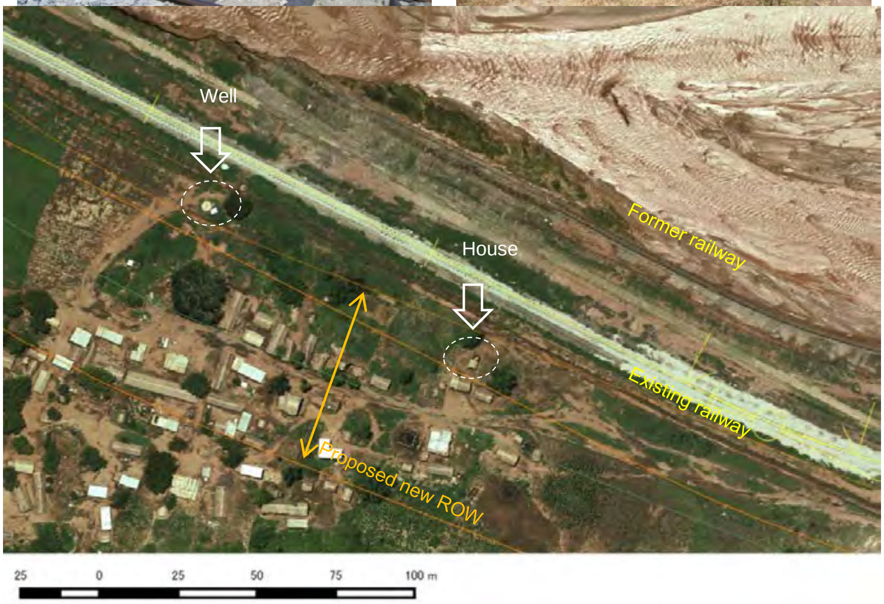
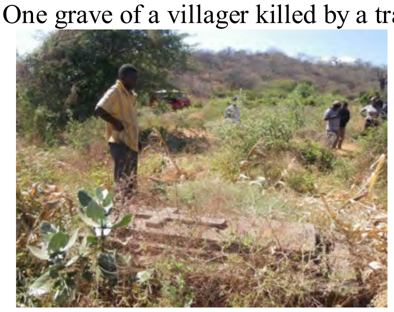
(2) Compensation for Assets in the Existing Right of Way (ROW)

The area within the existing ROW, thirty meters width from the center line of the railway track, is owned by RAHCO and any erection of structures and execution of works are forbidden without permission. Considering that WB OP4.12 recognizes those persons who encroaches the ROW as eligible for the compensation while Tanzanian law does not, the status of each affected asset in the existing ROW are investigated. The results and the resettlement policy for each case are presented in Table 13.32 and Table 13.33.

Table 13.32: Affected Assets in the Existing ROW

Survey date: 14-16 June, 2016

No.	Location	Type of Asset and the Condition
1	Km 302 Munisagara Rerouting section (2)-600m	Three structures. Not in the new ROW.   
2	Km 305 Munisagara Rerouting section (2)-3800m	Two structures. Not in the new ROW.  

No.	Location	Type of Asset and the Condition
3,4	Km 315 Kikundi Rerouting section (3) - 2500m	One house and one well. The well is not in the new ROW, while the house is.   
5	Km 371 Gulwe Rerouting section (9)- 8800m	【Just outside of the existing ROW】 One grave of a villager killed by a train accident in 2004.  

No.	Location	Type of Asset and the Condition
6	Km 305 Munisagara Rerouting section (2)-3600m	Crops (sunflower, maize) along the railway, about 200m. 
7	Km 371 Gulwe Rerouting section (9)-8200-8800m	Crops (sunflower, maize) along the railway, about 600m. 

Source: JICA Study Team

Table 13.33: Resettlement Policy on Assets without Land in the Existing ROW

No.[*1]		Type of Asset	Condition: Within the Existing ROW? (30m from the existing rail)	Condition: Recognized as Encroacher?	Condition: Within the New ROW?	Resettlement Policy
1		Three structures	**Yes**	**Yes**	No	No resettlement
2[*2]	2-1	Two structures	**Yes**	**Yes**	No	No resettlement
	2-2	One structure	No	No	No (To be scrutinized in the detailed design stage.)	No resettlement (same policy in case the structure will be within the new ROW)
3		One structure	**Yes**	No	**Yes**	It will be compensated by the Tanzanian Government because the structure is in the existing ROW due to the relocation of the existing railway.
4		Well	**Yes**	No	No	It needs to be relocated because it will be separated from the community. Development of a new well at the resettlement site has already been planned.
5		Grave	No	No	**Yes**	It will be compensated by the Tanzanian Government
6		Crop	**Yes**	**Yes**	**Yes**	The PAP is allowed harvesting crops that are within the affected area. The deadline for the harvest shall be discussed and determined with the PAP during the Detailed Design stage.
7		Crop	**Yes**	**Yes**	**Yes**	The PAP is allowed harvesting crops that are within the affected area. The deadline for the harvest shall be discussed and determined with the PAP during the Detailed Design stage.

*1 The number is consistent with Table 13.32.

*2 The three structures are owned by one household and the structure 2-2 is their residence. In case the structure 2-2 would be resettled, JICA thinks that the other two structures 2-1 should be resettled together. However, the other two structures cannot be compensated under the Tanzanian laws and regulations because they are in the existing ROW. Therefore, RAHCO and JICA came to an understanding that it might be better to have an option for the PAPs that the three structures can be left there even though the residence might cross the new ROW because the construction activities can be implemented not affecting the structures. RAHCO pointed out that in case the structures would be left there, the PAPs shall not make any new development with the proposed ROW. The decision on this matter would be made in close consultation with the PAPs during the Detailed Design.

Source: JICA Study Team

(3) Livelihood Restoration Program

During the socio-economic interview survey, it was asked to the PAPs what kind of assistance they prefer for compensating their affected livelihood. As summarized in Table 13.34, 67 out of 171 respondents answered they preferred agricultural land-based assistance, such as training on modern farming, while the other 104 preferred non-land-based assistance, such as trading and enterprising. The latter preference is basically from the younger generations who seem to be unsatisfied by the livelihood conditions in the project area.

According to the Kilosa District Office, the District government has experiences of providing training on agriculture, beekeeping, poultry, entrepreneurship, and savings/loans in other areas in the District. That training and implementation are deemed to be applicable to the affected area for this project with the cooperation of the Districts. The details shall be discussed in the detailed design stage.

Table 13.34: Summary of the PAP's Livelihood Restoration Preference

Livelihood Restoration Preference		Number of respondents	Description of the respondents
(1)	Agricultural production based assistance (land based): training on modern/scientific farming, access to credits and lucrative markets.	67	Mainly aged PAPs (50 years and above), PAPs who have extra land either within the same village or in another village PAPs who preferred land for land compensation, Vulnerable households headed by the older persons.
(2)	Non-farm based assistance (non-land based): training on small enterprising especially in agricultural products; access to credits, practical skills training, e.g., carpentry, masonry, tailoring, etc.	104	Mainly persons of young age, in their 20s to early 40s.

Source: JICA Study Team

(4) Resettlement Site

The railway rerouting was planned to avoid residential area as much as possible; however, it is not avoidable that the section at Km315-316 affects a community in Kikundi Village. As there is not enough spare land for relocating the affected residents, it was requested by the villagers to develop a resettlement site at the mountain slope within the village (Figure 13.10).

The resettlement site is planned to be about one hectare, which is equivalent to the area of the affected community. The land belongs to the village and currently not used for any purpose, and is covered by vegetation (Figure 13.11). Environmental and social impacts are hardly expected for the development as it is not a primary forest and it is easily accessible from the existing residential area. As shown in Table 13.35, available infrastructure in the new resettlement site will be the same with the current settlement.

The construction outline and the settlement procedure are planned as follows:

(Construction)

- After clearing the vegetation, the slope is leveled by excavating and spreading the excavated soil.

- The leveled land is compacted and rainwater drainages are installed.
- One well with hand pump is installed.
- The construction cost is shown in Table 13.36.

(Settlement)
- After identification of the households to be relocated to the site, the procedure for selecting plots are discussed and confirmed among the PAPs; for example, selection by lottery.
- The PAPs build their structure at the allocated plots by themselves and move to.
- The District Officers or assigned NGO staff assists the procedure coordinating with the village government if necessary.

Expected schedule of the resettlement is presented in Table 13.37.

Table 13.35: Comparison of the Infrastructure in the Current Settlement and the New Resettlement Site

Infrastructure	Current Affected Settlement	Plan of the New Resettlement Site
Area	About one hectare	Planned to be one hectare.
Water source	A communal well with hand pump	A new communal well with hand pump is installed.
Rainwater drainage	(none)	Rainwater drainages are installed.
Road	A communal road	A communal road is planned in the area to connect with the existing .residential area adjacent to the site.

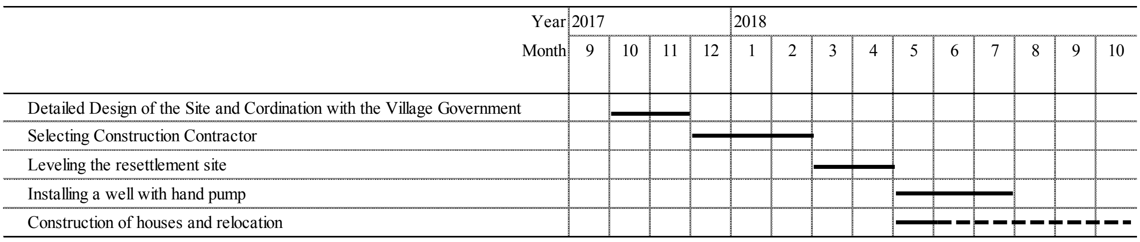
Source: JICA Study Team

Table 13.36: Construction Cost of the Resettlement Site Development

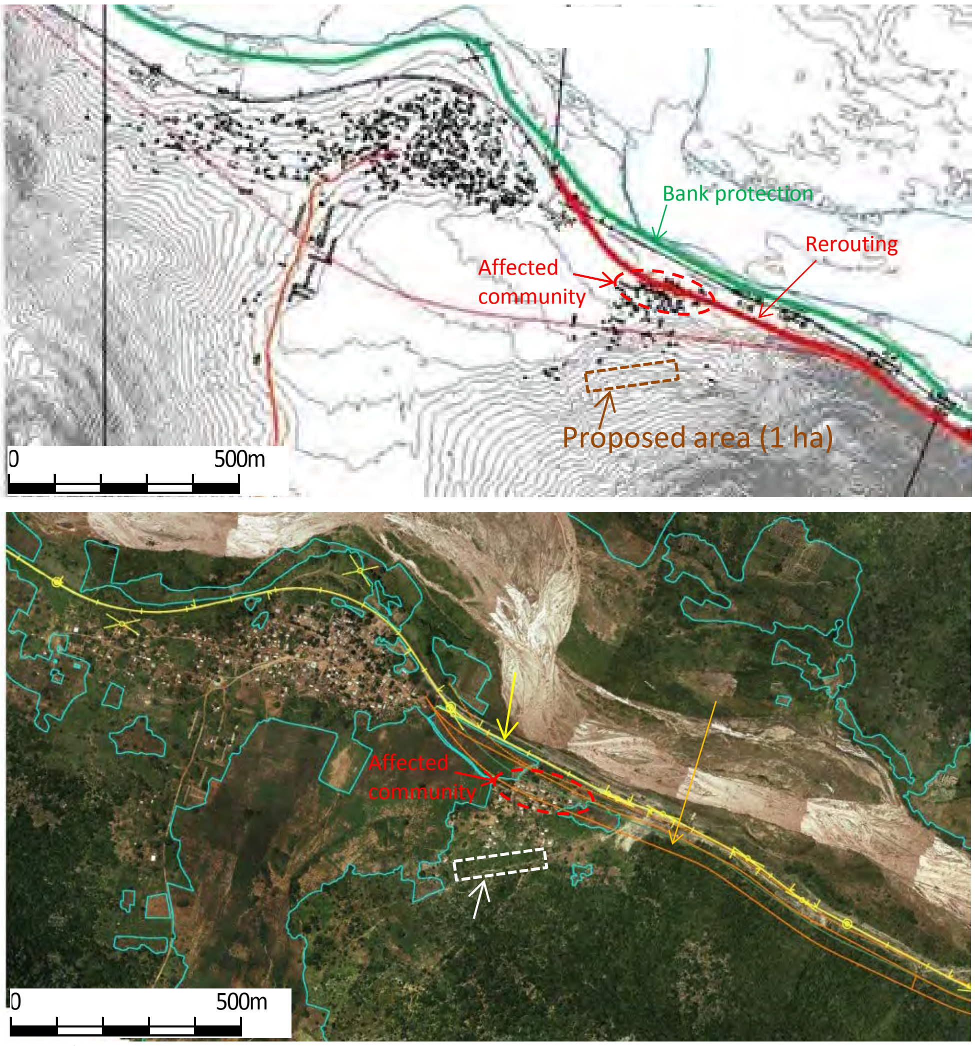
Items	TZS
Land development (including drainages)	309,705,732
Development of a well	30,508,317
Total	340,214,049

Source: JICA Study Team

Table 13.37: Expected Schedule of the Site Preparation and Resettlement



Source: JICA Study Team



Source: JICA Study Team

Figure 13.10: Location of the Affected Community and the Proposed Resettlement Site

Source: JICA Study Team

Figure 13.11: Condition of the Proposed Resettlement Site

13.2.6 Implementation Schedule

Expected implementation schedule of the CRP is presented in Table 13.38. As the CRP prepared in this Study is recognized as the Preliminary CRP with a preliminary valuation, it needs to be updated together with the implementation of official asset valuation. The survey will be commenced after the project area is demarcated on the ground based on the detailed design.

Table 13.38: Implementation Schedule of the CRP

Year	2017				2018									
Month	9	10	11	12	1	2	3	4	5	6	7	8	9	10
1. Demarcation of the project area														
2. Compensation Process														
2.1 Consultation with PAPs/Establishment of Committee														
2.2 Census and Socio-Economic Survey				official cut-off-date										
2.3 Valuation (field survey and filling valuation form)														
2.4 Preparing the Report (CRP/Valuation Report)														
2.5 Approval of the CRP/Valuation Report by the Ministry of Land including coordination with local government														
2.6 Compensation Payment														
2.7 Handling Greivances														
3. Preparing Resettlement Site and LRP														
3.1 Detailed Design of the Resettlement Site and Cordination with the Village Government														
3.2 Selecting Construction Contractor for the Resettlement Site														
3.3 Construction of the Resettlement Site														
3.4 Preparing Implementation Plan of the LRP														
4. Relocation/LRP/Monitoring														

Source: JICA Study Team

13.2.7 Cost and Budget

The estimated cost for implementing the CRP is presented in Table 13.39. The budgetary responsibility is under the project proponent, RAHCO.

Table 13.39: Cost for Implementing the CRP

	Resettlement Activity	Cost (TZS)	Contingency (TZS)	Total (TZS)
1	Compensation costs for Crops and Trees	14,415,000	1,441,500	15,856,500
2	Compensation costs for Land	439,569,200	43,956,920	483,526,120
3	Compensation costs for Housing Structures	484,098,731	48,409,873	532,508,604
4	Transport allowance	3,300,000	330,000	3,630,000
5.	Disturbance allowance	46,904,147	4,690,415	51,594,562
6.	Accommodation allowance	76,946,000	7,694,600	84,640,600
7.	Resettlement Assistance	100,000,000	10,000,000	110,000,000
8.	Community support	217,844,429	21,784,443	239,628,872
9.	Livelihood Restoration Program	1,200,000,000	120,000,000	1,320,000,000
10.	Grievance handling	12,000,000	1,200,000	13,200,000
11.	Management & administration	80,000,000	8,000,000	88,000,000
12	Monitoring & evaluation	200,000,000	20,000,000	220,000,000
	Total			3,162,585,258

Note: contingency is estimated as 10% of the cost.
Source: JICA Study Team

13.2.8 Monitoring Plan

RAHCO shall take full responsibility for conducting regular monitoring of the CRP implementation. Indicators of the monitoring are listed in Table 13.40. The monitoring shall be continued until the project activities are completed.

In addition to the internal monitoring, RAHCO shall engage an independent agency to undertake the external monitoring. TOR for the external monitoring is presented in Table 13.41.

