NORTH-SOUTH CORRIDOR (KVESHETI-KOBI) ROAD PROJECT
STAKEHOLDER BRIEF: ASSESSMENT OF ALIGNMENT ALTERNATIVES

საქართველოს საავტომობილო გზების დეპარტამენტი
ROADS DEPARTMENT OF GEORGIA

ADB

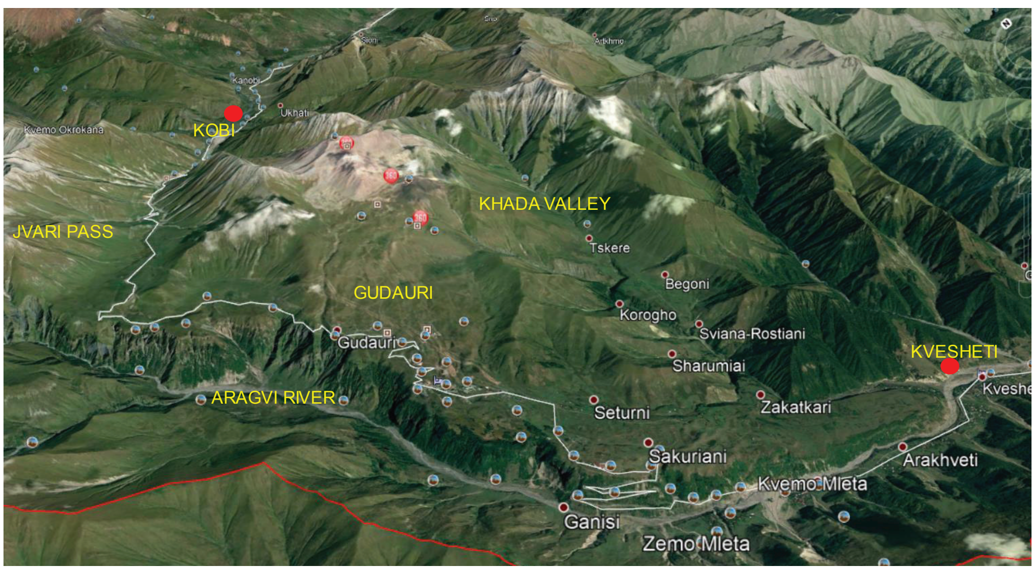
July 2019

INTRODUCTION

This brief aims to provide project stakeholders with a better understanding of the process, analyses, and findings that led to the selection of the final project road alignment. The main focus is on the geo-engineering assessments undertaken, as ultimately it was geological constraints and risks that determined the final road corridor, within which the alignment is located (Figure 1).

The brief is a non-technical summary that complements other publicly available resources (listed at the end of the brief) and builds on stakeholder engagement events held during 2018–2019, which included a number of discussions on assessment of alignment alternatives.

Figure 1: Project Area



Source: Google Earth (2019)

KEY FACTS AND FINDINGS

An international team of over 20 key experts supported by more than 50 engineers, geologists and other specialists were engaged to identify and assess alignment options for the Kvesheti-Kobi road section of the North-South Corridor. The experts used a wide range of methods and extensive field work over a 2-year period (2017–2018) to conduct detailed assessments on traffic demand, geo-engineering, and other relevant aspects.

Upgrading the existing alignment over the Jvari pass to European highway design standards was deemed technically unfeasible. Therefore, three potential road corridors and various alignments within these were identified to bypass the Jvari Pass. After further analyses, two corridors (Gudauri valley and Tetri Aragvi river) were ruled out due to unacceptably high geological risks.

The Khada valley corridor was selected as the only technically feasible option, and further detailed design work was undertaken to create the final alignment. This was informed by a range of criteria including: geological risks, natural hazards, impacts on human settlements, cultural heritage sites, and the natural environment.

PROJECT OBJECTIVES AND CONSTRAINTS

The project is an essential part of the Government of Georgia's program to progressively upgrade the North–South Corridor between Jinvali and Larsi (approximately 100 km). The project road has been designed in accordance with the following objectives:

(i) conform to European highway design standards for safety and operation;
(ii) allow all year-round operation;
(iii) enable traffic speed of 80km per hour;
(iv) cope with expected increases in traffic volume, including freight trucks; and
(v) avoid major social and environmental impacts during construction and operation.

