

### 2-2-2-5 Longitudinal plan of Awash Bridge

The following three options of the longitudinal alignment for Awash Bridge were compared.

- ① Option 1: 3.28 % longitudinal slope on the bridge
- ② Option 2: 2.60 % longitudinal slope on the bridge
- ③ Option 3: 0.50 % longitudinal slope on the bridge

From the result of the comparison of the three options mentioned above, ERA agreed to select the Option 1 (3.28 % longitudinal slope on the bridge) for the following reasons.

- ① While the existing access road has a section with the maximum longitudinal slope of 7 %, the section under the Grant Aid assistance will not have a section with a longitudinal slope of 7 % and the access road as a whole will have the best drivability among the three options in the Option 1.
- ② Although the longitudinal slope on the bridge of 3.28 % is the largest among the three options, the slope will not pose any specific structural problem.
- ③ Since the amount of the cutting is the smallest among the three options, the Option 1 will have the smallest environmental impact.
- ④ The Option 1 is the most efficient economically.

Figure 2-2-7 and Table 2-2-8 show the longitudinal section of the existing road and the comparison of the longitudinal sections, respectively.

ERA requested an examination of the possibility of raising the height of the bridge in order to reduce the longitudinal slope ( $i = 3.28 \%$ ) in the Alternative 1 further. However, the survey team carried out the examination and concluded that the height could not be raised higher than that in the Option 1 for the following reasons:

- ① The cutting for the existing road on the Djibouti side will continue endlessly.
- ② The height of the embankment on the Djibouti side will be as high as approx. 15m.
- ③ The existing road will become unusable because it will be buried under the slope of the above-mentioned high embankment.
- ④ In order to use the existing road, construction of a detour will be required. It will extremely difficult to construct such a detour because of the huge amount of cutting from the slope of the railroad track required.

Figure 2-2-8 and Figure 2-2-9 show the comparison of the longitudinal sections and the comparison of the linearity diagrams, respectively.