Table 13.40: Monitoring Indicators

Items	Indicators
Progress of compensation and relocation	− Number of compensation payments − Number of prepared relocation plots − Number of structures constructed − Number of PAPs relocated − Number of vulnerable people assisted
Procedure	− Institutional establishment (internal unit in RAHCO and CRP Committee) − Grievance mechanism − Consultation meetings with PAPs
Grievance	− Logged grievance and the solutions
Livelihood Restoration Program	− Number of participants/beneficiaries − Implementation of the activates
Socio-economic conditions	− Income change between before and after the relocation − Accessibility to public infrastructure/services

Source: JICA Study Team

Table 13.41: TOR for External Monitoring

A. Project Background
Reli Assets Holding Company (RAHCO) has intended to improve the section between Kilosa and Gulwe of the Central Railway Line which is suffering from the frequent damages caused by the floods. To implement the improvemet, the Project will require land acquisition and involuntary resettlement for rerouting the existing railway with the length of 25km which will affect households according to the land acquisition and resettlement action plan. RAHCO will implement land acquisition and resettlement activities following the updated RAP to meet the requirements of lenders. RAHCO seeks to engage an independent External Monitoring Agency (EMA) to undertake monitoring and evaluation of the RAP implementation process.

B. Key Objective of External Monitoring
Monitoring is an integral part of the resettlement process. The External Monitoring Agency (EMA) will review implementation process as per set policies and criteria in the RAPs report, assess the achievement of resettlement objectives, the changes in living standards and livelihoods, restoration of the economic and social base of the project affected people, the effectiveness, impact and sustainability of entitlements, the need for further mitigation measures if any, and to learn strategic lessons for future policy formulation and planning.

C. Scope of Work
The scope of work of the External Monitoring Agency (EMA) will include the following activities:-

1. To develop specific monitoring indicators for undertaking monitoring of the Resettlement Action Plans (RAPs).
2. To review and verify the progress in land acquisition/resettlement implementation of the Project.
3. Identify the strengths and weaknesses of the land acquisition/resettlement objectives and

approaches as well as implementation strategies.

4. Evaluate and assess the adequacy of compensation given to the APs and the livelihood opportunities and incomes as well as the quality of life of APs of project-induced changes.
5. Identification of the categories of impacts and evaluation of the quality and timeliness of delivering entitlements (compensation and rehabilitation measures) for each category and how the entitlements were used and their impacts and adequacy to meet the specified objectives of the Plans. The quality and timeliness of delivering entitlements, and the sufficiency of entitlements as per approved entitlement matrix.
6. Provide a summary of whether involuntary resettlement was implemented (a) in accordance with the RAPs, and (b) in accordance with the stated policy.
7. To review the quality and suitability of the relocation sites from the perspective of the both affected and host communities.
8. Verify expenditure & adequacy of budget for resettlement activities.
9. To analyze the pre-and post-project socio-economic conditions of the affected people. The methodology for assessment should be very explicit, noting any qualifications.
10. Review results of internal monitoring and verify claims through sampling check at the field level to assess whether land acquisition/resettlement objectives have been generally met. Involve the affected people and community groups in assessing the impacts of land acquisition for monitoring and evaluation purposes.
11. To monitor and assess the adequacy and effectiveness of the consultative process with affected people, particularly those vulnerable, including the adequacy and effectiveness of grievance procedures and legal redress available to the affected parties, and dissemination of information about these.
12. Identify, quantify, and qualify the types of conflicts and grievances reported and resolved and the consultation and participation procedures.
13. Describe any outstanding actions that are required to bring the resettlement activities in line with the policy. Describe further mitigation measures needed to meet the needs of any affected person or families judged and/or perceiving themselves to be worse off as a result of the Project. Provide a timetable and define budget requirements for these supplementary mitigation measures.
14. Describe any lessons learned that might be useful in developing the new national resettlement policy and legal/institutional framework for involuntary resettlement.
15. Verifying internal reports by field-checking delivery of compensation to PAPs, including the levels and timing of the compensation; readjustment of land; preparation and adequacy of resettlement sites; construction of houses; provision of employment, the adequacy of the employment, and income levels; training; special assistance for vulnerable groups; repair, relocation, or replacement of infrastructure; relocation of enterprises, compensation, and adequacy of the compensation; and transition allowances;
16. Interviewing a random sample of PAPs in open-ended discussions, to assess their knowledge and concerns about the resettlement process, their entitlements, and the rehabilitation measures;
17. Observing the functioning of the resettlement operation at all levels, to assess its effectiveness and compliance with the RAP;
18. Checking the type of grievance issues and the functioning of grievance redress mechanisms by reviewing the processing of appeals at all levels and interviewing aggrieved PAPs:
19. Advising RAHCO regarding possible improvements in the implementation of the RAP.

D. Methodology and Approach

The general approach to be used is to monitor activities and evaluate impacts ensuring participation of all stakeholders especially women and vulnerable groups. Monitoring tools should include both quantitative and qualitative methods. The external monitor should reach out to cover:

- PAPs who had property, assets, incomes and activities severely affected by Project works and had to relocate either to resettlement sites or who chose to self-relocate, or whosesource of income was severely affected.
- PAPs who had property, assets, incomes and activities marginally affected by Project works and did not have to relocate;

- PAPs by off-site project activities by contractors and sub-contractors, including employment, use of land for contractor's camps, pollution, public health etc.;

Supplemented by Focused Group Discussions (FGD) which would allow the monitors to consult arrangement of stakeholders (local government, resettlement field staff, NGOs, community leaders, and most importantly, APs), community public meetings: Open public meetings at resettlement sites to elicit information about performance of various resettlement activities.

E. Other Stakeholders and their Responsibility
1. Responsibility of the executing Agencies (EAs)
The EAs through their Project Implementation Unit (PIU) will ensure timely supply of background references, data and other necessary information to the EMA and provide access to project sites and relevant places to let the EMA implement external monitoring activity.

2. Responsibility of the Implementing organization(s)
Organizations that will assist EAs in implementing land acquisition and resettlement activities will provide information required by the EMA at site and at their Project Offices. It will on behalf of EAs ensure free access to project sites and related areas and the database on land acquisition and resettlement activities.

F. Team Composition of the External Monitoring Agency
The EMA should focus on Data collection, processing and analysis to pin point problem areas and weaknesses, and to light on deserving measures to achieve the objectives on schedule are the special interest of the subject. Thus, there is a need for a dedicated monitoring team with adequate gender representation. Further, it is essential that the central team or field level coordinators responsible for monitoring, are skilled and trained in data base management, interview technique, and social and economic/finance. Keeping in mind these criteria, the team should ideally include:

Position/expertise	Qualification and experience
1. Team Leader/ Implementation Specialist	Master in social science with 10-year working experience in social impact assessment including census and socioeconomic surveys, stakeholders' consultation, and analyzing social impacts to identify mitigation measures in compliance with social safeguard policies of the international development financing institutions and national legislations. Experience of preparing resettlement framework and action plans and implementation of plans for externally financed projects is essential.
2. Social Impact Specialist	Master in social science with 5-year working experience in social impact assessment including census and socioeconomic surveys, stakeholders' consultation, and analyzing social impacts to identify mitigation measures in compliance with social safeguard policies of the international development financing institutions and national legislations. Experience of preparing resettlement framework and action plans and implementation of plans for externally financed projects is essential.
3. Data Analyst	Graduate with working experience and knowledge of software such as SPSS (Statistical Package for the Social Sciences)

G.Time Frame and Reporting
The EMA will be employed over a period of 3 years with intermittent inputs from the professional team to continue 2 years after completion of the RAP implementation.
Quarterly and annual monitoring reports should be submitted to RAHCO with copies to JICA. An evaluation report at the end of the project should be submitted to RAHCO and concerned parties with critical analysis of the achievement of the program and performance of EAs and implementing organizations.

The external monitors will provide monitoring and evaluation report covering the following aspects:
- Whether the resettlement activities have been completed as planned and budgeted;
- The extent to which the specific objectives and the expected outcomes/results havebeen achieved and the factors affecting their achievement or non-achievement;

- The extent to which the overall objective of the Resettlement Plan, pre project orimproved social and economic status, livelihood status, have been achieved and thereasons for achievement / non achievement;
- Major areas of improvement and key risk factors;
- Major lessons learnt; and
- Recommendations.

Formats for collection and presentation of monitoring data will be designed in consultation with EAs.

H. Qualification of the External Monitoring Agency
The EMA will have at least 10 years of experience in resettlement policy analysis and implementation of resettlement plans. Further, work experience and familiarity with all aspects of resettlement operations would be desirable. NGOs, Consulting Firms or University Departments (consultant organization) having requisite capacity and experience on the same can qualify for services

Interested agencies should submit a proposal to RAHCO with a brief statement of the approach, methodology, and relevant information concerning previous experience on monitoring of resettlement implementation and preparation of reports.

The profile of its agency, along with full signed CVs of the team to be engaged, must be submitted along with the technical proposal.

I. Budget and Logistics
The budget should include all expenses such as staff salary, office accommodation, training, computer/software, transport, field expenses and other logistics necessary for field activities, data collection, processing and analysis for monitoring and evaluation work. Additional expense claims whatsoever outside the proposed and negotiated budget will not be entertained. VAT, Income Tax and other charges admissible will be deducted at source as per Government laws.

Source: JICA Study Team

13.2.9 Consultation Meetings

(1) Meetings in December 2015

A series of consultation meetings with the PAPs were held at six villages to be directly affected by the land acquisition for the railway rerouting and the river-training works (Table 13.42). The purpose of the meeting was to disclose the proposed project location, identify the affected individuals, and obtain their opinion/consensus on the compensation policies. The meeting was called by the village leaders thorough the network among the villagers.

Agenda and the points of explanation in the meetings are listed below:

1. Opening remarks/self-introduction of the survey team
2. Purpose and meeting objective
   - ✓ It was explained that the survey is preliminary survey as a part of the feasibility study and the official valuation for compensation will be conducted after the official decision of the project.
3. Project information
   - ✓ The place which needs land acquisition was explained using project maps and clarification with attendees.
   - ✓ Draft plan of the temporary construction access road was also explained.
4. Ordinal compensation process based on the Tanzanian laws
   - ✓ District valuers explained the process of asset valuation and compensation as well as allowances in accordance with the Tanzanian laws.
5. Compensation policies considering JICA’s policies

- ✓ It was explained that the JICA's compensation policies would also be applied, combining with the Tanzanian laws, to minimize the social impacts.
- ✓ Entitlement Matrix (in Swahili) which shows compensation policies for this project was explained and provided to the village leaders.
- ✓ It was explained that Livelihood Restoration Program (LRP) is provided to the affected people and the contents would be decided based on the people's requirements.
- ✓ Although it cannot be the official cut-off-date to restrict the land use and the transaction, it was explained that unnecessary development for being compensated should be prevented under observation by the village leaders and the villagers after the completion of the survey.

6. Identification of the affected people
   - ✓ At the end of the meeting, affected people claimed to be identified under the witness of the other villagers.

The participants raised questions on the compensation policies and the details of the procedures, which were answered by the consultants and RAHCO (Table 13.43). No dissenting voice or objection against the project or the compensation policies was identified through the meetings.

Table 13.42: Consultation Meetings with the PAPs (1–7 December 2015)

Date	Village name (Ward and District name)	Number of participants Total	(Women)
1Dec.	Munisagara (Msanze, Kilosa)	130	(32)
	Mzaganza (Kidete, Kilosa)	30	(7)
2 Dec.	Kikundi (Kidete, Kilosa)	173	(74)
6 Dec.	Kisisi (Godegode, Mpwapwa)	116	(74)
	Godegode (Godegode, Mpwapwa)	181	(54)
7 Dec.	Gulwe (Gulwe, Mpwapwa)	138	(23)

Source: JICA Study Team

Table 13.43: Major Comments and Response in the Meetings (1–7 December 2015)

Subjects		Raised Issues	Response
Project implementation /general frameworks	1)	When will the construction activities be commenced? (Munisagara)	After completion of the feasibility study and the compensation.
	2)	PAPs to be informed early in advance before project implementation to avoid further use of the project area.(Mzaganza)	PAPs will be informed when the official valuation is carried out.
	3)	Who is going to compensate? The government of Tanzania or Japan? (Munisagara)	The government of Japan funds for the project. Compensation will be paid by the government of Tanzania.
	4)	Progress of each step of the project should be informed from time to time after the meeting. (Mzaganza)	Noted.
Compensation / valuation	5)	Does RAHCO commit compensating for encroachers? (Munisagara)	RAHCO is requested to comply with JICA's policy to compensate for encroachers.
	6)	Will it be compensated if only half of the structure is affected? (Munisagara)	Yes. All affected asset will be compensated.
	7)	Is it possible to continue construction of the house if it is already under construction? (Kikundi, Godegode)	Yes, because it is still preliminary valuation stage.

Subjects	Raised Issues	Response
	8) Many people are lack of legal documents of land ownership. Is it possible to be compensated? (Kisisi)	Land ownership is recognized by inheritance, traditional and legal ownership.
	9) What about if graves are affected? (Kikundi, Godegode, Gulwe)	There is a law for compensating graves.
	10) What about if watering place is affected? (Kikundi)	If the land belongs to the village, the village will be compensated.
	11) Will natural tree be compensated? (Kisisi)	If it has value, it will be compensated.
	12) Compensation should be paid fairly, promptly and timely. (Munisagara) 13) The government should fairly compensate to all affected persons in order to maintain their living standard together with their families (Mzaganza)	It will be made in accordance with law.
	14) Assure of the compensation because the Tanzanian system is so prolonged. (Kisisi)	RAP committee team will be established for assurance.
	15) Construction should be started after compensation and resettlement (Mzaganza)	It will in accordance with both Tanzanian law and JICA's policy.
	16) What can we do if we don't satisfy the compensation payment? (Mzaganza, Kikundi, Gulwe)	You can appeal through the grievance mechanism.
	17) Valuation schedule should be informed in advance to the PAPs. (Munisagara)	Noted.

Source: JICA Study Team

(2) Meetings in June 2016

In order to provide a feedback of the results of the CRP, another series of consultation meetings with the PAPs were held at six affected villages (Table 13.44). The main purpose of the meetings was to confirm the compensation policy and finalize their consensus. The participants were the PAPs called by the village leaders, and the word officers.

Agenda and the points of explanation in the meetings are listed below:

1. Introduction
   - ✓ It was announced that the preliminary CRP has been completed in this study.
   - ✓ It was informed that the final CRP would be taken place, expected to be in 2017.
2. Compensation policy of affected structure
   - ✓ It was explained that the Tanzanian law would be the base of the valuation for compensation. The PAPs consent on this policy was confirmed.
   - ✓ In addition, it was explained that a community support would be provided by JICA through RAHCO in accordance with JICA's policy.
   - ✓ Although the details of the community support would be decided in the next study stage, the PAPs were inquired about their requests on the community support for information for the next stage.
3. Compensation policy of affected land
   - ✓ Considering that the alternative spare land is limited in the project area, it was explained that land-for-land compensation would not be feasible although it was recommended by JICA's policy. The PAPs opinion on this issue was collected.

- ✓ It was confirmed that a Livelihood Restoration Program (LRP) would be provided based on the JICA's policy for the PAPs who lose farmland. PAPs were inquired about their requests on the contents of the LRP.

4. Cut-off-date
   - ✓ It was confirmed that unnecessary development should be prevented until the final CRP survey stage.
   - ✓ It was explained that a legal cut-off-date would be established in the final CRP which was expected to be taken place in 2017.
5. Grievance redress mechanism
   - ✓ Grievance redress mechanism proposed in the CRP was introduced to the PAPs.
6. Provision of the reports
   - ✓ Following documents were introduced and provided to the village leaders.
     - Summary of the preliminary RAP (CRP)
     - Entitlement matrix
     - Summary of ESIA report

The major results of the meetings are listed below:

- All participants at each village agreed that the compensation of structure would be based on Tanzanian law. They also appreciated the community support. They understood that the details of the support would be decided in the next stage together with the budget scale.
- All participants at each village agreed with cash compensation for the affected land considering limitation of spare land with exception of residential land in Kikundi. (In Kikundi, it was already agreed that residential land to be resettled would be developed for the PAPs.)
- Requests on the community support and the LRP are listed in Table 13.45 and Table 13.46.

