Ethiopian Roads Authority
The Federal Democratic
Republic of Ethiopia

PREPARATORY SURVEY REPORT
ON
THE PROJECT FOR
REPLACEMENT OF AWASH BRIDGE
ON A1 TRUNK ROAD
IN
THE FEDERAL DEMOCRATIC REPUBLIC OF ETHIOPIA

January 2011

JAPAN INTERNATIONAL COOPERATION AGENCY

CENTRAL CONSULTANT INC.

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Preface

Japan International Cooperation Agency (JICA) conducted the preparatory survey on the project for replacement of Awash Bridge on A1 trunk road in the Federal Democratic Republic of Ethiopia, and dispatched the first survey team from April 26th to May 27th and the second survey team from June 28th to August 2nd, 2010.

The survey team held a series of discussions with the officials concerned of the Government of Ethiopia, and conducted field investigations. After further studies in Japan, as a result of explanation of the outline design in Ethiopia made from December 9th to 18th, 2010, the present report was finalized.

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

Finally, I wish to express my sincere appreciation to the officials concerned of the Government of Ethiopia for their close cooperation extended to the survey team.

January 2011

Atsufumi Konishi

Director,

Economic Infrastructure Department,

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Summary

Summary

(1) Overview of the Country

The Federal Democratic Republic of Ethiopia (hereinafter "Ethiopia") is a landlocked country bordering Djibouti, Eritrea, Sudan, Kenya and Somalia. Ethiopia has an area of 1,104,000 km^2, a population of 82,820,000 (in 2009) and, thus, a population density of 75 people/km^2.

Geographically, Ethiopia is located in the "African Great Rift Valley" which runs in a north-south direction on the Ethiopian Plateau. Most of the land is located on the Ethiopian Plateau with an elevation of between 1,500 m and 3,000 m (average elevation 2,300 m above sea level).

The area below 1,500 m belongs to the subtropical climate zone with an annual average temperature of 27°C and annual precipitation of only 500 mm. The climate in the plateau area between 1,500 m and 2,400 m above sea level also has the characteristics of the subtropical climate zone. However, the annual average temperature is lower (approximately 22°C) and the annual precipitation is higher (1,500 mm) in this area than in the area with lower elevation. The area above 2,400 m has a cool climate with an annual average temperature of 16°C. The rainy season is from mid-June to mid-September in most parts of the country.

The project site is located in the African Great Rift Valley. The annual average temperature and precipitation at the site are 26°C and 510 mm, respectively. Most of the rain is observed in the rainy season.

The *per capita* GNI (gross national income) of Ethiopia is US$ 330 (in 2009). The economy depends on production of primary products with agriculture accounting for approximately 85% and 45% of employment and GNI, respectively. The main exports are coffee and oil seeds. Thus, the economy is likely to be affected by the state of the international markets in these commodities and the weather.

The civil war, which lasted for 17 years from 1977, and drought severely impoverished the Ethiopian economy. A new economic strategy, the "Agricultural Development Led Industrialization (ADLI) strategy," was prepared by the interim government which was established in 1991. In January 1995, the "Five-Year Program on Development, Peace and Democracy (Five-Year National Development Plan)" was prepared based on a review of the ADLI strategy. The program gave the highest priority to improvement of agricultural productivity, education, roads and public hygiene. Following the preparation of the five-year plan until 1998, the economy regained stability with net economic growth reaching approximately 6% per year on average and inflation remaining below 5%. However, GDP decreased in 1998 because of the drastic decline in agricultural production caused by drought and the decline in the price of coffee, the main export commodity of Ethiopia, on the global market. In addition, a large number of people became refugees or internally displaced during the border conflict with Eritrea. These events caused great damage to the Ethiopian economy.

In order to deal with the post-conflict economic problems, the Government of Ethiopia prepared a "Second Five-Year National Development Plan" based on a review of the Five-Year National Development Plan in 2000. The government prepared the Poverty Reduction Strategy Paper on the

basis of the Second National Development Plan in October 2002 and established the "New Coalition for Food Security in Ethiopia" in 2003. In December 2005, the government launched the "Plan for Accelerated and Sustained Development to End Poverty (PASDEP)," a development plan for the subsequent five-year period. The Ethiopian economy grew at double digit rates during the six-year period up to 2009. In the fall of 2010, the "Growth and Transformation Plan (GTP)," a five-year development plan to succeed PASDEP, was prepared.

(2) Background and Outline of the Project

While road traffic and transport account for 95% of inter-city traffic and transport in Ethiopia, the low road density (38.6 km/1000 km^2 or 0.55 km/1000 people) is the biggest problem in the road sector. While the Government of Ethiopia has repaired trunk roads and constructed provincial roads and ring roads with assistance from aid organizations of various countries, further improvement of trunk roads and expansion of rural road networks are required to increase the road density. There are 2,800 bridges in the national trunk road network. Forty percent of the bridges were built in the 1940s and 1950s. Therefore, the need for reconstruction or maintenance in accordance with the extent of their degradation is recognized. In order to meet this need, the Ethiopian Roads Authority (ERA) is taking the lead in the improvement of the road network with assistance from international financial institutions and aid organizations of various countries in accordance with the Road Sector Development Program (RSDP).

Since the improvement of the road infrastructure including bridges is extremely important for the improvement of the trunk road network in Ethiopia, as mentioned above, JICA has been implementing a four-year project, the "Capacity Development Project on Bridge Management," since January 2007 at the request of the Government of Ethiopia. In this project, activities for bridge management have been implemented with particular focus on promotion of effective use of the bridge management system, and the priorities for bridge reconstruction proposed by the Ethiopian side have been reviewed.

In the trunk road network, the A1 Trunk Road involved in this project is considered important as a major trade route connecting the Port of Djibouti, which handles 90% of Ethiopia's exports and imports, and the capital, Addis Ababa. The Awash Bridge is essential for north-bound traffic from Addis Ababa and is heavily used. It is a long bridge with a length of 109 m. Traffic on the bridge is restricted to one vehicle in one direction at a time because of insufficient load-carrying capacity.

Against this background, the Government of Ethiopia submitted a request for Grant Aid assistance for the construction of a new bridge to replace the existing Awash Bridge to the Government of Japan.

In response to the request, the Japan International Cooperation Agency (JICA) conducted a preliminary survey on this project for the purpose of confirming the request contents and the conditions of the project site and the existing bridge and road, implementing EIA in accordance with the JICA Guidelines for Environmental and Social Considerations and verifying the removal of landmines, and confirmed the need and relevance of the reconstruction of the Awash Bridge on the basis of the survey results.

(3) Outline of the Survey Results and Contents of the Project

Following the above-mentioned preliminary survey, JICA dispatched the first and second preparatory survey teams to Ethiopia from April 26th to May 27th and from June 28th to August 2nd, 2010, respectively. The survey teams conducted studies and verifications mainly of the bridge construction site, access road, longitudinal plan, cross section, bridge structure, environmental and social considerations, natural conditions, traffic volume, procurement of construction materials and equipment, operation and management structure and demining through discussions with relevant personnel on the Ethiopian side.

After the study had been made of the bridge, access road and implementation schedule and the outline design including project cost estimation had been prepared on the basis of the results of these surveys, JICA dispatched a survey team to explain the outline design to Ethiopia from December 9th to 18th, 2010. The survey team and the Ethiopian side discussed, confirmed and agreed on the contents of the outline design and the scope of works of the Ethiopian side.

A location which satisfied the following three conditions was selected as the site for the new bridge construction: 1) in terms of alignment, the access road to the new bridge should have no s-shaped curve like the one found in the existing access road; 2) in terms of profile, the new access road should have no steep slope like the one found in the existing access road (7%); and 3) the costs for the construction of the new bridge and access road should be reasonable in terms of cost-efficiency. Ethiopian and Japanese standards were followed in deciding the structure of the bridge and the specifications of the access road, taking into consideration cost-reduction, and the basic designs for the bridge and access road were prepared with appropriate scales and specifications for them to perform their expected functions. Cost-efficiency-oriented methods were adopted for the construction work in particular, while completing the construction work in the shortest possible time was also taken into consideration in the selection of the methods.

The table below shows the outline of the final proposal for the project with the above-mentioned incorporated.

Bridge structure		PC continuous rigid-frame box-girder bridge with three connected spans
Bridge length		43.0 m + 70.0 m + 32.0 m = 145.0 m
Width		Carriageway: 3.65 m × 2 = 7.3 m, Shoulder: 1.0 m × 2 = 2.0 m Total: 9.3 m (Effective width), (Gross width: 10.3 m)
Surface type		Asphalt pavement (70 mm on the carriageway)
Abutment structure		Abutment A1: reverse-T type (with spread foundation) Abutment A2: reverse-T type (with spread foundation)
Pier structure		Pier P1: Rectangular-shaped (with spread foundation) Pier P2: Rectangular-shaped (with spread foundation)
Access road	Total length	On the origin (Addis Ababa) side: approx. 527 m, on the destination (Djibouti) side: approx. 408 m, total: 935 m
	Width	Carriageway: 3.65 m × 2 = 7.3 m, Shoulder:2.5 m×2 = 5.0 m Total: 12.3 m (Effective width) Soft shoulder: 1.0 m x 2 = 2.0 m, Total: 14.3 m (Gross width)
	Surface type	Asphalt pavement (surface course: 50 mm, base course: 200 mm, subbase course: 100 cm)

(4) Implementation Period and Estimated Cost of the Project

Approximately 34.0 months will be required for the implementation of the entire project, including the tender, if this project is implemented under Japanese Grant Aid (8.0 months for the execution design and 26.0 months for the construction). The project cost is estimated at approximately 1.36 million yen to be borne by the Ethiopian side.

(5) Evaluation of the Project

1) Relevance

The relevance of implementing this project under Japanese Grant Aid is justified for the following reasons.

① The number of beneficiaries of this project is expected to be very large as the project is expected to benefit Ethiopians at large, including the poor in the north (82,820,000 Ethiopians as the direct beneficiaries and 820,000 Djiboutians as the indirect beneficiaries).

② Implementation of the project is urgently required to improve the livelihood of the people because of the expected effects which include strengthening of the international trunk road transport network with improvement of the most important route in Ethiopia, stable and more efficient road traffic, promotion of social and economic activities and poverty reduction among the people living along the road.

③ Since the operation and management of the bridge and access road to be constructed will not require excessively sophisticated technologies, it will be possible for the Ethiopian side to operate and manage them with its own financial and human resources and technical capacity.

④ RSDP considers this project to be a concrete strategy and the Awash Bridge is the most important facility for the project to improve the A1 Trunk Road, an international trunk road in Ethiopia.

⑤ This project is expected to have little negative environmental impact.

⑥ It will be possible to use the Japanese Grant Aid scheme for the implementation of this project without any particular problem.

⑦ It is necessary and advantageous to use Japanese technologies in the construction of the bridge because it is technically difficult for the Ethiopian side to design and construct such a long PC bridge (bridge length: 145 m).

