GEORGIA ELECTRICITY TRANSMISSION NETWORK DEVELOPMENT PROJECTS

Environmental and Social Impact Assessment

Volume 5 Physical Environment

Document 5.1 Project –wide Assessment

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DOCUMENT REFERENCES

TABLES

IMAGES

Acronyms

Acronym	Description
AA	Appropriate Assessment
AC/DC	Alternating current/direct current
AD	Anno Domini (also known as Common Era)
AMSL	Above mean sea level
AOP	Protected Designation of Origin
APA	Agency of Protected Area
AIS	Air insulated switchgear
ASL	Above Sea Level
BC	Before Christ (also known as Before Common Era)
BCoW	Biodiversity Clark of Works
BD	Bird Directive
[BIO-N]	Measure number N committed in Volume 3 Biodiversity of the ESIA Report
BP	British Petroleum
[CC]	Environmental and social management actions under the responsibility of the Contractor relevant to both substations and transmission line
CCTV	Closed circuit Television
CENN	Caucasus Environmental Network
CESMP	Construction Environmental and Social Management Plan
CH	Critical Habitat
CHS	Community Health and Safety
CLOs	Community Liaison Officers
[CO]	Construction
CSE	Cable Sealing End
dB(A)	Decibels (A weighted)
[DD]	Detailed design
EBRD	European Bank for Reconstruction and Development
EIA	Environmental Impact Assessment
EHS	Environmental, Health and Safety

ELF	Extremely Low Frequency
EMF	Electromagnetic Fields
ENTSO	European Network of Transmission System Operators' for Electricity
EPC	Engineering-Procurement-Construction
E&S	Environmental & Social
ERS	External Relations Stakeholder
ESHS	Environment, Social, Health and Safety
ESIA	Environmental & Social Impact Assessment
ESMP	Environmental & Social Management Plan
ESMS	Environmental and Social Management System
EU	European Union
FAO	Food and Agriculture Organisation of the United Nations
[GC]	Government of Georgia E&S management actions
GE00000X	Candidate Emerald Site identifier
GEL	Georgian Lari
GEOSTAT	National Statistics Office of Georgia
GIP	Good International Practice
GIS	Gas insulated switchgear
GLAC	Guide to Land Acquisition and Compensation
GLVIA	United Kingdom Guidelines for Landscape and Visual Impact Assessment
GRC	Grievance Resolution Committee
GRM	Grievance Resolution Mechanism
GSE	Georgian State Electrosystem
GVWR	Gross Vehicle Weight Rating
ha	hectare
HD	Habitats Directive
HDV	Heavy Duty Vehicle
HGV	Heavy Goods Vehicle
HPP	Hydropower Project
H&S/HS	Health and Safety
HSMS	Health and Safety Management System

HVDC	High Voltage Direct Current
[HYD-N]	Measure number N committed in the Hydrology, Geology and Geohazards Assessment in Volume 5 Physical Environment of the ESIA Report
Hz	Hertz
IAS	Invasive Alien Species
IBA	Important Bird Area
ICNIRP	International Commission on Non-Ionizing Radiation Protection
IDP	Internally Displaced Persons
IFC	International Finance Cooperation
IFC PS	IFC Performance Standards
ILO	International Labour Organization
JSCNH	Developer of Nenskra HPP
Key Biodiversity Area	KBA
KfW	KfW Development Bank
kHz	Kilohertz
km	Kilometre
KM	Kilometre markers along each proposed transmission line
kV	Kilovolt
L&V	Landscape and visual
LARCF	Land Acquisition and Resettlement Compensation Framework
LNK	Lower Namakhvani
LVIA	Landscape and visual impact assessment
[LVIA-N]	Measure number N committed in the Landscape and Visual Assessment in Volume 5 Physical Environment of the ESIA Report
m	Metre
MEPA	Ministry of Environmental Protection and Agriculture
mASL	Metres above sea level
MCP	Management of Change Procedure
MLARO	Municipal Land Acquisition and Resettlement Office
MoESD	Ministry of Economy and Sustainable Development
MoF	Ministry of Finance
MVA	Mega volt-ampere

MW	Megawatt
NACHP	National Agency for Cultural Heritage Preservation of Georgia
NACRES	Centre for Biodiversity Conservation and Research
NAPR	National Agency of Public Registry
NBSAP	The 2nd National Biodiversity Strategy and Action Plan
NGO	Non-Governmental Organisation
NOI	Noise ESMP action
NOx	Oxides of nitrogen
NP	National park
NTS	Non-Technical Summary
[OC]	Owner Construction ESMS management actions
OHL	Overhead line
[OP]	Operation
PAH	Project Affected Household
PAP	Project Affected Person(s)
PBF	Priority Biodiversity Feature
PCBs	Polychlorinated Biphenyls
PDO	Protected Designation of Origin
PPE	Personal Protection Equipment
PR	EBRD Performance Requirement
PRRC	Property Rights Recognition Commission
PS	KfW Performance Standard
RAP	Resettlement Action Plan
RMT	Resettlement Management Team
RoW	Right of way
SEP	Stakeholder Engagement Plan
SF_6	Sulphur hexaflouride
[SOC-N]	measure number N committed in Volume 4 Social of the ESIA Report
SPAB	Special Protection Area for Birds
TMP	Traffic Management Plan
TYNDP	GSE's Ten Year Network Development Plan of Georgia

UK	United Kingdom
UNECE	United Nations Economic Commission for Europe
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNK	Upper Namakhvani
VSC	Valued Social Components
WHO	World Health Organisation
WHS	World Heritage Site

Preamble

This document is the Physical Environment assessment of the Georgian Electricity Transmission Network Development projects (Project). It forms **Volume 5** of the Environmental and Social Impact Assessment (ESIA) Report. The Project being developed by the Georgian State Electrosystem (GSE) comprises the construction of new and in some cases rehabilitation of existing transmission lines and substations.

The Project being developed by the Georgian State Electrosystem (GSE) comprises the construction of new and in some cases rehabilitation of existing transmission lines and substations. In summary, the Project is formed into 5 geographical component areas (Project Components), Components A, B, C1, C2 and D. Each new or rehabilitated line and substation is given a Project name which is used throughout the documents. The following table provides an overview of the Project Components and the Project names.

Component	Line description	Project name
A - Samtskhe-Javakheti & Imereti	Tskaltubo to Akhaltsikhe and on to Turkey border at Vale: - 500kV Tskaltubo to Akhaltsikhe Substation - 400kV Akhaltsikhe to Turkey border (and on to Tortum in Turkey) - Extension to the existing Akhaltsikhe Substation	Sairme line Tao line Akhaltsikhe extension
B - Guria	Ozurgeti to Zoti HPP and connection from Ozurgeti to the Paliastomi line: - 110kV Ozurgeti to Zoti HPP powerhouse - 220kV Ozurgeti to Paliastomi loop in connection - 110/220kV Ozurgeti Substation	Guria line Paliastomi loop Ozurgeti Substation
C1 - Svaneti	Nenskra to Mestia: - 110/220/500kV Nenskra Substation - 110kV Nenskra Substation to Mestia HPPs - 500kV Kavkasioni loop in loop out to Nenskra Substation - 220kV Nenskra substation to Nenskra HPP Powerhouse	Nenskra Substation Mestia line Kavkasioni loop Nenskra HPP underground cable line
C2 – Racha Lechkhumi & Imereti	Lajanuri connections to Kheledula HPP, Oni HPP and Tskaltubo: - 110/500kV Lajanuri Substation - 220kV Lajanuri to Oni HPP - 220kV Lajanuri to Kheledula HPP - 500kV Lajanuri to Tskaltubo - 220kV Rehabilitation of the existing 220kV Derchi line from Lajanuri to Tskaltubo, with new connections into Namakhvani Cascade HPP - 220kV Lajanuri Substation to Lajanuri HPP	Lajanuri Substation Oni HPP line Kheledula HPP line Lechkhumi line New Derchi line Lajanuri HPP line
D - Kakheti	Reinforcement of the transmission infrastructure in Kakheti: - 110/220kV line from Gurjaani to Telavi, constructed on 220kV towers - 110kV line from Telavi to Akhmeta, constructed on 220kV towers - 110kV loop to Tsinandali	Gurjaani line Akhmeta line Tsinandali line

	- 110kV loop to Mukuzani - Rehabilitation and extension of 110kV Akhmeta Substation - Rehabilitation and extension of 110/220kV Telavi Substation - Rehabilitation of 110kV Tsinandali Substation - Rehabilitation and extension of 110kV Mukuzani Substation - Rehabilitation and upgrade of 110/220kV Gurjaani substation	Mukuzani line Akhmeta Substation Telavi Substation Tsinandali Substation Mukuzani Substation Gurjaani Substation

The ESIA Report is formed of a number of volumes and documents, as follows:

- Volume 1 – Non Technical Summary;
- Volume 2 –Project Definition – including Project introduction, need and alternatives and project description;
- Volume 3 – Biodiversity:
  - Document 3.1 Biodiversity Project-wide Assessment
  - Document 3.2 Biodiversity Project Component Specific Assessment
  - Document 3.3 Biodiversity Figures
  - Document 3.4 Biodiversity Appendices
- Volume 4 – Social – including assessments on people, communities, the economy, cultural heritage and Electromagnetic Fields (EMF):
  - Document 4.1 Social Project-wide Assessment
  - Document 4.2 Social Project Component Specific Assessment
- Volume 5 – Physical Environment– including assessments on landscape and visual, noise, air quality:
  - **Document 5.1 Physical Environment Project-wide Assessment (this Report)**;
  - Document 5.2 Physical Environment Project Component Specific Assessment;
- Volume 6 – Stakeholder Engagement Plan (SEP);
- Volume 7 – Land Acquisition, Resettlement and Compensation Framework (LARCF);
- Volume 8 – Environmental and Social Management Plan (ESMP):
  - Document 8.1 Project-wide ESMP;
  - Document 8.2 Transmission Lines ESMP;
  - Document 8.3 Substations ESMP.

1.0 Introduction

1.1 Background

This report (**Volume 5**) presents the assessment of the Georgia Electricity Transmission Network Development Project (Project) on the Physical Environment, comprising landscape and visual, air quality, noise and hydrology and geology. Where impacts have been predicted, mitigation measures are presented. These mitigation measures are taken forward into the Environmental and Social Management Plan (ESMP) for the Project (**Volume 8**).

The assessment of the Project on the physical environment presents the following:

- A landscape and visual assessment - the purpose of the assessment is to review the general principles of the Project in the context of the baseline landscape and visual receptors, evaluating the potential impacts that may arise and to ensure that the most sensitive landscape environments are avoided where practically possible;
- For air quality – an overview of the impacts of the Project on air quality and the proposed mitigation is provided. Air quality impacts are such that their management by mitigation measures (as set out in the **ESMP** (**Volume 8**)) would prevent the occurrence of significant impacts. The detailed assessment of air quality has, therefore, been scoped out of this ESIA Report.
- Similarly for construction noise – Good International Practice (GIP) and other mitigation measures, (as set out in the **ESMP** (**Volume 8**)) will be used to ensure compliance with the relevant guidelines and thereby prevent the occurrence of significant impacts. Construction noise has also, therefore, been scoped out and the reasoning for this is expanded upon in this report. An assessment of operational noise impacts is, however, presented.
- Hydrology, geology and geohazard impacts, including geomorphology, soils and groundwater will also be controlled through measures in the **ESMP** (**Volume 8**) so that there would be no significant impacts as a result of the Project. Therefore, a detailed assessment of Project impacts on water quality and flood risk is scoped out. Nevertheless, key hydrological features (such as large river crossings) are mapped and described so that likely constraints can be established to inform the necessary mitigation measures and the appropriate specifications for the ESMP.

1.2 Structure of the Report

This report comprises two documents: **Document 5.1** which provides introductory information, details of the methodologies and approaches and the Project-wide assessments and mitigation measures which are relevant to all of the Project Components; and **Document 5.2** which describes the Project Component assessments and mitigation information.

Document 5.1 (this document) is structured into 3 sub-sections as follows:

- Section 1 – Landscape and Visual;
- Section 2 – Air Quality;
- Section 3 – Noise and Vibration; and
- Section 4 – Hydrology, Geology and Geohazards

Each of these sub-sections provides the following information:

- Section X.1 – Introduces the studies;

- Section X.2 – outlines the Georgian and international Policy and Legislative Framework relevant to that section;
- Section X.3 - describes the Methodology employed for each element being assessed, including the reasoning for scoping out any topics from the assessment;
- Sections X.4, X.5 and X.6 – provides the Project-wide Baseline Overview, Project-wide Impact Assessment and Project-wide Mitigation respectively for each assessment. These comprise an assessment of the impacts that are relevant across each Project Component; and
- Section X.7 - presents in tabular form, a Project-wide Summary of Impacts and Commitments, including assessment of potential significance without mitigation, the mitigation/commitment necessary and the significance of the residual impact following the implementation of the mitigation proposed.

Document 5.2 comprises specific Project component information. For each topic taken forward for detailed component-specific assessment, i.e. landscape and visual and hydrology, geology and geohazards, each Project component is addressed in turn and includes:

- Baseline context;
- Impact assessment;
- Mitigation;
- Cumulative assessment; and
- Summary of impacts and commitments, again in tabular form as for the Project-wide Assessment document.

Component A (in particular for the Tao line) and Component D also include an assessment of transboundary impacts.

There is no Noise or Air Quality Project Component Assessments as these are addressed within the Project-wide assessment and the **ESMP (Volume 8)**.

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2.0 Landscape and Visual

2.1 Policy and Legislative Framework

2.1.1 Georgian Requirements

There are no specific standards, guidelines or policy provisions relating to landscape and visual effects of proposed developments.

Georgia is a signatory to the European Landscape Convention, which emphasises the importance placed on landscapes in Georgia and places greater responsibility on the nation to protect and manage all landscapes. As a result, this ESIA includes a landscape and visual assessment. Landscape, as defined in the European Landscape Convention, is "*an area, as perceived by people, whose character is the result of the action and interaction of natural and/or human factors*", (Council of Europe, 2000[1]). Landscape does not apply only to special or designated places, nor is it limited to countryside.