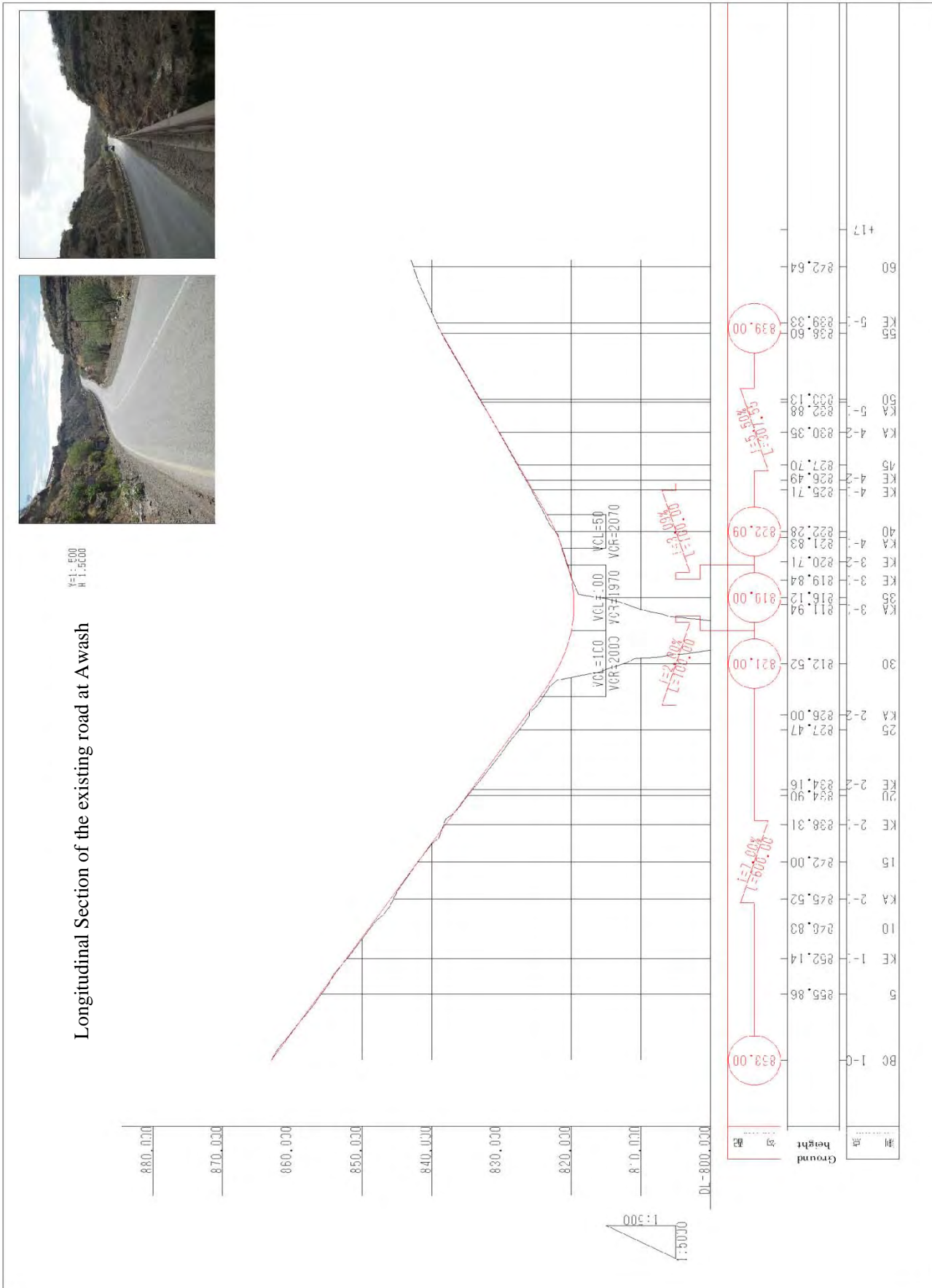