2) Effectiveness

i) Quantitative Effects

① While traffic on the bridge is restricted to only one vehicle in one direction at a time and vehicles have to stop before the bridge for an average of three minutes/vehicle at the existing Awash Bridge, the construction of the new Awash Bridge will enable vehicles to cross the bridge in either direction without stopping before the bridge.

② The weight limit of vehicles permitted to cross the bridge will be increased from the current 32.6 tons to 40.8 tons. Thus, it will be possible to respond to the increase in the traffic volume of large trucks in particular.

③ While the speed limit is placed on vehicles at the existing Awash Bridge at present, the construction of the new bridge will enable the speed limit of the vehicles on the bridge to be increased to 85 km/h from the current 20 km/h.

ii) Qualitative Effects

① The improvement of the A1 Trunk Road, an international trunk road, will enable stable and quick access to the Port of Djibouti, which handles 90% of Ethiopia's exports and imports, and, thus, contribute to the economic development of Ethiopia and Djibouti.

② This access for the northern region, which is less developed than the southern region, will be facilitated as the improvement of the load-carrying capacity of the bridge concerned will establish a reliable transport route. This will contribute to the economic development poverty reduction in the region.

③ As the existing bridge will be used as a pedestrian bridge, the new bridge will be restricted to vehicles, which separates pedestrian and vehicle traffic completely. Thus, the risk of traffic accidents involving pedestrians and livestock will be reduced.

④ While there is no detour for the existing bridge at present, it will be possible to use the existing bridge as an emergency detour/ evacuation route after the construction of the new bridge near the existing bridge has been completed.

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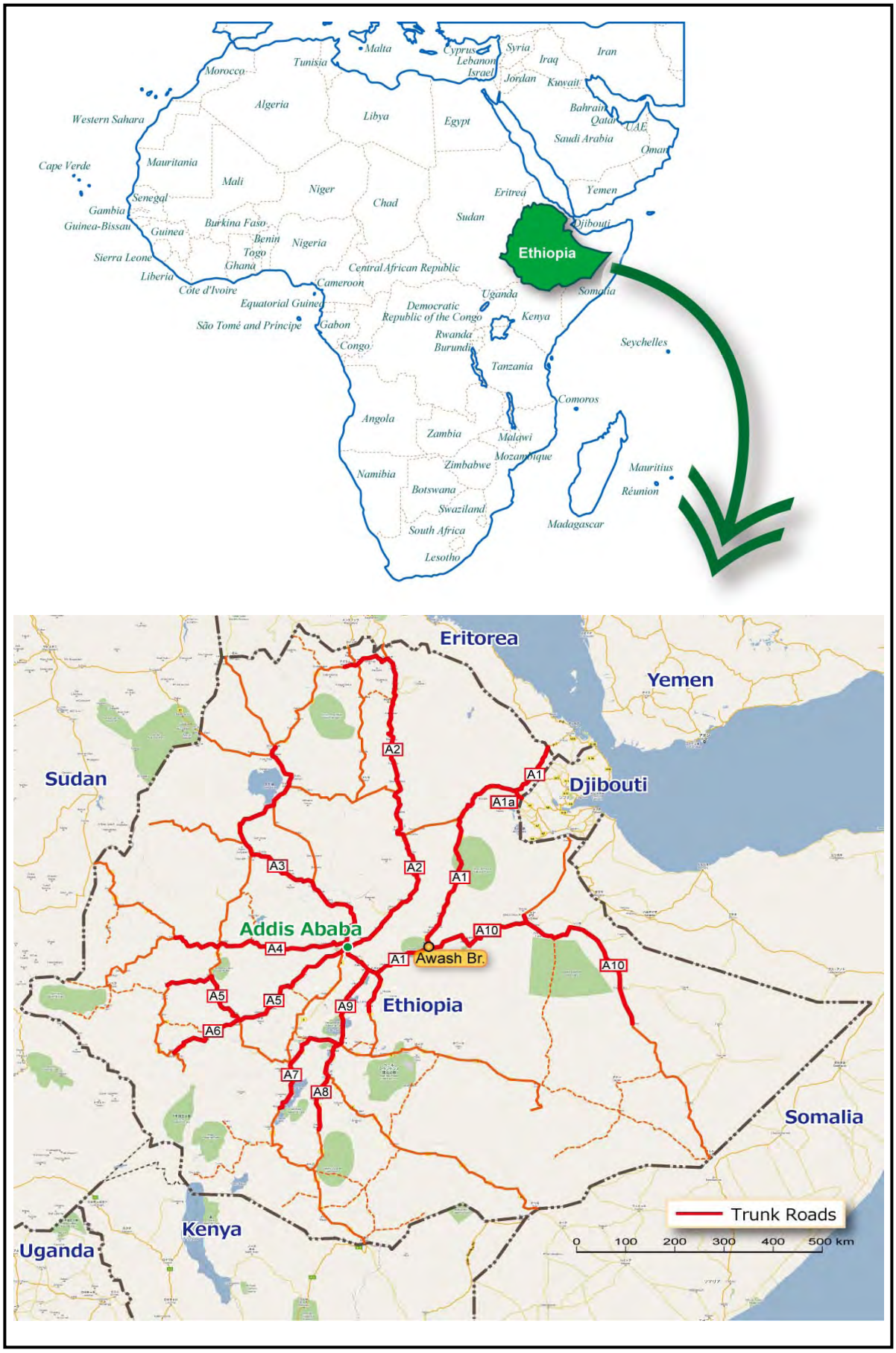
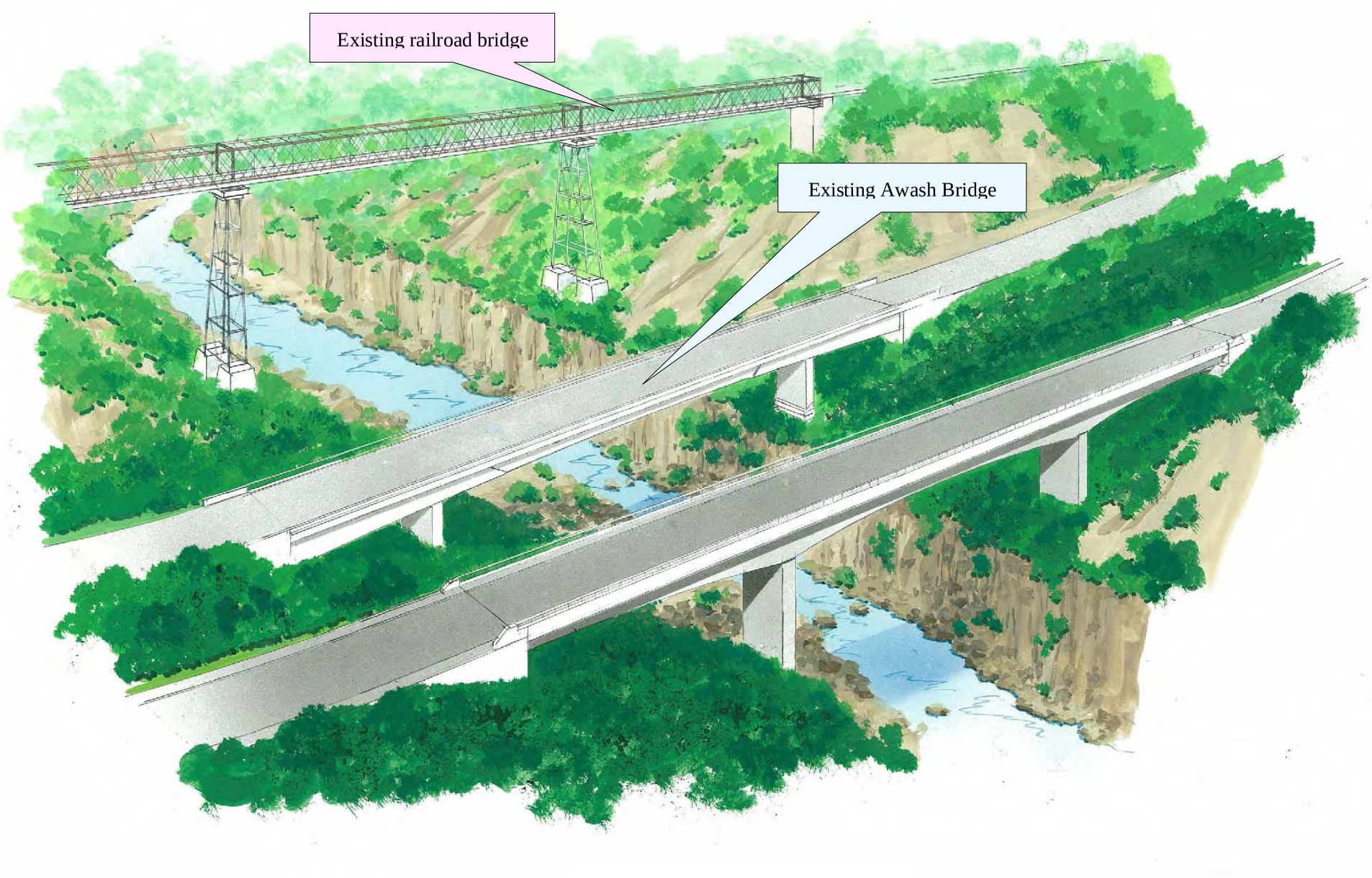


Location Map



Perspective view of Awash Bridge

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Abbreviations

AADT	Annual average daily traffic
AASHTO	American Association of State Highway and Transportation Officials
AfDB	African Development Bank
BADEA	Arab Bank for Economic Development in Africa
BMS	Bridge Management System
BRP	Bridge Rehabilitation Program
CBR	California Bearing Ratio
COMESA	Common Market for Eastern and Southern Africa
EIA	Environmental Impact Assessment
EMAO	Ethiopian Mine Action Office
EMSB	Environmental Monitoring and Safety Branch
EPA	Environmental Protection Authority
ERA	Ethiopian Roads Authority
EU	European Union
GNI	Gross National Income
HDM	Highway Development Management
HIV/AIDS	Human Immunodeficiency Virus/ Acquired Immunodeficiency Syndrome
IDA	International Development Association
IEE	Initial Environmental Evaluation
JICA	Japan International Cooperation Agency
M/D	Minutes of Discussion
MDG s	Millenium Development Goals
MOFED	Ministry of Finance and Economic Development
NDF	Nordic Development Fund
NGO	Non Governmental Organization
NMA	National Meteorological Agency
OFID	OPEC Fund for International Development
PAP	Project Affected Persons
PASDEP	Plan for Accelerated and Sustained Development to End Poverty
PC	Prestressed Concrete
RC	Reinforced Concrete
ROW	Right of Way
RSDP	Road Sector Development Program
SDPRP	Sustainable Development and Poverty Reduction Program
UXO	Unexploded Ordnance
WB	World Bank

Chapter 1

Background of the Project

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1-1 Backgound and Outline of the Grant Aid Project

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1-2 Natural Conditions

(1) Meteorological Survey

1) Temperature

The highest maximum temperature of 37°C is observed in June and the lowest average minimum temperature over an eleven-year period of 18°C is observed in November in the vicinity of the Awash Bridge. The annual average temperature in the area is 25°C.