The assessments conducted for the road alignment selection were necessarily extensive and complex due to the challenging conditions for road construction in the project area, which include:

(i) mountainous terrain (Figure 1);
(ii) complex geology including prior volcanic activity (Figure 3);
(iii) exposure to natural hazards such as floods, landslides, heavy snow fall, and avalanches;
(iv) proximity of human settlements and cultural heritage sites; and
(v) proximity of Kazbegi National Park and protected areas.

Based on the project's overall objectives and challenges, the key input criteria for assessing the alignment options were as follows:

(i) road functionality and safety;
(ii) geological conditions and natural hazards;
(iii) construction feasibility;
(iv) environmental sustainability;
(v) landscape preservation;
(vi) impacts on communities; and
(vii) financial investment.

OVERVIEW OF THE ROAD DESIGN PROCESS

International and national firms and experts were mobilized during 2017–2018 to identify technically feasible options for upgrading the road and to establish which alignment is most appropriate for the project. A summary of the assessment stages, aims, and main methods is provided in Table 1.

Table 1: Summary of Assessment Stages, Aims, and Methods

Stage	Aim	Geo-Engineering Methods	Other Methods
Pre-feasibility assessment	Identify options: upgrading the current alignment plus alternatives	• Map-based analyses • Geological mapping • Boreholes • Ground water monitoring and tests • Pressure-meter tests • Laboratory tests • Geochemical and mineralogical tests • Electrical resistivity tomography and seismic refraction	• Technical feasibility assessments • Initial cost estimates • Economic analysis
Feasibility assessment	Detailed assessments to choose the best alignment option		• Multicriteria assessment, including environmental and social impact as factors
Detailed design	Fine-tune and finalize a "project-ready" alignment		• European highway design standards • Road safety audit • Environmental impact assessment • Land acquisition and resettlement plan • Climate change assessment • Gender assessment

Source: Author

The project assessments were led by the Spanish consulting firm IDOM with support from several specialized consulting firms and individual experts. The assessment of geotechnical aspects alone involved six other organizations and about 45 technical experts as summarized in Table 2. Social, environmental, and other project assessments or reviews have been financed by the Asian Development Bank (ADB), European Bank for Reconstruction and Development (EBRD), and the World Bank.

Table 2: Organizations for the Geo-Engineering Assessments

Organization	Role
IDOM (Spain)	Overall coordination, supervision, verification, and design based on the assessments
Geoengineering (Georgia)	Borehole drilling, field tests, laboratory tests
Institute of Earth Sciences and National Seismic Monitoring Centre - Illia University (Georgia)	Seismic assessments, shallow geophysical surveying
Department of Geology Applied to Engineering – University of Oviedo (Spain)	Geological mapping, hydrogeology, geomechanics
International Geophysical Technology (Spain)	Deep geophysical surveying
Subterra Ingenieria (Spain)	Tunnel and earthworks geotechnical design
GeoConsult (Spain)	Tunnel and earthworks geotechnical design
Corelogs (Spain)	Pressure-meter tests and shallow geophysical interpretation

Source: IDOM (2019)

PRE-FEASIBILITY ASSESSMENT

The Jvari Pass Bottleneck

The initial pre-feasibility assessments identified the Kvesheti–Kobi section, including the Jvari Pass, as the major bottleneck of the Jinvali–Larsi road and the priority focus for the project. The Jvari Pass experiences heavy traffic and is unsafe as a result of a low standard alignment that rapidly ascends and descends to and from a high point of 2,400 meters above sea level. The current road alignment is inadequate for the challenging geographical and climatic conditions faced in this mountainous terrain, especially in winter. Avalanches, landslides, and snow load risks are significant and cause frequent and extended delays and road closures (an average of 44 days per year during 2012–2016). The existing alignment is characterized by tight switchbacks, and substandard open tunnels and avalanche galleries that are not wide enough for trucks to pass through in opposing directions. With these conditions, road accidents occur regularly along this road section.