Law of Georgia on System of Protected Areas (1997, amend. 2003, 2004, 2005, 2006, 2007) sets categories of the protected area (including national park, state reserves, managed reserves) and defines activities allowed in their boundaries. Activities are permitted considering the purpose of the area, requirements set out in legislation and individual regulations, management plans of protected areas, as well as international agreements and conventions signed by Georgia. The law provides restrictions over use of natural resources in national parks and other protected areas.

The 'national park' designation is of particular relevance to landscape and visual. This is the only designation which includes an aspect of promotion for public use to enjoy the landscape, rather than being more specifically associated with other objectives e.g. protection of wildlife habitats or species.

2.1.2 International Requirements

With the exception of the European Landscape Convention, referred to above, there are no international guidelines that provide specific or detailed advice relating to landscape and visual issues.

International guidelines

IFC/World Bank Environmental, Health, and Safety Guidelines for Electric Power Transmission and Distribution state the mitigation measures set out in Table 2.1 should be met with respect to Visual Amenity:

Table 2.1 IFC World Bank EHS Guidelines for Electric Power Transmission and Distribution Mitigation Requirements for Visual Amenity

Requirement	Where considered in the ESIA Report
Extensive public consultation during the planning of power line and power line right-of-way locations;	See the **Stakeholder Engagement Plan (Volume 7)**
Siting power lines, and designing substations, with due consideration to landscape views and important environmental and community features;	See Section 2.5.1 of this document and also the landscape and visual assessment presented in **Document 5.2**. Also refer to Chapter 2 of **Volume 2 Project Definition**

[1] Council for Europe (2000) European Landscape Convention, Strasbourg: Council of Europe https://www.coe.int/en/web/conventions/full-list/-/conventions/treaty/176

Requirement	Where considered in the ESIA Report
Location of high-voltage transmission and distribution lines in less populated areas, where possible;	See Section 2.5.1 of this document and also the landscape, visual assessment presented in **Document 5.2**. and also Section 2.3 **Volume 2 Project Definition**
Burying transmission or distribution lines when power must be transported through dense residential or commercial areas	A 3.3km length of underground cable is proposed for the Gurjaani line (KM26 to KM29) to reduce impacts on visual amenity.

EBRD

The EBRD Environmental and Social Policy[2] does not contain any specific guidance with respect to landscape and visual impacts. However, Performance Requirement 1 sets out general expectations in relation to the identification and evaluation of potential environmental and social impacts of a project, together with appropriate mitigation. Potential landscape impacts are referred to specifically in the context of Performance Requirements 6 and 8.

2.2 Methodology

2.2.1 Introduction

The purpose of the assessment is to review the general principles of the Project in the context of the baseline landscape and visual receptors, evaluating the potential impacts that may arise. This assessment is based upon broad parameters reflecting the various elements of the Project. The potential impacts associated with construction and operation have been assessed together rather than separately. This is partly due to the high level nature of this assessment. In addition, the greatest potential impact on landscape and visual receptors are likely to relate to the operational phase of the development due to its duration.

As there is no defined approach to landscape and visual appraisal in Georgia or in the EBRD guidelines, methodology and approach is based on the United Kingdom Guidelines for Landscape and Visual Impact Assessment (GLVIA3) (Landscape Institute and Institute of Environmental Management and Assessment, third edition, 2013 [3]). This is relevant as it is the formal requirement for environmental impact assessment in response to European Union Directives 85/337/EEC[4] and 2011/92/EU [5] (as amended) on the Assessment of the Effects of Certain Public and Private Projects on the Environment. GLVIA3 was prepared taking account inter alia the European Landscape Convention1. The appraisal provides a summary of the key considerations that contribute to the judgements that have been made in relation to the potential landscape and visual impacts.

Landscape and Visual Impact Assessment (LVIA) is a tool used to identify the impacts of development on "landscape as an environmental resource in its own right and on people's views and visual amenity" (GLVIA3,

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[2] Environmental and Social Policy, EBRD, May 2014
https://www.ebrd.com/news/publications/policies/environmental-and-social-policy-esp.html

[3] Landscape Institute and Institute of Environmental Management & Assessment (2013) Guidelines for Landscape and Visual Impact Assessment. Third Edition. Oxon: Routledge

[4] Council Directive of 27 June 1985 on the assessment of the effects of certain public and private projects on the environment, Official Journal of the European Union

[5] Council Directive 2011/92/EU of the European Parliament and of the Council of 13 December 2011 on the assessment of the effects of certain public and private projects on the environment, Official Journal of the European Union

paragraph 1.1). GLVIA3 paragraph 2.22 states that, these two elements, although inter-related, should be assessed separately.

As GLVIA3 paragraph 2.23 states, professional judgement is an important part of the LVIA process: whilst there is scope for objective measurement of landscape and visual changes, much of the assessment must rely on qualitative judgements. It is critical that these judgements are based upon a clear and transparent method so that the reasoning can be followed and examined by others.

Landscape and visual impacts can be positive, negative or neutral in nature. Positive impacts are those which enhance and/or reinforce the characteristics which are valued. Negative impacts are those which remove and/or undermine the characteristics which are valued. Neutral impacts are changes which are consistent with the characteristics of the landscape or view.

The high level desk based landscape and visual (L&V) appraisal has been undertaken for the Project has:

- Concentrated on areas of greatest change i.e.:
  - new routes rather than rehabilitation of existing lines e.g., Kakheti and Derchi line in Racha;
  - undisturbed areas versus modified landscapes;
- Focused generally on landscape impacts rather than visual; however, visual impacts have also been considered, particularly in relation to residents and tourist resources/destinations;
- Identified how the Project design has evolved to take account of L&V considerations; and
- Identified possible measures to avoid, reduce or control L&V effects, for inclusion in the ESMP, however, the principal method used to reduce landscape and visual impacts has been the selection of appropriate routes as described in Section 2.3 **Volume 2 Project Definition**.

Due to the scale of the Project, the aim of the baseline assessment has been to undertake the following:

- Identify key landscape receptors e.g. proposed and designated national protected areas and other important features;
- Identify key visual receptors e.g. settlements, recreational resources, tourist destinations; and
- Use key information sources – baseline mapping, aerial photography, local knowledge/information from project team, guidebooks/tourist guides.

Landscape Impacts

Landscape, as defined in the European Landscape Convention, is defined as "*an area, as perceived by people, whose character is the result of the action and interaction of natural and/or human factors*", (Council of Europe, 2000[1]). Landscape does not apply only to special or designated places, nor is it limited to countryside.

GLVIA3 recommends that the effect of the development on landscape receptors is assessed (paragraph 5.34). Landscape receptors are the components of the landscape that are likely to be affected by the scheme, and can include individual elements (such as scrub or buildings), aesthetic characteristics (for example, tranquillity or openness), or, at a larger scale, the character of a defined character area or landscape type.

Judging landscape impacts requires a structured assessment of the sensitivity of the landscape receptors to the Project and the magnitude of impact which would be experienced by each receptor.

Visual Impacts

Visual receptors are the people whose views may be affected by the proposals. They generally include users of recreational facilities; travellers who may pass through the study area because they are visiting, or living or working there; residents living in the study area, either as individuals or, more often, as a community; and people at their place of work.

Viewpoints can be selected for a variety of reasons, but most commonly because they represent views experienced by relevant groups of people.

2.2.2 Study Area

The appraisal concentrates on the route of each Project Component. In addition, landscape and visual receptors and potential effects within an area extending to approximately 5km surrounding the Project Components are considered in the appraisal. Experience of assessing transmission line projects indicates that the main landscape and visual impacts are likely to occur within 5km of an overhead line, with significant impacts typically identified within 2 to 3km. This is because of the decreasing visibility of the Project with distance. Much, however, depends on the relationship of the project with the surrounding landscape and the screening resulting from terrain and vegetation.

2.2.3 Assessment Methodology

Judging the significance of landscape and visual impacts requires a methodical assessment of the sensitivity of the receptors to the Project and the magnitude of impact which would be experienced by each receptor.

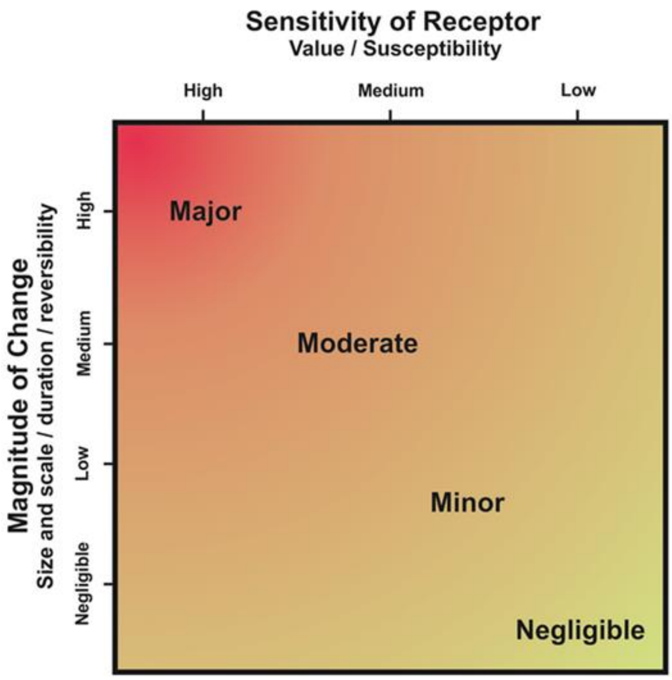
The sensitivity of landscape and visual receptors is assessed by combining the susceptibility of receptors to the type of change which is proposed with the value attached to that receptor (i.e. landscape or view). Sensitivity is judged to be low, medium or high.

The magnitude of landscape or visual change is defined by assessing the size or scale of change, the geographical extent of the area influenced and the duration and reversibility of the change. These three factors that contribute to assessment of the magnitude of landscape change combine to reach an overall judgement in relation to the magnitude of change. Magnitude of change is judged to be substantial, medium, slight or negligible, for example a substantial magnitude of change would result from a large-scale change that extends over a large area and would be long term or permanent.

The assessment of landscape and visual impacts is defined in terms of the relationship between the sensitivity of the landscape receptors (value and susceptibility) and the magnitude of the change. The diagram in Image 3.1 summarises the nature of the relationship but it is not formulaic. Judgements are made about each landscape or visual impact using this diagram only as a guide.

Impacts that fall in the red (darker) section of the diagram, that is those which are considered to be major and major/moderate impacts by virtue of being a more sensitive receptor with a greater magnitude of change, are generally considered here to be the significant landscape and visual impacts. Those impacts falling outside the major or major/moderate categories are generally considered to be not significant. For consistency with other assessments being undertaken for this Project the terminology high, moderate and low has been applied. Relating these levels of impact to Image 3.1, a high impact would be equivalent to major, and minor being equivalent to low. In addition, intermediate levels of impact (high/moderate and moderate/minor) have been stated where these are considered appropriate.

Image 3.1: Assessment of Visual Impacts



2.2.4 Assessment Limitations

The appraisal has been undertaken as a desk based exercise utilising mapping and aerial photography, with no fieldwork by the L&V specialist. However, it has drawn on the experience and knowledge of project team members that have undertaken site based work.

In addition, as the detailed design of the Project has not yet taken place the appraisal concentrates on the broad Project corridor, as set out in **Volume 2 Project Description**, Section 3.2 Project Design Status.

2.3 Project-wide Baseline Information

The Project Components cross a range of different landscape types and would be experienced by people (visual receptors) engaged in a range of different activities. The landscapes that the Project Components are located in vary from relatively low lying agricultural area, some of which are associated with the urban fringes of larger settlements, together with elevated landscapes of the Caucasus Mountains (Greater and Lesser Caucasus). The landscapes that are more sensitive to the Project are those associated with the more remote areas, where human influences on the landscape are less pronounced.

The key visual receptors that are of high sensitivity to the Project are the residents of local settlements. These are primarily located within the low lying agricultural areas referred to above. In addition there are recreational receptors e.g. people visiting destinations (such as Bakhmaro) and walking trails in the Caucasus Mountains which are considered to be sensitive to the changes in the landscape.

Potential landscape and visual receptors are described in more detail in relation to each Project Component in **Document 5.2**.

2.4 Project-wide Impact Assessment

It is predicted that there will be a range of landscape and visual effects associated with each Project Component. Direct landscape effects will include the loss of vegetation along the routes of the overhead lines, underground cable and at substations, together with the construction of temporary and/or ancillary elements such as access tracks and construction compounds. The Project Components also have the potential to affect the perception of landscape character as a result of the vegetation clearance and also the introduction of new structures. In addition, the creation of new tracks across the landscape could also result in consequential changes due to the increased accessibility to more remote locations. Potential landscape effects are generally predicted to be greater in more remote locations where there are fewer human influences and the landscape is more remote and wild, for example, the central section of Components A and B.

Visual effects are generally predicted to be greater where the Project Components cross or are located close to settlements, which are predominately found in the lower lying agricultural areas. However, where the largest settlements are found the relative level of change is likely to be reduced by the existing built development that forms part of the baseline. Therefore, the greatest effects are likely to be associated with the residents of more remote communities, where built development that forms part of the baseline is less and, therefore, the change resulting from the Project is likely to be more prominent.

2.5 Project-wide Mitigation

Mitigation measures in this section are relevant to the Project as a whole and discussed and then summarised under the heading 'mitigation requirement.' Each mitigation measure is given a reference code using the format [L&V-x]. These are used to summarise and tag measures in the **ESMP (Volume 8)** to ensure implementation of the measures set out.

A range of measures are incorporated in the Project to help reduce potential landscape and visual impacts. This are primarily associated with the routing of the overhead lines and the replacement of existing infrastructure where possible.

In addition, a range of measures could be implemented at the detailed design stage to further reduce potential residual impacts.

2.5.1 Overhead lines – Avoidance Measures

A key element of the design of the transmission line routes has been the avoidance of environmental and social impacts wherever possible. A number of design principles have been adopted and these have been a key consideration when reviewing alternative routes and then work which is ongoing to optimise the transmission lines. The design principles have included the following aspects wherever possible with respect to landscape and visual impacts:

- Avoidance of protected areas;
- Avoidance of settlements and properties;
- Avoidance of key sensitive landscapes and their immediate surroundings;
- Avoidance of high value biodiversity features, such as primary forest (forest not touched by human intervention);
- Keeping transmission lines to landscapes already impacted by transmission lines rather than affecting untouched landscapes;
- Minimising vegetation removal within the right of way corridor;
- Keeping the alignment of the transmission line as straight as possible, reducing the use of angle towers and also reducing the potential complexity in appearance and confusion that can result from a transmission line that changes direction multiple times;
- The landform and land cover should be used where possible to reduce potential impacts. Using higher ground as a backdrop to the transmission line and avoiding ridgelines reduces its visual prominence.