The other major questions/comments from the participants and the responses by the consultant, RAHCO and the JICA Study Team are listed in Table 13.47.

Table 13.44: Consultation Meetings with the PAPs (14–16 June 2016)

Date	Village name (Ward and District name)	Number of participants* Total	(Women)
Tuesday 14 June.	Munisagara (Msanze, Kilosa)	26	(5)
Wednesday 15 June	Mzaganza (Kidete, Kilosa)	60	(17)
	Kikundi (Kidete, Kilosa)	38	(10)
	Kisisi (Godegode, Mpwapwa)	9	(0)
Thursday 16 June	Godegode (Godegode, Mpwapwa)	27	(6)
	Gulwe (Gulwe, Mpwapwa)	66	(12)

'* including village leaders and word officers
Source: JICA Study Team

Table 13.45: Request of the Community Support

Village name	Requests
Munisagara	− School infrastructure - especially class rooms and teachers' houses are inadequate; − Road to the village - the community faces difficulty and risk by utilising the railway as access to the village; − Dispensary – needs to be repaired
Mzaganza	− Dispensary since there is none; − Access road to the village since there is no road; − Safe and clean water supply - the villagers currently fetch water for domestic use from the river which is always turbid and not safe; − Completion of Kidete dam embankment - so that flooding to the downstream can be controlled; − Rehabilitation of church (Roman Catholic) buildings; − Rehabilitation of class rooms and teachers' house - since the school has 6 class rooms which are dilapidated and pause a safety risk to pupils; − Construction of village office
Kikundi	− Dispensary since there is none in the village; − Class rooms for their primary school since there are only 2 rooms; − Teachers' house - the school has no teacher's house which makes it difficult for teachers to stay far from school premises; − Water supply - requesting an additional water well; − Rehabilitation of the existing road to Mpwapwa
Kisisi	− Water supply for the village - water is a problem since they depend on Chinyasungwe river and others where they have to walk 7km to reach; − Dispensary - since they have to travel 9km to Godegode in search for health services; − Class rooms - Kisisi Primary School has 4 rooms where only 2 rooms are in use. The other 2 are out of order and pose safety risks to pupils. Other pupils take their classes outside, sitting under tree shades
Godegode	− Health centre - the existing dispensary is overloaded − Water supply - the village is experiencing water scarcity − Police station - to boost security
Gulwe	− Water supply - since the currently used sources are not reliable and unsafe; − Secondary school - since the village has no secondary school. Students travel a distance of between 15 to 20km daily for studies; − Health centre - since the existing serves 3 villages of Chiseyu, Uyuma and Gulwe, all found in Gulwe Ward.

Source: JICA Study Team

Table 13.46: Request of Livelihood Restoration Program (LRP)

Village name	Requests
Munisagara	− Assistance for agriculture − Poultry
Mzaganza	− Irrigation infrastructure − Bee-keeping − Entrepreneurship training e.g. soap making, raising of livestock (cows, poultry)
Kikundi	− Farming implements and inputs i.e. seeds, insecticides, machinery etc.
Kisisi	− Equipment for increasing agricultural production - tractors, ox, fertiliser, etc. − Capacity building on how to increase land productivity − Fish farming − Modern livestock keeping

Village name	Requests
Godegode	− Water pumps to enable water for irrigation reach their farms − Agricultural implements, e.g. tractors, power tillers etc. − Skills development through trainings on entrepreneurship
Gulwe	− Poultry − Open up vegetable gardens and give training on how to grow healthy vegetables − Piggery and milk cows raring − Training on carpentry − Provision of agricultural implements − Beekeeping − Fish farming

Source: JICA Study Team

Table 13.47: Questions/Comments and Response in the Meeting (14–16 June 2016)

Subjects	Raised Issues	Response
RAP survey	1) How will I be compensated since I was not considered in the previous survey? (Godegode)	The survey exercise will be repeated. The previous survey was to get the overview of the situation. In the second survey, PAPs will be photographed while standing in their piece of land to be taken by the project and requested to sign valuation report. Therefore, there is still a chance to come for updating the PAPs database.
	2) A tenant was recorded on my land and not me, how will I be considered? (Godegode)	There will be another survey which gathers PAPs details.
Compensation of structure	3) What Tanzania laws state for valuation and compensation of assets? (Mzaganza)	Tanzania laws take into consideration type of house, type of construction materials, age and current condition at the time of valuation (depreciation).
	4) If PAPs want to rebuild the affected house, how will it be considered during valuation? (Gulwe)	The laws in Tanzania do not consider replacement; only gives cash compensation.
	5) There was a plan that the project would re-build the affected houses at the resettlement site in Kikundi. Is the plan still valid? (Kikundi)	If the PAPs chose in-kind compensation, namely compensation by re-built houses, community support program will not be provided. ->The PAPs agreed with cash compensation so that they could build the houses at the resettlement site by themselves.
Compensation of land	6) Shall land be sold or taken by the project? (Mzaganza)	No land shall be taken without compensation.
	7) If I sell a piece of land to someone and that person constructs a house, how will that be handles? (Kikundi)	Compensation will be on owner of that land. However, that will be confirmed at the final survey to be undertaken in 2017.
	8) I have a piece of land on which a tenant has constructed a residential house. What will I get? (Kikundi)	Owner of the house will be compensated for a house and land owner shall be compensated for land.
	9) What guide is used to determine value of PAPs' land? (Godegode)	Value of land depends on size, location and current local price. The district has guidelines in determining the value of land for the entire district council jurisdiction.

Subjects	Raised Issues	Response
	10) I used to cultivate food crops on my land. How will I continue my livelihood? (Godegode)	Land in Tanzania is vested in the custody of the President of the United Republic. If the government has national interest in your piece of land, then there are procedures laid down by law on how to acquire that land.
	11) Why is allowance not given on disturbance due to loss of land since it might take longer for PAPs to get a new piece of land considering the fact that land is limited in the village? (Godegode)	Bare land does not be considered for disturbance allowance. Moreover, land grown with crops is considered i.e. land is compensated and crops compensated as well
Community support	12) Who specifically are the beneficiaries of the community support program? (Munisagara)	Community support program intends to benefit the entire community.
	13) How do PAPs benefit if their assets are affected but community support program is extended to the entire community and not the PAPs? (Kisisi)	Apart from the compensation to each PAP, JICA wishes to contribute to the community of which structures are affected.
	14) Why is the entire community benefiting from JICA through community support program while the PAPs are compensated by Tanzania only? (Godegode)	Compensation for structures shall be governed by Tanzania laws, which take into consideration value of structures and some additional allowances but no more support. JICA proposes to assist the entire community/village from which built structures are lost to the proposed project.
Livelihood Restoration Program	15) How long will the Livelihood Restoration Program last?	The program can be operated by JICA for 2- 3 years after which PAPs should be able to continue by themselves.
	16) Will the money for livelihood restoration be given directly to PAPs or shall be channeled through the district office?	Livelihood Restoration Program does not involve provision of cash to PAPs. The program shall sponsor what is required or requested by PAPs.
Cut-off-date	17) Since the valuation exercise is planned in 2017, can we continue crop cultivation until that time? (Munisagara, Gulwe)	Cultivation can be continued until the cut-off date is announced in the final RAP expected to be in 2017.
	18) If not compensated within 6 months of the cut-off date, where should we report? (Mzaganza)	Grievance handling procedure shall be established.
	19) What about those PAPs who had plans to construct extra rooms to their houses and now are not supposed to do any developments to the existing situation, how should they live? (Mzaganza)	Developments can be undertaken on emergency cases. If the PAP had plans to add rooms to the house before the preliminary survey was undertaken, it means there was need to do so in order to shelter the family.
	20) I was told to stop construction of my house. (Godegode)	If you already began constructing and you have a great need for that house for habitat and that there no other alternatives then should continue with construction. However,

Subjects	Raised Issues	Response
		PAPs were cautioned not to construct houses beyond their requirements.
	21) What if land owners decide to build houses on the land earmarked for the project provided they are in need of that house? (Godegode)	Buildings to be compensated should be on felt and genuine requirements only and not targeting compensations. If extra houses are found and the assessment identifies possibilities of conflict raptures, it might be required to liaise with neighbors to the newly built houses on the reasons for building that house or otherwise the design might be forced to change.
Others	22) How will PAPs be sure that their money posted in the bank account is what was agreed upon? (Kikundi)	PAPs will be informed of the total amount of their compensation. If the amount posted is not what the PAP signed, then there will be a desk to handle such grievances.
	23) How will compensation be handled if the previously identified owner of land passed away? (Godegode)	In case the departed person did not prepare a will, then it is the family to resolve the ownership so that there wouldn't be setbacks during valuation exercise.
	24) What is the plan to deal with special groups of PAPs (disabled, elderly, and children) who are not able or capable to make use of compensation to rebuild their lives? (Gulwe)	Vulnerable groups will be assisted.
	25) Where will mobilization vehicles pass during re-routing of the railway? (Gulwe)	The temporary road to be used for mobilization shall be opened within 30m buffer zone and other public roads that exist in the area. But if it is necessary to open up a route across the community areas, there will be memorandum of understanding signed between the Contractor and the particular person.
	26) A PAP has a conflict of land ownership with the village government of an area preliminary identified as affected by the re-routing. How will that be handled during valuation? (Gulwe)	The compensation team will not work on areas with conflicts. The village government was advised to resolve the misunderstandings so that during the valuation exercise, all conflicts should have been solved.

Source: JICA Study Team

13.3 Checklist and Monitoring Form under JICA's Guidelines

The environmental checklist for the railway project was filled, as per Table 13.48.

Table 13.48: Environmental Checklist

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
1 Permits and Explanation	(1) EIA and Environmental Permits	(a) Have EIA reports been already prepared in official process? (b) Have EIA reports been approved by authorities of the host country's government? (c) Have EIA reports been unconditionally approved? If conditions are imposed on the approval of EIA reports, are the conditions satisfied? (d) In addition to the above approvals, have other required environmental permits been obtained from the appropriate regulatory authorities of the host country's government?	(a)Y (b)N (c)N/A (d)N	(a) The report was prepared in January 2016. (b) The report was submitted to NEMC in March 2016. (c) N/A (d) The other permits will be obtained/renewed in a timely manner; those are a permission for transportation of heavy cargo for construction, environmental certificate to open a new quarry, works permit for construction workers, a permit for transportation of chemicals, and a permit for transportation of waste.
	(2) Explanation to the Local stakeholders	(a) Have contents of the project and the potential impacts been adequately explained to the Local stakeholders based on appropriate procedures, including information disclosure? Is understanding obtained from the Local stakeholders? (b) Have the comment from the stakeholders (such as local residents) been reflected to the project design?	(a)Y (b)Y	(a) A series of local stakeholder meetings were held at the scoping stage and the final stage of the EIA Study. The project outlines, potential impacts and the mitigation measures were explained and accepted. (b) Comments from the stakeholders at the scoping stage were incorporated in the EMP.
	(3) Examination of Alternatives	(a) Have alternative plans of the project been examined with social and environmental considerations?	(a)Y	(a) The rerouting sections were selected from six alternatives based on the results of comparison in terms of the economic and physical feasibility and minimization of resettlement and land acquisition.
2 Pollution Control	(1) Water Quality	(a) Is there a possibility that soil runoff from the bare lands resulting from earthmoving activities, such as cutting and filling will cause water quality degradation in downstream water areas? (b) Do effluents from the project facilities, such as stations, comply with the country's effluent standards and ambient water quality standards? Is there a possibility that the effluents will cause areas not to comply with the country's ambient water quality standards?	(a)N (b)Y	(a) As the turbidity is already high in the rivers, soil runoff will not affect the water quality. However, the condition will be monitored. (b) The station facilities newly planned for this project will be designed to be equipped with enough capacity for the domestic wastewater treatment. As the discharge volume will be limited, it will not cause significant water pollution.
	(2) Wastes	(a) Are wastes generated from the project facilities, such as stations and depot, properly treated and disposed of in accordance with the country's regulations?	(a)Y	(a) Waste disposal by the passengers at the stations is limited. The collected waste is disposed in accordance with the village rules.
	(3) Noise and Vibration	(a) Do noise and vibrations from the vehicle and train traffic comply with the country's standards?	(a)N/A	(a) Tanzania does not have ambient noise and vibration standards. Impacts of noise and vibration by trains will be the same as with the present condition.
	(4) Subsidence	(a) In the case of extraction of a large volume of groundwater, is there a possibility that the extraction of groundwater will cause subsidence (especially in case of Undergrounds/Subways)?	(a)N/A	(a) Extraction of a large volume of groundwater is not planned.

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
3 Natural Environment	(1) Protected Areas	(a) Is the project site located in protected areas designated by the country's laws or international treaties and conventions? Is there a possibility that the project will affect the protected areas?	(a)N	(a) The project area is not located in protected areas.
	(2) Ecosystem	(a) Does the project site encompass primeval forests, tropical rain forests, ecologically valuable habitats (e.g., coral reefs, mangroves, or tidal flats)? (b) Does the project site encompass the protected habitats of endangered species designated by the country's laws or international treaties and conventions? (c) If significant ecological impacts are anticipated, are adequate protection measures taken to reduce the impacts on the ecosystem? (d) Are adequate protection measures taken to prevent impacts, such as disruption of migration routes, habitat fragmentation, and traffic accident of wildlife and livestock? (e) Is there a possibility that installation of rail roads will have impacts, such as destruction of forest, poaching, desertification, reduction in wetland areas, and disturbance of ecosystems due to introduction of exotic (non-native invasive) species and pests? Are adequate measures for preventing such impacts considered? (f) In cases the project site is located at undeveloped areas, is there a possibility that the new development will result in extensive loss of natural environments?	(a)N (b)N (c)Y (d)Y (e)N (f)N/A	(a) The project site does not encompass ecologically-valuable habitats such as primeval forests. (b) Although some species to be protected according to the IUCN list were reported, the project site does not encompass the protected habitats of those species. (c) Although significant ecological impacts are not anticipated, flora and vegetation conservation plans will be developed before the construction commences to secure bio-diversity. (d) Terrestrial migratory species were not found in the project area. Habitat fragmentation is not anticipated as the railway already exists. For livestock, culverts will be installed at the rerouting sections to secure pathways to cross the rail. (e) As the project is not to install a new railway, those impacts are not anticipated. (f) The project site is not an undeveloped area with the existing railway.
	(3) Hydrology	(a) Is there a possibility that alteration of topographic features and installation of structures, such as tunnels will adversely affect surface water and groundwater flows?	(a)N	(a) River-training works will change the river course; however, it will not cause adverse impacts because it is within the flood plain.
	(4) Topography and Geology	(a) Is there a soft ground on the route that may cause slope failures or landslides? Are adequate measures considered to prevent slope failures or landslides, where needed? (b) Is there a possibility that civil works, such as cutting and filling will cause slope failures or landslides? Are adequate measures considered to prevent slope failures or landslides? (c) Is there a possibility that soil runoff will result from cut and fill areas, waste soil disposal sites, and borrow sites? Are adequate measures taken to prevent soil runoff?	(a)N (b)N (c)Y	(a) Mountain slopes to be cut for rerouting consist of hard rocks. (b) Slope failures or landslides are not anticipated. (c) Measures for managing soil erosion and the runoff will be applied; for example, controlling work areas of equipment/vehicles, preparing sedimentation ponds, and compacting disturbed areas.
4 Social Environment	(1) Resettlement	(a) Is involuntary resettlement caused by project implementation? If involuntary resettlement is caused, are efforts made to minimize the impacts caused by the resettlement? (b) Is adequate explanation on compensation and resettlement	(a)Y (b)Y (c)Y (d)Y	(a) A Livelihood Restoration Program will be provided for minimizing the impacts caused by the agricultural land acquisition. (b) During this Study, compensation and assistance policy

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
		assistance given to affected people prior to resettlement? (c) Is the resettlement plan, including compensation with full replacement costs, restoration of livelihoods and living standards developed based on socioeconomic studies on resettlement? (d) Are the compensations going to be paid prior to the resettlement? (e) Are the compensation policies prepared in document? (f) Does the resettlement plan pay particular attention to vulnerable groups or people, including women, children, the elderly, people below the poverty line, ethnic minorities, and indigenous peoples? (g) Are agreements with the affected people obtained prior to resettlement? (h) Is the organizational framework established to properly implement resettlement? Are the capacity and budget secured to implement the plan? (i) Are any plans developed to monitor the impacts of resettlement? (j) Is the grievance redress mechanism established?	(e)Y (f)Y (g)Y (h)Y (i)Y (j)Y	based on both Tanzanian law and JICA's policies were explained to the affected people. (c) The preliminary resettlement plan was developed during the Study including compensation policies and the socioeconomic Study results. It will be updated and detailed after the project implementation is officially decided. (d) Both Tanzanian law and JICA's policies regulate the payment to be prior to the resettlement. (e) The compensation policies are presented in the report of this Study. (f) The policy includes the assistance for old people, women heads of households, widows, single mothers, orphans, physically and mentally challenged and the infirmed people. (g) So far, there have been no objections from the affected people. (h) RAHCO will establish an internal unit and the CRP Committee with local governments. RAHCO takes full responsibility for budgetary preparation. (i) Internal and external monitoring will be conducted by RAHCO. (j) It will be established under cooperation of the local governments.
	(2) Living and Livelihood	(a) Where railways are newly installed, is there a possibility that the project will affect the existing means of transportation and the associated workers? Is there a possibility that the project will cause significant impacts, such as extensive alteration of existing land uses, changes in sources of livelihood, or unemployment? Are adequate measures considered for preventing these impacts? (b) Is there any possibility that the project will adversely affect the living conditions of inhabitants other than the affected inhabitants? Are adequate measures considered to reduce the impacts, if necessary? (c) Is there any possibility that diseases, including infectious diseases, such as HIV will be brought due to immigration of workers associated with the project? Are adequate considerations given to public health, if necessary? (d) Is there any possibility that the project will adversely affect road traffic in the surrounding areas (e.g., by causing increases in traffic congestion and traffic accidents)?	(a)N/A (b)N (c)Y (d)N (e)N (f)N	(a) The railway is not newly-installed, but already exists. (b) The project will not cause impacts widely spread out of the affected communities. (c) The inflow of construction workers may bring infectious diseases. Prevention programs will be established with the cooperation with local government officers. (d) Traffic congestion is not anticipated as the existing traffic is limited. (e) Culverts will be installed at the rerouting sections to secure pathways to cross the rail. (f) Structures with high altitudes which will cause sun-shading and radio interference are not planned.