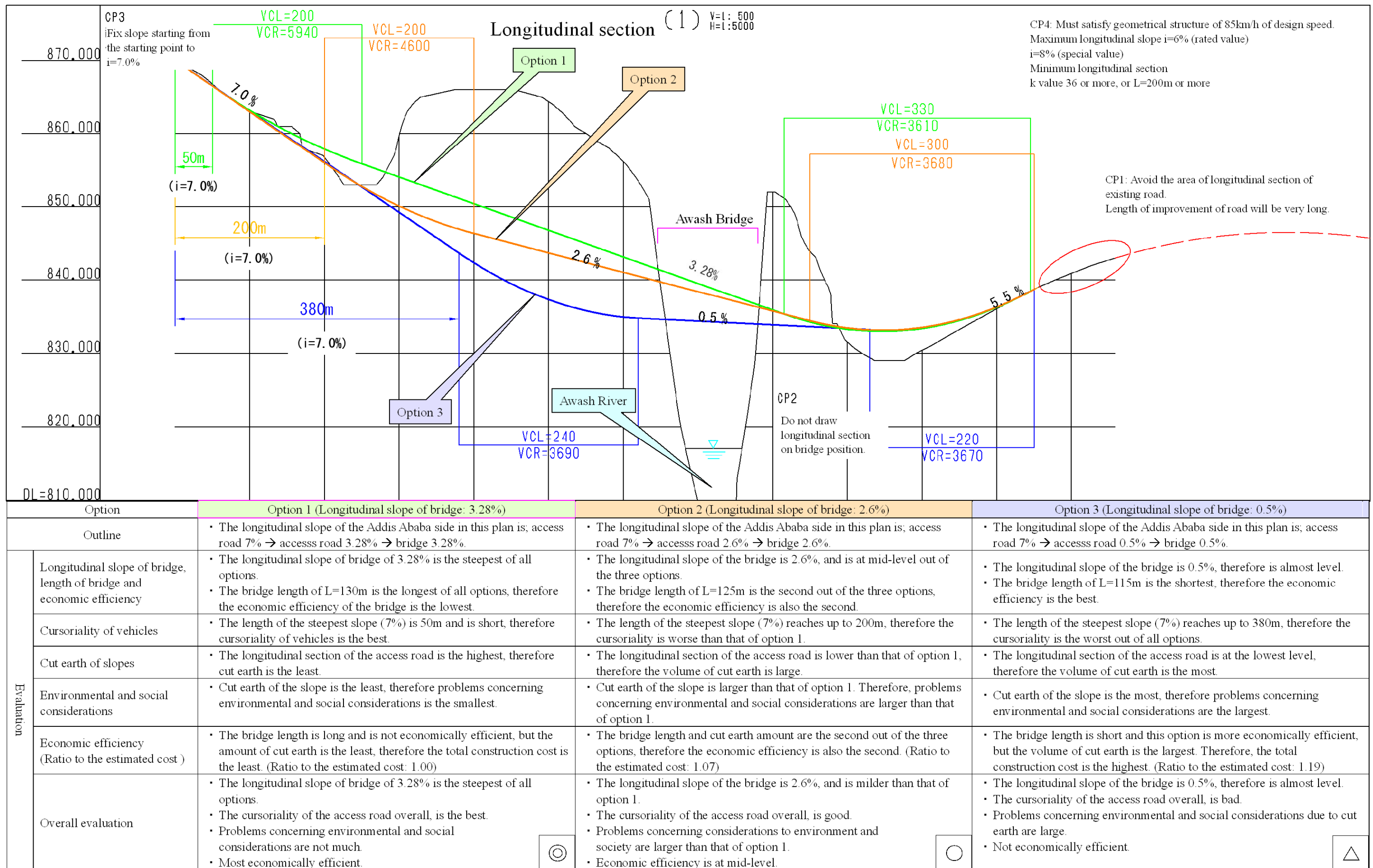