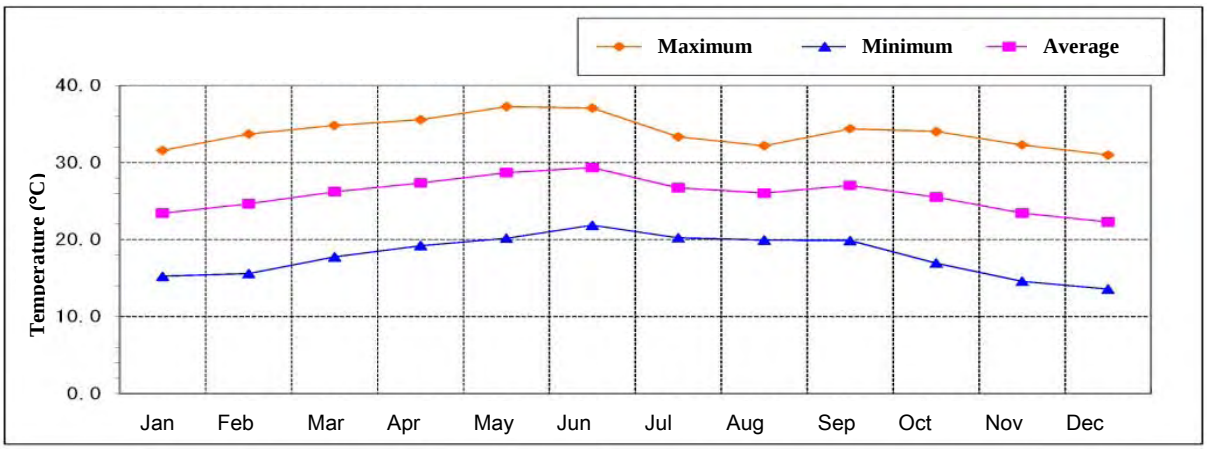


Figure 1-2-1 Monthly temperatures

2) Wind speed and direction

The wind speed is between 2.0 m/s and 3.0 m/s throughout the year in the vicinity of the Awash Bridge and there is no significant change in wind speed between the rainy and dry seasons. The average annual wind speed is 2.5 m/s in the area.

3) Humidity

The highest humidity of 64% and the lowest humidity of 47% are observed in August in the rainy season and November in the dry season, respectively, in the vicinity of the Awash Bridge. The average annual humidity in the area is approximately 54%.

4) Precipitation

i) Monthly precipitation

The average annual precipitation was approximately 510 mm at the project site for the five-year period from 2005 to 2009. The annual precipitation differs little by year for the same period, ranging from a minimum of 443 mm to a maximum of 578 mm. August is the month with the highest precipitation in the year and little precipitation is recorded from November to February.

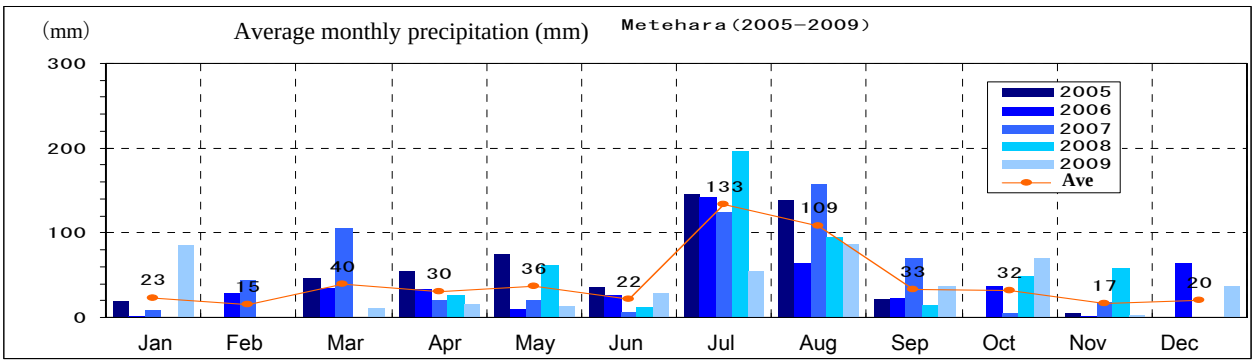


Figure 1-2-2 Monthly precipitation

ii) Maximum daily precipitation

The figures for the average maximum daily precipitation in the dry and rainy seasons are approximately 10 mm and 20 mm, respectively. The highest average maximum daily precipitation of 33 mm is recorded in July. The highest maximum daily precipitation of 52.4 mm was recorded in August 2009.

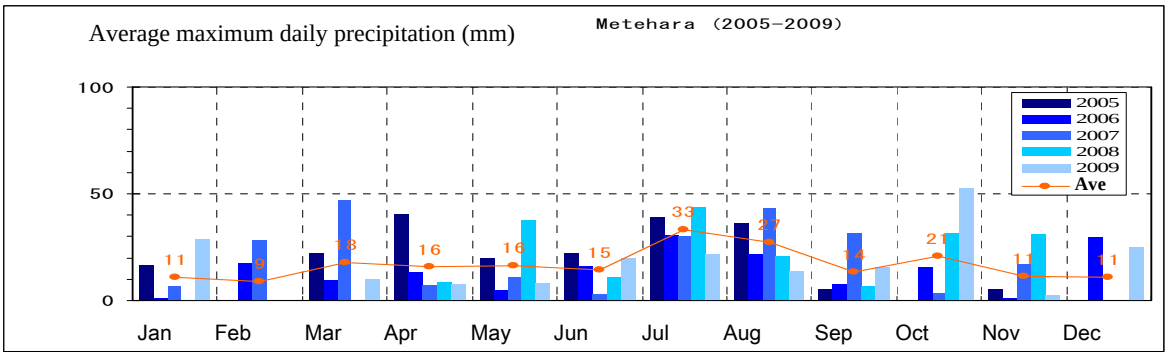


Figure 1-2-3 Maximum daily precipitation

(2) Hydrological Survey

1) River basin

One of the major characteristics of the river flowing at the new bridge site is that it is a natural river. The catchment area of the river is 19,111 km^2. Figure 1-2-4 shows the map of the Awash River Basin.

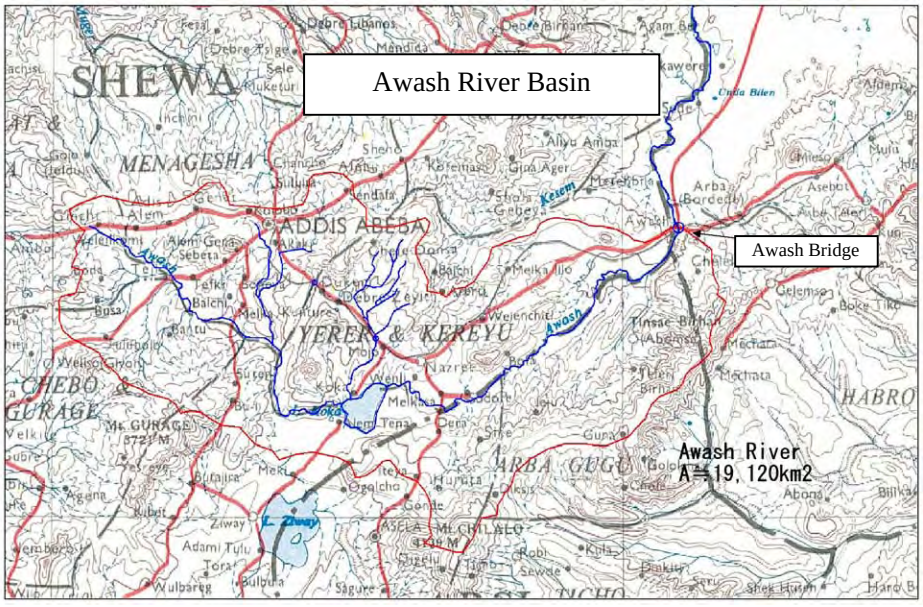


Figure 1-2-4 Map of the Awash River Basin

(3) Condition of the River

Water is found flowing in the river channel throughout the year. The river has almost the same width upstream and downstream of the existing bridge, where no steep slopes were found in the river bed. The river has an approximately 20 m-deep u-shaped channel and the low-flow channel is

approximately 50m wide. Bare basalt is found on the river bed and bare rock is found on the riverbanks. There are V-shaped slopes above the river channel. No trace of water flow was found on the slopes. The foundations of the existing road bridge and the railway bridge are located just above the upper end of the river channel. No trace of inundation in the past was found on the foundations.

On the upstream side (The foundations of the railway bridge are located above the low-flow channel.)

On the downstream side (The low-flow channel has approximately the same

(4) Hydraulic Parameters

The flow rate of the Awash River was measured at the Awash Observatory (No. 032004) upstream of the planned bridge construction site. Although the flow rate was not measured on certain days, the team obtained data on the average daily water level and flow rate measured at the observatory. The data were used to calculate the maximum flow rate for each year. The maximum flow rates thus obtained were analyzed by probabilistic and statistical methods to obtain the one hundred-year flow. The high water level was then estimated by carrying out hydraulic calculation using the data obtained from the river cross-section survey.

1) Design flow rate

The three widely-used methods for probabilistic analysis of hydrological parameters, "lognormal distribution method," "Iwai method" and "Gumbel method," were used to obtain the one hundred-year flow, which is an indicator of design flood discharge. From the results of the analysis shown in the table below, the one hundred-year flow (at the peak) of the Awash River is estimated at 1,590 m^3/s as shown in the table below.

Table 1-2-1 One hundred-year flow

Method of probabilistic analysis	One hundred-year flow (m^3/s) (before correction)	One hundred-year flow (m^3/s) (after correction)
Lognormal distribution method	982.5	1,473.8
Iwai method	1,059.5	1,589.3
Gumbel method	1,040.4	1,560.6

2) Design High-Water Level (HWL)

The outputs of the survey of the Awash River were used for estimation of the design high-water level at the bridge construction site. The coefficient of roughness (n) of the river channel was assumed at n = 0.030, taking into consideration the smooth alignment of the river channel with the almost straight river channel and the riverbanks with little ruggedness despite bare rock exposed on the surface of the

riverbed and the riverbanks. The shape of the cross-section of the river channel upstream and downstream of the construction site is almost identical with almost identical width and height. The average riverbed slope (i) is estimated at i = 1/500. From the figures mentioned above, the design high-water level at the construction site is estimated at 800.159 m.