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
		(e) Is there any possibility that railways will impede the movement of inhabitants? (f) Is there any possibility that structures associated with railways (such as bridges) will cause a sun shading and radio interference?		
4 Social Environment	(3) Heritage	(a) Is there a possibility that the project will damage the local archeological, historical, cultural, and religious heritage? Are adequate measures considered to protect these sites in accordance with the country's laws?	(a)Y	(a) Although the archaeological and cultural heritage of the project area remains unknown, some archaeological sites were found around the project site. In accordance with the EMP, the contractor has to observe and record the resources discovery during the earthworks and inform to the Ministry of Natural Resources and Tourism if something is discovered.
	(4) Landscape	(a) Is there a possibility that the project will adversely affect the local landscape? Are necessary measures taken?	(a)N/A	(a) There is no specific landscape to be protected.
	(5) Ethnic Minorities and Indigenous Peoples	(a) Are considerations given to reduce impacts on the culture and lifestyle of ethnic minorities and indigenous peoples? (b) Are all of the rights of ethnic minorities and indigenous peoples in relation to land and resources respected?	(a)N/A (b)N/A	(a)(b) There are no ethnic minorities nor indigenous people to be considered.
	(6) Working Conditions	(a) Is the project proponent not violating any laws and ordinances associated with the working conditions of the country which the project proponent should observe in the project? (b) Are tangible safety considerations in place for individuals involved in the project, such as the installation of safety equipment which prevents industrial accidents, and management of hazardous materials? (c) Are intangible measures being planned and implemented for individuals involved in the project, such as the establishment of a safety and health program, and safety training (including traffic safety and public health) for workers etc.? (d) Are appropriate measures taken to ensure that security guards involved in the project not to violate safety of other individuals involved, or local residents?	(a)Y (b)Y (c)Y (d)N/A	(a) RAHCO and TRL comply with the Occupational Health and Safety Act No. 5 (2003), Employment and Labor Relations Act No.6 (2004), Workers' Compensation Act Cap 263 (2008) and other relevant regulations. (b) Protective masks will be provided to the construction workers who are involved in the dust generation works. Fire extinguisher and fire alarms are equipped in the TRL offices. Gumboots, groves, overcoats, and helmets are provided to staffs working at workshops. For gang men, gumboots and groves are provided. (c) For the construction workers, a "public health and safety and construction health and safety plan" and "construction site management plan" will be established and implemented. For operation, TRL will prepare/update the safety program including safety training. (d) It is hardly expected that the project security guard violate the other individual's safety.
5 Others	(1) Impacts during Construction	(a) Are adequate measures considered to reduce impacts during construction (e.g., noise, vibrations, turbid water, dust, exhaust gases, and wastes)? (b) If construction activities adversely affect the natural environment (ecosystem), are adequate measures considered to reduce impacts?	(a)Y (b)Y (c)Y (d)N/A	(a) Management of the construction noise, water pollution, air pollution and waste are included in the EMP. (b) In accordance with the EMP, investigation of flora and fauna has to be conducted before commencement of the construction works. If protected species are found, measures

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
		(c) If construction activities adversely affect the social environment, are adequate measures considered to reduce impacts? (d) If the construction activities might cause traffic congestion, are adequate measures considered to reduce such impacts?		such as re-planting needs to be considered. (c) Temporary disturbance of socioeconomic activities and public health and safety hazards are managed in accordance with the EMP. (d) Traffic congestion is not anticipated.
	(2) Monitoring	(a) Does the proponent develop and implement monitoring program for the environmental items that are considered to have potential impacts? (b) What are the items, methods and frequencies of the monitoring program? (c) Does the proponent establish an adequate monitoring framework (organization, personnel, equipment, and adequate budget to sustain the monitoring framework)? (d) Are any regulatory requirements pertaining to the monitoring report system identified, such as the format and frequency of reports from the proponent to the regulatory authorities?	(a)Y (b)Y (c)Y (d)Y	(a) The monitoring plan was developed as a part of the EIA. (b) The items, parameters, frequency, and areas are described in the monitoring plan in the EIA. (c) The Environmental Control Officer (ECO) of RAHCO will take responsibility on the monitoring. The budget is under the responsible of RAHCO. (d) NEMC can request proponents to submit the monitoring results.

Source: Input by the JICA Study Team, using JICA template.

Table 13.49: Environmental Monitoring Form for Construction Stage

Potential Impact	Item	Monitoring area	Parameter to be monitored	Baseline (Average/Max/Total, etc.)	Result (Average/ Max/ Total, etc.)	Measurement unit	Target level or standard	Monitoring frequency
Mobilization								
Impact # 1: Land disturbances / soil erosion at onsite and offsite location	Land surface condition	Project site	Rills and gullies Sediments in receiving water bodies			None mg/l	No erosion None	Once every six months
Impact # 2: Loss / damage / disturbance of indigenous vegetation and contained biodiversity species	Vegetation and wild animals	Entire project site	Types of vegetation being cleared, Existence of endemic /protected species, Area being cleared			Numbers	No endemic/ protected species cleared Clearance should be restricted to project corridor	Continuously during mobilization and construction phase
Impact # 3: Depletion at point source	Material procurement	Point of sourcing and Project site	Procurement records			all procurements from licensed operator	No material from unlicensed supplier, No new borrow pit	Monthly during construction
Impact # 4: Impaired air quality & contribution to climate change due to release of dust, greenhouse gases and other noxious air pollutants	Air quality	Construction site	CO2, NOx, dust			mg/l, ppm	NOx = 150 µg/ Nm3 for 24-hours average value [1] CO = Daily average of hourly values shall not exceed 10mg/kg and average of hourly values in eight consecutive hours shall not exceed 20 mg/kg. Dust (measured as PM10) = 150µg/m3 measured over 24hour average [2]	Once every six month
Impact # 5: Release of oils and fuels in the aquatic environment	Water quality (oil)	Surface water bodies	Oil contents			mg/l	10 [3]	Once every six month

Potential Impact	Item	Monitoring area	Parameter to be monitored	Baseline (Average/Max/Total, etc.)	Result (Average/ Max/ Total, etc.)	Measurement unit	Target level or standard	Monitoring frequency
Impact # 6: Contamination of surface waters with demolition debris and soils	Water quality (turbidity etc.)	Project site	All types of waste including § Heaps of soils § Plastics wastes § Glass wastes § Turbidity § Suspended solids in receiving water bodies § BOD			None NTU mg/l mg/l	No haphazard disposal of waste 300 [3] 100 [3] 30 [3]	Continuous throughout the project cycle
Construction								
Impact # 7: Land disturbances / soil erosion	Land surface condition	Construction site	Rills and gulliesSediments in receiving water bodies			Nonemg/l	No erosionNone	Once every six months
Impact # 8: Impaired air quality & contribution to climate change due to release of dust (including fugitive (unavoidable, residual), greenhouse gases and other noxious air pollutants	Air quality	Construction site	CO2, NOx, dust			mg/l, ppm	NOx = 150 µg/ Nm3 for 24-hours average value [1] CO = Daily average of hourly values shall not exceed 10mg/kg and average of hourly values in eight consecutive hours shall not exceed 20 mg/kg. Dust (measured as PM10) = 150µg/m3 measured over 24hour average [2]	Once every year
Impact # 9: Impaired land and water qualities and contained resources from discharge of pollutants (wastes, oily substances etc.)	Water quality	Surface water bodies	Oil contents All types of waste including § Heaps of soils § Plastics wastes § Glass wastes § Turbidity § Suspended solids in receiving water bodies § BOD			mg/l None NTU mg/l mg/l	10 [3] No haphazard disposal of waste 300 [3] 100 [3] 30 [3]	Once every year

Potential Impact	Item	Monitoring area	Parameter to be monitored	Baseline (Average/Max/Total, etc.)	Result (Average/ Max/ Total, etc.)	Measurement unit	Target level or standard	Monitoring frequency
Impact # 10: Temporary disturbances / flight of aquatic fauna from noise emission	Noise	Project site	Noise levels			dB	<85 dB [4]	Once month after commencement of construction
Impact # 11: Destruction of archeological and Cultural heritage resources	Archeological and cultural heritage	Project site	No. of discoveries			Number	All discoveries should be reported	Continuously
Impact # 12: Change or modification of population and its quality of life due to land take	Affected people	All villages along the project corridor	Existing of land related conflicts, Types of land use			Number of conflicts	Zero	Continuously
Impact # 13: Construction health and safety hazards	Health and safety	Construction site	･ Personnel health records ･ Noise levels ･ Concentration of pollutants such as dust in the working environment ･ Number injuries			None dB ppm numbers	 Noise = <85dB Dust = Not to exceed 250 mg/Nm3(24h mean value) [1] Zero injuries	Once every year
Impact # 14: Temporary disruption of socioeconomic activities	Socioeconomic activities	Entire project site	Existence of complaints			Number of complaints	As minimum as possible	Continuously during construction
Impact # 15: Loss of aesthetics due to haphazard disposal of demolition waste	Waste	Project site	All types of waste including § Heaps of soils § Plastics wastes § Glass wastes § Turbidity § Suspended solids in receiving water bodies § BOD			None NTU mg/l mg/l	No haphazard disposal of waste 300 [3] 100 [3] 30 [3]	Continuous throughout the project cycle

Potential Impact	Item	Monitoring area	Parameter to be monitored	Baseline (Average/Max/Total, etc.)	Result (Average/ Max/ Total, etc.)	Measurement unit	Target level or standard	Monitoring frequency
Impact # 16: Nuisance and disturbances from noise / vibrations (exceeding allowable level for people comfort) due to construction activities	Noise	Project site	Noise levels			dB	<85 dB [4]	Once month after commencement of construction
Impact # 17: Occupational Health and Security and Safety (HSS) risks	Health and safety	Project area	Incidences of breach of health and safety			Number of incidents	Zero	Continuously
Impact # 18: Public HSS risks: traffic accidents, Risks of human-human transmission of diseases (STD, HIV, etc.) Infections from putrescible wastes with disease pathogens	Infectious disease	hospital / dispensary	STDsHIV/AIDS infectionsCholera			Number of people infected	No or as minimum infectious cases	At the beginning of the project and once every year
Impact # 19: Vandalism of structures / equipment, theft of materials and portable items during construction	Vandalism	Construction site and stores	Destroyed infrastructure and loss of equipment			Number of theft incidences	No or minimum destruction, theft incidences	Continuously during construction

[1] Environmental Management (air Quality Standard)Regulation of 2007
[2] USA National Air Quality Standard
[3] Environmental Management (Water Quality Standards) Regulations 2007
[4] Environmental Management (Noise and Vibration Management and Control) Regulations of 2007
Source: JICA Study Team

Table 13.50: Environmental Monitoring Form for Operation Stage

Potential Impact	Item	Monitoring area	Parameter to be monitored	Baseline (Average/Max/ Total, etc.)	Result (Average/Max/ Total, etc.)	Measurement unit	Target level or standard	Monitoring frequency
Impact # 20: Release of oils and fuels in the environment	Water quality	Surface water bodies	Oil contents			mg/L	10 [1]	Once every six month
Impact # 21: Impairment of local air quality	Air quality	Along railway	CO_2, NO_x, dust			mg/L, ppm	NO_x = 150 µg/ Nm3 for 24-hours average value [2] CO = Daily average of hourly values shall not exceed 10mg/kg and average of hourly values in eight consecutive hours shall not exceed 20 mg/kg. Dust (measured as PM10) = 150µg/m3 measured over 24hour average [3]	Once every six month
Impact # 22: Occupational and Public health and safety	Health and safety	Project site	・ Personnel health records ・ Noise levels ・ Concentration of pollutants such as dust in the working environment ・ Number injuries			None dB ppm numbers	 Noise = <85dB Dust = Not to exceed 250 mg/Nm3(24h mean value) [2] Zero injuries	Once every year
Impact # 23: Potential loss of lives and property as a result of falling off from moving train, collision with train at road crossing as a result of increased train frequencies	Accidents	Railway stations	Reported cases of such injuries			Number	Zero	Once every month

Potential Impact	Item	Monitoring area	Parameter to be monitored	Baseline (Average/Max/ Total, etc.)	Result (Average/Max/ Total, etc.)	Measurement unit	Target level or standard	Monitoring frequency
Impact # 24: Additional pressure and demands on local social services and resources (increase water users, toilet users)	Social services	Railway stations	Number of toilets at each station Incidences of open defecations			Number of functioning toilets, Clean water Signs of open defecation	As many as possible No open defecation	Once at the beginning of operation and then one year and availability of clean water Continuously
Impact # 25: Vandalism of structures / equipment, theft of materials and portable items	Vandalism	Entire project	Reported cases of vandals			Reported cases	No or minimum vandalism cases	Continuously
Impact # 26: Physical damage of project structures and disruption of railway operations and schedules due to natural causes	Project structure	Project site	Physical strength of impacted structure			None	No structure weakness	Once every year
Impact # 27: Impairment of environmental quality due to accidental event	Accidents	Site of accident	Vegetation, Oil contamination			Decontaminated soils and plants mg/L	10 [1]	Immediately after accident and once every six months
Impact #28 Impairment of railway operations as a result of flooding of Gombe Dam	Flood at dam	Gombe Dam Area	Flooding tendencies			Visual	Flood should not extent beyond the dam boundaries	Continuously during rainy season
Impact # 29: Increased train frequencies and therefore smoothen passenger and cargo movement	Number of passenger	TRL Head Quarters	Train frequencies			Number	At least one passenger train per day	Once every year
Impact # 30: Protection of roads from heavy cargo as is the current practice	Number of cargo	TRL Head Quarters	Cargo tonnage transported by train			Tonnage	At least 80% of cargo is reported by train by 2019	Once every year