Figure 2-2-7 Longitudinal section of the existing road

Table 2-2-8 Comparison of the longitudinal sections



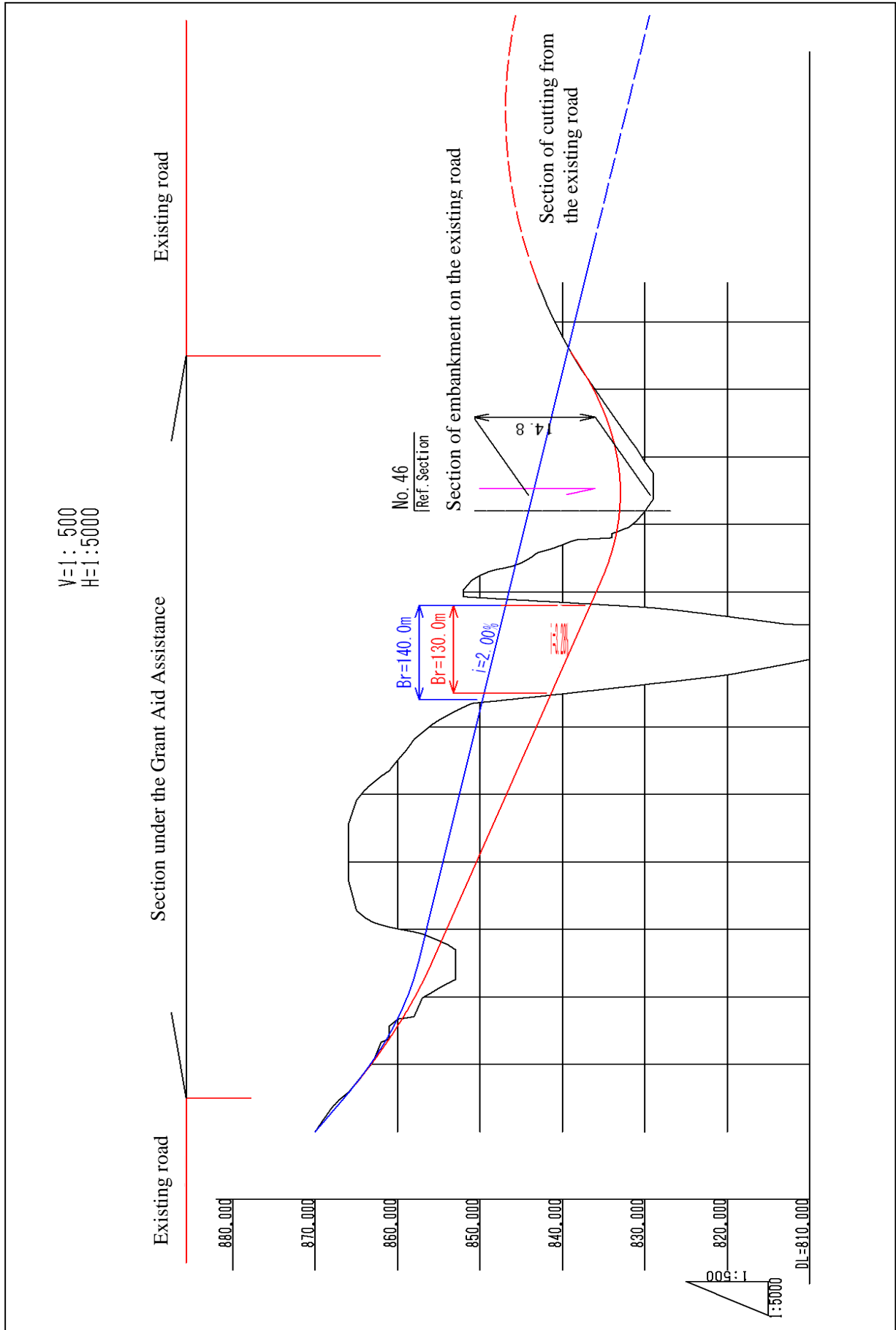


Figure 2-2-8 Comparison of the Longitudinal section

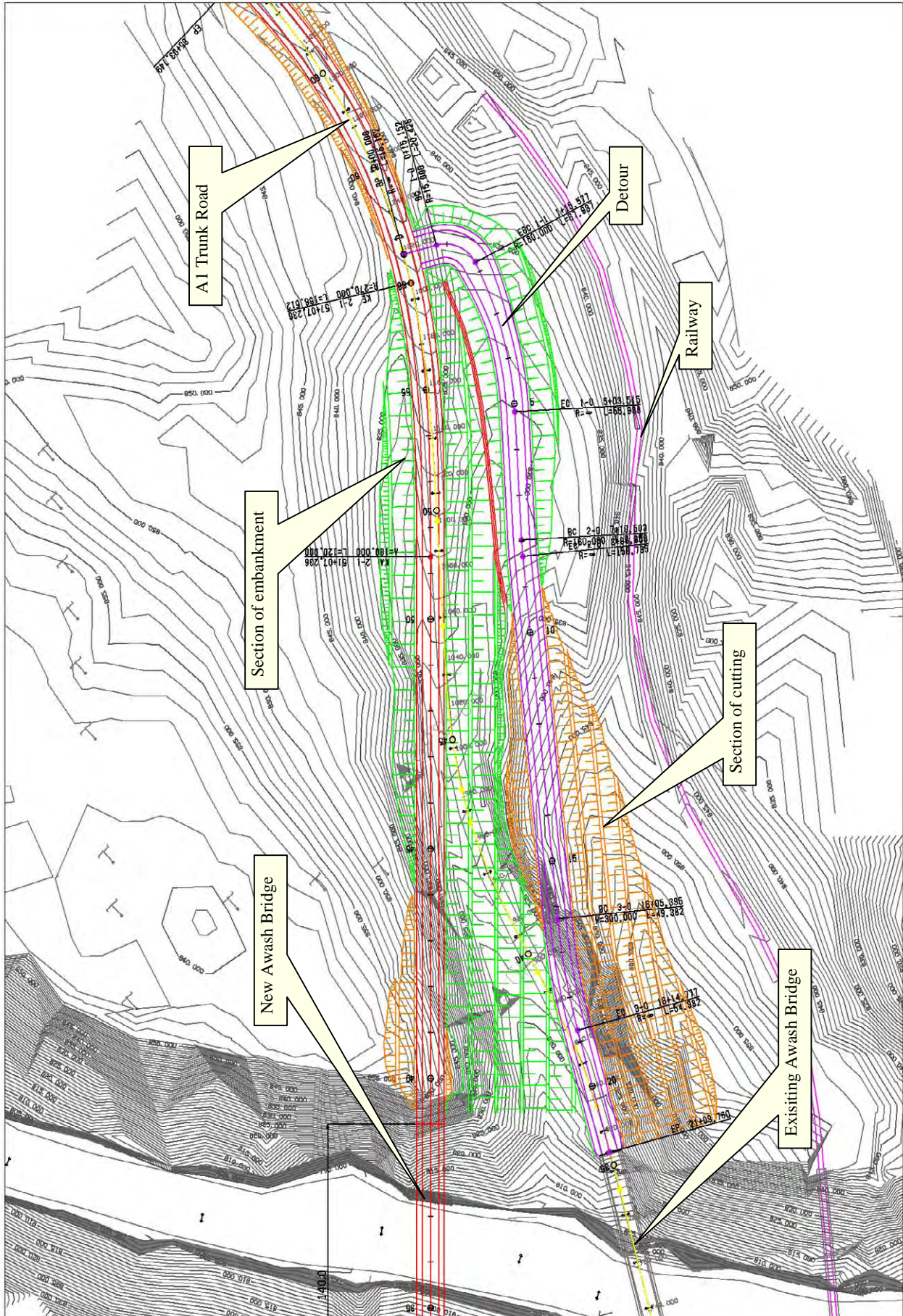


Figure 2-2-9 Comparison of the linearity

### 2-2-2-6 Economic Loss Expected from Collapse of the Awash Bridge

#### (3) Contribution of A1 Trunk Road to Import and Export Activities in Ethiopia

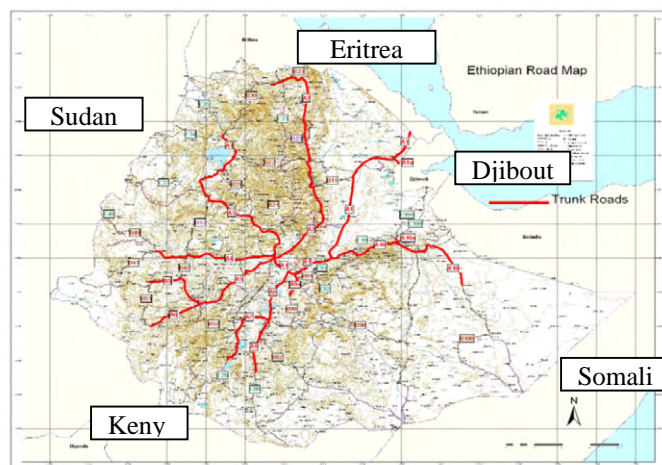


Figure 2-2-1 Road network in Ethiopia

Landlocked Ethiopia has to rely on ports in neighboring countries, namely ports in Djibouti, Sudan and Mombasa (Kenya), for importing and exporting goods. The database of the Common Market for Eastern and Southern Africa (COMESA), of which Ethiopia is a member, reveals that exports to **Djibouti**, Sudan, Egypt and Kenya account for **53.1%**, 34.1%, 8.9% and 2.6%, respectively, of exports from Ethiopia and imports from **Djibouti**, Sudan, Egypt, Kenya, Swaziland and Burundi account for **44.4%**, 19.1%, 16.1%, 16.1%, 1.9% and 1.6%, respectively, of imports to Ethiopia in trade within the COMESA area on a monetary basis.

The figures above show that approximately half of the trading activities in Ethiopia depend on physical distribution by the A1 Trunk Road, including the Awash Bridge.

It is clear that Ethiopia depends heavily on Djibouti for its trading activities. Ethiopia's strong dependency on Djibouti for international physical distribution is also seen clearly in the statistics on road traffic. The annual average daily traffic (AADT) on the A1 Trunk Road near the border with Djibouti, the A2 Trunk Road Extension near the border with Eritrea, the A3 Trunk Road Extension near the border with Sudan and the A8 Trunk Road Extension near the border with Kenya is 1,022, 529, 528 and 203 vehicles, respectively. In other words, the A1 Trunk Road has the heaviest traffic. In addition, the A1 Trunk Road has the highest commercial vehicle ratio (86%) of the four Trunk Roads.