Road closures and delays

Accidents

Upgrading the Existing Road Alignment

During the pre-feasibility phase, this option was assessed from a technical, financial, and socio-environmental perspective. A minor upgrade would entail new paving; the addition of safety barriers and additional galleries; refurbishment of retaining walls, structures, and cut slopes; and improvements to the alignment of some curves. The construction work would not create significant environmental or social impacts. However, even with these improvements, the overall functionality, safety, and climate resilience of the road would remain inadequate and well below the European standards required, particularly considering the projected increase in traffic using the road.

A major upgrade of the existing road section was also looked at. This would require large gradient changes that could only be achieved by deep-cutting slopes; building new tunnels, bridges, and more. Such an upgrade would have unacceptably severe impacts on local communities and the wider economy. Portions of the road would have to be closed over a period of years to enable the construction, which would create significant disruptions and economic losses. The outcome of such an upgrade would still be a road considerably less functional or safe than required, and also less than other options assessed. From a geological perspective, the road would face ongoing medium to high risks of landslides and similar events. In addition, the road passes through around 6 km of Kazbegi National Park and construction works would likely have significant impacts on biodiversity. As a result of these factors, upgrading the existing road alignment over the Jvari pass was ruled out.

Current road: switchbacks on steep slopes

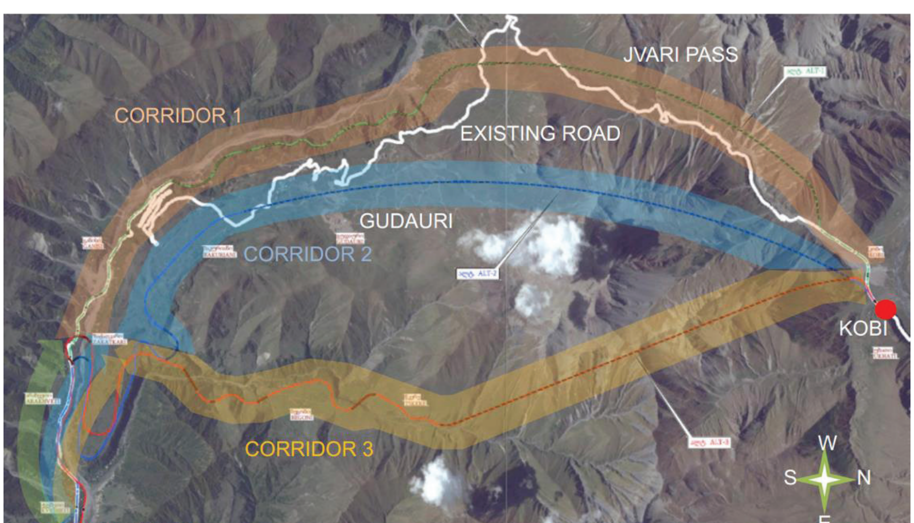
Current road: narrow, unlit tunnels

Alternative Options

During the pre-feasibility phase, the design team assessed alternative alignments that would bypass the mountainous Jvari Pass road segment. From an initial map-based analysis, about 40 alignment options were identified in two general areas: the Guduari valley/Tetri Aragvi river near the current road alignment, and the Khada valley, slightly to the east.

Further analyses identified a number of alignments for further investigation. It is important to note that by this stage of the assessment it was clear that all alignment options would require at least one major tunnel. In this mountainous terrain, tunnels help avoid large-scale environmental and social impacts and are a high cost, but essential means to overcome many of the challenges that hinder the current road alignment (high elevation, steep gradients, natural hazards etc.). From further assessments, the identified alignments were narrowed down to four alignments in the three studied corridors (Figure 2).