Potential Impact	Item	Monitoring area	Parameter to be monitored	Baseline (Average/Max/ Total, etc.)	Result (Average/Max/ Total, etc.)	Measurement unit	Target level or standard	Monitoring frequency
Impact # 31: Increased income to local suppliers	Local economy	Procurement supply list	Supplies and services received from the residents			Number of supplies and services from the residents	As many supplies and services from the residents	Monthly
Impact # 32: Employment opportunities	Employment	Employed employees	Number of residents employed			Number of employees	As many tenant employees as possible	Every year
Impact # 33: Increased income and improved or livelihoods as result of increased agricultural production, trading activities, and movement of people within the region and bordering countries	Local economy	Affected villages	Incomes of local people in the project area			Per capita income	National per capita income average	Once every year
Impact # 34: Improved comfort of passengers as a result of increased train frequencies	Comfor of passengers	Affected villages	Passenger perception			Perception	Positive perception	Once (six months after commissioning of the project sections)
Impact # 35: Improved quality of the landscape features and appearance of the river embankments	Landscape	The project area	Landscape			Visual appearance	Attractive visual appearance	Once after completing the construction work
Impact # 36: Improved flood management emanating from proper operation of the Gombe Dam	Flood at dam	Dam area	Flooding tendencies			Over flooding	No flooding beyond the border of the dam	Continuously during rainy season

[1] Environmental Management (Water Quality Standards) Regulations 2007
[2] Environmental Management (air Quality Standard)Regulation of 2007
[3] USA National Air Quality Standard
Source: JICA Study Team

Table 13.51: Monitoring Form for Land Acquisition

Progress of Land Acquisition

	Kilosa	Mpwapwa	(Expected) Date of Completion
Vacation of Land(% of progress)			YYYY/MM
Number of Affected Households			

Procedures

Procedure		Date
Institutional Arrangement		
Establishment of Project Management Unit		YYYY/MM/DD
Establishment of Grievance Redress Committee		YYYY/MM/DD
Detailed Measurement Survey (DMS) and Replacement Cost Survey (RCS)		
Bidding and Contract Process to hire independent agency	YYYY/MM/DD	
Start of DMS & RCS	YYYY/MM/DD	

Submission of Monitoring Report

	Internal Monitoring	External Monitoring
2017 (1st qtr)	YYYY/MM/DD	YYYY/MM/DD
2018 (1st qtr)	YYYY/MM/DD	YYYY/MM/DD
2018 (2nd qtr)	YYYY/MM/DD	YYYY/MM/DD
2018 (3rd qtr)	YYYY/MM/DD	YYYY/MM/DD
2018 (4th qtr)	YYYY/MM/DD	YYYY/MM/DD
2019 (1st qtr)	YYYY/MM/DD	YYYY/MM/DD

Grievance Redress

	Grievance received	Grievance resolved		Note (if any)
1	YYYY/MM/DD	YYYY/MM/DD		
2	YYYY/MM/DD	YYYY/MM/DD		
3	YYYY/MM/DD	YYYY/MM/DD		
	YYYY/MM/DD	YYYY/MM/DD		
	YYYY/MM/DD	YYYY/MM/DD		

Public Information Meeting

	Agenda	Date	Place	Number of Participants
1		YYYY/MM/DD		
2		YYYY/MM/DD		
3		YYYY/MM/DD		
		YYYY/MM/DD		
		YYYY/MM/DD		

Income
Restoration
Program

	Content of Activity	Date	Place	Number of Participants
1		YYYY/MM/DD		
2		YYYY/MM/DD		
3		YYYY/MM/DD		
		YYYY/MM/DD		
		YYYY/MM/DD		

Source: JICA Study Team

14. Project Evaluation and Estimation of Project Effects

In this chapter, an economic and financial analysis of the Project was conducted for the evaluation period of 2016–2044, i.e., from the year of project commencement to the final year of the 30-year planning period (2015–2044) employed in Chapter 8. Inflation was not considered in the analysis. The chapter also presents the performance indicators to be used for ex-post evaluation of the Project.

14.1 With- and Without-Project Scenarios

In the economic and financial analysis, costs and benefits/revenues were estimated by comparing the with- and without-project scenarios. The railway traffic for these scenarios is set out as shown in Table 14.1. Note that this traffic projection is based on the transport capacity assessed in Subsection 9.3.3 while the traffic demand forecast in Chapter 4 was provided without considering particular constraints on the transport capacity.

Table 14.1: Rail Traffic Projection for With- and Without-Project Scenarios

Scenario	Rail Traffic Projection
With-Project Scenario	• To reach the estimated transport capacity in 2025, the fourth year after project completion, i.e., 1.34 million tons for freight and 0.87 million passengers per year. - Assumptions for freight traffic: 6 trains per direction/day, 20 wagons per train, 40 tons per wagon, empty backhaul, 10% empty wagon ratio, 0.85 load factor for loaded wagons, and 365 days of operation per year, leading to 1.34 million tons per year. - Assumptions for passenger traffic: 6 train per direction/week, 1,400 passengers per train, and 52 weeks of operation per year, leading to 0.87 million passengers per year. • To assume that the freight and passenger traffic in 2022–2024 will be 70%, 80%, and 90% of the above capacity, respectively, gradually increasing to the transport capacity. • To assume that the freight and passenger traffic in 2022 will be two-thirds of a full-year projection taking into account the project schedule. • To assume that the traffic after 2025 will remain the same as that in 2025. • To assume that the average length of haul for freight is 980 km and the average travel distance for passengers 643 km, based on the past rail traffic statistics.
Without-Project Scenario	• To assume that the freight and passenger traffic will remain the same as that in 2014, i.e., 0.19 million tons of freight and 0.30 million passengers. • To assume the same average length of haul for freight and the same average travel distance for passengers as those for the with-project scenario.

Source: JICA Study Team

14.2 Economic Analysis

14.2.1 Costs

The following costs were considered in the economic analysis:

- Project costs:
  - The Project costs include construction costs, consulting fees, physical contingencies, land acquisition costs, and compensation for relocation of affected people, and administration costs.
  - A residual value of the construction costs (including the physical contingencies) at the end of the evaluation period was considered assuming the average economic life of 40 years for the infrastructure to be developed by the Project.
- Operation and maintenance (O&M) costs:
  - The O&M costs for the incremental traffic were estimated using the unit costs set out

based on relevant data from various sources[1].

- Additional maintenance and recovery cost:
  - The maintenance and recovery cost for the infrastructure/facilities to be developed by the Project was also considered in the analysis (see Subsection 10.3.3 (5) of Chapter 10 for detailed items and estimates of this cost)[2].

14.2.2 Benefits

The benefits quantified in the economic analysis include the following:

- Avoidance of road vehicle operating costs that would be required if the incremental rail traffic caused by the Project were to go via road rather than rail[3].
- Avoidance of road maintenance costs that would be required in the same way as above[4].
- Avoidance of rail investment costs for flood recovery that would be required without the Project[5].
- Reduction in CO_2 emissions[6].
- Negative benefits due to longer travel time of passengers by rail than by road (note that the time of freight transport for rail and road was estimated to be comparable and thus was not considered in the analysis)[7].

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[1] For the with-project scenario, the average unit O&M cost is assumed at USD 0.038 per freight ton-km, referring to the OPEX estimates in RAHCO/World Bank, Financial and Economic Analysis of TIRP, Final Report, September 2013 (RAHCO/World Bank Study) and USD 0.017 per passenger-km, as estimated in Phase II of the Study for the Dar es Salaam-Isaka-Kigali/Keza-Musongati Railway Project, Final Report, March 2014 (Railway Extension Study). For the without-project scenario, the average unit O&M cost is assumed at USD 0.050 per freight ton-km, referring to the OPEX estimates in the RAHCO/World Bank Study and JICA, Comprehensive Transport and Trade System Development Master Plan in Tanzania, Final Report, March 2014 (JICA Master Plan) and USD 0.022 per passenger-km, based on the unit cost figures above.

[2] This maintenance and recovery cost is estimated at TZS 2,085 million per year as described in Subsection 10.3.3 (5). For the economic analysis, this amount is converted to the economic cost (resulting in TZS 1,812 million per year) using the standard conversion factor of 0.869 (see Subsection 14.2.3 for the standard conversion factor).

[3] The operating costs for trucks, buses, and passenger cars were estimated assuming the unit costs as follows: USD 0.078 per ton-km for trucks (referring to the tariff data from the RAHCO/World Bank Study and the Railway Extension Study), USD 0.018 per passenger-km for buses (estimated based on the bus fares set by SUMATRA), and USD 0.096 per passenger-km for passenger cars (based on the VOC estimates by JICA, Project Formulation Study on Road Transport Network – New Bagamoyo Road in Tanzania, Final Report, August 2008, adjusted for inflation).

[4] The road maintenance costs that would be avoided were estimated using the unit maintenance costs for trucks, buses and cars presented in the Railway Extension Study.

[5] The flood recovery cost during the evaluation period is assumed at USD 1.52 million per year based on the record of investment for flood recovery works in 1997 (December)–98 (USD 7.8 million), 2009–10 (USD 17 million), and 2014 (USD 1 million) over the 17-year period.

[6] For freight transport, the basic unit of CO_2 emissions was assumed at 22 g/ton-km for rail and 144 g/ton-km for trucks, following the assumptions by METI of Japan, Study on the Central Corridor Railway Revitalization and Energy Efficiency Project in Tanzania, February 2014. For passenger transport, 22 g/passenger-km for rail, 68 g/paasenger-km for buses, and 158 g/passenger-km for cars were used, based on the assumptions by the European Environment Agency (http://www.eea.europa.eu/media/infographics/co2-emissions-from-passenger-transport/view) and the Ministry of Land, Infrastructure, Transport and Tourism (MLIT) of Japan (http://www.mlit.go.jp/sogoseisaku/environment/sosei_environment_tk_000007.html).

[7] For passenger transport, the average speed of road transport is estimated at 64 km/hour based on the travel times by bus on the Central Corridor, while the average speed by rail is set at 37 km/hour. It is assumed that by 2044 the average speed of road transport will decrease by 10% considering that traffic congestion in and around urban areas would increasingly affect intercity road transport. On the other hand, the transit time by truck between Dar es Salaam and Isaka is estimated at approximately 36 hours based on the data in Central Corridor Transit Transportation Facilitation Agency (CCTTFA), Central Corridor Transport Observatory Annual Report 2014, April 2015. This is comparable to the target transit time by rail, which is 36 hours between Dar es Salaam and Isaka.

14.2.3 EIRR Estimation

For the economic analysis, financial costs were converted to economic costs using a standard conversion factor of 0.869, which was taken from a past transport study in Tanzania funded by JICA[8]. The exchange rate of TZS 2,189.67 : USD 1.0 was used for the analysis. The economic internal rate of return (EIRR) was used as the measure for economic evaluation, which is the rate of discount at which cost and benefit streams over the evaluation period are equalized.

Since most of the benefits result from freight transport, benefits and costs were first compared by considering the freight transport alone. As shown in Table 14.2, the EIRR is estimated at 12.2%.

Table 14.2: Benefit and Cost Streams and EIRR for Freight Transport

Unit: Million TZS

Year	Cost			Benefit				Net benefit stream
	Project cost	O&M cost	Additional maintenance & recovery cost	VOC avoidance	Road maintenance cost avoidance	Flood recovery cost avoidance	Reduction in CO_2 emissions	
2016	19,342	0	0	0	0	0	0	-19,342
2017	24,084	0	0	0	0	0	0	-24,084
2018	10,843	0	0	0	0	0	0	-10,843
2019	223,327	0	0	0	0	0	0	-223,327
2020	137,934	0	0	0	0	0	0	-137,934
2021	135,935	0	0	0	0	0	0	-135,935
2022	45,965	32,511	1,208	72,551	1,699	1,920	3,265	-250
2023	27,226	58,264	1,812	128,321	3,005	2,880	5,774	52,678
2024	0	67,761	1,812	147,816	3,462	2,880	6,651	91,235
2025	0	77,258	1,812	167,310	3,918	2,880	7,528	102,566
2026	0	77,258	1,812	167,310	3,918	2,880	7,528	102,566
2027	0	77,258	1,812	167,310	3,918	2,880	7,528	102,566
2028	0	77,258	1,812	167,310	3,918	2,880	7,528	102,566
2029	0	77,258	1,812	167,310	3,918	2,880	7,528	102,566
2030	0	77,258	1,812	167,310	3,918	2,880	7,528	102,566
2031	0	77,258	1,812	167,310	3,918	2,880	7,528	102,566
2032	0	77,258	1,812	167,310	3,918	2,880	7,528	102,566
2033	0	77,258	1,812	167,310	3,918	2,880	7,528	102,566
2034	0	77,258	1,812	167,310	3,918	2,880	7,528	102,566
2035	0	77,258	1,812	167,310	3,918	2,880	7,528	102,566
2036	0	77,258	1,812	167,310	3,918	2,880	7,528	102,566
2037	0	77,258	1,812	167,310	3,918	2,880	7,528	102,566
2038	0	77,258	1,812	167,310	3,918	2,880	7,528	102,566
2039	0	77,258	1,812	167,310	3,918	2,880	7,528	102,566
2040	0	77,258	1,812	167,310	3,918	2,880	7,528	102,566
2041	0	77,258	1,812	167,310	3,918	2,880	7,528	102,566
2042	0	77,258	1,812	167,310	3,918	2,880	7,528	102,566
2043	0	77,258	1,812	167,310	3,918	2,880	7,528	102,566
2044	-207,798	77,258	1,812	167,310	3,918	2,880	7,528	310,364

Source: JICA Study Team **EIRR = 12.2%**

Considerting both freight and passenger transport, the EIRR is estimated slightly higher, at 12.9%, as shown in Table 14.3. The net benefit for passenger transport is significantly lower than that for freight, indicating that the economic benefit of the Project will be mostly generated by the freight transport.

[8] Source: JICA, Dar es Salaam Transport Policy and System Development Master Plan, June 2008.

Table 14.3: Benefit and Cost Streams and EIRR for Freight and Passenger Transport

Unit: Million TZS

Year	Freight	Passenger						Net benefit stream for freight and passenger
		Cost	Benefit					
	Net benefit stream for freight	O&M cost	VOC avoidance	Road maintenance cost avoidance	Travel time savings	Reduction in CO_2 emissions	Net benefit stream for passenger	
2016	-19,342	0	0	0	0	0	0	-19,342
2017	-24,084	0	0	0	0	0	0	-24,084
2018	-10,843	0	0	0	0	0	0	-10,843
2019	-223,327	0	0	0	0	0	0	-223,327
2020	-137,934	0	0	0	0	0	0	-137,934
2021	-135,935	0	0	0	0	0	0	-135,935
2022	-250	3,177	7,656	54	-3,217	1,513	2,829	2,579
2023	52,678	6,583	14,659	103	-6,120	2,897	4,956	57,634
2024	91,235	8,400	17,833	126	-7,398	3,524	5,685	96,920
2025	102,566	10,217	21,008	148	-8,659	4,151	6,431	108,997
2026	102,566	10,217	21,008	148	-8,602	4,151	6,488	109,054
2027	102,566	10,217	21,008	148	-8,545	4,151	6,545	109,111
2028	102,566	10,217	21,008	148	-8,487	4,151	6,603	109,169
2029	102,566	10,217	21,008	148	-8,428	4,151	6,662	109,228
2030	102,566	10,217	21,008	148	-8,370	4,151	6,721	109,287
2031	102,566	10,217	21,008	148	-8,310	4,151	6,780	109,346
2032	102,566	10,217	21,008	148	-8,250	4,151	6,840	109,406
2033	102,566	10,217	21,008	148	-8,189	4,151	6,901	109,467
2034	102,566	10,217	21,008	148	-8,128	4,151	6,962	109,528
2035	102,566	10,217	21,008	148	-8,066	4,151	7,024	109,590
2036	102,566	10,217	21,008	148	-8,004	4,151	7,086	109,652
2037	102,566	10,217	21,008	148	-7,941	4,151	7,149	109,715
2038	102,566	10,217	21,008	148	-7,877	4,151	7,213	109,779
2039	102,566	10,217	21,008	148	-7,813	4,151	7,277	109,843
2040	102,566	10,217	21,008	148	-7,748	4,151	7,342	109,908
2041	102,566	10,217	21,008	148	-7,683	4,151	7,408	109,973
2042	102,566	10,217	21,008	148	-7,616	4,151	7,474	110,040
2043	102,566	10,217	21,008	148	-7,550	4,151	7,541	110,107
2044	310,364	10,217	21,008	148	-7,482	4,151	7,608	317,972

Source: JICA Study Team **EIRR = 12.9%**

14.2.4 Sensitivity Analysis

In view of the inevitable uncertainty concerning the precise values of key variables in the economic analysis, a sensitivity analysis was conducted. Table 14.4 shows the sensitivity of the EIRR with respect to changes in the Project cost and rail traffic. The EIRR for both freight and passenger transport is still estimated to be above 10% in the pessimistic case that the Project cost increases by 10% and the rail traffic decreases by 10%.