Table 2-2-1 AADT and commercial vehicle ratios near the border

Trunk road	Bordering country	AADT near the border (2008)	Commercial vehicle ratio
A1	Djibouti	1,022 vehicles	86%
A2	Eritrea	529 vehicles	54%
A3	Sudan	528 vehicles	63%
A8	Kenya	203 vehicles	49%

Source: Prepared by the Study Team

**(4) Establishment of Detour Route**

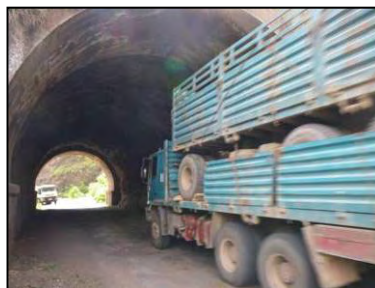
Because there is no appropriate detour route in the vicinity in the event of closure of the Awash Bridge, the bridge is recognized as a transport facility that is extremely important for social and economic activities in Ethiopia and is guarded on both sides by the armed forces. Traffic restriction of one vehicle in one direction at a time on the bridge is also enforced.

Meanwhile, the A2 Trunk Road runs parallel with the A1 Trunk Road which runs from Djibouti to the capital, Addis Ababa. The B11 Road running from Mile to Kombolcha connects the two trunk roads. While the A2 Trunk Road passes through mountainous areas and has sections under construction, most of the A2 Trunk Road is thought to be available for heavy vehicles.

Meanwhile, the B11 Road is unpaved and so narrow that it is difficult for large trucks to pass each other. Its tunnels, masonry bridges and other structures are in a dilapidated condition. For these reasons, it is not considered feasible to use the B11 Road as a detour for the A1 Trunk Road.