A hydraulic analysis report by ERA cites a report by a guard (police officer) at the bridge that the highest water level ever observed was seven to eight meters above the river bed. The maximum flow rate found in the obtained record of flow rates is 1,328 m^3/s recorded in 2003. These figures suggest that the HWL estimated in this survey is reasonable. ※ The lowest riverbed elevation at the location of the existing bridge is EL = 790.1 m. A water depth of h = 10.0 m is required for the design river channel to accommodate the design flood discharge of Q = 1,590 m^3/s

(5) Topographic and geological survey

1) Outline of the topography

Ethiopia is located in the northeast of the African continent between 3° and 15° north and 33° and 48° east. It has an area of 1,100,000 km^2. As shown in Figure 1-2-5, Ethiopia is located in the north of the African Great Rift Valley. The Great Rift Valley is a gigantic valley running in the north-south direction through the eastern part of the African Continent and one of the boundaries between the earth's crust plates. Its formation is thought to have begun five to ten million years ago. In most part, the Great Rift Valley has a width of between 35 km and 100 km and its length from Mozambique in the south to the Red Sea in the north reaches 4,500 km. The total length of the Great Rift Valley is thought to be 7,000 km as it extends further north from the Red Sea to Israel and the Jordan Valley. The Great Rift Valley is characterized by unique meteorological, natural and biological environments which include scarps more than 100 m high on both sides of the graben created by normal faults, highland beyond the scarps and ascending air currents created by heating of the graben.

Ethiopia has three topographical zones, i) the Ethiopian (Abyssinian) Plateau on the west, ii) the Somali Plateau on the east and iii) the graben in the middle. Although the rift valley has been formed by sinking of the central block and lifting of the two outer blocks by diastrophism, volcanic activity is still evident in the graben and the many lakes found throughout the graben provide a rich habitat for natatorial and migratory birds.

The vast Ethiopian Plateau is located at an elevation of over 2,000m. The highest mountain in the plateau, Ras Dashen, reaches an elevation of 4,620 m. The elevation of the plateau gradually decreases westward toward Sudan. The highest mountain in the eastern plateau, Mount Batu, reaches an elevation of 4,307 m. The elevation of the eastern plateau decreases southeastward toward Somalia. The plateau turns into desert at its extremities. The central graben begins increasing in width northward from Nazreth, which is located southeast of Addis Ababa, to form a fan shape. The western escarpment extends north toward the Red Sea, while the eastern escarpment extends east toward the Gulf of Aden. The triangular area bordered by the escarpments, which includes Djibouti, is called the Afar Depression. The continuous downthrow has created areas below sea level in the depression. It was at Hadar north of the Afar Depression that the complete fossilized female skeleton

of *Australopithecus afarensis*, "Lucy," considered to be the earliest bipedal ancestor of humans estimated to have lived 3.2 million years ago, was discovered in 1974. Ever since, the Afar Depression has been an important field for anthropological studies with discoveries of many important Australopithecine fossils there.

Rivers in Ethiopia have their source in the central area of the country and from there flow in every direction following the topographic gradient. The Awash River, which has its source near Addis Ababa, flows southeast into the graben, turns northeast to flow through the planned new Awash Bridge site and disappears in the desert in the north of the country near Hadar.

The Awash Bridge which is the subject of this preparatory survey is located in the Ethiopian (Abyssinian) Plateau with an average elevation of 2,000 – 2,300 m and the graben. It is located 227 km east of Addis Ababa at an elevation of 831 m. Its location is in the pivotal area of fan-shaped lowland in the Afar Delta in the Great Rift Valley. The Awash River flows from south to north forming a steep valley in the hilly terrain in the vicinity of the bridge site.

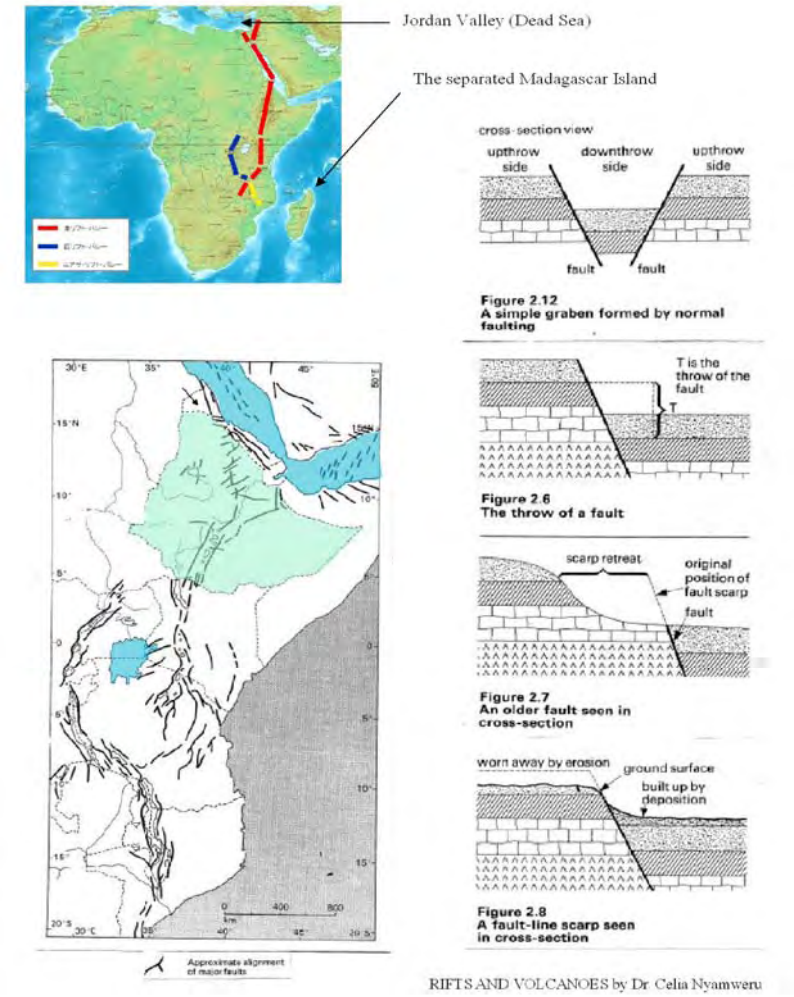


Figure 1-2-5 African Great Rift Valley

2) Results of the survey

The figure below shows the results of the survey at the site of the bridge concerned.

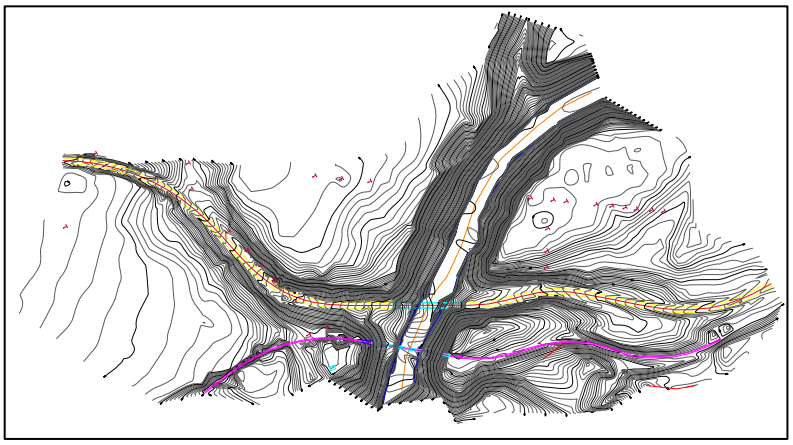


Figure 1-2-6 Results of the level survey at the Awash Bridge

3) Outline of the Geology

Figure 1-2-7 shows a general outline geologic map of Ethiopia. Lava such as ballast, a type of Tertiary/Cenozoic volcanic rock, and tuff are widely found in the entire Ethiopian Plateau. However, more recent Quaternary/Cenozoic lava and tuff are found in some parts of the plateau. Some of the Quaternary tuff is found to have been consolidated by welding. Horizontal or slightly inclined strata of Jurassic/Mesozoic marine sedimentary rock of limestone, shale, sandstone, etc., have been formed to a thickness of more than 1,000 m below the lava. Below the marine sedimentary rock strata is the clino-unconformable bedrock of Precambrian crystalline schist and gneiss. This bedrock is found exposed on the surface at the northern and western peripheries of the Ethiopian Plateau below 1,500 m. It is deduced from these observations that the current topography of the plateau was formed by the uplift caused by diastrophism in the early Tertiary Period and subsequent fault movement and volcanic activity in the Rift Valley in the early Quaternary.

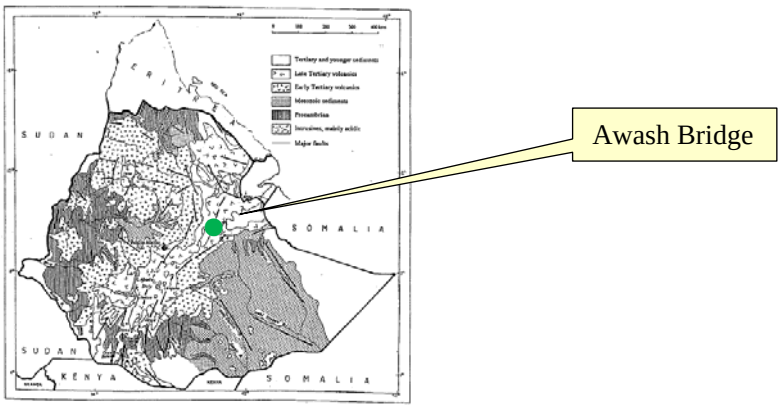


Figure 1-2-7 Outline geologic map of Ethiopia

4) Geological characteristics at the Awash Bridge

The subsurface layer at the site consists of Pleistocene/Quaternary/Cenozoic volcanic products with alternating strata of rhyolite lava and consolidated tuff. Although there is a 2 m-thick stratum of unconsolidated weathered volcanic ash interposed in the middle, the volcanic products are found in quasi-horizontal layers as a whole. The bedrock is assumed to be of Pleistocene/Quaternary rhyolite.

The boring survey revealed a relatively thick layer of hard tuff in the subsurface area. The strength of the tuff layer differs horizontally. Since local strength degradation on the northern cut slope of the existing access road on the Djibouti side has caused thin slips, appropriate measures will have to be taken to stabilize the cut surface of the new access road. A thick unintrusive bedrock layer, presumably of rhyolite, is found below the above-mentioned layers. The figure below shows the geological profile at the bridge site.