Figure 2: The Three Corridors and Four Alignments



Source: IDOM (2018)

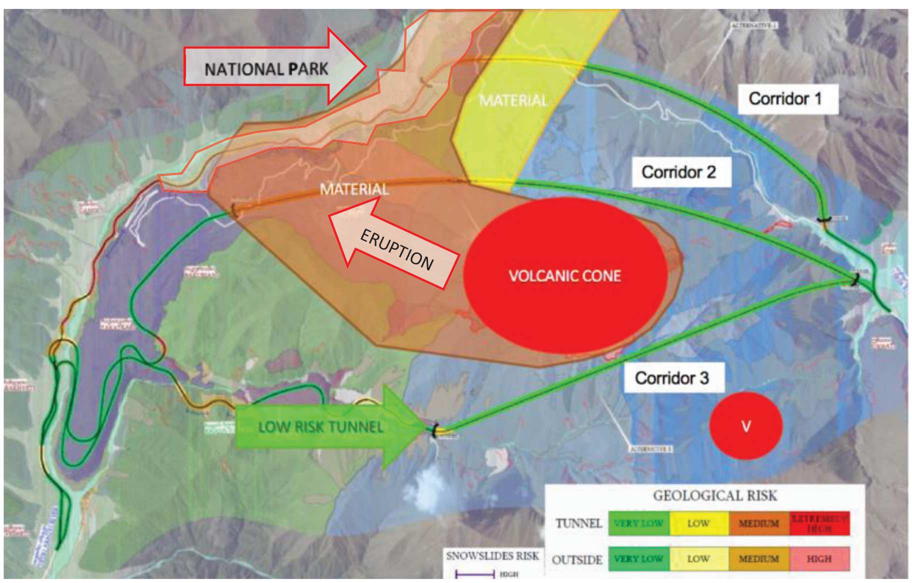
These alignments were then assessed in more depth. To complement further geo-technical analyses, a multicriteria assessment (MCA) was applied. The MCA used weighted criteria under four categories covering both construction and operation stages:

(i) Road functionality. This included alignment features, estimated traffic flows, travel time for vehicles, and population served.
(ii) Economic considerations. This included total investment cost, ongoing maintenance costs, and economic benefits.
(iii) Environmental impacts. This included biodiversity, surface and ground water, protected areas, soil, landscape;
(iv) Social impacts. This included resettlement, cultural heritage, and road safety.

Corridor 1: Tetri Aragvi River
Starting near Kvesheti village, this alignment follows and improves the existing road north alongside the Tetri Aragvi river. From where the existing road begins its zig-zag alignment up to Gudauri (7.5 km past Kvesheti), this alignment would continue to follow the river for another 5.5 km. It would require a sequence of bridges over streams joining the main river before entering the southern portal of a 8.4 km long tunnel under the Jvari pass (slightly north of the current road). From the tunnel's northern portal entrance, a further 2 km of road would be upgraded along the existing road to just after Kobi village.

Although the alignment has positive aspects such as minimal impact on human settlements and cultural heritage sites, it faces major issues. One is that road construction and operation here would pose significant risks to biodiversity as the alignment would pass through about 6 km of Kazbegi National Park. The other key issue is the unsuitable geological conditions. As is shown in Figure 3, materials deposited from a now extinct volcano cover a large area, including a significant portion of the 8.4 km tunnel. Constructing a tunnel through this material would be high risk.

Figure 3: Volcanic Materials and Risks Level for Road Construction



Source: IDOM (2018)

Geological testing by deep bore holes and other methods established that these deposits include large areas of black shale and would make tunnel construction unacceptably dangerous. There would be a real risk of stress-caused "squeezing" which could lead to tunnel collapse, either during construction or operation. In addition, at the required tunnel depth, high temperatures and water springs would add considerably to the risks. This corridor is also very exposed to landsides, for which there are limited engineering mitigation options. Taking these factors into consideration, the geological risks ruled out Corridor 1 as a feasible corridor option.

Corridor 2: Gudauri Valley
From Kvesheti, this alignment follows the existing road north for 3 km to just past Arakveti village before crossing the Tetri Aragvi river and heading back downstream. It then makes it way up an incline to the Kvesheti plateau and continues toward Gudauri. Before it reaches Gudauri, a 11.4 km tunnel would take the road under the Jvari pass (just south of the current alignment). The tunnel would exit near Kobi.