A2 Trunk Road in mountainous area



Tunnel on B11 Road



Section of B11 Road where it is difficult for vehicles to pass each other

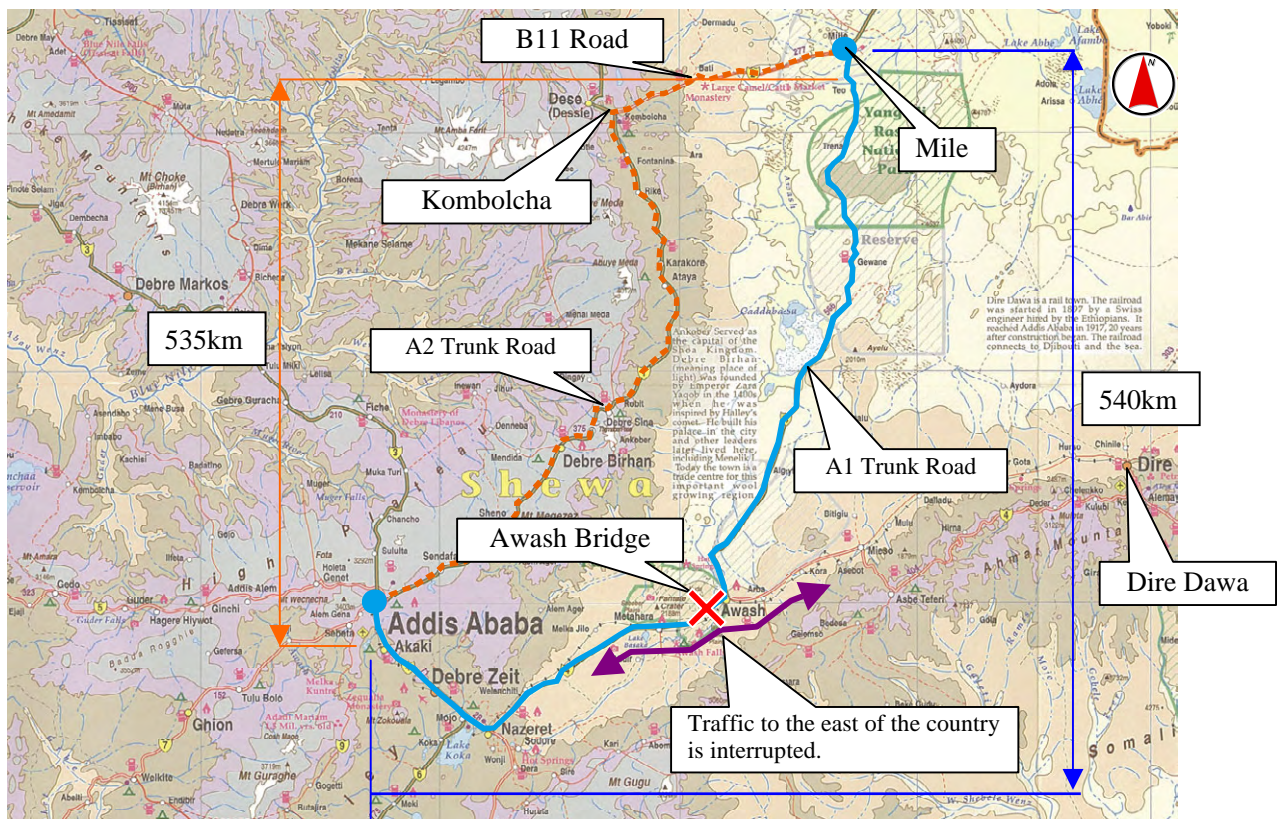


Figure 2-2-2 National road network

(5) Current Traffic Volume

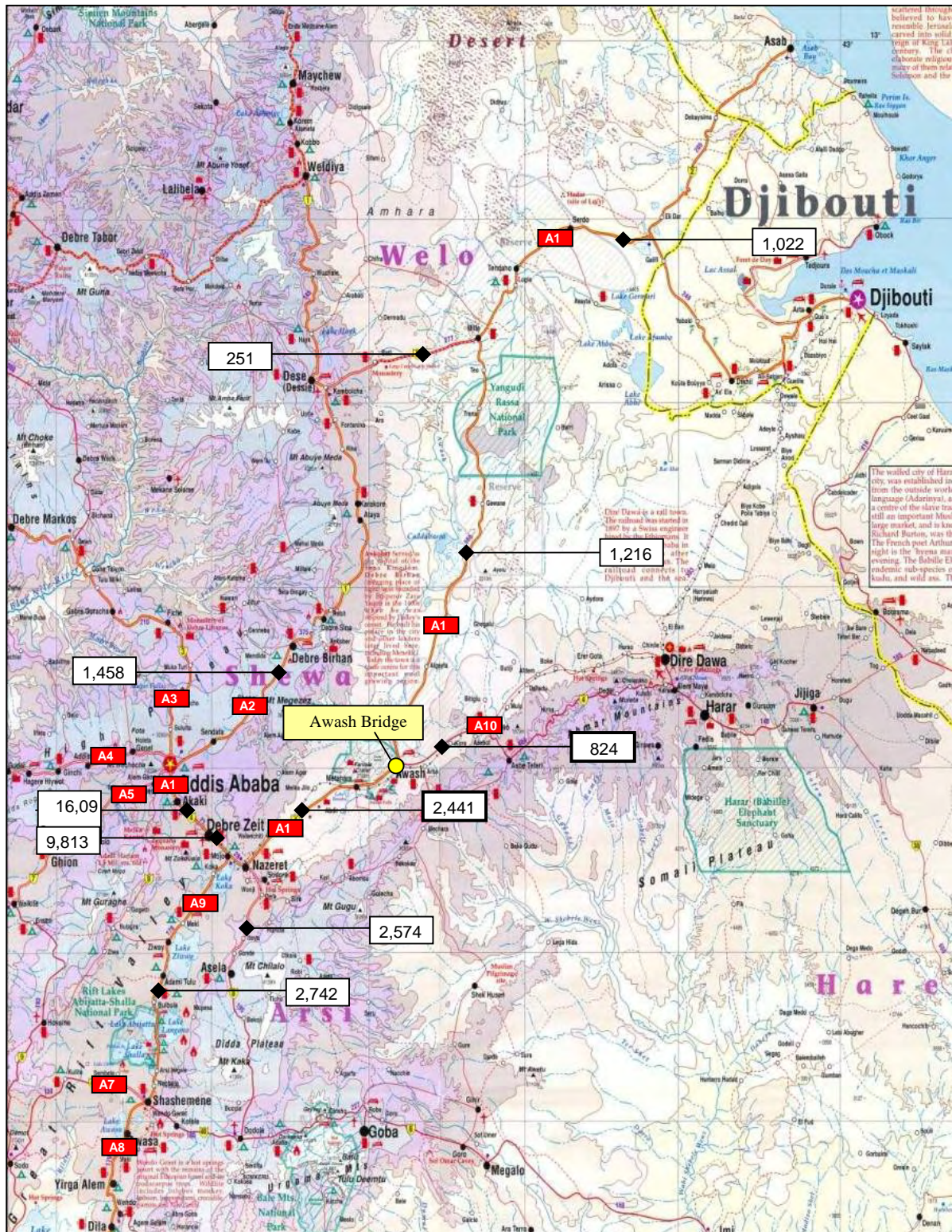


Figure 2-2-3 Overview of the traffic (AADT) at the project site and vicinity (ERA 2008)