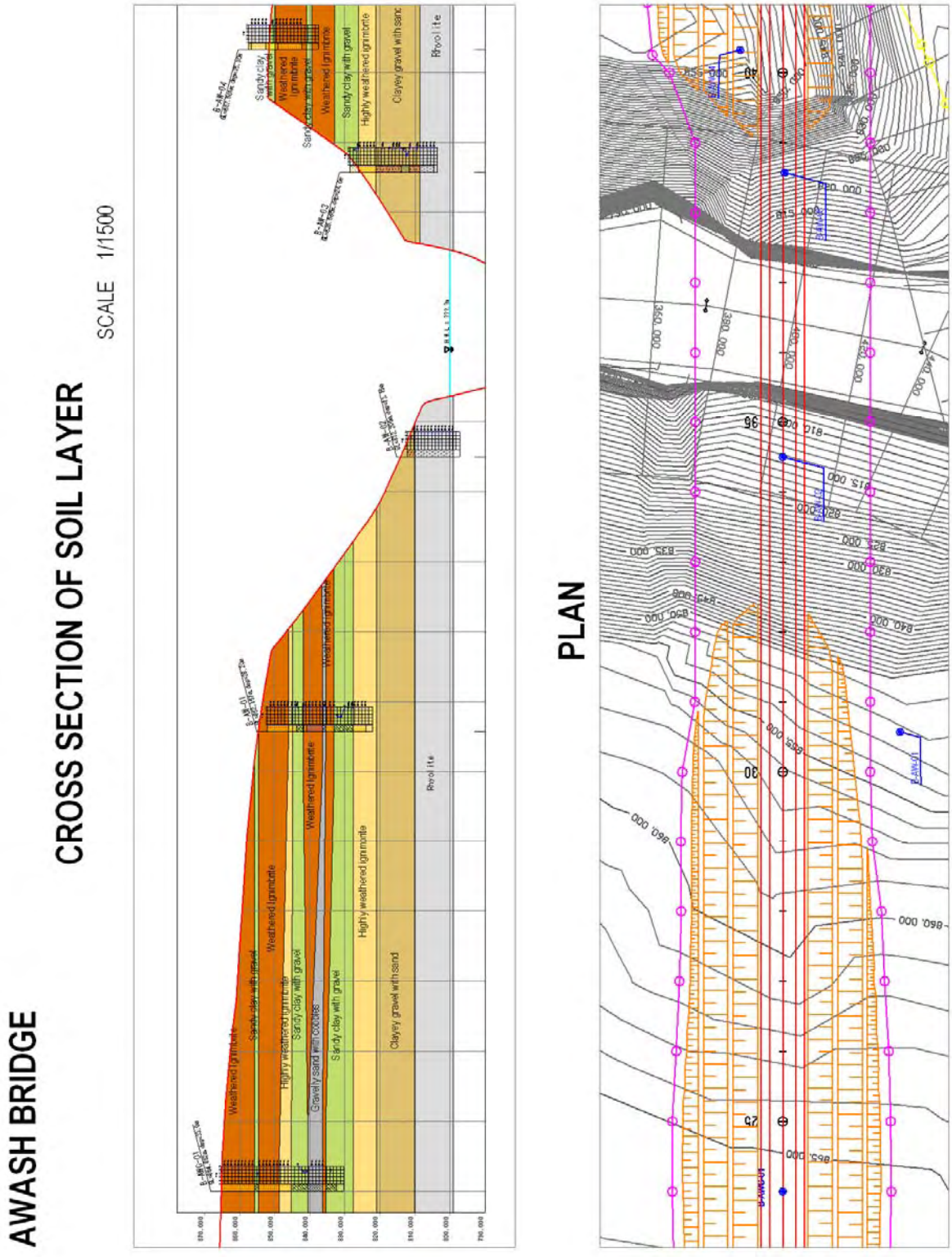


Figure 1-2-8 Geological profile

(6) Seismic survey

Table 1-2-2 summarizes the earthquakes that occurred in Ethiopia in the period between 1906 and 2005.

Table 1-2-2 Outlines of the earthquakes that occurred in Ethiopia

Epicenter	Year of occurrence	Magnitude (M)	Distance from Addis Ababa to the epicenter (km)	Damage caused
Langano	1906	6.8	110	Tremor was felt in Addis Ababa.
Karakore	1961	6.7	150	Town of Majete was completely destroyed. Karakore was destroyed.
Central Afar Division	1969			Town of Serdo was destroyed.
Wendgenet	1983		300	
Langano	1985	6.2	110	
Great Rift Valley	1987	6.2	200	Tremor was felt and damage was reported over wide area.
Dobi	1989	6.3	200	Several bridges were damaged.
Nazreth	1993	6.0	＜100	Some injuries and damage in Nazreth.
Lake Shalla Adami Tulu	1999		250	
Northern Ethiopia (at entrance to Red Sea)	2005	5.5	550	50,000 nomadic people sought refuge. A huge fissure (6 m wide and 60 km long) was created.

1-3 Environmental and Social Consideration

(1) Examination and Certification of Environmental Impact Assessment for Road Projects

The Environmental Protection Authority (EPA) is the supervising authority for the environmental management in Ethiopia and the law requires all projects to have their EIA examined by EPA and to obtain EIA certification from EPA. Figure 1-3-1shows the procedures to survey, examine and certify environmental impact of projects.

However, because of the shortage of staff at the department responsible for the examination in EPA, EPA officially transferred the authority to approve and issue the environmental licenses to relevant government offices with the Delegation Letters dated November 20th, 2008, addressed to them, in order to improve efficiency of the examination. At present, the Ethiopian Roads Authority (ERA) examines and approves environmental impact assessment of all road projects. The Environmental Monitoring and Safety Branch (EMSB) established in the Planning and Programming Division is responsible for the environmental management in ERA.

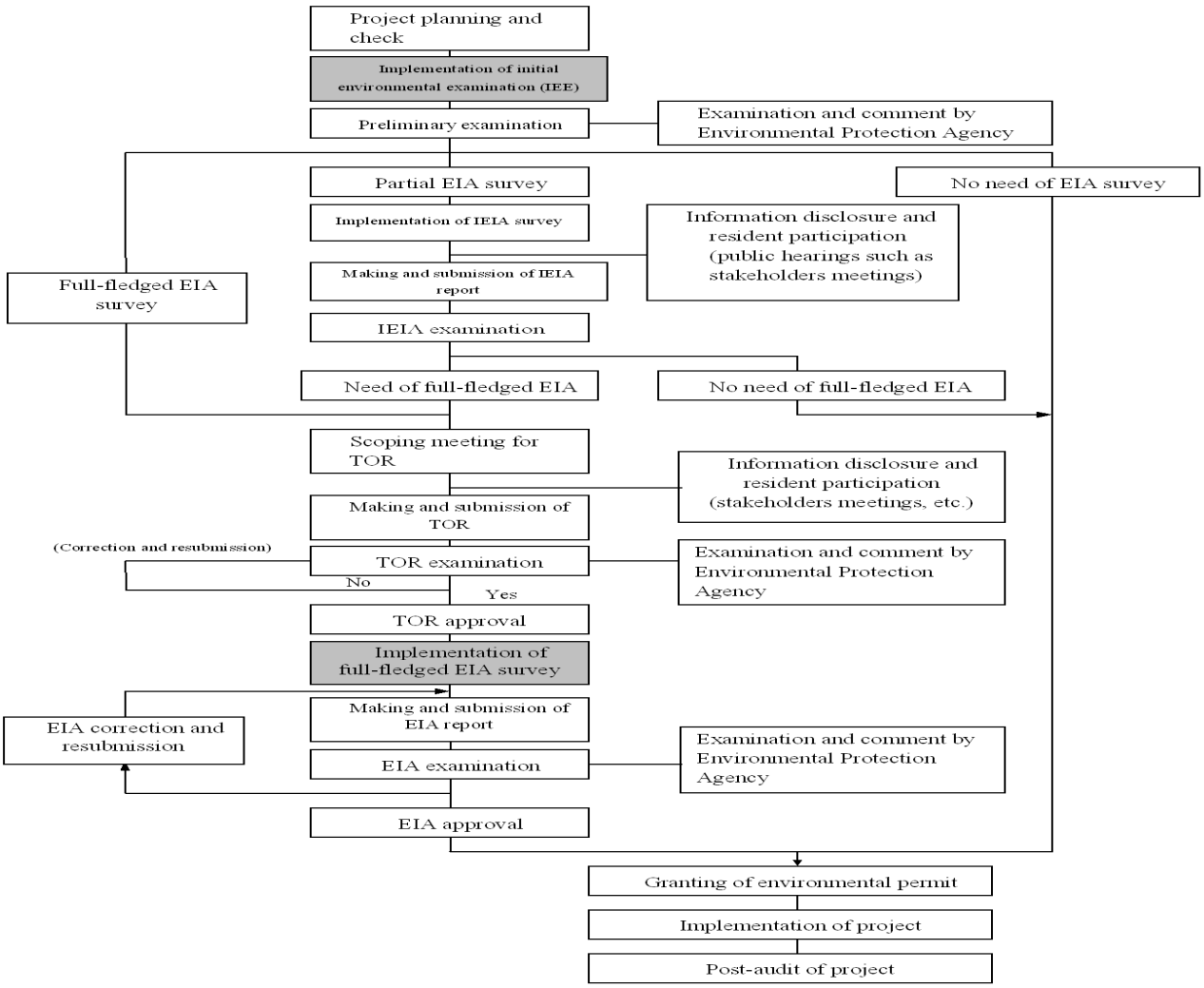


Figure 1-3-1 Procedure of EIA permission

As shown in the Figure 1-3-1, initial environmental examination (IEE) is implemented at first, followed by judgment on whether to implement EIA or IEIA in accordance with the environmental category classification, and, then, survey, examination and certification will be implemented in accordance with the judgment.

Since this project is categorized into Schedule II, but not into Schedule I which is the category for projects with serious environmental and social impact (a Schedule I project is a project which is expected to affect 200 or more people in 40 or more households and whose implementation requires full EIA), in accordance with the environmental guidelines of ERA, submission of an IEIA report is required. An IEIA report must be accompanied by an abbreviated resettlement action plan (AbRAP). With regard to the environmental license for this project which had to be obtained prior to the project implementation, the president of ERA approved the IEIA and AbRAP prepared by EMSB for this project in his letter to JICA Ethiopia Office dated December 3rd, 2010, (See the Submission Letter attached hereto).

The duties and organization of ERA-EMSB are mainly for environmental management and EIA survey and examination for road projects using the Environmental Assessment Guidelines of EPA and ERA's own standards. ERA-EMSB and EPA work in cooperation. For example, ERA-EMSB occasionally asks EPA for its comment on TOR and (draft) EIA/IEIA reports prepared in accordance with the TOR. As of July 2010, EMSB had nine staff members, the branch head/engineer, two ecologists, three sociologists, a hydrologist and a health officer. EMSB was supervising all the environmental monitoring for all road-related projects. Since EMSB does not have its own Environmental Laboratory, it outsources almost all the surveys, examinations and analyses. Meanwhile, EMSB sometimes cooperates with relevant ERA District Offices in environment monitoring.

(2) Laws, Regulations and Systems for Land Expropriation

1) Systems and laws on land expropriation and compensation for the land

The Right of Way and Protection Branch (RoWPB) in the Construction Contract Implementation Division is responsible for land acquisition and compensation for land in ERA.