Crossing ridgelines obliquely and preferably where there is a dip can reduce visual prominence. Where possible, use existing vegetation in the landscape to provide screening; and

- Where transmission lines cross valleys placing the opposing towers away from the break in slope could reduce visual prominence. Alternatively ensuring the landscape forms the backdrop to towers would help to integrate them with the local landscape.

For the final detailed design, prior to construction, the routing would adopt these principles. Consideration would be given to ensure that the distance between the transmission line and sensitive features such as settlements is not reduced and the relationship between the route and the local landscape would be considered carefully i.e. the local landform and woodland cover could be used to maximise potential for screening. At the detailed design stage, any project infrastructure which is proposed to be located outside the environmental assessment corridor must also be subject to environmental assessment In accordance with the 'Management of Change Procedure' which is set out in the **ESMP** (Section 5.4, **Volume 8**).

Mitigation requirement

- [L&V-1] Adherence to design principles during refinement of the transmission line routes and substations, as outlined in Section 3.2.1 of the **ESMP** (**Document 8.2**).
- [L&V-2] Inclusion of the landscape and visual design principles in a management of change process for the environmental assessment of new transmission line routing or substation locations proposed to be located outside the assessment corridor of this study.

2.5.2 Substations

The most important consideration is likely to be location and size/scale of structures within each substation or substation extension/rehabilitation. During the detailed design of the substation layouts, if possible infrastructure would be positioned to take advantage of screening provided by local features such as landform and vegetation and also internal screening within each substation. Where possible, careful placement of structures within a substation, including terminal towers and gantries, would help to reduce the prominence of the development and, therefore, the scale of change that would occur.

Linked with the size/scale considerations is the elevation of the development platform. Positioning this away from breaks in slope is likely to reduce the visibility of the structure from locations from areas of lower topography.

Materials selection could contribute to a reduction in the level of landscape and visual impacts. The use of recessive colours and non-reflective materials (including fencing) would help to reduce the prominence of the structures.

Mitigation requirement

- [L&V-3] Consideration of design principles, such as the selection of materials and finishes, during detailed design of the substations/substation extensions.

A well-considered landscape strategy is likely to be important to ensure the new substation or substation extension can be integrated as effectively as possible. The consideration of fencing material and placement, e.g. choosing coloured rather than galvanised fencing and placing fencing inside planting, would also help to reduce localised impacts around the perimeter of the site. Restoration of vegetation and planting would be useful in reducing local impacts. The reference to effectiveness of planting is very much linked with the overall scale, and particularly the height, of the proposed substation/substation extension. Surplus soils would also be used to create bunds around the facility, which could help to screen potential views.

Mitigation requirement

- [L&V-4] Reinstatement of vegetation and soils complementing surrounding landscapes must be undertaken to ensure that the substation fits in to its surrounding landscape.

2.5.3 Temporary Construction Infrastructure

Comprehensive restoration following construction is likely to be the most effective way to reduce the landscape and visual impacts associated with access tracks, temporary construction compounds and borrow pits.

Areas used for construction should be restored in accordance with a Reinstatement Plan (see Section 5.3.10 of the **ESMP**, **Document 8.1**). Buildings, areas of hardstanding and tracks should be removed where possible and the land restored to a use and land cover compatible with the immediate surroundings. Ideally top soils should be removed prior to the establishment of the construction phase and stored appropriately in accordance with GIP (i.e. in low mounds, stabilised by establishing a grass mix) (see Section 5.3.6 of the **ESMP**, **Document 8.1**). This would help to ensure the preservation of the soil structure and composition. This stripping and storage of soils would help to retain the seed bank, which would aid the subsequent restoration and establishment of vegetation that is comparable with the baseline.

Native tree and shrub planting, together with appropriate ground cover (e.g. grass/wildflower mix) would mitigate some of the impacts of the project. A sensitive approach would help to compensate for vegetation loss due to construction and aid the integration of the restored site.

For any borrow pits, ensuring the final landform complements the local context, particularly in relation to gradients and heights, will help to reduce potential impacts. Blending the bases of new slopes with the adjacent terrain would also help to integrate the new landforms. Sensitive design of the borrow pits could help to reduce the prominence of these project elements, with potential measures including consideration of final slopes and/or rock faces, reducing the areas of working where practical and establishment of vegetation in areas to be restored as soon as possible to aid their integration with the surrounding landscape and help provide ground stability. Additional selective blasting of rock faces and grading of slopes could help to achieve a more natural appearance and aid the establishment of vegetation.

Mitigation requirement

- [L&V-5] Preparation and implementation of a Reinstatement Plan containing landscape and visual prescriptions relevant to temporary construction compounds, access tracks and borrow pits.

Where feasible, cutting into the hillside to form access tracks and other infrastructure should be minimised to reduce potential scarring resulting from exposed faces adjacent to the road or compound. Similarly, the gradients of fill slopes or side cast material should be minimised where possible. Application of soils and a suitable grass mix, potentially combined with geotextile membrane for steeper faces, would reduce the prominence of exposed ground and also help to reduce the potential for land instability and the release of mud and sediment. Stabilising this material will reduce the prominence of the tracks and the associated potential landscape and visual impacts. The use of a low bund on the downhill side of the track or compound could help to reduce its prominence, while also potentially helping to use materials that may otherwise need to be disposed of.

Mitigation requirement

- [L&V-6] Gradients of cut and fill and slope creation and the side casting of materials to be minimised and stabilisation techniques to be used to avoid large visible exposed slopes during construction of ancillary and temporary infrastructure.

Should borrow pits be required as a source of construction materials a range of GIP measures could be considered to mitigate any potential landscape and visual impacts. The selection of environmentally appropriate and well-screened sites for the winning of materials will reduce potential impacts.

Mitigation requirement

- [L&V-7] Use of GIP during excavation and use of borrow pits.
- [L&V-8] The selection of borrow pit sites should consider the visual impacts and where possible the Contractor would seek to position them in areas screened from the most sensitive landscapes.

2.6 Project-wide Summary of Impacts and Mitigation Commitments

The Project would introduce new structures and elements that have the potential to adversely affect landscape and visual receptors. Some of the Project Components cross relatively undeveloped, remote landscapes, where the potential landscape effects are likely to be greatest. In addition, people living in and visiting the areas surrounding the Project Components will experience change resulting from the proposed development. Visual change and effects are likely to be greatest for local residents that are closest to the Project Components.

A range of measures are incorporated in the Project to help reduce potential landscape and visual effects. These are primarily associated with the routing of the overhead lines and the replacement of existing infrastructure where possible. In addition, a range of measures could be implemented at the detailed design stage to further reduce potential residual effects. These could include the micro-siting of new structures, together with the incorporation of measures such as planting and bunding to reduce the prominence of new structures.

Impact Producing factor	Construction	Operation	Assessment of significance without mitigation or compensation High Hi Moderate M Low Lo [+] positive, [-] negative Likelihood, Magnitude, Extent, Duration		Commitments Key Mitigation, Compensation or Management measures	Predicted residual impacts	Management Action where the mitigation or compensation measure is addressed in the ESMP
Landscape and Visual							
Direct impacts on landscape fabric e.g. vegetation loss/removal	✓	✓	M	**[-] Permanent vegetation loss would occur along the route of the overhead line, access tracks, at the substation extension and construction compounds. Clearance would be repeated during the operational phase.**	• [L&V-1] Adherence to design principles during refinement of the transmission line routes as outlined in Section 3.2.1 of the ESMP (Document 8.2).	M [-]	ESMP Document 8.1, Sections 5.3.6 and 5.3.10, Document 8.2 Section 3.2.1 and Document 8.3 Section 3.6.1
Presence of transmission line/substation extension and access tracks	✓	✓	Hi	**[-] Some temporary aspects in relation to construction. Permanent change to landscape character during the operational phase. Impact will be greatest in undeveloped, more remote areas.**	• [L&V-2] Inclusion of the landscape and visual design principles in a management of change process for the environmental assessment of new transmission line routing or substation locations proposed to be located outside the assessment corridor of this study.	Hi [-]	
Changes in view for residents	✓	✓	Hi	**[-] Permanent change to views seen by local residents. The level of effect will vary based on the relationship between a specific local and the Component.**	• [L&V-3]	Lo [-]	

Impact Producing factor	Construction	Operation	Assessment of significance without mitigation or compensation High Hi Moderate M Low Lo [+] positive, [-] negative Likelihood, Magnitude, Extent, Duration		Commitments Key Mitigation, Compensation or Management measures	Predicted residual impacts	Management Action where the mitigation or compensation measure is addressed in the ESMP
Changes in views for road users	✓	✓	M	**[-] Permanent change to views seen by road users. The lower sensitivity of the receptor would reduce the likely level of effect.**	Consideration of design principles, such as the selection of materials and finishes, during detailed design of the substations/substation extensions • [L&V-4] Reinstatement of vegetation and soils complementing	M [-]	

Impact Producing factor	Construction	Operation	Assessment of significance without mitigation or compensation High Hi Moderate M Low Lo [+] positive, [-] negative Likelihood, Magnitude, Extent, Duration		Commitments Key Mitigation, Compensation or Management measures	Predicted residual impacts	Management Action where the mitigation or compensation measure is addressed in the ESMP
Changes in views for people engaged in recreation	✓	✓	Hi	**[-] Permanent change to views seen by people engaged in outdoor recreation. Assessment is moderate due to the relatively limited presence of recreational uses focussed on the appreciation of the landscape.**	surrounding landscapes must be undertaken to ensure that the substation fits in to its surrounding landscape. • [L&V-5] Preparation and implementation of a Reinstatement Plan containing landscape and visual prescriptions relevant to temporary construction compounds, access tracks and borrow pits. • [L&V-6] Gradients of cut and fill and slope creation and the side casting of materials to be minimised and stabilisation techniques to be used to avoid large visible exposed slopes during construction of ancillary and temporary	Hi [-]	

Impact Producing factor	Construction	Operation	Assessment of significance without mitigation or compensation High Hi Moderate M Low Lo [+] positive, [-] negative Likelihood, Magnitude, Extent, Duration		Commitments Key Mitigation, Compensation or Management measures	Predicted residual impacts	Management Action where the mitigation or compensation measure is addressed in the ESMP
					infrastructure. • [L&V-7] Use of GIP during excavation and use of borrow pits. • [L&V-8] The selection of borrow pit sites should consider the visual impacts and where possible the Contractor would seek to position them in areas screened from the most sensitive landscapes.		

3.0 Air Quality

3.1 Policy and Legislative Framework

3.1.1 Georgian Requirements

The Law of Georgia on Protection of Ambient Air (1999, amend. 2000, 2007) regulates protection of the atmospheric air from adverse anthropogenic impact within Georgia. Adverse anthropogenic impact is any man-caused effect on atmospheric air causing or capable to cause negative impact on human health and environment. The regulation aims to bring Georgia in line with the requirements of the EU directives (and thereby those of the WHO) on air quality, but this has not as yet been brought into effect.

The hygienic standards on Maximum Permissible Concentrations of Air Bourne Pollutants for Settlements (HN 2.1.6. 002-01) set the following maximum (instantaneous) limits of relevance to vehicular emissions from the Project, which are:

- Nitrogen oxides 400µg/m^3;
- Nitrogen dioxide 200µg/m^3; and
- Sulphur dioxide 500µg/m^3.

3.1.2 International Requirements

International Guidelines

WHO

The latest edition of WHO Air Quality Guidelines for ambient air pollutants was published in 2006[6], and included the following recommendations for the air pollutants of relevance to the Project.

Table 3.1 WHO Air Quality Guidelines

Pollutant	Measuring period	Guideline (µg/m^3)
Particulate matter PM10	Annual mean	20
	24-hour average	50
Particulate matter PM2.5	Annual mean	10
	24-hour average	25
Nitrogen dioxide	Annual mean	40
	Hourly	200
Sulphur dioxide	24-hour average	20
	10-minute average	500
Ozone	Daily maximum 8-hour mean	100

[6] Air Quality Guidelines. Global Update 2005. Particulate matter, ozone, nitrogen dioxide and sulfur dioxide

EBRD

EBRD Performance Requirement 4 Health and Safety requires that developers anticipate, assess, and prevent or minimise adverse impacts on the health of project-affected communities. It establishes the requirement to develop protection, prevention and mitigation measures proportionate to the impacts and risks, and appropriate to the stage, size and nature of the project.

EBRD Performance Requirement 3 'Resource Efficiency and Pollution Prevention and Control requires that funded developments meet relevant EU substantive environmental standards. The EU has set ambient air quality limit values for the protection of human health for a number of pollutants and averaging periods based on the WHO guidelines as set out in Table 3.1 for those pollutants which are of relevance to the Project.

In addition Performance Requirement 3 requires the application of pollution prevention and control techniques consistent with the mitigation hierarchy approach to minimise potential adverse impacts on human health.

The IFC/World Bank EHS Guidelines

The International Finance Corporation/World Bank Group Environmental, Health, and Safety Guidelines (EHS Guidelines)[7] state:

'*Projects with significant sources of air emissions, and potential for significant impacts to ambient air quality, should prevent or minimize impacts by ensuring that:*

- *Emissions do not result in pollutant concentrations that reach or exceed relevant ambient quality guidelines and standards by applying national legislated standards, or in their absence, the current WHO Air Quality Guidelines or other internationally recognized sources;*
- *Emissions do not contribute a significant portion to the attainment of relevant ambient air quality guidelines or standards. As a general rule, this Guideline suggests 25 percent of the applicable air quality standards to allow additional, future sustainable development in the same airshed'.*

The guidelines go on to state the following with respect to particulate matter which is relevant to the Project during the construction phase:

"This is released during certain operations, such as transport and open storage of solid materials, and from exposed soil surfaces, including unpaved roads.