## **(6) Economic Loss Caused by Detour**

The following were assumed as the conditions for estimating the economic loss caused by the detour.

- ① Economic loss was estimated on the assumption that fatal damage to the Awash Bridge forced its closure and created the need to construct a new bridge and the closure lasted for a three-year period, the period required for constructing a new bridge (one year for the design and two years for the construction work).
- ② The economic activities in Dire Dawa were estimated by dividing the GDP of Ethiopia (US\$ 25.73 billion in 2008) by the proportion of the population of Dire Dawa to the total population of Ethiopia.
- ③ It was assumed that 10% of small passenger vehicles and 50% of trucks would use a significantly longer detour route during the closure of the Awash Bridge.

### **1) Loss Resulting from the Detour for the A1 Trunk Road**

The closure of the Awash Bridge is expected to cause economic loss to transport using the A1 Trunk Road, since the closure will force vehicles which would otherwise use the A1 Trunk Road (between Djibouti and Addis Ababa) to use a detour route and the use of such a detour route will incur additional expenses. The closure of the Awash Bridge for three years is expected to create a total loss of approximately US\$ 36 million, consisting of a “loss resulting from an increase in driving time” of approximately US\$ 12 million (or a 110% increase compared with before the closure) and a “loss resulting from an increase in driving costs” of approximately US\$ 24 million (or a 5% increase compared with before the closure).

### **2) Loss Resulting from Closure to Traffic To and From the City of Dire Dawa in the East of Ethiopia**

Dire Dawa, a major city in the east of the country, is located on the A10 Trunk Road which diverges from the A1 Trunk Road at a junction a short distance north of the Awash Bridge. Therefore, closure of the Awash Bridge would cut off the route between Dire Dawa and the capital, Addis Ababa, completely and cause severe damage to socio-economic activities in Dire Dawa.

Vehicles from Dire Dawa could reach Addis Ababa via Mile, as is the case with vehicles on the A1 Trunk Road detour, by using the A10 Trunk Road as far as the Awash Junction mentioned above and the northbound A1 from there. However, since this detour is longer by a very large margin than the ordinary route, the economic loss was estimated in the following two alternative cases:

- i) When economic activities at Dire Dawa are completely interrupted.
- ii) When the very long detour route via Mile on the A1 Trunk Road is used.

In case i) in which economic activities at Dire Dawa are completely interrupted, US\$ 360 million-worth of economic activities are expected to be affected by the closure of the Awash Bridge for three years because the local GDP in Dire Dawa is estimated at US\$ 119.26 million per year.

Meanwhile, in case ii) in which the long detour route via the A1 Trunk Road and Mile is used, the driving distance between Addis Ababa and Dire Dawa will increase by approximately 70% from 829 km on the ordinary route to 1,430 km on the detour route.

Taking the above-mentioned into consideration, the three-year closure of the Awash Bridge is expected to create a total loss of approximately US\$ 92 million in economic activities in Dire Dawa, consisting of a “loss resulting from an increase in driving time” of approximately US\$ 15 million (or a 267% increase compared with before the closure) and a “loss resulting from an increase in driving costs” of approximately US\$ 78 million (or an 85% increase compared with before the closure).

### **3) Conclusion**

As mentioned above, an unexpected accident on the Awash Bridge could create an estimated economic loss of US\$ 130 – 400 million. The closure of the Awash Bridge is also expected to affect approximately half the vehicle traffic engaged in the import and export business. Thus, the closure of the bridge will have a huge effect on socio-economic activities in Ethiopia.

This observation also justifies the significance of the need to reconstruct the Awash Bridge.