While EMSB is involved in projects as a whole until the very end of the project, RoWPB is to take all responsibility of land acquisition and estimation and payment of compensation after the declaration of a cutoff date. Land to be acquired and compensated includes borrow pits, quarries, waste earth disposal sites and land to construct accommodations for construction workers.

The Ethiopian Roads Authority (ERA) Establishment Proclamation (No. 80/1997) on establishment of ERA allows ERA to use land and other resources required for road construction, to obtain construction materials from quarries and borrow pits and to use land for site offices, accommodations for workers, material depots, construction waste disposal/treatment plants at will. One of the important issues in the proclamation is appropriate implementation of an approved resettlement action plan prepared by EMSB. Assets incidental to land to be expropriated are to be compensated in accordance with various laws.

The Resettlement/Rehabilitation Policy Framework (February 2002) of ERA follows the OP4.12 of the World Bank almost in its entirety and specifies that an asset concerned should be compensated at its reacquisition price (market price of the asset concerned + costs of relocation + fees for land registration + taxes + other expenses) without depreciation. However, as land is regarded as communal assets, the expropriated land is, in principle, compensated not with money but with a piece of land of equivalent value. This is because that the Constitution of Ethiopia stipulates that all the land is owned communally by the nation and the people and an individual may have a right to use and benefit from a piece of land after his/her application for the right to the land has been approved. Therefore, compensation to be paid should include compensation for personal assets on the land to be expropriated and the benefit expected from the use of the land when land is to be acquired for road construction. "A Proclamation to Provide for the Expropriation of Land Holdings for Public Purposes and Payment of Compensation (Proclamation No. 455/2005) and Regulations on the Payment of Compensation for Property Situated on Landholdings Expropriated for Public Purposes

(Regulation No. 135/2007) are the basis of compensation for land acquisition for public purposes. These documents provide rules for land expropriation for public purposes and payment of compensation for assets incidental to land to be expropriated. Specific rules includes those on the authority to expropriate land, public notice on land expropriation, responsibility of organizations expropriating land, procedures to remove utilities and compensation for trees, crops, pasture, relocation to alternative land, land with mineral resources and graveyards. There are even rules for how to calculate the amount of compensation including temporary rent for land, establishment of a compensation evaluation committee, complaints and lawsuits in these documents.

These documents specify that reacquisition prices based on market prices should be applied in the calculation of compensation.

Figure 1-3-2shows the procedures for land expropriation and compensation in road projects by ERA.

It should be noted in Figure 1-3-2 that a cut-off date is to be established on the day when a stakeholders' meeting on land required for a project is held and the issues concerning the land were explained and discussed.

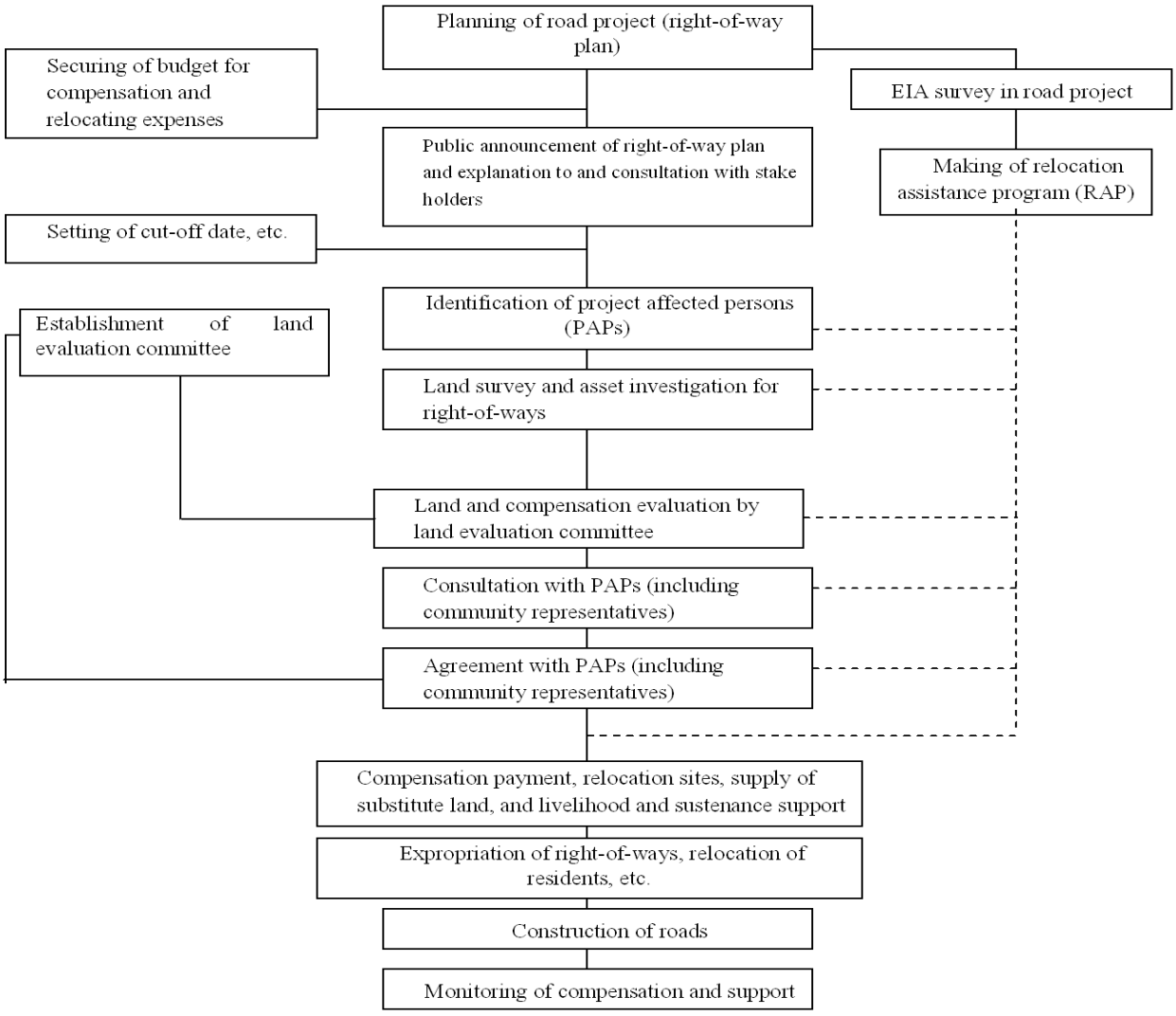


Figure 1-3-2 Procedure of land expropriation, compensation, etc. in road project

2) Setting of right-of-way (ROW)

The right-of-way (ROW) used as the basis of environmental and social impact evaluation in this project is set as the range of 50 m, 25 m each on both sides from the centerline of the road when conducting environmental and social impact survey. The design manual issued by ERA in 2002 classifies roads into DS1 to DS10 categories in accordance with the traffic volumes and assigns DS1 to DS5 to Trunk Roads, stipulating various specifications of them and defining the ROW for them as 50 m regardless of the topographic features. For other road categories, the ROW decreases as 40 m, 30, and 20 m in accordance with a decreasing traffic volume, with the Feeder Roads DS10 being the smallest. The bridge in this project ranks as Trunk Roads from the beginning, which has been examined with a ROW of 50 m as for DS1 or DS2. On the other hand, the design manual specifies that, when any of the ROWs is to be changed, an approval must be obtained after clarifying the reasons, in the same way as for other specifications. One of the reasons for this requirement is environmental consideration for alleviating the relocation of residents. For example, there is a reported case of one local road (IDA assistance) with a ROW of 30 m, which was reduced to 20 m in the section where it passes through an urban built-up area. The design manual adds a clearance of 3 m to the width to allow for the top of cutting slope or toe of banking slope when cutting or banking is needed depending on the topographical feature. Since the Awash Bridge approach road requires deep cutting, the cutting slope top + 3 m exceeds a width of 25 m from the centerline in a certain section, for which a wider ROW has been set.

(3) Environmental and Social Consideration Survey

1) Consistency between JICA guidelines and Ethiopian rules

The 2004 JICA Environmental and Social Consideration Guidelines are applied to this project. However, the environmental rules of Ethiopia have been established, in principle, in accordance with the environmental standards of the World Bank and, in particular, the resettlement policy OP4.14 is applied. There is no great discrepancy because the 2004 JICA Guidelines also specify that the international standards of advanced countries should be applied (Note: The new JICA Guidelines issued in April 2010 specifies OP4.12). However, attention must be paid to the point that the compensation to be made in acquisition of land for a public purpose is not monetary compensation for the land itself but only supply of substitute land, showing a great gap with the international standards.

2) Scoping result and categorization

In accordance with the JICA guidelines, we found that this project is not expected to have a great impact on the social and natural environment items, in particular the resettlement and the valuable ecological system in national parks, in any of the areas surrounding the bridge. Therefore, the project was concluded as Category B that required Initial Environmental Examination (IEE). On the other hand, a joint environmental survey conducted in collaboration with ERA-EMSB in the first field reconnaissance concluded that this project is not a Schedule I project that requires EIA survey but a Schedule II project that requires the initial environmental impact assessment (IEIA). An IEIA report must be accompanied with

an Abbreviated Relocation Assistance Program (Abbreviated RAP) in accordance with the WB standard. Therefore, we concluded that an IEIA report based on the Ethiopian standard sufficiently corresponds to an IEE report based on the JICA standard, and confirmed again with the Ethiopian side in a statement of mutual agreement that an IEIA report would be submitted by them.