Table 14.4: Sensivity of EIRR

Case	EIRR for freight alone	EIRR for freight and passenger
(a) Base Case	12.2%	12.9%
(b) Project Cost: 10% up	11.1%	11.8%
(c) Rail Traffic: 10% down	10.9%	11.5%
(d) Combination of (b) and (c)	9.9%	10.5%

Source: JICA Study Team

14.3 Financial Analysis

The Project intends to restore the transport capacity of the entire Central Railway Line by targeting the Kilosa-Gulwe section, the biggest bottleneck of the line, leading to an increase in rail traffic and revenues. The financial analysis examines the cash-generating capacity of the

Project by estimating a financial internal rate of return (FIRR) from the total investment point of view (also called a Project IRR).

14.3.1 General Assumptions and Conditions

The following assumptions/conditions are employed in the financial analysis:

- Project cash flow: The analysis focuses on the cash flows from the total investment point of view, and does not consider the items related to financing activities such as loans, interests, equitities, and dividend.
- Evaluation period: The evaluation period for the financial analysis is the same as that for the economic analysis, i.e., 2016–2044.
- Project schedule: The commencement of the Project is in 2016, and the construction is to end at the beginning of 2022, followed by the start of cash inflows by the Project in 2022.
- Inflation: Inflation is not considered in the analysis.

14.3.2 Cash Inflows

i) Traffic volume

The incremental freight and passenger traffic on the Central Railway Line is used for revenue calculation. As was done for the economic evaluation, the incremental traffic is calculated as the difference in traffic between the with- and without-project scenarios.

ii) Unit values of freight and passenger revenues

Table 14.5 shows the unit values of fright revenue by commodity and those of passenger revenue by class used for the analysis. These figures are estimated based on the TRL revenue data in 2013/14 and 2014/15. The table also shows the composition of freight and passenger traffic used for the analysis.

Table 14.5: Unit Values of Freight and Passenger Revenues

Freight Transport		
Commodity	Unit Freight Revenue (TZS/ton)	Traffic Share[1] (%)
Domestic		
Cement	88,462	6.23%
Coffee	86,205	0.77%
Cotton	86,205	1.06%
Cotton Cake	86,205	0.47%
Fertilizer	72,421	0.93%
General Cargo	88,525	21.73%
Grains	65,039	1.31%
Gypsum	46,119	0.97%
Livestock	53,407	0.53%
Maize	52,511	1.85%
Petroleum/Oil	118,877	0.93%
Salt	109,555	6.40%
Sugar	86,205	0.60%
Timber	48,926	1.81%
Tobacco	111,972	0.35%
Parcels/Luggage	160,272	1.67%
Transit Sub-total	98,063	52.38%
Total	-	100%

Passenger Transport		
Class	Unit Passenger Revenue (TZS/passenger)	Traffic Share[2] (%)
First	71,584	0.80%
Second-Sleeping	43,185	3.33%
Second-Sitting	37,518	0.37%
Third	18,189	76.41%
TTE's[3]	22,827	19.09%
Total	-	100%

Note: (1) These are the traffic shares for 2023 estimated in the potential traffic demand forecast presented in Chapter 4. (2) These are actual traffic shares in 2014/15. (3) TTE stands for Traveling Ticket Examiner, and these figures are based on ticket sales collected by TTE's onboard the trains.
Source: JICA Study Team

14.3.3 Cash Outflows

The following costs were considered for the cash outflows:

- The costs considered in the economic analysis, including the Project cost, the O&M costs for the incremental traffic, and the additional maintenance cost for the infrastrucrture/facilities to be developed by the Project.
- The residual value of the construction costs (including the physical contingencies), which was added back at the end of the evaluation period.
- The rail investment costs for flood recovery that would be required without the Project, which were subtracted from the cost outflows.

All of the costs are financial costs valued in current prices, and tax is not taken into account.

14.3.4 FIRR Estimation

Based on the cash inflows and outflows described above, an FIRR (or a Project IRR) was computed. As was done for the EIRR, the FIRR for freight transport alone was first estimated at -0.05% (Table 14.6), and that for both freight and passenger transport at -0.03% (Table 14.7). The FIRR estimated at around zero indicates that the Project would be capable of generating cash that could more or less cover both investment and O&M costs.

Table 14.6: Cash Flows and FIRR for Freight Transport

Year	Cash outflow				Cash inflow	Net cash flow for freight
	Project cost	O&M cost	Additional maintenance & recovery cost	Flood recovery cost avoidance	Revenue	
2016	22,258	0	0	0	0	-22,258
2017	27,715	0	0	0	0	-27,715
2018	12,477	0	0	0	0	-12,477
2019	256,993	0	0	0	0	-256,993
2020	158,727	0	0	0	0	-158,727
2021	156,427	0	0	0	0	-156,427
2022	52,894	37,412	1,390	-2,209	47,238	-42,249
2023	31,330	67,047	2,085	-3,314	83,551	-13,598
2024	0	77,976	2,085	-3,314	96,244	19,496
2025	0	88,905	2,085	-3,314	108,937	21,260
2026	0	88,905	2,085	-3,314	108,937	21,260
2027	0	88,905	2,085	-3,314	108,937	21,260
2028	0	88,905	2,085	-3,314	108,937	21,260
2029	0	88,905	2,085	-3,314	108,937	21,260
2030	0	88,905	2,085	-3,314	108,937	21,260
2031	0	88,905	2,085	-3,314	108,937	21,260
2032	0	88,905	2,085	-3,314	108,937	21,260
2033	0	88,905	2,085	-3,314	108,937	21,260
2034	0	88,905	2,085	-3,314	108,937	21,260
2035	0	88,905	2,085	-3,314	108,937	21,260
2036	0	88,905	2,085	-3,314	108,937	21,260
2037	0	88,905	2,085	-3,314	108,937	21,260
2038	0	88,905	2,085	-3,314	108,937	21,260
2039	0	88,905	2,085	-3,314	108,937	21,260
2040	0	88,905	2,085	-3,314	108,937	21,260
2041	0	88,905	2,085	-3,314	108,937	21,260
2042	0	88,905	2,085	-3,314	108,937	21,260
2043	0	88,905	2,085	-3,314	108,937	21,260
2044	-239,123	88,905	2,085	-3,314	108,937	260,383

Source: JICA Study Team **FIRR = -0.05%**

Note: Tax is not taken into account in the analysis.

Table 14.7: Cash Flows and FIRR for Freight and Passenger Transport

Unit: Million TZS

Year	Freight	Passenger		Net cash flow for freight and passenger
	Net cash flow for freight	Cash outflow	Cash inflow	
		O&M cost	Revenue	
2016	-22,258	0	0	-22,258
2017	-27,715	0	0	-27,715
2018	-12,477	0	0	-12,477
2019	-256,993	0	0	-256,993
2020	-158,727	0	0	-158,727
2021	-156,427	0	0	-156,427
2022	-42,249	3,656	4,299	-41,606
2023	-13,598	7,575	8,232	-12,941
2024	19,496	9,666	10,014	19,845
2025	21,260	11,757	11,797	21,300
2026	21,260	11,757	11,797	21,300
2027	21,260	11,757	11,797	21,300
2028	21,260	11,757	11,797	21,300
2029	21,260	11,757	11,797	21,300
2030	21,260	11,757	11,797	21,300
2031	21,260	11,757	11,797	21,300
2032	21,260	11,757	11,797	21,300
2033	21,260	11,757	11,797	21,300
2034	21,260	11,757	11,797	21,300
2035	21,260	11,757	11,797	21,300
2036	21,260	11,757	11,797	21,300
2037	21,260	11,757	11,797	21,300
2038	21,260	11,757	11,797	21,300
2039	21,260	11,757	11,797	21,300
2040	21,260	11,757	11,797	21,300
2041	21,260	11,757	11,797	21,300
2042	21,260	11,757	11,797	21,300
2043	21,260	11,757	11,797	21,300
2044	260,383	11,757	11,797	260,423

Source: JICA Study Team **FIRR = -0.03%**

Note: Tax is not taken into account in the analysis.

14.4 Setting of Operation and Effect Indicators

Perfomance indicators for the Project (called the “operation and effect indicators” by JICA) have been set as shown in Table 14.8 and Table 14.9, based on JICA Operation Indicator and Effect Indicator Reference in ODA Loan Projects (July 2014). Considering the reliability and availability of required data and information, five operation indicators (Table 14.8) and four effect indicators (Table 14.9) have been proposed with baseline values (prior to the Project) and target values (two years after completion of the Project).

Table 14.8: Operation Indicators

Category	Name	Purpose	Reference Value, Source	Remark
Basic	Freight traffic on the entire Central Railway Line (ton/year, ton-km/year)	To identify the level of facility utilization. This gives basic data in transport planning.	1) Baseline value (TRL 2014 data): ・0.19 mil. ton/year ・200 mil. ton-km/year 2) Target value (two years after project completion): ・1.07 mil. ton/year ・1,051 mil. ton-km/year	The Project is intended to relieve the biggest bottleneck of the Central Railway Line; thus, it is appropriate to measure the transport volume on the entire line.
Basic	Passenger traffic on the entire Central Railway Line (passenger/year, passenger-km/year)	Same as above	1) Baseline value (TRL 2014 data): ・0.30 mil. passenger/year ・205 mil. passenger-km/year 2) Target value (two years after project completion): ・0.70 mil. passenger/year ・449 mil. passenger-km/year	Same as above
Auxiliary	Number of running trains on the entire Central Railway Line (/year)	To identify the level of facility utilization. This gives most basic data on transport capacity in transport planning worked out from the above tons of cargo and number of passengers transported.	1) Baseline value (eatimates based on TRL 2014 data): ・833/year (freight 622, passenger 211) 2) Target value (two years after project completion): ・4,003/year (freight 3,504, passenger 499)	The Project is intended to relieve the biggest bottleneck of the Central Railway Line; thus, it is appropriate to measure the number of train on the entire line.
Auxiliary	Number of days when water levels were monitored along the mainstream (days/year) (at Kilosa G/S and Gulwe G/S)	To evaluate flood monitoring practices through a deepening of understanding regarding flood risk and disaster management among the responsible agencies by means of implementation of flood protection measures	1) Baseline value (not established yet) ・Zero/year (at both Kilosa G/S and Gulwe G/S) 2) Target value (2 years after project completion) ・151 days/year (at both Kilosa G/S and Gulwe G/S) (total numbers of day from December to April which falls in rainy period in normal year)	Monitoring of water levels is an important task during rainy season to secure safe operation of railway. Utilization of staff gauges installed by the Project shall be confirmed through verification of the indicators.
Auxiliary	Number of culverts inspected (sites/year) (between Kilosa and Gulwe)	To evaluate number of inspected culverts to check clogging by debris as one of preventive measures prior to rainy season	1) Baseline value ・36 sites/year (numbers of site identified as high risk by Flood Risk Assessment in December 2014) 2) Target value (2 years after project completion) ・100 sites/year (approx. 30% of total number of culverts)	Regular inspection of culverts is a fundamental action to mitigate flood damage as one of preventive measures prior to the rainy season.

Notes: The basic indicators are generally deemed necessary regardless of the characteristics of the Project, for which data collection is deemed possible. The auxiliary indicators are likely to be needed depending on the characteristics and components of the Project, or they are indicators where data collection is difficult although they are deemed necessary indicators.
Abbreviation: GS = gauging station
Source: JICA Study Team

Table 14.9: Effect Indicators

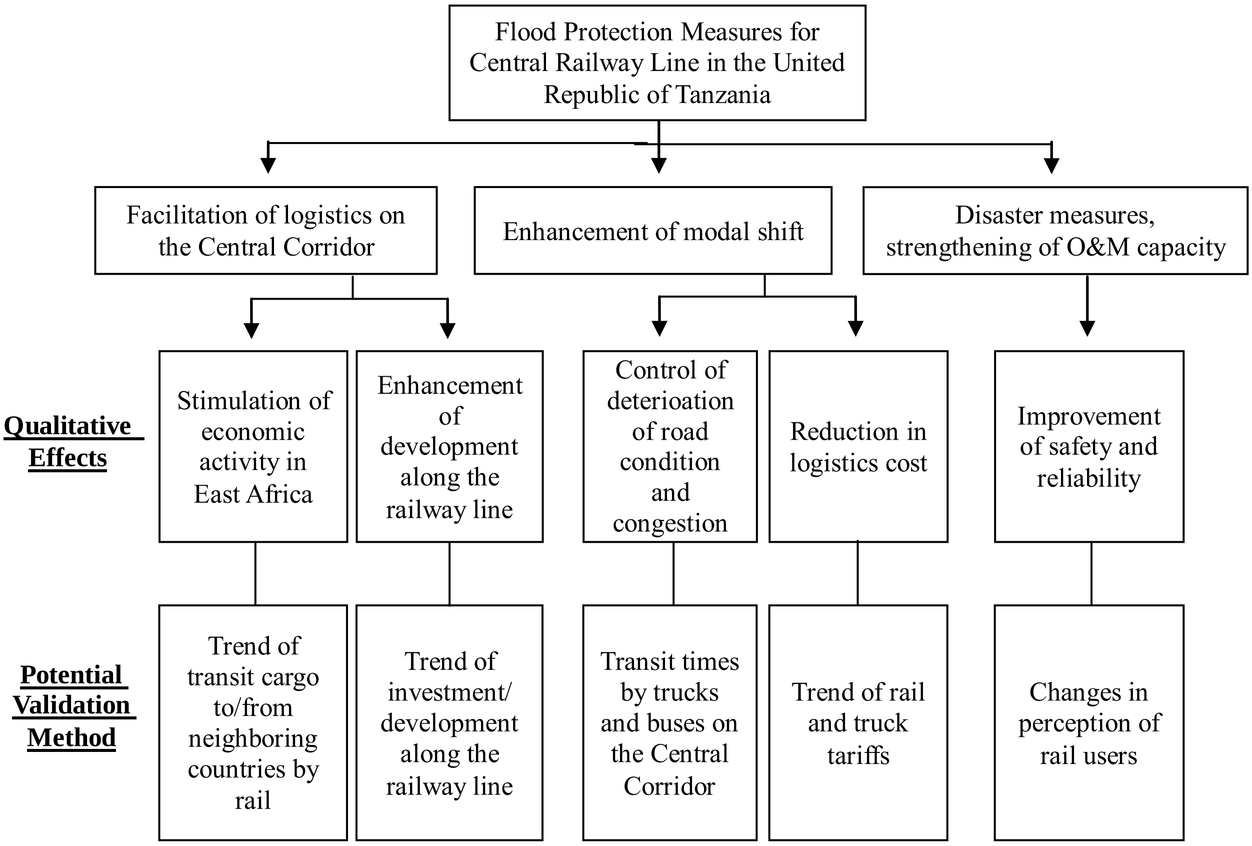
Category	Name	Purpose	Reference Value, Source	Remark
Basic	Times of occurrence of flood and sediment disasters in target area	To verify contribution to an increase of freight volume of railway by flood damage reduction directly	1) Baseline value ・8 times/year (average annual occurrences in past 4 year records) 2) Target value (2 years after project completion) ・4 times/year	The target areas for verification will be the 7 re-routing sections of track (total 25 km long) and 20 bank protection sites (total 15 km long), resulting a total of 40 km approximately.
Basic	Times of occurrence of over-topping of tracks by flood flow from major tributaries	To verify effects of flood and sediment disaster measures at bottlenecks of two tributaries (at Maswala and Mzase)	1) Baseline value ・10 times/year (maximum annual occurrences of two tributaries in past 4 year records, which was in 2014) 2) Target value (2 years after project completion) ・2 times/year	The target sites for verification will be crossings with track over two tributaries of the Maswala and the Mzase. By means of the protectipon measures proposed against bank erosion, the extent of damge will be substantially reduced.
Auxiliary	Transit time of freight trains for the Dar es Salaam–Isaka section	To identity whether the Project contributes to the reliability of cargo transportation on the Central Corridor	1) Baseline value (2015 TRL estimate): ・72 hours 2) Target value (two years after project completion): ・36 hours	This includes loading/unloading times at Dar es Salaam and Isaka, and is regarded as an auxiliary indicator due to uncertainty of accurate data collection.
Auxiliary	Transit time of passenger trains for the Dar es Salaam–Tabora section	To identify whether the Project contributes to the safety of railway transportation	1) Baseline value (average in March 2016): ・27.6 hours for regular trains ・22.6 hours for Deluxe trains 2) Target value (two years after project completion): ・24 hours for regular trains ・22 hours for Deluxe trains	Regular trains stop at every station while Deluxe trains, introduced in April 2015, stop at major stations. Although the transit time depends also on track and other conditions outside the Project section, it is appropriate to collect this data for each train especially in latest months.