Recommended prevention and control of these emissions sources include:

- *Use of dust control methods, such as covers, water suppression, or increased moisture content for open materials storage piles, …;*
- *Use of water suppression for control of loose materials on paved or unpaved road surfaces. Oil and oil by-products is not a recommended method to control road dust. Examples of additional control options for unpaved roads include those summarized in Annex 1.1.5"*

An approach to the limitation of emissions from on-road and off-road vehicles is also provided. These aspects are considered in Section 5.3.8 of the **ESMP Document 8.1**.

The IFC/World Bank EHS Guidelines - Electric Power Transmission and Distribution

The IFC/World Bank guidelines that are specific to the transmission of electricity[8] note that ozone (a colourless gas with a pungent odour), may be produced by transmission lines. However, the guidelines go on to state that

[7] www.ifc.org/ehsguidelines

this is not associated with any known health risks. In addition studies[9,10] undertaken to measure ozone in the vicinity of high voltage transmission lines concluded that high voltage lines do not generate ozone measurable above the ambient at ground level under any weather conditions. Therefore, no mitigation for ozone is proposed for the Project.

3.2 Methodology

3.2.1 Introduction

This section provides an overview of the approach, the impacts of the Project on air quality and sets out why the assessment of these has been scoped out of this ESIA Report.

3.2.2 Construction

Project construction impacts on air quality will be managed by a number of mitigation measures as set out in the **ESMP** (**Volume 8**). These include GIP measures that are typically adopted on construction projects, which are designed to prevent the occurrence of significant impacts. Consequently, and as highlighted previously in this report, it is considered that the use of GIP, will ensure that no significant air quality impacts would occur due to the construction of the Project and the assessment of air quality is scoped out of this ESIA Report. This is justified further in this section.

The key pollutants of concern that may give rise to significant air quality effects during the construction phase are:

- Fugitive dust from construction related activities (effecting human and ecological receptors), including: earthwork activities such as soil stripping, ground levelling, and excavation; construction activities, which includes any activity involved in the provision of a new structure or modification to an existing structure; and construction traffic transporting dust and dirt from any Project compound or site access track onto the public road network, where it may be deposited and re-suspended by other vehicles using local roads;
- Vehicle exhaust emissions of oxides of nitrogen (NOx) (impacting human and ecological receptors) and fine particulate matter (PM) (impacting human receptors (impacts on lung functions)) from construction traffic, particularly heavy duty vehicles (HDV); and
- Vehicle exhaust emissions from non-road mobile machinery (impacting human and ecological receptors).

The risk of dust impacts associated with each construction activity will be considered by the Contractor to define the required dust control levels for each activity to ensure that no significant impact would occur as a result of construction activities which have the potential to generate dust. Mitigation, as set out in Section 5.3.8 of the **ESMP** (**Document 8.1**) would be employed to ensure no significant impacts occur.

While the anticipated traffic numbers associated with the construction of the Project are not as yet fully known, the majority of the construction works would be undertaken in remote areas where existing road traffic levels are low and air quality is generally currently good. In addition, the construction of the

[8] IFC, Environmental, Health and Safety Guidelines for Electric Power Transmission and Distribution, April 2007
[9] Field Investigation of Ozone Adjacent to High Voltage Transmission Lines, WJ Fern, RI Brabets http://www.arlis.org/docs/vol2/hydropower/APA_DOC_no._2004.pdf
[10] Examination of ozone emanating from EHV transmission line corona discharges, IEEE Transactions on Power Apparatus and Systems (Volume: 95 , Issue: 2 , Mar 1976) https://slrgroup.sharepoint.com/teams/acc/europe/accounts/SitePages/Accounting%20Timetable.aspx

transmission lines would be transitory with work in any one place being of short duration (10 towers in good weather and favourable topography would typically be constructed in one month, with work at each location being intermittent within this time period). In the absence of Georgian or Lenders' guidance, guidance is taken from Europe in the form of the UK guidance on the number of vehicles that trigger the need for an air quality assessment (UK Institute of Air Quality Management (IAQM) Guidance IAQM guidance document 'Land-Use Planning & Development Control: Planning for Air Quality') in a sensitive area, is greater than 100 annual average daily traffic movements. This threshold will not be exceeded. Peak traffic numbers will be associated with the construction of the substations where construction staff will be bused to site and at a maximum would be expected to be less than 20 vehicles per day (see Section 3.5.11 **Volume 2 Project Definition**). It is therefore considered that, with the use of mitigation, that impacts on both short and long term levels of fine particulate matter and oxides of nitrogen due to Project construction traffic are unlikely to result in exceedances of the air quality limits and guidelines set out in Section 3.1 above and the assessment of traffic emissions on local air quality are therefore scoped out of further assessment.

The construction activities required for the Project are not of a nature nor would they employ methods or processes that could give rise to odour (odour is caused by a mixture of chemicals that interact and cause an odour).

3.2.3 Operation

During the operation phase it is not anticipated that there would be any significant emissions to air from the operation of the Project and no significant air quality impacts would occur. The assessment of air quality impacts during the operational phase is, therefore, scoped out of this ESIA Report:

- Once constructed, operational traffic would consist of not more than monthly inspections in light vehicles and would not approach the trigger values presented in the previous section;
- The proposed substations may include Gas Insulated Switchgear (GIS), which use sulphur hexafluoride (SF_6) gas as an electrical insulator. This is a greenhouse gas rather than a local air quality pollutant. However, manufacturers now produce GIS switchgear that is guaranteed to have no or minimal leakage and there would be no resulting local air quality or greenhouse gas impacts;
- Substation auxiliary plant includes standby diesel generators. Standby generators are usually run for one hour per month during the operational phase to prove reliability, and four hours every six months for maintenance. Continuous operation would only be expected during an emergency scenario, when all external power supplies to the substation had been lost. Being new substations, built to modern international standards, this is anticipated to be a rare occurrence. For example the standby diesel generators at Akhaltsikhe Substation (constructed 2013) have not as yet needed to operate other than during testing. As such, standby generators are considered unlikely to have significant impacts on local air quality and are not considered further here; and
- Ozone, a colourless gas with a pungent odour, may also be produced by corona discharge in transmission lines, however the quantities produced are small, temporary, and localised and not at a level that could be harmful to human health being well below the WHO guideline level or result in odour nuisance. Therefore, no significant sources of odour are expected during the operational phase of the Project that could give rise to odour impacts.

4.0 Noise and vibration

4.1 Policy and Legislative Framework

As the components of the Project will operate continuously, the Project must comply with the most stringent limits i.e. those applicable at night-time. In addition, background noise levels will vary, and usually increase during day time and evening periods. As such, any assessment against daytime or evening background noise levels would lead to a lower magnitude of effect as any difference in noise levels would be lower, when compared to a night-time assessment. Therefore, only night-time noise limits are considered here.

4.1.1 Georgian Requirements

Georgian standards (Decree 398, 2017[11]) set the following night-time noise limits for Georgia:

- Residential receptor: Evening and Night-Time (19:00 – 08:00) an internal ambient limit of 30dB(A).

The Georgian permissible level relates to an internal limit and when the noise attenuation of an open window (i.e. a 15dB reduction[12]) is considered, this equates to an external night-time limit of 45dB(A), equivalent to that of the IFC/World Bank (see below in the next section).

4.1.2 International Requirements

There are no relevant international standards though there are international guidelines which are usually adopted for Projects of this type.

International Guidelines

WHO

The Guidelines for Community Noise[13] and Night Noise Guidelines for Europe[14] recommend guideline noise levels regardless of the current noise environment. The WHO suggests suitable noise levels for both indoor and outdoor living areas during daytime and night-time periods, and these levels are set regardless of the noise type or noise source. It advises on the minimum levels of noise before critical health effects, including annoyance, occur. In this regard, the WHO guidelines state:

> *"an $L_{night,\ outside}$ of 40 dB should be the target of the night noise guideline (NNG) to protect the public, including the most vulnerable groups such as children, the chronically ill and the elderly. $L_{night,\ outside}$ value of 55 dB is recommended as an interim target for the countries where the NNG cannot be achieved in the short term for various reasons, and where policy-makers choose to adopt a stepwise approach."*

The IFC/World Bank EHS Guidelines

The EHS Guidelines contain the performance levels and measures that are normally acceptable to IFC. The more stringent night-time limits that are of relevance as follows:

- Residential receptor: Night-Time (22:00 – 07:00) external ambient limit of 45dB(A); and

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[11] Ordinance of the Government of Georgia #398 ,15th August, 2017, Tbilisi
[12] World Health Organization (WHO), B Berglund, T Lindvall, D H Schwela, Guidelines for Community Noise, 1999 http://www.who.int/docstore/peh/noise/Comnoise-4.pdf
[13] Guidelines for Community Noise, edited by Birgitta Berglund , Thomas Lindvall, Dietrich H Schwela, World Health Organization 1999
[14] Night Noise Guidelines for Europe, World Health Organization 2009

- Industrial receptor: Night time and Day time external ambient limit of 70dB(A).

Alternatively, the IFC/World Bank EHS guidelines also refer to a maximum increase in background levels of 3dB at the nearest receptor location off-site. Both these guidelines are considered here for the sake of completeness, however precedence has been given to the absolute night –time limits as, as acknowledged by international guidance (e.g. BS4142:2014, in the absence of Georgian, EU or other directly relevant guidance)), where background sound levels are low "*absolute levels might be as, or more, relevant than the margin by which the [rating level] exceeds the background. This is especially true at night*"[15].

The IFC/World Bank EHS Guidelines - Electric Power Transmission and Distribution

The IFC/World Bank guidelines that are specific to the transmission of electricity note noise in the form of buzzing or humming can often be heard around transformers or high voltage power lines producing corona discharges (i.e. an electrical discharge brought on by the ionization of the air surrounding the conductor, most significantly during precipitation). However, this noise is not associated with any known health risks.

The guidelines go on to state that:

> "*The acoustic noise produced by transmission lines is greater with high voltage power lines (400-800 kilo volts [kV]) and even greater with ultra-high voltage lines (1000 kV and higher).*
>
> *Noise from transmission lines reaches its maximum during periods of precipitation, including rain, sleet, snow or hail, or as the result of fog. The sound of rain typically masks the increase in noise produced by the transmission lines, but during other forms of precipitation (e.g. snow and sleet) and fog, the noise from overhead power lines can be troubling to nearby residents.*
>
> *Measures to mitigate this impact may be addressed during project planning stages to locate rights-of-way away from human receptors, to the extent possible. Use of noise barriers or noise cancelling acoustic devices should be considered as necessary*."

The noise limits taken forward for consideration against Project impacts are set out in Section 4.2.2.

4.2 Methodology

4.2.1 Construction

The principal construction noise and vibration sources predicted as a result of the construction of the Project include the following:

- Deliveries of staff, materials, construction plant and machinery;
- Site preparation and construction of compounds and access tracks;
- Foundations for towers (either by excavation or piling);
- Preparing substation foundations;
- Removal of existing transmission lines;
- Installation of substation equipment and towers;
- Welding and grinding; and
- Restoration works.

[15] BRITISH STANDARDS INSTITUTE (2014) BS4142:2014, Methods for rating and assessing industrial and commercial sound, British Standards Institution

The majority of these activities would take place at locations remote from sensitive receptors; however, where properties are close to the construction works mitigation to meet the guidelines will be employed as outlined in the following paragraph. Night-time working is not generally proposed, except under special circumstances as described in Chapter 3, **Volume 2 Project Definition**. Traffic movements through built-up areas such as the villages and towns along the route of Component D will not be permitted during night-time hours: heavy vehicles would not use public roads at night between 22:00 and 06:00; and no Project vehicles will be allowed in villages between 20:00 and 08:00.

The impacts of construction noise from the Project would be controlled by the Contractor. The Contractor(s) would use GIP and mitigation measures and would prepare and implement a Noise and Vibration Management Plan. This would outline the measures needed to ensure that the equipment, and construction and transport methods used so do not generate noise levels at the nearest occupied off-site receptor in excess of threshold values recommended by guidelines for noise at construction sites. There are no Georgian standards for construction noise and the IFC EHS standards are also not designed for construction works, which are typically temporary and short term in nature. For this reason, noise limits taken from GIP would be appropriate and would be determined in consultation with GSE/Implementation Consultant. Appropriate GIP for construction noise limits would be the British Standard BS5228:2009+A1:2014 - Code of Practice for Noise and Vibration Control on Construction and Open Sites' Parts 1 – Noise. Measures included in the NVMP would include:

- High noise generating works (e.g. pile driving, blasting, rock clearing, drilling, percussion drilling) would be programmed in line with national regulations and will respect maximum ambient noise-levels and night time rest hours at the nearest receptors. A receptor is defined as an area used for nocturnal socio-economic activities (e.g. accommodation camps, residential areas, hotels, health centres).
- Where communities are located close to working areas, access roads, and public roads used by Project vehicles the Contractor shall propose, implement and monitor the efficiency of, all reasonable and practicable measures to minimise noise resulting from the activity and to minimise the acoustic nuisances to adjacent households during day and night. These measures may potentially include noise barriers or acoustic shields. Such locations include, in particular, the rehabilitation and extension of the existing substations (at Akhmeta, Telavi, Tsinandali, Mukuzani and Gurjaani) where works would be in close proximity to housing. However, works here would be of shorter duration than for the proposed new substations.
- The Contractor shall locate stationary equipment (such as power generators and compressors) as far as possible from nearby receptors (e.g. worker resting areas, populated areas and environmentally sensitive areas). Equipment known to emit noise strongly in one direction, whenever possible, would be orientated so that the noise is directed away from sensitive receptors.
- The Contractor shall monitor the vibration level at buildings nearest to the works during activities which could generate offsite vibration effects at these receptors.

The mitigation to be employed will ensure compliance with the relevant noise and vibration guidelines and thereby prevent the occurrence of significant impacts. Further assessment of construction noise is scoped out of the ESIA Report.

Mitigation requirement

- [NOI-1] The contractor would develop a Noise and Vibration Management Plan outlining the GIP measures to be adopted to control construction noise and vibration.
- [NOI-2] The Contractor would monitor vibration levels at buildings nearest to the works during project activities that could result in vibration impacts against appropriate standards such as BS5228:2009+A1:2014 - Code of Practice for Noise and Vibration Control on Construction and Open Sites' Parts 2 – Vibration or the German standard DIN-4150-3 Structural Vibration.