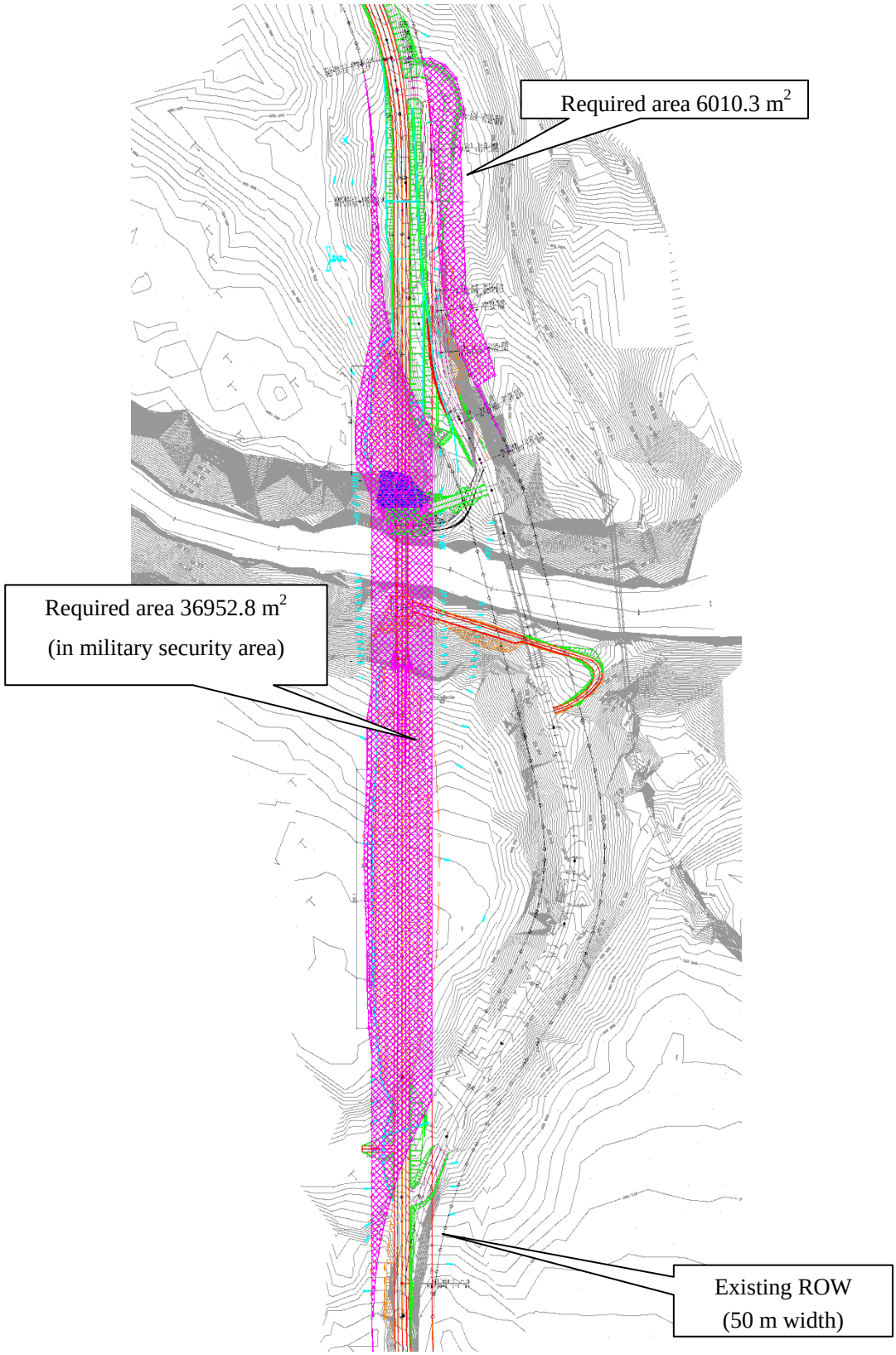
3) Land to be acquired and proportion of private land to the total area

Figure 1-3-3 shows the map of land that needs to be acquired for the site, which has been made after the final route is determined. Using this site map, a joint field reconnaissance survey was conducted in collaboration with ERA-EMSB to check the usage conditions of the required land. Then, area calculation was conducted using the survey drawing to obtain approximate areas of the site as shown inTable 1-3-1.

Table 1-3-1 Area of land needing to be acquired (m^2)

Classification		Awash Bridge
Permanently acquired land	National land	43,000
	Private land	0
Total		43,000
Temporarily leased land	National land	40,000
	Private land	0
Total		40,000
Sum total		83,000

Source: ERA's Abbreviated Relocation Assistance Program (Abbreviated RAP since October 2010)



Required area = 36952.8+6010.3＝42963.1 m^2 (No private land)

Figure 1-3-3 Map of required land for Awash Bridge

4) Consultation with stakeholders and setting of cut-off date

Figure 1-3-2 shows the procedure of land expropriation, compensation, etc. in road projects, which require public announcement of a site plan and explanation to and consultation with stakeholders before the setting of a cut-off date. In accordance with this procedure, the explanation of the project was provided in the first stakeholder consultation held in May, and the explanation of required land was scheduled for the second stakeholder consultation. Thus, we provided explanation on Awash Bridge on July 29 at Awash Town Hall, with the assistance of the Local Administration Department in charge of this project, which ended successfully.

As a traditional practice, the cut-off date after which entry to the required land is prohibited is the date of signatures affixed by the administrative division in charge and the representative of consultation participants in the minutes of stakeholder consultation. However, it was reported that the cut-off date for this project is the date of each consultation. Furthermore, ERA notified us that public announcement of the cut-off date would also be made on newspapers.

The organizations and associations regarded to have direct and indirect interests and therefore requested to participate in stakeholder consultations include district organization offices, affected municipal offices, Wereda (county)-level offices, district water resource offices, district telegram and telephone offices, district E.P.C. offices, Wereda-level water resource offices, district organizations in charge of statistics, and Wereda-level organizations in charge of agriculture, Kebele (district) offices in rural villages and cities, and elders in communities.

Note that it is desirable to hold a stakeholder consultation every time there is a new development in the project.

5) Results of survey on social environment including resettlement

On July 13 and 14 after the completion of maps of required land for the planned three bridge sites, a joint field reconnaissance with the environmental protection division of ERA was conducted on the natural environment and social impacts. Furthermore, interviews were held in the field for directly and indirectly affected residents.

Table 1-3-2 shows the number of households (organization) influencing land acquisition in this project.

Table 1-3-2 Number of households (organization) influencing land acquisition

Site	①Land acquisition only	② Land acquisition and building relocation	③ Land tenancy only	④ Land tenancy and building relocation	⑤ Electric wire, telephone cable, and water pipe relocation	PAPs Total
Awash Bridge	0	1* (Surveillance hut)			1* (Electric wires)	2

The land in the Awash Bridge ① case is in the military security area with its surveillance hut. The public facility in case ⑤ is the power and telephone company, and there is no relocation of ordinary houses. Around the bridge, there are no kiosks or mobile stores, unlike in other bridge projects in which many are encountered.

6) Positional relationship with Awash National Park

Awash Bridge is out of the Awash National Park but is as close as about 10 km to its border (See Figure 1-3-4). In the mid-point between them, Awash Town with a population of about 30,000, the largest center of this district is located.

→

Figure 1-3-4 Locations of Awash National Park and Awash Bridge

Awash National Park, Ethiopia's first national park that was legally designated in 1966, was established according to advice from UNESCO which recognized its high potential values as a habitat for diverse wild animals (mammals) and birds and a sightseeing spot. With a total area of 756km^2, this park is a savanna in terms of vegetation, dotted with open forests of acacias, etc. The inhabitants are 81 types of mammals (including bats) and 453 types of birds.

7) Mitigation measures against environmental loads

Figure 1-3-4 shows the mitigation measures against expected environmental loads. The environmental load items in this project does not include those under A rating that are expected to have serous impacts but only those under B rating that are expected to have minor impacts. Among all the expected environmental loads, those in social environment items including resettlement shall be handled on the initiative of ERA by implementing mitigation and countermeasures against them.

On the other hand, the environmental loads caused by the construction work on the natural environment including the social environment and pollutions shall be defined in the construction specification prepared for tendering, and a building contractor shall be required to submit before the start of construction an environmental management plan (EMP), which shall be examined and approved with the consent of ERA. Then, a construction supervisor and the contractor's employee in charge of EMP shall be selected to perform monitoring of EMP compliance status during construction. Furthermore, the contractor shall be required to submit a monthly report on the compliance status, and quick action shall be taken on the site as required. Environmental monitoring form is shown in Annex-2 of M/D at the time of draft overall design explanation.

All of these progress statuses and results shall be reported to JICA in monthly reports. For particularly important items, reports on strictly lawful compensation progress statuses and results are

required for land use and resettlement. As early as possible before the start of construction, the baseline data for the natural environment and pollutions shall be acquired and confirmed.

8) Checklist required for future environmental management

In Preparatory Survey Part 1 (2009), the sector-by-sector "environmental checklist" to be used for check survey for environmental and social consideration in the project were applied to roads and bridges, and the check items were checked at the time of Preparatory Survey Part 1 (2009). In the implementation stage of this survey Part 2, a final decision was made on the candidate routes, and the decision was confirmed, as summarized in Annex-3.

Table 1-3-3 Environment assessment and Mitigation measure

		Environmental issue	Assessment: During the construction	Assessment: After being put into use	Basis of assessment	Mitigation measure
Social environment	1	Land use/involuntary resettlement	**B**	**D**	Only construction of a new road in a military security zone off-limits to the general public and relocation of the guard house at the bridge and communication cables will be required.	The relocation has to be completed before the commencement of the construction
	2	Local economy (income sources, employment, etc.)	**D**	**D**	No impact because the project site is off-limits to the general public	
	3	Use of land and local resources	**D**	**D**	The site is on a river flowing through a steep and deep valley. Water, crushed stones, earth and sand for the construction will be transported from outside.	
	4	Structure of the local society (local decision-making organs, etc.)	**B**	**B**	Two meetings have been held with the community residents. Although people rarely let donkeys use the bridge, they will be able to use the existing bridge for the same purpose after the new bridge has been constructed.	During the construction and after being put in use: Stakeholder meetings will be held at appropriate time.
	5	Existing social infrastructure and social services	**D**	**D**	The existing bridge will be retained for the time of emergency. While pedestrians and domestic animals could use it, little use of the existing bridge by them has been observed.	
	6	Socially vulnerable groups, such as the poor and indigenous people	**D**	**D**	It will be possible to use the existing bridge during the construction. However, little use of the bridge by donkeys has been observed.	
	7	Damage, benefits and fairness in the developmental process	**D**	**D**	Only the military and electric cables will be affected. There will be no impact on the general public.	
	8	Conflict of interest in the community	**D**	**D**	None	
	9	Historical remains and cultural assets	**D**	**D**	None in the vicinity	
	10	Water use rights, fishing rights and communal land use rights	**D**	**D**	A new road in the military security zone off-limits to the general public	
	11	Health and public hygiene (mainly concerning exhaust gases and dust)	**D**	**D**	During the construction, vehicles will stop before the bridge, the speed limit will be enforced and one vehicle in one direction will be allowed on the bridge at a time. There is no private house near the bridge.	
	12	Infectious diseases including HIV/AIDS	**B**	**D**	During the construction, workers coming from outside will stay at the site.	The Guidelines for the Environmental Management Plan (EMP) of ERA will be strictly followed in the management of the accommodations for the construction workers during the construction.
	13	Disaster risk (mainly regarding soil stability)	**B**	**B**	A large scale cutting and embankment work will be required. Since the site is on horizontal bed rocks, there is no risk factor derived from fault movement, such as landslides.	During the construction and after being put into use: Monitoring of the cuts and embankment and measures to protect them in the rainy season will be required. Thorough examination on the monitoring method and the measures to be taken will be carried out at the design stage.
	14	Accidents (traffic accidents, etc.)	**B**	**D**	During the construction, traffic accidents and congestion are expected at the intersection of the existing road and the new road.	Safety measures for accident prevention and traffic control will be strictly enforced during the construction.