While social and environmental impacts were not identified as particularly high, the tunnel in the Corridor 2 alignment faces the same geological conditions and risks as for Corridor 1, notably the presence of old volcanic event materials, which also made this option technically unfeasible.

Corridor 3: Khada Valley
This corridor included two possible alignments. Both cross the Tetri Aragvi river adjacent to Kvesheti village and ascend to the Kvesheti plateau before following the Khada valley for about 10 km as far as Tskere village. The major difference between the two alignments was the geometry for the incline segment up to the Kvesheti plateau. The alignments cross the Khada river at various points for more advantageous geological conditions. From Tskere village, a 9 km tunnel would see the road emerge near Kobi at the same point as the Corridor 2 tunnel.

As Figure 3 shows, the flow direction of volcanic materials from the volcanic cone is away from the Khada valley. This means the geological conditions in the Khada valley are significantly different, and more suitable, than in the other two corridors. Extensive tests in the Khada valley concluded that the tunnel from Tskere to Kobi could be built without significant risk. The assessments also revealed that risks from natural hazards such as avalanches, landslides, and heavy snow fall could be successfully addressed by engineering design solutions and fine-tuning of the alignment. As a result, the pre-feasibility engineering studies concluded that the Khada valley corridor was the only technically feasible option for the project.

FEASIBILITY ASSESSMENT

With the Khada valley corridor identified as the technically feasible option for the project, further assessments were conducted to identify the best alignment for the road within this corridor. Three alignment options were identified and further analyzed before the preferred alignment was settled upon, which is shown in red color in Figure 4.

Environment and social aspects (including biodiversity and cultural heritage) were also assessed and culminated in the preparation of an environmental impact assessment (EIA) report. Findings of the draft EIA has been discussed with potentially affected communities, civil society organizations, universities, and national and local authorities through public meetings, expert group meetings, focus group discussions, and one-on-one meetings.

Figure 4: Alignment Options Within the Khada Valley Corridor

Source: IDOM (2018)

The selected project road alignment is about 22.6 km long and from adjacent to Kvesheti village it crosses the Tetri Argavi river via a 492 meter-long bridge before entering a 4.5% gradient tunnel that exits at the top of the Kvesheti plateau. From there it enters the Khada valley via a 164 meter-high arch bridge to cross the Khada valley. Two more bridges and two more tunnels are needed to reach the Begoni plateau. After passing through a gallery, another bridge crosses the river to the right bank and the road then continues up to Tskere village where the main 9 km tunnel to Kobi begins.

DETAILED DESIGN

The final step in design process was to fine-tune the selected alignment to reflect the best combination of traffic, technical, environmental, and social factors. Land acquisition and resettlement plans have also been prepared for the long tunnel section (also referred to as Lot 1) and the road section (also referred to as Lot 2). Consultations with local communities during 2018 led to a number of design modifications to minimize negative impacts and increase positive impacts for local communities. Some examples include placement of access roads, tunnel portal extension, and new underpasses for better livestock and pedestrian access. The alignment that is now finalized and being prepared for contract procurement and construction is the outcome of this process.

A video animation of the road alignment and its major features can be viewed here:
http://www.georoad.ge/?lang=geo&act=gallery&func=menu&uid=1536737916&type=2
A detailed map of the project road is available for download on the Roads' Department websites (see weblinks below).

MORE INFORMATION

The following documents can be downloaded from the ADB website (English):
https://www.adb.org/projects/51257-001/main#project-documents
and the Roads Department website (Georgian and English):
http://www.georoad.ge/?lang=geo&act=pages&func=menu&pid=1536737215
(i) Environmental Impact Assessment
(ii) Land Acquisition and Resettlement Plans
(iii) Project Fact Sheet
(iv) Frequently Asked Questions
(v) Project map (on Roads Department website)
(vi) Project video

Copies of the prefeasibility and feasibility studies may be reviewed at the Roads Department of Georgia in Tbilisi (12 Kazbegi Avenue) with prior arrangement.