4.2.2 Operation

Introduction

There are two main sources of Operational Noise associated with the Project:

- High voltage transmission lines (i.e. 220kV and above), which can make noise during certain weather conditions (described as wet noise and dry noise which is described in the following paragraphs); and
- Substations, in particular transformers and reactive plant (which are in continuous or semi-continuous operation).

High voltage transmission lines can produce audible noise under certain conditions. The principal noise source would be corona discharge on the surface of the conductors. Conductor system noise occurs when the electric stress at the conductor surface exceeds the inception level for corona discharge activity, a level of around 17-20kV/cm. Most transmission line conductors are designed to operate below this threshold and usually operate quietly in dry weather conditions. However, small areas of surface contamination on conductors that spoil the otherwise smooth conductor surface would cause a local enhancement of electric stress which may be sufficiently high to initiate localised discharge activity. At each discharge location, a limited electrical breakdown of the air occurs. A portion of the energy associated with this breakdown is released as acoustic energy which radiates into the air as sound pressure waves.

The highest noise levels generated by a transmission line generally occur during and soon after periods of rainfall. Water droplets may accumulate on the surface of the conductor and initiate multiple corona discharges. The number of droplets, and hence the noise level, would depend primarily on the rate of rainfall. Fog may also give rise to increased noise levels, although these levels are less than those during rain. Noise generated under these circumstances is referred to as ‘wet noise’. However, in the case of wet noise due to rainfall, some of the effect of this increased noise is masked by increased ambient noise due to rainfall (either directly due to raindrops falling on hard surfaces or nearby foliage, or indirectly due to increased vehicle tyre/road interaction noise on local wet roads).

Similarly, after a prolonged spell of dry weather without heavy rain to wash the conductors, contamination may accumulate sufficiently to result in increased noise. Under these circumstances the noise is referred to as ‘dry noise’. During the next occurrence of heavy rain, these discharge sources are washed away and the line would resume its normal quieter operation. Consequently, dry noise is infrequent and generally quieter than wet noise such that it is rarely noticed and no significant impacts are predicted. Dry noise is, therefore, scoped out of this assessment.

The audible noise from a transmission line is generally categorised as a broadband ‘crackle’, or a tonal ’hum’, according to its tonal content. Crackle may occur alone, but hum will usually occur only in conjunction with crackle. Crackle is a sound containing a random mixture of frequencies over a wide range, typically 1kHz to 10kHz where individual tones are not audible. Crackle has a generally similar spectral content to the sound of rainfall. Hum is a sound containing a single pure tone or tones. For transmission lines in wet weather, generally the 100Hz frequency tone is the most significant, but other higher order harmonics i.e. 200Hz and 300Hz may also occur to a lesser extent. Hum typically occurs during rainfall in excess of about 1mm/hour. The proposed transmission lines will, therefore, produce noise during certain weather conditions, although these effects would only be noticeable close to the conductors, i.e. beneath or generally within approximately 5m.

Lower voltage transmission lines (i.e. the 110kV lines of the Project) are considered to be ‘practically quiet’ in operation due to the relatively low electrical stresses on these lines resulting in noise levels generally below the thresholds for audible noise perception. Under certain conditions, however, there may be some low level noise from an 110kV line which would be noticeable only when standing close to the line. The level, occurrence and duration of this noise are such that it is not considered to be significant. Therefore, the assessment of operational noise from the proposed 110kV transmission line is scoped out of the assessment (Guria line). While the proposed Akhmeta line and one of the two circuits of the Gurjaani line are proposed to operate at 110kV, these will be installed on 220kV towers and may, therefore, be operated at 220kV in the future. The operational noise from these lines operating at 220kV is considered in the assessment.

Underground cables and cable sealing end platform towers are quiet in operation. Therefore, operational noise from this equipment is scoped out and no further analysis has been undertaken.

Most maintenance activities for transmission lines, substations and underground cable are not significant sources of operational noise and would generally be undertaken during the normal working day. For instance, visual inspections are undertaken annually from the public highway, by foot or by all-terrain vehicle, or by helicopter as appropriate to the location and type of system asset and proximity of access required for the inspection.

Routine maintenance would include: the use of vehicles for the transport of staff and machinery to and from Project infrastructure sites; the use of machinery for vegetation clearance; the re-painting of infrastructure; and the testing and servicing of cables, and substation components. Maintenance activities in substations do not create additional noise which is discernible beyond the substation fence.

Due to the long operational life of the assets, midlife refurbishment such as replacement of transmission line fittings could take place, perhaps on a 20 year cycle. Any noise produced by these activities would be of a similar magnitude, but lesser duration to that discussed above with respect to construction noise and would be mitigated in a similar manner, such that no significant impacts are anticipated.

The noise levels resulting from the operation of Project are considered with reference to the following bullet points, as described in Section 4.1.

- Limit to be met externally to residential buildings - 45dB(A), in accordance with both Georgian and IFC/World Bank guidelines/limits.
- A maximum increase in background levels of 3dB at the nearest receptor location off-site, in accordance with the IFC/World Bank guideline, generally a more stringent requirement than that night-time noise limit in Georgia.

Consideration is also given to the WHO target of an L_{night}, outside of 40dB (again a more stringent level than that required in Georgia) and the guideline defined for noise at industrial locations by the IFC/World Bank of 70dB(A).

Study area

A Study Area has been selected for each of the high voltage transmission lines on the basis of the results of the noise modelling undertaken (see section 4.4.1). The Study Area encompasses a corridor around each high voltage transmission line that extends to the distance where the noise guidelines/limits are anticipated to no longer be exceeded by the peak wet noise generated by the Project. For example for the 500kV Sairme line, the most stringent limit (i.e. background plus 3dB) will be met at a distance of 140m from the centreline of the transmission line (see Table 4.2). The Study Area for this line has, therefore, been taken to be 140m either side of the transmission line centre line. Sensitive receptors within the Study Area have been identified using aerial photography available from Google Maps.

For those transmission lines which would achieve compliance at the edge of the Right of Way (e.g. Kheledula HPP line, see Table 4.2), no Study Area has been defined. A Right of Way has been determined for each transmission line in accordance with Decree 366 (Government of Georgia, 2014[16]). This decree requires that no buildings be located within a defined distance or protection zone from transmission lines (i.e. the Right of

[16] Government of Georgia (24 December 2014) Decree #366 On Regulation for Protection of Linear Structures of Power Networks and Determination of Zones of Protection

Way), depending on voltage. As there would be no houses in the Right of Way, there can be no exceedance of the limits/guidelines and no significant environmental impact.

Assessment Methodology

High voltage transmission line noise

A high level desk based appraisal of wet noise due to the operational phase has been undertaken for the high voltage transmission lines (220/400/500kV).

Calculations were made for peak wet noise levels (i.e. L5 conditions, - the noise level which is exceeded 5% of the time during rain) and for typical wet noise levels (i.e., L50 conditions - the noise level which is exceeded 50% of the time in one year during rain). The calculations to establish typical wet noise (i.e. L50 conditions) were based on the generally accepted method proposed by V. L. Chartier and R. D. Stearns[17].

For peak wet noise (i.e. L5 conditions), the audible noise caused by corona discharges assuming heavy rain conditions as described in Kwang H Yanh et al[18] was estimated through prediction formulas based on industry standard modelling.

Calculations were undertaken assuming the phase distances defined by the suspension tower and conductor types and the ground clearances of the lowest positioned conductors as per EN 50341-1:2012 (Section 5.9)[19] as set out in Table 4.1. Flat ground was considered and the noise level was calculated throughout a horizontal axis perpendicular to the transmission line with a vertical offset of the minimum ground clearance prescribed for populated areas from the lowest point of the lowest phase (i.e. ground level).

Table 4.1 Tower and Conductor Configurations Considered in Noise Modelling

Configuration	Components	Tower Type	Conductor Type	Lowest Ground Clearance of Conductors (m)
500kV – double circuit - Sairme line and Kavkasioni loop and single circuit – Lechkhumi line[20]	A and C1 C2	52NS	ACSR 400/51 (three conductors per phase)	12
400kV – single circuit - Tao line	A	41NS	ACSR Cardinal (three conductors per phase)	11
220kV – double circuit - New Derchi	C2	NST2	ACSR 400/51 (one conductor per	9

[17] V. L. Chartier, R. D. Stearns, "Formulas for predicting audible noise from overhead high voltage AC and DC lines", IEEE Transactions on PAS, Vol. PAS-100, No. 1, January 1981

[18] Kwang H. Yanh et al, "New Formulas for Predicting Audible Noise from Overhead HVAC lines using Evolutionary Computations". IEEE Transactions on Power Delivery (Volume: 15, Issue: 4, Oct 2000).

[19] BS EN 50341-1:2012 Overhead electrical lines exceeding AC 1 kV. General requirements. Common specifications

[20] In the absence of detailed design and noise modelling data for a single circuit 500kV line, the Lechkhumi line is considered with the double circuit 500kV lines as a worst case.

Configuration	Components	Tower Type	Conductor Type	Lowest Ground Clearance of Conductors (m)
			phase).	
220kV – double circuit - Kheledula HPP, Oni HPP Paliastomi loop, Gurjaani, Akhmeta, Tsinandali loop, Mukuzani loop	B, C2, D	NST2	ACSR 400/51 (two conductors per phase).	9
220kV – single circuit – Lajanuri HPP line	C2	NST2	ACSR 400/51 (one conductor per phase).	9

Substation noise

There are three basic sources of audible noise from substations: transformers and shunt reactors; switchgear; and auxiliary plant. Each of these has its own characteristic frequency spectrum and pattern of occurrence due to the nature of the noise-generating mechanisms involved:

- Transformer and shunt reactor noise is effectively constant, with a low frequency hum occurring at the exact harmonics of the electricity supply frequency; 100Hz and 200Hz components are usually dominant. Transformers generally run continuously except for occasional maintenance and fault outages. The shunt reactors proposed for the Project would also be in service for the majority of the time. Transformer and shunt reactor coolers generate broadband noise and their operation depends on temperature and loading.
- Switchgear noise is generated, in the main, by the operation of circuit breakers whose noise is 'impulsive' in character (i.e. of short duration). Switchgear operations would be very infrequent. Modern Sulphur Hexafluoride (SF_6) switchgear operates with a dull 'thud', similar to the slam of a car door.
- Substation auxiliary plant includes standby diesel generators. Standby generators are usually run for one hour per month during the operational phase to prove reliability, and four hours every six months for maintenance, usually during daytime periods. Continuous operation would only be expected during a rare emergency scenario, when all external power supplies to the substation had been lost. Generators are usually housed in a building or outdoor acoustic enclosure. Noise emissions would generally not be discernible beyond the substation perimeter fence and are not, therefore, considered further here.

Tsinandali and Mukuzani Substations will have no new noise sources. The detailed layouts of the proposed substations at Ozurgeti, Nenskra, Lajanuri and the extensions/upgrade of the substations at Akhaltsikhe, Gurjaani, Telavi, Akhmeta, would not be known until the detailed design stage. At this time the Contractor(s) would be required to design the substations/new equipment to meet the Georgian and IFC/World Bank limits/guidelines with respect to night-time noise levels. There are houses within close proximity (<100m) of Telavi and Akhmeta Substations that may be impacted without mitigation. Detailed noise modelling would be required and would need to include for a noise penalty to account for the tonal element of the proposed switchgear.

The sound power levels of the transformers and shunt reactors would be specified as part of the design to minimise the effect of operational noise on residential receptors. This would include the selection of low noise equipment, or alternatively may involve the use of standard equipment with appropriate levels of acoustic enclosures and screening. The Contractor(s) would also be able to consider the use of mitigation such as acoustic screening and also substation layout within the design of the new plant to ensure compliance with the limits and ensure no significant impacts on nearby residential receptors are likely. Substation noise is not, therefore, considered further here.

Mitigation requirement

- [NOI-3] The Substation Contractor will undertake noise modelling as required for substations, and in particular for Telavi and Akhmeta substations, to ensure that designs are able to meet the specified standards. Mitigation measures such as layout, acoustic screening and enclosures will be considered where necessary.

Assessment limitations

The modelling of peak wet noise (i.e. L5 conditions) has been based on that proposed by Kwang H Yanh et al[18] . These formulas were obtained on the basis of data from transmission lines throughout the world and may not correspond exactly to the conditions in Georgia.

The model has assumed flat ground, which may, therefore, result in an underestimation of noise levels at locations significantly higher than the transmission line. However, the assessment is based on those occurring during rainfall (i.e. wet noise levels) which are higher than those associated with the majority of weather conditions, including fog, snow, and dry weather. The occurrence of rainfall is also on an annual basis significantly less frequent than dry conditions. The results of the noise modelling are, therefore, considered to be worst case in this regard and are only applicable for a small percentage of the year (e.g. days with precipitation occur for less than 150 days per year in Kutaisi [21]).

In addition, as outlined in Section 4.3 with respect to baseline noise levels, in order to enable a comparison with the IFC guideline (a maximum increase in background levels of 3dB, see Section 4.12)) a background noise level of 30dB(A) has been assumed, rather than the use of extensive noise monitoring to establish more accurate baselines in the vicinity of the proposed transmission lines. The reasoning and limitations of this are explained in Section 4.3. A background of 30dB(A) is considered to be conservative, with levels in both rural and urban areas likely, in the main, to be higher.

The assessment is based on the distance between receptors and the centre line of the transmission lines. Some receptors may have an increased magnitude of effect if during the detailed design, the centre line moves closer towards them. Design changes will be managed in accordance with a Management Change Procedure as set out in Section 3.3 of the **ESMP** (**Document 8.2**). Design changes would, therefore, be undertaken in accordance with a mitigation hierarchy approach and would be required inter alia to minimise nuisances to community due to noise.

4.3 Project-wide Baseline Information

Taking account of the largely rural nature of the Project area, a uniform night-time noise background (L_{A90}) of 30dB has been assumed for all residential receptors for all components of the Project to enable comparison with the guideline and limit values (see Section 2.1.3). This is considered an appropriate level for a reasonable worst case assessment. This background level is considered representative of night time levels when people are likely to be sleeping. During the daytime period, background noise levels are likely to increase, and as such

[21] http://kutaisi.gov.ge/

the magnitude of effect due to the noise from the overhead line would be reduced. Baseline night-time noise levels in the area of the Project components are likely to remain broadly similar to this assumed level throughout the lifetime of the Project.