Notes: The basic indicators are generally deemed necessary regardless of the characteristics of the Project, for which data collection is deemed possible. The auxiliary indicators are likely to be needed depending on the characteristics and components of the Project, or they are indicators where data collection is difficult although they are deemed necessary indicators.

Source: JICA Study Team

14.5 Examination of Qualitative Effects

The Project aims at improving the reliability of railway transportation by providing long-term flood protection measures, thereby ensuring the safety and reliability of cargo and passenger transportation on the Central Corridor, and stimulating the economic activities in the East African region. Figure 14.1 presents major qualitative effects that would be brought about by the Project and potential methods to validate these effects relatively less costly.



Source: JICA Study Team

Figure 14.1: Major Qualitative Effects and Potential Validation Method

15. Conclusions and Recommendations

15.1 Conclusions

(1) Project Feasibility

- Alternative B-2 should be implemented, as the Study proves that this alternative can be feasible in terms of its technical, economical, financial, environmental, and social elements.[1]
- The EIRR considering freight transport alone was first estimated at 12.2%, and that for both freight and passenger transport at 12.9%. These results indicate that the Project is considered feasible from the national economy's point of view.
- The FIRR was estimated at around zero, suggesting that the Project should be implemented with the use of a long-term soft loan such as an ODA Loan.

(2) Proposed Flood Protection Measures

(a) Basic Policy in Formulating Alternatives

JICA Study Team defines long-term flood protection measures as solutions that are most effective for eliminating flood damages to the greatest extent possible while being economically viable. As explained in Chapter 8, the proposed Alternative B-2 is found to be economically viable and can have significant effects to eliminate large- and medium-scale flood damages, allowing smooth train operations throughout the year with minimum interruptions.[2] While this alternative has certain limitations as explained below (c), the potential damages are expected to be minimal and can be further mitigated by taking appropriate measures that combine hard and soft measures as follows:

Hard Measures

The Study proposes flood protection measures that combine flood protection works with maintenance after completion of the Project. As annual proper maintenance is essential to ensure the Project's effectiveness, the proposed measures were planned based on the assumption that proper maintenance will be carried out afterwards. This maintenance work includes the removal of deposited sand in and around culverts and drainage infrastructure.

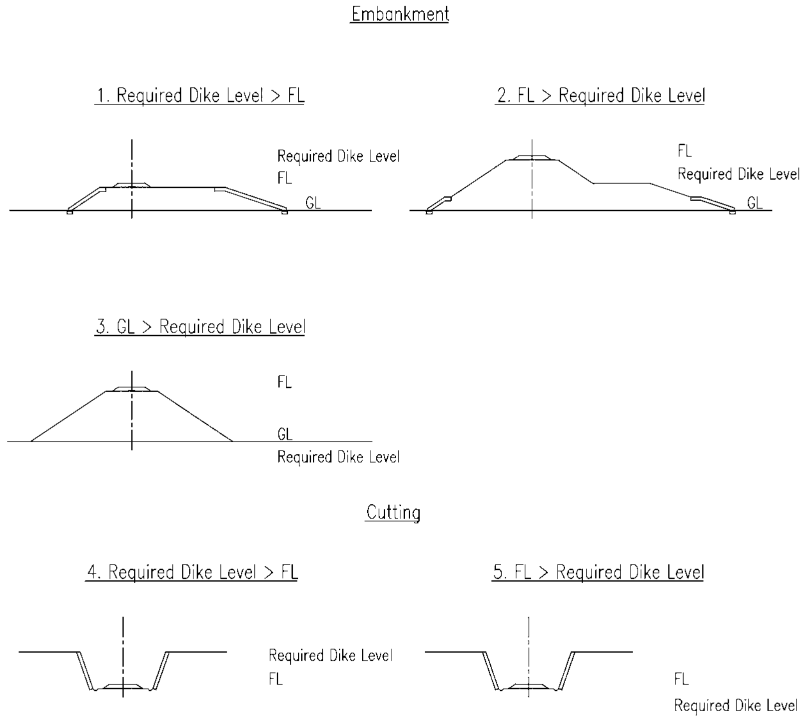
Soft Measures

In the situation in which design floods occur in sections where no protection works have been provided, the plans assume the possibility that inundation/overtopping of railway embankment occurs and can last from a few hours to a few days. To ensure the safety of train movements during such times, a suspension of operation or enforcement of temporary speed restrictions is likely to be required.

(b) Project Effectiveness

Figure 15.1 classifies the results of rerouting in terms of the relationship between the required dike level (RDL) and the formation/ground level (FL/GL).[3] Table 15.1 further shows the relationship between train operation safety and planned formation level based on these categories. The achievements of the Project are also explained below:

[1] In order to avoid any flood damages and continue train operation, considerable budget is required. This in turn leads to a conclusion that the investment is not justified economically. Alternative B-2 therefore was selected as a well-balanced measure from technical and economical points of view.
[2] Based on TRL data, 91% of the line closure resulting from floods during 2011-14 can be prevented with Alternative B-2.
[3] The required dike level (RDL) is a sum of the Design High Water Level (DHWL) and the freeboard.



Notes: (i) The section of drawing numbers 1 and 4 is located in an approach section from the existing line. (ii) The section of drawing number 2 is located in an approach section from the existing line, and a section where sufficient horizontal distance cannot be provided due to narrow topographical condition of the valley.
Source: JICA Study Team

Figure 15.1: Relationship between Required Dike Level and FL/GL

Rerouting Sections

The Project ensures the ability to have the following patterns of train operations in case of design floods:

- Train service shall be suspended over a total of 4,680 m (18.5%) as the formation level (FL) is lower than RDL
- Trains shall be operated with caution over a total of 5,060 m (20.1%) as FL is higher than RDL in embankment sections
- Trains shall be operated safely over a total of 15,480 m (61.4%) as FL is higher than RDL in cutting sections

Table 15.1: Patterns of Train Operations in Rerouting Sections (m)

Relationship between RDL and FL/GL	**Dwg. No.**	**Train Operation**	**Rerouting Section No.**							**Total (%)**
			1	**2**	**3**	**5**	**7**	**8**	**9**	
RDL > FL (Embank.)	1	Suspended	1,040	200	260	240	0	0	440	2,180 (8.6)
RDL > FL (Cutting)	4		700	480	260	380	340	0	340	2,500 (9.9)
FL > RDL	2	Caution	100	2,160	500	60	0	0	2,240	5,060 (20.1)
GL > RDL	3	Safe	0	440	60	180	160	1,620	5,040	7,500 (29.7)
FL > RDL	5		40	2,720	1,700	920	1,380	200	1,020	7,980 (31.7)
Total	-	-	1,880	6,000	2,780	1,780	1,880	1,820	9,080	25,220 (100.0)

Note: Each length is rounded to 20 m, thus the total is not equal to the exact length of 25.134 km.
Abbreviation: FL = Formation Level, GL = Ground Level, RDL = Required Dike Level
Source: JICA Study Team

Non-Rerouting Sections

Table 15.2 shows the patterns of train operations in case of design flood (i.e., DHWL) in non-rerouting sections, which is summarized as follows:

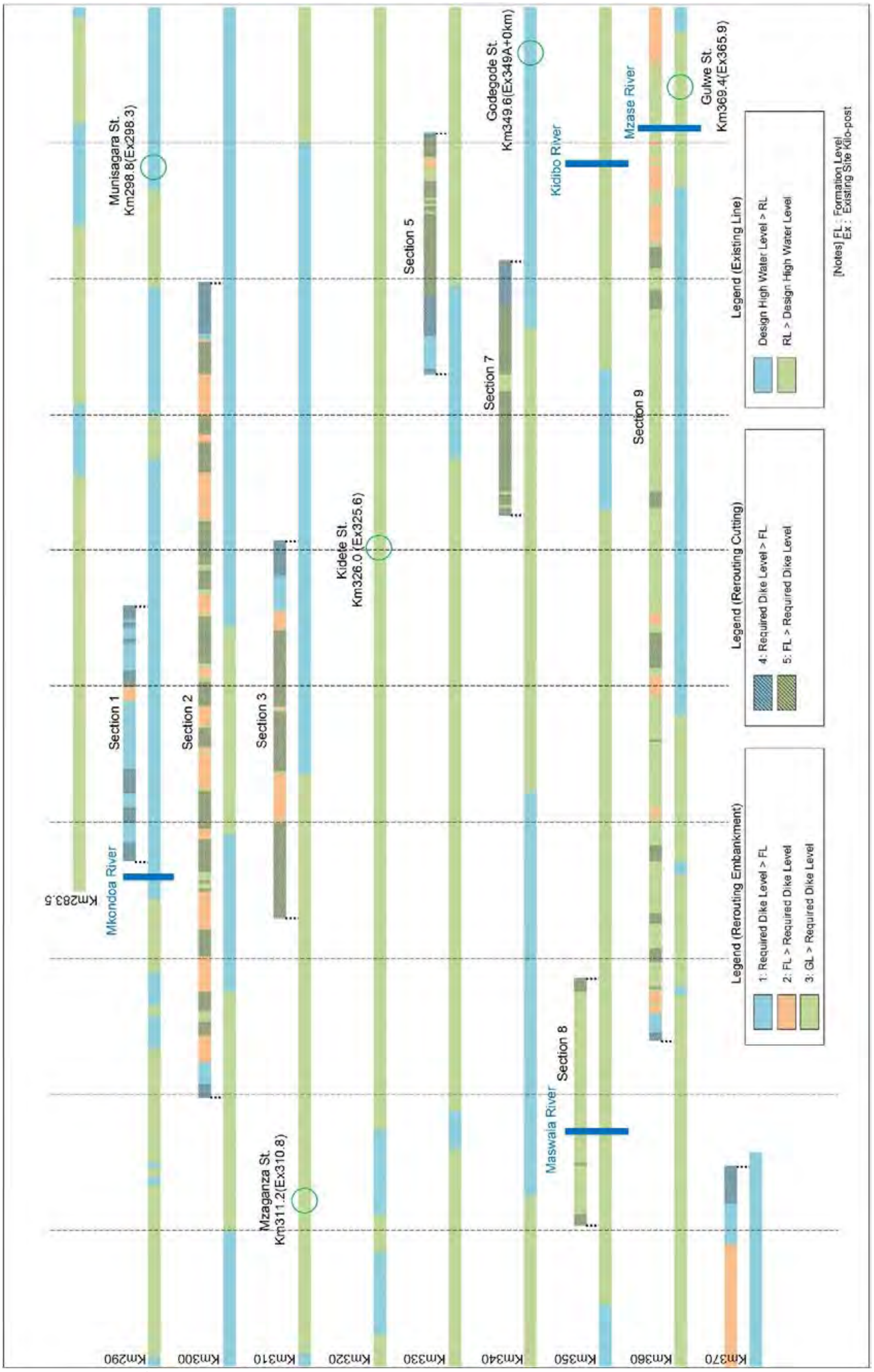
- Train service shall be suspended over a total of 20,230 m (32.4%) as the rail level (RL) is lower than DHWL
- Train shall be operated with caution or safely over a total of 42,500 m (67.6%) as RL is higher than DHWL

Table 15.2: Patterns of Train Operations in Non-Rerouting Sections

Type	Train Operation	Section between each rerouting section (m)							Total (%)
		Start-1	1 - 2	2 - 3	3 - 5	5 - 7	7 - 8	8 - 9	
DHWL > RL	Suspended	2,280	4,440	2,140	5,060	2,980	2,440	1,040	20,230 (32.4)
RL > DHWL	Caution/ Safe	7,940	2,020	3,200	16,180	4,060	580	8,520	42,500 (67.6)
Total	-	10,220	6,460	5,340	21,240	7,040	3,020	9,560	62,880 (100.0)

Note: Each length is rounded to 20 m, thus the total is not equal to the exact length of 62.873km.
Abbreviation: RL = Rail Level, DHWL = Design High Water Level
Source: JICA Study Team

Figure 15.2 illustrates the patterns of train operations over the Kilosa-Gulwe section during design floods (See Appendix AA for its detail).



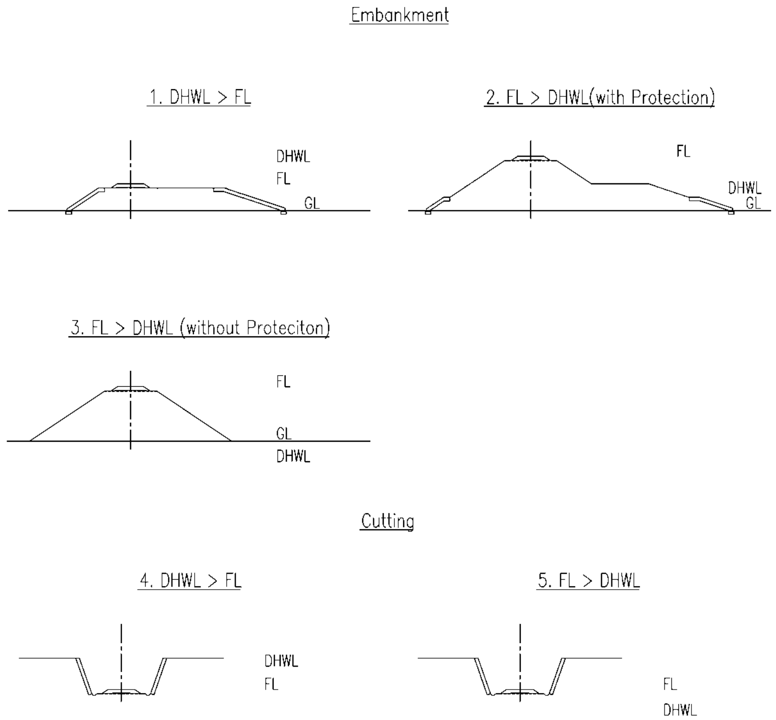
Source: JICA Study Team

Figure 15.2: Patterns of Train Operations during Design Floods

(c) Project Limitation

While Alternative B-2 eliminates large- and medium-scale flood damages, it does not address small-scale flood damages. This indicates that there will be some sections that are under the Design High Water Level (DHWL) after the completion of the Project. These sections are subject to inundation and/or overtopping by floodwaters in case of design floods, and require regulation of train operations.

Figure 15.3 classifies the relation between DHWL and the formation level (FL). Table 15.3 and Table 15.4 further show these relations in the rerouting and non-rerouting sections respectively.



Source: JICA Study Team

Figure 15.3: Relationship between DHWL and FL

Rerouting Sections

Table 15.3 indicates the length of inundation/overtopping in each rerouting section (i.e., embankment sections, cutting sections) in case of design floods, which is summarized as follows:

- A total of 1,360 m (9.2% of all the embankment sections) is subject to inundation and/or overtopping as the FL is lower than the DHWL.
- A total of 1,960 m (18.7% of all the cutting sections) is subject to inundation and/or overtopping as the FL is lower than the DHWL.