	15	Security (safety)	**B**	**D**	Although removal of landmines has been confirmed, risk of landmines will be kept in mind.	Risk and removal of landmines will be reconfirmed before the commencement of the construction.
Natural environment	16	Topography and geology (mainly concerning stability of the ground)	**B**	**B**	During the construction and after being put into use: A large scale cutting work will be required for the construction of the access road to the new bridge (a total length of 1,155 m).	Thorough examination will be carried out at the design stage. Adherence to the construction safety/EMP and implementation of the monitoring
	17	Soil erosion	**B**	**B**	During the construction: A horizontally-distributed relatively-hard volcanic rocks are predominant at the site. Pieces of rock may fall off from cracks created by the construction work.	Ditto
	18	Condition of groundwater	**D**	**D**	There is no plan to use polluted river water or groundwater at the construction site located downstream of a national park.	
	19	Condition of the water flow and hydrological characteristics	**D**	**D**	No impact is expected because the foundations of the piers are to be constructed in the bed rock of volcanic rock far above the maximum water level of the river.	
	20	Conditions of coastal areas	**D**	**D**	Not applicable because the site is in an inland area.	
	21	Flora, fauna and ecosystem	**B**	**B**	During the construction and after being put into use: The Awash National Park is located 10 km west of the bridge. Although only scattered shrubs are found in the vicinity, birds are observed along the Awash River Valley.	During the construction: Prohibition on unnecessary tree felling, adherence to EMP and implementation of monitoring on noise, vibration and exhaust gases
	22	Designated areas (for nature conservation, etc.)	**B**	**B**	During the construction and after being put into use: Although the site is not in a designate area, many birds are observed there. No fish is found in the river because of the water pollution.	Consideration to the nature and strict prohibition on unnecessary tree felling Adherence to EMP and implementation of monitoring
	23	Scenery	**D**	**D**	May an addition of a new bridge to the two existing bridges, road and railway bridges, make the place worthy of sightseeing?	
	24	Regional climate	**D**	**D**	Reduction in exhaust gases is expected because the longitudinal slope of the access road to the new bridge is smaller than the slope of the road to the existing one.	
	25	Regional warming	**D**	**D**	Ditto	
Pollution	26	Air pollution	**B**	**D**	During the construction: Air pollution is expected from slow-moving construction vehicles and the construction work.	Adherence to EMP and implementation of monitoring
	27	Water pollution	**B**	**D**	During the construction: Discharge of waste water and oil leak from the construction site, heavy machinery, vehicles and accommodation for construction workers	Adherence to EMP and implementation of monitoring
	28	Soil pollution	**B**	**D**		
	29	Sediment pollution	**B**	**D**	During the construction: Ditto and discharge of earth and sand to the river	Measures to prevent the discharge, adherence to EMP and implementation of monitoring
	30	Waste	**B**	**D**	During the construction: Works at the construction site, heavy equipment and vehicles and construction of the accommodation for construction workers may have impact on the issues. However, there is no risk of ground subsidence because there is no soft ground at the site.	A comprehensive supervision, including enforcement of adherence to EMP and implementation of monitoring, will be required.
	31	Noise and vibration	**B**	**D**		
	32	Ground subsidence	**D**	**D**		
	33	Bad smell	**B**	**D**		

A: Serious impact is expected. B: Some impact is expected. C: Impact is unknown at present. D: little impact is expected.

1-4 Other Surveys

1-4-1 Traffic Volume Survey

(1) Outline of the Survey

1) Purpose of the Survey

A traffic volume survey was implemented for the purpose of collecting basic data to be used for elucidation of the traffic conditions on and near the bridge concerned, future traffic volume projections for establishing road standards and establishment of traffic classifications for the surface design.

Since the ERA has survey data on the traffic volume on trunk roads by year, these data were used as reference when projecting the rate of increase in traffic volume.

In addition, since future traffic volume projections (for the Addis-Adama Highway and A1 Trunk Road) were carried out in the feasibility study for the Addis-Adama Highway construction project (financed by China) currently in progress, the data from this feasibility study were reviewed and referred to as basic data for establishing the future traffic volume.

2) Date and Time of the Survey

i) Duration of the Survey

The daily traffic volume was measured on the following weekday and weekend.

Weekend: Sunday, May 30th, 2010

Weekday: Monday, May 31st, 2010

ii) Survey Hours

The survey was carried out of traffic in both directions at 15-minute intervals for a 24-hour period from 6 a.m. to 6 a.m. on the following day.

3) Outline of the Traffic

The figure below shows the outline of the traffic at the bridge site.

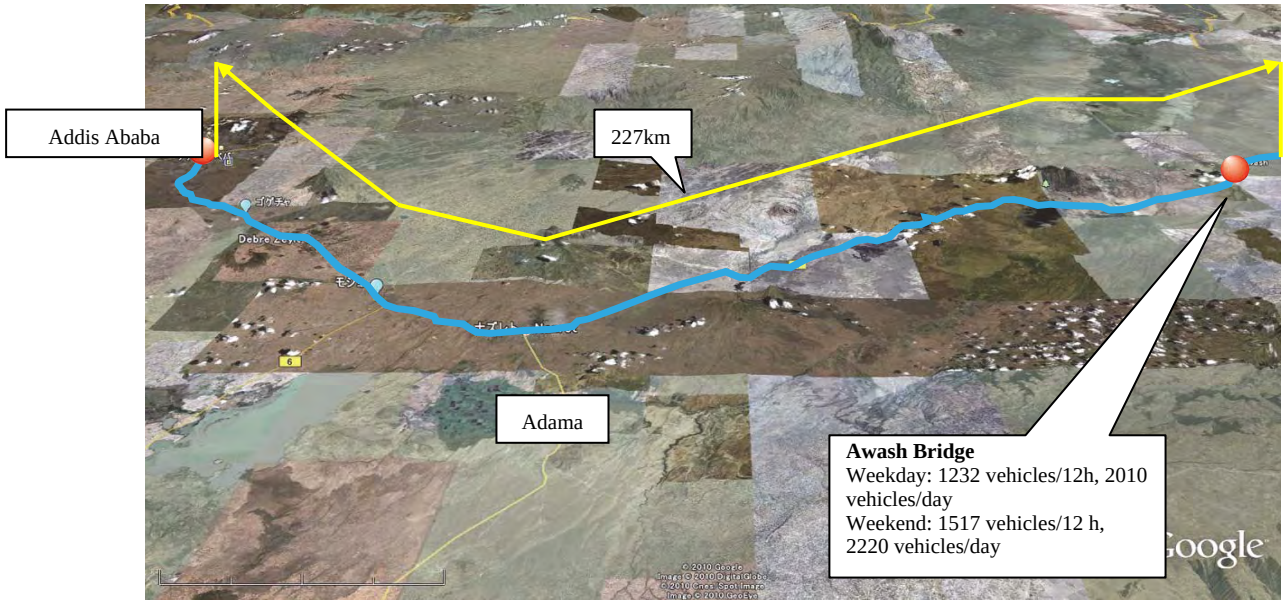


Figure 1-4-1 Traffic Volume Survey

(2) Summary of the Survey Results

1) Summary of Pedestrian and Bicycle Traffic Volume

The table below shows the pedestrian, light vehicle and domestic animal traffic on the Awash Bridge. There is almost no demand from pedestrians, etc. for the bridge.

Table 1-4-1 Pedestrian, light vehicle and domestic animal traffic

Type of user	Weekday/weekend	Awash Bridge
3 -wheel light vehicle	Weekday	0
	Weekend	0
Motorbike & bicycle	Weekday	0
	Weekend	0
Animal driven cart	Weekday	0
	Weekend	0
Donkey & horse	Weekday	0
	Weekend	0
Pedestrian	Weekday	0
	Weekend	0
Other	Weekday	1
	Weekend	0

2) Summary of Vehicle Traffic Volume

i) Spot Traffic Volume (in both directions)

The spot traffic volume on the Awash Bridge was 2,000 vehicles/day (with a heavy vehicle ratio of 48%) on the weekday and 2,200 vehicles/day (with a heavy vehicle ratio of 56%) at the weekend.

ii) Characteristics of the Road Traffic

a) Heavy vehicle Ratio

The heavy vehicle ratio reached 60% in the daytime at the weekend. The ratio was higher at the weekend than on the weekday.

b) Ratio of Daily Traffic to Daytime Traffic

High ratios of daily traffic to daytime traffic (24-hour traffic volume/12-hour traffic volume in the daytime) of 1.63 on the weekday and 1.46 at the weekend were observed. While not many small passenger vehicles cross the bridge during the night, many long-distance trucks cross it day and night. These figures and the high heavy vehicle ratio mentioned above suggest that the bridge is used heavily for long-distance transport of goods.

Table 1-4-2 Ratio of daily traffic to daytime traffic

		Daytime traffic (6 a.m. – 6 p.m.)	Nighttime traffic (6 p.m. – 6 a.m.)	Daily traffic	Ratio of daily traffic to daytime traffic
Awash	Weekday	1,232	778	2,010	1.63
Bridge	Weekend	1,517	703	2,220	1.46

c) Comparison of the Traffic Volume on Weekday and at Weekend

The traffic volume changes little throughout the day. While small passenger vehicle traffic is extremely light, truck and trailer traffic is predominant on the bridge (see Figure 1-4-2).

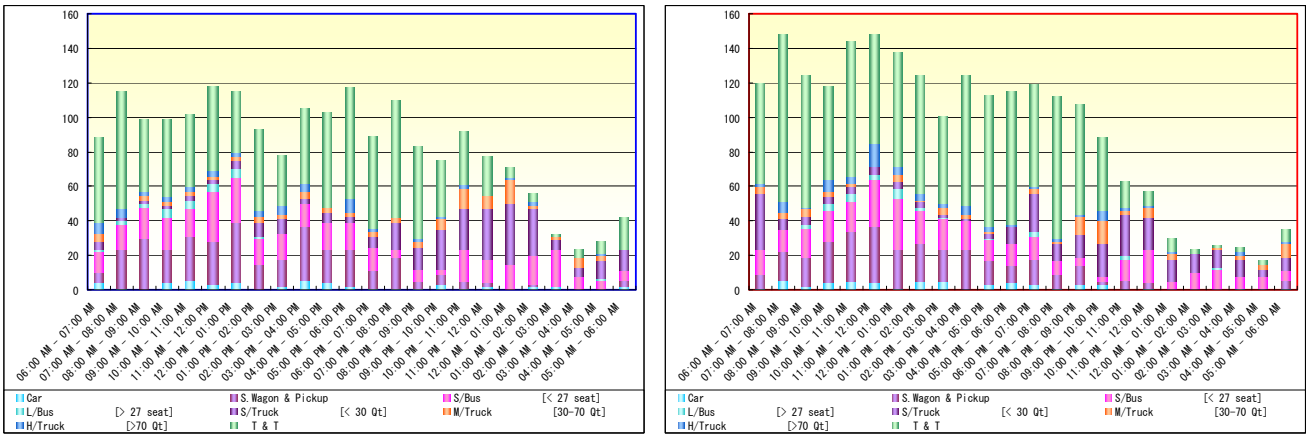


Figure 1-4-2 Traffic volume by day of week, time of day and vehicle type