The adoption of a background noise "floor" of 30dB avoids an overestimation of the likely impact of noise where background noise levels are very low and takes account of European guidance in the form of British Standard method to assess the acceptability of the levels of noise from a proposed new noise source BS4142:2014[15] (in the absence of Georgian, EU or other directly relevant guidance), which states that "*where background sound levels and rating levels are low, absolute levels might be as, or more, relevant than the margin by which the rating level exceeds the background. This is especially true at night.*"

In certain rural locations, this assumed figure may be higher than the background noise levels experienced during quiet night-time periods. However, it must be remembered that the assessment considers wet noise only and during rainfall background noise levels would be higher than those during dry weather, depending on the intensity of the rainfall.

4.4 Project-wide Impact Assessment

4.4.1 Operational noise

The characteristics of high voltage transmission line noise are set out in Section 4.2.2. Wet noise levels due to the different proposed voltages and design of the transmission lines have been modelled and the results set out in Table 4.2. The final column of the table comprises the distance from the centre line of the transmission line to the L_5 peak noise level being 33dB(A), i.e. a background of 30dB(A)(see Section 4.3) plus 3dB(A) for consideration against the IFC guideline.

Table 4.2 Indicative Wet Noise Levels at the Edge of the Right of Way due to the High Voltage Transmission Lines

Configuration	Component	Distance to edge or right of way from centreline (m)	Total L5 ie peak noise level at edge of right of way, including background noise (dB(A))	Total L50 ie typical noise level at edge of right of way, including background noise (dB(A))	Distance to L5 (ie peak noise) plus background being 33dB(A) from centre line (m)
500kV double circuit, 3 conductors per phase – Sairme line and Kavkasioni loop and Lechkhumi line	A, C1 and C2	37.5	43.6	40.7	140
400kV – single circuit, 3 conductors per phase - Tao line	A	40	39.8	37.1	95
220kV – double circuit, one conductor per phase –New Derchi	C2	30	33.6	30.2	42

Configuration	Component	Distance to edge or right of way from centreline (m)	Total L5 ie peak noise level at edge of right of way, including background noise (dB(A))	Total L50 ie typical noise level at edge of right of way, including background noise (dB(A))	Distance to L5 (ie peak noise) plus background being 33dB(A) from centre line (m)
220kV – double circuit, two conductors per phase - Kheledula HPP, Oni HPP Paliastomi loop, Gurjaani, Akhmeta[22], Tsinandali, Mukuzani	B, C2, D	30	31.9	30.1	Not relevant
220kV – single circuit, one conductor per phase - Lajanuri HPP	C2	30	33.8	30.1	33

The transmission line wet noise levels, both typical and peak, at the edge of the Right of Way (and therefore at the shortest distance to where housing may be located) are all below the night-time noise limits to be met externally to residential buildings (45dB(A)), as required by both Georgian and IFC/World Bank guidelines/limits. In addition it is only the 500kV transmission lines (Sairme and Kavkasioni) that exceed the WHO target night noise guideline of 40 dB(A). Levels are all well within the WHO interim target of 55 dB(A).

The predicted peak and typical wet noise levels at the edge of the Right of Way for each transmission line are all well within the WHO guideline defined for noise of 70dB(A) at industrial locations such as on the edge of Kutaisi.

With regards to the more stringent IFC alternative relative guideline level (background noise level plus 3dB(A)) of 33dB(A), this level is exceeded at the edge of the Right of Way by the L5 peak levels by the Sairme, Kavkasioni, Lechkhumi, Tao, New Derchi and Lajanuri HPP lines. Table 4.2 indicates that this level is met at distances of just 140m, 95m, 42 and 33m from the centre-line of these transmission lines. Inspection of aerial imagery for these lines indicates that the following approximate number of residential receptors may, therefore, experience noise levels in excess of this alternative guideline due to peak levels during wet weather, on the basis of the current alignments:

- Sairme line – between 37.5m and 140m (i.e. from edge of Right of Way to point at which background plus 3dB criteria is met)- 58 residential buildings plus approximately 15 shepherds huts;
- Kavkasioni loop – between 37.5m and 140m – 1 residential building;
- Lechkhumi line - between 37.5m and 140m – 22 residential buildings;
- Tao line - between 40m and 95m – 5 residential buildings;
- New Derchi line – between 30m and 42m - 3 residential buildings; and
- Lajanuri HPP line – between 30m and 33m – no residential buildings.

[22] Included as may become double circuit in the future

It must be remembered that during periods of rain background noise levels would be higher. The background level of 30dB(A) that has been considered in the calculations and as a comparator for the background plus 3dB(A) guideline is, as noted in Section 4.3, a worst case level with levels in both rural and urban areas likely, in the main, to be higher. More typical background noise levels during light rain in rural areas fall in the range between 42dB(A)to 46dBL_{A90})[23]. When a level of 42dB(A) is assumed as the background level, the number of residential receptors where the background plus 3dB(A) guideline is exceeded falls to just two houses and two shepherd huts for the Project as a whole. It is, therefore, considered that the numbers of residential buildings identified above are considered to be overestimates and that at these locations the guideline level would only be exceeded for a small length of time in any year, e.g. at times of fog, mist or low cloud.

The assessment gives an indication of the significance of impacts of operational noise from the conductors during realistic worst case conditions, such as during wet weather or after prolonged dry spells, and against the quietest background levels. For much of the time the proposed transmission line would give rise to impacts of lower significance than those calculated. Significant impacts are not, therefore, anticipated.

4.5 Project-wide Mitigation

Mitigation measures in this section are relevant to the Project as a whole and discussed and then summarised under the heading 'mitigation requirement.' Each mitigation measure is given a reference code using the format [NOI-x]. These are used to summarise and tag measures in the **ESMP** (**Volume 8**) to ensure implementation of the measures set out.

Audible noise due to the operation of the transmission lines was considered with respect to alternatives selection and also routing by maximising distance from residential receptors, where practicable to do so in accordance with other environmental criteria and technological constraints (see Chapter 2 **Volume 2 Project Definition**). Should the alignment be refined prior to construction, then the routing must also consider distance to residential receptors. The design of the transmission lines by the contractors will be required to meet the Georgian and international standards. The Contractor will be contractually obliged to provide a completion certificate that the noise standards have been met.

Mitigation requirement

- [NOI-4] Maximisation of distance to housing during detailed design of the transmission line routes

Quality assurance during manufacturing and transportation would be undertaken to avoid damage to transmission line conductors which can increase potential noise effects.

Mitigation requirement

- [NOI-5] Quality assurance through manufacturing and transportation to avoid damage to transmission line conductors.

Care would be taken during installation to ensure that conductors are kept clean and free of surface contaminants during stringing. This would minimise the risk of excessive dry noise on energisation of the new transmission lines.

Mitigation requirement

- [NOI-6] Maintain conductors clean and free of surface contaminants during stringing.

[23] National Grid Technical Report TR(T)94 'A Method for Assessing Community Response to Overhead Line Noise', the increase in background noise levels due to rainfall can be assessed against the 'R-2 Miller Curve'.

Whilst the Contractor would be required, by a contractual obligation, to design the transmission lines and substations/new equipment to meet the Georgian and IFC/World Bank limits/guidelines with respect to night-time noise levels, it is proposed that in the event of a complaint, the complaint be investigated by GSE and, if appropriate, that noise monitoring be undertaken to establish compliance or not with the guidelines. The requirement for noise mitigation will then be investigated, which could include adjusting the design of the Project or providing noise screening. This mitigation is addressed in the **Social Project-wide Assessment**, **Document 4.1, Volume 4** and in the **Project-wide ESMP**, **Document 6.1**, **Volume 6**.

4.6 Project-wide Summary of Impacts and Mitigation Commitments

Impact Producing factor	Construction	Operation	Assessment of significance without mitigation or compensation High Hi Moderate M Low Lo [+] positive, [-] negative Likelihood, Magnitude, Extent, Duration		Commitments Key Mitigation, Compensation or Management measures	Predicted residual impacts	Management Action where the mitigation or compensation measure is addressed in the ESMP
Noise and Vibration							
High voltage transmission lines (i.e. 220kV and above), resulting in noise during wet weather conditions at residential properties in excess of guideline levels		✓	Lo	[-] possible exceedance of most stringent guideline (IFC background plus 3dB(A)) at a number of locations where housing close to the Sairme, Kavkasioni, Lechkhumi, Tao, New Derchi and Lajanuri HPP lines, magnitude of impact low as other guidelines met and background likely to be higher than that considered, moderate impacts may occur at times of fog, mist or low cloud for the lifetime of the project at a small number of receptors, however overall an impact of low significance is anticipated.	– [NOI-1] The contractor would develop a Noise and Vibration Management Plan outlining the GIP measures to be adopted to control construction noise and vibration. – [NOI-2] the Contractor would monitor vibration levels at buildings nearest to the works during project activities that could result in vibration impacts against appropriate standards such as BS5228:2009+A1:2014 - Code of Practice for Noise and Vibration Control on Construction and Open Sites' Parts 2 – Vibration. [NOI-3] The Substation Contractor will undertake noise modelling as required for substations, and in particular for Telavi and Akhmeta substations, to ensure that designs are able to meet the specified standards. Mitigation measures such as layout, acoustic screening and	Lo	ESMP Document 8.1, Section 5.3.9, Document 8.2, Sections 3.2.1 and 3.10.1 and Document 8.3, Section 3.2.1

Impact Producing factor	Construction	Operation	Assessment of significance without mitigation or compensation High Hi Moderate M Low Lo [+] positive, [-] negative Likelihood, Magnitude, Extent, Duration		Commitments Key Mitigation, Compensation or Management measures	Predicted residual impacts	Management Action where the mitigation or compensation measure is addressed in the ESMP
					enclosures will be considered where necessary. – [NOI-4] Maximisation of distance to housing during detailed design of the transmission line routes – [NOI-5] Quality assurance through manufacturing and transportation to avoid damage to transmission line conductors. – [NOI-6] Maintain conductors clean and free of surface contaminants during stringing		

5.0 Hydrology, Geology and Geohazards

5.1 Policy and Legislative Framework

5.1.1 Georgian Requirements

The Law of Georgia on Water (adopted in 1997) regulates and requires:

- between the state governmental bodies and physical/legal persons in the field of water protection, study and consumption;
- in the field of water protection, study and consumption on land, underground, continental shelf, territorial water and especially active economic zones;
- in the sphere of commercial water production and international trade in water;
- defines competences of autonomous republics, local government and self-government in water related relations;
- in the sphere of groundwater protection, study and consumption consistent with requirements of the law of Georgia on "Natural Resources";
- in the field of aquatic life protection, study, reproduction and consumption, in compliance with the law of Georgia on Fauna;
- regarding consumption of fauna, flora, forest, land and other natural resources whilst water utilization.

Consistent with the legislation, water within the territory of Georgia is in state ownership and can be provided only for consumption. Any actions directly or indirectly violating the state ownership rights for water are prohibited.

The law of Georgia on Soil Protection (1994) aims to ensure preservation of integrity and improves fertility of soil. It defines obligation and responsibility of land users and the state regarding provision of soil protection conditions and ecologically safe production. The law sets the maximum permissible concentrations of hazardous matter in soil.

The law restricts: the use of fertile soil for non-agricultural purposes; execution of any activity without stripping and preservation of top soil; open quarry processing without subsequent re-cultivation of the site; terracing without preliminary survey of the area and approved design; overgrazing; wood cutting; damage of soil protection facilities; any activity deteriorating soil quality (e.g. unauthorised chemicals/fertilisers).

In Georgia soil quality is assessed by Methodological Guides on Assessment of Level of Chemical Pollution of Soil (MG 2.1.7.004-02). Standards for groundwater quality are not set under Georgian law. Drinking water quality standards are commonly used instead as assessment criteria for groundwater.

Quality of surface water is defined by order #130 on Protection of Georgian Surface Water by the Minister of Environmental Protection and Natural Resources of Georgia, 17 September 1996 and Sanitary Rules and Standards on Prevention of Surface Water Pollution approved by order #297/n on Approval of Environmental Qualitative Norms by Minister of Labour, health and Social Affairs, 16 August 2001.

5.1.2 International Requirements

International guidelines

Georgia is currently working towards compliance with the European Union Water Framework Directive which aims for 'good status' for all groundwater and surface water. Surface waters are assessed according to criteria relating to: biological quality (fish, benthic invertebrates, aquatic flora); hydromorphological quality such as river bank structure; physical-chemical quality (e.g. temperature, oxygenation and nutrient conditions) and chemical quality. Maximum concentrations for specific water pollutants are stipulated.

Relevant international conventions would be the:

- Basel Convention on the Control of Transboundary Movements of Hazardous Waste and their Disposal; and
- Stockholm Convention on Persistent Organic Pollutants.

The following guidelines also apply to the Project:

The IFC/World Bank EHS Guidelines Discharges of stormwater to surface water

Discharges of storm water should not result in contaminant concentrations in excess of local ambient water quality criteria or, in the absence of local criteria, other sources of ambient water quality criteria. Guidance is provided on surface water management, including:

- Surface runoff from process areas or potential sources of contamination should be prevented or where this is not practical, drainage should be segregated from potentially less contaminated runoff;
- Runoff from areas without potential sources of contamination should be minimised (e.g. by minimising the area of impermeable surfaces) and the peak discharge rate should be reduced (e.g. by using vegetated swales and retention ponds); and
- Oil water separators and grease traps should be installed and maintained as appropriate at refuelling facilities, workshops, parking areas, fuel storage and containment areas.

In addition, the guidelines require that contaminated land should be managed to avoid risk to human health and ecological receptors.

The IFC/World Bank EHS Guidelines - Electric Power Transmission and Distribution

Specific IFC/World Bank guidelines for transmission lines and substations require that:

- Any soil exposed to PCB leakage from substation equipment should be assessed, and appropriate removal and / or remediation measures should be implemented;
- The guidelines note that the use of herbicides may be justified where an integrated approach to vegetation management indicates that this is the preferred approach to control fast-growing vegetation. If application is warranted, they should be applied, stored, and handled to avoid their migration into off-site land or water environment; and
- Where machinery or equipment is used to control vegetation then Manufacturers' guidelines, procedures with regard to oil spill prevention and emergency response should be observed.