Table 15.3: Section by Inundation/Overtopping in Rerouting Sections (m)

Relationship between DHWL and FL	Dwg. No.	Rerouting Section No.							Total (%)
		1	2	3	5	7	8	9	
DHWL > FL (Embank.)	1	820	0	160	240	0	0	140	1,360 (9.2)
DHWL > FL (Cutting)	4	620	300	280	160	260	40	300	1,960 (18.7)

Abbreviation: FL = DHWL = Design High Water Level, FL = Formation Level
Source: JICA Study Team

Non-Rerouting Sections

Table 15.4 shows the length of inundation/overtopping in non-rerouting sections in case of design floods, which is summarized as follows:

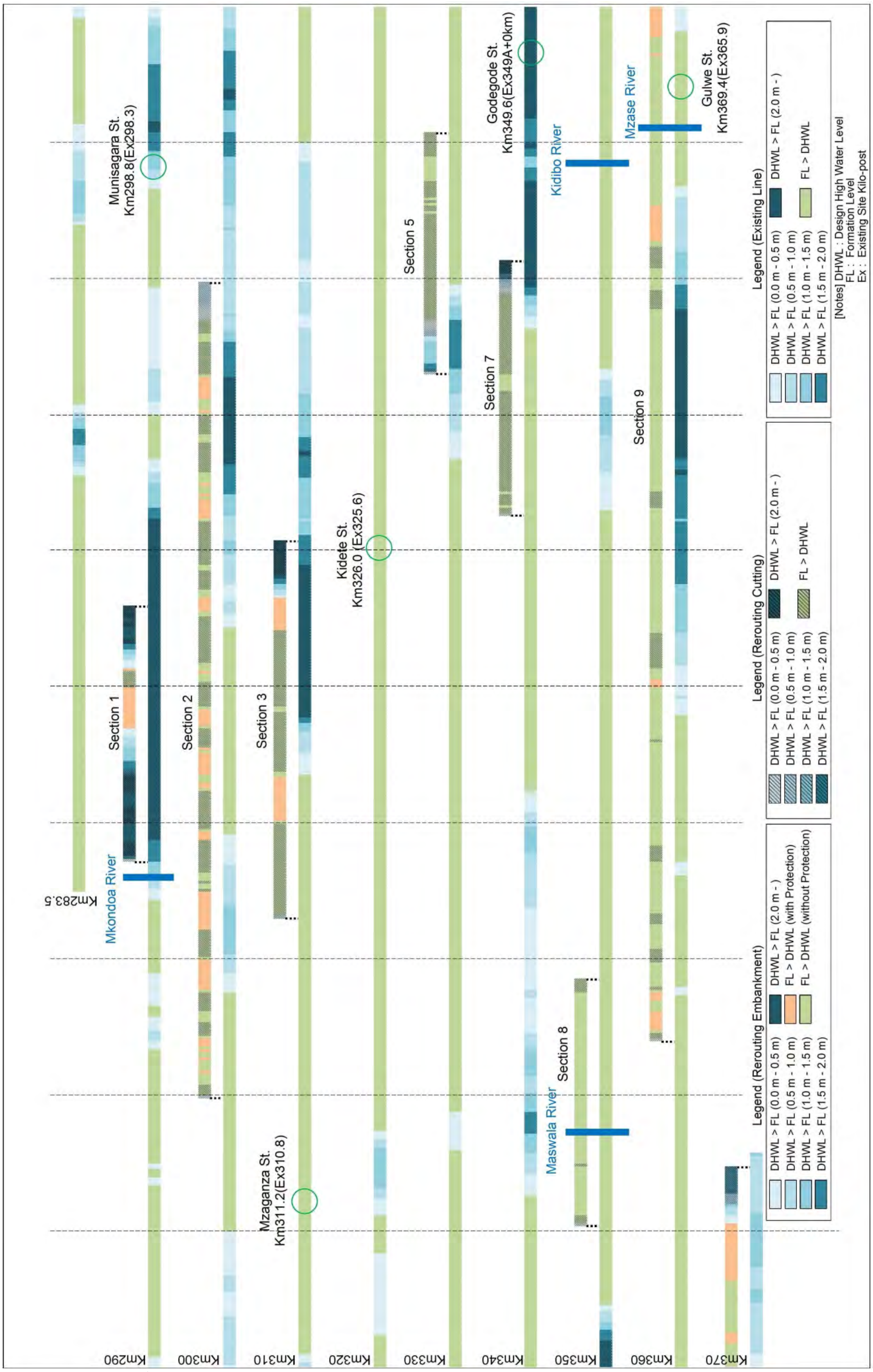
- A total of 20,230 m (32.4% of all the non-rerouting sections) is subject to inundation and/or overtopping as the FL is lower than the DHWL.

Table 15.4: Section by Inundation/Overtopping in Non-Rerouting Sections

Type	Section between each rerouting section (m)							Total (%)
	Start-1	1 - 2	2 - 3	3 - 5	5 - 7	7 - 8	8 - 9	
DHWL > FL	2,280	4,440	2,140	5,060	2,980	2,440	1,040	20,230 (32.4)

Note: Figures are same with Table 15.2 since it is assumed that FL = RL because accurate FL on site is unknown.
Abbreviation: FL = DHWL = Design High Water Level, FL = Formation Level
Source: JICA Study Team

Figure 15.4 illustrates the extent of sections with inundation/overtopping over the Kilosa–Gulwe section during design floods (See Appendix AA for additional detail).



Source: JICA Study Team

Figure 15.4: Length of Sections by Inundation/Overtopping during Design Floods

(d) Further Actions Required

<u>During Detailed Design Stage</u>

Considering the extent of the damages from a series of floods occurring from January to April 2016, minor modifications of the preliminary design of flood protection measures will be necessary in the Detailed Design stage. In particular, it is required to adjust the layout and major dimensions of the proposed structures, which should be further clarified through additional topographic survey and geotechnical investigations, etc., in the beginning of Detailed Design. Essentially, the protection measures in the affected areas to be reviewed, which have been recognized through the joint site inspection by the JICA Study Team and RAHCO/TRL representatives in April 2016, are as follows:

i) Mzase River
- The protection of the second priority area at the upstream (embankment, bank protection, etc.)
- In-depth review of the proposed river-training works in the first priority area at the downstream due to heavy deposition of sediment material in 2016 (channel geometry/alignment, embankment, groundsills, etc.)

ii) Maswala River
- In-depth review of the proposed river-training works with consideration of the new water course traced by the floods and heavy sediment deposition in January/ February 2016 (channel geometry/alignment, embankment, groundsills, check dam, etc.)

iii) Riverbank protection along the mainstream
- The joint site inspection has revealed that some large-scale sand bars were eroded and shifted after the floods in 2016, particularly at Km 297-298, Km 304-305, Km 307-308, Km 316-317, etc. (mostly downstream sections). Therefore, the newly damaged sections due to 2016 floods including the prioritized sections selected for riverbank protection during DF/R will be totally reviewed in the Detailed Design stage.

<u>After Completion of the Project</u>

- Further measures for the elimination of inundation/overtopping beyond the current proposal may be implemented in the future when railway traffic increases to the extent that justifies additional investments.
- River basin management in the upstream of tributaries, discussed in Subsection 15.2 (9), should be initiated by the relevant stakeholders to reduce the volume of sediments, which is a major origin of flood damages to the railway.

(3) Annual Maintenance after Project Completion

The Study proposes flood protection measures that combine flood protection works with maintenance after completion of the Project. Conducting annual proper maintenance is essential to keep the Project effectiveness. In order to operate trains safely, continuous monitoring of flood prevention structures and annual proper maintenance are essential. Among the maintenance, sediment control is of utmost importance considering the anticipated sediment discharge. This involves the management of discharged sediment in the vicinity of railway track, namely, the removal of deposited sand in and around culverts and drainage infrastructure especially at the Maswala and Mzase tributaries. This work needs to be carried out not only regularly but also urgently after the occurrence of floods. For this to materialize, strengthening of (i) regular maintenance organization (in terms of budget, staffing, and roles), which is a prerequisite of sustainable flood protection measures, and (ii) emergency work organization during floods is imperative. It is considered effective to implement these activities under the Project.

(4) Safety of Train Operation

The principal rules regarding operation and mainteance of railway faclities during the rainy season (or any other instance of heavy rain) is described in the Genral Rules[4] and the Civil Engineering Manual[5]. It is required to confirm actual operation of these rules/manuals, and verify whether (i) the contents are in line with the actual conditions in light of recent flood disasters, and (ii) there is a need to update/revise rules that lead to preventing accidents caused by flood disasters. The Study prepared hazard maps indicating, among other things, the critical sites requirng the utmost attension (e.g., track sections repeatedly damaged by erosion and the intersection of the track and the tributaries where severe sedimentation is observed), past flood records, and flood marks (See Appendix T). While accumulating data through (i) regular observation of rainfall in the river basin and water levels in rainy seasons (at Gulwe and Kilosa), and (ii) continuous record of river bank erosion progress, it is desired that these data (including the hazard maps) be utilized for safety of train operation (i.e., speed restriction, service suspension).

Active participation of RAHCO/TRL staff in these activities is essential. It is therefore important to include the activities above under the Project.

(5) Impact on the Project due to Climate Change

Any reference regarding discussions and/or research on the future trends of rainfall intensity of short-duration in Tanzania, which commonly causes flood and sediment disasters, is not available at the present time. However, the projection of annual and seasonal rainfall change in the central region, where the target area of the Project is located, is available in the “Climate Change Project for Tanzania” prepared by Tanzania Meteorological Agency in 2015. The results indicate that future rainfall during rainy seasons from December to February might increase as compared with the present climate, whereas the future rainfall from March to May might not change drastically (-3.7% to -2.8% of the March to May seasonal rainfall value at 2050). In this context, the Project might be able to persist even with a change of rainfall intensity in the future.

(6) Application of Japanese Technologies

There are five Japanese technologies that have been proposed for application in the Project. These include, among others, branch block and in-situ stabilized excavated materials (INSEM) methods. Application of these two technologies (or construction methods) is mainly subject to (i) scouring phenomena and sediment behavior in the river channel, and (ii) in-situ materials, including sand and stone. It is necessary therefore to determine during Detailed Design the extent of revetment and shape of foundation, etc. through trial construction and hydraulic laboratory test, etc.

15.2 Recommendations

(1) Project Implementation Structure

Following the implementation structure for the World Bank-assisted TIRP, it is recommended that RAHCO be the Executing Agency for the Project, and that a Project Management Team (PMT) be established with core personnel provided by RAHCO and the Project. The core

[4] See 230. Warning Order (p.157) and 236. Floods and Landslides (p.167)
[5] See 15.3.12 Precautions before and during rains (p.15-20)

personnel is to consist of: Chief of PMT, Deputy Chief of PMT, Project Engineers (two), Accounting Specialist, Procurement Specialist, Assistant Project Engineers (two), Environmental and Social Specialist, and support staff . It is also recommended to prepare an operation manual for implementation of the Project that may be similar to that for TIRP.

(2) Project O&M Structure

- In order to undertake train operation and infrastructure maintenance safely and efficiently during the construction stage of the Project, it is recommended that an Operation, Maintenance and Safety (OMS) Team be set up, consisting of representatives from RAHCO, TRL, the supervision consultant, and the contractors for the Project.
- Strengthening the capacity of RAHCO and TRL is essential for revitalizing the Central Railway Line before introducing new institutional arrangements, including the implementation of the Open Access Policy.
- Considering that the railway sector of Tanzania in the past experienced a failure of a concession arrangement, any re-use of PPP to provide railway services should be carefully approached. For example, the sector should aim at achieving the level of rail freight tonnage during the peak times (2001–04) under the current institutional setup before any re-use of PPP (including the Open Access Policy) is implemented.
- It is recommended that the Tanzanian railway sector focus more on freight transport that will contribute to the improvement of financial performance of the railway system while placing a lower priority on passenger services that would require operating subsidy.
- It is also recommended that the sector should not rush toward complete vertical separation of the railway system considering that, even in Europe, there is no evidence indicating that vertical separation leads to better railway performance compared to vertically-integrated systems.

(3) Decision-Making Process

- Based on the lessons learned by TIRP, it is recommended that the Managing Director of the Executing Agency be the accounting officer for the Project, and that the accounting officer exchange directly with the Attorney General the draft contract (the value of which is TZS 50 million or above) for vetting.[6]
- Even in the case that the Executing Agency is obliged to submit the draft contract via the supervising ministry for review as with the case of TIRP, it is recommended that the review period by the ministry be defined and followed strictly.[7]

(4) Capacity Building for Flood Protection through the Improvement of Train Operation Safety

A possibility of overtopping/inundation during floods will remain mainly in the non-rerouting sections after completion of the Project, which may create suspension/speed restriction of train

[6] The Public Procurement Regulations (PPR) 2013 has provisions for vetting of contracts by the Attorney General (no. 59) as follows: 59-(1) Any formal contract arising out of the acceptance of tender whose value is fifty million shillings or more shall be vetted by the Attorney General before the contract is signed by the parties. (2) Subject to sub-regulation (1), a contract whose value is fifty million shillings and above, which is not vetted by the Attorney General shall be void. (3) The accounting officer shall, within three working days after being notified by the tender board of its award decision, submit to the Attorney General the draft contract for vetting. (4) The Attorney General shall, within twenty one working days upon receiving the draft contract from the accounting officer, vet the draft contract and provide comments to the accounting officer, if any. (5) The accounting officer shall, upon receiving the comments on the draft contract from the Attorney General, incorporate them in the draft contract.

[7] In addition to sending every draft contract over TZS 50 million to the Attorney General for his/her endorsement, RAHCO is obliged to send them via the MoWTC for review (on the way out and on the way back) under TIRP. These processes have been a major barrier to efficient progress according to the TIRP PIT Quarterly Report covering 1 October to 31 December 2015.

operations and further train accidents. In order to improve safety of train operations, following measures are required:

- Review of the current annual monitoring and maintenance plan being employed by RAHCO/TRL so that they would be suited to the current site conditions of the Kilosa–Gulwe section.
- Confirmation of actual operation of rules/manuals regarding train operations during the rainy season (or heavy rain) described in the Genral Rules and the Civil Engineering Manual, and verification of (i) the contents in terms of the actual conditions in light of recent flood disasters and (ii) a need to update/revise rules that lead to preventing accidents caused by floods.

From the view to the above, it is recommended to strengthening the capability of RAHCO/TRL to prevent train accidents caused by floods through the implementation of the measures above under the Project.

(5) Further Consideration of Shortening the Construction Period

It was estimated that up to 36 months would be required for construction works including embankment and cutting works, track installation work, and bridge work. This includes annual three-month non- working period for bridge works in the tributaries considering the rainy seasons. Nevertheless, the exact candidates of the quarry site, borrow pit, and disposal area for the Project will be selected during Detailed Design; therefore, further consideration should be given to shortening of the construction work period.

(6) Consideration of Phased Completion Inspection (Opening)

Completion inspection is planned to be undertaken after completion of all construction works. In order to remove the possibility of flood damages as early as possible, however, it is proposed that consideration be given during Detailed Design to the implementation of phased completion inspections. In so doing, the priority order of work completion should also be considered.

(7) Securing of Adequate Contingency

As the Kilosa–Gulwe section suffers from flood and sediment disasters almost every year, there is an extremely high likelihood that the section will be damaged by floods prior to completion of the Project. In fact, the January 2016 floods damaged several parts of the railway system, halting train services between Dar es Salaam and Dodoma for about 2.5 months. As there is a possibility of variation in design, work period, and project cost, it is recommended that contingency and work period be decided with careful consideration.

(8) Countermeasures Upstream of Maswala and Mzase Tributaries

As a means of regulating sediment discharge at the Maswala and Mzase tributaries, first and second priority countermeasures have been proposed. The first priority covers downstream areas, while the second priority is at upstream areas. The Project is limited to covering downstream areas (i.e., the first priority), which directly affect the track and appurtenant structures. Any countermeasures in the sediment production in upstream areas are not included in the Project. It is thus recommended that upstream areas (i.e., the second priority) in these tributaries be targeted shortly after the completion of the Project.

(9) River Basin Management

In order to reduce flood damages, it is recommended that river basin management upstream of the three tributaries (i.e., Maswala, Kidibo, and Mzase) and other tributaries with high sediment productivity (e.g., Sikoko, Mangweta, and Lumuma) be implemented in coordination with concerned responsible agencies such as the Ministry of Agriculture and Local Government Authorities. River basin management includes, among other things, control of sediment discharge from cultivated areas, livestock grazing control, land use regulations, tree-planting, and hillside works.

(10) Application of In-situ Excavation Material (INSEM)

As for construction of the ground sills and check dam in the Maswala and Mzase River basins, the in-situ excavation material (INSEM) method will be able to apply as mentioned in Subsection 10.4.3., which is one of Japanese technologies. However, it should be noted that material investigation, sampling, trial mixing, and confirmation of mix proportion based on the results of hexavalent chromium elution test, are required before construction by INSEM. Mix proportion shall be conducted considering the reduction of elution on proceeding hydration exothermic reaction.