5.2 Methodology

5.2.1 Introduction

The overall aim of this study is to assess potential Project impacts, risks and their mitigation related to hydrology and geology and also geomorphology. The assessment also makes a preliminary identification of geohazards that could affect the project facilities, and which need to be considered in the Project design. The study has been undertaken to evaluate the Project in accordance with PR3.

The study presented in this document is a high-level assessment and the level of detail has been defined so that the potential impacts, risks and mitigation measures can be presented in a concise manner and avoiding repetition. The reasons for adopting this approach are as follows:

- The Project has a total length of transmission line of over 560km and comprises 5 components across 6 regions of Georgia; the study consequently covers a significant area;
- The Project design is currently at the feasibility stage, only preliminary geotechnical studies are available, and no field work has been undertaken to characterise the physical environment or identify the location of geohazards, and
- The types of potential impacts for each component and section of the transmission line within each component are expected to be similar and will be managed in similar ways.

5.2.2 Study Area

The study area comprises the footprint occupied by the Project's permanent facilities plus the 500m corridor for transmission lines and 50m buffer for substations as defined in Section 3.2 in **Volume 2 Project Definition**. The routes taken by the five Project components are illustrated on the map provided as Figure 1, **Volume 2 Project Definition**.

5.2.3 Assessment Methodology

The method used in the assessment is the overlay method, supplemented by a number of general site visits to Georgia during the examination and selection of transmission line routes and is described as follows:

- A number of site visits to the feasibility study routes and also other alternatives have been undertaken by the ESIA team and also the engineering team responsible for the feasibility designs. Where possible the results of these site visits have enabled the routes to avoid the most significant areas such as minimising watercourse crossings, avoiding the steepest slopes or areas of unstable ground where an alternative route is available;
- Electronic files of the transmission line routes viewed in Google Earth Pro;
- For each component, the satellite imagery - with the transmission line route clearly visible - was re-orientated in horizontal and vertical planes in order that topography, land cover, land use, and location of rivers were clearly visible;
- Screen captures of the re-orientated satellite imagery were made, i.e. several views from different orientations of each route; and
- The screen captures were reviewed to identify the following:
    - Type of land cover and terrain crossed by the transmission lines;
    - Location of moderate or steep slopes crossed by the transmission lines;
    - River crossings, and
    - Zones potentially subject to soil erosion or slope instability.

The types of geological strata underlying the transmission line routes have also been identified using the overlay method. The transmission line routes have been overlaid on the geological map of Georgia, and the geology of the strata crossed by the transmission lines, and proximity of tectonic fault lines identified.

In accordance with PR3, the assessment has considered the requirement for mitigation based on the principles of the mitigation hierarchy whereby measures are first proposed to avoid and minimise potential impacts. Most of the measures proposed are designed to avoid impacts and they are based on GIP and would be implemented through the ESMP.

5.2.4 Assessment Limitations

The following limitations should be noted:

- The assessment has considered permanent facilities only, as the location of temporary construction facilities will be defined by the Project at a later stage;
- New access tracks are not assessed as the Project will define their routing at a later stage. However, the assessment considers that new access tracks will be required and that they may generate impacts for which mitigation will be required.
- The baseline description provides information on the geomorphology, hydrology and geology of the routes taken by the main transmission lines and for the new substations at Lajanuri and Nenskra (including the Nenskra HPP cable line). However, the assessment does not go into the detail of describing these aspects for other substations or for short sections of transmission line that tie-in or branch off the main transmission lines. However, the type of impacts and mitigation measures described in the assessment would also apply to these substations and short section of lines that tie-in or branch off.

5.3 Project-wide Baseline Information

5.3.1 Geology

A summary of the types of geology of the routes taken by the Project is provided in Table 5.1. In general, the areas crossed comprise different types of limestone.

5.3.2 Hydrology

The routes of all the components include crossings of watercourses and several of the components are in river valleys and follow the river. The principal crossing are as summarised below:

- Sairme line – will cross the Rioni River (1km wide) and several – at least six - mountain torrents, some of which may be seasonal.
- Tao line – will cross approximately 14 watercourses, including the wide Bolianis Chai River.
- Guria line – will cross 10 mountain streams, some of which may be seasonal, and connects to the Zoti HPP situated in the Gubazeuli River situated a deep and steep sided river gorge. The transmission line will cross this river also.
- Paliastomi line – will cross three small watercourses.
- Mestia line – will cross at least 12 mountain torrents some of which may be seasonal. Some of the torrents are in steep sided gullies;
- Oni HPP line – will cross the Lajanuri gorge/reservoir, two large torrents and two smaller streams and follows the Rioni River in a large gorge for 2km;
- Kheledula HPP line – The route is close to and follows the Tskhenistskali River for 6km in a steep sided valley; the transmission line will cross several mountain torrents in steep sided gullies and also the Lajanuri HPP reservoir.
- Lechkhumi line – will cross the Rioni River in a large gorge at two locations.
- New Derchi line - will cross the Rioni River in a large gorge at two locations
- Lajanuri HPP line – will cross the Rioni River in a large gorge at two locations.
- Gurjaani– line will cross 18 watercourses, some small and others quite large. The streams descend from the hills located to the southwest of the route, cross the route in a perpendicular direction and flow into the Alazani River. The watercourses in this region are typically dry ephemeral rivers but their

presence is indicative of high flow events most probably after heavy rainfall. The line is orientated parallel to the Alazani River but generally at a distance of approximately 10km from the Alazani River.

- Akhmeta line - will cross a number of large and small watercourses which descend from the hills located to the southwest, which are mostly dry river beds. The line is also orientated parallel to the Alazani River again at a distance of approximately 10km from the river until the last 10km which runs within 200m to 1km of the Alazani River.-

5.3.3 Geomorphology

The Project Components are situated in six regions of Georgia, and the geomorphology of the routes have both similarities and differences. A summary of key baseline geomorphological features for the components is provided in Table 5.2.

The Project Components A to C are situated in the Lesser Caucasus Mountains, the Greater Caucasus Mountains, and the plain situated between the Lesser and Greater Caucasus Mountains. The routes taken by these Project Components cross similar terrain comprising some mountainous areas and crossing areas characterised by steep and moderate slopes with some localised zones that could potentially be subject to erosion and instability.

The geomorphology of the Gurjaani and Akhmeta lines in Component D is markedly different to that of Components A to C. They are located in Kakheti and are situated on the edge of a plain, at the foot of the Tsiv-Gombori mountain range. These transmission lines have a rectilinear alignment crossing terrain characterised by steeply incised river valley slopes (from Gurjaani to Arashenda (km18 of the Akhmeta line)) and then gentle slopes with a lack of topographical features for the remainder of this line. These lines do not pass through high mountain terrain and the slopes throughout are at a much more gentle angle than transmission lines in Component A to C.

Table 5.1 Baseline Geology

Name	Component	Description	Length (km)	Underlying geological strata
Sairme line Tao line	A	Tskaltubo to Akhaltsikhe Akhaltsikhe to the Turkish border	135	Undifferentiated Pleistocene / Middle Eocene marine volcanic rock /Upper Eocene-Oligocene
Guria line	B	Ozurgeti to Zoti HPP	33	Undifferentiated Pleistocene / Middle Eocene marine volcanic rock
Paliastomi loop	B	Ozurgeti to Paliastomi line	3	Undifferentiated Pleistocene
Mestia line	C1	Nenskra to Mestia	90	Lower Middle Jurassic
Kavkasioni line	C1	Kavkasioni line to Nenskra Substation	0.5	Lower Middle Jurassic
Oni HPP line	C2	Lajanuri to Oni HPP	60	Upper Cretaceous Eocene / Upper Eocene-Oligocene Undifferentiated Miocene / Lower Cretaceous/Lower-Middle Jurassic
Kheledula HPP line	C2	Lajanuri to Kheledula HPP	60	Lower-Middle Jurassic / Middle-Upper Jurassic /Lower Cretaceous / Undifferentiated Miocene
Lechkhumi line	C2	Lajanuri to Tskaltubo	70	Upper Cretaceous Eocene and Upper Eocene-Oligocene /Middle-Upper Jurassic / Lower-Middle Jurassic
New Derchi line	C2	Lajanuri to Tskaltubo	54	Upper Cretaceous Eocene and Upper Eocene-Oligocene /Middle-Upper Jurassic / Lower-Middle Jurassic
Lajanuri HPP line	C2	Lajanuri to Lajanuri HPP	4	Undifferentiated Miocene
Gurjaani line Akhmeta line	D	Gurjaani to Telavi Telavi to Akhmeta	68	Undifferentiated Pleistocene / Upper Pliocene – Quaternary

Table 5.2 Baseline Geomorphology

Name	Description	Length (km)	Type(s) of terrain	Key geomorphological features
Sairme line Tao line	Tskaltubo to Akhaltsikhe Akhaltsikhe to the Turkish border	135	Flood plain/ farmland Pre-Alpine mountains Farmland	Steep sided ridges Moderate slopes - some wooded Gullies – some steep sided Undulating farmland Gentle sloped and moderate sloped alpine and subalpine pastures
Guria line	Ozurgeti to Zoti HPP	33	Pre-Alpine mountains	Moderate slopes - some wooded Gullies – some steep sided Undulating farmland Gentle sloped and moderate sloped subalpine pastures
Paliastomi loop	Ozurgeti to Paliastomi line	3	Flood plain/ farmland	Undulating farmland
Mestia line	Nenskra to Mestia	90	Alpine mountains	Steep and moderate slopes - some wooded Gullies – some steep sided Gentle sloped and moderate sloped alpine and subalpine pastures
Kavkasioni line	Kavkasioni line to Nenskra Substation	0.5	Alpine mountains	Steep and moderate slopes - some wooded
Oni HPP line	Lajanuri to Oni HPP	60	Pre-Alpine mountains Pre-Alpine river valley	Steep and moderate slopes - some wooded Gullies – some steep sided Gentle sloped and moderate sloped alpine and subalpine pastures

Name	Description	Length (km)	Type(s) of terrain	Key geomorphological features
Kheledula HPP line	Lajanuri to Kheledula HPP	60	Pre-Alpine mountains Pre-Alpine river valley	
Lechkhumi line	Lajanuri to Tskaltubo	70	Pre-Alpine mountains	
New Derchi line	Lajanuri to Tskaltubo	54	Pre-Alpine mountains	
Lajanuri HPP line	Lajanuri to Lajanuri HPP	4	Pre-Alpine mountains	Steep and moderate slopes - some wooded Gullies – some steep sided
Gurjaani line Akhmeta line	Gurjaani to Telavi Telavi to Akhmeta	68	Plain	Gentle sloped farmland, but with some deeply incised river valley slopes which have formed steep and potential unstable slopes in some very localised areas.

5.3.4 Geohazards

The geohazards present along the routes include slope instability, tectonic fault lines, avalanche, flood/debris flow, mudflow (at river crossings), as follows.

- Sairme line – slope instability, river crossings (floods, debris flow, mudflow);
- Tao line - slope instability, river crossings (floods, debris flow, mudflow);
- Guria line – slope instability, river crossings (floods, debris flow, mudflow);
- Paliastomi loop – Non-identified;
- Mestia line – slope instability, river crossings (floods, debris flow, mudflow), avalanche;
- Kavkasioni line – slope instability, avalanche;
- Oni HPP line – slope instability, river crossings (floods, debris flow, mudflow);
- Kheledula HPP line – slope instability, river crossings (floods, debris flow, mudflow);
- Lechkhumi line – slope instability, river crossings (floods, debris flow, mudflow);
- New Derchi line - slope instability, river crossings (floods, debris flow, mudflow);
- Lajanuri HPP line - slope instability, river crossings (floods, debris flow, mudflow);
- Gurjaani line – slope instability, river crossings (floods, debris flow, mudflow);
- Akhmeta line - slope instability, river crossings (floods, debris flow, mudflow);
- Nenskra substation and Nenskra HPP Cable line – slope stability, flood risk and erosion, avalanche; and
- Lajanuri substation – slope instability.

5.4 Project-wide Impact Assessment

5.4.1 Introduction

The assessment is structured around the project activities that can be considered as Impact Producing Factors.

5.4.2 Construction

Land Degradation and Slope Instability

The construction of the permanent and temporary facilities such as access tracks, construction compounds, substations, tower foundations and tree and vegetation clearance for the transmission line rights of way can potentially cause land degradation impacts if adequate control and mitigation measures are not implemented. The activities and potential impacts expected are as follows:

- Clearing tree and vegetation from sections of line Rights of Way or access tracks which are located on moderate or steep slopes may create areas with increased soil erosion and result in localised slope instability;
- Cutting and filling activities needed for the access tracks, construction compounds, tower and substation foundations on sloping terrain may trigger localised slope failure;
- Tower foundations and access tracks that are constructed on steep-sided ridges which are subject to soil erosion and instability may increase the risk of slope failure or landslide. Any such event, if it were to occur, would also probably damage the transmission line;

- Construction of access tracks can change the runoff patterns causing localised soil erosion and slope instability, and
- Side casting used in the construction of access tracks, tower foundations or other facilities on sloped terrain can cause land degradation. The side cast material can be unstable, it will release mud and sediment during rain which is carried down the slope covering vegetation and possibly increasing sediment loads in surface water. The side casting has an aesthetic impact as it is visible from a distance and increases the visual impact of the transmission line and the roads.

The individual impacts at the sites of towers and substations are expected to be localised. However, tower foundations would be constructed at regular intervals along the transmission line routes and significant parts of the routes cross sloped terrain, including areas that are potentially subject to erosion and slope instability. Consequently, the impacts may occur at regular intervals along significant sections of the Project.

The duration of potential impacts is expected to be long-term. The consequences of the construction of the facilities without adequate control and mitigation measures are expected to potentially continue into the operation phase.

Sedimentation

If not adequately controlled, runoff from worksites may cause increased sediment loading in nearby watercourses or cause the deposition of sediment on the land around the worksite. There would be worksites for the construction of the access track, substations, and towers.

Each of the transmission lines would cross several watercourses, including major rivers, mountain torrents and small streams. However, it should be considered that mountain torrents are generally naturally characterised by high sediment loading, and that the effect of the runoff with additional sediment may be negligible or minor, i.e. the increase in sediment loading would be within the natural seasonal variations, and during the period of high seasonal flow any accumulated sediment would be carried downstream and the watercourse returned to its natural situation.

Pollution from Accidental Spills and Leaks of Hazardous Substances

Small inventories of various hazardous substances such as fuel, oil, paint or hazardous waste such as used oils will probably be present on worksites. If ineffective control and mitigation measures are implemented, the accidental spill or leaks of these substances may potentially pollute underlying soils and groundwater, and runoff may entrain the pollution into nearby surface water.

Pollution from contaminated materials on previously developed land

Sections of the proposed transmission lines pass through previously developed areas and in such cases contaminated soils may be present. During the excavation of tower foundations, these contaminated substances could be mobilised either into groundwater or as stored or disposed soil material which could erode and enter nearby watercourses.

Although GSE has indicated that existing substation transformers do not contain PCBs, there is the potential that PCBs could be present where old transformers exist and where evidence of leaks and spills are present, particularly in the Kakheti substations. Excavations in such locations could mobilise this oil contamination into the environment or present a risk to human health. Removal of any oil from old transformers also needs to be handled with care.

Risk of damage to Project infrastructure from Geohazard Events

Sections of the transmission lines and at some substation locations there could potentially be some of the following geohazards:

- Sections of access track and transmission line constructed on slopes subject to erosion and instability would be exposed to risk of landslip, landslide and rockfall. Substations located next to steep slopes could also be at risk. The construction works, and physical presence of new structures, may increase the likelihood of these events, and, if they were to occur, the transmission line or access track may be damaged.

- River crossings would be exposed to risk of floods, debris flow, and mud flow. The likelihood of these events would not be increased by the Project. However, if they were to occur and towers or section of access tracks are in the affected area, these assets may be damaged.

5.4.3 Operation

Continuation of Impacts Incurred during Construction

During the operation phase; in the absence of control, mitigation and corrective measures, the land degradation and slope instability impacts incurred during construction will continue during the operating life of the transmission line. The risk of damage to the line from geohazards will also continue.

Pollution from Accidental Spills and Leaks of Hazardous Substances

The principal hazardous substances required for the operation of the Project is transformer oil that may be present in the transformers located at the substations. In the past, some types of transformer oil contained Polychlorinated Biphenyls (PCBs), though this is now prohibited in the European Union and most other countries. PCBs will not be permitted in the Project's transformer oil. Accidental leaks of transformer oil may still potentially pollute soils, groundwater and if carried offsite by runoff may also pollute surface waters.

5.3.3 Use of Herbicides

The transmission line Right of Way will need to maintain the necessary clearances of trees and vegetation and will therefore require periodic clearing of vegetation. Herbicides can be used to prevent or control the development of vegetation. The adoption of inappropriate herbicides and/or use of inappropriate methods of spraying may cause chemical pollution of soils, groundwater and surface water.

Risk of damage to the Project from Geohazard Events

The risk of damage to the Project infrastructure from geohazards described for the construction also applies to the operational phase.

5.5 Project-wide Mitigation

5.5.1 Introduction

Mitigation measures in this section are relevant to the Project as a whole and discussed and then summarised under the heading 'mitigation requirement.' Each mitigation measure is given a reference code using the format [HYD -x]. These are used to summarise and tag measures in the **ESMP** (**Volume 8**) to ensure implementation of the measures set out.

Recommended general mitigation measures for control of runoff and sedimentation, and alteration of hydrological patterns during construction of tower pads, access roads and maintenance roads are set out in the following sections.

5.5.2 Mitigation of Land Degradation, Slope Instability and Sedimentation

Transmission line routes have been designed, as far as practicable, to avoid impacts on water bodies, floodplains and wetlands. Any future refinement of the route must also consider this requirement, in accordance with the 'Management of Change Procedure' which is set out in the **ESMP** (Section 3.3, **Document 8.2**).

Mitigation requirement

- [HYD-1] Adherence to design principles for refinement of the transmission line routes to avoid high risk hydrology and geohazard areas.
- [HYD-2] Implementation of a management of change process for the environmental assessment of new transmission line routing or substation locations proposed to be located outside the assessment corridor of this study.

Where watercourses must be crossed, special precautions would be adopted to minimise the impact on the watercourse geomorphology and to minimise watercourse bank erosion and sedimentation of flows. Where possible, single-span bridges would be used to minimise the impact on the bed of the watercourse. For smaller watercourses it may be appropriate to use small pre-cast culvert bridges. If crossings can be avoided by routing access tracks around them without increasing impacts on other environmental or social issues crossings would be avoided. Prior to any works as part of the detailed design, the contractor would plan the construction works to include access track and watercourse crossing locations. Sediment and erosion control measures would be integrated into this detailed design.

Mitigation requirement

- [HYD-3] The Contractor shall prepare and implement sediment and erosion control measures with respect to access track construction and use; and
- [HYD-4] Watercourse crossings to be designed in accordance with GIP to protect the water environment and watercourse geomorphology.

Measures to prevent, avoid or minimise impacts during construction will include the preparation and implementation of a Soil Management Plan which sets out how excavated soils and spoil are to be handled. Where not to be re-used on site for restoration, excavated top soil from the construction works should be used immediately for plantation/agriculture/ landscaping (as appropriate). Where topsoil is to be used for restoration, this should be stored in accordance with GIP in accordance with the **ESMP** (**Volume 8**).

Mitigation requirement

- [HYD-5] Prepare and implement a Soil Management Plan.

Erosion control measures will also be implemented in accordance with the following GIP measures:

- Worksite areas are to be equipped with sediment traps or screens to control runoff and sedimentation;
- Any filling and cutting required should be balanced to avoid the need to manage excess waste material;
- Creation of cut slopes and embankments which are of an angle greater than the natural angle of repose for the local soil type should be avoided;
- Cleared areas and slopes modified by during construction should be replanted with suitable local species to reduce erosion and reduce stability problems; it should be undertaken as early as possible in the construction process, before erosion becomes too advanced;
- Roads are to be equipped will ample culverts where there are small stream crossings or areas where runoff would collect;
- Design drainage ditches to avoid affecting nearby lands; and
- Side casting is to be avoided.

Mitigation requirement

- [HYD-6] Implement erosion control measures in accordance with GIP measures outlined in this ESIA.

5.5.3 Control of Risk of Accidental Spills and Leaks of Hazardous Substances

Hazardous substance handling and storage management measures would be prepared and implemented as part of a Site Waste Management Plan. This would incorporate *inter alia* the following measures:

- Facilities and equipment for the storage and handling of hazardous substances is adopt GIP design standards;
- Hazardous substance storage areas are to be protected from rain and equipped with bunding;
- Hazardous substances handling areas are to be impervious;
- Rainwater drains are to be equipped with sumps containing oil/water separator to trap oil and hydrocarbons;
- Spill clean-up equipment is to be available on site;
- Spill response and clean-up plans are to be prepared;
- Contaminated soils are to be managed as hazardous waste in an authorised waste management facility;
- Transformers are to be in alignment with GIP design standards; and
- PCB containing transformer oils are to be prohibited.

Mitigation requirement

- [HYD-7] Implement hazardous substance handling and storage measures as part of a Site Waste Management Plan implementing the measures described in this ESIA.

5.5.4 Mitigation of Impacts from Herbicides

The preferred method of clearing vegetation from the Rights of Way is to be by mechanical clearing techniques. In order to protect the water environment the use of herbicides is to be avoided.

Mitigation requirement

- [HYD-8] Use of mechanical clearing techniques only for the removal of tree and vegetation. Herbicides are not to be used for the removal of trees and vegetation.

5.5.5 Prevention of Pollution from Disturbed Contaminated Materials

The Contractor would be required to undertake a land contamination desk study in areas suspected to be contaminated (e.g. former industrial areas and existing substations) to establish the presence of any contaminated areas that may be disturbed by the Project. This would be to ensure that any potential impacts associated with contamination are adequately characterised and assessed and appropriate mitigation is implemented.

Mitigation requirement

- [HYD-9] A desk study to identify, characterise, and assess the potential for disturbance of contaminated land in former industrial areas and existing substations. Also the subsequent identification and implementation of appropriate mitigation measures if contamination is suspected and confirmed by site investigation.

GIP mitigation measures would be adopted to prevent the pollution of land by construction activities. A protocol for dealing with any unexpected contamination identified during construction, would be developed and implemented to ensure that its immediate effect is minimised and that appropriate mitigation is undertaken;

GIP would also be undertaken during the construction phase to protect construction workers from the effects of land contamination.

Mitigation requirement

- [HYD-10] Development and implementation of a protocol for dealing with any unexpected contamination identified during construction to ensure that its immediate effect is minimised and that appropriate mitigation is undertaken.

5.5.6 Management of Geohazards

Project feasibility design criteria have included high level geohazard constraints. Detailed design of the transmission line routes must be based on the findings further geohazard studies. The measures to manage geohazards for each of the Project Components are as follows:

- Geohazards studies are to be carried out covering the length of each route during the detailed design phase. The study is to identify and characterise geohazards and define mitigation measures to protect the project structures and personnel from geohazard events. Geohazards which are to be considered will include, but not limited to: seismicity; avalanche; landslide; rockfall; floods; debris flow/mud flow and erosion. The design will also account for any man-made features which could pose a risk to stability such as mining or quarrying areas, including those that might be planned in the future. The studies are to consider both permanent structures and temporary facilities such as construction compounds, worker camps and access tracks. Preliminary geohazard risk maps are included in the Project Component Assessment which has informed the impact assessment and the need for the contractor to focus their geotechnical investigations. Further details of specific geohazard risk areas for the Project Components is given in the **Physical Environment Project Component Assessment**, Document 5.2.
- Specific slope erosion and slope stability studies are to be carried out for sections of the transmission lines on or close to areas potentially subject to erosion from runoff, slope instability or which are close to rivers and may be exposed to floods or areas of soft ground. The studies should evaluate the risk and define what slope stability measures and rainwater drainage control measures are needed to ensure the structural integrity of the tower foundations over the design life of the transmission line.
- Transmission line routing is to be modified if geohazard risks cannot be mitigated through design.

Mitigation requirement

- [HYD-11] Use of geohazard studies and specific slope-erosion and slope-stability studies to inform detailed design.

5.6 Project-wide Summary of Impacts and Mitigation Commitments

Impact Producing factor	Construction	Operation	Assessment of significance without mitigation or compensation High Hi Moderate M Low Lo [+] positive, [-] negative Likelihood, Magnitude, Extent, Duration		Commitments Key Mitigation, Compensation or Management measures	Predicted residual impacts	Management Action where the mitigation or compensation measure is addressed in the ESMP
Hydrology, Geology and Geohazards							
Changes to the design leading to additional impacts on hydrology and geology	✓	✓	Hi	[-] possible, undefined number of severity of impacts but if left unassessed and uncontrolled could result in significant impact	– [HYD-1] Adherence to design principles for refinement of the transmission line routes to avoid high risk hydrology and geohazard areas – [HYD-2] Implementation of a management of change process for the environmental assessment of new transmission line routing or substation locations proposed to be located outside the assessment corridor of this study. – [HYD-4] Watercourse crossings to be designed in accordance with GIP to protect the water environment and watercourse geomorphology	Lo [-]	ESMP, Document 8.1 Section 5.3.6 and Document 8.2, Section 3.2.1 and 3.3.1
Facilities construction (vegetation clearing, grading, cutting and filling), side casting	✓	✓	Hi	[-] Likely, numerous small localised areas of land degradation in rivers at regular intervals along the transmission lines, long-term duration	– [HYD-3] The Contractor shall prepare and implement sediment and erosion control measures with respect to access track construction and use – [HYD -5] Prepare and implement	M [-]	ESMP Document 8.1 Section 5.3.6

Impact Producing factor	Construction	Operation	Assessment of significance without mitigation or compensation High Hi Moderate M Low Lo [+] positive, [-] negative Likelihood, Magnitude, Extent, Duration		Commitments Key Mitigation, Compensation or Management measures	Predicted residual impacts	Management Action where the mitigation or compensation measure is addressed in the ESMP
					a Soil Management Plan		
Uncontrolled runoff from worksite near river crossings	✓	x	M	[-] Likely, watercourses crossed by the lines affected by sedimentation, short-term duration if worksite rehabilitated at the end of construction, otherwise long-term duration.	– [HYD-3] The Contractor shall prepare and implement sediment and erosion control measures with respect to access track construction and use – [HYD-4] Watercourse crossings to be designed in accordance with GIP to protect the water environment and watercourse geomorphology	Lo [-]	ESMP Document 8.1 Section 5.3.6
Accidental spills and leaks of hazardous substances at construction sites	✓	x	M	[-] Likelihood variable – large spill unlikely, small spill likely. Localised pollution at the worksite, potential small-scale area of pollution at regular intervals along the whole length of the lines, long-term duration	– [HYD-7] Implement hazardous substance handling and storage measures as part of a Site Waste Management Plan implementing the measures described in this ESIA	Lo [-]	ESMP Document 8.1 Section 5.3.7
Line damaged from geohazards	✓	✓	Hi	[-] Possible, there are localised areas potentially subject to geohazards along all components	– [HYD-11] Use of geohazard studies and specific slope-erosion and slope-stability studies to inform detailed design.	M [-]	ESMP Document 8.2 Section 3.2.1
Inappropriate use of herbicides	x	✓	Hi	[-] Likely, areas of pollution along the whole length of the line, possible long-term if bioaccumulating chemicals are used, and	– [HYD-8] Use of mechanical clearing techniques only for the removal of tree and vegetation.	Lo [-]	ESMP Document 8.2 Section 3.4.3 and 5.2.1

Impact Producing factor	Construction	Operation	Assessment of significance without mitigation or compensation High Hi Moderate M Low Lo [+] positive, [-] negative Likelihood, Magnitude, Extent, Duration		Commitments Key Mitigation, Compensation or Management measures	Predicted residual impacts	Management Action where the mitigation or compensation measure is addressed in the ESMP
				herbicides are applied regularly (ever year for example)	Herbicides are not to be used for the removal of trees and vegetation.		
Pollution due to disturbed contaminated materials	✓	x	Hi	[-] Possible, there may be localised contaminated areas along all components	– [HYD-9] A desk study to identify, characterise, and assess the potential for disturbance of contaminated land in former industrial areas and existing substations. Also the subsequent identification and implementation of appropriate mitigation measures if contamination is suspected and confirmed by site investigation.	Lo	ESMP Document 8.2 Section 3.6.1

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